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UNI EN ISO 9001 Certified Quality System

http://www.pmm.it

Operating Manual

PMM 8000 Plus

EMI Receiver
9 kHz ÷ 1200 MHz

EQUIPMENT SERIAL NUMBER
You can find the Serial Number on the rear panel of your instrument.
Serial Number is in the form : 0000X00000.
The first four digits and the letter are the Serial Number prefix, the last five digits are the Serial Number suffix. The prefix is the same for identical instruments, it changes only when a configuration change is made to the instrument.
The suffix is different for each instrument.

Document P/N 8000PEN-30706-1.36 - © PMM 2003

NOTE:

This product and related documentation must be reviewed carefully for familiarization with safety instructions before operation.

To ensure correct equipment operation and safety, the user of this product must fulfill all information and warnings contained in this document.

This product is a **Safety Class I** instrument according to IEC classification (provided with a protective earth terminal), and has been designed to meet the requirements of EN61010-1 (Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use).

This product is an **Installation Category II** instrument intended for operation from a normal single phase supply.

This product has a **Pollution Degree II** normally only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation must be expected.

An uninterruptible safety earth ground must be provided from the main power source to the product protective earth connection before operation.

If this product is to be connected to other equipment or accessories, prior to energizing either unit verify that a common ground exists between them.

The information contained in this document is subject to change without notice.

EXPLANATION OF ELECTRICAL AND SAFETY SYMBOLS:

- Caution, shock hazard

- Read operating manual and instruction, observe safety symbols used

- Protective ground connection

- Ground

- Unit ground

- Equipotential, (floating ground)

EXPLANATION OF SYMBOLS USED IN THIS DOCUMENT:

- WARNING: The WARNING sign brings into evidence a potential hazard of personal injury. All conditions indicated in the associated text must be fully understood and met before proceed.

- CAUTION: The CAUTION sign brings into evidence a potential hazard of damage of the equipment. All conditions indicated in the associated text must be fully understood and met before proceed.

- NOTE: The NOTE sign brings into evidence an important information.

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CE

EC Declaration of Conformity

(to EMC Directive 89/336/EEC and Low Voltage Directive 73/23/EEC)

This is to certify that the product: PMM 8000 Plus EMI Receiver 9 kHz - 1200 MHz

manufactured by: PMM S.r.l. Via Benessea, 29/B
Cisano sul Neva (SV) I-17035 – ITALY

conforms to the following European Standards:
Safety: EN 61010-1:1993 + A2:1995
EMC: EN 55011 - EN 50082-1

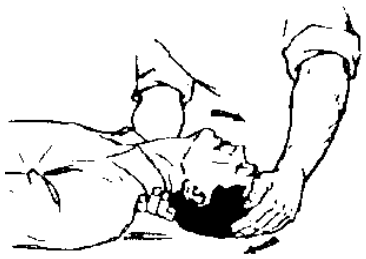
The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC, amended by 93/68/EEC, and the EMC Directive 89/336/EEC amended by 92/31/EEC, 93/68/EEC, 93/97/EEC.

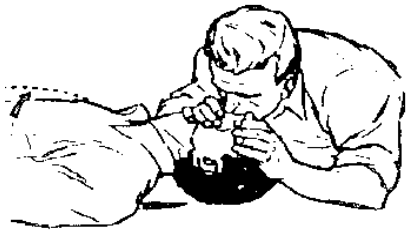
PMM S.r.l.

SAFETY CONSIDERATIONS AND INSTRUCTIONS

This unit has been designed and tested in Italy, it has left the manufacturer's premises in a state fully complying with the safety standards; in order to maintain the unit in a safe state and to ensure safe operation, the following instructions must be reviewed and fully understood before operation.

- When the unit is to be permanently cabled, first connect an uninterruptible protective earth ground conductor before making any other connections.
- If the unit is to be connected to other equipment or accessories, prior to energizing either unit verify that a common ground exists between them.
- For permanently cabled unit without built-in fuses, automatic circuit breakers or similar protective facilities, the power supply line shall be provided with fuses or protections rated to the unit.
- Verify that the unit is set to match the available mains voltage and correct fuse rating is installed before applying power.
- The Safety Class I units provided with disconnectible AC supply cable and plug may only be operated from a power socket with protective earth ground connection.
- Any interruption or loosening of the protective earth ground conductor, either inside or outside the unit or in an extension cable will cause a potential shock hazard that could result in personal injury.
- The protective earth ground conductor shall not be interrupted intentionally.
- To avoid electrical shock do not remove protections or covers of the unit , refer to qualified PMM Service Center for maintenance of the unit.
- For continued protection against fire hazard, replace the line fuse(s) only with the same type and current rating of fuse.
- Observe safety regulations and rules and also the additional safety instructions specified in this manual for prevention of accidents





FIRST AID in case of electric shock:

1) lay the victim on his back;
2) clear victim's mouth and throat;
3) Tilt victim's head back as far as possible and rise his head;
4) pinch victim's nostrils;
5) take a deep breath;
6) cover the victim's mouth with yours and blow, watching his chest rise;

NOTE: blow forcefully into adults, but gently into children;

7) move your face away to allow victim to breathe out, watching his chest fall;
8) repeat first five to ten breaths at a rapid rate, thereafter; take one breath every three to five seconds;
9) keep victim's head back as far as possible all the time;
10) **have someone else sent for a Doctor**;
11) **keep patient warm and loosen his clothings**.

DO NOT GIVE LIQUIDS UNTIL PATIENT IS CONSCIOUS

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1 - General Information

1.1 Documentation

Enclosed with this manual are:

- a service questionnaire to send back to PMM if equipment service is required.
- an accessories check list to verify all accessories enclosed in the packaging.

1.2 Instruments Covered by this Manual

You can find the Series Number on the rear panel of your instrument. Series Number is in the form: 0000X00000. The first four digits and the letter are the Series Number prefix, the last five digits are the Series Number suffix. The prefix is the same for identical instruments, it changes only when a configuration change is made to the instrument. The suffix is different for each instrument.

1.3 Introduction to PMM 8000 Plus

The evolution of the well known PMM 9000 high performances receiver.
Low cost, full compliant to C.I.S.P.R. 16-1, even with single pulse test in the 9 kHz - 1,2 GHz frequency range. The PMM 8000 Plus measuring system for conducted and radiated interferences performs either manually or automatically all the measurements requested by several standards in the 9 kHz - 1,2 GHz frequency range.
The PMM 8000 Plus system is driven via RS232 interface from a user PC for easy one click operation. Both digital and analog data display on the PC screen; simultaneous Peak, Quasi-Peak and Average detectors display. The automatic mode of operation allows accurate and fast measurement: the operator is only requested to preset the frequency band and the standard; the receiver will execute a high speed sweep with Peak detection: and when, on those frequencies where the level was found close or exceeding the specification reference mask, the PMM 8000 Plus will turn on the Quasi-Peak detector. This measurement system has been designed for use on any PC with the Windows™ Operating System.

FEATURES	BENEFITS
• Fully CISPR 16 compliance	• Final certification
• From 9 kHz to 1.2 GHz	• Conducted and radiated emissions
• 3 simultaneous detectors	• Fast measurement
• Two inputs	• High input voltage protection
• PC driven	• Low cost
• Small size and weight	• Ideal for on site testing
• Automatic Correlation for GTEM to OATS	• High testing throughput
• Automatic LISN control	• Time saving
• Built in 10 dB Preamplifier	• Auto calibration
• Up to 4 antenna factors tables	• Automatic correction of antenna, cables, connectors or preamplifier
• Tracking generator	• Filter measurement and insertion loss according to

	EN55015 testing

1.4 Instrument Items

The PMM 8000 Plus includes the following items:

- 9 kHz to 1,2 GHz EMI receiver;
- software on 3½" diskette;
- RS232 serial cable with 9/25 pin adapter;
- N-N cable;
- N-BNC connector adpter;
- power supply cable;
- LISN power cable;
- Operating Manual.

1.5 PMM Options

PMM 8000 Plus can be used with several accessories.
The possible options are:

- L1-150 : Single line LISN, 150A (50Ω//1 Ω+5μH)
- L2-16 : Two lines, Single phase, 16A LISN, (50Ω//5 Ω+50μH)
- L3-32 : Four lines, 3-phase, 32A LISN, (50Ω//5 Ω+50μH)
- L3-64 : Four lines, 3-phase, 64A LISN, (50Ω//5 Ω+50μH)
- L3-100 : Four lines, 3-phase, 100A LISN, (50Ω//5 Ω+50μH)
- L3-500 : Four lines, 3-phase, 350A LISN, (50Ω//5 Ω+50μH)
- SHC-1 : 35 dB Voltage probe, 1500Ω
- SHC-2 : 30 dB Voltage probe, 1500Ω
- AC-01 : Absorbing clamp, 30 MHz – 1 GHz
- AS-01 : Antenna set (Biconic, log-periodic, tripod, 5 m. cable, carring case)
- 7405 : Set of Near Field Probes EMCO
- CTK-01 : Set of active Near Probes Credence Tecn.
- SB600 : Slide Bar
- GTEM Cells
- SW-04 : Correlation software
- PA-01 : 10 dB Preamplifier 30 MHz – 1000 MHz
- RF-300 : Van Veen Loop
- DL-XX : Dummy lamp (specify size)
- TRF-1 : Balanced to unbalanced transformer

1.6 PMM 8000 Plus Main Specifications

Table 1-1 lists the PMM 8000 Plus performance specifications.
The following conditions apply to all specifications:

- The PMM 8000 Plus needs at least a 15 minutes warm-up before to operate.
- The ambient temperature shall be 10° to 40° C.

TABLE 1-1 PMM 8000 Plus Main Specifications

Electrical Characteristics	**Performance Limits**
Frequency range……	9 kHz to 1,2 GHz (Input A) 9 kHz to 30 MHz (Input B with Pulse Limiter)
Resolution……	10 Hz (Range 9 kHz to 150 kHz) 100 Hz (Range 150 kHz to 1,2 GHz)
Setting error……	$< 2 \times 10^{-6}$
RF input……	Z_{in} 50 Ω, built in N connector (Input A) Z_{in} 50 Ω, built in BNC connector (Input B)
VSWR……	< 1,2 with ≥ 10 dB RF attenuation < 2 with 0 dB RF attenuation
Oscill. reradiation at RF inp Interference rejection…… Preamplifier gain……	< 20 dBµV > 80 dB 10 dB
Preselector Fixed-tuned bandpass filters	(7 fixed-tuned and 5 tracking filters) 9 kHz to < 40 kHz 40 kHz to < 150 kHz 150 kHz to < 500 kHz 500 kHz to < 3 MHz 3 MHz to < 10 MHz 10 MHz to < 20 MHz 20 MHz to < 30 MHz
Tracking bandpass filters	30 MHz to < 70 MHz 70 MHz to < 170 MHz 170 MHz to 330 MHz 330 MHz to < 600 MHz 600 MHz to < 1000 MHz
Maximum input level Sine wave AC voltage…… Pulse spectral density……	(without equipment damage) 127 dBµV 90 dBµV/MHz
Display units……	dBm, dBµV, dBµA, dBpW, dBµV/m, dBµA/m

Noise indication

Freq. (MHz)	**IF BW (kHz)**	**Peak (dBµV)**		**Qpeak (dBµV)**		**AVG (dBµV)**	
		Preamp. OFF	**Preamp. ON**	**Preamp. OFF**	**Preamp. ON**	**Preamp. OFF**	**Preamp. ON**
0,009 ÷ 0,05	0,2	-2	-7	-5	-10	-7	-12
0,05 ÷ 0,15		-7	-12	-9	-14	-12	-17
0,15 ÷ 30	9	-2	-7	-7	-12	-9	-14
30 ÷ 300	120	8	3	3	-2	1	-4
300 ÷ 1000		12	7	6	1	4	-1
1000 ÷ 1200		14	9	8	3	6	-1

RF output (tracking gener.)	Z_{out} into 50 Ω, N connector
Frequency range……..	9 kHz to 1,2 GHz
Level……	90 dBµV ± 1 dB

Measuring error Frequency range……	(after calibration) 150 kHz to 500 MHz ± 1 dB 9 kHz to 150 kHz ± 1.5 dB 500 MHz to 1 GHz ± 1.5 dB 1 GHz to 1.2 GHz ± 2 dB
Intermediate frequency Range 9 kHz to 30 MHz… Range 30 MHz to 1,2 GHz	 139,3 / 10,7 / 0,455 MHz 1889,3 / 139,3 / 10,7 MHz
IF bandwidth (- 6 dB)……	0,2 / 9 / 120 kHz (CISPR tolerance)
Level measuring time……	Peak, Quasi-peak and Average parallel detectors: 2 ms to 30 sec. (CISPR default)
Demodulation……..	AM/FM with built-in loudspeaker

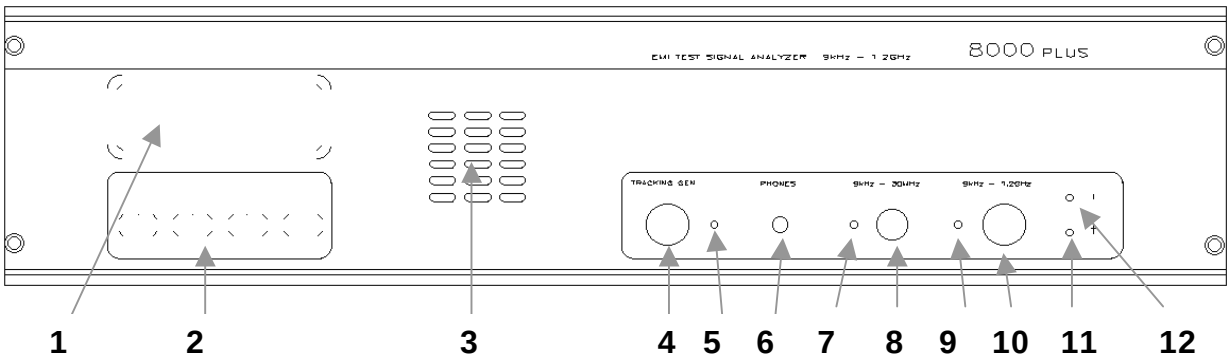
TABLE 1-2 PMM 8000 Plus General Data

I/O Interface……..…..…	RS-232 standard
Output User port…..……	8 bit, TTL level
Power supply.……..……..	85 to 264 Vac/120 to 370 Vdc 12.5 to 15 Vdc
Power consumption…….	60 VA max
Operating frequency……	47 to 440 Hz
Protection fuse……..…...	T 1.5 A - 85 to 264 VAC
Loudspeaker……..….	Built-in
Operating temperature…	10° to 40°C
Size (W x L x H)..…….....	47 x 43 x 11
Weight……..…..…..	8 Kg.

NOTE: All specifications are subject to change without notice.

1.7 PMM 8000 Plus Front and Rear Panel

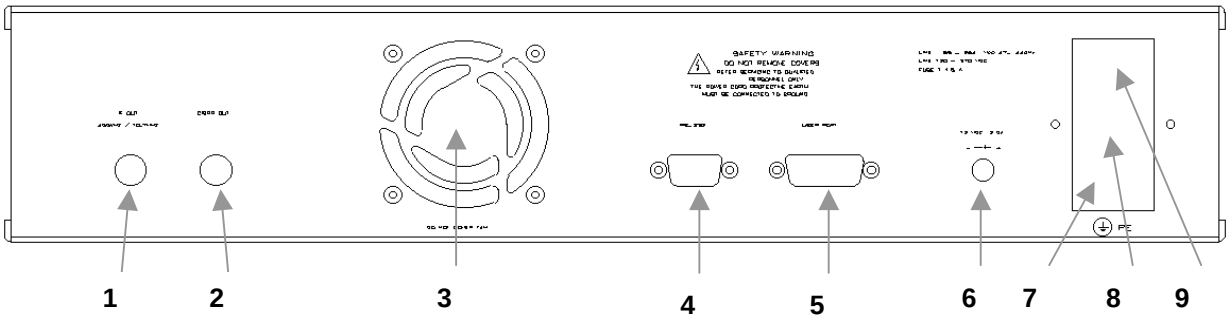
Fig. 1-1 Front Panel



Legend:

1 = Alfanumeric Display
2 = Keyboard
3 = Internal speaker
4 = Tracking Generator Output
5 = Tracking Generator Led
6 = Headphones audio out
7 = 9 kHz 30 MHz input Led
8 = 9 kHz 30 MHz input connector
9 = 9 kHz 1,2 GHz input Led
10 = 9 kHz 1,2 GHz input connector
11 = Power ON Led
12 = Alarm Led

Fig. 1-2 Rear Panel



Legend:

1 = IF Out
2 = CISPR Out
3 = Fan
4 = RS232 connector
5 = User Port
6 = 12 V Power connector
7 = Main Line power connector
8 = Fuse holder
9 = Power ON switch

1.8 Functional Description

PMM 8000 Plus philosophy is based on the superheterodyne principle. By this principle any high frequency input signal, in a defined frequency range, is converted into a number of fixed lower intermediate frequency.
The PMM 8000 Plus functional diagram is shown in the following Figure:

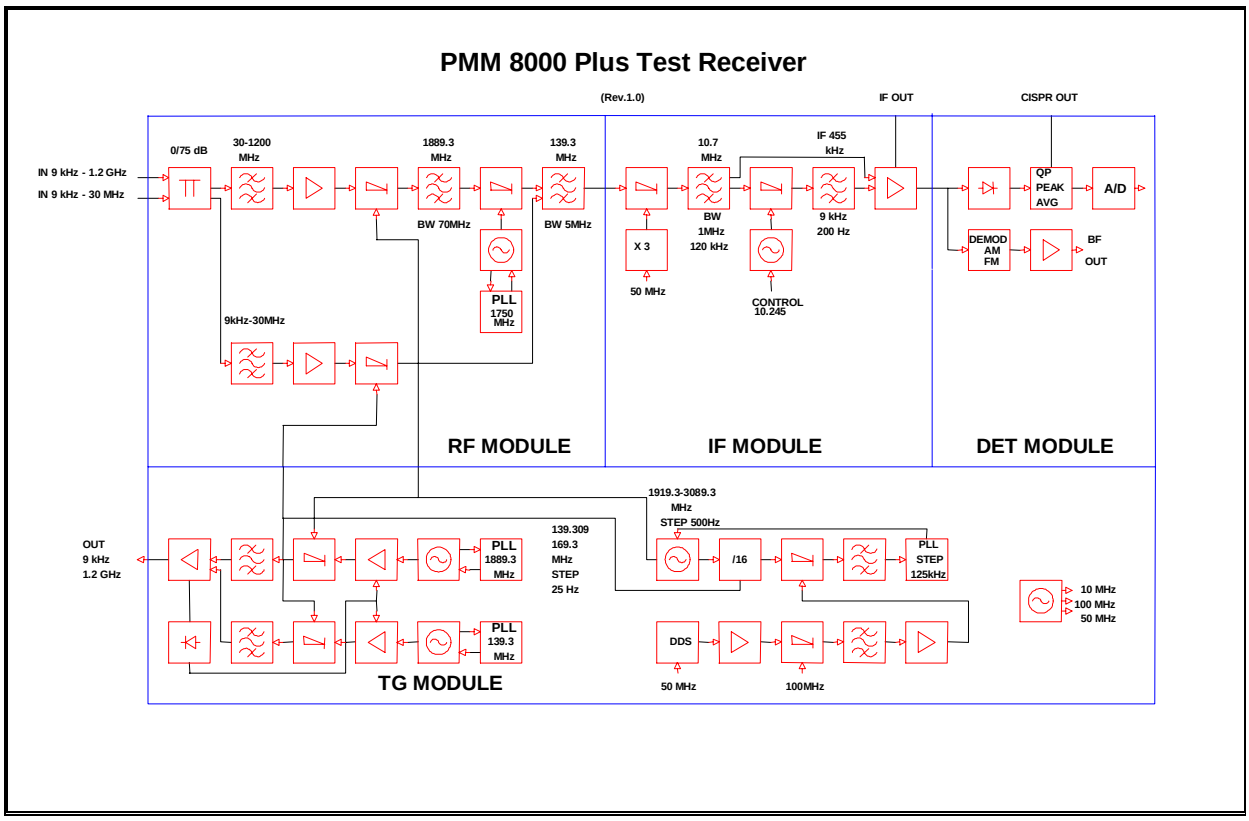


Fig. 1-3 PMM 8000 Plus Functional Diagram

1.9 Emission measurement

All electric, electromechanical and electronic devices are potential generators of electromagnetic interference (EMI).
The term EMI thus refers to the electromagnetic fields emitted by a device which propagate themselves along cables or through the air and couple with other devices that are present in the surroundings.
These electromagnetic fields (conducted noise or radiated interference) coupling with nearby equipment can cause possible malfunctions.
Today, thanks to international standards (IEC) and the European directives implemented by the member states of the European community, products commercialization is subject to the measurement of this interference, which must be within well defined limits.

