

Test Report

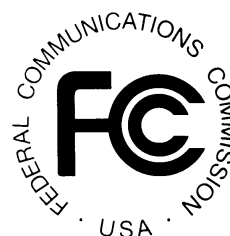
Customer:

Tyco Fire Protection Products TOTAL
WALTHER GmbH
Frankfurter Ring 17
80807 Munich
Germany

Tel.: +49 89 354754-36
Fax: +49 89 354754-81

RF test report

140206-AU01+W02_R1



Industry
Canada Industrie
Canada

**Tyco Fire Protection Products TOTAL
WALTHER GmbH**

Task Manager Station with RFID reader for
EZCare Nurse Call Systems
5009-9103



The test result refers exclusively
to the tested model.
This test report may not be copied or
published in a part without the written
authorization
of the accreditation agency and/or
EMV **TESTHAUS** GmbH
Revision: 1.0



Deutsche
Akkreditierungsstelle
D-PL-12155-01-01

EMV **TESTHAUS** GmbH

Gustav-Hertz-Straße 35
94315 Straubing
Tel.: +49 9421 56868-0
Fax: +49 9421 56868-100
Email: info@emv-testhaus.com

Accreditation:



FCC facility registration number: 221458
Test Firm Type "2.948 listed": Valid until 2017-04-22
Test Firm Type "accredited": Valid until 2015-06-11
MRA US-EU, FCC designation number: DE0010
BnetzA-CAB-02/21-02/04 Valid until 2018-11-27

Industry Canada test site number: 3472A-1
Registration expiry date: 2015-10-02

Test Laboratory:

EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany

The technical accuracy is guaranteed through the quality management of the
EMV **TESTHAUS** GmbH



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 2 of 48

Table of contents

1	Test regulations	5
2	Equipment under Test (EUT)	6
3	AC power line conducted emissions	10
4	Radiated emission measurement (<1 GHz)	20
5	Radiated emission measurement (>1 GHz)	30
6	Carrier frequency stability	36
7	Bandwidths	39
8	Equipment calibration status	44
9	Measurement uncertainty	46
10	Summary	47
11	Revision History	48



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 3 of 48

List of pictures

Picture 1: Outline of conducted emission test setup	11
Picture 2: Graphic - Conducted emission on mains, phase 1 (without termination).....	12
Picture 3: Table - Conducted emission on mains, phase 1 (without termination)	13
Picture 4: Graphic - Conducted emission on mains, neutral (without termination).....	14
Picture 5: Table - Conducted emission on mains, neutral (without termination)	15
Picture 6: Graphic - Conducted emission on mains, phase 1 (with termination 50 Ω)	16
Picture 7: Table - Conducted emission on mains, phase 1 (with termination 50 Ω).....	17
Picture 8: Graphic - Conducted emission on mains, neutral (with termination 50 Ω)	18
Picture 9: Table - Conducted emission on mains, neutral (with termination 50 Ω)	19
Picture 10: Test setup for radiated emission measurement (< 30 MHz).....	23
Picture 11: Test setup for radiated emission measurement (< 1 GHz)	23
Picture 12: Radiated emission 9 kHz – 30 MHz @ 3m distance (13.56 MHz)	25
Picture 13: Radiated emission 30 MHz – 1000MHz @ 3m distance, horizontal polarization	26
Picture 14: Radiated emission 30 MHz – 1000MHz @ 3m distance, vertical polarization	27
Picture 15: Spectrum mask for 13.56 MHz @ 3m distance.....	29
Picture 16: Outline of radiated emission measurement (> 1 GHz)	33
Picture 17: Radiated emission (> 1 GHz), horizontal polarization	34
Picture 18: Radiated emission (> 1 GHz), vertical polarization	35
Picture 19: Test setup for carrier frequency stability measurement.....	37
Picture 20: Occupied bandwidth (99 %).....	41
Picture 21: -6 dB emission bandwidth.....	42
Picture 22: -20 dB emission bandwidth.....	43

List of tables

Table 1: Equipment calibration status.....	44
Table 2: Measurement uncertainty	46



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 4 of 48

1 Test regulations

47 CFR Part 2: 10-2013	Code of Federal Regulations Part 2 (Frequency allocation and radio treaty matters; General rules and regulations) of the Federal Communication Commission (FCC)
47 CFR Part 15: 10-2013	Code of Federal Regulations Part 15 (Radio Frequency Devices) of the Federal Communication Commission (FCC)
ANSI C63.4: September 2009	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
RSS-Gen Issue 4, November 2014	General Requirements for Compliance of Radio Apparatus
RSS-102 Issue 4, March 2010, updated December 2010	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
RSS-210 Issue 8, December 2010	Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment

1.1 Summary of test results

Standard	Test result
47 CFR Part 15, sections 15.207 and 15.225	Passed
RSS-210 Issue 8 Annex A2.6 (with appropriate references to RSS-Gen Issue 4)	Passed



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 5 of 48

2 Equipment under Test (EUT)

Product type: Task Manager Station with RFID reader for EZCare Nurse Call Systems
Model Name: 5009-9103

Note:

5009-9103 (B), EZCare Task Manager Station with blue function button
5009-9103 (R), EZCare Task Manager Station with red function button

Applicant: Tyco Fire Protection Products TOTAL WALTHER GmbH

Manufacturer: Tyco Fire & Integrated Solutions SRO
Osovobozeni 363
679 02 Rajecko
Czech Republic

Serial number: ---

FCC ID: YS4-50099103

IC certification number: 9247A-50099103

Application frequency band: 13.110 to 14.010 MHz

Frequency range: 13.560 MHz

Operating frequency: 13.560 MHz

Number of RF-channels: 1

Modulation: ASK

Antenna types: PCB antenna

☐ detachable ☒ not detachable

Power supply: External power source
nominal: 24.0 VDC

Power source of RFID reader system:
nominal: 5.0 V DC (via DC/DC converter)

Temperature range: -20°C to +50°C

Remark:
The tests were performed with 120V AC / 60Hz.



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 6 of 48

2.1 Photo documentation

For external photos of the EUT see annex B, for internal ones see annex C.
For photos taken during testing and EUT-positions see annex A.

2.2 Short description of the EUT

EUT is a room terminal IP Device with RFID reader (13.56 MHz). It is called “Task Manager Station” and part of “EZCare Nurse Call Systems”

2.3 Operation mode

During the pre-tests it was observed that the “continuous-tag-reading-mode” is the respective worst- case. Therefore this mode was selected for final testing. The device was configured by manufacturer to activate the RFID reader for continuous transmission via RFID card.

Equipment is designed for wall-mounted operation and therefore was tested as tabletop EUT (see ANSI C63.4 clause 6.3.4).



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 7 of 48

2.4 Configuration

The following peripheral devices and interface cables were connected during the tests:

Device	Model:	Count	Serial or inventory no.
Task Manager Station with RFID reader for EZCare Nurse Call Systems	5009-9103	1	---
RFID tag	---	1	N/A
VL base module	125.0500	1	N/A
VL base module buzzer	125.0002	1	N/A
VL base module	125.0520	6	N/A
Overdoor light	130.010	1	N/A
Patch panel ¹	---	1	N/A
GNCS touch ²	130.3630	1	N/A
Gateway ²	130.8000	1	N/A
Notebook ²	Fujitsu Lifebook A531	1	E00520
Power supply ¹	Statron 3231.1	1	E00017

2.5 Used cables

Count	Description (type / lengths / remarks)	Serial no.
9	Installation cable, 5m	N/A
1	LAN cable, 2m (EUT ↔ patch panel)	N/A
1	LAN cable, 2m (patch panel ↔ gateway)	N/A
1	LAN cable, 2m (patch panel ↔ notebook)	N/A

¹ Placed outside the test environment for radiated tests.

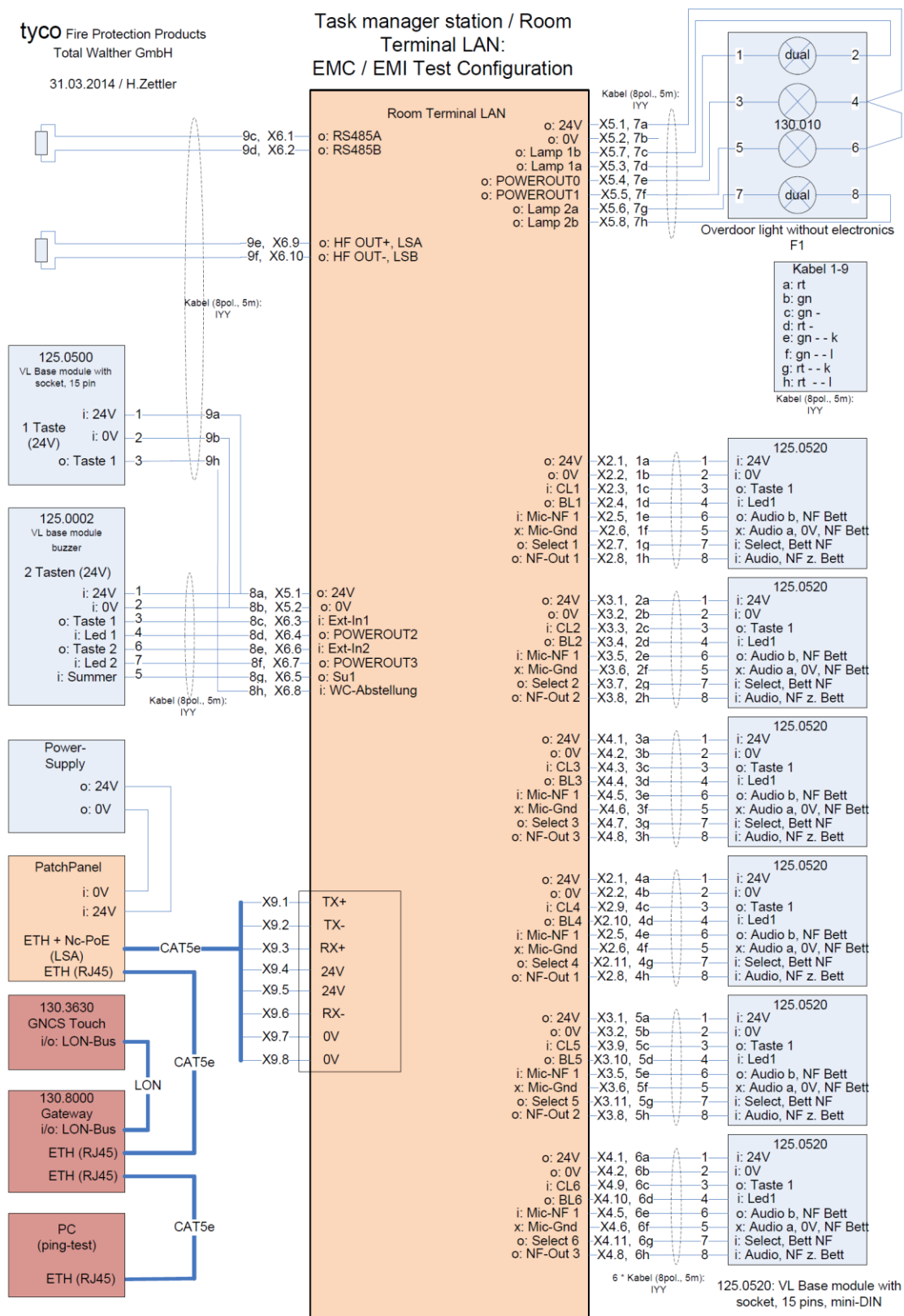
² Placed outside the test environment for conducted and radiated tests.



