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PMM ER9000

User's Manual

EMI RECEIVER
10 Hz ÷ 30 MHz (option 00)
10 Hz ÷ 3000 MHz (option 01)

SERIAL NUMBER OF THE INSTRUMENT
You can find the Serial Number on the rear panel of the 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.

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NOTE:

® Names and Logo are registered trademarks of Narda Safety Test Solutions GmbH – Trade names are trademarks of the owners.

⚠ CAUTION | If the instrument is used in any other way than as described in this User's Manual, it may become unsafe.

Before using this product, the related documentation must be read with great care and fully understood to familiarize with all the safety prescriptions.

To ensure the correct use and the maximum safety level, the User shall know all the instructions and recommendations contained in this document.

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

In accordance with the IEC classification, the power supply of this product meets requirements **Safety Class II** and **Installation Category II** (having double insulation and able to carry out mono-phase power supply operations).

It complies with the requirements of **Pollution Class II** (usually only non-conductive pollution). However, occasionally it may become temporarily conductive due to condense on it.

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

EXPLANATION OF ELECTRICAL AND SAFETY SYMBOLS :

You now own a high-quality instrument that will give you many years of reliable service. Nevertheless, even this product will eventually become obsolete. When that time comes, please remember that electronic equipment must be disposed of in accordance with local regulations. This product conforms to the WEEE Directive of the European Union (2002/96/EC) and belongs to Category 9 (Monitoring and Control Instruments). You can return the instrument to us free of charge for proper environment friendly disposal. You can obtain further information from your local Narda Sales Partner or by visiting our website at www.narda-sts.it .

Warning, danger of electric shock	**Earth**
Read carefully the Operating Manual and its instructions, pay attention to the safety symbols.	**Unit Earth Connection**
Earth Protection	**Equipotential**

EXPLANATION OF SYMBOLS USED IN THIS DOCUMENT :

⚠ DANGER | **The DANGER sign draws attention to a serious risk to a person's safety, which, if not avoided, will result in death or serious injury. All the precautions must be fully understood and applied before proceeding.**

⚠ WARNING | **The WARNING sign indicates a hazardous situation, which, if not avoided, could result in death or serious injury. All the precautions must be fully understood and applied before proceeding.**

⚠ CAUTION | **The CAUTION sign indicates a hazardous situation, which, if not avoided, could result in minor or moderate injury.**

NOTICE | **The NOTICE sign draws attention to a potential risk of damage to the apparatus or loss of data.**

☞ NOTE | **The NOTE sign draws attention to important information.**

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⚠ WARNING | *SAFETY RECOMMENDATIONS AND INSTRUCTIONS*

This unit has been designed and tested in Italy, according to IEC 348 standard and 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 NARDA Servicing Center for maintenance of the unit.
- To maintain adequate protection against fire hazard, replace fuses only with others of the same type and rating;
- Observe safety regulations and rules and also the additional safety instructions specified in this manual for prevention of accidents.

Dichiarazione di Conformità
EC Declaration of Conformity $C\mathcal{E}$

In accordo alla Decisione 768/2008/EC, conforme alle direttive EMC 2014/30/UE, Bassa Tensione 2014/35/UE e RoHS 2011/65/UE, ed anche alle norme ISO/IEC 17050-1 e 17050-2.
In accordance with the Decision 768/2008/EC, compliant to the Directives EMC 2014/30/UE, Low Voltage 2014/35/UE and RoHS 2011/65/EU, also compliant to the ISO/IEC standard 17050-1 and 17050-2

Il costruttore *The manufacturer*	**narda Safety Test Solutions S.r.l. Socio Unico**
Indirizzo *Address*	**Via Benessea, 29 / B**
	I-17035 Cisano sul Neva (SV) - Italy

sulla base delle seguenti norme europee armonizzate, applicate con esito positivo:
based on the following harmonized European Standards, successfully applied:

EMC - Emissioni: *EMC - Emission:*	**IEC EN 61326-1** (2021)
EMC - Immunità: *EMC - Immunity:*	**IEC EN 61326-1** (2021)
Sicurezza: *Safety:*	**EN 61010-1** (2010)

dichiara, sotto la propria responsabilità, che il prodotto:
declares, under its sole responsibility, that the product:

Descrizione *Description*	**EMI RECEIVER**
Modello *Model*	**PMM ER9000**

è conforme ai requisiti essenziali delle seguenti Direttive:
conforms with the essential requirements of the following Directives:

Bassa Tensione *Low Voltage*	**2014/35/EU**
Compatibiltà Elettromagnetica *EMC*	**2014/30/EU**
RoHS *RoHS*	**2011/65/EU**

Cisano sul Neva, 14 October 2022   **Egon Stocca**

General Manager

VIII		EC Conformity

1 – General Information

1.1 Documentation

Enclosed with this manual are:

- a service questionnaire to send back to NARDA in case an equipment service is needed
- an accessories checklist to verify all accessories enclosed in the packaging.

1.2 Operating Manual Changes

Instruments manufactured after the printing of this manual may have a serial number prefix not listed on the title page; this indicates that instruments with different Serial Number prefix may be different from those documented in this manual.

1.3 Introduction to PMM ER9000

PMM ER9000 is a powerful EMI receiver, fully CISPR 16-1-1 compliant, to measure conducted and radiated interferences from 10 Hz up to 30 MHz (opt. 00), or even up to 3 GHz (opt. 01). All measurements performed by the PMM ER9000 are according to the most accepted standards like: IEC, CISPR, EN (EuroNorm), FCC, VDE,..

Thanks to its built-in signal generator, PMM ER9000 is also suitable for characterizing and testing EUTs or other receivers.

The PMM ER9000 has been designed adopting an innovative philosophy made possible only in the recent years by the availability of superior technology components. This equipment is fully digital but the input preselector and attenuator, and therefore combines into a pure EMI Receiver and Signal Analyzer the precision and accuracy of a numeric approach, with flexibility and user friendly approach typical of a modern instrument.

1.4 Instrument Items

PMM ER9000 includes the following items:
- EMI Receiver from 10 Hz up to 30 MHz (opt.00) or 10 Hz to 3000 MHz (opt.01)
- Soft carrying case
- AC/DC Converter with plug adapters;
- N male to BNC female Adapter;
- BNC-BNC coaxial cable 2m length;
- RS232 cable, 2m;
- USB-RS232 serial converter;
- USB cable, 2m;
- Operating manual;
- PMM ER9000 Utility Software on Software Media;
- Certificate of Calibration;
- Return for Repair Form.

1.5 Optional accessories

PMM ER9000 can be used with several optional accessories, the most common being the following:
- PMM 9010-RMA Rack Mount Adapter for Rack 19";
- ER8000/GND Ground connection;
- 9010/CC Rigid Carrying Case;
- L2-16B: 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);
- L3-64/690: Four lines, 3-phase, 64A - 690Vac LISN, (50Ω//5 Ω+50μH);
- L3-100: Four lines, 3-phase, 100A LISN, (50Ω//5 Ω+50μH);
- L1-150M: Multi-standard Single line LISN, 150A (50Ω//1 Ω+5μH) (100 kHz to 200 MHz);
- L1-150M1: Multi-standard Single line LISN, 150A (50Ω//1 Ω+5μH) (10 kHz to 400 MHz);
- L1-500: Single line LISN, 500A (50Ω//5 Ω+50μH);
- L3-500: Four lines, 3-phase, LISN 500A (50Ω//5 Ω+50μH);
- SBRF4 RF Switching Box (Switching Box for LISNs and Loop Antennas)
- LISN Service Kit (AC-BNC adapter for LISNs verification and calibration)
- SHC-1/1000: 35 dB CISPR Voltage probe, 1500Ω;
- SHC-2/1000: 30 dB CISPR Voltage probe, 1500Ω;
- RA-01: Rod Antenna (9 kHz – 30 MHz);
- RA-01-MIL: Rod Antenna (9 kHz – 30 MHz);
- RA-01-HV: Rod Antenna (150 kHz – 30 MHz);
- BC-01: Biconical Antenna (30 – 200 MHz)
- BL-01: Biconical Log Periodic Antenna 30 MHz to 6 GHz
- LP-02: Log Periodic Antenna 200 MHz to 3 GHz
- LP-03: Log Periodic Antenna 800 MHz to 6 GHz
- LP-04: Log Periodic Antenna 200 MHz to 6 GHz
- TR-01: Antenna Tripod
- Antenna Set AS-02 (BC01+LP02+TR01)
- Antenna Set AS-04 (BC01+LP04+TR01)
- Antenna Set AS-07 (BL01+TR01)
- VDH-01: Van der Hoofden Test Head 20 kHz to 10 MHz
- RF-300 : Van Veen Loop

1.6 Other accessories

The PMM ER9000 can also be used with other accessories available on the market, like:
- LISNs, any type;
- Antennas and Loops;
- Near Field Probes;
- Various TEM/GTEM Cells;
- Triple Loop Antenna

1.7 Main Specifications

Table 1-1 lists the PMM ER9000 performance specifications.
The following conditions apply to all specifications:

- The ambient temperature shall be -5°C to 45°C

<table>
<tr><td colspan="2" align="center">TABLE 1-1 Main Specifications</td></tr>
<tr><td>Frequency</td><td></td></tr>
<tr><td>Range</td><td>10 Hz to 30 MHz (Opt. 00)   10 Hz to 3 GHz (Opt. 01)</td></tr>
<tr><td>Resolution</td><td>0.1 Hz;   10 Hz above 30 MHz (Opt. 01)</td></tr>
<tr><td>Reference frequency</td><td>< 1 ppM</td></tr>
<tr><td>Spectrum analysis method</td><td>FFT, size up to 8192, minimum overlap 89%</td></tr>
<tr><td>RF input
VSWR</td><td>Z_{in} 50 Ω, N fem.</td></tr>
<tr><td>10 dB RF att.</td><td>< 1.2; < 2 above 1 GHz</td></tr>
<tr><td>0 dB RF att.</td><td>< 1.6; < 2 above 30 MHz</td></tr>
<tr><td>Attenuator</td><td>0 dB to 55 dB (5 dB steps)</td></tr>
<tr><td>Preamplifier gain</td><td>20 dB; 10 dB above 30 MHz Low saturation preamplifier (after preselector)
20 dB; 10 dB above 30 MHz Low noise preamplifier (before attenuator)</td></tr>
<tr><td>Pulse limiter</td><td>Built in (selectable) below 30 MHz</td></tr>
<tr><td>Max input level (without equipment damage)
Sinewave AC
Voltage pulse spectral density
Max. pulse voltage
Max. DC voltage</td><td>140 dBuV (2 W); 137 dBuV (1 W) above 30 MHz
176 dBuV/MHz below 150 kHz; 130 dBuV/MHz below 30 MHz; 97 dBuV/MHz below 1 GHz
200V (≤ 20 us)
25V; 50V above 1 kHz</td></tr>
<tr><td>Preselector
Frequency ranges</td><td>(Thirteen BP filters – 7.5 / 15 MHz BW to ADC)
10 Hz to 9 KHz   22.5 MHz to 30 MHz
1 kHz to 9 kHz   15 MHz to 30 MHz
9 kHz to 150 kHz   30 MHz to 96.6 MHz tracking (Opt. 01)
150 kHz to 7.5 MHz   96.6 MHz to 311 MHz tracking (Opt. 01)
7.5 MHz to 15 MHz   311 MHz to 1000 MHz tracking (Opt. 01)
150 kHz to 15 MHz   1 GHz to 3 GHz (Opt. 01)
15 MHz to 22.5 MHz</td></tr>
<tr><td>IF bandwidth
3 and 6dB</td><td>10 Hz, 20 Hz, 30 Hz, 50 Hz, 100 Hz, 200 Hz, 300 Hz, 500 Hz
1 kHz, 2 kHz, 3 kHz, 5 kHz, 10 kHz, 20 kHz, 30 kHz, 50 kHz, 100 kHz, 200 kHz, 300 kHz, 500 kHz, 1 MHz, 2 MHz, 3 MHz</td></tr>
<tr><td>CISPR 16-1-1</td><td>200 Hz, 9 kHz, 120kHz, 1 MHz</td></tr>
<tr><td>Displayed Average Noise Level

Preselector OFF, preamplifiers OFF, HT 1s</td><td>9 kHz to 150 kHz (200 Hz RBW)   < -17 dBuV
0.15 MHz to 30 MHz (9 kHz RBW)   < 0 dBuV
30 MHz to 300 MHz (120 kHz RBW) < 4 dBuV (Opt. 01)
300 MHz to 3 GHz (120 kHz RBW)   < 10 dBuV (Opt. 01)</td></tr>
<tr><td>Preselector OFF, low noise preamplifier ON, HT 1s</td><td>9 kHz to 150 kHz (200 Hz RBW)   < -32 dBuV
0.15 MHz to 30 MHz (9 kHz RBW)   < -19 dBuV
30 MHz to 300 MHz (120 kHz RBW) < -9 dBuV (Opt. 01)
300 MHz to 3 GHz (120 kHz RBW)   < -4 dBuV (Opt. 01)</td></tr>
<tr><td>Preselector ON, preamplifiers OFF, HT 1s</td><td>9 kHz to 150 kHz (200 Hz RBW)   < -14 dBuV
0.15 MHz to 30 MHz (9 kHz RBW)   < 3 dBuV
30 MHz to 300 MHz (120 kHz RBW) < 1 dBuV (Opt. 01)
300 MHz to 3 GHz (120 kHz RBW)   < 6 dBuV (Opt. 01)</td></tr>
<tr><td>Preselector ON, low dist. preamplifier ON, HT 1s</td><td>9 kHz to 150 kHz (200 Hz RBW)   < -27 dBuV
0.15 MHz to 30 MHz (9 kHz RBW)   < -14 dBuV
30 MHz to 300 MHz (120 kHz RBW) < -5 dBuV (Opt. 01)
300 MHz to 3 GHz (120 kHz RBW)   < 0 dBuV (Opt. 01)</td></tr>
<tr><td>Detectors</td><td>Peak, Quasi-Peak, RMS, Average, RMS-Average, C-Average.
Smart Detector function above 30 MHz (Opt. 01)</td></tr>
</table>

Scan time	SWEEP MODE (CISPR: preselector ON, QP detector)	ANALYZER MODE (preselector OFF, Peak detector, Hold time lowest)
A band (9 kHz to 150 kHz) 200 Hz RBW	< 2 s (Hold time 1 s) < 3 s (Hold time 2 s)	< 50 ms (Ht 27 ms)
B band (150 kHz to 30 MHz) 9 kHz RBW	< 3 s (Hold time 1 s) < 5 s (Hold time 2 s)	< 10 ms (Ht 525 us)
C band (30 MHz to 300 MHz) 120 kHz RBW	< 20 s (Hold time 1 s) < 40 s (Hold time 2 s)	< 100 ms (Ht 32 us)
D band (300 MHz to 1 GHz) 120 kHz RBW	< 40 s (Hold time 1 s) < 80 s (Hold time 2 s)	< 500 ms (Hold time 32 us)
E band (1 GHz to 3 GHz) 1 MHz RBW	< 160 s (Hold time 1 s) < 320 s (Hold time 2 s)	< 400 ms (Hold time 4 us)
Level measuring time (Hold time)	CISPR 16-1-1 as default. 2 us to 120 s	
Measurement accuracy **S/N > 20 dB**	10 Hz to 9 kHz ± 1.0 dB (typ.) 9 kHz to 30 MHz ± 0.8 dB 30 MHz to 1 GHz ± 1.0 dB 1 to 3 GHz ± 1.5 dB	
Recommended calibration interval	24 months	
Stand-alone main measure functions Or with free system SW PMM Emission Suite	Manual, spectrum analyser and sweep modes. Waterfall Standard and user definable limits Conversion and correction factors Control of DDA (Click) analyser, LISNs and other accessories. Auto diagnosis Auto calibration Test reporting	
Units (80 to 200 dB selectable dynamic)	dBm, dBµV, dBµA, dBpW, dBµV/m, dBµA/m, dBpT	
Demodulation	AM – FM Internal loudspeaker	

RF output
Tracking (manual mode only) & CW generator
    Frequency range
    Level range
    Level accuracy
CISPR pulse generator
    Pulse repetition frequency
    PRF accuracy
	Z$_{out}$ 50 Ω, BNC female
	
	10 Hz to 30 MHz
	60 to 90 dBµV (0.1 dB step)
	0.5 dB
	
	1 to 1000 Hz
	0.1%	

Autocalibration	Internal reference source	
Display	Color 6.2" TFT LCD touch panel	
I/O Interface	RS-232 DB9, USB 2.0 type B, User port DB15 (Drives PMM LISNs and accessories) USB type A for memory sticks, Serial Optical interface RP02, Ethernet 10/100 BaseT RJ45	
Operating temperature	-5° to 45°C	
Power supply	10 - 15 Vdc, 2.5 A with AC universal adapter/charger Li-ion rechargeable & replaceable battery (BP-02)	
Dimensions	235x105x300 mm	
Weight	5.0 kg	

1.8 Front Panel

Fig. 1-1 Front Panel

Legend from left to right:

- **USB** slave connector for memory sticks

- ⏻ **:** Switch ON pushbutton with integrated red/green LED which indicates the power status

- Touch screen **display**

- **Knob** with integrated pushbutton

- **Grid:** Speaker grid

- **RF Input connector:** Receiver Input

1.9 Rear Panel

Fig. 1-2 Rear Panel

Legend from left to right:

- Product Label and Serial Number

- Li-ion removable battery .

- RF OUT BNC connector: internal RF signal generator output

- Power supply connector: 10 – 15 Vdc 5 A max power supply input

- Fan   Cooling Fan controlled by firmware

- Earth ground connector

- USER PORT   User I/O Port

- RS232   9 pin, DB9 connector

- USB   USB 2.0 Port

- Optic   fiber optic RP02 connector

- LAN   Ethernet port 10-100BaseT RJ45 connector

1.10 Functional Description

The PMM ER9000 features a completely new receiver architecture based on the most recent DSP and FPGA technology, as shown on the diagram below.
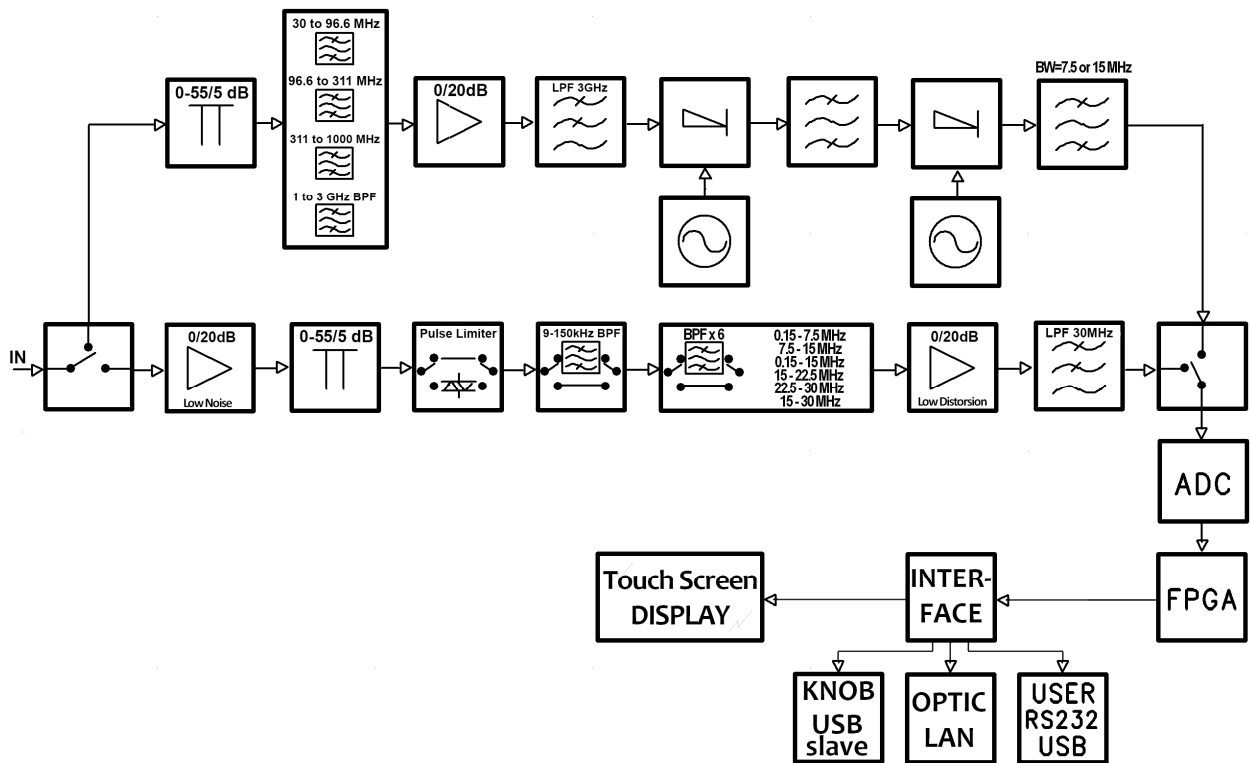
Fig. 1-3 PMM ER9000 Functional BLOCK Diagram

The input stage integrates a switch system able to address the signal source coming from the N panel connector to the low (conducted) or high (radiated) frequency modules. The RF (Radiated) module is equipped with its own attenuator and preselection filters bank. The A to D conversion and processing stages are in common between conducted and radiated modules.

