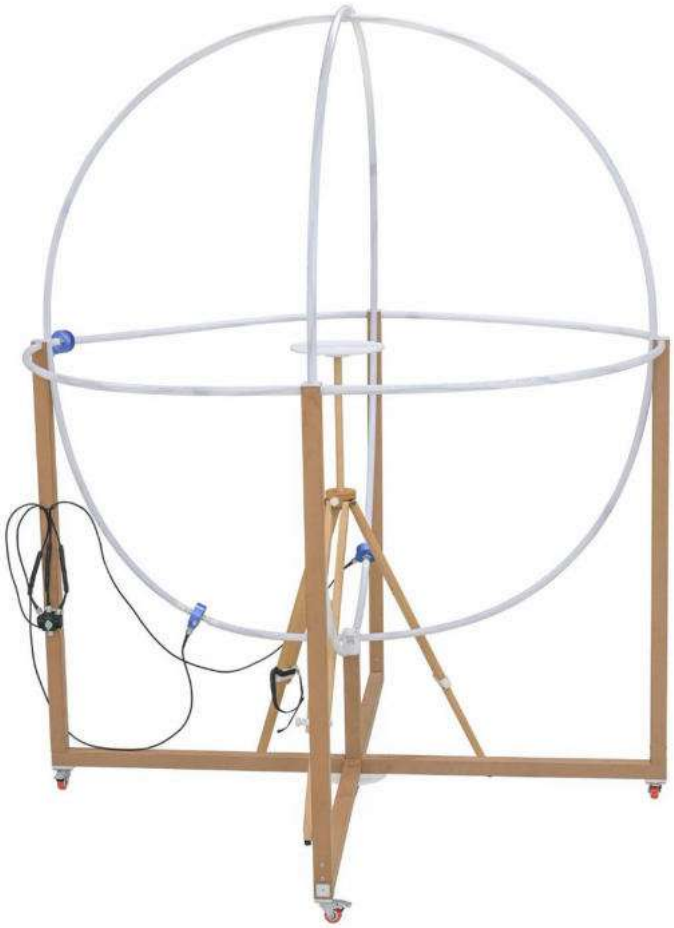
9 KHz – 30 MHz Large Loop Antenna

1. Introduction

The TBLLA-2M is a large loop antenna (LLA) with three orthogonal loops, as required by CISPR 16-1-4 and CISPR 15 / EN 55015.

The LLA is used to measure the current induced by the magnetic field emitted by luminaries. Section 4.4 of EN 55015 specifies the test setup and measuring procedures.



The TBLLA-2M consists of three perpendicular 2-meter diameter loop antennas on three orthogonal planes (X/Y/Z), set on lightweight hollow WPC frames with a total height of 2.5m. The loops' lowest point is 0.5m above ground. Each loop element receives magnetic field radiation normal to the containing plane and generates a voltage signal proportionate to the strength of the H-field radiation at the output port of the RF transducer connected to the loop.
The TBLLA-2M is equipped with three TekBox TBCCP1-2K70 coaxial RF current monitoring probes (transducers), with a flat transfer impedance of 0 dBΩ (1V/A) from 9 kHz to 30 MHz when loaded with 50Ω. The kit comprises all required coaxial cables, ferrite clamps, a manual RF coaxial switch to select loops, and a TBTP3 tripod with a plastic DUT support plate.
A calibration dipole with support structure is available as optional accessory.

