



**Group of Administrative Co-operation
Under the R&TTE Directive**

**6th R&TTE Market Surveillance Campaign
on Mobile Phone Repeaters**



*REPORT
ON THE 6TH JOINT CROSS-BORDER
R&TTE MARKET SURVEILLANCE CAMPAIGN
(2014)*

MOBILE PHONE REPEATERS

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CONTENTS

<u>A. EXECUTIVE SUMMARY</u>	3
<u>B. ELEMENTS OF THE CAMPAIGN</u>	4
1. REASONS FOR THE CAMPAIGN	4
1.1. LEGAL ASPECTS OF THE USE OF MOBILE PHONE REPEATERS IN EUROPE	4
1.2. INFLUENCE OF MOBILE PHONE REPEATERS ON BASE STATIONS	4
2. SCOPE OF THE CAMPAIGN	5
3. PARTICIPATION IN THE CAMPAIGN	5
4. TIMING	5
5. SAMPLING	5
6. DOCUMENTS	6
7. ASSESSMENT PROCEDURE	6
<u>C. RESULTS</u>	8
1. ADMINISTRATIVE COMPLIANCE	8
1.1. CE MARKING	8
1.2. EC DECLARATION OF CONFORMITY	8
1.3. TECHNICAL DOCUMENTATION (TD)	9
1.4. INFORMATION TO THE USER	9
2. TECHNICAL COMPLIANCE	9
3. OVERALL COMPLIANCE	11
4. OTHER OBSERVATIONS	12
4.1. STOP ADVERTISING (NORWAY)	12
4.2. TEST OF MOBILE PHONE REPEATERS (FINLAND)	12
4.3. STATE OF THE ART	12
<u>D. CONCLUSIONS AND RECOMMENDATIONS</u>	14
1. CONCLUSIONS	14
2. RECOMMENDATIONS	15
<u>E. REFERENCES</u>	16
<u>F. ABBREVIATIONS</u>	16

A. EXECUTIVE SUMMARY

ADCO R&TTE (Group of Administrative Co-operation under the R&TTE Directive) agreed during the 44th meeting in Budapest to dedicate the sixth joint cross-border R&TTE market surveillance campaign to the assess the compliance of mobile phone repeaters with administrative requirements and essential requirements in relation to the effective use of spectrum (article 3.2 R&TTE Directive). The scope of products was limited to mobile phone repeaters available on the European Market for private persons.

Due the fact that mobile phone repeaters utilize frequency bands exclusively allocated to mobile network operators, any technical non-compliance of that group of products can cause malfunctioning of cell phone networks. Improper installation of such devices can lead to a degradation of network coverage, a growth of noise level in the uplink band, increase the amount of interrupted phone calls and even cause a blockage to certain sectors of the mobile phone base station.

This report provides an overview of the findings, presents detailed results with corresponding conclusions and makes recommendations on next steps and future actions.

The Campaign was conducted between 1st of January 2014 and 31st of May 2014. Fourteen (14) European countries participated in the campaign. Forty seven (47) samples were randomly taken from the market. Thirty one (31) mobile phone repeaters were checked in line with the code of practise of the campaign.

The Campaign revealed that the overall level of compliance with assessed requirements is extremely low. Only two (2) checked products were compliant with all administrative requirements and the essential requirement on the effective use of spectrum. The campaign showed that technical compliance of CDMA UTRA/E-UTRA repeaters (50%) is noticeably better than GSM repeaters (21%), and with the implementation of advanced function, partially prevents mobile phone repeaters from interfering with mobile base stations.

B. ELEMENTS OF THE CAMPAIGN

1. Reasons for the campaign

A mobile phone repeater is a device used for boosting the cell phone reception to the local area by the usage of a reception antenna, a signal amplifier and a transmission antenna.

In several countries, interference to mobile phone public networks (as GSM, UMTS, LTE) has been identified due to non-compliant mobile phone repeaters used by private persons. Such non-compliant mobile phone repeaters, mostly mass market equipment, have been found on the market in a rapidly increasing number and are likely to enhance the risk of harmful interference, especially due to malfunctions of the repeaters in the performance of the network due to this non-compliance, which includes both lack of compliance with the requirements of the standards and poor design and constructions.

Network operators have also forwarded data and complaints indicating that such equipment represented a higher risk of causing harmful interference when not co-ordinated in a proper way with the design of the networks in the same area where they are installed.