2.6 Block diagram of test setup

tyco Fire Protection Products
Total Walther GmbH
31.03.2014 / H.Zettler

Task manager station / Room
Terminal LAN:
EMC / EMI Test Configuration



3 AC power line conducted emissions

according to 47 CFR Part 15, section 15.207, and
RSS-210, section 2.1 with RSS-Gen, section 8.8

3.1 Test location

Description	Manufacturer	Inventory No.
Shielded room	Siemens - Matsushita	E00107

3.2 Test instruments

	Description	Manufacturer	Inventory No.
<input checked="" type="checkbox"/>	ESCS 30	Rohde & Schwarz	E00003
<input type="checkbox"/>	ESU 26	Rohde & Schwarz	W00002
<input type="checkbox"/>	ESCI	Rohde & Schwarz	E00001
<input type="checkbox"/>	ESH3 Z2	Rohde & Schwarz	E00028
<input checked="" type="checkbox"/>	ESH 2-Z5	Rohde & Schwarz	E00004
<input checked="" type="checkbox"/>	ESH 2-Z5	Rohde & Schwarz	E00005
<input checked="" type="checkbox"/>	Cable set shielded room	Huber + Suhner	E00424

3.3 Limits

Frequency [MHz]	Quasi-peak [dBµV]	Avarage [dBµV]
0.15 – 0.5	66 – 56	56 – 46
0.5 – 5.0	56	46
5 – 30	60	50



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

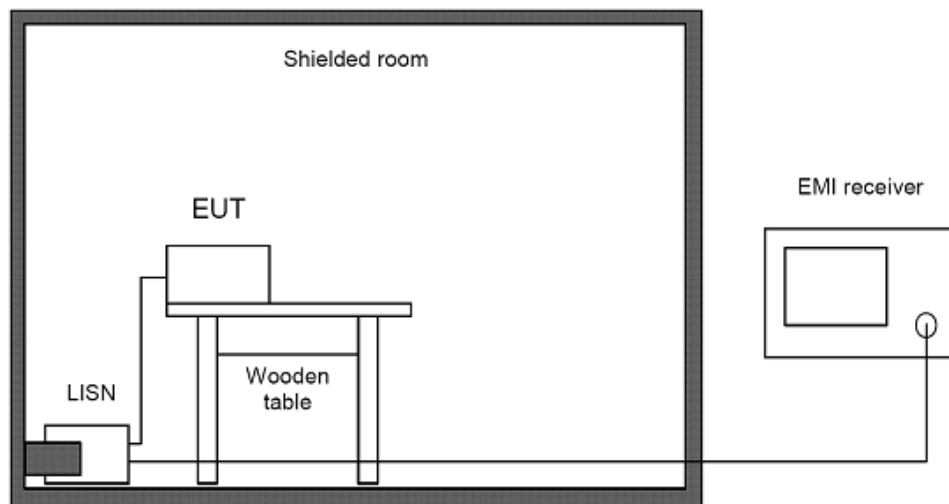
Page 10 of 48

3.4 Test procedure

1. The tests of conducted emission were carried out in a shielded room using a line impedance stabilization network (LISN) 50 μ H/50 Ohms and an EMI test receiver.
2. The EMI test receiver was connected to the LISN and set to a measurement bandwidth of 9 kHz in the frequency range from 0.15 MHz to 30 MHz.
3. The EUT was placed on a wooden table and connected to the LISN.
4. To accelerate the measurement the detector of the EMI test receiver was set to peak and the whole frequency range from 0.15 MHz to 30 MHz were scanned.
5. After that all peaks values with fewer margins than 10 dB to quasi-peak limit or exceeding the limit were marked and re-measured with quasi-peak detector.
6. If after that all values are under the average limit no addition measurement is necessary. In case there are still values between quasi-peak and average limit than these values were re-measured again with an average detector.
7. These measurements were done on all current carrying conductors.

According to ANSI C63.4, section 13.3.1 testing of intentional radiators with detachable antennas shall be done with a dummy load otherwise the tests should be done with connected antenna and if adjustable fully extended.

3.5 Test setup

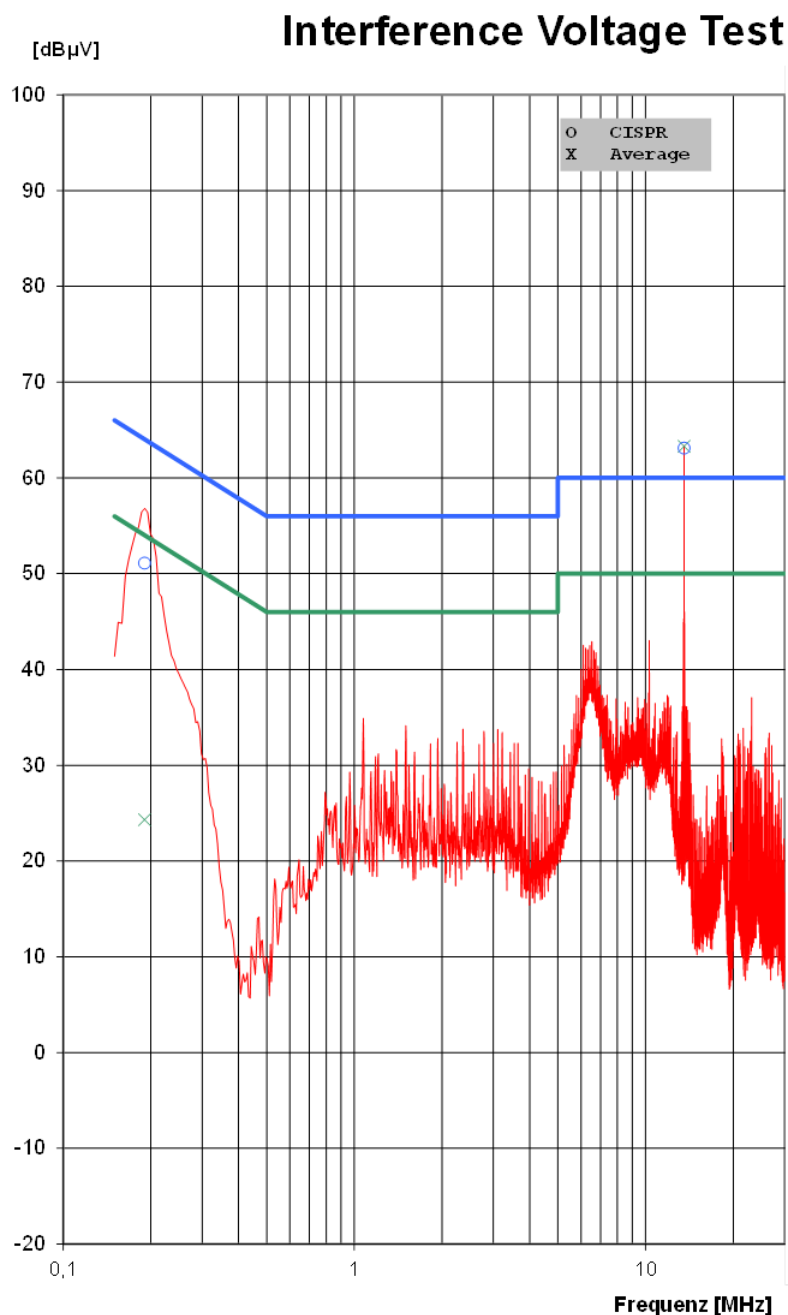


Picture 1: Outline of conducted emission test setup

Comments: All peripheral devices were additionally decoupled by means of a line stabilization network.

3.6 Test results

Temperature:	20°C	Humidity:	41%
Tested by:	Martin Müller	Test date:	2014-04-02



REGULATIONS:
EN 55022 Class B
PEAK / CISPR / AV

TEST EQUIPMENT:
R&S ESCS30 (E00003)
R&S ESH2-Z5 (E00004)

ORDER NO.:
140206-AU01+W02

EUT:
Tyco Fire Protection Products
TOTAL WALTHER GmbH
LAN-Terminal

OPERATION MODE:
connected
nurse present
without termination

Mains 120V AC /60Hz
Phase

TEST FACILITY:
EMV TESTHAUS GmbH
Gustav-Hertz-Straße 35
94315 Straubing

DATE / TIME:
2014-04-02 15:01:20
20°C 41% 97kPa

TEST ENGINEER:
Martin Müller

Picture 2: Graphic - Conducted emission on mains, phase 1 (without termination)



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

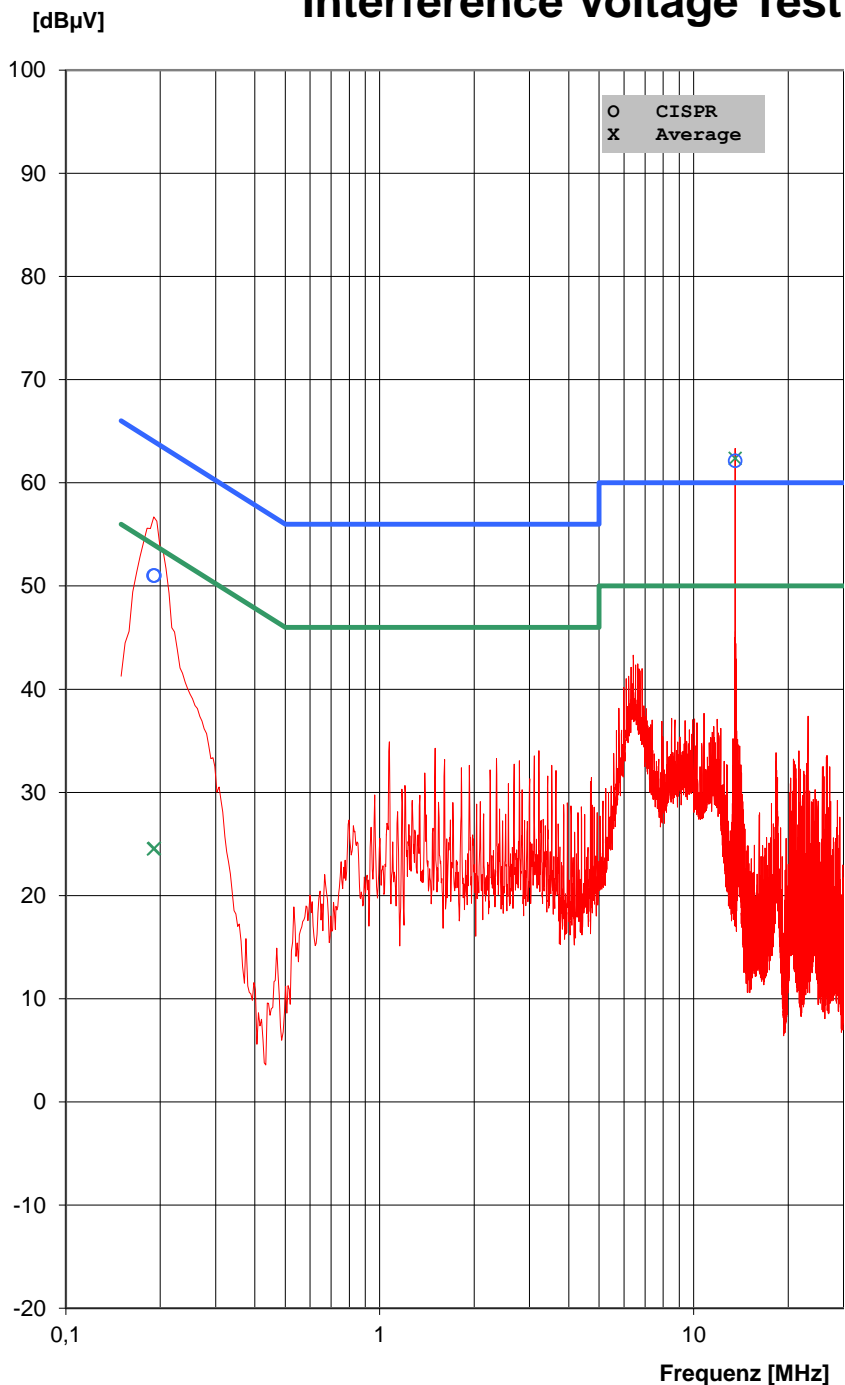
Page 12 of 48

Interference Voltage Test

Freq. [MHz]	U_CISPR [dBµV]	Limit [dBµV]	delta_U [dB]	U_AV [dBµV]	Limit [dBµV]	delta_U [dB]	Corr. [dB]	Remark
0,19	51,1	64,0	12,9	24,3	54,0	29,7	0,0	StöSp. L1, without F10
13,56	63,1	60,0	-3,1	63,3	50,0	-13,3	0,0	

