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VTS – Voluntary Testing Standard 2102

Static Indoor Mobile Phone Repeaters

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1. Foreword

Background

1.1 In our final statement, dated 4 November 2021 and entitled "Mobile Phone Repeaters" (the "**2021 Statement**")[1], we explained that we have decided to extend the range of static indoor repeaters available for people to buy and install themselves without a wireless telegraphy licence. In particular, we decided that it would be appropriate to allow the use of provider-specific repeaters and multi-operator repeaters.

1.2 In each case the repeaters must meet appropriate technical requirements specified by Ofcom. These technical requirements are set out in the Wireless Telegraphy (Mobile Repeater) (Exemption) Regulations 2022 (the "**Exemption Regulations**") which come into force on 16 June 2022. They are also summarised in UK Interface Requirement IR 2102.1 and IR 2102.3 (the "**Interface requirements**"), a copy of which is provided below.[2]

1.3 We also explained in the 2021 Statement that, to help the public identify static indoor repeaters that can be used 'legally' without a licence – rather than 'illegal' devices that risk causing interference – we also intend to publish on our website a list of mobile phone repeaters that we understand comply with the technical requirements of our licence exemption regime ("**Ofcom's List**").

1.4 To be clear, Ofcom will not endorse or approve particular products. Instead, Ofcom's List will simply identify devices that have been subjected to testing by an accredited test house to show they meet our technical requirements, using this voluntary testing standard produced by Ofcom. For the avoidance of doubt, we only intend at present to include static indoor mobile phone repeaters on Ofcom's List; we do not intend to include in-vehicle repeaters which meet the technical requirements set out in IR 2102.2 in that list.

Purpose of this document

1.5 This document sets out Ofcom's voluntary testing standard (referred to as the "**VTS**"). It is intended to provide guidance on the testing of static indoor mobile phone repeaters for a number of the technical requirements in the Exemption Regulations. It is therefore relevant for the testing of provider-specific (including single-operator) and multi-operator mobile phone repeaters which operate in all or parts of the frequency bands listed in Table 1. As noted above, it is not relevant for the testing of in-vehicle repeaters. Readers should be advised that (i) successful testing in accordance with this VTS does not guarantee that a repeater device satisfies the technical requirements in the Exemption Regulations, and (ii) where there is not a test standard within this VTS for some of the applicable technical requirements (e.g., the requirement that a repeater not cause undue interference), those

[1] Statement: Mobile Phone Repeaters (ofcom.org.uk)
[2] The Exemption Regulations set out the detail of the technical requirements in full and, in the event of any inconsistency between the Exemption Regulations and IR 2102, the Exemption Regulations shall take precedence.

technical requirements must still be satisfied in order for that device to benefit from licence exemption in the UK.

Table 1: Service frequency bands

Direction of transmission	Frequency Bands
Uplink	700 (703-733 MHz) 800 (832-862 MHz) 900 (880-915 MHz) 1800 (1710-1785 MHz) 2100 (1920-1980 MHz)
Downlink	700 (758-788 MHz) 800 (791-821 MHz) 900 (925-960 MHz) 1800 (1805-1880 MHz) 2100 (2110-2170 MHz)

1.6 This VTS does not provide guidance on meeting the requirements of the Radio Equipment Directive 2014/53/EU or the Radio Equipment Regulations 2017, which requirements are separate from the technical requirements set out in the Exemption Regulations.

1.7 Manufacturers are not required to follow the VTS in order to satisfy themselves that their equipment is compliant with the Exemption Regulations. It is however necessary should a device manufacturer wish for its device to be included on Ofcom's List. In particular, where a manufacturer is able to provide sufficient evidence to demonstrate that a mobile repeater device has been tested by an accredited test house in accordance with this VTS, we would expect to include this on Ofcom's List.[3]

1.8 This VTS should not be relied upon as legal advice or understood as modifying any legal obligations which may otherwise apply.

1.9 Ofcom makes no representation or warranty, express or implied, with respect to the information contained in the VTS and any liability is therefore expressly disclaimed.

1.10 Ofcom reserves the right to modify the VTS from time to time. If we do so, we may require devices on Ofcom's List to be removed from that list until such time as it can be demonstrated that they have been tested in accordance with the modified VTS.

[3] Whether or not a particular device will be included in Ofcom's List is at Ofcom's discretion. Whilst confirmation that a device has been tested in accordance with the VTS by an accredited test house is a pre-condition of inclusion on Ofcom's List, Ofcom may seek assurance on other matters before a device is included on its website. For example, Ofcom would also expect to be satisfied that a device is compliant with other national regulatory requirements (for example, that it was designed and manufactured in accordance with the essential requirements in the Radio Equipment Regulations 2017).

2. Minimum Technical Requirements

2.1 The technical requirements with which static mobile phone repeaters for indoor use must comply to be exempt from the requirement for a wireless telegraphy licence in the United Kingdom are set out in the Exemption Regulations. A copy of the Exemption Regulations is available at legislation.gov.uk.

2.2 We appreciate that some stakeholders may be accustomed to the style and format of Interface Requirements. To aid readers, we have therefore also published the minimum technical requirements for mobile repeaters in the format of Interface Requirements alongside the Exemption Regulations. A copy of IR 2102.1 and 2102.3 (which apply to static indoor mobile phone repeaters) is below. Readers should be advised that, to the extent that there is any inconsistency between the Interface Requirements and/or this VTS and the requirements in the Exemption Regulations, the Exemption Regulations shall take precedence.

IR2102.1: Minimum requirements for the use of provider-specific static mobile phone repeaters for indoor use

Mandatory (1-11)			
1	Radiocommunication Service	Mobile	
2	Application	Provider-specific static mobile phone repeaters for indoor use	
3	Frequency bands	700	703-733 MHz (Uplink) 758-788 MHz (Downlink)
		800	791-821 MHz (Downlink) 832-862 MHz (Uplink)
		900	880-915 MHz (Uplink) 925-960 MHz (Downlink)
		1800	1710-1785 MHz (Uplink) 1805-1880 MHz (Downlink)
		2100	1920-1980 MHz (Uplink) 2110-2170 MHz (Downlink)
4	Channelling	Not specified	
5	Modulation / Occupied bandwidth	Not specified	
6	Direction / Separation	Repeater transmit/receive	
7	Transmit power/Power density	See Table A1	

8	Channel access and occupation rules	Transmit Gain Control The uplink and downlink system gain in dB of a repeater, referenced to its input and output ports, shall not exceed BSCL−30, where BSCL (base station coupling loss) is the path loss between the base station and the repeater. Where BSCL cannot be determined, the repeater must not transmit. The uplink and downlink system gain of a repeater shall not exceed 100 dB. The apparatus shall determine the value of BSCL by calculating the difference between the carrier power received at the repeater and the carrier power transmitted from the base station. The carrier power transmitted by the base station may be determined from the system information messages sent by the base station on its control channels.
		Automatic Standby When the repeater is no longer serving an active connection between a mobile device operating on the network of a particular mobile network operator and that mobile network, it must, after no more than 5 minutes, reduce any uplink noise power associated with the frequencies licensed to that mobile network operator to no more than −70 dBm/MHz EIRP.
		Anti-Oscillation Repeaters must detect and stop (i.e. by automatic gain reduction or shut down) any oscillations in uplink and downlink frequency bands. Oscillation detection must occur automatically within: • 0.3 seconds in the uplink band; and • 1 second in the downlink band. In cases where oscillation is detected, the repeater must continue any anti-oscillation technique for at least one minute. After anti-oscillation techniques have been used five times, the repeater must cease transmitting and cannot resume operation until manually reset.

		Provider Specific configuration Where a repeater is only capable of amplifying frequencies licensed to one mobile network operator at a time, the Transmit Power/Power Density and Transmit Gain Control requirements shall be calculated and applied individually for each uplink and downlink frequency band (as defined in Mandatory 3) that is being amplified by that repeater. Where a repeater is capable of amplifying frequencies licensed to more than one mobile network operator at the same time, those requirements shall be calculated and applied individually for each of the uplink and downlink frequency bands licensed to each mobile network operator that is being amplified by that repeater.
		Noise Figure The repeater system noise figure shall not exceed 7 dB.
9	Authorisation regime	**Licence Exempt** [4] The deployment of a 4G only provider-specific static mobile phone repeater is not permitted. When amplifying a 4G signal licensed to a mobile network operator, all provider-specific static mobile phone repeaters must also amplify a 2G and/or a 3G signal licensed to that mobile network operator.
10	Additional essential requirements	Nil
11	Frequency planning assumptions	Not specified
Informative (12-15)		
12	Planned changes	Nil
13	Reference	EN 303 609 EN 301 908-11 EN 301 908-15