The philosophy used for the PMM 8000 Plus was that of developing a simple and reliable system of measurement for classifying or inspecting any electric or electronic device from the first stages of design to the final certification.

The mandatory measurement of emitted and radiated noise obliges equipment constructors to respect the limits foreseen by basic standards or specified for each product category.

The PMM 8000 Plus receiver is the ideal solution for prototype debugging and certification.
The recommendations and standards in force specify the measurement criteria, the environment for carrying out tests and the instrumentation to be employed; this is so that everyone can perform the same measurement with the same results.

The PMM 8000 Plus control software permits rapid use of the instrument without any special difficulties. All operations, calculations and preparations are made automatically. Thus, the operator can concentrate just on analyzing the measurement results.

The PMM 8000 Plus software has also been designed for rapid and easy installation on any PC with the Windows™ operating system and with at least one free serial port.

The typical objective in using the PMM 8000 Plus EMI receiver is that of measuring, frequency by frequency, the maximum noise emitted by equipment under test in the 9 kHz to 1,2 GHz frequency range, as well as conducted along power cables and radiated through the air.

The standards also specify that the measurement environment should have a ground plane or mass plane and other facilities, like rotating platform and antenna mast.
The device under test (DUT) must be installed according to the procedures indicated in the constructor's manual and normal operating conditions respected.

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2 - Installation

2.1 Introduction

This section provides the information needed to install your PMM 8000 Plus.
Included is information pertinent to initial inspection, power requirements, power cables, interconnection, environment, instrument mounting, cleaning, storage and shipment.

2.2 Initial Inspection

To avoid hazardous electrical shock, do not turn on the instrument when there are signs of shipping damage to any portion of it.

2.3 Packing and Unpacking

Inspect the shipping container for damage.
If the shipping container or cushion material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically.
Verify the accessories availability in the shipping referring to the accessories check list enclosed with the Operating Manual.
Notify any damage to the carrier personnel as well as the PMM Representative.

2.4 Preparation for Use

This is a Safety Class I equipment, it is provided with a protective earth terminal. An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals through the power cable (or supplied power cable set). Verify the safety earth ground functionality before operation.

Before plugging PMM 8000 Plus into the main supply line ensure that the line voltage is in the range specified, and that the appropriate fuse have been selected.

2.5 Line Voltage

The PMM 8000 Plus's power supply voltage input is factory set.
The internal power supply is made of switching type, it allows a wide input line voltage range covering all international mains supply standards, thus no manual line voltage selection is required for proper operation.

2.6 Fuse Selection

Line Voltage	Fuse Rating	Type
85 to 264 Vac	1,5 A	T (Time delay slow-blow)

WARNING

- **Disconnect the power cable before fuse substitution.**
- **When needed use only replacement fuses of the same type and rating.**

The safety fuse is housed in a special receptacle located near the power cable connector.

WARNING

Before connecting this instrument, ensure that an uninterruptible safety earth ground is provided from the main power source to the product protective earth connection. If this instrument is to be connected to other equipment or accessories, prior to energizing either unit verify that a common ground exists between them.
Any interruption or loosening of the protective earth ground conductor, either inside or outside the unit or in an extension cable will cause a potential shock hazard that could result in personal injury. Verify the safety earth ground functionality before operation.

2.7 Power Cable

This instrument is equipped with a three wires power cable. When connected to an appropriate AC power receptacle, this cable grounds the instrument chassis.

2.8 Environment

The operating environment is specified to be within the following limitations:

- Temperature 0° to +45° C
- Humidity < 90% relative
- Altitude 4000 meters

The instrument should be stored in a clean, dry environment
The storage and shipping environment is specified to be within the following limitations:

- Temperature -25° to + 70° C
- Humidity < 95% relative
- Altitude 15000 meters

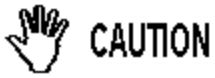
2.9 Return for Service

If the instrument should be returned to PMM for service, please complete the service questionnaire enclosed with the Operating Manual and attach it to the instrument.
To minimize the repair time, be as specific as possible when describing the failure. If the failure only occurs under certain conditions, explain how to duplicate the failure.
If possible, reusing of the original packaging to ship the equipment is preferable. In case other package should be used, ensure to wrap the instrument in heavy paper or plastic.
Use a strong shipping container and use enough shock absorbing material around all sides of the equipment to provide a firm cushion and prevent movement in the container.
To prevent damage during shipment in particular protect the front panel and connectors.
Seal the shipping container securely.

Mark the shipping container FRAGILE to encourage careful handling.

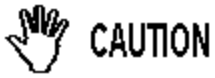
2.10 Equipment Cleaning

Use a clean, dry, non abrasive cloth for external cleaning of the equipment.



To clean the equipment do not use any solvent, thinner, turpentine, acid, acetone or similar substance to avoid damage to external plastic or display surface.

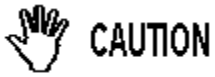
2.11 Equipment ventilation



To allow correct equipment ventilation ensure that the vent grids on the rear of the equipment cover and on the lower side be free by any obstructing object.

2.12 Operating PMM 8000 Plus with Artificial Mains Network

To avoid any damage caused by transient current pulses, connect the RF cable to the receiver only after the PMM 8000 Plus and EUT AC supply have been switched on.



Using an external Artificial Mains Network to avoid any damage caused by transient current pulses, disconnect the PMM 8000 input before switching Equipment Under Test AC supply on or off

2.13 Installation Check list

Before operation ensure the following steps are taken:

- Check the line voltage to ensure the compatibility with the equipment requirements.
- Ensure that the to be provided fuse or breaker current rating is appropriate for the equipment setup.
- Protection earth line is connected to mains supply input on the rear panel.
- Prior to energizing either unit connected to PMM 8000 Plus verify that a common ground and safety protection earth connection exists between all equipment in the test setup.

2.14 Hardware Installation

The PMM 8000 Plus receiver can only function properly when connected to a Personal Computer via the RS232 serial cable.

The below procedure should be followed:

- Plug the PMM 8000 Plus RS232 cable connector into a free serial port on the PC using the supplied serial cable. The software will automatically recognize the serial port being used.
- Plug in the PC and PMM 8000 Plus power cables.
- Switch on the PC and PMM 8000 Plus.
- Now run the PMM 8000 Plus software to take the measurement.

2.15 Software Installation

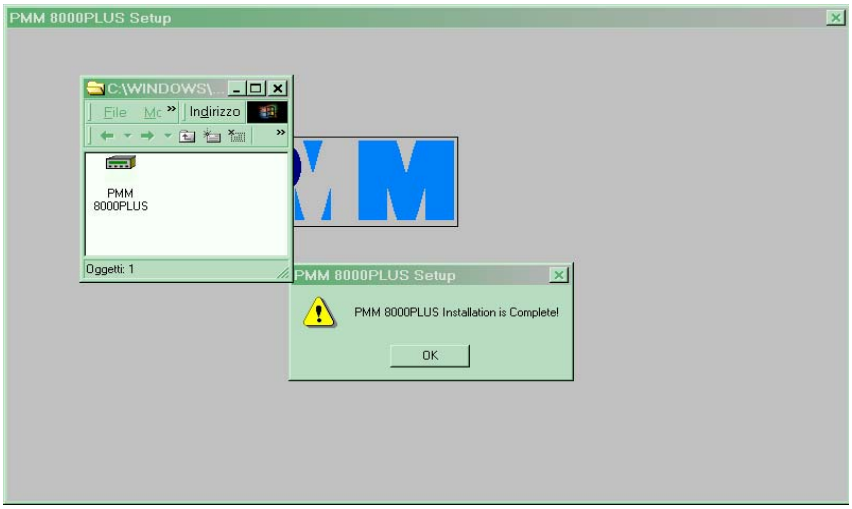
In order to use the PMM 8000 Plus all of the files contained on the supplied diskette must be installed on the PC Hard Disk.

Follow the procedure below:

- switch on the PC and launch the Windows™ operating system.
- insert the PMM 8000 Plus diskette in the diskette drive;
- invoke the "**Run**" function from the Program Manager
- enter the command "**A:SETUP**" and press <Enter>.

During the installation phase, the program will request confirmation of the directory on which the files are to be installed. Reply with **OK** if you wish to confirm the directory **8000PLUS**, otherwise type in a new name.
The screen display will be similar to the following:

Click on the **Continue** button to continue with the installation procedure, or **Exit Setup** to abort it. Near the end of the installation procedure the program will ask if the demonstration program is to be also installed.
Reply with **OK** to install the software demo.
The software will automatically create the PMM icon. For your convenience drag the icon to the desktop. If necessary with the Property function, you can change the name of it.

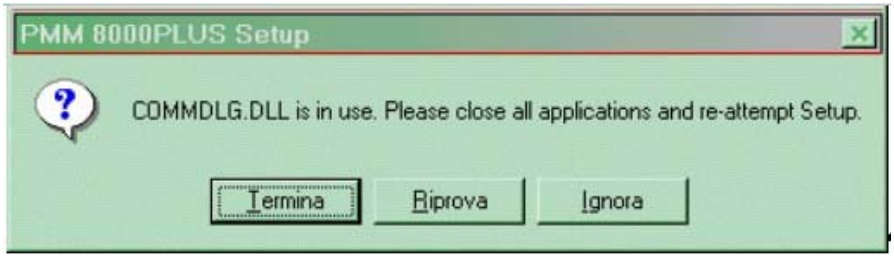


NOTE

During installation, it could happen that a warning window appears on the PC informing that the software can not copy the file SETUP1 (Could not copy SETUP1.exe message). To overcome this problem, with the Program manager go to Windows directory and cancel or rename this file.
Then start again with the installation.

NOTE

The installation program try to install some system files needed to work correctly, if such files have been already installed in your system you may get the following warning:



If the case, select **Ignore** to go on with software installation, the files already installed in the system will be maintained.

2.16 Serial port selection

NOTE

Normally the program automatically identifies the serial port where the receiver is connected to. If you wish to force the use of a specific port, the following procedure should be used:

- activate the **Program Manager**;
- invoke the **Proprieties** command;
- type on the command line: **8000PLUS.exe COMM=N** (where N is the serial port number, COMM=N in upper case)

The PMM 8000 Plus software is composed of various files, some are only accessible to the user (e.g. **Header.TXT**) after their installation, while others, although indispensable for correct system operation, are totally transparent to the operator.

2.17 Program run

To run the 8000PLUS program simply double click on the program icon

2.18 Antennas usage

When using one or more antennas, or near field probes, you should load the antenna factors to a PMM 8000 Plus file. In this way PMM 8000 Plus will correct the absolute measurement adding or subtracting the correction factors frequency by frequency (see applicable software section).
When using two different antennas (i:e: Biconic and Log-periodic), K-factor table automatically takes into account correction factors and software prompt advises the operator to change antenna, pausing in the meantime measurement. Once finished the sweep, PMM 8000 Plus will combine the two measurements into a single graph.

2.19 Artificial Mains Network usage

To acquire and measure conducted noise on power cables of any type of electrical or electronic device it is necessary to use an artificial mains (LISN) inserted between the mains and the device in question. The LISN employed must conform to CISPR 16 standard.

WARNING: in order to use the artificial mains an isolating transformer must be placed between the mains and the LISN. This is to avoid the safety cut out always being activated due to the high current dispersions of the mains themselves.

The PMM 8000 Plus receiver can be used with a external PMM Artificial Mains Network connecting it to the User Port connector on the rear panel.
Noise measurement on each single phase and neutral is automatically selected via software.

An input connector for the 9 kHz - 30 MHz range is provided on the receiver front panel to allow usage of the external Artificial Mains Network.

2.20 Using Voltage probes

The voltage probe must be used when measurements are made at terminals other than mains ones, such as the load or command terminals for example. The voltage probe can also be used on power supply terminals when the V type artificial mains cannot be used without excessively influencing the equipment under test or when a LISN of adequate power is unavailable.
The voltage probe contains a resistor with a minimum resistance of 1500 ohm, in series with a capacitor of insignificant reactivity in ratio to the resistance (in the 150 kHz to 30 MHz range). See art. 12 of CISPR Publication 16.
Measurements must be corrected in accordance to the voltage split between the probe and the measurement equipment.
PMM offers two probes with attenuation of 30 or 35 dB for currents up to 1000 A.
The probe's attenuation value is specified in the PMM 8000 Plus software by entering the appropriate attenuation factor by the **Factor** function.

2.21 Pulse Limiter

The pulse limiter is an useful device to protect the input of the receiver from overvoltages. Quite often the conducted disturbances are too high, even if you cannot see them on the PMM 8000 Plus because they are out of measurement bandwidth, and the associate energy is high enough to damage the input attenuator or mixer. If you have no idea about your input signal strenght, use an oscilloscope to measure the maximum amplitude before feeding it to PMM 8000 Plus.

The pulse limiter is directly built in to the 9 kHz - 30 MHz input of PMM 8000 Plus.

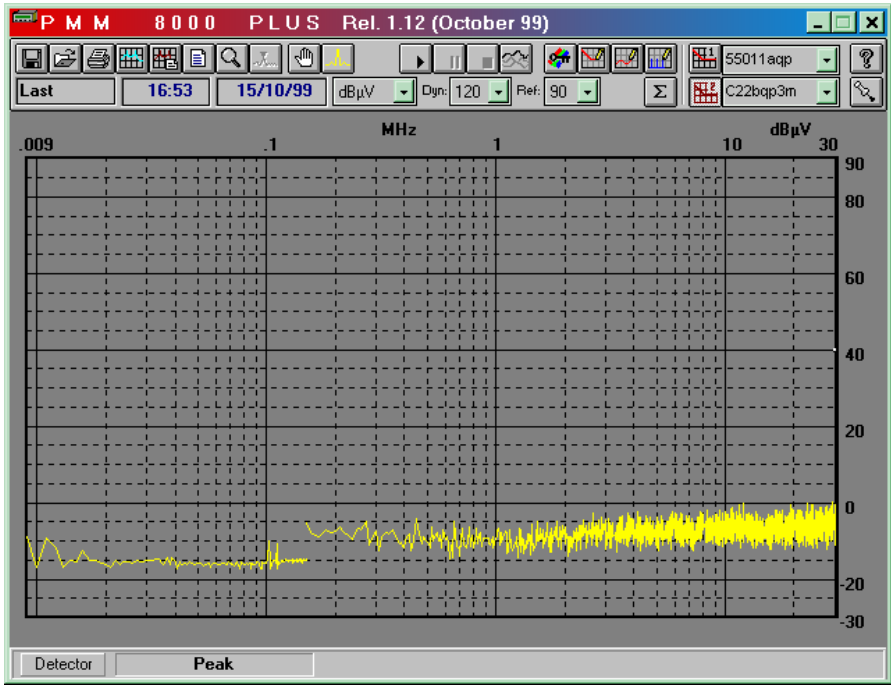
3 - Operating Instructions

3.1 Introduction

PMM 8000 Plus has been designed with a user friendly software control interface to be used by EMC engineer as well by non-skilled personnel.
Before running the program, ensure that the PMM 8000 Plus is correctly connected and switched on.
Check the serial connection between the PC and the receiver.

3.2 Program start-up

Once launched via the run command or double clicking on the PMM 8000 Plus Icon, a window indicating the software release and issue date will be displayed for a few seconds, after which the PMM 8000 Plus main menu will be shown.
The screen display will be similar to the following:



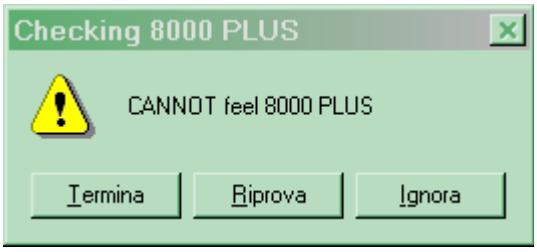
Main window example

3.3 Show mode

The user can starts the program in **Show** mode, thus allowing the program to run without the receiver connected to the PC.
The **Show** mode is particularly useful to learn program functions and receiver use, preparing measurement set-ups, watch saved measurement data or write test reports without connecting the receiver to the PC.
To start the **Show** mode run the program from the program manager with the option **/U**.
The command line will be: **C:\8000Plus\8000PLUS.EXE /U**

If the receiver is either not connected or switched-off the program can run in the **Show** mode only.

