OPERATING MANUAL

LARGE LOOP ANTENNA SYSTEM (LLAS)

VVL 1530

REVISION LEVEL 2.2

GENERAL INFORMATION

The information contained herein, are provided in connection with the usage of AFJ VVL 1530 Large Loop Antenna System (LLAS) only.

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All efforts have been made to ensure the accuracy of the contents of this document. However, the supplier can assume no liability whatsoever for any errors in this manual or their consequences, direct and/or indirect.

STATEMENT OF COMPLIANCE

The AFJ VVL 1530 Large Loop antenna system (LLAS) is designed and manufactured compliant to CISPR 16-1-4 requirements for measurements of radiated electromagnetic disturbances from 9kHz to 30MHz. CISPR 15 (lighting equipment industry) and CISPR 14-1 (household appliances industry) product standards as well as others require this kind of measurements.

Applies to the emission (radiated and conducted) of radio frequency disturbances from: all lighting equipment with a primary function of generating and/or distributing light intended for illumination purposes, and intended either for connection to the low voltage electricity supply or for battery operation; the lighting part of multi-function equipment where one of the primary functions of this is illumination; independent auxiliaries exclusively for use with lighting equipment; UV and IR radiation appliances; neon advertising signs; street/flood lighting intended for outdoor use; transport lighting (installed in buses and trains)

WARRANTY

Systems, options and accessories thereof, manufactured and shipped under the AFJ Instruments brand name, are warranted to be free from manufacturing defects for a period of twelve (12) months from the date of shipment.

AFJ Instruments certifies that all products are tested and inspected to comply with the published specifications originating from the company. Calibration procedure includes Calculation of uncertainty using ISO model and traceability.

- Warranty is provided “Ex-Works”: therefore, AFJ Instruments will be responsible of the amendment of failures arising from ascertained manufacturing defects only.
- Warranty will not be applicable in case of mishandling, unauthorized opening of the cabinets, improper use, and unauthorized repairs. In such cases, the warranty will be terminated.
- A repair under warranty will not extend the original term of validity of the warranty itself.
- All products or parts thereof, to be subject to a warranty operation, shall be shipped to the appropriate AFJ Instruments Warranty Centre, at Customer’s charge.
- If a delivery back to the supplier is necessary we recommend keeping the original transport case. In such case, refer to the following Return Procedure.

Return Procedure

To return the VVL 1530 antenna to AFJ Instruments, use the following procedure:

- Briefly describe the problem in writing (Service Requested form). Include the serial number of the item being returned;
- Give details regarding the observed symptom(s), and whether the problem is constant or intermittent in nature. If you have talked previously to AFJ representative about the problem, provide such information also;
- Package the unit parts carefully, using the original boxes and packing materials, if possible. If not, use the most protective envelope at disposal (Damages due to transport are not covered from any guarantee);
- Before return the system back to AFJ, wait for RMA number (Returned Material Authorization).

DISCLAIMER OF LIABILITY

In no event shall AFJ Instruments be held liable for incidental or consequential damages of any kind whatsoever caused, or alleged to be caused directly or indirectly by the usage and operation of products herein, to customers or any third party, including, but not limited to, loss of use, loss of profit or any commercial loss.

Products described herein, do not imply any stated or alleged fitness for use, or any feasibility for business purpose, or expectation of profit. AFJ Instruments sole and only commitment is the compliance with the published product specifications.
All information in this manual is given in good faith. However, AFJ Instruments shall not be liable for any loss or damage whatsoever arising from the use of this manual, or any errors or omissions herein.

VVL 1530 – LARGE LOOP ANTENNA SYSTEM (LLAS)
OPERATING MANUAL

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SECTION A: GENERAL INFORMATION

The AFJ VVL 1530 Large Loop antenna system (LLAS) has been developed to meet the requirements of CISPR 15, Section 9.3.2, which refers to CISPR 16-1-4, Section 4.7.
This specifies the limits for magnetic field induced current for luminaries with lamp operating frequencies more than 100Hz.
Test set-up and measurement shall be conducted as required by CISPR 15, Section 9.3.2.

The AFJ VVL 1530 Large Loop antenna system (LLAS) has been developed to meet the requirements of CISPR 14-1, Section 4.3.2, which refers to CISPR 16-1-4, Section 4.7.
This specifies the limits for magnetic field induced current for induction cooking appliances and equipment using IPT (inductive power transfer).
Test set-up and measurement shall be conducted as required by CISPR 14-1, Section 5.3.2.

Construction of the VVL 1530 is as detailed in Annex C of CISPR 16-1-4.
VVL 1530 Large Loop antenna system (LLAS) is fully compliant with the standard and details of the validation procedure are included in this manual.

Fig.1: AFJ VVL 1530 Large Loop antenna system (LLAS) with AFJ CK 1530 calibration kit inside

The VVL 1530 is a complete 3-axis antenna with a switching unit to select each loop in turn. The loops are 2 metre in diameter with the lowest point 0,5 metre above ground and are fitted with specially designed current probes in fully screened housings.

The main framework is manufactured in wood with 25 mm diameter plastic tubing for the loops. When erected, a 2-metre Large Loop antenna system (LLAS) is a surprisingly large item: so, for ease of transportation and storage, the VVL 1530 is designed to be collapse down to subunit of convenient size.

When used with the AFJ software supplied with the FFT3000 EMI receivers, the software displays the CISPR 15 limits corrected for 2-meter loops.

A.1 EU standard EN 55015 (CISPR 15)

Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment.

SCOPE:
This standard applies to the conducted and radiated emission of electromagnetic frequency disturbances from:

- all lighting equipment with a primary function of generating and/or distributing light intended for illumination purposes, and intended either for connection to the low voltage electricity supply or for battery operation;
- the lighting part of multi-function equipment where one of the primary functions of this is illumination;
- independent auxiliaries exclusively for use with lighting equipment;
- UV and IR radiation appliances;
- neon advertising signs;
- street/flood lighting intended for outdoor use only;
- transport lighting (installed in buses, trains, etc.).