[4] See remarks

14	Remarks	Nil
15	Notification Number (in respect of Northern Ireland)	2021/7013/XI

Table A1			
Band	**Technology**	**Maximum Uplink Power**	**Maximum Downlink Power (indoor use only)**
700 & 800	Technology Neutral	23 dBm EIRP	PSD 10 dBm / 5 MHz EIRP; and Total 17 dBm EIRP
900	GSM	33 dBm EIRP	10 dBm EIRP
1800	GSM	30 dBm EIRP	10 dBm EIRP
900, 1800 & 2100	3G	24 dBm EIRP	PSD 10 dBm / 5 MHz EIRP; and Total 17 dBm EIRP
900 & 1800	Technology Neutral (excluding GSM and 3G)	23 dBm EIRP	PSD 10 dBm / 5 MHz EIRP; and Total 17 dBm EIRP
2100	Technology Neutral (excluding 3G)	24 dBm EIRP	PSD 10 dBm / 5 MHz EIRP; and Total 17 dBm EIRP
Where PSD is power spectral density			

IR2102.3: Minimum requirements for the use of multi-operator static mobile phone repeaters for indoor use

Mandatory (1-11)			
1	Radiocommunication Service	Mobile	
2	Application	Multi-operator static mobile phone repeaters for indoor use	
3	Frequency band	700	703-733 MHz (Uplink) 758-788 MHz (Downlink)
		800	791-821 MHz (Downlink) 832-862 MHz (Uplink)
		900	880-915 MHz (Uplink) 925-960 MHz (Downlink)
		1800	1710-1785 MHz (Uplink) 1805-1880 MHz (Downlink)
		2100	1920-1980 MHz (Uplink) 2110-2170 MHz (Downlink)
4	Channelling	Not specified	
5	Modulation / Occupied bandwidth	Not specified	
6	Direction / Separation	Repeater transmit/receive	
7	Transmit power/Power density	Maximum Uplink Power for each Frequency Band	17dBm/ 5 MHz EIRP
		Maximum Downlink Power for each Frequency Band	10dBm / 5 MHz EIRP (indoor use only)
8	Channel access and occupation rules	Transmit Gain Control The uplink and downlink system gain in dB of a repeater, referenced to its input and output ports, shall not exceed 10-RSSI, where RSSI is the downlink composite received signal power in dBm at the repeater donor port, for all base stations in the band of operation.	

		A repeater shall provide the same uplink and downlink system gain. The uplink and downlink system gain of a repeater shall not exceed 100 dB.
		Automatic Standby When the repeater does not serve an active connection between a mobile device and a mobile network it must, after no more than 5 minutes, reduce any uplink noise power to no more than −70 dBm/MHz EIRP.
		Anti-Oscillation Repeaters must detect and stop (i.e. by automatic gain reduction or shut down) any oscillations in uplink and downlink frequency bands. Oscillation detection must occur automatically within: • 0.3 seconds in the uplink band; and • 1 second in the downlink band. In cases where oscillation is detected, the repeater must continue any anti-oscillation technique for at least one minute. After anti-oscillation techniques have been used five times, the repeater must cease transmitting and cannot resume operation until manually reset.
		Noise Figure The repeater system noise figure shall not exceed 7 dB.
		Intermodulation due to signals within the frequency band(s) of operation For each frequency band that is being amplified by the repeater, transmitted intermodulation products due to input signals within that band shall not exceed −19dBm at the donor and coverage ports.

9	Authorisation regime	**License Exempt** [5] All multi-operator static mobile phone repeaters must transmit the entirety of the 900, 1800 and 2100 frequency bands as defined in **Mandatory 3**. This requirement ensures that the 2G/3G layers of all MNOs are repeated by the multi-operator repeater, ensuring that 4G-only hotspots are not created in premises using a licence-exempt repeater.
10	Additional essential requirements	Nil
11	Frequency planning assumptions	Not specified
Informative (12-15)		
12	Planned changes	Nil
13	Reference	EN 303 609 EN 301 908-11 EN 301 908-15
14	Remarks	Nil
15	Notification Number (in respect of Northern Ireland)	2021/7013/XI

[5] See remarks

3. Testing for compliance with the minimum technical requirements

3.1 A mobile phone repeater supplied by a manufacturer for testing will be referred to as a unit under test (UUT) in this section.

Conditions for testing

Normal and extreme test conditions

3.2 It should usually be sufficient for all tests to be conducted under normal test conditions as declared by the manufacturer (e.g., operating temperature, humidity, voltage), except where otherwise stated.

3.3 Where technical performance varies under extreme environmental conditions, as declared by the manufacturer, the tests defined in the present document shall be carried out at representative points within the boundary limits of the declared operational environmental profile (i.e., at points between the minimum and maximum operating temperature and humidity).

3.4 Where required, tests shall be repeated under a sufficient variety of environmental conditions to give confidence of compliance for the affected technical requirements.

3.5 The UUT must be switched on for at least 20 minutes before any tests can be carried out.

Antennas: Integral and external antennas

3.6 External antennas are antennas that are physically external to the equipment and are assessed in combination with the equipment against the requirements in the Exemption Regulations.

3.7 An antenna assembly referred to in the present document is understood as the combination of the antenna (integral or external), its coaxial cable and, if applicable, its antenna connector and associated switching components.

3.8 For a UUT with antenna connector(s) and using external antenna(s), or for a UUT with integral antenna(s) but with a temporary antenna connector(s) provided, conducted measurements shall be used in conjunction with the stated antenna assembly gain(s).

3.9 For a UUT with integral antenna(s) and without a temporary antenna connector(s), radiated measurements shall be used.

3.10 Where an external antenna is supplied, independent evidence shall be provided to the test house to validate the antenna specification declared by the manufacturer. Independent evidence may include data sheets or calibration certificates.

Information to be provided by the manufacturer

3.11 The following information relating to the UUT should be provided to the test house: [6]

- Type of mobile phone repeater described as: a provider-specific mobile repeater device or a multi-operator mobile repeater device.
- The intended technology (e.g., 2G, 3G, 4G, 5G).
- The operating frequency range(s) of the equipment.
- The nominal channel bandwidth(s) that the equipment can support.
- The Automatic Gain Control (AGC) level.
- The external antenna gain (dBi) and power/power spectrum density (dBm or dBm/measured BW) of the antenna assembly intended to be used in combination with the equipment (if used).
- The integral antenna design used by the equipment, and measures to prevent the user from connecting a different antenna (if used).
- Rated output power of the repeater i.e., the mean power level per carrier available at the antenna connector port.
- The maximum EIRP level.
- Normal and extreme operating conditions (e.g., temperature and humidity range, operating voltage).
- The device type, model identifier, serial number, device emission class and firmware version of the repeater.

3.12 The following information shall be declared in the report provided by the test house to Ofcom:

- A declaration from the test house that the mobile repeater equipment has been tested in accordance with the VTS.
- A description of all components used during the testing including, but not limited to, transition connectors, cables and couplers.
- The normal and the extreme operating conditions (e.g., voltage and temperature) that were applied to the equipment during testing.
- A description of the test equipment used during testing including, where available, details of any relevant calibration.
- Results of test suites including comparison with limits set out in the Exemption Regulations (and summarised in the Interface Requirements).
- All results shall include the values obtained before and after system correction. For example, showing results before adjusting for cable/transmission loss and results after adjusting for cable/transmission loss.
- Any information that has been provided by the manufacturer as listed in paragraph 3.11.

[6] Although we would expect this information to be shared with tests houses to assist with testing, it is not a requirement for demonstrating conformity with the VTS

Test suites: Frequency band of operation and transmit gain control

3.13 This test suite applies to the frequency band rules and system gain requirements defined in the Exemption Regulations. Specifically:

- Rules applicable to all mobile repeater devices: 5(2)
- Additional rules applicable to provider-specific mobile repeater devices: 9, 12(1), 12(2)
- Additional rules applicable to multi-operator mobile repeater devices: 13, 16(1)

3.14 This test will identify the frequency at which the maximum gain is realised within each UUT operational band. The UUT shall reject amplification of other signals outside of its passband for it to be able to pass the test.

3.15 Results obtained shall be compared to limits set in the Exemption Regulations (and summarised in the Interface Requirements) to validate the UUTs compliance.

Test method for multi-operator repeaters

3.16 The test method applies to conducted measurements.

3.17 Step 1

- The UUT shall be connected as shown in Figure 1 found in Annex 1, either in test mode or normal mode.
- The spectrum analyser shall be configured with the following settings:

Centre Frequency:	Centre frequency of the operating frequency under test.
Resolution Bandwidth:	100 kHz
Video Bandwidth:	≥ 3 x RBW
Detector Type:	Peak
Trace Mode:	Max Hold
Sweep Time:	Auto
Span:	1 MHz

3.18 Step 2

- The signal generator should be used to generate a CW signal with centre frequency of the operating band being tested.
- The signal generator power shall be initially set to a level that is at least 6 dB below the AGC level specified by the manufacturer.
- Slowly increase the signal generator power level until the output signal reaches the AGC operational level.
- Record this level.

- Reduce the signal generator power to a level that is 3 dB below the AGC operating level, then manually reset the UUT.

