TEST REPORT

MANUFACTURER	:	Shenzhen Chainway Information Technology Co.,Ltd.
PRODUCT NAME	:	Mobile Data Terminal
MODEL NAME	:	C72
BRAND NAME	:	CHAINWAY
STANDARD(S)	:	ETSI EN 302 208 V3.1.1 (2016-11)
TEST DATE	:	2018-05-21 to 2018-05-24
ISSUE DATE	:	2019-03-26

Tested by: Tu Ya'nan

Tu Ya'nan (Test Engineer)

Approved by: Andy Yeh

Andy Yeh (Technical Director)

DIRECTORY

Change History		
Version	**Date**	**Reason for change**
1.0	2018-05-28	First edition
2.0	2019-03-26	Corrected the error report number

1. Technical Information

Note: Provide by manufacturer.

1.1. Manufacturer and Factory Information

Manufacturer:	Shenzhen Chainway Information Technology Co.,Ltd.
Manufacturer Address:	9/F, Building 2, Daqian Industrial Park, Longchang Rd., District 67, Bao'an, Shenzhen
Factory:	Shenzhen Chainway Information Technology Co.,Ltd.
Factory Address:	9/F, Building 2, Daqian Industrial Park, Longchang Rd., District 67, Bao'an, Shenzhen

1.2. Equipment Under Test (EUT) Description

<table>
<tr><td>Product Name:</td><td colspan="2">Mobile Data Terminal</td></tr>
<tr><td>Operating Frequency Range:</td><td colspan="2">865.7MHz-867.5MHz
(4 channels, at intervals of 600kHz)</td></tr>
<tr><td>Antenna Type:</td><td colspan="2">PCB Antenna</td></tr>
<tr><td>Antenna Gain:</td><td colspan="2">4.0dBi</td></tr>
<tr><td rowspan="3">Operating voltage:</td><td>Normal:</td><td>3.8V</td></tr>
<tr><td>Lowest:</td><td>3.6V</td></tr>
<tr><td>Highest:</td><td>4.35V</td></tr>
<tr><td rowspan="3">Operating temperature:</td><td>Normal:</td><td>25°C</td></tr>
<tr><td>Lowest:</td><td>-20°C</td></tr>
<tr><td>Highest:</td><td>50°C</td></tr>
</table>

Note 1: For a more detailed description, please refer to Specification or User's Manual supplied by the applicant and/or manufacturer.

1.3. The channel number and frequency of EUT

Channel	Frequency(MHz)	Channel	Frequency(MHz)
1	865.7	3	866.9
2	866.3	4	867.5

1.4. Test Standards and Results

The EUT has been tested according to ETSI EN 302 208 V3.1.1 (2016-11).

ETSI EN 302 208 V3.1.1 (2016-11)	Radio Frequency Identification Equipment operating in the band 865 MHz to 868 MHz with power levels up to 2 W and in the band 915 MHz to 921 MHz with power levels up to 4 W; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU

Test items and the results are as bellow:

EN Reference		Test Items	Test Engineer	Result
№	Sub clause			
1	4.3.1	Frequency error	Tu Ya'nan	**NA**Note1
2	4.3.2	Frequency stability under low voltage conditions	Tu Ya'nan	**NA**Note2
3	4.3.3	Effective radiated power	Tu Ya'nan	**PASS**
4	4.3.4	Transmitter antenna beam-width	Tu Ya'nan	**PASS**
5	4.3.5	Transmission spectrum masks	Tu Ya'nan	**PASS**
6	4.3.6	Transmitter spurious emissions	Tu Ya'nan Wu Zhongwen	**PASS**
7	4.3.7	Transmission times	Tu Ya'nan	**PASS**
8	4.3.8	Mitigation using DAA	Tu Ya'nan	**NA** Note3
9	4.4.1	Receiver selectivity	Tu Ya'nan	**PASS**
10	4.4.2	Receiver blocking	Tu Ya'nan	**PASS**
11	4.4.3	Receiver spurious emissions	Tu Ya'nan Wu Zhongwen	**PASS**
12	4.5.1	Tag radiated power	Tu Ya'nan	**NA** Note4
13	4.5.2	Tag unwanted emissions	Tu Ya'nan	**NA** Note4

Note1: The test item apply to interrogators able to transmit a modulated and un-modulated signal, the EUT can't transmit un-modulated signal.

Note2: The item applies to battery powered and can transmit carrier frequency interrogators, but the EUT(interrogators) can't transmit a carrier frequency.

Note3: The test case only applies to all interrogators that are sharing the sub-band 918 MHz to 921 MHz with ER-GSM.

Note4: The test case only Applies to tags.

1.5. EUT Setup and Operating Conditions

The EUT is activated and controlled by the System Simulator and software. The EUT is powered by a battery.

1.6. Environmental Conditions

Ambient temperature: +15~+35°C
Relative humidity: 20~75%
Atmosphere pressure: 86-106kPa

2. Test procedure and results

2.1. EN 302 208 §4.3.1 Frequency error

2.1.1. Definition

The frequency error, known as frequency drift, is the difference between the frequency of the device under test measured under normal test conditions (see clause 5.1.1.1) and the frequency measured under extreme test conditions (see clause 5.1.1.2)..

2.1.2. Limits

The maximum permitted frequency error, defined as the absolute value of fe-f, shall not exceed ±10 ppm relative to the nominal centre frequency of each of the applicable channels, where:

• f = the frequency measured under normal test conditions (see clause 5.1.1.1).

• fe = the maximum frequency drift as measured in clause 5.1.1.2.

NOTE: Where multiple interrogators are co-located, tighter limits may be necessary to avoid unacceptable beat tones.

2.1.3. Conformance

The conformance test suite for frequency error shall be as defined in clause 5.5.1 of the present document.

2.1.4. Measurement methods

The measurements shall be made with the interrogator set to transmit a continuous un-modulated carrier and performed at each of the applicable frequencies specified in clause 4.2.3:

a) Under normal test conditions:

- The signal transmitted by the interrogator shall be connected by suitable means to the input of a frequency counter. The frequency displayed on the frequency counter shall be recorded.

b) Under extreme test conditions:

- For each combination of extreme voltage and temperature (see clause 5.1.3) the frequency displayed on the frequency counter shall be recorded. Four values shall be measured.

The results from the measurements shall be recorded in the test report.

2.1.5. Result

Note: The test item apply to interrogators able to transmit a modulated and un-modulated signal, the EUT can’t transmit un-modulated signal.

2.2. EN 302 208 §4.3.2 Frequency stability under low voltage conditions

2.2.1. Definition

The frequency stability under low voltage conditions is the ability of the equipment to remain within its permitted frequency limits when the battery voltage falls below the lowest extreme voltage level.

2.2.2. Limits

The equipment shall either:

• transmit with a carrier frequency within the limits of ±10 ppm whilst the radiated or conducted power is below the spurious emission limits; or

• automatically cease to function below the provider's declared operating voltage.

NOTE: Where multiple interrogators are co-located, tighter limits may be necessary to avoid unacceptable beat ones.

2.2.3. Conformance

The conformance test suite for frequency stability shall be as defined in clause 5.5.2 of the present document.

2.2.4. Measurement methods

This test is for battery operated equipment.

Step 1: An interrogator shall be set up to transmit a continuous un-modulated carrier. The signal transmitted by the interrogator shall be connected by suitable means to the input of a frequency counter.

Step 2: The frequency displayed on the frequency counter shall be recorded.

Step 3: The voltage from the test power source shall be reduced below the lower extreme test voltage limit owards zero. Whilst the voltage is reduced the carrier frequency shall be monitored. The results from the measurements shall be recorded in the test report.

2.2.5. Result

Note: The item applies to battery powered and can transmit carrier frequency interrogators, but the EUT(interrogators) can’t transmit a carrier frequency.

2.3. EN 302 208 §4.3.3 Effective radiated power

2.3.1. Definition

The effective radiated power is the product of the power supplied to the antenna and its gain relative to a half wave dipole in the direction of maximum gain.

2.3.2. Limits

Operation in the lower band (865 MHz to 868 MHz)
The effective radiated power on each of the four high power channels specified in figure 3 shall not exceed 33 dBm e.r.p. specified in a bandwidth of 200 kHz.
Operation in the upper band (915 MHz to 928 MHz)
The effective radiated power on each of the four high power channels specified in figure 4 shall not exceed 36 dBm e.r.p. specified in a bandwidth of 400 kHz.

2.3.3. Conformance

The conformance test suite for the effective radiated power requirement shall be as defined in clause 5.5.3 of the present

2.3.4. Effective radiated power measurement methods

Radiated measurement
This measurement shall be carried out under normal test conditions only (see clause 5.1.1.1). The following steps shall be carried out in each of the bands specified in figures 1 and 2 in which the interrogator is designed to operate.
Step 1: On a test site, selected from annex B, the interrogator shall be placed at the specified height on a support, as specified in annex B, and in the position closest to normal use as declared by the provider.
Step 2: The interrogator shall be set to transmit continuously, with an unmodulated carrier, on one of the high power channels in the selected band. Alternatively if the interrogator is tested in its normal operational mode, it shall transmit repeatedly on the selected channel in accordance with the normal test signals for data specified in clause 5.3.2.2. The measuring receiver shall be positioned in the far field as defined in annex B and tuned to the frequency of the transmission under test.
Step 3: A test antenna shall be oriented initially for vertical polarization and shall be chosen to correspond to the carrier frequency of the interrogator. The output of the test antenna shall be connected to a measuring receiver.

Step 4: The measuring receiver shall be set to the following values:
a) Resolution bandwidth: 300 kHz.
b) Video bandwidth: Equal to the RBW.
c) Sweep Time: Auto.
d) Span: 1 MHz.
e) Trace mode: Max. hold sufficient to capture all emissions.
f) Detection mode: RMS.
For measurements in the upper band of an interrogator in its normal operational mode, the RBW shall be set to 1 MHz. Step 5: The test antenna shall be raised and lowered through the specified heights until the maximum signal level is detected by the measuring receiver.
Step 6: The interrogator shall then be rotated through 360º in the horizontal plane, until the maximum signal level is detected by the measuring receiver.
Step 7: The test antenna shall be raised and lowered again through the specified heights until the maximum signal level is detected by the measuring receiver. The maximum signal level detected by the measuring receiver shall be noted.
Step 8: The interrogator shall be replaced by a substitution antenna as defined in clause B.1.6. The substitution antenna shall be connected to a calibrated signal generator. The substitution antenna shall be orientated for vertical polarization and the length of the substitution antenna shall be adjusted to correspond to the frequency of transmission of the interrogator. If necessary, the setting of the input attenuator of the measuring receiver shall be adjusted in order to increase the sensitivity of the measuring receiver.
Step 9: The test antenna shall be raised and lowered through the specified heights to ensure that the maximum signal is received.
Step 10: The input signal to the substitution antenna shall be adjusted to give a level at the measuring receiver that is equal to the radiated power previously measured from the interrogator, corrected for any change to the setting of the input attenuator to the measuring receiver.
Step 11: The input level to the substitution antenna shall be recorded as the power level, corrected for any change of input attenuator setting of the measuring receiver.
Step 12: The measurement shall be repeated with the test antenna and the substitution antenna orientated for horizontal polarization.
Step 13: The measure of the effective radiated power is the larger of the two levels recorded at the input to the substitution antenna, corrected if necessary for the gain of the substitution antenna.
Step 14: With the interrogator fitted into a suitable test fixture, the relative change of the effective radiated power between normal and extreme test conditions (see clauses 5.1.1.1 and 5.1.1.2 applied simultaneously) shall be compared. Any increase in the radiated power under extreme test conditions shall not cause the level to exceed the limits specified in clause 4.3.3.

Conducted measurement

Where an interrogator is fitted with an external antenna connector it is permissible to measure the conducted power. In this case the provider shall declare the maximum gain and beam-width(s) of the external antenna(s) at the time that the equipment is presented for test. The following steps shall be carried out in each of the bands specified in figures 1 and 2 in which the interrogator is designed to operate.

Step 1: The transmitter shall be configured to operate on one of the high power channels in the selected

band and shall be connected to an artificial antenna (see clause 5.3.2.3). The carrier or mean power delivered to the artificial antenna shall be measured under normal test conditions (see clause 5.1.1.1).

Step 2: The measurement shall be repeated under extreme test conditions (see clauses 5.1.1.2 and 5.1.2.3 applied simultaneously).

Step 3: The recorded value shall be corrected for each of the antenna gains and be stated in e.r.p. To calculate the allowed conducted power with a circularly polarized antenna, formula (1) shall be used:

$$P_C = P_{erp} - G_{IC} + 5{,}15 + C_L \quad \text{dBm} \qquad (1)$$

Where:

PC = interrogator conducted transmit power in dBm;

GIC = antenna gain of a circular antenna in dBic;

CL = total cable loss in dB.

Step 4: Where the interrogator switches between multiple transmitter outputs, the power level shall be measured at each output.

The results from the measurements shall be recorded in the test report.

2.3.5. Result (Conducted)

Channel		Perp=Pconducted+Antenna gain(dBm)		Limit (dBm)	Verdict
		Pconducted	Perp		
1	865.7MHz	30.06	31.91	≤33	PASS
2	866.3MHz	30.41	32.26	≤33	PASS
3	866.9MHz	30.58	32.43	≤33	PASS
4	867.5MHz	30.46	32.31	≤33	PASS
Antenna Gain=1.85dBd (4dBi)					

2.4. EN 302 208 §4.3.4 Transmitter antenna beam-width

2.4.1. Definition

The beam-width of an antenna is the angle between the two half-power (-3 dB) points of the main lobe, when referenced to the peak effective radiated power of the main lobe.

2.4.2. Limit

The beam-width(s) of the antenna(s) in the horizontal orientation for the lower band shall comply with the following limits:
• For transmissions ≤ 500 mW e.r.p. there shall be no restriction on beam-width.
• For transmissions of > 500 mW e.r.p. to ≤ 1 000 mW e.r.p. beam-widths shall be ≤ 180º.
• For transmissions of > 1 000 mW e.r.p. to 2 000 mW e.r.p. beam-widths shall be ≤ 90º.
The beam-width(s) of the antenna(s) in the horizontal orientation in the upper band shall comply with the following limits:
• For transmissions ≤ 1 000 mW e.r.p. there shall be no restriction on beam-width.
• For transmissions of > 1 000 mW e.r.p. to ≤ 2 000 mW e.r.p. beam-widths shall be ≤ 180º.
• For transmissions of > 2 000 mW e.r.p. to 4 000 mW e.r.p. beam-widths shall be ≤ 90º.

2.4.3. Conformance

The conformance test suite for the transmitter antenna beam-width shall be as defined in clause 5.5.4 of the present document.

2.4.4. Methods of measurement(Radiated)

These measurements shall be performed with an un-modulated carrier at the highest power level in each band at which the transmitter is intended to operate. Alternatively the interrogator shall be set to the highest power level in the intended band and transmit repeatedly in its normal operational mode. The measuring receiver shall be set up in accordance with the requirements of clause 5.3.2.6.
The following steps shall be carried out in each of the bands specified in figures 1 and 2 in which the interrogator is designed to operate.
Step 1: On a test site, selected from annex B, the interrogator shall be placed at the specified height on a support, as specified in annex B, and in the position closest to normal use as declared by the provider.
Step 2: A test antenna shall be oriented initially for vertical polarization and shall be chosen to correspond to the carrier frequency of the interrogator. The output of the test antenna shall be

connected to a measuring receiver.

Step 3: The interrogator shall be set to transmit continuously, without modulation, on one of the high power channels in the selected band. The measuring receiver shall be positioned in the far field as defined in annex B and tuned to the frequency of the transmission under test.

Step 4: The test antenna shall be raised and lowered through the specified heights until the maximum signal level is detected by the measuring receiver.

Step 5: The interrogator shall then be rotated through 360º in the horizontal plane, until the maximum signal level is detected by the measuring receiver.

Step 6: The test antenna shall be raised and lowered again through the specified heights until the maximum signal level is detected by the measuring receiver. The maximum signal level detected by the measuring receiver shall be noted.

Step 7: The antenna of the interrogator shall be rotated in the horizontal plane in both directions to positions where the signal at the measuring receiver is reduced by 3 dB. The total angle of rotation (which is the horizontal beam-width of the antenna) shall be recorded.

2.4.5. Result

Test Channel		E.R.P. (dBm)	Test Value	Limit	Verdict
1	865.7MHz	31.91	132°	≤180°	PASS
4	867.5MHz	32.31	124°	≤180°	PASS

2.5. EN 302 208 §4.3.5 Transmission spectrum masks

2.5.1. Definition

A spectrum mask is a mathematically defined set of lines applied to the levels of radio transmissions.

2.5.2. Limits

Limits for lower band (865 MHz to 868 MHz)

For measurements performed in the lower band, the absolute levels of RF power at any frequency shall not exceed the limits defined by the envelope in the spectrum mask at figure 5 in which the Y axis is scaled in dBm e.r.p. and referenced to 1 kHz resolution bandwidth.

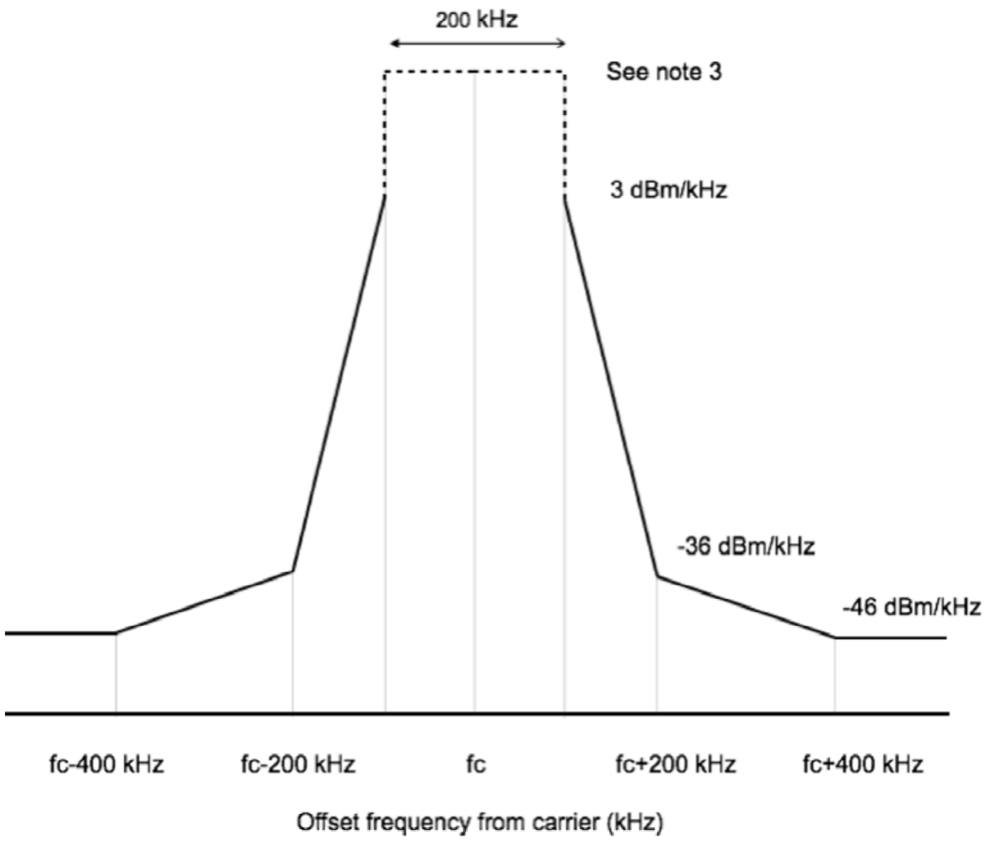


Figure 5: Spectrum mask for modulated signals in the lower band

NOTE 1: Where fc is the centre frequency of the carrier transmitted by the interrogator applicable over the frequency range fc ± 500 kHz.