If the case the following window is displayed after the program start:



- **Exit** to exit the program;
- **Retry** to retry after PMM 8000 Plus switch on or connection check;
- **Ignore** to start the program in **Show** mode.

NOTE

Starting the program without the option **/U** and further selecting **Ignore** the program tries to find the PMM 8000 Plus, opening the first available RS232 COM port, if the case that port will remain opened and then unavailable for other applications until program exit.
When Show mode is needed and to avoid conflict with other applications always run the program with the /U option.

Some functions are not active in **Show** mode: they are Manual, Spectrum and Sweep mode.

3.4 Main program window

The main window is divided into three fields:

- Command bar at the top;
- Graphical data window in the middle;
- Status bar at the bottom.

3.5 Command bar

The Command bar is divided into several virtual buttons and text fields, a brief description of each button and field is available in the Status bar whenever the mouse pointer pass over each button or field.

Command bar description:

Save button: allows to save the following file type on disk:

- **Draft**: (*.SWH) program proprietary format to save and load measurement data included graphical data and comments.
- **Bitmap**: (*.BMP) standard bitmap image format to save graphical data window as image.
- **ASCII**: (*.TXT) standard ASCII text format to save measurement data table.
- **Panel**: (*.ST9) program proprietary format to save and load measurement data included graphical data and Scan Table configuration panel.

Load button: allows to load the following files from disk:

- **Draft**: (*.SWH) program proprietary format to save and load measurement data included graphical data and comments.
- **Panel**: (*.ST9) program proprietary format to save and load measurement data included graphical data and Scan Table configuration panel.

On the right of the Load window there is the **Compare** selection.
It is possible to compare files already stored on disk; you can load up to two files. The first should be loaded without using **Compare** function, the second must be loaded with **Compare** enabled.

The Limit related disk files, like Table or Antenna factor must be saved and loaded from the associated function window.

Print button: when this command is activated it invokes the Windows™ Print Manager, after which all the normal functions for managing document printing will be operative.
If the comments function is enabled will be printed also the comment.

The printer must be set with landscape (horizontal) orientation.

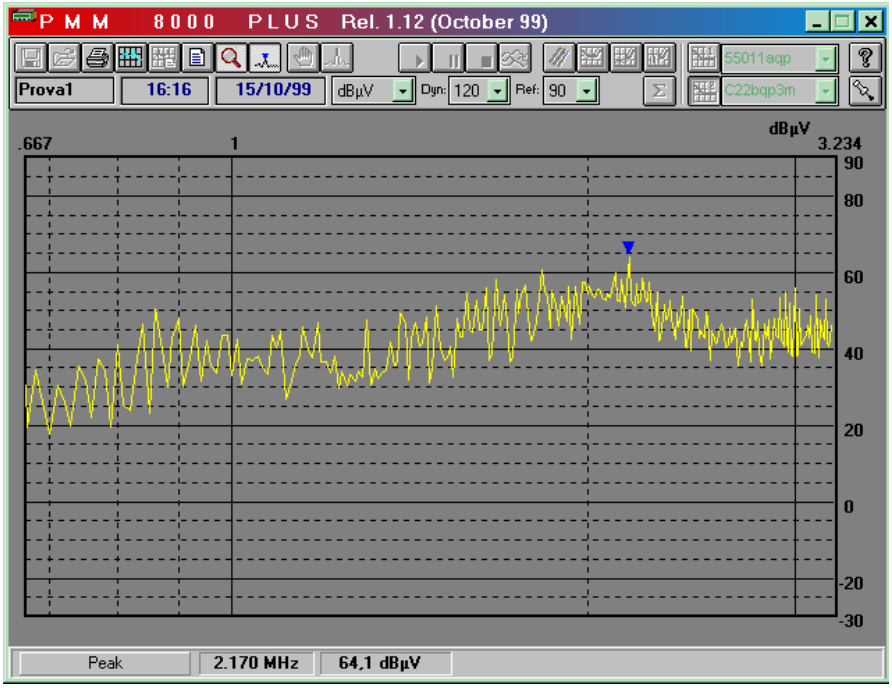
Redraw button: refreshes the screen image. This function is useful to clean the screen when several applications are running simultaneously and the PC do not have enough memory.

Comment lines can be added via the **Comment** button.
The program will add a window at the bottom of the graph where comments and remarks can be viewed and edited. The comment window only displays two lines at a time, but it is possible to write as many lines as required. Use the keyboard's up and down arrow keys to show other lines not displayed.
The comments will be saved in the Draft file.

The **Make report** command allows the creation of test reports.
The software will create a table showing all frequencies where the levels are above the **Limit 1** of an amount of dBs (or all frequencies where the levels are under or above above the **Limit 1** of an amount of dBs depending on OFFSET specified into Setup menu).
The resulting table can be printed with the internal Print command or saved as a text file, i.e. in ASCII
All report files have the **.RPT** extension.

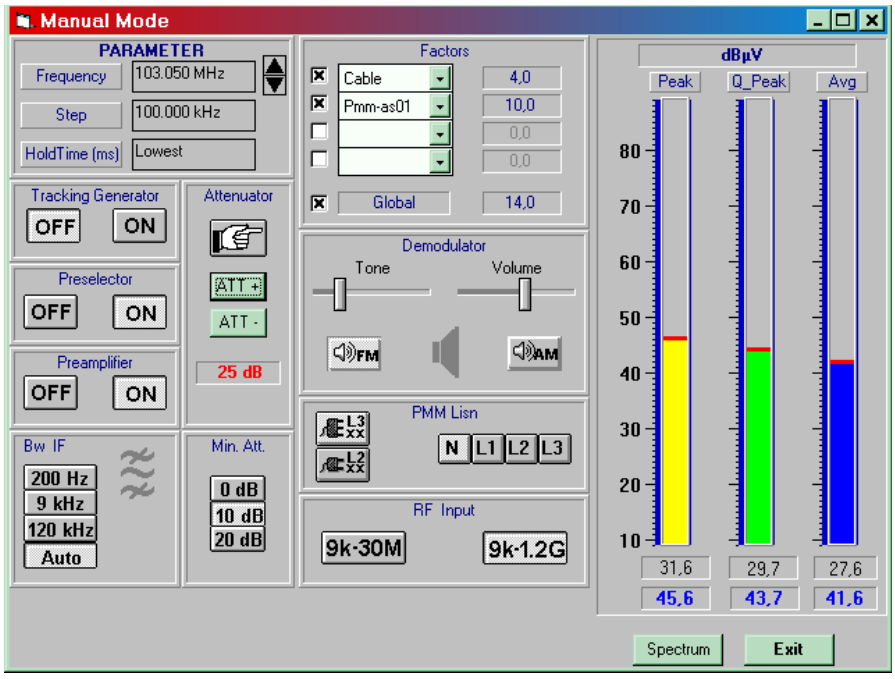
The **Zoom mode** command is used to enlarge a portion of the graph:
Enabling Zoom mode, the software will show two vertical bars located at the beginning and at the end of the graph.
Using mouse you can drag and drop them to any position in order to establish the portion of the display that has to be enlarged. Clicking inside the selected zoom window with the mouse activates the zoom function.
Moving again the two vertical bars the same operation can be repeated to get additional enlargements.
To deactivate the zoom function simply deselect the Zoom mode button.

Marker mode: is active in Zoom mode only. Is it possible to show a small arrow along the graphic curve, and select by the mouse every measured point of the graph. The Marker position frequency and level are displayed on the Status window at the bottom.



Marker mode example

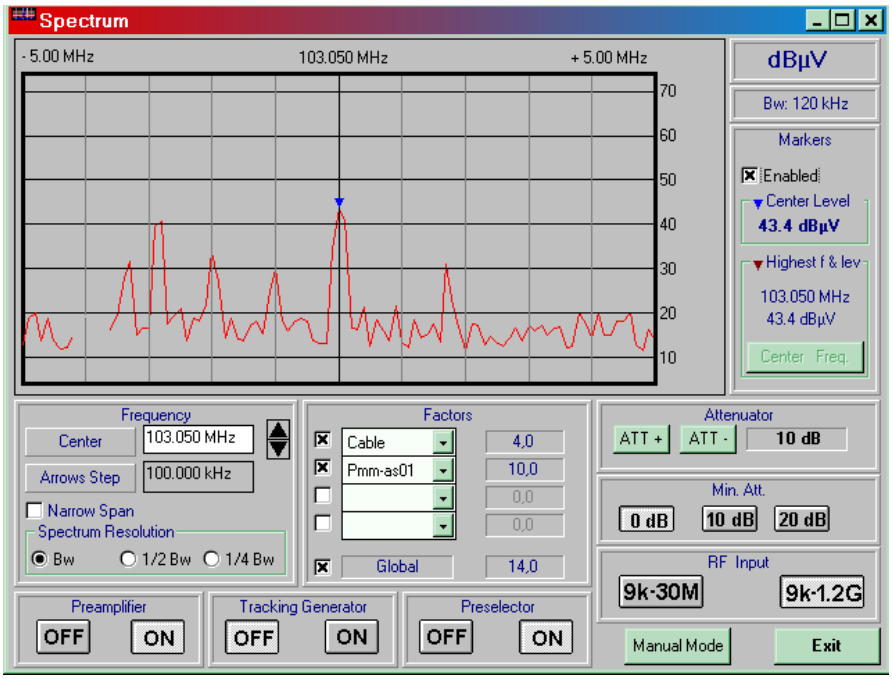
MANUAL mode: is a useful feature to control the receiver manually and to study electrical signals.
For example, if your emission signals exceeds the limit, you can observe them frequency by frequency, detect if they are real disturbances or signals coming from broadcasting stations by the demodulator feature.
Also you can see the signal values measured by the 3 detectors simultaneously.
Entering **Manual Mode** from the main menu, the display will look like the following:



Manual Mode is detailed in the chapter 4 "Manual Mode Operating Instruction" of this Manual.

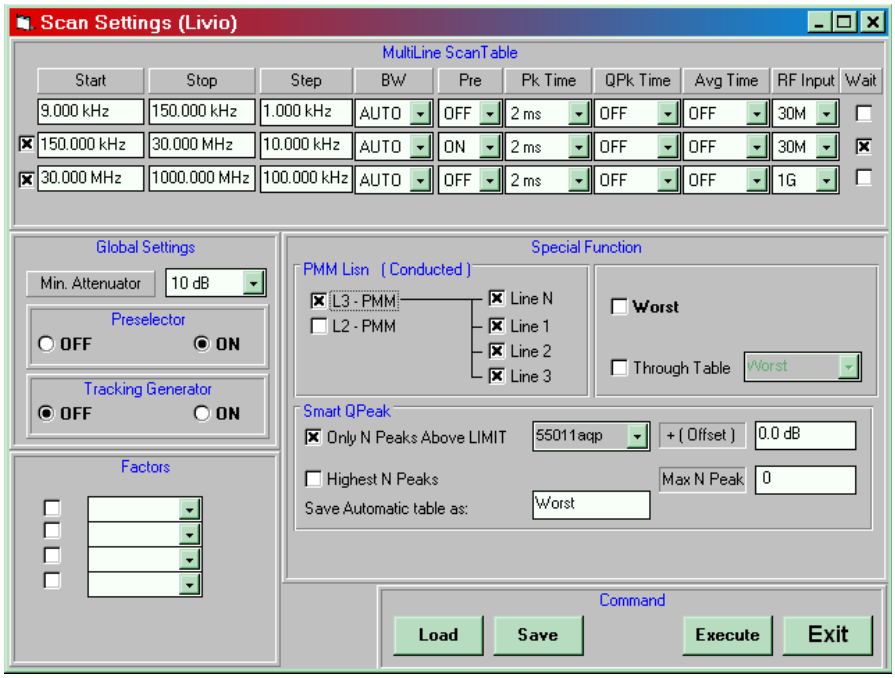
SPECTRUM mode: The display shows the "spectrum analysis" (span max ± 5 MHz) in the frequency domain of a signal tuned at a given frequency. Using the marker facility the user can accomplish a very accurate measurement of the signals either in frequency as well as in level.
The analysis is done at the selected span frequency.

Entering **Spectrum Mode** from the main menu, the display will look like the following:



Spectrum Mode is detailed in the chapter 5 "Spectrum Mode Operating Instruction" of this Manual.

SCAN mode: opens the scan setup window and allows to start a full scan:

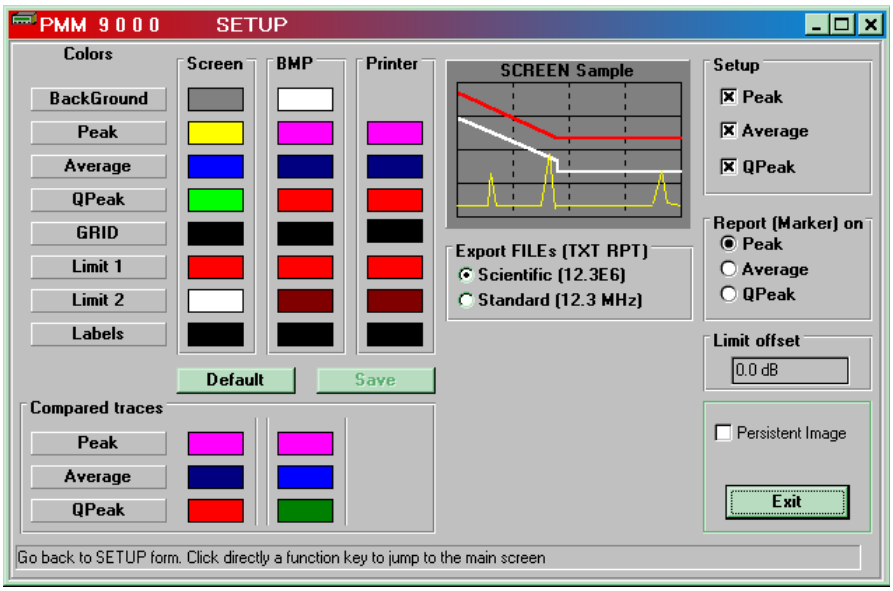


Scan Mode is detailed in the chapter 6 "Scan Mode Operating Instruction" of this Manual.

Worst mode command is used to get the worst case condition after having acquired several Scan sweeps, all worst peak detected are saved.
To stop the Worst mode simply press again the Worst mode push-button.
The user can view the worst peak detected using the Make report function.

General SETUP. This button is used to define which colors have to be used to display the graph; and limits, detectors, report type, offset, etc.
A brief description of each command is shown in the status line when mouse pointer is over each command.

When you click it the display will be:



Colors: from this menu you can select all colors associated with graph. Each individual items (background, detectors, grid, limits, labels or compared traces) can have an own color.
This setup is useful to chose graph colors for the printed result or which colors should have the file saved as bit mapped. If you want to save the new color configuration, you should use the button **SAVE**.
The **Default** button is used to load the colors predefined by PMM.

Export FILEs (TXT RPT)
The user can select Scientific or Standard number notation to export file to be used by other Windows applications.

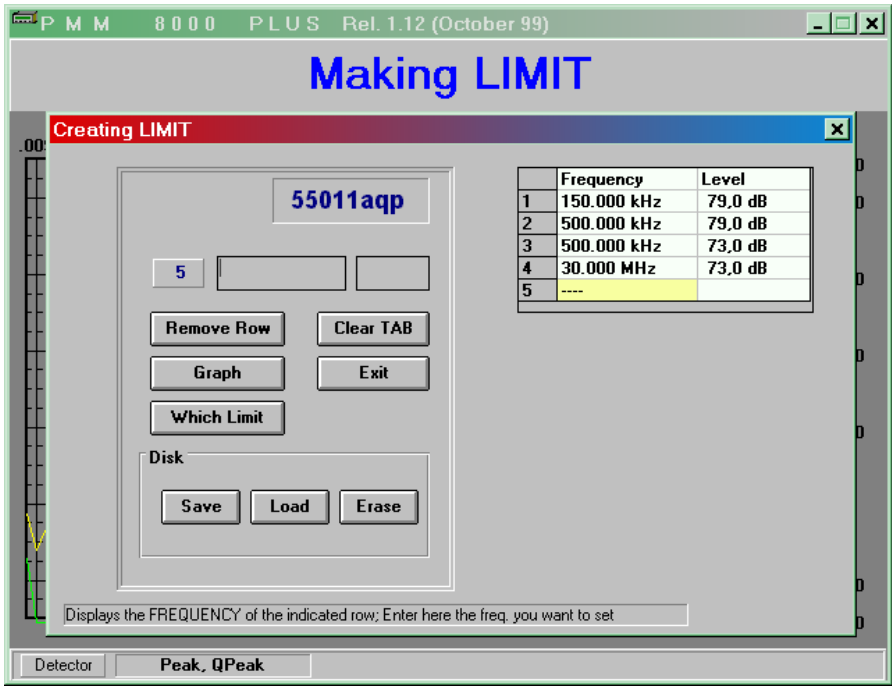
Setup
This function is used to select which measurements associated with a specific detector has to be displayed.

Report (Marker) on
This function is used to define where the marker have to be applied when making a report.

Limit offset
Inside this window you can write an offset to be used when Report mode of operation is called. The value can be positive or negative.

Persistent image
Enabling it, you do not need to use Redraw function to clear the display when it is eventually incomplete.
Of course this function will slow down the PC on drawing graphics.

Make Limit: This command is used to create or modify the limits.
When enabled, the limits are graphically shown on the graphical window. Clicking on the **Limit** button gives access to a special editor for creating and/or modifying limits. The screen display will resemble the following:



To assign frequency and level values just click on the desired row with the mouse and directly type in the frequency value and the level in dB.

Commands:

Remove row Rows in the table relative to a specific limit can be deleted with the **Remove Row** command.

The **Clear TAB** command permits a limit that is no longer used to be cancelled.
Before canceling the limit, the program displays a confirmation prompt.
An **OK** reply will effectively cancel the limit.

The **Graph** command, instead, is used to define the limits in a graphical manner. The program displays a window showing the frequency and level indicated by cross-wires. Clicking on adds the point to the limit table under construction. Step by step, move the cross-wires with the mouse to a certain point on the screen that has the desired frequency and level and then click on to add the point to the table.

Click on the **Back to Table** button to automatically pass from the graphical layout back to the tabular format for the current table.