3.19 Step 3

- Adjust the spectrum analyser span to double the frequency bandwidth being tested.
- Adjust the tuned frequency of the signal generator to sweep double the frequency bandwidth using the sweep function.
- The signal generator power shall be below the AGC operating level when carrying out this test.
- Using three markers, identify the signal band edges and the frequency with the highest power.
- These values should be recorded.

3.20 Step 4

- To ensure that the entirety of the 900, 1800 and 2100 frequency bands are in use and no 4G-only hotspots are created, connect a second signal generator to the UUT with a 4G frequency band and configure the first signal generator to operate in either a 2G or 3G frequency band.
- Use a step attenuator and a combiner to combine both signals.
- Using three markers, identify the signal band edges and the frequency with the highest power for all the selected frequency bands in the previous step.
- These values should be recorded.

3.21 Step 5

- Repeat steps one to four for all operational uplink and downlink bands.

Test method for provider-specific repeaters

3.22 Step 1

- Set up the UUT in normal mode as shown in Figure 7 found in Annex 1.
- Set the base station simulator #2 transmitting the relevant MNO provider signal to the UUT.
- The base station simulator #1 should be switched off.
- Set the level of the base station simulator such that the UUT reaches maximum output power in the downlink direction.

3.23 Step 2

- The spectrum analyser shall be configured with the following settings:

Centre Frequency:	Centre frequency of the operating frequency under test.
Resolution Bandwidth:	100 kHz
Video Bandwidth:	≥ 3 x RBW
Detector Type:	Peak
Trace Mode:	Max Hold
Sweep Time:	Auto
Span:	5 MHz

3.24 Step 3

- The signal generator should be used to generate a CW signal[7] with centre frequency of the operating band being tested, or used to generate an Additive White Gaussian Noise (AWGN) signal with 90% BW.
- The signal generator power shall be initially set to a level that is at least 6 dB below the AGC level specified by the manufacturer.
- Slowly increase the signal generator power level until the output signal reaches the AGC operational level.
- Record this level.
- Reduce the signal generator power to a level that is 3 dB below the AGC operating level, then manually reset the UUT.

3.25 Step 4

- Adjust the spectrum analyser span to double the frequency bandwidth being tested.
- Adjust the tuned frequency of the signal generator to sweep double the frequency bandwidth using the sweep function.
- The signal generator power shall be below the AGC operating level when carrying out this test.

3.26 Step 5

- Using three markers, identify the signal band edges and the frequency with the highest power.
- These values should be recorded.

3.27 Step 6

- Repeat Steps 1 to 5 for all operational uplink and downlink bands.
- For 4G bands, verify that the UUT is not transmitting without the presence of a 2G/3G signal.

[7] Some Repeaters will decode the signal before retransmitting. In that specific case a signal with the technology type associated with the provider within the spectrum block under test can be used instead of a CW signal.

3.28 Step 7

- To test a 4G spectrum block, a second signal generator shall be connected to the UUT.
- One signal generator shall be set up to use the 2G or 3G frequency band allocation as specified by the provider and the second signal generator shall be set up with the 4G frequency band allocation as specified by the provider.
- Use a step attenuator and a combiner to combine both signal generators.

3.29 Step 8

- Repeat Steps 1 and 2.
- Set the level of the uplink signal generator such that the UUT reaches maximum output power in the uplink direction.
- Set the centre frequency of the donor port spectrum analyser to one of the supported uplink spectrum blocks, and coverage port spectrum analyser to one of the supported downlink spectrum blocks.
- Ensure that the power averaging RMS detector is selected on the spectrum analyser.

3.30 Step 9

- Measure and record the transmit power levels in both the uplink and downlink directions.

3.31 Step 10

- Change the base station or signal generator simulator signal to a non-authorised MNO provider signal at the same centre frequency.

3.32 Step 11

- Reset the UUT.

3.33 Step 12

- Measure and record the maximum transmitter noise power level in both the uplink and downlink directions.
- Calculate the UUT gain level in the uplink direction. The formula is provided in paragraph 3.59.

3.34 Step 13

- Save the spectrum analyser plot as necessary for inclusion in the final test report.

3.35 Step 14

- Repeat Steps 10 to 13 for two additional non-authorised MNO provider bands.

3.36 Step 15

- Set the base station simulator #1 transmitting the relevant MNO provider signal to the UUT.
- Set base station simulator #2 transmitting on an un-authorised, co-channel MNO provider signal to the UUT. Make sure that the signal band uses the same technology as base station simulator #2

- Set both simulators such that the level at the donor port is set at -85dBm.
- Set the attenuator to 20dB.

3.37 Step 16

- The uplink spectrum analyser shall be re-configured with the following settings:

Centre Frequency:	Centre frequency of the uplink operating frequency under test.
Resolution Bandwidth:	1MHz
Video Bandwidth:	≥ 3 x RBW
Detector Type:	Power averaging (RMS)
Trace Mode:	Max Hold
Sweep Time:	Single sweep of at least 10 seconds
Span:	0 Hz

- The downlink spectrum analyser shall be re-configured with the following settings:

Centre Frequency:	Centre frequency of the downlink operating frequency under test.
Resolution Bandwidth:	1MHz
Video Bandwidth:	≥ 3 x RBW
Detector Type:	Power averaging (RMS)
Trace Mode:	Max Hold
Sweep Time:	Single sweep of at least 10 seconds
Span:	0 Hz

3.38 Step 17

- Change the step attenuator to 0dB in one step.
- Verify that the UUT output drops below the automatic standby mode limit within the time specified in the Exemption Regulations (and summarised in the Interface Requirements) in both uplink and downlink directions and save the spectrum analyser plots for inclusion in the final test report.

3.39 Step 18

- Repeat Steps 15 to 17 using different technology types.

3.40 Step 19

- Repeat Steps 1 to 18 for all permitted MNO bands.
- For 4G bands, a second signal generator is used as specified in paragraph 3.28.

Test suites: Maximum uplink and downlink power

3.41 This test suite applies to the power limits and power spectral density requirements defined in the Exemption Regulations. Specifically:

- Additional rules applicable to provider-specific mobile repeater devices: 11(a), 11(b), 11(c), 11(d), 11(e), 11(f), 11(g), 11(h)
- Additional rules applicable to multi-operator mobile repeater devices: 15(1), 15(2)

3.42 Results obtained shall be compared to the power limits set in the Exemption Regulations (and summarised in the Interface Requirements) to validate the repeaters compliance to the set power limits.

Test method for multi-operator repeaters

3.43 Step 1

- The UUT shall be connected as shown in Figure 1 found in Annex 1.
- The spectrum analyser shall be configured with the following settings:

Centre Frequency:	Set at the highest power captured in paragraph 3.18. The centre frequency should not be closer than 2.5MHz to the band edge
Frequency Span:	≥10 MHz
Resolution Bandwidth:	100 kHz
Video Bandwidth:	≥ 3 x RBW
Detector Type:	Peak
Trace Mode:	Max Hold
Sweep Time:	Auto

3.44 Step 2

- The signal generator power shall be initially set to a level which will cause AGC activation as verified in paragraph 3.18.
- Slowly increase the signal generator power level until the output signal reaches the AGC operational limit (i.e., no further increase in output power as input power increases).
- Reduce the signal generator power to ensure that the AGC is not controlling the power output.

3.45 Step 3

- Slowly increase the signal generator power to a level just below (and within 0.5 dB of) the AGC limit without triggering the AGC.
- Note this value as Power input, P_{in}.

3.46 Step 4

- Measure the output power, P_{out}, with the spectrum analyser as follows:

Centre Frequency:	No closer than 2.5MHz to the band edge
Frequency Span:	≥10 MHz.
Resolution Bandwidth:	100 kHz for AWGN, 300kHz for CW and 300kHz for GSM
Video Bandwidth:	≥ 3 x RBW
Trace Mode:	≥ 100 traces in power averaging
Sweep Time:	Auto
Detector Type:	Power averaging (RMS) detector
Measurement Mode:	BURST POWER or CHANNEL POWER
Channel Power Integration bandwidth (for AWGN):	99% BW for AWGN signals

- Record the measured power level P_{out}, for both the GSM (or CW input stimulus instead), and another set of results for the AWGN input stimulus.

3.47 Step 5

- Repeat Steps 2 to 4 while increasing the signal generator amplitude in 2 dB steps until the maximum input level of -20dBm is reached
- If the UUT has shut down at any point during the input power steps, it should be noted, and these steps shall be repeated at an input level 1 dB less than the input level value found to cause the shutdown.

3.48 Step 6

- Record and repeat Steps 1 to 5 for all operational uplink and downlink bands of the UUT.

3.49 Step 7

- If an external antenna is used, calculate the power density using the gain of the external antenna obtained from the manufacturer.
- The radiated power spectrum density shall be calculated by adding the conducted power (or the power spectral density declared by the manufacturer) to the antenna gain and UUT nominal gain obtained while conducting the “Frequency band of operation and the maximum system gain” test suite.

- The power and declared gain should be used to determine the maximum uplink and downlink power.