NOTE 2: All limits are shown with reference to a resolution bandwidth of 1 kHz

NOTE 3: Measurements in the frequency range fc ± 100 kHz shall be made in accordance with clauses 4.3.3 and 5.5.3.

Limits for upper band (915 MHz to 921 MHz)

For measurements performed in the upper band the absolute levels of RF power at any frequency shall not exceed the limits defined by the envelope in the spectrum mask at figure 6 in which the Y axis is scaled in dBm e.r.p. and referenced to 1 kHz resolution bandwidth.

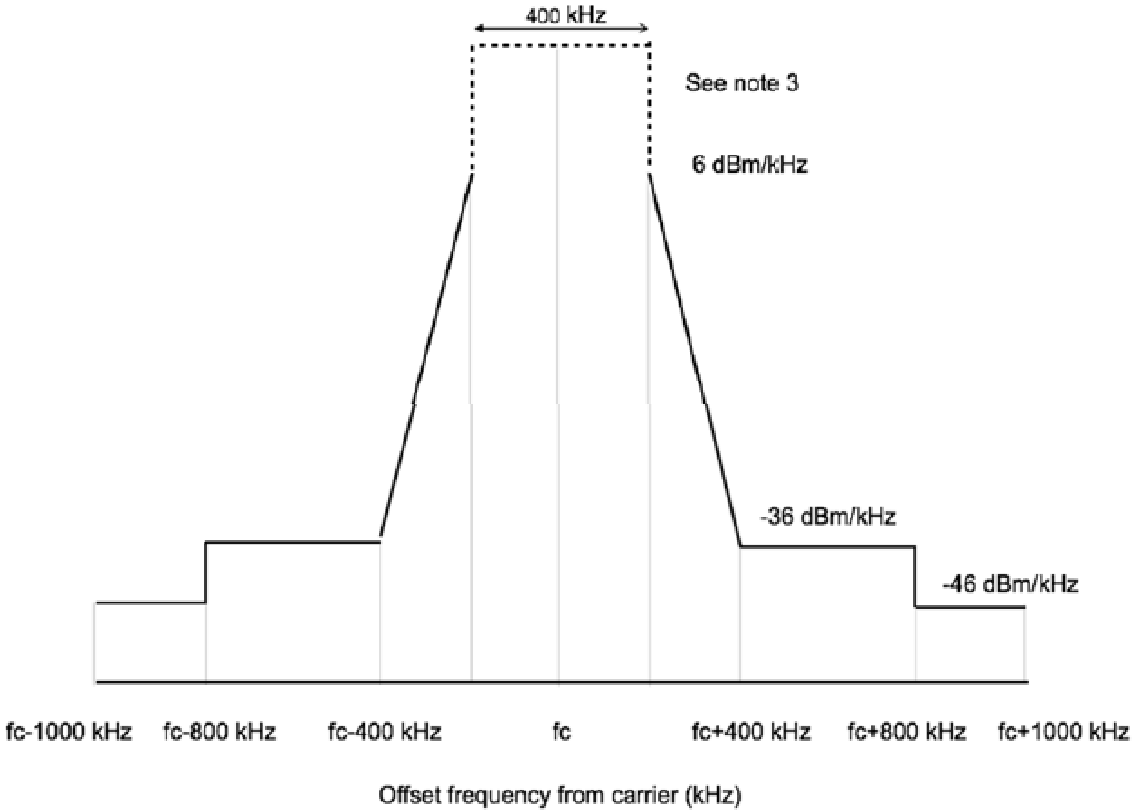


Figure 6: Spectrum mask for modulated signals in the upper band

NOTE 1: Where fc is the centre frequency of the carrier transmitted by the interrogator applicable over the frequency range fc ±1 000 kHz.

NOTE 2: All limits are shown with reference to a resolution bandwidth of 1 kHz.

NOTE 3: Measurements in the frequency range fc±200 kHz shall be made in accordance with clauses 4.3.3 and 5.5.3.

2.5.3. Conformance

The conformance test suite for the transmitter spectrum masks shall be as defined in clause 5.5.5 of the present document.

2.5.4. Method of measurement

The following steps shall be carried out in each of the bands specified in figures 1 and 2 in which the interrogator is designed to operate.

The RF output of the equipment shall be connected to a spectrum analyser via a 50 Ω connector. In the case of equipment with an integral antenna, the equipment shall be placed in the test fixture (see clause 5.4.5) and the test fixture shall be connected to the spectrum analyser. Measurements shall be made on the declared channels of operation of the interrogator on those channels requiring full tests as defined in figures 3 and 4.

Step 1: The interrogator shall be operated at the carrier power measured under normal test conditions in clause 5.1.1.1. The attenuator shall be adjusted to give an appropriate display on the spectrum analyser screen.

Step 2: The interrogator shall be configured to generate a succession of modulated transmit pulses. Each transmit pulse shall be modulated by the normal test signal (see clause 5.3.2.2). The length of each transmit pulse shall be not less than 10 ms and not greater than 50 ms. The interval between successive transmit pulses shall be not less than 1 ms and shall not exceed 10 ms.

Step 3: The output power of the interrogator, with or without a test fixture, shall be measured using a spectrum analyser, which shall be set to the following values:

a) Resolution bandwidth: 1 kHz.

b) Video bandwidth: Equal to the RBW.

c) Sweep Time: Auto.

d) Span: 1 MHz.

e) Trace mode: Max. hold sufficient to capture all emissions.

f) Detection mode: Average.

Step 4: For frequencies inside fc ± 500 kHz in the lower band and for frequencies inside fc ± 1 000 kHz in the upper band, the measured values are the absolute values. The absolute levels of RF power shall be compared to the spectrum mask at figures 5 and 6. (See notes 1 and 2).

Step 5: Where the interrogator includes multiple transmitter outputs, all of the outputs shall be connected via a suitable combiner network to the spectrum analyser. With the interrogator set up as in step 1 and configured to transmit the test signal described in step 2 while in its operational mode, the spectrum mask shall be measured at the spectrum analyser. The measured values shall be adjusted to compensate for the attenuation of the combiners and compared to the spectrum mask at figures 5 and 6.

NOTE: If for any reason the spectrum is measured with a resolution bandwidth other than 1 kHz, the measured values may be converted to the absolute values using formula (2):

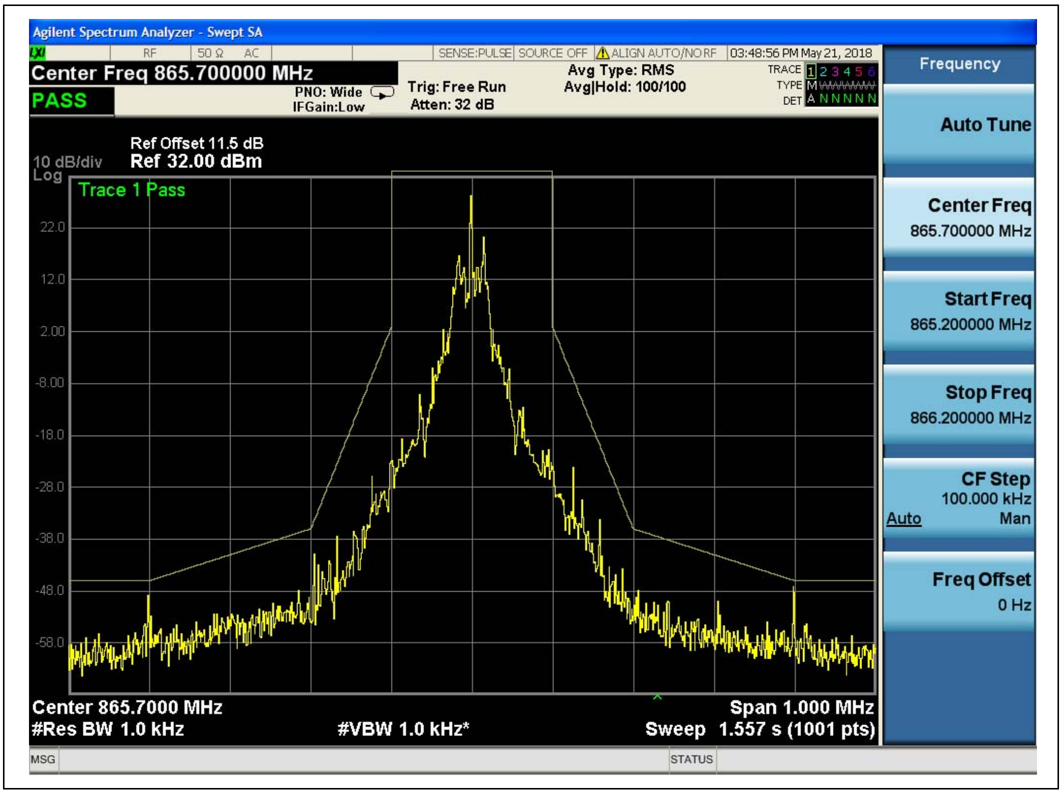
$$B = A + 10\log\frac{1kHz}{BW_{MEASURED}} \qquad (2)$$

Where:

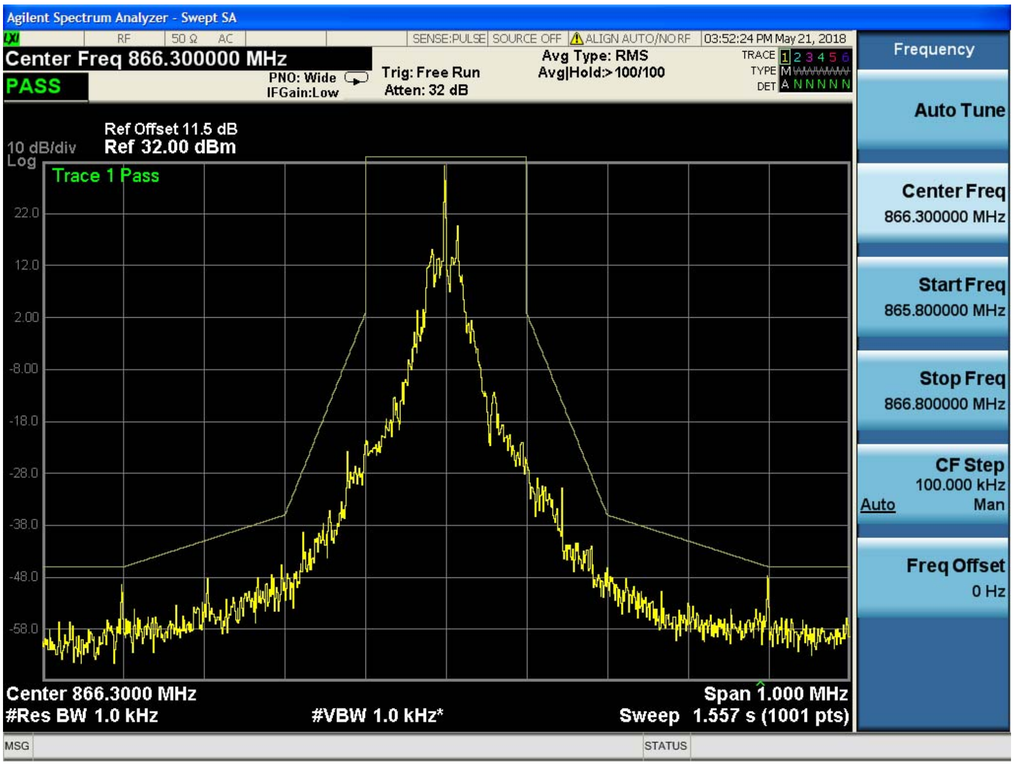
- A is the value at the measured resolution bandwidth;
- B is the absolute value referred to a 1 kHz reference bandwidth; or
- use the measured value, A, directly if the measured spectrum is a discrete spectral line (a discretespectrum line is defined as a narrow peak with a level of at least 6 dB above the average levelinside the measurement bandwidth).

2.5.5. Result

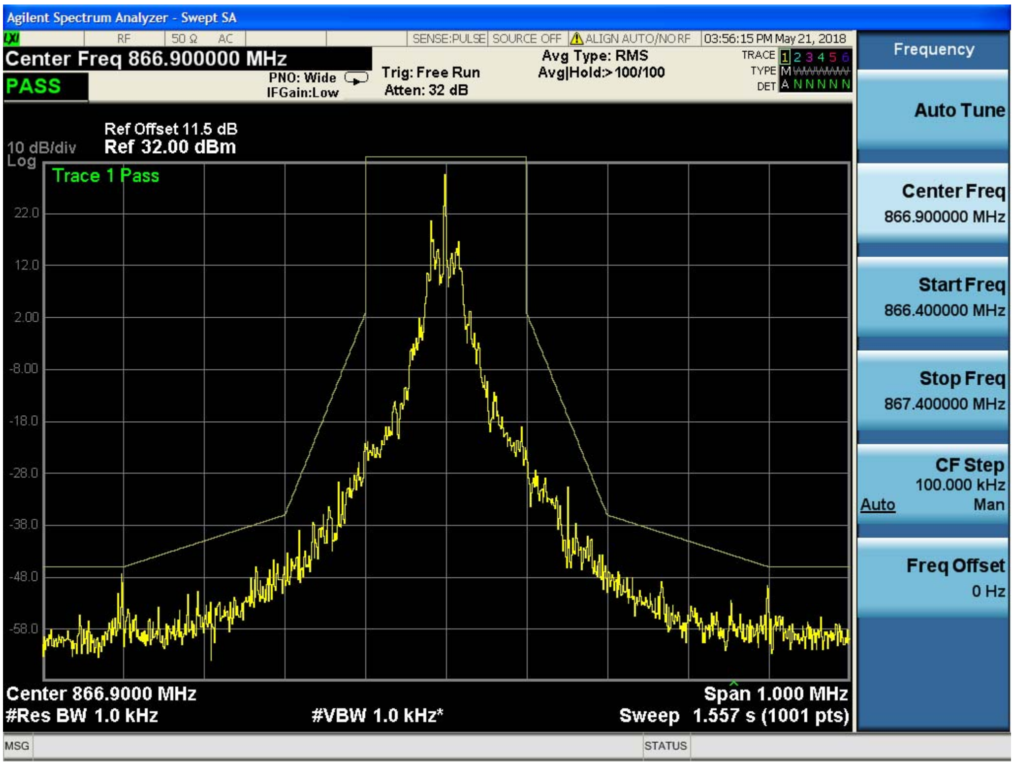
Channel	Frequency (MHz)	Test Value	Limit	Verdict
		Refer to Plot		
1	865.7	Plot A		PASS
2	866.3	Plot B		
3	866.9	Plot C		
4	867.5	Plot D		PASS



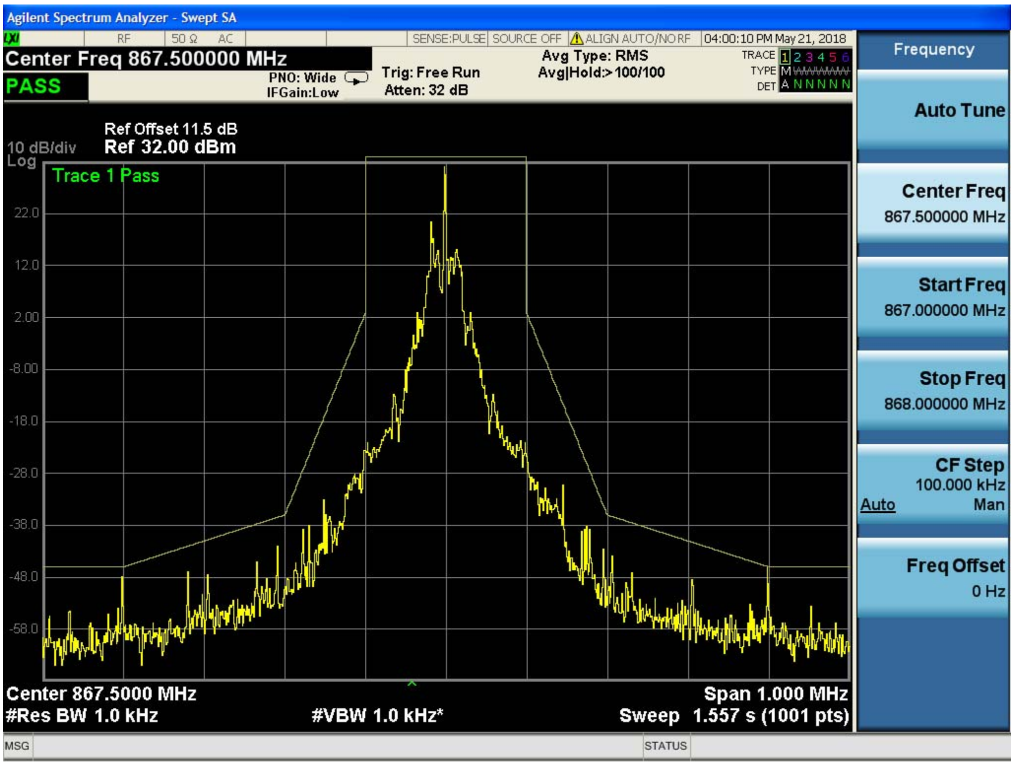
Plot A, 865.7MHz



Plot B, 866.3MHz



Plot C, 866.9MHz



Plot D, 867.5MHz

2.6. EN 302 208 §4.3.6 Transmitter spurious emissions

2.6.1. Definition

A spurious emission is any signal produced by the interrogator that falls outside of the band on which the equipment is meant to operate.