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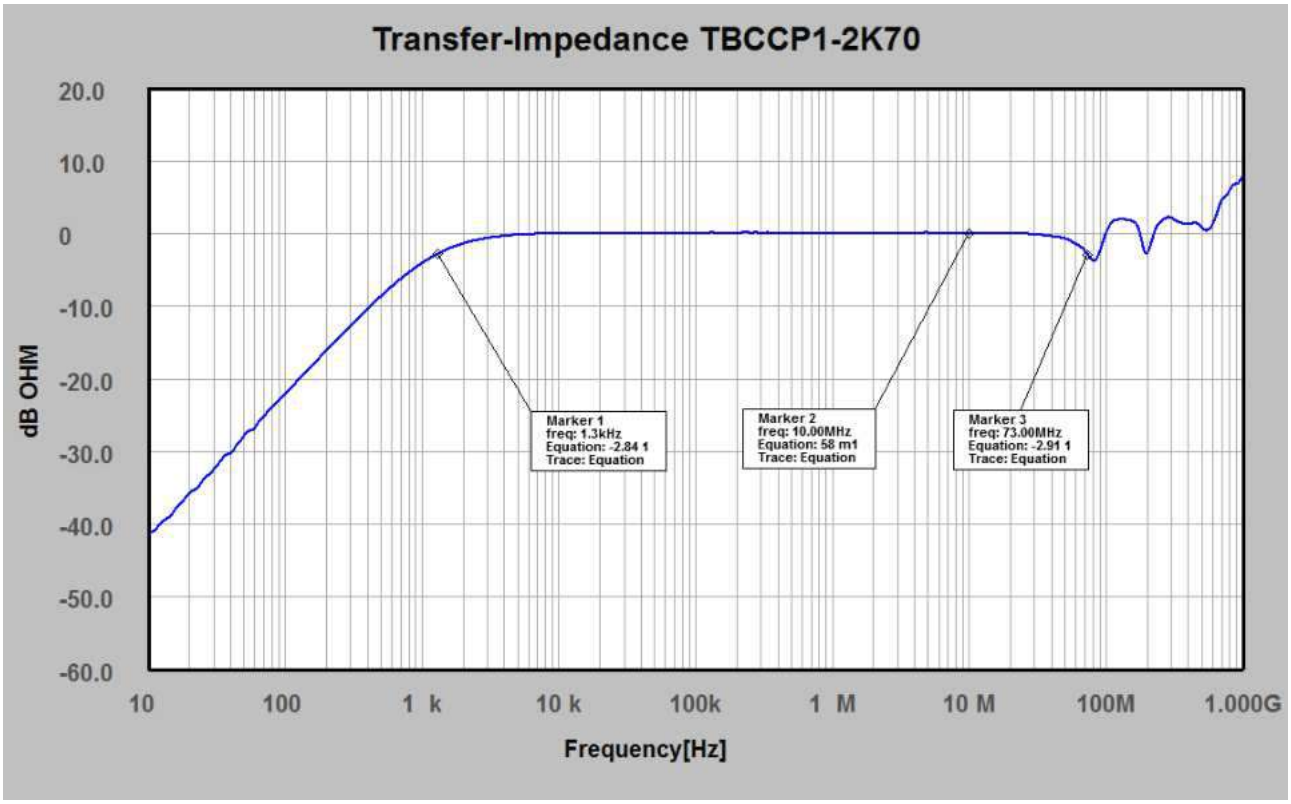
2. Technical specifications

Type	Large Loop Antenna (triple loop)
Frequency range	9 kHz– 30 MHz
Standards	CISPR 16-1-4, CISPR 15
Loops	3 perpendicular loops with 2m diameter
Loop construction	RG223U sections with over-molded slits inside PEX tube
RF transducer transfer impedance	typical 0 dBΩ ; 1V/A @ 9kHz to 30 MHz
RF transducer output connector	N-female, 50 Ω
Antenna validation factor	within ±2 dB compared to the theoretical validation factor for 2m diameter LLA given in CISPR 16-1-4
Effective antenna correction factor	0 dB
CM resistance of the ferrite absorbers	> 200 Ω @ 10 MHz
Mechanical Dimensions	L x W x H: 2062 mm x 2062 mm x 2547 mm (81.2” x 81.2” x 100”)
Weight	25 kg (55.12 lbs)