The stages designed for conducted measurements are able to handle frequencies from 10 Hz up to 30.1 MHz and the radiated module can handle frequencies from 28 up to 3000 MHz.

The second IF can be set for a 15 MHz width, useful to speed up measurements, or for a 7.5 MHz width, more suitable for strong wideband disturbances.

All the IF filters are numerically calculated by the FPGA-DSP so they are very stable and do not need neither to be retuned at all, nor frequent recalibration.

The human Interface unit is equipped with a powerful DSP processor, which drives the touch panel display and all the communication ports.

1.11 Ultra fast measurement: a unique feature of the PMM ER9000

In the CISPR bands A (9 kHz ÷ 150 kHz), B (150 kHz ÷ 30 MHz), C (30 ÷ 300 MHz) and D (300 ÷ 1000 MHz) the standards requires the use of specially shaped 200 Hz, 9 kHz, and 120 kHz RBW filters.

For example, in the CISPR band A (9 ÷ 150 kHz), the standards requires the use of a 200 Hz filter that is, by nature, a filter that implies a long measurement time: a complete scan may require even more than 10 minutes, depending on the detector in use.

Thanks to its architecture and to the large internal memory capability, the PMM ER9000 can take a "snapshot" of the whole band in just one second and, using a gap-less true built-in FFT capability, perfectly displays the complete band in all its details. This feature is not only useful to greatly increase the productivity of the test lab, but also to make better and more comprehensive analysis in case the disturbance to be evaluated is somehow intermittent and with an irregular repetition rate; its analysis with a traditional receiver could be hardly made in a proper way (even if an FFT capability is available: this feature needs a very comprehensive design), as irregular pulses could be lost during a usual sweep.

To be noted that during the FFT analysis, the PMM ER9000 makes use of internal filters mathematically modelled to the perfection using a FIR technique.

1.12 Emission measurements

All electric and electronic devices are potential generators of Electro-Magnetic Interference (EMI).

The term EMI thus refers to the electromagnetic energy emitted by a device which propagates itself along cables or through the air and couples with other devices that are present in the surroundings.

These electromagnetic fields (conducted or radiated interferences) may generate interfering currents and voltages into nearby equipment and therefore can cause possible malfunctions.

In order to prevent and control such interferences there are nowadays a number of national and international standards, like IEC and CISPR, which specifies limits and methods of tests. Moreover, within the European Union the application of several European Norms on Electromagnetic Compatibility is enforced by law and therefore the commercialization and use of all the electric and electronic equipment is subject to the measurement of the EMC characteristics, which must be within well defined limits.

The design approach adopted for the PMM ER9000 is that the instrument shall be innovative, full compliant with all the relevant standards and at the same time simple and reliable to use, to be the base building block for any possible emission system to measure and evaluate any electric or electronic device from the very first design stages to the final certification.

The need to precisely measure the conducted and radiated EMI noises forces the equipment manufactures to use reliable equipment to verify the limits imposed by the relevant standards and/or enforced by local rules.

In this view the PMM ER9000 receiver is the ideal solution from prototype debugging to final certification, as it fully meets all the performance criteria dictated by these standards, although it remains small, lightweight and very easy to use.

The PMM ER9000 Utility control software permits an immediate use of the instrument without any training or special difficulties: the operator can concentrate just on analyzing the measurement results.

Moreover, the PMM ER9000 software has also been designed for a fast and easy installation on any PC with the Windows™ operating system and with at least one free USB or Serial Port.

The device under test (DUT) must be installed according to the procedures indicated in the constructor's manual and normal operating conditions respected.

NOTICE

Be sure not to overload PMM ER9000: the input signal should not exceed the maximum level indicated in the specifications (see § 1.7) .

1.13 Principle of operation

The ER9000 is a real-time gapless receiver based on FFT (Fast Fourier Transform) which evaluates N frequencies in a single shot.

Real time means that the FFT calculation must be as fast as the incoming data are sampled to achieve the result that no data are missed.

FFT itself would be not adequate for full compliant measurements without preventing:

- Aliasing effect, by adopting an appropriate input filter which suppresses the frequencies beyond the Nyquist limit.

- Spectrum leakage, due to the fact that observation of the input signal must be limited to a finite interval (an infinite series of subsequent finite intervals in our method). An appropriate time-windowing function is applied so that the spreading or leakage of the spectral components away from the correct frequencies is negligible.

- Picket fence effect, related to the resolution bias error that may cause in an FFT spectrum the peaks to be measured too low and the valleys too high in level. This phenomenon is avoided by adding a certain number of overlapped FFTs, calculated in parallel over almost the same input samples.

Thanks to these techniques, the PMM ER9000 has no gaps and detects any CISPR pulse even at the lowest repetition rates.

The ER9000 processes 6 detectors x 8192 frequencies x 10 FFTs at once.

In this way it is possible, for example, to carry out a complete fully CISPR 16.1.1 compliant measurement with 2 seconds observation time, over the A band (9 -150 kHz with a 200 Hz RBW filter), or with 1 second over the B band (150 kHz – 30 MHz with a 9 kHz RBW filter) in less than 3 seconds.

2 - Installation

2.1 Introduction

This section provides the information needed to install your PMM ER9000.
It includes the information pertinent to initial inspection and power requirements, connections, operating environment, instrument mounting, cleaning, storage and shipment.

2.2 Initial Inspection

When receiving the equipment, first inspect the shipping cardbox for any damages.
If the shipping box 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.

2.3 Packing and Unpacking

Verify the availability of all the shipped items with reference to the shipping check list enclosed with the Operating Manual.
Notify any damage to the forwarder personnel as well as to your NARDA Representative.

NOTICE

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

2.4 Preparation for Use

⚠ CAUTION

This is a Safety Class II apparatus, but it is also equipped with a protective/functional earth terminal on the rear panel. A good safety/functional ground connection should be provided before to operate the receiver.

2.5 AC/DC Power Supply

The power supply supplied with the receiver can work at either 50 Hz or 60 Hz with a supply voltage rated between 100 and 240 Volt.
It is supplied with different connectors to fit all the possible outlets in accordance with the various National standards.

- → ⊙ — +

Battery charger: DC, 10 - 15 V, ~ 5 A
=> DC Connector

2.5.1 To replace the mains connector of AC/DC Power Supply

To replace the mains connector, simply remove the one installed on the Power supply sliding it off, and insert the one that fits the outlets in use.

2.5.2 Switch ON pushbutton with integrated led

To switch the unit ON, press the square button and keep it pressed till the led lights up, then release the button; the boot sequence takes place automatically.
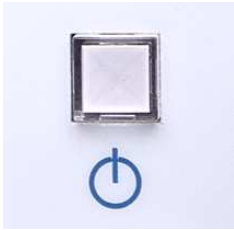
When the led inside the button becomes green, the instrument is ready for use.

NOTE

The led inside the button is red until the unit is ready.

2.6 Environment

The operating environment of the receiver is specified to be within the following limits:

- Temperature   -5° to +45° C
- Humidity   < 90% relative
- Altitude   4000 meters

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

- Temperature   -40° to + 50° C
- Humidity   < 95% relative
- Altitude   15.000 meters

2.7 Return for Service   If the instrument should be returned to NARDA 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 box and use enough shock absorbing material all around the equipment to provide a firm cushion and prevent movement in the shipping box; in particular protect the front panel.

Seal the shipping box securely.

Mark the shipping box FRAGILE to encourage careful handling.

NOTE   Nowadays there are restrictions on the shipment of hazardous materials, eg. some types of lithium batteries.

Please, check the proper, safe, shipping mode, with the help of your courier, in the case the product is equipped with batteries.

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

NOTICE   **To clean the equipment do not use any solvent, thinner, turpentine, acid, acetone or similar matter to avoid damage to external plastic or display surfaces.**

2.9 Equipment ventilation

NOTICE   **To allow correct equipment ventilation ensure that the vent grids on the rear panel and on the bottom of the receiver are free by any obstructing object.**

2.10 Hardware Installation   PMM ER9000 is delivered from factory ready to use. Remove the receiver from its cardboard shipping box and keep the "ON" button pressed until the PW Led lights up (about 1 second), then release the button. To avoid unwanted starts, if the "ON" button is kept pressed for a too short time or for more then 2 seconds the instrument is switched automatically off.

After having been switched ON, the PMM ER9000 boots with its internal BIOS and runs the firmware which manages the receiver.

At the beginning the instrument performs a diagnostic test to check if everything is working properly.

The boot sequence is very fast and the receiver is ready to use in less than ten seconds after having pressed the ON button.

Just before the end of the boot up, you will see all the front panel LED's flashing ON and then only the Power green LED and the RF IN remain ON.

The receiver is now ready to operate.

Prepare the connection to the external LISN or connect the output of any antenna, or absorbing clamp or any other transducers to the RF input.

When using a PMM LISN, it is possible to control from the receiver the lines of the LISN and automatically switch between them connecting a special cable between the User Port of the receiver and the LISN remote control input.

Push and keep pressed the "ON/OFF" button for more then 2 seconds to switch off the receiver.

2.11 Using an Artificial Mains Network (AMN or LISN)

When the PMM ER9000 receiver is connected to an external LISN to perform conducted interference measurements of the EUT, the RF output of the LISN shall be connected to the RF input of the receiver (see Fig. 4-3 on page 4-4). In order to switch automatically between the lines of the LISN, it shall be connected to the User Port of the receiver thanks to the dedicated cable supplied with the LISN .

Using PMM ER9000 Software Utility it is possible to carry out an automatic measurements on all mains lines and get the worst case.

⚠ CAUTION

In order to avoid the unwanted tripping of the protection devices, an insulation transformer shall always be used between the mains supply and a LISN.

2.12 Using the Pulse Limiter

The built in pulse limiter is a useful device to protect the input of the receiver from transient over voltages. Sometime the conducted disturbances entering the receiver through the LISN are too high - even if they cannot be seen on the PMM ER9000 because they are out of measurement bandwidth - and the associate energy is high enough to damage the input circuit.

The pulse limiter shall be used only as a protection of the input from unexpected pulses.

NOTICE

When using an external Artificial Mains Network, to reduce the probability of damages caused by transient voltage pulses always disconnect the PMM ER9000 RF input before switching Equipment Under Test supply ON or OFF.

Installation

2.13 Using Current and Voltage Probes

When a LISN cannot be used – e.g. when measurements have to be made on terminals other than the mains ones, such as load or command terminals, sensitive to inserted capacities for example, or when LISNs of adequate current capabilities aren't available, or when the line voltage is too high – a current or voltage probe can be used.

The characteristics of these probes, and some advises on their uses, are given in §5 of CISPR 16-1-2.

The CISPR voltage probe contains a resistor with a minimum resistance of 1500 ohm, in series with a capacitor of negligible reactance vs. the resistance (in the 150 kHz to 30 MHz range), and it is insulated at least up to 1500V.

All these probes have an insertion loss and a frequency response that can be stored in the memory of the PMM ER9000, so that the actual readings of the receiver can be automatically corrected by these characteristics values.

2.14 Using Antennas and other Transducers

In the frequency range from 10 Hz to 30 MHz (opt.00) or 10 Hz to 3 GHz (opt.01) any other transducer can be used to pick-up and measure RF conducted and radiated emissions, like active and passive loop antennas, rod antennas, near field probes etc.

The characteristics of these transducers are usually specified in the relevant standards (e.g. Military or Automotive Standards).

Their use with PMM ER9000 is very easy, as it's enough to enter their response with the frequency into the memory of the receiver to have the readings automatically corrected. When the cable is not calibrated together with the transducer, even the cable loss can be entered.

2.15 The User Port

The PMM ER9000 features on the rear panel a programmable User Port that can be used to drive external devices or, more generally, to output signals and data.

The User Port can easily be programmed and managed; the connector has the following hardware connection:

PIN #	Signal
1	IN3
2	IN1
3	+ 12 VDC (max 50 mA)
4	OUT 0
5	OUT 2
6	Not Connected
7	Not Connected
8 and 9	IN 2
10	IN 0
11	GND
12	OUT 1
13	OUT 3
14	Not Connected
15	Not Connected

Data output (OUT 0 to OUT 3) and input (IN 0 to IN 3) are opto-coupled TTL level with max. 1 mA draining.

2.16 PMM L2-16A Remote Cable configuration for PMM ER9000

The following figure shows the LISN remote cable pin configuration. This cable is normally provided in L2-16A package, alternatively it can be requested to Narda or arranged locally.

NOTE

The PMM L2-16A is no longer supported. Please, check the manufacturing status of the Narda products from the website at http://www.narda-sts.it or contact your Narda – PMM local Dealer
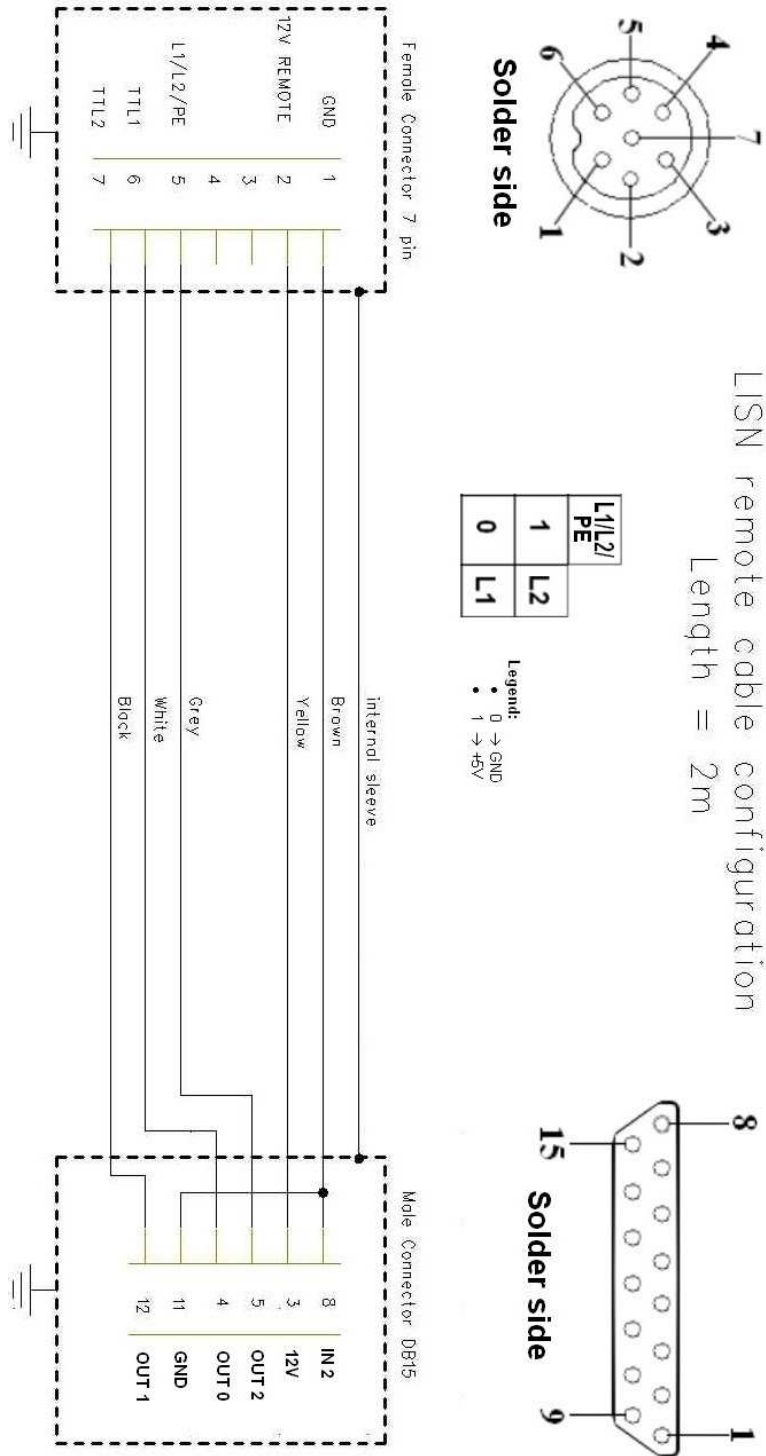
Fig. 2-1 PMM L2-16A remote cable configuration for PMM ER9000

2.17 PMM LISNs Three Phase Remote Cable configuration for PMM ER9000 (L3-25 excluded)

The following figure shows the LISN remote cable pin configuration. The cable can be requested to Narda or arranged locally.
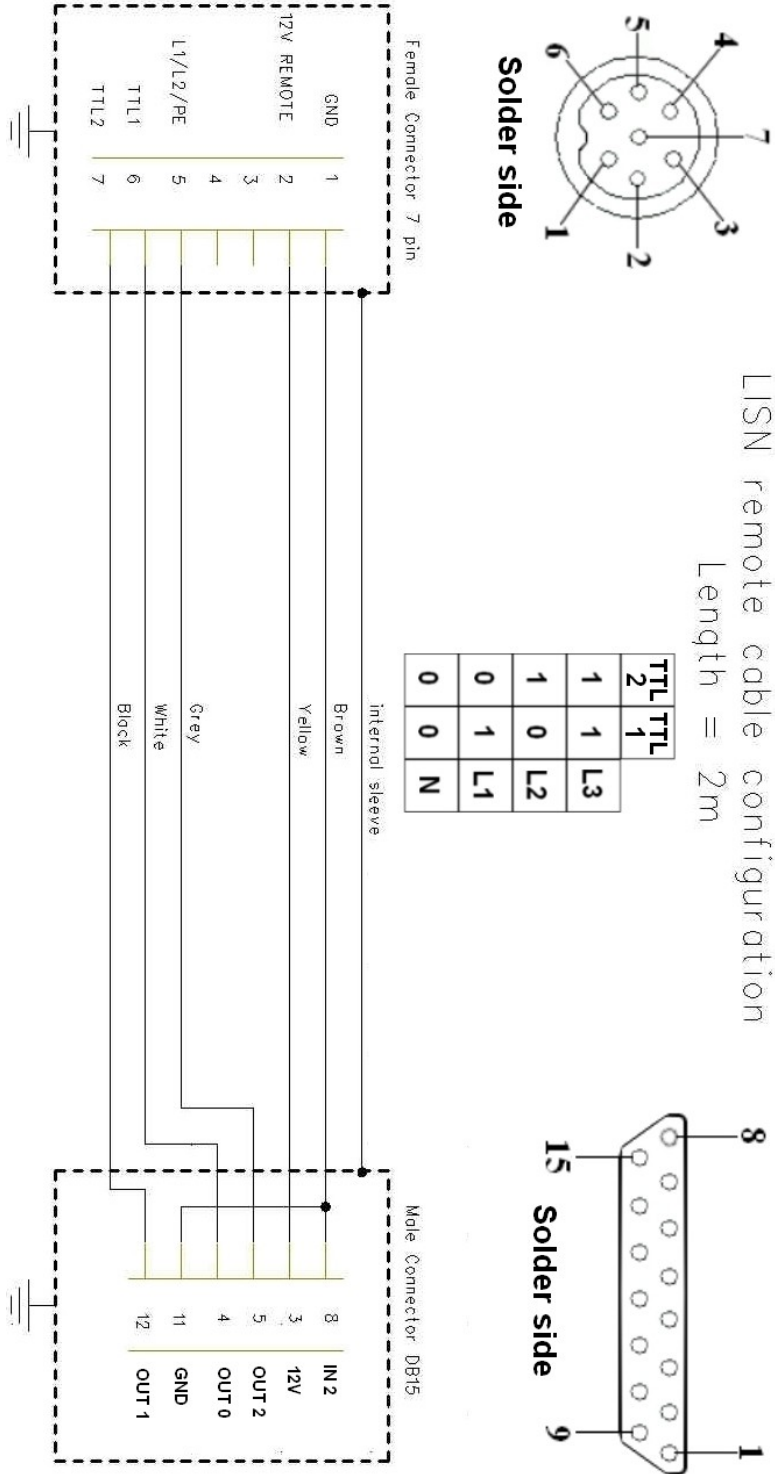
Fig. 2-2 PMM LISN three phase remote cable configuration for PMM ER9000

2.18 PMM L3-25 Remote Cable configuration for PMM ER9000

NOTE

The following figure shows the LISN remote cable pin configuration. The cable can be requested to Narda or arranged locally.

