



# TBMR-110M

1 Hz - 110 MHz high speed EMI-Analyzer

## Quick Reference Manual

Rev.1.2

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# 1 Introduction to the TBMR-110M EMI analyzer

## 1.1 Safety

	<b>Before using the instrument, carefully read the safety chapters in the TBMR-110M Operation Manual!</b>
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	<b>Warning: Manual mains voltage selection is required</b> Ensure that the mains voltage selector switch is set correctly to avoid damaging the instrument.
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## 1.2 Main Features

- **EMI Analyzer 1Hz - 110 MHz (Measurement Receiver)**
  - -162 dBm/Hz noise floor down to 1 kHz
  - 7-band hardware pre-selector filter bank.
  - 30 dBm maximum input power
  - CISPR-16, ANSI and MIL-STD compliant detectors
  - Peak, Quasi-Peak, Average, CISPR-Average, RMS and CISPR-RMS detectors working in parallel.
  - Sweep, STFFT and direct parallel resolution bandwidth setting (-3 dB and -6dB)
  - Numerous predefined Standards, ready to load and use
  - Pre-measurement with selective Peak measurement
  - Direct fast compliant STFFT measurement
  - Many pre-defined transducers, antenna factors and various other compensation files
  - Many data manipulation, display and documentation features
  - Direct control from EMCview or standalone operation
  - Quick load of predefined setups
- **Spectrum Analyzer**
  - 1Hz - 110 MHz measurement range
  - Tracking Generator
  - 0.1 Hz to 3.5 MHz arbitrary RBW and VBW setting
  - Zero Span operation with time domain triggering
  - Linear, log amplitude and frequency display
  - Sweep, STFFT and direct parallel resolution bandwidth setting
  - Parallel RMS, Pos./Neg. peak and average detector
  - Trace Memory option, normalization
  - Equation based trace display
  - Peak hold
  - Noise marker, max and band power display
  - Quick load of predefined setups

- **Tracking Analyzer 1 Hz - 110 MHz**
  - Linear and logarithmic sweep
  - -50 dBm to 0 dBm adjustable TG power
  - 120 dB dynamic range
  - Use of power correction file and level correction file
  - Quick load of predefined setups.
  
- **Noise Analyzer 1 Hz - 110 MHz**
  - Measurement of absolute RMS noise power or voltage spectral density
  - Noise figure measurement
  - Noise can be referenced to the input or output of devices under test
  
- **Oscilloscope 250 MS/s, DC - 110 MHz**
  - 1 ns/DIV to 1 s/DIV horizontal resolution
  - Interpolated sampling up to 4 GS/s
  - Real-time Sampling up to 250 MS/s, 14 Bit
  - Up to 16 MS sampling size
  - Various Trigger options
  - Vertical CIC Filter option for noise reduction
  - Many automatic measurement features
  
- **Demodulator**
  - Direct demodulation into the PC sound system
  - FM, AM and SSB demodulator
  - Adjustable bandwidth, center frequency and demodulator parameters
  - Automatic demodulation parameter measurements
  
- **IQ Stream Generator**
  - GNU-Radio data source.
  - Directly stream floating point I and Q data into file or network
  - Adjustable center frequency and bandwidth
  
- **Remote Control**
  - Direct remote control of the EMI Analyzer over network
  - Text based protocol
  - EMCview compatible

### 1.3 Application Overview

After launching the TBMR-110M software, a primary window with a variety of apps appears:

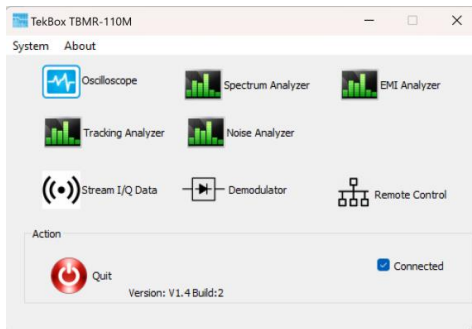


Figure 1-1 TBMR-110M software, primary window

### 1.4 System Requirements

The TBMR-110M system software requires a Microsoft Windows(R) 7 (SP1) 64 Bit, Windows 10 (R), Windows 11 (R) compatible computer with an USB 2.0 high speed interface, about 200 MB free disk space, an Intel Core I5 (R) processor with 3 GHz clock speed (or equivalent) and 4 GB of system memory as minimum recommendation. However, a multi-core processor like Intel i-12000 (R) or better is recommended. The CPU must support AVX2 CPU extension technology. Please note that the software uses heavy multithreading for STFFT and parallel computation. A high- resolution screen of better or equal than 1280x1024 pixels is required, 4k resolution is recommended for more detailed data display.

### 1.5 Packaging List

When opening the TBMR-110M box please check if following items are included in the package:

- TBMR-110M EMI-analyzer
- USB cable with type A and type B connector
- IEC power cord
- TBFL1 combined attenuator/ high pass filter / limiter
- USB Stick containing the TBMR-110M software, EMCview software and manual
- Quick Start Guide

### 1.6 Unpacking and Preparations for First Use.



Figure 1-2 TBMR-110M side view

Carefully unpack the shipping box and remove the packaging material. Carefully check your TBMR-110M for any shipping damage.

Check if the receiver's AC mains supply voltage matches the power grid voltage in your country. To do so, turn the analyzer around and have a look at the rear panel.

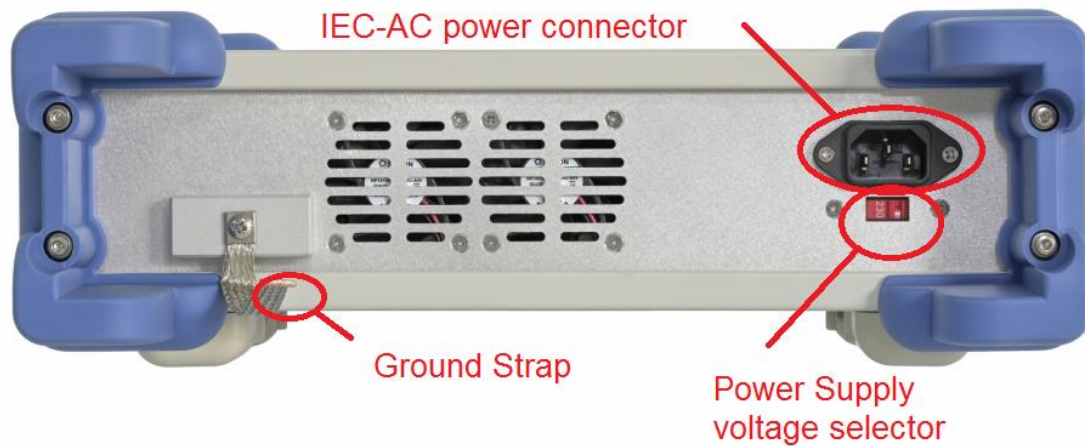


Figure 1-3 TBMR-110M rear view

Check the currently selected AC mains supply voltage on the power supply voltage selector.




Figure 1-4 TBMR-110M mains supply voltage selector

If the displayed voltage DOES NOT match your country's power grid voltage, please move the voltage selector switch in the opposite direction using a fitting tool, e.g. screw-driver.

Possible settings are: **115 VAC and 230 VAC.**

For voltages in the range 100 VAC to 120 VAC use the 115 VAC setting.

For voltages in the range 200 VAC to 240 VAC use the 230 VAC setting.

	<b>Warning: Mains voltage selector</b>  Operating the TBMR-110M Analyzer set to the wrong mains supply voltage may damage the equipment.
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Connect the Ground Strap of the receiver to your reference ground plane. This will ensure minimum noise and interference pick-up. Please note that all metal parts of the analyzer are connected to ground internally as well as to the ground wire of the IEC cable.


	<b>Proper grounding is necessary to achieve accurate measurements</b>
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Figure 1-5 IEC cable connector



supplied USB cable

Use your supplied IEC-power-chord and plug it into the TBMR power inlet on the back of the device. Plug the power cable then into a suitable power plug. Now connect the TBMR-USB port to your PC using the supplied USB cable.

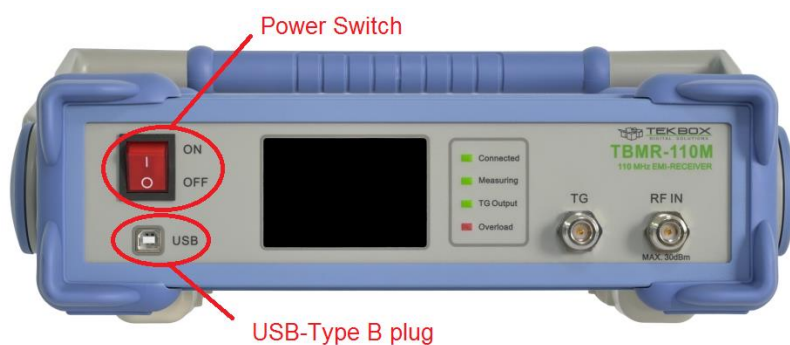


Figure 1-6 TBMR-110M front view

## 1.7 Software Installation

Plug the supplied USB Stick into the USB port of the PC which you want to connect to the receiver and open the software folder. Start the "Setup\_TBMR-110M\_Vxxx.exe" file as administrator. The Installer will guide you through the rest of the Installation.



Welcome to TBMR-110M Measurement  
Receiver Setup

110 MHz EMI Receiver

Install

[Options](#)

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Figure 1-7 TBMR-110M SW installer window

The Installer will install both the receiver software as well as the device driver.

## 1.8 First Power - On

After the software has been successfully installed and the PC is linked to the receiver, the device can be powered on. To do so, turn on the power switch shown in Figure 1.6 and look at the receiver's TFT display.

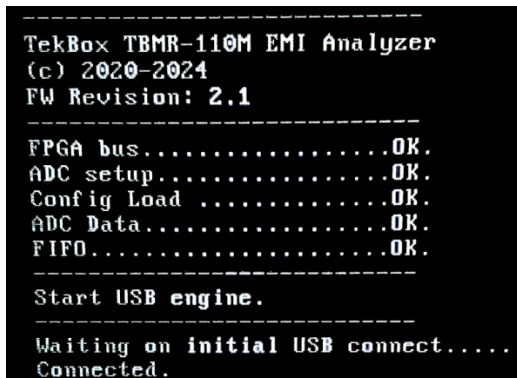


Figure 1-8 TBMR-110M auxiliary TFT display

The receiver performs several power-on self-tests (POST) and displays the results on the display. All test shall be OK to perform correct operation. If the USB driver is loaded correctly, the text "Connected" will be displayed on the TFT screen and the green LED "Connected" will light up on the analyzer front panel. The display can also be configured to display the measurement graphs.

