

**Application Note: TBMR-110M Mains Harmonics Analyzer App**

## 1. Introduction

IEC / EN 61000-3-2 specifies limits for mains harmonics generated by mains-supplied electrical / electronic equipment in the frequency range of up to 20 kHz.

The standard establishes four classes of equipment, each with their own harmonic emission limits: Class B for portable tools; Class C for lighting equipment, including dimmers; Class D for industrial and consumer equipment containing switched mode power supplies or VFDs, such for example IT and multimedia equipment and similar with a power consumption between 75W and 600W; Class A for everything else, particularly balanced 3-phase equipment.

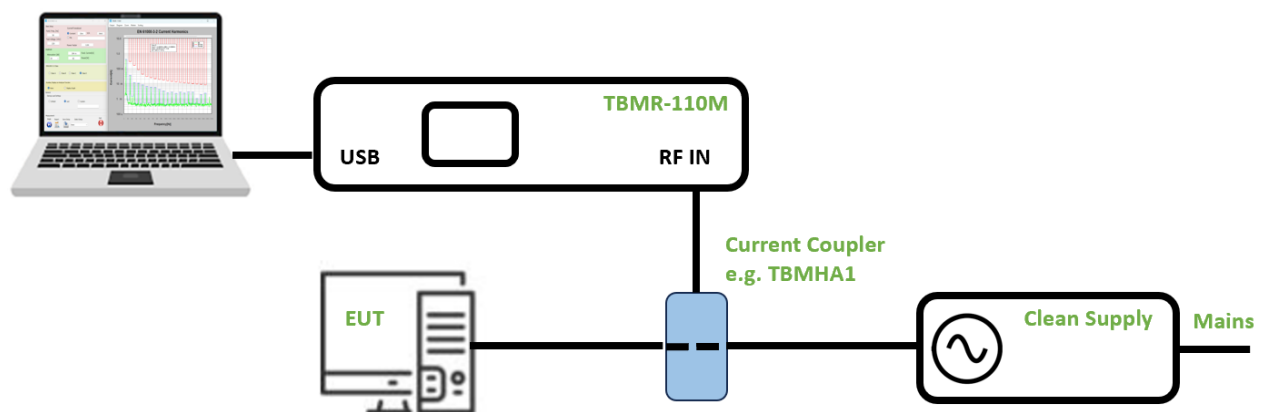
Given the TBMR-110M measurement receiver's low frequency measurement capabilities, it makes sense to also use it for mains harmonics measurement. The latest software, V1.5, now includes a Mains Harmonics Analysis Application.

IEC / EN 61000-3-2 limits are calculated based on the real power consumption of the Equipment Under Test. Consequently, supply voltage and the phase of the RMS supply current needs to be known.

In contrast to special mains harmonics analyzers, the TBMR-110M has only one measurement channel and hence cannot measure the phase of the mains current. This shortcoming can be overcome by utilizing an external power meter to measure or compute the power factor. The TBMR-110M application, in combination with an external current coupler, measures the RMS mains current for all relevant harmonics. The limits are then computed using the PFC input entered into the app and the measured RMS value of the fundamental mains current.

The current transducer factor is entered according to the characteristics of the current coupler and the PFC is entered based on the measurements taken with an external power meter.

## 2. Mains harmonics measurement setup



*Principle setup*

Harmonic currents are measured using a suitable current coupler. The current coupler might be a current probe, a current shunt with a differential isolation amplifier, or a current coupler like the Tekbox TBMHA1 mains harmonics adapter. The TBMHA1 is based on a REO WKO/CL-P25 compensated current transformer, which has a 25 A measurement range and a current output. Terminated with 50 Ohm, the TBMHA1 has a transducer factor of 50 mV/A.

Because the mains supply may contain harmonics that interfere with the measurement, a "clean supply" is advised. Quality AC power supplies, such as the Kikusui PCR2000MA or similar products, provide a spectrally pure supply voltage for the equipment being tested.

