





- The RvA is a signatory to the EA MLA.
- The RvA is a signatory to the ILAC MRA.
- The RvA is a signatory to the IAF MLA.

Assessment report No:
 2278176.0501A-RSM

ASSESSMENT REPORT RF EXPSOURE - MPE

(*) Identification of item to be assessed	Multifunctional battery powered LoRaWAN Transmitter with input for Thermocouple, RTD, Vibration Sensor, Ratiometric Sensor or other.
(*) Trademark	NEON
(*) Model and /or type reference	DS-LD-02-00
(*) Features, other identification of the product	LoRaWAN FCC ID: 2ATYF-DS02B ICC ID:28385-DS02B HW version: F1 SW Version: V1.0.0
(*) Derived model(s)	Please refer to nomenclature breakdown on page 8
(*) Applicant's name / address	TWTG Schaardijk 386, 2909 LA Capelle aan den IJssel
Assessment method requested, standard	FCC 47 CFR Part 2.1091 Radiofrequency radiation exposure evaluation: mobile devices. FCC 47 CFR Part 1.1307: Actions that may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared. FCC 47 CFR Part 1.1310: Radiofrequency radiation exposure limits.
Verdict Summary	IN COMPLIANCE
Assessment performed by (name / position & signature)	Jose Carlos Luque Technical Professional EMC&Wireless 
Approved by (name / position & signature)	Sedat Eser Technical Professional EMC&Wireless 
Date of issue	2024-05-06
Report template No	TRF_RSM_MPE_FCC2.1091_dev_R2.0 (*) "Data provided by the applicant"

INDEX

	page
Competences and Guarantees.....	3
General conditions.....	3
Possible Assessment case verdicts.....	3
Definition of symbols used in this Assessment report	3
Abbreviations.....	4
Data provided by the applicant.....	5
Document History	6
Conclusion, Remarks and Comments	6
1. General Information	7
2. RF Exposure Assessment result and verdict	9
3. ANNEX 1 - FCC RF Exposure Information	10

COMPETENCES AND GUARANTEES

DEKRA is a testing laboratory competent to carry out the tests described in this report.

In order to assure the traceability to other national and international laboratories, DEKRA has a calibration and maintenance program for its measurement equipment.

DEKRA guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated in the report and it is based on the knowledge and technical facilities available at DEKRA at the time of performance of the test.

DEKRA is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

The results presented in this Test Report apply only to the particular item under test established in this document.

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GENERAL CONDITIONS

1. This report is only referred to the item that has undergone the assessment.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or Competent Authorities.
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POSSIBLE ASSESSMENT CASE VERDICTS

Assessment case does not apply to test object	N/A
Assessment object does meet requirement	P (Pass) / PASS
Assessment object does not meet requirement	F (Fail) / FAIL

DEFINITION OF SYMBOLS USED IN THIS ASSESSMENT REPORT

<input checked="" type="checkbox"/> Indicates that the listed condition, standard or equipment is applicable for this report/Assessment/EUT.			
<input type="checkbox"/> Indicates that the listed condition, standard or equipment is not applicable for this report/Assessment/EUT.			
Decimal separator used in this report	<input checked="" type="checkbox"/>	Comma (,)	<input type="checkbox"/> Point (.)

ABBREVIATIONS

For the purposes of the present document, the following abbreviations apply:

ASK	: Amplitude Shift Keying
BER	: Bit Error Rate
ERP/e.r.p.	: effective radiated power
EMC	: ElectroMagnetic Compatibility
EMF/emf	: ElectroMagnetic Field
ERC	: European Radiocommunications Committee
EUT / DUT	: Equipment Under Test / Device Under Test
HF	: High Frequency (range)
ISM	: Industrial, Scientific and Medical
ITU-T	: ITU-Telecommunication sector
LF	: Low Frequency
NFC	: Near Field Communication
OATS	: Open Area Test Site
OBW	: Occupied BandWidth
OFR	: Operating Frequency Range
R&TTE	: Radio and Telecommunications Terminal Equipment
RF	: Radio Frequency
RFID	: Radio Frequency Identification
RMS	: Root Mean Square
RX	: Receiver
SND	: Signal, Noise and Distortion
SND/ND	: Signal, Noise and Distortion over Noise and Distortion
SRD	: Short Range Device
TR	: Technical Report
TX	: Transmitter
MS	: Mobile Station

DATA PROVIDED BY THE APPLICANT

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item to be assessed", "Trademark", "Model and/or type reference", Features and "Derived model(s)").
2. Derived model not assessed. These models have been declared by the applicant as being the same as the model under assessment.
3. Maximum output power and maximum antenna gain information.
4. Information provided by the client in the form AFRM_RF_Expsoure_Rev-1.0.docx

DEKRA Certification B.V. declines any responsibility with respect to the information provided by the applicant and that may affect the validity of results.

According to the manufacturer, during its normal use, the separation distance between the device and the body of nearby users will be greater than 20cm. In order to perform the assessment a conservative evaluation distance of minimum compliance distance (normally 20 cm) has been used.