The PMM L3-25 is no longer supported. Please, check the manufacturing status of the Narda products from the website at http://www.narda-sts.it or contact your Narda – PMM local Dealer
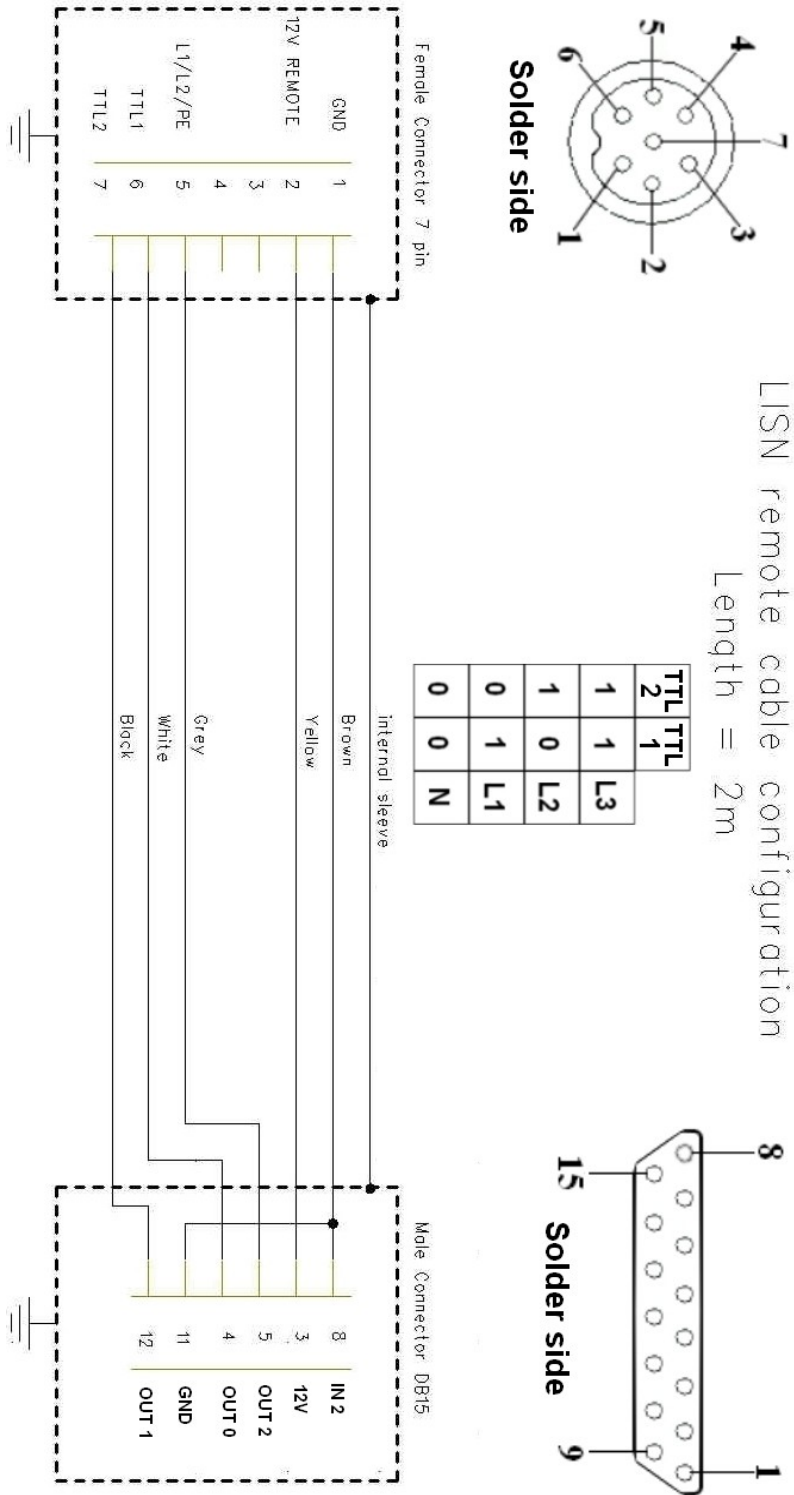
Fig. 2-3 PMM L3-25 remote cable configuration for PMM ER9000

3 – Operating Instructions

3.1 Introduction

The PMM ER9000 EMI Receiver can be operated as a stand-alone receiver or remotely driven by a PC through an USB connection.

The system is provided with a specifically developed software called PMM Emission Suite, which installer utility is stored on the Software Media shipped together with the instrument.

Please refer to the PMM Emission Suite Manual for any information and instruction concerning the operation of the software.

3.2 Operating Modes

Both in stand-alone and under the control of the PMM Emission Suite PC Software, it is possible to use the receiver in different modes of operation.
They are: Manual, Sweep and Analyzer mode.
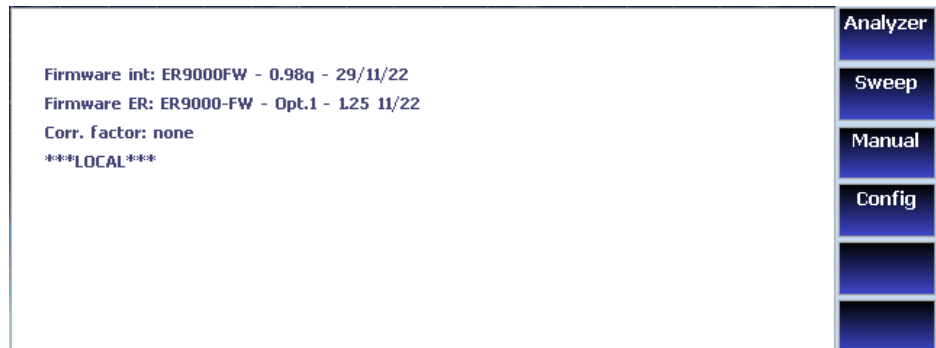
3.2.1 SWEEP MODE   The **Sweep Mode** is the most common way to perform measurements in the EMI environment.
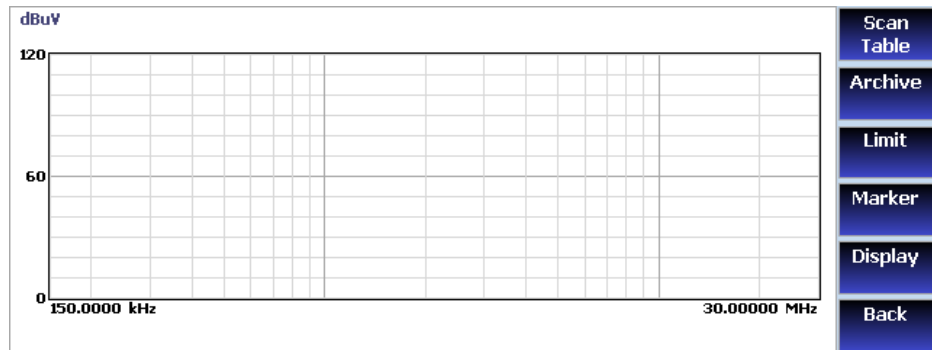
3.2.1.1 Scan Table   The Sweep mode is conceived to operate the PMM ER9000 as a powerful scanning EMI receiver. To enter in this mode it is enough to touch the Sweep software key on the main screen, and immediately the scan window pops up and allows the operator to set the parameters for the scan. Tap the "Scan Table" software button to enter the setup window. All the automatic settings (RBW, frequency step, etc.) refer to the CISPR standard.

In Sweep mode the Peak, QPeak, C-Rms, RMS, C-Avg, Avg detectors are available.

All the relevant information are reported on the screen (or the PC running the PMM Emission Suite. In this case, please refer to the software User's Manual for further details).

In this way, the User can see which detector is in use and the relevant hold time; if the function "Smart Detector" is activated and which one, and if a Minimum attenuation is set.

Under the display menu, of the main screen, it is possible to choose the Reference level and dynamic range. During the scan, in the center above the graph, the actual frequency measured is displayed and continuously updated.

Below the graph the start and the stop frequency, and loaded limits, if any, are shown.

When the sweep has been executed, on the bottom of the screen the most important sweep parameters are repeated.

Always use **Back** button to return to the previous view/condition.

3.2.1.2 Archive

The Archive menu allows the operator to load, save sweeps and export them to a USB stick for later further processing.

F Start\Stop\Step MHz/MHz/KHz	Detector	Holdtime (s)	RBW list	Min Att	Presel	Preamp	Anciillary

Buttons: Load Sweep, Save Sweep, Export USB, Back

3.2.1.3 Limit

Each emission standard has one or more limits the User shall comply with. The PMM ER9000 receiver has the possibility to load and activate one limit with a simple touch of a button.

The preloaded standard limits refer to the most popular EMC emission standards: CISPR22, CISPR14 and CISPR11.

Other limits – or any custom designed limit – can be created, managed, selected and loaded through the PMM ER9000 Software Utility running on a PC.

LIMITS list: 022av-a, 022av-b, 022qp-a, 022qp-b, 55011aa, 55011aqp, 55011bav, 55011bqp, 55022aav, 55022aqp, 55022bav

Buttons: Ok, None, Back
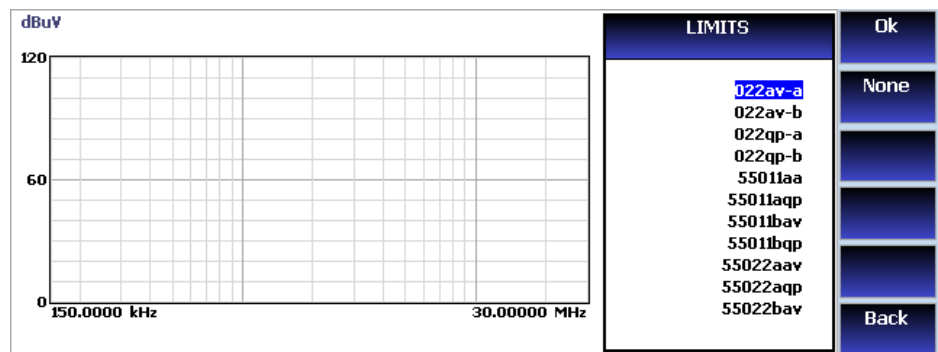
The limits are shown on the scan display and they appear like a thin black line when the Smart Detector function is not enabled, while one of them appears in bold black when the Smart Detector function is active.

By touching the NONE button all limits are deactivated.

Always use **Back** button to return to the previous view/condition.

3.2.1.4 Marker
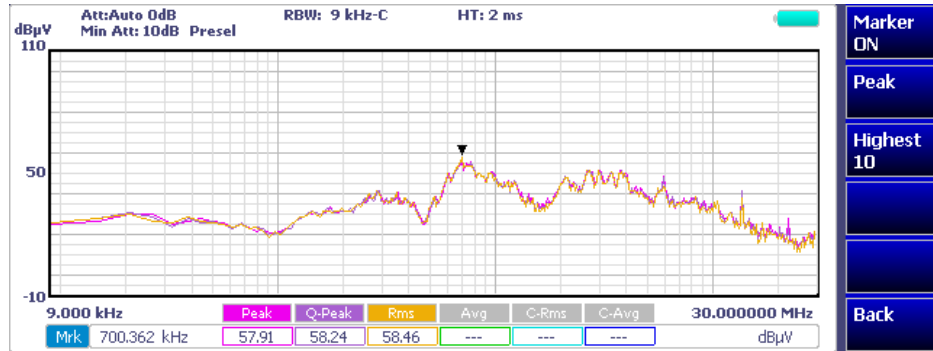
Selecting this function, a **Marker** is immediately enabled, and it appears on the screen as a small black pointing down arrow corresponding to the highest reading; simultaneously a small window shows up in the bottom left corner of the screen, indicating the actual frequency and level read by the marker.

Selecting **Highest X** – where X represents the maximum number of markers found by the receiver during its sweep – few more markers are added, each one "diamond" shaped, defined as per the previous explanation.
The maximum number of markers available is 10.

By using the **Next** and **Prev** software buttons, it is possible to quickly move on markers from higher amplitude (left arrow) to lower amplitude (right arrow), i.e. if the highest is selected, tapping the **Next** button the 2nd highest is selected, then touching again the same key the 3rd highest and so on and so forth.
It is also possible to use the rotary knob to move from a marker to the next one.
The marker under analysis (main marker) is a black arrow pointing down, the others are diamond shaped.
Touching the **Highest** button the marker returns to the highest reading.

In order to make easier and faster the evaluation of the more noisy signals, the User can now select either the **Analyzer** or the **Tune** function, entering respectively into a spectrum analysis of main marker position or in the manual mode evaluation of it. To operate this two conditions please refer to the appropriate section of this Operating Manual.
In manual mode, i.e. having selected **Tune** on the main marker, it is possible to navigate from one peak to the other just tapping the arrow keys, without to come back to the Sweep display and remaining in manual mode.
This is another smart feature of PMM ER9000 to improve the productivity of the test lab and make easier the work of the test engineer.

The **Marker Off** exits from the marker function.

Always use **Back** button to return to the previous view/condition.

3.2.1.5 Display   Touching the **Display** button, it is possible to set two parameters: the visualized **Dynamic** range (chosen between 60, 80, 100 and 120 dB) and the **Reference Level,** that can be increased or reduced by steps of 5 dB and 10 dB.
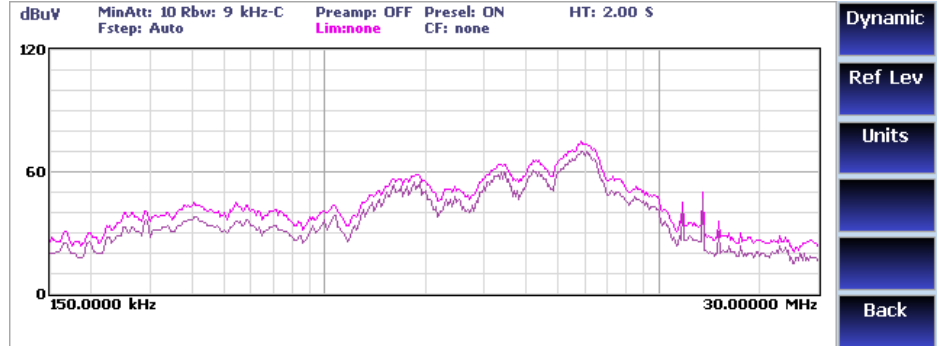
Always use **Back** button to return to the previous view/condition.

3.2.2 ANALYZER MODE

The purpose of this operating mode is to make an easy and fast debugging tool available to the User.

To enter the **ANALYZER Mode** it's enough to tap the Analyzer software key on the main screen.
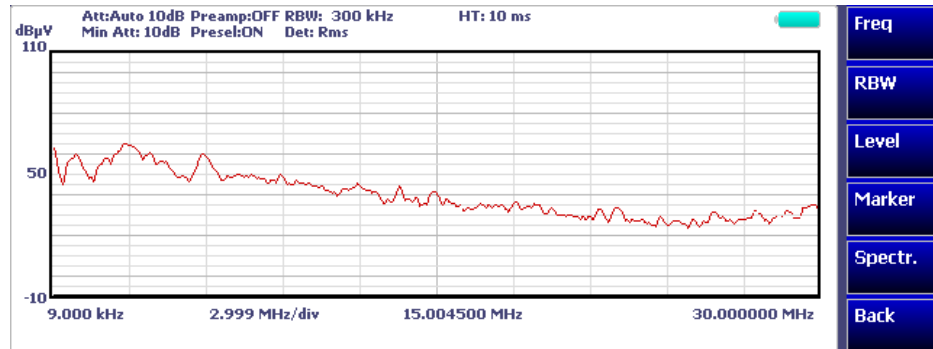
In this mode the receiver works as a powerful Spectrum Analyzer and the display shows the "spectrum analysis" in the frequency domain.

The analysis is done at the selected span frequency.

Using the marker facility the User can accomplish a very accurate measurement of the signals either in frequency as well as in level.

On the screen of the Analyzer Mode all the relevant information are reported.

So that the User can see which detector is in use and the relevant hold time; if the input attenuation is Automatic or Manual and the set attenuation and the Minimum attenuation.

Near the graph there is the Reference level, the Resolution bandwidth and the span value.

Below the graph the start, center and stop frequency.

A proper box is dedicated to the marker indication, with actual frequency and level of the marker.

3.2.2.1 Frequency

The **Frequency** menu features five function buttons:

Touch **Center** to enter the center (mean) frequency for the analysis.

Touch **Start** to enter the start (minimum) frequency for the analysis.

Touch **Stop** to enter the stop (maximum) frequency for the analysis.

Touch **Span** to enter the frequency span (width) for the analysis

Using these buttons, the User can set any frequency interval for the measurement; to enter the frequency values, tap the corresponding function keys.

When one of these function keys is touched, a software keyboard appears, allowing the User to enter numerically the desired frequency and unit (Hz, kHz, MHz or GHz) as well as the decimal dot and the Back Space.

3.2.2.2 RBW

The **Resolution Bandwidth** menu is used to select the bandwidth of the measuring filter. Up to twentyseven filters are available, depending on the tuned frequency band:

- 3 MHz -6dB
- 2 MHz -6dB
- 1 MHz -6dB
- 500 kHz -6dB
- 300 kHz -6dB
- 200 kHz -6dB
- 100 kHz -6dB
- 50 kHz -6dB
- 30 kHz -6dB
- 20 kHz -6dB
- 10 kHz -6dB
- 5 kHz -6dB
- 3 kHz -6dB
- 2 kHz -6dB
- 1 kHz -6dB
- 500 Hz -6dB
- 300 Hz -6dB
- 200 Hz -6dB
- 100 Hz -6dB
- 50 Hz -6dB
- 30 Hz -6dB
- 20 Hz -6dB
- 10 Hz -6dB
- 1 MHz-C CISPR 16 shaped at -6dB
- 120 kHz- C CISPR 16 shaped at -6dB
- 9 kHz- C CISPR 16 shaped at -6dB
- 200 Hz CISPR 16 shaped at -6dB

Use the knob to select the desired filter and press the button (or the **Enter** software button) to confirm.
These filters are mathematically modeled using FIR (Finite Impulse Response) technique and they are exactly as required by the standards.
Some filters are CISPR 16 compliant and other are for specific applications, e.g. to cover Military Standards requirements, etc.

Always use **Back** button to return to the previous view/condition.

3.2.2.3 Level

Display

Input

Misc

Detector

Units

Back

The **Level** function has 5 sub-menus, each one with several options.

Touching the **Display** button it is possible to set two parameters: the visualized Dynamic range (chosen between 60, 80, 100 and 120dB) and the Reference Level, that can be increased or reduced by steps of 5dB or 10dB; in operating modes Analyzer and Manual the min.-max. values of the reference level are in function of the input attenuator and preamplifier settings.

The **Input** button opens a submenu, which is dedicated to the setting of the input attenuator, and to switch on-off the built-in preamplifier.