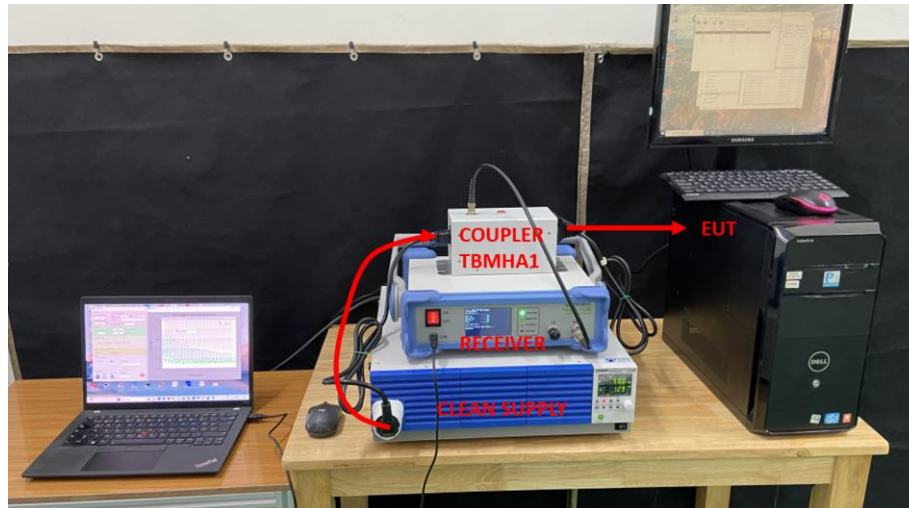
The PCR2000MA measures max. current, RMS current and real power. This allows calculation of the power factor correction, which is then entered into the mains harmonics app of the measurement receiver to compute the limit lines.

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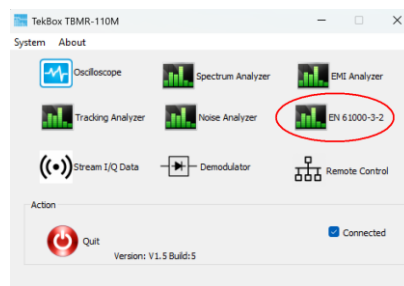
### 3. Measurement example

The mains harmonics of a personal computer shall be measured. The photo below shows the setup.

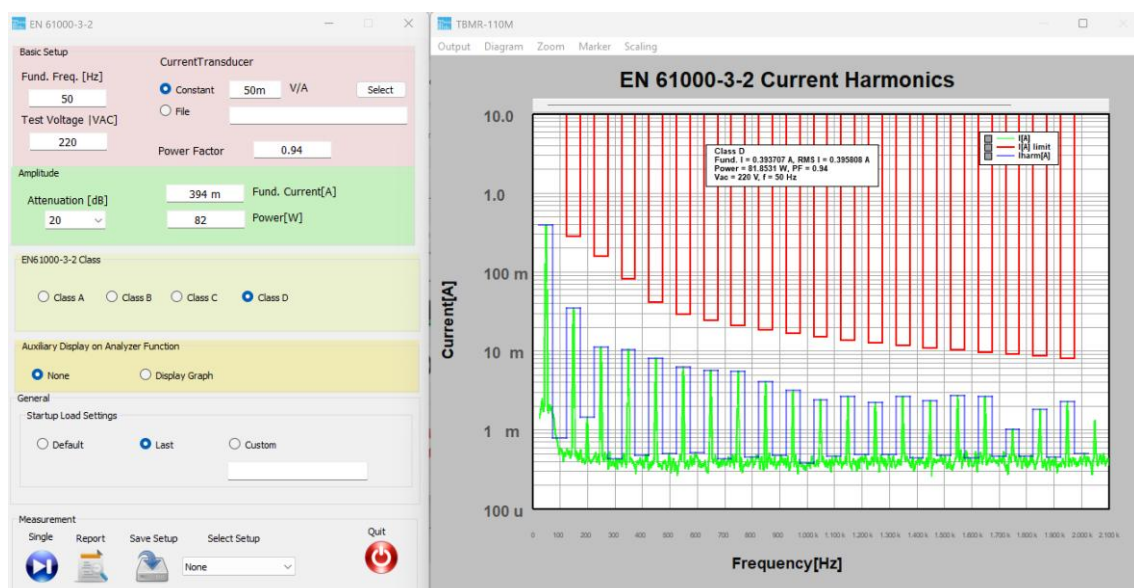


lab setup

Start the TBMR-100M software and select the mains harmonics application:



Enter the Basic Setup parameters and power on the EUT. Read the RMS current and real power consumption from the AC power supply display and calculate the power factor. Enter the power factor parameter into the App. Select EN 61000-3-2 class D, 20 dB attenuation and press the measurement button.



