



EMI Analyser

Application User Manual

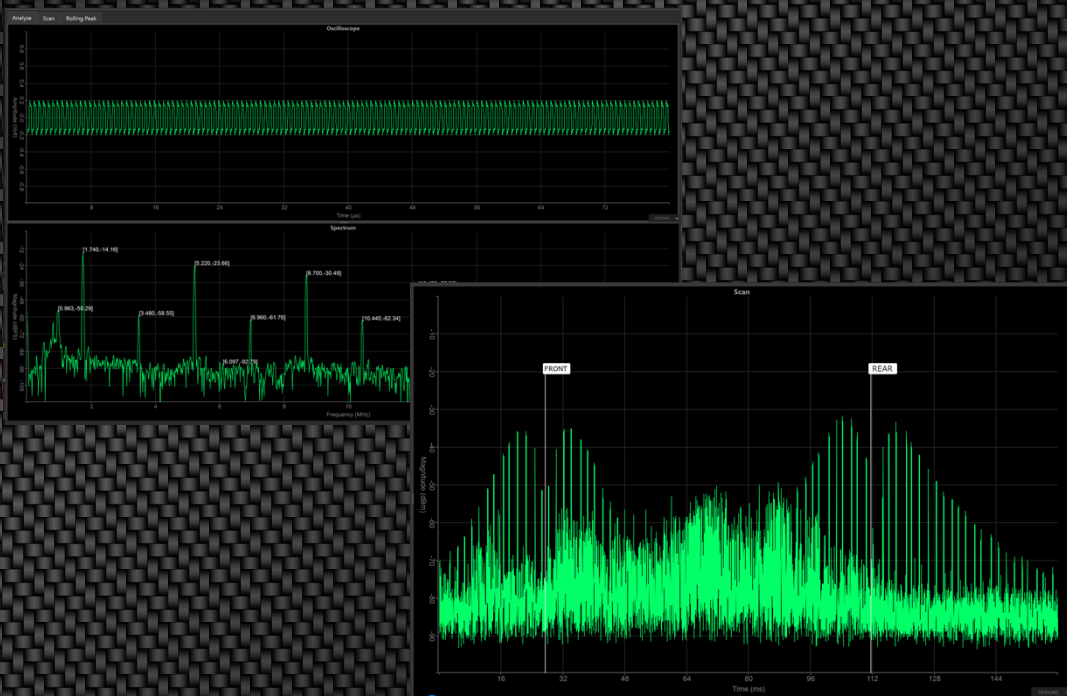




Table of Contents

INTRODUCTION	- 2 -
CONNECTION	- 3 -
USB INTERFACE	- 3 -
ETHERNET INTERFACE	- 3 -
MODES	- 4 -
ANALYSE MODE	- 4 -
<i>Near Field Antenna</i>	- 6 -
<i>Static EMI Source Finding</i>	- 6 -
<i>Replay EMI analysis</i>	- 6 -
SCAN MODE.....	- 7 -
<i>Loop Antenna</i>	- 9 -
<i>Dynamic EMI Source Finding</i>	- 9 -
<i>Replay EMI scans</i>	- 10 -
ROLLING PEAK MODE	- 10 -
DIAGNOSTICS	- 11 -
TOOLS	- 12 -
HARMONIC CALCULATOR.....	- 12 -
MEASURE TOOL	- 12 -
EXPORTER TOOL	- 13 -
SAVE GRAPH	- 13 -
DISCLAIMER	- 14 -



Introduction

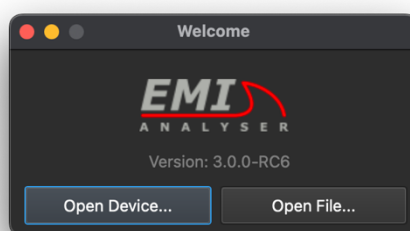
The EMI Analyser System is specially developed for EMI research on hybrid and electric (racing) cars. It consists of 3 main components:

1. Receptor Device
2. EMI Analyser Application
3. NF (Near Field) Antenna

The EMI Analyser application (Analyser) is used to visualize the measurements and control the Receptor. The Analyser is available for Windows.

This manual describes the EMI Analyser Application.