2.6.2. Limits

The level of any spurious emission, conducted or radiated, outside the relevant necessary bands shall not exceed the values given in table 2.

Table 2: Spurious emission limits in e.r.p.

State	47 MHz to 74 MHz 87,5 MHz to 118 MHz 174 MHz to 230 MHz 470 MHz to 862 MHz	Other frequencies below 1 000 MHz	Frequencies above 1 000 MHz
Operating	4 nW (-54 dBm)	250 nW (-36 dBm)	1 μW (-30 dBm)
Standby	2 nW (-57 dBm)	2 nW (-57 dBm)	20 nW (-47 dBm)

NOTE: For frequencies below 1 000 MHz limits are specified for a RBW of 100 kHz. Above 1 000 MHz a RBW of 1 MHz applies.

2.6.3. Conformance

The conformance test suite for the spurious emission limits shall be as defined in clause 5.5.6 of the present document.

2.6.4. Method of measurement

Spurious emissions shall be measured at frequencies outside fc ± 500 kHz for the lower band and frequencies outside fc ± 1 000 kHz for the upper band, as specified in figures 10 and 11 below. The level of spurious emissions shall be measured as:

either:

a) i) their power level in a specified load (conducted spurious emission); and ii) their effective radiated power when radiated by the cabinet and structure of the equipment (cabinet radiation); or

b) their effective radiated power when radiated by the cabinet and the integral antenna, in the case of equipment fitted with such an antenna and no external RF connector.

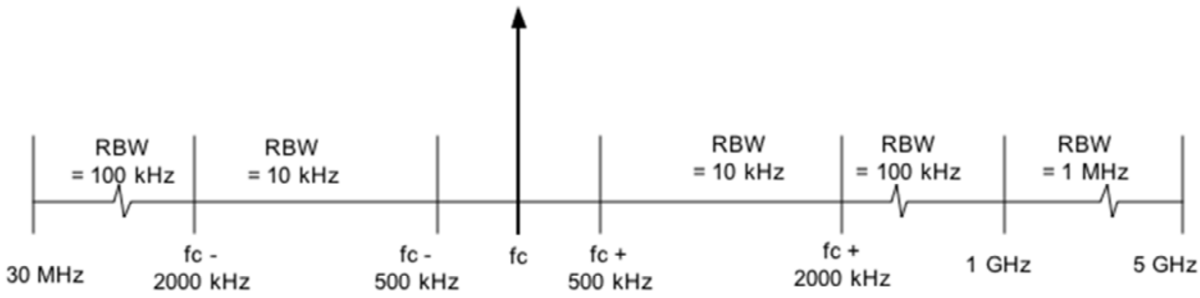


Figure 10: Resolution bandwidths for spurious emission in the lower band

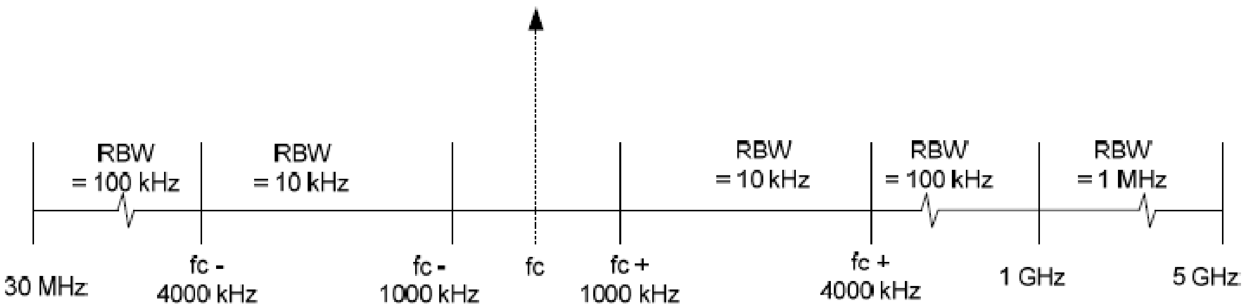


Figure 11: Resolution bandwidths for spurious emission in the upper band

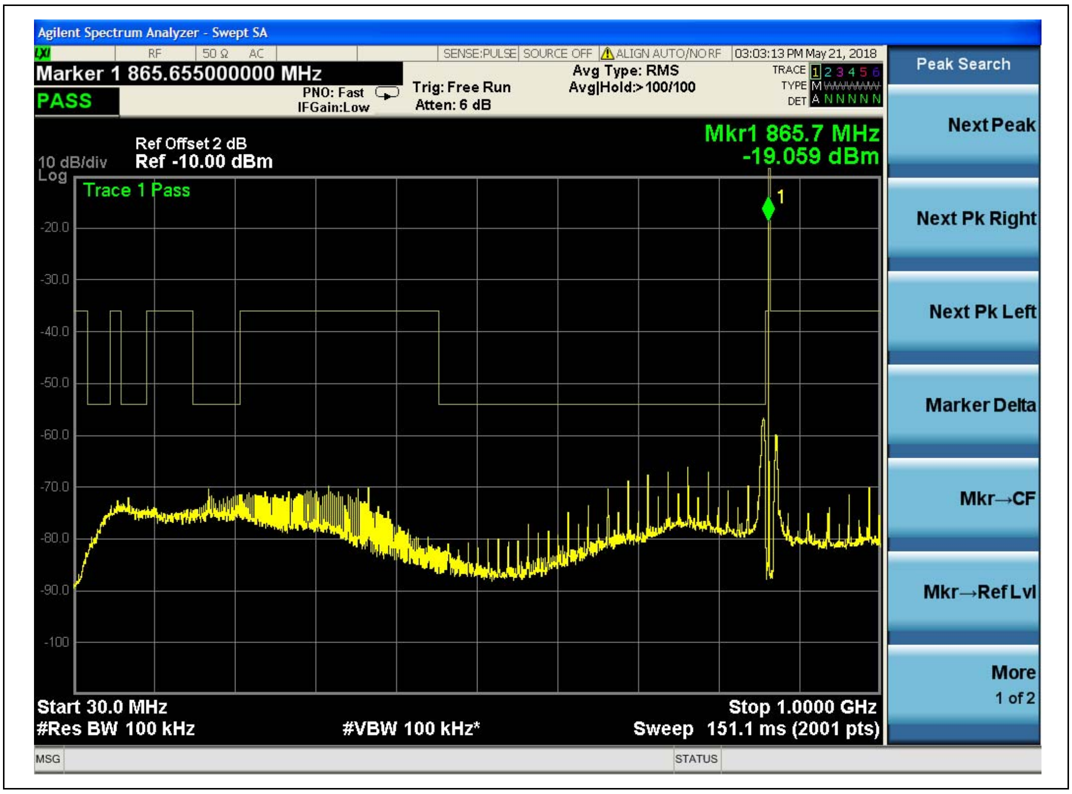
The level of spurious emissions at any frequency shall not exceed the limits specified in table 2.

2.6.5. Results

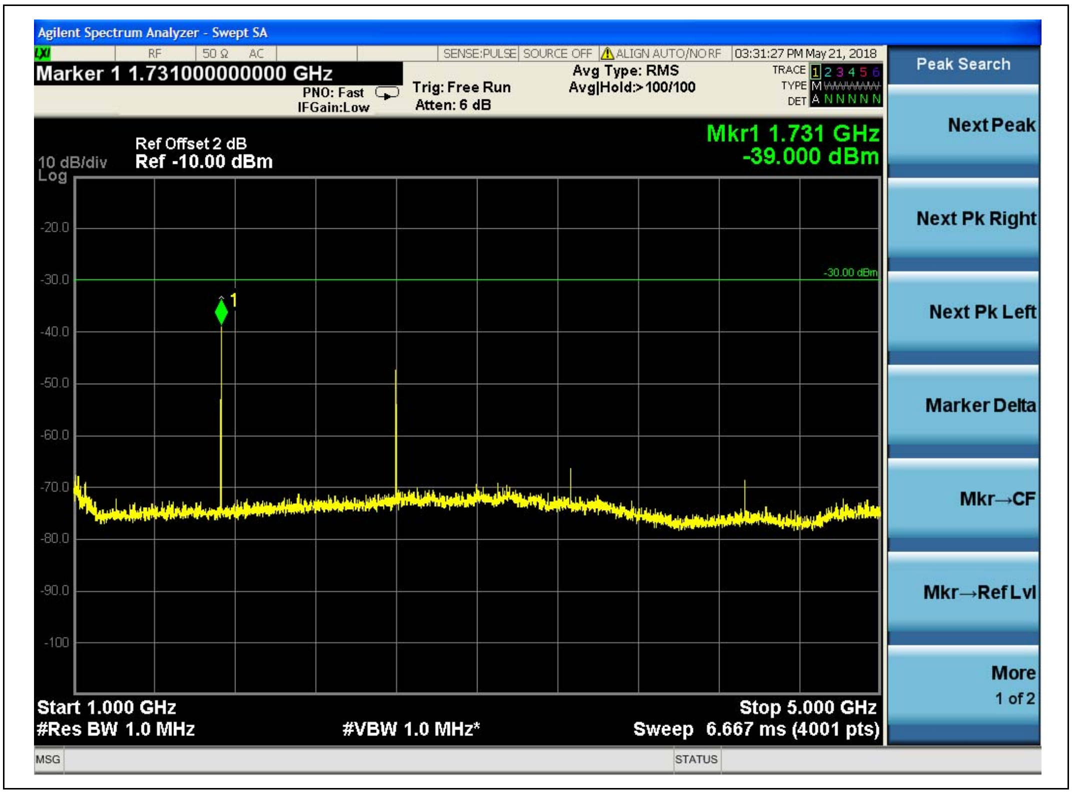
Conducted test result

Test Channel		Frequency		Limit (dBm)	Refer to Plot	Verdict
		Start	Stop			
1	865.7MHz	30MHz	1G	\	Plot A	PASS
		1G	5G	-30	Plot B	PASS
4	867.5MHz	30MHz	1G	\	Plot C	PASS
		1G	5G	-30	Plot D	PASS

Plot for Channel=1

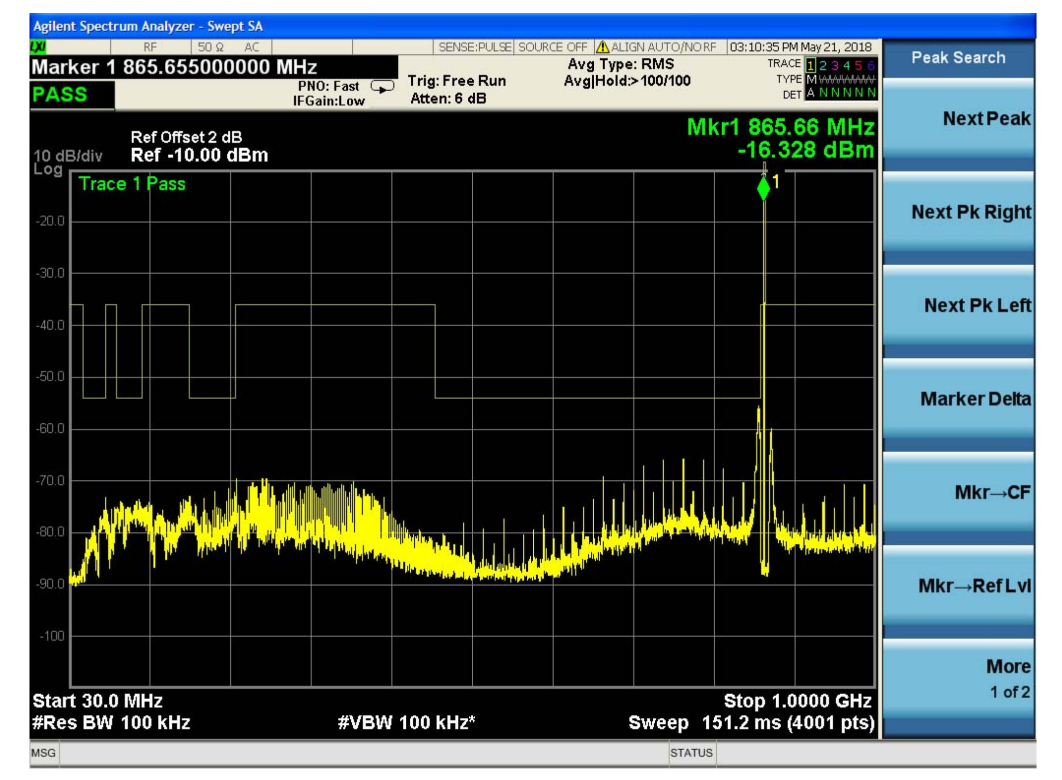


(Plot A: 30MHz to 1GHz, Channel 1)

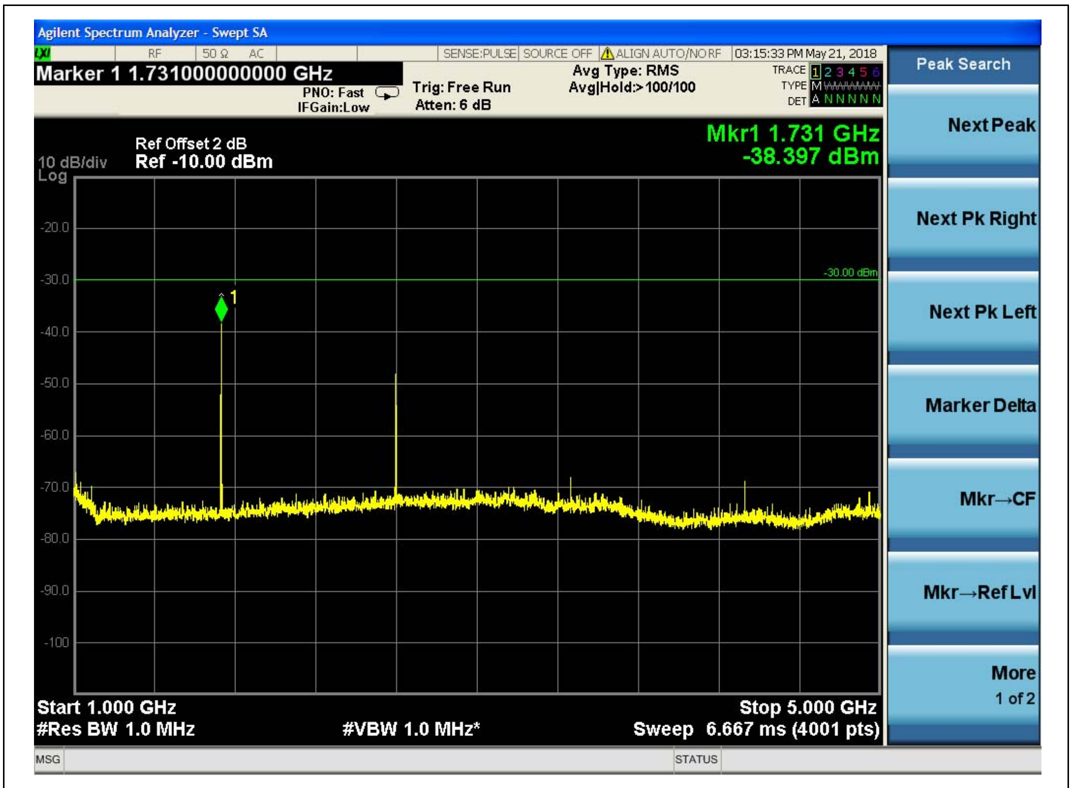


(Plot B: 1GHz to 5GHz, Channel 1)

Plot for Channel=4



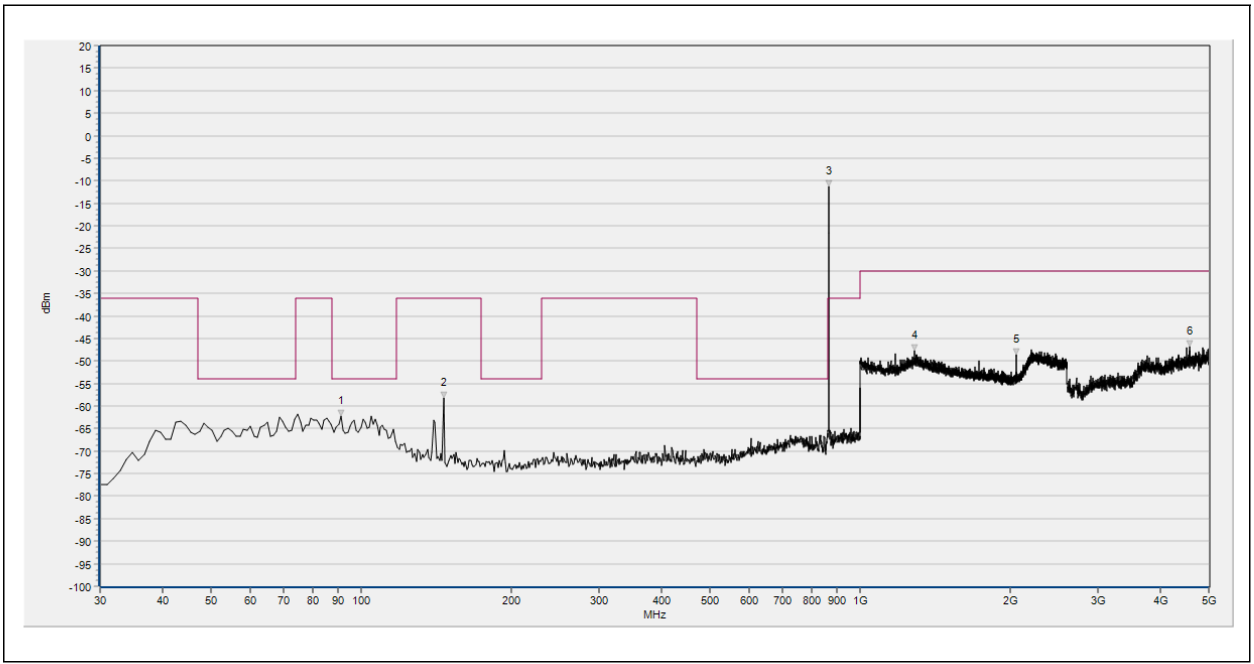
(Plot C: 30MHz to 1GHz, Channel 4)



(Plot D: 1GHz to 5GHz, Channel 4)