Transducer transfer impedance

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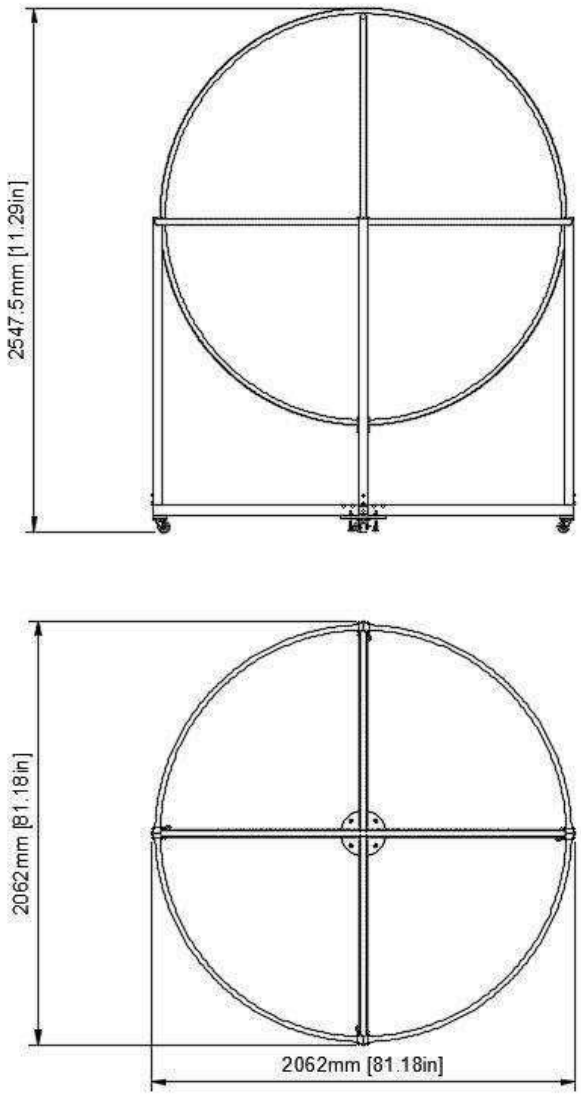

Outer dimensions

3. Antenna validation factor

The validation of the large loop antenna is performed by measuring the amount of induced current in each of those three large loops inside the system by means of connecting the calibration dipole to the RF-output of a 50Ω RF signal generator. The magnetic field radiated by the calibration dipole allows verification of the magnetic field sensitivity of the large loop antenna.
The induced current shall be measured as a function of frequency in the range of 9 KHz to 30 MHz at eight positions of the calibration dipole shown in figure C.7 of CISPR-16-1-4 standard, at least for following frequency points:
9 kHz, 100 kHz, 1 MHz, 2 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz, 25 MHz, and 30 MHz.

For each of the eight positions, the calibration dipole is in the plane of the loop under test, resulting into 24 sets of measurements for the entire antenna.
The measurement results of the 8 positions per plane and frequency point are averaged, resulting in 3 values per frequency.

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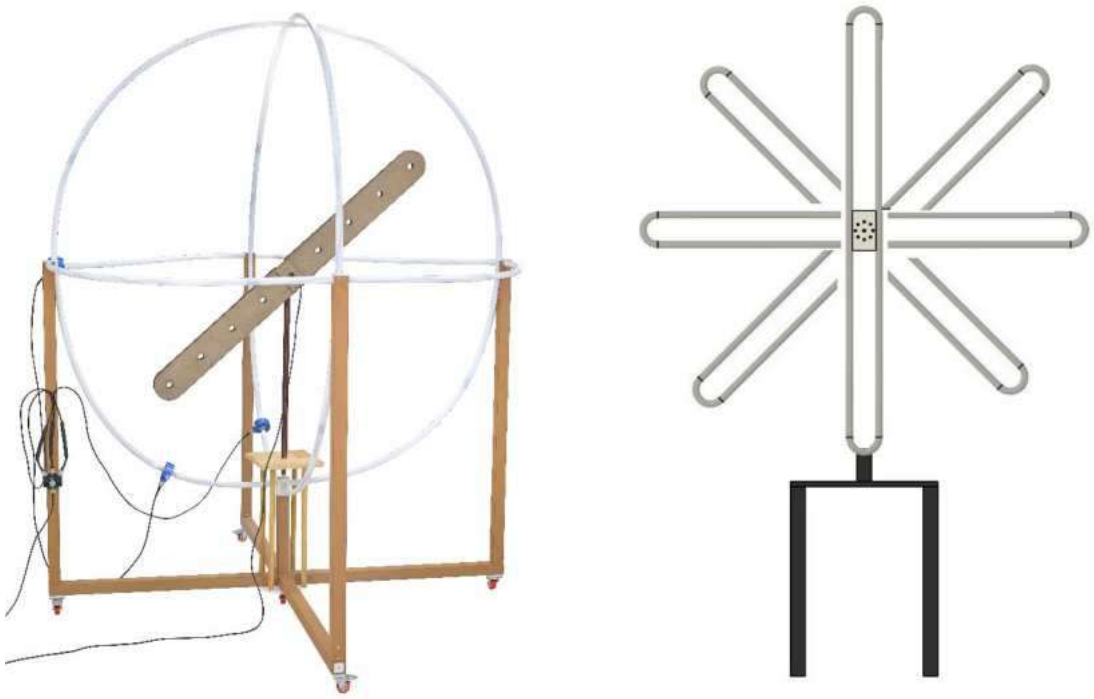

