TEST REPORT

Test report no.: 1-9702-25-01-07_TR1-R01

RF Exposure consideration according to FCC447498D04 V1

Testing laboratory

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Accredited Testing Laboratory:
The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2018-03) 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-12047-01-00.
ISED Testing Laboratory Recognized Listing Number: DE0001
FCC designation number: DE0002

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Test Item

Kind of test item:	**INDOOR/OUTDOOR MLAT ADS-B RTX System with Site Monitor**
Model name:	**RTX103025S**
FCC ID:	**2BNLVRTXSICE25S**
Frequency:	RTX: TX 1030 MHz RX 1090 MHz Site Monitor: TX 1090 MHz
Technology:	MLAT

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1 Table of contents

1 Table of contents 2

2 General Information 3

2.1 Notes and Disclaimer 3
2.2 References 3
2.3 Structure of this Document 3

3 General RF Exposure Test Exemptions 4

3.1 1 mW Test Exemption 5
3.2 MPE-Based Test Exemption 5
3.3 SAR-Based Test Exemption 5
3.4 Simultaneous Transmission 6

4 1 mW Test Exemption 7

4.1 Detailed Description 7
4.2 Results 7

5 MPE-Based Test Exemption 8

5.1 Detailed Description 8
5.2 Results 9

6 SAR-Based Test Exemption 10

6.1 Detailed Description 10
6.2 Results 11

7 Simultaneous Transmission 12

7.1 Detailed Description 12
7.2 Result 13

8 Conclusion 13

2 General Information

2.1 Notes and Disclaimer

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2.2 References

Guidance	Version	Description
47 CFR 1.1307		Actions that may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared.
47 CFR 2.1091		Radiofrequency radiation exposure evaluation: mobile devices.
47 CFR 2.1093		Radiofrequency radiation exposure evaluation: portable devices.
KDB 447498 D04	v01	Interim General RF Exposure Guidance: RF Exposure Procedures and Equipment Authorization Policies for Mobile and Portable Devices

2.3 Structure of this Document

In chapter 3 general methods are being described to comply with the RF exposure test exemptions. In chapters 4, 5, 6 (single sources), and 7 (multiple sources) each of these methods is being described in much more details and results are being recorded. In chapter 8 the conclusion is summarized.

3 General RF Exposure Test Exemptions

KDB 447498 D04 Interim General RF Exposure Guidance v01, section 2.1.1:

RF exposure test exemptions provide means to obtain certification without the need of showing data (measurements, or analytical/numerical modeling) to demonstrate compliance. Hereafter, in this context, an RF source is referred to as "exempt RF device" in the sense that it is not required to show data demonstrating compliance to RF exposure limits.
Test exemptions apply for devices used in general population/uncontrolled exposure environments, according to the SAR-based, or MPE-based exemption thresholds. However, it is always possible, especially when the potential for exposure cannot be easily determined, that an RF exposure evaluation may become required according §§ 1.1307(c) and (d).
As detailed in Section 3.1 (see KDB 447498 D04, Section 2.1.2), the 1-mW and SAR-based test exemption conditions are in terms of source-based available maximum time-averaged (matched conducted) output power for all operating configurations, adjusted for tune-up tolerance, and at the minimum test separation distance required for the particular RF exposure scenario under consideration. This minimum test separation distance is determined by the smallest distance from the antenna and radiating structures or outer surface of the device, according to the host form factor, exposure conditions and platform requirements, to any part of the body or extremity of a user or bystander. To qualify for SAR test exemption, the test separation distances applied must be fully explained and justified (typically in the SAR measurement, or SAR analysis report, according to KDB Pub. 865664) by showing the actual operating configurations and exposure conditions of the transmitter, and applicable host platform requirements (e.g., KDB Pubs. 648474, 616217, 941225)
When no other RF exposure testing or reporting is required, a statement of justification and compliance must be included in the equipment approval, in lieu of the SAR report, to qualify for SAR test exemption.
If RF exposure testing requirements for a specific device are covered in a KDB publication, those requirements must be satisfied before applying any SAR test exemption provisions. For example, this is the case for handheld PTT two-way radios, handsets, laptops, and tablets, etc. Finally, when 10-g extremity SAR applies, SAR test exemption may be considered by applying a factor of 2.5 to the SAR-based exemption thresholds.