In the device manager a new device folder "TekBox" should appear:

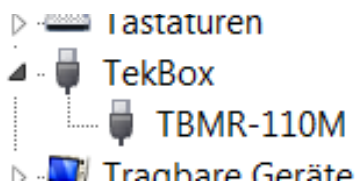


Figure 1-9 Windows Device Manager indicating that the receiver is successfully connected

If the analyzer does not connect successfully to your PC, please verify the USB connection. Turn off the analyzer and turn it back on after 2 seconds to check Windows Status outputs in the right lower corner of the screen.

If everything is correctly installed, you can now invoke the main application by double-clicking the Desktop icon or selecting the application from the program list.

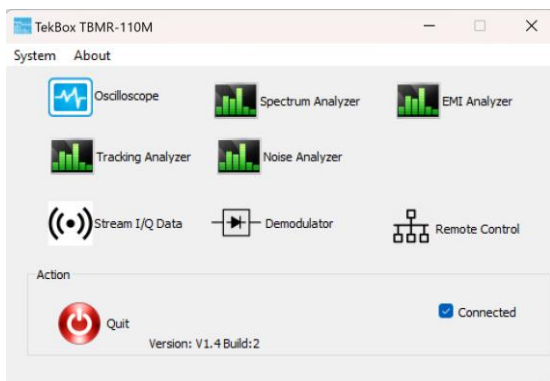


Figure 1-10 Main application window

If the device driver is properly loaded, the "Connected" - box is checked and the receiver is ready for operation.

For a first test, click on the EMI Analyzer icon. Following window will pop up:

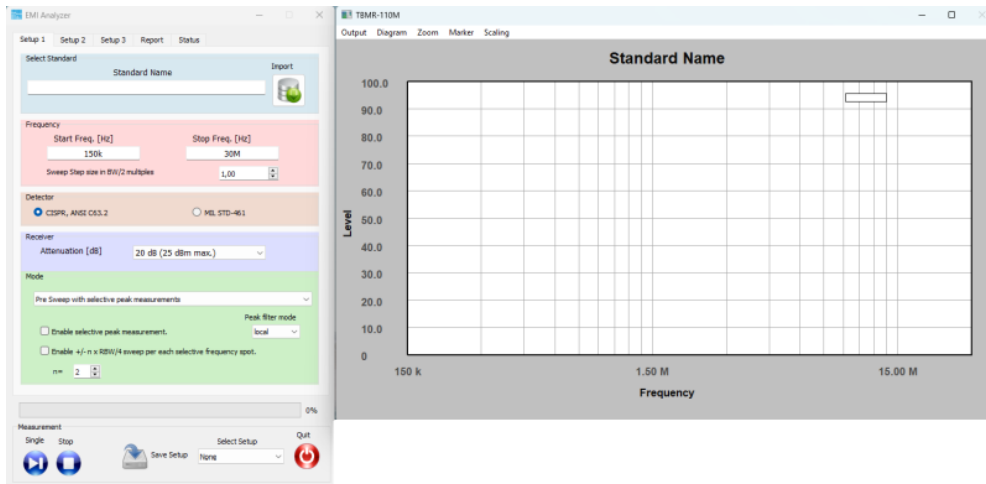


Figure 1-11 Main EMI analyzer window

Now click on the Import Icon on the top of the window and navigate to a project file folder, e.g.:

CISPR 32\_EN55032\_V1\_3\CN

Select a project file, e.g.:

CN\_CISPR32\_EN55032\_CLASS\_A\_Mains.prj

and press the "Open" button.

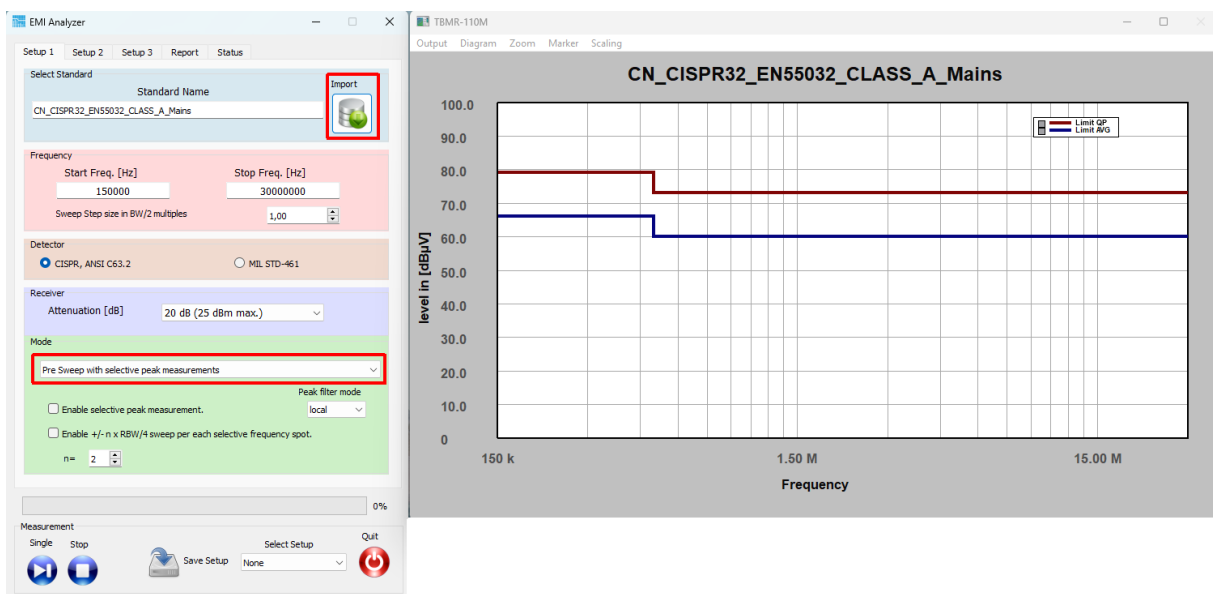


Figure 1-12 EN 55032 project loaded

Next, select Pre FFT Sweep with selective peak measurements.

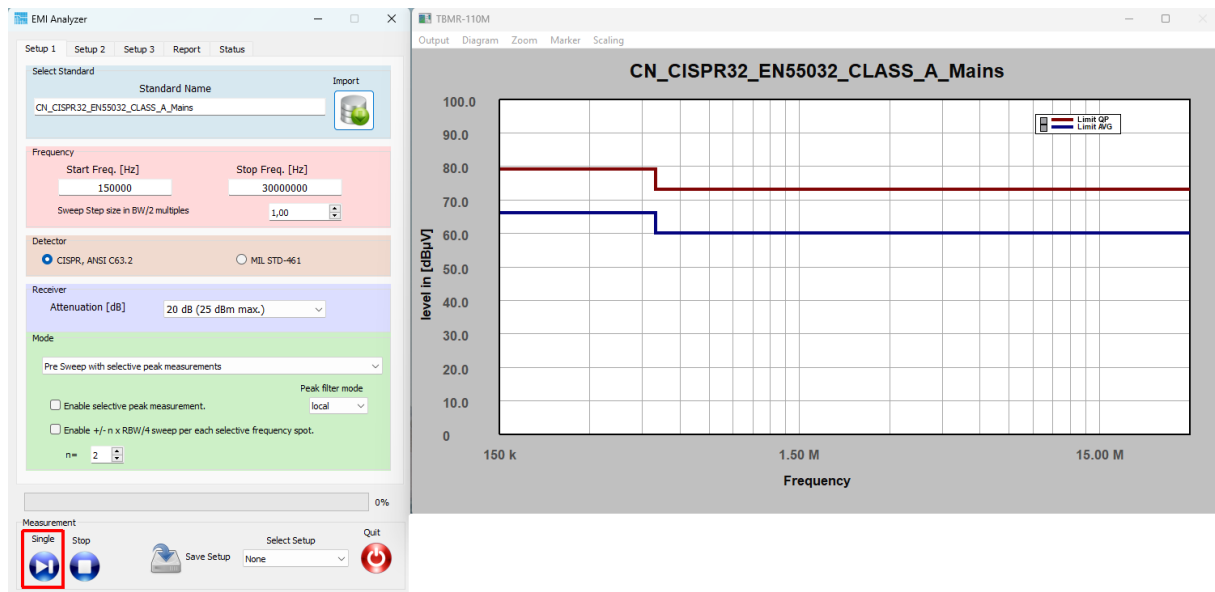


Figure 1-13 Press the “Start Single Measurement” button

Without signal applied, after a few seconds of operation, the diagram window should show a result similar to the figure shown below:

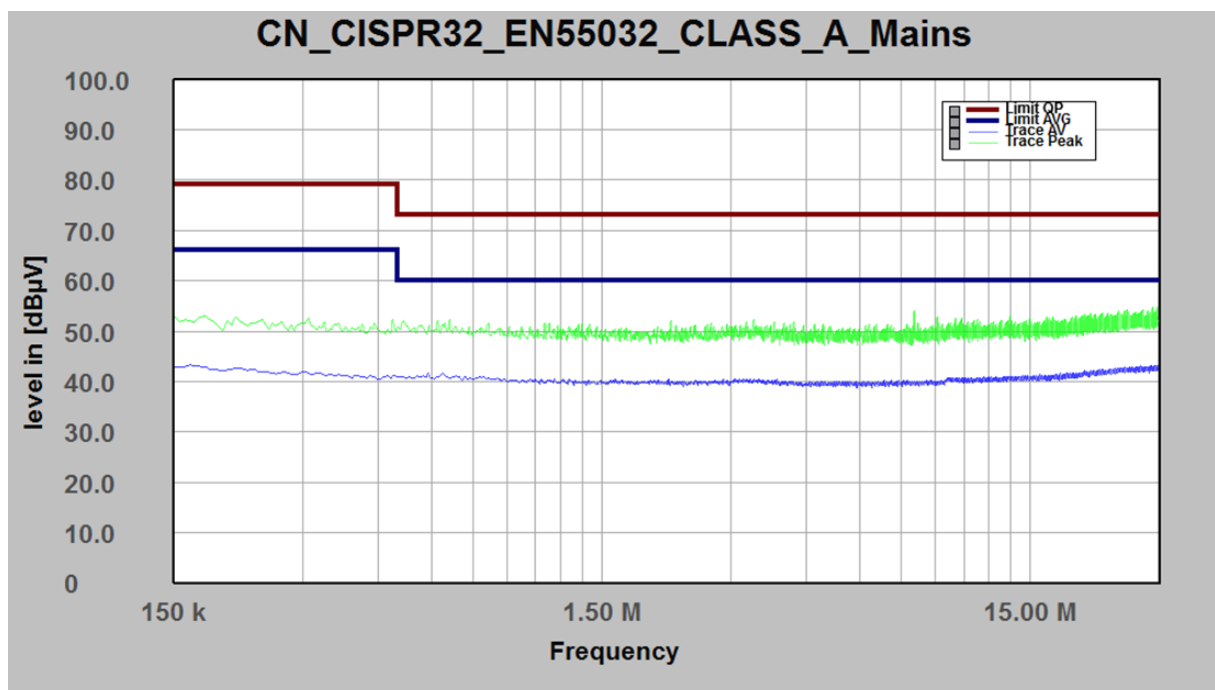


Figure 1-14 Measurement result; no signal connected to the RF-input

Congratulations! You have made your first EMI measurement with the TBMR-110M.