TBLLA-2M with calibration dipole TBLLA-CDP

The measured validation factor in each of the eight positions is given in dBΩ as 20log(V_{GO}/I1), where V_{GO} is the open circuit voltage of the RF generator output and I1 is the measured loop current.

If the antenna calibration results fall within ±2 dB of the theoretical validation factor of the CISPR 16-1-4 standard across the antenna frequency range, then the effective antenna factor can be considered to be zero.

Applying the antenna correction factor converts the measured voltage at the transducer output (in dBµV) to a current value (in dBµA) that represents the current flowing through the loop (I1). This current is considered as the level of radiated disturbance. The radiated disturbance level is then compared against the radiated emissions limits of CISPR 15 standard. Below the equation used for calculating the radiated disturbance level:

Radiated Disturbance Level (loop current) = Measured Voltage + Antenna Correction Factor
(in dBuA) (in dBuV) (in dB)

The TBLLA-2M antenna correction factor is within ±2 dB compared to the theoretical validation factor of the CISPR 16-1-4 standard. Consequently, the measured output voltage does not need to be corrected and represents the radiated disturbance level, which is compared against CISPR15 radiated emissions limits.

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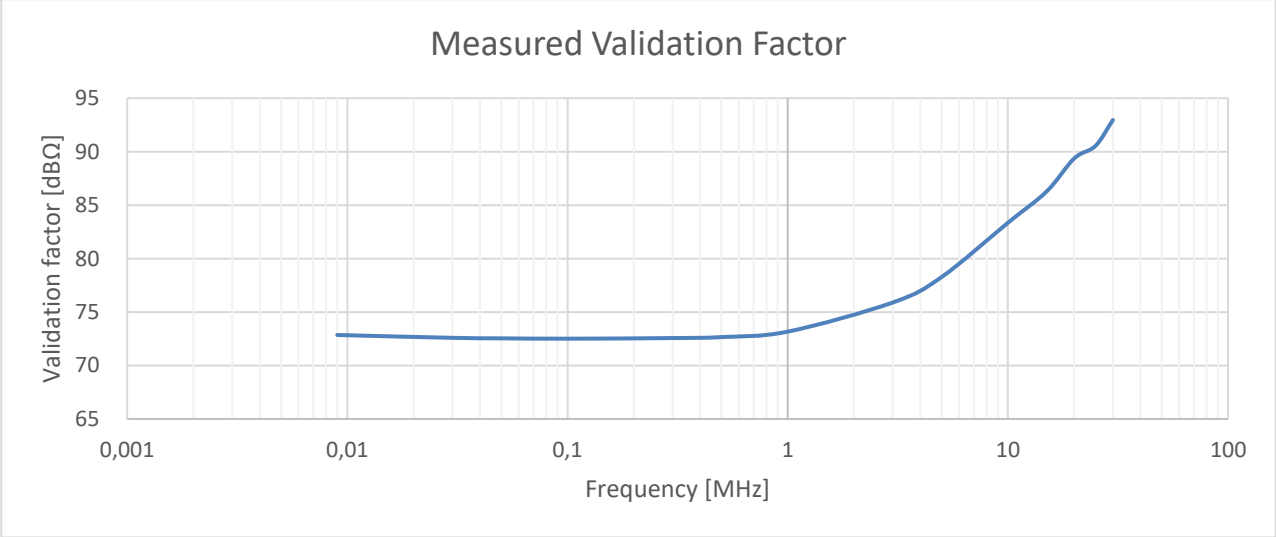
4. TBLLA-2M Antenna Validation Factor