The PMM ER9000 receiver takes automatically into account the settings of all the Input parameters and always displays the correct value of the level. The User does not need to calculate any correction to the readings.

Under **Misc** menu it is possible to switch the input **Preselector**, **Pulse Limiter**, and to control the internal signal generator.

The **Detector** software button opens a submenu where the observation time (**Hold Time**) can be set, and the User can also choose the desired detector.

The Units software key is intended for choosing the desired level unit, among: dBm, dBμV, dBμA, dBpW, dBμV/m, dBμA/m, dBpT.

Always use **Back** button to return to the previous view/condition.

3.2.2.4 Marker

With this command the **Marker** function can be enabled.

Switched ON the marker, it appears on the screen as a small black pointing down arrow, and simultaneously a small window shows up in the bottom left corner of the screen, indicating the actual frequency and level read by the marker.

Touching the **Peak** button the marker will automatically move to the highest signal found in the span range in that given moment, and with the help of the **Center** button the frequency selected by the marker becomes the center frequency on the screen, making very easy any signal analysis.
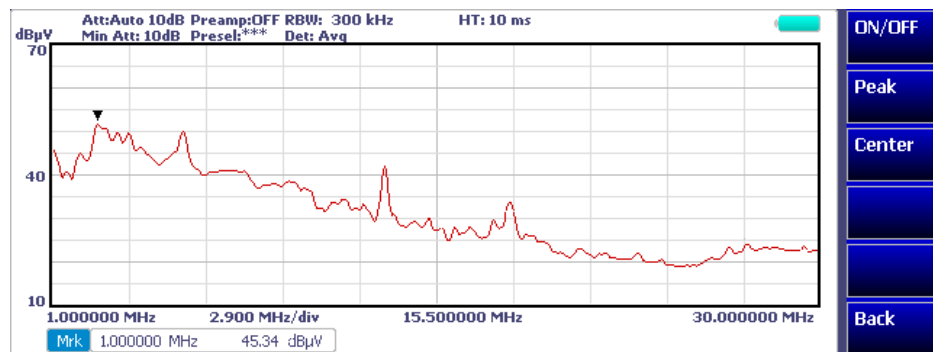
3.2.3 MANUAL MODE The **MANUAL mode** is a very useful feature to manually control the receiver and to deeply investigate electrical signals modifying the parameters of receiver exactly as per the needs of the Test Engineer.
In this operating mode, the instrument continuously display the signal level at a desired fixed frequency (not sweeping).
It is possible, for example, to observe the signals exceeding the limits frequency by frequency; evaluating their levels measured simultaneously with 4 different detectors (Peak, QuasiPeak, Average and RMS); listening to them after a demodulation, etc.

To enter in **Manual Mode** touch the key in the main menu, and immediately the first Manual window opens.
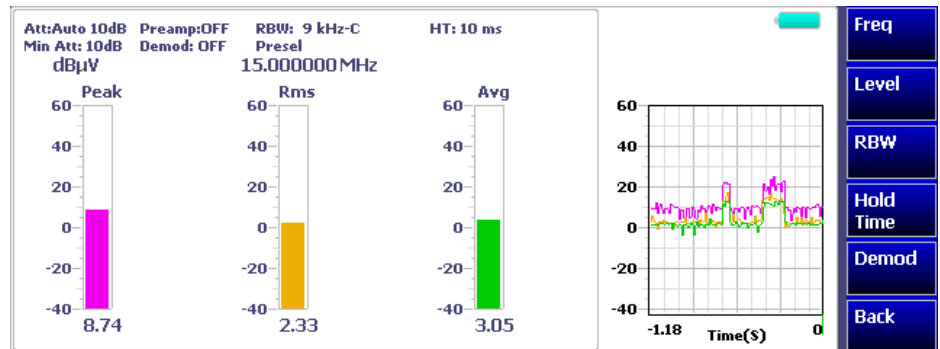
In manual mode, the levels corresponding to the detectors in use are displayed both in analogue and in digits format and, exactly as for the other operating modes, all the relevant information are reported on the screen.
The User can see the resolution bandwidth, the longest hold time associated to the detectors in use; if the input attenuation is Automatic or Manual and the set attenuation and the Minimum attenuation.
Also the Demodulator can be switched on and set to AM or FM, and the audio volume regulated as wished and represented by a simple bar.
Then there are three up to six vertical bars representing the detectors and indicating in analogue and digital (the figures below each bar) the level measured; on top of the bars the relevant detector, the unit in use and the tuned frequency. The analogue scale of the analogue bars is set automatically by the firmware, in accordance with the Reference Level.

☞ NOTE

In case an OVERLOAD indication occurs it is necessary to add an external attenuator to carry on the measurement without overpassing the declared limit for continuous power or spectral density.

NOTICE

Using 0 dB attenuation PMM ER9000 has no input protection.
This is a potentially 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 Vpp (or 120 dBμV).
Before to apply an unknown signal to PMM ER9000 receiver, use an oscilloscope or a wide band RF voltmeter to measure it. In any case set Min. ATT at 10 dB and select the maximum available attenuation.
If needed, add an external coaxial attenuator on the input signal line.

3.2.3.1 Detectors

PMM ER9000 has been designed to allow the use of many kinds of detectors. CISPR Standard has introduced the application of two detectors that are derived from the Root Mean Squared and from the Average ones.

3.2.3.2 RMS-AVG Definition

The RMS-Average detector is a special function, defined by the CISPR standard, implemented in the PMM ER9000 receiver.

🖐 NOTE

The RMS-Average detector, according to the CISPR 16-1-1 standard, supplies a reading of the input signal that is weighted, for repeated pulses, such that for a constant indication, the relationship between amplitude and repetition frequency is in accordance with the following rule:
The Amplitude is proportional to (repetition frequency)-1/2
The value is the maximum level during the measurement time (Hold Time) and the averaging is carried out with a lowpass filter of the 2nd order to simulate a mechanical instrument.
The calibration is in reference to the RMS value of an unmodulated sine wave signal.

3.2.3.3 C-AVG Definition

CISPR 16-1-1 defines the Average detector as designed to give the maximum value of the weighted average value of the envelope of the signal passed through the pre-detector stages.

The detector is used, for example, to measure pulsed sinusoidal signals with a low pulse repetition rate, what the standards refer to as intermittent, unsteady and drifting disturbances.
The measurement result of the response to intermittent, unsteady and drifting narrowband disturbances must be equivalent to the peak reading of an instrument with a meter time constant, independent of the observation time (Hold time), of 160 ms for Bands A and B, and of 100 ms for CISPR Bands C, D and E. A meter-simulating network following the envelope detector of the receiver can accomplish this.

The average detector is useful to measure narrowband signals, to overcome problems associated with either modulation content or the presence of broadband noise.
When the Average is measured according to CISPR 16-1-1, the maximum value of the linear mean envelope during the measurement interval is shown.

3.2.3.4 Manual Mode Menu

Freq

Level

RBW

Hold Time

Demod

Back

The Manual mode function has five sub windows:

- Frequency
- Level
- Resolution Bandwidth
- Hold Time
- Demodulation

Always use Esc button to return to the previous view/condition.

3.2.3.5 Frequency

Tune

Knob

Back

Under this menu it is possible to set the tuning frequency and also the knob step.

The center Frequency of the reading can be directly edited into the **Tune** window or set by rotating the knob.
The figures entered appear in a small window just below the graph and the default unit is MHz.

Having selected **Tune**, a keyboard pops up on the display and the value can be easily entered by tapping the corresponding figures 0, 1, 2, 3 etc. as well as the decimal point, followed by the desired unit: Hz, kHz, MHz or GHz.
A Cancel key is also available in case of mistakes.

Frequency Tune:			Hz
			kHz
7	8	9	MHz
4	5	6	GHz
1	2	3	
0	.	C	Back

If **Knob** is selected, another keyboard appears on the right side of the display and the knob step can be entered freely, following the same rules of the tuning frequency. After having fixed the step size, rotate the knob and tune the desired frequency.

3.2.3.6 Level

The Level function has 4 sub-menus.

Touching the **Display** button it is possible to set two parameters: the visualized **Dynamic** range (chosen between 60, 80, 100 and 120dB) and the **Reference Level,** that can be increased or reduced by steps of 5 or 10 dB.
In operating modes Analyzer and Manual the min.-max. values of the reference level are in function of the input attenuator and preamplifier settings.

The **Input** button opens a submenu which is dedicated to the setting of the input attenuator and to switch on-off the built-in preamplifier.

The PMM ER9000 receiver takes automatically into account the settings of all the Input parameters and always displays the correct value of the level. The User is not required to make any correction to the readings.

3.2.3.7 Input: Attenuator end Preamplifier

Being entered in the Input submenu, touch Att to choose the proper input attenuation by using the list or **+5dB** / **-5dB** buttons. Setting the attenuation this way, forces the receiver in manual attenuation.

The **Min Att** button acts as a low limiter and its value can be selected freely from the list. When the minimum attenuation is selected, the attenuator – doesn't matter if in automatic or in manual condition - cannot be lowered under the minimum value set.
Unless specifically required by the test conditions, do not remove the default minimum attenuation of 10 dB.

With the **Preamp** key it is possible to cycle among ON, LN and OFF. When ON is shown, the Low Distortion 20 dB preamplifier is activated (when available). When LN is shown, the Low Noise 20 dB preamplifier is activated (when available). OFF means all input preamplifiers are excluded
The internal 20 dB preamplifier can be used when very weak signals have to be investigated.
The LN (Low Noise) preamplifier is a very low noise one, located before the input preselection filters. The LD (Low Distorsion) preamplifier is a low noise one, located at the end of the attenuators and preselection filters chain.

The LN preamplifier has the advantage of being at the input of the signal path, where the insertion losses are still minimal. For this reason, its Noise Figure is the best achievable. On the other hand, however, it does not have filters that precede it and therefore is at risk of saturation if a strong signal arrives.

To provide all possible solutions to the most demanding User, the PMM ER9000 integrates also a LD preamplifier. It is placed after the input preselection filters, attenuators and pulse limiter and so it shows a higher noise figure than the LN one but it is more robust against wideband strong disturbances.

As already mentioned, with the preamplifier ON, the receiver takes automatically care of the 20 dB gain when measuring the signals.

The **Att Auto** button is used to switch from manual to automatic condition for the attenuation setting.
Please note that the switching of the attenuators is relatively noisy and you can perceive it distinctly with a "click" for each switch operation.

NOTICE

Using 0 dB attenuation PMM ER9000 has no input protection.
This is a potentially 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 ER9000 receiver, use an oscilloscope or a wide band RF voltmeter to measure it. In any case set Min. ATT at 10 dB and select the maximum available attenuation with preamplifier OFF.
If needed, add an external coaxial attenuator on the input signal line.

NOTE

In case an OVERLOAD indication occurs, please check a sufficient input attenuation is set. In case of very high signals, it is possible to add an external attenuator to carry on the measurement without overpassing the declared limit for continuous power or spectral density.

3.2.3.8 Misc

Under the **Miscellaneous** functions menu it is possible to activate or exclude the **Preselector** filters, the **Pulse Limiter**, and also to set the internal **Signal generator**.

The **Preselector** is composed by a group of filters automatically selected by the PMM ER9000 while it is sweeping or anyway measuring. The aim of the preselector is to reduce the amount of out-of-band energy entering in the receiver, thus helping a lot in reducing intermodulation problems and similar undesired behaviors.
It can be set either ON or OFF with the associated button, and normally it should be always enabled.
On the middle top of the screen, the indication "Presel" is displayed when active.

The **Pulse Limiter** is a very useful device to protect the input of the receiver from transient overvoltages. Doing conducted emission tests, quite often there are conducted disturbances (usually associated to switching operations in the EUT or along the line under test) which are too high and that propagates through the LISN up to the receiver. Sometime these disturbances cannot be seen on the receiver because they are out of measurement bandwidth, nevertheless the associate energy is high enough to damage the input attenuator and/or the Analog-to-Digital Converter of the PMM ER9000 (the first mixer in a traditional receiver).
This pulse limiter has an integrated 30 MHz low-pass filter.
When the Pulse Limiter is selected, on the upper right part of the screen the letters **PL** appear and the reading on the receiver is automatically corrected for the presence of the Pulse Limiter.

Touching the **RF OUT** button, the receiver enters the **Signal generator** menu.

The **signal generator** is an internal, high stability and accuracy, 50 Ohm RF generator ranging from 10 Hz to 30 MHz.

In Manual Mode only, it can be set to operate as a tracking generator. When **Tracking On** function is selected, the generator is always tuned at the same PMM ER9000 measurement frequency, and scans the range together with the receiver. This is the standard way a tracking generator works in all spectrum analyzers.
If the Tracking On function is disabled, the generator becomes a CW signal source tuned at the frequency set under the **RF OUT Freq** window.
As usual, to set a given frequency it is therefore enough to edit the value with the software keys, confirming the selections entering the units value (Hz, kHz, MHz or GHz).

In both operating modes (tracking or fixed frequency) the output level can be set between 60,0 and 90,0 dBµV with 0,1dB steps using the **RF OUT Level** button.

If a higher or lower level is needed, the User shall adopt either an external amplifier or an external attenuator.

With the RF OUT On and Off button, the signal generator output can be switched on and off.

The tracking generator is extremely useful for several applications: first of all it is essential to calibrate the receiver itself, thanks to the automatic internal routines specifically developed to this extent.

PMM ER9000 integrates also a CISPR 16 Band-A and Band-B pulse generator for special testing. It consists of an instrument capable of generating time-domain rectangular pulses, which produce an almost flat response over frequency.

This pulse generator has a spectrum distribution in accordance with CISPR 16-1-1. The reference spectral voltage amplitude density, for each frequency band, is defined in CISPR 16-1-1.

Gen On button switches the pulse generator on and off.

The attenuator can be used to set the output level.

The third button is designed to enter the pulse repetition frequency.

The Band button can be used to select the CISPR16 Band A or Band B.

NOTE

It is suggested to turn off the internal Generator, when not necessary, to achieve the maximum sensitivity.

3.2.3.9 RBW   The **Resolution Bandwidth** menu is used to select the bandwidth of the measuring filter. Up to twentyseven filters are available, depending on the tuned frequency band:

- 3 MHz -6dB
- 2 MHz -6dB
- 1 MHz -6dB
- 500 kHz -6dB
- 300 kHz -6dB
- 200 kHz -6dB
- 100 kHz -6dB
- 50 kHz -6dB
- 30 kHz -6dB
- 20 kHz -6dB
- 10 kHz -6dB
- 5 kHz -6dB
- 3 kHz -6dB
- 2 kHz -6dB
- 1 kHz -6dB
- 500 Hz -6dB
- 300 Hz -6dB
- 200 Hz -6dB
- 100 Hz -6dB
- 50 Hz -6dB
- 30 Hz -6dB
- 20 Hz -6dB
- 10 Hz -6dB
- 1 MHz-C CISPR 16 shaped at -6dB
- 120 kHz- C CISPR 16 shaped at -6dB
- 9 kHz- C CISPR 16 shaped at -6dB
- 200 Hz CISPR 16 shaped at -6dB

Use the knob to select the desired filter and press the button (or the **Enter** software button) to confirm.
These filters are mathematically modeled using FIR (Finite Impulse Response) technique and they are exactly as required by the standards.
Some filters are CISPR 16 compliant and other are for specific applications, e.g. to cover Military Standards requirements, etc.

When a non-CISPR filter is selected, the Quasi Peak detector is disabled.

3.2.3.10 Hold Time   The observation time (expressed in milliseconds) represents the time the receiver uses to "take a snapshot" of the incoming signal and to measure it with the chosen detector. When selecting a detector, the default hold time value is automatically loaded, but in some cases, this time is not appropriate, e.g. when the interference signals have a low repetition rate. In this case, the PMM ER9000 sees a high input signal and therefore tries to set the proper attenuation automatically, increasing the value or the input attenuators. However, when the input attenuation is set the signal is gone, so the receiver lowers the attenuation, but then a new peak arrives, and so on and so forth…

On the other hand, if the Hold Time is too long, the measurement takes a lot of time and, in some cases, the receiver maintains unnecessary attenuation, so wasting sensitivity.

In this situation the Hold Time value should be manually set to find a correct compromise.

To set the Hold Time to the lowest possible value (this value dynamically depends from the measurement conditions), enter the figure 0; if a value lower than the allowed is entered, the lowest possible value is automatically selected.

The max. Hold Time that can be set is 120 sec (120.000 ms).

☞ NOTE   **With Hold Time lower than 500 ms, Quasi-Peak, RMS-Average and C-Average detectors are not available.**

3.2.3.11 Demodulator   Switching ON the built-in AM or FM demodulator, the volume can be adjusted with the rotating knob, and the level is shown by the black bar on the screen.

The demodulated signals can be heard from the small speaker located in the front panel of the receiver.

3.2.4 Smart Detector

The **Smart Detector** is a special function implemented in the PMM ER9000 receiver with the purpose of reducing the test time and increasing the productivity of the lab.

This function works only in the C, D and E bands when at least one limit is loaded, therefore remember to enable a limit to run the Smart detector function.

Selecting one out of the five **Smart detectors** the receiver will execute the scan using at first the Peak detector and, if a peak value is found over the selected limit minus a **Margin** set with the specific button, the reading is re-measured and displayed with the chosen (C-Avg, AVG, C-Rms, RMS or QPeak) detector.

Obviously this way of operation results in a much faster scan sweep and moreover it immediately draws the attention of the test Engineer to the most critical points. The limit associated to the Margin is displayed as a bold colored line and is automatically selected by the receiver depending which Smart detector is chosen; for example, if a Smart QP is selected, the associated QP limit line will be displayed as a bold colored line.

To deselect the Smart Detector function simply select a single detector.

NOTE

The weighting time must be properly set in the Hold Time window to allow the Smart detectors functions to operate as intended.

The Hold Time is the measurement time the receiver takes to value the input signal and form result weighted by the selected detector.

When using the **C-Avg** (CISPR-Average) or the **C-RMS** (CISPR-RMS) detector, since for definition they are characterized by a long time constant, the minimum measurement time should be set long enough to allow a correct measurement.

For this reason, **when unknown signal are to be measured, the Hold Time should be at least 2 s** to correctly weight signals pulsed at a rate of 5 Hz or faster, and longer for lower repetition rates.

NOTE

With the Peak, RMS and AVG detectors the smallest settable measurement time depends on the RBW.
If several detectors are used contemporarily the Hold Time should be set to meet the requirement of the slowest one, so that the results of the measurement are correct for all them.

When a frequency change or an attenuation variation occurs, PMM ER9000 waits automatically the time needed to the internal circuits to overcome the transient before the measurement time starts again.

3.3 RBW Filters

The **Resolution Bandwidth** box is used to select the bandwidth of the measuring filter.
The drop-down menu allows the User to select from the list, the filter desired.
These filters are mathematically modeled using digital techniques and, concerning the 200 Hz, 9 kHz and 120 kHz, they are compliant to the CISPR 16-1-1 standard.

Other additional -6dB bandwidth filters are also available: please refer to the instrument specifications paragraph for the complete list.

3.3.1 MIL Filters

The 100 Hz, 1 kHz, 10 kHz and 100 kHz provided filters are MIL-STD-461E (they are not optional but always available).

NOTE

When a non-CISPR filter is selected, the Quasi Peak, C-RMS and C-AVG detectors are disabled.

NOTICE

Be sure not to overload PMM ER9000: the input signal should not exceed the maximum level indicated in the main specifications in chapter 1.

NOTE

The measuring time must be properly set in the Hold Time window to allow the desired detectors to operate as intended.

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4 – Applications

4.1 Measuring the EMI Voltage

ElectroMagnetic Interference (EMI) voltage measurements on power supply lines or on signal lines are carried out by means of "Coupling Networks" (e.g. LISNs) or other transducers (e.g. voltage probes). The frequency range is dictated by the applicable standard, however it is generally limited from 9 kHz to 30 MHz in commercial applications, while for measurements on other equipment/accessories - e.g. military, automotive, information technology and communication equipment (ITE), ISDN devices, etc. - the frequency range extends up to 200 MHz, depending the relevant standards. Nevertheless, the most common tests in the frequency range covered by PMM ER9000 are certainly the conducted measurements, done with the help of a LISN, and the ratiated ones, for which various types of antennas can be used.