Test method for provider-specific repeaters

3.50 Step 1

- The UUT shall be connected as shown in Figure 7 found in Annex 1.
- The spectrum analyser shall be configured with the following settings:

Centre Frequency:	Set at the highest power captured in paragraph3.24. The centre frequency should not be closer than 2.5MHz to the band edge
Frequency Span:	≥10 MHz
Resolution Bandwidth	100 kHz
Video Bandwidth:	≥ 3 x RBW
Detector Type:	Peak
Trace Mode:	Max Hold
Sweep Time:	Auto

3.51 Step 2

- Set the base station simulator #2 transmitting a supported MNO provider signal to the UUT.
- The base station simulator #1 should be switched off.
- The signal type should be set as a AWGN signal with occupied bandwidth equal to the bands under test.
- For 4G bands a second signal generator is used as specified in paragraph 3.28.

3.52 Step 3

- The signal generator power shall be initially set to a level which will cause AGC activation as verified in paragraph 3.24.
- Slowly increase the signal generator power level until the output signal reaches the AGC operational limit (i.e., no further increase in output power as input power increases).
- Reduce the signal generator power to ensure that the AGC is not controlling the power output.

3.53 Step 4

- Slowly increase the signal generator power to a level just below (and within 0.5 dB of) the AGC limit without triggering the AGC.
- Note this value as Power input, P_{in}.

3.54 Step 5

- Record and repeat Steps 1 to 4 for all operational uplink and downlink bands of the repeater.

3.55 Step 6

- If an external antenna is used, calculate the power density using the gain value of the external antenna obtained from the manufacturer.
- The radiated power spectrum density shall be calculated by adding the conducted power (or the power spectral density declared by the manufacturer) to the antenna gain and UUT nominal gain obtained while conducting the "Frequency band of operation and the maximum system gain" test suite.
- The power and declared gain should be used to determine the maximum uplink and downlink power.

Test suites: System gain

3.56 This test suite applies to the system gain limits defined in the Exemption Regulations. Specifically:

- Additional rules applicable to provider-specific mobile repeater devices: 12(1), 12(2), 12(3), 12(4), 12(5)
- Additional rules applicable to multi-operator mobile repeater devices: 16(1), 16(2)

3.57 This section provides calculations for maximum gain based on the data obtained as part of the tests described at paragraphs 3.41-3.55.

3.58 Results obtained shall be compared to limits set in the Exemption Regulations (and summarised in the Interface Requirements) to validate the repeater's compliance to the set limits.

Test method for multi-operator and provider-specific repeaters

3.59 Step 1

- For both the uplink and downlink in each supported frequency band, use each of the P_{OUT} and P_{IN} result from values obtained in power measurements procedures in the following equation to obtain the maximum gain, G:

$$G(dB) = P_{OUT}(dBm) - P_{IN}(dBm)$$

3.60 Step 2

- Record the maximum gain of the uplink and downlink paths for each supported frequency band.

3.61 Step 3

- Calculate the total system gain, including the external antenna where applicable, for the UUT.
- Verify that the uplink and downlink system gain of the UUT does not exceed 100 dB.

3.62 Step 4

- Provide tabulated results and applicable limit comparison in the test report.

Test suites: Additional test requirements for system gain

3.63 This test suite applies to the system gain limits defined in the Exemption Regulations. Specifically:

- Additional rules applicable to provider-specific mobile repeater devices: 12(3b), 12(4), 12(5)
- Additional rules applicable to multi-operator mobile repeater devices: 16(1)(a)(ii), 16(1)(b), 16(2)

3.64 The RSSI is varied over a range of values as specified within the procedure.

3.65 The BSCL is varied over a range of values by adjusting the variable attenuator between base station simulator (or signal generator) and the repeater as specified within the procedure.

3.66 Results obtained shall be compared to limits set in the Exemption Regulations (and summarised in the Interface Requirements) to validate the repeater's compliance to the set limits.

Test method for multi-operator repeaters

3.67 Step 1

- Connect the UUT to the test equipment as shown in Figure 5 found in Annex 1.
- Ensure that the coupled path of the RF coupler is connected to the spectrum analyser.

3.68 Step 2

- Configure downlink signal generator #1 and uplink signal generator #2 for AWGN operation with a 99% BW.
- Set the frequency of signal generator #1 to the centre of the frequency band under test.
- Set the power level and frequency of signal generator #2 to a value that is 8 dB below the AGC level determined from paragraph 3.18.

3.69 Step 3

- The spectrum analyser shall be configured with the following settings:

Resolution Bandwidth:	100 kHz
Video Bandwidth:	≥ 3 x RBW
Sweep Time:	Auto
Detector Type:	Power averaging (RMS) detector
Number of measurement points per sweep:	≥ (2×span)/RBW
Channel Power:	selected

Trace Average:	10 traces in power averaging mode

3.70 Step 4

- Measure the maximum channel power and compute maximum gain when varying the signal generator downlink output to a level from −100 dBm to −30 dBm, as measured at the coverage port, in 5 dB steps.
- Compute the margin difference between the RSSI and gain values.

3.71 Step 5

- Repeat Steps 1 to 4 for all supported uplink bands.
- For 4G bands a second signal generator is used as specified in paragraph 3.28.

3.72 Step 6

- Calculate the system level gain including external antenna gain, and any cable loss for the system level gain calculations.

Test method for provider-specific repeaters

3.73 Step 1

- Connect the UUT to the test equipment as shown in Figure 7 found in Annex 1.
- A signal generator could be used as an alternative to a base station simulator.

3.74 Step 2

- Configure the base station simulator #2 for the transmission of a base station signal according to the type of technology being tested (2G/3G/4G).
- Base station simulator #1 should be switched off.
- Set the base station forward pilot/control channel transmit power to a fixed value that can achieve the dynamic range indicated in the following procedure.
- Set the power level and frequency of the signal generator to a value 5 dB below the AGC threshold level as verified in paragraph 3.24.
- The uplink signal generator should be configured for AWGN operation with 99% BW, tuned to the centre of the frequency band under test.
- For 4G bands a second signal generator is used as specified in paragraph 3.28.

3.75 Step 3

- The spectrum analyser shall be configured with the following settings:

Resolution Bandwidth:	100 kHz
Video Bandwidth:	≥ 3 x RBW
Sweep Time:	Auto
Detector Type:	Power averaging (RMS) detector
Number of measurement points per sweep:	≥ (2×span)/RBW

Channel Power:	selected
Trace Average:	10 traces in power averaging mode

3.76 Step 4

- Measure the maximum channel power in both uplink and downlink direction and compute maximum gain when varying the variable attenuator to the received downlink output level from −100 dBm to −30 dBm, as measured at the coverage port, in 5 dB steps.
- BSCL should be determined by calculating the difference between channel power received at the UUT and the carrier power transmitted from the base station.
- If a signal generator is used, a +25 dBm per channel assumption could be used instead. BSCL is then determined by calculating the difference between +25dBm and the total downlink channel power.
- Compute the margin difference between the BSCL and gain values.

3.77 Step 5

- Repeat Steps 1 to 4 for all supported uplink bands.
- For 4G bands a second signal generator is used as specified in paragraph 3.28.

3.78 Step 6

- Calculate the system level gain including external antenna gain, and any cable loss for the system level gain calculations.

Test suites: Intermodulation products

3.79 This test suite applies to transmitted intermodulation products defined in the Exemption Regulations. Specifically:

- Additional rules applicable to multi-operator mobile repeater devices: 17(1), 17(2)

3.80 Results obtained shall be compared to limits set in the Exemption Regulations (as summarised in the Interface Requirements) to validate the repeater's compliance to the set limits.

Test method for multi-operator repeaters

3.81 Testing procedures for intermodulation are specified in ETSI standards: EN 301 908-11 Section 5.3.4, EN 301 908-15 Section 5.3.4, EN 301 908-15 Section 5.3.5 and EN 301 908-11 Section 5.3.5.

3.82 To ensure compliance with the Exemption Regulations, an additional measurement using the same test procedures in paragraph 3.81 shall be made using two tone CW 300 kHz below and above the frequency under test with the highest power as recorded in paragraph 3.20. The test should be repeated for each supported frequency band of operation.

3.83 The test should be performed twice, once using the maximum output power without activating the AGC and another 10dB above the AGC.

3.84 Results should be recorded and compared with limits specified in the Exemption Regulations (as summarised in the Interface Requirements).

Test suites: System Noise Figure

3.85 This test suite applies to the system noise figure limit defined in the Exemption Regulations. Specifically:

- Rules applicable to all mobile repeater devices: 8(1), 8(2)

3.86 Results obtained shall be compared to limits set in the Exemption Regulations (as summarised in the Interface requirements) to validate the repeater's compliance to the set limits.

Test method for multi-operator repeaters

3.87 Step 1

- Connect the UUT to the test equipment as shown in Figure 2 found in Annex 1.
- When measuring uplink noise, connect the coverage port to the spectrum analyser (with the matched load connected to the donor port).
- When measuring downlink noise, connect the donor port to the spectrum analyser (with the matched load connected to the coverage port).
- If the UUT is only active when an input is required, connect a second signal generator with a RF signal simulating this function.