Picture 3: Table - Conducted emission on mains, phase 1 (without termination)

Interference Voltage Test



REGULATIONS:
EN 55022 Class B
PEAK / CISPR / AV

TEST EQUIPMENT:
R&S ESCS30 (E00003)
R&S ESH2-Z5 (E00004)

ORDER NO.:
140206-AU01+W02

EUT:
Tyco Fire Protection Products
TOTAL WALTHER GmbH
LAN-Terminal

OPERATION MODE:
connected
nurse present
without termination

Mains 120V AC /60Hz
Neutral

TEST FACILITY:
EMV TESTHAUS GmbH
Gustav-Hertz-Straße 35
94315 Straubing

DATE / TIME:
2014-04-02 15:02:29
20°C 41% n97kPa

TEST ENGINEER:
Martin Müller

StöSp_N_without.E10

Picture 4: Graphic - Conducted emission on mains, neutral (without termination)



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 14 of 48

Interference Voltage Test

Freq. [MHz]	U_CISPR [dBμV]	Limit [dBμV]	delta_U [dB]	U_AV [dBμV]	Limit [dBμV]	delta_U [dB]	Corr. [dB]	Remark
0,19	51,0	64,0	13,0	24,6	54,0	29,4	0,0	StöSp_N_without F10
0,19	51,0	64,0	13,0	24,5	54,0	29,5	0,0	
13,56	62,1	60,0	-2,1	62,4	50,0	-12,4	0,0	

Picture 5: Table - Conducted emission on mains, neutral (without termination)



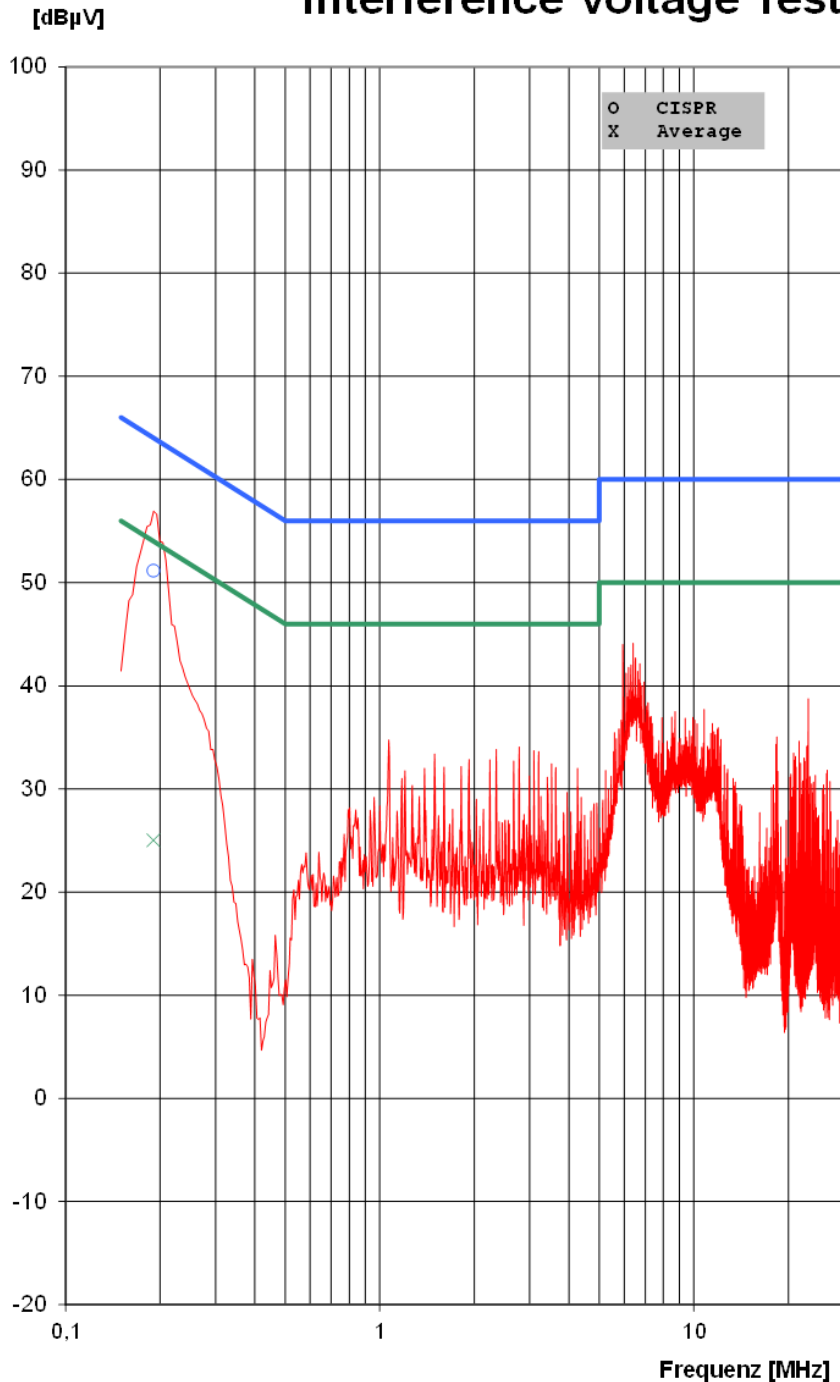
EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 15 of 48

Interference Voltage Test



REGULATIONS:
EN 55022 Class B
PEAK / CISPR / AV

TEST EQUIPMENT:
R&S ESCS30 (E00003)
R&S ESH2-Z5 (E00004)

ORDER NO.:
140206-AU01+W02

EUT:
Tyco Fire Protection Products
TOTAL WALTHER GmbH
LAN-Terminal

OPERATION MODE:
connected
nurse present
with termination 50 Ohm

Mains 120V AC /60Hz
Phase

TEST FACILITY:
EMV TESTHAUS GmbH
Gustav-Hertz-Straße 35
94315 Straubing

DATE / TIME:
2014-04-02 15:23:16
20°C 41% 97kPa

TEST ENGINEER:
Martin Müller

StöSp_L1_withTerm.E10

Picture 6: Graphic - Conducted emission on mains, phase 1 (with termination 50 Ω)



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

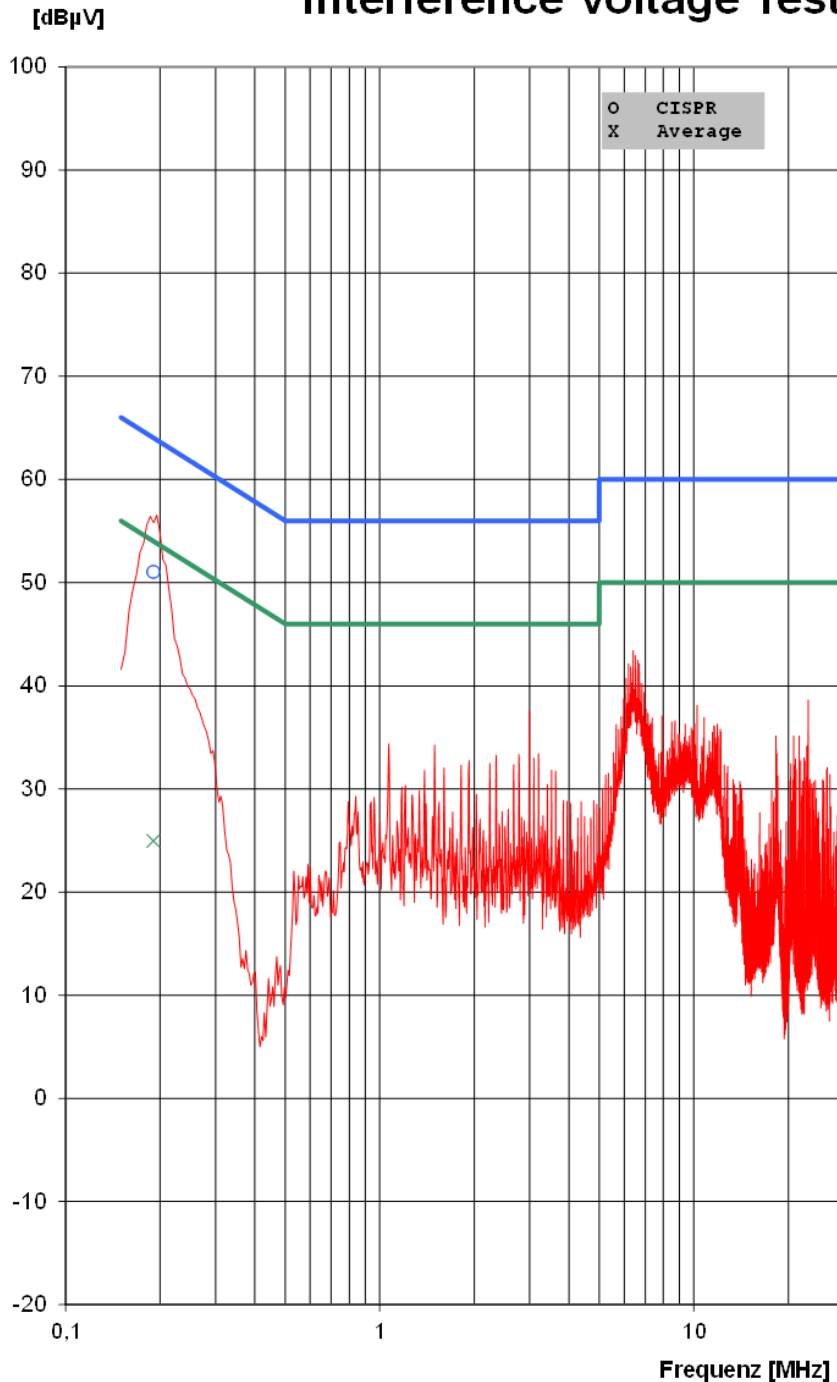
Page 16 of 48

Interference Voltage Test

Freq. [MHz]	U_CISPR [dBµV]	Limit [dBµV]	delta_U [dB]	U_AV [dBµV]	Limit [dBµV]	delta_U [dB]	Corr. [dB]	Remark
0,19	51,2	64,0	12,9	25,0	54,0	29,0	0,0	StöSp_L1_withTerm F10

Picture 7: Table - Conducted emission on mains, phase 1 (with termination 50 Ω)

Interference Voltage Test



REGULATIONS:
EN 55022 Class B
PEAK / CISPR / AV

TEST EQUIPMENT:
R&S ESCS30 (E00003)
R&S ESH2-Z5 (E00004)

ORDER NO.:
140206-AU01+W02

EUT:
Tyco Fire Protection Products
TOTAL WALTHER GmbH
LAN-Terminal

OPERATION MODE:
connected
nurse present
with termination 50 Ohm

Mains 120V AC /60Hz
Neutral

TEST FACILITY:
EMV TESTHAUS GmbH
Gustav-Hertz-Straße 35
94315 Straubing

DATE / TIME:
2014-04-02 15:23:43
20°C 41% n97kPa

TEST ENGINEER:
Martin Müller

StöSp_N_withTerm.E10

Picture 8: Graphic - Conducted emission on mains, neutral (with termination 50 Ω)



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 18 of 48

Interference Voltage Test

Freq.	U_CISPR	Limit	delta_U	U_AV	Limit	delta_U	Corr.	Remark
[MHz]	[dBµV]	[dBµV]	[dB]	[dBµV]	[dBµV]	[dB]	[dB]	
0,19	51,0	64,0	13,0	25,0	54,0	29,0	0,0	StöSp_N_withTerm F10
0,19	51,0	64,0	13,0	25,0	54,0	29,1	0,0	

Picture 9: Table - Conducted emission on mains, neutral (with termination 50 Ω)

4 Radiated emission measurement (<1 GHz)

according to 47 CFR Part 15, section 15.205(a), 15.209(a), 15.225(a) to (d), and
RSS-210, section 2.5 and Annex 2.6 with RSS-Gen, sections 8.9 and 8.10

4.1 Test Location

- ☒ Scan with peak detector in 3 m CDC.
- ☒ Final CISPR measurement with quasi peak detector on 3 m open area test site.