Since mobile networks today have gained increased importance for social and society functions, the ADCO R&TTE have found it necessary to introduce a market surveillance campaign for cellular repeaters. Such a campaign is a major reaction in order to show the operators and the market that action is being taken to protect mobile phone networks from harmful interference.

1.1. Legal aspects of the use of mobile phone repeaters in Europe

The use of a mobile phone repeater in Europe is subject to restrictions. In some countries, users need to have an individual licence from the regulator, while in most countries, users need the permission of the mobile phone operator of which the frequencies are repeated.

The rules for the installation of mobile phone repeaters are quite different through Europe. In some countries, such equipment is exclusively installed by the mobile phone operators themselves (with or without selling the equipment to the user). In other countries, the user has to mandate an agreed installer. In the remaining countries, the user may install the equipment himself.

Some operators only allow channel selective repeaters, but most of the repeaters in use are broadband repeaters. Some operators also specify the mobile phone repeaters that can be used and other not.

1.2. Influence of mobile phone repeaters on base stations

European Enforcement Authorities constantly receive complaints on interference to mobile phone public networks. Several investigations have revealed that majority of these interference cases are caused by mobile phone repeaters which are either:

- technically non-compliant,
- attached to omnidirectional outdoor antenna,
- overdriven,
- installed too close to the base station,
- inadequate to the user requirements.

Extensive spectrum measurements have proven that even repeaters which are compliant with essential requirements and installed in accordance with technical knowledge raise the noise level of the uplink band by approximately +1dB in the proximity of the mobile phone base

station and slightly downgrades its coverage. This effect is being multiplied when more than one GSM repeater is affecting the same sector of the mobile phone base station.

The influence of non-compliant GSM repeaters or compliant GSM repeaters improperly installed (e.g. too close to the mobile phone base station) is significant. These repeaters heavily raise the noise level in the uplink band (+5dB up to 50dB) in the proximity of mobile phone base stations, downgrade the coverage or even disable the sector of mobile phone base station. It misguides subscribers due the fact that level of downlink signal is high but cell phones cannot connect to the network. Furthermore, in these cases the number of interrupted phone calls heavily increases. From a mobile phone operators point of view the noise level exceeding -100dBm is unacceptable.

2. Scope of the campaign

The primary purpose of the campaign was to determine the compliance level of mobile phone repeaters available on the European Market for private persons. Market Surveillance Authorities (MSA) have assessed products against all administrative requirements and carried out a conformity assessment with the essential requirement of the effective use of the spectrum (article 3.2 R&TTED). Measurements against the requirements of the electrical health and safety (article 3.1.a R&TTED) and electromagnetic compatibility (article 3.1.b R&TTED) were carried out on a voluntary basis.

The key element of the campaign was the verification of the content of the user manual from the R&TTED perspective.

The campaign was also intended to provide market surveillance authorities with the opportunity to participate in R&TTE market surveillance, to improve the exchange of information and to raise consumer's awareness of the impact of mobile phone repeaters on mobile phone networks.

It was agreed that TCAM, ECC, R&TTE CA and ETSI will be informed of this campaign and its results.

3. Participation in the campaign

Participation in the campaign was voluntary, and was open to all members of R&TTE ADCO. Fourteen European countries participated in the campaign: Finland, France, Germany, Greece, Lithuania, the Netherlands, Norway, Poland, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

4. Timing

The campaign commenced on the 1st January 2014. The information gathering, testing and data reporting phases of the campaign ended on the 31st May 2014. Within that period, MSAs carried out their operations to their own timescales. A further 30 days, ended on the 30th June 2014, were allowed for results to be uploaded to ICSMS.

5. Sampling

Participating MSAs took 3 to 10 mobile phone repeaters (GSM, UMTS, LTE, ...) available for private persons on their national market. For this reason products were selected from Market places for End Users (not from Economic operators selling solely to Network operators) and could include eCommerce stores (like eBay, Amazon etc.). However, to avoid double sampling, participating MSAs were encouraged to register details of their selections to ICSMS as early in the campaign as possible.