Frequency (MHz)	Validation Measurement Values					CISPR 16-1-4 Validation Factor (dBΩ)	Antenna Correction Factor (dB)
	X-axis (dBΩ)	Y-axis (dBΩ)	Z-axis (dBΩ)	Maximum Deviation from Average (dB)	Average X/Y/Z Values (dBΩ)		
0.009	72,89	72,72	72,95	0,13	72,85	74	-1,15
0.01	72,85	72,71	72,93	0,12	72,83	74	-1,17
0.03	72,61	72,43	72,72	0,16	72,59	73.8	-1,21
0.05	72,58	72,39	72,65	0,15	72,54	73.8	-1,26
0.1	72,56	72,35	72,61	0,16	72,51	73.8	-1,29
0.3	72,63	72,41	72,66	0,16	72,57	73.9	-1,33
0.5	72,74	72,49	72,74	0,17	72,66	74	-1,34
1	73,19	73,06	73,25	0,11	73,17	74.3	-1,13
3	75,95	75,74	75,98	0,15	75,89	76.2	-0,31
5	78,34	78,09	78,38	0,18	78,27	78.7	-0,43
10	83,41	83,17	83,45	0,17	83,34	83.5	-0,16
15	86,34	86,11	86,38	0,17	86,28	86.5	-0,22
20	89,41	89,23	89,44	0,13	89,36	88.3	1,06
25	90,58	90,43	90,61	0,11	90,54	89.7	0,84
30	93,03	92,82	93,02	0,14	92,96	91.2	1,76