For the Receptor device, please refer to the Receptor User Manual



Screenshot 1. Start up screen

The system has 3 operation modes:

In **Analyse** mode the Receptor is connected to the NF Antenna, supplied by TMS. The measurements are filtered by an analog low pass filter (0 - 10 MHz). The measurements are shown in real time as a function of time (oscilloscope window) and as a function of frequency (spectrum window). The repetition rate, harmonics and amplitude of the EMI can be analyzed, giving more inside on the source of the EMI. All measurements can be recorded in an EMI file. The Analyser can replay the EMI-file. Analyse mode is mostly used by teams for EMI source finding.

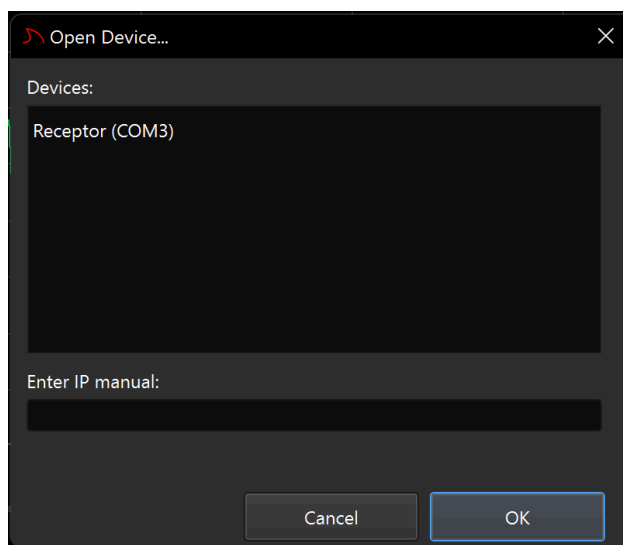
In **Scan** mode, the Receptor works as a logarithmic amplifier and the Analyser shows the magnitude versus time. This measurement is triggered with a user defined trigger level. All measurements can be saved in a SCN-file. The SCN-file can be read with the Analyser. Scan mode is mostly used by federations to inform teams on EMI issues.

In **Rolling Peak** mode, the Receptor works as in Analyse mode accept that it saves all measurements in internal non-volatile memory when powered until the memory is full. Log mode is mostly used by engineers in factories for car design issues that influence the Transponder signal.



Connection

The Receptor has two communication interfaces, USB-C and Ethernet. Both interfaces can be used for power supply and data at the same time.



Screenshot 2. Device Selection Dialog

USB Interface

Connect the Receptor using an USB-C cable to the computer.

- Select from the menu bar: Device → Open or from start-up 'Open Device'
- Select from the list 'Receptor (*com port*)'

Ethernet Interface

Power the Receptor via the DC power supply, USB-C port or with passive POE.

Connect the Receptor to your LAN with a CAT-5 cable.

- Select from the menu bar: Device → Open or from start-up 'Open Device'
- Select from the list 'EMI Acquisition Receptor (*IP address – EA address*)'.

When the Receptor is behind a firewall, it is possible the Receptor is not shown in the list. In this case the IP address can be manually entered below.

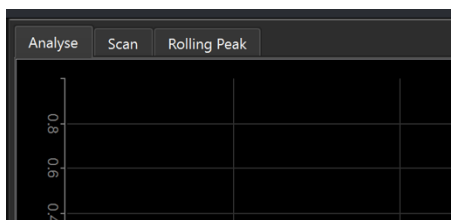
Please refer to the Receptor User Manual to change the Network Settings of the Receptor via the Receptor Web Interface.



