

Application Note: TBMR-110M – Creating EMI projects



1. Introduction

This paper explains how to create EMI projects.

The TBMR-110M was designed for conducted emission testing. However, certain standards include radiated emission tests, which can be done with the receiver

2. CISPR 11 radiated emission tests, 150kHz – 30 MHz

CISPR 11 specifies the following radiated emission tests in the frequency range of 150 kHz and 30 MHz.

Class A / Group 1 measured in situ:

Frequency range [MHz]	RBW [kHz]	Detector	30 m distance	
			Electric field [dB μ V/m]	Magnetic field [dB μ A/m]
0.15 – 0.49	9	Quasi Peak	-	13.5
0.49 – 3.95			-	3.5
3.95 – 20			-	-11.5
20 – 30			-	-21.5

Class A Group 2 measured in situ:

Frequency range [MHz]	RBW [kHz]	Detector	Limits for a measuring distance of D in m from the exterior wall of the building	
			Electric field [dB μ V/m]	Magnetic field [dB μ A/m]
0.15 – 0.49	9	Quasi Peak	-	23.5
0.49 – 1.705			-	13.5
1.705 – 2.149			-	18.5
2.149 – 3.95			-	13.5
3.95 – 20			-	-1.5
20 – 30			-	-11.5

For group 2 equipment measured *in situ*, the measuring distance D from the exterior wall of the building in which the equipment is situated equals $(30 + \sqrt{x})$ m or 100 m whichever is smaller, provided that the measuring distance D is within the boundary of the premises. In the case where the calculated distance D is beyond the boundary of the premises, the measuring distance D equals x or 30 m, whichever is longer.

Class A / Group 2 measured on a test site:

Frequency range [MHz]	RBW [kHz]	Detector	30 m distance		10 m distance		3 m distance	
			Electric field [dB μ V/m]	Magnetic field [dB μ A/m]	Electric field [dB μ V/m]	Magnetic field [dB μ A/m]	Electric field [dB μ V/m]	Magnetic field [dB μ A/m]
0.15 – 0.49	9	Quasi Peak	-	33.5	-	57.5	-	82
0.49 – 1.705			-	23.5	-	47.5	-	72
1.705 – 2.149			-	28.5	-	52.5	-	77
2.149 – 3.95			-	23.5	-	43.5	-	68
3.95 – 11			-	8.5	-	18.5	-	43,5 – 28,5 decreasing linearly with logarithm of frequency
11 – 20			-	8.5	-	18.5	-	28.5
20 – 30	-	-	-1.5	-	8.5	-	18.5	

Class B / Group 2 measured on a test site:

Frequency range [MHz]	RBW [kHz]	Detector	10 m distance	3 m distance	
			Electric field [dB μ V/m]	Electric field [dB μ V/m]	Magnetic field [dB μ A/m]
0.15 – 30	9	Quasi Peak	-	-	39 – 3 decreasing linearly with logarithm of frequency

The measurements are carried out with a 60 cm magnetic loop antenna.

3. Creating limit files

We begin by altering an existing project file, for example, CN_CISPR11_EN55011_Class_B_Gr1_QP.lim
 We open the file and save it as: RN_CISPR11_EN55011_Class_A_GR1_in_situ_9kHz_30MHz_QP.lim
 The “RN” at the beginning of the file name denotes a radiated emission measurement.

Next we modify the limit file to match the specification below:

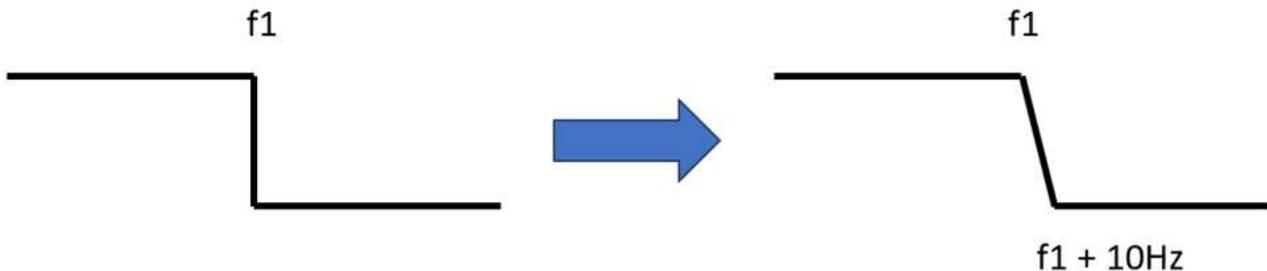
Class A / Group 1 measured in situ:

Frequency range [MHz]	RBW [kHz]	Detector	30 m distance	
			Electric field [dBµV/m]	Magnetic field [dBµA/m]
0.15 – 0.49	9	Quasi Peak	-	13.5
0.49 – 3.95			-	3.5
3.95 - 20			-	-11.5
20 - 30			-	-21.5

```

[Application]
Software=TekBox RP-W32-D11 (keep same)
Version=EmcView V08.50 (keep same)
Date=03/04/2023 12:21:02 (keep same)
[General]
Name= RN_CISPR11_EN55011_Class_A_GR1_in_situ_9kHz_30MHz_QP.lim (change file name)
Level_Interplot_Mode=log (keep same)
Units=dBµA/m (change units to dBµA/m)
[Data]
Freq1=150.000 (same start frequency)
Lev1=13.5 (change limit level to 13.5)
Freq2=490.000 (change frequency)
Lev2=13.5 (keep level constant)
Freq3=490.010 (create steep step)
Lev3=3.5 (new level: 3.5)
Freq4=3.950.000 (change frequency)
Lev4=3.5 (keep level constant)
Freq5=3.950.010 (create steep step)
Lev5=-11.5 (new level: -11.5)
Freq6=20.000.000 (change frequency)
Lev6=-11.5 (keep level constant)
Freq7=20.000.010 (create steep step)
Lev7=-21.5 (keep level constant)
Freq8=30.000.010 (stop frequency)
Lev8=-21.5 (keep level constant)
    
```

The process to create a limit file is straight forward. However, right angle steps have to be converted into steep slopes:



Create a new directory C:\user\username\Tekbox\TBMR-110M\EMC_Standards\SRC\CISPR11\RN and save the file.

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Next we create the remaining limit files:

Class A Group 2 measured in situ:

Frequency range [MHz]	RBW [kHz]	Detector	Limits for a measuring distance of <i>D</i> in m from the exterior wall of the building	
			Electric field [dB μ V/m]	Magnetic field [dB μ A/m]
0.15 – 0.49	9	Quasi Peak	-	23.5
0.49 – 1.705			-	13.5
1.705 – 2.149			-	18.5
2.149 – 3.95			-	13.5
3.95 – 20			-	-1.5
20 – 30			-	-11.5

We save the previous limit file as RN_CISPR11_EN55011_Class_A_GR2_in_situ_9kHz_30MHz_QP.lim
Then we modify it based on the limit table above

[Application]

Software=TekBox RP-W32-D11

Version=EmcView V08.50

Date=03/04/2023 12:21:02

[General]

Name=RN_CISPR11_EN55011_Class_A_GR2_in_situ_9kHz_30MHz_QP.lim

Level_Interplot_Mode=log

Units=dB μ A/m

[Data]

Freq1=150.000

Lev1=23.5

Freq2=490.000

Lev2=23.5

Freq3=490.010

Lev3=13.5

Freq4=1.705.000

Lev4=13.5

Freq5=1.705.010

Lev5=18.5

Freq6=2.149.000

Lev6=18.5

Freq7=2.149.010

Lev7=13.5

Freq8=3.950.000

Lev8=13.5

Freq9=3.950.010

Lev9=-1.5

Freq10=20.000.000

Lev10=-1.5

Freq11=20.000.010

Lev11=-11.5

Freq12=30.000.000

Lev12=-11.5

After editing, save it in the directory

C:\user\username\Tekbox\TBMR-110M\EMC_Standards\SRC\CISPR11\RN

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We need to create three limit files for the table below:

Class A / Group 2 measured on a test site:

Frequency range [MHz]	RBW [kHz]	Detector	30 m distance		10 m distance		3 m distance	
			Electric field [dB μ V/m]	Magnetic field [dB μ A/m]	Electric field [dB μ V/m]	Magnetic field [dB μ A/m]	Electric field [dB μ V/m]	Magnetic field [dB μ A/m]
0.15 – 0.49	9	Quasi Peak	-	33.5	-	57.5	-	82
0.49 – 1.705			-	23.5	-	47.5	-	72
1.705 – 2.149			-	28.5	-	52.5	-	77
2.149 – 3.95			-	23.5	-	43.5	-	68
3.95 - 11			-	8.5	-	18.5	-	43,5 – 28,5 decreasing linearly with logarithm of frequency
11 - 20			-	8.5	-	18.5	-	28.5
20 - 30			-	-1.5	-	8.5	-	18.5

Start with the limits for 30 m measurement distance. Take the previous file and save it as RN_CISPR11_EN55011_Class_A_GR2_Test_Site_9kHz_30MHz_30m_QP.lim

[Application]

Software=TekBox RP-W32-D11

Version=EmcView V08.50

Date=03/04/2023 12:21:02

[General]

Name=RN_CISPR11_EN55011_Class_A_GR2_Test_Site_9kHz_30MHz_30m_QP.lim

Level_Interplot_Mode=log

Units=dB μ A/m

[Data]

Freq1=150.000

Lev1=33.5

Freq2=490.000

Lev2=33.5

Freq3=490.010

Lev3=23.5

Freq4=1.705.000

Lev4=23.5

Freq5=1.705.010

Lev5=28.5

Freq6=2.149.000

Lev6=28.5

Freq7=2.149.010

Lev7=23.5

Freq8=3.950.000

Lev8=23.5

Freq9=3.950.010

Lev9=8.5

Freq10=20.000.000

Lev10=8.5

Freq11=20.000.010

Lev11=-1.5

Freq12=30.000.000

Lev12=-1.5

The limits from 3,5 to 11 MHz and 11 MHz to 20 MHz are the same. We do not need to add an additional frequency point at 11 MHz.

Next we create a file for 10 meter measuring distance. This is straightforward; we only need to change the filename and limit values.

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[Application]

Software=TekBox RP-W32-D11

Version=EmcView V08.50

Date=03/04/2023 12:21:02

[General]

Name=RN_CISPR11_EN55011_Class_A_GR2_Test_Site_9kHz_30MHz_10m_QP.lim

Level_Interplot_Mode=log

Units=dBμA/m

[Data]

Freq1=150.000

Lev1=57.5

Freq2=490.000

Lev2=57.5

Freq3=490.010

Lev3=47.5

Freq4=1.705.000

Lev4=47.5

Freq5=1.705.010

Lev5=52.5

Freq6=2.149.000

Lev6=52.5

Freq7=2.149.010

Lev7=43.5

Freq8=3.950.000

Lev8=43.5

Freq9=3.950.010

Lev9=18.5

Freq10=20.000.000

Lev10=18.5

Freq11=20.000.010

Lev11=8.5

Freq12=30.000.000

Lev12=8.5

The limit file for 3 meter measuring distance needs an extra frequency point

[Application]

Software=TekBox RP-W32-D11

Version=EmcView V08.50

Date=03/04/2023 12:21:02

[General]

Name=RN_CISPR11_EN55011_Class_A_GR2_Test_Site_9kHz_30MHz_3m_QP.lim

Level_Interplot_Mode=log

Units=dBμA/m

[Data]

Freq1=150.000

Lev1=82

Freq2=490.000

Lev2=82

Freq3=490.010

Lev3=72

Freq4=1.705.000

Lev4=72

Freq5=1.705.010

Lev5=77

Freq6=2.149.000

Lev6=77

Freq7=2.149.010

Lev7=68

Freq8=3.950.000

Lev8=68

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Freq9=3.950.010
 Lev9=43
 Freq10=11.000.000
 Lev10=28.5
 Freq11=20.000.010
 Lev11=28.5
 Freq12=20.000.010
 Lev12=18.5
 Freq12=30.000.010
 Lev12=18.5

And finally the limit file for

Class B / Group 2 measured on a test site:

Frequency range [MHz]	RBW [kHz]	Detector	10 m distance		3 m distance	
			Electric field [dB μ V/m]	Electric field [dB μ V/m]	Magnetic field [dB μ A/m]	
0.15 – 30	9	Quasi Peak	-	-	39 – 3 decreasing linearly with logarithm of frequency	

[Application]

Software=TekBox RP-W32-D11

Version=EmcView V08.50

Date=03/04/2023 12:21:02

[General]

Name=RN_CISPR11_EN55011_Class_B_GR2_Test_Site_9kHz_30MHz_3m_QP.lim

Level_Interplot_Mode=log

Units=dB μ A/m

[Data]

Freq1=150.000

Lev1=39

Freq2=30.000.000

Lev2=3

4. Creating project files

Class A / Group 1 measured in situ:

We take any existing limit file, and save it as:

RN_CISPR11_EN55011_Class_A_GR1_in_situ_9kHz_30MHz.prj

First we specify Start- and Stop frequency. Then we set the Y-axis limits of the Graph window. We choose 40 dB μ A for the maximum- and -60 dB μ A for the minimum level. Detector is set to CISPR 16, as it is a CISPR project. The limits are specified for the Quasi-Peak detector, and there is only one limit line.

LIMDET1 specifies the detector and LIM1 specifies the limit file. For the antenna we choose the TBMA6-P antenna factor file.

[Application]

Product=TekBox Measurement Receiver

Date=03/04/2023 12:21:02

[SetUp]

Start_Hz=150000

Stop_Hz=30000000

High_Pegel=40

Low_Pegel=-60

DETECTOR=CISPR16

LIMDET1=QP

LIM1=RN_CISPR11_EN55011_Class_A_GR1_in_situ_9kHz_30MHz_QP.lim

CABLE=testcable.cac

AMP=none

ANT=TBMA6-P_MAG.ant

LISN=none

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The remaining project files only differ with respect to the Y-axis limits and the corresponding limit file. We will match the Y-axis limits with the respective limit lines. It is good practice to display the maximum level of the limit line at approximately 70% of the Y-axis maximum amplitude.

Class A Group 2 measured in situ

Project file name: RN_CISPR11_EN55011_Class_A_GR2_in_situ_9kHz_30MHz.prj

```
[Application]
Product=TekBox Measurement Receiver
Date=03/04/2023 12:21:02
[SetUp]
Start_Hz=150000
Stop_Hz=30000000
High_Pegel=50
Low_Pegel=-50
DETECTOR=CISPR16
LIMDET1=QP
LIM1=RN_CISPR11_EN55011_Class_A_GR2_in_situ_9kHz_30MHz_QP.lim
CABLE=testcable.cac
AMP=none
ANT=TBMA6-P_MAG.ant
LISN=none
```

Class A / Group 2 measured on a test site, 30 meter measurement distance

Project file name: RN_CISPR11_EN55011_Class_A_GR2_Test_Site_9kHz_30MHz_30m.prj

```
[Application]
Product=TekBox Measurement Receiver
Date=03/04/2023 12:21:02
[SetUp]
Start_Hz=150000
Stop_Hz=30000000
High_Pegel=60
Low_Pegel=-40
DETECTOR=CISPR16
LIMDET1=QP
LIM1= RN_CISPR11_EN55011_Class_A_GR2_Test_Site_9kHz_30MHz_30m_QP.lim
CABLE=testcable.cac
AMP=none
ANT=TBMA6-P_MAG.ant
LISN=none
```

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Class A / Group 2 measured on a test site, 10 meter measurement distance

File name: RN_CISPR11_EN55011_Class_A_GR2_Test_Site_9kHz_30MHz_10m.prj

```
[Application]
Product=TekBox Measurement Receiver
Date=03/04/2023 12:21:02
[SetUp]
Start_Hz=150000
Stop_Hz=30000000
High_Pegel=80
Low_Pegel=-20
DETECTOR=CISPR16
LIMDET1=QP
LIM1= RN_CISPR11_EN55011_Class_A_GR2_Test_Site_9kHz_30MHz_10m_QP.lim
CABLE=testcable.cac
AMP=none
ANT=TBMA6-P_MAG.ant
LISN=none
```

