RF Exposure Calculation

Voxter® VT5
Version: 1.04

Contents

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1 Description of the product:

The Voxter VT5 is a mobile voice terminal. It includes the processor NXP i.MX 8M Mini ARM® Quad Cortex-A53, 1,6 GHz with the operating system Android Industrial+ (Version 9.0)
It contains a WiFi and Bluetooth combination module for communication.
The unit is mainly used in logistics to optimize warehouse processes.

The product also includes NFC (Near Field Communication).
In accordance with FCC 2.1093(c)(2), the NFC is excluded from routine evaluation of RF Exposure.

A pre-certified combination module is used for WiFi and Bluetooth (H&D Wireless, FCC ID: XO2-SPB228D).
The SPB228 includes the chip set W8997-M1216 of Marvell and is according to 802.11 ac/a/b/g/n 2x2 MU-MIMO and Bluetooth 5.
There are two antennas connected to the SPB228. Both can be used for WiFi 2,4/5 GHz in diversity mode.
Just one Antenna is used for Bluetooth.
The antennas are dipole with 2.5 dBi gain on 2,4 GHz and 4.4 dBi gain on 5 GHz.

The Voxter VT5 is battery powered with Lithium-Ion 1S2P 3,6V/4,2V (nominal/charge) 24.48Wh/6.8Ah

2 RF exposure calculation

2.1 Used formula according to KDB447498 sub clause 4.3.1 a).

The Voxter® VT5 is a body worn product. Therefore a threshold of 3 is used.

$$\frac{Power\ of\ channel\ [mW]}{Test\ distance\ [mm]} \times \sqrt{f\ [GHz]} \leq 3$$

2.2 Maximum transmit power level

The values of the conducted output power are taken from the Grant of the original certification file
FCC ID: XO2-SPB228D.
The manufacturer defines test distance as 15,1mm; please refer to paragraph “Test distance definition”.
Power listed is the maximum combined conducted output power.

Parameter	Grant Notes	FCC Rule Parts	Frequency Range [MHZ]	Conducted Output Power [mW]	[dBm]
2.4G/Output power	CC MO	**15C**	**2412.0 - 2462.0**	**932**	**29,7**
	CC	**15C**	**2402.0 - 2480.0**	3	4,8
5G/Output power	38 CC MO	**15E**	**5180.0 - 5240.0**	152	21,8
	38 CC MO ND	**15E**	**5260.0 - 5320.0**	148	21,7
	38 CC MO ND	**15E**	**5500.0 - 5700.0**	137	21,4
	38 CC MO	**15E**	**5745.0 - 5825.0**	**194**	**22,9**

38: This device has shown compliance, in all grant-listed U-NII sub-bands, with the new rules for U-NII devices adopted under Docket No. 13-49 and may be marketed, manufactured or imported after the June 1, 2016 transition deadline.

CC: This device is certified pursuant to two different Part 15 rules sections.

MO: This Multiple Input Multiple Output (MIMO) device was evaluated for multiple transmitted signals as indicated in the filing.

ND: This UNII device complies with the Transmit Power Control (TPC) and Dynamic Frequency Selection (DFS) requirements in Section 15.407(h).

2.3 Calculation of Effective Power:

Parameter	max. Output Power [mW]	Duty Cycle [%]	Effective Power [mW]
2.4G/Output power	932	2,28%	21,25
5G/Output power	194	2,28%	4,42

2.4 SAR Calculation:

Parameter	Frequency [GHz]	Effective Power [mW]	Test Distance [mm]	Result	Limit	Pass / Fail
2.4G/Output power	2,4	21	15	**2,17**	3	**Pass**
5G/Output power	5	4	15	**0,60**	3	**Pass**