Modes

Analyse Mode

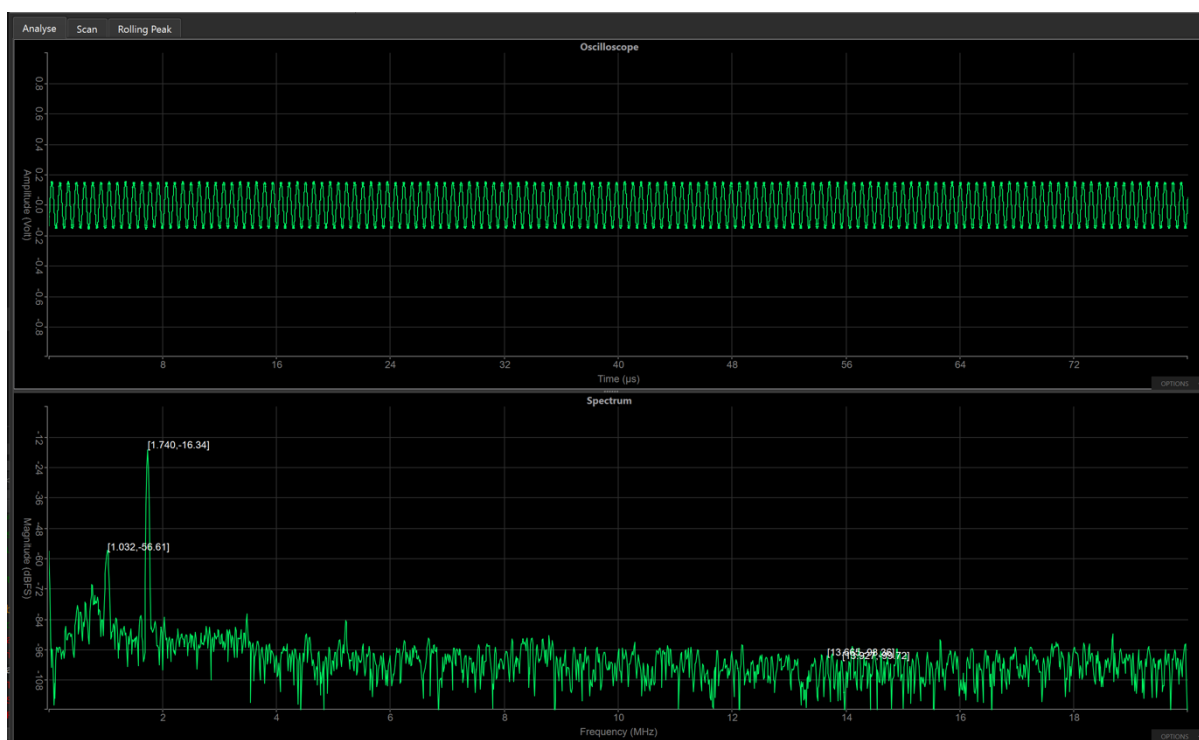
Analyse mode is mostly used by teams to do ‘static’ tests in the factory or pit box after an EMI issue is found. To start searching for an EMI source switch to Analyse mode by clicking the TAB ‘Analyse’ in the upper left corner.



In Analyse mode the EMI Application will show real time signal information.

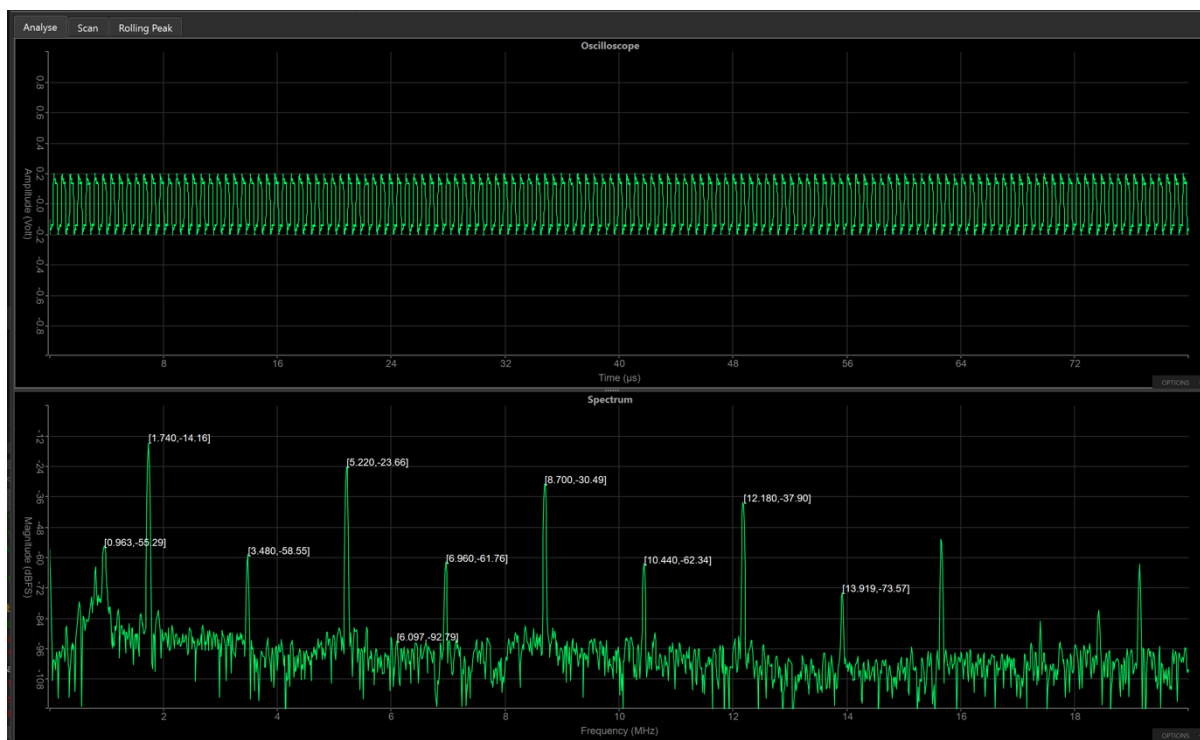
The upper window shows the received signal in the time domain, which is comparable with what an oscilloscope would show.