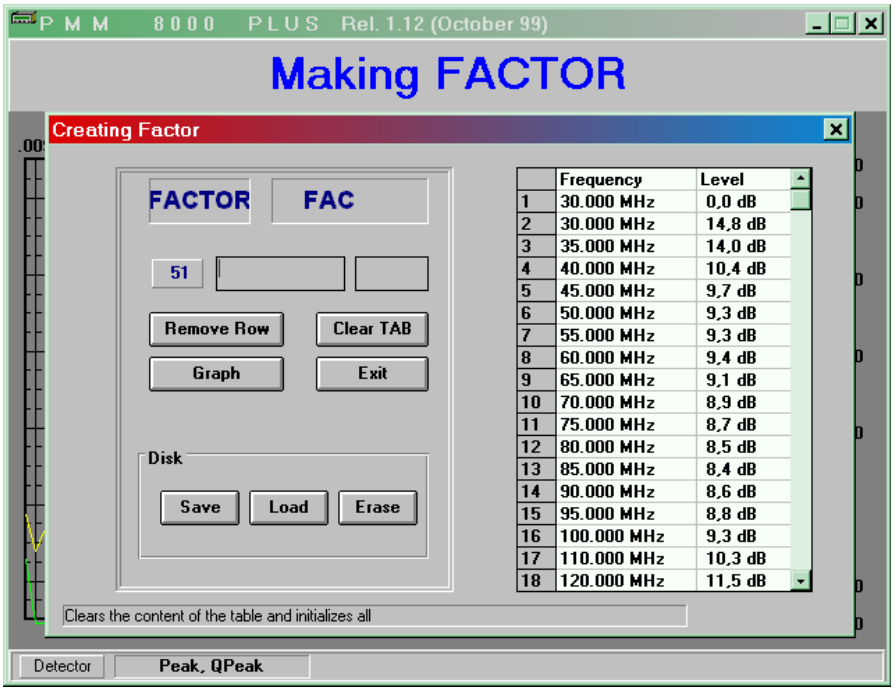
The **Exit** command exits the limits editor.
When a limit has been created, whether in tabular or graphical form, it should be saved using the **Save** command.
Clicking on **Save** enters the File Manager for assigning a name to the file to be saved. All limit files have the **.Lim** extension.

Clicking on **Load** will cause the File Manager to display all the limit files available for loading.
Select the limit you are interested for and push **OK**.

Which Limit. Enabling this function you move from Limit 1 to Limit 2 and viceversa.

Make Factor: This command is used to create, modify or load a saved frequency and level Factor table.
When using any transducers (e.g. an antenna or a probe) to feed the electrical signals to the receiver you shall compensate the measurements taking into account the gain or loss of the transducer itself and connecting cables as well, at any frequency to get the absolute value.
When you select **Factor** function you will get all the facilities to make a graph or a table to correct automatically your measurements.
The PMM 8000 Plus can handle factors ≥ -60 and ≤ 120.

Clicking on the **Make Factor** button gives access to a special editor for create or load the Factor table.
The screen display will resemble the following:



To use the Factor Table function follow this procedure:

- Create or load a table with factor frequencies and levels in dB.
- Start Scan then in the Factor section of the configuration window select up to four Factor Table to be added and chose the associated Factor file by the pull-down menu.
- Toggle Execute to start Scan.

Commands:

Remove row Rows in the Table relative to a specific frequency can be deleted with the **Remove Row** command.

The **Clear TAB** command permits a Table that is no longer used to be cancelled.
Before canceling the Table, the program displays a confirmation prompt.
An **OK** reply will effectively cancel the Table.

The **Graph** command, instead, is used to define the factor data in a graphical manner. The program displays a window showing the frequency and level associated to the position of the cross-wires. Clicking on, when in place with the mouse cursor, adds the point to the factor table under construction. Step by step, move the cross-wires with the mouse to a certain point on the screen that has the desired frequency and level and then click on to add the point to the table.

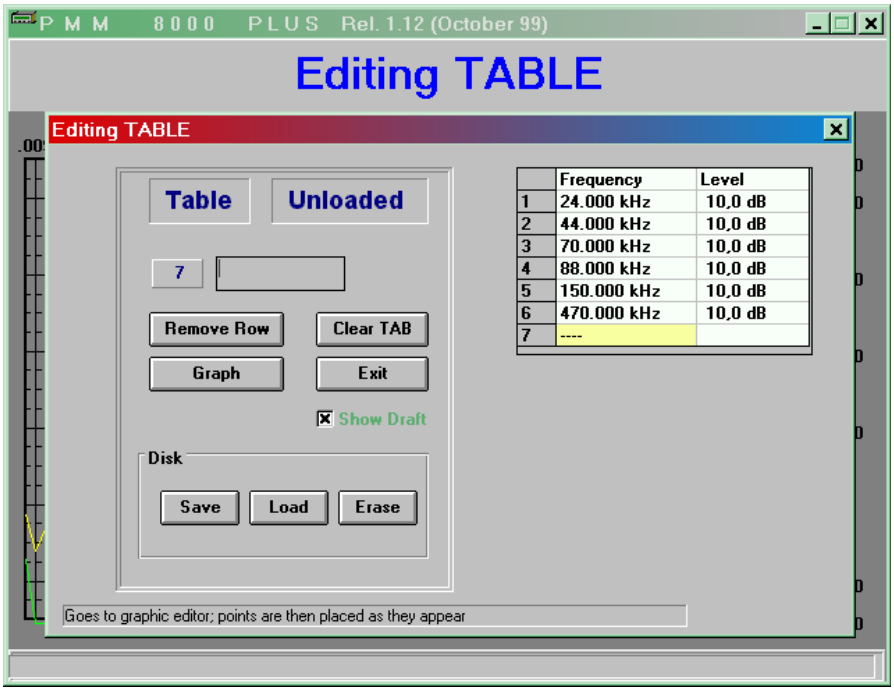
Click on the **Back to Table** button to automatically pass from the graphical layout back to the tabular format for the current table.

The **Exit** command exits the Factor Table editor.
When a Table has been created, whether in tabular or graphical form, it can be saved using the **Save** command.
Clicking on **Save** enters the File Manager for assigning a name to the file to be saved. All Table files have the **.ce9** extension.

Clicking on **Load** will cause the File Manager to display all the Factor Table files available for loading.
Select the Factor Table file you are interested for and push **OK**.

Clicking on **Erase** enters the File Manager for select a file name and to erase it from disk.
Before canceling the file, the program displays a confirmation prompt.
An **OK** reply will effectively cancel the file.

Make Table: This command is used to create or load a saved frequency table. With this function the user can make a Scan only on those frequencies selected in the loaded table. This procedure greatly reduce the Scan time. It is very useful when only some frequencies must be monitored eg. for debugging.
Clicking on the **Make Table** button gives access to a special editor for create or load the table.
The screen display will resemble the following:



To use the Table function follow this procedure:

- Create or load a table with needed frequencies.
- Start Scan, in the Special function section of the configuration window select Through table and set the Table file by the pull-down menu.
- Toggle Execute to start Scan.

NOTE

Creating a new table the level of 10 dB is set by default for each input frequency. After a Scan session these level values will be updated with the actual measured ones.
The user can save the Table with measured levels for future use or for reporting purposes.

Commands:

Remove row Rows in the Table relative to a specific frequency can be deleted with the **Remove Row** command.

The **Clear TAB** command permits a Table that is no longer used to be cancelled.
Before canceling the Table, the program displays a confirmation prompt. An **OK** reply will effectively cancel the Table.

The **Graph** command, instead, is used to define the limits in a graphical manner. The program displays a window showing the frequency indicated by cross-wires. Clicking on adds the point to the limit table under construction. Step by step, move the cross-wires with the mouse to a certain point on the screen that has the desired frequency and then click on to add the point to the table.

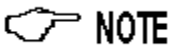
Click on the **Back to Table** button to automatically pass from the graphical layout back to the tabular format for the current table.

The **Exit** command exits the Table editor.
When a Table has been created, whether in tabular or graphical form, it can be saved using the **Save** command.
Clicking on **Save** enters the File Manager for assigning a name to the file to be saved. All Table files have the **.tb9** extension.

Clicking on **Load** will cause the File Manager to display all the Table files available for loading.
Select the Table you are interested for and push **OK**.

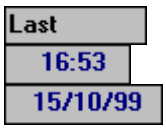
Clicking on **Erase** enters the File Manager for select a file name and to erase it from disk.
Before canceling the file, the program displays a confirmation prompt.
An **OK** reply will effectively cancel the file.

Activate Limit 1 and **Activate Limit 2** allows to insert one or two limits lines on the graphic window. Several limits files are available according to general standard.
Furthermore the user can set and save its own limits using the **Make Limit** function described above. The desired limit can be selected from the pull-down menu on the right side of each Activate Limit button.

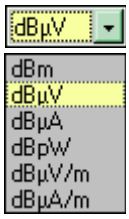


Making a report with **Make report** function described above, only **Make Limit 1** is taken into account to compare level data and limit.

Help: activating it, the user can get some helpful information about the software.

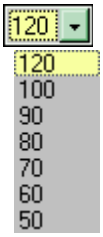


The **Name**, **Time** and **Date of sweep** are automatically set by the software at the start of the sweep. The user can edit them, if needed, simply typing new values on each window.

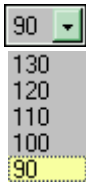


Unit command : the PMM 8000 Plus always measures voltages.
Therefore depending on your transducer, you should apply for the correct unit reading.
For example if you are using the LISN you should select dBµV.
If you use antennas you should change the unit to dBµV/m.
Using absorbing Clamp select dBpW.
From the **Unit** command you can select UNITs function in order to establish the unit to be used and displayed by the PMM 8000 Plus.

When change a unit the program automatically converts in the selected unit considering a 50Ω impedance.



The **Dynamic** command allows the measurement's dynamic to be selected between 50 to 120 dB. The Dynamic represents the difference between the maximum and minimum values that you can measure.



The **Reference Level** command allows the measurement's reference level (full scale) to be selected between 10 to 130 dB. The lowest value depends from the Dynamic value selected and it is always the difference between the reference and dynamic.

GTEM Correlation

Introduction

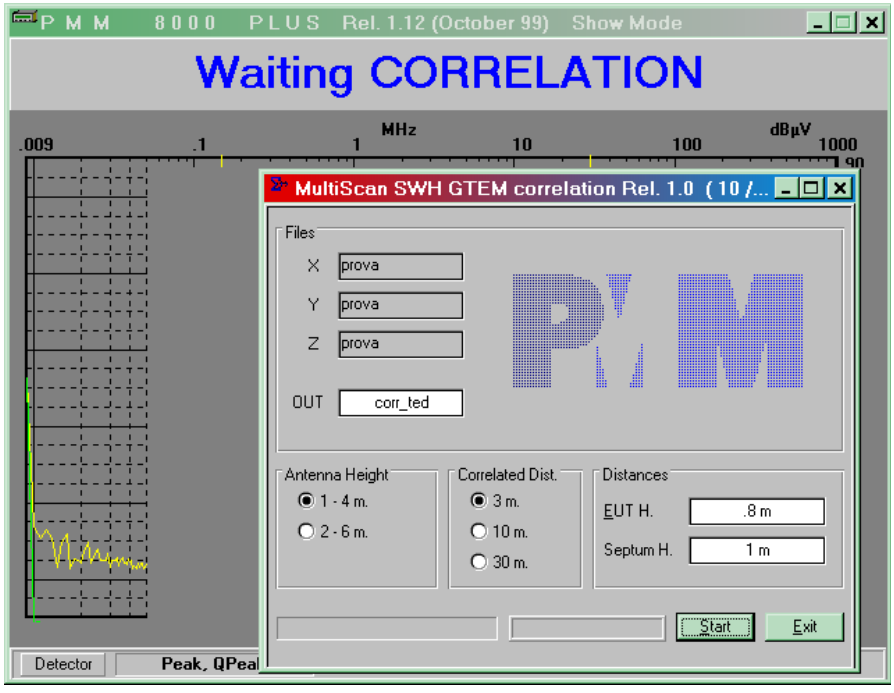
This program is used to interface data files generated by PMM 8000 Plus to the software supplied by EMCO concerning the correlation for measurements done with GTEMs to Open Area Test Site.
Before to start refer to the EMCO manual first.
The GTEM Correlation software implements an automatic procedure to get 3 sweeps from the PMM 8000 Plus, to correlate them with EMCO correlation software and after changing the format, recall the correlated data into PMM 8000 Plus to show the correlated results.

This program converts the voltages acquired by GTEM to the corresponding field strength values you can get from Open Area Test Site at 3, 10 or 30 meters.

The following procedure must be performed using the PMM 8000 Plus receiver.
You must perform 3 measurements. One every individual position of EUT (Equipment Under Test).
Then run the GTEM Correlation program, the software will generated a file with correlated data.

How to use

To run the correlation program click on Correlation icon; the screen looks like:



Correlation procedure

The procedure to get a correlated file is:

- To perform 3 measurements with PMM 8000 Plus;
- To run CORREL software (double click Correl icon);
- To enter files (X, Y, Z) and other pertinent parameters;
- To run correlation program clicking on Start button;
- To load the correlated file into the PMM 8000 Plus and to see the result.

Data entry

There are 8 data fields which are pertinent to the conversion process, or are desirable to save. These data windows are as follows:

- **Files** — this field should contains the input files and the output correlated file.

- **Antenna Height** — this is the antenna scan height which will correlate to the converted values. Only two choices are allowed (1-4 or 2-6 meters).

- **Correlated Dist** — this is the antenna distance which correlate to the converted values. Its value can be 3, 10 or 30 meters.

- Distances — this field provides the entry for EUT and Septum height.

EUT height — this is the measurement distance from the floor of the GTEM cell to the center of EUT. It MUST be less than the Septum Height.

Septum Height — this is the measured distance from the floor of the GTEM cell to a point on the Septum directly above the center of the EUT. It MUST be greater than EUT height.

- **Comment** — any pertinent comments or explanation about the device or test should entered here.

- **Status** — inform user about what Correl software is doing or ask for questions.

When you finished push Exit button**.**

From the main menu, you can invoke the load command to see the result of the correlation process. If the voltage level is too low or has negative number, you can select Min Level at -20 dB in order to have a better resolution.

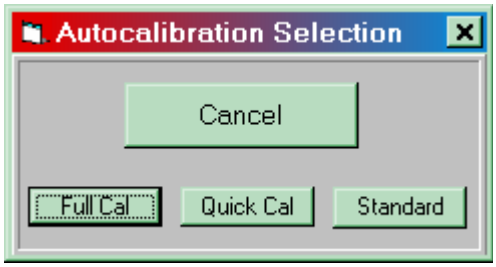
Autocalibration button starts an autocalibration session.

PMM 8000 Plus requires to be handled with care.
Calibration is required time to time or when you want to get the maximum accuracy in a peculiar measurement.
Each time you need to calibrate it, wait at least half an hour for warming it up.
PMM 8000 Plus has built in an high precision tracking generator that must be used to perform the calibration.
The tracking generator is an internal, high stability and accuracy, 50 Ohm RF generator (from 9 kHz to 1.2 GHz) always tuned at the same PMM 8000 Plus receiver frequency.

To calibrate the receiver follow this procedure:

- connect N-N coax cable, provided with the receiver, from RF Tracking Generator output to the 9 kHz - 1.2 GHz receiver input;
- turn PMM 8000 Plus on;
- wait at least ½ hour for warm up;
- push **Autocalibration** push-button;
- press **Quick CAL** key using functional key;

When the **Autocalibration** button is depressed the software will show:

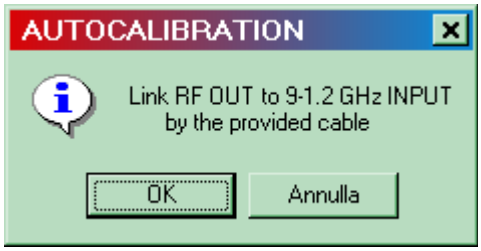


The choices are:

- **Full CAL** Preselector filters centering + level correction;
- **Quick CAL** Level correction only. Fastest mode;
- **Standard** recall of previously stored standard calibration file;
- **Cancel** aborts the Autocalibration session.

The level correction procedure will perform a calibration using any combination of preamplifier (on/off) and preselector (on/off).
That means PMM 8000 Plus will go through 4 calibration's steps.

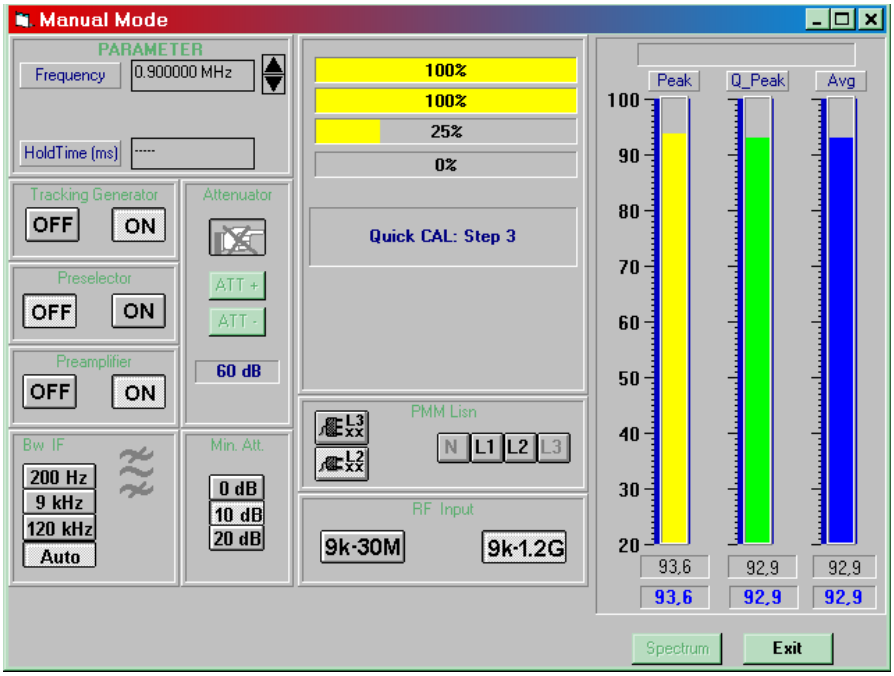
The following window will open to remember the user to connect the provided calibration cable:



Either Quick CAL or Full CAL can be performed, normally only Quick CAL is required for level correction, with Full CAL the preselector filters centering is also performed.

Quick CAL

Pressing OK the autocalibration starts performing the 4 calibration steps and showing the following table:

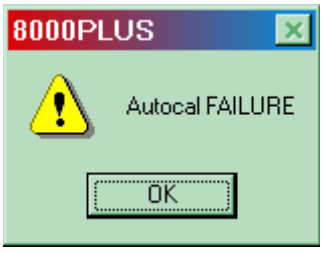


During the autocalibration four increasing bar will show the calibration progress. As soon as all steps are done, PMM 8000 Plus exits the calibration window and the calibration is finished and saved.

