

# Test Report

## 20-1-0127501T03a



Deutsche  
Akreditierungsstelle  
D-PL-12047-01-01  
D-PL-12047-01-03  
D-PL-12047-01-04

<b>Number of pages:</b>	16	<b>Date of Report:</b>	2021-Mar-04
<b>Testing company:</b>	CETECOM GmbH Im Teelbruch 116 45219 Essen Germany Tel. + 49 (0) 20 54 / 95 19-0 Fax: + 49 (0) 20 54 / 95 19-150	<b>Applicant:</b>	Elektroniksystem i Umeå AB
<b>Product:</b>	LoRa device		
<b>Model:</b>	EMS		
<b>FCC ID:</b>	2ANX3-EMS01	<b>IC:</b>	26904-EMS01
<b>Testing has been carried out in accordance with:</b>	<b>FCC Regulations</b> Part 1.1310 Part 2.1091  <b>IC-Regulations</b> RSS-102, Issue 5  Deviations, modifications or clarifications (if any) to above mentioned documents are written in each section under "Test method and limit".		
<b>Tested Technology:</b>	LoRa		
<b>Test Results:</b>	<input checked="" type="checkbox"/> <b>The EUT complies with the requirements in respect of all parameters subject to the test.</b> The test results relate only to devices specified in this document		
<b>Signatures:</b>	<div style="display: flex; justify-content: space-between;"><div style="width: 45%;"><p>Dipl.-Ing. Ninovic Perez Test Lab Manager Authorization of test report</p></div><div style="width: 45%; text-align: right;"><p>B.Eng. Martin Nunier Testing Expert Responsible of test report</p></div></div>		

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<b>Table of Annex</b>			
<b>Annex No.</b>	<b>Contents</b>	<b>Reference Description</b>	<b>Total Pages</b>
<b>Annex 1</b>	External photographs of EUT	<b>CETECOM_TR20_1_0127501T03a_A1</b>	4
<b>Annex 2</b>	Tune up Information	<b>Tune up_Information_ElektronikSystem i Umeå AB (Elsys)</b>	1
<b>Annex 3</b>	Antenna datasheet	<b>Exhibit_11_Antenna-data-sheet EMS</b>	9
The listed attachments are separate documents.			

# 1 General information

## 1.1 Disclaimer and Notes

The test results of this test report relate exclusively to the test item specified in this test report as specified in chapter 2.7. CETECOM 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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Also we refer on special conditions which the applicant should fulfill according §2.927 to §2.948, special focus regarding modification of the equipment and availability of sample equipment for market surveillance tests.

## 1.2 Attestation

I declare that all measurements were performed by me or under my supervision and that all measurements have been performed and are correct to my best knowledge and belief to Industry Canada standards. All of the above requirements are met in accordance with enumerated standards.

### 1.3 Summary of Test Results

The test results apply exclusively to the test samples as presented in this Report. The CETECOM GmbH does not assume responsibility for any conclusions and generalizations taken in conjunction with other specimens or samples of the type of the item presented to tests.

The presented Equipment Under Test (in this report, hereinafter referred as EUT) integrates a LoRa RF Transceiver. Other implemented wireless technologies were not considered within this test report.

Following tests have been performed to show compliance with applicable FCC Part 2.1091 and FCC Part 1.1310 of the FCC CFR 47 Rules and ICED RSS standards.

RF-Exposure Evaluation (separation distance user to RF-radiating element greater 20cm)								
Test cases	Port	References & Limits				EUT set-up	EUT op. mode	Result
		FCC Standard	Test Limit	RSS Standard	Test Limit			
Radio frequency radiation exposure Requirements	Cabinet	§1.1310 §2.1091	RF-Field Strength Limits: FCC: "general population/ uncontrolled" environment	RSS-102, Issue 5	Chapter 4 Table 4	1	1	PASSED

**Remark:** Calculations based on Datasheet delivered by applicant

- PASSED                      The EUT complies with the essential requirements in the standard.
- FAILED                     The EUT does not comply with the essential requirements in the standard.
- NP                            The test was not performed by the CETECOM Laboratory.
- NT                            Not tested
- N/A                          Not applicable