The lower window shows the received signal in the frequency domain, which is comparable with what a spectrum analyser would show. 0-20 MHz is shown.



Screenshot 3. Analyse Mode, sine wave at 1.740 MHz

Above screenshot 3 shows an almost clean sine wave at 1.740 MHz coming from a signal generator. The signal generator however also produces an approximately 40dB lower unwanted signal at 1.032MHz as can be seen in the lower (spectrum analyser) window.

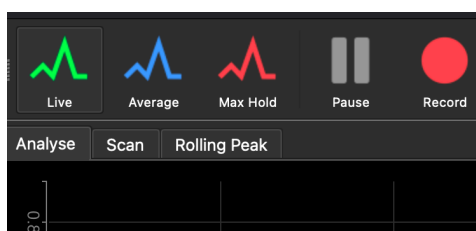


Screenshot 4. Analyse Mode, block wave at 1.740 MHz

Above screenshot 4 shows block wave at 1.740 MHz coming from a signal generator. The unwanted signal frequency has slightly changed to 0.963 MHz as can be seen in the lower (spectrum analyser) window. As this is a block wave all harmonic frequencies due to fast slopes in the block wave signal are shown i.e; 3.480 MHz, 5.220 MHz, 6.960 MHz etc.

Above principal is used to find EMI sources by finding the base frequency of the source. To find the actual physical location/device that is generating the EMI with help of the NF Antenna which is handheld/portable and can therefore be used to search for the EMI source.

In addition to the real time view a few options are available in the Analyse mode. These options can be found in the top menu bar.



- Live** Real time signal analysis.
- Average** Shows an average (blue) line in the live spectrum.
- Max Hold** Shows a peak hold line (red) in the live spectrum.
- Pause** Live mode is paused and EMI-file the screen is not updated with new measurements.
- Record** Record the measurements for later review.



Near Field Antenna

The near field (NF) antenna is a small handheld device connected to the Receptor via a COAX cable. The antenna can be fixed at a specific location and successive measurements can be compared to determine changes in EMI when making changes to the surrounding electronics or cables.

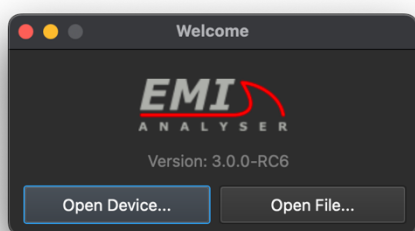
To locate the actual source of EMI, the antenna can be moved around and the software will show the received EMI in real time.

Static EMI Source Finding

Typical workflow searching for EMI source(s) with help of the Analyse mode.

- Start the EMI Analyser application
- Connect the TMS Receptor with an USB cable or network cable.
- Connect the NF antenna to the receptor
- Select the TAB “Analyse”
- The upper graph shows the measured signal versus time
- The lower graph shows the measured signal magnitude versus frequency
- Place the NF Antenna in the transponder position
- Create a snapshot of the spectrum by clicking on the “options” button in the right-bottom corner of the spectrum graph to save it
- Move the NF Antenna around and check for changes in the spectrum graph

Replay EMI analysis



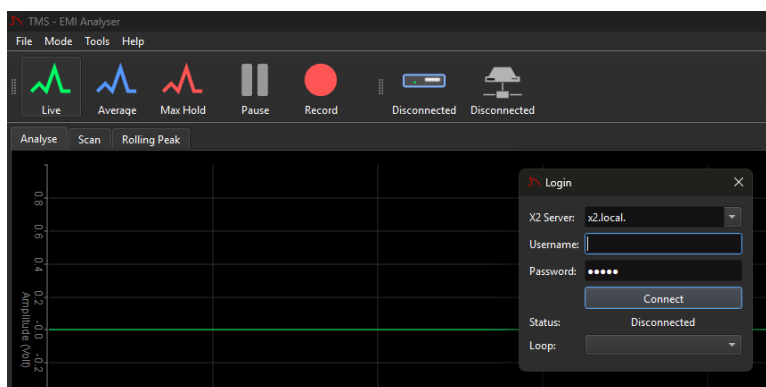
To replay EMI measurement, at startup choose ‘Open File’ instead of connecting to the Receptor or open the .emi file from the ‘File’ menu and choose ‘Open’.