3.88 Step 2

- Measure the uplink or downlink noise power with the spectrum analyser as follows:

Centre Frequency:	Centre frequency of the operating frequency under test.
Resolution Bandwidth:	1MHz
Video Bandwidth:	≥ 3 x RBW
Detector Type:	Peak
Trace Mode:	Max Hold
Sweep Time:	Auto
Span:	Double the BW under test

3.89 Step 3

- Repeat Steps 1 and 2 for all supported uplink and downlink bands and record the results.

3.90 Step 4

- Connect the UUT to the test equipment as shown in Figure 2 found in Annex 1, for uplink noise power measurement (coverage port connected to spectrum analyser) in the presence of a downlink signal.
- Ensure the coupled path of the RF coupler is connected to the spectrum analyser.

3.91 Proceed to paragraph 3.97.

Test method for provider-specific repeaters

3.92 Step 1

- Connect the UUT to the test equipment as shown in Figure 8 found in Annex 1.
- Set the UUT to maximum gain and minimal passband BW.
- If the UUT is only active when an input is required, connect a second signal generator with a RF signal simulating this function.

3.93 Step 2

- Measure the uplink or downlink noise power with the spectrum analyser as follows:

Centre Frequency:	Centre frequency of the operating frequency under test.
Resolution Bandwidth:	1MHz
Video Bandwidth:	≥ 3 x RBW
Detector Type:	Peak
Trace Mode:	Max Hold
Sweep Time:	Auto
Span:	Double the BW under test

3.94 Step 3

- Repeat Steps 1 and 2 for all supported uplink and downlink bands and record the results.

3.95 Step 4

- Connect the UUT to the test equipment as shown in Figure 9 found in Annex 1 for the uplink noise figure measurement or Figure 10 found in Annex 1 for the downlink noise figure measurement.
- For uplink noise measurements, set the spectrum analyser centre frequency for the uplink frequency and set the signal from the signal generator to the centre of the paired downlink frequency.

- For downlink noise measurements, set the spectrum analyser centre frequency for the downlink frequency and set the signal from the signal generator to the centre of the paired uplink frequency.
- Configure the UUT and RF filter (if used) to the edge of the frequency band.

3.96 Proceed to paragraph 3.97.

Test method common to both multi-operator and provider-specific repeaters

3.97 Step 5

- Configure the signal generator for AWGN operation with a 99% BW.

3.98 Step 6

- The spectrum analyser shall be configured with the following settings:

Centre Frequency:	Centre frequency of the operating uplink frequency under test. (The signal generator should be tuned to the centre of the paired downlink band).
Resolution Bandwidth:	1MHz
Video Bandwidth:	≥ 3 x RBW
Detector Type:	Power averaging (RMS)
Sweep Time:	Auto

- If the additional filter is needed, ensure that no additional noise is added within or outside the passband.
- Ensure that the signal generator does not contribute to the noise level in band or out of band.

3.99 Step 7

- Measure the uplink noise power density (P_{nout}) while varying the downlink signal generator output level from −90 dBm to −20 dBm with 2dB steps.
- Noise figure level should be obtained using the following equation:

$$Noise\ Figure(dB) = P_{nout}(dBm/Hz) + 174(dBm) - \mathrm{Gain(dB)} - 10log_{10}(BW)$$

- Plot the RSSI vs uplink noise power.

3.100 Step 8

- Note the downlink signal generator output level when the noise level is no longer affected by the output level.

3.101 Step 9

- Repeat Steps 5 to 8 Step 11 for all uplink bands.
- For 4G bands a second signal generator is used as specified in paragraph 3.28.

3.102 Step 13

- Calculate the total system noise figure by including the external antenna (if used) noise figure in the noise figure calculations.

Test suites: Automatic standby

3.103 This test suite applies to the automatic standby requirement defined in the Exemption Regulations. Specifically:

- Additional rules applicable to provider-specific mobile repeater devices: 10(1), 10(2)
- Additional rules applicable to multi-operator mobile repeater devices: 14(1), 14(2)

3.104 Results obtained shall be compared with limits specified in the Exemption Regulations (as summarised in the Interface Requirements).

Test method for multi-operator and provider specific repeaters

3.105 Step 1

- Connect the UUT to the test equipment as shown in Figure 6 found in Annex 1 for multi-operator repeater or Figure 7 in Annex 1 for provider specific repeater.
- The spectrum analyser shall be configured with the following settings:

Centre Frequency:	Centre frequency to the centre of the supported uplink band.
Frequency Span:	0 Hz
Resolution Bandwidth:	1 MHz
Video Bandwidth:	≥ 3 x RBW
Sweep Time:	Minimum 330 seconds for multi-operator or 30 seconds for provider specific repeater.
Detector Type:	Power averaging (RMS)

3.106 Step 2

- Start to capture a new trace using the spectrum analyser MAX HOLD function.
- For multi-operator repeaters, after approximately 15 seconds turn on the UUT power.
- For provider specific repeaters, after approximately 15 seconds turn on the Signal generator output and then turn it off again after a further 5 seconds.

3.107 Step 3

- After the full spectrum analyser trace is complete, place a marker on the leading edge of the pulse.
- Using a second marker, use the delta marker function on the spectrum analyser to measure the time until the uplink becomes inactive.

- Measure noise power level using the system noise figure procedures in paragraphs 3.87-3.102.
- Ensure that the noise level is below the uplink inactivity noise power limit, as specified in the Exemption Regulations (and Interface Requirement).

3.108 Step 4

- Capture the plot for inclusion in the test report.

3.109 Step 5

- Repeat Steps 1 to 4 for all supported uplink bands.

Test suites: Anti-oscillation

3.110 This test suite applies to the anti-oscillation requirements defined in the Exemption Regulations. Specifically:

- Rules applicable to all mobile repeater devices: 7(1), 7(2), 7(3), 7(4), 7(5), 7(6), 7(7).

3.111 Results obtained shall be compared to the limits set in the Exemption Regulations and Interface Requirements to validate the repeater's compliance to the set limits.

Test method for multi-operator repeaters

3.112 Step 1

- Connect the UUT to the test equipment as shown in Figure 4 found in Annex 1.
- Confirm that the RF coupled path is connected to the spectrum analyser.

3.113 Step 2

- The spectrum analyser shall be configured with the following settings:

Centre Frequency:	Centre frequency at the centre of the band under test
Resolution Bandwidth:	1 MHz
Video Bandwidth:	≥ 3 x RBW
Frequency Span:	1.1x the BW
Sweep Time:	Auto
Detector Type:	Power averaging (RMS)

3.114 Step 3

- Set the variable attenuator to its maximum attenuation setting.
- Decrease the variable attenuator until the spectrum analyser displays a signal within the band under test.

- Using a marker, identify the approximate centre frequency of this signal on the max-hold display, increase the attenuation by 10 dB, then reset the UUT.

3.115 Step 4

- Repeat Step 3 twice to ensure that the centre of the signal created by the UUT remains within the edge limits displayed by the spectrum analyser.
- If the frequency of the signal is unstable, confirm that the spectrum analyser display is centred between the extremes of the frequency response observed.
- Reset the UUT after each oscillation event, if necessary.
- Set the spectrum analyser sweep trigger level to just below the peak amplitude of the displayed UUT oscillation signal.

3.116 Proceed to paragraph 3.123.

Test method for provider-specific repeaters

3.117 Step 1

- Connect the UUT to the test equipment as shown in Figure 11 found in Annex 1 for the uplink anti-oscillation test or Figure 12 found in Annex 1 for the downlink anti-oscillation test.

3.118 Step 2

- Set the variable attenuator, between the combiner and splitter, to its maximum attenuation setting and set the other step attenuator such that the UUT is operating at maximum gain and the minimum input level required for normal operation.

3.119 Step 3

- Set the spectrum analyser to zero-span, with a sweep time of 5 seconds, and single-sweep with max-hold function.
- The spectrum analyser sweep trigger level in this and the subsequent steps shall be the level identified in Step 2.

Centre Frequency:	Centre frequency at the centre of the band under test
Resolution Bandwidth:	1 MHz
Video Bandwidth:	≥ 3 x RBW
Frequency Span:	0 Hz
Detector Type:	Power averaging (RMS)
Sweep time:	5 seconds
Sweep trigger:	The output power level described in Steps 4 or 3dB below the power level described in Step 5 depending on repeater type.

3.120 Step 4

- Decrease the step attenuator, between the combiner and splitter, from 110 dB until the sweep is triggered at oscillation onset. This step may require several tries to find the precise setting where oscillation occurs, or up to a level equal to the repeater maximum gain.

3.121 Step 5

- Reset the zero-span trigger of the spectrum analyser, then repeat Step 4 twice to ensure that the spectrum analyser is reliably triggered, resetting the UUT after each oscillation event if necessary.

3.122 Proceed to paragraph 3.123.

Test method common to both multi-operator and provider-specific repeaters

3.123 Step 6

- Reset the zero-span sweep trigger of the spectrum analyser and reset the UUT.