The equipment specifications declared by the manufacturer for each supported technology and band is:

Technology / Mode	Operating Band	Frequency under evaluation (MHz)	Maximum Conducted Output Power (dBm)	Antenna peak gain (dBi)	Cable loss (dBi)	Maximum E.R.P. (dBm)	Maximum E.R.P. (mW)	Maximum E.I.R.P. (dBm)	Maximum E.I.R.P. (mW)
LoRa	ISM (USA)	902 - 928	15,92	-3,00	0,00	10,77	11,94	12,92	19,59

Table: Equipment specification

DOCUMENT HISTORY

Report nr.	Date	Description
2278176.0501-RSM	2023-10-25	First release.
2278176.0501A-RSM	2024-05-06	Second release. The model name, FCC ID, IC ID are update updated on first page. The RF output power and the gain of the antenna are updated. This modification of the test report cancels and replaces the test report 2278176.0501-RSM.

CONCLUSION, REMARKS AND COMMENTS

This is an assessment report. It encloses the assessment results given at chapter 2 and 3. Refer to this chapter for further details.

The equipment under test (EUT) meets the requirements of the applicable standard(s).

The assessment results stated in this report of model DS02 are also representative for model(s) DS-LD-02-DD, DS-TT-02-DD, DS-RT-02-DD.

1. GENERAL INFORMATION

Description of the item.....:	Multifunctional battery powered LoRaWAN Transmitter with input for Thermocouple, RTD, Vibration Sensor, Ratiometric Sensor or other, depending on product variant
Model / Type number	DS-LD-02-00
Trademark	NEON
Manufacturer.....:	TWTG

Operating frequency range(s) – Tx :	902MHz to 928MHz
Operating frequency range(s) – Rx :	902MHz to 928MHz
Type of Modulation.....:	LoRaWAN Modulated TX
Number of channel.....:	64 (125KHz) + 8 (500 KHz)
Antenna type.....:	Internal
Antenna gain.....:	-3 dBi
Tlow.....:	-40° C
Thigh.....:	+80° C

Ports	Port name and description	Cable					
		Specified max length [m]	Attached during test	Shielded	Coupled		
		M12 connector DS-LD-02-00	> 3 meter	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
		M12 connector DS-TT-02-00	> 3 meter	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	M12 connector DS-RT-02-00	> 3 meter	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
Supplementary information to the ports.....:	DS-TT-02-00 is used with thermocouples of RTD sensors, noise on cable may affect measurements.						
Rated power supply.....:	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	<input type="checkbox"/>	AC: 220 – 240 V, 50/60 Hz	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	AC: 100 – 240 V, 50/60 Hz	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	DC: 12 V, 24 V, 12 / 24 V					
<input checked="" type="checkbox"/>	Battery: Internal Battery 3.6V 17000 mAh LiSoCl4						
Rated Power	0,367 W						
Clock frequencies.....:	32 MHz, 32,768 KHz						
Other parameters.....:	Data not provided						
Software version	1.0						
Hardware version.....:	F1						
Dimensions in cm (W x H x D) :	10,0x7,0x5,7						
Mounting position	<input type="checkbox"/>	Table top equipment					
	<input type="checkbox"/>	Wall/Ceiling mounted equipment					
	<input type="checkbox"/>	Floor standing equipment					
	<input type="checkbox"/>	Hand-held equipment					
	<input checked="" type="checkbox"/>	Other: Variable equipment					

No	Documents as provided by the applicant - Description	File name	Issue date
1	Declaration of equipment data	FDT30_18	2023-10-09
2	Application Form – RF Exposure Assessment	AFRM_RF_Exposure Assessment v1.0.pdf	2023-10-18

1.1 Derived models.

The following model number combinations are declared by the applicant as possible derived models with no EMC related changes.

Each TWTG manufactured product within the DS-02 family follows the same nomenclature:

- AA-BB-CC-DD
- Where:
 - AA = Product Family
 - BB = Product Variant
 - CC = Product Revision
 - DD = Region

The product family designator is DS, which stands for Diversity Sensor.

The identifier can be used to define the hardware variant of the DS Transmitter, as well as the sensor type for a TWTG designed sensor with the DS family.

The following DS Transmitter hardware variant are currently available or part of the product roadmap:

- LD = LVDS Transmitter
- TT = Temperature Transmitter
- RT = Ratiometric Transmitter
- FT = 4 to 20 mA Transmitter (2023/2024)
- MT = Modbus transmitter (2023/2024)

and the following sensors:

- VB = Vibration Sensor (compatible with "LD")
- PG = Pressure Gauge (compatible with "RT")

2. RF Exposure Assessment result and verdict

RF Exposure Exemption evaluation:

Technology / Mode	Operating Band	Frequency under evaluation (MHz)	Distance (cm)	Maximum E.R.P. (mW)	§1.1307(b)(3).i.(C) Exposure Limit (mW)	Verdict for exemption § 1.1307(b)(3).i
LoRa	ISM (USA)	902 - 928	20,00	11,94	461,82	Pass

Table: FCC Exemption Evaluation Results

The computed value(s) are below the exemption limit(s), so these modes meet the requirements stated in FCC 47 CFR Part 1.1307.