Excluded from the scope of this standard are:

- apparatus for which the electromagnetic compatibility requirements in the radio frequency range are explicitly formulated in other IEC or CISPR standards.
  Note - Examples are:
  - built-in lighting devices in other equipment, for example scale illumination or neon indicators;
  - photocopiers;
  - slide projectors.

EMISSION MEASUREMENTS

1. Radiated:

   Requires the use of a 'Large Loop Antenna System' (LLAS) to measure the level of RF energy radiated from the product into 'space'. Frequency range from 9kHz to 30MHz.

2. Conducted:

   The RF conducted back down the mains lead is measured preferably with a LISN (Line Impedance Stabilisation Network), or alternatively with a voltage probe if a LISN is not suitable. Frequency range from 9kHz to 30MHz.

SECTION B: PACKING LIST

On receipt of the AFJ VVL 1530, check the contents of the packages as per Fig. 2.

Fig. 2: Contents of the VVL 1530 packages

Identify each component and check for shortages.
See also list overleaf.

Qty	Item
	<u>VVL 1530</u>
N. 3	Large loops with current probes
N. 1	Wooden structure:
	N. 4 - Corner posts
	N. 4 - Base extensions
	N. 1 - Central pillar
N. 20	Cable ties
N. 1	Manual switch unit
N. 3	N - BNC cable fitted with ferrite absorbers
N. 1	VVL 1530 Calibration certificate
	<u>Optional accessories</u>
N. 1	Calibration kit (CK 1530):
	N. 1 - Calibration loop
	N. 1 - Support for calibration loop
	N. 2 - Wood stools (ES 1530)
N. 2	Wood stools (ES 1530)

SECTION C: ASSEMBLY

Herein below the main steps to assembly the AFJ VVL 1530.

1. Establish an appropriate area to erect the VVL 1530. This needs to be a clear area at least 4m square with a flat floor and a ceiling height of at least 3m.

2. In the centre of this area, set the central pillar as the sequence shown in Fig. 3.

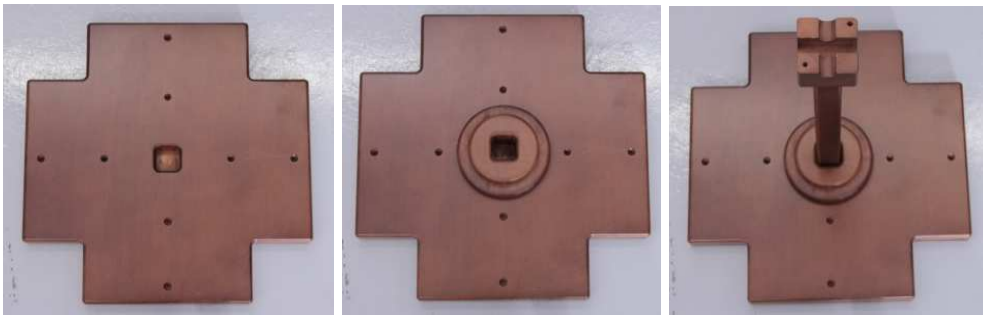


Fig. 3: Central pillar setting

3. Fit the base extensions as shown in Fig. 4.

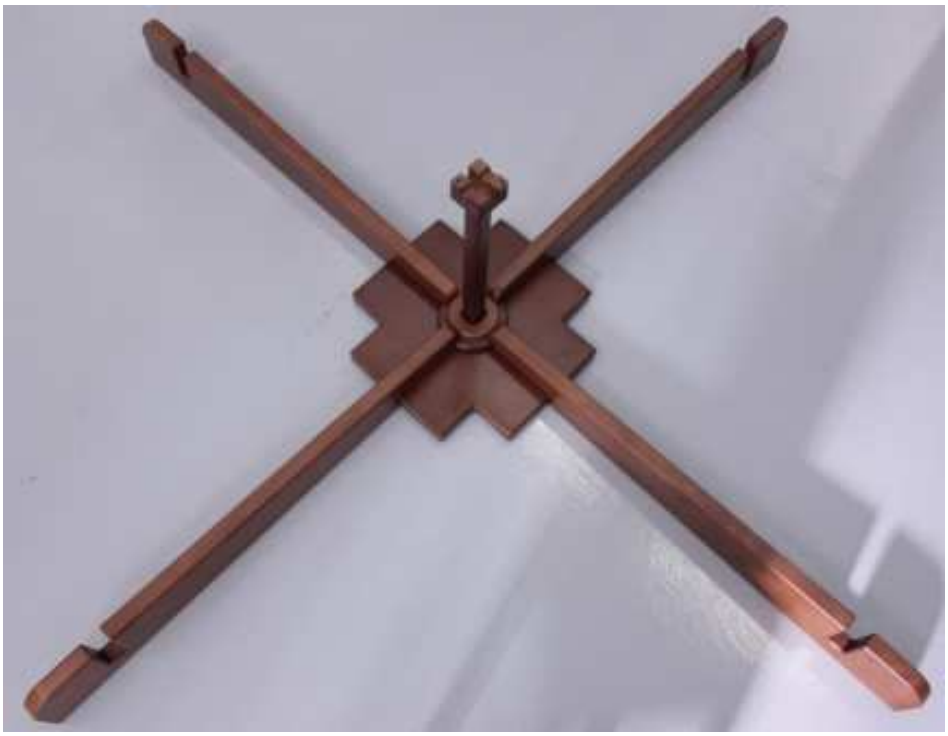


Fig. 4: Base assembly with set centre and base extensions

4. Slot the corner posts into the square hole at the end of each base as shown in Fig. 5.

Fig. 5: Corner posts setting

5. The 3 loops are delivered with current probes connected at one side. The connectors on each end of the loop are mated with the sockets for each current probe connection. Any loop and its current probe are indicated with X, Y and Z labels and stickers. See Fig. 6.