4.1.1 Measuring Principle with a LISN

In the case of a system with two floating conductors, the EMI voltages of the two conductors relative to each other and with reference to the ground form a vector system where three kind of RFI voltages are present (sometime EMI is also referred as RFI: Radio Frequency Interference). 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 EMI components are measured between the electrical midpoint of the two conductor voltages and reference ground. Usually these are the components most likely to cause interference effects.
- Unsymmetrical voltages. These RFI components are measured from each line conductor and the reference ground. They consist of symmetrical and asymmetrical components. The measurement of these RFI voltages is the easiest to do and the most commonly performed.

Indeed, for practical reasons, Standards mostly specify the measurements of unsymmetrical voltages instead of the theoretically more meaningful common mode EMI, but the standard doesn't necessarily reflect the real life exactly as it is: it shall be a common practice reference aiming to create a database of fully comparable results.

See figure 4-1 for a graphic explanations of these differences between the EMI voltages.

Some Regulations require both measurement of symmetrical and asymmetrical RFI voltages, also defining separate and different limits for them.

4.1.2 Coupling Networks

Coupling Networks are electrical interfaces which allow to "transfer" the quantity to be measured (e.g. EMI voltages or currents) from the lines under test to the receiver.

Some types of Coupling Networks are: AMN (Artificial Mains Network), also known as "LISN" (Line Impedance Stabilization Network), Current Probe and Voltage Probe. Again, Fig. 4-1 also shows the AMN principle.
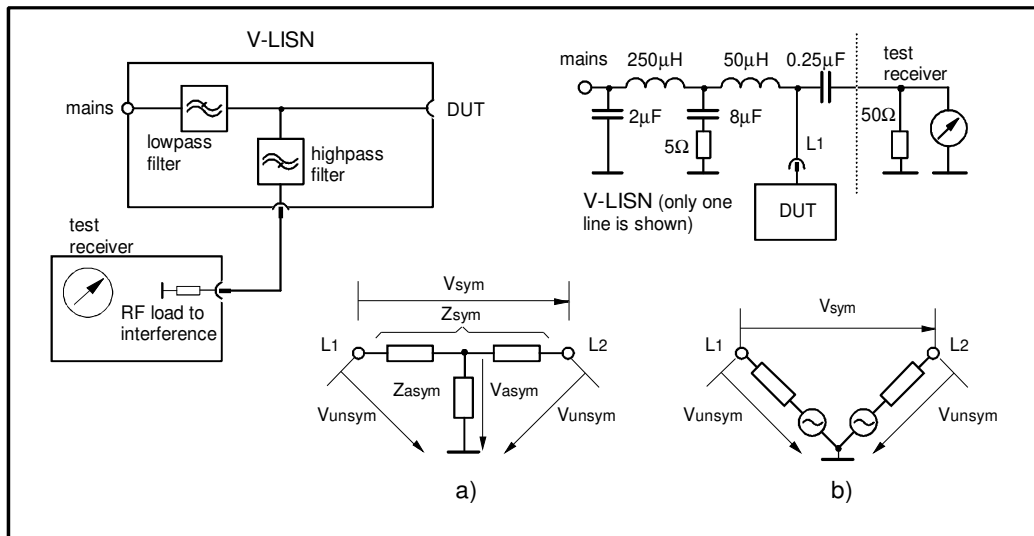
Fig. 4-1 AMN Principle: a) Δ-type or T-type LISN ; b) V-type LISN

4.1.2.1 AMN

AMNs are usually classified depending their configuration: V-type Networks, Δ-type Networks, T-type Networks.

- The V-type Network is used for measuring the unsymmetrical RFI voltage on AC and DC supply line. Standard impedances specified by CISPR and other international standards are 50Ω // 50 μH+5Ω and 50Ω // 5 μH+1Ω.

- The 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 usually specify the T-type Network instead. The most common impedance for Δ-type Network is 150Ω.

- The 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 as well.

An Artificial Mains Network shall be designed in order to:

1. terminate each line (power, signal, etc.) of the EUT (Equipment Under Test) with a standardized impedance;

2. permit the feeding of the EUT with the proper supply voltage and current or with the signal and data required for operations;

3. isolate the side of the test circuit where EMI voltages are measured against interference coming from mains network or from the auxiliary equipment supplying the EUT with the required data;

4. provide a suitable test point – to be connected to the test receiver - to pick up the RFI voltages from the conductor under test;

5. ensure that the impedance of the source (power, signal) is not varied in a significant way, otherwise EUT response to the interference may change.

4.1.2.2 Current Probe

Current Probes may be Clamp-on Probes or Fixed-ring Probes.
Current Probes are used to measure differential or common mode RFI currents. In some cases it may be important to make a distinction between the two kinds of current flowing in a system.

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

4.1.2.3 Voltage Probe

Voltage Probes include Active Probes and Passive Probes.
Active Probe has a very high input impedance $Zin > 100$ KΩ // < 10 pF.
Passive Probe has a standard impedance $Zin = 1{,}5$ 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 signal lines), when measuring on a EUT (Equipment Under Test) which would not operate correctly using V-type LISN or a DUT (Device Under Test) requiring very high power supply current 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.

4.1.3 Test Setup

A general test layout for a simple table top EUT is according to figure 4-2. Some product/family product standards may prescribe different requirements.
The EUT shall be placed 0,4m from a ground reference plane of at least 2m x 2m in size, either horizontal or vertical. If the measurements are made in a shielded room, the EUT shall be placed 0,4m from either one of the walls of the room or the conducting floor.
All other earthed conducting surfaces shall be at least 0,8m apart from the EUT.
Floor-standing EUTs are subject to the same provisions as above with the exception that they shall be placed on a floor, the points of contact being consistent with normal use. In this case the ground reference plane end shall extend at least 50 cm beyond the boundaries of the EUT and have minimum dimensions of 2m by 2m. The floor standing EUT shall be isolated by the ground reference floor and kept at a maximum distance of 0,15m.
The power cable should be 1m long; longer cable should be centrally bundled for at least 0,4m.
EUTs without a PE (Protective Earth) conductor and handheld DUTs shall be measured in conjunction with an auxiliary screen or an "Artificial Hand", as duly specified in the relevant standards.
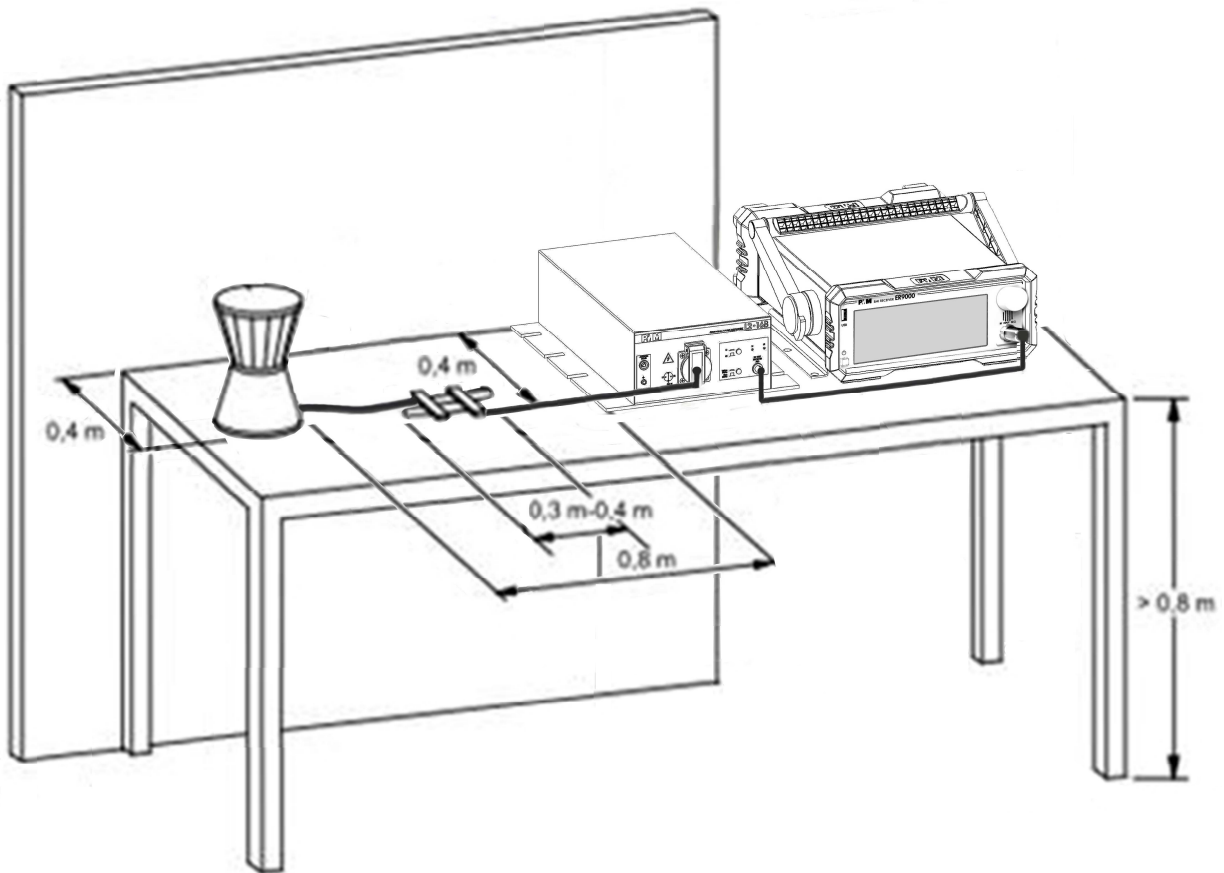
Fig. 4-2 ER9000 with external L2-16B LISN

Applications

4.1.4 Guidance on a preliminary Measuring Procedure

A step-by-step example of a conducted test is the following:

1. Connect the EUT to the front panel socket and the mains network to the rear plug trough a proper isolation transformer. Leave the EUT switched off;
2. Switch ON the PMM ER9000 and wait for it to be ready;
3. Run the PMM Emission Suite software;
4. Enter the Sweep Mode by clicking the related tab;
5. Set the Display Dynamics to 120 dB;
6. Choose a Reference Level between 100 and 125 dBμV;
7. Click right key onto the Scan Table and choose the B band;
8. The Minimum Attenuation should be 10 dB;
9. Set the Pulse Limiter in the Front End box on the right of the screen, to protect the input against voltage spikes;
10. The Detector should be Peak;
11. Select the desired phase/line of the LISN in the Ancillary column of the Scan Table after having chosen the proper LISN model in the Ancillary box on the right of the screen;
12. With the EUT switched OFF, click the Execute soft button and wait until the first scan has been finished;
13. Carry out an overview of the whole spectrum and check the by executing a pre-measurement with peak detector that the ambient RF disturbances are at least 20 dB below the desired emission levels;
14. If the ambient noises are low enough continue to the next step, otherwise take all the necessary steps to reduce the ambient disturbances (e.g. go to a shielded room, etc.);
15. Switch ON the EUT and then **Redo Sweep** again and wait until the scan has been finished;
16. Adjust the Dynamic Range and the Reference Level for the most convenient visualization;
17. If the results are satisfactory select the cursor **Marker** (or the **Multi Marker**) and fond the Highest **Peak(s)** and then either click **Analyzer** or **Manual** to enter respectively in Spectrum Mode or in Manual Mode and deeply investigate the highest signals;
18. If the results of the scan need to be compared to a defined level, select a **Limit**, if appropriate, and then measure again.

4.1.5 Remarks and Hints for Measuring

To avoid errors caused by ambient interference, measurements should be carried out inside a properly certified anechoic chamber or open site (OATS). Different sites, like basements or other shielded rooms with low ambient interferences, are often sufficient for a precertification evaluation and for debug purposes.

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5 – Updating firmware

5.1 Introduction

The PMM ER9000 features a simple and user-friendly method for updating its internal firmware through a Personal Computer (PC).
This section provides all the information required for easy updating.

NOTE

The following procedure works both for the ER9000/00 and ER9000/01 options.

5.2 System requirements

The minimum requirements to allow the software to operate properly are the following:
- USB memory stick
- PC running Windows10™
- 1 free RS232 or USB Port

The PMM ER9000 receiver has 2 internal levels of firmware: one called "Int", which drives interfaces, peripherals and display, and another called "ER" which is dedicated to the receiver and signal processing.

The upgrade of the Int firmware needs a USB stick containing the updated file, while the upgrade of the ER firmware is carried out via the PC through serial connection.

5.3 ER firmware update

Use a RS232 or USB port for updating ER9000 internal firmware. For normal operation, instead, the ER9000 needs to be driven by a PC through an USB connection as reported on §3.1 and §7.1 .
Turn off the PMM ER9000 and connect the serial cable supplied with the apparatus, to the RS232 or USB socket situated on the back panel of PMM ER9000 on one side and to a free port (again RS232 or USB) on the PC side.
The first free port will be automatically detected by the Firmware Update Program during installation. In case of troubles please check port assignments on the PC through the Control Panel utility.

5.3.1 Software Installation

The Update Firmware executable program is provided together with the ER9000 Software Utility stored on Software Media and included in PMM ER9000 Receiver package; anyway it's always possible to check for newer releases and download them from official NARDA Italy Web Site Support page www.narda-sts.it.

NOTE

The User must have administrator privileges to install the ER8000SeriesUp software in Windows; right click on the program .exe file and click on "Run as administrator" to temporarily run the program or application as an administrator until close it (Windows also allows to mark an application so that it always runs with administrator rights).

Once the **ER8000SeriesUp Setup** has been installed in the PC, another item is created in the Programs list at Start Menu, which is "**PMM Emission Suite**", from where the "**ER8000SeriesUp**" program must be run from.
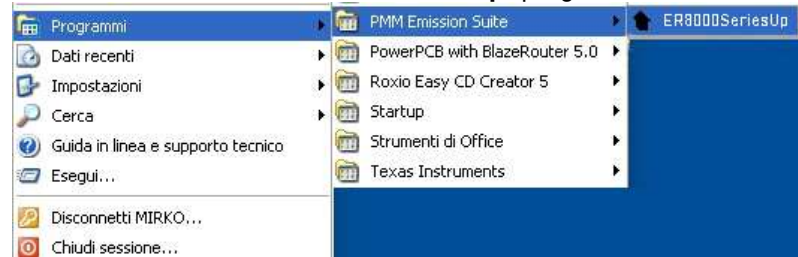
Click on "**ER8000SeriesUp" (ER8000SeriesUp.exe)** once for running the update program, so getting the following window:

Two firmware components can be updated by this application: Firmware, which is the receiver internal program, and FPGA, to update the internal programmable logic.
The **ER8000FW.ldr** file required for Firmware updating and the **mainER8000.bin** file for FPGA are automatically stored in the same directory of the **ER8000SeriesUp.exe**, otherwise just copy them there before performing the upgrade.

Be sure the power to the PMM ER8000 is stable and reliable before performing the FW Upgrade, otherwise the upgrade progress could not terminate properly.

NOTICE

Anyway, even in case of failure, the internal BIOS will never be corrupted and you'll just need to repeat the procedure once more (this is a unique feature!).

Should FW Upgrade procedure stop before reaching the 100% completion that will have not to be considered a trouble but simply an intermediate step: in this case please switch OFF and ON the receiver and repeat the FW Upgrade procedure once more until the end.
Always cycle power OFF and ON again after every FW Upgrade.

Choose the COM port from the pulldown menu.

Press **RS232** button or **Enter** key to set the com port.

The program will display the following window:
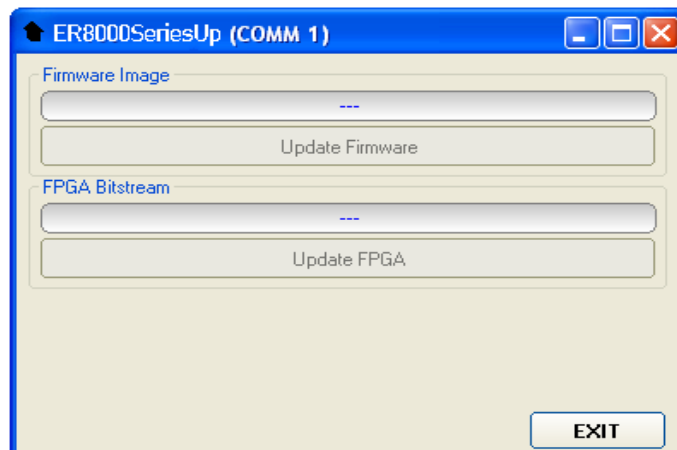
5.3.2 To transfer data

To start the process simply switch PMM ER9000 on, select **Update Firmware** or **Update FPGA** button, and wait until the automatic transfer is completed.
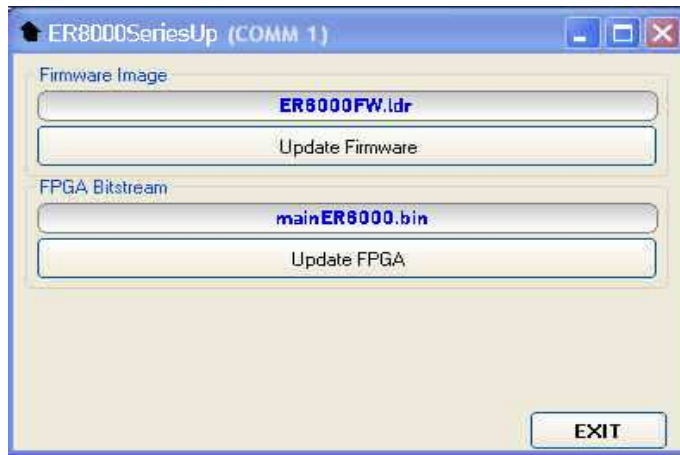
During the firmware storing procedure, a blue bar will progress from left to right in the window of the PC, showing percentage of downloading time by time until 100%.
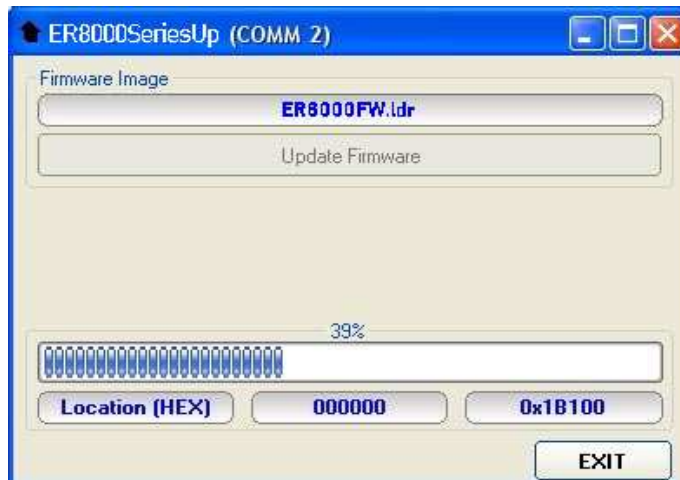
In the meanwhile on the ER9000 front panel the DATA RX and TX led will blink to indicate a serial communication is going on.

When FW download finishes, following message appears to show that everything was properly completed:

The length of the file can change with the version.

In case of failure, an error message is showed instead.

After Firmware Update is successfully completed, switch OFF and then ON again the PMM ER9000, looking at screen, and then perform Auto-calibration.

It is now possible to disconnect the cable connected to the PC, with the PMM ER9000 receiver either switched On or Off.

NOTE

To obtain up-to-date Firmware or PC Utility for PMM ER9000, the user can contact his NARDA distributor or download it directly from Support area of EMC Product Range on the following Web Site: www.narda-sts.it.