6. Documents

A Code of Practice was drawn up to provide guidance and a common understanding of the purpose of the campaign and to ensure, as far as possible, the adoption of harmonised practices during the operational phase of the campaign. The results of the assessment of each of the mobile phone repeaters were recorded on a common electronic data input form for R&TTE (R&TTE DIF) and complementary technical data input form (Annex C)

7. Assessment procedure

Participating MSAs had to assess the product against all administrative requirements paying attention to:

- product identification (name of the manufacturer or the party responsible for placing on the market, type designation, batch and serial number),
- CE marking (CE mark layout and height) on equipment, it's packaging and on the accompanying documents,
- involvement of Notified Body in the conformity assessment process,
- description of intended use and information on restriction of use for radio equipment,
- obligatory elements of DoC or it's short form,
- information on standards applied by the manufacturer to show compliance with article 3.1.a (electrical health and safety), article 3.1.b (electromagnetic compatibility) and article 3.2 (effective use of the spectrum).

If the DoC was not provided with the product, the participating MSA had to request it from the person responsible for placing the item on the Market.

The participating MSAs had to request, as a minimum, the following elements of the technical documentation from the party responsible for placing on the Market:

- test reports to demonstrate compliance with the requirement on effective use of spectrum (article 3.2 R&TTED),
- explanation on solutions adopted by the manufacturer if Harmonised Standards have not been or only partly used.

Participating MSAs had to check the content of the products' user manual from the R&TTED perspective. Market Surveillance Authorities have verified:

- information on the legal conditions for use of the repeater in the country where the MSA is located,
- information on how to install and operate the repeater to avoid interference with mobile communication networks,
- information about precautions to be taken from the EMF perspective.

Participants of the campaign took measurements against the requirement in relation to the effective use of the spectrum (article 3.2 R&TTED) using the applicable relevant Harmonised Standard. The results were compared directly with the limit in the Harmonised Standard, taking into account the measurement uncertainty defined in it.

Measurements were carried out on the basis of applicable harmonised standards reflecting the moment the product became available on the market following the table below.

Table 1 : List of harmonised standards		
GSM	EN 300 609-4 V10.2.1	Global System for Mobile communications (GSM);Part 4: Harmonized EN for GSM Repeaters covering the essential requirements of article 3.2 of the R&TTE Directive
UTRA	EN 301 908-11 V5.2.1	IMT cellular networks; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive; Part 11: CDMA Direct Spread (UTRA FDD) (Repeaters)
CDMA 2000	EN 301 908-12 V4.2.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Base Stations (BS), Repeaters and User Equipment (UE) for IMT-2000 Third-Generation cellular networks; Part 12: Harmonized EN for IMT-2000, CDMA Multi-Carrier (cdma2000) (Repeaters) covering the essential requirements of article 3.2 of the R&TTE Directive
E-UTRA	EN 301 908-15 V5.2.1	IMT cellular networks; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive; Part 15: Evolved Universal Terrestrial Radio Access (E-UTRA FDD) (Repeaters)

In cases where a previous version of the current harmonised standard were available at the point of placing on the market, then the measurements were carried out against the previous version. In cases where two (or more) harmonised standards could be applicable at the point of placing on the market, then measurements were carried out against the least stringent one.

Measurements against requirements on the electrical health and safety (article 3.1.a R&TTED) and electromagnetic compatibility (article 3.1.b R&TTED) could be carried out on a voluntary basis.

Results of the assessment were recorded on special forms dedicated for the campaign and analyzed from a statistical point of view.

C. RESULTS

Participating MSAs have taken forty seven (47) samples of mobile phone repeaters available for private persons available on their national markets. Forty two (42) products were assessed against administrative requirements, in forty one (41) cases technical surveys were conducted but technical compliance of thirty six (36) products were checked in accredited test laboratories.

The majority of tested mobile phone repeaters were manufactured in countries of the Far East (83%), are broadband (86%), amplify signals on 900MHz frequency band (83%) with the gain between 60dB and 69dB (46%).

1. Administrative compliance

Twelve (12) participating MSAs have checked forty two (42) mobile phone repeaters against administrative requirements including CE marking, content of Declaration of Conformity, notification obligation and content of technical documentation. Only five (5) products (12%) were assessed as compliant with administrative requirements.

1.1. CE marking

The level of compliance of mobile phone repeaters with CE marking requirements is approximately 24%. The table below presents the number of non-compliant products in scope of listed requirements and overall level of compliance with CE marking requirements.

Table 2 : Reasons of CE marking non-compliance			
Detailed requirement	on product	on packaging	on documents
Missing name of the manufacturer	8		
Incorrect type designation	8		
Missing batch and/or serial number	3		
Incorrect CE mark layout or height	12	20	
Not compliant class identifier, it's layout or height	17	21	

1.2. EC Declaration of Conformity

From forty two (42) mobile phone repeaters assessed against the DoC requirements, in 27 cases complete or short forms of the DoC were available. From those, 18 were found compliant. The overall level of compliance is about 43%.

