

TEST REPORT

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EUT DESCRIPTION Digging measurement system for Excavator

EUT TRADEMARK C.O.B.O. S.p.A. - Divisione 3B6
Complex Electronics Ltd.
WESTLINE sarl

EUT MODEL **Remote sensor RAL S02**

REFERENCE STANDARDS : **FCC 47 CFR part 15 subpart C section 15.249**

TEST REPORT NUMBER **FCC.TR.TX.08.1505-2**


TEST REPORT ISSUE DATE 03/03/2009


TESTING LABORATORY Prima Ricerca & Sviluppo S.r.l.
Via Campagna, 92 -22020 Faloppio (Co) –Italy

TESTING LOCATION As Above

DATE OF TEST SAMPLE RECEIPT 23/09/2008

DATE OF TEST 13-14/01-03/03/2009

TESTED BY Andrea Bortolotti 

APPROVED BY Massimo Maltempi 

*The test results reported in this test report shall refer only to the sample actually tested and shall not refer or be deemed to refer to bulk from which such a sample may be said to have been obtained.
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1. TECHNICAL INFORMATION OF EQUIPMENT UNDER TEST (EUT)

1.1 Identification

Brand name: C.O.B.O. S.p.A. - Divisione 3B6
Complex Electronics Ltd.
WESTLINE sarl

Manufacturer: C.O.B.O. S.p.A. - Divisione 3B6
Complex Electronics Ltd.
WESTLINE sarl

Equipment : Digging measurement system for Excavator

Serial number : Not present

FCC ID : WXNEZDIGPRO

Country of manufacturer: ITALY

1.2 Technical data

FCC class: 47 CFR FCC Part 15 Subpart C § 15.249

Product type: WLAN

Radio type: Intentional transceiver

Power type : Battery


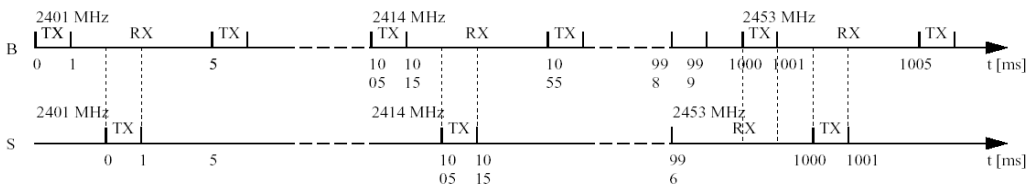
Frequency range : 2400 – 2483.5 MHz


Channel number : 6

**Carrier Frequency for 20MHz
bandwidth (protocol b/g/n):** Channel No.1: 2401 MHz
Channel No.2: 2414 MHz
Channel No.3: 2427 MHz
Channel No.4: 2440 MHz
Channel No.5: 2453 MHz
Channel No.6: 2466 MHz

Field Antenna : Antenna Type: wire

1.3 General Technical data

	QUALITY SISTEM PROJECT SPECIFICATION		Document: SP EZDig System Radio - UK
	Date: 23 / 09 / 2008	Page: 1 / 3	Project Code: EDZ System
<p><u>Application Description</u></p> <p>Digging measurement system for Excavator</p> <p><u>EZDig System Radio Description</u></p> <p>The base, transmitter and receiver module (MD360R - EZD001-SE01 - Led Display) sends a synch packet (it takes about 500 μs to send it), then it goes in RX and listens for a response packet of one sensor (RALS01 - EZD002-0010 - angle sensor & RALS02 - EZD003-0010 - angle sensor and laser receiver) for 4 ms; after that, it sends a synch again and waits the remaining 4 ms without going in RX.</p> <p>This time slot of 10 ms is repeated for 10 times at a specified carrier frequency, that is changed at the end.</p> <p>The first frequency used is 2401 MHz, then 2414 MHz, 2427 MHz, 2440 MHz, 2453 MHz, and finally 2466 MHz. So 6 frequency hops are used in cycle mode. Every next hop is obtained by adding 13 MHz to the current one.</p> <p>The transmission is done in GFSK modulation at the nominal power of 0 dBm, with 250 kbps data rate.</p> <p>The synch packets are 11 bytes long and they are made of 1 byte Preamble, 4 bytes Address, 4 bytes Payload, 2 bytes CRC.</p> <p>The sensors (up to 8) transmit a response packet (about 500 μs to send it) every 100 ms; every response is sent at one of the 6 carriers, in cycle mode. The response sending is repeated 10 times, then, before sending for the 11th time, the sensors go in RX for 4 ms to receive the base synch.</p> <p>The transmission is done in GFSK modulation at the nominal power of 0 dBm, with 250 kbps data rate.</p> <p>The response packets are 11 bytes long and they are made of 1 byte Preamble, 4 bytes Address, 4 bytes Payload, 2 bytes CRC.</p>			
			
Rev.	Changes Description		Page
Compiled by : Valerio Cappelli		Reviewed by : Diego Dell' Orto	

	QUALITY SISTEM PROJECT SPECIFICATION					Document: SP EZDig System Radio - UK Project Code: EDZ System				
	Date: 23 / 09 / 2008			Page: 2 / 3						
<u>Radio packet</u>										
Byte10	Byte9	Byte8	Byte7	Byte6	Byte5	Byte4	Byte3	Byte2	Byte1	Byte0
Preamble	Address				Payload				CRC	
<u>Receiver Classification</u>										
Class 3 according to ETSI 300440 - 1.										
<u>Technical Data</u>										
MD360R - EZD001-SE01 - Led Display										
<ul style="list-style-type: none"> • Power supply: 9 + 30 Vdc • Supply Current : 300 mA • Operating Temperature Range: from -20°C to +70°C • Storage Temperature Range: from -30°C to + 85°C • Protection: IP54 										
RALS01 - EZD002-0010 - Angle Sensor										
Angle Sensor										
<ul style="list-style-type: none"> • Measurement Range : 360° • Resolution: 0.3° • Accuracy: ± 0,2° • Max thermal drift ± 0,5° on the operating temperature range 										
<ul style="list-style-type: none"> • Power supply: 2,7 ÷ 4,2 Vdc by 3,6 V 750 mA Li-ion battery • Supply Current : 6 mA • Operating Temperature Range: from -20°C to +70°C • Storage Temperature Range: from -30°C to + 85°C • Protection: IP67 										
RALS02 - EZD003-0010 - Angle Sensor and Laser Receiver										
Angle Sensor										
<ul style="list-style-type: none"> • Measurement Range : 360° • Resolution: 0.3° • Accuracy: ± 0,2° • Max thermal drift ± 0,5° on the operating temperature range 										
Laser Receiver										
<ul style="list-style-type: none"> • Measurement Range : 80 mm • Resolution: 2 mm • Accuracy: ± 2 mm 										
<ul style="list-style-type: none"> • Power supply: 2,7 ÷ 4,2 Vdc by 3,6 V 750 mA Li-ion battery • Supply Current : 6 mA (13 mA with laser receiver active) • Operating Temperature Range: from -20°C to +70°C • Storage Temperature Range: from -30°C to + 85°C • Protection: IP67 										



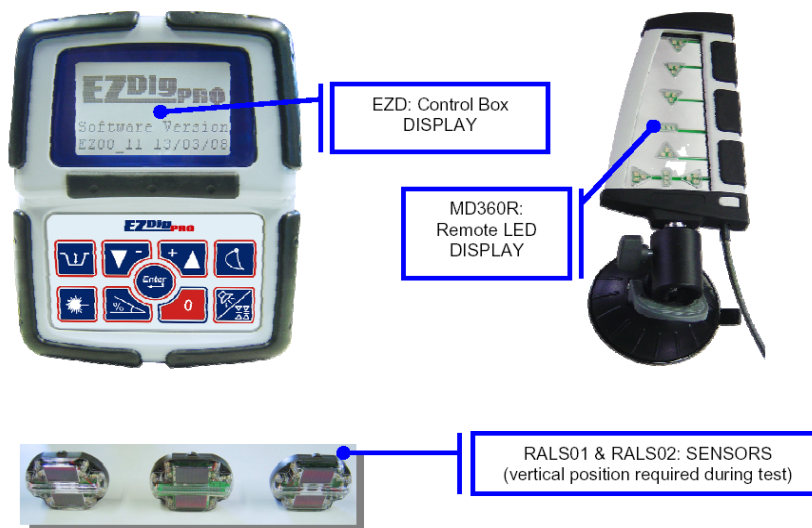
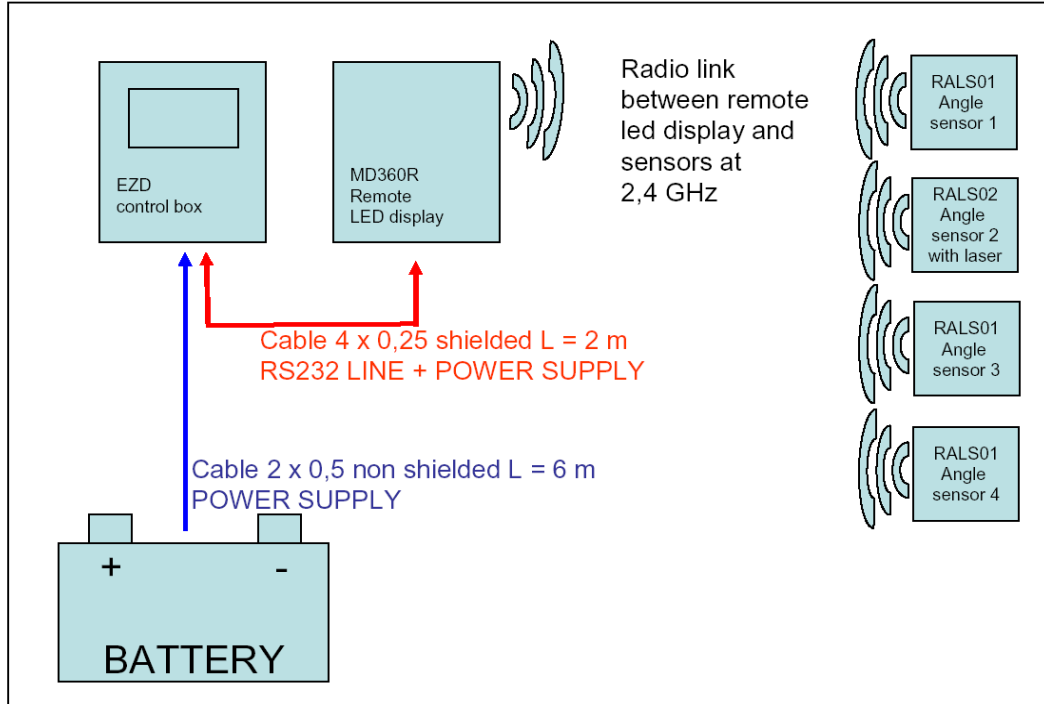
**QUALITY SYSTEM
PROJECT SPECIFICATION**

Date: 23 / 09 / 2008

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Document:
SP EZDig System Radio -
UK
Project Code:
EDZ System

System Layout



1.4 Transceiver data

PRODUCT SPECIFICATION



Single chip 2.4 GHz Transceiver

nRF2401

FEATURES

- True single chip GFSK transceiver in a small 24-pin package (QFN24 5x5mm)
- Data rate 0 to 1Mbps
- Only 2 external components
- Multi channel operation
 - 125 channels
 - Channel switching time <200µs.
 - Support frequency hopping
- Data slicer / clock recovery of data
- Address and CRC computation
- DuoCeiver™ for simultaneous dual receiver topology
- ShockBurst™ mode for ultra-low power operation and relaxed MCU performance
- Power supply range: 1.9 to 3.6 V
- Low supply current (TX), typical 10.5mA peak @ -5dBm output power
- Low supply current (RX), typical 18mA peak in receive mode
- 100 % RF tested
- No need for external SAW filter
- World wide use

APPLICATIONS

- Wireless mouse, keyboard, joystick
- Keyless entry
- Wireless data communication
- Alarm and security systems
- Home automation
- Surveillance
- Automotive
- Telemetry
- Intelligent sports equipment
- Industrial sensors
- Toys

GENERAL DESCRIPTION

nRF2401 is a single-chip radio transceiver for the world wide 2.4 - 2.5 GHz ISM band. The transceiver consists of a fully integrated frequency synthesizer, a power amplifier, a crystal oscillator and a modulator. Output power and frequency channels are easily programmable by use of the 3-wire serial interface. Current consumption is very low, only 10.5mA at an output power of -5dBm and 18mA in receive mode. Built-in Power Down modes makes power saving easily realizable.

QUICK REFERENCE DATA

Parameter	Value	Unit
Minimum supply voltage	1.9	V
Maximum output power	0	dBm
Maximum data rate	1000	kbps
Supply current in transmit @ -5dBm output power	10.5	mA
Supply current in receive mode	18	mA
Temperature range	-40 to +85	°C
Sensitivity	-90	dBm
Supply current in Power Down mode	400	nA

Table 1 nRF2401 quick reference data

ELECTRICAL SPECIFICATIONS

Conditions: VDD = +3V, VSS = 0V, T_A = - 40°C to + 85°C

Symbol	Parameter (condition)	Notes	Min.	Typ.	Max.	Units
Operating conditions						
VDD	Supply voltage		1.9	3.0	3.6	V
TEMP	Operating Temperature		-40	+27	+85	°C
Digital input pin						
V _{IH}	HIGH level input voltage		VDD- 0.3		VDD	V
V _{IL}	LOW level input voltage		V _{ss}		0.3	V
Digital output pin						
V _{OH}	HIGH level output voltage (I _{OH} =-0.5mA)		VDD- 0.3		VDD	V
V _{OL}	LOW level output voltage (I _{OL} =0.5mA)		V _{ss}		0.3	V
General RF conditions						
f _{OP}	Operating frequency	1)	2400		2524	MHz
f _{XTAL}	Crystal frequency	2)	4		20	MHz
Δf	Frequency deviation			±156		kHz
R _{GFSK}	Data rate ShockBurst™		>0		1000	kbps
R _{GFSK}	Data rate Direct Mode	3)	250		1000	kbps
F _{CHANNEL}	Channel spacing			1		MHz
Transmitter operation						
P _{RF}	Maximum Output Power	4)		0	+4	dBm
P _{RFC}	RF Power Control Range		16	20		dB
P _{RFCR}	RF Power Control Range Resolution				±3	dB
P _{BW}	20dB Bandwidth for Modulated Carrier				1000	kHz
P _{RF2}	2 nd Adjacent Channel Transmit Power 2MHz				-20	dBm
P _{RF3}	3 rd Adjacent Channel Transmit Power 3MHz				-40	dBm
I _{VDD}	Supply current @ 0dBm output power	5)		13		mA
I _{VDD}	Supply current @ -20dBm output power	5)		8.8		mA
I _{VDD}	Average Supply current @ -5dBm output power, ShockBurst™	6)		0.8		mA
I _{VDD}	Average Supply current in stand-by mode	7)		12		μA
I _{VDD}	Average Supply current in power down			400		nA
Receiver operation						
I _{VDD}	Supply current one channel 250kbps			18		mA
I _{VDD}	Supply current one channel 1000kbps			19		mA
I _{VDD}	Supply current two channels 250kbps			23		mA
I _{VDD}	Supply current two channels 1000kbps			25		mA
R _{XSENS}	Sensitivity at 0.1%BER (@250kbps)			-90		dBm
R _{XSENS}	Sensitivity at 0.1%BER (@1000kbps)			-80		dBm
C/I _{CO}	C/I Co-channel	8)		10/4		dB
C/I _{1ST}	1 st Adjacent Channel Selectivity C/I 1MHz	8)		-20/0		dB
C/I _{2ND}	2 nd Adjacent Channel Selectivity C/I 2MHz	8)		-37/-20		dB
C/I _{3RD}	3 rd Adjacent Channel Selectivity C/I 3MHz	8)		-43/-30		dB
R _{XB}	Blocking Data Channel 2			-45/-41		dB

- Usable band is determined by local regulations
- The crystal frequency may be chosen from 5 different values (4, 8, 12, 16, and 20MHz) which are specified in the configuration word, see Table 9. 16MHz are required for 1Mbps operation.
- Data rate must be either 250kbps or 1000kbps.
- Antenna load impedance = 100Ω+j175Ω
- Antenna load impedance = 100Ω+j175Ω. Effective data rate 250kbps or 1Mbps.
- Antenna load impedance = 100Ω+j175Ω. Effective data rate 10kbps.
- Current if 4 MHz crystal is used.
- 250kbps/1000kbps.

1.5 **Modifications incorporated in E.U.T.**

The following items are the modifications introduced in the equipment under test :

- None

1.6 **Ports identification**

This section contains descriptions of all signal ports and AC/DC power input/output ports, the length and the type of the cable provided by manufacturer needed for the tests.

Moreover it is specified if the ports are ever or optionally connected.

Port		Description	Connection
1	Enclosure	Plastic case	By screws and by pressure
2	AC power input/output ports	-----	-----
3	DC power input/output ports	3.6Vdc	Internal battery connector
4	Signals / control lines	-----	-----
5	Telecommunication ports	-----	-----

Note: During the tests all cables must be what provided the manufacturer or the same that used in the real employment of the EUT.

1.7 **Auxiliary equipment**

- none

2. TEST CONDITIONS

2.1 *Operating test modes and test conditions*

The equipment has been tested according to the operative conditions described in the user/installation manual provided by the manufacturer and by following reference standards :

Reference Standard:

- 47 CFR FCC Part 15 Subpart C § 15.249(a) sub-clauses (c) , (d), (e)

In the following table there are the operating conditions adopted during tests identified by an indicator (#..) at which has been referred the item “Operating condition of the equipment under test” of all technical sheets of the tests (see Section 4)

<i>Operating condition</i>	<i>Description</i>
#1	<i>TX in Operating Mode</i>

2.2 *Test overview*

The appliance is classified as “*Intentional radiator*” in conformity to FCC Part 15 Subpart C § 15.249.

3. REFERENCE STANDARD FOR PERFORMED TESTS

The measurements and test results shown in this test report were made in accordance with the procedures and found in compliance with the limit given in ANSI C63.4-2003 and 47 CFR FCC Part 15 Subpart C.

4. SUMMARY OF TEST RESULTS

	Phenomena	Basic standard FCC part 15 section	Operating condition ¹	Result
1	Field strength of emissions from intentional radiators	15.249(a)	#1	PASS
2	Fixed, point-to-point operation equipment	15.249(b)	-	N.A. ¹
3	Field strength limits are specified at a distance of 3 meters	15.249(c)	-	Considered
4	Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.	15.249(d) 15.209	#1	PASS ²
5	For frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits.	15.249(e) 15.35(b)	-	Considered
6	Peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.	15.249(e)	#1	PASS ³
7	For point-to-point operation under paragraph (b) of this section, the peak field strength shall not exceed 2500 millivolts/meter at 3 meters along the antenna azimuth.	15.249(e)	-	N.A. ⁴
8	Parties considering the manufacture, importation, marketing or operation of equipment under this section should also note the requirement in 15.37(d).	15.249(f) 15.37 (d)	-	N.A. ⁵

¹ appliance is not Fixed and/or for point-to-point operation

² emission limits in § 15.209, is the lesser attenuation

³ worst condition has been considered

⁴ appliance is not for point-to-point operation

⁵ appliance does not operate as intentional radiator in the band 902-905 MHz

5. TEST RESULTS

FIELD STRENGTH OF EMISSIONS FROM INTENTIONAL RADIATORS (FUNDAMENTAL EMISSION)	14
RADIATED EMISSION (SPURIUS)	16
20 DB BANDWIDTH OF THE EMISSION	33

**TEST
1**

FIELD STRENGTH OF EMISSIONS FROM INTENTIONAL RADIATORS (FUNDAMENTAL EMISSION)

REFERENCE DOCUMENT FCC 47CFR Part 15 sub part C
Section 15.249(a)

- **TEST LOCATION:** Semi-anechoic chamber
- **TEST EQUIPMENT USED FOR TEST:** EMI receiver Rohde & Schwarz Mod. ESU40
Spectrum Analyzer Rohde & Schwarz Mod. FSP40
Log periodic antenna broad band 1-18 GHz R&S HL025
- **TESTED PORT:** Enclosure
- **EMISSION LIMITS:** Acc. to Section 15.249(d), (e), 15.209 of reference document
- **UNCERTAINTY OF MEASURE:** Combined uncertainty = ± 1.75 dB
Total uncertainty = $(k=2) \pm 3.5$ dB

TEST CONDITIONS:		MEASURED
Ambient temperature :	15 - 35 °C	23,5 \pm 3 °C
Ambient humidity :	25 - 75 %rH	39 \pm 5 %rH
Pressure :	85 - 106 kPa (860 mbar - 1060 mbar)	950 \pm 50 mbar

OPERATING CONDITION (Rif. Section. 2) : #1

RESULT: WITHIN THE LIMIT

<i>Frequency</i> [MHz]	<i>Angle</i> [degree]	<i>Height</i> [cm]	<i>Polar</i> [H/V]	<i>Maximum level</i> [mV/m]	<i>Limit</i> [mV/m]	<i>Result</i>
Low channel						
2401	17.0	165	V	0,298	50	Pass
2401	23.0	172	H	0,133	50	Pass
Middle channel						
2427	4.0	170	V	0,473	50	Pass
2427	1.0	171	H	0,237	50	Pass
High channel						
2466	4.0	174	V	0,375	50	Pass
2466	1.0	174	H	0,188	50	Pass

**TEST
2**

RADIATED EMISSION (SPURIUS)

REFERENCE DOCUMENT FCC 47CFR Part 15
Section 15.249(d), (e), 15.209

- **TEST LOCATION:** Semi-anechoic chamber
- **TEST EQUIPMENT USED FOR TEST:** EMI receiver Rohde & Schwarz Mod. ESU 40
Chase Antenna Mod. CBL 6111 A
Bilog Antenna Mod. HL025
- **TESTED PORT:** Enclosure
- **EMISSION LIMITS:** Acc. to Section 15.209 of reference document
- **UNCERTAINTY OF MEASURE:** Combined uncertainty = ± 1.75 dB
Total uncertainty = $(k=2) \pm 3.5$ dB

TEST CONDITIONS:	MEASURED
Ambient temperature : 15 - 35 °C	23,5 \pm 3 °C
Ambient humidity : 25 - 75 %rH	39 \pm 5 %rH
Pressure : 85 - 106 kPa (860 mbar - 1060 mbar)	950 \pm 50 mbar

OPERATING CONDITION (Rif. Section. 2) : #1

RESULT: WITHIN THE LIMIT

CH1	2401MHz
CH3	2427MHz
CH6	2466MHz

EMI Auto Test Template: Electric Field Strength FCC

Hardware Setup: Electric Field Strength FCC
 Measurement Type: Open-Area-Test-Site
 Frequency Range: 30 MHz - 18 GHz
 Graphics Level Range: 0 dB μ V/m - 80 dB μ V/m

Data Reduction:
 Limit Line #1: FCC 15 249 Peak
 Limit Line #2: FCC 15 249 AV
 Peak Search: 6 dB
 Maximum Results: 4
 Subrange Maxima: 0
 Maxima per Subrange: 1
 Acceptance Offset: -10 dB
 Maximum Number of Results: 4

Subrange	Detectors	IF Bandwidth	Meas. Time	Receiver
30 MHz - 1 GHz	MaxPeak; Average	120 kHz	1 s	Receiver
1 GHz - 2.8 GHz	MaxPeak; Average	1 MHz	0.1 s	Receiver
2.8 GHz - 18 GHz	MaxPeak; Average	1 MHz	0.1 s	Receiver



PRIMA

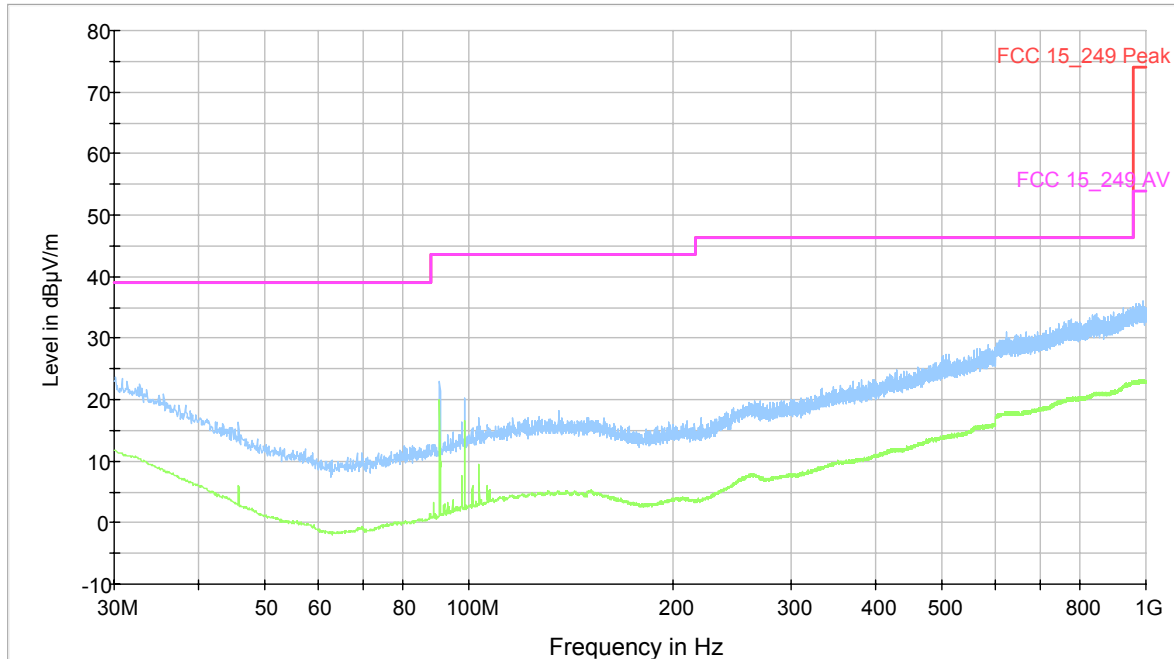
RICERCA & SVILUPPO

CH1: 30-1000MHz

VERTICAL

FCC.TR.TX
08.1505-2

Electric Field Strength FCC

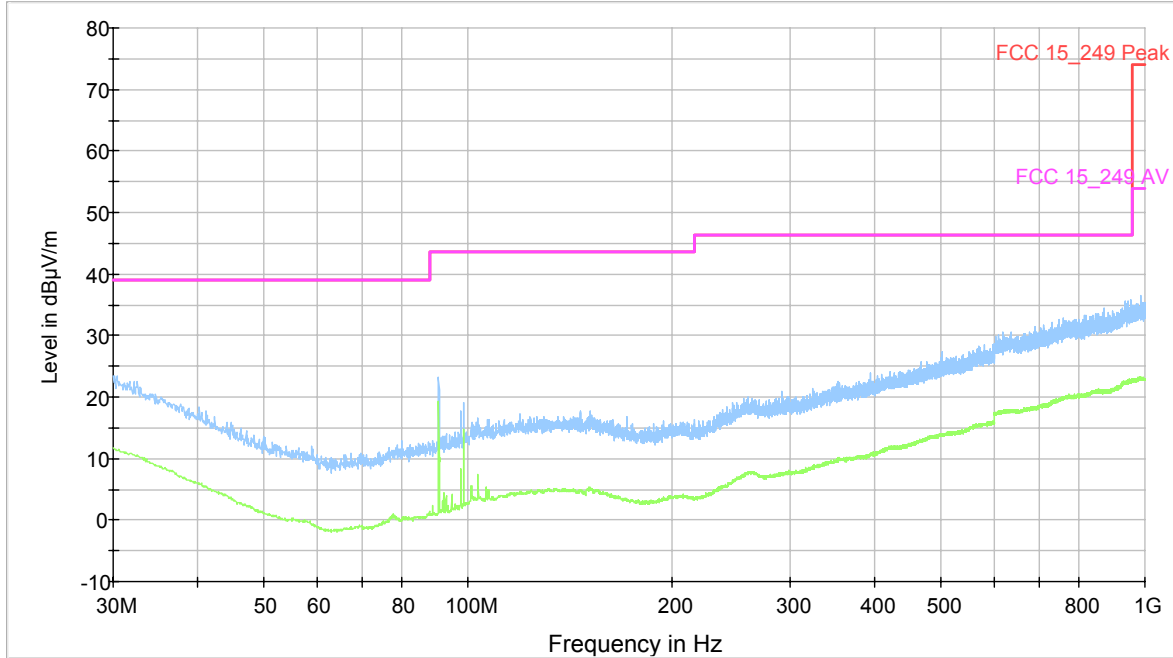


— FCC 15_249 Peak.LimitLine — FCC 15_249 AV.LimitLine — Preview Result 1 — Preview Result 2



Horizontal

Electric Field Strength FCC



— FCC 15_249 Peak.LimitLine — FCC 15_249 AV.LimitLine — Preview Result 1 — Preview Result 2



PRIMA

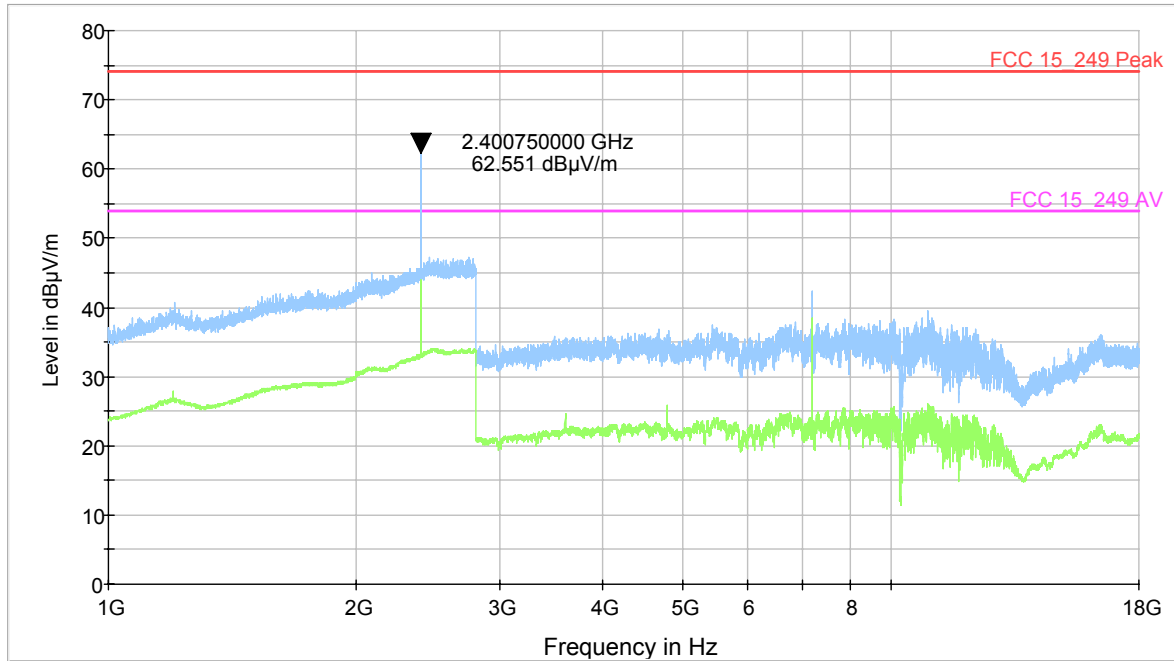
RICERCA & SVILUPPO

CH1: 1-18GHz

Vertical

FCC.TR.TX
08.1505-2

Electric Field Strength FCC

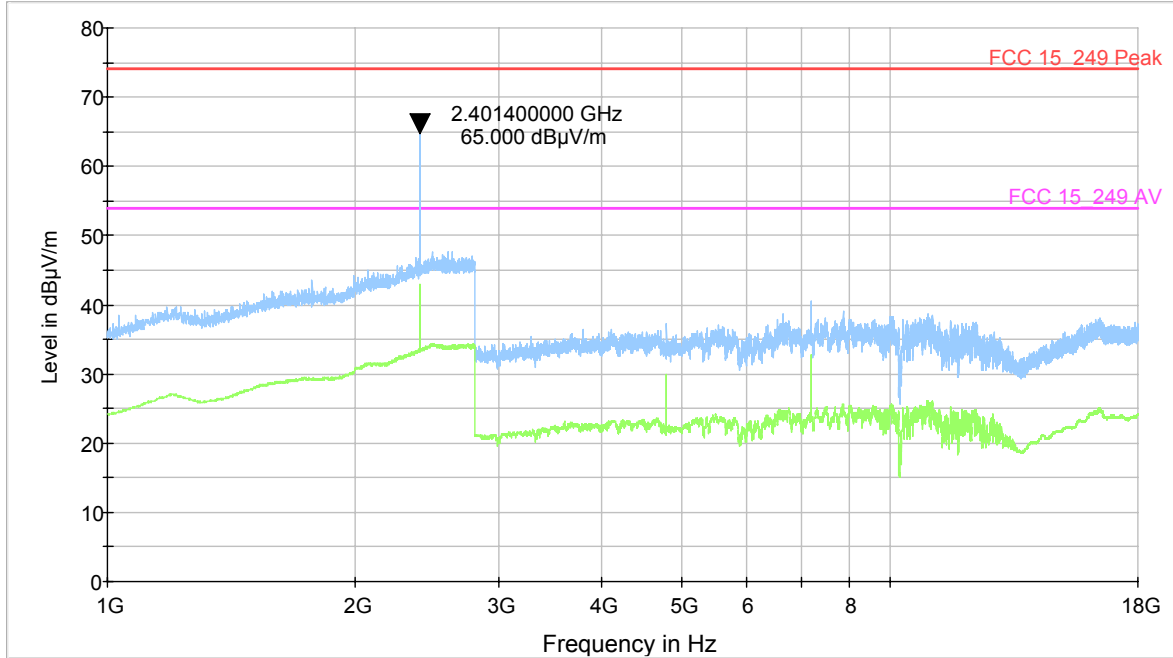


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Horizontal

Electric Field Strength FCC

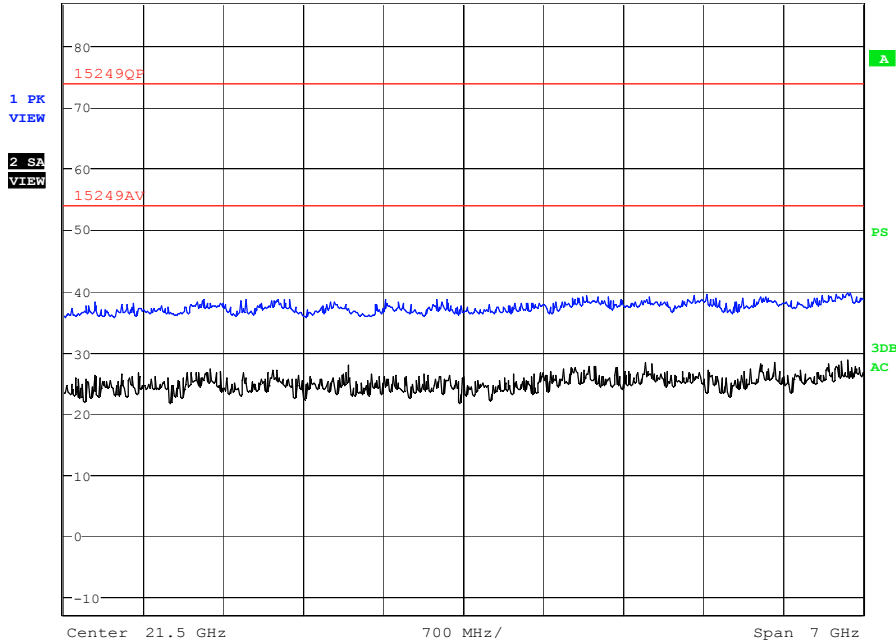


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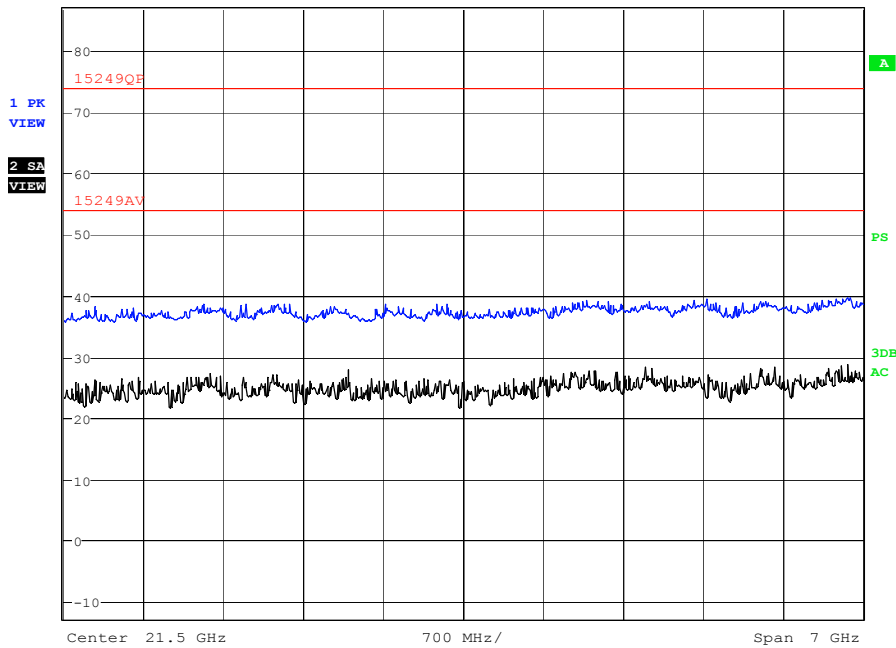


CH1: 18-25GHz

Vertical



Horizontal*



* No disturbance above CSA noise level in both polarization. The plot from 18GHz to 25GHz are equal.



PRIMA

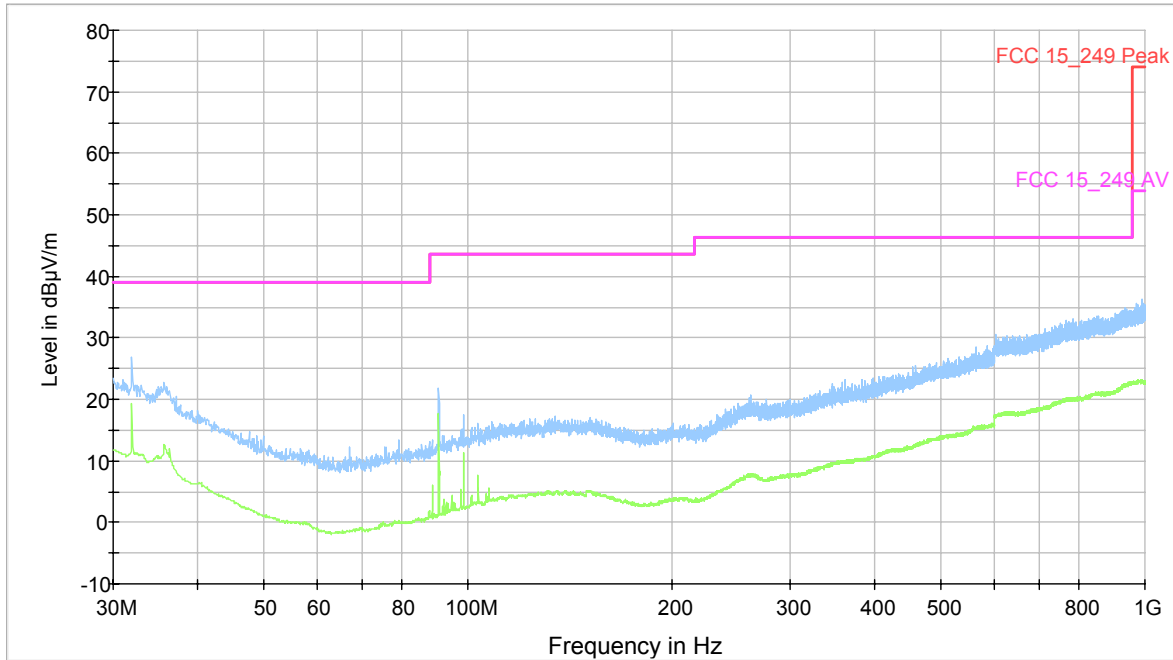
RICERCA & SVILUPPO

CH3: 30-1000 MHz

Vertical

FCC.TR.TX
08.1505-2

Electric Field Strength FCC



— FCC 15_249 Peak.LimitLine — FCC 15_249 AV.LimitLine — Preview Result 1 — Preview Result 2



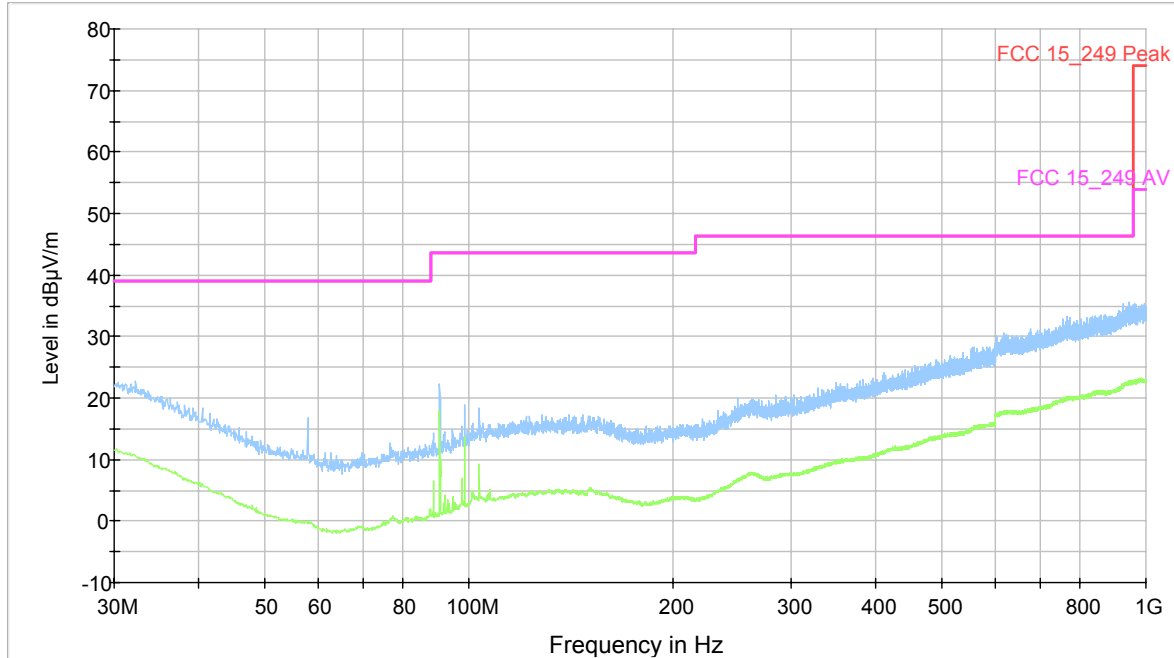
PRIMA

RICERCA & SVILUPPO

Horizontal

FCC.TR.TX
08.1505-2

Electric Field Strength FCC



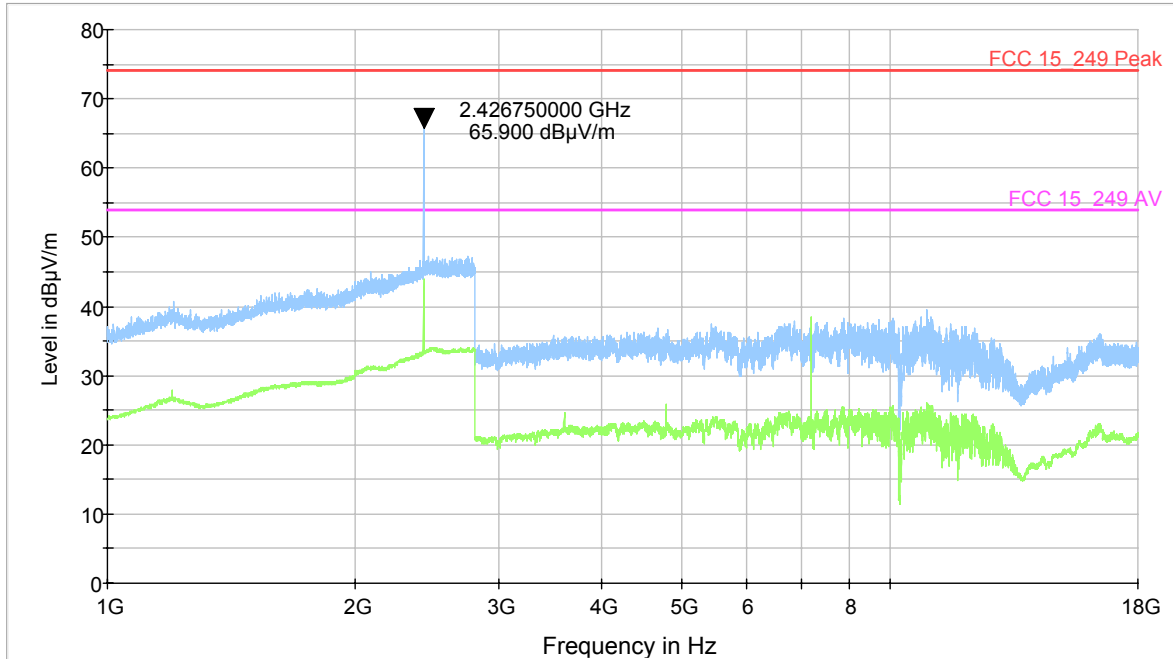
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CH3: 1-18GHz

Vertical

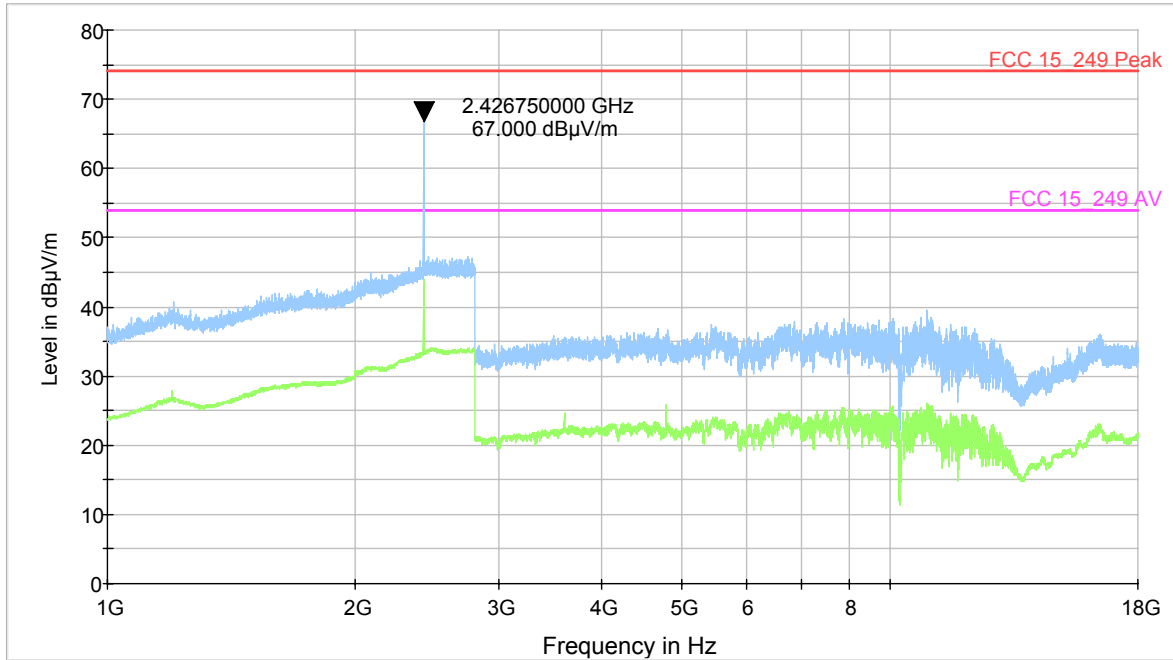
Electric Field Strength FCC



— FCC 15_249 Peak.LimitLine — FCC 15_249 AV.LimitLine — Preview Result 1 — Preview Result 2

Horizontal

Electric Field Strength FCC

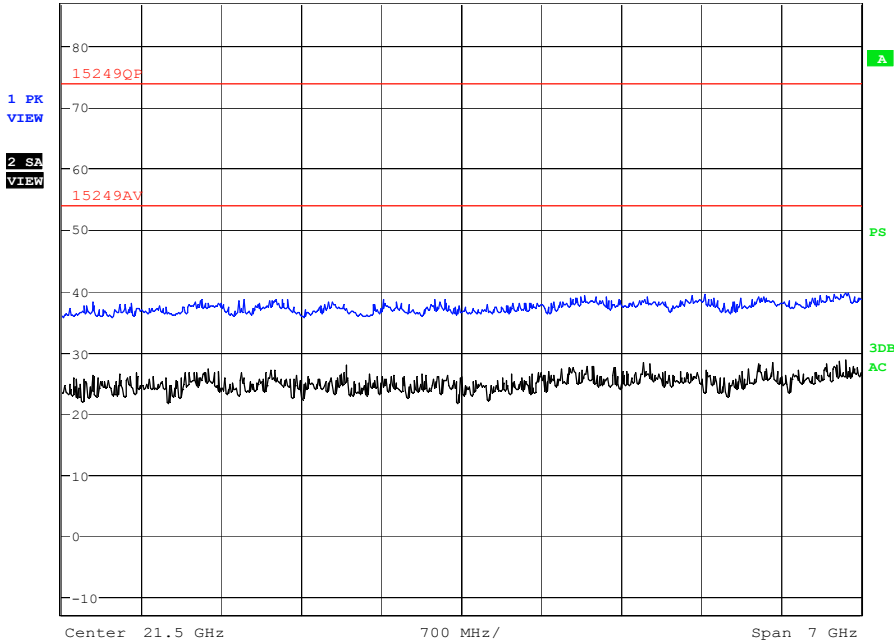


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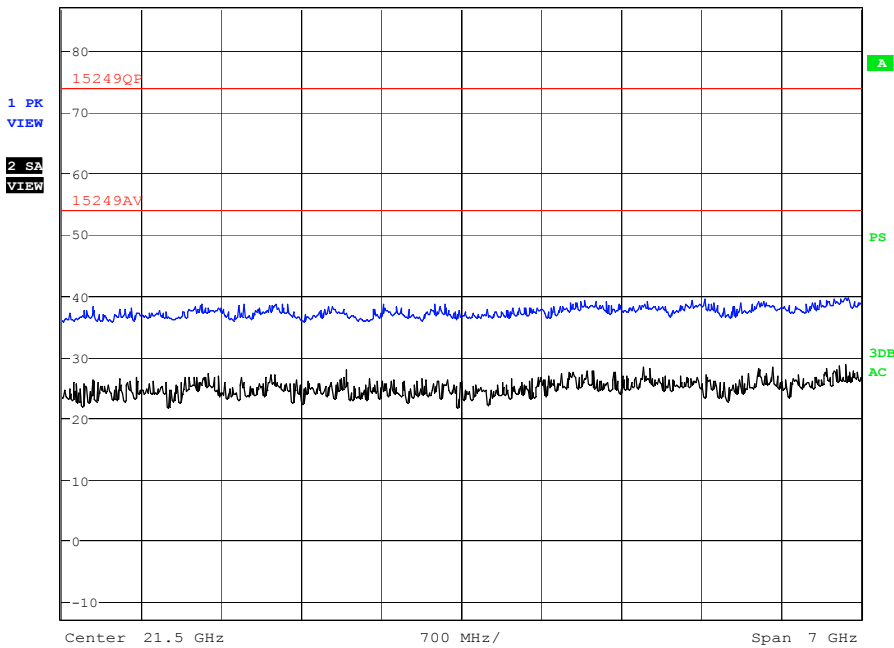


CH3: 18-25GHz

Vertical



Horizontal*

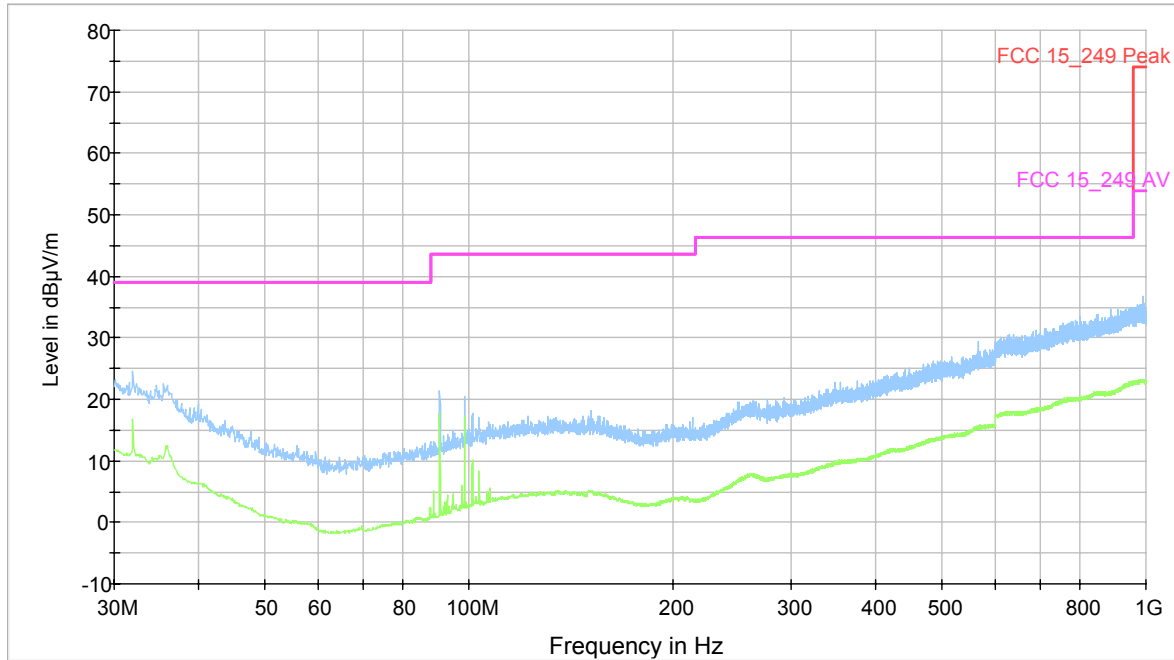


* No disturbance above CSA noise level in both polarization. The plot from 18GHz to 25GHz are equal.

CH6: 30-1000MHz

Vertical

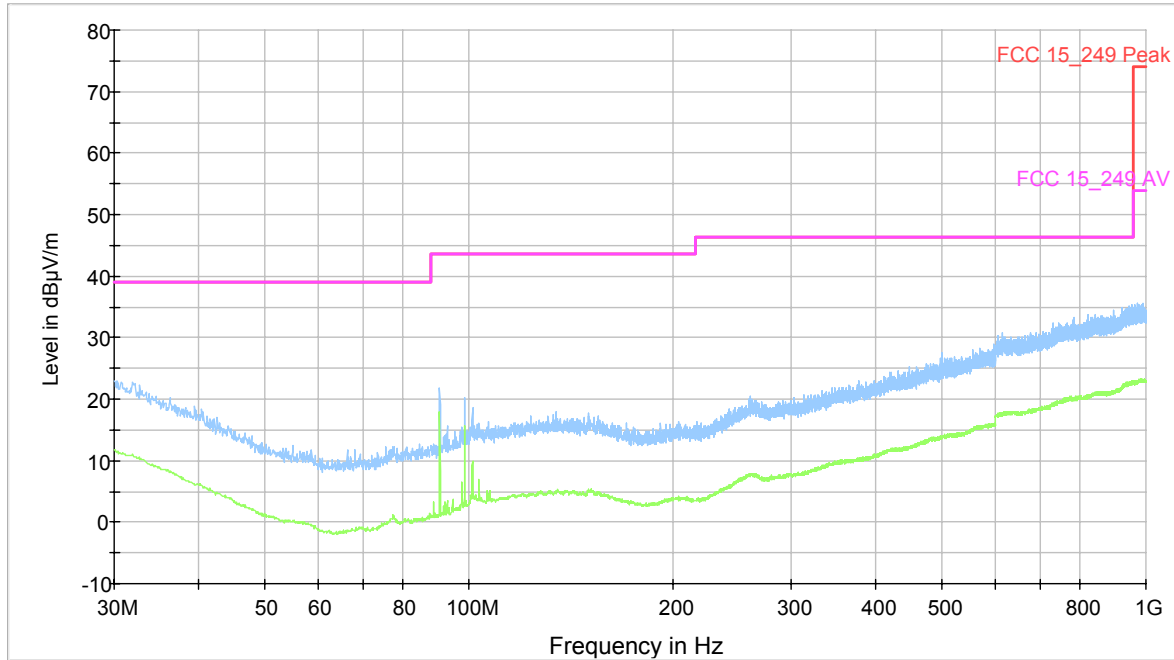
Electric Field Strength FCC



— FCC 15_249 Peak.LimitLine — FCC 15_249 AV.LimitLine — Preview Result 1 — Preview Result 2

Horizontal

Electric Field Strength FCC



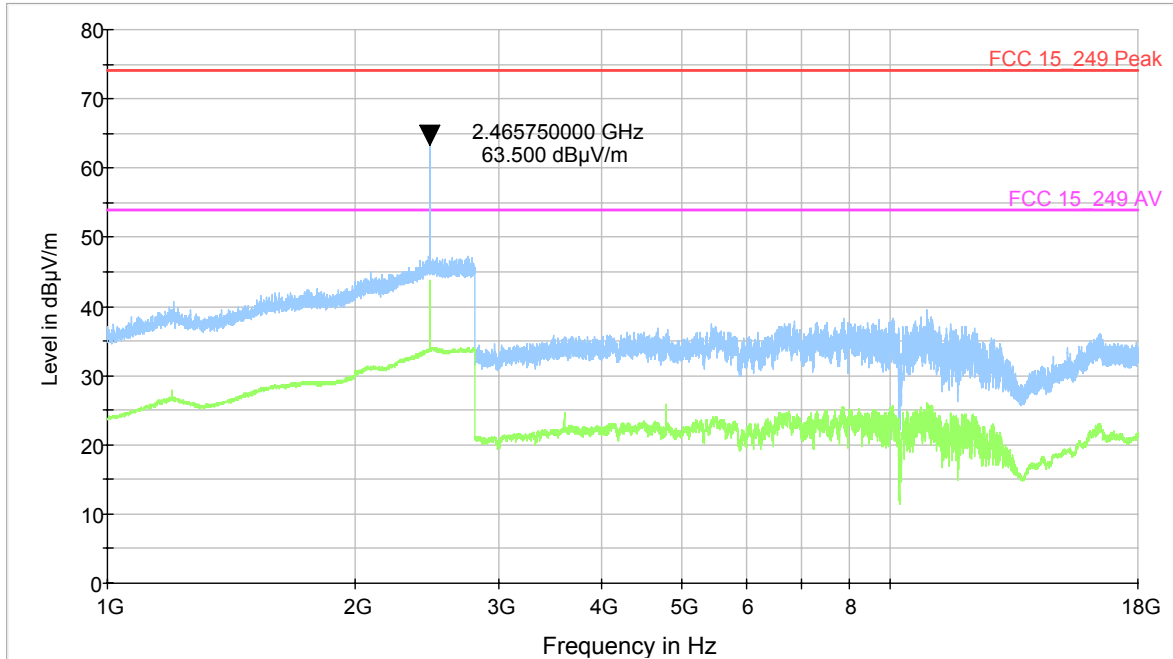
— FCC 15_249 Peak.LimitLine — FCC 15_249 AV.LimitLine — Preview Result 1 — Preview Result 2



CH6:1-18GHz

Vertical

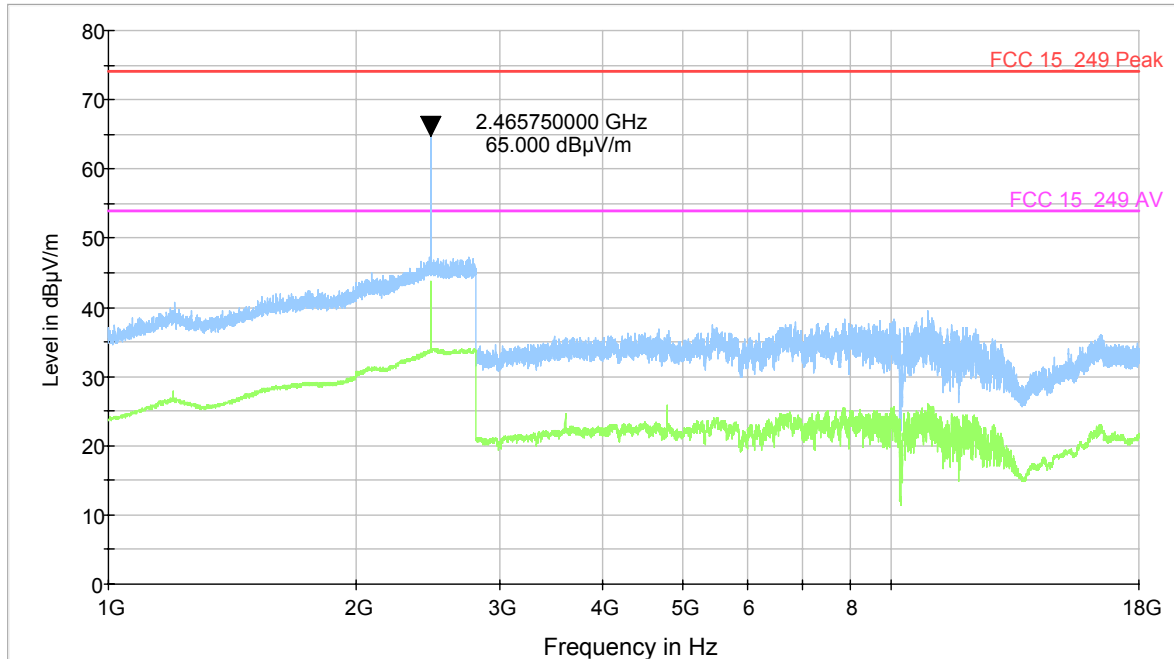
Electric Field Strength FCC



— FCC 15_249 Peak.LimitLine — FCC 15_249 AV.LimitLine — Preview Result 1 — Preview Result 2

Horizontal

Electric Field Strength FCC



— FCC 15_249 Peak.LimitLine — FCC 15_249 AV.LimitLine — Preview Result 1 — Preview Result 2

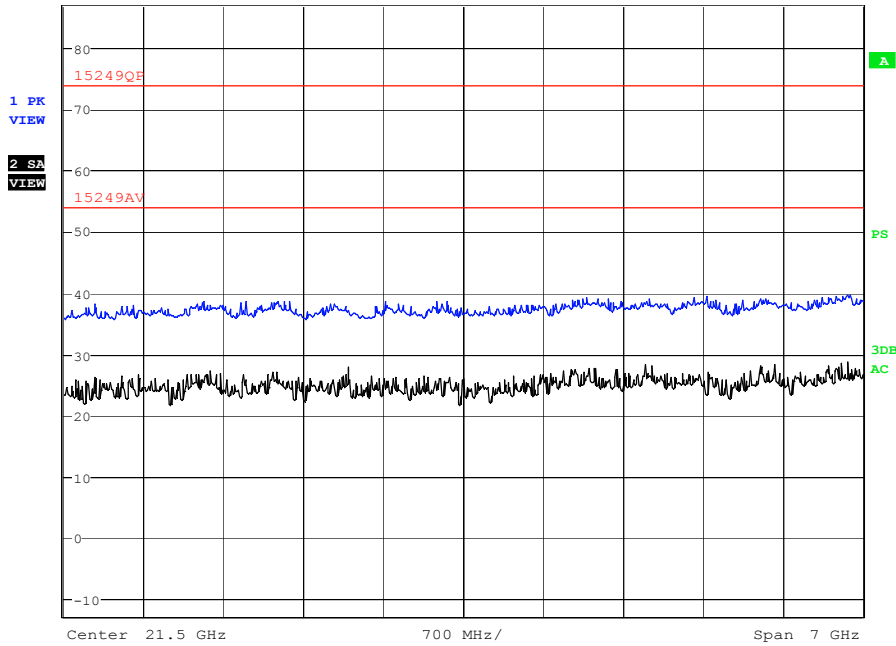


PRIMA

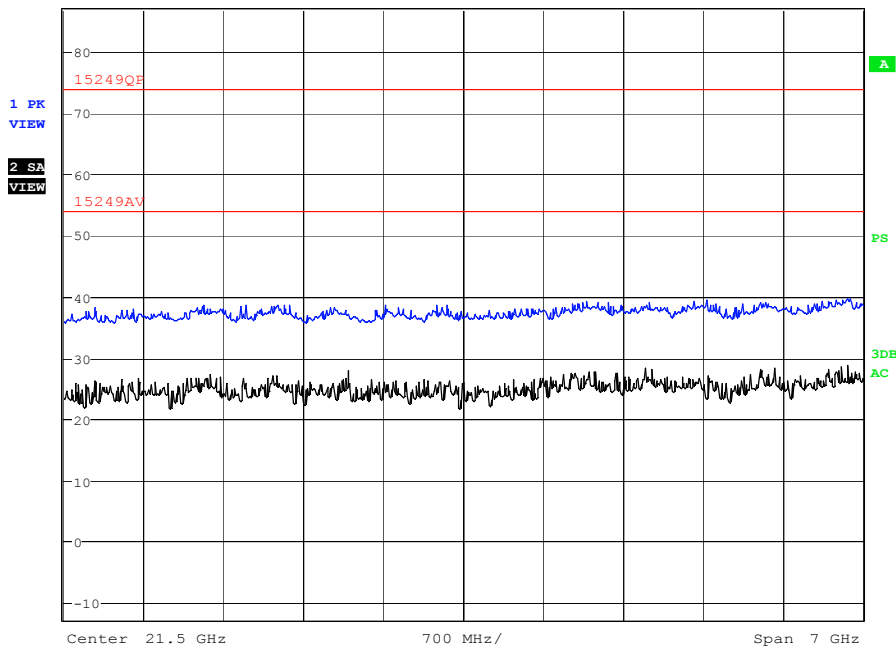
RICERCA & SVILUPPO

CH6: 18-25GHz

Vertical



Horizontal*



* No disturbance above CSA noise level in both polarization. The plot from 18GHz to 25GHz are equal.

**TEST
3**

20 dB BANDWIDTH OF THE EMISSION

REFERENCE DOCUMENT FCC 47CFR Part 15 sub part C
Section 15.249(e)

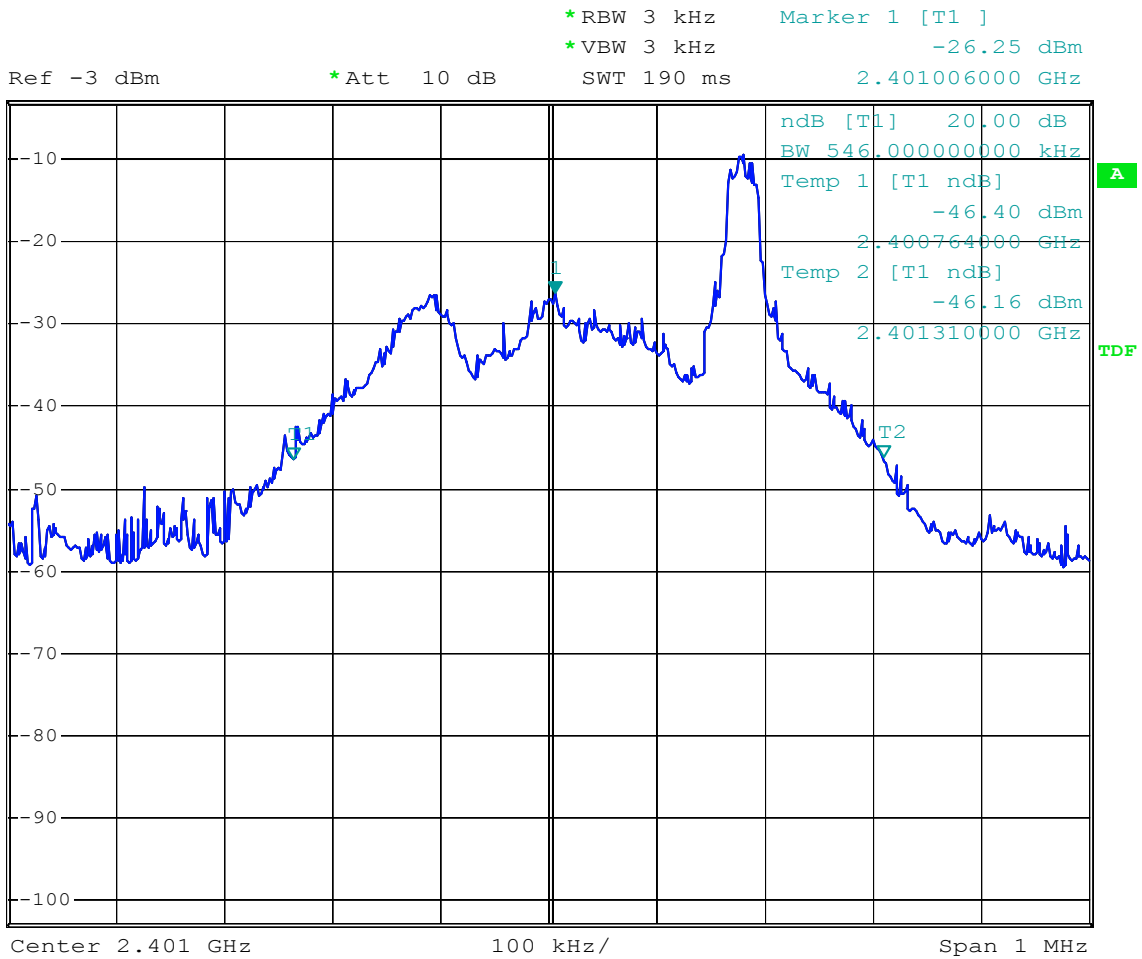
- **TEST LOCATION:** Semi-anechoic chamber
- **TEST EQUIPMENT USED FOR TEST:** Spectrum Analyzer Rohde & Schwarz Mod. FSP40
- **TESTED PORT:** Enclosure
- **EMISSION LIMITS:** Acc. to Section 15.249(e)
- **UNCERTAINTY OF MEASURE:** Combined uncertainty = ± 1.75 dB
Total uncertainty = (k=2) ± 3.5 dB

TEST CONDITIONS:	MEASURED
Ambient temperature : 15 - 35 °C	23,5 \pm 3 °C
Ambient humidity : 25 - 75 %rH	39 \pm 5 %rH
Pressure : 85 - 106 kPa (860 mbar - 1060 mbar)	950 \pm 50 mbar

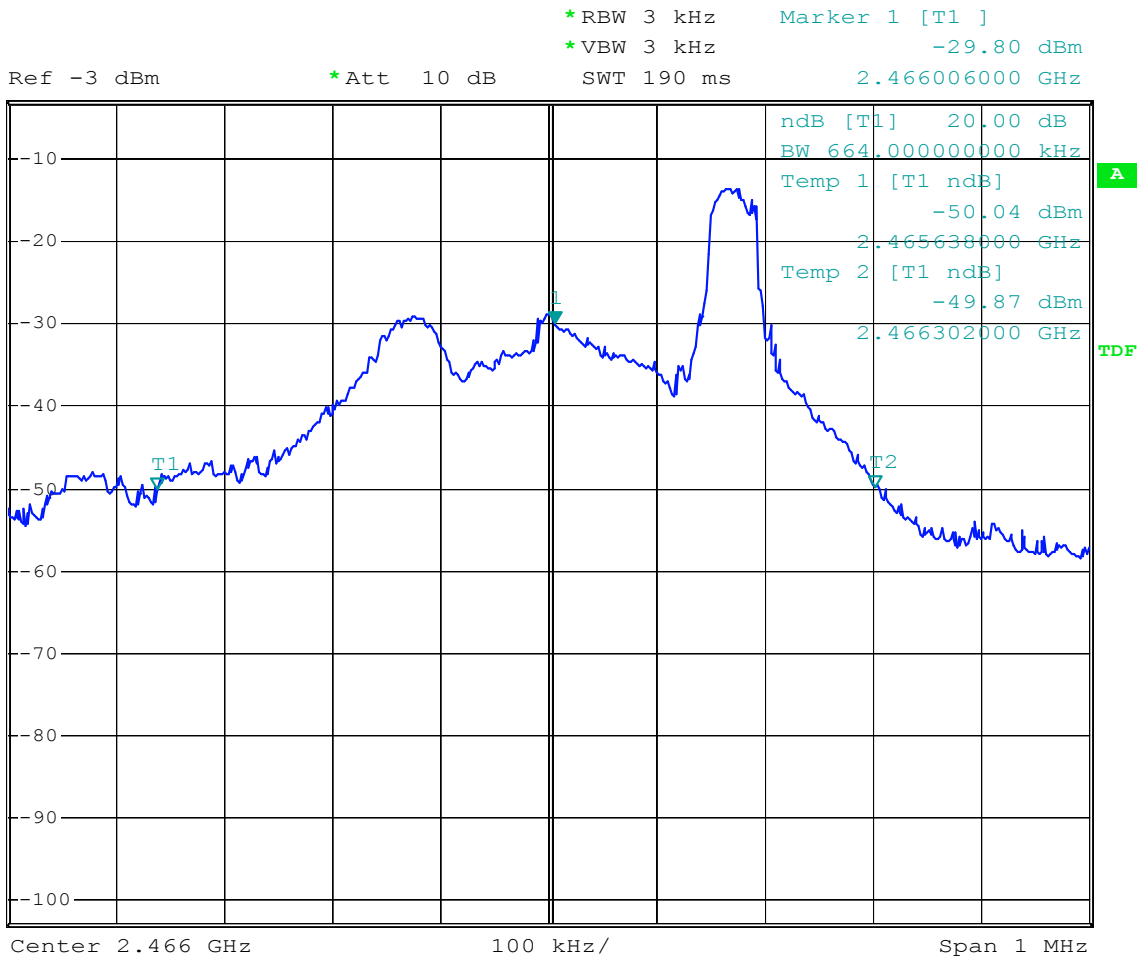
OPERATING CONDITION (Rif. Section. 2) : #1

RESULT: WITHIN THE LIMIT

2401 MHz



2466 MHz



5.1 Photographic documentation

PHOTO 1 – E.U.T. IDENTIFICATION

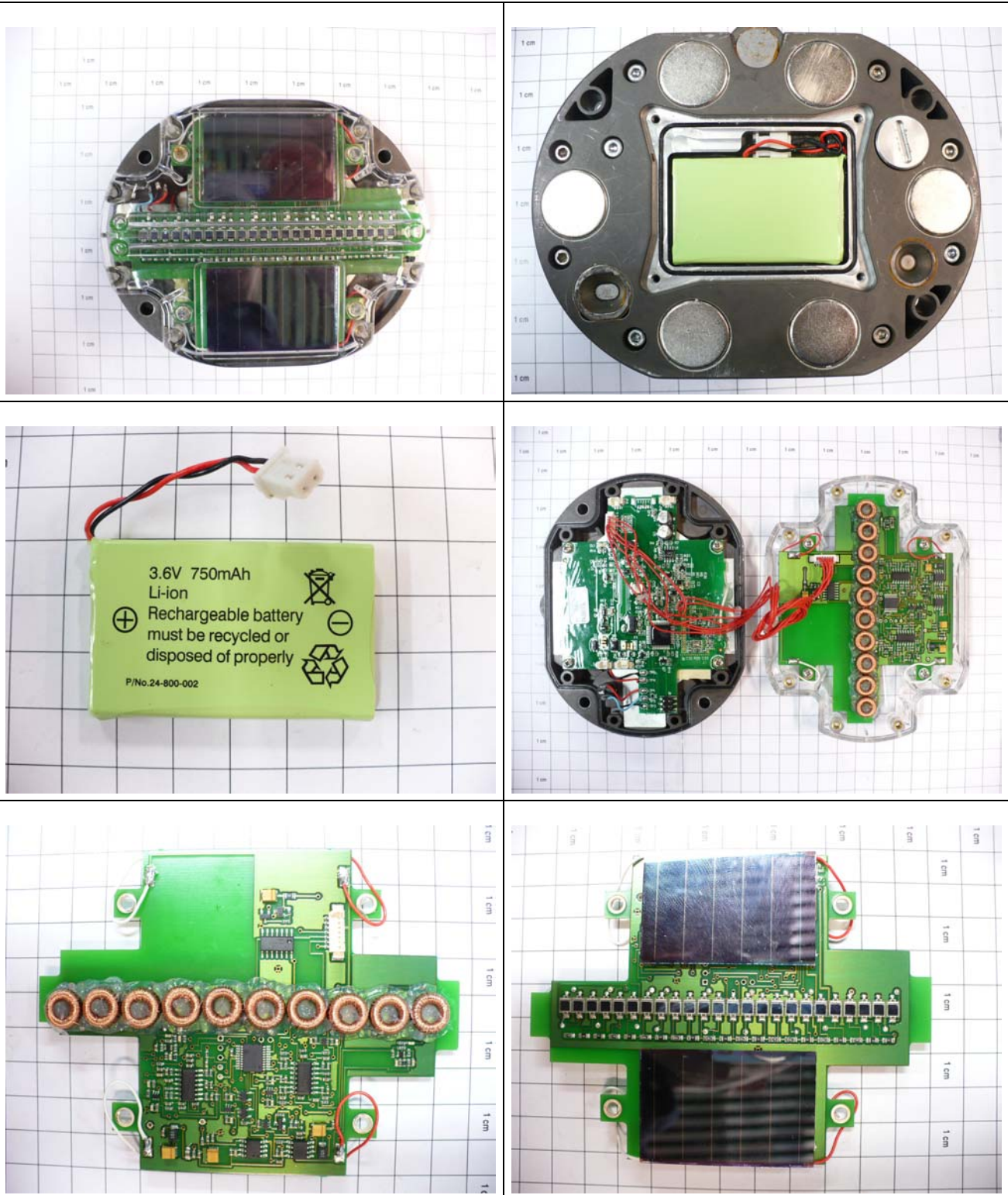


PHOTO 2 – SET-UP FOR EMISSION RADIATED TEST



6. TEST EQUIPMENT LIST

6.1 Equipment List

EQUIPMENT	MANUFACTURER	MODEL	SERIAL N.	CAL. DUE
EMI TEST RECEIVER 20HZ 40GHZ	ROHDE & SCHWARZ	ESU40	100111	JUL 2009
ARTIFICIAL MAINS NETWORK	ROHDE & SCHWARZ	ESH 2 - Z5	841887/011	SEPT.2009
ABSORBING CLAMP	ROHDE & SCHWARZ	MDS21	840031/005	JUL.2009
RF SEMI-ANECHOIC CHAMBER (CSSA)	SIEMENS	B83117-D6019-T232	003-005-134/94C	APR.2010
BILOG ANTENNA	CHASE	CBL6111A	1798	JUL.2009
BILOG ANTENNA	CHASE	CBL6111C	2717	JUL.2009
ESD GENERATOR	SCHAFFNER	NSG435-01	1063	APR.2009
RF SIGNAL GENERATOR 9 KHZ - 6 GHZ	ROHDE & SCHWARZ	SMB100A	100831	JUN 2011
LOG PERIODIC ANTENNA BROAD BAND 1-18 GHZ	ROHDE & SCHWARZ	HL025	350380/007	DEC.2009
SPECTRUM ANALYZER	ROHDE & SCHWARZ	FSP40	100038	FEB.2009
PROGRAMMABLE DC POWER SUPPLY	HEWLETT PACKARD	6623A	3448A04501	SEPT.2009
RF PREAMPLIFIER	BONN ELEKTRONIK	BLMA 1840-1A	087084B	AUG 2009
RF PREAMPLIFIER	BONN ELEKTRONIK	BLMA 0118-M	087084A	AUG 2009
RF SIGNAL GENERATOR 40 GHZ	ROHDE & SCHWARZ	SMP 04	825007/005	AUG 2009
DOUBLE RIDGED GUIDE ANTENNA	ELECTRO-METRICS	EM-6961	6278	JUL.2009
DIGITAL OSCILLOSCOPE	TEKTRONIX	TDS 680B	B010130	MAY.2009