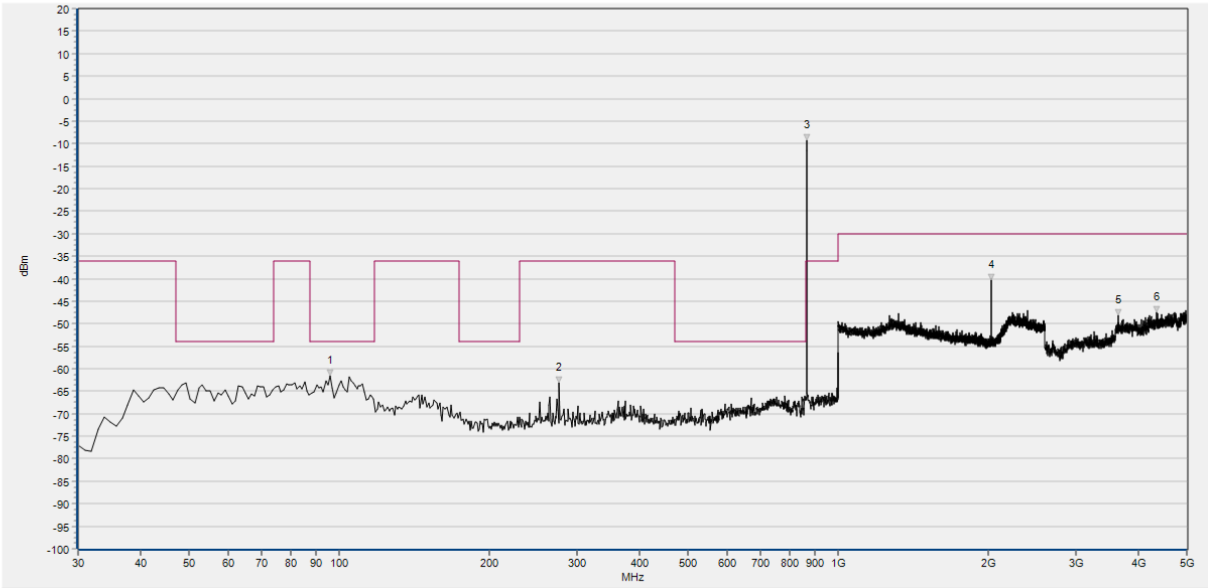
Radiated test result

Plot for Channel=1



(Plot C.1: 30MHz to 5GHz, Antenna Horizontal, Channel 1)

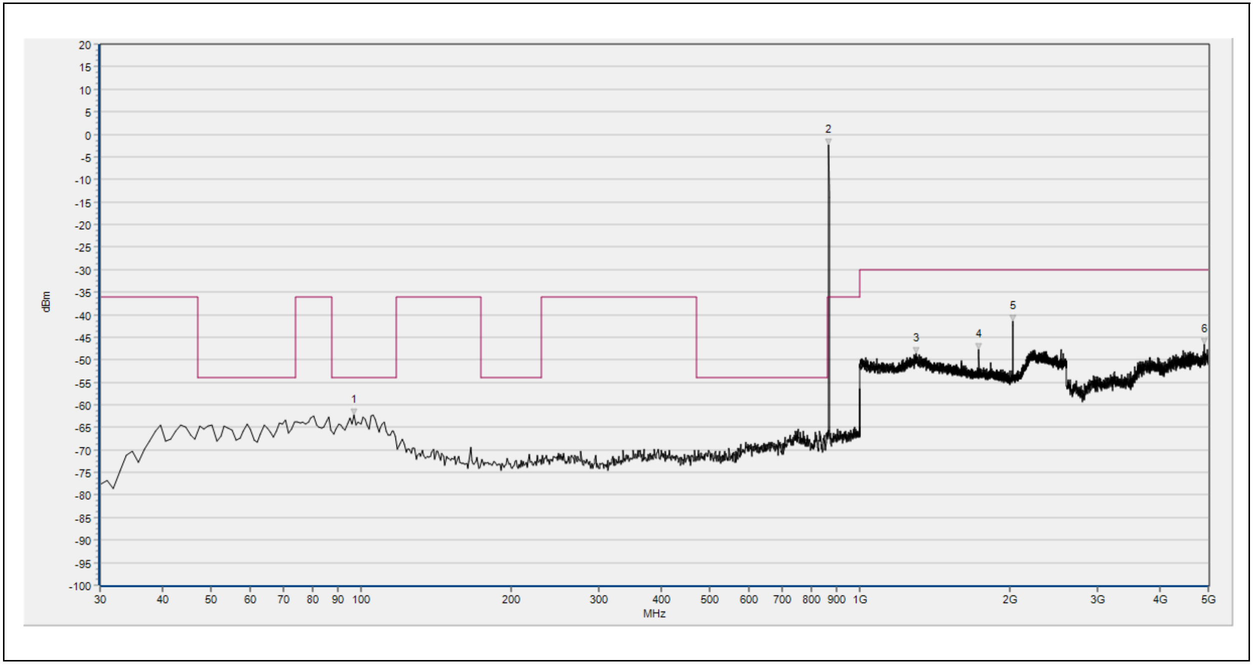
Test frequency range 30MHz to 5 GHz	Channel = 1				
	Transmitter with modulation Mode at 865.7MHz				
	Frequency (MHz)	**Peak (dBm)**	**Limit(PK)**	**Antenna**	**Verdict**
	91.110	-62.30	-54.00	Horizontal	PASS
	146.400	-58.29	-36.00	Horizontal	PASS
	866.140	-11.32	-36.00	Horizontal	N/A
	1286.933	-47.82	-30.00	Horizontal	PASS
	2055.467	-48.59	-30.00	Horizontal	PASS
	4571.130	-46.90	-30.00	Horizontal	PASS



(Plot C.2: 30MHz to 5GHz, Antenna Vertical, Channel 1)

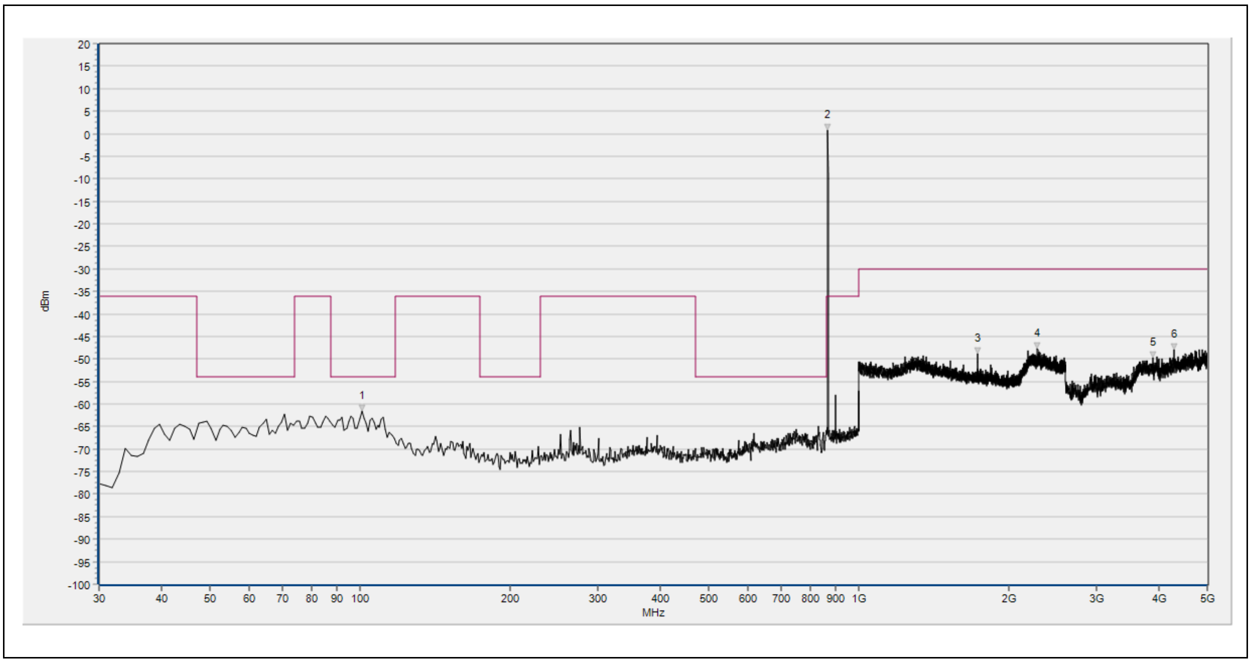
Test frequency range 30MHz to 5 GHz	Channel = 1				
	Transmitter with modulation Mode at 865.7MHz				
	Frequency (MHz)	**Peak (dBm)**	**Limit(PK)**	**Antenna**	**Verdict**
	95.960	-61.62	-54.00	Vertical	PASS
	276.380	-63.20	-36.00	Vertical	PASS
	866.140	-9.22	-36.00	Vertical	N/A
	2025.067	-40.35	-30.00	Vertical	PASS
	3643.420	-48.21	-30.00	Vertical	PASS
	4355.950	-47.46	-30.00	Vertical	PASS

Plot for Channel=4



(Plot C.1: 30MHz to 5GHz, Antenna Horizontal, Channel 4)

Test frequency range 30MHz to 5 GHz	Channel = 4				
	Transmitter with modulation Mode at 867.5MHz				
	Frequency (MHz)	**Peak (dBm)**	**Limit(PK)**	**Antenna**	**Verdict**
	96.930	-62.18	-54.00	Horizontal	PASS
	867.110	-2.45	-36.00	Horizontal	N/A
	1295.467	-48.53	-30.00	Horizontal	PASS
	1734.933	-47.80	-30.00	Horizontal	PASS
	2029.333	-41.46	-30.00	Horizontal	PASS
	4908.110	-46.60	-30.00	Horizontal	PASS



(Plot C.2: 30MHz to 5GHz, Antenna Vertical, Channel 4)

Test frequency range 30MHz to 5 GHz	Channel = 4				
	Transmitter with modulation Mode at 867.5MHz				
	Frequency (MHz)	**Peak (dBm)**	**Limit(PK)**	**Antenna**	**Verdict**
	100.810	-61.62	-54.00	Vertical	PASS
	867.110	0.88	-36.00	Vertical	N/A
	1734.933	-48.88	-30.00	Vertical	PASS
	2283.200	-47.77	-30.00	Vertical	PASS
	3884.990	-49.75	-30.00	Vertical	PASS
	4280.840	-47.96	-30.00	Vertical	PASS

2.7. EN 302 208 §4.3.7 Transmission times

2.7.1. Definition

The transmission time is the period of continuous transmission generated by an interrogator.
NOTE: The maximum period of continuous transmission and the period between consecutive transmissions on the same channel are specified in order to ensure most efficient use of available channels for the general benefit of all users.

2.7.2. Limits

For interrogators designed of operate in the lower band the manufacturer shall declare that the measured length of transmission at step 3 of clause 5.5.7.1 is no greater than is required to read the tags present in the field and to verify that there are no additional tags present.
In addition, the maximum length of continuous transmission and the interval between repeated transmissions measured at step 6 of clause 5.5.7.1 shall comply with the two limits in figure 7.

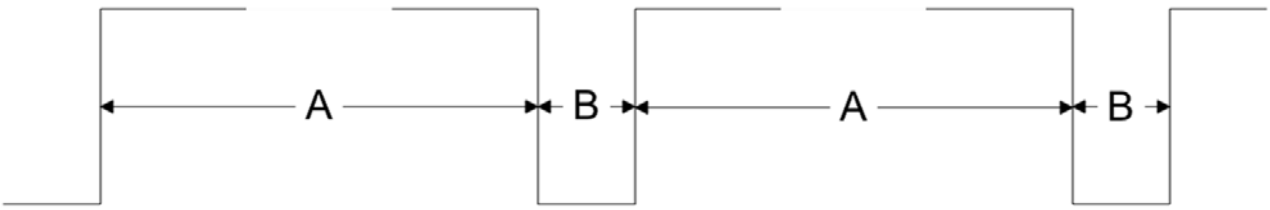


Figure 7: Repeated transmissions on the same channel

Where:
1) the on-duration of A shall not exceed 4 s;
2) the off-duration of B shall be not less than 100 ms.
In some applications (i.e. conveyor systems) it may be necessary for interrogators to transmit while tags are not present. To accommodate such requirements, manufacturers shall include within interrogators a means to minimize the overall length of transmission commensurate with the application. This may include the provision of trigger mechanisms within interrogators to initiate transmissions.
It is permitted for an interrogator to switch its transmission repeatedly between channels at intervals not exceeding 4 s. An interrogator shall not return to a previous channel within a period of less than 100 ms.
There is no specific limit to the length of transmission for interrogators when transmitting in the upper band. However interrogators shall transmit for no longer than is necessary to perform the intended operation.

2.7.3. Conformance

The conformance test suite for the transmission times shall be as defined in clause 5.5.7 of the present document.

2.7.4. Method of measurement

This test shall apply to interrogators intended for operation in the lower band and is designed to verify that the interrogator shall transmit no longer than is necessary to perform the intended operation.
Step 1: On a test site, selected from annex B, the equipment shall be placed at the specified height on a non-conducting support and in the position closest to normal use as declared by the provider. The interrogator shall be configured to operate on one of the high power channels shown in figure 1. A small quantity of tags (typically up to 3) shall be positioned within the interrogation field of the interrogator.
Step 2: A probe shall be positioned close to the antenna of the interrogator and arranged such that it will trigger a digital storage oscilloscope.
Step 3: The interrogator shall initiate an interrogation sequence and the trace generated by the transmission shall be recorded on the digital storage scope. The length of the transmission shall be measured.
Step 4: The interrogator shall then be configured to demonstrate reading an unlimited number of tags in the interrogation field. This may be achieved either by setting the interrogator to its "global scroll" mode with a single tag in the field or by replacing the tags with a test fixture that simulates an infinite number of tags.
Step 5: The transmission from the interrogator shall be monitored on a digital storage oscilloscope using a probe positioned close to the antenna of the interrogator.
Step 6: The maximum length of continuous transmission and the interval between repeated transmissions recorded on the digital storage oscilloscope shall comply with the permitted limits.

2.7.5. Results

Test Channel		Test Result				
		Maximum length of continuous transmission		Interval between repeated transmissions		Verdict
		Test Value	Limit	Test Value	Limit	
1	865.7MHz	17ms	≤4s	254ms	≥100ms	PASS
2	866.3MHz	17ms		254ms		PASS
3	866.9MHz	17ms		253ms		PASS
4	867.5MHz	17ms		253ms		PASS

2.8. EN 302 208 §4.3.8 Mitigation using DAA

2.8.1. Definition

This requirement applies to all interrogators that are sharing the sub-band 918 MHz to 921 MHz with ER-GSM.

2.8.2. Limits

The GSM-R receiver and interrogator under test shall detect and decode BCCH signals correctly at levels down to -98 dBm.

1) Method 1. For the tests in accordance with Method 1, the interrogator shall prevent transmission on either of its designated channels if they are within 700 kHz of an allocated ER-GSM channel. Manufacturers shall declare that their interrogators shall automatically perform a scan of the band 918 MHz to 925 MHz as specified in clause C.3 at least once every 24 hours.

2) Method 2. For the tests in accordance with Method 2 the interrogator shall prevent transmission on either of its designated channels if they are within 700 kHz of an allocated ER-GSM channel. In addition the interrogator shall prevent transmission on both designated channels in the ER-GSM band if it detects that a BTS has been allocated a channel within the frequency range 918 MHz to 921 MHz. Manufacturers shall declare that their interrogators shall automatically perform a scan of the band 918 MHz to 925 MHz as specified in clause C.4 at least once every 24 hours.

2.8.3. Conformance

The conformance test suite for the mitigation requirement of the interrogator shall be as defined in clause 5.5.8 of the present document.

2.8.4. Method of measurement

For the purposes of this clause the following meanings shall apply:

• ER-GSM refers to the operation of railway GSM equipment in the extended band 918 MHz to 921 MHz. Note that an ER-GSM receiver covers the full frequency range 918 MHz to 921 MHz.

• R-GSM refers to the operation of railway GSM equipment in the band 921 MHz to 925 MHz.

• GSM-R is the collective term for railway GSM equipment operational in the band 918 MHz to 925 MHz. Diagrams of the set-up to perform the tests are shown in figures 12 and 13 below. Where interrogators handle both the detection of the GSM-R signals and transmissions to the tags, the diagram in figure 12 should be used. It is irrelevant whether detection of the response from the tags is on the same port or a separate port.

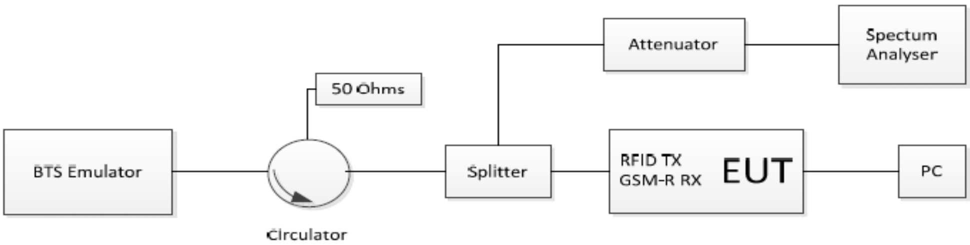


Figure 12: Set-up of equipment for mitigation test using splitter

Some interrogators may use a separate antenna to detect the GSM-R BCCH. Where this applies, the BTS emulator shall be connected directly to the input for the GSM signal on the GSM-R receiver. The port for transmissions by the interrogator to the RFID antenna shall be connected via the attenuator to the spectrum analyser. It is irrelevant whether detection of the response from the tags is on the same port or a separate port. This is illustrated in figure 13 below.