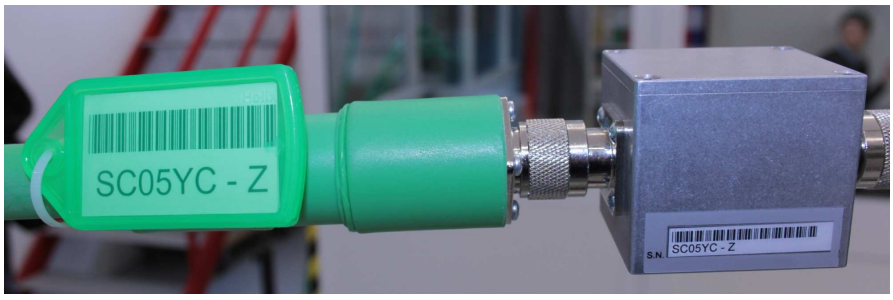


Fig. 6: Current probe connection

The first loop to mount is the horizontal loop. To mount the loops, at least two people are required. Mount the loop in the recesses at the top of each corner post with the current probe close to (within 5 cm) of a corner post. See Fig. 7. Slight 'drooping' of the loop between the posts has no effect on the performance of the antenna.

Fig. 7: Horizontal loop installation

6. The second loop is fitted inside the first (horizontal) loop, orientated so that it fits in the lower 'slot' in the central pillar and is held between the 'ears' on the corner posts as shown in Fig. 8. Arrange the loop so that the current probe is within 20 cm of the central pillar. For the moment, the loop will sag and generally not hold its shape. This will be resolved later.

Fig. 8: Second loop installation

7. The final loop is fitted INSIDE the other two as shown in Fig. 9. This fits in the upper slot in the central pillar, between the corner post ‘ears’ and under the other vertical loop at the top. Again arrange the loop so the current probe is close to the central pillar.

Fig. 9: Final loop installation

8. The loops can now be adjusted for best shape and position. The vertical loops shall be inserted into the guides on the top of the central pillar, which shall be closed fixing the cover according to the sequence with steps a, b, c and d shown in Fig. 10.

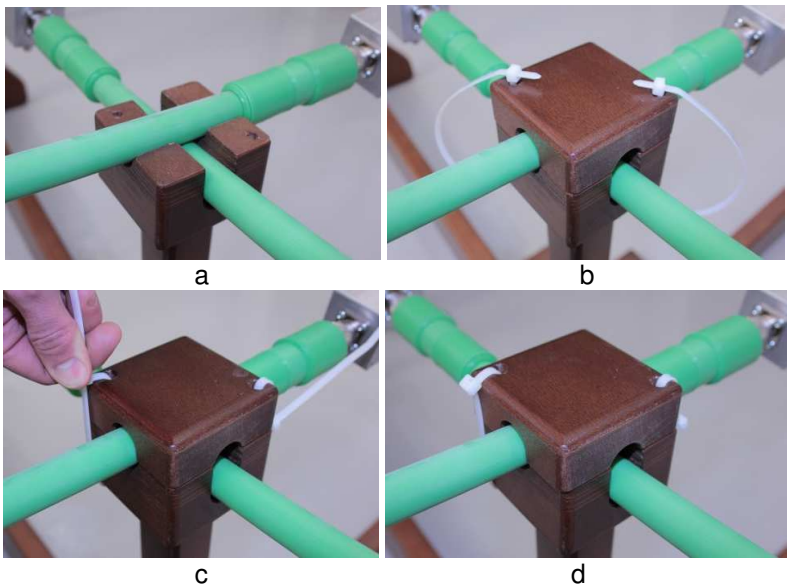


Fig. 10: Vertical loops and central pillar connection

The top of the vertical loops can be adjusted for best shape and position according to the sequence with steps a, b, c, d, e and f shown in Fig. 11.