Scan Mode

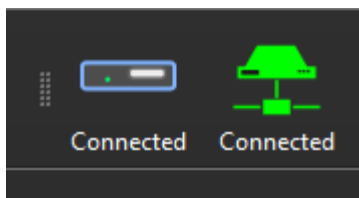
Scan mode is mostly used by federations to do constant 'dynamic' tests on track. The application connects to the Receptor to get the scans and connects to the MYLAPS X2 server to get the Transponder timestamps. Connect to the MYLAPS X2 Server by clicking on the Server/Network icon.

Configure the right X2 Server, user credentials and choose the loop that is connected to the Receptor.



The Receptor is equipped with a GPS receiver to synchronise in time with the X2 Server. To start scanning for noise coming from a competitor switch to Scan mode by clicking the TAB 'Scan' in the upper left corner.

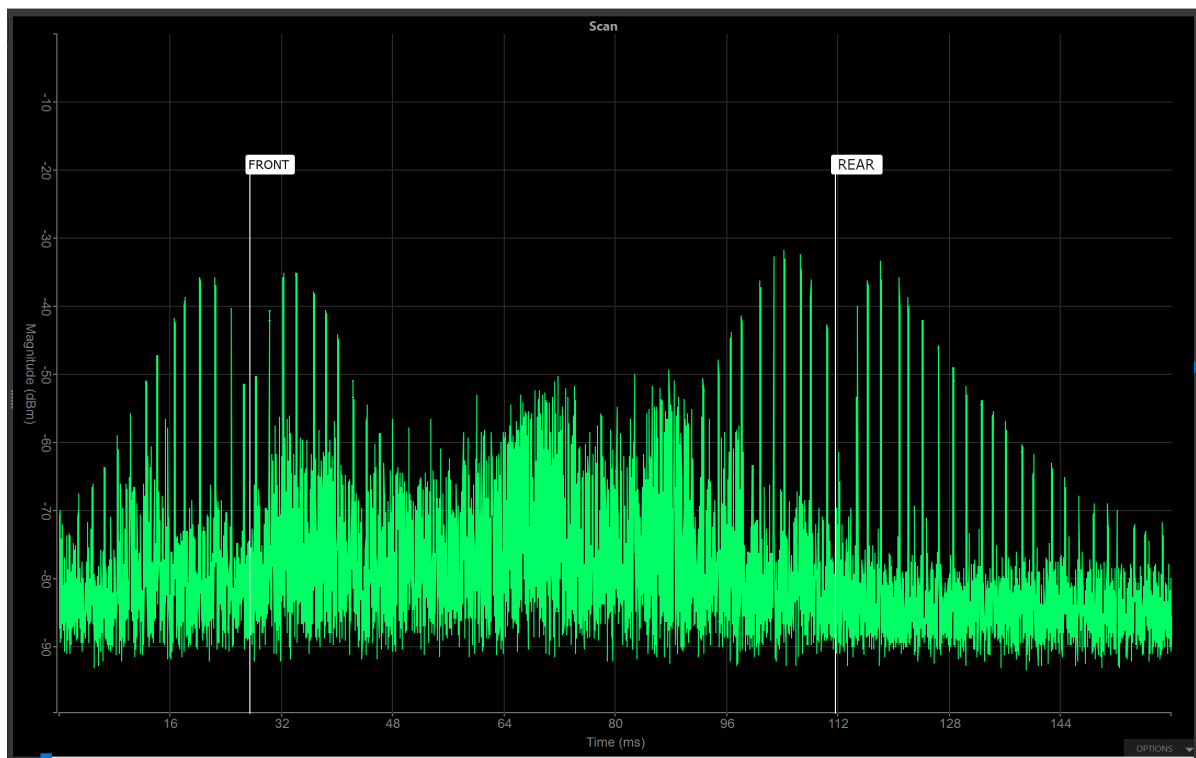
Make sure both the Receptor and X2 Server are connected before starting the Scans.