### Measurement result

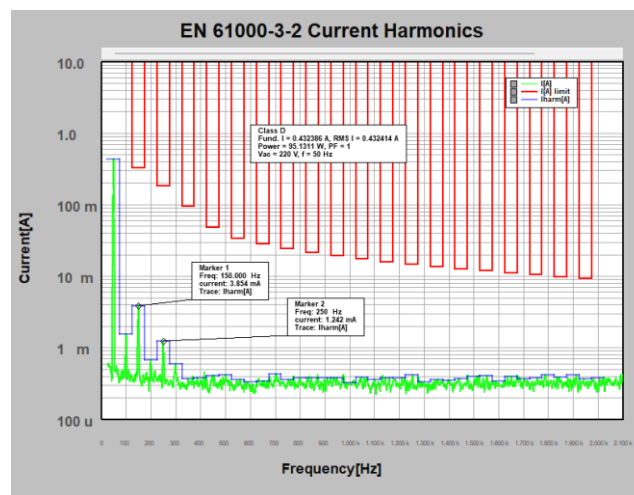
## 4. Clean supply

EN 61000-3-2 specifies following requirement for the supply source:

The harmonic ratios of the test voltage shall not exceed the following values with the EUT connected as in normal operation:

- 0,9 % for harmonic of order 3;
- 0,4 % for harmonic of order 5;
- 0,3 % for harmonic of order 7;
- 0,2 % for harmonic of order 9;
- 0,2 % for even harmonics of order from 2 to 10;
- 0,1 % for harmonics of order from 11 to 40.

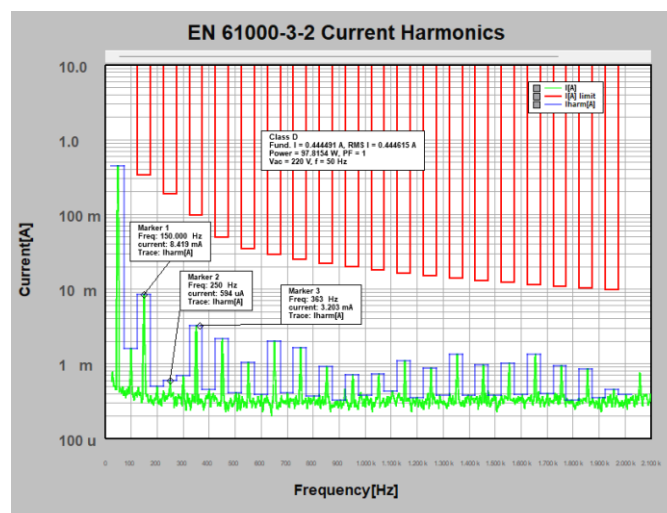
The harmonic content of the supply source can be measured by using a rheostat as load. The screenshot below shows the result of the Kikusui PCR2000MA AC power supply loaded with a rheostat. The power is set to 95W.



PCR2000MA source harmonics measurement

The first harmonic current value is 0.4324 mA RMS. The third harmonic's amplitude is 3.854 mA RMS (0.89%), whereas the fifth harmonic's amplitude is 1.242 mA RMS (2.8%). This proves that the PCR2000MA meets the requirements for EN 61000-3-2 supply sources under the conditions of the measurement setup.

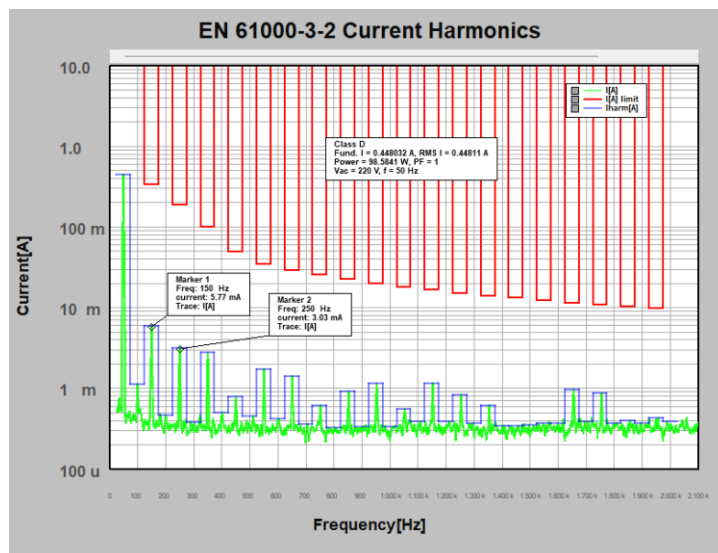
Some sources suggest using isolation transformers as alternative source for pre-compliance measurements. The screenshot below shows the measurement result with the AC power supply replaced by an isolation transformer. The measurement took place during working hours at a factory.



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*Isolation transformer source harmonics measurement, factory environment, working hours*

A second measurement was carried out after working hours:



*Isolation transformer source harmonics measurement, factory environment, after working hours*

The harmonic currents decreased compared to the previous test, but they do not fulfill the standard's requirements. Nonetheless, the results are not representative of any mains supply, therefore checking the mains with a resistive load is useful.

Version	Date	Author	Changes
V 1.0	30.11.2025	Mayerhofer	Creation of the document