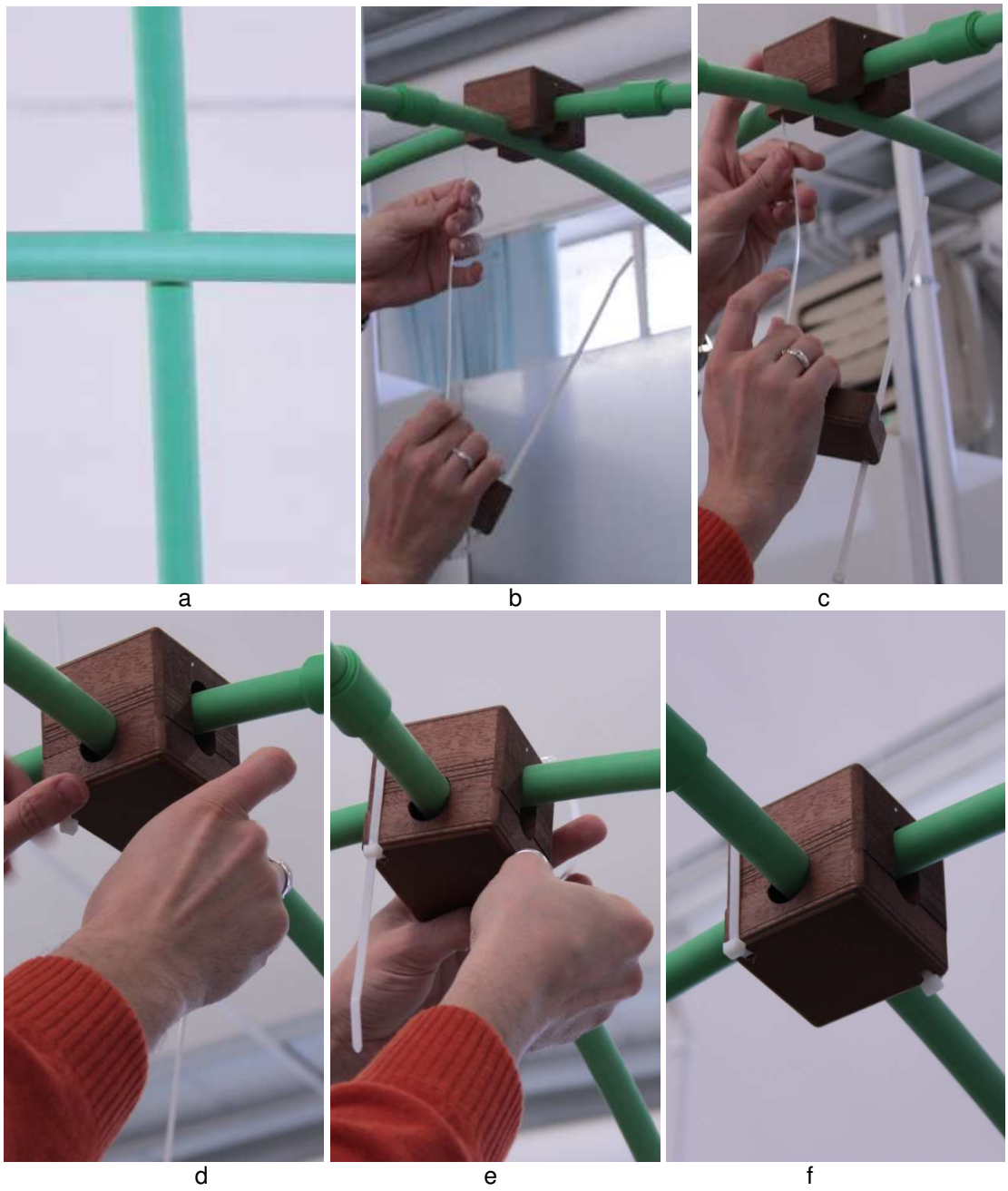


Fig. 11: Vertical loops top connection

Note that the exact shape is not critical. Deviation from perfect circles is inevitable but this has no significant effect on antenna performance.

9. Connect the current probes to the switch unit as shown in Fig. 12. The 3 current probe cables are identified by having thick RF absorber filters along their length. Fit the cables so that these filters are nearest to the switch unit, which is intended for mounting on the antenna itself, according to the picture below. The N connector output from the switch unit is connected directly to the analyser or receiver through cable at customer care.

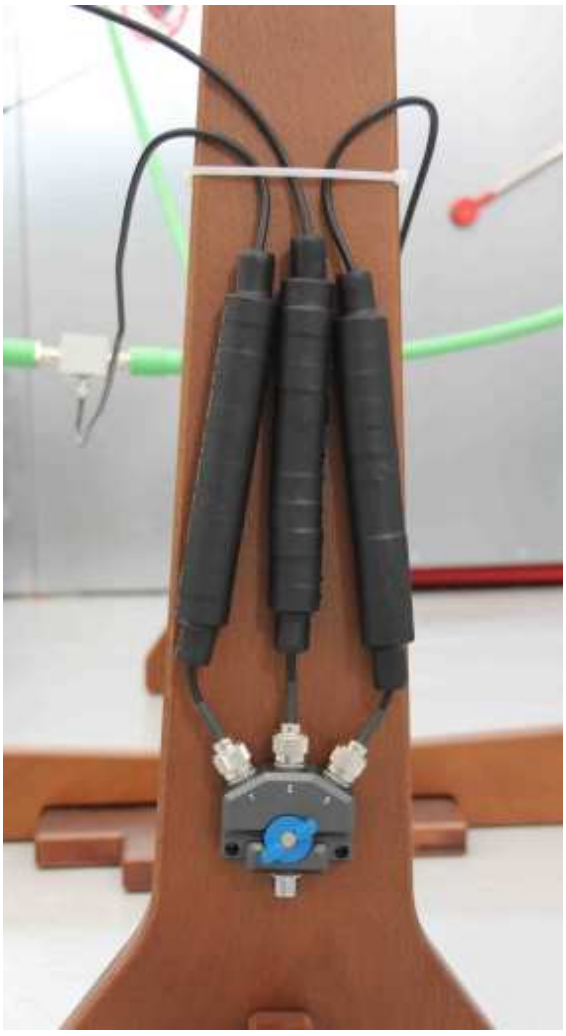
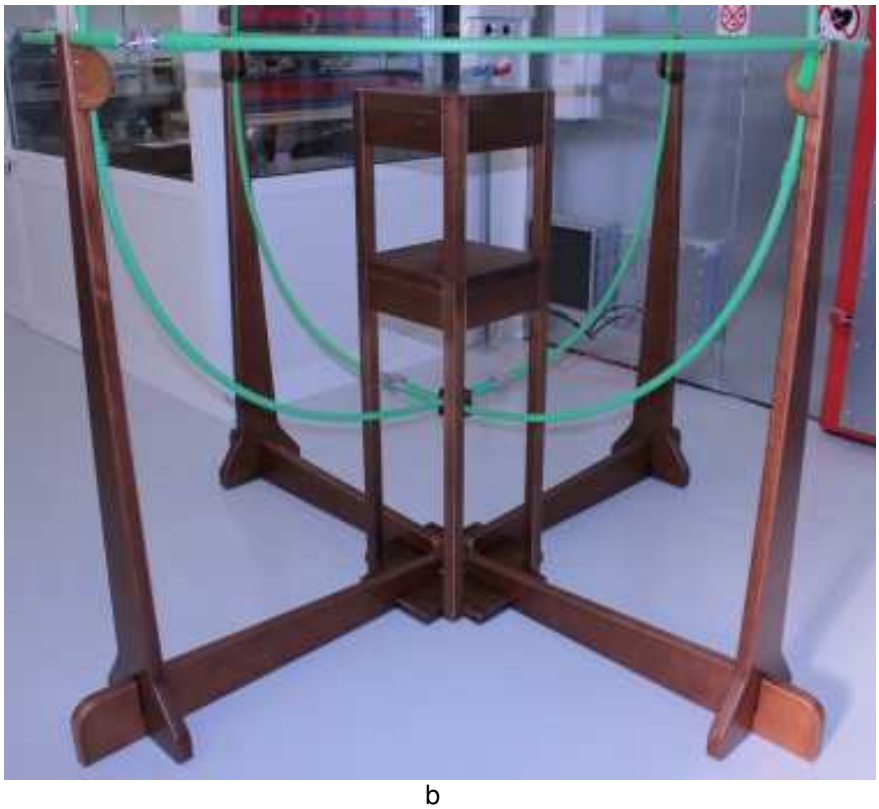