Description	Manufacturer	Inventory No.
CDC	Albatross Projects	E00026
Open site area	EMV TESTHAUS GmbH	E00354

4.2 Test instruments

	Description	Manufacturer	Inventory No.
<input checked="" type="checkbox"/>	ESCS 30 (FF)	Rohde & Schwarz	E00551
<input type="checkbox"/>	ESU 26	Rohde & Schwarz	W00002
<input checked="" type="checkbox"/>	ESCI (CDC)	Rohde & Schwarz	E00001
<input checked="" type="checkbox"/>	VULB 9163 (FF)	Schwarzbeck	E00013
<input checked="" type="checkbox"/>	VULB 9160 (CDC)	Schwarzbeck	E00011
<input checked="" type="checkbox"/>	HFH2-Z2	Rohde & Schwarz	E00060
<input checked="" type="checkbox"/>	Cable set CDC	Huber + Suhner	E00459, E00460
<input checked="" type="checkbox"/>	Cable set OATS 3 m	Huber + Suhner	E00453, E00456, E00458
<input type="checkbox"/>	Cable set OATS 10 m	Huber + Suhner	E00453, E00455, E00458



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 20 of 48

4.3 Limits

The field strength of any emissions appearing outside of the 13.110 to 14.010 MHz band including spurious emissions falling into restricted bands as specified in 15.205(a) shall not exceed the general radiated emission limits as specified in 15.209.

Frequency [MHz]	Field strength Fs [μV/m]	Field strength [dBμV/m]	Measurement distance d [m]
0.009 – 0.490	266.6 – 4.9	48.5 – 13.8	300
0.490 – 1.705	48.98 – 14.08	33.8 – 22.97	30
1.705 – 30.0	30	29.54	30
30 – 88	100	40	3
88 – 216	150	43.5	3
216 - 960	200	46	3
Above 960	500	54	3

As noted in 15.205(d)(7) devices according to 15.225 are exempt from complying with restricted band requirements for the 13.36 to 13.41 MHz band. Instead they have to comply with the limits as specified in 15.225 (a) to (d):

Frequency [MHz]	Field strength Fs [μV/m]	Field strength [dBμV/m]	Measurement distance d [m]
13.553 - 13.567	15,848	84	30
13.410 - 13.553	334	50.47	30
13.567 - 13.710	334	50.47	30
13.110 - 13.410	106	40.51	30
13.710 - 14.010	106	40.51	30
f < 13.110	according to limits in §15.209		
f > 14.010			



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 21 of 48

4.4 Test procedure

1. Configure the EUT according to ANSI C63.4. The EUT was placed on the top of the turntable 0.8 meter above ground. The receiving antenna was placed 3 meters from the turntable. The test setup was placed inside a compact diagnostic chamber.
2. Power on the EUT and all peripherals.
3. The broadband antenna was set to vertical polarization.
4. The EMI receiver performed a scan from 30 MHz to 1000 MHz with the detector set to peak and the measurement bandwidth to 120 kHz.
5. The turn table was rotated to 6 different positions ($360^\circ / 6$) and the antenna polarization was changed to horizontal.
6. Repeat the test procedure at step 4 and 5.
7. The test setup was then placed in an OATS at 3 m distance and all peak values over or with less distance to limit then 6dB were marked and re-measured with a quasi-peak detector.
8. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
9. The height of the broadband receiving antenna was varied between one meter and four meters above ground to find the maximum emissions field strength of both horizontal and vertical polarization. The highest value was recorded.
10. For emissions below 30 MHz, measurements were done with a loop antenna. The recorded data were measured in QP mode of the receiver. Antenna height was not changed during this test. Appropriate CISPR bandwidths of 200 Hz for frequencies up to 150 kHz and 9 or 10 kHz for frequencies above were used.



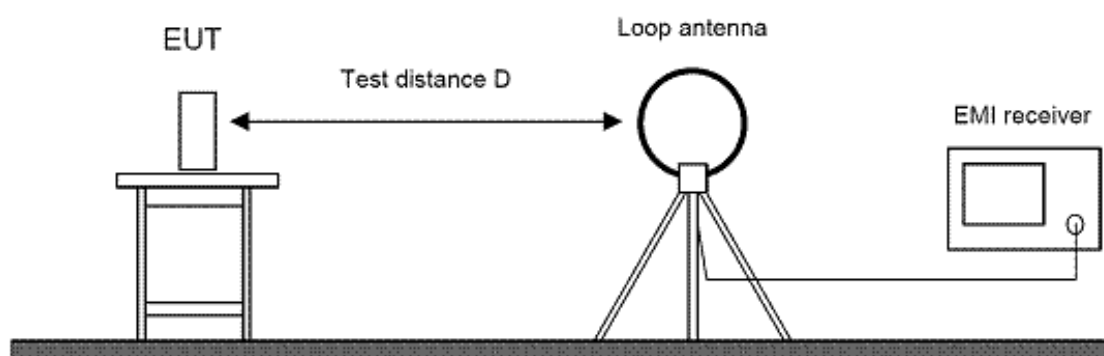
EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

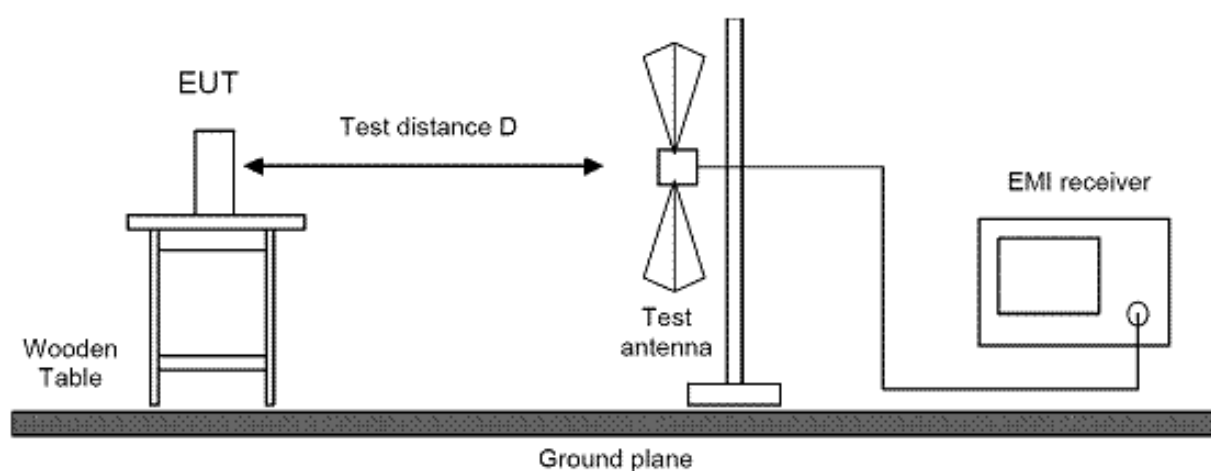
140206-AU01+W02_R1

Page 22 of 48

4.5 Test setup



Picture 10: Test setup for radiated emission measurement (< 30 MHz)



Picture 11: Test setup for radiated emission measurement (< 1 GHz)

4.6 Test deviation

There is no deviation from the standards referred to.

4.7 Test results

Temperature:	20°C	Humidity:	41%
Tested by:	Martin Müller	Test date:	2014-04-02

Radiated Emission Measurement 9 kHz – 30 MHz

Test procedure

The EUT was placed in a full anechoic chamber and the spurious emission testing was performed in accordance with ANSI C63.4, 47 CFR Part 15, Subpart C. The measurement distance was 3 m.

The following picture shows the worst-case-emissions.

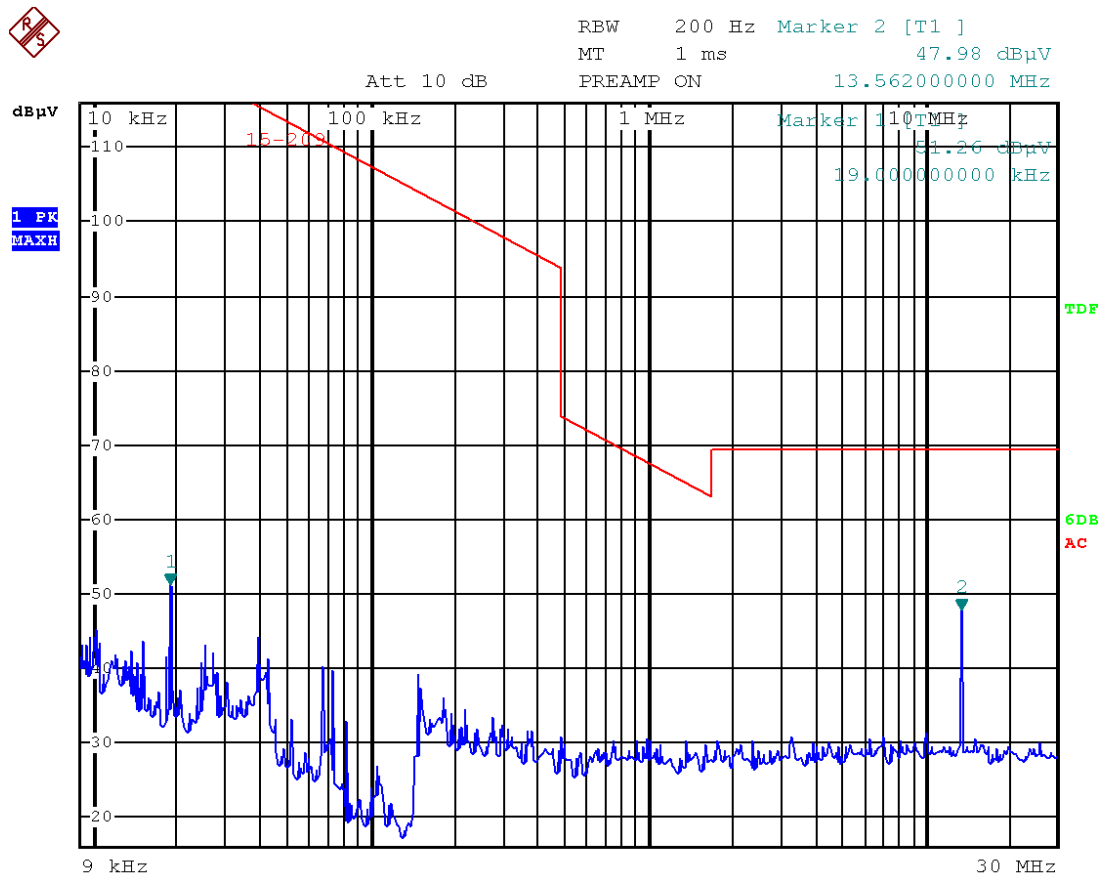


EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 24 of 48



Picture 12: Radiated emission 9 kHz – 30 MHz @ 3m distance (13.56 MHz)

Frequency (MHz)	Reading (dBμV)	Detector	Recalculation factor (dB/decade)	Field strength (dBμV)	Limit (dBμV)	Margin	Result
13.56	47.98	QP	40	7.98	84	-76.02	PASS

Note:

Measured value = 47.98 dBμV @ 3 m

Recalculation factor = 40 dB / decade

Recalculated value = 47.98 dBμV @ 3 m - 40 dB = **7.98 dBμV @ 30 m**

Note: Spurious emission at 19 kHz ("Marker 1") not caused by RFID reader.



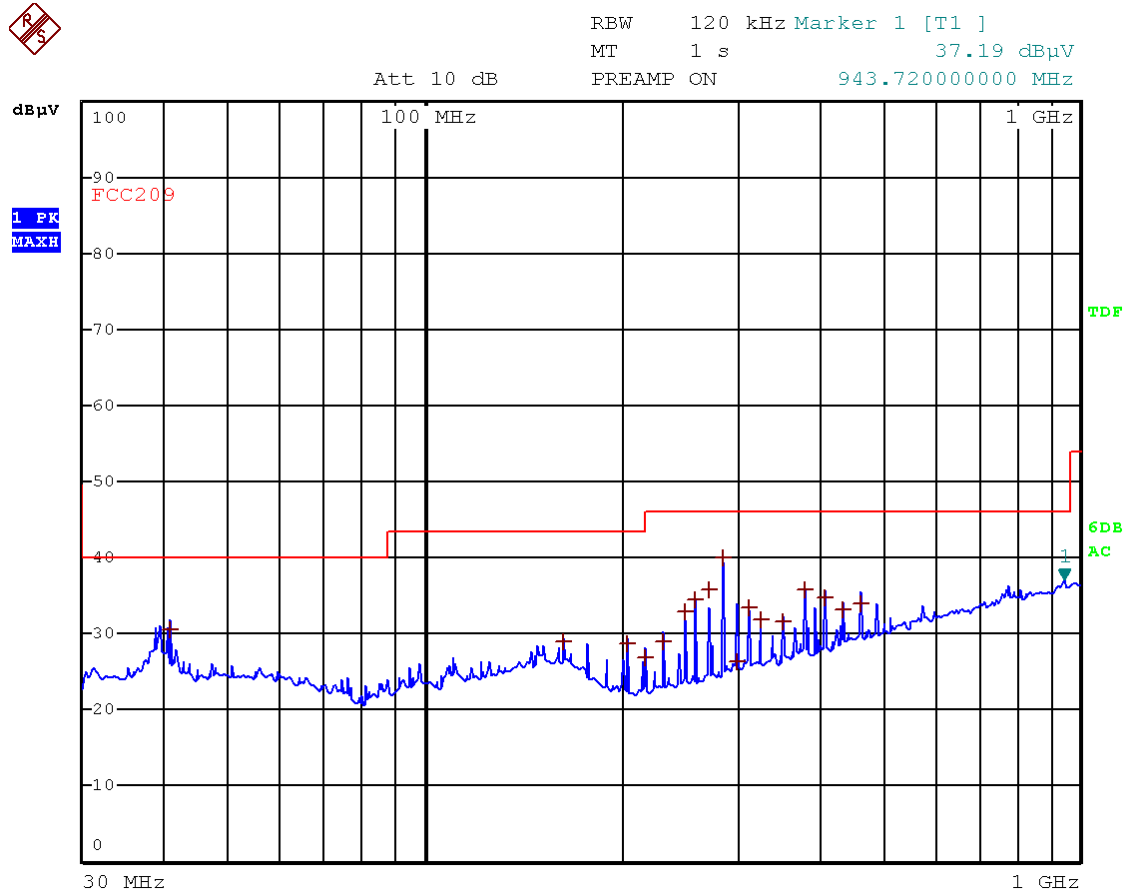
EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 25 of 48

Radiated Emission Measurement 30 MHz – 1000 MHz



EDIT PEAK LIST (Final Measurement Results)				
Trace1:	FCC209			
Trace2:	---			
Trace3:	---			
TRACE	FREQUENCY	LEVEL dBµV	DELTA LIMIT dB	
1 Quasi Peak	40.68 MHz	30.44	-9.55	
1 Quasi Peak	162.72 MHz	28.91	-14.58	
1 Quasi Peak	203.4 MHz	28.70	-14.79	
1 Quasi Peak	216 MHz	26.92	-19.07	
1 Quasi Peak	230.52 MHz	29.03	-16.96	
1 Quasi Peak	250 MHz	32.88	-13.11	
1 Quasi Peak	257.64 MHz	34.58	-11.41	
1 Quasi Peak	271.2 MHz	35.93	-10.06	
1 Quasi Peak	284.76 MHz	40.02	-5.97	
1 Quasi Peak	298.32 MHz	26.48	-19.51	
1 Quasi Peak	311.88 MHz	33.50	-12.49	
1 Quasi Peak	325.44 MHz	31.97	-14.02	
1 Quasi Peak	352.56 MHz	31.66	-14.33	
1 Quasi Peak	379.68 MHz	35.77	-10.22	
1 Quasi Peak	406.8 MHz	34.79	-11.20	
1 Quasi Peak	433.92 MHz	33.25	-12.75	
1 Quasi Peak	461.04 MHz	34.07	-11.92	

Picture 13: Radiated emission 30 MHz – 1000MHz @ 3m distance, horizontal polarization

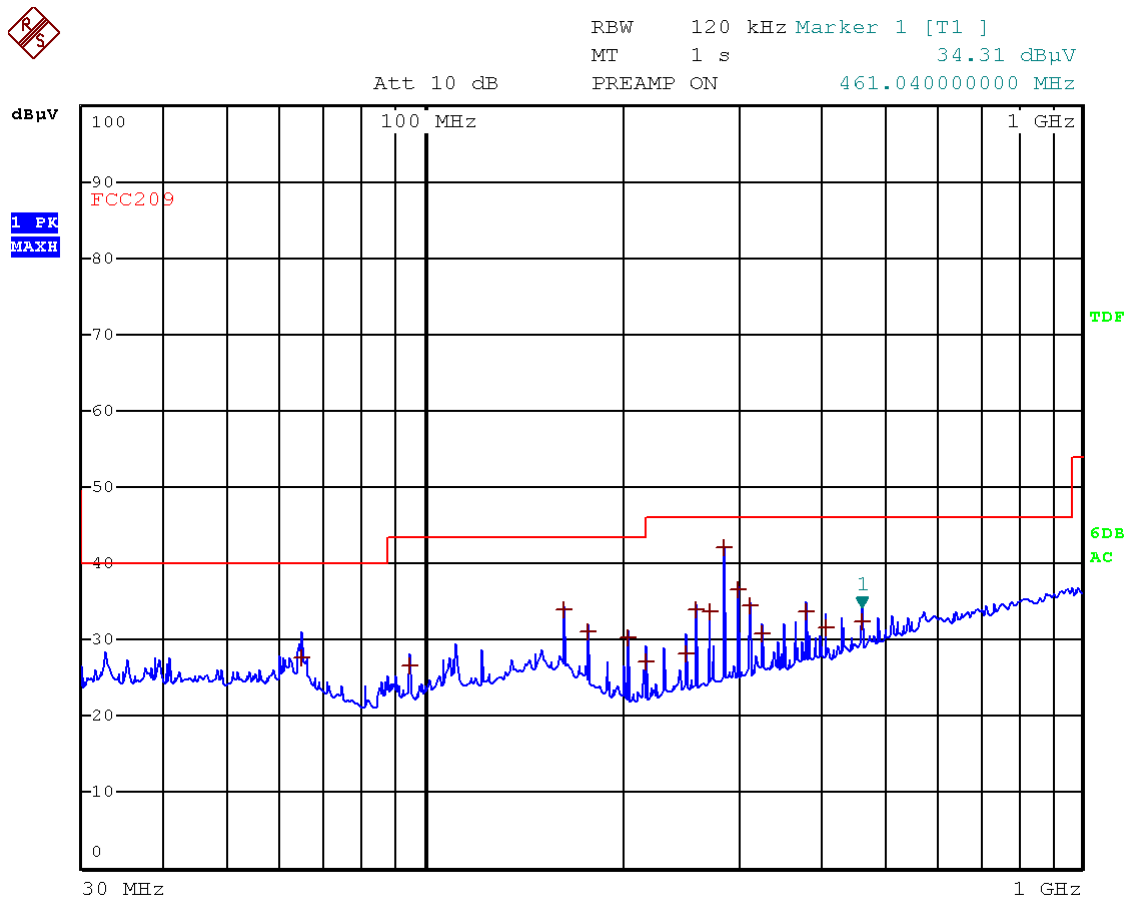


EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 26 of 48



EDIT PEAK LIST (Final Measurement Results)				
Trace1:	FCC209			
Trace2:	---			
Trace3:	---			
TRACE	FREQUENCY	LEVEL dBμV	DELTA	LIMIT dB
1 Quasi Peak	64.76 MHz	27.75	-12.24	
1 Quasi Peak	94.92 MHz	26.70	-16.80	
1 Quasi Peak	162.72 MHz	33.87	-9.62	
1 Quasi Peak	176.28 MHz	30.99	-12.50	
1 Quasi Peak	203.4 MHz	30.21	-13.28	
1 Quasi Peak	216 MHz	27.21	-18.78	
1 Quasi Peak	250 MHz	28.33	-17.66	
1 Quasi Peak	257.64 MHz	33.93	-12.06	
1 Quasi Peak	271.2 MHz	33.85	-12.14	
1 Quasi Peak	284.76 MHz	42.11	-3.88	
1 Quasi Peak	298.32 MHz	36.54	-9.45	
1 Quasi Peak	311.88 MHz	34.49	-11.50	
1 Quasi Peak	325.44 MHz	30.84	-15.15	
1 Quasi Peak	379.68 MHz	33.74	-12.25	
1 Quasi Peak	406.8 MHz	31.52	-14.47	
1 Quasi Peak	461.04 MHz	32.47	-13.52	

Picture 14: Radiated emission 30 MHz – 1000MHz @ 3m distance, vertical polarization

Spectrum Mask

Test procedure

The EUT was placed in a full anechoic chamber and the emission bandwidth testing was performed in accordance with ANSI C63.4 and 47 CFR Part 15, section 15.225 (a) - (d). The measurement distance was 3 m. To find the closest margin of the spectrum to the limit mask adapted to the test distance the EUT was rotated by 360 degrees with detector of the test receiver set to peak. The loop antenna placed in a fixed height of 1 meter was rotated by 360 degrees to get the maximum of emission. In case of exceeding the limits the detector is switched to quasi peak for final testing in position of maximum emission.



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

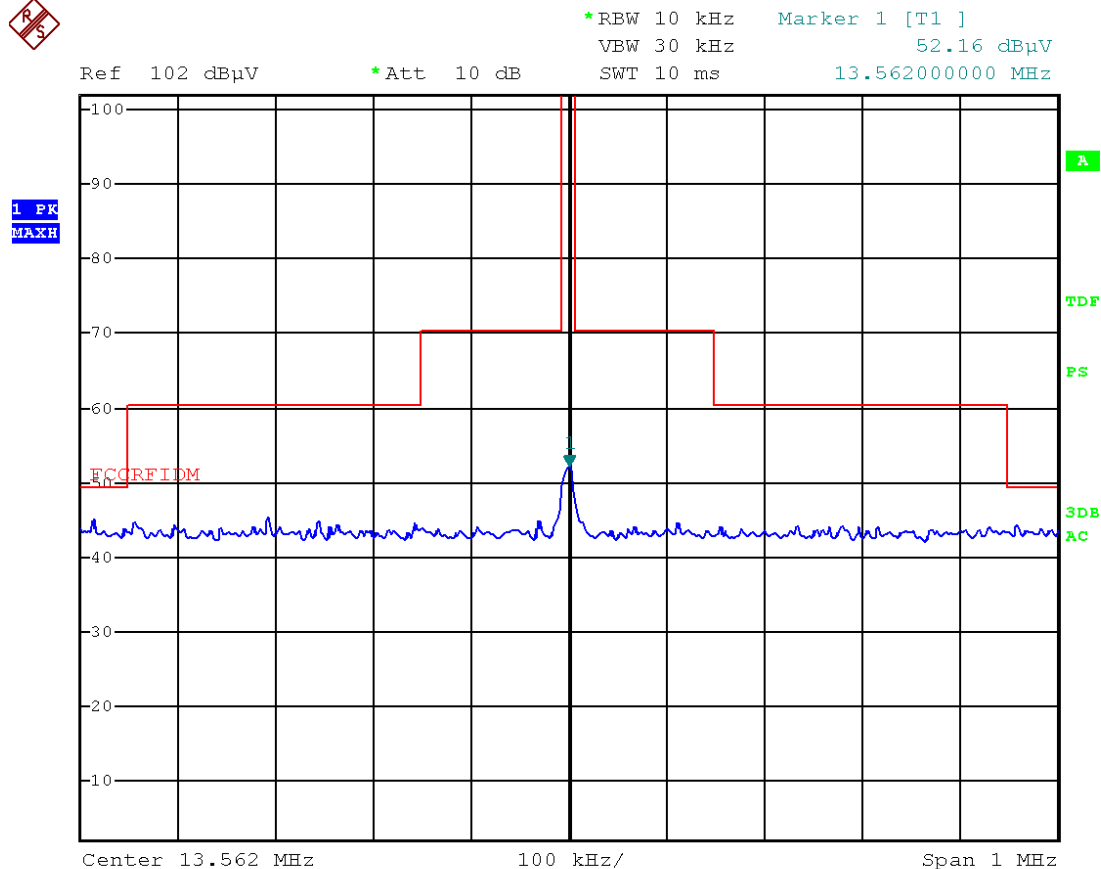
Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 28 of 48

Test result

Temperature:	20°C	Humidity:	41%
Tested by:	Martin Müller	Test date:	2014-04-02



Picture 15: Spectrum mask for 13.56 MHz @ 3m distance

f_{meas} [MHz]	E_{meas} @ 3m [dBμV/m]	Correction 3m -> 30m	Calc. Value [dBμV/m]	Limit @ 30m	Result
13.562	52.16	-40 dB	12.16	84 dBμV/m	Pass



EMV **TESTHAUS** GmbH
 Gustav-Hertz-Straße 35
 94315 Straubing
 Germany
 Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
 Task Manager Station with RFID reader for EZCare
 Nurse Call Systems
 5009-9103

140206-AU01+W02_R1

Page 29 of 48

5 Radiated emission measurement (>1 GHz)

according to 47 CFR Part 15, section 15.209(a), and
RSS-210, section 2.5 and Annex 2.6 with RSS-Gen, section 8.9

5.1 Radiated emission measurement above 1000 MHz

- ☒ Scan with peak and average detector in 3 m anechoic chamber.
- ☒ Final measurement with peak and average detector in 3 m anechoic chamber.

5.2 Location of measurement

Description	Manufacturer	Inventory No.
Anechoic chamber	EMV TESTHAUS GmbH	E00100

5.3 Test instruments

	Description	Manufacturer	Inventory No.
<input checked="" type="checkbox"/>	ESU26	Rohde & Schwarz	W00002
<input checked="" type="checkbox"/>	AMF-5D-00501800-28-13P	Miteq	W00089
<input type="checkbox"/>	AMF-6F-16002650-25-10P	Miteq	W00090
<input checked="" type="checkbox"/>	BBHA 9120D	Schwarzbeck	W00053
<input type="checkbox"/>	BBHA 9170	Schwarzbeck	W00055
<input checked="" type="checkbox"/>	COSB 4-1-26	Conformitas	W00091



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 30 of 48

5.4 Limits

The field strength of any emissions appearing outside of the 13.110 to 14.010 MHz band including spurious emissions falling into restricted bands as specified in 15.205(a) shall not exceed the general radiated emission limits as specified in 15.209.

Frequency [MHz]	Field strength Fs [μ V/m]	Field strength [dB μ V/m]	Measurement distance d [m]
0.009 – 0.490	266.6 – 4.9	48.5 – 13.8	300
0.490 – 1.705	48.98 – 14.08	33.8 – 22.97	30
1.705 – 30.0	30	29.54	30
30 – 88	100	40	3
88 – 216	150	43.5	3
216 - 960	200	46	3
Above 960	500	54	3

Note:

This measurement was performed up to 2 GHz because

- the intentional radiator operates below 10 GHz and tenth harmonic of the highest fundamental frequency is lower than 1 GHz (see 47 CFR Part 15, section 15.33(a)(1), and RSS-Gen, section 6.13), and
- the digital part of the device does not generate or use internal frequencies higher than 500 MHz (see 47 CFR Part 15 section 15.33(b)(1), and RSS-Gen, section 2.3.3 with ICES-003, section 6.2).



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 31 of 48

5.5 Test procedure

1. Configure the EUT according to ANSI C63.4. The EUT was placed on the top of the turntable 0.8 meter above ground. The receiving antenna was placed 3 meters from the turntable. The test setup was placed inside a semi anechoic chamber with floor absorbers.
2. Power on the EUT and all peripherals.
3. The receiving antenna was set to vertical polarization.
4. The maximum frequency to be tested is the tenth harmonic of the highest fundamental frequency of the intentional radiator part of the EUT, or the frequency required for the digital part of the EUT according to 47 CFR Part 15 section 15.33(b)(1), whichever is higher. The EMI receiver performed a scan from 1 GHz to the maximum frequency with detectors set to peak and average and measurement bandwidth 1 MHz.
5. The test was started with antenna in vertical polarization. During prescan the turn table was rotated continuously at very low speed and measurement time set to 10 ms to ensure that one complete scan is finished within a few degrees movement of the turn table antenna polarization was changed to horizontal.
6. Repeat the test procedure at step 4 and 5.
7. All peak values over or with less distance to limit then 6 dB were marked and re-measured with peak or average detector with measurement time set to 1 s.
8. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
9. The height of the receiving antenna was varied to find the maximum emissions field strength of both horizontal and vertical polarization. The highest value was recorded.



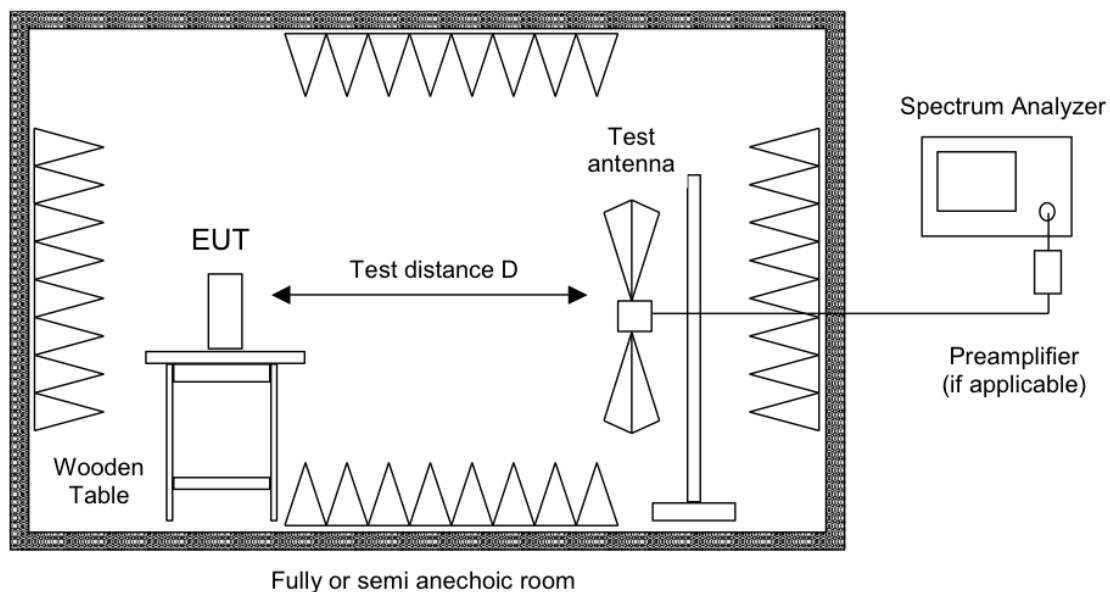
EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 32 of 48

5.6 Test setup



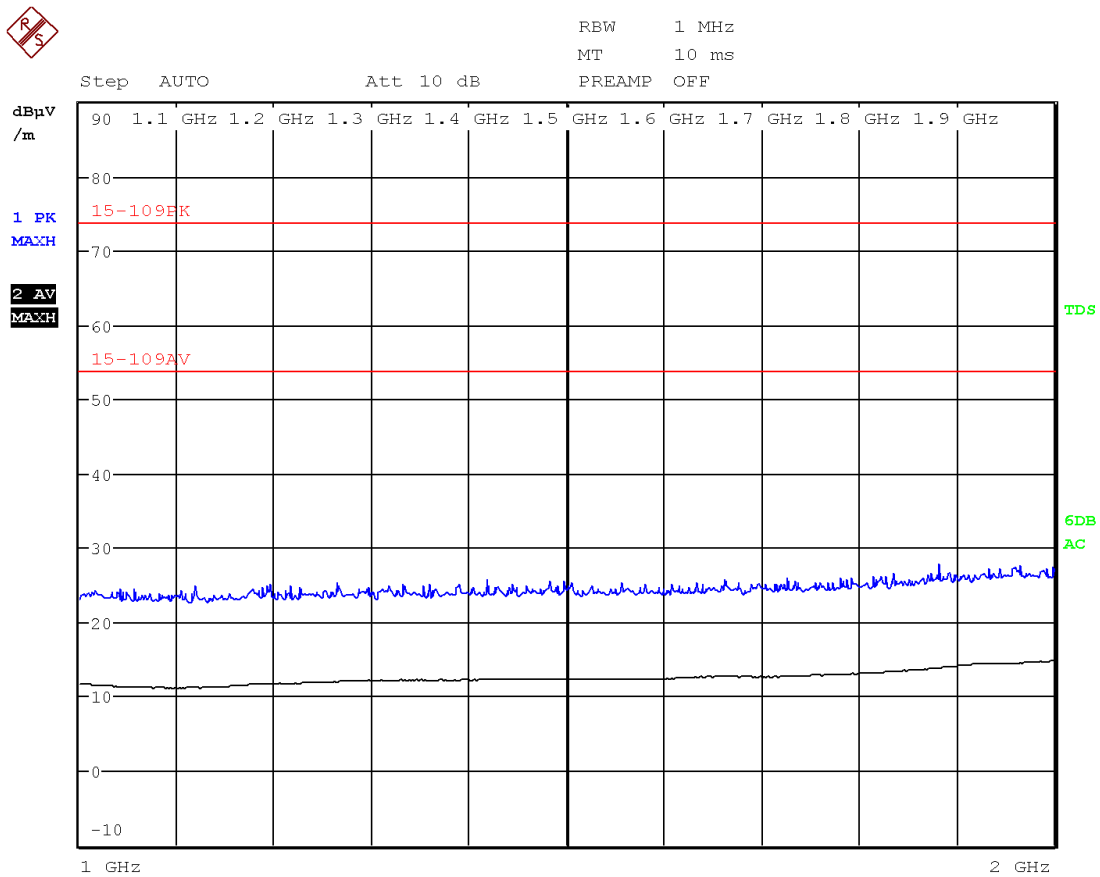
Picture 16: Outline of radiated emission measurement (> 1 GHz)

5.7 Test deviation

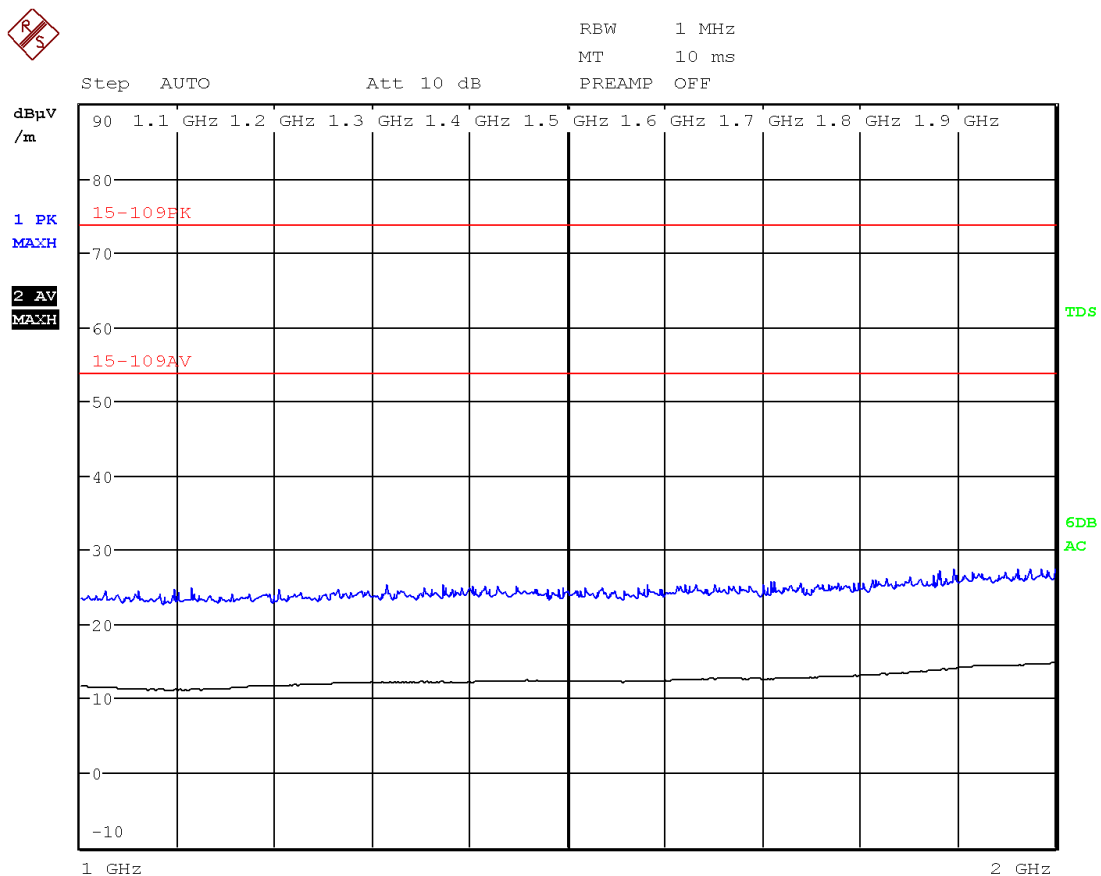
There is no deviation from the standards referred to.

5.8 Test results

Temperature:	20°C	Humidity:	41%
Tested by:	Martin Müller	Test date:	2014-04-02



Picture 17: Radiated emission (> 1 GHz), horizontal polarization



Picture 18: Radiated emission (> 1 GHz), vertical polarization

6 Carrier frequency stability

according to CFR 47 Part 15, section 15.225(e), and
RSS-210, Annex A2.6 with RSS-Gen, section 6.11

6.1 Test Location

	Description	Manufacturer	Inventory No.
<input checked="" type="checkbox"/>	Climatic chamber VC 4100	Vötsch Industrietechnik	C00014

6.2 Test instruments

	Description	Manufacturer	Inventory No.
<input type="checkbox"/>	ESU 26	Rohde & Schwarz	W00002
<input checked="" type="checkbox"/>	ESCI 3	Rohde & Schwarz	E00552
<input checked="" type="checkbox"/>	LF-R 400	Langer EMV-Technik	E00270

6.3 Limits

The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ (100 ppm) of the operating frequency over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C.

For battery operated equipment, the equipment tests shall be performed using a new battery. Alternatively, an external supply voltage can be used and set at the battery nominal voltage, and again at the battery operating end point voltage which must be specified by the equipment manufacturer.



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

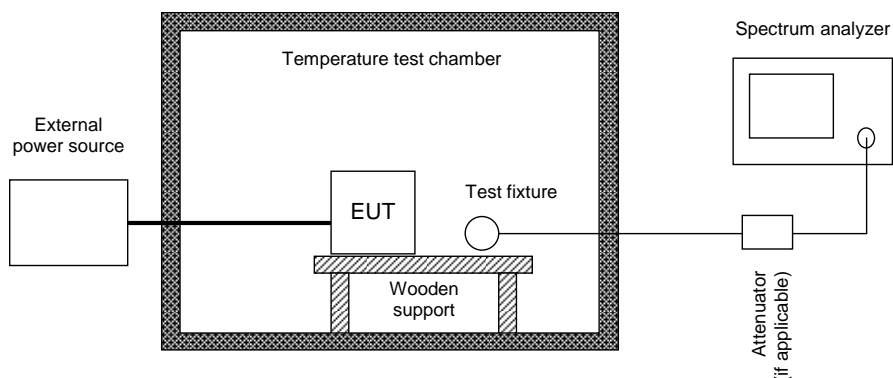
140206-AU01+W02_R1

Page 36 of 48

6.4 Test procedure

1. If possible EUT is operating providing an unmodulated carrier. The peak detector of the spectrum analyzer is selected and resolution as well as video bandwidth are set to values appropriate to the shape of the spectrum of the EUT. The frequency counter mode of the spectrum analyzer is used to maximize the accuracy of the measured frequency tolerance.
If an unmodulated carrier is not available a significant and stable point on the spectrum is selected and the span is reduced to a value that delivers an accuracy which shall be better than 1% of the maximum frequency tolerance allowed for the carrier signal. This method may be performed as long as the margin to the frequency tolerance allowed is larger than the uncertainty of the measured frequency tolerance.
2. The carrier frequency is measured depending on the variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment an external supply voltage can be used and set at the battery nominal voltage, and again at the battery operating end point voltage which must be specified by the equipment manufacturer. Alternatively, tests shall be performed using a new battery.
3. The carrier frequency is measured over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage.

6.5 Test setup



Picture 19: Test setup for carrier frequency stability measurement

6.6 Test deviation

There is no deviation from the standards referred to.

Test result

Temperature:	20°C	Humidity:	41%
Tested by:	Martin Müller	Test date:	2014-04-02

Temperature: 20° C		
Carrier Frequency	Voltage range	Frequency change
13.56 MHz	Nominal: 5.0 V DC	--
13.56 MHz	4.25 V DC (85%)	< 0.01 %
13.56 MHz	5.75 V DC (115%)	< 0.01 %

Voltage 24 V DC:		
Carrier Frequency	Temperature range	Frequency change
13.56 MHz	-20 °C	< 0.01 %
13.56 MHz	-10 °C	< 0.01 %
13.56 MHz	0 °C	< 0.01 %
13.56 MHz	10 °C	< 0.01 %
13.56 MHz	20 °C	---
13.56 MHz	30 °C	< 0.01 %
13.56 MHz	40 °C	< 0.01 %
13.56 MHz	50°C	< 0.01 %



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 38 of 48

7 Bandwidths

according to CFR 47 Part 2, section 2.202(a), and RSS-Gen, section 6.6

7.1 Test Location

See clause 4.1 on page 20.

7.2 Test instruments

See clause 4.2 on page 20.

7.3 Limits

The bandwidths are recorded only. There are no limits specified in CFR 47 Part 15, section 15.225, and RSS-210, Annex 2.6

7.4 Test setup

See clause 4.5 on page 23.

7.5 Test deviation

There is no deviation from the standards referred to.



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 39 of 48

7.6 Test results

Temperature:	20°C	Humidity:	41%
Tested by:	Martin Müller	Test date:	2014-04-02

Occupied bandwidth (99 %)

Test procedure

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99% emission bandwidth, as calculated or measured. The transmitter shall be operated at its maximum carrier power measured under normal test conditions.

The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts. The resolution bandwidth shall be set to as close to 1% of the selected span as is possible without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth. Video averaging is not permitted. Where practical, a sampling detector shall be used given that a peak or peak hold may produce a wider bandwidth than actual.

The trace data points are recovered and directly summed in linear terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points. This frequency is recorded. The span between the two recorded frequencies is the occupied bandwidth. For this purpose the appropriate measurement function of the spectrum analyzer is used.