NOTE

The user can exits the calibration session at any time pressing the Exit button, in this case, the receiver will use the last stored calibration, if calibration is needed, it shall be restarted from the very beginning.

If calibration fails the PMM 8000 Plus displays a warning message to indicate that it can not perform internal Auto Calibration. The display will be:

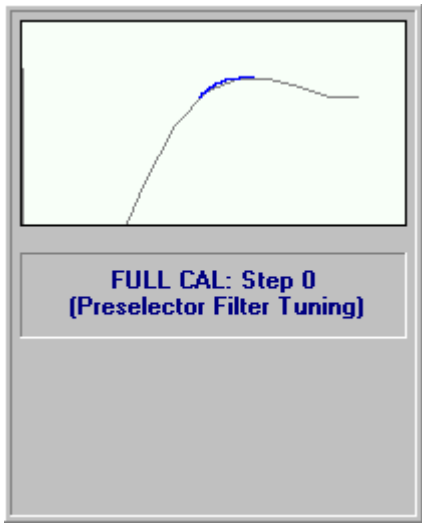


If the case try first to change the calibration cable provided, otherwise the equipment need to be repaired, contact your PMM representative.

Full CAL

Full CAL performs the input preselector filters centering and the four steps of the level correction as well.
It takes a longer time to end compared to Quick CAL.

The preselector filters correction shows the following subwindow in the autocal table:



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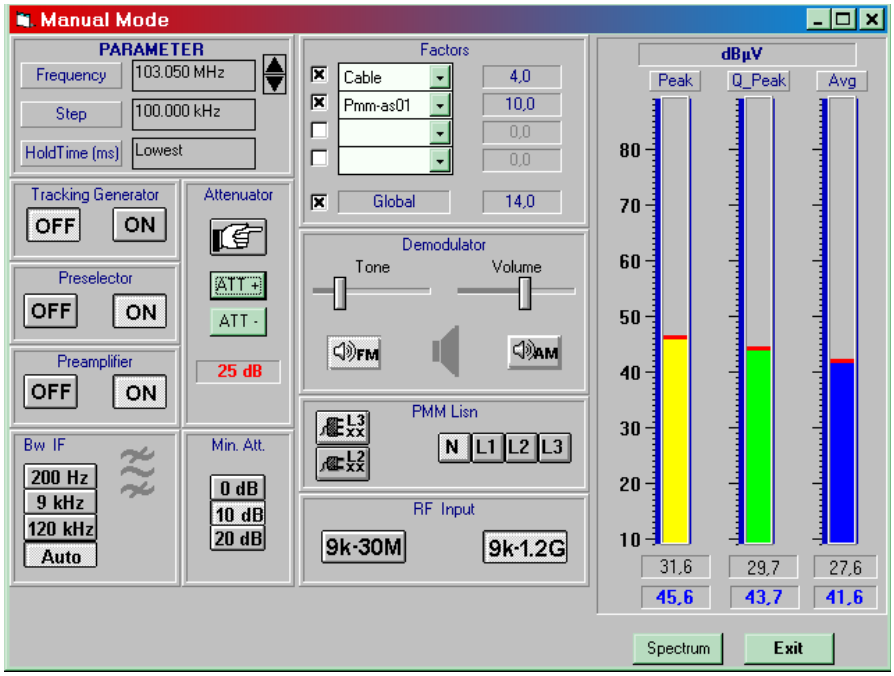
4 - Manual Mode Operating Instructions

MANUAL mode: is a useful feature to control the receiver manually and to study electrical signals.
For example, if your emission signals exceeds the limit, you can observe them frequency by frequency, detect if they are real disturbances or signals coming from broadcasting stations by the demodulator feature.
Also you can see the signal values measured by the 3 detectors simultaneously.

Entering **Manual Mode** from the main menu, the display will look like the following:



The Manual mode table is divided into twelve sub windows:

- **Parameter**
- **Tracking generator**
- **Preselector**
- **Preamplifier**
- **Bw IF**
- **Attenuator**
- **Min. Att.**
- **Factors**
- **Demodulator**
- **PMM Lisn**
- **RF Input**
- **Detector reading bars**

4.1 Parameter

Allows the user to set the main parameters.

The center **Frequency** of the reading. It can be directly edited into the window or set by the up-down arrow buttons.

Step command is used to select the frequency step associated with the up and down keys.

Hold time (ms)
Some times the interference signals have a low repetition rate. In this case PMM 8000 Plus tries to find the proper attenuation setting changing up and down the internal attenuator. If the **HOLD TIME** is too low the PMM 8000 Plus can not set the proper attenuation. The result is that PMM 8000 Plus continues to change the attenuation displaying a continuous different value. On the other hand if the **HOLD TIME** is too high the PMM 8000 Plus can not properly follow signals.
The **HOLD TIME** value should be set to find a correct compromise.
A small horizontal indicator is shown in the upper most of each detector vertical reading bar showing the value of the measure taken at each Hold Time interval. It is associated to the digital value shown in the bottom windows.
When the **HOLD TIME** is set to below 11 msec. the Hold Time window shows “Lowest” instead of the typed value. The max. **HOLD TIME** should be lower than 30 sec (30000 ms).

4.2 Tracking generator

The tracking generator is an internal, high stability and accuracy, 50 Ohm RF generator (from 9 kHz to 1.2 GHz) always tuned at the same PMM 8000 Plus measurement frequency. It is used for several applications. The tracking generator is mandatory to calibrate the receiver itself, or to use PMM 8000 Plus as a network analyzer or for other functions like design and test of RF filters. **Tracking Generator** has a fixed output of 90 dBµV; If you require higher or lower level, provide for an attenuator or an amplifier.
In this case we recommend to use the **Correction Factor** mode to create a table to take in account the attenuation or gain provided by your device.
It can be set either On or OFF with the associated button.

4.3 Preselector

The preselector is a group of filters selected automatically by the PMM 8000 Plus while it is sweeping. The preselector avoids all mixer intermodulation problems. Normally it should be always enabled.
It can be set either On or OFF with the associated button.

4.4 Preamplifier

The internal 10 dB preamplifier can be used when very weak signals have to be investigated. It can be set either On or OFF with the associated button. With preamplifier ON the receiver takes automatically care of the 10 dB gain when measuring the signals.

4.5 Bw IF

Bw IF command is used to select the bandwidth of the intermediate frequency measuring filter. Three bandwidth filters are available:

- 200 Hz from 9 to 150 kHz
- 9 kHz from 150 kHz to 30 MHz
- 120 kHz from 30 MHz to 1.2 GHz

You can choose any possible filter or use automatic selection with the **AUTO** function. In **AUTO** the filter will be automatically selected according to CISPR 16-1 standard, depending on the sweeping frequency range selected.

4.6 Attenuator

Using 0 dB attenuation PMM 8000 Plus has no input protection.
This is a potential dangerous condition for the input stage of the receiver.
Use 0 dB attenuation only if you are very sure that your input signal is less than 1 V (or 120 dBμV).
Before to apply an unknown signal to PMM 8000 Plus receiver, use an oscilloscope or a wide band RF voltmeter to measure it. In any case set Min. ATT at 20 dB with preamplifier OFF.
If needed, add a crossing power attenuator to the input signal line.

CAUTION

The manual attenuator can be inserted or excluded using the button.
With **ATT +** and **ATT -** buttons the user can set the attenuation value up and down at 5 dB step.

4.7 Min. Att.

This window allows the minimum attenuation to be set either to 0, 10 or 20 dB. When the minimum attenuation is active, the manual attenuator cannot be lowered under the set value.
The value set is showed in lighter gray color.

4.8 Factors

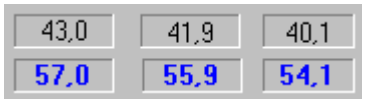
When using any transducers (e.g. an antenna or a probe) to feed the electrical signals to the receiver you shall compensate the measurements taking into account the gain or loss of the transducer itself and connecting cables as well, at any frequency to get the absolute value.
When you select **Factor** function you will get all the facilities to make a graph or a table to correct automatically your measurements.
Any measurement already taken can be later recalculated using data stored in the above mentioned tables or graph to linearize any non linear devices connected to the receiver.

By the **Factors** window the user can select up to four different correction factors tables from the files previously stored with the **Factor** function.

The **Global** selection allows to activate or deactivate all loaded factors.

The factor value at the center frequency is displayed on the right of each box. The total factor applied is displayed afterwards the Global box.

NOTE



On the bottom of the bar window the digital readout is simultaneously shown for each detector, the top line reports the actual values and the bottom line the absolute values taking into account the loaded correction factor or factors.

4.9 Demodulator

In the **Demodulator** window the demodulation capability of the PMM 8000 Plus can be activated. This feature is useful to discriminate if the measured emission disturbances come from the EUT or from nearby broadcasting stations. FM and AM demodulators are available.
The FM demodulator is set to FM WIDE over 30 MHz and FM NARROW below 30 MHz.
You can use PMM 8000 Plus as a radio.

NOTE

Depending on your local law, we advise you that could be forbidden to listen some specific communication frequencies.
PMM denies any responsibility due to the improper use of the receiver.

Either the built in loudspeaker or external phones can be used to ear the received signals.
Slide volume and tone controls allow to easily suite the operator needs.

4.10 PMM Lisn

By this window the user can take the control of a external PMM Line Impedance Network connected to the User Port on the rear panel of the PMM 8000 Plus to perform conducted interference measurements of the EUT.

L3 selects a four phase LISN.
L2 selects a single phase LISN.
N, L1, L2 and L3 are used to select the line where the manual measure should be taken.

WARNING

Before connecting the LISN, ensure that an uninterruptible safety earth ground is provided from the main power source to the product protective earth connection. When the LISN is to be connected to other equipment like the PMM 8000 Plus or accessories, prior to energizing either unit verify that a common ground exists between them.
Any interruption or loosening of the protective earth ground conductor, either inside or outside the unit or in an extension cable will cause a potential shock hazard that could result in personal injury. Verify the safety earth ground functionality before operation.

WARNING

The leakage currents between the phases and the earth line of a LISN generally exceed permitted limits for typical environments due to internal capacitors; for this reason it is mandatory to use a current rated insulating transformer to supply the PMM LISN.

WARNING

The LISN, the insulating transformer and Equipment Under Test must be provided by an appropriate current rated contact breaker or fuses as closest as possible on the supply line and with a safety indication of equipment operated by.

CAUTION

To avoid any damage caused by transient current pulses, disconnect the PMM 8000 Plus input from the LISN output before switching the LISN AC supply on or off

---

4.11 RF Input

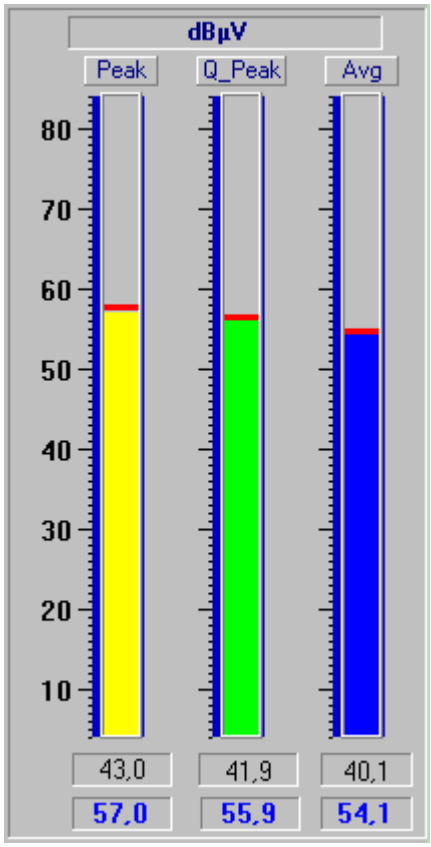
This command window allows to select the proper receiver input:

The **9 kHz - 30 MHz** input should be used when a conducted measurement with an artificial mains network must be performed, this input has a built in pulse limiter. It works until 30 MHz only.
The pulse limiter a useful device to protect the input of the receiver from overvoltages. Quite often the conducted disturbances are too high, even if you cannot see them on PMM 8000 Plus because they are out of measurement bandwidth, and the associate energy is high enough to damage the input attenuator or mixer.

If you have no idea about your input signal, use an oscilloscope to measure the maximum amplitude before feeding it to PMM 8000 Plus, if it is to high, use an external 20 dB attenuator.

The **9 kHz - 1,2 GHz** input instead is straight connected to the first receiver input stage.

4.12 Detector reading bars



Either analog and digital readout are available in this window.

The unit (dBm, dBµV, dBµA, dBpW, dBµV/m, dBµA/m) set on the main panel is shown in the uppermost window side.
Three vertical bar, one for each detector, display the analog value, the proper signal scale is automatically set.

On the bottom the digital readout are shown.

4.13 Spectrum

Spectrum button switches the receiver in spectrum mode.

4.14 Exit

Exit button exits the receiver from manual mode to the main window.

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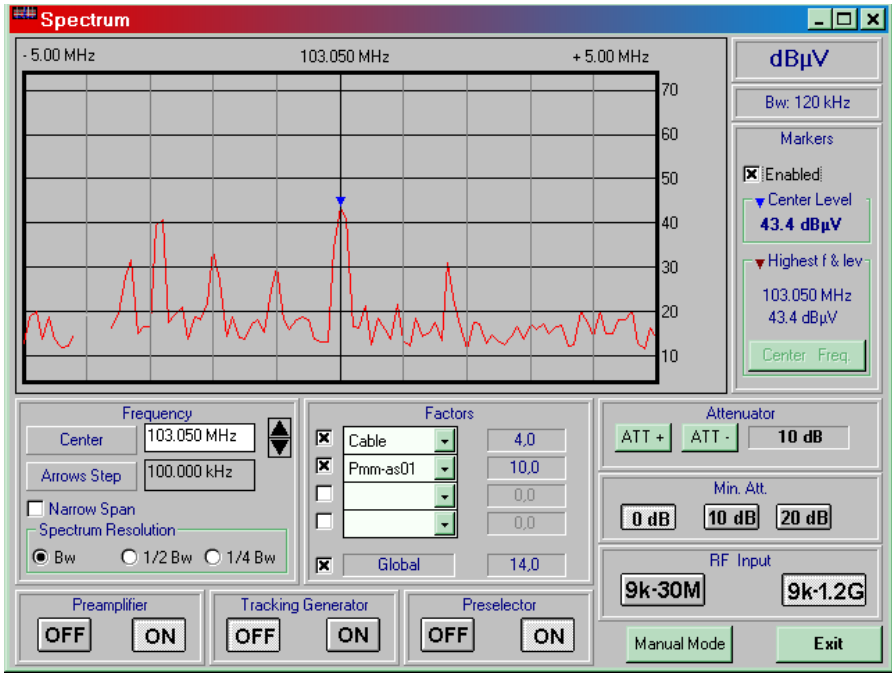
5 - Spectrum Mode Operating Instructions

SPECTRUM mode: The display shows the "spectrum analysis" (span max ± 5 MHz) in the frequency domain of a signal tuned at a given frequency. Using the marker facility the user can accomplish a very accurate measurement of the signals either in frequency as well as in level.
The analysis is done at the selected span frequency.

Entering **Spectrum Mode** from the main menu, the display will look like the following:



NOTE

The spectrum mode is enabled above 150 kHz.

The Spectrum mode table is divided into twelve sub windows:

- **Frequency**
- **Factors**
- **Preamplifier**
- **Tracking generator**
- **Preselector**
- **Attenuator**
- **Min. Att.**
- **RF Input**
- **Unit**
- **Bw IF**
- **Markers**
- **Spectrum graphical display**

5.1 Frequency

Allows the user to set the main parameters.

The **Center** frequency of the Spectrum window. It can be directly edited into the window or set by the up-down arrow buttons.

Arrows Step command is used to select the frequency step associated with the up and down keys.

Spectrum Resolution
The spectrum span can be set selecting the corresponding check box, the value selected is directly shown on the spectrum window.
Bw = ± 5 MHz
1/2 Bw = ± 2,5 MHz
1/4 Bw = ± 1,25 MHz

When **Narrow Span** is checked the spectrum span is halved.

5.2 Factors

When using any transducers (e.g. an antenna or a probe) to feed the electrical signals to the receiver you shall compensate the measurements taking into account the gain or loss of the transducer itself and connecting cables as well, at any frequency to get the absolute value.
When you select **Factor** function you will get all the facilities to make a graph or a table to correct automatically your measurements.

By the **Factors** window the user can select up to four different correction factors tables from the files previously stored with the **Factor** function.

The **Global** selection allows to activate or deactivate all loaded factors.

The factor value at the center frequency is displayed on the right of each box. The total factor applied is displayed afterwards the Global box.

5.3 Preamplifier

The internal 10 dB preamplifier can be used when very weak signals have to be investigated.
It can be set either On or OFF with the associated button.

5.4 Tracking generator

The tracking generator is an internal, high stability and accuracy, 50 Ohm RF generator (from 9 kHz to 1.2 GHz) always tuned at the same PMM 8000 Plus measurement frequency. It is used for several applications. The tracking generator is mandatory to calibrate the receiver itself, or to use PMM 8000 Plus as a network analyzer or for other functions like design and test of RF filters. **Tracking Generator** has a fixed output of 90 dBµV; If you require higher or lower level, provide for an attenuator or an amplifier.
In this case we recommend to use the **Correction Factor** mode to create a table to take in account the attenuation or gain provided by your device.
It can be set either On or OFF with the associated button.

5.5 Preselector

The preselector is a group of filters selected automatically by the PMM 8000 Plus while it is sweeping. The preselector avoids all mixer intermodulation problems. Normally it should be always enabled.
It can be set either On or OFF with the associated button.

5.6 Attenuator

Using 0 dB attenuation PMM 8000 Plus has no input protection.
This is a potential dangerous condition for the input stage of the receiver.

CAUTION

Use 0 dB attenuation only if you are very sure that your input signal is less than 1 V (or 120 dBμV).
Before to apply an unknown signal to PMM 8000 Plus receiver, use an oscilloscope or a wide band RF voltmeter to measure it. In any case set Min. ATT at 20 dB with preamplifier OFF.
If needed, add a crossing power attenuator to the input signal line.

With **ATT +** and **ATT -** buttons the user can set the attenuation value up and down at 5 dB step.

5.7 Min. Att.

This window allows to set the minimum attenuation either to 0, 10 or 20 dB. When the minimum attenuation is active, the manual attenuator cannot be lowered under the set value.
The value set is showed in lighter gray color.

A Over Range indication will automatically inform the user if level of signals in the spectrum window is too high and thus a higher attenuation should be set.