## 2 Operation

### 2.1 Front Panel Elements.

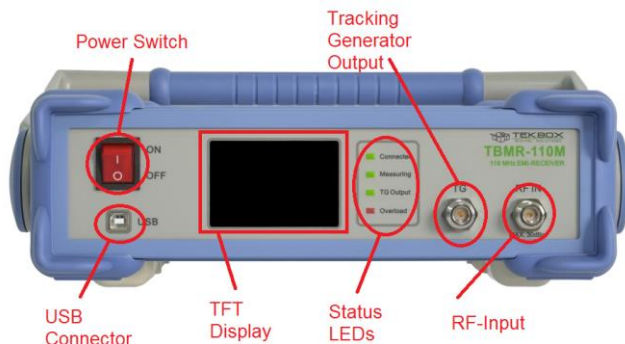


Figure 2-1 Front panel

- Power Switch: Turns the Analyzer on or off
- USB Connector: Connecting the Analyzer to a Computer
- TFT Display: For Status and Data Display
- Status LEDs:
  - Connected: indicates, that the USB connection to the control-PC is established
  - Measuring: indicates an ongoing measurement
  - TG Output: indicates, that the Tracking Generator is enabled
  - Overload: indicates a RF-input overload condition **during** a measurement, accompanied by buzzer sound
- Tracking Generator Output: DC - 100 MHz Tracking Generator Output
- RF-Input: Analyzer RF signal input (maximum rating 30 dBm)

	<p><b>Warning: Maximum RF input power rating</b></p> <p>The maximum allowed RF input power is +30 dBm (1 W or 7V) continuous power. However, this value is only achieved, when 30 dB of internal attenuation is selected! For lower internal attenuation or internal gain, the input power must be reduced accordingly! Exceeding +15 dBm can damage the analyzer. Be aware this also holds true for short transients or bursts!</p> <p>An overload condition will be only detected during a running measurement!</p> <p><b>Exceeding the maximum RF input power or voltage will damage the instrument!</b></p>
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### 2.2 Starting the Software

The TBM-110M software can be launched by either double-clicking the desktop icon or by selecting it from the TekBox Program folder. The following window will appear when the software starts:

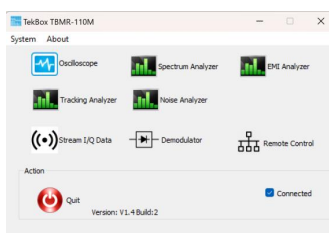


Figure 2-2 Main window, USB connected

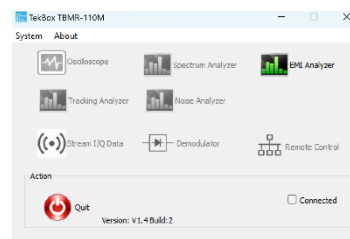


Figure 2-3 Main window, No USB connection

Following command line options are available:

- -platform windows:dpiawareness=0  
This option allows to scale the GUI in order to display the fonts correctly. Setting this option allows for compensation on font scaling. Use it, if you have an HDR monitor.
- dark  
This option enables a dark-style GUI display. Please keep in mind that only Windows 10 and Windows 11 will render Windows titles in black.
- remote  
This option will start the "remote control" application directly and hide the main window.
- nodebug  
This option will hide the debug text information during remote control operation. Note: option remote already disables debug information.

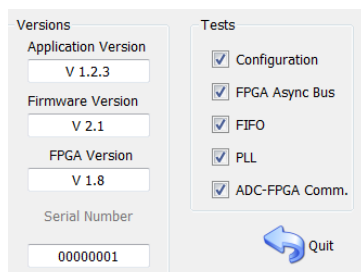
If a TBMR-100M analyzer is detected via USB, the "connected" box will be checked. Otherwise, all application icons will be grayed out and not accessible. The Quit button will terminate the application.

Besides the applications, the main window contains two menu items:

### **System menu**

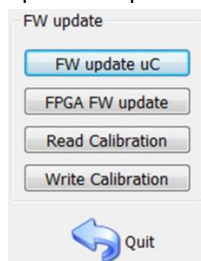
The **System** Menu contains following sub items:

- Select Home Path  
This item let you select a different home path folder for data and setup storage. Default is: <UserProfile>/TekBox/TBMR-110M
- System Test  
This item will perform several hardware tests and display version information. An unchecked test checkbox will indicate a hardware malfunction.




*Figure 2-4 System menu*

- System Service  
This item will only be accessible after entering a valid password. It allows to update the microcontroller Firmware and FPGA Firmware of the analyzer. This is explained in detail in the FW update chapter



*Figure 2-5 Service menu*

- Read Calibration  
Saves the analyzer's calibration data to the computer
- Write calibration  
Loads a calibration file from the computer and stores it on the analyzer. Needs an analyzer power cycle to be activated.
- Unlock Calibration  
Entering the password will unlock the calibration functionality and enable the System Service item. The default password is a zero-string, which means just press <Enter>.
- Change Password  
This menu item will allow you to alter the calibration password.

	<b>The default password upon delivery is a zero-length string, so simply press &lt;Enter&gt;</b>
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### About menu

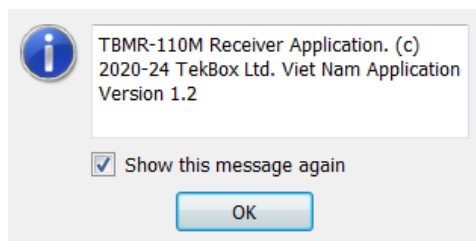


Figure 2-6 About menu, displaying the application software version

## 2.3 EMI Analyzer Application

### Setup 1 Tab

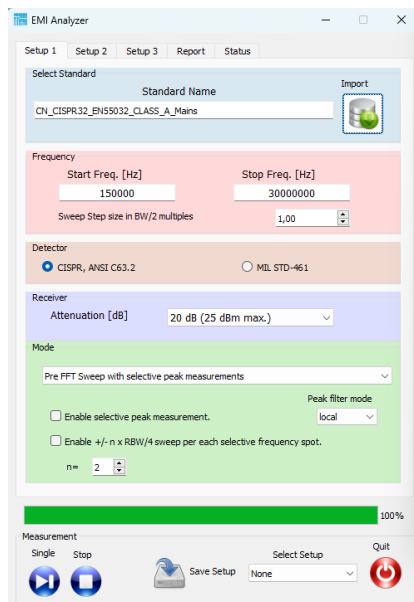



Figure 2-7 EMI Analyzer window; Setup 1 Tab, EN 55032 project loaded from the list of pre-configured projects

The EMI Analyzer GUI has been arranged in a top to down workflow structure.

EMC measurements can be configured manually, however all conducted emission tests of major standards are already implemented.

First load a suitable EMI Project from a pre-defined list. The projects are sorted in EMI standard sub-directories and contain all relevant emission limits. The standards are implemented as text files, very similar to the EMCview project file standard. Consult the EMCview manual on more details about the project files.

Upon loading a project file, the measurement frequency range will be loaded automatically. Following CISPR 16, the spacing of two adjacent frequency points (sweep step size) is predefined to RBW/2. A value between 0.0 and 1.0 would increase the measurement resolution while a value > 1.0 would reduce it.

	<p><b>CISPR 16: Two adjacent frequency points shall not be spaced more than half of the resolution bandwidth.</b></p> <p>A sweep step size &gt; 1 will create gaps in the spectrum and results may appear to low in amplitude and shifted in frequency</p>
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Detector settings are specified in the pre-configured project files and can be selected according to CISPR 16-1, ANSI C63.2 or MIL Std-461, DO-160.

The implemented detectors emulate the hardware description of the corresponding standard as closely as possible. This is in reference to the rise and fall times of the Quasi-peak detector, as well the meter constant. The EMI Analyzer Software will select the correct resolution bandwidth and detector constants automatically during measurement.

CISPR Band	A	B	C
Frequency Range	9 kHz - 150 kHz	150 kHz - 30 MHz	30 MHz - 110 MHz
-6 dB Bandwidth	200 Hz	9 kHz	120 kHz
QP charge time	45 ms	1 ms	1 ms
QP discharge time	500 ms	160 ms	100 ms
Meter constant	160 ms	160 ms	100 ms

Table 2-1 CISPR and ANSI detector parameters

Frequency Range	- 6dB Bandwidth
30 Hz - 1000 Hz	10 Hz
1 kHz - 10 kHz	100 Hz
10 kHz - 150 kHz	1 kHz
150 kHz - 10 MHz	10 kHz
10 MHz - 30 MHz	10 kHz
30 MHz - 1 GHz	100 kHz


Table 2-2 MIL-STD-461 and DO-160 detector parameters

The next section sets the input attenuator or amplifier. Maximum linear input power rating for the selected attenuation / gain is always given in brackets:

Attenuation [dB]	Absolute Max. Input Level [dBm, dBμV, V]
30	30 dBm, 137 dBuV, 7 V
20	30 dBm, 137 dBuV, 7 V
10	25 dBm, 132 dBuV, 4 V
0	15 dBm, 122 dBuV, 1.25 V
-10 (equivalent 10dB gain)	15 dBm, 122 dBuV, 1.25 V
-20 (equivalent 20dB gain)	15 dBm, 122 dBuV, 1.25 V
-30 (equivalent 30dB gain)	15 dBm, 122 dBuV, 1.25 V

Table 2-3 Absolute Maximum RF input power and corresponding attenuator / gain settings, exceeding these levels will cause permanent damage to the analyzer

Always use an external attenuator/limiter, if you test an unknown EUT / source. Levels above the given input power / voltage rating (even for short bursts) will trigger an overload condition only during an active measurement.