5.4 Updating Int firmware Turn off the PMM ER9000 and insert the USB stick with the Int firmware file stored in its root. The file is called ER9000FW.LDR
Press the front knob-button and keep it pressed while switching the unit on. Release the button and press the orange softbutton.

```
Flash 0 ID:      SSTVF128B (128M)
Flash 1 ID:      SSTVF128B (128M)          Press to
Firmware:        ER9000BF - 1.04 13/04/21   update
                                            Firmware
```
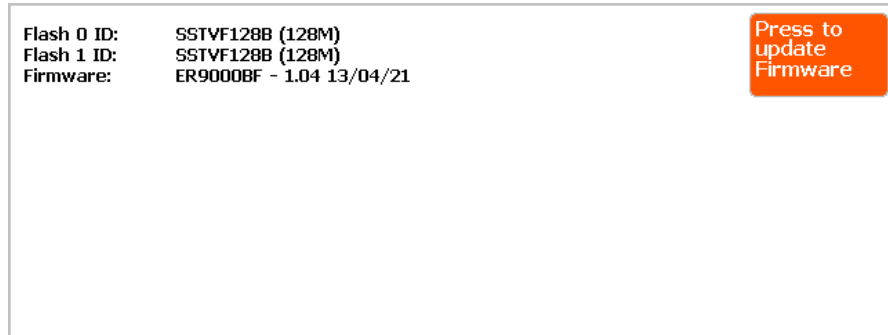
5.4.1 During the upgrade The upgrading procedure starts and the display shows its status.

```
ER9000FW.LDR found.
Loading Firmware from USB disk....

Save Firmware to EEPROM....
. . . . . . . . . . . . . . . . . . . . . .
```
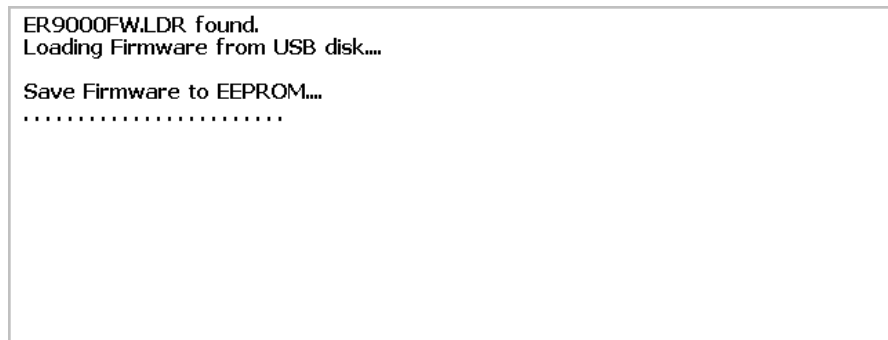
5.4.2 Upgrade completed When the new firmware has been completely stored onto the internal flash memories, the following screen is displayed and the system is automatically restarted.

```
ER9000FW.LDR found.
Loading Firmware from USB disk....

Save Firmware to EEPROM....
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
. . . . . . . . . . . . . . . . . . . . . .
ER9000 Firmware stored.
The system will be restarted.
```
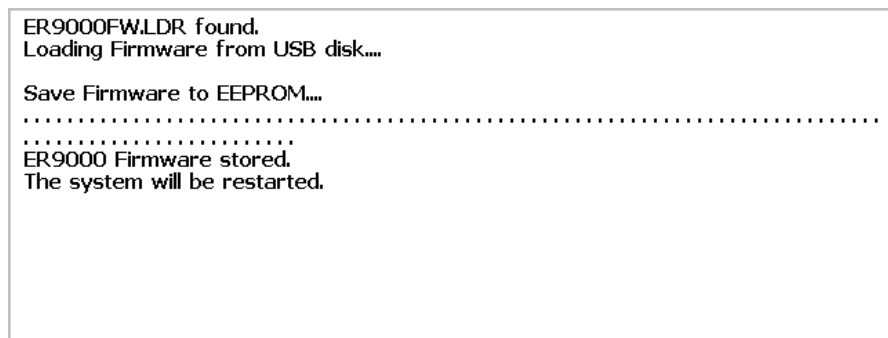
Completed the upgrade, the USB stick can be removed.

6 – PMM 9010-RMA
Rack Mount Adapter for Rack 19"
(Option)

6.1 Introduction

A **19-inch rack** is a standardized frame or enclosure for mounting multiple equipment modules. Equipment designed to be placed in a rack is typically described as **rack-mount** or simply **chassis**; the height of the electronic modules is standardized as multiples of 1.75 inches (44.5 mm) or one rack unit or "U". Each module has a front panel that is 19 inches (482.6 mm) wide, including edges that protrude on each side which allow the module to be fastened to the rack frame with screws.

6.2 Instrument Items

PMM 9010-RMA Rack Mount Adapter includes the following items:

- Rack Mount kit (screws, plastic round washers and cage nuts).
- Return for Repair Form.

6.3 PMM 9010-RMA Main Specifications

Table 6-1 lists the PMM 9010-RMA specifications.

TABLE 6-1 Technical Specifications	
Environment temperature	-5° to 45°C
Rack unit	3U
Dimensions	483 x 410 x 132,5 mm (WxDxH)
Weight	5,5 Kg (without instruments)

6.4 PMM 9010-RMA Front view
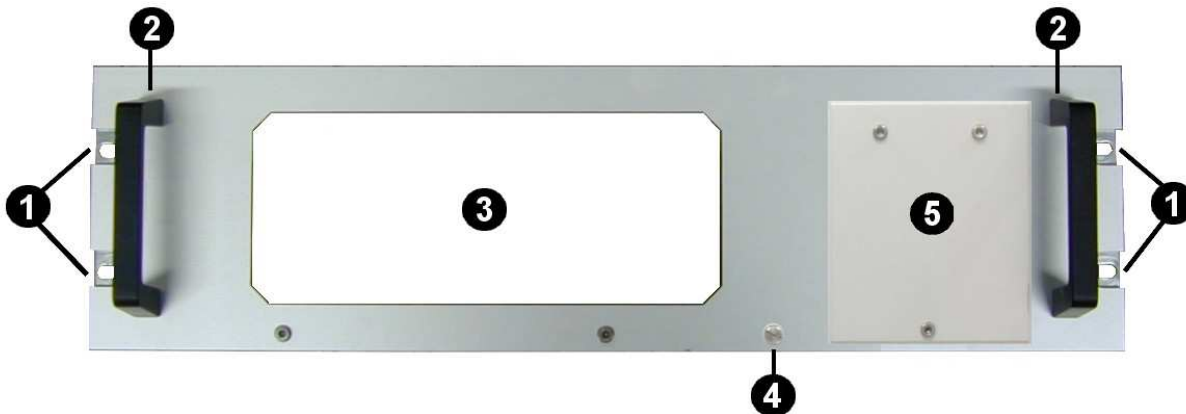
Fig. 6-1 Front view

Legend::
- **1 –** Holes Flanges used to fix the Rack Mount to the Rack
- **2 –** Handles used to carry the Rack Mount
- **3 –** PMM ER9000 window
- **4 –** Milled knob used to fix the frontal panel to the Rack
- **5 –** Cover for future implementation

6.5 PMM 9010-RMA Inside view

Fig. 6-2 Inside view

Legend::
- **1 –** Round holes of service
- **2 –** Rectangular holes used to put ER9000 Instrument;
- **3** – ER9000 straps;
- **4 –** Rectangular holes for future implementation;
- **5 –** Straps for future implementation.

6.6 Rack Requirements   The rack must be of the following type:

- Standard 19 inch (483 mm) with mounting rails that conform to English universal hole spacing per section 1 of ANSI/EIA-310-D-1992.

- The minimum vertical rack space per chassis must be 3U (rack units), equal to 3 inches (132,5 mm).

6.7 Required Equipment   Before you begin the installation, ensure that you have the following items:

- Crosshead screwdriver (not provided)

- Flat-blade screwdriver or rack-insertion tool (not provided)

- Tape measure and level (not provided)

- Rack Mount kit (provided)

6.8 Moving chassis   When lifting the chassis, be aware of its weight, and follow these guidelines:

- Disconnect all power and external cables before lifting the chassis.

- Remove all instruments from the chassis before lifting.

NOTICE   - **Make sure that the milled knob well locking.**

- Using the two handles, lift the PMM 9010-RMA slowly keeping your back straight. Lift with your legs, not with your back. Bend at the knees, not at the waist.

6.9 Installation guidelines

When installing the chassis, follow these guidelines:

- Plan your site configuration and prepare the site before installing the chassis.

- Ensure that there is adequate space around the rack to allow for servicing the chassis and for airflow.

- If the rack has wheels, ensure that the brakes are engaged or that the rack is otherwise stabilized

NOTICE   **- For a round hole (tapped) rack, use clip nuts with M6 x 16 screw (not provided).**
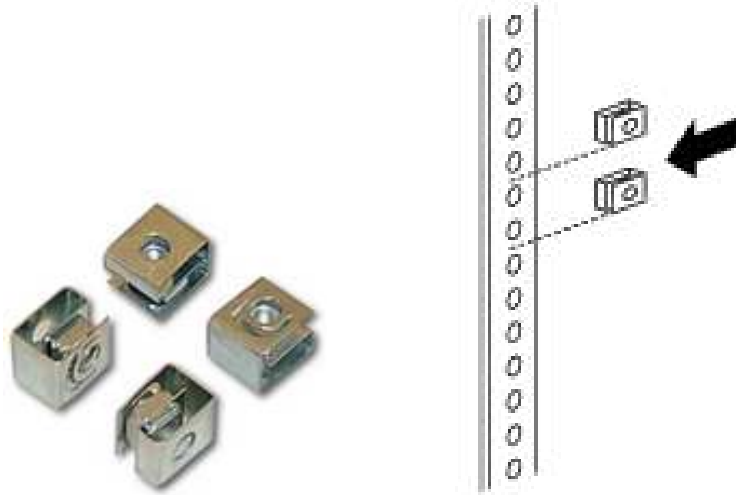
NOTICE   **- For a square hole (untapped) rack (shown below), use M6 x 16 screws, plastic round washers head screws and M6 cage nut (provided).**

6.10 Installing the PMM 9010-RMA

This section describes how to install the PMM 9010-RMA Rack Mount Adapter:

- Insert the cage nuts <u>behind</u> the vertical rails with respect to the Rack Unit Boundary and the distance show below:
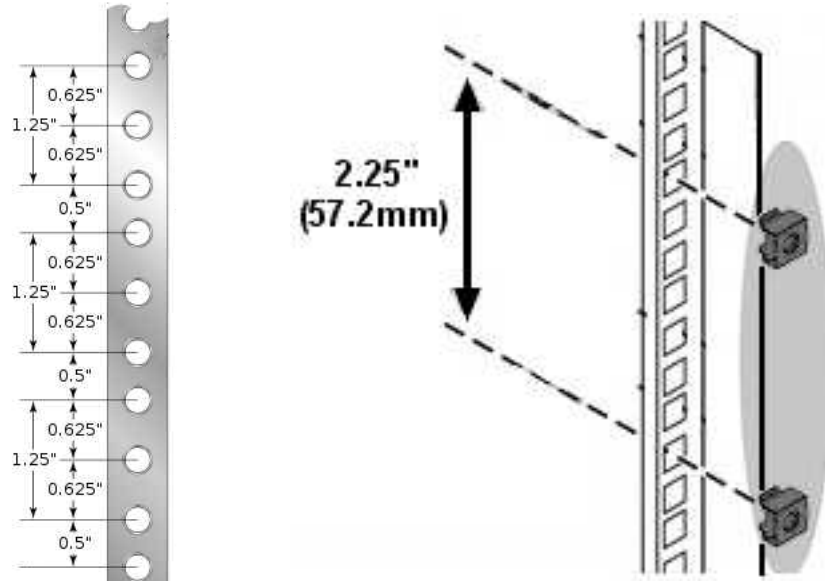
- You can use a rack-insertion tool or a flat-blade screwdriver to install the cage nuts.
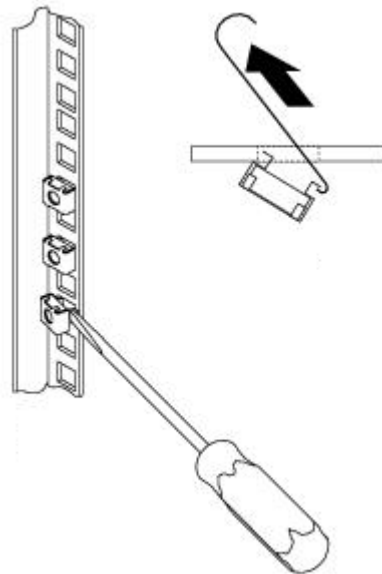
- Insert the chassis into the rack.

- Slide the chassis into the rack until the front flange is flat against the cage nuts.

- Using the four screws and black plastic washers, fix the chassis by its flanges to the rack.

6.11 Use of the PMM 9010-RMA with PMM ER9000

The following procedure is indifferently referred to the ER9000/00 or ER9000/01.

This section provides the information needed to install your ER9000 Instrument on the PMM 9010-RMA Rack Mount Adapter.

- Remove the frontal panel from the Rack unscrewing the milled knob without loosing it completely.

- Using the handles, open the PMM 9010-RMA slowly.

- Place the instrument by the rectangular holes and drag the instrument in contact with the frontal panel.

- To ensure the necessary stability, the instrument must be fastened to the unit using the straps.

- Connect the cables on the rear panel (see "Installation" chapter for further information)

- To fix the rear cables to the Rack Mount insert plastic straps by of the round holes.

- Using the handles, close the PMM 9010-RMA slowly.

Fig. 6-3 PMM 9010-RMA with ER9000 Instrument

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7 – Remote control

7.1 Introduction

PMM ER9000 has been designed to allow remote control operations through its USB (Rear) port.

A RS232 serial port is also provided for service activities.

7.2 Communication

Full duplex communication is implemented. The RS232 port has a DB-9 female connector and the USB 2.0 has a USB-B connector.

A built-in automatic tool identify the type of communication used.

The communication is at 115200 bit/sec with 8 bit words, one start bit, one stop bit and no parity (**115200 N 8 1**).

7.3 Protocol

Be aware that only the PC can send the commands. PMM ER9000 will answer when inquired only.

The communication uses strings with variable byte width.

Every string starts with the special character "#" and stops with "*".

7.3.1 Binary mode (fast) and compatibility mode

Since the family of ER receivers is much faster than the previous ones, a new communication method has been specifically designed to exploit its full potential. Later in this chapter the new method will be called binary mode. In order to maintain compatibility with previously develop software, the consolidated commands have been kept. The old method will be called compatibility mode.

The main difference among the two methods is that in the compatibility mode the controlling PC queries for a single measurement and the receiver replies consequently, while in the new binary mode the PC triggers the start of measurement and the receiver provides fast results continuously until a stop command is sent.

7.4 Format

Commands are made of ASCII strings delimited by the character "#" (0x23) and the character "*"(0x2A)

Replies are terminated with <CR><LF> (\r\n)

NOTE

The following examples are referred, some to the PMM ER9000/00 and some to the ER9000/01.

7.5 List of commands

Query COMMANDs

Syntax   Function

?3PR*	Tells whether the apparatus is in Conducted or Radiated range
?AAT*	Requests the Attenuator status for Analyzer mode.
?ACE*	Requests the Center frequency for analyzer mode
?ADT*	Requests the detector used for Analyzer mode
?AHT*	Requests the Hold Time for Analyzer mode.
?AOP*	Requests the Stop frequency for analyzer mode
?ART*	Requests the Start frequency for analyzer mode
?ASP*	Requests the Span frequency for analyzer mode
?BAT	Requests the Battery voltage
?BWL	Requests the RBW filter list
?CFA*	Sends back the ID of the conversion factor
?CRA*	Tells whether RMS-AVG detector is available
?DET*	Reports the five detector for manual mode
?DMD*	Requests the status of demodulator.
?DMV*	Requests the volume of demodulator.
?FPGA	Sends back a string containing information about version of FPGA.
?HIS	Requests the High sensitivity mode status
?IDN*	Requests model, release and date of firmware
?MAA	Requests maximum available attenuation
?MAF*	Requests the tuning frequency for manual mode
?MAT*	Requests the Attenuator status for Manual mode
?MFS	Requests minimum available frequency
?MHT*	Requests the Hold Time for manual mode
?MPA*	Requests the Preamplifier status for Manual mode
?MPS*	Requests the Preselector status for Manual mode
?PAM	Requests the mode of the Preamplifier for the Conducted range
?RBW	Sends back a string expressing the selected RBW
?RFS	Request the status of the RF Module for Radiated range
?S/N*	Requests Serial Number internally stored by manufacturer
?TAT*	Requests the MinAtt value
?TGF	Requests the tuning frequency of the internal CW signal generator
?TGL	Requests the output level of internal CW signal generator
?TGS	Requests the status of the internal signal generator
?TGT	Requests the tracking mode of the internal CW signal generator
?TMP	Sends back a string showing the temperature expressed in Celsius (°C)
?UHT*	Requests the actual Hold Time currently or lastly used
?UPP*	Requests the status of input PINs of the User Port

Setting COMMANDs

Syntax	Function
&SAO	Exits to main mode
ASBK	Aborts a sweep currently in progress
ASPA	Suspends a sweep currently in progress
ASRE	Resumes a sweep previously paused
S3PRC	Sets the input for bands A, B
S3PRR	Sets the input for bands C, D and E
SAAT a	Sets Attenuator for Analyzer Mode
SADT b	Sets the Detector for Analyzer Mode.
SAFD	Analyzer mode setting command
SAFF start,stop	Sets both Start and Stop frequency for Analyzer mode.
SAGO	Sets the ER9000 in Analyzer mode
SAHT h	Sets Hold Time for Analyzer mode.
SANR	Requests to enter Analyzer mode (binary mode)
SAOP f	Sets the Stop frequency for Analyzer mode
SART f	Sets the Start frequency for Analyzer mode
SCFA n	Activates the conversion factor stored in the ER9000
SCFE n, name	Saves the conversion factor (made by **SCFW**).
SCFW n, freq; lev	Creates a conversion factor frequency by frequency.
SCNF	Conversion Factor setting command
SDMD a	Switches the Demodulator **On** or **OFF**
SDMV v	Sets the volume of Demodulator
SGAT n	Sets the output Attenuator for the internal generator
SGBN b	Selects the frequency band for internal Pulse generator
SGOU m	Selects the internal generator mode
SHIS s	Switches between High Sensitivity or Fast mode
SLDW n, freq; levq, leva	Sets the custom double value limit frequency by frequency
SLIE name	Name the custom limit and making it active or deactivating it.
SLIM n	Sets the Margin to be used with Smart Detector function
SLIW n, freq; lev	Sets the custom limit frequency by frequency
SLMT	Limit setting command
SMAF f	Sets the tuning frequency for manual mode
SMAT a	Sets Attenuator for Manual Mode.
SMFD	Manual mode setting command
SMHT h	Sets Hold Time for manual mode
SMPA a	Sets the Preamplifier LN, LD or OFF
SMPS p	Sets the Preselector On or Off
SPAM p	Selects the desired Preamplifier for conducted range
SPRF r	Sets the repetition frequency for the internal Pulse generator
SPWD p	Switches the internal Pulse generator On or Off
SRBW b	Sets Resolution BandWidth
SSFD	Sets parameters and triggers a sweep
SSFDS	Sets parameters and triggers a sweep with custom freq.step
SSSW	Sets generic parameters for Sweep mode
SSTP	Stops abruptly a running sweep in Analyzer mode
STAT b	Sets MinAtt
STGF f	Sets the tuning frequency for the internal CW generator
STGL l	Sets the output level for the internal CW generator
STGS a	Switches the internal generator **On** or **OFF**
STGT t	Changes the internal CW generator tracking mode **On** or **OFF**
SUPP n	Outputs on the User Port bit by bit the argument n

7.6 PMM ER9000 COMMANDs	Following are Commands to control and set various operating modes of PMM ER9000, that can be distinguished in two main groups: • Query Commands • Setting Commands