## 2 Administrative Data

### 2.1 Identification of the Testing Laboratory

Company name:	CETECOM GmbH
Address:	Im Teelbruch 116 45219 Essen - Kettwig Germany
Responsible for testing laboratory:	Ninovic Perez
Accreditation scope:	<a href="#">DAkkS Webpage</a>
Test location:	CETECOM GmbH; Im Teelbruch 116; 45219 Essen - Kettwig

### 2.2 General limits for environmental conditions

Temperature:	22±2 °C
Relative. humidity:	45±15% rH

### 2.3 Test Laboratories sub-contracted

Company name:	
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### 2.4 Organizational Items

Responsible test manager:	B.Eng. Martin Nunier
Receipt of EUT:	27.11.2020
Date(s) of test:	2021-Mar-04 – 2021-Mar-04
Version of template:	21.1

### 2.5 Applicant's details

Applicant's name:	Elektroniksystem i Umeå AB
Address:	Industrivägen 10 90130, Umeå Sweden
Contact Person:	Johan Haake
Contact Person's Email:	johan.haake@elsys.se

### 2.6 Manufacturer's details

Manufacturer's name:	See applicant's details
Address:	See applicant's details

## 2.7 EUT: Type, S/N etc. and short descriptions used in this test report

Short description*)	PMT Sample No.	Product	Model	Type	S/N	HW status	SW status
EUT 01		LoRa device	EMS	--		8	2

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

## 2.8 Auxiliary Equipment (AE): Type, S/N etc. and short descriptions

Short description*)	PMT Sample No.	Auxiliary Equipment	Type	S/N	HW status	SW status

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

## 2.9 Connected cables

Short description*)	PMT Sample No.	Cable type	Connectors	Length

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

## 2.10 Software

Short description*)	PMT Sample No.	Software	Type	S/N	HW status	SW status

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

## 2.11 EUT set-ups

set-up no.*)	Combination of EUT and AE	Description
SET 01	EUT 01	Used for theoretical calculation

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

## 2.12 EUT operation modes

EUT operating mode no. *)	Operating modes	Additional information
op. 1	LoRa TX	Only theoretical calculation

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

## 3 Equipment under test (EUT)

### 3.1 General Data of Main EUT as Declared by Applicant

<b>Product name</b>	EMS
<b>Kind of product</b>	LoRa device
<b>Radio access technology</b>	LoRa
<b>For further details refer Applicants Declaration and technical documents</b>	

### 3.2 Detailed Technical data of Main EUT as Declared by Applicant

<b>Frequency Band</b>	LoRa 902 – 928 MHz
<b>Antenna Type(s)</b>	Integrated SMD chip antenna
<b>Antenna Gain(s)</b>	Please refer to Annex 3
<b>FCC label attached</b>	No
<b>For further details refer Applicants Declaration and technical documents</b>	



## 4 Measurements

### 4.1 Radio Frequency Exposure Evaluation §2.1091

#### 4.1.1 Test location and equipment (for reference numbers please see chapter 'List of test equipment')

<b>Test location</b>	See Chapter 2.1
<b>Equipment</b>	For Evaluation instruments are not needed. Results are determined by calculation based on applicants delivered Tune-Up procedure.

#### 4.1.2 Requirements

FCC: §1.1310	<p><i>The criteria used for the evaluation of human exposure to radio frequency radiation is table 1 according FCC §1.1310 and table chapter 4.2 of RSS-102 standard and it is subject for evaluation of the RF exposure prior to equipment authorization.</i></p> <p><i>As the mobile equipment is authorized under Part 22 (Subpart H) and Part 24 of the FCC Rules, it is subject for evaluation of the RF exposure prior to equipment authorization.</i></p>
FCC § 2.1091	<p><i>Further information on evaluating compliance with these limits can be found in the FCC’s OST/OET Bulletin Number 65, “Evaluating Compliance with FCC-Specified Guidelines for Human Exposure to Radiofrequency Radiation.”</i></p> <p><i>For purposes of these requirements mobile devices are defined by the FCC as transmitters designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between radiating structures and the body of the user or nearby persons. These devices are normally evaluated for exposure potential with relation to the MPE limits given in Table 1 of Appendix A.</i></p>

