



# **OPERATING MANUAL**

## **ARTIFICIAL MAINS NETWORK (LISN)**

### **LT32C/10 THREE PHASE**

REVISION LEVEL 4.7

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## **WARNING!**

A **LISN** (LINE IMPEDANCE STABILISATION NETWORK) IS A VOLTAGE OPERATED ELECTRICAL DEVICE, WHICH IS DANGEROUS TO LIFE. FOR THIS REASON ONLY TRAINED PERSONNEL ACQUAINTED WITH THE DANGERS CONNECTED WITH THIS SHOULD PUT THIS DEVICE INTO OPERATION.

LIKEWISE, SERVICE AND REPAIR WORK MAY ONLY BE CARRIED OUT BY PERSONS, PLEASE INFORM THE MANUFACTURER AND STATE THE SERIAL NUMBER OF THIS DEVICE IN CORRESPONDENCE IN THIS REGARD.

A **LISN** MUST BE CONNECTED TO EARTH BEFORE IT IS CONNECTED TO THE MAINS.

SINCE THE USAGE OF LEAK CURRENT SWITCHES ON THE AC LINE POWERING A LISN IS NOT POSSIBLE, AN ISOLATION TRANSFORMER MUST BE INTERPOSED BETWEEN THE MAINS AND THE LISN ITSELF.

THE CONNECTION OF THE SAFETY EARTH MUST BE PERFORMED ANYWAY, REGARDLESS OF THE USAGE OR NOT OF AN INSULATION TRANSFORMER, BY CONNECTING THE REAR PANEL GROUND SCREW, TO A SUITABLE EXTERNAL GROUND REFERENCE. NO OTHER CONNECTION POINTS ON THE LISN CABINET MUST BE USED FOR SAFETY PURPOSE.

### NOTICE:

The AFJ LISN LT32C/10 is supplied in proper special packaging due to its heavy weight. We strongly recommend you to save packaging for next transport.

## ELECTRICAL SHOCK FIRST AID PROCEDURE

Before touching a person being electrocuted break, first switch off power supply or send away, using a non-conductive object, the wire or the part under HV in contact with the person being electrocuted. Then immediately the first aid electrical shock procedure must start.

If the victim doesn't breath, or its heart doesn't beats, immediately the electrical shock first aid procedure must be applied.

**A. If the victim doesn't breath,** proceed as follows:

1. Lay down on the back on a solid surface like ground or pavement (not bed or sofa), the person being electrocuted
2. Fold the head of the victim backwards keeping it straight. Lift the neck as much as possible towards height (to avoid tongue obstruct the breath way).
3. Open the mouth and lean resolutely on the mouth of the person being electrocuted and simultaneously close the nostrils with two fingers.
4. Blow into the mouth (or in to the noose, closing the mouth), in steady way until its thorax lift up again.
5. Remove the mouth to consent the victim to breath passively and observe if its thorax go down.
6. Repeat the cycle, with a rhythm of a breath every 5 second.

### NOTE

If do not succeed in entering air into the victim respiratory system, check quickly the head position and the perfect air tight around the mouth.

If subsequent endeavor still doesn't succeed, put the fingers into the mouth and in the throat, to remove intruding parts.

If the helper doesn't succeed to remove intruding parts, turn the victim on a side and beat some dryly stroke between the shoulders blade, to release the respiratory channel.

After four quick breaths, stop and check if the heart beat regularly, feeling if carotid rhythm.

If the heart beat, start again the mouth breathing until victim start to breath.

**B. If the carotid beating is absent or uncertain,** supply the artificial circulation, through an external cardiac compression.

1. Lean the palm of the hand in the lower half of the breastbone and the other hand upon it.
2. Push down with the shoulders movement, with sufficient strength to compress the breastbone of about 4 to 5cm.
3. Lift immediately the hands after each compression to consent the natural thorax expansion
4. Repeat the compression at a rhythm of about one per second. Compression should be regular constant and uninterrupted. If the helper is alone with the victim he may alternate the mouth breath with the external cardiac compression at the rate of 2 breaths followed from 15 cardiac compressions. If the helper may be supported, the rates are of 5 cardiac compression for each breath; however after 5 cardiac compression, ASK FOR HELP. Go on with one or both method until the victim has been taken into the hospital.