3. ANNEX 1 - FCC RF Exposure Information

FCC RF Exposure determination of exemption

According to FCC 47 CFR §1.1307 (b)(3) Determination of exemption:

(i) For single RF sources (i.e., any single fixed RF source, mobile device, or portable device, as defined in paragraph (b)(2), a single RF source is exempt if:

(A) The available maximum time-averaged power is no more than 1 mW, regardless of separation distance. This exemption may not be used in conjunction with other exemption criteria other than those in paragraph (b)(3)(ii)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(ii)(A);

(B) Or the available maximum time-averaged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold P_{th} (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 centimeters to 40 centimeters and at frequencies from 0.3 GHz to 6 GHz (inclusive). P_{th} is given by:

$$P_{th} \text{ (mW)} = \begin{cases} ERP_{20 \text{ cm}} (d/20 \text{ cm})^x & d \leq 20 \text{ cm} \\ ERP_{20 \text{ cm}} & 20 \text{ cm} < d \leq 40 \text{ cm} \end{cases}$$

Where

$$x = -\log_{10} \left(\frac{60}{ERP_{20 \text{ cm}} \sqrt{f}} \right) \text{ and } f \text{ is in GHz;}$$

and

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

d = the separation distance (cm);

(C) Or using Table 1 and the minimum separation distance (R in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, R must be at least $\lambda/2\pi$, where λ is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP 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 (1.64 linear value).

TABLE 1 TO §1.1307(b)(3)(i)(C)—SINGLE RF SOURCES SUBJECT TO ROUTINE ENVIRONMENTAL EVALUATION

RF Source frequency (MHz)	Threshold ERP (watts)
0.3-1.34	$1,920 R^2$
1.34-30	$3,450 R^2/f^2$
30-300	$3.83 R^2$
300-1,500	$0.0128 R^2 f$
1,500-100,000	$19.2 R^2$

(ii) For multiple RF sources: Multiple RF sources are exempt if:

(A) 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).

(B) in the case of fixed RF sources operating in the same time-averaging period, or of multiple mobile or portable RF sources within a device operating in the same time averaging period, if the sum of the fractional contributions to the applicable thresholds is less than or equal to 1 as indicated in the following equation.

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

Where:

a = number of fixed, mobile, or portable RF sources claiming exemption using paragraph (b)(3)(i)(B) of this section for Pth, including existing exempt transmitters and those being added.

b = number of fixed, mobile, or portable RF sources claiming exemption using paragraph (b)(3)(i)(C) of this section 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 including existing evaluated transmitters.

Pi = 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).

Pth,i = the exemption threshold power (Pth) according to paragraph (b)(3)(i)(B) of this section for fixed, mobile, or portable RF source i.

ERPj = the ERP of fixed, mobile, or portable RF source j.

ERPth,j = exemption threshold ERP for fixed, mobile, or portable RF source j, at a distance of at least $\lambda/2\pi$ according to the applicable formula of paragraph (b)(3)(i)(C) of this section.

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 at the location of exposure.

Exposure Limit,k = either the general population/uncontrolled maximum permissible exposure (MPE) or specific absorption rate (SAR) limit for each fixed, mobile, or portable RF source k, as applicable from §1.1310 of this chapter.

FCC RF Exposure evaluation

Limits for Maximum Permissible Exposure (MPE) for RF sources are defined in FCC 47 CFR “§1.1310 Radiation Exposure limits, paragraph (e)”:

TABLE 1 TO §1.1310(E)(1)—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(i) Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	*(100)	≤6
3.0-30	1842/f	4.89/f	*(900/f ²)	<6
30-300	61.4	0.163	1.0	<6
300-1,500			f/300	<6
1,500-100,000			5	<6
(ii) 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 ²)	<30
30-300	27.5	0.073	0.2	<30
300-1,500			f/1500	<30
1,500-100,000			1.0	<30

f = frequency in MHz. * = Plane-wave equivalent power density.

Each supported transmission technology will be evaluated to determine if it is in compliance with limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields.

In order to perform the assessment, the following equations have been used for the calculations; these equations are accurate in the far-field of an antenna and will over-predict power density in the near field, where they could be used for making a "worst-case" or conservative prediction:

$$\text{Power density: } S[\text{mW}/\text{cm}^2] = \frac{P_{E.I.R.P.}[\text{mW}]}{4\pi R[\text{cm}]^2}$$

Where:

S = power density

$P_{E.I.R.P.}$ = Equivalent isotropically radiated power

R = distance to the center of radiation of the antenna (evaluation distance)

$$P_{E.I.R.P.} = P_T + G_T - L_C$$

Where:

P_T = transmitter time-averaged output power (including Duty Cycle and tune-up tolerance, if applicable)

G_T = gain of the transmitting antenna

L_C = signal attenuation in the connecting cable between the transmitter and the antenna if applicable