In Scan mode the EMI Application will show real time signal information.

A time base will be shown. This mode is especially useful in finding the location of radiated emissions coming from a car using its hybrid system at full power. As layout of cables and structural design of the car influences the way radiated emissions is generated these scans are very useful to analyze changes made to the car design.

To capture the scans a trigger level can be set at the lower left corner of the screen. Each time a signal with a magnitude above the trigger level is received, the analyser will save a scan.



Screenshot 6. Scan mode

Above screenshot 6 shows an example of a hybrid racing car with a front and rear Transponder passing a loop antenna.

Set the signal level trigger level for each scan with help of the slider vertical slider on the right.

The horizontal slider can be used optional to shift the trigger moment in time.



Loop Antenna

Connect the Receptor input with a 75ohm coax cable to a standard loop antenna of 60cm width. The track position of the loop should be at a location where it is expected that the power unit will use its electrical (MGU) system.

Dynamic EMI Source Finding

Typical workflow searching for EMI source(s) with help of the scan mode

- Connect the TMS Receptor with a coax cable to a track loop
- Make sure the Receptor has good GNSS reception with an external GNSS antenna
- Start the EMI Analyser application
- Connect to the TMS Receptor
- Connect to a MYLAPS X2 Server if available (synchronize with Transponder signals)
- Switch to the scan tab
- Set the signal trigger level above the average noise level received in order to avoid false triggers
- Make sure passings are captured when there is track activity
- Save all passings to file

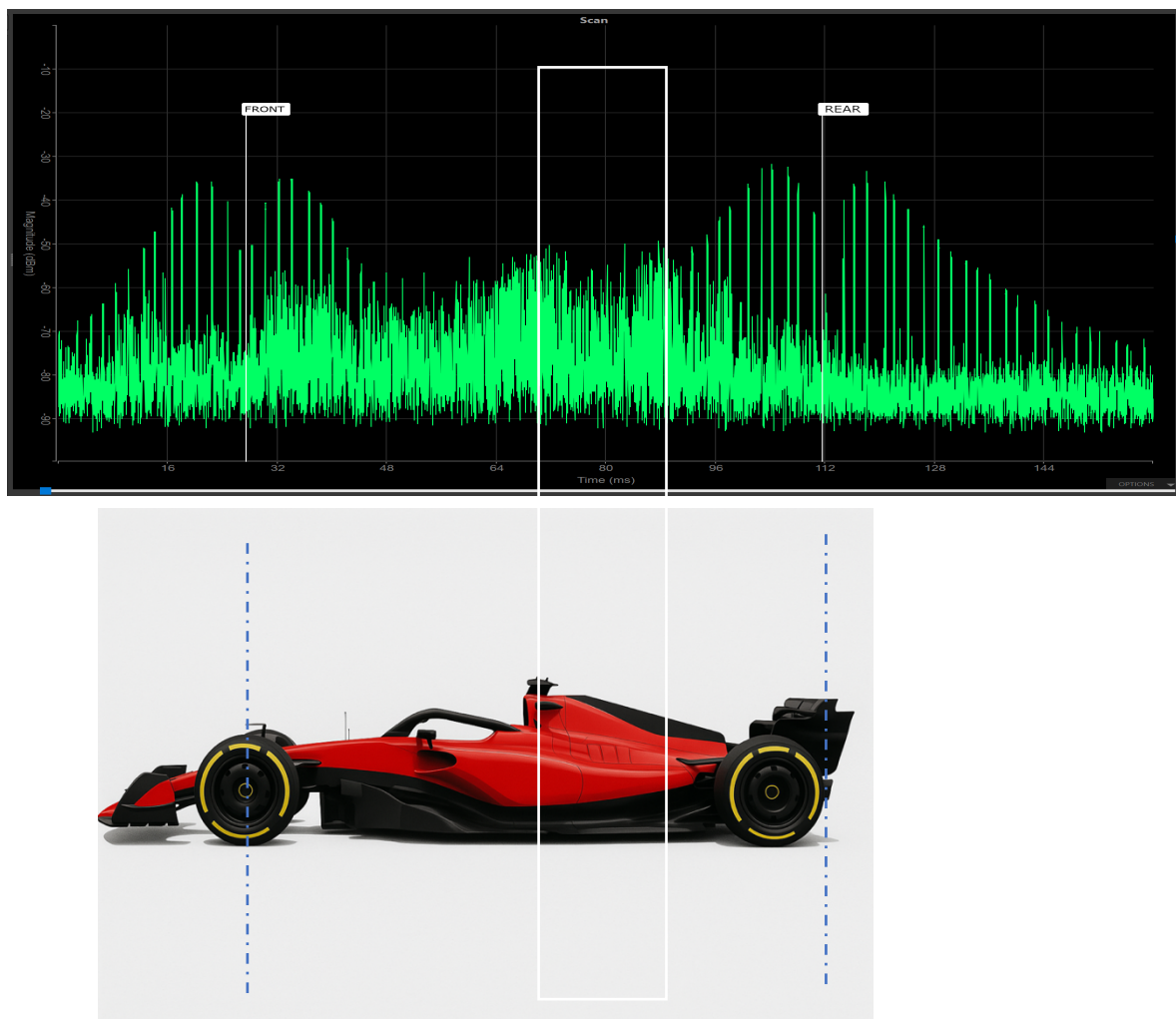
A timeboxed frame of scans can be exported to a file location with help of the exporter tool in order to distribute the information.