Table 3 : Compliance with DoC requirements				
Number assessed	DoC available*	DoC available [%]	DoC compliant	DoC compliance level [%]
42	27	64%	18	43%
* Note: complete form and short form.				

1.3. Technical documentation (TD)

From twenty seven (27) mobile phone repeaters assessed against the TD requirements, in 17 cases TD were made available. In 9 cases technical documentations were compliant. Overall level of compliance is approximately 53%.

Table 4 : Compliance with TD requirements				
Number assessed	TD available	TD available [%]	TD compliant	TD compliance level [%]
27	17	63%	9	53%

1.4. Information to the user

The use of mobile phone repeaters in EU, EEA and EFTA countries is limited to parties which have frequency license or written agreement with mobile phone operators to co-use frequency channels assigned to their networks. That information should be incorporated into user manuals to minimize the risk of unauthorized use of mobile phone repeaters and frequency interference. Participating administrations have checked the content of 38 user manuals on that aspect. In 61% of cases, information concerning license requirements was found.

Mobile phone repeaters should be installed in the correct way to avoid oscillation and unwanted emissions. In 60% of cases, information about the risk of oscillation was included into user manuals and in 56% of cases, user manuals explained how to avoid that effect.

Only in 26% of cases did user manuals contain information about possible risks to human beings or health in general with the use of mobile phone repeaters.

Table 5 : Reasons of non compliances in the field of information to the user			
Detailed requirement	on product	on packaging	on documents
No specification of countries where the radio equipment is intended to be used		19	17
Not compliant information on intended use			6
Not compliant information on restrictions of use for radio equipment			15
Not compliant information on interfaces of public telecommunication networks to which the equipment is intended to be connected			3

2. Technical compliance

Eleven (11) participating MSAs have checked thirty six (36) mobile phone repeaters against the requirement of the effective use of the spectrum (article 3.2 R&TTED) according to the applicable relevant Harmonised Standard. Depending on test laboratories' procedure, which made measurements, products were tested in a whole scope of tests described in harmonized standards or test procedures were stopped after the first non-compliance. Only six (6 of 28) GSM repeaters (21%) and four (4 of 8) CDMS/UTRA/E-UTRA repeaters (50%) were assessed as compliant.

The majority of tested mobile phone repeaters are broadband (31 of 36) but the level of compliance of that group of products is significantly low (16%). All band selective repeaters (5 of 36) emerged as compliant. Detailed statistical information is presented in table below.

Table 6 : Repeater type and technical compliance					
Repeater type	GSM		CDMA/UTRA/E-UTRA		Overall level of compliance
	Number of compliant products	Level of compliance	Number of compliant products	Level of compliance	
Broadband	4 of 26	15%	1 of 5	20%	16%
Band selective	2 of 2	100%	3 of 3	100%	100%
Overall	6 of 28	21%	4 of 8	50%	28%

Test measurements have revealed that intermodulation attenuation and out-of-band gain are the main reason for non-compliance of mobile phone repeaters. All causes of technical non-compliance are shown in next table

Table 7 : Reasons of technical non-compliance		
Conformance requirements	Number of products which did not pass the test	
	GSM	CDMA/UTRA/ E-UTRA
Conducted spurious emissions	4 of 28	1 of 8
Radiated spurious emission	3 of 19	
Intermodulation attenuation	18 of 24	
Out-of-band gain	22 of 28	4 of 7
Frequency error	1 of 5	

Manufacturers equipped some mobile phone repeaters with advanced features like automatic setup, variable gain or oscillation detection to minimize the potential negative impact on mobile phone networks. The following table presents the assessed influence of these features on repeaters' technical compliance

Table 8: Influence of extra feature on repeater's technical compliance				
Repeater extra feature	Installed		Not installed	
	Number of compliant products	Level of compliance	Number of compliant products	Level of compliance
Automatic setup feature	4 of 8	50%	4 of 22	18%
Variable gain	7 of 18	39%	0 of 11	0%
Shut-down if oscillation detected	6 of 9	67%	1 of 13	8%
Shut-down if other error detected	3 of 3	100%	2 of 17	12%
Protection on input overload	7 of 13	54%	0 of 14	0%