	<p><b>Warning: Maximum RF input power handling</b></p> <p>The maximum allowed RF input power is +30 dBm (1 W or 7V) continuous power. However, this value is only allowed when 30 dB of internal attenuation is selected! For lower internal attenuation or internal gain, the input power must be reduced accordingly!</p> <p><b>Exceeding the maximum RF input power or voltage will damage the instrument!</b></p>
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Upon starting the EMI Analyzer, the receiver attenuation is set to 20 dB. Once you've confirmed that there are no signals with excessive amplitude, you may want to reduce attenuation or increase gain to achieve adequate dynamic range. For a CISPR-compliant measurement, the base noise floor must be at least 6 dB lower than the limit line's lowest level.

Following measurement methods can be selected:

- **Pre Sweep with selective peak measurements**  
This method uses frequency stepping of a digital heterodyne receiver, where a first, faster sweep is made using Peak and Average or RMS detector. Thereafter, each limit violation will be re-measured using standard compliant Quasi-Peak and CISPR-Average detectors. The receiver measures like a classic swept receiver, one frequency point after another.
- **Pre parallel Sweep with selective peak measurements**  
Similar to the method above, this implementation uses frequency stepping of a digital heterodyne receiver, where a first, faster sweep is made using Peak and Average or RMS detector. Thereafter, each limit violation will be re-measured using standard compliant Quasi-Peak and CISPR-Average detectors. In contrary to the method above, the pre-sweep is made using software parallel filters and detectors and consequently will be considerable faster. The resulting speed depends on how many parallel cores are available in the CPU of the involved PC.
- **Pre FFT Sweep with selective peak measurements**  
This is another measurement method, where a first faster sweep is made with Peak and Average or RMS detector. Thereafter, each limit violation will be re-measured using standard compliant Quasi-Peak and CISPR-Average detectors. The pre-sweep is fast, using software STFFT and parallel detectors.
- **Direct parallel full compliance measurement**  
This measurement method will directly measure with Quasi-Peak and CISPR-Average detectors and uses software parallel filters and detectors. It is faster than the classic approach
- **Direct FFT full compliance measurement**  
This option will also directly measure with Quasi-Peak and CISPR-Average detectors and uses software STFFT filters and detectors. It is the fastest compliance option.

The checkbox "Enable selective peak measurements" will enable peak re-measurement for the first three options above. If left unchecked only a pre-sweep is performed.

The Checkbox " Enable +/- n x RBW/4 sweep per each selective frequency spot." will do a local frequency sweep around each detected peak. This is especially useful for measurements on devices which may change their EMI

frequency spectrum e.g. during warm up. This peak-search will ensure that the highest peak will be detected in a window of  $n \times \text{RBW}/4$ . The factor  $n$  can be adjusted.

Peak filter mode:

- **none**  
No peak filter technique is used, every violation of the peak threshold is re-measured for each point of the current sweep.
- **local**  
Each local peak will be re-measured.
- **max**  
A peak must violate the threshold and then drop below the threshold again to consider it a peak for re-measurement.

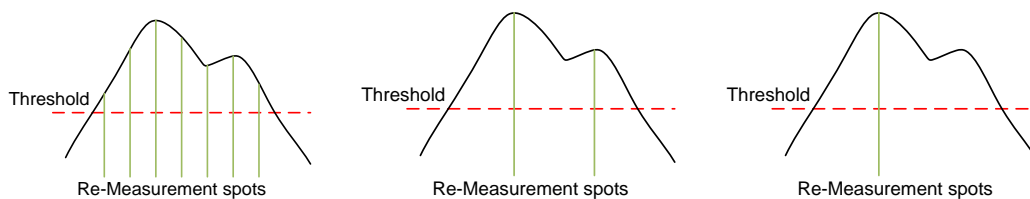


Figure 2-8 Peak filter mode: none, local, max (from left to right)

## Setup 2 Tab

In the Setup 2 tab, sweep parameters and compensation files are configured

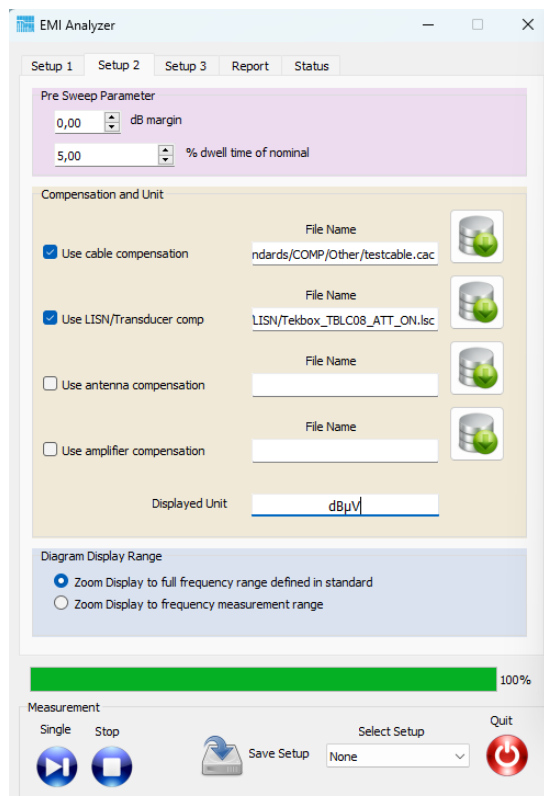


Figure 2-9 EMI Analyzer window; Setup 2 Tab, compensation files automatically loaded when importing a project

#### Pre Sweep parameters:

- **dB margin:**  
Sets the threshold for peak detection from the given standard limits. Each measured value above the threshold is potentially re-measured using compliance detectors.
- **% dwell time of nominal:**  
The default measurement speed of the pre-sweep is faster than the nominal compliant measurement time. This value sets the measurement time in percent of the nominal time. Increasing the time increases the chance to capture sporadic EMI events for EUTs, which perform many different tasks. When testing switched mode regulators which are not subject to sporadic load changes, there is no necessity to use a long dwell time.



**A short dwell time can result in missing peaks.  
A long dwell time results in long measurement time.**

#### Compensation settings:

Compensation files correct for the frequency response of components of the EMC test setup. These are typically cables, transducers such as LISN, RF current monitoring probes, attenuators or amplifiers.

Certain compensation files also carry out unit conversions, such as transimpedance files of RF current monitoring probes, which convert the voltage at the probe output into the current flowing through the aperture or antenna factor files, which convert the antenna voltage into electrical or magnetic field-strength.

Compensation files are self-explaining text files. As an example, an attenuator file would contain frequency points with the corresponding attenuation at this frequency. LISN files contain frequency points with the voltage division ratio value of the corresponding frequency. Any frequency points in between will be interpolated.

The compensation implements following equation:

$$\text{Displayed\_Value} = \text{Measured\_Value} - \text{Cable\_Comp} - \text{LISN/Trans\_Comp} + \text{Antenna\_Comp} - \text{Amplifier\_Comp}$$

With all values to be in the logarithmic domain (dB).

The compensation file format follows the syntax as described in Appendix -> Correction File Format.

The displayed unit does not to be configured manually. It is specified in the limit files of the standard. The TBMR-110M software automatically loads suitable compensation files, when loading a project. Compensation files for most Tekbox transducers and for a few third-party transducers are already pre-installed. Tekbox typically releases compensation files for new products on the product websites. These can be downloaded and copied into the compensation file folders of the TBMR-110M software.

## Setup 3 Tab

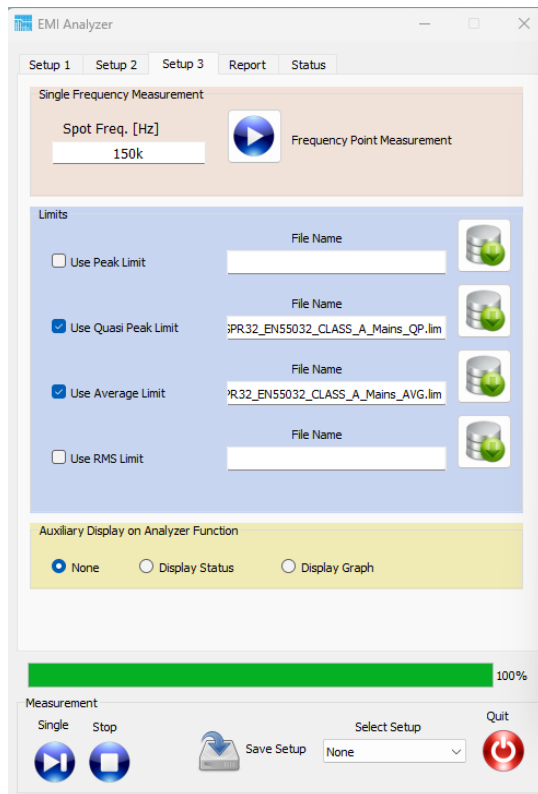


Figure 2-10 EMI Analyzer window; Setup 3 Tab; limit files of the selected project automatically loaded

Setup Tab 3 top does allow for single frequency spot measurement. If some peak seems suspicious or another not covered frequency band is of interest this is a convenient way to measure a single frequency location. Just enter the desired frequency value and press the "Play" button. Another window will pop up and continuously measure and update the result according to the selected standard.

Freq:

150.00 kHz

RBW:

9.000 kHz

Dwell Time:

1000 ms

---

	Value	Limit	Margin
RMS:	43.9 dBμV	n.a.	n.a.
Peak:	53.9 dBμV	n.a.	n.a.
Average:	42.8 dBμV	66.0 dBμV	23.2 dB
QP:	48.8 dBμV	79.0 dBμV	30.2 dB

Figure 2-11 Example; spot measurement according to EN 55032 Class A

Moreover, the Setup 3 tab contains the limit files of the imported standard. The files are loaded automatically when a project file is imported. Furthermore, it is possible to independently load different or customized limit lines for each detector. Detectors are specified in the limit files. Measurement results are only displayed when limit files are present.

In the Setup 3 tab, you can configure the use of the auxiliary TFT display at the front panel of the receiver. It can be set to display nothing except the boot screen, display status messages during measurements or to display the measurement graph.