Class A / Group 2 measured on a test site, 3 meter measurement distance

File name: RN_CISPR11_EN55011_Class_A_GR2_Test_Site_9kHz_30MHz_3m.prj

```
[Application]
Product=TekBox Measurement Receiver
Date=03/04/2023 12:21:02
[SetUp]
Start_Hz=150000
Stop_Hz=30000000
High_Pegel=100
Low_Pegel=0
DETECTOR=CISPR16
LIMDET1=QP
LIM1= RN_CISPR11_EN55011_Class_A_GR2_Test_Site_9kHz_30MHz_3m_QP.lim
CABLE=testcable.cac
AMP=none
ANT=TBMA6-P_MAG.ant
LISN=none
```

Class B / Group 2 measured on a test site:

File name: RN_CISPR11_EN55011_Class_B_GR2_Test_Site_9kHz_30MHz_3m.prj

[Application]

Product=TekBox Measurement Receiver

Date=03/04/2023 12:21:02

[SetUp]

Start_Hz=150000

Stop_Hz=30000000

High_Pegel=70

Low_Pegel=-30

DETECTOR=CISPR16

LIMDET1=QP

LIM1= RN_CISPR11_EN55011_Class_B_GR2_Test_Site_9kHz_30MHz_3m_QP.lim

CABLE=testcable.cac

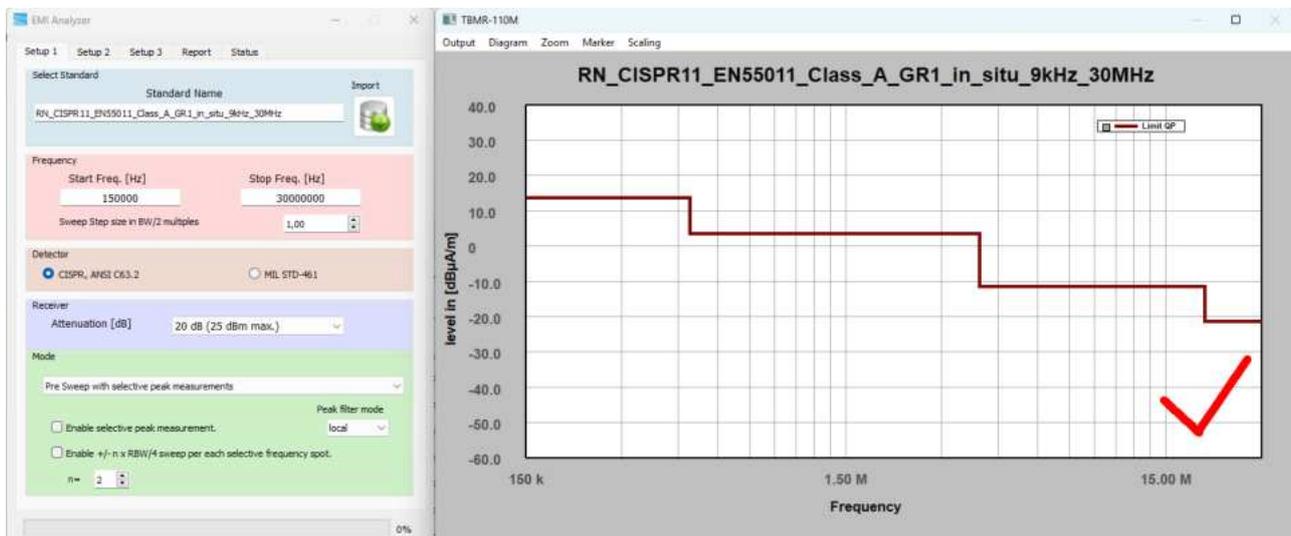
AMP=none

ANT=TBMA6-P_MAG.ant

LISN=none

5. Verification

After saving all limit files and project files in C:\Users\username\TekBox\TBMR-110M\EMC_Standards\CISPR 11_EN55011_V1_5\RN, we launch the EMI-Analyzer, load each project and compare the displayed limit lines with the standard.



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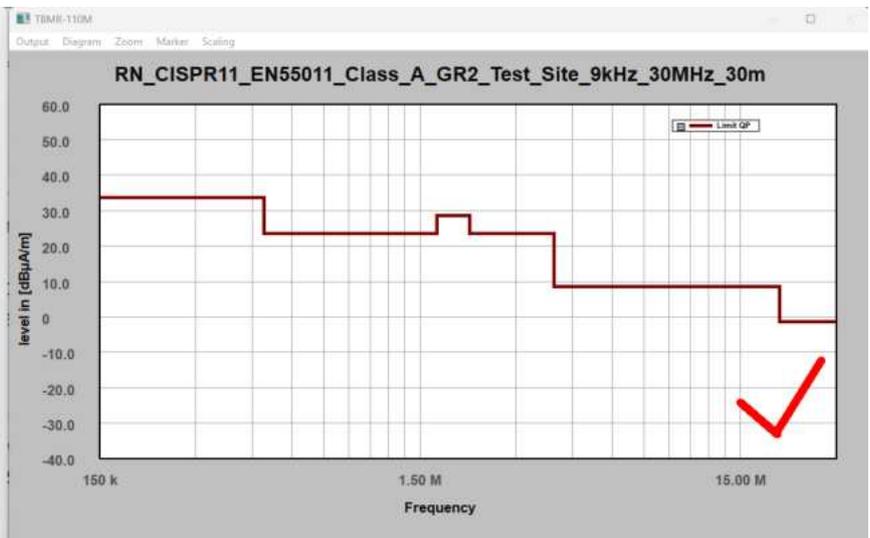
EMI Analyzer configuration window showing the following settings:

- Standard Name: RN_CISPR11_EN55011_Class_A_GR2_in_situ_9kHz_30MHz
- Frequency: Start Freq. [Hz] = 150000, Stop Freq. [Hz] = 30000000, Sweep Step size in BW/2 multiples = 1.00
- Detector: CISPR, ANSI C63.2
- Receiver: Attenuation [dB] = 20 dB (25 dBm max.)
- Mode: Pre Sweep with selective peak measurements, Peak filter mode = local
- Options: Enable selective peak measurement (unchecked), Enable +/- n x RBW/4 sweep per each selective frequency spot (unchecked), n = 2



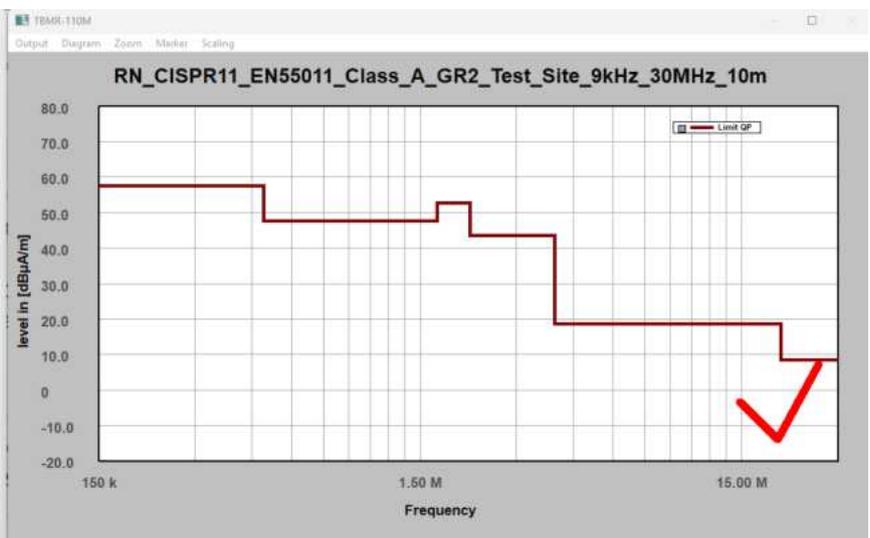
EMI Analyzer configuration window showing the following settings:

- Standard Name: RN_CISPR11_EN55011_Class_A_GR2_Test_Site_9kHz_30MHz_30m
- Frequency: Start Freq. [Hz] = 150000, Stop Freq. [Hz] = 30000000, Sweep Step size in BW/2 multiples = 1.00
- Detector: CISPR, ANSI C63.2
- Receiver: Attenuation [dB] = 20 dB (25 dBm max.)
- Mode: Pre Sweep with selective peak measurements, Peak filter mode = local
- Options: Enable selective peak measurement (unchecked), Enable +/- n x RBW/4 sweep per each selective frequency spot (unchecked), n = 2



EMI Analyzer configuration window showing the following settings:

- Standard Name: RN_CISPR11_EN55011_Class_A_GR2_Test_Site_9kHz_30MHz_10m
- Frequency: Start Freq. [Hz] = 150000, Stop Freq. [Hz] = 30000000, Sweep Step size in BW/2 multiples = 1.00
- Detector: CISPR, ANSI C63.2
- Receiver: Attenuation [dB] = 20 dB (25 dBm max.)
- Mode: Pre Sweep with selective peak measurements, Peak filter mode = local
- Options: Enable selective peak measurement (unchecked), Enable +/- n x RBW/4 sweep per each selective frequency spot (unchecked), n = 2



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EMI Analyzer

Setup 1 Setup 2 Setup 3 Report Status

Select Standard

Standard Name Import

RN_CISPR11_EN55011_Class_A_GR2_Test_Site_9kHz_30MHz_3m

Frequency

Start Freq. [Hz] 150000 Stop Freq. [Hz] 30000000

Sweep Step size in BW/2 multiples 1.00

Detector

CISPR, ANSI C63.2 MIL-STD-461

Receiver

Attenuation [dB] 20 dB (25 dBm max.)

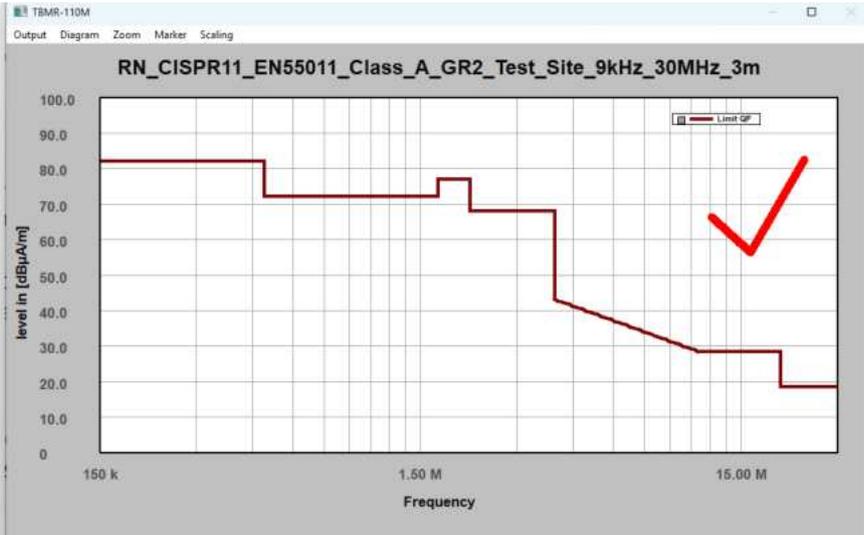
Mode

Pre Sweep with selective peak measurements

Enable selective peak measurement. Peak filter mode local

Enable +/- n x RBW/4 sweep per each selective frequency spot.

n= 2



EMI Analyzer

Setup 1 Setup 2 Setup 3 Report Status

Select Standard

Standard Name Import

RN_CISPR11_EN55011_Class_B_GR2_Test_Site_9kHz_30MHz_3m

Frequency

Start Freq. [Hz] 150000 Stop Freq. [Hz] 30000000

Sweep Step size in BW/2 multiples 1.00

Detector

CISPR, ANSI C63.2 MIL-STD-461

Receiver

Attenuation [dB] 20 dB (25 dBm max.)

Mode

Pre Sweep with selective peak measurements

Enable selective peak measurement. Peak filter mode local

Enable +/- n x RBW/4 sweep per each selective frequency spot.

n= 2



Version	Date	Author	Changes
V 1.0	23.04.2024	Mayerhofer	Creation of the document