5.8 RF Input

This command window allows to select the proper receiver input:

The **9 kHz - 30 MHz** input should be used when a conducted measurement with an artificial mains network must be performed, this input has a built in pulse limiter. It works until 30 MHz only.
The pulse limiter a useful device to protect the input of the receiver from overvoltages. Quite often the conducted disturbances are too high, even if you cannot see them on PMM 8000 Plus because they are out of measurement bandwidth, and the associate energy is high enough to damage the input attenuator or mixer.
If you have no idea about your input signal, use an oscilloscope to measure the maximum amplitude before feeding it to PMM 8000 Plus.
The **9 kHz - 1,2 GHz** input instead is straight connected to the first receiver input stage.

5.9 Unit

The measure unit (dBm, dBμV, dBμA, dBpW, dBμV/m, dBμA/m) set on the main panel is shown in this window.

5.10 Bw IF

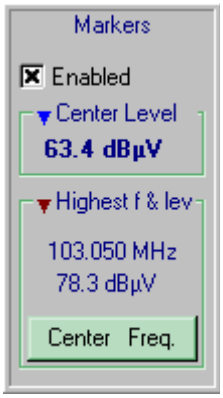
The bandwidth of the intermediate frequency measuring filter is shown in this window. The bandwidth can be set in Manual mode.
Three bandwidth filters are available:

- 200 Hz
- 9 kHz
- 120 kHz

You can choose any possible filter or use automatic selection with the **AUTO** function. In **AUTO** the filter will be automatically selected according to CISPR 16-1 standard, depending on the sweeping frequency range selected.

5.11 Markers

In this window two different **Markers** can be **Enabled**.

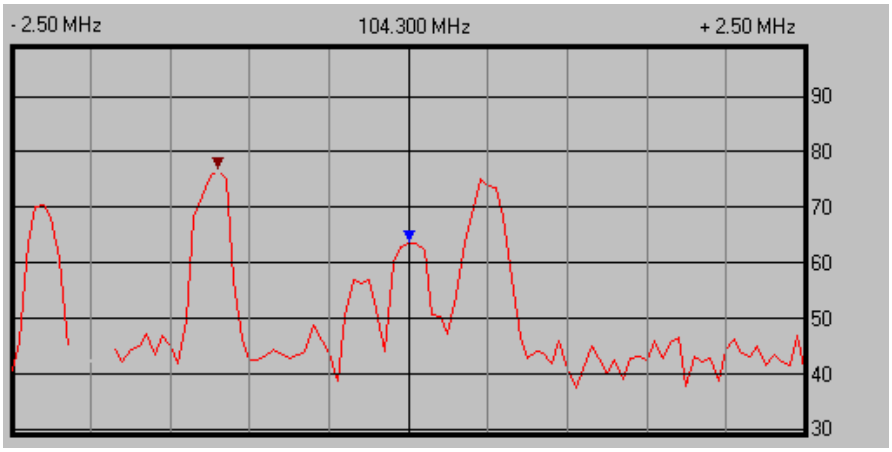


The **Center Level** marker is shown in the spectrum window by a small blue arrow and the read level value is displayed.

The **Highest f & lev** marker will automatically point to the frequency with the highest signal level found in the span range of the spectrum window by a small black arrow.
Both frequency and level are displayed.

By selecting the **Center Freq**. button the center frequency of the spectrum window will be automatically set on the highest signal level found.
This is very useful when worst signal shall be investigated.

The spectrum graphical display look like the following:



5.12 Manual Mode

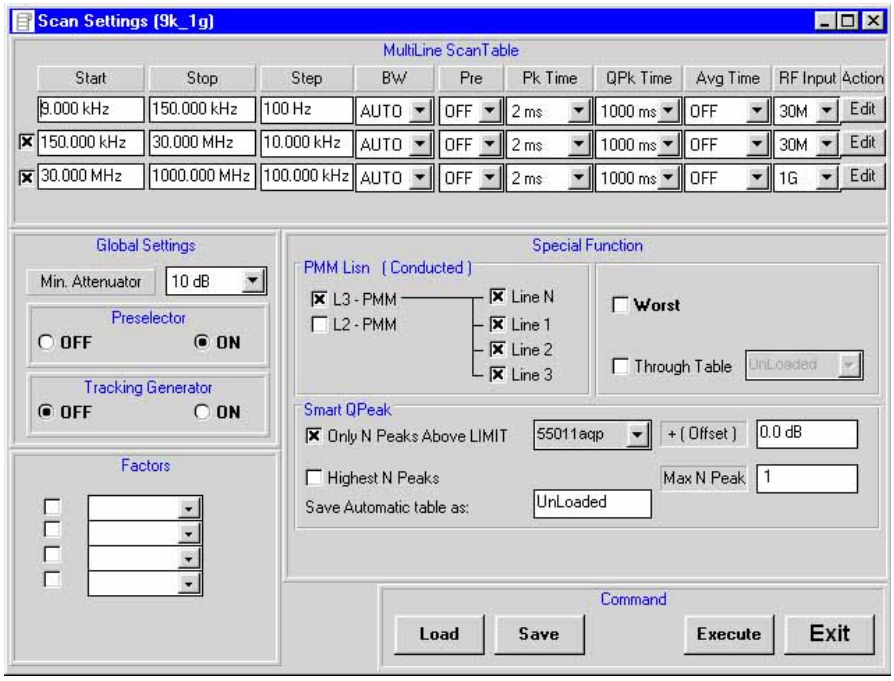
Manual button switches the receiver in manual mode.

5.13 Exit

Exit button exits the receiver from spectrum mode to the main window.

6 - Scan Mode Operating Instructions

SCAN mode: opens the scan setup window and allows to start a full scan:



As the configuration is finished the user can either select to **Save** it into a **ScanTab** file that will store configuration data in a program proprietary format (*.ST9) for next measurement the file can be loaded clicking on the **Load** button.
The measurement scan starts toggling the **Execute** button.
Exit button exits the configuration table.
Once the scan starts it can be paused or stopped during execution by the two push buttons in the main window:

 Pause button  Stop button

NOTE

Start, Stop and Pause of the Scan mode can be executed also by the key-buttons on the front panel of the receiver. The corresponding function of each key-button is shown on the PMM 8000 Plus display.

The scan setting configuration table is divided into five sub windows:

- **Multi Line Scan Table**
- **Global Settings**
- **Factors**
- **Special Function**
- **Command**

6.1 Multi Line Scan Table

Allows the user to set the main scan parameters. Three different ranges and/or setting are available.
The setting lines 2 and 3 can be enabled selecting the square at the very beginning of every line.

NOTE

Note that the receiver works into 3 main frequency band:

- **9 kHz to 150 kHz**
- **150 kHz to 30 MHz**
- **30 MHz to 1200 MHz**

This must be taken into account when setting the to be measured frequency range. Setting a single range exceeding the above band limits will open an error window as follow:

For each line scan table the user can set the following:

- Scan ***Start*** and ***Stop*** frequencies simply writing them down;
- ***Step*** between each next measured frequency according to standard requirement or user need;
- ***BW*** Intermediate Frequency bandwidth allows to set by the pull-down menu between:
  - *AUTO*matic program selection
  - *200* Hz
  - *9* kHz
  - *120* kHz
- ***PRE***amplifier *ON* or *OFF*;
- ***Pk Time***: the maximum time the receiver stops on each measured frequency for the Peak detector, it can be set, by the pull-down menu, between: 2, 4, 10, 50, 100, 200, 500, 1000, 2000 and 5000 ms;
- ***QPk Time*** the maximum time the receiver stops on each measured frequency for the Quasi-Peak detector, it can be set, by the pull-down menu, between: OFF, 500, 1000, 2000 and 5000 ms;
- ***Avg Time*** the maximum time the receiver stops on each measured frequency for the Average detector, it can be set, by the pull-down menu, between: OFF, 10, 50, 100, 200, 500, 1000, 2000 and 5000 ms;
- ***RF Input*** to select the equipment front panel input between 9 kHz - 30 MHz and 9 kHz - 1,2 GHz.
- ***Action*** when **Edit** is selected allows to pause the current scan to change antenna or equipment set up etc, and also to set a desired output to the User Port as explained in 6.1.1.

6.1.1 Action

Allows the user to output data to the user port. Just before the sweep starts the receiver will send <data> to the **User Port** and the <data> will be kept until another different sweep starts.

In this way it is possible to have an output available for external equipment control such as PMM LISN or other.

The weights (values) associated with each BIT are:

BIT	**D0**	**D1**	**D2**	**D3**
Weight	1	2	4	8

PIN #	**Signal**
11	ground
3	+ 12 VDC (max 50 mA)
4	D0
5	D2
6	D4 (not implemented)
12	D1
13	D3

Data output (D0 to D3) are TTL level with max. 1 mA draining.

if you need to output **"1100"** to the user port, you must use Edit feature writing the instruction **"12" ;** where 12 is the equivalent in decimal base of 1100 obtained adding all the **Weights**.
In our example is: 8+4+0+0 = 12.

Example:

User Port = 1	Line-1 activation
User Port = 2	Line-2 activation
User Port = 3	Line-3 activation

With the above example, PMM 8000 PLUS will perform in sequence, as soon as you push **EXEC** command, the following steps:

1. Write 1 to the user port. In our case PMM 8000 PLUS will enable LINE 1 of LISN. Then sweeps with the parameters written into Scan table and displays the graph to the screen;
2. Write 2 (decimal value) to the user port. In our case PMM 8000 PLUS will enable LINE 2 of the LISN. Then sweeps again with the parameters written in the second line of the table and displays to the screen the new trace keeping the first one;
3. Write 3 (decimal value) to the user port. In our case PMM 8000 PLUS will enable LINE 3 of the LISN. Then sweeps again with the parameters of the third line and displays to the screen also this trace;

In this way it is possible a direct compare between subsequent sweeps.

6.2 Global Settings

Allows the user to set the global receiver parameters:

- **Min. Attenuator**
- **Preselector**
- **Tracking Generator**

Min. Attenuator

Enables the minimum attenuator setting between 10 and 60 dB at 10 dB step.

NOTE

During Scan mode the receiver adjusts automatically the internal input attenuators to match the input signal strength.
When the input signal strength is not known and can have some very high peak signals, to preserve the receiver input from damage the user can set the PMM 8000 Plus so that the automatic attenuation can not go down the Min. Attenuator value set.

Preselector

The preselector is a group of filters selected automatically by PMM 8000 Plus while it is sweeping.
The preselector avoids all mixer intermodulation problems.
Normally it should be always enabled.
The user has two choices:

- Preselector ON
- Preselector OFF

Tracking Generator

The tracking generator is an internal, high stability and accuracy, 50 Ohm RF generator (from 9 kHz to 1.2 GHz) always tuned at the same PMM 8000 Plus measurement frequency.
It is used for several applications.
The tracking generator is mandatory to calibrate the receiver itself, or to use PMM 8000 Plus as a network analyzer or for other functions like design and test of RF filters.
The Tracking Generator has a fixed output of 90 dBµV; If you require higher or lower level, provide for an attenuator or an amplifier.
In this case we recommend to use the **Correction Factor** mode to create a table to take in account the attenuation or gain provided by your device.

CAUTION

Be sure not to overload PMM 8000 Plus: the input signal should not exceed 127 dBµV.
Also do not apply any signal to RF generator output connector.

NOTE

Turn Off the tracking generator while you are in **Scan Mode**.
This prevents interferences and the measurements are more clean and accurate.

6.3 Factors

Allows the user to set the Factor receiver parameters, up to four different factors can be loaded and added each other.

When using any transducers (e.g. an antenna or a probe) to feed the electrical signals to the receiver you shall compensate the measurements taking into account the gain or loss of the transducer itself and connecting cables as well, at any frequency to get the absolute value.

When you select a **Factor** you will load a correction factor table to make a graph or a table that correct automatically your measurements.

Any measurement already taken can be later recalculated using measurement data stored to linearize any non linear devices connected to the receiver.

The PMM 8000 Plus can handle factors ≥ -60 and ≤ 120.

6.4 Special Function

Allows the user to set several receiver Special function parameters:

- **PMM Lisn (Conducted)**
- **Worst**
- **Through Table**
- **Smart QPeak**

PMM Lisn (Conducted)
The user can select to control via the PMM 8000 Plus user port either a three phase PMM Lisn (PMM-L3) or a single phase PMM Lisn (PMM-L2).
For each Lisn one or more mains line phase to be measured can be selected.
The receiver makes a complete scan on the first selected phase, then repeat the scan on and automatically switching the Lisn to the next selected phase and so on, during the process the software stores only the worst measured level for each measured point (frequency).
The result is a single graph where the worst result of the total taken measurement is represented.

Worst can be selected to get the worst case condition after having acquired several Scan sweeps, all worst peak detected are saved.
This selection acts like the Worst push-button on the main panel.
To stop the Worst mode simply press the Worst mode push-button on the main panel.
The user can view the worst peak detected by the Make report function.

Through Table this function allows to make a Scan only on those frequencies defined in the loaded table.

☞ NOTE

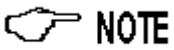
The Table file , created with the Make Table function, can be selected and loaded by the pull-down menu window.
This procedure greatly reduce the Scan time. It is very useful when only some frequencies must be monitored or measured, eg. for debugging.
The Scan table can be created automatically using the Smart Qpeak functon.

Smart Qpeak

Only N Peaks Above LIMIT
The software is creating a table where only the N Peaks found over the selected limit ± the selected OFFSET are stored.
This is useful in case a lot of points are well above the limit thus creating very large tables and files, with this function the user can define only higher values referred to the limit and concentrate the debugging on them.
Another case can be to store a table with all the points that are nearest but not above the limit inside a user defined - OFFSET.
Moreover, with this function, only those points found out of limit during the Peak scan are immediately measured and stored with the QuasiPeak detector, thus resulting in a faster scan sweep.

The limit can be either loaded on the main window by the **Activate Limit 1** and **Activate Limit 2** push-button or selected from the pull-down menu.
The required + or - **Offset** value can be directly edited into the window.

Highest N peaks
With **Highest N peaks** selected only the highest N peaks frequency value found in a Peak scan are stored and then measured with the Qpeak detector.
The number of points N to be measured can be directly edited into the **Max N Peak** window.
Writing down a file name into the **Save Automatic Table as** window allows to save the process result into a Table file that can be later reloaded.



The Qpk Time must be set on the MultiLine Scan Table to allow to the Smart Qpeak functions to take effect.

6.5 Command

On the command line the user can either **Load** or **Save** the *.st9 file with the Scan Settings.
Clicking on **Save** or **Load** enters the File Manager for assigning a name to the file to be saved or loaded.

Execute run the scan, this button is disabled with the program in Show mode.

Exit exits the Scan mode.

7 - Applications

7.1 Measuring the RFI Voltage

RFI voltage measurements are carried out on power supply lines or on signal lines by means of "Coupling Networks". The frequency range is generally limited from 9 kHz to 30 MHz in commercial Standards, but for measurements on automotive accessories and on communication equipment (ITE) or ISDN devices, the frequency range extends respectively up to 108 MHz and up to 150 MHz. Some military Standards request RFI voltage measurements in the range 0.1 MHz to 200 MHz.

7.1.1 Measuring Principle

In the case of a system with two floating conductors, the RFI voltages of two conductors relative to each other and to reference ground form a vector system where three types of RFI voltages are present. They are:

- Symmetrical (or differential mode) voltages. These RFI components are measured between the two conductors. They behave like the wanted signal on the forward and return lines.
- Asymmetrical (or common mode) voltages. These RFI components are measured between the electrical midpoint of the two conductor voltages and reference ground. These are the most important components which cause interference effects.
- Unsymmetrical voltages. These RFI components are measured from each line conductor and reference ground. They consist of symmetrical and asymmetrical components. Measurements of these RFI voltages are the most common.

For practical reasons, Standards specify the measurements of unsymmetrical voltages instead of the more significant common mode RFI voltages. However, they make measurements valid by standardization.
Some Regulations request both measurement of symmetrical and asymmetrical RFI voltages. They also define separate limits for them.

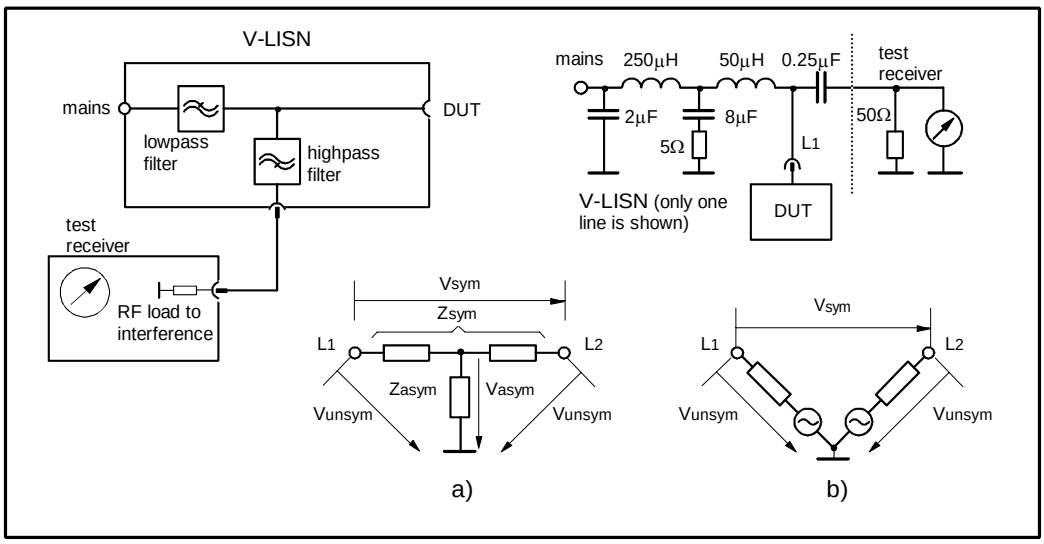


Fig. 7-1 AMN Principle: a) Δ-type or T-type LISN ; b) V-type LISN

7.1.2 Coupling Networks

Coupling Networks are electrical interfaces which allow to transfer the quantity to be measured from the lines to the test receiver. Some types of Coupling Networks are: AMN (Artificial Mains Network), named also "LISN" (Line Impedance Stabilization Network), Current Probe and Voltage Probe. Fig. 7-1 shows the AMN principle.

AMN

AMNs comprise V-type Networks, Δ-type Networks, T-type Networks.