**After the person being electrocuted start again to breathe, check carefully about an eventual physical shock happened.** The physical sock is a collapse state or prostration that interfere against the normal function of the nervous system; the symptoms are: feeble beats, cold feeling, sickness and pallor. To oppose the shock:

1. Stretch out the victim, if possible with the head lower than the foots;
2. Loosen the garments;
3. Make sure that victim has plentiful breathable air around.
4. Wind the victim with a quilt or garments as soon as possible, keeping the patient warm and calm waiting for aid arrival.

## GENERAL INFORMATION

The information contained herein, are provided in connection with the usage of **AFJ LISN LT32C/10** three phase V-type Artificial Mains Networks (LISN) only.

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All information contained herein, are subject to change without prior notice.

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.

## 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. All calibration measurements are traceable to an independent Test House.

The Warranty is provided “Ex-Works”: therefore, AFJ Instruments will be responsible of the amendment of failures arising from ascertained manufacturing defects only.

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## CE MANUFACTURER DECLARATION OF CONFORMITY

Manufacturer                      AFJ INSTRUMENTS SRL  
    Via Gavirate 16  
    20148 Milano  
    Italy

Product Type                      LISN model LS16C/10

We hereby declare that the aforementioned equipment complies with the requirements set out in the Council Directive on the Approximation of the Law of Member States relating to:

- Electromagnetic Compatibility, Directive 2014/30/EC  
IEC 61326-1 Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements
  - IEC 61326-1 Class B (Emission)
  - IEC 61326-1 (Immunity, laboratory)
- Low Voltage Equipment Directive (2014/35/EC) and EN 61010-1 ("Safety of Electrical Measuring Apparatus").



## UKCA DECLARATION OF CONFORMITY

Manufacturer                      AFJ INSTRUMENTS SRL  
Via Gavirate 16  
20148 Milano  
Italy

Product Type                      LISN model LS16C/10

We hereby declare that the aforementioned equipment complies with the relevant requirements of the below referenced specifications. The unit complies with all applicable essential requirements of the directives.

Electromagnetic Compatibility Regulations 2016

Electrical Equipment (Safety) Regulations 2016

The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012

EN 61326-1:2021 Electrical equipment for measurement, control and laboratory use – EMC requirements - Part 1: General requirements

- EN / IEC 61326-1 Class B (Emission)
- EN / IEC 61326-1 (Immunity, Laboratory)

EN 61010-1:2010 Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements

## LT32C/10 V-TYPE ARTIFICIAL MAINS OPERATING MANUAL

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## SECTION A: GENERAL INFORMATION

### A.1 • SAFETY

This device was built and tested according to CISPR 16-1-2. LISN has been supplied from the factory in a technical faultless state.

LISN's from AFJ Instruments may use only on power supplies secured by fuses with prescribed safety devices.

With no safety condition as:

- Device with visible damages,
- Device with loosed parts,
- Device not working,
- Device after storage under bad conditions (in humid or dirty rooms),

it is not allowed switch on any devices.

### A.2 • WORKING CONDITIONS

The allowed temperature range during use of the device is +0°C to +45°C. In cases of storage or transport this range may exceed by -20°C to +70°C.

It is possible that condense water originates inside the device due to storage or transport conditions. In this case realize a period of 2 hours for acclimatize without use.

The LISN is to use in dry and clean rooms. Avoid conditions like dust, air-humidity, danger of explosion and aggressive chemical environment. During use a sufficient air circulation is to realize.

- Do not cover the ventilation holes.
- Internal cooling fans automatically switch on in case of LT32C/10 overheating ONLY.



Fig. A.1: AFJ LT32C/10



### A.3 • CONSTRUCTION

The assignment of the Line Impedance Stabilization Network is to give defined load impedance for the measurement of the device under test (DUT).