## Report Tab

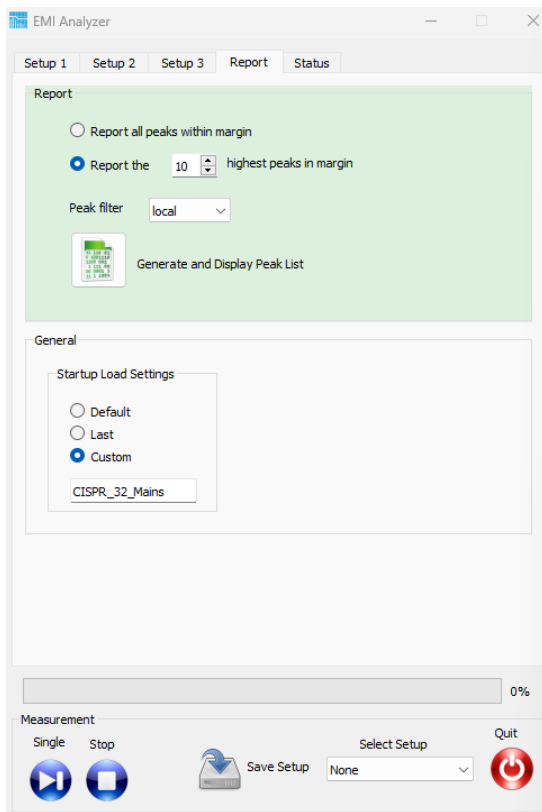


Figure 2-12 EMI Analyzer window; Report Tab

In the report tab, a CSV file with a peak report can be configured and exported. Run the receiver remotely with EMCview, if you want to create more detailed reports.

Furthermore, you can configure the appearance of the EMI analyzer after startup. When using any TBMR-110M application, it is recommended to arrange the app window and graph window according to personal preference and configure the “Startup Load Settings” to “Last”.

- **“Default” Startup:**  
The application window will pop up in the center of the display. The graph window can be attached to the application window, by pressing the “CTRL” button, while shifting it with the mouse. With the next start of the app, the relative position of the graph window with respect to the app window will be restored.
- **“Last” Startup:**  
Restarts the application with the settings from the previous session.
- **“Custom” Startup:**  
Restarts the application using a custom configuration. The setup must be found among the saved setups. The name of the setup must be entered manually.

## Status Tab

The status tab window displays status messages that were created during measurement. It can be used for debugging purposes.

## 2.4 Spectrum Analyzer Application

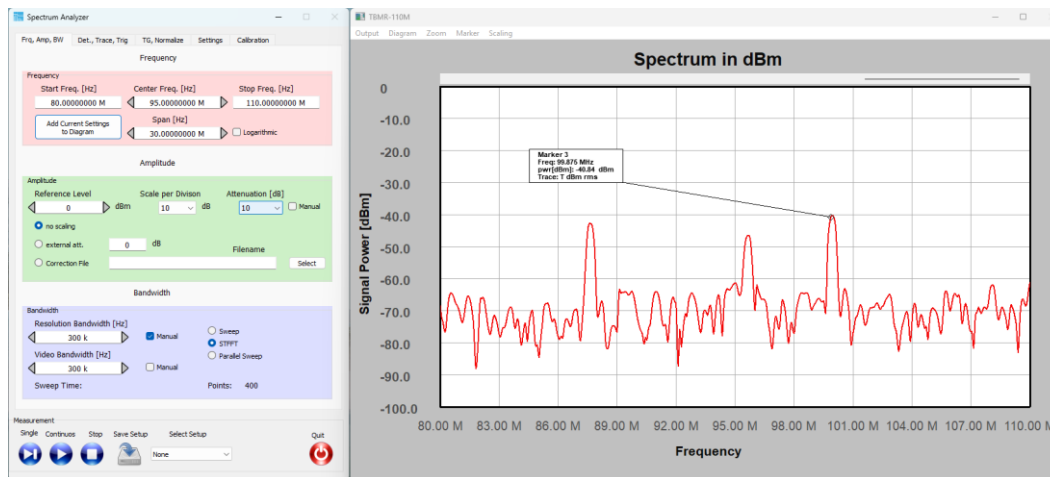


Figure 2-13 Example; screen shot of the spectrum analyzer application

The spectrum analyzer application has essentially the same functionality as most traditional spectrum analyzers. However, it is unique in its measurement capability at low frequencies.

### Frequency / Amplitude / Resolution Bandwidth Tab

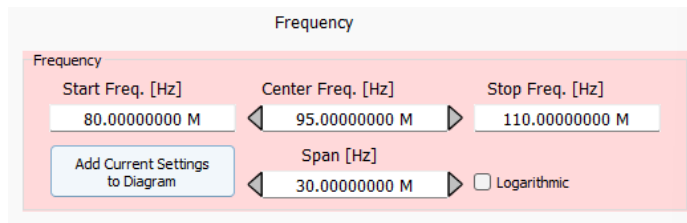


Figure 2-14 Frequency menu

When modifying Start- and Stop - Frequency settings, ensure that the entered value of the start frequency is lower than the stop frequency or vice versa.

By default, the frequency axis is linear. Use the "Logarithmic" checkbox to change to a logarithmic frequency axis. Please note that the display will change to a logarithmic scaling but the frequency sweep will maintain equidistant frequency steps. This leads to a lower step resolution at lower frequencies.

The button "Add Current Settings to Diagram" will add a label containing the RBW, VBW and Attenuation settings to the diagram.

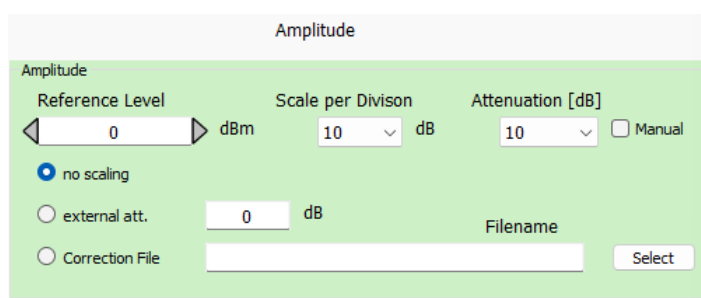


Figure 2-15 Amplitude menu


When adjusting the Reference Level, it is best to leave the "Manual" checkbox unchecked. The attenuation will be automatically matched to the reference level. Be mindful of how the Attenuation / Gain settings affects the TBMR-110M's maximum RF input power rating. Scaling is utilized for compensating, when employing external attenuators or transducers.

Maximum linear input power rating versus attenuation / gain settings:

Attenuation [dB]	Max. Input Level [dBm, dBμV, V]
30	30 dBm, 137 dBuV, 7 V
20	25 dBm, 132 dBuV, 2.2 V
10	15 dBm, 122 dBuV, 0.7 V
0	5 dBm, 112 dBuV, 0.22 V
-10 (equivalent 10dB gain)	-5 dBm, 102 dBuV, 0.07 V
-20 (equivalent 20dB gain)	-15 dBm, 92 dBuV, 0.02 V
-30 (equivalent 30dB gain)	-25 dBm, 82 dBuV, 0.007 V

Table 2-4 Maximum RF input power and corresponding attenuator / gain settings

Always use an external attenuator/limiter, if you test an unknown EUT / source. Levels above the given input power / voltage rating (even for short bursts) will trigger an overload condition only during an active measurement.

	<p><b>Warning: Maximum RF input power rating</b></p> <p>The maximum allowed RF input power is +30 dBm (1 W or 7V) continuous power. However, this value is only achieved, when 30 dB of internal attenuation is selected! For lower internal attenuation or internal gain, the input power must be reduced accordingly! <b>Exceeding the maximum RF input power or voltage will damage the instrument!</b></p>
--	--

Attenuation [dB]	Absolute Max. Input Level [dBm, dBμV, V]
30	30 dBm, 137 dBuV, 7 V
20	30 dBm, 137 dBuV, 7 V
10	25 dBm, 132 dBuV, 4 V
0	15 dBm, 122 dBuV, 1.25 V
-10 (equivalent 10dB gain)	15 dBm, 122 dBuV, 1.25 V
-20 (equivalent 20dB gain)	15 dBm, 122 dBuV, 1.25 V
-30 (equivalent 30dB gain)	15 dBm, 122 dBuV, 1.25 V

Table 2-5 Absolute Maximum RF input power and corresponding attenuator / gain settings, exceeding these levels will cause permanent damage to the analyzer.

#### Amplitude offset / correction

- **No scaling:**  
The graph displays the exact amplitude measured at the RF-Input of the TBMR-110M
- **External attenuation:**  
Enter the attenuation value, when using an external attenuator
- **Correction file:**  
When using a combined attenuator / filter / limiter such as the TBFL1, load the corresponding compensation file

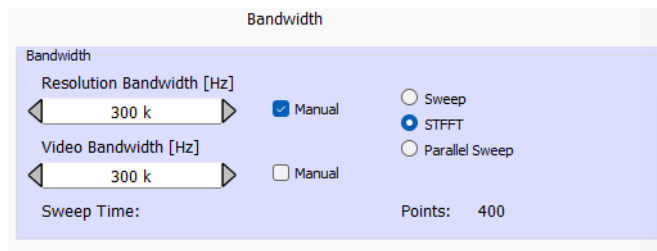


Figure 2-16 Bandwidth menu

The Resolution Bandwidth refers to Gaussian filters specified over their 3dB bandwidth. When manually decreasing resolution bandwidth, the number of measured frequency-points each sweep increases in order to avoid spectrum gaps between adjacent frequency-points. The number of frequency points per sweep is displayed in the lower right corner of the bandwidth menu.

The number of points approaches an unfeasible figure for a certain resolution bandwidth, at which time additional RBW reduction is prevented.

For further RBW reduction, it is recommended to reduce the frequency span.

### Detector / Trace / Trigger Tab

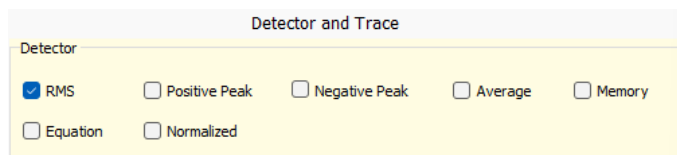


Figure 2-17 Detector and Trace menu

- RMS, Positive Peak, Negative Peak, Average**  
 All detectors are available in parallel. A separate trace for each detector will be added to the graph window automatically.
- Equation**  
 A trace-arithmetic feature, which can be used to convert the measurement values into other units or to carry out calculations. The syntax for the Equation is described in the Annex.
- Memory**  
 Displays a trace, which was stored in memory. In contrary to traces, which are stored using features of the graph window, the Memory-trace can also be used for normalization.
- Normalized**  
 Normalizes a trace against the trace stored in memory. This feature can be used to display the difference between two traces, e.g. when investigating the effect of modifications.