3 Duty Cycle Calculation

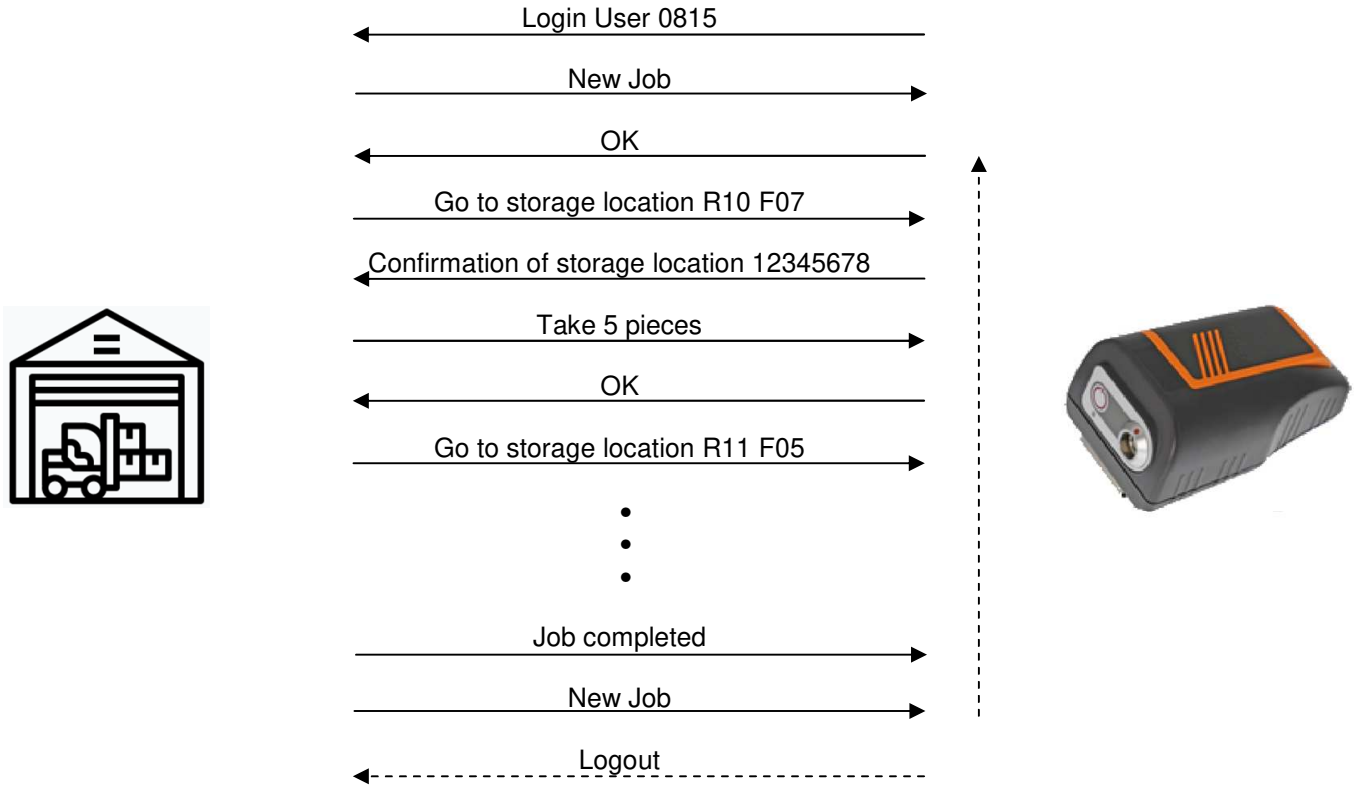
The time variation was used, because of the very low WiFi traffic. WiFi is only used to send a view text based data packages (XML files). During the measurement

3.1 Operational Description

The Voxter VT5 is mainly used in warehouse management systems.
The Lydia software from Topsystem runs on the Voxter VT5. This is started automatically during the boot process. After booting the Voxter VT5, it automatically connects to the WiFi infrastructure. The user is requested by voice to log on to the warehouse management system server with a user ID and password. After successful registration, the warehouse management system takes over the rest of the process. No intervention in the process is possible for the end user. He can only process the tasks assigned to him.
The default process is as follows:

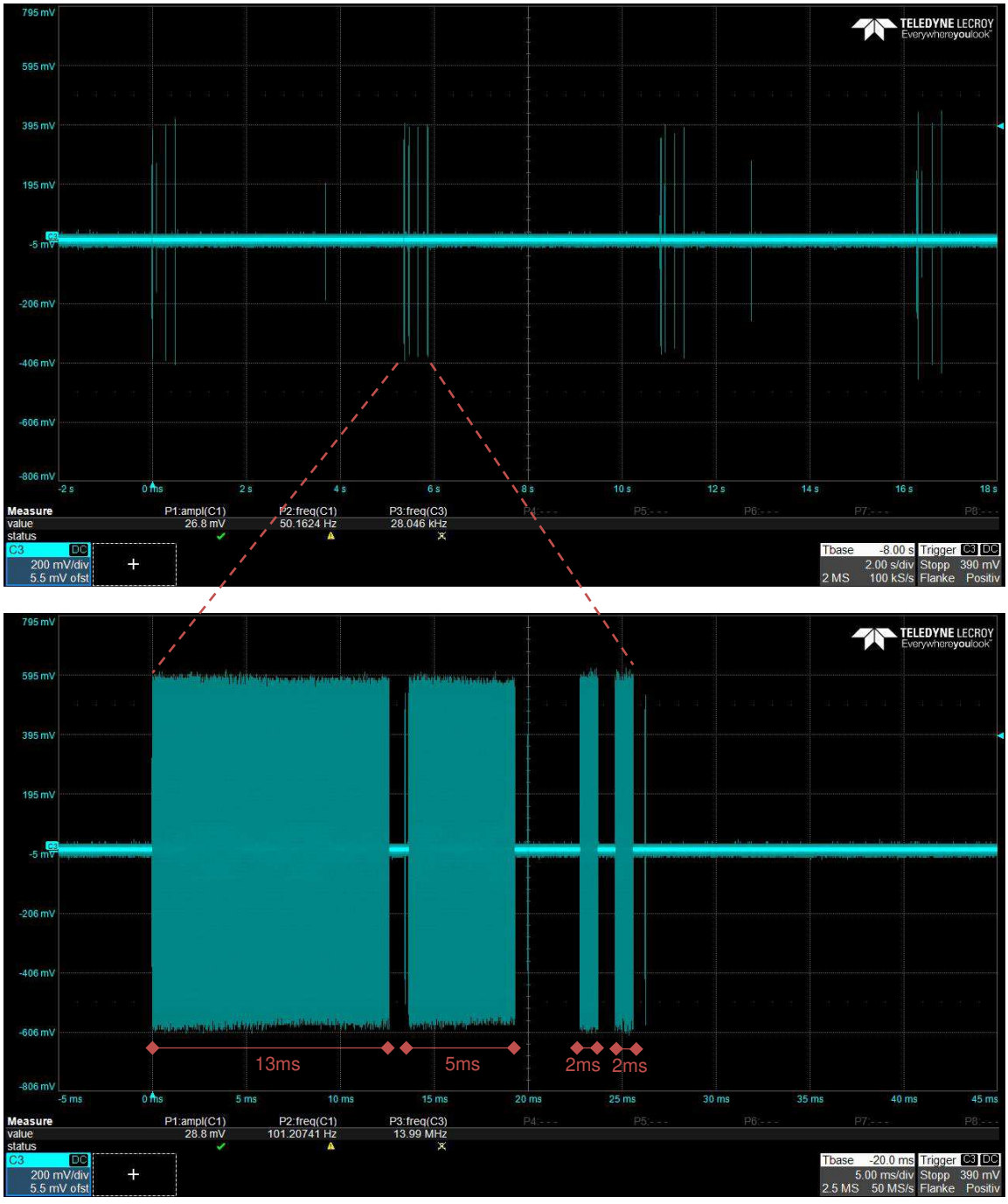
An order is transferred from the warehouse management system to the Voxter VT5 via WiFi. According to the data contained, a voice output is generated on the Voxter VT5 and output via a wired headset or via a Bluetooth headset. The user performs the task and confirms this by voice input. The speech recognition is carried out in the Voxter VT5 and the recognized command is extracted. The answer is sent back to the warehouse management system via WiFi.
NFC is used to pair a Bluetooth headset, or optionally a Bluetooth barcode scanner. It is not used for normal operation in the warehouse.