Fig. 12: Connections to switch unit

10. Within the loop a wooden stand or table can be used for EUT settings. AFJ ES 1530 is the optional available accessory for EUT supporting according to customer needs. Designed with two separated parts, it allows end user to set two different heights for EUT settings during measurements. See steps a and b in Fig. 13.

a



b

Fig. 13: AFJ ES 1530 EUT support settings

SECTION D: CALIBRATION LOOP

The AFJ CK 1530 calibration kit includes:

- calibration loop manufactured to comply with CISPR 16-1-4, Annex C;
- support for the calibration loop:
- AFJ ES 1530.

CISPR 16-1-4 asks for setting calibration loop in horizontal and vertical position.

To set calibration loop in horizontal position, ES 1530 shall be set within the loops as shown in Fig. 13 with its five holes aligned as shown in Fig. 14.

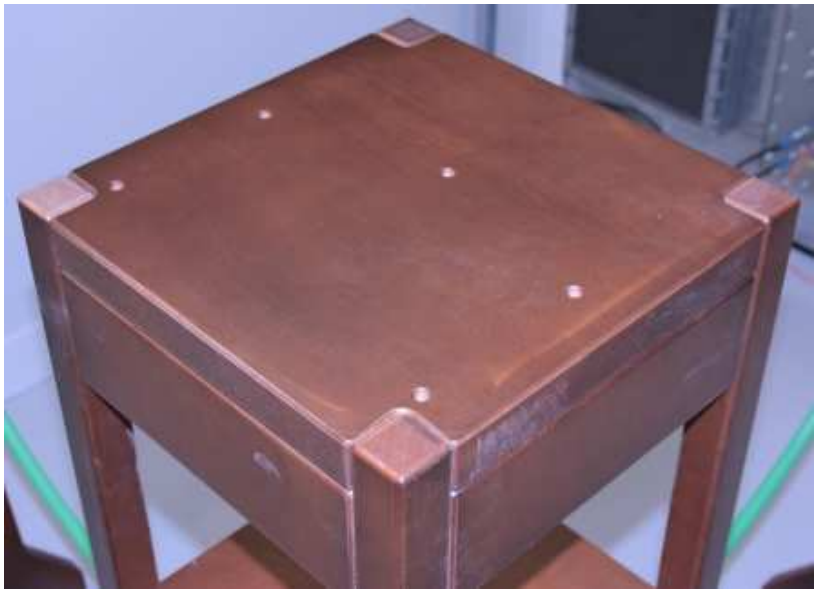


Fig. 14: ES 1530 alignment for calibration loop in horizontal position

Set the support for the calibration loop on ES 1530 as shown in Fig. 15.

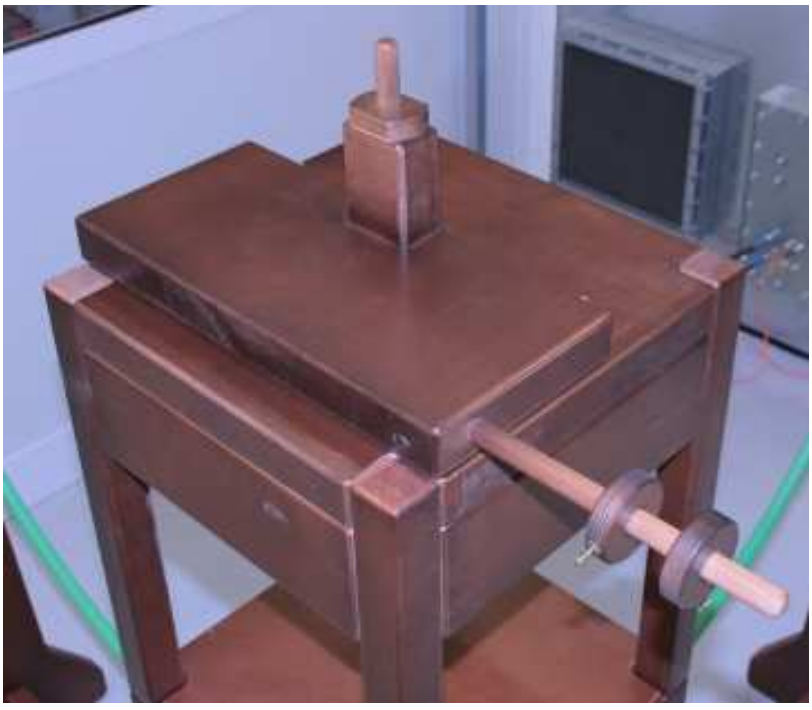


Fig. 15: Support setting for calibration loop in horizontal position

Install the calibration loop on its support as shown in Fig. 16.

Fig. 16: CS 1530 installation for calibration loop in horizontal position

To set calibration loop in vertical position, ES 1530 shall be set within the loops as shown in Fig. 17. with its five holes aligned as shown in Fig. 18.