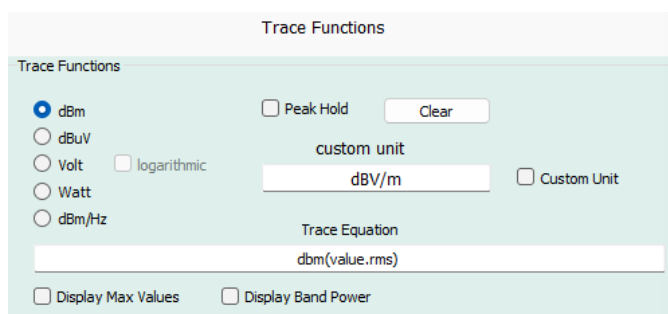


Figure 2-18 Trace functions menu

Check the “Custom Unit” box to select units which are not listed in the left column of the window.  
To display special results, such as for example dBμW/Hz or nV/Sqrt(Hz), use an equation for trace arithmetic.

- **Logarithmic**  
Changes the amplitude axis between linear and logarithmic
- **Peak (Max) Hold**  
Useful for continuous swept frequency measurements where it shows the history of peak values across the frequency axis. Peak Hold shows the maximum level the signal reaches. It is also useful for finding infrequent spurious.
- **Display Max values**  
Adds a text box to the graph window, which displays the maximum peak, RMS and Average values of the highest peak within the swept frequency span.
- **Display Band power**  
Adds a text box to the graph window, which displays the RMS power integrated over the swept frequency span.

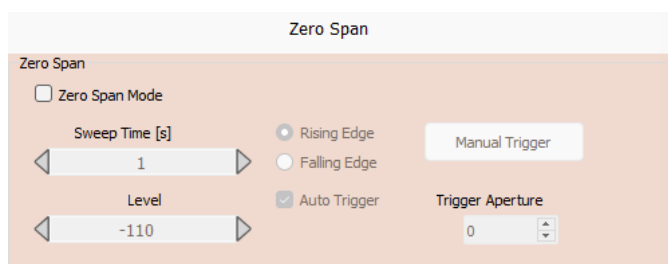


Figure 2-19 Trace functions menu

When set to Zero Span Mode, the analyzer displays the signal at the centre frequency in time domain mode. Sweep time and Trigger settings can be configured.

### Tracking Generator / Normalize Tab

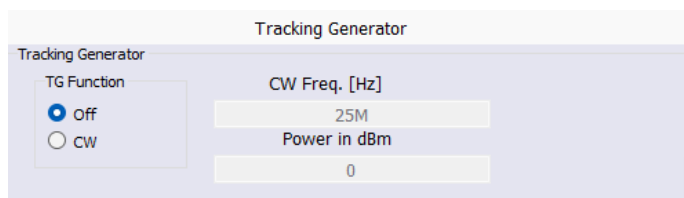


Figure 2-20 Tracking Generator Menu

The tracking generator produces a single tone at the specified frequency when the CW checkbox is enabled. Note that the tracking generator output power cannot achieve 0 dBm at frequencies > 100 MHz. If you require a consistent output power across all frequencies, lower the level to between -5 and -10 dBm.

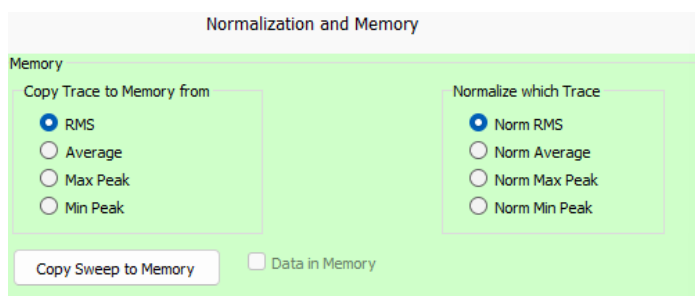


Figure 2-21 Normalization / Memory Menu

To use the Normalization feature, copy the reference trace to memory. Normalization can be used to display the difference between two traces, for example, when investigating the impact of modifications.



Figure 2-22 Limits Menu

This feature opens an editor to create limit lines.

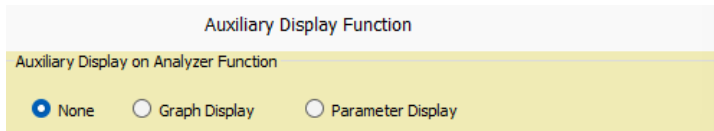


Figure 2-23 Auxiliary Display Menu

Configure the use of the auxiliary TFT display at the front panel of the receiver. It can be set to display nothing except the boot screen, display the measurement graph or display the configured parameters of the spectrum analyzer.

### **Settings Tab**

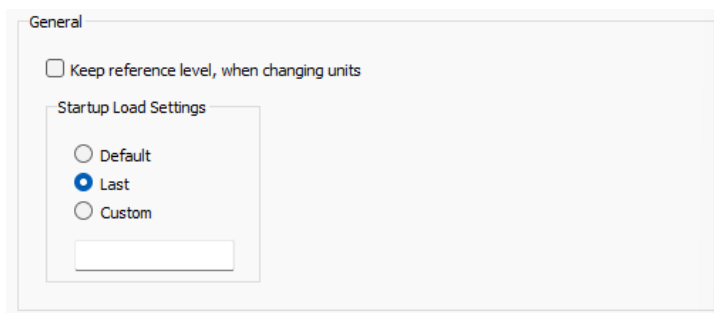


Figure 2-24 Settings Menu

Configure the appearance of the spectrum analyzer after startup. When using any TBMR-110M application, it is recommended to arrange the app window and graph window according to personal preference and configure the “Startup Load Settings” to “Last”.

- **“Default” Startup:**  
The application window will pop up in the center of the display. The graph window can be attached to the application window, by pressing the “CTRL” button, while shifting it with the mouse. With the next start of the app, the relative position of the graph window with respect to the app window will be restored.
- **“Last” Startup:**  
Restarts the application with the settings from the previous session.
- **“Custom” Startup:**  
Restarts the application using a custom configuration. The setup must be found among the saved setups. The name of the setup must be entered manually.

## Calibration Tab



The calibration tab is utilized for factory calibration or periodic re-calibration of the receiver. It requires a GPIB to USB converter in order to control a NIST-calibrated RF signal generator to calibrate the analyzer and a NIST-calibrated spectrum analyzer to calibrate the tracking generator. A separate calibration instruction is available upon request from Tekbox.

Figure 2-25 Settings Menu

## 2.5 Tracking Analyzer Application

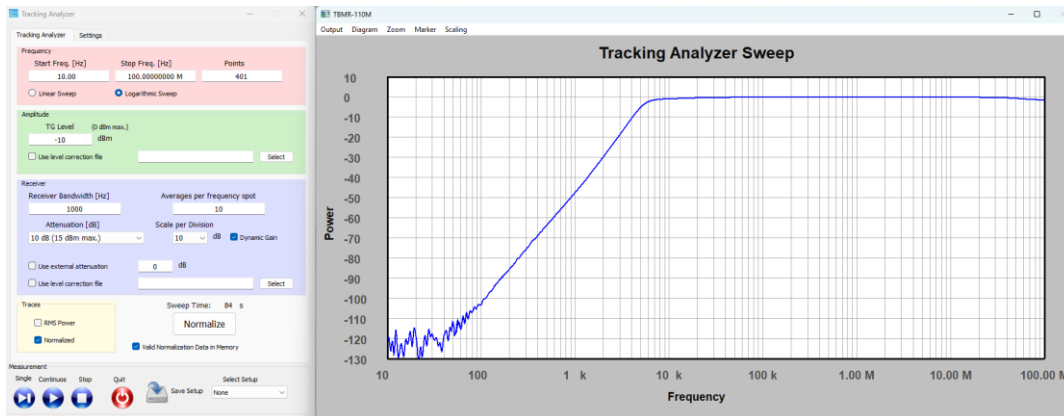


Figure 2-26 Scalar network analyzer, DC to 110 MHz, dynamic gain control; example: frequency response of a high-pass filter

Application: Characterizing the frequency response of transducers from very low frequencies up to 110 MHz.



Figure 2-27 Tracking analyzer tab

The implementation of the tracking analyzer is similar to most conventional spectrum analyzers with tracking generator. A coaxial cable connects the tracking generator output with the RF input of the TBMR-110 M for normalization. After normalization, a transducer or other EUT is connected in between tracking generator output and RF-input to measure the frequency response.

Figure 2-28 Sweep Menu

Enter start and stop frequency of the measurement range and select between linear or logarithmic sweep.

Figure 2-29 Amplitude Menu

If an amplifier is placed in the measurement path to increase the tracking generator signal, a level correction file can be utilized to compensate. To maximize dynamic range while measuring passive devices, set the tracking generator level to between -10 dBm and 0 dBm.

Figure 2-30 Receiver Menu

The receiver bandwidth specifies the greatest resolution bandwidth used during the sweep. At low frequencies, especially during a logarithmic sweep, the bandwidth is automatically reduced to more appropriate values.

Dynamic gain control is recommended for a maximum dynamic range of 110 dB. With dynamic gain control enabled, the preset attenuation refers to the maximum attenuation, which is automatically adjusted to maximize the measurement's dynamic range.

External attenuators or other additional components in the measurement path can be compensated using the external attenuation setting and appropriate level correction files.

Furthermore, averaging can be employed to smooth out the measurement graph.

Figure 2-31 Normalization Menu

Upon successful normalizing, a checkbox will indicate that valid normalisation data has been stored to the memory. Both the normalized trace and the non-normalized trace can be displayed.

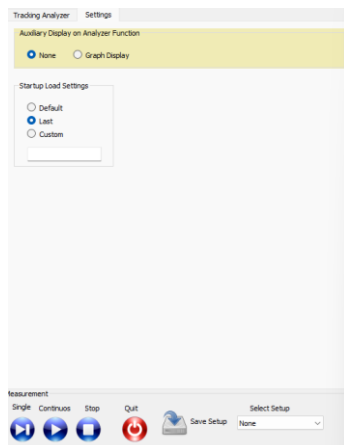


Figure 2-32 Startup load settings tab

Configure the appearance of the tracking analyzer after startup. When using any TBMR-110M application, it is recommended to arrange the app window and graph window according to personal preference and configure the “Startup Load Settings” to “Last”.