##### 4.1.2.1 Valid for FCC

Table 1: LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)				
Frequency range [MHz]	Electric field strength [V/m]	Magnetic field strength [A/m]	Power density [mW/cm <sup>2</sup> ]	Averaging time [minutes]
30 - 300	61.4	0.163	1.0	6
300 - 1500	-	-	f/300	6
1500 – 100.000	-	-	5	6
(B) Limits for General Population / Uncontrolled Exposure				
0.3 – 1.34	614	1.63	*(100)	30
1.34 – 30	824/f	2.19/f	*(180/f <sup>2</sup> )	30
30 - 300	27.5	0.073	0.2	30
300 - 1500	-	-	f/1500	30
1500 – 100.0	-	-	1.0	30

f= frequency in MHz

\*Plane-wave equivalent power density

NOTE1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure. These limits apply to amateur station licensees and members of their immediate household as discussed in the text.

NOTE2: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure. As discussed in the text, these limits apply to neighbors living near amateur radio stations.

**4.1.3 General Limits:**

FCC: §1.1307	<i>Cellular Radiotelephone Service (subpart H of part 22) Non-building-mounted antennas: height above ground level to lowest point of antenna &lt; 10 m and total power of all channels &gt; 1000 W ERP (1640 W EIRP)</i>
FCC §1.1307	<i>Personal Communications Services (part 24) Broadband PCS (subpart E): non-building-mounted antennas: height above ground level to lowest point of antenna &lt; 10 m and total power of all channels &gt; 2000 W ERP (3280 W EIRP)</i>
FCC §1.1310	<i>LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE) Table 1(B) Limits for General Population/Uncontrolled Exposure 300–1500 MHz: <math>f/1500 \text{ mW/cm}^2</math> 1500–100.000 MHz: <math>1.0 \text{ mW/cm}^2</math></i>
FCC §2.1091	<i>Subject to routine evaluation is required when the device operate at frequencies of 1.5 GHz or below and their effective radiated power (ERP) is 1.5 watts or more, or if they operate at frequencies above 1.5 GHz and their ERP is 3 watts or more.</i>
FCC §24.232	<i>(a) Base stations are limited to 1640 watt peak equivalent isotropically radiated power (e.i.r.p.) with an antenna height up to 300 meters HAAT. b) Mobile/portable stations are limited to 2 watt e.i.r.p. peak power, ...</i>
FCC §22.913	<i>(a) Maximum ERP. The effective radiated power (ERP) of base transmitters and cellular repeaters must not exceed 500 Watts. The ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 Watts.</i>
FCC §27.50 (C )(10)	<i>(10) Portable stations (hand-held devices) are limited to 3 watt ERP; and</i>
FCC §27.50(d)	<i>(4) Fixed, mobile, and portable (hand-held) stations operating in the 1710-1755 MHz band are limited to 1 watt EIRP.</i>
KDBs	<i>No. 447498 D01 v06</i>