- V-type Network is used for measuring the unsymmetrical RFI voltage on AC and DC supply line. Standard impedances are 50Ω // 50 μH+5Ω and 50Ω // 5 μH+1Ω.
- Δ-type Network is used for measuring the symmetrical RFI voltage on balanced telecommunication lines. It is generally designed to permit switchover between symmetrical and asymmetrical RFI measurements. Its use is limited; Standards generally specify the T-type Network instead. Standard impedance is 150Ω.
- T-type Network is used for measuring the asymmetrical RFI voltage on balanced (electrically symmetrical) audio frequency, control and data lines. Standard impedance is 150Ω.

The Artificial Mains Network must fulfill the following tasks:

1. It terminates the RFI voltage source of the DUT in every power line with standardized impedance to reference ground.
2. It provides the DUT with the supply voltage and current or with the signal and data required for operation.
3. It isolates the test circuit against interference coming from mains network or from equipment supplying the DUT with data during measurements.
4. It routes the RFI from the conductor under test to the test receiver.
5. It does not introduce any variation in the source impedance of the supply system, otherwise DUT reaction to interference may change.

Current Probe

Current Probes comprise Clamp-on Probe or Fixed-ring Probe.

Current Probes is used for measuring differential or common mode RFI currents. In some cases may be important to make a distinction between the two kinds of current which flow in a system.

RFI current measurements with Current Probe may be required, for example, when measuring RFI on shielded lines or on complex wiring systems, when finding interference sources among other sources in a system, when testing devices for interference suppression, when performing compliance to some Standards, etc.

Voltage Probe

Voltage Probes includes Active Probes and Passive Probes.

Active Probe has a very high input impedance $Z_{in} \geq 100$ KΩ // ≤ 10 pF.
Passive Probe has a standard impedance $Z_{in} = 1.5$ KΩ // ≤ 10 pF.

Voltage Probe is used for measuring the unsymmetrical RFI voltage when it is not possible to carry out measurement by interconnecting an Artificial V-type Network. Such situation may occur, for example, when measuring on lines on which only small loads are permissible (control and signalling lines), when measuring on DUTs which would not operate correctly using V-type LISN or DUTs requiring very high power supply currents for which no V-type LISN is available.

For diagnostic or design purposes on high impedance circuits, Voltage Probe may be used to determine, for example, noisy components or conductors that cause interference on CMOS PC boards.

Some Regulations give statements when Voltage Probe are to be used and specify relevant setup and RFI voltage limits.

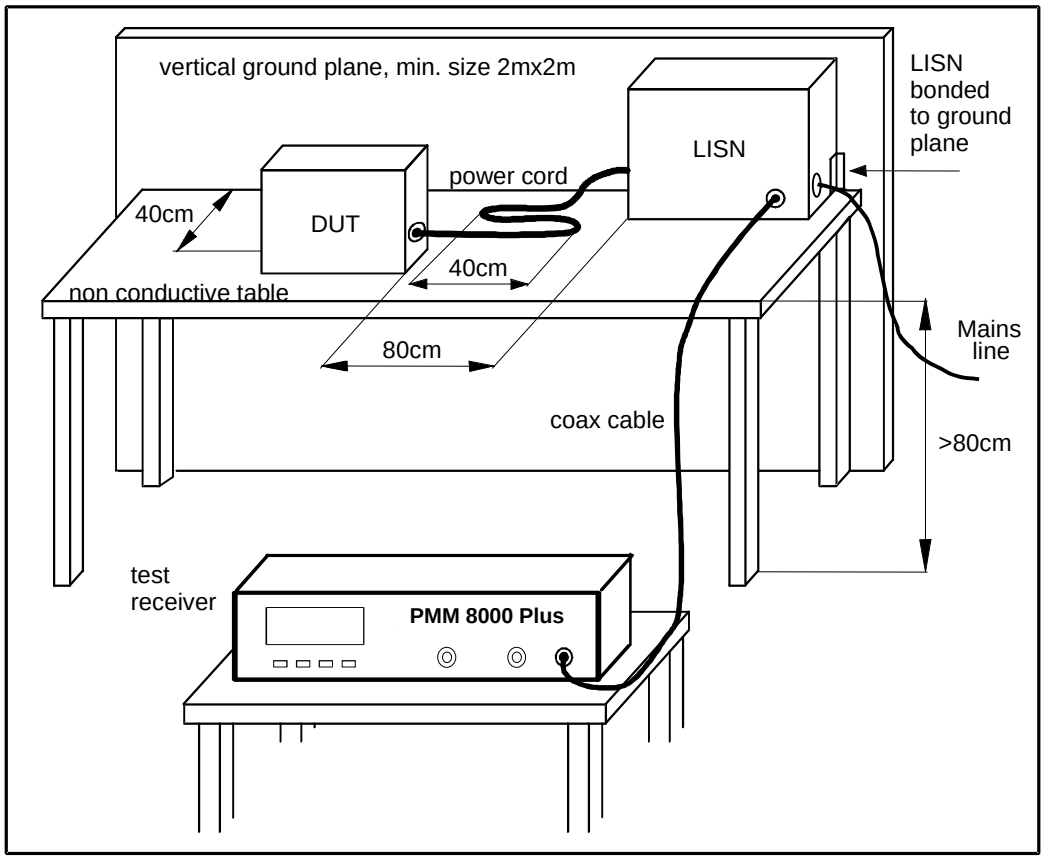


Fig. 7-2 Example of Test Setup for RFI Voltage Measurement

7.1.3 Test Setup

FIG. 7-2. shows an example of test setup for RFI voltage measurement.
For more details see the appropriate Standard: EN 55011, EN 55022, EN 55014, CISPR 16-1.
The DUT is placed 0.4 m from an horizontal or vertical earthed conducting surface of at least 2 m x 2 m in size.
The DUT is placed 0.8 m from the LISN and at least 0.8 m from any other earthed conducting surface. If the measurements are made in a shielded room, the DUT shall be placed 0.4 m from one of the walls of the room.
The LISN shall be bonded to the reference conducting surface.
Floor standing DUTs is placed 0.1 m above an horizontal earthed conducting surface of at least 2 m x 2 m in size. This size shall be exceeded by at least 0.5 m the projection of the DUT on the conducting surface.
The power cable should be 1m long; longer cable should be centrally bunched over 40 cm.
DUTs without a protective conductor and manually operated DUTs shall be measured in conjunction with an auxiliary screen or Artificial Hand.
Detailed information on the test setup can be looked up in the latest version of the applicable Regulation.

7.1.4 Guiding Measuring Procedure

A step-by-step manually performed procedure are given below.

1. Set the receiver parameters as follow:
2. Freq. range = 9 kHz - 150 kHz ; IF_{bw} = 200 Hz ; Step size = 100 Hz
   Freq. range = 150 kHz - 30 MHz ; IF_{bw} = 10 kHz ; Step size = 5 kHz
   Premeasurement: Detector = peak/average ; Dwell time = 20ms
   Final measurement: Detector = quasi-peak /average ; Dwell time = 1s
3. Setup all the devices for the test according to the applicable Regulation.
4. Carry out an overview of the whole spectrum (with the DUT switched off) by executing a premeasurement with peak detector.
5. If the ambient RF disturbances are $\geq$ 20 dB below the measured emission level, go on to the next step, otherwise, in the case of measurements with V-type LISN, fit in an RFI suppression filter between the mains and the LISN.
6. If the decoupling is not enough, or in the case of measurements on lines not carrying AC power, RFI voltage measurements shall be performed in a shielded room.
7. Switch on the DUT and select the line to be measured (if a V-type LISN is used).
8. Execute a premeasurement with peak and/or average detector.
9. Record the set of frequencies at which the peak value is near the quasi-peak limit and the average value is near the average limit.
10. Tune in the test receiver to the first frequency of the set.
11. Execute a final measurement with quasi-peak detector.
12. Record the result for this frequency.
13. Repeat the steps 9. to 11. for all the frequencies of the set.
14. Repeat the steps 6. to 12. for all the lines to be measured, if any.
15. For documentation, fill in a table with all the previously recorded results.

7.1.5 Note and Hints for Measuring

To avoid errors caused by ambient interference, measurements should be carried out inside a shielded room. Other sites, like cellar rooms, with low ambient interferences are often sufficient.

Time-Saving

Test time-saving is achieved by using the data reduction method which includes "subranges" and "acceptance margin". See Par. 5.4.1.

Automation

For complete automation of the measuring procedure, a V-type LISN with remote control interface for line switching can be used. During the measurements, if any frequency level should reach or exceed the acceptance margin within a subrange, automatic comparison measurements will be executed on all other lines by a dedicated software.

7.2 Measuring the RFI Power

According to CISPR Standard, the RF power at the signal and supply lines exceeding a length of 1 m is to be measured within the frequency range 30 MHz to 300 MHz. This measurement technique is an alternative to RFI field strength for DUTs whose dimensions are small compared with the wavelength of the measuring frequency. The absorbing clamp is used for this measurement. It is supplied with the transducer factor for determination of the RF power in dBpW using the RF voltage picked up by the test receiver. The signal and supply lines are lengthened to approx. 6 m (half the wavelength at 30 MHz plus the length of the clamp). The clamp has to be slid by half the wavelength at various frequencies up to the maximum indication of the test receiver. Regulations request that the level at various specific frequencies as well as the maxima be stated. The frequency ranges between this specific frequencies must also be determined in order to find the maxima. Therefore, the complete spectrum should be measured every 10 cm. The test separation of 10 cm is required because it must be significantly smaller than $\lambda/2$ (at 300 MHz the wavelength λ = 1 m) in order to pick up the maximum of the standing wave whose physical position change with the frequency. As the complete test would take more than 30 hours, a shorter algorithm is recommended.
For more details see the EN 55014 and CISPR 16-1 Standard.

7.2.1 Measuring Principle

The absorbing clamp incorporates a ferrite absorber which encloses the line to be tested over a length of about 0.6 m, acting as a resistance to the RFI power. A test receiver connected to the clamp measures the RF current flowing through the absorber via a current transformer. The absorber also serves the purpose of isolating the current transformer against mains disturbances. In some cases an additional absorber is necessary for decoupling. With this test setup, there is no accurate matching between the RFI source impedance of the DUT, the line under test and the absorber. For this reason, standing waves occur on the line under test due to the reflection of forward travelling RFI energy. When measuring, therefore, the absorbing clamp must be slid along the line until a maximum reading is obtained on the test receiver.
Fig. 7-3 shows the principle and the parameters involved with RFI power measurement.

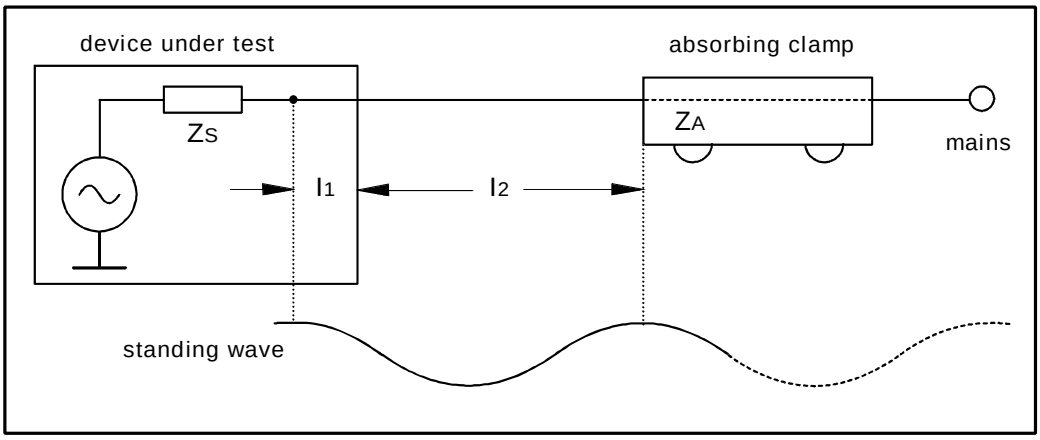


Fig 7-3 Parameters involved with RFI Power Measurement

The RF current entering into the clamp never becomes zero since the clamp does not terminate the interference source with a high impedance. That is why the entire spectrum can be covered at one position (closest to

the DUT) by an "offset margin" of approx. 10 dB.

7.2.2 Test Setup

Fig. 7-4 shows the setup for RFI power measurement.

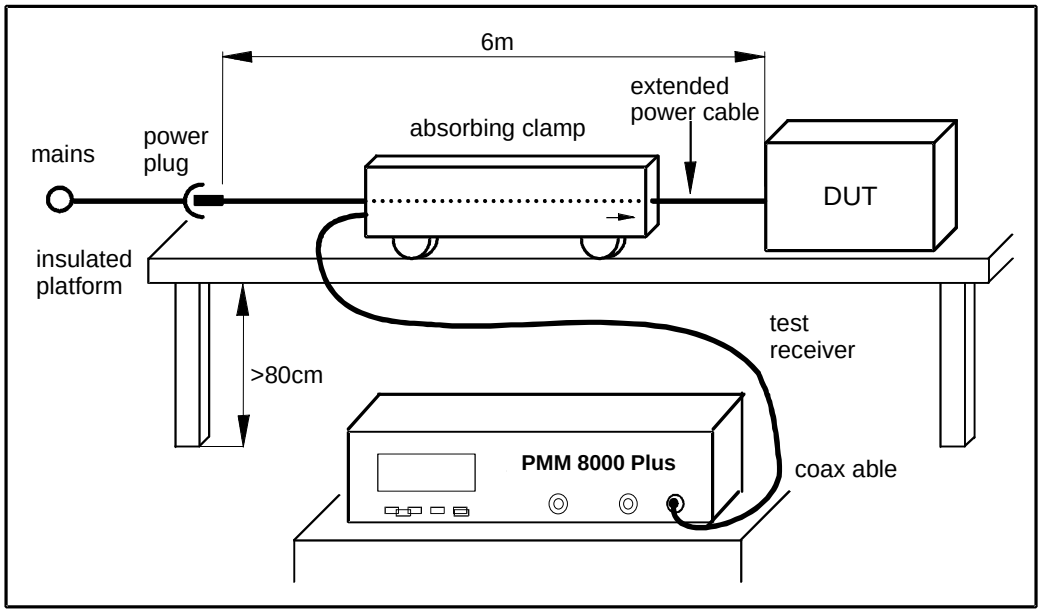


Fig. 7-4 Test Setup for RFI Power Measurement

The DUT is placed on a non metallic table at least 0.8 m away from other metallic objects and the lead to be measured on is stretched in a straight line for about 6 m and laid horizontally over the test table away from the DUT. The absorbing clamp is placed around the lead with the transformer end facing the DUT.
It should be possible to move the absorbing clamp at the test receiver. This could be achieved by rollers supporting the clamp and a cord connecting the clamp to the test receiver.
In case of large DUT standing directly on the floor, the line under test has to be positioned 0.4 m above the floor.
It is useful to mark the measuring table with a frequency scale such that the frequency value is entered at a distance of half the wavelength from the DUT respectively, for example: "300 MHz" with 0.5 m ; "200 MHz" with 0.75 m ; "150 MHz" with 1 m ; "100 MHz" with 1.5 m ; ....."30 MHz" with 5 m. As the sliding range of the clamp decreases with increasing frequency, a reduction in test time is achieved; the number of test frequencies goes down as the distance from the DUT increases.
Detailed information on the height of the measuring table, the distance between the clamp and the wall, etc., can be looked up in the latest version of the applicable Regulation.

7.2.3 Guiding Measuring Procedure

A step-by-step manually performed procedure are given below.

1. Set the receiver parameters as follow:
2. Freq. range = 30 MHz- 300 MHz ; IF_{bw} = 120 kHz ; Step size = 60 kHz
   Premeasurement: Detector = peak/average ; Dwell time = 20ms
   Final measurement: Detector = quasi-peak /average ; Dwell time = 1s
3. Setup all the devices for the test according to the applicable Regulation.
4. Carry out an overview of the whole spectrum (with the DUT switched off) by executing a premeasurement with peak detector.
5. If the ambient RF disturbances are $\geq$ 10 dB below the measured emission level, go on to the next step, otherwise, in case of measurements on AC power cord, place additional ferrite absorber on the cord at the side near the mains network.
6. If the decoupling is not enough, or in case of measurements on lines not carrying AC power, RFI power measurements shall be performed in a shielded room.
7. Switch on the DUT and slide the absorbing clamp as near as possible to the DUT (zero position).
8. Execute a premeasurement with peak and/or average detector.
9. If the separation of the measured values to the quasi peak and/or average limit is > 10 dB, the measurement is finished, otherwise, go on to the next step.
10. Record the set of frequencies at which the peak value is near the quasi-peak limit and the average value is near the average limit.
11. Tune in the test receiver to the first frequency of the set.
12. Slide the clamp from the zero position until the first maximum of the standing wave has been found.
13. Execute a final measurement with quasi-peak detector.
14. Record the result for this frequency.
15. Repeat the steps 10. to 13. for all the frequencies of the set.
16. For documentation, fill in a table with all the previously recorded results.

7.2.4 Note and Hints for Measuring

To avoid errors due to ambient interference, the test should be performed in a shielded room. Other sites, like cellar rooms, with low ambient interferences are often sufficient. Ambient interferences should be at least 10 below the measured emission level.

Time-Saving

Test time-saving is achieved by using the data reduction method with "subranges" explained as follow. See also Par. 5.4.1.
The entire frequency range is divided up into a sufficient amount of subranges (10-20), featuring nearly the same conditions for all frequencies (i.e., source and load impedances are nearly equal).
In fact, it can be assumed that the standing wave of the subrange maximum (maximum level of the subrange spectrum with fixed clamp) has its local maximum (the first maximum occurring with sliding the clamp) at the same locations as all the others frequencies of this subrange and that all level relations within the subrange remain nearly constant. The subrange maximum thus becomes the representative frequency of the frequency subrange. In the Fig. 7-3 impedances Z_s, Z_A and length of the lines l_1 are nearly constant within one subrange; it is thus sufficient to determine the local maximum at length l_2 of the subrange maximum.
Using 10 or 20 subranges is sufficient to minimize the amount of errors.
Fulfill a final measurement with quasi-peak and/or average detector at each subrange maximum of the previous premeasurement.

Automation

For complete automation of the measuring procedure, a remote controlled drive like the PMM CP100 and PMM Slide Bar should be used for moving the clamp.

7.3 Measuring the RFI Field strength

RFI field strength measurements in line with commercial Standards EN 55011, EN 55022, CISPR 16-1 are performed in the frequency range 9 kHz to 1000 MHz in an open area test site or in a shielded absorber enclosure. They are seldom required in the lower frequency range of 9 kHz to 30 MHz. In this case, the magnetic component of the field is usually measured with a shielded loop antenna. In the frequency range 30 MHz to 1000 MHz the electric field strength is measured with a linear polarized antenna (broadband dipole, log-periodic antenna, biconical antenna).