A further task of the LISN is the separation of the DUT from the mains concerning the high frequency interference's.

Therefore the construction of the LISN LT32C/10 has a simulation impedance of:

$$(50\mu\text{H} + 5\text{ Ohm}) // 50\text{ Ohm}.$$

The term in brackets is the impedance of the LISN.

The 50 Ohms in parallel is the input impedance of the measuring device.

The value is defined in the regulation CISPR 16-1-2 (Fig. A.2).

Because of the common connection of the four simulation impedances (L1, L2, L3, N) to Earth/Ground, the LISN is a V-type and just to use for measuring of non-symmetrical interferences.

To avoid to take an effect from one line to the other the simulation impedances are high frequency separated.

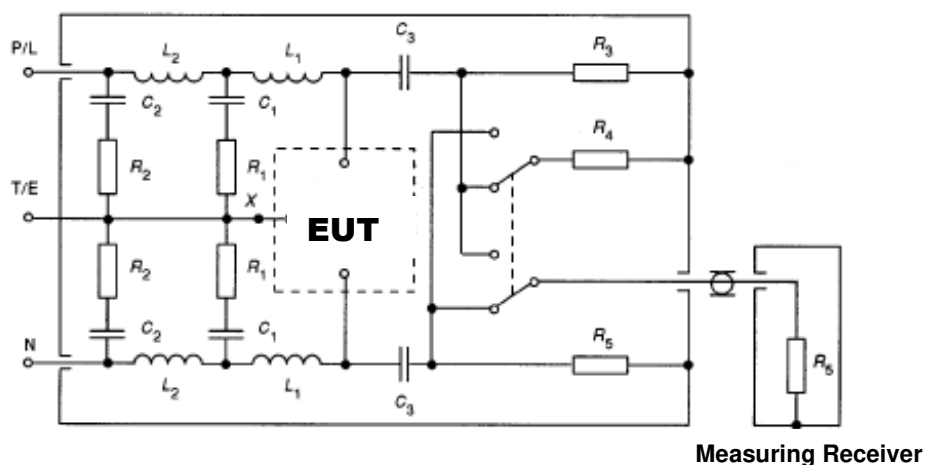


Fig. A.2: Example of artificial mains ( $50\mu\text{H} + 5\Omega$ ) //  $50\Omega$  V-network (single phase)

## SECTION B: TECHNICAL DESCRIPTION

### B.1 • GENERAL

In order to get reliable and comparable test results versus the provisions set forth by the European and International regulating Authorities, when measuring distortion signals generated by the DUT and injected into the mains through its power cord, standardized and reproducible test conditions must be used.

Since the power of the DUT-generated distortion signals, can be compared to the acceptable standards by measuring the signal amplitude across known impedance, an ARTIFICIAL MAINS NETWORK CIRCUIT (also called LISN, Line Impedance Stabilization Network) is used.

An ARTIFICIAL MAINS NETWORK CIRCUIT has to provide the SPECIFIED IMPEDANCE OVER THE WORKING FREQUENCY RANGE (usually, for the case of interest, from 9kHz to 30MHz). Since the INPUT IMPEDANCE of the MEASURING RECEIVER is  $50\Omega$ , the SOURCE IMPEDANCE (output of the LISN), must also be  $50\Omega$ , over the specified Frequency Range.

Moreover, it has to provide sufficient isolation to spurious signals arising from the mains supply (such signals should be at least 10dB lower than the measurement level, at the measuring receiver), and also to prevent the mains voltage from being applied to the measuring receiver. The above must hold for each of the conductors of the mains.

The LISN must also incorporate a switch to enable the connection of the measuring receiver to the conductor under test, providing the correct termination to the other mains conductors.

When a disturbance output terminal is not connected to the measuring receiver, it shall be terminated by  $50\Omega$ .

The AFJ LISN LT32C/10 has been developed for measurement of line-bound interference's according to standards. It corresponds to CISPR 16-1-2 directives. The construction uses air coils in the current path in order to avoid saturation effects with high current strengths. Concerning the construction the LISN is a V-network because the position of the vectors of the interference voltage.