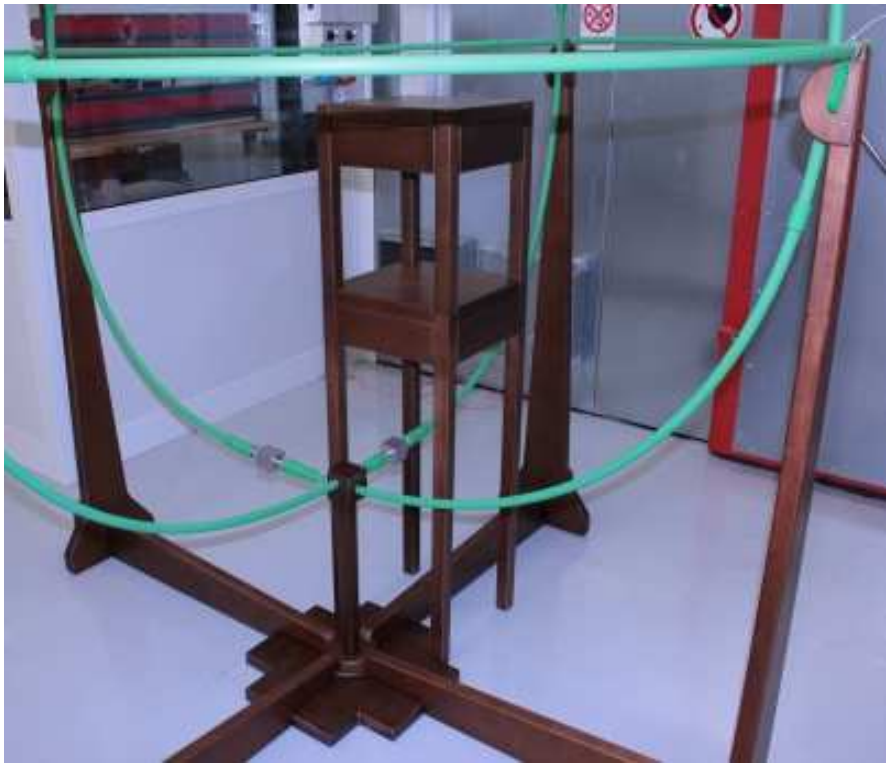


Fig. 17: ES 1530 set within loops for calibration loop in vertical position

Fig. 18: ES 1530 alignment for calibration loop in vertical position

Set the support for the calibration loop on ES 1530 as shown in Fig. 19.

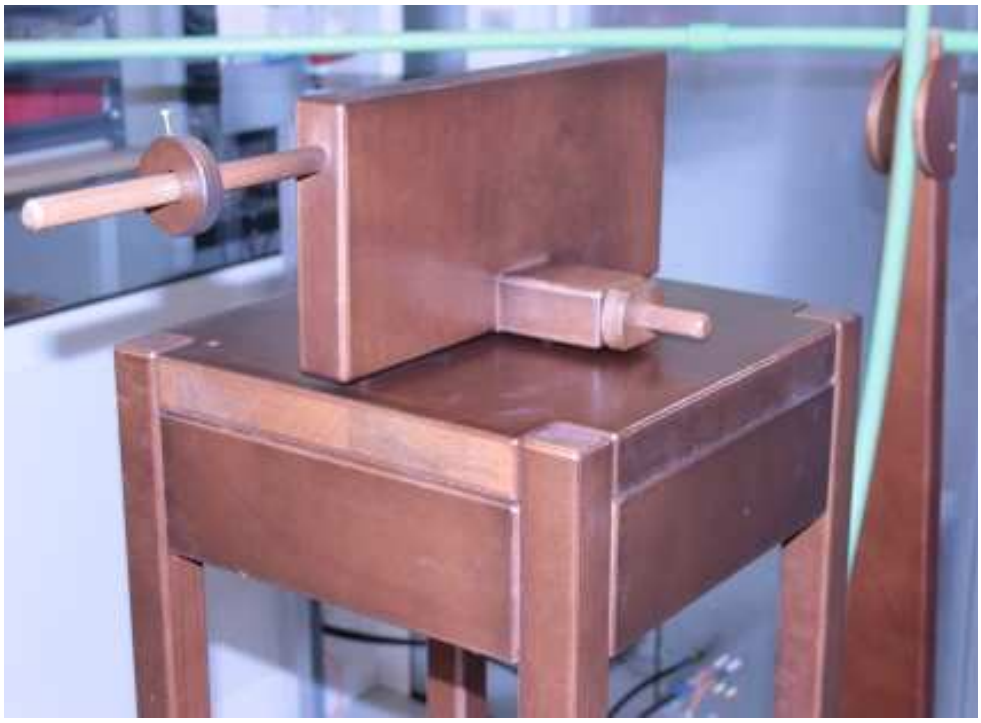


Fig. 19: Support setting for calibration loop in vertical position

Install the calibration loop on its support as shown in Fig. 20.

Fig. 20: CS 1530 installation for calibration loop vertical position

Full details of the use of the calibration loop are provided in this manual.

SECTION E: OPERATION

The method of measurement is given in CISPR 15, section 9.3.2. A copy of this should be consulted if performing compliance tests.

The EUT should be mounted on a wooden frame or table in the centre of the antenna. The position is not critical.

To avoid unwanted capacitive coupling between the EUT and the large antenna system, the distance between the EUT and components of the Large Loop antenna system (LLAS) should be at least 0,10 times the loop diameter. Particular attention must be paid to the leads of an EUT. Cables should be routed together and leave the loop antenna volume in the same octant of the cell, no closer than 0,4m to any of the large antenna system, as shown in Fig. 21 (Ref. CISPR 16-1-4, Annex C).