The scans can be useful to determine where EMI sources are physically located.

This is best described in the below example picture.

As the transponders are timestamped in the scan the transponder location on the car can be synchronized to these timestamps.

In the below example the higher noise (dens green signals) seem to be coming from the middle of the car.



Replay EMI scans

All scans can be retrieved and reviewed by opening the saved scans file from the file menu.

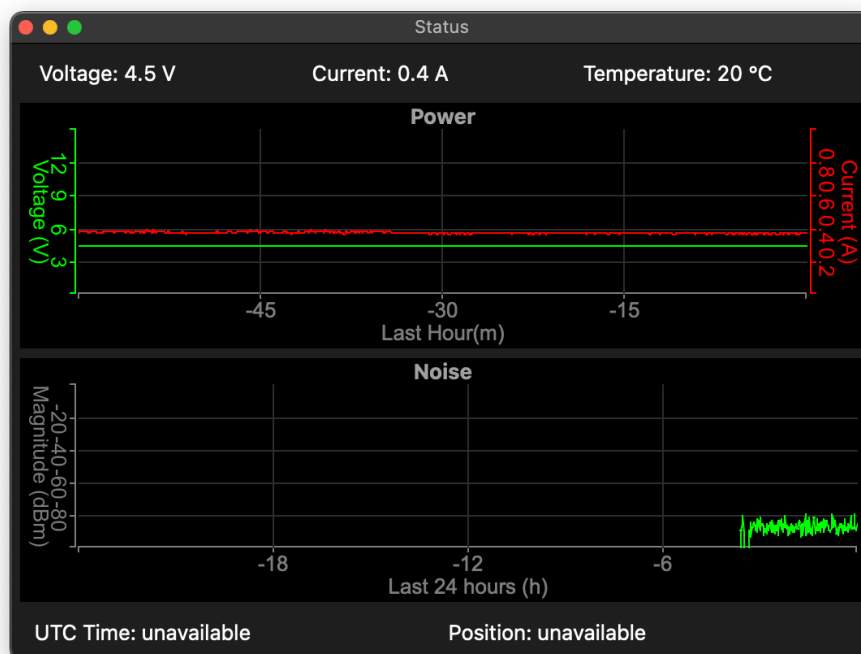
Rolling Peak Mode

In Rolling Peak mode, the Receptor stores all measurements into internal non-volatile memory when powered. The Rolling Peak mode can be used to determine signal signatures coming from a Transponder. This kind of measurements require a Timing Transponder specialist to analyze issues with Transponder installations.



Diagnostics

When a Receptor is connected, the voltage and current can be monitored by clicking the status bar showing the connected device name. This will show two graphs with the voltage and current from the last hour.