KDB 447498 D04 Interim General RF Exposure Guidance v01, Appendix A:

Frequency-dependent and distance-dependent power thresholds were adopted in Report and Order FCC 19-126. Appendix D of NPRM FCC 13-39 has the derivation of the frequency- dependent and distance-dependent time-averaged power thresholds, below which single portable RF sources operating in the frequency range of 300 MHz (0.3 GHz) to 6 GHz may be exempt from RF evaluation.
The previous power exclusion thresholds for mobile devices in § 2.1091(c) were 1.5 W ERP for transmitters operating at frequencies at or below 1.5 GHz, and 3 W ERP for transmitters operating at frequencies above 1.5 GHz. The new exemption criteria are similar to the previous power exclusion thresholds above 1.5 GHz between 20 cm and 40 cm but consider the potential for whole body resonance at frequencies below 1.5 GHz. The new exemption criteria are less restrictive than the previous power exclusion thresholds between 0.8 GHz and 1.5 GHz, and additionally support extension of these exclusion thresholds down to 0.3 GHz. The new exemption criteria can be used out to a separation distance of 40 cm for mobile and fixed RF sources operating between 300 MHz and 6 GHz. At 40 cm, the MPE-based exemption criteria and the SAR-based exemption criteria are equal.
Generally, the sequence to apply for single portable RF sources includes the following steps:Generally, the sequence to apply for single portable RF sources includes the following steps:

1) determination of 1 mW blanket exemption under § 1.1307(b)(3)(i)(A)
2) determination of exemption under the MPE-based § 1.1307(b)(3)(i)(C) if 1) is not met
3) determination of exemption under the SAR-based § 1.1307(b)(3)(i)(B) if both 1) and 2) are not met.

[…]

3.1 1 mW Test Exemption

KDB 447498 D04 Interim General RF Exposure Guidance v01, section 2.1.2:

Per § 1.1307(b)(3)(i)(A), a single RF source is *exempt RF device* (from the requirement to show data demonstrating compliance to RF exposure limits, as previously mentioned) if the available maximum time-averaged power is no more than 1 mW, regardless of separation distance.
This exemption applies to all operating configurations and exposure conditions, for the frequency range 100 kHz to 100 GHz, regardless of fixed, mobile, or portable device exposure conditions. This is a standalone exemption, and it cannot be applied in conjunction with any other test exemption.

Note: Further information can be found in section 4.1 of this document.

3.2 MPE-Based Test Exemption

KDB 447498 D04 Interim General RF Exposure Guidance v01, section 2.1.4:

An alternative to the SAR-based exemption is provided in § 1.1307(b)(3)(i)(C), for a much wider frequency range, from 300 kHz to 100 GHz, applicable for separation distances greater or equal to $\lambda/2\pi$, where λ is the free-space operating wavelength in meters. The MPE-based test exemption condition is in terms of ERP, defined as the product of the maximum antenna gain and the delivered maximum time-averaged power. For this case, a RF source is an RF exempt device if its ERP (watts) is no more than a frequency-dependent value, as detailed tabular form in Appendix B. These limits have been derived based on the basic specifications on Maximum Permissible Exposure (MPE) considered for the FCC rules in § 1.1310(e)(1).

Note: Further information can be found in section 5.1 of this document.

3.3 SAR-Based Test Exemption

KDB 447498 D04 Interim General RF Exposure Guidance v01, section 2.1.3:

A more comprehensive exemption, considering a variable power threshold that depends on both the separation distance and power, is provided in § 1.1307(b)(3)(i)(B). This exemption is applicable to the frequency range between 300 MHz and 6 GHz, with test separation distances between 0.5 cm and 40 cm, and for all RF sources in fixed, mobile, and portable device exposure conditions.
Accordingly, a RF source is considered an RF exempt device if its available maximum time- averaged (matched conducted) power or its effective radiated power (ERP), whichever is greater, are below a specified threshold. This exemption threshold was derived based on general population 1-g SAR requirements.

Note: Further information can be found in section 6.1 of this document.

3.4 Simultaneous Transmission

KDB 447498 D04 Interim General RF Exposure Guidance v01, section 2.2.1:

As discussed in § 1.1307(b)(3)(ii)(A), the 1-mW exemption intended for single transmitters may be also applied to simultaneous transmission conditions, within the same host device, according one of the following criteria:

a) When maximum available power each individual transmitting antenna within the same time averaging period is ≤ 1 mW, and the nearest parts of the antenna structures of the simultaneously operating transmitters are separated by at least 2 cm.
b) When the aggregate maximum available power of all transmitting antennas is ≤ 1 mW in the same time-averaging period. This exemption may not be combined with any other exemption.

Note: Further information can be found in sections 3.1 of this document.

KDB 447498 D04 Interim General RF Exposure Guidance v01, section 2.1.2:

This case is described in detail in § 1.1307(b)(3)(ii)(B) and covers the situations where both SAR-based and MPE-based exemption may be considered for test exemption in fixed, mobile, or portable device exposure conditions. For these cases, a device with multiple RF sources transmitting simultaneously will be considered an *RF exempt device* if the condition of Formula (4) (see section 7.1) is satisfied.

For these test exemptions to apply, the maximum output power, duty factor, and other applicable parameters used in the standalone ERP determination tests, must be the same, or corresponding to a more conservative choice, than those required for simultaneous transmission.
The power level of the standalone SAR used to qualify for SAR test exemption, or additional test exemption, must be clearly explained in the SAR report. When simultaneous transmission SAR- based test exemptions, or when the *SPLSR* test exemption cannot be applied, *enlarged zoom scan* SAR measurements must be performed at the maximum output power required for the applicable simultaneous transmission scenarios. This power level shall account for the *tune-up tolerance* requirements of all transmitters, but not more than
2 dB lower than the maximum tune-up tolerance limit.

Note: Further information can be found in section 7.1 of this document.

4 1 mW Test Exemption

4.1 Detailed Description

The 1 mW Blanket Exemption of § 1.1307(b)(3)(i)(A) applies for single fixed, mobile, and portable RF sources with available maximum time-averaged power of no more than 1 mW, regardless of separation distance.
The 1 mW blanket exemption applies at separation distances less than 0.5 cm, including where there is no separation. This exemption shall not be used in conjunction with other exemption criteria other than those for multiple RF sources in paragraph § 1.1307(b)(3)(ii)(A).
The 1 mW exemption is independent of service type and covers the full range of 100 kHz to 100 GHz, but it shall not be used in conjunction with other exemption criteria or in devices with higher-power transmitters operating in the same time-averaging period. Exposure from such higher-power transmitters would invalidate the underlying assumption that exposure from the lower-power transmitter is the only contributor to SAR in the relevant volume of tissue.

4.2 Results

For this product 1 mW test exemption is not applicable.

5 MPE-Based Test Exemption

5.1 Detailed Description

General frequency and separation-distance dependent MPE-based effective radiated power (ERP) thresholds are in Table 1 [Table 1 of § 1.1307(b)(1)(i)(C)] to support an exemption from further evaluation from 300 kHz through 100 GHz.

Table 1: Thresholds for single RF sources subject to routine environmental evaluation. Frequency f in MHz, wavelength in m, distance R in m.

RF Source Frequency			Minimum Distance			Threshold ERP
f_L MHz		f_H MHz	λ_L / 2π		λ_H / 2π	W
0.3	–	1.34	159 m	–	35.6 m	1,920 R^2
1.34	–	30	35.6 m	–	1.6 m	3,450 R^2/f^2
30	–	300	1.6 m	–	159 mm	3.83 R^2
300	–	1,500	159 mm	–	31.8 mm	0.0128 $R^2 f$
1,500	–	100,000	31.8 mm	–	0.5 mm	19.2R^2
Subscripts L and H are low and high; λ is wavelength. From § 1.1307(b)(3)(i)(C), modified by adding Minimum Distance columns.						

The table applies to any RF source (i.e., single fixed, mobile, and portable transmitters) and specifies power and distance criteria for each of the five frequency ranges used for the MPE limits. These criteria apply at separation distances from any part of the radiating structure of at least λ/2π. The thresholds are based on the general population MPE limits with a single perfect reflection, outside of the reactive near-field, and in the main beam of the radiator.
For mobile devices that are not exempt per Table 1 [Table 1 of § 1.1307(b)(1)(i)(C)] at distances from 20 cm to 40 cm and in 0.3 GHz to 6 GHz, evaluation of compliance with the exposure limits in § 1.1310 is necessary if the ERP of the device is greater than ERP_{20cm} in Formula (1) [repeated from § 2.1091(c)(1) and § 1.1307(b)(1)(i)(B)].

$$P_{th}(mW) = ERP_{20cm}(mW) = \begin{cases} 2040f & ,0.3\ GHz \leq f \leq 1.5\ GHz \\ 3060 & ,1.5\ GHz \leq f \leq 6\ GHz \end{cases} \quad (1)$$

Note: This method is equal to the one described in section 6.1 of this document.

If the ERP is not easily obtained, then the available maximum time-averaged power may be used (i.e., without consideration of ERP only if the physical dimensions of the radiating structure(s) do not exceed the electrical length of λ/4 or if the antenna gain is less than that of a half-wave dipole.
SAR-based exemptions are constant at separation distances between 20 cm and 40 cm to avoid discontinuities in the threshold when transitioning between SAR-based and MPE-based exemption criteria at 40 cm, considering the importance of reflections.

5.2 Results

Declared test separation distance by customer: d = 200 mm

SRD Technology	Frequency [MHz]		Ref.	Note	Wavel. [mm]	Output Power [dBm]			Output Power [mW]		Share of Limit
	f_{Min}	f_{Max}	#	#	λ/2π	P_{EIRP}	P_{ERP}	$P_{RF\ Exp}$	P_{Result}	P_{Limit}	%
MLAT	1030	1030	A,B		46	28,35	26,2	**26,2**	**417**	**527**	**79,0%**
MLAT	1090	1090	A,B		44	-40,2	-42,3	**-42,3**	**0**	**558**	**0,0%**

Values:

Value	*Explanation*
P_{Max}	Maximum rated time-averaged radiated power as defined in customer's tune-up including duty cycle factors. Example: 23 dBm (target value) ± 2 dB (tune-up/tolerance) → P_{Max} = 25 dBm
P_{Meas}	Maximum time-averaged power as measured in the test report(s).
P_{EIRP}	Maximum time-averaged EIRP as measured in the test report(s) (for frequencies > 1 GHz).
P_{ERP}	Maximum time-averaged ERP as measured in the test report(s) (for frequencies < 1 GHz). For frequencies > 1 GHz the ERP is being recalculated: $P_{ERP} = P_{EIRP} - 2.15$ dBm
$P_{RF\ Exp}$	Power considered for RF Exposure: Maximum time-averaged ERP (P_{ERP}), corrected by tune-up. Example: P_{Max} = 25 dBm, P_{Meas} = 23.7 dBm, P_{ERP} = **26.2** dBm. Correction factor = P_{Max} - P_{Meas} = 25 dBm - 23.7 dBm = **1.3** dBm $P_{RF\ Exp}$ = **26.2** dBm + **1.3** dBm = **27.5** dBm
P_{Result}	$P_{RF\ Exp}$ in mW.
P_{Limit}	SAR-based threshold in mW.
Share of Limit	P_{Result} / P_{Limit}

Referenced Documents:

#	*Document*	*Document Type*	*Additional Information*
A	1-9702-25-01-19_TR1-R01	*cetecom advanced report*	*Pg. 15*
A	antenna_info_dbs	Customer Document	-/-

6 SAR-Based Test Exemption

6.1 Detailed Description

SAR-based thresholds are derived based on frequency, power, and separation distance of the RF source. The formula defines the thresholds in general for either available maximum time- averaged power or maximum time-averaged ERP, whichever is greater.
If the ERP of a device is not easily determined, such as for a portable device with a small form factor, the applicant may use the available maximum time-averaged power exclusively if the device antenna or radiating structure does not exceed an electrical length of λ/4.
As for devices with antennas of length greater than λ/4 where the gain is not well defined, but always less than that of a half-wave dipole (length λ/2), the available maximum time-averaged power generated by the device may be used in place of the maximum time-averaged ERP, where that value is not known.
The separation distance is the smallest distance from any part of the antenna or radiating structure for all persons, during operation at the applicable ERP. In the case of mobile or portable devices, the separation distance is from the outer housing of the device where it is closest to the antenna.
The SAR-based exemption formula of § 1.1307(b)(3)(i)(B), repeated here as Formula (2), applies for single fixed, mobile, and portable RF sources with available maximum time-averaged power or effective radiated power (ERP), whichever is greater, of less than or equal to the threshold P_{th} (mW).
This method shall only be used at separation distances from 0.5 cm to 40 cm and at frequencies from 0.3 GHz to 6 GHz (inclusive). P_{th} is given by Formula (2).

$$P_{th}(mW) = \begin{cases} ERP_{20cm}\left(\frac{d}{20\ cm}\right)^{x} & , d \leq 20\ cm \\ ERP_{20cm} & , 20\ cm \leq d \leq 40\ cm \end{cases} \tag{2}$$

where

$$x = -\log_{10}\left(\frac{60}{ERP_{20cm}\sqrt{f}}\right) \tag{3}$$

and f is in GHz, d is the separation distance (cm), and ERP_{20cm} is per Formula (1). The example values shown in Table 2 are for illustration only.

Table 2: Example Power Thresholds (mW)

Frequency (MHz)	Distance (mm)									
	5	10	15	20	25	30	35	40	45	50
300	39	65	88	110	129	148	166	184	201	217
450	22	44	67	89	112	135	158	180	203	226
835	9	25	44	66	90	116	145	175	207	240
1900	3	12	26	44	66	92	122	157	195	236
2450	3	10	22	38	59	83	111	143	179	219
3600	2	8	18	32	49	71	96	125	158	195
5800	1	6	14	25	40	58	80	106	136	169

6.2 Results

For this product SAR-based test exemption is not applicable.

7 Simultaneous Transmission

7.1 Detailed Description

KDB 447498 D04 Interim General RF Exposure Guidance v01, Appendix C.:

Either SAR-based or MPE-based exemption may be considered for test exemption for fixed, mobile, or portable device exposure conditions; therefore, the contributions from each exemption in conjunction with the measured SAR (*Evaluated*$_k$ term) shall be used to determine exemption for simultaneous transmission according to Formula 4 [repeated from § 1.1307(b)(3)(ii)(B)].

$$\sum_{i=1}^{a} \frac{P_i}{P_{th,i}} + \sum_{j=1}^{b} \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^{c} \frac{Evaluated}{Exposure\ Limit_k} \leq 1 \qquad (4)$$

where:

a	number of fixed, mobile, or portable RF sources claiming exemption using the § 1.1307(b)(3)(i)(B) formula for P_{th}, including existing exempt transmitters and those being added.
b	number of fixed, mobile, or portable RF sources claiming exemption using the applicable § 1.1307(b)(3)(i)(C) Table 1 formula for Threshold ERP, including existing exempt transmitters and those being added.
c	number of existing fixed, mobile, or portable RF sources with known evaluation for the specified minimum distance.
P_i	the available maximum time-averaged power or the ERP, whichever is greater, for fixed, mobile, or portable RF source *i* at a distance between 0.5 cm and 40 cm (inclusive).
$P_{th,i}$	the exemption threshold power (Pth) according to the § 1.1307(b)(3)(i)(B) formula for fixed, mobile, or portable RF source *i*.
ERP_j	the available maximum time-averaged power or the ERP, whichever is greater, of fixed, mobile, or portable RF source *j*.
$ERP_{th,j}$	exemption threshold ERP for fixed, mobile, or portable RF source *j*, at a distance of at least λ/2π, according to the applicable § 1.1307(b)(3)(i)(C) Table 1 formula at the location in question
$Evaluated_j$	the maximum reported SAR or MPE of fixed, mobile, or portable RF source *k* either in the device or at the transmitter site from an existing evaluation.
$Exposure\ Limit_{th,j}$	either the general population/uncontrolled maximum permissible exposure (MPE) or specific absorption rate (SAR) limit for each fixed, mobile, or portable sources, as applicable

The sum of the ratios of the applicable terms for SAR-based, MPE-based and measured SAR or MPE shall be less than 1, to determine simultaneous transmission exposure compliance.

7.2 Result

Technology	Share of Limit
MLAT 1030 MHz	79,05%
MLAT 1090 MHz	0,00%
Sum	**79,05%**

8 Conclusion

According to KDB 447498 v01 (Interim General RF Exposure Guidance: RF Exposure Procedures and Equipment Authorization Policies for Mobile and Portable Devices) the RF Exposure Test Exemptions applies.

Result:
All ratios are below 1 (≤ 100 %). Certification can be obtained without the need of showing data (measurements, or analytical/numerical modeling) to demonstrate RF Exposure compliance.