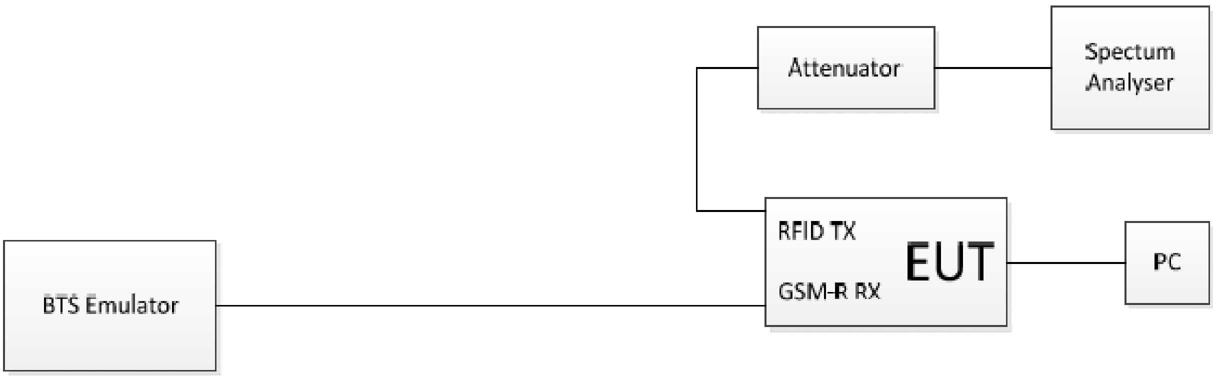


Figure 13: Set-up of equipment for mitigation test

Simulation of the BTS for GSM-R shall be by means of a Universal Radio Communications Tester or equivalent GSMR emulator. The equipment should be configured to transmit a BCCH signal at selected frequencies within the bands specified in either clause 5.5.8.2 or clause 5.5.8.3. The BCCH shall contain SYSTEM INFORMATION 1, which shall include the Cell Channel Description giving details of any TCH channels and BTS operating in the ER-GSM band (see IEC 60489-3 [i.4]). The GSM-R emulator shall be configured to transmit on a channel as specified in either Method 1 or Method 2 as appropriate. It shall include the information in its BCCH as specified in the following four scenarios.

1) Channel 941 (centre frequency of 918,4 MHz) included in ARFCN list.

2) Channel 948 (centre frequency of 919,8 MHz) included in ARFCN list.

3) Both channels 941 and 948 included in ARFCN list.

4) An ER-GSM BTS transmitting on channel 944 (centre frequency of 919,0 MHz) in the ARFCN list. For all tests in clause 5.5.8 the RBW of the measuring receiver shall be set to 1 MHz.

Tests for Mitigation Method 1

These tests shall be performed using an ER-GSM receiver capable of receiving BTS transmissions across the frequency range 918 MHz to 925 MHz. The tests are designed to demonstrate that the interrogator complies with the mitigation technique described in clause C.6.

With the equipment connected in accordance with either figure 12 or figure 13, the following tests shall be performed:

Test 1 Operation with channel 941 (918,4 MHz) in the ARCFN list

The purpose of this test is to confirm that the interrogator is able to detect and decode a BCCH signal at levels down to -98 dBm. Furthermore the test will verify that, where the ER-GSM channel is within 700 kHz of the centre frequency of transmission of the interrogator (918,7 MHz), it will cease to transmit at this frequency.

Step 1: The interrogator shall be configured to transmit at 918,7 MHz.

Step 2: The interrogator shall be switched on and, after initialization, a check shall be made that the interrogator transmits at 918,7 MHz.

Step 3: The interrogator shall be switched off.

Step 4: The GSM-R emulator shall be configured to transmit a BCCH on a channel within the band 918 MHz to 925 MHz. The BCCH shall include channel 941 in its ARCFN list. The output from the GSM-R emulator shall be adjusted to give a signal level at the input to the ER-GSM receiver of -98 dBm assuming a 0 dBd antenna gain.

Step 5: The interrogator shall be switched on and a check shall be made that the interrogator has ceased to transmit.

Step 6: Without changing the settings of the GSM-R emulator, the interrogator shall be configured to transmit at 919,9 MHz.

Step 7: A check shall be made to verify that the interrogator transmits at 919,9 MHz.

Test 2 Operation with channel 948 (919,8 MHz) in the BCCH ARCFN list

This test is identical to test 1 except that it confirms correct operation of the interrogator at a transmit frequency of 919,9 MHz.

Step1: The interrogator shall be configured to transmit at 919,9 MHz.

Step 2: The interrogator shall be switched on and, after initialization, a check shall be made that the interrogator transmits at 919,9 MHz.

Step 3: The interrogator shall be switched off.

Step 4: The GSM-R emulator shall be configured to transmit a BCCH on a channel within the band 918 MHz to 925 MHz, The BCCH shall include channel 948 in its ARCFN list. The output from the GSM-R emulator shall be adjusted to give a signal level at the input to the ER-GSM receiver of -98 dBm assuming a 0 dBd antenna gain.

Step 5: The interrogator shall be switched on and, after initialization, a check shall be made that the interrogator does not transmit at 919,9 MHz.

Step 6: Without changing the settings of the GSM-R emulator, the interrogator shall be configured to transmit at 918,7 MHz.

Step 7: A check shall be made to verify that the interrogator transmits at 918,7 MHz.

Test 3 Operation with both channel 941 and channel 948 in the BCCH ARCFN list

The purpose of this test is to verify that, where the ER-GSM channels are within 700 kHz of either centre frequency of transmission of the interrogator (918,7 MHz or 919,9 MHz), it will cease all transmission.

Step1: The interrogator shall be configured to transmit at both 918,7 MHz and 919,9 MHz.

Step 2: The interrogator shall be switched on and, after initialization, a check shall be made that the interrogator is able to transmit at either 918,7 MHz or 919,9 MHz.

Step 3: The GSM-R emulator shall be configured to transmit a BCCH signal on a channel within the band 915 MHz to 925 MHz, The BCCH shall include both channels 941 and 948 in its ARCFN list. The output from the GSM-R emulator shall be adjusted to give a signal level at the input to the ERGSM receiver of -98 dBm assuming a 0 dBd antenna gain.

Step 4: The interrogator shall be switched on and, after initialization, a check shall be made to ensure that the interrogator does not transmit at either frequency.

Tests for Mitigation Method 2

These tests shall be performed in situations where an ER-GSM receiver is unavailable and an R-GSM receiver is used to implement the mitigation technique described in clause C.7. The R-GSM receiver shall be capable of receiving BTS transmissions across the frequency range 921 MHz to 925 MHz. The tests are designed to demonstrate that in the event that ER-GSM is deployed at some point in the future, the mitigation technique will still ensure that ER-GSM is protected. With the equipment connected in accordance with either figure 12 or figure 13, the following tests shall be performed.

Test 1 Operation with channel 941 (918,4 MHz) in the ARCFN list

The purpose of this test is to confirm that the interrogator is able to detect and decode a R-GSM BCCH at levels down to -98 dBm. Furthermore the test will verify that, where an ER-GSM channel is within 700 kHz of the centre frequency of transmission of the interrogator (918,7 MHz), it will cease to transmit at this frequency.

Step 1: The interrogator shall be configured to transmit at 918,7 MHz.

Step 2: The interrogator shall be switched on and, after initialization, a check shall be made that the interrogator transmits at 918,7 MHz.

Step 3: The interrogator shall be switched off.

Step 4: The GSM-R emulator shall be configured to transmit a BCCH on a channel within the band 921 MHz to 925 MHz, The BCCH shall include channel 941 in its ARCFN list. The output from the GSM-R emulator shall be adjusted to give a signal level at the input to the R-GSM receiver of -98 dBm assuming a 0 dBd antenna gain.

Step 5: The interrogator shall be switched on and a check shall be made that the interrogator has ceased to transmit.

Step 6: Without changing the settings of the GSM-R emulator, the interrogator shall be configured to transmit at 919,9 MHz.

Step 7: A check shall be made to verify that the interrogator transmits at 919,9 MHz.

Test 2 Operation with channel 948 (919,8 MHz) in the ARCFN list

This test is identical to the test 1 except that it confirms correct operation of the interrogator at a transmit frequency of 919,9 MHz.

Step 1: The interrogator shall be configured to transmit at 919,9 MHz.

Step 2: The interrogator shall be switched on and, after initialization, a check shall be made that the interrogator transmits at 919,9 MHz.

Step 3: The interrogator shall be switched off.

Step 4: The GSM-R emulator shall be configured to transmit a BCCH on a channel within the band 921 MHz to 925 MHz, The BCCH shall include channel 948 in its ARCFN list. The output from the GSM-R emulator shall be adjusted to give a signal level at the input to the R-GSM receiver of -98 dBm assuming a 0 dBd antenna gain.

Step 5: The interrogator shall be switched on and, after initialization, a check shall be made that the interrogator does not transmit at 919,9 MHz.

Step 6: Without changing the settings of the GSM-R emulator, the interrogator shall be configured to transmit at 918,7 MHz.

Step 7: A check shall be made to verify that the interrogator transmits at 918,7 MHz.

Test 3 Operation with both channel 941 and channel 948 in the ARCFN list

The purpose of this test is to verify that, where the ER-GSM channels are within 700 kHz of either centre frequency of transmission of the interrogator (918,7 MHz or 919,9 MHz), it will cease all transmission.

Step 1: The interrogator shall be configured to transmit at both 918,7 MHz and 919,9 MHz.

Step 2: The interrogator shall be switched on and, after initialization, a check shall be made that the interrogator is able to transmit at either 918,7 MHz or 919,9 MHz.

Step 3: The GSM-R emulator shall be configured to transmit a BCCH on a channel within the band 921 MHz to 925 MHz, The BCCH shall include both channels 941 and 948 in its ARCFN list. The output from the GSM-R emulator shall be adjusted to give a signal level at the input to the R-GSM receiver of -98 dBm assuming a 0 dBd antenna gain.

Step 4: The interrogator shall be switched on and, after initialization, a check shall be made to ensure that the interrogator does not transmit at either frequency.

Test 4: A BTS on channel 944 (centre frequency of 919,0 MHz) in the ARFCN list

The purpose of this test is to demonstrate that, if at some point in the future a BTS is assigned to the ER-GSM band, its presence will be detected and the interrogator will be prevented from transmitting on both of its high power channels in the ER-GSM band.

Step 1: The interrogator shall be configured to transmit at both 918,7 MHz and 919,9 MHz.

Step 2: The interrogator shall be switched off.

Step 3: The GSM-R emulator shall be configured to transmit a BCCH signal on a channel within the band 921 MHz to 925 MHz. The BCCH signal shall include a BTS on channel 944 (919,0 MHz) in the ARFCN list. The output from the GSM-R emulator shall be adjusted to give a signal level at the input to the R-GSM receiver of -98 dBm assuming a 0 dBd antenna gain.

Step 4: The interrogator shall be switched on and, after initialization, a check shall be made to

ensure that the interrogator does not transmit at either 918,7 MHz or 919,9 MHz.
The results of the tests shall be recorded in the test report.

2.8.5. Results

Note: The test case only applies to all interrogators that are sharing the sub-band 918 MHz to 921 MHz with ER-GSM.

2.9. EN 302 208 §4.4.1 Receiver selectivity

2.9.1. Definition

The adjacent channel selectivity is a measure of the capability of the receiver in an interrogator to identify a tag while rejecting an unwanted signal from another device transmitting in one of the adjacent high power channels. The adjacent channel in the lower band shall be at a frequency of ±0,6 MHz from the centre frequency of the selected channel. For the upper band the adjacent channel shall be at a frequency of ±1,2 MHz from the centre frequency of the selected channel.

2.9.2. Limits

The adjacent channel selectivity measured at the receiver of the interrogator shall be equal to or better than -26 dBm.

2.9.3. Conformance

The conformance test suite for the adjacent channel selectivity shall be as defined in clause 5.6.1 of the present document.

2.9.4. Method of measurement

General

This measurement is required to ensure satisfactory operation of equipment in accordance with the band plan. Two alternative methods are specified, which lead to different results. This provides the flexibility to measure interrogators with both high and low gain antennas. The method of measuring radiated signals requires correction as specified in Step 10 of clause 5.6.1.2.

Where the interrogator is not fitted with an external antenna connector, the measurement shall be made as described in clause 5.6.1.2.

Method of measuring radiated signals

Step 1: An interrogator shall be set up to operate at its maximum output power on a known channel in the lower band either in an anechoic chamber or on an open air test site as specified in annex B. The offset frequency shall be set to approximately 300 kHz. The interrogator shall be connected to an antenna with combined Tx and Rx functionality.

Step 2: A tag shall be selected with an antenna gain of greater than 0 dBi and a sensitivity of better than -15 dBm. With the tag in its preferred orientation it shall be moved slowly towards the interrogator in the direction of maximum gain of its antenna to a point where the tag is just identified. The distance d between the antenna of the interrogator and the tag shall be measured. If the distance between the tag and the interrogator is too great to fit within the anechoic chamber, an

attenuator may be inserted between the interrogator and its antenna.
Step 3: The tag shall then be moved to a new position that is at a distance of 0,7 d from the interrogator in the direction of maximum gain of its antenna.
Step 4: A signal generator fitted with a horn antenna shall be set up in accordance with figure 14 and its transmission directed at the antenna of the interrogator.

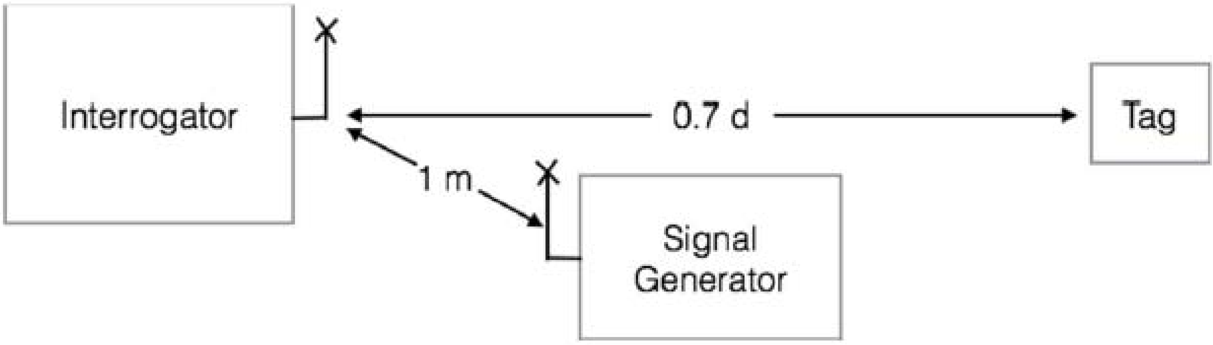


Figure 14: Radiated test set up for adjacent channel selectivity

Step 5: The signal generator shall be adjusted to radiate a signal at a test frequency that lies at the midpoint of the upper adjacent channel. The signal shall be an AM modulated sine wave to a depth of 80 % at a frequency of 40 kHz.
Step 6: The level of the signal generator shall be increased until the interrogator just ceases to identify the tag. The level of the signal generator shall then be reduced in 1 dB steps until the interrogator just identifies the tag again.
Step 7: The interrogator shall be removed and replaced by a measurement antenna connected to a measurement receiver set to a resolution bandwidth of 100 kHz. The level of signal from the signal generator received at the measurement receiver shall be recorded.
Step 8: The measurement shall be repeated for the lower adjacent channel.
Step 9: Steps 1 to 8 shall be repeated for the upper band using an offset frequency of approximately 600 kHz.
Step 10: The absolute levels of the signals received by the measurement receiver from the signal generator shall be corrected using formula 3.

$$SACH = PMR - GMR \quad (3)$$

Where:
SACH is the adjacent channel selectivity in dBm.
PMR is the signal strength received at the measurement receiver.
GMR is the antenna gain of the measurement receiver antenna in dBi;
The corrected power level for each measurement shall be not less than the limit specified in clause 4.4.1.3.

Conducted method of measurement

Where the interrogator is fitted with an external antenna connector, the measurement may be made using a modified tag that provides a hard-wire connection.

Step 1: An interrogator shall be configured to operate in the lower band in accordance with figure 15 below. The offset frequency shall be set to approximately 300 kHz.

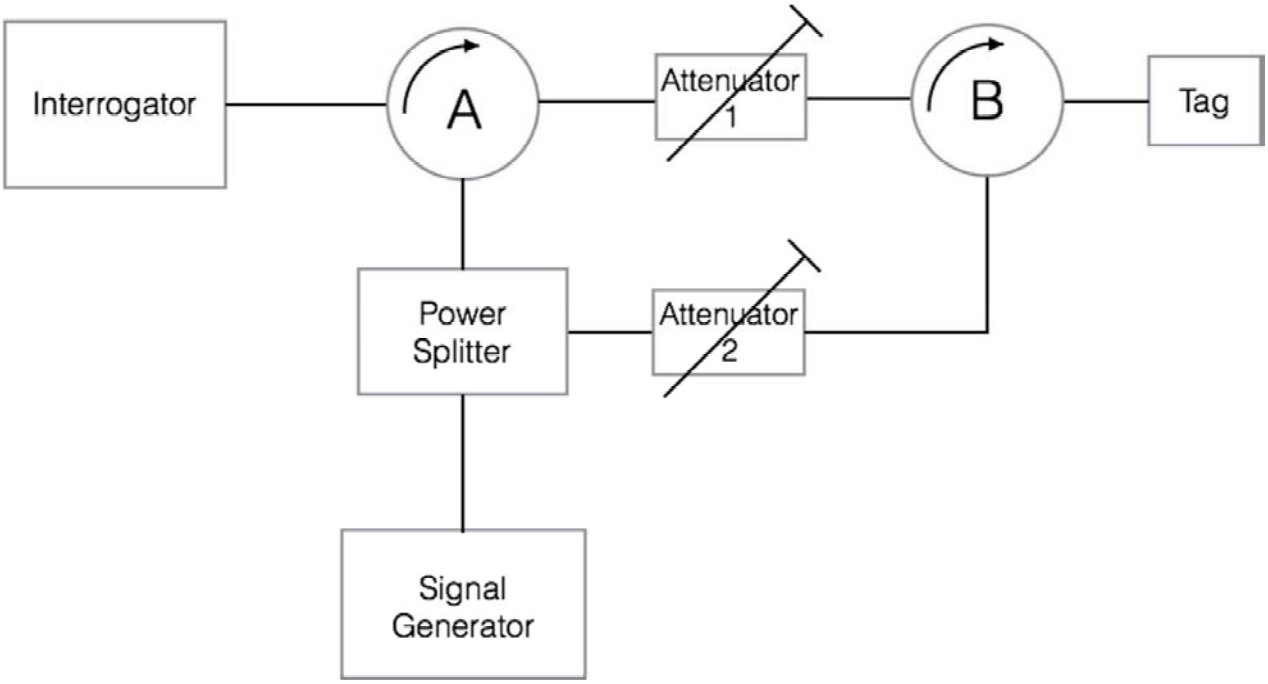


Figure 15: Conducted test set up for adjacent channel selectivity

Step 2: To check that the tag is not activated by the interrogator via attenuator 2, attenuator 1 shall be removed from the circuit. The open port of circulators A and B shall each be terminated by a 50 Ohm load resistor. With the signal generator switched off, the interrogator shall be switched on at its maximum output power on a known channel in the lower band. Attenuator 2 shall be increased until the interrogator just ceases to identify the tag. The value of attenuator 2 shall be noted. For the remainder of the test attenuator 2 shall not be reduced below this figure.

