

FCC RF Exposure Assessment

on

SARA-S520BM10

FCC ID: XPYUBX24KM03

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Note:

The following test results relate only to the devices specified in this document. This report shall not be reproduced in parts without the written approval of the test laboratory.

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1 Applied Standards

Type of Authorization

Certification for an Intentional Radiator

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 1 and 2 (10-1-23 Edition). The following subparts are applicable to the results in this test report.

Part 1, Subpart I

Practice and Procedure, Procedures Implementing the National Environmental Policy Act of 1969

§ 1.1307:

Actions that may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared.

Part 2, Subpart J

Equipment Authorization Procedures, Certification

§ 2.1091:

Radiofrequency radiation exposure evaluation: mobile devices.

§ 2.1093:

Radiofrequency radiation exposure evaluation: portable devices.

The following KDB is applied:

KDB 447498 D04, v01:

Interim General RF Exposure Guidance
RF Exposure Procedures and Equipment Authorization Policies for
Mobile and Portable Devices

2 Summary

This RF-exposure evaluation according to the – in chapter 1 - mentioned rule parts and KDB shows, that the worst-case RF exposure values of the assessed radio technologies and bands are below the exemption limits of the mentioned rule parts. The following exemption rule part(s) were selected:

☐	1-mW Test Exemption, § 1.1307(b)(3)(i)(A) 447498 D04 Interim General RF Exposure Guidance v01, 2.1.2 Per § 1.1307(b)(3)(i)(A), a single RF source is <i>exempt RF device</i> (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.
☐	MPE based test exemption, § 1.1307(b)(3)(i)(C) 447498 D04 Interim General RF Exposure Guidance v01, 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.¹⁰ For this case, a RF source is an <i>RF exempt device</i> 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).
☒	SAR based test exemption, § 1.1307(b)(3)(i)(B) 447498 D04 Interim General RF Exposure Guidance v01, 2.1.3 A more comprehensive exemption, considering a variable power threshold that depends on both the <i>separation distance</i> 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 <i>test separation distances</i> 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 <i>RF exempt device</i> 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.
☐	1-mW Test Exemption for Multiple Sources, § 1.1307(b)(3)(ii)(A) 447498 D04 Interim General RF Exposure Guidance v01, 2.2.1
☐	Simultaneous Transmission with both SAR-based and MPE-Based Test Exemptions, § 1.1307(b)(3)(ii)(B) 447498 D04 Interim General RF Exposure Guidance v01, 2.2.2

Declared separation distance by the customer: 20 cm

Final Result:

According to the checked 47 CFR rule parts and KDB 447498 v01 subchapters, the RF Exposure Test Exemptions apply.

All ratios – for the declared separation distances(s) - are below 1 ($\leq 100\%$).

Certification can be obtained without the need of showing data (measurements, or analytical/numerical modelling) to demonstrate RF Exposure compliance.

COMMENTS:

- The assessment is limited to supported North American frequency bands



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3 Revision History

Report version control			
Version	Release date	Change Description	Version validity
initial	2025-11-12	--	valid
Rev01	2025-12-19	Output power measurements for SatCom evaluation added	valid

4 Administrative Data

4.1 Testing Laboratory

Company Name: 7layers GmbH

Address: Borsigstr. 11
40880 Ratingen
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Laboratory accreditation no: DAKkS D-PL-12140-01-00

ISED CAB Identifier DE0007; ISED#: 3699A

FCC Designation Number: DE0015

FCC Test Firm Registration: 929146

Responsible for accreditation scope: Dipl.-Ing. Marco Kullik

Report Template Version: 2025-04-01

4.2 Project Data

Responsible for report: Dipl.-Ing. Michael Albert

Date of Report: 2025-12-19

4.3 Applicant Data

Company Name: Trident IoT LLC

Address: 1903 Wright Place, Suite, 360
Carlsbad, CA 92008
United States (USA)

Contact Person: Jake Bascon

4.4 Manufacturer Data

Company Name: u-blox AG

Address: Zürcherstrasse 68
8800 Thalwil
Switzerland

Contact Person: Filip Kruzela

5 Test object Data

Declared EUT data by the supplier	
Kind of Device product description	Multimode module: LTE CAT-M1 and ORBCOMM satellite connectivity with GNSS positioning
Product name	SARA-S520BM10
Type	SARA-S520BM10
HW/SW	HW: UBX-443E03 / SW: LTE CAT-M1: 06.01.A00.01, SatCom: S01.00
Integrated transmitter	LTE CAT-M1 / ORBCOMM satellite connectivity
Cellular Radio Module SARA-S520BM10	
supported Radio technologies	LTE CAT-M1: eFDD2 / LTE eFDD4 / eFDD5 / eFDD8 / eFDD12 / eFDD13 / eFDD25 / eFDD26 / eFDD66 /eFDD71 /eFDD85 Satellite: L-band Uplink: 1626.5 - 1660.5 MHz Downlink: 1525 - 1559 MHz
FCC ID	XPYUBX24KM03
Supplied document(s)	Tune-up values: Trident IoT: SARA-S520BM10_Tune-up_Procedure
Antenna	N/A
Supplied document(s)	-

6 Assessment

6.1 Assessment method and technologies of assessment

Specific information:

- Values used for calculation are based on supplied documents.
- Output power values are based on the supplied document SARA-S520BM10_Tune-up_Procedure.

Worst case considerations:

- Main beams of the antennas are directed to the same point in the prediction distance.
- Cable loss of internal antenna cables set to 0
- Duty factor LTE CAT-M1 = 1
- Duty factor ORBCOMM satellite connection = 0.4
- The radio modules cannot transmit independently from each other.

6.2 RF Output Power Measurement for SatCom

In order to verify the SatCom output power of the EUT compared with the values defined for SatCom in the Tune-up procedure the output power was measured as detailed below.

6.2.1 Test Description

The EUT was connected to the test system as described in the block diagram below. The complete attenuation of the measurement path is known and considered. The measurement was performed conducted. The measurement was performed using a Spectrum Analyzer with settings as listed below:

Reference level: +33.0dBm

Offset 30.7dB (loss of cable, DC block and attenuators)

RBW: 3.9kHz

VBW: 30kHz

SWT: 3s

Span: zero span mode

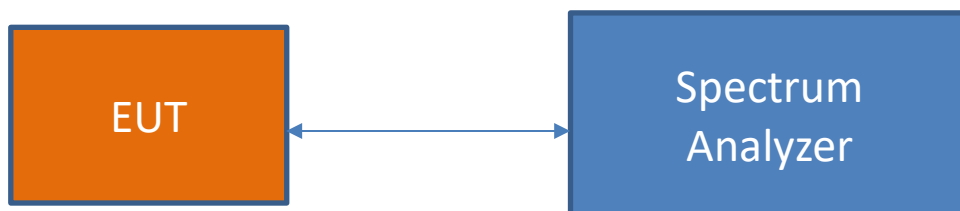
Detector type: RMS

Trigger: Video

Measurement function: TDP RMS

The reference level of the spectrum analyser was set higher than the expected output power of the EUT. The power was measured with the function TD power RMS averaged over 2 bursts.

The EUT was connected to the test setup according to the following diagram:



Test Setup FCC; Output Power Measurement

The EUT was set to transmit using local TX mode according to the instructions given by the customer. The duty cycle was set to 40%.

6.2.2 Test Protocol

Ambient temperature: 23 °C
 Relative humidity: 38 %

OP-Mode	Channel	Frequency [MHz]	Conducted Average Power [dBm]
TX-CM	low	1626.5	30.0
TX-CM	mid	1643.5	29.7
TX-CM	high	1660.5	28.7

Used Test Equipment:

Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
FSW43	Spectrum Analyzer	Rohde & Schwarz	102013-Fc	2025-09	2027-09
Attenuator	10dB attenuator	Mini-Circuits	-	N/A	N/A
Attenuator	20dB attenuator	-	-	N/A	N/A
DC Block 7003	DC Block	Weinschel	-	N/A	N/A
Astrolab 2443	RF cable	Huber & Suhner	760541	N/A	N/A

6.3 Single RF Source exemption limits

6.3.1 1 mw Blanket Exemption

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.

6.3.2 MPE-based Exemption

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

RF Source Frequency			Minimum Distance			Threshold ERP
f_L MHz		f_H MHz	$\lambda_L/2\pi$		$\lambda_H/2\pi$	W
0.3	-	1.34	159 m	-	35.6 m	$1.920 R^2$
1.34	-	30	35.6 m	-	1.6 m	$3450 R^2/f^2$
30	-	300	1.6 m	-	159 mm	$3.83 R^2$
300	-	1500	159 mm	-	31.8 mm	$0.0128 R^2 f$
1500	-	100000	31.8 mm	-	0.5 mm	$19.2 R^2$
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 $\lambda/2\pi$. 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 B.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 (B.1) [repeated from § 2.1091(c)(1) and § 1.1307(b)(1)(i)(B)].

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

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 $\lambda/4$ 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.

6.3.3 SAR-based Exemption

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 $\lambda/4$.

As for devices with antennas of length greater than $\lambda/4$ where the gain is not well defined, but always less than that of a half-wave dipole (length $\lambda/2$), 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 (B.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 (B.2).

$$P_{th} (mW) = \begin{cases} ERP_{20cm} \left(\frac{d}{20cm}\right)^x & d \leq 20 \text{ cm} \\ ERP_{20cm} & 20 \text{ cm} < d < 40 \text{ cm} \end{cases} \quad (B.2)$$

where

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

and f is in GHz, d is the separation distance (cm), and ERP_{20cm} is per Formula (B.1).

6.4 Multiple RF Source exemption limits

6.4.1 1-mW Test Exemption for Multiple Sources

The available maximum time-averaged power of each source is no more than 1 mW and there is a separation distance of two centimeters between any portion of a radiating structure operating and the nearest portion of any other radiating structure in the same device, except if the sum of multiple sources is less than 1 mW during the time-averaging period, in which case they may be treated as a single source (separation is not required). This exemption may not be used in conjunction with other exemption criteria other than those in paragraph (b)(3)(i)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(i)(A).

6.4.2 Simultaneous Transmission with both SAR-Based and MPE-Based exemption limits

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 (C.1) [repeated from § 1.1307(b)(3)(ii)(B)].

$$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{j=1}^b \frac{ERP_j}{ERP_{th,i}} + \sum_{k=1}^c \frac{Evaluated_k}{Exposure Limit_k} \leq 1 \quad (C.1)$$

- 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 (P_{th}) 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 .
- $ERP_{th,i}$ exemption threshold ERP for fixed, mobile, or portable RF source j , at a distance of at least $\lambda/2\pi$, according to the applicable § 1.1307(b)(3)(i)(C) Table 1 formula at the location in question.
- $Evaluated_k$ 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.
- $Exposure Limit_k$ 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.

6.5 Calculation

6.5.1 Calculation of single-frequency exposures

Table 1: Single RF Sources Subject to Routine Environmental Evaluation

Limit: FCC §1.1307(b)(3)(i)(B)

Prediction Distance d in cm =>	20			Maximum Conducted Power during Transmission	Duty factor (lin.)	Duty factor (log.)	Average (temporal) power (log.)	Average (temporal) power (lin.)	Gain (log.)	Gain (log.)	Gain (lin.)	ERP Power	ERP Power limit at distance d & frequency f _i	Ratio to exposure reference level	Compliance, if ERP _i /ERP _{Thi} < 1
		f _{Band}	f _i	P _{dBm}	-	-	P _{dBm}	P _{mW}	g _{dB} i	g _{dB} d	G _d	ERP _i	ERP _{Thi}	ERP _i /ERP _{Thi}	-
Radio technology	Band	MHz	MHz		-	dB	dBm	mW	dB	dBd	-	mW	mW	-	-
LTE	eFDD2	1850 - 1910	1850.7	25.0	1.000	0.0	25.0	316.23	11.9	9.8	9.46	2992.265	3060.000	0.978	Pass
LTE	eFDD4	1710 - 1755	1710.7	25.0	1.000	0.0	25.0	316.23	11.9	9.8	9.46	2992.265	3060.000	0.978	Pass
LTE	eFDD5	824 - 849	824.7	25.0	1.000	0.0	25.0	316.23	9.3	7.2	5.20	1644.372	1682.388	0.977	Pass
LTE	eFDD8	880 - 915	898.2	25.0	1.000	0.0	25.0	316.23	9.7	7.6	5.70	1803.018	1832.328	0.984	Pass
LTE	eFDD12	699 - 716	699.7	25.0	1.000	0.0	25.0	316.23	8.7	6.5	4.49	1419.058	1427.388	0.994	Pass
LTE	eFDD13	777 - 787	779.5	25.0	1.000	0.0	25.0	316.23	9.1	7.0	4.97	1570.363	1590.180	0.988	Pass
LTE	eFDD25	1850 - 1915	1850.7	25.0	1.000	0.0	25.0	316.23	11.9	9.8	9.46	2992.265	3060.000	0.978	Pass
LTE	eFDD26	814 - 849	814.7	25.0	1.000	0.0	25.0	316.23	9.3	7.2	5.20	1644.372	1661.988	0.989	Pass
LTE	eFDD66	1710 - 1780	1710.7	25.0	1.000	0.0	25.0	316.23	11.9	9.8	9.46	2992.265	3060.000	0.978	Pass
LTE	eFDD71	663 - 698	663.7	25.0	1.000	0.0	25.0	316.23	8.4	6.3	4.23	1336.596	1353.948	0.987	Pass
LTE	eFDD85	698 - 716	698.7	25.0	1.000	0.0	25.0	316.23	8.6	6.5	4.43	1399.587	1425.348	0.982	Pass
SatCom	L-band	1626.5 - 1660.5	1626.5	31.0	0.400	-4.0	27.0	503.57	9.9	7.8	5.97	3006.492	3060.000	0.983	Pass

Bold marked = worst case band of the radio technology

Yellow highlighted = maximum allowed antenna gain

Summary related to maximum antenna gain of antennas to be used with SARA-S520BM10

The maximum allowed antenna gain to meet the FCC SAR exemption requirements according to KDB 447498 is defined in table 1, column "Gain (log.) / g_{dB}i" for each supported technology and frequency band.

The maximum antenna gain values listed in the table above are only valid for the MPE evaluation.

Note: The value in the column "Maximum Conducted Power during Transmission" contains the maximum Tune-up tolerance, if applicable!

6.5.2 Calculation of multi-frequency exposures

Not applicable for this EUT

*****END OF REPORT*****