7.6.1 Query COMMANDs

<div align="center">

Description

</div>

?3PR	This query command **#?3PR *** sends back a string expressing whether the apparatus is a PMM ER9000 and in which mode. The reply is either: • **3PR =CON** (The PMM ER9000 is ready for conducted frequency range) • **3PR =RAD** (The PMM ER9000 is ready for radiated frequency range) • **3PR=NUL** (The PMM ER9000 is not ready)
?AAT	This query command **#?AAT *** sends back a string expressing the Attenuator status for Analyzer mode. The reply is made of 2 fields: • **AAT =AUTO (**ER9000 automatically selects the most suitable attenuator to get best dynamic range) or **AAT =MAN** (operator selects manually the attenuator) • **Value** (in dB) of current attenuator Example of reply: **AAT =AUTO; 20** which means that the Attenuator is now switched to 20dB automatically by ER9000
?ACE	This query command **#?ACE*** sends back a string expressing the Center frequency, in exponential notation, for analyzer mode. Unit is fixed MHz. Example of reply: **ACE = 1.500000e+07** which means that the Center frequency in Analyzer mode is 15MHz
?ADT	This query command **#?ADT *** sends back a string expressing the detector used for Analyzer mode. The reply cab be: • **ADT =Peak** • **ADT =Avg** • **ADT =Rms**
?AHT	This query command **#?AHT*** sends back a string expressing the HOLD TIME for Analyzer mode. Unit is fixed ms. Example of reply: **AHT= 1000 ms** which means that the hold time in Analyzer mode is 1000ms (or 1s)
?AOP	This query command **#?AOP*** sends back a string expressing the Stop frequency, in exponential notation, for analyzer mode. Unit is fixed MHz. Example of reply: **AOP = 3.000000e+07** which means that the Stop frequency in Analyzer mode is 30MHz
?ART	This query command **#?ART*** sends back a string expressing the Start frequency, in exponential notation, for analyzer mode. Unit is fixed MHz. Example of reply: **ART = 1.500000e+07** which means that the start frequency in Analyzer mode is 15MHz

?ASP	This query command **#?ASP*** sends back a string expressing the Spanfrequency, in exponential notation, for analyzer mode. Unit is fixed MHz. Example of reply**: ASP = 3.000000e+07** which means that the Span frequency in Analyzer mode is 30MHz
?BAT	This query command **#?BAT *** sends back a string expressing the battery voltage and status. The reply is made of the string "**BAT=**" followed by the magnitude of voltage ranging from 0 to 8.42 V. Example of reply: **BAT= 8.20 V** (The battery voltage is 8.2 Volt)
?BWL	This query command **#?BWL*** sends back a list of the available RBW filters, in the format **#ER&BWL *rbw_id;rbw_name**** for each available filter. Optional RBWs that are not available appear as **#ER&BWL *rbw_id;---* *** The final string that concludes the filter list is: **#ER&BWL END*** Example of reply**:** **#ER&BWL 0; 3 MHz*#ER&BWL 1; 2 MHz*#ER&BWL 2; 1 MHz*#ER&BWL 3; 500 kHz*#ER&BWL 4; 300 kHz*#ER&BWL 5; 200 kHz*#ER&BWL 6; 100 kHz*#ER&BWL 7; 50 kHz*#ER&BWL 8; 30 kHz*#ER&BWL 9; 20 kHz*#ER&BWL 10; 10 kHz*#ER&BWL 11; 5 kHz*#ER&BWL 12; 3 kHz*#ER&BWL 13; 2 kHz*#ER&BWL 14; 1 kHz*#ER&BWL 15; 500 Hz*#ER&BWL 16; 300 Hz*#ER&BWL 17; 200 Hz*#ER&BWL 18; 100 Hz*#ER&BWL 19; 50 Hz*#ER&BWL 20; 30 Hz*#ER&BWL 21; 20 Hz*#ER&BWL 22; 10 Hz*#ER&BWL 23; 1 MHz-C*#ER&BWL 24; 120 kHz-C*#ER&BWL 25; 9 kHz-C*#ER&BWL 26; 200 Hz-C*#ER&BWL END***
?CFA	This query command **#?CFA*** sends back a string in the format **CFA=n,(LABEL)** where **n** is the ID of the conversion factor as shown in ER9000 menu and **LABEL** is its temporary name as it was last labelled. If No conversion factor is active the reply is: **CFA= NONE** Example of reply**: CFA=1,(PROBE)** means that conversion factor 1 is active and it was last named as PROBE
?CRA	This query command **#?CRA*** sends back a string telling whether RMS-AVG detector is available. Reply is: • **CRA=N/A** if RMS-AVG detector is NOT available • **CRA=OK** if RMS-AVG detector is available

?DET	This query command **#?DET*** sends back a string reporting the six detector for manual mode. Unit is fixed dBµV. Each value is separated by a semicolon. The order is Peak; Qpeak; RMS;AVG;C-RMS:C-AVG In case Qpeak is not available (RBW other than 9kHz [only for Band B] ,120kHz) Qpeak field is replaced by the string "----". In case C-RMS or C-AVG is not available (RBW other than 9kHz,120kHz) respective field is replaced by the string "----". An additional string "OVER;" is appended at the end whenever an over range condition occurred Example of reply**: DET=23.22;17.09;16.23;11.36,16.01,15.50;** (which means Peak=**23.22**; Qpeak=**17.09**; RMS=**16.23**;AVG=**11.36**;C-RMS=**16.01**;C-Avg=**15.50** Example of reply (No Cispr filter selected, over range shown)**:** **DET=17.20;-----;11.98;9.57;-----;-----;OVER;**
?DMD	This query command **#?DMD *** sends back a string expressing the status of demodulator. The reply is either: • **DMD=Off** (The Demodulator is OFF) • **DMD =AM** (The Demodulator is On and demodulating AM) • **DMD =FM** (The Demodulator is On and demodulating FM)
?DMV	This query command **#?DMV *** sends back a string expressing the volume of demodulator. The reply is made of the string "**DMV="** followed by the magnitude of volume ranging from 0 to 100. Example of reply: **DMV=50** (The Demodulator Volume is 50)
?FPGA	This query command **#?FPGA*** sends back a string containing information about version of FPGA. Example of reply: **FPGA=0x14**
?HIS	This query command **#?HIS *** sends back a string expressing the status of the high sensitivity mode. When the ER ER receiver in 7.5 MHz High Sensitivity mode (1), or in 15 MHz Fast mode (0). The reply is either: • **HIS=0** The Fast mode is enabled (15 MHz) • **HIS=1** The High Sensitivity mode is enabled (7.5 MHz)
?IDN	This query command **#?IDN*** sends back a string containing information about model, release and date of firmware. Note that the two bytes <CR><LF> are appended to the string before the terminator. Example of reply: **IDN=ER9000-FW – Opt.1 – 0.52 21/21**<CR><LF>

?MAA	This query command #?MAA* sends back the value of the maximum available attenuation, in dB. Example of reply: MAA= 45 which means that the maximum available attenuation is 45 dB
?MAF	This query command **#?MAF*** sends back a string expressing the tuning frequency, in exponential notation, for manual mode. Unit is fixed MHz. Example of reply**: MAF= 1.500000e+07** which means that the tuned frequency in manual mode is 15MHz
?MAT	This query command **#?MAT *** sends back a string expressing the Attenuator status for Manual mode. The reply is made of 2 fields: • **MAT=AUTO (**ER9000 automatically selects the most suitable attenuator to get best dynamic range) or **MAT=MAN** (the operator selects manually the attenuator) • **Value** (in dB) of current attenuator Example of reply**: MAT=AUTO; 20** which means that the Attenuator is now switched to 20dB automatically by ER9000
?MFS	This query command **#?MFS*** sends back a string expressing the minimum tunable frequency, in Hz. Example of reply**: MFS= 10** which means that the minimum available frequency is 10 Hz
?MHT	This query command **#?MHT*** sends back a string expressing the HOLD TIME for manual mode. Unit is fixed ms. Example of reply**: MHT= 1000 ms** which means that the hold time in manual mode is 1000ms (or 1s)
?MPA	This query command **#?MPA*** sends back a string telling whether the Preamplifier is On or Off. Example of reply**: MPA=OFF** which means that the input low distortion preamplifier is not active
?MPS	This query command **#?MPS*** sends back a string telling whether the Preselector filter is On or Off. Example of reply**: MPS=ON** which means that the input preselection filter is inserted
?PAM	This query command #?PAM* sends back a string telling whether the selected Preamplifier, for conducted range, is the Low Distortion or the Low Noise one. - **0** for Low Noise - **1** for Low Distortion Example of reply: **PAM=0** which means that the selected Preamplifier, for conducted range, is the Low Distortion preamplifier.

?RBW	This query command **#?RBW*** sends back a string expressing the selected RBW. The reply is made of 3 fields:
	  1. **RBW=MAN** (Operator selects manually the RBW)
	  2. **Id** identify the RBW as per the list available with command ?BWL.
	  3. **RBW NickName** (a mnemonic name)
	
	Example of reply**: RBW=MAN 25 (9 kHz-C)** which means that selection is manually made, the RBW id is 25 **(9 kHz (Cispr 16-1-1)). (9 kHz-C)** is the nickname to quickly identify it

?RFS	This query command **#?RFS*** sends back a string expressing the status of the RF Module for the radiated range. The reply can be one of the following:
	  - **0x0** RF module Ready
	  - **0x40** Receiver in Conducted range (RF module OFF)
	  - **0x100** RF module not responding
	  - **0x8000** RF module not responding correctly
	
	Example of reply**: RFS=0x0** which means that the RF Module for radiated range is ready

?S/N	This query command **#?S/N*** sends back a string containing the serial number internally stored by manufacturer. Example of reply: **S/N=000WE50327**
?TAT	This query command **#?TAT *** sends back a string expressing MinAtt value. The reply is a string representing the minimum reachable value of attenuator in dB Example of reply**: TAT=10** which means that MinAtt is 10dB
?TMP	This query command **#?TMP*** sends back a string showing the temperature expressed in Celsius (°C) . Example of reply**: TMP= 40.50<LF>**

?TGF	This query command **#?TGF*** sends back a string expressing the tuning frequency, in exponential notation, for the internal CW signal generator. Unit is fixed MHz. Example of reply: **TGF = 1.500000e+07** which means that the tuning frequency for CW generator **(when it is not tracking)** is 15 MHz
?TGL	This query command **#?TGL*** sends back a string expressing the output level of the internal CW signal generator. Unit is fixed dBµV. Example of reply: **TGL = 90.0** which means that the output level of the CW generator 90.0 dBµV
?TGS	This query command **#?TGS*** sends back a string expressing the built-in generator status. The reply is either: • **TGS=Off** (Built-in generator is disabled) • **TGS=On** (Built-in generator is active)
?TGT	This query command **#?TGT*** sends back a string expressing the Tracking status of built-in CW signal generator. The reply is either: • **TGT=Off** (Built-in generator is no tracking but is tuned on a fixed frequency, set by STGF) • **TGT =On** (Built-In generator is tracking the same frequency tuned on the receiver. Available in Manual Mode only.)
?UHT	This query command **#?UHT*** sends back a string expressing the actual hold time currently or lastly used Example of reply: **UHT=1.9ms**
?UPP	This query command **#?UPP*** sends back a string expressing the status of input PIN of the User Port. Example of reply**: UPP= 1** means that user port pin IN0 is high level

7.6.2 SETTING
Commands   Behaviour

&SAO	This command exits to main mode. The reply is **#ER&SAO=OK*** After this command has been acknowledged, the replies to non-binary commands will not show the #ER preamble anymore.
ASBK	This command aborts a sweep currently in progress previously started by command **SSFD**. The reply is either: • **#ERASBK=OK*** which means the sweep has been stopped and all setting commands are available again. • **#ERSBK=SERR*** which informs that the sweep was not in need to be stopped
ASPA	This command suspends a sweep currently in progress previously started by command **SSFD**. There is no reply unless a sweep is not in progress in which case the reply is: • **SPA=SERR** which informs that the sweep was not in need to be paused
ASRE	This command resumes a sweep previously paused by command **ASPA**. There is no reply unless a sweep is not in progress in which case the reply is: • **SRE=SERR** which informs that the sweep was not in need to be resumed
S3PRC	This setting command **#S3PRC *** sets the input for bands A, B. The reply is: • **3PR=OK** (The input has been set for bands A, B) • **3PR =BERR** (The command has been ignored for the following: • The instrument is not idling and therefore cannot switch to a different mode. In such an event, stop the current process (Manual, Analyzer or Sweep) and put it back to Idle. • **3PR =SERR** (The command contains a syntax error)
S3PRR	This setting command **#S3PRR *** sets the input for bands C, D and E. The reply is: • **3PR=OK** (The input has been set for bands C, D and E) • **3PR =BERR** (The command has been ignored for the following: • The instrument is not idling and therefore cannot switch to a different mode. In such an event, stop the current process (Manual, Analyzer or Sweep) and put it back to Idle. • **3PR =SERR** (The command contains a syntax error)
SAAT a	This setting command sets Attenuator, for Analyzer Mode, to the value indicated by (a) which can be 0 to 45. Automatic Attenuator feature is disabled. If (a) is a negative figure then the Automatic Attenuator feature is turned on. The reply is **AAT=OK** which acknowledges the command has been granted or **AAT =SERR** if the command has been ignored. Note: the maximum available attenuation can be read with command ?MAA. Example: **# AAT 15*** (set attenuator to 15dB and disable Automatic Attenuator feature) Example: **# AAT -1*** (Enable Automatic Attenuator feature)

SADT b	This setting command sets the detector for Analyzer Mode. The argument (b) should be a index representing the detetector as follows:
	
	      o **1 →Peak**
	      o **2 →Avg**
	      o **3 →Rms**
	
	The reply is **SADT =OK** which acknowledges the command has been granted or **SADT =SERR** if the command has been ignored.
	Example: **# SADT 1*** sets the detector to Peak for Analyzer Mode

SAFD	This setting command sets the parameters for Analyzer mode with the following sintax: **#SAFD f_start [Hz];f_stop [Hz];det;hold_t [s];rbw_id;att [dB];preAmp[Off/On];preSel[Off/On]; PulseLim[Off/On]*** ER9000 replies **AFD=OK** or **AFD=ERR code** Note: "-1" in att field means automatic attenuator WARNING: The expected number of steps (given by the selected span and RBW) must be in the range [50;500e3]. If this range is not respected, AFD=ERR 4 is replied. Example:**#SAFD 5e6;15e6;P;0;8;10;OFF;OFF;OFF*** sets the Analyzer mode from 5 to 15 MHz, with peak detector and lowest hold time, 30 kHz RBW filter, 10 dB input attenuator; Preamplifier, Preselector and Pulse limiter disabled.
SAFF start,stop	This setting command sets both Start and Stop frequency for Analyzer mode. The strings (Start and Stop) can be in exponential form and should be expressed in Hz. The reply is **AFF=OK** which acknowledges the command has been granted or **AFF =SERR** if the command has been ignored. Example: **#SAFF 150e3,30e6*** Sets the Start frequency to 150kHz and Stop frequency to 30MHz for Analyzer mode
SAGO	This setting command puts the ER9000 in Analyzer mode. The reply is always **SAGO=OK,** which acknowledges the command has been granted, followed by an array, variable in size, representing the reply. Please refer to **"Analyzer Reply"** section for details of the response. The ER9000 goes to Analyzer mode. Example: **#SAGO***
SAHT h	This setting command sets hold time for Analyzer mode. The string (h) should be expressed in ms. The reply is **AHT=OK** which acknowledges the command has been granted or **AHT =SERR** if the command has been ignored. Example: **#S AHT 1500*** Sets the hold time, for Analyzer mode, to 1500 ms (or 1.5s)

SANR	This setting command requests to enter Analyzer mode (binary mode). The reply is **#ER&ANR=OK*** which acknowledges the command has been granted, followed by: **#ER&ANH 9.000000e+03;3.000000e+07;1.562500e+04;2;10.000000;6;100 kHz;15;Auto;10;ON ;OFF;OFF;0.000000;C;1920*** which contains info data for analyzer mode in the format: **f_start[Hz];f_stop[Hz];f_step[Hz];id_detector; hold_time[s];rbw_id;rbw_name; att[dB];att_auto[Man/Auto];min_att[dB];pre_amp[OFF/ON/LN]; pre_sel[OFF/ON];pulse_lim[OFF/ON];reserved;expected_step;conrad[C/R]** If too many steps are expected (RBW setting not aligned with span setting) the following error message is returned: **#ER&ANH ERR 105*** Data are exchanged via serial communication as binary data. Levels are 16-bit integer values that express hundredths of dBm. The 14th bit is used as an overload flag: when 14th bit and 15th bit do not match the overload condition is present. Special value are 0xC000, 0x3FFE, 0x3FFD: • 0xC000 is NO_LEVEL • 0x3FFE is DATA_START • 0x3FFD is DATA_END Once in Analyser mode, no further serial commands are needed to get subsequent sweeps plus the attenuator code (negative value in case of automatic attenuator). Each sweep starts with "0x3FFE" and ends with "0x3FFD". The first value after "0x3FFE" represents the attenuator code; the sign "-" indicates that the attenuator is automatic. The second, third and fourth values are reserved. The expected number of steps follow. Example: **#SANR***
SAOP f	This setting command sets the Stop frequency for Analyzer mode. The string (f) can be in exponential form and should be expressed in Hz. The reply is **AOP=OK** which acknowledges the command has been granted or **AOP =SERR** if the command has been ignored. Example: **#SAOP 10e6*** Sets the Stop frequency, for Analyzer mode, to 10MHz
SART f	This setting command sets the Start frequency for Analyzer mode. The string (f) can be in exponential form and should be expressed in Hz. The reply is **ART=OK** which acknowledges the command has been granted or **ART =SERR** if the command has been ignored. Example: **#SART 150e3*** Sets the Start frequency, for Analyzer mode, to 150kHz
SCFA	This setting command activates (or deactivates) the conversion factor stored in the ER9000 (if any) where n is the ID of the conversion factor. If **n** is not in the range 1 to 4, no conversion factor is active The reply is: **CFA=OK (OFF)** in case there is not active conversion factor **CFA=OK** in case the conversion factor is active Example: **#SCFA 0*** Deactivates any CF

SCFE n, name	This setting command is used for saving the conversion factor (made by **SCFW)**. The command is made of the string:
	
	  • **FCE** (the command itself),
	  • **n** is the index and should be 0 (other index are ignored because into memory can be saved one index only).
	  • **name** which is a string representing the name of it
	
	This command is intended for creating a conversion factor into PMMER9000. For further information see command **SCFW**..
	When the command is received the conversion factor is checked and, if data (frequency and level) are coherent, the command is granted by replying **SCFW =OK** otherwise the replay is **SCFW =SERR**
	
	Example: **#SCFE 0,Probe*** checks the data previously loaded by **SCFW** commands, names it as "Probe**"** and activates it.

SCFW n,freq;lev	This setting command is used for creating a conversion factor frequency by frequency. It consists of three fields as follows: • **n** is the index of frequency being written and it should range from 0 to 499 • **freq** is the frequency, expressed in Hz (exponential notation allowed), being written • **lev** is the conversion factor and is expressed in dB The procedure to creating a conversion factor on PMMER9000 is the following: • Send as many commands as the frequency points of limit are in upwards order. • Terminate (and make it active) by sending the command **SFCE** Here is an example how to make a custom correction factor on PMMER9000: • #SCFW 0, 150e3; -1 * Send the first line 150kHz -1 dB • # SCFW 1, 500e3; 0 * Send the second line 500kHz 0 dB • # SCFW 2, 5e6; 1.2 * Send the third line 5MHz +1.2 dB • # SCFW 3, 50e6; 1.1 * Send the fourth line 50MHz +1.1 dB • # SCFW 4, 300e6; 1 * Send the fifth line 300MHz +1 dB • #SCFE 0,Probe* Save it permanently as #0 into ER9000 and name it as "PROBE" Note that all the higher indexes in the conversion factor are cleared. Therefore, a conversion factor must be made upwards otherwise all points, having a higher index previously written, are cleared. It is **responsibility of the user to make sure** the data sent are correct and coherent. The reply is **SCFW =OK** which acknowledges the command has been granted or **LCFW =SERR** if the command has been ignored.

SCNF	This setting command is used for setting a conversion factor. It needs two fields as follows: **#SCNF\<array\>\<checksum\>***
	
	The **array** represents the hex-ascii 8064-character-size file, made of ascii text that contains hexadecimal characters encoding the complete structure of conversion factor.
	The structure is of the type:
	<pre> struct LIMIT_STRUCT{
	                float freq;
	                short Lev[2];
	        };
	
	        struct CONV_FACTOR{
	                short Valid;
	                char Name[14];
	                short CurrVal;
	                short Spare[7];
	                struct LIMIT_STRUCT Factor[500];
	        };</pre>
	where **Valid** must be 0x1234 in little endian format.
	Every single byte should be sent by splitting into two ascii characters, e.g. 0xA5 becomes 'A' and '5'.
	