The AFJ LISN LT32C/10 is used for the measurements in connection with a spectrum analyser or a measurement receiver. The continuous current load-bearing capacity of 32A is ensured by the use of large wire cross-sections for the coils. The design of the stabilisation network is continuously low-impedance for minimum losses.

The compact form of construction, despite the high current-bearing capacity, makes easy use of the AFJ LISN LT32C/10 for the measurement of high currents directly at the piece of use of the consumer possible. In this way, measurements of mains-borne interferences can be carried out under conditions corresponding to practice.

## B.2 • TECHNICAL SPECIFICATIONS

### Electrical properties:

Frequency range:	9kHz ÷ 30MHz
Rated voltage:	230V AC / 150V DC – 450V AC / 300V DC
Impedance:	(50μH+5Ω) // 50Ω
Number of Phases:	3+N
Tolerance:	<20%
Rated Current load:	4 x 32A
Max. permitted frequency	DC ÷ 63Hz supplies
Built-in pulse limiter and attenuator	10dB

### Terminals:

Output impedance:	50Ω
Connector:	BNC female
Artificial Hand:	220pF + 510Ω
Artificial PE:	50μH // 50Ω
Interface:	DB15 M/F for AFJ equipment

### General Data:

Rated temperature	0°C to 45°C
Storage temperature	-20°C to +70°C
Dimensions	480 x 550 x 280 mm (W x L x H)
Weight	28kg

## FRONT AND REAR PANEL FUNCTIONAL LAYOUT

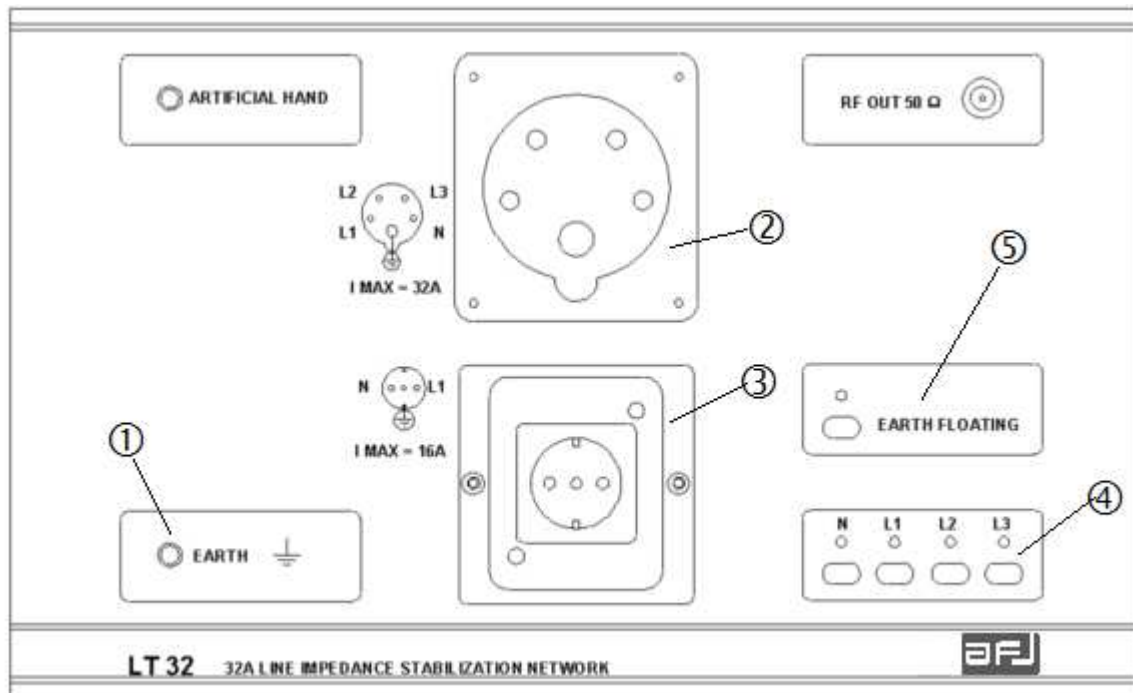


Fig. B.1: LT32C/10 Front Panel

### REFERENCES:

1÷7: System ground connections  
 3: To single phase DUT power supply  
 5: Floating artificial earth selector

