DEKRA Testing and Certification, S.A.U.
Parque Tecnológico de Andalucía,
c/ Severo Ochoa nº 2 · 29590 Campanillas · Málaga · España
C.I.F. A29 507 456

Test report No:
NIE: 59196RAN.002

Assessment report
RF EXPOSURE REPORT ACCORDING TO
FCC 47 CFR Part 2.1091

(*) Identification of item under evaluation	LoRa sensor to detect the open / closed status of a valve
(*) Trademark	TWTG
(*) Model and /or type reference	VS-915-01-QT02
Other identification of the product	HW version: V2.0.2 SW version: v0-3-1-86de4a23-1557416690 FCC ID: 2ATYF-C19-001
(*) Features	Valve open / closed status reporting, heartbeat messaging
Manufacturer	TWTG Schaardijk 386, 2909 LA, Capelle a/d IJssel
Test method requested, standard	FCC 47 CFR Part 2.1091 Radiofrequency radiation exposure evaluation: mobile devices. ISED RSS-102 Issue 5 (2015-03) – Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands) IEEE Std C95.3™ -2002 (R2008). IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields With Respect to Human Exposure to Such Fields, 100 kHz–300 GHz
Summary	IN COMPLIANCE
Approved by (name / position & signature)	Miguel Lacave Antennas Lab Manager  MIGUEL LACAVE GARCÍA 2019.09.27 10:46:56 +02'00'
Date of issue	2019-09-27
Report template No	FAN36_01 (*) "Data provided by the client"

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Competences and guarantees

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Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").

2. The sample consists of a LoRa sensor to detect the open / closed status of a valve. The sensor detects the open / closed status of a valve by sensing the field created by a magnet placed on the valve stem. It reports the status when it changes, using LoRa modulation. It also provides a daily “heartbeat” message.

2. Maximum output power and maximum antenna gain information.

3. The manufacturer declares the equivalence of the products TS-fff-01-xx and VS-fff-01-xx with respect to EMC / RED directive requirements:

Declaration of Cross-Model Compatibility

Concerning products:

- TS-fff-01-xxyy
- VS-fff-01-xxyy

Where:

- TS indicates the temperature sensor product.
- VS indicates the valve sensor product.
- fff indicates operating frequency (868 or 915 MHz).
- xx indicates the software functionality
- yy indicates a regional variant, such as EU or US.

Specifically:

Intended region		
Europe	United States	Singapore
TS-868-01-01	TS-915-01-02	TS-915-01-03
VS-868-01-QT01	VS-915-01-QT02	VS-915-01-QT03
VS-868-01-MT01	VS-915-01-MT02	VS-915-01-MT03

NB - presence in the same **column** above indicates electromagnetically comparable devices. The columns are separated based on operating frequency only.

NB - The model TS-868-01-01 was tested for safety, owing to its mounting arrangements leading to the most onerous conditions. All models are exactly comparable in this respect, as they will not exceed the worst cases brought about by the TS model.

NB - The model VS-868-01-QT01 was tested for European EM compliance, as it is believed this model offers the most onerous conditions.

NB - The model VS-915-01-QT01 was tested for FCC compliance, as it is believed this model offers the most onerous conditions.

Hereby, TWTG (The Manufacturer), declares the equivalence of the two listed products with respect to EMC / RED directive requirements. Given that only the VS product appears on the reporting, we include this to confirm compliance of the TS product also. This is evidenced as follows:

Software differences between the products:

- Both products are based on the Mbed “operating system”, including the supplied LoRa software stack.
    - Mbed-OS 5.8.
    - Supporting v1.0.3 of the LoRaWAN standard.
        - Valid at time of testing.
- Where operating frequencies differ, this is done by changing a particular variable within the application software.
- Where the main products differ, this is done with different application software, but uses the same major and LoRa stacks.
- No changes are made to the LoRa stack as supplied by Mbed.

Hardware differences between the products:

- Both products use the same PCB base files, and a base schematic, for production.
- Differences between the products are handled by the appropriate mounting and dismounting of components.
    - TS
        - FIT - C38; U8.
        - NO-FIT - C31,32,33,40,41,42,43; R7,8; U6,7,11.
    - VS
        - FIT - C31,32,33,40,41,42,43; R7,8; U6,7,11.
        - NO-FIT - C38; U8.
- U6 and 7 supply a low frequency analogue output to the MCU.
- U8 and U11 are both I^2C components, so no signaling changes between models, including the bus clock, though obviously individual data changes
- The remaining components are supporting passives for the semiconductors which are placed or otherwise.

Operational differences between the products:

- Both products send a single daily heartbeat message. The valve sensor also transmits on events, whereas the temperature sensor sends at (configurable) pre-defined intervals. Both transmission schemes fully respect the LoRa standards.
- Both products have configurable sense rates, which affect only the duty cycle of the I^2C bus, with the same maximum. This will have negligible impact, if any, on EM emissions.

From the provided information, it is clear that the proffered declaration is valid, based on the overwhelming similarity between the devices at a technical level.

Authorised by signatories:

Berin Casey, responsible engineer;
Capelle a/d IJssel, 28/08/19.

Joost Peters, product owner;
Capelle a/d IJssel, 28/08/19.

DEKRA Testing and Certification S.A.U. declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

Identification of the client

TWTG

Schaardijk 386, 2909 LA, Capelle a/d IJssel, The Netherlands

Document history

Report number	Date	Description
59196RAN.002	2019-09-27	First release

General description of the device under evaluation

The device under evaluation consists of a LoRa sensor to detect the open / closed status of a valve. The sensor detects the open / closed status of a valve by sensing the field created by a magnet placed on the valve stem. It reports the status when it changes, using LoRa modulation. It also provides a daily “heartbeat” message.

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

The equipment specifications declared by the manufacturer for each supported feature are:

Technology / Mode	Band	Frequency (MHz)	Maximum Conducted Output Power (dBm)	Antenna peak gain (dBi)	Maximum E.I.R.P. (dBm)	Maximum E.I.R.P. (mW)
LoRa	ISM (USA)	902 - 928	20.00	-4.00	16.00	39.81

Table 1: Equipment specifications

RF Exposure Assessment result and verdict

Limits for Maximum Permissible Exposure (MPE) to comply with FCC 47 CFR § 2.1091 are defined in “§1.1310 Radiation Exposure limits, paragraph (e)”:

Technology / Mode	Band	Frequency (MHz)	Distance (cm)	Power density (mW/cm^2)	FCC General Population Limit (mW/cm^2)	Verdict
LoRa	ISM (USA)	902 - 928	20.00	0.01	0.60	**Pass**

Table 2: Assessment result and verdict

Appendix A: FCC RF Exposure information

FCC RF Exposure evaluation

Devices operating in standalone mobile device exposure conditions may contain a single transmitter or multiple transmitters that do not transmit simultaneously. A minimum test separation distance ≥ 20 cm is required between the antenna and radiating structures of the device and nearby persons to apply mobile device exposure limits. The distance must be at least 20 cm and fully supported by the operating and installation configurations of the transmitter and its antenna(s), according to the source-based time-averaged maximum power requirements of § 2.1091(d)(2). In cases where cable losses or other attenuations are applied to determine compliance, the most conservative operating configurations and exposure conditions must be evaluated. The minimum test separation distance required for a device to comply with mobile device exposure conditions must be clearly identified in the installation and operating instructions, for all installation and exposure conditions, to enable users and installers to comply with RF exposure requirements. For mobile devices that have the potential to operate in portable device exposure conditions, similar to the configurations described in § 2.1091(d)(4), a KDB inquiry is required to determine the SAR test requirements for demonstrating compliance.

When a device qualifies for the categorical exclusion provision of § 2.1091(c), the minimum test separation distance may be estimated, when applicable, by simple calculations according to plane-wave equivalent conditions, to ensure the transmitter and its antenna(s) can operate in manners that meet or exceed the estimated distance. The source-based time-averaged maximum radiated power, according to the maximum antenna gain, must be applied to calculate the field strength and power density required to establish the minimum test separation distance. When the estimated test separation distance becomes overly conservative and does not support compliance, MPE measurement or computational modeling may be used to determine the required minimum separation distance.

According to §1.1310 Radiofrequency radiation exposure limits, paragraph (e), the limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields are:

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposure				
0.3–3.0	614	1.63	*100	6
3.0–30	1842/f	4.89/f	*900/f²	6
30–300	61.4	0.163	1.0	6
300–1,500			f/300	6
1,500–100,000			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/f²	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

FCC MPE Evaluation

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:

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

Minimum compliance distance: $R_{\min}[cm] = \sqrt{\frac{P_{E.I.R.P.}[mW]}{4\Pi S[mW/cm^2]}}$

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)

$R_{\min}$ = distance to the center of radiation of the antenna