3.2 Exemplary process

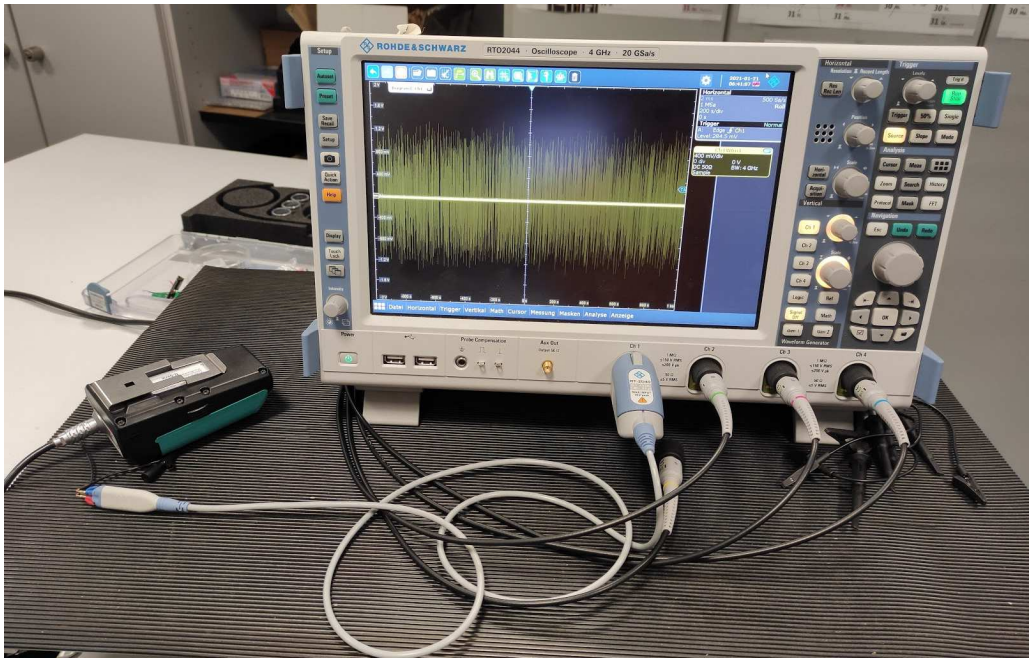


3.3 Measurement

Voxter® VT5 was developed specifically for Lydia® voice applications. Voice recognition and voice output via the headset are controlled locally and the device is directly connected to the higher-level system via Wi-Fi. After voice recognition the result package is send to a server (up to 2048 Byte). The server will send back the next task to the Voxter® VT5 depending on the recognition result (up to 2048 Byte).
The voice recognition also as the voice generation is done on the Voxter® VT5. Therefore no voice is transmitted over Wi-Fi.
The following figures shows the communication to the server and back to the Voxter® VT5 with a data package of 2048 Byte in both direction every five seconds.

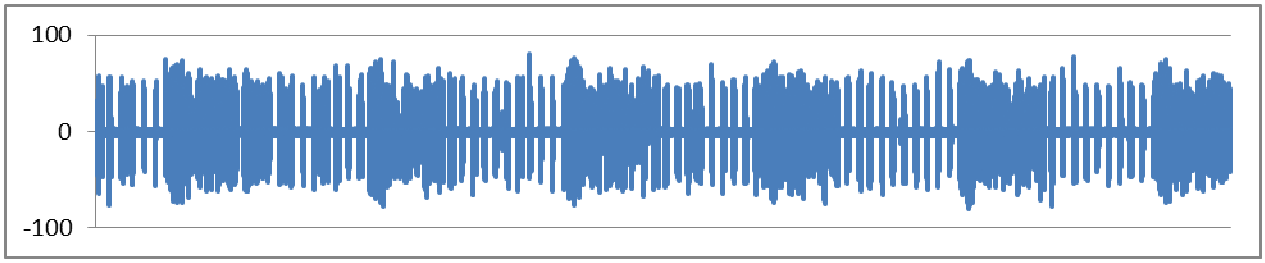


Since there are also some Wi-Fi protocol packages, all Wi-Fi traffic was measured over a period of once 30 minutes and once 100 seconds.
During this time, 60 roaming processes (30 minutes) and 3 roaming processes (100 seconds) were carried out between two access points.
To simulate possible retransmissions, the transmission interval was reduced from 5 seconds to 1 second and the data packet size was doubled to 4096 bytes. This corresponds to a repetition of each data packet 10 times. The test setup corresponds to an absolute worst case scenario, which will not happen in praxis.

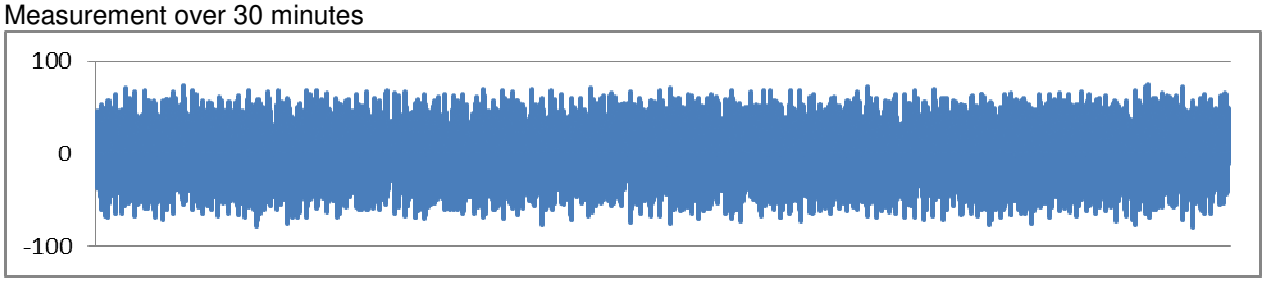


When WLAN is not active, the values range is between -2 and 2. A threshold was set at -4 to 4.
If a value is greater than 4 or less than -4, it is rated as WLAN activity. In order to also evaluate zero crossings, a value is evaluated as active when the value before and after is also active.
The duty cycle in percent results from the ratio of the values set as active to all values.

Measurement over 100 seconds



Measurement over 30 minutes



The duty cycle is calculated as the following:

	Measurement 100 seconds	Measurement 30 minutes
Duty Cycle Calculation	2,03%	2,28%
Used Duty Cycle for SAR calculation	**2,28%**	

4 Test distance definition