2: To three phase DUT power supply  
 4: Mains conductor selection (manual use)  
 6: LISN to three phase connector

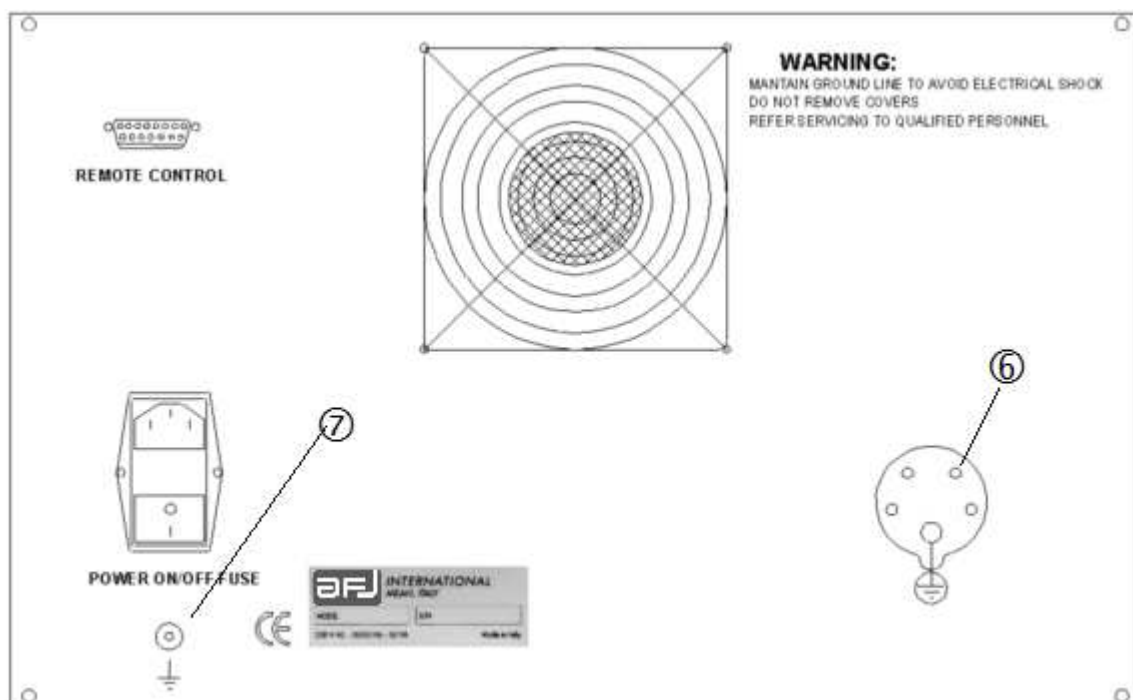


Fig. B.2: LT32C/10 Rear Panel

## SECTION C: LISN SETUP

### C.1 • GENERAL

In setting-up the LISN-DUT-Receiver configuration to perform a test, please strictly adhere the following sequence:

1. Connect the protective earth cable between the rear panel screw (indicated by the DIN “ground” symbol ), and a suitable reference ground.
2. In case **AFJ FFT 3010 EMI receiver** or **AFJ DDA55 Click Analyser** are used, connect the LISN 15-pin remote control connector on the receivers, to the corresponding 15-pin connector on the LISN, via the appropriate logic signal cable supplied. In such case, totally automatic control of the LISN can be achieved, via the instruments software interface. AFJ LISN LT32C/10 offers current meter to read and measure Switching Operations and EUT absorption current, as per CISPR 14-1 requirements (see Section E).
3. Connect the DUT power cord to the appropriate LISN power output.
4. Plug the LISN mains cord, into the LISN socket on the rear panel.
5. Plug the mains cord into an appropriate mains outlet (if applicable, an isolation transformer will be interposed), different from the one used to power any other instrument.
6. Switch the LISN power-on, and power-on the test equipment.
7. Connect the AFJ FFT 3010 EMI receiver (or any other receiver / spectrum analyser) or AFJ DDA55 Click Analyser N 50Ω coaxial input to the LISN BNC 50Ω coaxial output through appropriate coaxial cable.
8. **Important:** the built-in pulse limiter and attenuator introduces 10dB attenuation during measurement. Such attenuation shall be compensated to get proper results, so it is recommended to insert a correction factor via the software of the measuring equipment used together with the LISN, before starting any measuring session.  
This correction factor shall be defined with reference to the Voltage Division Factor data of the certificate of calibration of the LISN:
  - during conducted emission measurement with AFJ FFT 3010 EMI receiver (or any other receiver / spectrum analyser), using the data from 9kHz to 30MHz for each phase (L1, L2, L3 and N);
  - during click measurements with AFJ DDA55 Click Analyser, using the data of the four analysis frequencies (150kHz, 500kHz, 1.4MHz and 30MHz) for each phase (L1, L2, L3 and N).

### C.2 • SELECTION OF THE CONDUCTOR UNDER TEST

The “CONDUCTOR UNDER TEST” (L1, L2, L3 and N), can be selected in manual operation of the LISN via the relevant button on the LISN front panel.

In automatic operation, such selection is performed via or AFJ FFT 3010 EMI receiver either AFJ DDA555 Click Analyser control software.

### C.3 • USE OF THE ARTIFICIAL HAND

An artificial hand, simulating  $510\Omega + 220\text{pF}$  impedance, in accordance with CISPR 16-1 requirements, is provided via a specific outlet on the front panel of the LISN.

Such outlet should be used to connect the metal foil wrapping the handle, or holding appendices, of an appliance, or DUT anyway, built under CLASS II (no Protective Earth circuit) insulation rules, when subject to test as per CISPR 16 recommendations.

The purpose of the metal foil is to simulate the capacity of a human hand holding the DUT (therefore, “artificial hand”).

### C.4 • THE AUXILIARY EARTH

An auxiliary earth outlet, indicated by the DIN “ground” symbol, is also provided on the front panel of the LISN.

It can be used whenever a supplementary ground is required during a measurement.

It is NOT SUITABLE as a PROTECTIVE EARTH for the LISN.

### C.5 • THE FLOATING EARTH

During normal operation, the artificial earth condition must be “non floating” (such condition is attained by the relevant pushbutton on the LISN front panel, and the LED must be OFF).

Whenever the DUT dimensions are such that the Protective Earth conductor is long enough to show a significant impedance, or be close to  $\frac{1}{4}$  of a possible wavelength, or the enclosure has poor conductivity, the test will be performed using the non-fused, built-in artificial protective earth (as requested, i.e., by VDE 0877 part 1).

The artificial protective earth, implements a standardized reference impedance of  $50\Omega // 50\mu\text{H}$ , as requested by the applicable documentation.

The protection capabilities of the non-fused protective earth still hold.

## SECTION D: OPERATING INSTRUCTIONS

### D.1 • CURRENT LOAD

When performing measurements using **LINE IMPEDANCE STABILISATION NETWORKS**, the test setup and the test procedures, are based on the recommendations of the relevant reference documents.

The maximum current consumption of the connected test object may not exceed 32A in continuous operation. In ambient temperature of 23°C is presupposed.

At higher ambient temperatures, a reduction of the maximum current consumption is necessary. In any case, a good possibility of ventilation of the line impedance stabilisation network is to be ensured. The intake and outlet openings for the ventilators on the rear of the device must be freely accessible in any case, in order to ensure good ventilation.

The line impedance stabilisation network has not been provided with its own protective device. Please ensure that no overload results in operation due to the flow of current. The high-current coils in the interior of the line impedance stabilisation network are not protected against overload. An excessively intake of current would destroy the integrated coils with a thermal overload.