3.124 Step 7

- Force the UUT into oscillation by reducing the RF attenuation for multi-operator repeater or the step attenuator, between the combiner and splitter, for provider specific repeater.

3.125 Step 8

- Use the marker function of the spectrum analyser to measure the time from the onset of oscillation until the UUT turns off.
- The spectrum analyser sweep time may be adjusted to improve the time resolution of these cursors.

3.126 Step 9

- Capture the spectrum analyser zero-span trace for inclusion in the test report.
- Report the power level associated with the oscillation separately if it cannot be displayed on the trace.

3.127 Step 10

- Repeat all preceding steps for all supported uplink and downlink bands.
- For 4G bands a second signal generator is used as specified in paragraph 3.28.

3.128 Step 11

- Set the spectrum analyser zero-span sweep time for longer than 60 seconds, then measure the restart time for each supported uplink and downlink band.

3.129 Step 12

- Set the spectrum analyser zero-span time for a minimum of 120 seconds, and a single sweep.
- Manually trigger the spectrum analyser zero-span sweep, and manually force the UUT into oscillation as described in Step 7.

3.130 Step 13

- When the sweep is complete, place cursors between the first two oscillation detections, and save the plot for inclusion in the test report.

3.131 Step 14

- Repeat Steps 12 to 13 five times for all supported uplink and downlink bands.
- Verify that the UUT does not resume operation until manually reset.
- For 4G bands a second signal generator is used as specified in paragraph 3.28.

3.132 Step 15

- The next steps are intended to test mitigation or shutdown mode and are common to both provider specific and multi-operator repeaters.
- Connect the UUT to the test equipment as shown in Figure 4 found in Annex 1.

3.133 Step 16

- The spectrum analyser shall be configured with the following settings:

Centre Frequency:	Centre frequency at the centre of the band under test
Resolution Bandwidth	30 kHz
Video Bandwidth:	≥ 3 x RBW
Detector Type:	Power average (RMS)
Frequency Span:	> 1.2 x BW

3.134 Step 17

- Configure the signal generator as follows:

    1. Configure for AWGN operation with 99% BW.
    2. Tune to the frequency of 2.5 MHz above the lower edge or below the upper edge of the operating band under test.
    3. Adjust the RF output level of the signal generator such that the measured power level of the AWGN signal is 30dB lower than the maximum power level of the UUT.
    4. Verify that the input signal is not obstructing the measurement of the strongest oscillation peak in the band and is not included within the span in the measurement.
    5. A CW signal source or MNO signal sources (i.e., 2G/3G/4G technology) may be used at the band edge rather than AWGN.

3.135 Step 18

- Set the variable attenuator to a high attenuation setting such that the UUT will operate at maximum gain as recorded in the "Frequency band of operation and the maximum system gain" test suite.
- Reset the UUT.
- Allow the UUT to complete its boot-up process, to reach full operational gain.

3.136 Step 19

- Set the variable attenuator such that the insertion loss for the centre of the band under test (isolation) between the UUT donor port and coverage port is 5 dB greater than the maximum gain, as recorded in the gain test procedure, for the specified frequencies.

3.137 Step 20

- Verify the UUT shuts down.
- If the UUT does not shut down, measure, and verify the peak oscillation level as follows:

    1. Allow the spectrum analyser trace to stabilize.
    2. Place the marker at the highest oscillation level occurring within the span and record its output level and frequency.
    3. Set the spectrum analyser centre frequency to the frequency with the highest oscillation signal level and reduce the span such that the upper and lower adjacent oscillation peaks are within the span.
    4. Use the Minimum Search Marker function to find the lowest output level that is within the span, and within the frequency band under test, and record its output level and frequency.
    5. Make sure that the peak oscillation level measured in (2) does not exceed by 12.0 dB the minimum output level measured in (4).
    6. Record the measurement results in tabular format for inclusion in the test report.

3.138 Step 21

- Decrease the variable attenuator in 1 dB steps and repeat Step 20 for each change in attenuator setting.
- Continue to decrease the attenuator setting until the insertion loss for the centre of the band under test (isolation) between the UUT donor port and coverage port is 5 dB lower than the maximum gain as recorded in the gain test procedure.

3.139 Step 22

- Repeat Steps 18 to Step 21 for the same frequency band five times and verify that the UUT does not resume operation until manually reset.

3.140 Step 23

- Repeat Step 15 to Step 22 for all supported uplink and downlink bands.
- For 4G bands a second signal generator is used as specified in paragraph 3.28.

4. Document History

Version	Date	Changes
1.0	27/05/2022	First release

A1. Measurement system set-up examples

A1.1 This annex gives examples of measurement system setups that can be used when verifying compliance with the Exemption Regulations. Alternative setups may be used provided they are fully documented in the test report provided to Ofcom.

Figure 1 – Multi-operator basic test setup

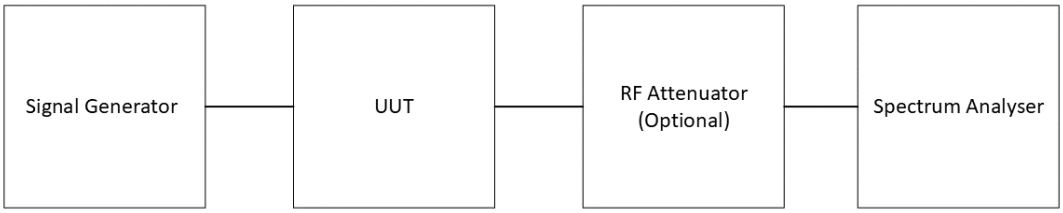


Figure 2 – Multi-operator Noise Figure test setup

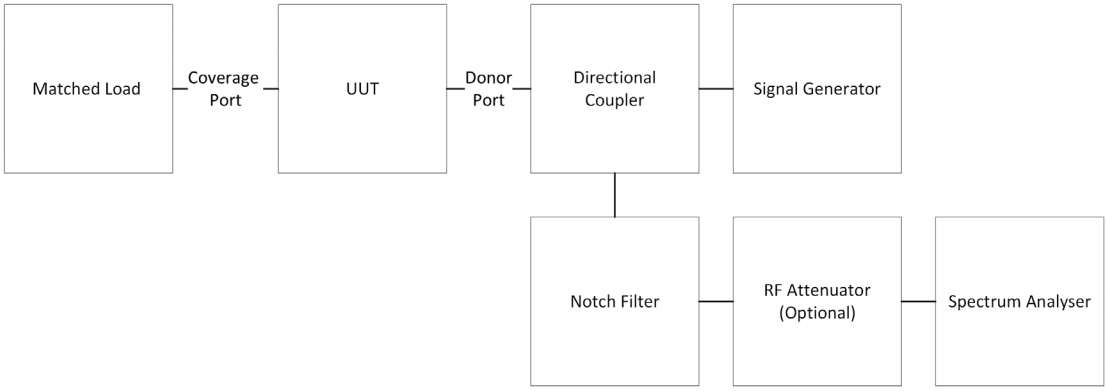


Figure 3 – Multi-operator anti-oscillation test setup

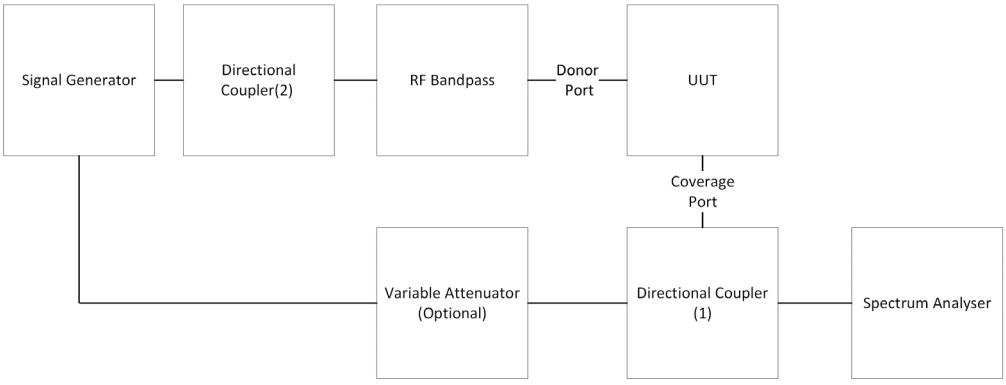


Figure 4 – Anti-oscillation shutdown test setup (common to both multi-operator and provider specific repeaters)