## 4.2 Requirements and limits for RSS Standard

RSS-102, Issue 5	<p><b>2.5 Exemption Limits for Routine Evaluation</b></p> <p>All transmitters are exempt from routine SAR and RF exposure evaluations provided that they comply with the requirements of <a href="#">sections 2.5.1</a> or <a href="#">2.5.2</a>. <b>If the equipment under test (EUT) meets the requirements of sections 2.5.1 or 2.5.2, applicants are only required to submit a properly signed declaration of compliance (see <a href="#">Annex C</a>)</b>. The information contained in the RF exposure technical brief may be limited to the value(s) of the maximum output power, the information that demonstrates how the maximum output power of the transmitter was derived and the rationale for the separation distances applied (see <a href="#">Table 1</a>), which must be based on the most conservative exposure condition for the applicable module or host platform test procedure requirements.</p>
	<p><b>2.5.2 Exemption Limits for Routine Evaluation — RF Exposure Evaluation</b></p> <p>RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:</p> <ul style="list-style-type: none"> <li>• below 20 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);</li> <li>• at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than <math>4.49/f^{0.5}</math> W (adjusted for tune-up tolerance), where <math>f</math> is in MHz;</li> <li>• at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);</li> <li>• <b>at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than <math>1.31 \times 10^{-2} f^{0.6834}</math> W (adjusted for tune-up tolerance), where <math>f</math> is in MHz;</b></li> <li>• at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).</li> </ul> <p>In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.</p>
	<p><b>2.6 User Manual Requirements</b></p> <p>The applicant is responsible for providing proper instructions to the user of the radio device, and any usage restrictions, including limits of exposure durations. The user manual shall provide installation and operation instructions, as well as any special usage conditions (e.g. proper accessory required, including the proper orientation of the device in the accessory, maximum antenna gain in the case of detachable antenna), in order to ensure compliance with SAR and/or RF field strength limits. For instance, compliance distance shall be clearly stated in the user manual.</p> <p>The user manual of devices intended for controlled use shall also include information relating to the operating characteristics of the device; the operating instructions to ensure compliance with SAR and/or RF field strength limits; information on the installation and operation of accessories to ensure compliance with SAR and/or RF field strength limits; and contact information where the user can obtain Canadian information on RF exposure and compliance. Other related information may also be included.</p>

### 4.3 MPE Calculation method

Predication of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{EIRP}{4\pi R^2} = \frac{P * G}{4\pi R^2}$$

$$G_{NUMERIC} = \frac{S * 4\pi R^2}{P}$$

Where: S= power density

P= power input to antenna

G= power gain of the antenna in the direction of interest relative to an isotropic radiator

R= distance to the center of radiation of the antenna

### 4.4 Evaluation Method

Please find in the following tables **the calculations based on applicants information**

## 4.5 Results for fixed and mobile operations

### 4.5.1 Results for FCC Standard

#### 4.5.1.1 Results for LoRa

Operating Mode	Frequency on channel	Declared maximum conducted output power	Max. positive tolerance according manufacturer	Declared Antenna Gain	Calculated maximum ERP (declared+ Tune-up+ antenna Gain)	Duty cycle	Calculated Maximum ERP	Equivalent ERP (maximum ERP x duty cycle)	MPE Limit accord. Table 1	MPE-Value	Margin to limit:	Fraction for Co-Location calculations	Max. Fraction-Value within Frequency-Band
	(MHz)	(dBm)	(dB)	(dBi)	(dBm)	(%)	(W)	(mW)	(mW/cm <sup>2</sup> )	(mW/cm <sup>2</sup> )	(mW/cm <sup>2</sup> )		
LoRa	902	14	0	-0.5	13.5	100%	0.022	22	0.6013	0.0045	0.5969	0.0074	0.0074
	915	14	0	-0.5	13.5		0.022	22	0.6100	0.0045	0.6055	0.0073	
	928	14	0	-0.5	13.5		0.022	22	0.6187	0.0045	0.6142	0.0072	

Maximum calculated MPE value:		
Lowest MPE-Limit in Frequency-Band:	0.6013	[mW/cm <sup>2</sup> ]
Highest MPE value in frequency-band:	0.0045	[mW/cm <sup>2</sup> ]
Lowest margin to limit in frequency band:	0.5969	[mW/cm <sup>2</sup> ]

The measurement results comply with the FCC Limit per 47 CFR 2.1091 for the uncontrolled RF Exposure of mobile device.

### 4.5.2 Results for RSS Standard

#### 4.5.2.1 Results for LoRa

Operating Mode	Channel frequency	Declared maximum conducted output power	Max. positive tolerance according manufacturer's tune-up info	Declared Antenna Gain	Calculated maximum ERP (declared+ Tune-up+ antenna Gain)	Duty-Cycle	Calculated Maximum ERP	Equivalent ERP (maximum ERP x duty cycle)	MPE Limit accord. Table 4 (ERP-Limit)	MPE-Value (ERP referred)	Margin to limit:	Fraction for Co-Location calculations	Maximum Fraction Value within Frequency band
	(MHz)	(dBm)	(dB)	(dBi)	(dBm)	(%)	(W)	(mW)	(W/m <sup>2</sup> )	(W/m <sup>2</sup> )	(W/m <sup>2</sup> )		
LoRa	902	14.0	0.0	-0.5	13.5	100%	0.0224	0.0224	2.7398	0.0445	2.6953	0.0163	0.016256
	915	14.0	0.0	-0.5	13.5	100%	0.0224	0.0224	2.7668	0.0445	2.7222	0.0161	
	928	14.0	0.0	-0.5	13.5	100%	0.0224	0.0224	2.7936	0.0445	2.7490	0.0159	