Step 3: The 50 Ohm load resistors shall be removed from circulators A and B and replaced by attenuator 1. With the signal generator switched off, the interrogator shall be switched on again at its maximum output power. Attenuator 1 shall be increased until it is just possible for the interrogator to read the tag. The setting of the attenuator 1 shall then be reduced by 10 dB to ensure that the tag remains fully activated.

Step 4: With the signal generator switched off, attenuator 2 shall be increased until the interrogator is just able to identify the tag. Attenuator 2 shall then be reduced by 3 dB to ensure that the interrogator receives an acceptable signal level from the tag.

Step 5: The signal generator shall be adjusted to generate a signal at a test frequency that lies at the mid-point of the upper adjacent channel. The signal shall be an AM sine wave modulated to a depth of 80 % at a frequency of 40 kHz.

Step 6: The level of the signal generator shall be increased until the interrogator just ceases to identify the tag. The level of the signal generator shall then be reduced in 1 dB steps until the interrogator just identifies the tag again. The level of signal from the signal generator shall be recorded.

Step 7: The level of signal from the signal generator shall be adjusted to compensate for the losses in both circulator A and the power splitter to give the corrected signal received in dBm at the input of the interrogator.

Step 8: The measurement shall be repeated for the lower adjacent channel.

Step 9: Steps 1 to 8 shall be repeated on the upper band using an offset frequency of approximately 600 kHz.

Step 10: The absolute level of the corrected signals from the signal generator referred to the input of the interrogator in dBm shall be not less than the limit specified in clause 4.4.1.3.

The results shall be recorded in the test report.

2.9.5. Result (Conducted)

Test Channel		Adjacent channel				
		Offest (KHz)	**Frequency (MHz)**	**Test Value (dBm)**	**Limit (dBm)**	**Verdict**
1	865.7MHz	+300	866	-19.42	≥-26	PASS
		-300	865.4	-16.43		PASS
4	867.5MHz	+300	867.8	-18.50		PASS
		-300	867.2	-15.66		PASS

2.10. EN 302 208 §4.4.2 Receiver blocking

2.10.1. Definition

Blocking or desensitization is a measure of the capability of the receiver to identify a tag in the presence of an unwanted input signal at frequencies other than those of the spurious responses or in the adjacent channels under normal test conditions.

2.10.2. Limits

The blocking level measured at the receiver to the interrogator under the above specified conditions shall be equal to or better than the following limits:
For (fc ± 2MHz): -23 dBm
For (fc ± 5MHz) : -14 dBm
For (fc ± 10MHz) : -8 dBm

2.10.3. Conformance

The conformance test suite for blocking or desensitization shall be as defined in clause 5.6.2 of the present document.

2.10.4. Method of measurement

General
This measurement is required to ensure satisfactory operation of equipment in accordance with the band plan. Two alternative methods are specified, which lead to different results. This provides the flexibility to measure interrogators with both high and low gain antennas. The method of measuring radiated signals requires correction as specified in Step 10.
Where the interrogator is not fitted with an external antenna connector, the measurement shall be made as described in clause 5.6.2.2.
Method of measuring radiated signals
Step 1: This test may be performed either in an anechoic chamber or on an open-air test site as specified in annex B. An interrogator shall be set up to operate on a known high power channel in the lower band using an offset frequency of approximately 300 kHz in accordance with figure 14.
Step 2: A tag shall be selected with an antenna gain of greater than 0 dBi and a sensitivity of better than - 15 dBm. The tag, in its preferred orientation, shall be moved slowly towards the interrogator in the direction of maximum gain of its antenna to a point where it is just identified. The distance d between the antenna of the interrogator and the tag shall be measured. If the distance between the tag and the interrogator is too great to fit within the anechoic chamber, an attenuator may be

inserted between the interrogator and its antenna.

Step 3: The tag shall then be moved to a new position that is at a distance of 0,7 × d from the interrogator in the direction of maximum gain of its antenna.

Step 4: A signal generator fitted with a horn antenna shall be set up in accordance with figure 14 and its transmission directed at the antenna of the interrogator.

Step 5: The signal generator shall be adjusted to radiate an un-modulated signal at test frequencies of approximately 2 MHz, 5MHz and 10 MHz above the centre frequency of the interrogator.

Step 6: At each test frequency the level of the signal generator shall be increased until the interrogator just ceases to identify the tag. The level of the signal generator shall then be reduced in 1 dB steps until the interrogator just identifies the tag again.

Step 7: The interrogator shall be removed and replaced by a measurement antenna connected to a measuring receiver set to a resolution bandwidth of 100 kHz. At each test frequency the level of signal from the signal generator received at the measuring receiver shall be recorded.

Step 8: The tests shall be repeated at approximately, -2 MHz, -5 MHz and -10 MHz from the carrier frequency of the interrogator.

Step 9: Steps 2 to 8 shall be repeated in the upper band using an offset frequency of approximately 600 kHz.

Step 10: The blocking or desensitization shall be recorded in the test report as the highest level in dBm at the input to the interrogator of the unwanted signal at which it is just possible to identify a tag. The absolute levels of the signals received by the measurement receiver from the signal generator shall be corrected using formula (4).

$$SBL = PMR - GMR \quad (4)$$

Where:

SBL is the blocking level in dBm.

PMR is the signal strength received at the measurement receiver.

GMR is the antenna gain of the measurement receiver antenna in dBi.

The highest corrected power level in dBm referred to the input to the interrogator at which it is just possible to identify a tag shall be not less than the limit specified in clause 4.4.2.3.

Conducted method of measurement

Where the interrogator is fitted with an external antenna connector, the measurement may be made using a modified tag that provides a hard-wire connection.

Step 1: An interrogator shall be set up to operate in the lower band using an offset frequency of approximately 300 kHz in accordance with figure 15 shown above.

Step 2: To check that the tag is not activated by the interrogator via attenuator 2, attenuator 1 shall be removed from the circuit. The open port of circulators A and B shall each be terminated by a 50 Ohm load resistor. With the signal generator switched off, the interrogator shall be switched on at its maximum output power on a known channel in the lower band. Attenuator 2 shall be increased until the interrogator just ceases to identify the tag. The value of attenuator 2 shall be noted. For

the remainder of the test attenuator 2 shall not be reduced below this figure.
Step 3: The 50 Ohm load resistors shall be removed from circulators A and B and replaced by attenuator 1. With the signal generator switched off, the interrogator shall be switched on again at its maximum output power. Attenuator 1 shall be increased until it is just possible for the interrogator to read the tag. The setting of the attenuator 1 shall then be reduced by 10 dB to ensure that the tag remains fully activated.
Step 4: With the signal generator switched off, attenuator 2 shall be increased until the interrogator is just able to identify the tag. Attenuator 2 shall then be reduced by 3 dB to ensure that the interrogator receives an acceptable signal level from the tag.
Step 5: The signal generator shall be adjusted to produce an un-modulated signal at test frequencies of approximately 2 MHz, 5 MHz and 10 MHz above the carrier frequency of the interrogator.
Step 6: At each test frequency the level of the signal generator shall be increased until the interrogator just ceases to identify the tag. The level of the signal generator shall then be reduced in 1 dB steps until the interrogator just identifies the tag again. The level of signals from the signal generator at which the interrogator just identifies the tag shall be recorded.
Step 7: The tests shall be repeated at approximately -2 MHz, -5 MHz and -10 MHz from the centre frequency of the interrogator.
Step 8: The recorded signals from the signal generator shall be corrected to compensate for any losses in both circulator A and in the power splitter to give the corrected signals received at the input to the interrogator.
Step 9: Steps 1 to 8 shall be repeated for the upper band using an offset frequency of approximately 600 kHz.
Step 10: At each test frequency the blocking or desensitization shall be recorded in the test report as the highest corrected level in dBm of the unwanted signal at which it is just possible to identify a tag. The corrected levels shall comply with the limits specified in clause 4.4.2.3.

2.10.5. Result (Conducted)

Test Channel		Blocking Signal				
		Offest (MHz)	Frequency (MHz)	Test Value (dBm)	Limit (dBm)	Verdict
1	865.7MHz	+2	867.7	-17.40	≥-23	PASS
		-2	863.7	-14.28		PASS
		+5	870.7	-8.36	≥-14	PASS
		-5	860.7	-7.72		PASS
		+10	875.7	-6.45	≥-8	PASS
		-10	855.7	-6.32		PASS
4	867.5MHz	+2	869.5	-16.46	≥-23	PASS
		-2	865.5	-15.30		PASS
		+5	872.5	-7.67	≥-14	PASS
		-5	862.5	-7.63		PASS
		+10	877.5	-5.22	≥-8	PASS
		-10	857.5	-5.13		PASS

2.11. EN 302 208 §4.4.3 Receiver spurious emissions

2.11.1. Definition

Spurious emissions from the receiver of an interrogator are emissions at any frequency when the equipment is not in the transmit mode.

2.11.2. Limits

The power of any spurious emission, radiated or conducted, shall not exceed the values given below:

a) 2 nW e.r.p. below 1 000 MHz;

b) 20 nW e.r.p. above 1 000 MHz.

2.11.3. Conformance

The conformance test suite for spurious emissions shall be as defined in clause 5.5.6 of the present document.

2.11.4. Method of measurement

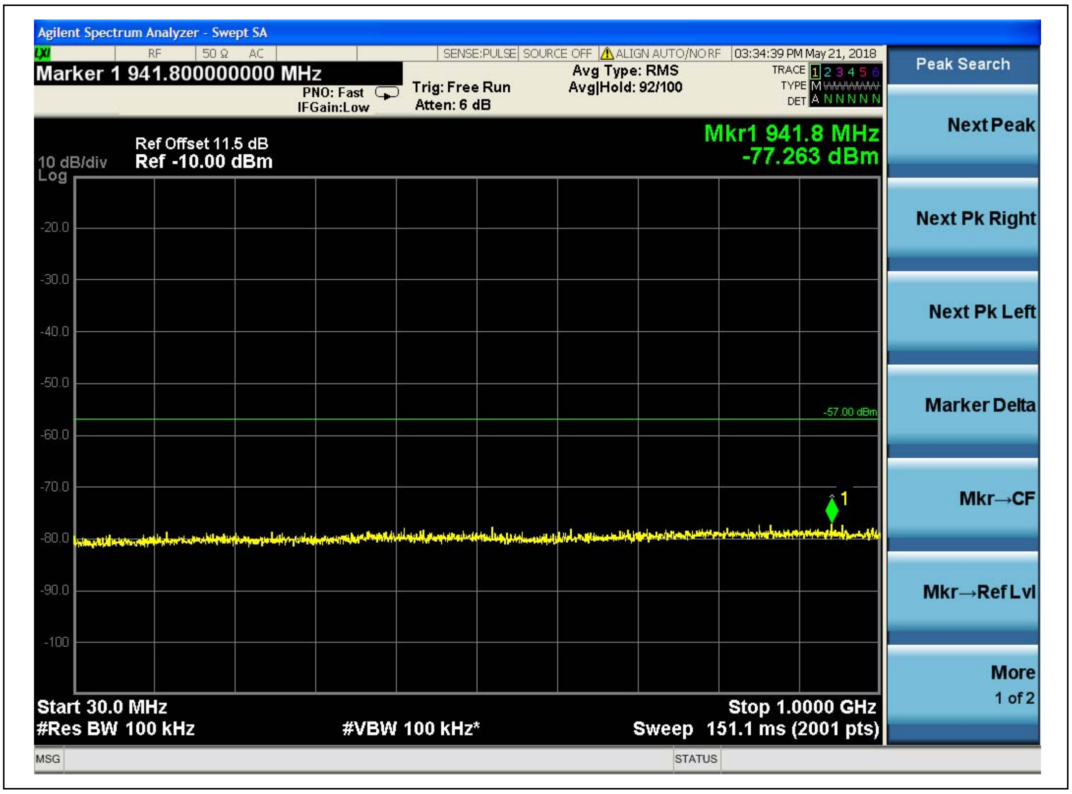
Please refer to clause 2.6.4 in the report.

2.11.5. Results

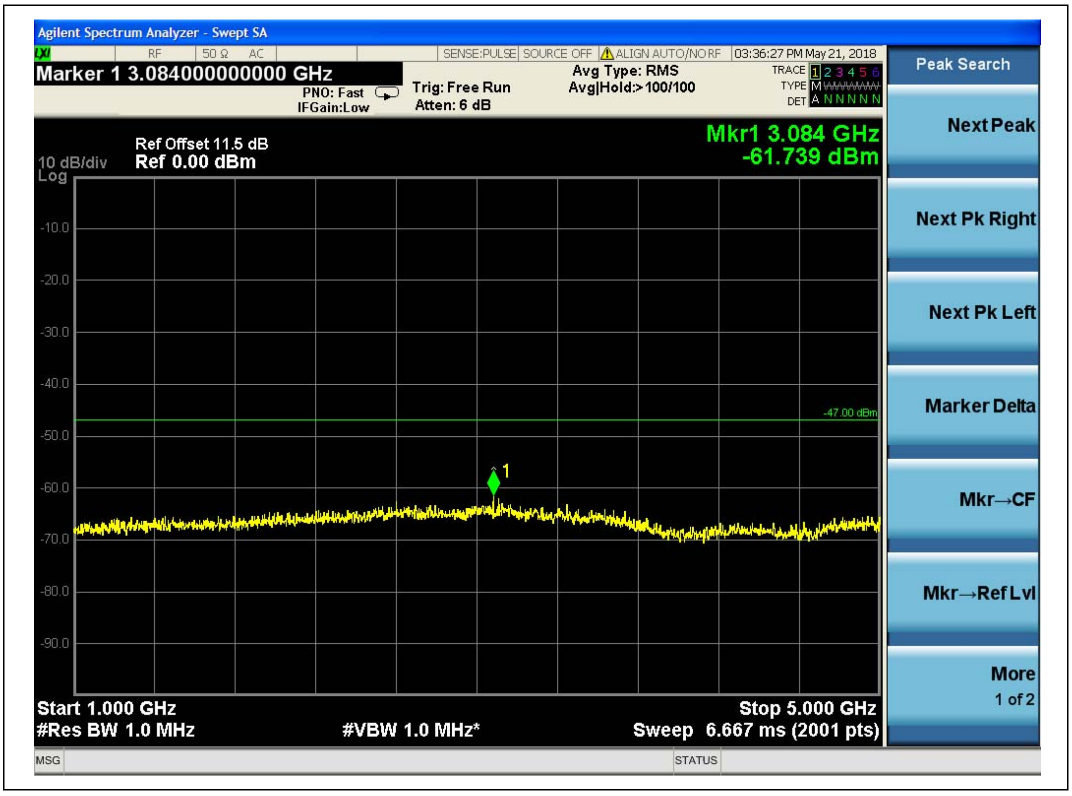
Conducted test result

Test Channel		Frequency		Limit (dBm)	Refer to Plot	Verdict
		Start	Stop			
1	865.7MHz	30MHz	1G	-57	Plot A	PASS
		1G	5G	-47	Plot B	PASS
4	867.5MHz	30MHz	1G	-57	Plot C	PASS
		1G	5G	-47	Plot D	PASS

Plot for Channel=1

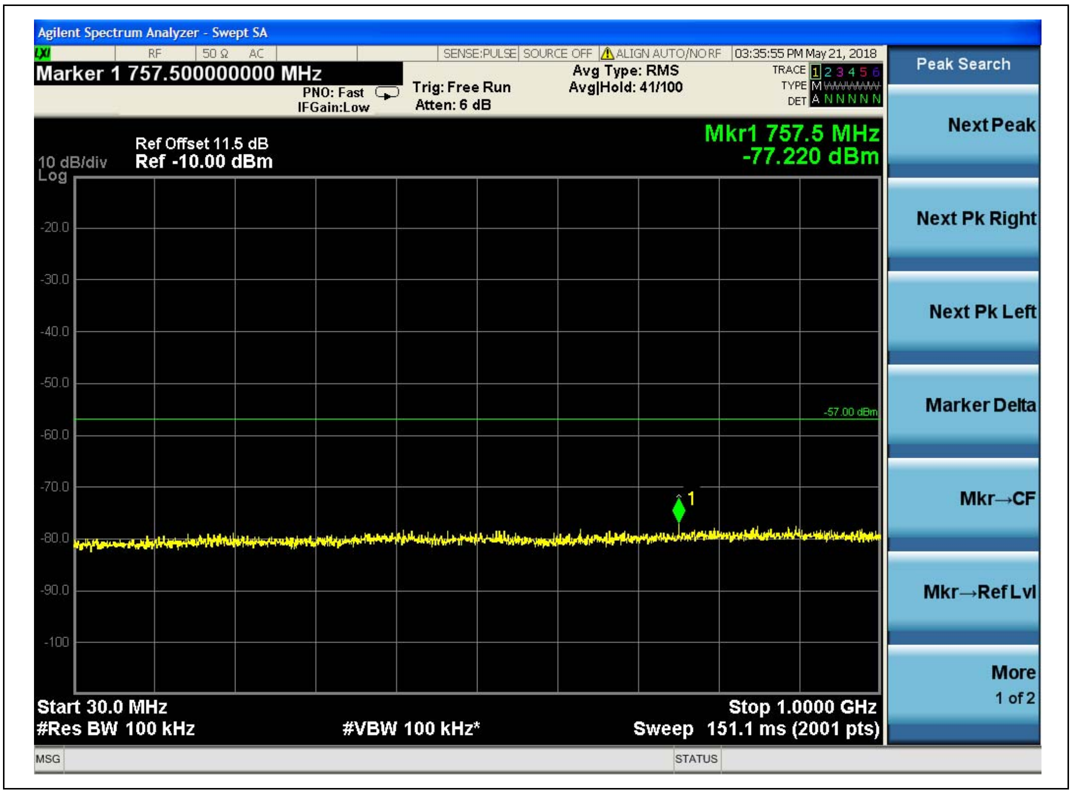


(Plot A: 30MHz to 1GHz, Channel 1)

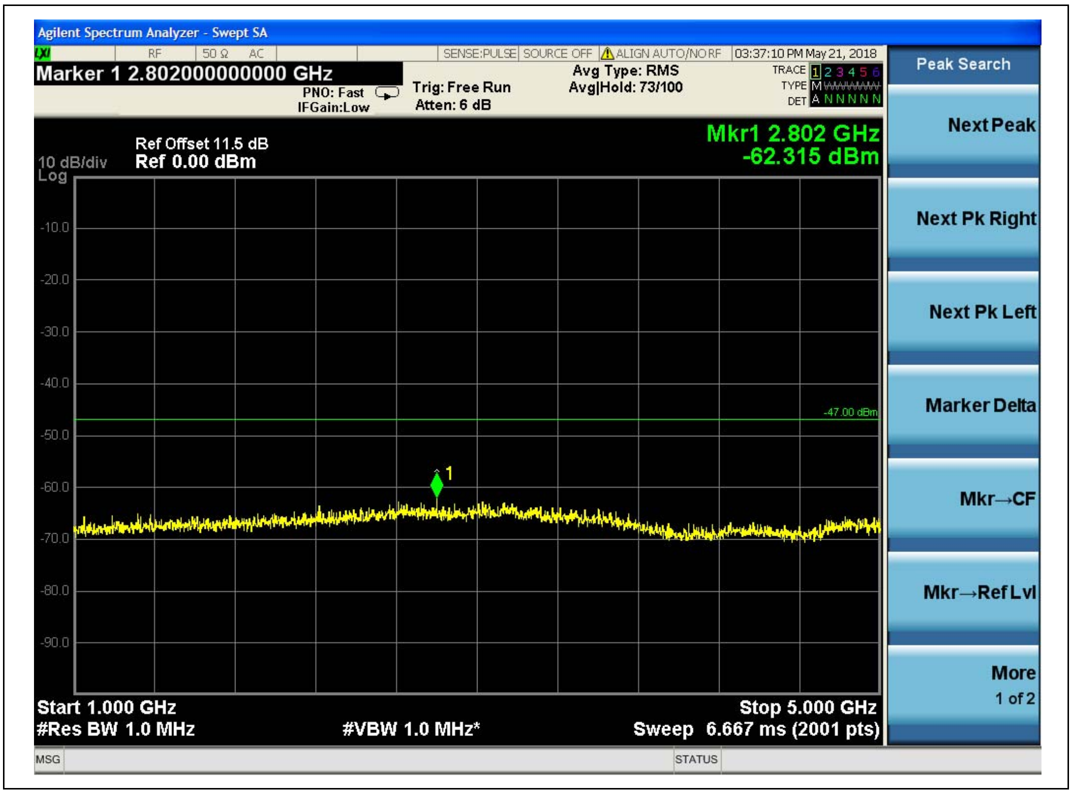


(Plot B: 1GHz to 5GHz, Channel 1)

Plot for Channel=4



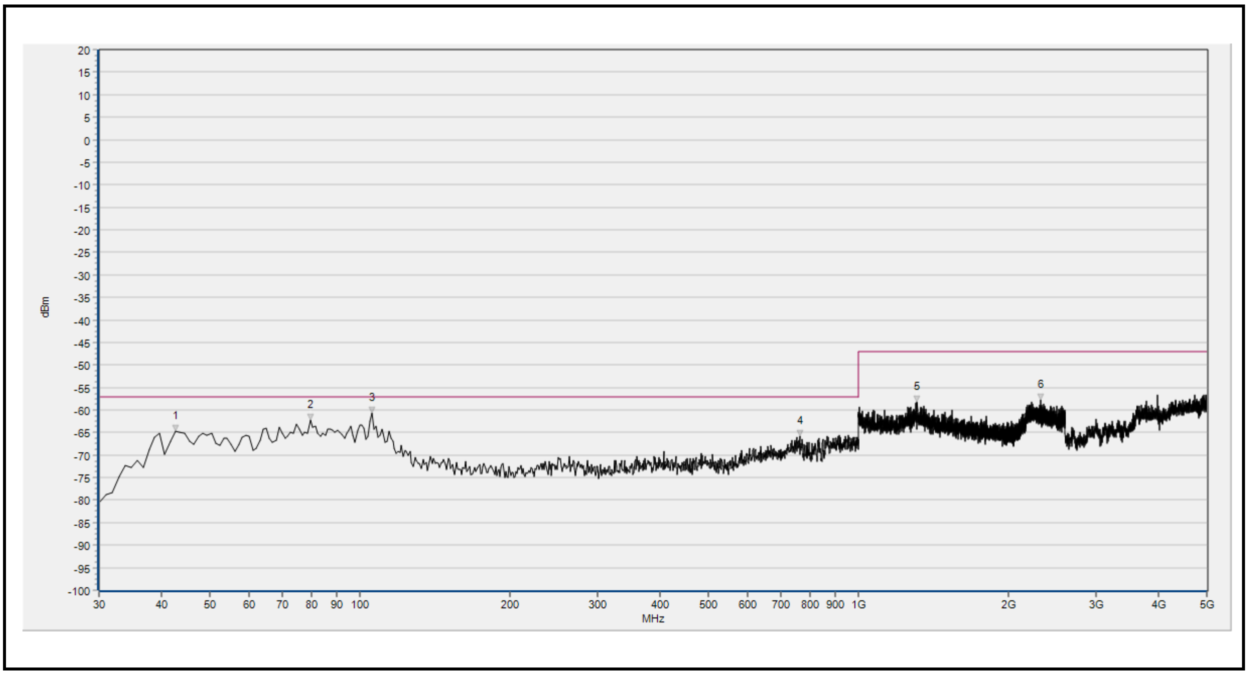
(Plot C: 30MHz to 1GHz, Channel 4)



(Plot D: 1GHz to 5GHz, Channel 4)

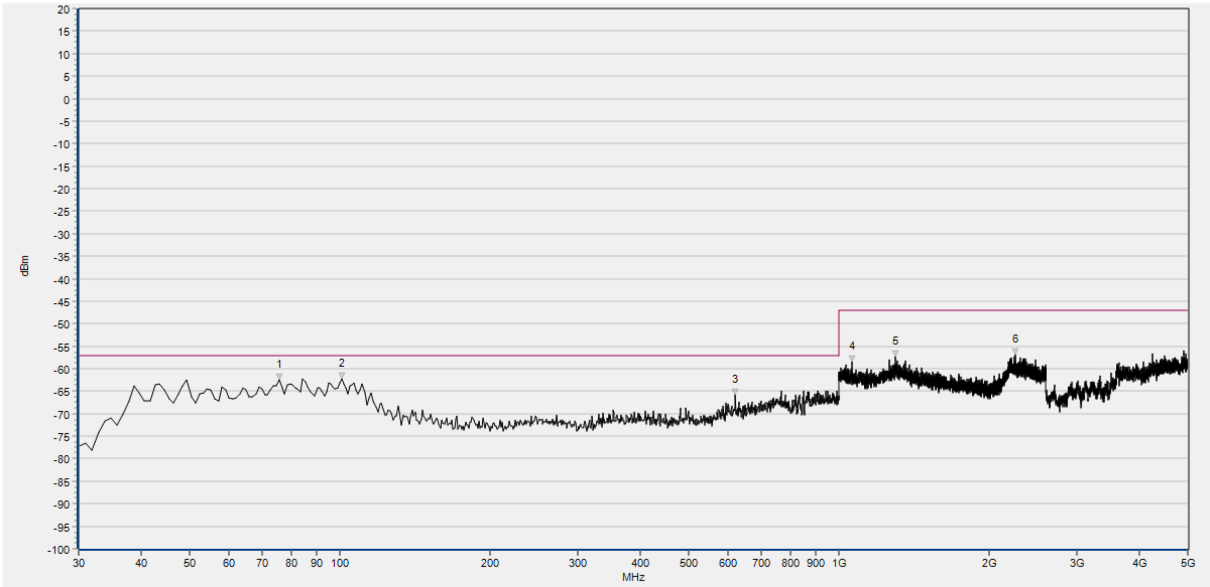
Radiated test result

Plot for Channel = 1



(Plot A.1: 30MHz to 5GHz, Antenna Horizontal, Channel 1)

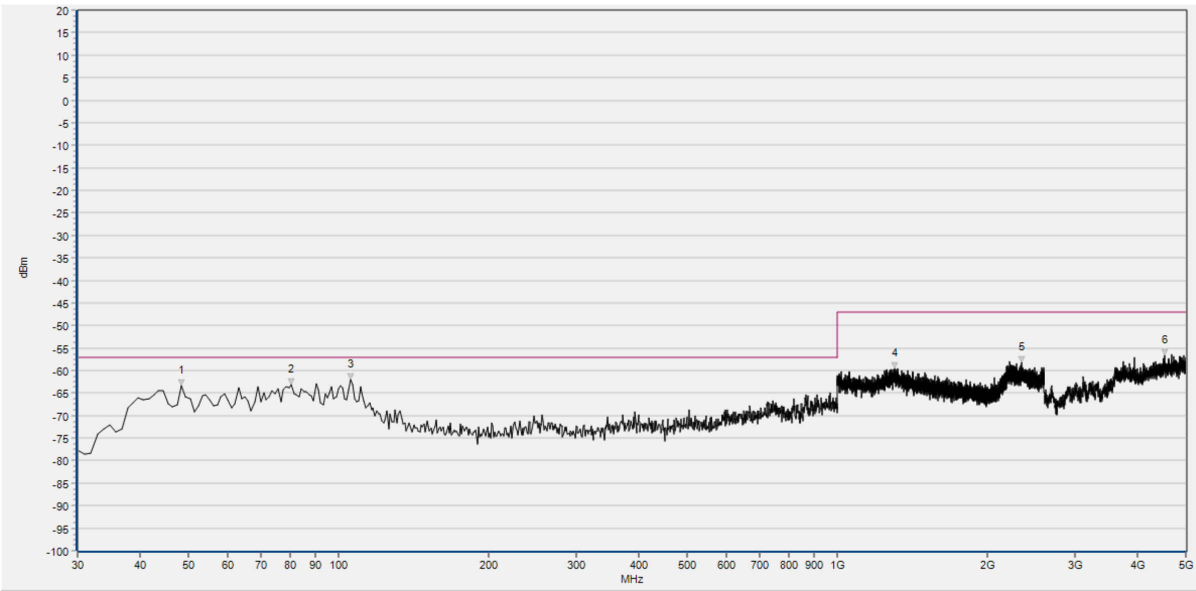
Test frequency range 30MHz to 5 GHz	Channel = 1				
	Receiver with modulation Mode at 865.7MHz				
	Frequency (MHz)	**Peak (dBm)**	**Limit(PK)**	**Antenna**	**Verdict**
	42.623	-64.59	-57.00	Horizontal	PASS
	79.520	-62.26	-57.00	Horizontal	PASS
	105.736	-60.70	-57.00	Horizontal	PASS
	762.112	-65.80	-57.00	Horizontal	PASS
	1312.533	-58.26	-47.00	Horizontal	PASS
	2322.133	-57.81	-47.00	Horizontal	PASS



(Plot A.2: 30MHz to 5GHz, Antenna Vertical, Channel 1)

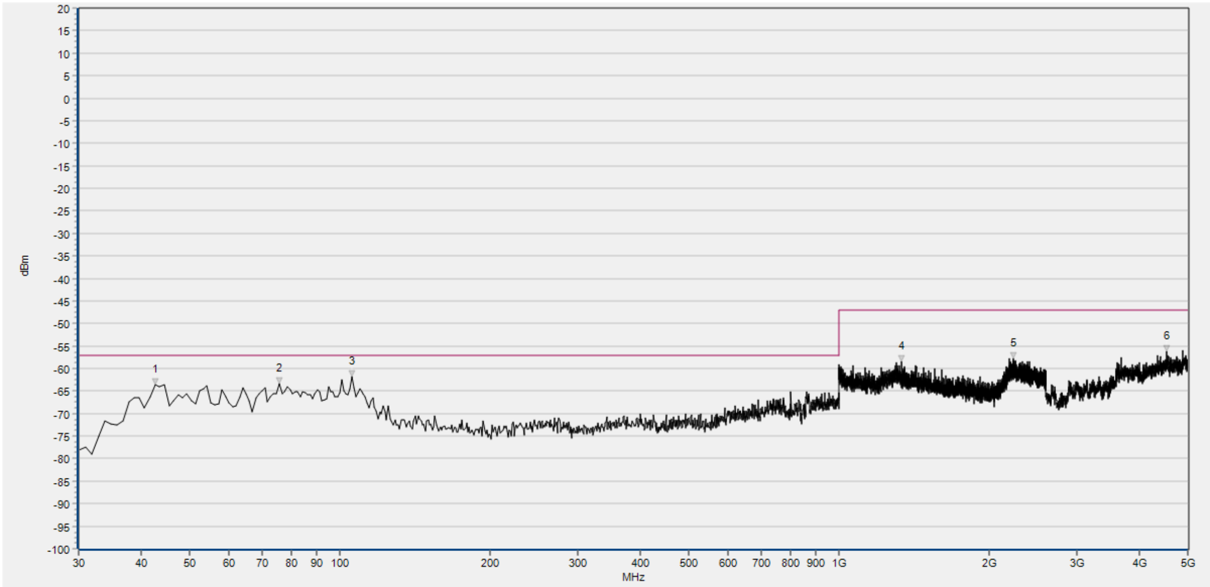
Test frequency range 30MHz to 5 GHz	Channel = 1				
	Receiver with modulation Mode at 865.7MHz				
	Frequency (MHz)	**Peak (dBm)**	**Limit(PK)**	**Antenna**	**Verdict**
	75.636	-62.44	-57.00	Vertical	PASS
	100.881	-62.25	-57.00	Vertical	PASS
	620.350	-65.90	-57.00	Vertical	PASS
	1063.467	-58.47	-47.00	Vertical	PASS
	1295.467	-57.27	-47.00	Vertical	PASS
	2254.933	-56.88	-47.00	Vertical	PASS

Plot for Channel = 4



(Plot A.1: 30MHz to 5GHz, Antenna Horizontal, Channel 4)

Test frequency range 30MHz to 5 GHz	Channel = 4				
	Receiver with modulation Mode at 867.5MHz				
	Frequency (MHz)	**Peak (dBm)**	**Limit(PK)**	**Antenna**	**Verdict**
	48.448	-63.34	-57.00	Horizontal	PASS
	80.490	-63.08	-57.00	Horizontal	PASS
	105.736	-62.03	-57.00	Horizontal	PASS
	1301.867	-59.50	-47.00	Horizontal	PASS
	2340.800	-58.22	-47.00	Horizontal	PASS
	4534.590	-56.63	-47.00	Horizontal	PASS



(Plot A.2: 30MHz to 5GHz, Antenna Vertical, Channel 4)

Test frequency range 30MHz to 5 GHz	Channel = 4				
	Receiver with modulation Mode at 867.5MHz				
	Frequency (MHz)	**Peak (dBm)**	**Limit(PK)**	**Antenna**	**Verdict**
	42.623	-63.66	-57.00	Vertical	PASS
	75.636	-63.44	-57.00	Vertical	PASS
	105.736	-61.79	-57.00	Vertical	PASS
	1337.600	-58.52	-47.00	Vertical	PASS
	2232.533	-57.66	-47.00	Vertical	PASS
	4530.530	-56.26	-47.00	Vertical	PASS

2.12. EN 302 208 §4.4.2 Tag radiated power

2.12.1. Definition

The effective radiated power of a tag is the power radiated by its antenna in its direction of maximum gain under specified conditions of measurement.

2.12.2. Limits

For the lower band the radiated power of the tag shall not exceed -20 dBm e.r.p., which is equivalent to a power spectrum density of -25 dBm/100 kHz e.r.p.
For the upper band the radiated power of the tag shall not exceed -10 dBm e.r.p., which is equivalent to a power spectrum density of -18 dBm/100 kHz e.r.p.

2.12.3. Conformance

The conformance test suite for the radiated power of a tag shall be as defined in clause 5.7.1 of the present document.

General

These tests shall be performed only in the bands in which the tag is intended to operate.
The measurement shall be performed using an interrogator, or an equivalent test fixture, and antenna under the same set-up conditions as used for the measurement of effective radiated power in clause 5.5.3. The intentional emissions from the tag shall be measured as:
either:
a) the power from a tag configured to emit an un-modulated sub-carrier; or
b) the power from a tag configured to emit a continuous modulated response.

Method of measuring the power in an un-modulated sub-carrier, clause 5.7.1.1 a)

This method applies to tags that may be set to emit an un-modulated sub-carrier.
Step 1: On a test site, selected from annex B, the interrogator shall be placed at the specified height on a non-conducting support and in the position closest to normal use as declared by the provider.
Step 2: In each band at which the tag is capable of operating, the interrogator shall be set to transmit at a single carrier frequency "fc" on a high power channel as determined by the test house. The interrogator shall provide an initial "wake up signal" to activate the tag followed by a continuous carrier at a power level of 2 W e.r.p.
Step 3: The tag under test shall be positioned in free space at a distance of 20 cm from the antenna of the interrogator in its direction of maximum gain and in an orientation that provides optimum coupling with the transmitted signal. For the lower band the tag shall be configured to emit an un-modulated sub-carrier at an approximate frequency of fc ± 300 kHz, or such other frequency

as declared by the manufacturer, (see figure 8). For the upper band the tag shall be configured to emit an unmodulated sub-carrier at an approximate frequency of fc ± 600 kHz, or such other frequency as declared by the manufacturer, (see figure 9).

Step 4: The measurement shall be carried out using a measuring receiver set to the following values:

a) Resolution bandwidth: 1 kHz;

b) Video bandwidth: Equal to the RBW;

c) Sweep time: Auto;

d) Span: 1 MHz;

e) Detection mode: Average.

Step 5: A measurement antenna shall be positioned at a distance of 1 m from the tag in the direction of maximum gain of the antenna of the interrogator. The measurement antenna shall be connected to the measuring receiver. The measurement antenna shall be orientated to obtain maximum signal. A diagram of the test configuration is shown in figure 16.

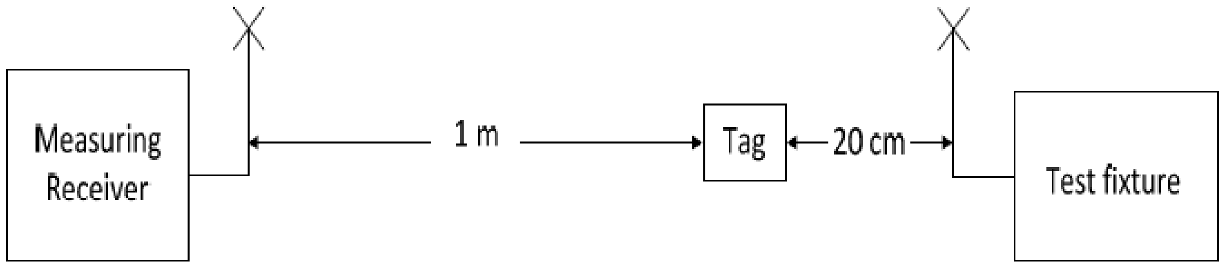


Figure 16: Measurement of tag emissions

Step 6: The measuring receiver shall be tuned to the frequency of the lower sub-carrier of the tag and the level of the combined emissions from both the tag and interrogator shall be recorded. The same procedure shall be repeated for the upper sub-carrier.