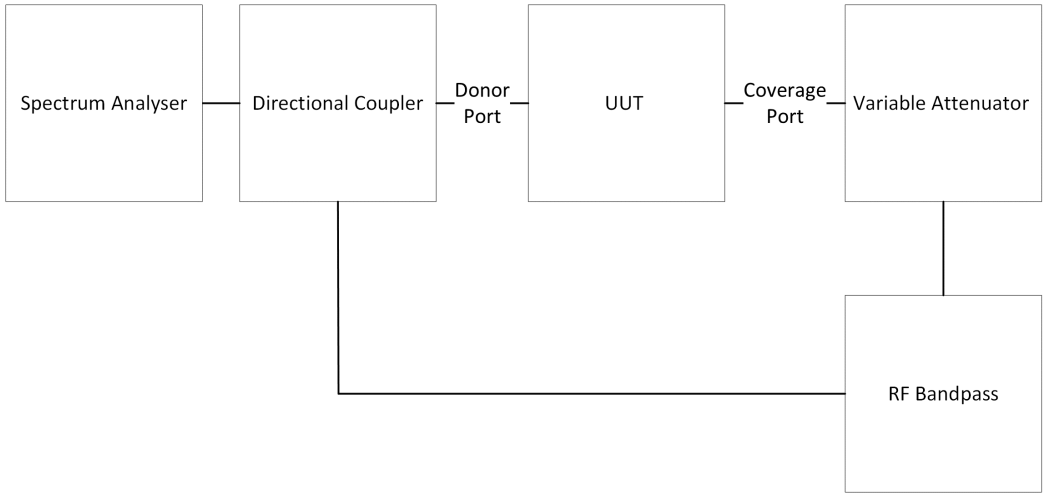


Figure 5- Multi-operator variable gain test setup

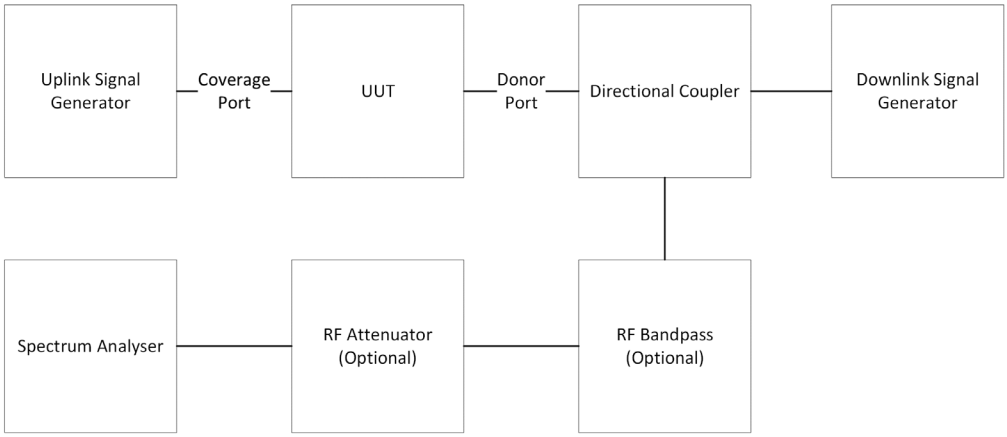


Figure 6- Multi-operator automatic standby test setup

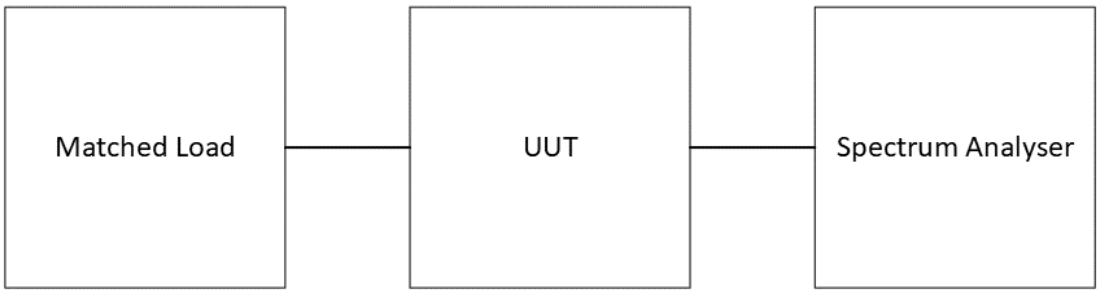


Figure 7- Provider specific basic test setup

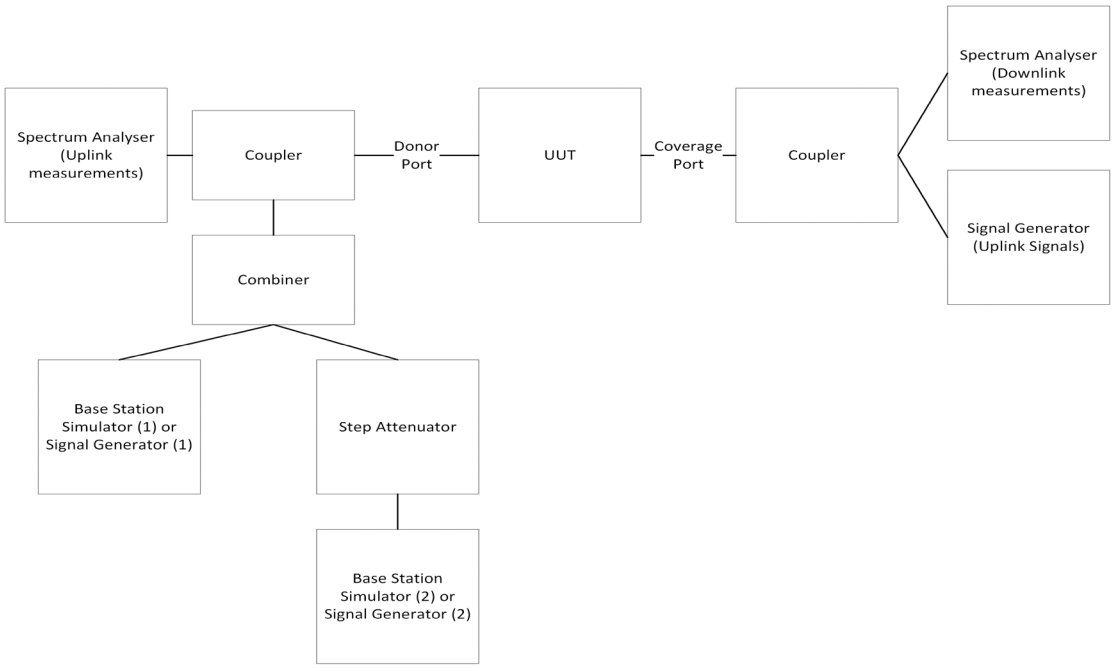


Figure 8- Provider specific basic Noise Figure test setup (Downlink configuration on the left, Uplink configuration on the right)