The majority of mobile phone repeaters (30 of 36) use 900 MHz band however only 20% of them were assessed as compliant. Extensive statistics are shown on the next table. Few products utilise more than one frequency band

Table 9: Frequency band and technical compliance				
Frequency band	GSM		CDMA/UTRA/E-UTRA	
	Number of compliant products	Level of compliance	Number of compliant products	Level of compliance
450 MHz	0 of 1	0%		
900 MHz	6 of 30	20%		
1800 MHz	2 of 5	40%		
2100 MHz			4 of 8	50%

3. Overall compliance

From the group of forty seven (47) samples of mobile phone repeaters assessed by participating MSAs, thirty one (31) products were verified in line with full assessment procedure described in point B.7. Only two (2) repeaters (6%) were assessed as fully compliant with administrative and essential requirements of R&TTE Directive. Detailed statistical information was presented in table below.

Table 10: Overall compliance		
Conformance requirements	Number of compliant products	Overall compliance [%]
Administrative compliance	3 of 31	10%
Technical compliance	10 of 31	32%
Overall compliance	2 of 31	6%

4. Other observations

4.1. Stop advertising (Norway)

In Norway, the big established dealers of R&TTE equipment does not sell mobile phone repeaters. They are mainly sold through small internet shops. The Norwegian Post and Telecommunications Authority (NPT) found 17 different kinds of mobile phone repeaters from 10 different internet shops that were called for test.

NPT experienced that instead of sending equipment for test, all of the 10 shops chose to stop selling products and that all advertisements for the called products has been removed. This led to the situation that NPT did not get any equipment to perform testing on. For this reason no results from Norway has been included in the campaign.

The positive side of this is that for the time being there are limited shops that sell mobile phone repeaters on the Norwegian market.

4.2. Test of mobile phone repeaters (Finland)

For the purpose of the 6th common market surveillance campaign the Finnish Communications Regulatory Authority (FICORA) has run an additional test in order to assess the probability of interference, when the repeater is brought into oscillation.

The test method of FICORA can be described as follows:

1. The antennas (tx and rx antennas) are connected into the repeater. Antennas are located as far as possible from each other. Isolation between the antennas is measured (in dB) by feeding a known value rf signal on a frequency which is on the repeater's operating band and then by measuring the received level from another antenna. The difference of generator output power and received power is the isolation between antennas. This value in dB is recorded. Location of antennas must remain unchanged.
2. A step attenuator is connected between the input antenna and repeater. Value of the step attenuator is switched to maximum attenuation. Attenuation is then reduced step by step until the repeater starts to oscillate. This value of the attenuator is recorded. Total isolation that brings the repeater into oscillation is thus the isolation between antennas (dB) + value of step attenuator (dB) = total isolation in dB for oscillation.
3. The output spectrum and tx power of the oscillating repeater is then measured by spectrum analyzer which is connected into the repeater output by using a directional coupler between the repeater output and tx antenna.
4. The tests were carried out in a shielded room in order to avoid interference with nearby mobile networks.

The test method has shown that even compliant repeaters, in certain circumstances can start to oscillate. The measured output level of the oscillation was up to 20dBm. Effects on the mobile phone network have been observed on distances of up to 19km.

4.3. State of the art

Current applicable harmonised standards that mirror the state of the art were mainly developed for mobile phone repeaters to be installed, used and maintain by professionals (mobile phone network operators or professional installers for them). Those people have the necessary knowledge in radio issues to choose the correct material (repeater type, antenna type and gain, distance to the base stations, bandwidth, operating frequency ...), install it according the state of the art and adjust the gain of the repeater.

Taking in account the recent development of such equipment and that more and more citizens are interested in better coverage at home, it should be analysed with ETSI if new harmonised standards for mobile phone repeaters aimed for unskilled people should be developed. Such standards should include functionalities that would prevent harmful interferences to public networks (e.g. automatic gain control, anti oscillation circuits, automatic frequency selection, bandwidth selection, operation only under control of base station...).

Furthermore, from a spectrum regulation viewpoint, the use and condition of use of such repeaters could be clarified from a harmonised point of view to help consumers.

