Methods for Measuring EMC in Telecommunications Systems

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Abstract - In this article, we will consider methods for measuring the electromagnetic compatibility of telecommunication systems and study the norms of compliance with EN 55022 standards. The test equipment is RF (Microwave radio) transceiver equipment. 1.4 GHz. QAM modulation (372 MHz) was enabled in real power mode, and several experiments were also conducted. Experiments show that the parasitic radiation through the image channel at an intermediate frequency in a superheterodyne receiver is 465. At a frequency of 371.94 MHz, deviations at the quasi-peak level are set to 51 dB mv/m.

Key-words: EMC, Standards, Radiated radiation, resistance to electromagnetic field

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1 Introduction

Any system or equipment capable of emitting or conducting electromagnetic waves must be checked for electromagnetic compatibility. To enter the market, the product must meet all the requirements and comply with the norms and standards for electromagnetic compatibility.

EMC compliance standards are in demand in various industries, they are used to protect consumers and manufacturers of electronic systems from the undesirable effects of electromagnetic interference. During the electromagnetic compatibility test, it is checked whether the device or system generates a large level of electromagnetic radiation and whether it will work correctly under the influence of external electromagnetic interference.

Ensuring the correct operation of simultaneously operating devices/devices is the purpose of studying the EMC of technical means as a scientific problem. Technical means for reducing the vulnerability of telecommunication systems

and ensuring their electromagnetic compatibility in smart buildings are based on the following main areas: grounding, shielding, filtration and ensuring the quality of electricity.

Measurements/tests of the microwave reception and transmission system f=300 MHz/1.4 GHz for compliance with EMC requirements were carried out using a spectrum analyzer, a measuring broadband antenna and a pre-amplification filter. Radiated and conducted electromagnetic interference tests inside the semi-anechoic chamber in accordance with EN 55022 (applicable to information technology equipment with a voltage of not more than 600 V).

In the article [1], an electronic device sensitive to these parasitic noises was developed and investigated. The article [2] discusses interference caused by electromagnetic radiation. In the article [3], systems have been developed that are affected to what extent by interference sources used in space and the aerospace industry. In [4], electronic systems that cause interference caused by these sources were tested. In the article [5], tests were carried out on modern electronic devices in which electromagnetic interference was installed. In works [6-8], tests and preliminary tests were carried out for compliance with EMI requirements. In [9,10,11,12,13], electromagnetic interference in a circuit was investigated using several methods to improve the noise.

In the study [14], a measuring device for checking electromagnetic radiation and a communication channel for the presence of electromagnetic interference caused by conducted radiation were investigated.

In [15,16] several methods of radiation testing for large-sized receiving antenna devices were developed.

The purpose of this work is a method for assessing electromagnetic compatibility by measuring in-system telecommunications equipment.

2 Research Method

It can be noted that in comparison the task of measuring the EMC in telecommunication systems is not fundamentally new and is reduced to a well-known problem against the background of interference suppression. This problem is classical in the theory of EMS RES, and the features of its solution in relation to telecommunication RRL equipment.

When considering the issues of interference suppression in channels of intermediate frequency paths, it should be taken into account that the retransmission subsystems consist of various cascades, the above blocks of electronic means can be used in various modes of retransmission, modulation of signal code structures are the most critical element for functioning with the required quality.

The height of the antenna was changed in the range of 1-4 m, and the angle of rotation of the EUT - in the range from -180^0 to 180^0 to maximize the measured emissions.

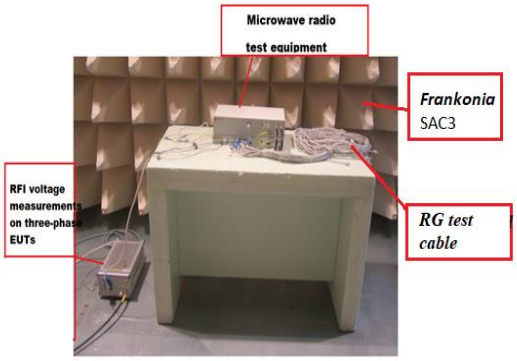

Fig. 1: Measurements of conductive emission

Figure 1 shows measurements of conductive emission. As can be seen from the figure, measurements of the connection transceiver under test are performed on power lines, and measurements are performed on telecommunication ports to ensure the stability of devices. Connecting an interference source via a dummy network with impedance.

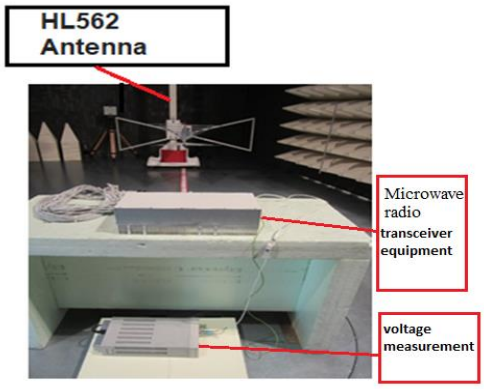

Fig. 2: Measurements on radiated emission (radiated radio frequency fields)

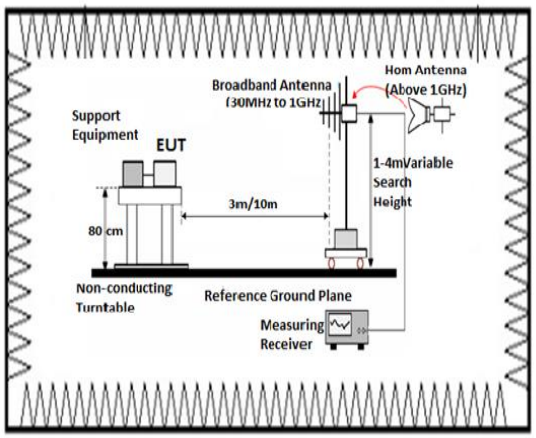

Fig. 3: Radiated emission Research method

In Fig. 2 and 3 show an antenna that was located at a distance of 3 m from UT. The height of the antenna varied within 1-4 m, and the angle of rotation UT was in the range from -180^0 to 180^0 of the maximum measured radiation.

The measuring antenna HL 562 is shown in the figure. 3. It is designed to operate in the frequency range from 30 MHz to 3 GHz and in its design combines the properties of a biconic and logoperiodic antenna. To increase sensitivity, especially in the frequency range above 1 GHz, the logoperiodic part has a V-shape.

Fig. 4: Measurements on radio frequency common mode immunity

Figure 4 shows the noise immunity measurements of the common-mode frequency range of radio frequencies performed using the signal levels defined in the test data, with amplitude modulation of 80% in the interference signal in a 1 kHz sine wave, with a pause to adjust the level of the radio frequency signal or to switch communication devices as needed.
At least ten single-contact discharges are applied to horizontal and vertical connecting plates.

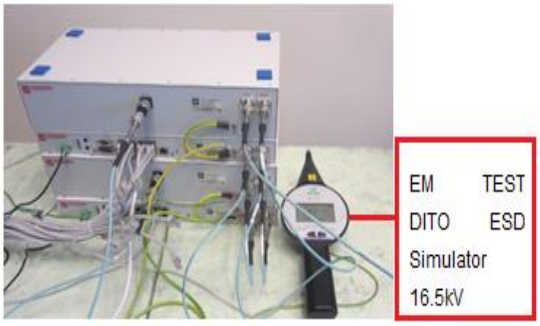

Fig. 5 Measurements on Electrostatic Discharge Simulator ESD

Figure 5 shows the measurements on the ESD electrostatic discharge simulator. As can be seen from the figure, the measurement is carried out using a portable electrostatic discharge generator that is sensitive to electrostatic discharges.
A time interval of 1 second is used between consecutive digits.

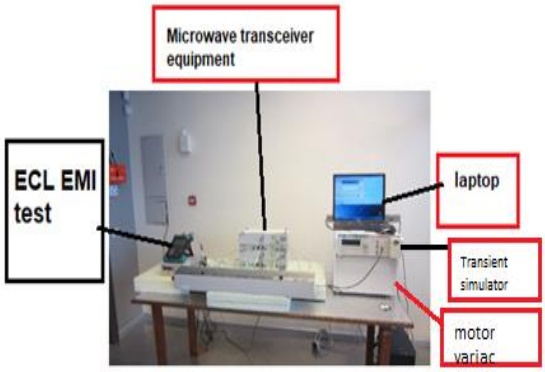

Fig. 6: Measurements on burst, surge, voltage dips/interruptions immunity

Figure 6 shows measurements of conductive emission. As can be seen from the figure, Test 7. demonstrates the resistance of electrical and electronic equipment to various temporary electromagnetic interference, similar to those that occur as a result of switching processes. The purpose of the test is to make sure that the test kit for measuring electrical fast transients (pulses) works correctly between calibrations. The test bench for testing electrical fast transients (pulses) includes: - generator of electrical fast transients (pulses) - connecting/disconnecting device - capacitive connecting clamp - connecting cables
On the AC network ports, the built-in connecting decoupling network is used to connect the EFT voltage/pulse interference. A capacitive clamp is used for DC/telecommunications/signal ports. The polarity of the EFT voltage/pulse interference changes during the test. The duration of the test is at least 1 minute, however, to avoid synchronization, the test time can be divided into six 10-second series, separated by a 10-second pause. It is not assumed that the packet is synchronized with the EUT signals.

3 Results

In this study, experimental work was carried out in the LEITC laboratory in 2016. Measurement/testing of an EMC kit using a spectrum analyzer, measurement of a broadband antenna, a pre-filter in the process.

Table 1. Radiated emissions test results

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin - QPK (dB)
371.940000	51.0	10000.0	120.000	100.0	H	0.0	15.0	-4.0

Peak detector;		QP detector;		Limit line;	
Method:	EN55032 class B	**Port:**	Enclosure		
Chamber:	SAC3	**Height:**	1-4m	**Mode:**	1
Distance:	3m	**Polarization:**	V+H	**Mod. State:**	1
Angle:	-180^0..+180^0	**File:**			

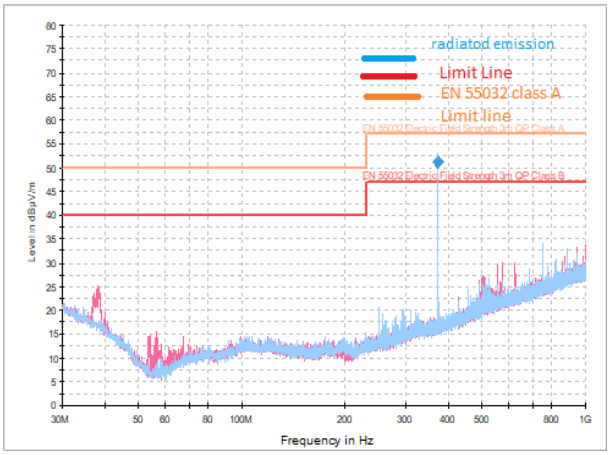

Fig. 7: Radiated emissions

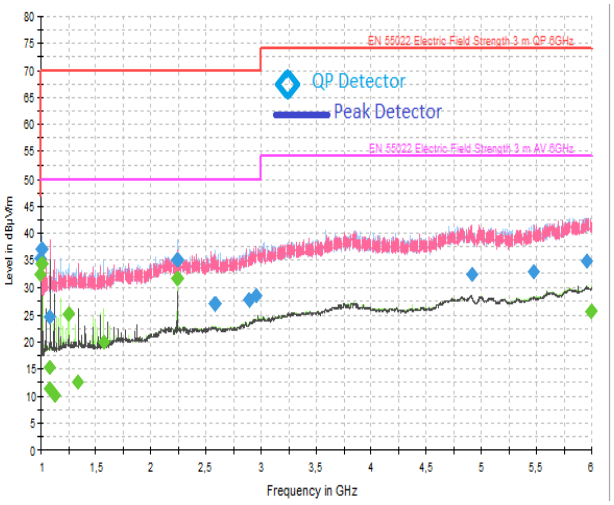

Fig. 8: Radiated emissions

Figure 8 shows measurements of radiated emissions. As can be seen from the figure, it was measured using the EN 55033 Class B method at a distance of 3 m, and the polarization of the V+H antenna measures the bandwidth from 1 to 6 GHz.

Peak detector; QP detector; Limit line;					
Method:	EN55032 class B	**Port:**	Enclosure		
Chamber:	SAC3	**Height:**	1-4m	**Mode:**	1
Distance:	3m	**Polarization:**	V+H	**Mod State:**	1
Angle:	$-180^0..+180^0$	**File:**			

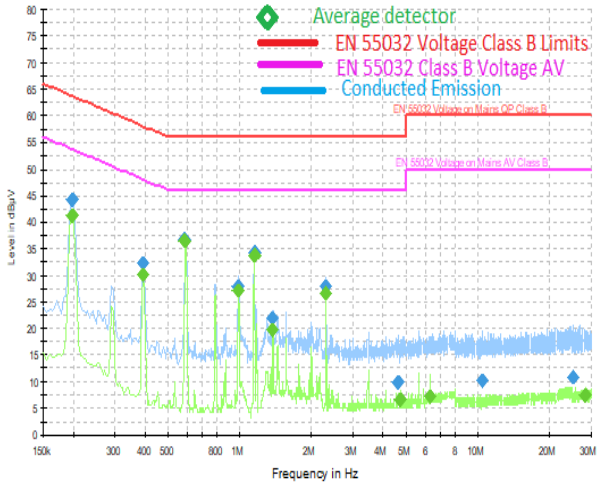

Fig. 9: Conducted emissions

Figure 9 shows the measurements of the emissions carried out. As can be seen from the figure, it is measured in accordance with EN 55033 bandwidth measurement class from 150 K to 30 m. Conducting emission standards with a frequency band from 0.15 MHz to 0.5 MHz, the norm of the quasi-peak value of dB (MV) 66-56, the norm (average value) 56-46 dB (MV) in the frequency band ≥5 MHz ≥30 MHz, the quasi-peak value of the norm of dB (MV) 60, the norm (average value) 50 dB (mv).

Peak detector; QP detector; Average detector; Average detector; L- Live, N-Neutral; PE- Earth						
Method:	EN55032		**Port:**	DC power port		
LISN:	ESH2-Z5				**Mod. State:**	1
			File:			

Table 2. Conducted emissions test results

Frequency (MHz)	Quasi Peak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBµV)
0.198	44.3	10.0	9.000	On	L1	9.7	19.4	63.7
0.394	32.2	10.0	9.000	On	L1	9.7	25.7	58.0
0.590	36.8	10.0	9.000	On	L1	9.8	19.2	56.0
0.986	27.9	10.0	9.000	On	L1	9.8	28.1	56.0
1.154	34.3	10.0	9.000	On	L1	9.8	21.7	56.0
1.378	21.9	10.0	9.000	On	L1	9.8	34.1	56.0
2.302	27.8	10.0	9.000	On	L1	9.9	28.2	56.0
4.602	10.0	10.0	9.000	On	N	10.0	46.0	56.0
10.498	10.2	10.0	9.000	On	L1	10.2	49.8	60.0
25.234	10.9	10.0	9.000	On	N	10.9	49.1	60.0
0.198	41.3	10.0	9.000	On	L1	9.7	12.4	53.7
0.394	30.0	10.0	9.000	On	L1	9.7	17.9	48.0
0.590	36.6	10.0	9.000	On	L1	9.8	9.4	46.0
0.986	27.2	10.0	9.000	On	L1	9.8	18.8	46.0
1.154	33.9	10.0	9.000	On	L1	9.8	12.1	46.0
1.378	19.7	10.0	9.000	On	L1	9.8	26.3	46.0
2.302	26.6	10.0	9.000	On	L1	9.9	19.4	46.0
4.730	6.6	10.0	9.000	On	L1	10.0	39.4	46.0
6.306	7.1	10.0	9.000	On	L1	10.0	42.9	50.0
28.366	7.4	10.0	9.000	On	N	10.9	42.6	50.0

Electric fast transients EFT/Burst immunity			
RESULT			
Ports:	AC power		**Recm'd Crit**
Method:	EN61000-4-4		N/A
Ports:	DC power		**Recm'd Crit**
Method:	EN61000-4-4		B
Ports:	I/O communication		**Recm'd Crit**
Method:	EN61000-4-4		B
Ports:	Signal		**Recm'd Crit**
Method:	EN61000-4-4		N/A

Oper. mode	Mod	Port	Level (kV)	Polarity	Frequency	Burst uration/ period(m	Test	Notes
1	1	DC power	0.5	+	5	15/300	5	#2
1	1	I/O communi cation	0.5	+	5	15/300	5	#2
#1, 2, 3... see Observations Table below								

Notes	Comments and Observations
#1	No effect observed
#2	TO has error on data transmitting

4 Conclusion

In 2016, measurements/tests of the EMC set were carried out at the LEITC laboratory using a spectrum analyzer, measurements of a broadband antenna, and a pre-gain filter. Radiated and conducted electromagnetic interference inside a semi-anechoic chamber, in accordance with EN 55022 (applicable to information technology equipment with a voltage of not more than 600 V), require conditions to ensure that several types of equipment do not cause collisions with each other and do not cause circumstances during simultaneous operation.

Experiments show parasitic radiation through the image channel at an intermediate frequency in a superheterodyne receiver 465. At a frequency of 371.94 MHz, the deviation at the quasi-peak level is set at 51 dB mv/m.

This overview document begins with a detailed discussion of the values and sources of electromagnetic interference that will be used according to background usage.

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Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

-Muratbek Jamanshalov did measurements and experimental work

-Murat Kunelbayev and Madina Mansurova are engaged in analytics

-Gulshat Amirkhanova organized and executed the experiments

-Gulnur Tyulepberdinova, Madina Alimova are experimental work