

## RF&MW Capabilities in Emerging Metrology Institutes

### Short Introduction

The radio frequency and microwave (RF&MW) field has undergone revolutionary changes in the last 40 years and today, RF&MW technology is more pervasive than ever. This is especially true for commercial markets, where modern applications include cellular and smart phones, wireless networking, direct broadcast satellite, television, global positioning systems, wideband radio and radar systems, microwave remote sensing systems for environment, biomedical and healthcare applications (to name but a few).

The project named “Development RF & Microwave Metrology Capability (EMPIR 15RPT01)” is supported by Horizon 2020 and project aims to develop research and measurement capacities as well as expertise for emerging EURAMET countries in RF&MW. It will do this by transferring theoretical and practical know-how between the partners and by combining their skills to focus on microwave and electromagnetic compatibility (EMC) measurements. The outcomes of this project will be instrumental for reducing the gap between the European countries in terms of metrological capabilities in radio frequency and microwave frequency ranges (100 kHz – 300 GHz).

Nowadays, new technologies in the health, energy, security, environmental, industrial and communication sectors require novel RF&MW devices and measurement methods which are still under development. However, these research and development efforts bring new challenges to the underpinning metrology for RF&MW and necessitate advanced technologies.

Scattering parameter (S-parameter) measurements, RF power measurements and EMC tests and calibrations are important areas in RF&MW metrology to ensure and increase product quality and end user confidence.

Most of the national metrology institutes (NMIs) participating in this project have had to decline requests to perform measurements in RF&MW from stakeholders due to a lack of knowledge and/or experience in these areas. Therefore there is a strong need to improve the abilities of these European NMIs. The gap between developed and currently developing countries is growing constantly and this situation is even more pronounced for RF&MW metrology where not only knowledge and expertise are required, but also experience is required. In order to prevent further widening of this gap in RF&MW metrology, the knowledge and expertise of the more developed NMIs needs to be transferred to NMIs with less experience. This sharing of knowledge and skills would help to strengthen the European RF&MW metrology network and would support a better and more effective cooperation between European NMIs. It would also ensure a joint effort from European NMIs on the big challenges in RF&MW metrology and be instrumental for establishing future collaborations.

The overall objective of “Development RF & Microwave Metrology Capability (EMPIR 15RPT01)” project is to improve the European measurement and research capability for RF&MW metrology and to establish a basis for future cooperation between European NMIs. This will enable less developed European NMIs to build necessary research capacity for challenging future joint projects, as well as improving their calibration and measurement capabilities (CMCs) and reducing the increasing technological gap between NMIs. The specific objectives related emerging countries NMI of the project are to:

- Develop an individual strategy for each partner for long-term operation of capacity development, including regulatory support, research collaborations, quality schemes

and accreditation. Each partner will also develop a strategy to offer calibration services in their own country and in neighbouring countries. The individual strategies should be discussed within the consortium and with other EURAMET NMIs/DIs to ensure that a coordinated and optimised approach to the development of traceability in RF&MW metrology is developed for Europe as a whole.

- Identify key industrial and scientific needs for stakeholders in RF&MW metrology. At the beginning of this project, a survey on stakeholders' needs will be conducted for these purposes. The results of this survey will be influential to maximise the impact of this project within the European community of NMIs and industrial end-users via knowledge transfer, training and dissemination for this purpose, meetings, hands-on training sessions, technical papers and best practice guides will be prepared.

Some emerging metrology institutes in European countries are not part of this consortium and do not have any RF&MW capabilities, however certain needs for providing basic traceability exist in those countries. Based on the needs of individual countries/regions in which a given NMI provides traceability and basic RF&MW and EMC research facilities, individual plans will be prepared by the consortium for the development of RF&MW and EMC capabilities.

In order to identify the RF&MW and EMC capabilities of NMIs outside of the consortium that does not have any RF&MW capabilities. A questionnaire has been produced by TUBITAK UME and NIS from contribution with the consortium and it is expected that this questionnaire would identify the needs of such NMIs outside of the consortium, according to the stakeholder requirements in these countries/regions. This questionnaire is given through the following pages.

The following questionnaire has been prepared in order to gather data and opinions on what is needed in 15RPT01 project for RF & Microwave Metrology capability. Your answers will help to define the contents of a training and a workshop which will be organised for NMIs outside of the consortium. This questionnaire can be accessed from <http://www.rfmw.cmi.cz/index.php/news-events.html> web page.

Questionnaire has two sections. The NMI's infrastructure is investigated in the first section, while the second section is related to the country level organizations and activities based on RF and Microwave metrology.

## Questionnaire

Please complete this form electronically and return it to: [murat.celep@tubitak.gov.tr](mailto:murat.celep@tubitak.gov.tr), [yaserabdo76@gmail.com](mailto:yaserabdo76@gmail.com) and cc to: [erkan.danaci@tubitak.gov.tr](mailto:erkan.danaci@tubitak.gov.tr) by **November 30, 2016**.

<b>NMI :</b>			
<b>Contact person:</b>		<b>E-mail:</b>	

### SECTION 1 NMI LEVEL QUESTIONS:

1	Does your NMI have RF&Microwave capabilities?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
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If your answer for question 1 is yes, please answer questions 2 to 10, otherwise skip to question 11.

2	How many staff work in RF & Microwave metrology at your NMI?	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	More <input type="checkbox"/>
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3	What kind of RF & Microwave equipment are available at your NMI? Please list the most important ones.	<ul style="list-style-type: none"> <li>•</li> </ul>
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4	What are the current RF & Microwave measurement capabilities at your NMI?	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 80%;"></th> <th style="width: 10%; text-align: center;">Min</th> <th style="width: 10%; text-align: center;">Max</th> </tr> </thead> <tbody> <tr> <td>Frequency range (GHz) for S parameters measurement</td> <td style="text-align: center;"> </td> <td style="text-align: center;"> </td> </tr> <tr> <td>Frequency range (GHz) for power measurement</td> <td style="text-align: center;"> </td> <td style="text-align: center;"> </td> </tr> <tr> <td>Power range (mW) for power measurement</td> <td style="text-align: center;"> </td> <td style="text-align: center;"> </td> </tr> <tr> <td>Frequency range (GHz) for pulse measurement</td> <td style="text-align: center;"> </td> <td style="text-align: center;"> </td> </tr> </tbody> </table>		Min	Max	Frequency range (GHz) for S parameters measurement			Frequency range (GHz) for power measurement			Power range (mW) for power measurement			Frequency range (GHz) for pulse measurement		
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Frequency range (GHz) for S parameters measurement																	
Frequency range (GHz) for power measurement																	
Power range (mW) for power measurement																	
Frequency range (GHz) for pulse measurement																	

5	Are there unmet customer demands for any RF & Microwave measurement, due to lack of service, equipment or knowledge?	<input type="checkbox"/> Yes	<input type="checkbox"/> No																																										
6	If the answer in question 5 is Yes, Please give some examples to the RF & Microwave measurements/calibrations which cannot be done at your NMI.	<ul style="list-style-type: none"> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> </ul>																																											
7	From which NMI/NMIs does your laboratory obtain SI traceability for RF & Microwave measurements, if any?	<ul style="list-style-type: none"> <li>•</li> <li>•</li> <li>•</li> </ul>																																											
8	Does your NMI provide RF & Microwave measurement traceability to other NMIs or calibration laboratories?	<input type="checkbox"/> Yes	<input type="checkbox"/> No																																										
9	Has your NMI organized any interlaboratory RF & Microwave measurement comparison in your country?	<input type="checkbox"/> Yes	<input type="checkbox"/> No																																										
10	How many international RF & Microwave measurement comparisons has your NMI joined? Please give the titles of the comparisons.	<table style="width: 100%; border: none;"> <tr> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> <td style="text-align: center;">3</td> <td style="text-align: center;">4</td> <td style="text-align: center;">more</td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> </tr> <tr> <td colspan="6">1.</td> </tr> <tr> <td colspan="6">2.</td> </tr> <tr> <td colspan="6">3.</td> </tr> <tr> <td colspan="6">4.</td> </tr> <tr> <td colspan="6">5.</td> </tr> </table>		0	1	2	3	4	more	<input type="checkbox"/>	1.						2.						3.						4.						5.										
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11	Is your NMI interested in establishing an RF & Microwave metrology laboratory?	<input type="checkbox"/> Yes	<input type="checkbox"/> No																																										
12	If the answer in question 11 is yes, when does your NMI plan to establish an RF & Microwave metrology laboratory?	<table style="width: 100%; border: none;"> <tr> <td style="text-align: left;">In Years</td> <td style="text-align: center;">1</td> <td style="text-align: center;">3</td> <td style="text-align: center;">5</td> <td style="text-align: center;">10</td> </tr> <tr> <td></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> </tr> </table>		In Years	1	3	5	10		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>																																
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	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>																																									
13	Does your NMI have any budget to establish an RF & Microwave metrology laboratory?	<input type="checkbox"/> Yes	<input type="checkbox"/> No																																										
14	How many people will your NMI dedicate to RF & Microwave metrology?	<table style="width: 100%; border: none;"> <tr> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> <td style="text-align: center;">3</td> <td style="text-align: center;">4</td> <td style="text-align: center;">More</td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> </tr> </table>		1	2	3	4	More	<input type="checkbox"/>																																				
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15	Would you be interested in attending training courses and workshops in RF & Microwave metrology, if organized in the last year of this project?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
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If question 15 is answered with Yes, Please suggest topics that should be covered in training courses or workshops

16	Does your NMI have any EMC test infrastructure?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
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If your answer for question 16 is Yes, please answer questions 17 to 23, otherwise skip to question 24.

17	How many staff at your NMI work in EMC testing?	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>	More <input type="checkbox"/>
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18	What kind of EMC testing equipment does your NMI have? Please list the most important ones.	<ul style="list-style-type: none"> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> </ul>
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19	What are the EMC testing capabilities at your NMI?	Radiated Immunity	Frequency Range (MHz)	
			Maximum Electric Field (V/m)	
		Radiated Emission	Frequency Range (MHz)	
			Measurement Distance	
		Conducted Emission	Measurement Method	Frequency Range (MHz)
			<input type="checkbox"/> LISN	
			<input type="checkbox"/> ISN	
			<input type="checkbox"/> Voltage Probe	
		Conducted Immunity	<input type="checkbox"/> Others	
			<input type="checkbox"/> CDN	
			<input type="checkbox"/> BCI	
			<input type="checkbox"/> EM Clamp	
	<input type="checkbox"/> Others			

20	Are there unmet customer demands for any EMC Tests, due to lack of service, equipment or knowledge?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
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21	If question 20 is answered with Yes, please give some examples of the EMC Tests which cannot be done at your NMI.	<ul style="list-style-type: none"> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> </ul>
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22	From which NMI/NMIs does your NMI obtain SI traceability for EMC testing equipment, if any?	<ul style="list-style-type: none"> <li>•</li> <li>•</li> <li>•</li> </ul>
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23	How many interlaboratory EMC testing comparisons has your NMI joined? Please give the titles of the comparisons.	0	1	2	3	4	More
		<input type="checkbox"/>					
		1.					
		2.					
		3.					
		4.					
		5.					
6.							

24	Is your NMI interested in establishing an EMC test laboratory?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
25	If your answer for question 24 is Yes, when does your NMI plan to establish an EMC test laboratory?	In Years	<input type="checkbox"/> 1 <input type="checkbox"/> 3 <input type="checkbox"/> 5 <input type="checkbox"/> 10
26	Does your NMI have any budget to establish an EMC test laboratory?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
27	How many people will your NMI dedicate to EMC testing?	<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6	
28	Would you be interested in attending training courses and workshops in EMC Testing, if organized in the last year of this project?	<input type="checkbox"/> Yes	<input type="checkbox"/> No

If question 28 is answered with Yes, Please suggest topics that should be covered in training courses or workshops

**SECTION 2 COUNTRY LEVEL QUESTIONS:**

29	Are there any secondary calibration laboratories in your country for RF & Microwave calibrations?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
30	If your answer for question 29 is Yes, are these calibration laboratories accredited?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> Partly
31	Is the staff at your institute supporting the accreditation body in your country as technical experts or assessors for RF & Microwave topics?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	

32	Are there any EMC test laboratories in your country in the private or public sector?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
33	Is there any regulation on RF & Microwave device calibration in your country?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
34	Are there any proficiency testing providers in your country for EMC tests?	<input type="checkbox"/> Yes	<input type="checkbox"/> No

**Please add any other comments :**