CONCLUSIONS AND RECOMMENDATIONS

5. Conclusions

- The vast majority of tested repeaters (83%) were manufactured in Far East countries, are broadband (86%) and amplify signals in the 900 MHz frequency band (83%).
- Most mobile phone repeaters are placed on the market by Internet.
- The overall compliance with the checked elements is too low, only 2 of 31 checked equipment had no shortcomings.
- With approximately 1 out of 10 mobile repeaters being compliant with the administrative requirements, the compliance rate is too low.
- The technical compliance rate is also too low, approximately 1 out of 4 repeaters was compliant with the essential requirement on the effective use of spectrum.
- The main reasons for technical non-compliances are intermodulation attenuation and out-of-band gain.
- Mobile phone repeaters equipped with sophisticated features that avoid harmful interferences (e.g. automatic gain control, anti oscillation circuits, ...) and have a higher compliance rate compared to those that are provided without such functionalities.
- Even if the number of band selective repeaters tested is low (5) compared to the number of checked broadband repeaters (31), they showed a higher compliance rate (100% for band selective repeaters against 16% for broadband repeaters).
- Users are not sufficiently informed on the precautions that should be taken during the installation and the use of mobile phone repeaters. Only 2 out of 3 had information on the risk of oscillation inside user manuals and only 1 of 2 user manuals explained how to avoid that effect.
- Only 1 out of 2 pieces of equipment were provided with information for the user explaining the need for a license from an authorisation.
- The current set of applicable harmonised standards for mobile phone repeaters is not fit for mobile phone repeaters for the mass market intended for installation and use by consumers.
- The campaign showed a good level of cooperation between MSAs.
- The resource in conducting this type of campaign is significant. Activities including preparation (eg. drafting its Code of Practice), coordination, tests, analysis of the results and the drafting of the report are carried out by R&TTE ADCO members in addition to their national activities.
- Manufacturers often used the CE-mark on non-compliant products.
- The popularity of repeaters could rise in the coming years because of better insulated/absorbed buildings and the popularity of smartphones.
- The results highlighted the importance of laboratory tests in the field of market surveillance.

6. Recommendations

- Market surveillance authorities should continue to check at national level such products and take all appropriate measures to ban non compliant products from the market.
- Spectrum regulators could analyse if changes are required to their current national spectrum rules in the field of use of mobile phone repeaters by end users.
- New harmonised standards for mobile phone repeaters for the mass market that include specific features to avoid harmful interference (e.g. automatic gain control, anti oscillation circuits, automatic frequency selection, bandwidth selection, operation only under control of base station ...) should be developed by ETSI.
- The cooperation at national level between interference management and market surveillance authorities should be improved to detect rapidly non compliant products as possible sources of interferences and to remove them from the market.
- All national MSA should participate in future market surveillance campaigns to fulfil the requirement of market surveillance obligations included in the New Legislative Framework (NLF).
- The results of the campaign should be publicized widely throughout Europe and to other countries of origin of the products.
- There should be press releases widely throughout Europe to educate the population and users in relation to the interference problems of repeaters.
- In line with the cooperation of customs, special attention should be given to the import checks of repeaters at the borderline.

D. References

EN 300 609-4 V10.2.1	Global System for Mobile communications (GSM); Part 4: Harmonized EN for GSM Repeaters covering the essential requirements of article 3.2 of the R&TTE Directive
EN 301 908-11 V5.2.1	IMT cellular networks; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive; Part 11: CDMA Direct Spread (UTRA FDD) (Repeaters)
EN 301 908-12 V4.2.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Base Stations (BS), Repeaters and User Equipment (UE) for IMT-2000 Third-Generation cellular networks; Part 12: Harmonized EN for IMT-2000, CDMA Multi-Carrier (cdma2000) (Repeaters) covering the essential requirements of article 3.2 of the R&TTE Directive
EN 301 908-15 V5.2.1	IMT cellular networks; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive; Part 15: Evolved Universal Terrestrial Radio Access (E-UTRA FDD) (Repeaters)

E. Abbreviations

ADCO R&TTE	Group of Administrative Cooperation for the sector of radio equipment and telecommunications terminal equipment
CIRCABC	Communication and Information Resource Centre for Administrations, Businesses and Citizens
DIF	Data Input Form
DoC	Declaration of Conformity
ECC	the Electronic Communications Committee
EEA	the European Economic Area
ETSI	European Telecommunications Standards Institute
ICSMS	Internet-based Information and Communication System for Europe wide cross-border Market Surveillance of technical products
MSA	Market Surveillance Authority
R&TTE CA	the Radio and Telecommunications Terminal Equipment Compliance Association
TCAM	the Telecommunication Conformity Assessment and Market Surveillance Committee
TD	technical documentation