7.3.1 Measuring Principle

Radiated emissions of an electric or electronic device are to be performed in a test site with very stringent requirements. An environment is required which assures valid, repeatable measurement result of disturbance field strength from equipment. These measurements are normally performed at an open area test site with a test antenna placed at a defined distance from the DUT. Possible distances are 3m, 10m, 30m, and 100m. They are specified by Regulations for different field of application. The most common measuring distance is 3 m. Since the device under test itself emits a directional radiation, it has to be turned in the various directions and, if necessary, be operated at different operating modes and with different cord arrangements. Measurements shall be taken both in horizontal and vertical polarization. Owing to the reflective ground plane, the receiving antenna shall be scanned vertically in order to find the maximum field strength at each frequency and for each polarization. The complete spectrum is usually covered with two antennas. Biconical antennas range from 30 MHz to 200 MHz, Log-periodic antennas range from 200 MHz to 1000 MHz. Special broadband antennas are available which range from 30 MHz to 1000 MHz.
Fig. 7-5 shows the principle of RFI field strength measurement.

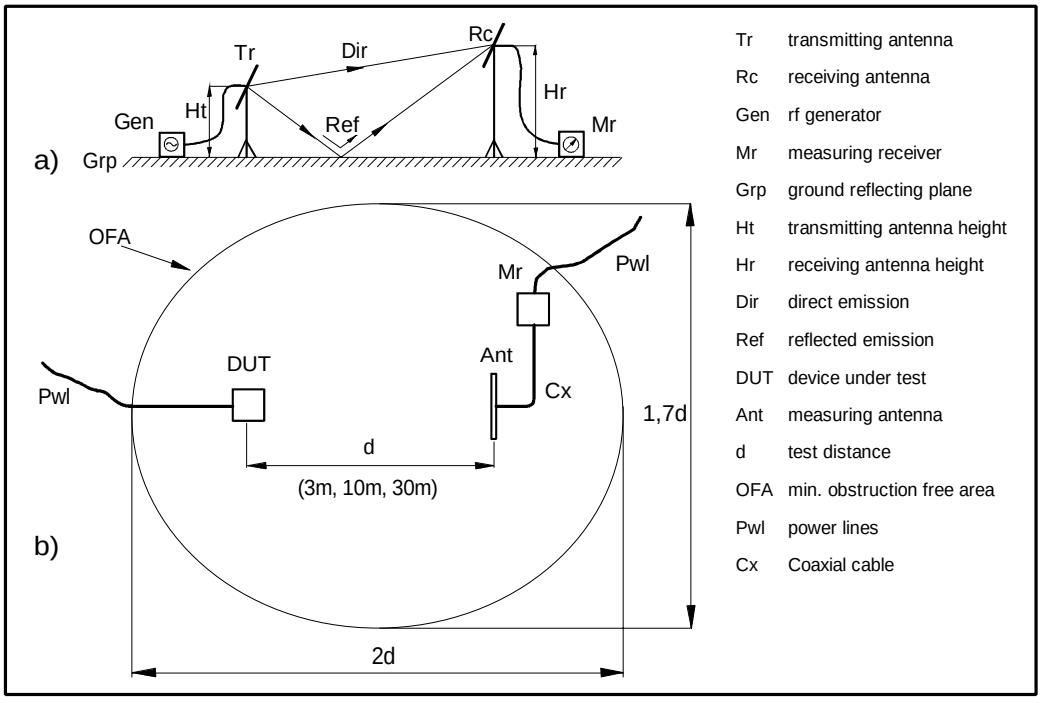


Fig. 7-5 RFI Field strength Principle: a) Reflecting ground; b) Test Site

7.3.2 Test Sites

Possible test sites are OATS (open area test site), absorber lined shielded rooms, semi-anechoic chambers, TEM-Cells and GTEM-Cells. Semi-anechoic chambers generally exhibits best performances, but at a higher cost than absorber lined shielded rooms. TEM-Cells and GTEM-Cells are less expensive than shielded rooms, but they are generally suitable only for DUTs of small dimensions. The shielded enclosures above indicated offer the advantage of preventing ambient interferences, however, they may impair the magnetic field especially in the case they are of small dimensions. Therefore, they are not usually used for RFI magnetic radiation in the range 9 kHz to 30 MHz. At any frequency too, in the range 9 kHz to 1000 GHz, a shielded enclosure hardly is a perfect test system.
For radiation measurements in the range 30 MHz to 1000 MHz, CISPR Standard recommends to use OATS or in the case of using other test sites, the measurements shall be correlated to OATS.
Guiding notes on requirements and validation tests for test sites are given below; some of them are also CISPR Standard specifications.

Magnetic field Test Site

The test site suitable for measurements of the magnetic field stength may be any site which is free from metallic object, buried cables, pipes, etc. between DUT and measuring antenna. A test site with a metallic ground plane may also be used for overview measurements.
The validation of this test site can be estimated by measuring the field strength at several distances and watching the decrease of the field strength. If the DUT is small compared with the wavelength (< 1/10λ), up to a distance of 0.1 λ the field strength is inversely proportional to the 3rd power of the distance, from 0.1λ to 3λ it is inversely proportional to the 2nd power of the distance and at a distance more than 3λ it is inversely proportional to the distance.

OATS

OATS is defined as the minimum obstruction free area, elliptically shaped, with the long axis equal to twice the measurement distance and the short axis equal to 1.73 times the measurement distance. The ground has to be flat and well conducting (metallic ground plane is preferable). OATS is an area characteristic of cleared level terrain. Such an area shall be free of any reflections which may be caused by building, metallic constructions, electric lines, fences, trees, etc. This area should preferably be free from underground cables, pipelines, etc., except as required to supply and operate the DUT. If underground cables exist, they have to run under the ground plane to the maximum extent possible and at right angle to the measurement axis.
The validation of this test site is defined by NSA (normalized site attenuation) values performed with two antennas oriented horizontally and vertically with respect to the ground. In case of using broadband antennas, the transmitting antenna is positioned 1m above the ground, the receiving antenna is moved from 1m to 4 m (or 2m to 6m for 30m measuring distance) above the ground in order to find the maximum indication of the test receiver. Measurements have to be taken with horizontal and vertical polarization. The attenuation measured has to be compared with the reference NSA values given by CISPR 16-1 Standard. This comparison shall give a difference within ± 4 dB.

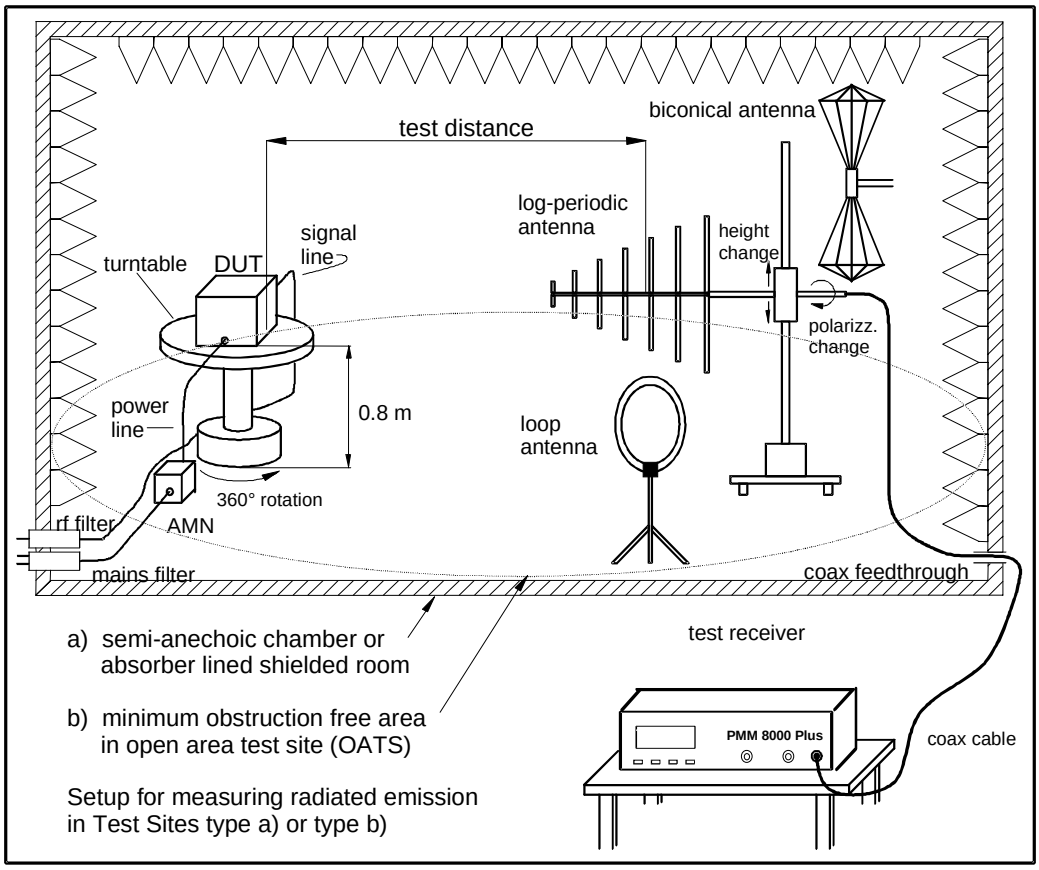


Fig. 7-6 Test Setup for RFI Field strength Measurement

7.3.3 Test Setup

Fig. 7-6 shows the setup for RFI field strength measurement.
The DUT is installed at a focal point of the ellipse on a non-conducting table at a height of 0.8m above the ground. It should be possible to rotate the DUT by 360° about its longitudinal axis (a turntable is recommended for convenience). For testing a floor-standing DUT, the turntable should be metal-covered, flush with the ground plane and conductively connected to it. The AC supply lines and signal lines shall be laid 1.5 m horizontally, then vertically to the ground and continued underground if possible. The power cable should be wound round an isolated drum 0.6m in diameter and connected to the mains supply via an AMN. The test antenna is setup at the other focal point of the ellipse and oriented to the main radiation direction of the DUT. The antenna is mounted on a non-conducting mast which will allow the antenna to be raised between 1m to 6m. Measuring apparatus and test personnel should be situated outside the obstruction free area. For preview measurements only, the antenna may be 45° polarized. In this way, one test run per frequency step is sufficient.
Detailed information on the height of the measuring table, the distance between the DUT and the antenna, etc., can be looked up in the latest version of the applicable Regulation.

7.3.4 Guiding Measuring Procedure at OATS

A step-by-step manually performed procedure are given below.

1. Set the receiver parameters as follow:
2. Freq. range = 9 kHz - 150 kHz ; IF_{bw} = 200 Hz ; Step size = 100 Hz
   Freq. range = 150 kHz - 30 MHz ; IF_{bw} = 10 kHz ; Step size = 5 kHz
   Freq. range = 30 MHz - 1 GHz ; IF_{bw} = 120 kHz ; Step size =60 kHz
   Pre-measurement: Detector = peak ; Dwell time = 20 ms
   Final measurement: Detector = quasi-peak ; Dwell time = 1s
3. Setup, according to the applicable Regulation, the correct test arrangement with loop antenna or broadband antenna.
4. Install, at the specified distance from the DUT, the appropriate antenna for the frequency range to be measured.
5. Carry out an overview of the whole spectrum (with the DUT switched off) by executing a pre-measurement with peak detector.
6. If the ambient RF disturbances are $\geq$ 6 dB below the measured emission level, go on to the next step, otherwise, move to other OATS location or into an anechoic chamber.

Frequency range 9 kHz to 30 MHz

7. Switch on the DUT and, beaming the test antenna for maximum level, execute a pre-measurement with peak detector.
8. Record the set of frequencies at which the peak value is near the quasi-peak limit.
9. Tune in the test receiver to the first frequency of the set.
10. Rotate the DUT over 360° until the maximum level is found.
11. Execute a final measurement with quasi-peak detector.
12. Record the result for this frequency.
13. Repeat the steps 8. to 11. for all the frequencies of the set.
14. For documentation, fill in a table with all the previously recorded results.

Frequency range 30 MHz to 1 GHz

15. With the test antenna horizontally polarized, do the actions as per steps up to 12. for various combinations of the DUT position and antenna height.
16. With the antenna vertically polarized, repeat all the preceding steps.
17. For documentation, fill in a table with the worst values of the all recorded results both for horizontal and for vertical polarization.

7.3.5 Note and Hints for Measuring

For perfect results, CISPR recommends an ambient level 20 dB below the measured emission level. It is advisable that pre-measurements be carried out in a shielded room. The final measurement, however, has to be performed on OATS. Correlation to OATS is required for measurements performed at other test sites. If the ambient is not at least 6 dB below the measured emission, before deciding to perform measurements in test sites other than OATS, check, with quasi peak detector, if the following condition are true: ambient is at least 4.8 dB below the limit level and at least 6 dB below the level measured with the DUT switched on. If it is the case, the final measurements should be considered valid.
In order to identify ambient interferences, an aural and visual check of the demodulated signal should be performed

Time-Saving

The amount of work involved in measuring RFI field strength can be cut down considerably by using test software implementing the data reduction method which includes "subranges" and "acceptance margin" functions. See Par. 5.4.1. Pre-measurements are performed by keeping the test antenna at a fixed height for each subrange. Final measurements are only executed at the subrange maxima exceeding the acceptance margin level.

Automation

A fully automatic measuring sequence is advisable only if the continuous and, particularly, the intermittent ambient interferences are low. If this is the case, remote controlled drives should be used for moving the turntable and the antenna mast and for changing the antenna polarization.

7.4 Supplementary information

Supplementary information and hints common to all measurements are given below.

7.4.1 Data Reduction Method

Data reduction method is an algorithm, performed by a firmware or software program, in which the "acceptance margin" function and the "subranges" function are executed.

Acceptance Margin

Acceptance margin is a limit line which is parallel to the line specified by the Standard to comply with, but a certain number of dB below. The task of acceptance margin is that, at all frequencies which reach or exceed this line, a final measurement will be performed. The appropriate number of dB is to be input into the test receiver or into the program software.

Subranges

Subranges function divides the whole to be measured frequency range into a certain number of ranges of equal distances. This is true for linear and logarithmic scaling and stepping. Subranges are performed as follow:

- a pre-measurement with predefined detectors is done within the first subrange,
- the level maximum (only one value) is determined within this subrange,
- if the level maximum exceeds the acceptance line, an action is taken, if not, pre-measurement is continued within the next subrange,
- a predefined final measurement with quasi-peak and/or average detector will be carried out on all phases to find the worst phase in each subrange level maximum.

The number of subranges determines the total number of final measurements. For quick time-saving pre-measurements with little exceeding values, only a few subranges (8-10) are recommended; for accurate measurements, many subranges (100 or more) should be used.

7.4.2 Scan Type

The scan type normally used are "normal scan" and "special scan".

Normal Scan

Normal scan is defined by start frequency, stop frequency and step size. It may be linear or logarithmic. For linear gapless measured scans step sizes of half the IF bandwidth are recommended. For logarithmic scans steps are given in percentage of the current measuring frequency. This steps are considerably larger than the IF bandwidth.

Special Scan

Special scan is a frequency scan according to a user defined frequency list. This list contains a certain number of discrete frequencies. Start, stop and step parameters are not needed. The special scan can replace the usual pre-measurement (normal scan) for DUTs whose "exceeding frequencies" are well known (e.g. harmonics of an oscillator). The test, then, can be only carried out on those frequencies.

7.4.3 Common Hints

If DUT only produces broadband interferences, the pre-measurements can be performed with logarithmic scans, thus, a pre-measurement time reduction is achieved. For DUTs whose "exceeding frequencies" are known, special scans can be executed and test time saving be gained.

Automation

By using an EMI application software (or test receiver firmware supporting macro functions) with interactive operation capability, all the indicated measuring procedures can be automated, the test time be very much lowered and the test reports be generated with results graphically or table oriented.

PMM Costruzioni Elettroniche Centro Misure Radioelettriche S.r.l.

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Mod. 18-1

Egregio Cliente
grazie per avere scelto prodotti e servizi PMM : siamo fiduciosi essi possano incontrare pienamente le Sue necessità.
PMM riconosce l'importanza del Cliente come ragione di esistenza : ciascun commento e suggerimento sottoposto all'attenzione della nostra organizzazione è tenuto in grande considerazione. La nostra qualità è alla ricerca del miglioramento continuo.
Se uno dei Suoi strumenti PMM necessita di riparazione o calibrazione può aiutarci a servirla più efficacemente compilando questa scheda e accludendola all'apparecchio.

Dear Customer
thank you for having chosen PMM products and services: we are confident they can fully meet your requirements.
PMM recognizes the importance of the Customer as reason of existence: in this view, any comment and suggestion you would like to submit to the attention of our service organization is kept in great consideration. Moreover, we are continuously improving our quality, but we know this is a never ending process. We would be glad if our present efforts are pleasing you.
Should one of your PMM equipment need service you can help us serve you more effectively filling out this card and enclosing it with the product.

☑ **Servizio richiesto:** ☑ *Service needed*:

☐☐ **Solo calibrazione** ☐ **Riparazione** ☐ **Riparazione & Calibrazione** ☐ **Taratura SIT** ☐ **Altro:**
☐ Calibration only ☐ Repair ☐ Repair & Calibration ☐ Certified Calibration ☐ Other:

Ditta:
Company:

Indirizzo:
Address:

Persona da contattare: *Technical contact person:*
Telefono: *Phone no.*

Modello: *Equipment model:*
Numero di serie: *Serial no.*

☑ ***Accessori ritornati con l'apparecchiatura:*** ☐ **Nessuno** ☐ **Cavo(i)** ☐ **Cavo di alimentazione** **Altro:**
☑ *Accessories returned with unit:* ☐ None ☐ Cable(s) ☐ Power cable Other:

☑ ***Sintomi o problemi osservati:*** ☑ *Observed symptoms/problems*:

☑ ***Guasto*: ☐ Fisso** ☐ **Intermittente** - ***Sensibile a* : ☐ Freddo** ☐ **Caldo** ☐ **Vibrazioni** ☐ **Altro**
☑ *Failure*: ☐ Solid ☐ Intermittent - *Sensitive to*: ☐ Cold ☐ Heat ☐ Vibration ☐ Other

Descrizione del guasto/condizioni di funzionamento:
Failure symptoms/special control settings description:

Se l'unità è parte di un sistema descriverne la configurazione:
If unit is part of system please list other interconnected equipment and system set up:

Suggerimenti / Commenti / Note:
Suggestions / Comments / Note: