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ERM Test Report

Wideband transmission systems

3D Measurement of the EIRP

Measurement of the conducted RF-output power

Calculation of the maximum isotropic antenna gain

Devices Tested: Victron project SM_P000301224

Customer: Victron Energy B.V.

Test Report No.: Victron/328/2023/338

May 11, 2023

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Subject: 3D Measurement of the EIRP

Measurement of the conducted RF-output power

Calculation of the maximum isotropic antenna gain

Customer:

Victron Energy B.V.

De Paal 35

1351 JG Almere

Netherlands

Device (DUT): Victron project SM_P000301224

Test Manager: Frank Tofahrn, ERM Test Lab

Date: May 11, 2023

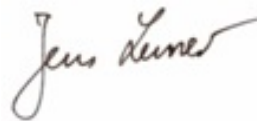
Originator:



Frank Tofahrn

Test Engineer

Approved:



Jens Lerner

Quality Assurance

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1 General

Description	Manufacturer Information	Customer Information
Company Name	Victron Energy B.V.	Same as manufacturer
Street Name, No.	De Paal 35	
PLZ/ZIP City	1351 JG Almere	
Country	Netherlands	
Contact Person	Nikolas Galanos	
Phone		
E-Mail	ngalanos@victronenergy.com	

Table 1: General Information

Subject: Electromagnetic Radio Spectrum Matters (ERM)

Test Engineer: Frank Tofahrn
IMST GmbH, Germany

Date of test item receipt: 04.05.2023

Date of test: 04.05.2023 & 08.05.2023

Place of test: Testcenter at IMST GmbH, ERM Test Lab
Kamp-Lintfort, Germany

Persons present during testing:

IMST GmbH	Customer
Frank Tofahrn	N/A

2 Description of the Device under Test (DUT)

2.1 General

The DUT is a Bluetooth module using an integral onboard antenna. For the test of the conducted rf-power a temporary antenna connector has been attached.

Without further action the DUT transmits on the BLE advertising channels 37, 38 and 39 after applying power. A companion device is not needed.

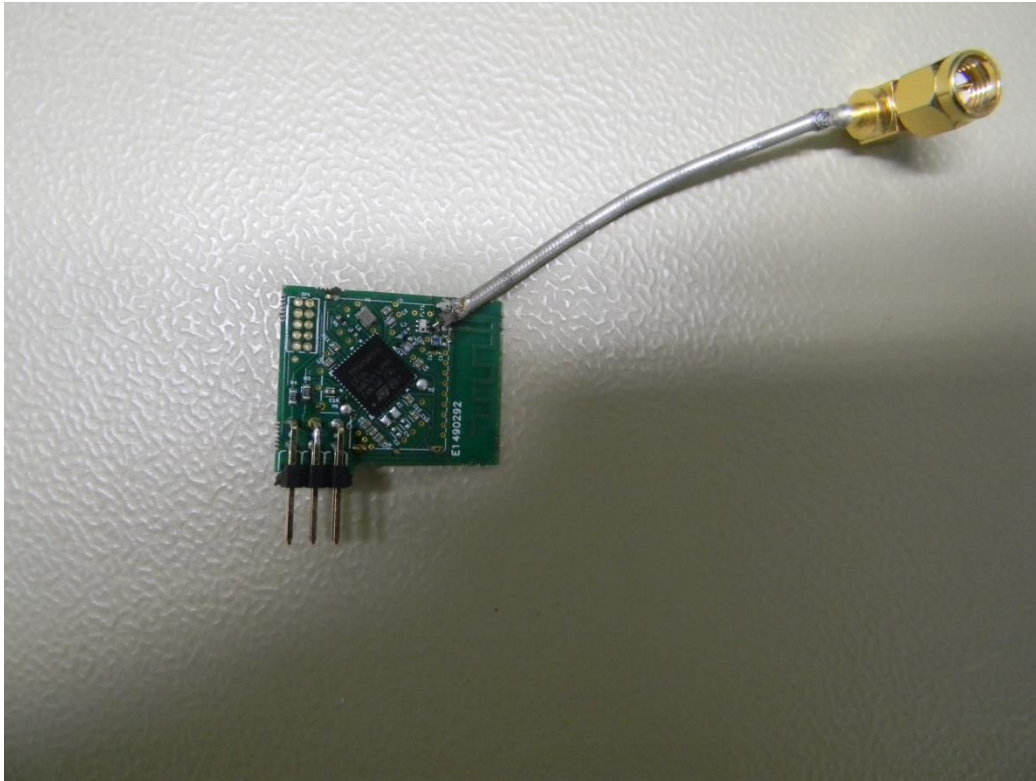


Figure 1 Picture of the DUT including the temporary antenna connector.

2.2 DUT Setup

Setup with an integral antenna and a temporary antenna connector.

2.3 DUT Peripherals

Carrier Board for power supply

2.4 DUT Modifications

Temporary antenna connector for conducted test

2.5 Supporting Equipment

Regulated power supply

3 Measurement Uncertainty

Harmonised Standard ETSI EN 300 328 / Measurement Uncertainty					
Requirement				Uncertainty	
No	Description	Clause(s) of the present document	Test Clause	Parameter	Uncertainty
1	RF Output Power	4.3.1.2 or 4.3.2.2	5.4.2	Power	Power conducted: $\pm 0,75$ dB Power radiated: $\pm 1,42$ dB
2	Power Spectral Density	4.3.2.3	5.4.3	Power	Power conducted: $\pm 1,42$ dB
3	Duty cycle, Tx-Sequence, Tx-gap	4.3.1.3 or 4.3.2.4	5.4.2	Time	$\pm 1,965\%$
4	Accumulated Transmit time, Frequency Occupation & Hopping Sequence	4.3.1.4	5.4.2	Time	$\pm 1,965\%$
5	Hopping Frequency Separation	4.3.1.5	5.4.5	Frequency	$\pm 1,29$ ppm
6	Medium Utilization	4.3.1.6 or 4.3.2.5	5.4.2	Power / Time	Power conducted: $\pm 0,75$ dB
7	Adaptivity	4.3.1.7 or 4.3.2.6	5.4.6	Power / Time	Power conducted: $\pm 0,75$ dB
8	Occupied Channel Bandwidth	4.3.1.8 or 4.3.2.7	5.4.7	Frequency	$\pm 1,29$ ppm
9	Transmitter unwanted emissions in the OOB domain	4.3.1.9 or 4.3.2.8	5.4.8	Power / Frequency	Power conducted: $\pm 0,75$ dB Frequency: $\pm 1,29$ ppm
10	Transmitter unwanted emissions in the spurious domain	4.3.1.10 or 4.3.2.9	5.4.9	Power / Frequency	Power radiated: $\pm 1,42$ dB Frequency: $\pm 1,29$ ppm
11	Receiver spurious emissions	4.3.1.11 or 4.3.2.10	5.4.10	Power / Frequency	Power radiated: $\pm 1,42$ dB Frequency: $\pm 1,29$ ppm
12	Receiver Blocking	4.3.1.12 or 4.3.2.11	5.4.11	Power	Power conducted: $\pm 0,75$ dB
13	Geo-location capability	4.3.1.13 or 4.3.2.12	No Test	./.	./.

Table 2 Conformance Requirements and Tests

For the test methods, according to the present document, the measurement uncertainty figures shall be calculated and shall correspond to an expansion factor (coverage factor) $k = 1,96$ or $k = 2$ (which provide confidence levels of respectively 95 % and 95,45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)). Principles for the calculation of measurement uncertainty are contained in ETSI TR 100 028-1 [4], in particular in annex D of the ETSI TR 100 028-2 [3].

3.1 Environmental conditions for testing

Unless noted otherwise the normal temperature and humidity conditions for tests are any convenient combination of temperature and humidity within the following ranges:

- temperature: $+15$ °C to $+35$ °C;
- relative humidity: 20 % to 75 %.

4 Purpose of the Test

The purpose of this test was the measurement of the radiated EIRP, the radiation pattern of the DUT using the integrated antenna, the measurement of the conducted RF-Power and the calculation of the maximum antenna gain from the measurement results.

5 Test Procedure

For the power measurements the procedures described in ETSI EN 300 328 subclause 5.4.2.2 was used. IMST GmbH is accredited for this measurement.

Both measurement procedures (radiated and conducted) measured the RMS-Power of single burst. The result of the measurement is the RMS-Burst-Power of the highest burst in the observation window.

The observation window is about 1 second to acquire a high number of bursts in order not to miss the bursts with the highest power level. This is important for this DUT for it transmits bursts on different power levels.

The procedure uses a non frequency selective broadband True-RMS power sensor that can catch all transmissions in hopping operation of the DUT.

6 Test Results

6.1 Transmitter Tests

6.1.1 RF Output Power conducted

6.1.1.1 Test conditions

The test has been conducted under normal conditions. See subclause 4.1

Method of Measurements: conducted.

6.1.1.2 Measurement Setup

Setup as described in ETSI EN 300 328 V2.2.2 subclause 5.4.2.2

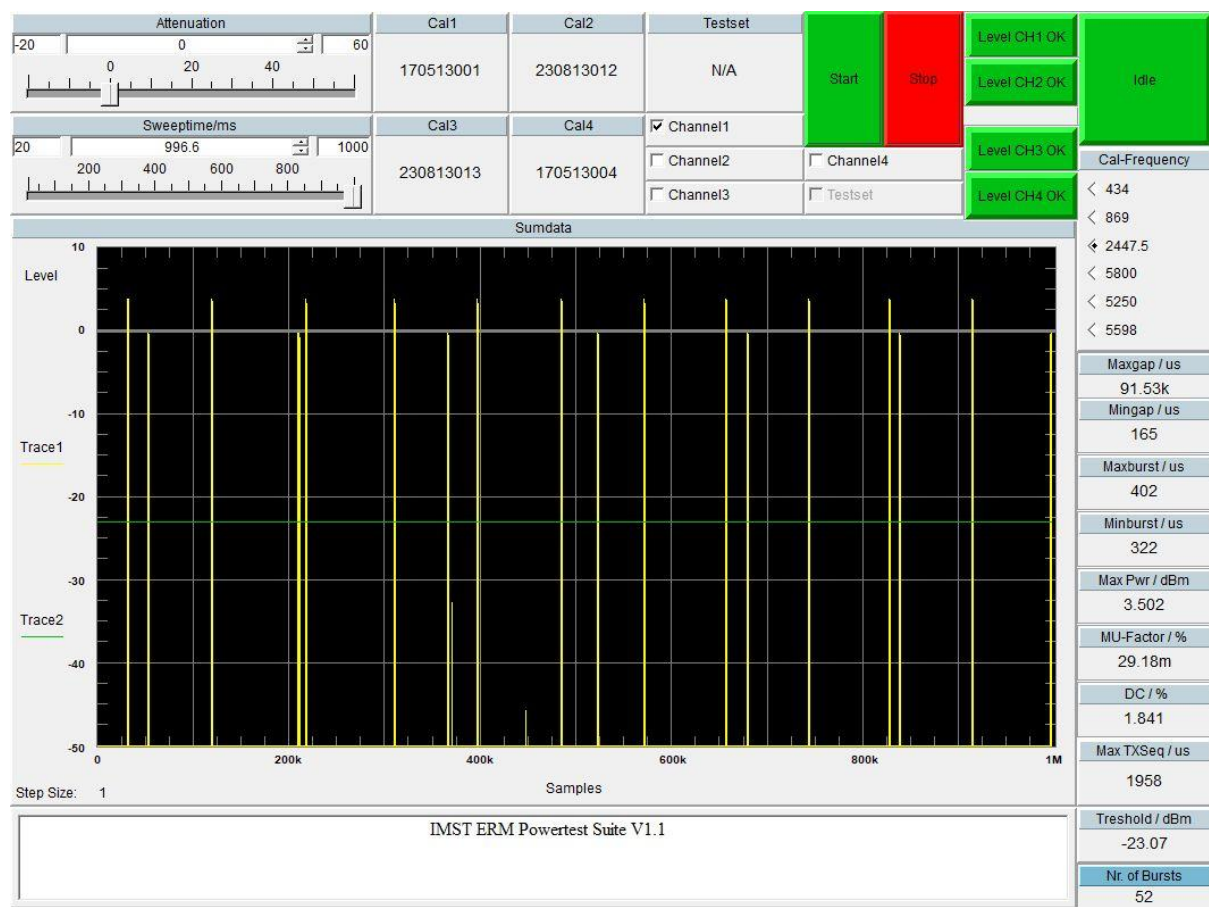
6.1.1.3 Measurement results (conducted)

The picture below shows the result of the conducted test using the IMST Powertest Suite.

The “Max Pwr / dBm” field shows the power value of the burst with the highest power level found in the observation window and is the relevant result for this test. The field “Nr. of Bursts” gives the number of bursts identified by the software within the observation window.

Note: Each transmission of the DUT consists of three bursts. This is not visible in the plot.

All other information in the plot are not relevant for this test.



Equipment used (see Annex): [20], [21], [101]

6.1.2 RF Output Power radiated

6.1.2.1 Test conditions

The test have been conducted under normal conditions. See subclause 4.1

Method of Measurements: radiated.

6.1.2.2 Measurement Setup

Setup as described in ETSI EN 300 328 V2.2.2 subclause 5.4.2.2.2

6.1.2.3 Measurement results (radiated)

The picture below shows the result of the radiated test using the IMST DARIC Software.

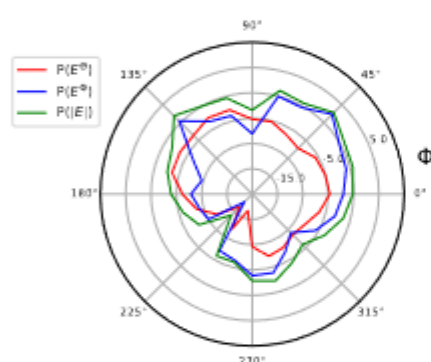
The maximum polarisation dependent EIRP is 3.5 dBm in the horizontal plane. This is the highest EIRP value for the highest frequency dependend correlated antenna gain and output power.