- “Default” Startup:**  
 The application window will pop up in the center of the display. The graph window can be attached to the application window, by pressing the “CTRL” button, while shifting it with the mouse. With the next start of the app, the relative position of the graph window with respect to the app window will be restored.
- “Last” Startup:**  
 Restarts the application with the settings from the previous session.
- “Custom” Startup:**  
 Restarts the application using a custom configuration. The setup must be found among the saved setups. The name of the setup must be entered manually.

If desired, the auxiliary TFT display on the TBMR-110M's front panel can be configured to display graph data.

## 2.6 Noise Analyzer Application

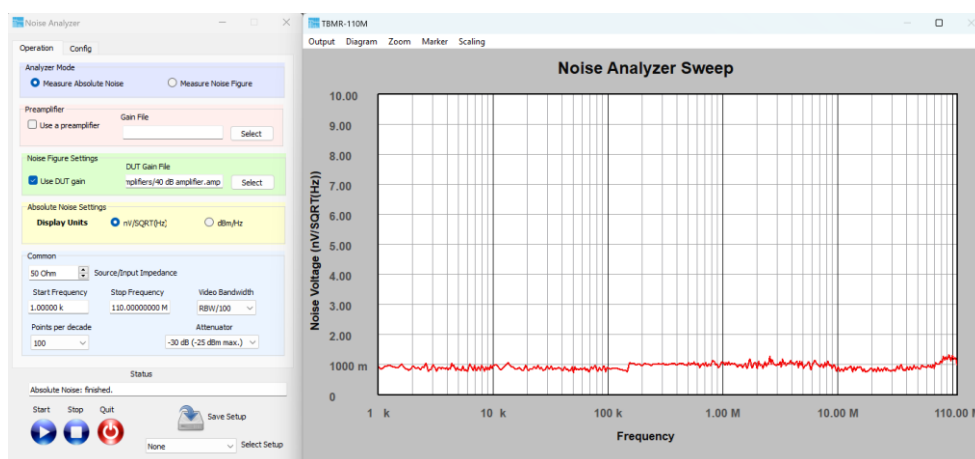


Figure 2-33 Noise Analyzer application

The noise-analyzer-application allows the user to measure the absolute noise power/voltage over a frequency range of 1 Hz to 110 MHz as well as the noise figure of any two-port device in the same frequency range. The mode of operation is selected in the "Analyzer-Mode" section. Choosing a different mode will automatically change diagram axis descriptions accordingly.

When evaluating the noise characteristics of low noise unity gain followers or amplifiers with a gain of less than 6dB, utilizing a preamplifier such as the Tekbox TBLNA-110M will increase measurement accuracy. When utilizing an LNA in the noise measurement setup, the gain-over-frequency characteristics of the amplifier must be loaded first. This file will either be supplied with the LNA or can be measured using the Tracking Generator application; just ensure that the gain data cover the entire frequency range of the intended noise measurement.

The "Noise Figure Settings" allows you to load the gain characteristics of the device under test (DUT). This gain file is necessary for noise figure or absolute noise measurements that refer to the DUT input. When the absolute noise measurement refers to the DUT output, no gain file is necessary. If the DUT gain is unknown, it can be measured using the Tracking Analyzer App.

In the "Absolute Noise Settings" section, you can choose to display RMS noise voltage in terms of V/VHz or noise power dBm/Hz. The "Common" section covers settings for the source impedance, start and stop frequencies, video bandwidth, points per decade, and attenuator settings.

The Video Bandwidth is specified proportional to the analyzer's automatically adjusted resolution bandwidth (RBW). The smaller the fraction, the smoother the noise figure, but at the expense of increased measuring time. For optimal noise sensitivity, the attenuator should always be set to the lowest practical value. Points per decade allows you to change the number of data points for each frequency decade. The status field displays the current segment measurement time. Please take note that only the measurement time is displayed. The total time will be much longer because it will include both measurement and data transfer time.

## 2.7 Oscilloscope Application

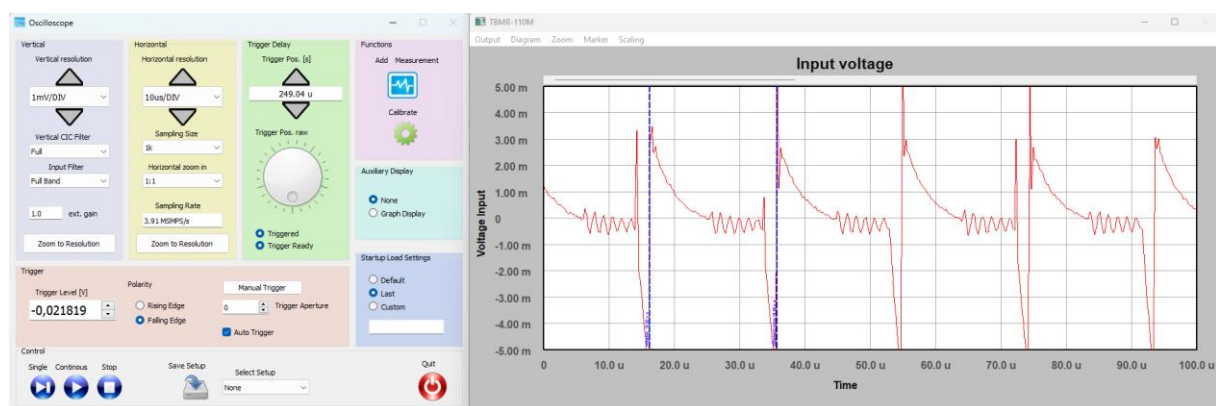
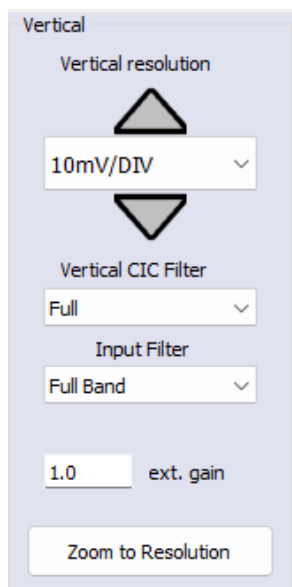


Figure 2-34 Oscilloscope application, DC to 110 MHz

The oscilloscope is useful, when the noise spectrum of an Equipment under Test has to be correlated with the time domain.

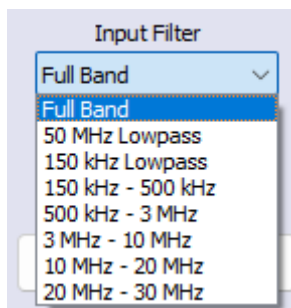


**In contrary to a typical oscilloscope, the implementation in the TBMR-110M lacks a high impedance input and input protection.**  
**The input impedance is 50 Ohm and the maximum input rating decreases as the sensitivity settings increase.**



The oscilloscope feature would typically be used with the TBMR-110M connected to a 50 Ohm transducer such as a LISN or a current monitoring probe. Before connecting the RF input to the transducer, set the Vertical resolution to the minimum sensitivity (5V/DIV). Thereafter start the measurement in order activate the Overload Detection. Only then connect the instrument to the transducer. Then, progressively increase sensitivity to a level appropriate for investigating the signal. The oscilloscope has an outstanding sensitivity of 1μV/DIV.

Figure 2-35 Vertical resolution settings



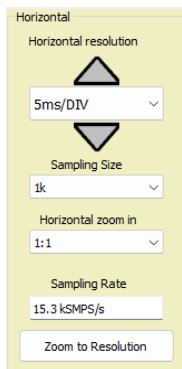
Using an Input filter may be helpful in case of trigger problems

Figure 2-36 Input filter settings

Attenuation [dB]	Absolute Max. Input Level [dBm, dBμV, V]
30	30 dBm, 137 dBuV, 7 V
20	30 dBm, 137 dBuV, 7 V
10	25 dBm, 132 dBuV, 4 V
0	15 dBm, 122 dBuV, 1.25 V
-10 (equivalent 10dB gain)	15 dBm, 122 dBuV, 1.25 V
-20 (equivalent 20dB gain)	15 dBm, 122 dBuV, 1.25 V
-30 (equivalent 30dB gain)	15 dBm, 122 dBuV, 1.25 V

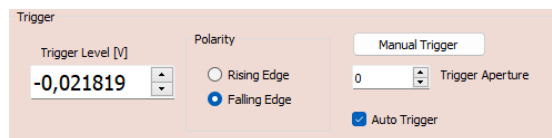
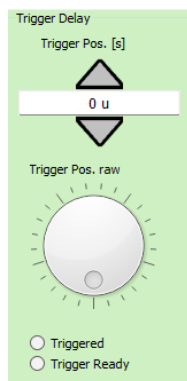
Table 2-6 Absolute Maximum RF input power and corresponding attenuator / gain settings, exceeding these levels will cause permanent damage to the analyzer.

Always use an external attenuator/limiter, if you test an unknown EUT / source. Levels above the given input power / voltage rating (even for short bursts) will trigger an overload condition only during an active measurement.



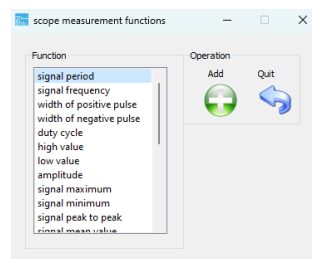
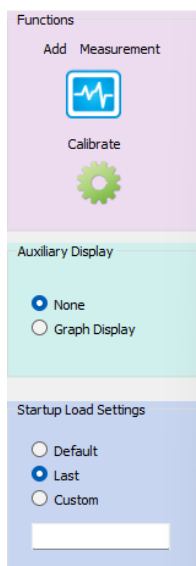
The horizontal resolution can be changed between 1ns/DIV and 1s/DIV.

Figure 2-37 Horizontal resolution settings



Use the trigger function to synchronize the horizontal sweep at the correct point of the signal. The default trigger position is shown as a green vertical line on the left side of the graph window. To see the signal before the trigger event, use the arrow or wheel to move the trigger position to the right. If a noisy signal prevents stable triggering, increase the value of the trigger aperture. If increasing the trigger aperture results in increased jitter, try reducing the noise with an adequate input filter setting. To utilize the manual trigger button, un-check the Auto Trigger box.

Figure 2-38 Trigger settings



Press the add measurement button to select from the numerous scope measurement functions. Press the add measurement button to select from the numerous scope measurement functions.

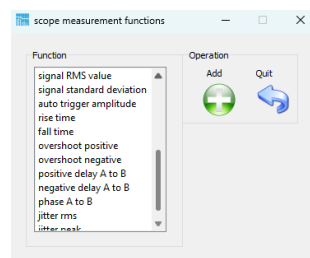


Figure 2-39 Scope measurement functions; Auxiliary display and Startup Load settings

The settings for the auxiliary display and the start-up load settings work same as with the EMI analyzer or spectrum analyzer.