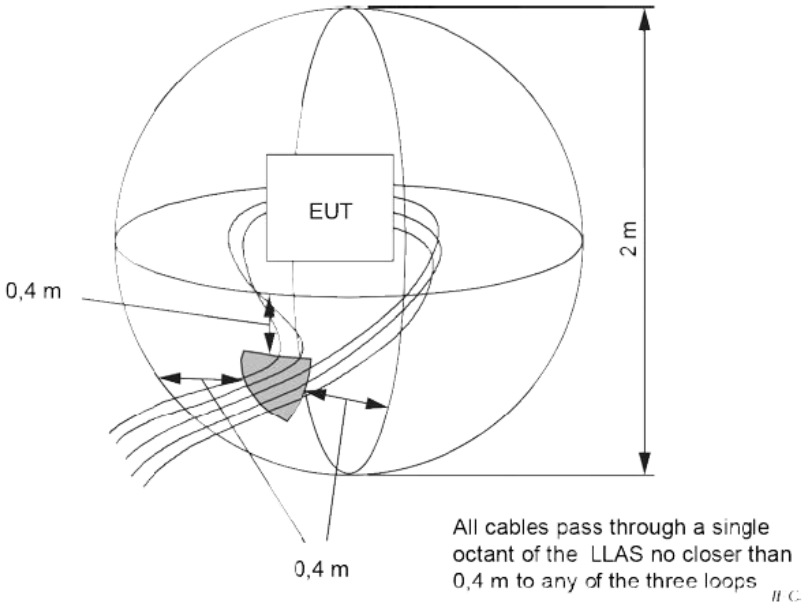


Fig. 21: Example showing the routing of several cables from an EUT to ensure that there is no capacitive coupling from the leads to the loop

Each axis (loop) should be measured in turn. Each should meet the requirements of the standard. The loops are individually selected by the switch shown in Fig. 22.

Fig. 22: Switch unit

EXAMPLE: Measurement with the AFJ FFT 3000 EMI Receivers

1. Select the CISPR 15 limit (EN15 QP loop 2m) (Fig. 23);

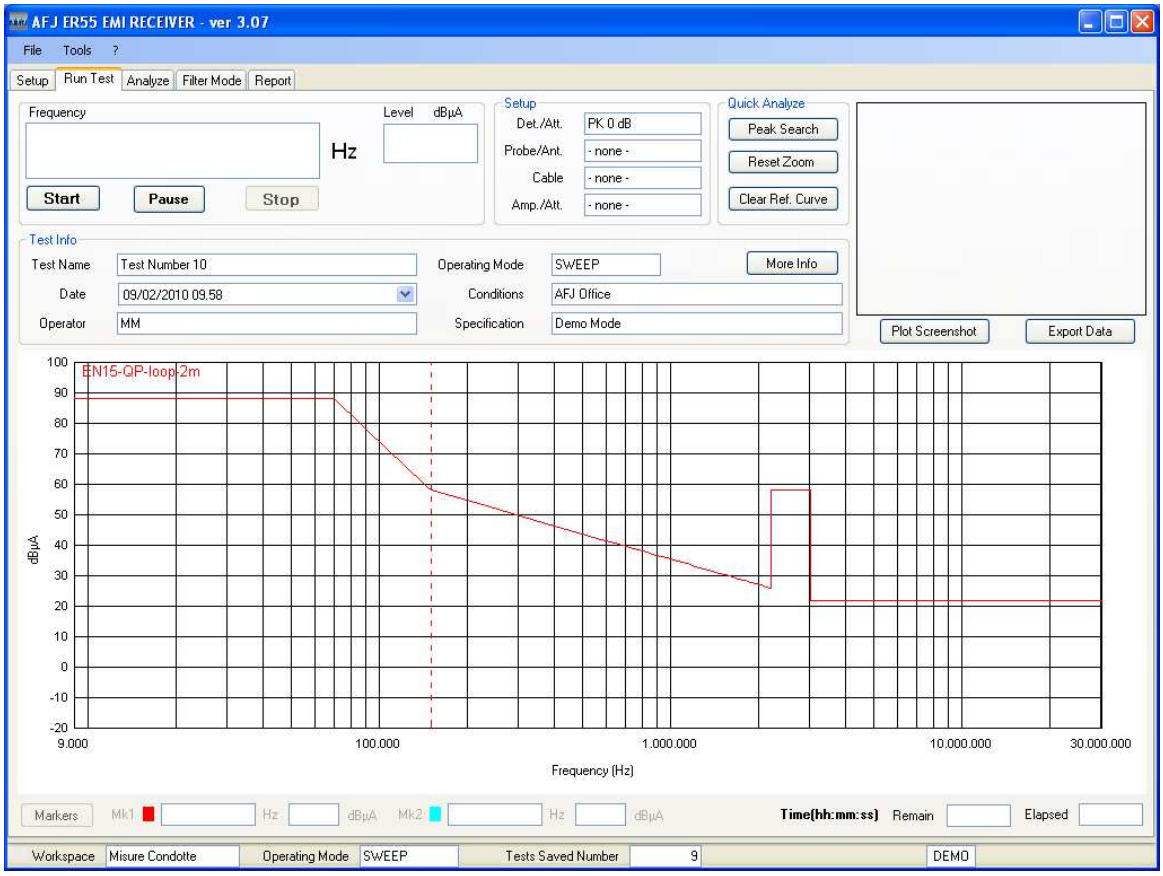


Fig. 23: Setting of CISPR 15 limit

2. Select the display unit of dBµA;

3. Set appropriate frequency parameters (in the section SINGLE TEST SETTINGS ► FREQUENCY TABLE);

4. Connect the switch unit to the appropriate EMI receiver 50Ω input;

5. With the EUT switched off, check the background signal level. If the background is too high, it is advisable to either find a 'quieter' location or screen the room;

6. Switch the EUT on. Check the levels of signal over the background levels using the techniques used for conventional radiated testing as described in the user guide. The levels displayed are fully compensated for the VVL 1530 characteristics and can be compared directly with the limit lines;

7. If the background and the product is 'quiet', and especially at frequencies above 20MHz, the pre-amplifier should be used to increase the sensitivity of the system. Set the Pre-amp buttons on the screen to **yes.** Care should be taken when using the pre-amplifier as the antenna then becomes extremely sensitive.