### D.2 • MEASUREMENT

The measuring device connected to the signal outlet on the front panel directly displays the interference voltage on the selected conductor L1 to L3 and N.

A LED displays the phase selected for measurement in each case.

During the measurement, the test object may only be switched on or off with the possibilities stated in its operating instructions. It's forbidden cutting off the supply lines under voltage. This is for safety reasons and to avoid uncontrollable excessive increases of by such manipulations due to the energy stored in the coils of the LISN. At the end of a measurement, it is recommended that the connected measuring device be removed from the circuit first and that only then the consumer be switched off.

The evaluation of a number of measurements has shown that a good suppression of interference's in the medium frequency range between 150kHz and 30MHz also has a distinct positive influence on the interference reflection above this range of frequencies with a corresponding design and arrangement of the mains filters.

AFJ Instruments will be pleased to help you with the design of a suitable mains interference elimination filter.

### D.3 • EUT'S UNDER INSULATION CLASS I

In general, CLASS I devices (power cord with GROUND wire) have good shielding capabilities thanks to a low-impedance PE (equipotential) protection circuit. In such cases, the earth connection, or PE conductor of the EUT, can be connected to the reference ground of the test setup.

Since, inside the EUT, the capacitance between the enclosure or Protective Earth terminal, and the mains conductors is low, at low frequencies the significant component for the test results, is the symmetric component. Therefore, in such conditions, it may often occur that all conductors show the same signal level values.

### D.4 • EUT'S UNDER INSULATION CLASS II

#### HANDHELD EQUIPMENT

In all cases where a GROUND wire is missing, the safety accomplishments are met using so-called “reinforced, or double insulation” design.

When a handle, or grip, made of insulating material, is provided to operate and control the equipment, the Reference Standards request that the measurements are performed somehow simulating the influence of the presence of a human hand on the coupling capacitance between the mains conductors inside the DUT and the enclosure, by wrapping a metal foil around such handle or grip. The size of the metal foil must be 60mm in width, as long as needed, and connected to the “Artificial Hand” outlet on the LISN front panel.

If the housing of the device is made of conducting material, a suitable hold point of the housing must be connected to said outlet.

In case of mixed nature of the housing (partly insulating, partly conducting), the metal foil shall be wrapped around the insulating part.

Both the metal foil, and the conducting housing, must be connected to the “Artificial Hand” outlet.

#### NON-HANDHELD EQUIPMENT

Since a GROUND wire is missing, in this case the earth reference is the metal sheet laid on the measurement table or floor, as specified in the Reference Documents. A suitable metal point on the, if applicable, non-conducting housing, shall be connected to such reference ground.

Up to frequencies of approximately 3MHz, the coupling between the DUT and the metal sheet is very low, thus giving rise to possible measurement gross errors, under the influence of external capacitance: therefore, avoid the proximity of operators, or objects that may be source of such disturbances.

Above 3MHz, the coupling becomes increasingly effective, and external perturbations affect the measurement to a lesser and lesser extent.



## SECTION E: SWITCHING OPERATION

### E.1 • GENERAL

Switching operations are defined in CISPR 14-1 as EUT supply current change; no other specifications are reported.

AFJ LISN LT32C/10 offers current meter to read and measure Switching Operations and EUT absorption current, as per CISPR 14-1 requirements.

Example of appliances for which the click rate N is derived from the number of switching operations:

- Thermostats for room heating equipment;
- Refrigerators;
- Freezers;
- Cooking with automatics plates;
- Appliances with one or more boiling plates controlled by thermostats;
- Irons;
- Sewing machine speed controls;
- Electro mechanical officer machines;
- Slide projector picture change device.