Typical Antenna Correction Factors Table



TBLLA-2M Validation Measurement, X/Y/Z average

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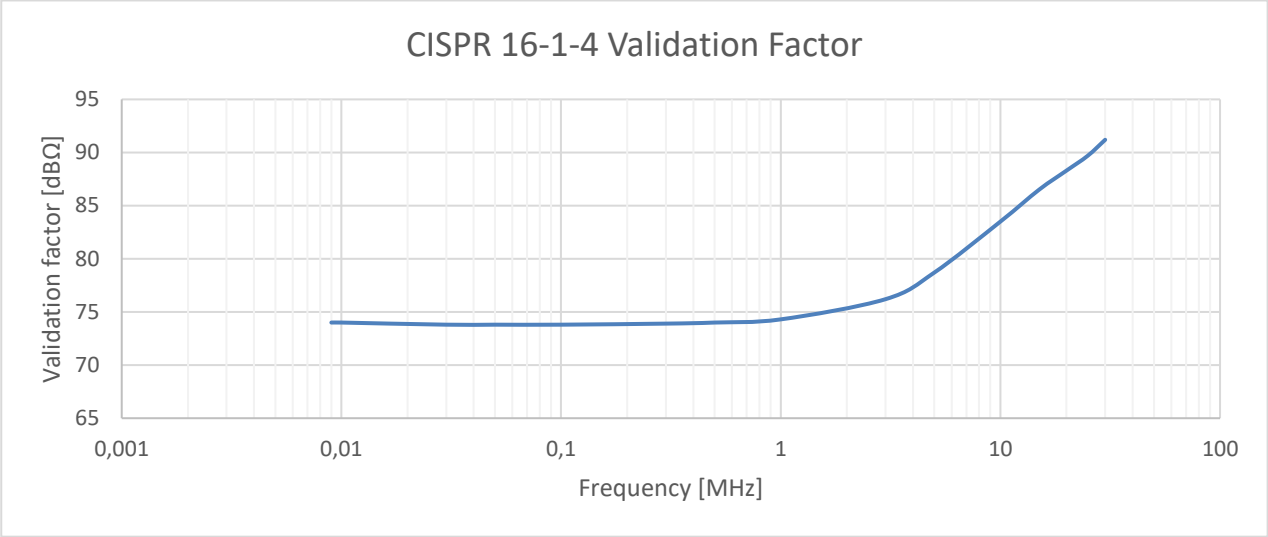
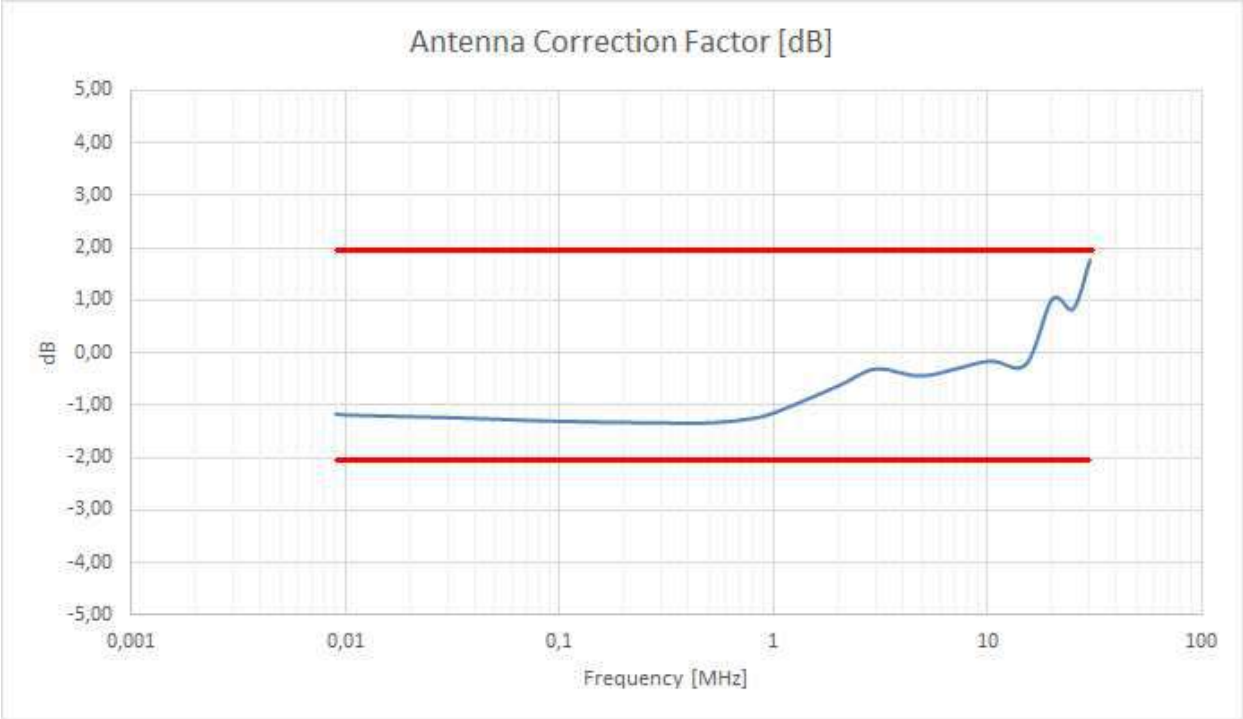


CISPR 16-1-4 Validation Factor



Deviation from CISPR 16-1-4 Validation Factor - antenna correction factor of TBLLA-2M

5. Calibration

The TBLLA-2M already comes with a factory calibration protocol. The optional calibration accessories including the calibration dipole, calibration dipole mounting structure and the interconnecting cables enable periodic re-calibration or validation of the performance, if required. The calibration process for obtaining the antenna validation factor and the antenna correction factor is based on the method explained in chapter C.4 of CISPR 16-1-4 standard.

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6. Ordering Information

Part Number	Description
TBLLA-2M	9 kHz – 30 MHz large loop antenna system with 2m diameter, TBTP3 wooden tripod, DUT plate, factory calibration report, assembly manual
TBLLA-CDP	Calibration dipole
TBLLA-CDP-SS	Support structure for calibration dipole

7. History

Version	Date	Author	Changes
V1.0	6.11.2024	Mayerhofer	Creation of the document