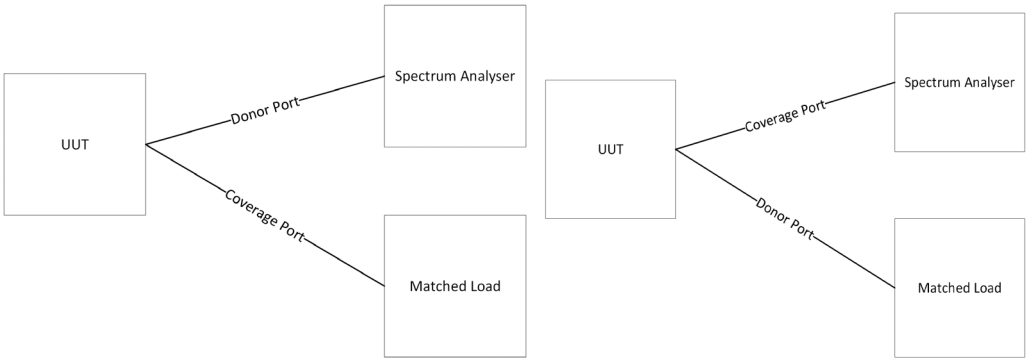


Figure 9- Provider specific detailed uplink Noise Figure test setup

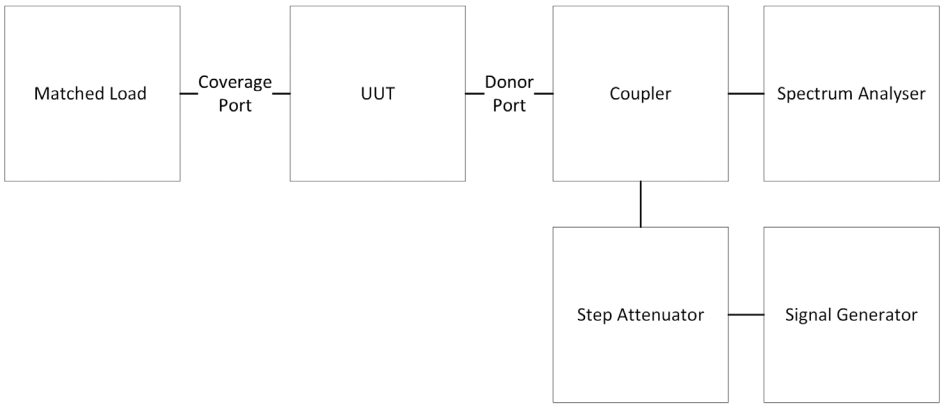


Figure 10- Provider specific detailed downlink Noise Figure test setup

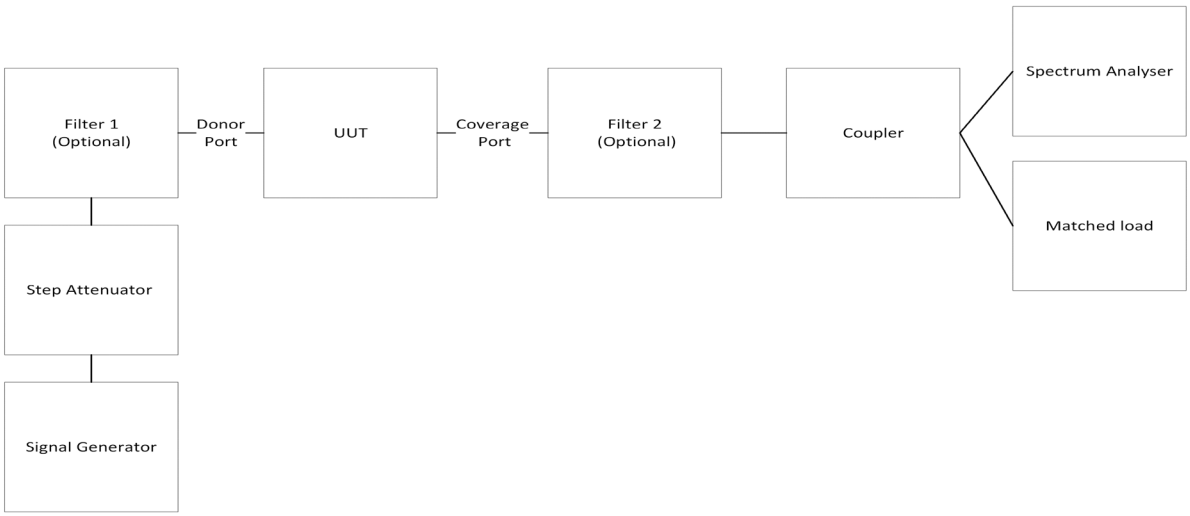


Figure 11- Provider specific uplink anti-oscillation test setup

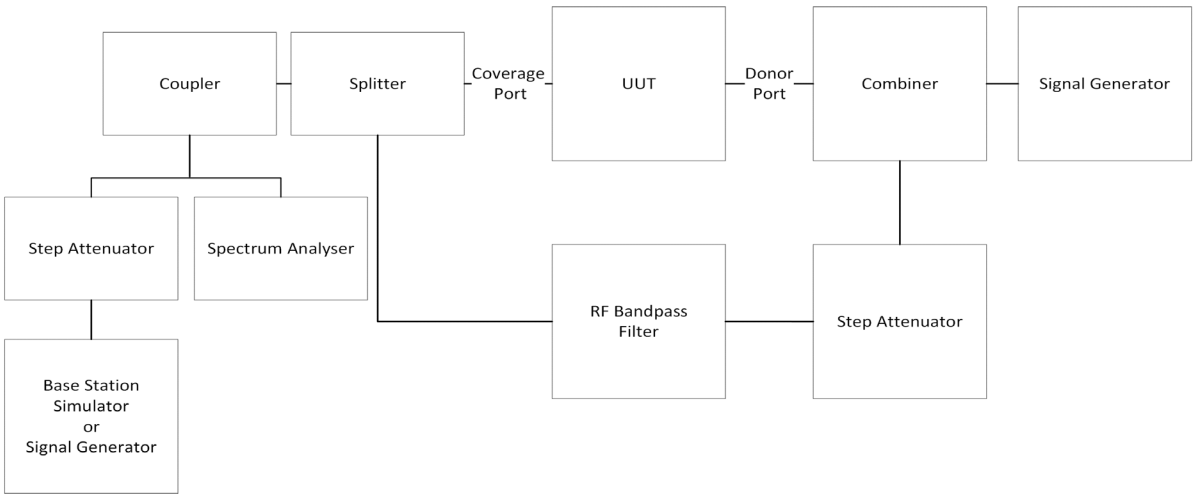
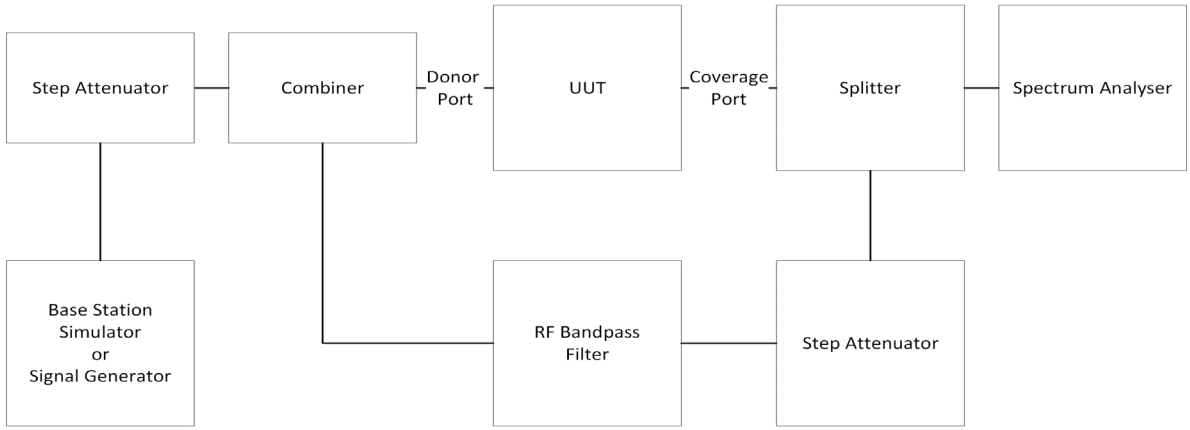


Figure 12- Provider specific downlink anti-oscillation test setup



A2. Definitions, symbols, and abbreviations

Definitions

For the purposes of the present document, the following definitions apply:

AGC	Automatic gain control used to increase and decrease the gain of the receiving amplifier according to the signal level received.
BSCL	The base station coupling loss, which is the difference between (i) the power transmitted by the base station (which may be determined from the system information messages sent by that base station on its control channels) and (ii) the power received by the mobile repeater device from the base station.
Coverage Port	The interface between a mobile repeater device and its coverage antenna.
Donor port	The interface between a mobile repeater device and its donor antenna.
GSM	An electronic communication networks network that complies with standards EN 301 502 and EN 301 511 published by ETSI for the Global System for Mobile Communications (also known as GSM).
Multi-operator mobile repeater	A repeater that amplifies signals carried by more than one MNO, with amplification by the same level and not calculated individually for each MNO. To be licence-exempt, such repeaters must comply with Regulations 5 to 12 and 13 to 17 of the Exemption Regulations (as summarised in IR 2102.3).
MSCL	The minimum coupling loss in dB between the wireless device and repeater's coverage port.
Provider specific mobile repeater	A repeater that amplifies signals carried by one or more MNOs, whilst individually setting the level of amplification for each MNO's signals. To be licence-exempt, such repeaters must comply with Regulations 5 to 12 of the Exemption Regulations (as summarised in IR 2102.1).
RSSI	The received signal strength indicator, which is the total downlink signal power received at the donor port of the mobile repeater device, for all base stations in the frequency band being transmitted.

Symbols

For the purposes of the present document, the following symbols apply:

dB	Decibel
dBi	Antenna gain in decibels referenced to an isotropic antenna
dBm	Decibel referenced to 1 mW.
MHz	106 Hz

Abbreviations

For the purposes of the present document, the following abbreviations apply:

AWGN	Additive White Gaussian Noise
BW	Bandwidth
CW	Continuous Wave carrier
EIRP	Equivalent Isotropically Radiated Power
IR	Interface Requirement
MNO	Mobile Network Operator
PSD	Power Spectral Density
RBW	Resolution Bandwidth
RF	Radio Frequency
RMS	Root Mean Square
Span	Frequency Span (frequency domain display)
UUT	Unit Under Test
VBW	Video Bandwidth
VTS	Voluntary Testing Standard

A3. References

[1]	EN 303 609	Global System for Mobile communications (GSM); GSM Repeaters; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU
[2]	EN 301 908-11	IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 11: CDMA Direct Spread (UTRA FDD) Repeaters
[3]	EN 301 908-15	IMT cellular networks; Harmonised Standard for access to radio spectrum; Part 15: Evolved Universal Terrestrial Radio Access (E-UTRA FDD) Repeaters
[4]	EN 301 908-1	Introduction and Common Requirements
[5]	EN 301 908-11	IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 3: CDMA Direct Spread (UTRA FDD) Base Stations (BS)
[6]	EN 301 908-15	IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 15: Evolved Universal Terrestrial Radio Access (E-UTRA FDD) Repeaters
[7]	ETSI TR 102 273	Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties
[7]	FCC 935210 D02	Federal Communication Commission, Office of Engineering and Technology: Signal Boosters Basic Certification Requirements v04r04
[8]	FCC 935210 D04	Federal Communication Commission, Office of Engineering and Technology: Provider Specific Consumer Signal Boosters Compliance Measurements Guidance v02r04