## 2.8 Demodulator Application

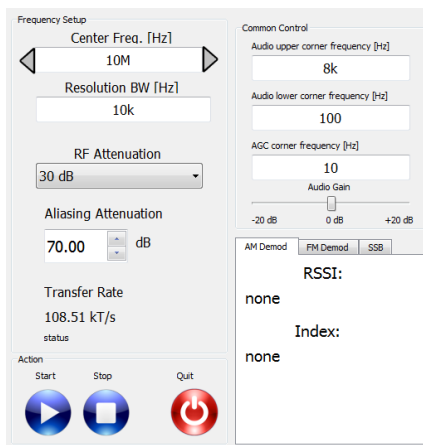


Figure 2-40 Demodulator panel

The demodulator application allows to utilize the TBMR-110M to demodulate an RF signal and transfer it to the computers sound card. Any sound processing, recording or analysis software can be used to select the demodulated audio as input signal. The following parameters can be configured:

- **Center Frequency**  
This value shall be set to the signal carrier frequency.
- **Resolution Bandwidth**  
Occupied -3 dB bandwidth of the modulated signal.
- **RF Attenuation**  
Set the attenuator according to the expected signal level.
- **Aliasing Attenuation**  
Should be kept at 70 dB; allows to change the required signal-to-noise ratio and data transfer rate.

Due to USB speed limits, the transfer rate must not exceed 1000 kT/s. One transfer consists of eight bytes: four bytes of in-phase data and four bytes of quadrature-phase data.

The "Common Control" group allows you to configure audio parameters such as upper and lower audio signal corner frequencies, automatic gain control, corner frequencies, and audio gain. The three tabs in the right bottom corner of the demodulator window allow you to select a demodulator.

### AM (amplitude modulation)-Demodulator:

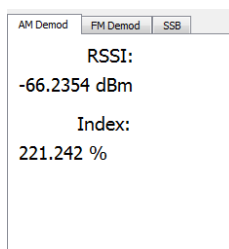


Figure 2-41 AM Demodulator tab.

If the AM demodulator tab is selected and the demodulator is launched, the box will display the following parameters:

- **RSSI** : Radio Signal Strength Indicator in dBm
- **Modulation Index**

### FM (frequency modulation) - Demodulator:

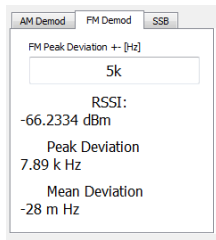


Figure 2-42 FM Demodulator tab.

FM is characterized by its frequency deviation: The FM peak Deviation

For narrowband FM the peak deviation is typically +/- 5 kHz (e.g. CB radio)

For wideband FM it is typically +/- 75 kHz (e.g. FM radio)

Following parameters are measured:

- RSSI : Radio Signal Strength Indicator in dBm
- Peak Deviation : Shows the peak deviation from the center frequency
- Mean Deviation : Shows the difference between the actual modulated carrier frequency and the configured center frequency. If the center frequency of the modulated signal equals the carrier frequency, the value should be zero

### SSB (single sideband) - Demodulator:

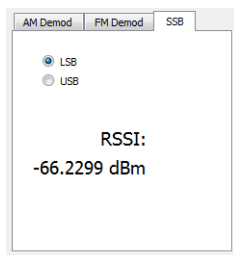


Figure 2-43 SSB Demodulator tab.

The type of SSB demodulator can be selected by the two radio-buttons

- LSB lower sideband
- USB upper sideband

Moreover, average band power is measured and displayed.



Figure 2-44 Action buttons.

The demodulation process is started with the Start button and stopped with the stop button. During an active demodulation process it is only possible to change the center-frequency and the audio controls. It is not possible to switch the demodulator type.

## 2.9 Remote Control Application

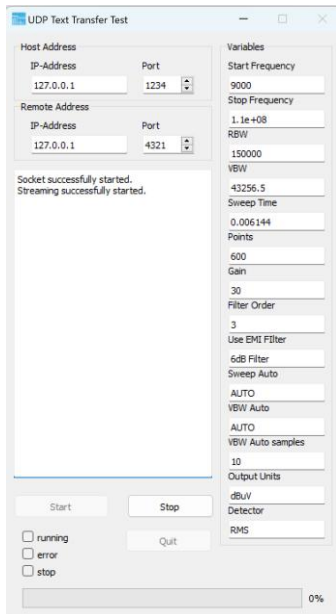


Figure 2-45 Remote Control Window

The Remote Control Application establishes a bidirectional UDP channel.

Refer to the Appendix for information on how to use the Remote Control Application for other purposes. The various variables in the GUI can be used to verify the remote controlled settings and the status windows will prompt any communication with the Host.

### **EMCview for TBMR-110M**

A customized version of EMCview comes as an accessory. However, due to the frequency range of the TBMR-110M, not all operation modes of the conventional EMCview (PRO) software are accessible.

Launch the EMCview installer provided on the USB stick with the TBMR-110M software.

After installation, turn on the TBMR-110M and connect it to the PC, using the supplied USB cable. Launch EMCview and enter the “Connect” menu.

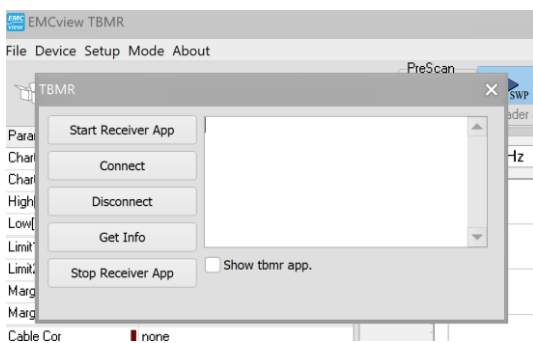


Figure 2-46 EMCview Device connection window

Press “Start Receiver App” and then “Connect”. EMCview starts the TMR-110M software and the remote application in the background. It will only be seen in the Windows task manager.

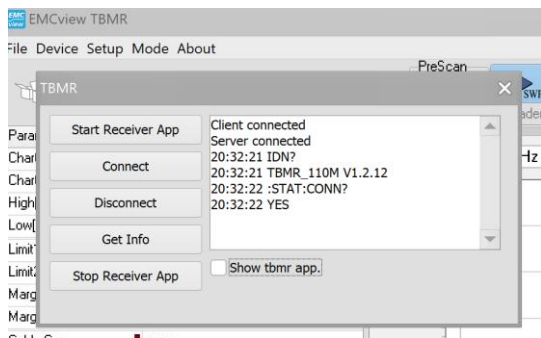


Figure 2-47 EMCview connected to TBMR-110M

Close the connection pop up window, clicking “X” and start using EMCview.

Refer to the EMCview manual and EMCview document for instructions on how to operate the software. Operation modes such as RF-coverage measuring and immunity-testing are inaccessible. Preconfigured radiated emission tests are also not available.

Because of the control and data transfer over UDP channel, measurements are slower than using the TBMR-110M software.

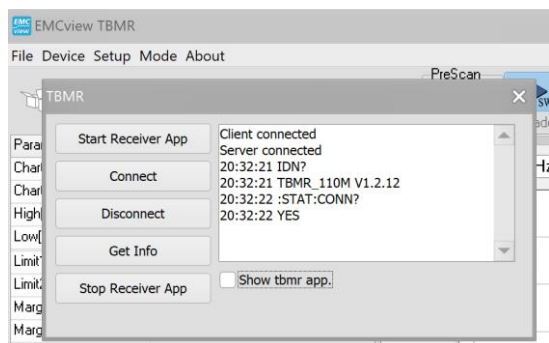


Figure 2-48 EMCview connected to TBMR-110M

After completing measurements, go to the “Device” menu, and select “Disconnect” and then “Stop Receiver App”. EMCview is ready to be shut down now.

If you forget to press the “Stop Receiver App” button and wish to use the TBMR-110M software, close it using the Windows Task Manager and then launch it normally.

## 2.10 I/Q Data Streaming Application

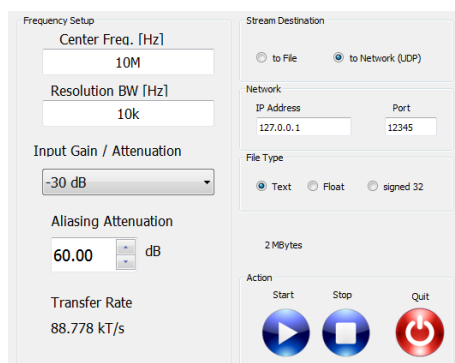


Figure 2-49 I/Q Data Streaming Application.

The I/Q Data streaming application allows you to store or transfer sampled baseband in-phase and quadrature-phase data words to a disc or network. These so called I-Q data words allow processing and demodulation of sophisticated modulation schemes. The signal at the selected center-frequency will be down-converted to the baseband and filtered according to the resolution bandwidth setting. Down-sampling will be automatically applied to reduce the transfer rate. The aliasing attenuation setting limits the maximum down sampling factor in order to maintain the given signal to noise ratio. 60 dB will suffice for most applications.

The continuous data stream can be either sent to a file or across a network using UDP protocol. The data-type of the streaming file can be Text, binary 4-Byte floating point or 4 Byte signed integer.

The network streaming option can be used as a data source in GNU-Radio:

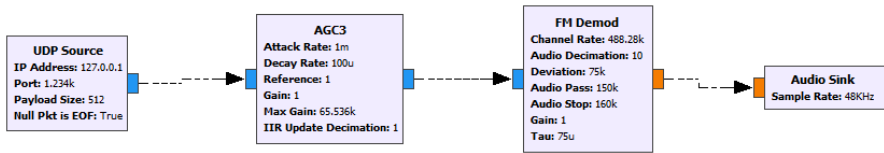


Figure 2-50 Simple FM Demodulator in GNU-Radio using the TBMR-110M as data source.

For the data source a UDP source is selected and the IP address and port settings must match the parameters in the streaming application GUI. Payload Size has to be set to 512 Bytes.

The transfer rate is limited to 1000 kT/s due to USB speed limitations

### 3 History

Version	Date	Application software version	Changes
V1.0	19.4.2024	V1.0	Initial document
V1.1	28.10.2024	V1.1	Type error correction
V1.2	16.1.2025	V1.4	Noise Analyzer application added

Table 3-1 Version History.

The application software version refers to the most recent version available at the time of writing the quick reference manual.