Step 7: Without moving the test antenna and the interrogator, the tag shall be removed from the proximity of the test area. The measuring receiver shall be tuned to the same frequencies as in step 6 and the levels of the emissions from the interrogator shall be recorded.

Step 8: The power emitted by the tag shall be determined by deducting the levels in μW recorded in step 7 from the corresponding levels recorded in step 6. The maximum value of the upper and lower sub-carrier frequencies shall be recorded as the emitted power.

Step 9: In normal operation the emissions from the tag in the lower band are spread across 300 kHz in the sidebands on both sides of fc. For the upper band the emissions from the tag are spread across 600 kHz in the sidebands on both sides of fc. (See figures 8 and 9) The power emitted shall be calculated as power spectrum density in 100 kHz using formula (5):

$$A = Pc + 10log\frac{100\ kHz}{BW} \qquad (5)$$

Where:

Pc is the radiated power of the unmodulated sub-carrier from the tag;

A is the absolute value of the power spectrum density referred to a 100 kHz reference bandwidth;
BW is the bandwidth occupied by the tag response in a single sideband as defined in step 9.

Method of measuring the power in a modulated sub-carrier, clause 5.7.1.1 b)

This method applies to tags that are able only to emit a modulated sub-carrier.

Step 1: On a test site, selected from annex B, the interrogator shall be placed at the specified height on a non-conducting support and in the position closest to normal use as declared by the provider.

Step 2: In each band in which the tag is capable of operating the interrogatory shall be set to transmit at a single carrier frequency "fc" on a high power channel as determined by the test house. The interrogator shall provide an initial "wake up command" to activate the tag followed by a continuous carrier at a power level of 2 W e.r.p.

Step 3: The tag under test shall be positioned in free space at a distance of 20 cm from the antenna of the interrogator in its direction of maximum gain and in an orientation that provides optimum coupling
with the transmitted signal. The tag shall be configured to emit a continuous modulated response as described in clause 5.4.9. For the lower band this response shall be centred at an approximate offset frequency of fc ± 300 kHz, or such other frequency as declared by the manufacturer. For the upper band this response shall be centred at an approximate offset frequency of fc ± 600 kHz, or such other frequency as declared by the manufacturer.

Step 4: The measurement shall be carried out using a measuring receiver set to the following values:

a) Resolution bandwidth: 1 kHz;

b) Video bandwidth: Equal to the RBW;

c) Sweep time: Auto;

d) Span: 1 MHz;

e) Detection mode: Average.

Step 5: A test antenna shall be positioned at a distance of 1 m from the tag in the direction of maximum gain of the antenna of the interrogator. The test antenna shall be connected to the measurement receiver. The measurement antenna shall be orientated to obtain maximum signal. A diagram of the test configuration is shown in figure 16.

Step 6: For the lower band a plot of the combined emissions from the tag and interrogator shall be recorded in increments of 3 kHz across the frequency range fc - 400 kHz to fc - 100 kHz. For the upper band the combined emissions from the tag and interrogator shall be recorded in increments of 3 kHz across the frequency range fc - 800 kHz to fc - 200 kHz.

Step 7: Without moving the test antenna and the interrogator, the tag shall be removed from the proximity of the test area. A plot shall be made of the emissions from the interrogator in increments of 3 kHz over the same frequency range.

Step 8: The power emitted by the tag shall be determined by deducting the levels in μW recorded in step 7 from levels recorded in step 6 for each increment of 3 kHz and summing the results to give the total power emitted by the tag.

Step 9: Steps 6 to 8 shall be repeated across the upper side-band. For the lower band this shall cover the range fc + 400 kHz to fc + 100 kHz. For the upper band this shall cover the range fc + 800 kHz to fc + 200 kHz. The higher of the values obtained in the lower and upper sidebands shall be recorded as the radiated power of the tag.

Step 10: The radiated power of the tag as derived in step 9 may be referred to a 100 kHz bandwidth using formula (6):

$$A = Pc + 10log\frac{100\ kHz}{BW} \qquad (6)$$

Where:

Pc is the radiated power of the tag;

A is the absolute value of the power spectrum density referred to a 100 kHz reference bandwidth;

BW is the bandwidth occupied by the tag response in a single sideband as defined in step 9.

The results shall be recorded in the test report.

2.12.4. Result

Note: The test case only applies to tags.

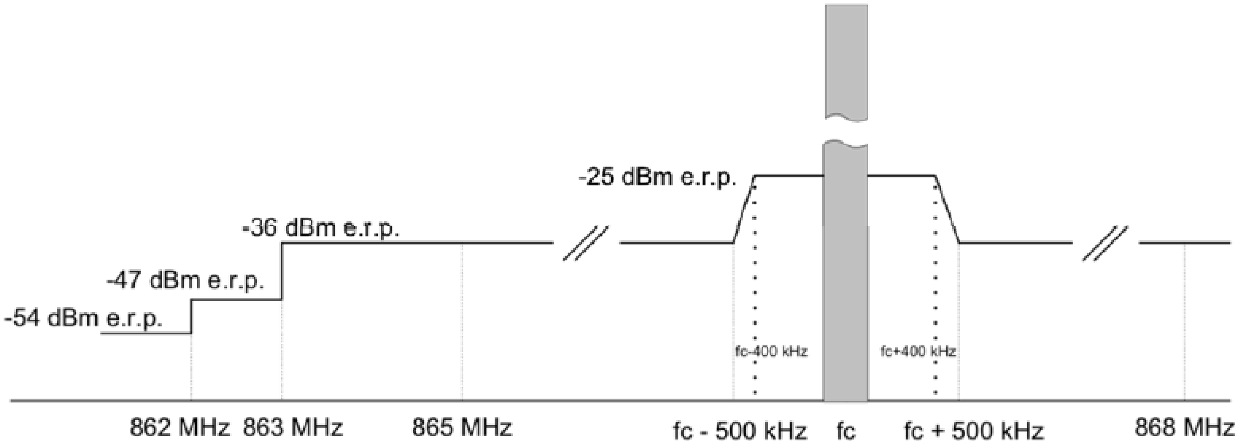
2.13. EN 302 208 §4.4.2 Tag unwanted emissions

2.13.1. Definition

The unwanted emissions from a tag include both the out-of-band and the spurious emissions from a continuously modulated tag measured outside its wanted carrier frequency and associated sidebands when the tag is orientated for optimum coupling at a defined distance from the antenna of an interrogator, which is transmitting a continuous unmodulated carrier at a specified power level.

2.13.2. Limits

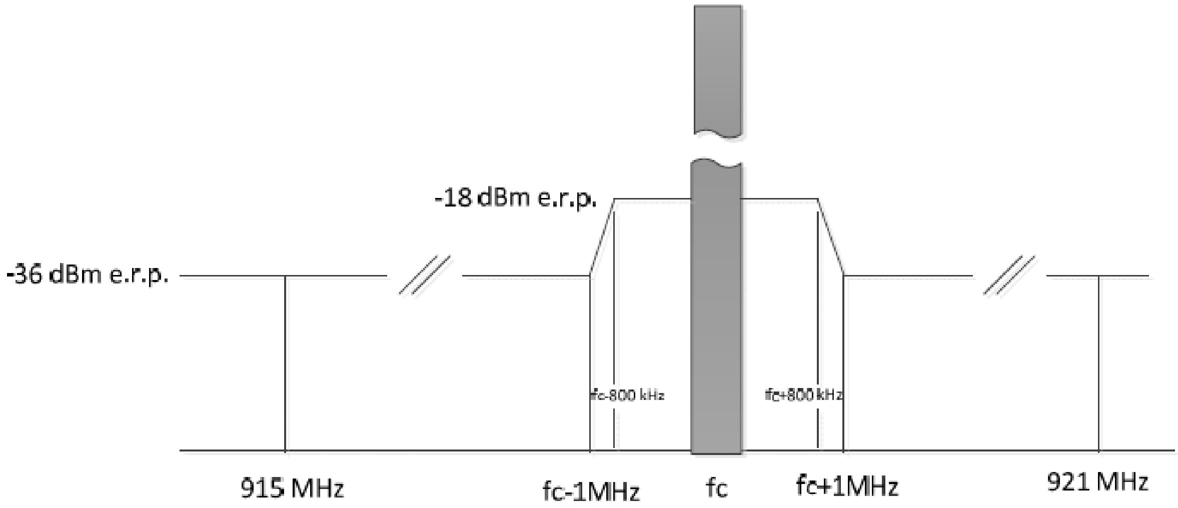
For the lower band the unwanted emissions from the tag under the above specified conditions at any frequency outside the band fc - 400 kHz to fc + 400 kHz shall not exceed the levels defined in the spectrum mask in figure 8.



NOTE 1: fc is the centre frequency of the carrier transmitted by the interrogator.
NOTE 2: The transmit channel occupied by the interrogator is shown in grey.
NOTE 3: All power levels in the unwanted domain relate to the resolution bandwidths in figure 10.

Figure 8: Spectrum mask for tag for the lower band

For the upper band the unwanted emissions from the tag under the above specified conditions at any frequency outside the band fc - 800 kHz to fc + 800 kHz shall not exceed the levels defined in the spectrum mask in figure 9.



NOTE 1: fc is the centre frequency of the carrier transmitted by the interrogator.
NOTE 2: The transmit channel occupied by the interrogator is shown in grey.
NOTE 3: All power levels in the unwanted domain relate to the resolution bandwidths in figure 11.

Figure 9: Spectrum mask for tag for the upper band

2.13.3. Conformance

The conformance test suite for the unwanted emissions from a tag shall be as defined in clause 5.7.2 of the present document.

2.13.4. Method of measurement

The measurement shall be performed using an interrogator, or equivalent test fixture, and antenna under the same set-up conditions as used for the measurement of effective radiated power in clause 5.5.3.

In the event that the carrier signal from the interrogator is too high for the dynamic range of the measurement receiver, a notch filter may optionally be connected between the measurement antenna and the measurement receiver to attenuate the carrier signal. This may be used for measurements at greater than 2 MHz from the carrier. The filter shall have a loss of less than 3 dB at ±1 MHz from fc.

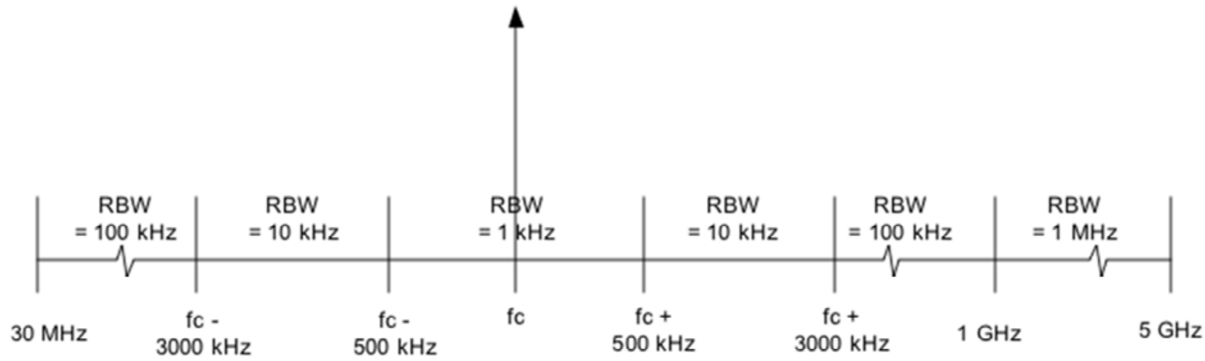
Step 1: On a test site, selected from annex B, the interrogator shall be placed at the specified height on a non-conducting support and in the position closest to normal use as declared by the provider.

Step 2: In each band at which the tag is capable of operating the interrogator shall be set to transmit at a single carrier frequency "fc" on a high power channel as determined by the test house. The interrogator shall provide an initial "wake up response" to activate the tag followed by a continuous carrier at a power level of 2 W e.r.p.

Step 3: The tag under test shall be positioned at a distance of 20 cm from the antenna of the interrogator in its direction of maximum gain and in an orientation that provides optimum coupling with the transmitted signal. The tag shall be configured to emit a continuous modulated response as described in clause 5.4.9 at an approximate offset frequency of either fc ± 300 kHz for the lower band or ±600 kHz for the upper band or such other frequency as declared by the manufacturer.

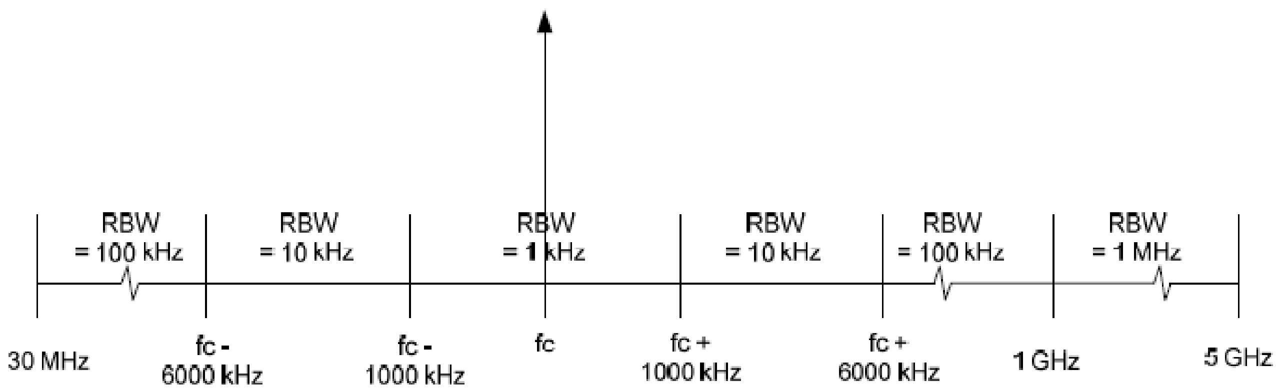
Step 4: The measurement shall be carried out using a measuring receiver set to the following values:

a) Resolution bandwidth: In accordance with the figures 17 or 18 as applicable;
b) Video bandwidth: Equal to the RBW;
c) Sweep time: Auto;
d) Span: As defined by the relevant frequency ranges in figures 17 or 18 as applicable;
e) Trace mode: Average;
f) Detection mode: Average.



NOTE: See clause 5.7.1 for measurement of the intentional power radiated by tags.

Figure 17: Resolution bandwidths for tag emissions in the lower band



NOTE: See clause 5.7.1 for measurement of the intentional power radiated by tags.

Figure 18: Resolution bandwidths for tag emissions in the upper band

Step 5: A test antenna shall be positioned at a distance of 1 m from the tag in the direction of maximum gain of the antenna of the interrogator. The test antenna shall be connected to the measuring receiver. The test antenna shall be orientated to obtain maximum signal. A diagram of

the test configuration is shown in figure 16.
Step 6: The measuring receiver shall be set to the resolution bandwidths specified in figures 17 or 18 as applicable, which are the same as the reference bandwidths. Alternatively a lower resolution bandwidth may be used to improve the measurement accuracy.
Step 7: A plot of the combined emissions from both the tag and interrogator shall be recorded.
Step 8: The tag shall be removed from the proximity of the test area. Without moving the test antenna and the interrogator a plot shall again be taken across the same frequency range.
Step 9: Where the specified resolution bandwidths in figures 17 or 18 are used, the unwanted emissions from the tag shall be determined by deducting the levels in μW recorded in step 8 from levels recorded in the step 7.
Step 10: At frequencies outside those measured in clause 5.7.1, the discrete spectral components within each reference band specified in figures 17 or 18 shall be recorded. The recorded values shall not exceed the limits specified for the operating mode in table 2.

2.13.5. Results

Note: The test case only applies to tags.

Annex A Photos of Test Setup

Radiated Measurement Setup

Conducted Measurement Setup

Annex B Testing Laboratory Information

1. Identification of the Responsible Testing Laboratory

Company Name:	Shenzhen Morlab Communications Technology Co., Ltd.
Department:	Morlab Laboratory
Address:	FL.3, Building A, FeiYang Science Park, No.8 LongChang Road, Block 67, BaoAn District, ShenZhen, GuangDong Province, P. R. China
Responsible Test Lab Manager:	Mr. Su Feng
Telephone:	+86 755 36698555
Facsimile:	+86 755 36698525

2. Identification of the Responsible Testing Location

Name:	Shenzhen Morlab Communications Technology Co., Ltd. Morlab Laboratory
Address:	FL.3, Building A, FeiYang Science Park, No.8 LongChang Road, Block 67, BaoAn District, ShenZhen, GuangDong Province, P. R. China

3. Test Equipments Utilized

3.1 Test system

Description	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Due
Base Station	Anritsu	MT8852B	6K00006210	2018.04.17	2019.04.16
Temperature Chamber	CHONGQING HANBA EXPERIMENTAL EQUIPMENT CO.,LTD	HUT705P	(N/A.)	2018.04.17	2019.04.16
Power Splitter	Mini-Circuits	ZFRSC-183+	SF808201417	2018.04.17	2019.04.16
DC Power Supply	Good Will Instrument Co.,Ltd.	(N/A)	(N/A)	2018.04.17	2019.04.16
Attenuator 1	Resnet	20dB	(N/A)	2018.04.17	2019.04.16
MXG Vector Signal Generator	Angilent	N5182B	MY53050961	2018.04.17	2019.04.16
EXG Analog Signal Generator	Angilent	N5171B	MY53050558	2018.04.17	2019.04.16
EXA Signal analyzer	Angilent	N9010A	MY53470836	2017.12.02	2018.12.01
USB Power Sensor	Angilent	U2021XA	MY54210011	2018.04.17	2019.04.16

3.2 List of Software Used

Description	Manufacturer	Software Version
Test system	Tonscend	V2.6
Power Panel	Agilent	V3.8

3.3 RSE Test System

Equipment Name	Serial No.	Type	Manufacturer	Cal. Date	Cal. Due
MXE EMI Receiver	MY54130016	N9038A	Agilent	2018.05.08	2019.05.07
Test Antenna - Bi-Log	9163-519	VULB 9163	Schwarzbeck	2018.05.08	2019.05.07
Test Antenna - Horn	01774	BBHA 9120D	Schwarzbeck	2017.09.13	2018.09.12
Anechoic Chamber	N/A	9m*6m*6m	CRT	2017.11.19	2020.11.18

——— END OF REPORT ———