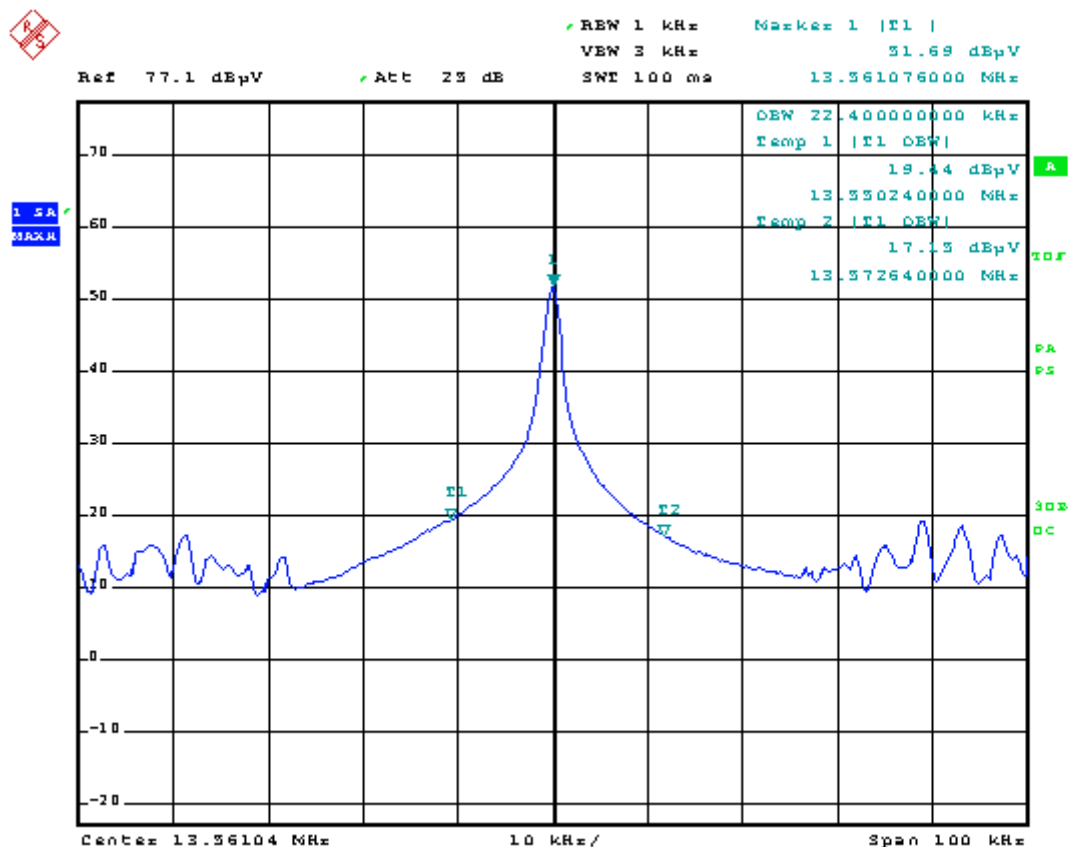


EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 40 of 48



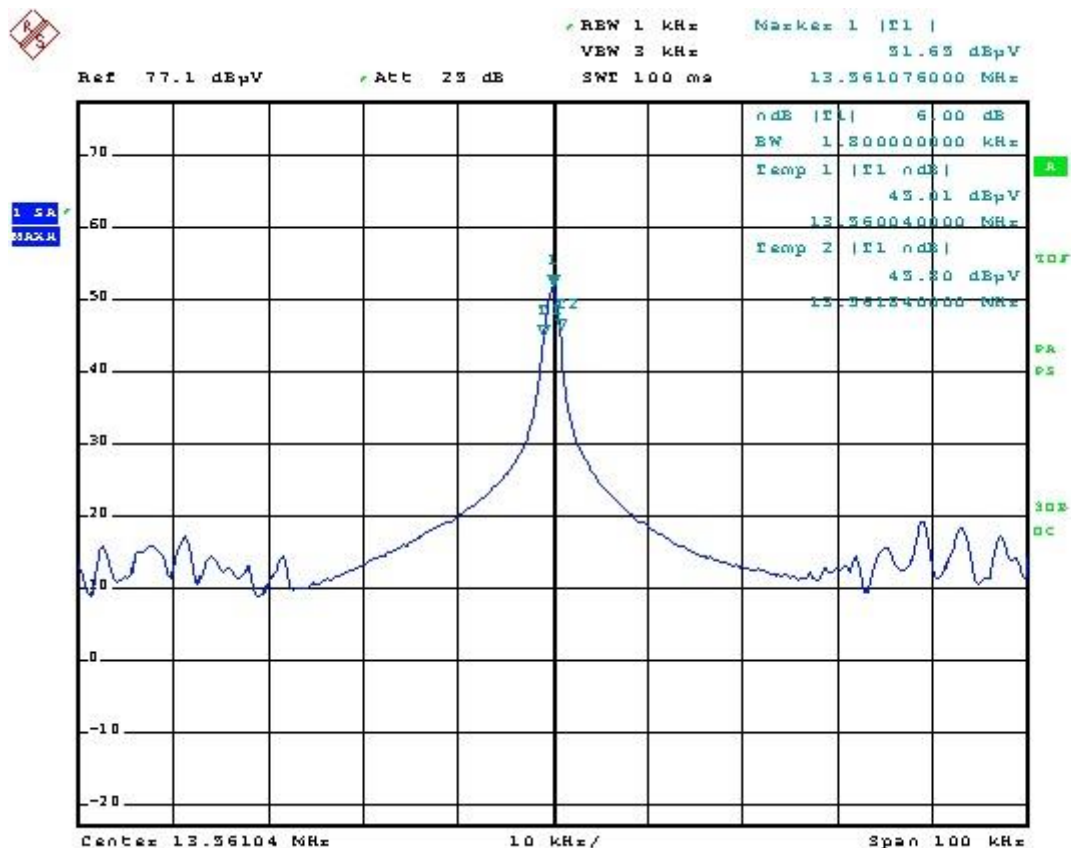
Picture 20: Occupied bandwidth (99 %)

Measured occupied bandwidth (99 %): **22.4 kHz**

-6 dB emission bandwidth

Test procedure

Where indicated, the -6 dB emission bandwidth is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated 6 dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth equal to approximately 1.0% of the emission bandwidth



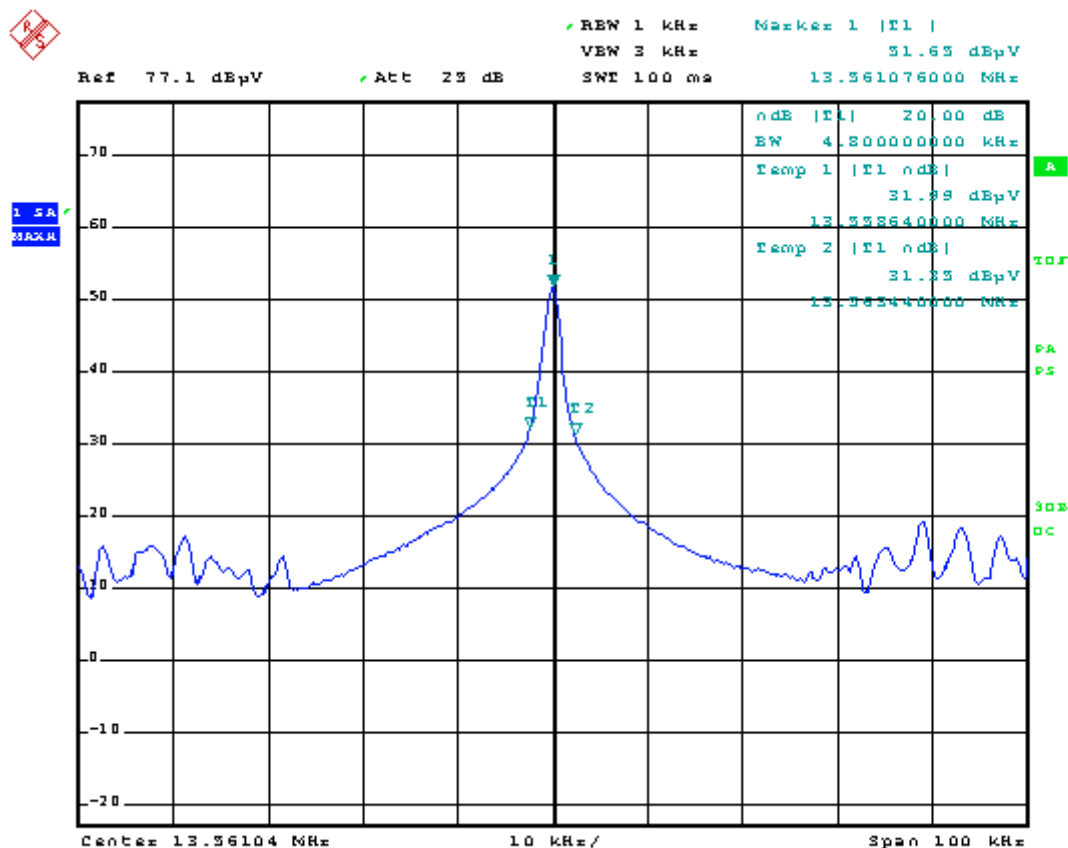
Picture 21: -6 dB emission bandwidth

Measured -6 dB emission bandwidth: **1.8 kHz**

-20 dB emission bandwidth

Test procedure

Where indicated, the -20 dB emission bandwidth is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated 20 dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth equal to approximately 1.0% of the emission bandwidth.



Picture 22: -20 dB emission bandwidth

Measured -20 dB emission bandwidth: **4.8 kHz**

8 Equipment calibration status

Description	Modell number	Serial number	Inventory number	Next calibration
Test receiver	ESU 26	100026	W00002	2016-02
Test receiver	ESCI 3	100013	E00001	2015-12
Test receiver	ESCI 3	100328	E00552	2016-07
Test receiver	ESCS 30	825442/0002	E00003	2015-02
Test receiver	ESCS 30	845552/0008	E00551	2015-01
LISN	ESH2-Z5	881362/037	E00004	2015-03
LISN	ESH2-Z5	893406/009	E00005	2016-01
Horn antenna	BBHA 9120D	9120D-593	W00053	2016-03
Broadband antenna	VULB 9163	9163-114	E00013	2015-09
Loop antenna	HFH2-Z2	871398/0050	E00004	2014-07
Magnetic field probe	LF-R 400	---	E00270	N/A (see note 1)
Shielded room	P92007	B83117C1109T211	E00107	N/A
Compact Diagnostic Chamber (CDC)	VK041.0174	D62128-A502-A69-2-0006	E00026	N/A
Fully anechoic room	---	---	E00100	N/A
Open area test site (OATS)	---	---	E00354	see note 2
Climatic chamber 990 I	VC 4100	59566102680010	C00014	2015-01
Cable set shielded room	Cable no. 30	---	E00424	2015-01
Cable set CDC	Cables no. 37 and 38	---	E00459 E00460	2015-01
Cable set OATS 3 m	Cables no. 19, 34 and 36	---	E00453 E00456 E00458	2014-10
Cable set OATS 10 m	Cables no. 19, 33 and 36	---	E00453 E00455 E00458	2014-10

Table 1: Equipment calibration status

Note 1: Used for relative measurements only (see test instruments for “Carrier frequency stability”, clause 6.2)



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 44 of 48

Note 2: Expiration date of measurement facility registration (OATS) by
- FCC (registration number 221458): 2017-04
- Industry Canada (test site number 3472A-1): 2015-10



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 45 of 48

9 Measurement uncertainty

Description	Max. deviation	k=
Conducted emission AMN (9kHz to 30 MHz)	± 3.8 dB	2
Radiated emission open field (3 m) (30 MHz to 300 MHz) (300MHz to 1 GHz)	± 5.4 dB ± 5.9 dB	2
Radiated emission absorber chamber (> 1000 MHz)	± 4.5 dB	2

Table 2: Measurement uncertainty

The uncertainty stated is the expanded uncertainty obtained by multiplying the standard uncertainty by the coverage factor k. For a confidence level of 95 % the coverage factor k is 2.



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 46 of 48

10 Summary

The EMC Regulations according to the marked specifications are

☒ **KEPT**

The EUT does fulfill the general approval requirements mentioned.

☐ **NOT KEPT**

The EUT does not fulfill the general approval requirements mentioned.

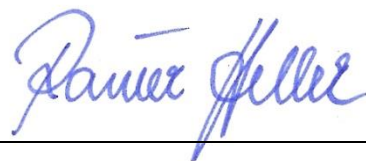
Place, Date: Straubing, November 19th, 2014



Martin Müller

Test engineer

EMV **TESTHAUS** GmbH



Rainer Heller

Head of EMC / radio department

EMV **TESTHAUS** GmbH



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 47 of 48

11 Revision History

Date	Description	Person	Revision
2014-04-08	First edition	M. Müller	---
2014-11-19	Applicant added and manufacturer changed on page 6; description of configuration of EUT revised (page 8) and block diagram of test setup added on page 9; note added regarding spurious emission higher than carrier on page 25; test cable sets added to appropriate list of test instruments and equipment calibration status list on page 44. References to RSS-Gen Issue 3 updated to Issue 4	M. Müller	R1



EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany
Revision: 1.0

Tyco Fire Protection Products TOTAL WALTHER GmbH
Task Manager Station with RFID reader for EZCare
Nurse Call Systems
5009-9103

140206-AU01+W02_R1

Page 48 of 48