The calculation of the EIRP represents the highest burst power in the observation window for each angular position. The procedure of calculation is identical to the procedure for conducted tests. The test has been performed with an angular resolution of 15 degrees for both axis. For the kind of antenna used (folded inverted F) a high grade of directivity maximums is not to be expected. So this angular resolution is assumed as sufficient.

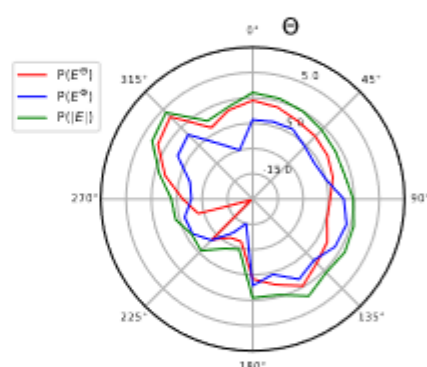
2440.0 MHz

Frequency: 2440000000 Hz

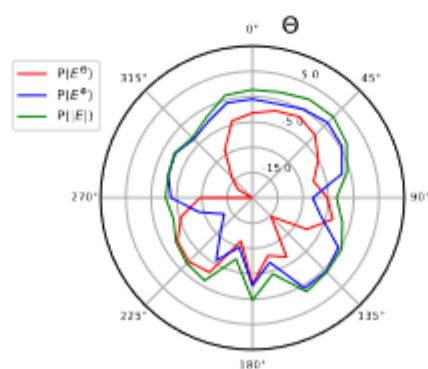
TRP: -0.5 dBm

max. EIRP (Θ): 3.5 dBm at ($\Theta=60.0^\circ$, $\Phi=150.0^\circ$)max. EIRP (Φ): 2.9 dBm at ($\Theta=60.0^\circ$, $\Phi=45.0^\circ$)max. EIRP (abs): 5.1 dBm at ($\Theta=60.0^\circ$, $\Phi=150.0^\circ$)

(a) xy-plane



(b) xz-plane



(c) yz-plane

Equipment used (see Annex): [4], [20], [22], [104]

7 Calculation of the maximum isotropic antenna gain

The measurement of the EIRP gives a maximum value of 3.5 dBm in the horizontal plane
The conducted RF-output power (P_{cond}) was measured as 3.5 dBm.

The maximum isotropic antenna gain is calculated as:

$$3.5 \text{ dBm EIRP} - 3.5 \text{ dBm } P_{\text{cond}} = 0 \text{ dBi Antenna gain}$$

8 Annex

8.1 List of Measurement Equipment used for Testing

8.1.1 Hardware

No.	Type of equipment	Manufacturer	Type / Notifier	Serial No.	Cal due:
1	Void				
2	Spectrum Analyzer	Rohde & Schwarz	FSV13	100784	2023/04
3	Power Supply	Agilent	E3632A	MY40001408	N/A
4	Anechoic Chamber, small	Siemens-Matsushita	Project No. 007-A34-089/99A	N/A	ANT, N/A
5	Anechoic Chamber, large	Siemens-Matsushita	IMST	N/A	EMC, N/A
6	Shielded Room	EMC	Proj.-Nr 0284	N/A	N/A
8	Temperature Chamber	All	All	N/A	N/A
9	Antenna (BiLog)	Chase	CBL 6111C	2794	N/A
10	Antenna (BiLog)	Chase	CBL 6112B	2426	2024/03
11	Void				
12	Void				
13	Antenna (dual ridged Horn, 0.8 - 12 GHz)	Satimo	SGH 800	Part of [4]	ANT, N/A
14	Void				
15	Void				
18	Vector Signal Generator	Rohde & Schwarz	SMJ 100A	N/A	N/A
19	Signal Generator	Agilent	ESG	N/A	N/A
20	Power Sensor	IMST	Watson 6000	all	N/A
21	Digital Scope	Agilent	MSO 8104A	all	N/A
22	Digital Scope	PicoScope	5244B	all	N/A

Table 3: Hardware Equipment

8.1.2 Software

No.	Program	Version	Purpose	Manufacturer
100	Occupation.vxe	V1.1	Occupation-Test	IMST
101	PowerMSO.vxe	V1.1	IMST ERM Power-Test Suite	IMST
102	MaxPowerDensity.vxe	V1.0	PSD-Test	IMST
103	Void			
104	DARIC	Current Version	EIRP and TRP Measurement, Operation Controller of turntable	IMST
105	OOB.VXE	V1.0	Out of Band Measurement	IMST
106	Spurious.VXE	V1.0	Spurious Emissions > 1 GHZ	IMST
107	Spurioushigh.VXE	V1.0	Spurious Emissions < 1 GHZ	IMST

Table 4: Software Equipment