SECTION F: TECHNICAL SPECIFICATION

Design:	Fully compliant to CISPR 16-1-4 standard
Frequency Range:	9kHz÷30MHz
Loops:	Triple independent 2m diameter loops switchable among X, Y, Z
Loop selector:	Manual switch unit
Output:	50Ω
Connector:	N Female
Operating temperature:	0 to 45°C
Storage temperature:	-20° to 70°C
Size (W x H x D)	2,1 x 2,6 x 2,1m

SECTION G: VALIDATION PROCEDURE

The calibration data for each loop is virtually identical. The following details therefore apply to all three axes. For reference, the 'ideal' curve is shown in Fig. 25 (Ref. CISPR 16-1-4, Annex C).

The validation factor is measured at the 8 positions of the calibration loop as stated in the CISPR-16-1-4, Annex C, according to Fig. 24.

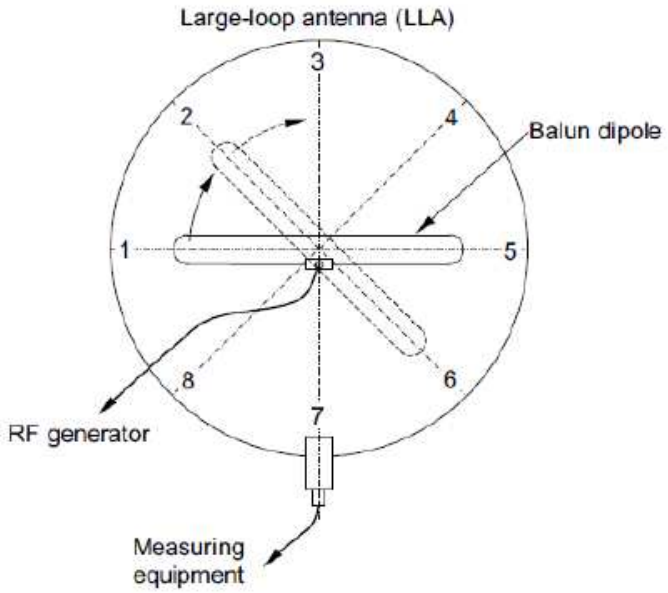


Fig. 24: Large Loop Antenna system (LLAS) calibration setup

In each of the eight positions, the validation factor [20 lg(*V*go/*I*) expressed in dB(Ω)] of the open circuit voltage of the RF generator (*V*go) and the measured current (*I*) shall not deviate more than ± 2 dB from the validation factor given in Figure 25.

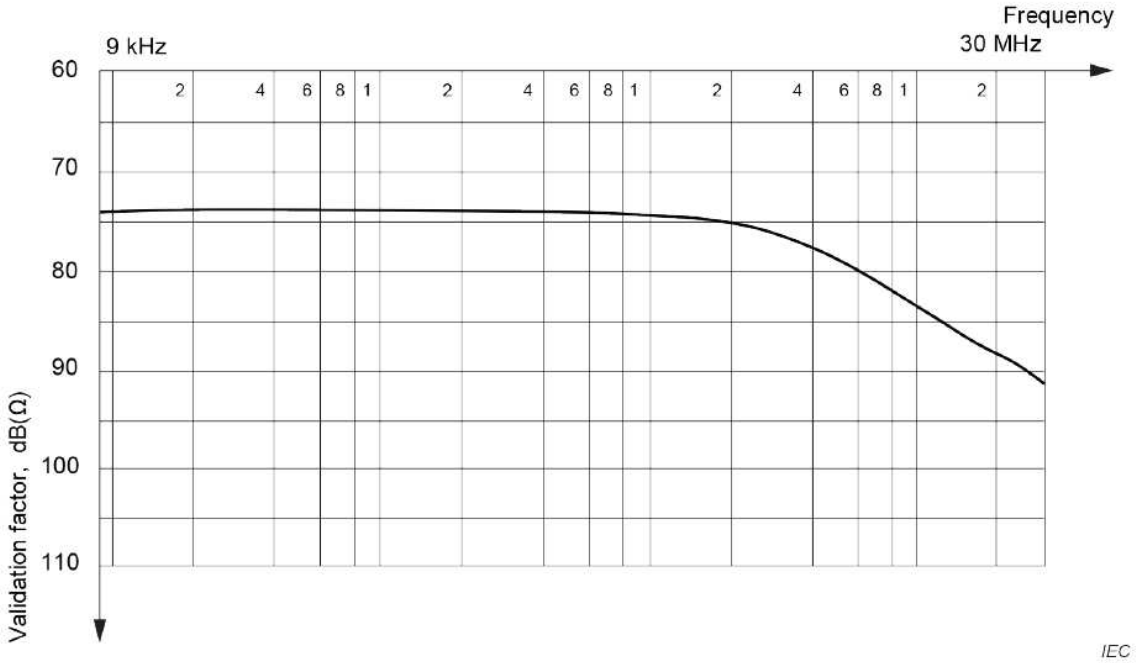


Fig. 25: Validation factor for an LLAS of 2 m diameter

- It has to be noted that in the formula V_{go} is equal to the open circuit voltage (EMF); this means that you have to add 6 dB to the voltage provided to the balun dipole.
- The VVL1530's current probe has a sensitivity of 1 V/A over the frequency range 9 kHz to 30 MHz (according to EN 55016 standard); this means that *I*[A] = ReceiverMeasure[V] / 1[Ω]

Numeric Example

Frequency: 200 [kHz]
RF Generator Level: 120 [dBµV]
Receiver Measure: 52 [dBµV]

V_{go} = 120 + 6 = 126 [dBµV]
I = 52 [dBµA]
ValidationFactor = V_{go} [dBµV] - *I* [dBµA] = 126 - 52 = 74 [dB(Ω)]