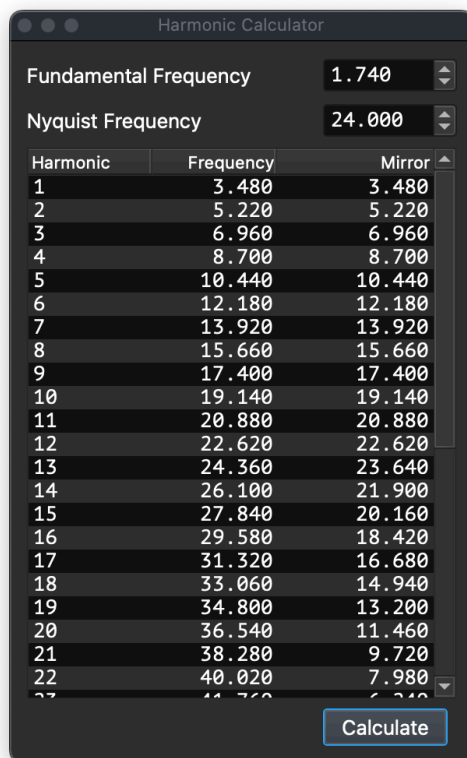


Screenshot 9. Device status



Tools

Harmonic Calculator

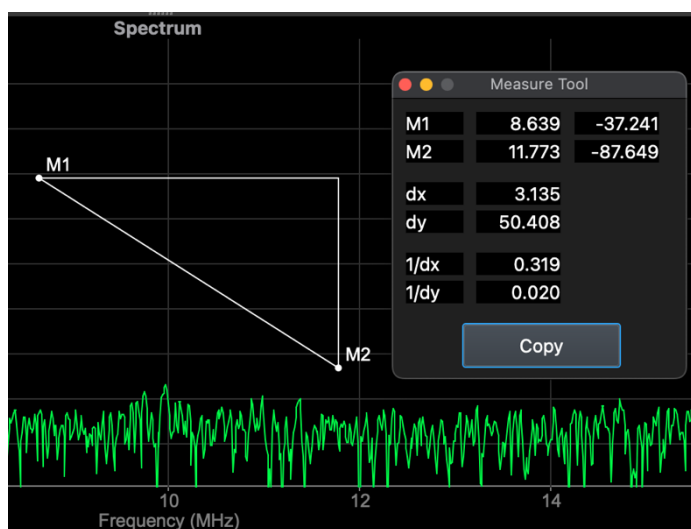


Screenshot 10. Harmonic Calculator

Select from the menu bar: Tools → Harmonics Calculator

The Harmonic Calculator can be used to find the fundamental frequency of a signal by calculating the harmonics.

Measure Tool

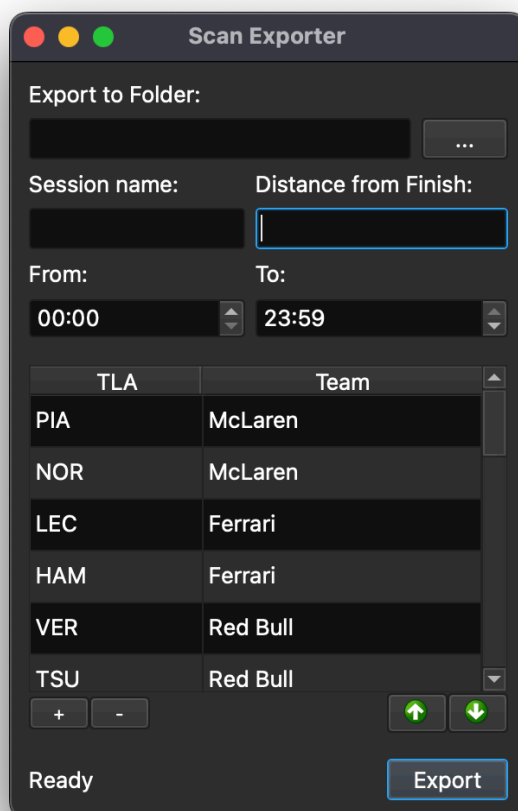


Screenshot 11. Measurement tool



The Measure Tool is available in every graph. Left click in the graph will add a measure point to the graph and the Measure Tool Dialog will appear. The second left click will add another measure point. The distance between the two measure points (delta X and delta Y) are calculated. A third left click will hide the Measure Tool.

Exporter Tool



Select from the menu bar: Tools → Exporter

The Exporter can be used to distribute scans to teams by assigning a TLA and team to a Transponder number and specifying the folder to export the data to.

Save Graph

Each graph can be saved as an PNG image. Select Options at the right bottom of the graph and then select Save...



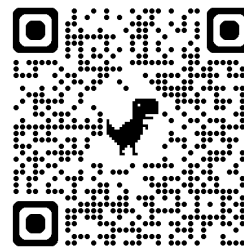
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