## SECTION F: LT32C/10 LINE IMPEDANCE VERIFICATION PROCEDURE

### F.1 • LINE IMPEDANCE MEASUREMENT

#### Test Equipment:

Network analyzer ( $f = 9\text{kHz} \div 30\text{MHz}$ )

AFJ LISN LT32C/10

50Ω BNC dummy load

SCHUKO to BNC adapter

#### Operations:

1. **Switch** the Network analyzer ON and wait for warming up enough according to the user manual;
2. **Switch** the LISN ON;
3. **check** that the Earth Floating LED is OFF;
4. **connect** the 50Ω dummy load to the BNC RF output of the LISN;
5. **connect** the network analyzer output port to the SCHUKO plug by means of the relevant adapter;
6. **set** the network analyzer for impedance measurement at the output port with the following parameters:
  - a) Start Freq.: 10kHz
  - b) Stop Freq.: 30MHz
  - c) IFBW: 300Hz
  - d) Power: -10dBm

7. **select** the line to be measured using the LISN front panel pushbutton;
8. **report** the measured impedance in the following table, according to the related frequencies. The last two columns carry the CISPR 16-1-2 impedance limits

f [MHz]	Z <sub>N</sub> [Ω]	Z <sub>L1</sub> [Ω]	Z <sub>L2</sub> [Ω]	Z <sub>L3</sub> [Ω]	Ref. -20%	Ref. +20%
0.01					4.29	6.43
0.02					5.80	8.70
0.08					16.95	25.43
0.15					26.17	39.26
0.30					34.60	51.89
0.50					37.77	56.66
0.80					39.08	58.62
1.00					39.41	59.11
2.00					39.85	59.77
3.00					39.93	59.90
8.00					39.99	59.99
15.00					40.00	60.00
20.00					40.00	60.00
30.00					40.00	60.00

**NOTE:** The connection between measuring instrument and EUT power plug is made using a custom adapter. This fixture is made by a standard male power plug, and two coaxial connectors. The central wires of the coax connectors have to be soldered to the power wires (L, N), while the coax shields have to be soldered to the Protective Earth conductor.

It is important to keep all connections within the adapter as short as possible, to avoid measuring errors at high frequency.

## SECTION G: LT32C/10 REMOTE CONTROL

### G.1 • GENERAL

To use AFJ LISN LT32C/10 in remote mode, input signal  $REM_{in}$  has to be grounded, so that  $REM_{out}$  signal (visualized by LED) became active

The signal S0 and S1 coincidence define the line selection as per the following list (Table G.1):

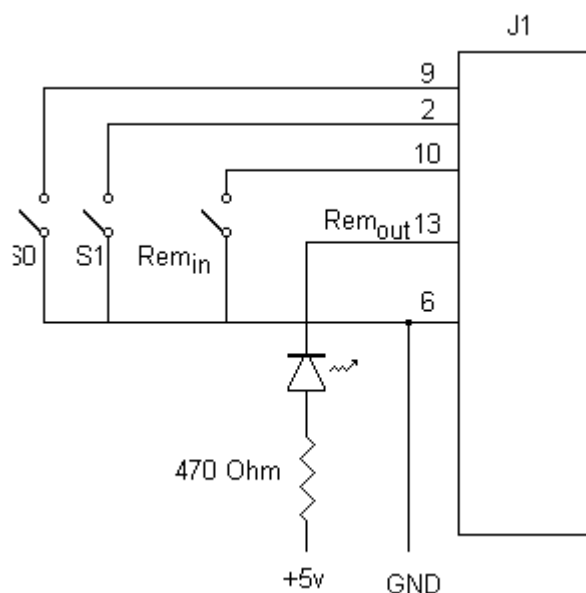
$REM_{in}$	S0	S1	$REM_{out}$	Active line
H	X	X	H (Led=off)	Manual
L	H	H	L	N
L	L	H	L	L
L	H	L	L	L2
L	L	L	L	L3

**Table G.1: LT32C/10 signals combination**

On the remote control connector there are four signals (Figure G.1):

1. S0 input signal;
2. S1 input signal;
3.  $REM_{in}$  input signal;
4.  $REM_{out}$  Output signal (open collector).

To make INPUT SIGNALS active is shall be sufficient putting them to ground.



**Figure G.1: Remote control connector**