Maximum calculated MPE value:		
Lowest MPE-Limit within frequency-band:	2.7398	[W/m <sup>2</sup> ]
Highest MPE value within frequency-band:	0.0445	[W/m <sup>2</sup> ]
Lowest margin to limit within frequency-band:	2.6953	[W/m <sup>2</sup> ]

The measurement results comply with the ISED Limit per RSS-102, Issue 5 for the uncontrolled RF Exposure of mobile device.

## 5 Abbreviations used in this report

The abbreviations	
ANSI	American National Standards Institute
AV , AVG, CAV	Average detector
EIRP	Equivalent isotropically radiated power, determined within a separate measurement
EGPRS	Enhanced General Packet Radio Service
ERP	Effective radiated power
EUT	Equipment Under Test
FCC	Federal Communications Commission, USA
ISED	Innovation, Science and Economic Development Canada
IC	Industry Canada
n.a.	not applicable
Op-Mode	Operating mode of the equipment
PK	Peak
RBW	resolution bandwidth
RF	Radio frequency
RSS	Radio Standards Specification, Documents from Industry Canada
Rx	Receiver
TCH	Traffic channel
Tx	Transmitter
QP	Quasi peak detector
VBW	Video bandwidth

## 6 Measurement Uncertainty valid for conducted/radiated measurements

The reported uncertainties are calculated based on the standard uncertainty multiplied with the appropriate coverage factor *k*, such that a confidence level of approximately 95% is achieved. For uncertainty determination, each component used in the concrete measurement set-up was taken in account and its contribution to the overall uncertainty according its statistical distribution calculated.

RF-Measurement	Reference	Frequency range	Calculated uncertainty based on a confidence level of 95%						Remarks
Conducted emissions ( <i>U</i> <sub>CISPR</sub> )	-	9 kHz - 150 kHz	4.0 dB						-
		150 kHz - 30 MHz	3.6 dB						
Power Output radiated	-	30 MHz - 4 GHz	3.17 dB						Substitution method
Power Output conducted	-	Set-up No.	Cel-C1	Cel-C2	BT1	W1	W2	--	-
		9 kHz - 12.75 GHz	N/A	0.60	0.7	0.25	N/A	--	
		12.75 GHz - 26.5 GHz	N/A	0.82	--	N/A	N/A	--	
Conducted emissions on RF-port	-	9 kHz - 2.8 GHz	0.70	N/A	0.70	N/A	0.69	--	N/A - not applicable
		2.8 GHz - 12.75 GHz	1.48	N/A	1.51	N/A	1.43	--	
		12.75 GHz – 18 GHz	1.81	N/A	1.83	N/A	1.77	--	
		18 GHz - 26.5 GHz	1.83	N/A	1.85	N/A	1.79	--	
Occupied bandwidth	-	9 kHz - 4 GHz	0.1272 ppm (Delta Marker)						Frequency error
			1.0 dB						Power
Emission bandwidth	-	9 kHz - 4 GHz	0.1272 ppm (Delta Marker)						Frequency error
			See above: 0.70 dB						Power
Frequency stability	-	9 kHz - 20 GHz	0.0636 ppm						-
Radiated emissions Enclosure	-	150 kHz - 30 MHz	5.01dB						Magnetic field strength
		30 MHz - 1 GHz	5.83 dB						Electrical Field strength
		1 GHz - 18 GHz	4.91 dB						
		18-26.5 GHz	5.06 dB						

## 7 Versions of test reports (change history)

Version	Applied changes	Date of release
--	Initial release	2021-Mar-04
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# End Of Test Report