	The **checksum** is a 2-character long text that represents the checksum. This figure is calculated by using **0xAA** as a seed and summing up ascii code of all transmitted characters (related to **array** only).
	
	ER9000 replies **CNF=OK** or **CNF=SERR** in case the calculated checksum does not match the checksum in the file.
	
	Example: **#SCNF341243465F\<further 8054 characters\> E1***

SDMD	This setting command switches the Demodulator; according the parameter (a) which can be **AM, FM** or **OFF**. The reply is **DMD =OK** which acknowledges the command has been granted or **DMD =SERR** if the command has been ignored. Example: **# DMD FM*** Example: **# DMD OFF***
SDMV v	This setting command sets the volume of demodulator. The string (v) should be in the range of 0 to 100. The reply is **DMV =OK** which acknowledges the command has been granted or **DMV =SERR** if the command has been ignored. Example: **#SDMV 50*** Sets the volume of demodulator to half of the audio power.

SGAT n	This setting command sets the 20 dB output Attenuator for the internal generator. The string (n) can be: - **0** to disable the output attenuator - **1** to insert the 20 dB output attenuator The reply is **GAT=OK** which acknowledges the command has been granted or **GAT=SERR** if the command has been ignored. Example: **#SGAT 0*** Uses the direct RF output, without attenuation.
SGBN b	This setting command selects the frequency band for the internal Pulse generator. The string (b) can be: - **A** for A band pulse generation - **B** for B band pulse generation The reply is **GBN=OK** which acknowledges the command has been granted or **GBN=SERR** if the command has been ignored. Example: **#SGBN B*** Selects B band pulse generation.
SGOU m	This setting command selects the type of signal to be generated by the internal generator, according to the string (m), which can be either: - **0** for Pulse generation - **1** for CW generation The reply is **GOU=OK** which acknowledges the command has been granted or **GOU=SERR** if the command has been ignored. Example: **#SGOU 1*** Selects the CW mode for signal generation.
SHIS s	This setting command switches between the High Sensitivity (7.5 MHz) or Fast (15 MHz) mode; according the parameter (s) which can be either: - 0 for Fast mode - 1 for High Sensitivity mode The reply is **HIS=OK** which acknowledges the command has been granted or **HIS=SERR** if the command has been ignored. Example: **#SHIS 0***

SLDW n,freq; levq,leva	This setting command is used for setting the custom double value limit frequency by frequency. It consists of four fields as follows: • **n** Is the index of frequency being written and it should range from 0 to 15 • **freq** Is the frequency, expressed in Hz (exponential notation allowed), being written • **levq** Is the level of the limit which refers to QPeak and is expressed in dBµV • **leva** Is the level of the limit which refers to the alternate detector and is expressed in dBµV The purpose of this command is to have a double value limit that can be used along with smart detector function when sweeping by the command **SSFD**: The procedure to set a custom double value limit on PMMER9000 is the following: • Send as many commands as the frequency points of limit are in upwards order. • Terminate (and make it active) by sending the command **SLIE** Here is an example how to make a custom limit on PMMER9000: • #SLDW 0, 150e3; 66,56 * Send the first line 150kHz 66 dBµV (QP) • #SLDW 1, 500e3; 56,46 * Send the second line 500kHz 56 dBµV (other det.) • #SLDW 2, 5e6; 56,46 * Send the third line 5MHz 56 dBµV • #SLDW 3, 5e6; 60,50 * Send the fourth line 5MHz 60 dBµV • #SLDW 4, 30e6; 60,50 * Send the fifth line 30MHz 60 dBµV • #SLIE Custom Double * Send the name and make the limit active Note that all the higher indexes in the limit are cleared. Therefore, a limit must be made in upwards order otherwise all points, having a higher index previously written, are cleared. It is **responsibility of the user to make sure** the data sent are correct and coherent. The reply is **SLDW =OK** which acknowledges the command has been granted or **LDW =SERR** if the command has been ignored.
SLIE name	This setting command is used for naming the custom limit and making it active or deactivating it. The command is made of the string **LIE** (the command itself) and a string which represents the name of the limit it will be shown. **It is suggested a name of maximum 10 characters.** Sending a **LIE** with no argument (Limit name) deactivates all limit active, if any. This command is intended for making a custom limit into PMM ER9000. For further information see command **SLIW**. When the command is received the limit is checked and, if data (frequency and level) are coherent, the command is granted by replying **SLIW =OK** otherwise the replay is **SLIW =SERR** Example: **# SLIE Custom Limit*** checks the data previously loaded by **SLIW** commands, names the limit as "**Custom Limit"** and activates it Example: **# SLIE *** deactivates any limits

SLIM n	This setting command sets the Margin to be used with Smart Detector function. The argument (n) in the range of -20 to 20. The reply is **LIM =OK** which acknowledges the command has been granted or **LIM =SERR** if the command has been ignored. Example: **#SLIM 2*** Sets the threshold of smart detector to 2 dB below the limit.

SLIW n,freq;lev	This setting command is used for setting the custom limit frequency by frequency. It consists of three fields as follows:
	  • **n** Is the index of frequency being written and it should range from 0 to 15
	  • **freq** Is the frequency, expressed in Hz (exponential notation allowed), being written
	  • **lev** Is the level of the limit and is expressed in dBμV
	
	The procedure to set a custom limit on PMMER9000 is the following:
	  • Send as many commands as the frequency points of limit are in upwards order.
	  • Terminate (and make it active) by sending the command **SLIE**
	Here is an example how to make a custom limit on PMMER9000:
	  • #SLIW 0, 150e3; 66 * Send the first line 150kHz 66 dBμV
	  • #SLIW 1, 500e3; 56 * Send the second line 500kHz 56 dBμV
	  • #SLIW 2, 5e6; 56 * Send the third line 5MHz 56 dBμV
	  • #SLIW 3, 5e6; 60 * Send the fourth line 5MHz 60 dBμV
	  • #SLIW 4, 30e6; 60 * Send the fifth line 30MHz 60 dBμV
	
	  • #SLIE Custom CISPR 14-1 * Send the name and make the limit active
	
	Note that all the higher indexes in the limit are cleared. Therefore, a limit must be made in upwards order otherwise all points, having a higher index previously written, are cleared.
	It is **responsibility of the user to make sure** the data sent are correct and coherent.
	
	The reply is **SLIW =OK** which acknowledges the command has been granted or **LIW =SERR** if the command has been ignored.

SLMT	This setting command is used for setting a limit. It needs two fields as follows:
	#SLMT\<array>\<checksum>*
	
	The **array** represents the hex-ascii 258-character-size file, made of ascii text that contains hexadecimal characters encoding the complete structure of limits.
	The structure is of the type:
	      struct LIMIT_STRUCT{
	            float freq;
	            short Lev[2];
	      };
	
	      struct LIMIT_STRUCT Limits[16];
	
	Every single byte should be sent by splitting into two ascii characters, e.g. 0xA5 becomes 'A' and '5'.
	
	The **checksum** is a 2-character long text that represents the checksum. This figure is calculated by using **0xAA** as a seed and summing up ascii code of all transmitted characters (related to **array** only).
	
	ER9000 replies **LMT=OK** or **LMT=SERR** in case the calculated checksum does not match the checksum in the file.
	
	Example: **#SLMT007C124811\<further 248 characters> B7***

SMAF f	This setting command sets the tuning frequency for manual mode. The string (f) can be in exponential form and should be expressed in Hz. The reply is **MAF=OK** which acknowledges the command has been granted or **MAF=SERR** if the command has been ignored. When the command is granted the ER9000 goes to manual mode automatically Example: **#SMAF150e3*** Sets the manual frequency to 150kHz
SMAT a	This setting command sets Attenuator, for Manual Mode, to the value indicated by (a) which can be 0 to 45. Automatic Attenuator feature is disabled. If (a) is a negative figure then the Automatic Attenuator feature is turned on. The reply is **MAT=OK** which acknowledges the command has been granted or **MAT =SERR** if the command has been ignored. When the command is granted the ER9000 goes to manual mode automatically. Note: the maximum available attenuation can be read with command ?MAA. Example: **#SMAT 15*** (set attenuator to 15dB and disable Automatic Attenuator feature) Example: **#SMAT -1*** (Enable Automatic Attenuator feature)

SMFD	This setting command sets measurement parameters for Manual Mode as follows: **#SMFD f_center [Hz];hold_t [s];rbw_id;att [dB];preAmp[Off/On/Ln];preSel[Off/On];** **MinAtt [dB];pulseLim[Off/On]*** ER9000 replies **MFD=OK** or **MFD=ERRcode** Example: **#SMFD 5e6;0.2;7;10;OFF;OFF;5;OFF***
SMHT h	This setting command sets hold time for manual mode. The string (h) should be expressed in ms. The reply is **MHT=OK** which acknowledges the command has been granted or **MHT =SERR** if the command has been ignored. When the command is granted the ER9000 goes to manual mode automatically. Example: **#SMHT 1500*** Sets the hold time, for manual mode, to 1500 ms (or 1.5s)
SMPA a	This setting command switches Preamplifier, for Manual Mode, according the parameter (a) which can be **ON, LN** or **OFF**. **ON** activates the low distortion preamplifier, **LN** activates the low noise preamplifier, **OFF** deactivates any preamplifier. Only one preamplifier can be active at a time. The reply is **MPA=OK** which acknowledges the command has been granted, or **MPA =SERR** if the command has been ignored. When the command is granted, the ER9000 goes to manual mode automatically (compatibility mode). Example: **#SMPA ON*** which switches the low distortion preamplifier on.
SMPS a	This setting command switches Preselector, for Manual Mode, according the parameter (a) which can be either **On** or **OFF**. The reply is **MPS=OK** which acknowledges the command has been granted, or **MPS =SERR** if the command has been ignored. When the command is granted, the ER9000 goes to manual mode automatically (compatibility mode). Example: **#SMPS OFF***

SPAM p	This setting command selects the desired Preamplifier for conducted range, according to the parameter (p) which can be either **0** or **1**.
	The reply is **PAM=OK** which acknowledges the command has been granted,
	 or **PAM =SERR** if the command has been ignored.
	
	    - 0 for Low Distortion Preamplifier
	    - 1 for Low Noise Preamplifier
	
	Note:
	SPAM 0 has the same effect of using ON as parameter for commands AFD, MFD, SFD, APA, MPA and SPA.
	SPAM 1 has the same effect of using LN as parameter for commands AFD, MFD, SFD, APA, MPA and SPA.
	
	Example: **#SPAM 0***

SPRF r	This setting command sets the repetition frequency for the internal Pulse generator. The argument (r) should be a string representing the Pulse Repetition Frequency in Hz as integer. Note: Single pulse can be generated with n=0, i.e. each time SPRF 0 is issued, a single pulse is generated. The reply is **PRF=OK** which acknowledges the command has been granted or **PRF=SERR** if the command has been ignored. Example: **#SPRF 100*** sets the PRF as 100 Hz (i.e. 100 pulses per second)
SPWD p	This setting command switches the internal Pulse generator, according to the parameter (p) which can be either **1000 (ON)** or **0 (OFF)**. Note: This command is compulsory to generate the pulse signal. The reply is **PWD=OK** which acknowledges the command has been granted, or **PWD =SERR** if the command has been ignored. Example: **#SPWD 1000*** which switches the internal Pulse generator On.
SRBW b	This setting command sets RBW. The argument (b) should be a string representing the RBW as per the list available with command ?BWL. The reply is **RBW =OK** which acknowledges the command has been granted or **RBW =SERR** if the command has been ignored. Example: **#SRBW 8*** sets the RBW to 30kHz

| **SSFD**
FreqStart;
FreqStop;
FreqStep;
Detector;
HoldTime; Rbw;
MinAtt; Preamp;
Preselector;
ScanHoldT | This setting command sets parameters and triggers a sweep.
Arguments are as follows:

• **FreqStart** = Sweep Start Frequency expressed in Hz
• **FreqStop** = Sweep Stop Frequency expressed in Hz
• **FreqStep** = Sweep Step Frequency expressed in Hz
  Note: the indicated frequency step is ignored and the most suitable one will be automatically calculated and used.
  If a custom frequency step is to be used, please send SSFDS command.
• **Detector**. In **non –smart mode**, any combination of the following detectors can be used and combined. All the detectors set will be measured and sent out. However, in **Smart Mode** only one detector at time, in addition to PEAK which is always present, can be set.
  ○ **Non Smart Mode** (All detectors can be indicated at once). Order is not important.
    ▪ **P →Peak**
    ▪ **Q → Q Peak**
    ▪ **N → C-Rms**
    ▪ **A →Avg**
    ▪ **R →Rms**
    ▪ **C →C-Avg**
  ○ **Smart Mode** (No more than 2 detectors can be indicated at once)
    ▪ **S → Smart Mode** (this must be the first in the string)
    ▪ **Q → Q Peak**
    ▪ **N → C-Rms**
    ▪ **A →Avg**
    ▪ **R →Rms**
    ▪ **C →C-Avg**
• **HoldTime** = Hold Time for each step and it is expressed in ms. Note that in case of Smart Mode HoldTime is used only when the disturbance is measured again by the alternative detector as minimum time, depending on the RBW set, is used for the fast scan.
• **RBW**. This is the index of RBW to be used for the scan. Neither automatic selection, nor automatic switch is performed. The user must issue a suitable RBW index according to the reply to the query command ?BWL.
• **MinAtt** = Minimum attenuation allowed during sweeping. This parameter ranges from 0 (no limitation) to the maximum available attenuation. This parameter is normally used to avoid switching up the sensitivity in order to either protect the input from high spikes or to prevent switching down the attenuation when, for instance, the limit is so high that it would be only waste of time.
  Note: In Sweep mode the Attenuator is always forced to AUTO
• **Preamp.** This Parameter switches the Preamplifier On or Off according to its content as follows.
  ○ **ON**. It turns on the Low Distortion preamplifier,
  ○ **LN** it turns on the Low Noise preamplifier,
  ○ **OFF.** It turns off the preamplifier.
• **Preselector.** This Parameter switches the Preselector On or Off according to its content as follows.
  ○ **On**. It turns ON the Preselector.
  ○ **Off.** It turns Off the Preselector.
• **ScanHoldT** = Hold Time used in Smart Mode when tuning for Peak for each step and it is expressed in ms. Note that this is used only in case of Smart Mode and not in standard sweep. This parameters is not compulsory and can be omitted if not required. I case it is not present, minimum time is taken. |

| (Continued)

SSFD FreqStart;
FreqStop;
FreqStep;
Detector;
HoldTime; Rbw;
MinAtt; Preamp;
Preselector;
ScanHoldT | This command triggers a free sweep (no automatic items are selected) based on the provided parameters. After this command has been received, all parameters issued in the command itself are checked out and, if coherent, a sweep starts otherwise the related error is notified and the sweep is not triggered.

After the command has been received, the ER9000 replies by sending a string which reflects the status of parameters check as follows:
• **SFD=OK**<CR><LF> No error in parameters and sweep started.
• **SFD=ERR 1**<CR><LF> An Error was found in **start** or **stop** frequencies. Errors can be one of the following:
  o Start Frequency lower than minimum allowed frequency
  o Stop Frequency higher than maximun allowed frequency
  o Start Frequency higher than Stop Frequency
• **SFD=ERR 2**<CR><LF> An Error was found in **step** frequency. Step is either
  o Too small.
  o Is equal to zero (use of Frequency-Scan-Tab) but there are less than two frequencies in the table
• **SFD=ERR 3**<CR><LF> An Error was found in **detector**. Errors can be one of the following:
  o Invalid Detector or no detector found. Detectors must be indicated by **'P','Q','R','A','N'** and **'S'** only
  o Smart Mode selected but no active limit
  o Smart Mode selected but no alternative detector
  o Smart Mode selected but more than two alternative detector indicated
• **SFD=ERR 4**<CR><LF> An Error was found in **HoldTime** value. **HoldTime** is either too big (>30s) or negative.
• **SFD=ERR 5**<CR><LF> An Error was found in **RBW**. Errors can be one of the following:
  o Unsuitable RBW for the active unit (for instance 200 Hz RBW while operating in bands C, D and E)
  o Unsuitable RBW for the detector previously selected (for instance 100 kHz RBW and QuasiPeak selected).
• **SFD=ERR 6**<CR><LF> An Error was found in **MinAtt** value. Errors can be one of the following:
  o **MinAtt** value is negative
  o **MinAtt** value is higher than maximum available attenuation
  o **MinAtt** value is not in step of 5
• **SFD=ERR 7**<CR><LF> An Error was found in **Preamp** string. **Preamp** string can be either **ON** or **OFF** only. String is not case sensitive.
• **SFD=ERR 8**<CR><LF> An Error was found in **Preselector** string. **Preselector** string can be either **ON** or **OFF** only. String is not case sensitive.
• **SFD=ERR 20**<CR><LF> An Error was found in the **Frequency Step**. **Step is too small.**
• **SFD=ERR 101**<CR><LF> A generic Error was found.
• **SFD=ERR 102**<CR><LF> A generic Error was found.
• **SFD=ERR 103**<CR><LF> Radiated Sweep Mode required but RF Module not yet ready. Please refer to command ?RFS. |

(Continued) **SSFD** FreqStart; FreqStop; FreqStep; Detector; HoldTime; Rbw; MinAtt; Preamp; Preselector; ScanHoldT	Once the sweep is started, the ER9000 sends back an array of 32 bytes where the first 4 bytes are a Little Endian 32 bit floating point figure representing the frequency step of the sweep itself. The remaining 28 bytes are reserved and can be ignored. Then the value of each detector chosen in the command step by step will follow. Each detector is made of a Little Endian 16 bit integer which represents the value of that specifically tuned frequency. The value is expressed in **hundredth of dBm**. Therefore, for each step, there will be a packet of **n** detectors (**n** *2 bytes). The order of detectors is fixed and is not related to the order issued in the command. For instance, PAQ is equivalent to QAP as well as RA is same as AR. The order of detector is as follows (from the first to the last): 1. Peak (which is always present) 2. QPeak (QuasiPeak) 3. RMS 4. AVG (Average) 5. C-RMS 6. C-AVG Special meaning has the value **NO_LEVEL**, **-16384** (0xC000), which informs that the detector has not been measured. This happens, for example, in Smart mode where the alternative detector is taken only for those frequencies the Peak was above the limit (minus margin). After having terminated all steps and sent all data, the string **SFD_END** is then sent, informing the user there are no more data left. Any started sweep can be stopped by sending the command **ASBK** which abruptly terminates it. In case the sweep was prematurely terminated by the command **ASBK,** the end of sweep (which will not contain all expected data) is **SBK=OK** Here is an example of the command: **#SSFD 1e6;10e6;10e3;PAR;0;25;10;OFF;ON;*** Which triggers a sweep from 1 MHz to 10 MHz (the 10 kHz step will be ignored). Detectors are Peak, AVG and RMS. The hold time will be the minimum suitable (automatically adjusted by the unit). RBW is 9kHz. MinAtt is 10 dB which means that the attenuator will not switch below 10 dB attenuation. Preamplifier is OFF while the Preselector is turned ON. Here, for each step there will be a packet of 3 detectors per step (Peak, AVG and RMS in this order) counting thus 6 bytes (3 * 2) per step. Here is another example: **#SSFDS 9e3;150e3;50;SPQ;2000;26;10;OFF;ON;100*** Which triggers a sweep from 9kHz to 150kHz using a step of 50 Hz. Detector is Smart QuasiPeak using a hold time of 2s in re-measuring those frequencies which value was over the limit scanned using 100ms holdtime . RBW is 200 Hz. MinAtt is 10 dB which means that the attenuator will not switch below 10 dB attenuation. Preamplifier is OFF while the Preselector is turned ON. Here, for each step there will be a packet of 2 detectors per step (Peak and QuasiPeak in this order) counting thus 4 bytes (2 * 2) per step. Of course, most of QuasiPeak value will be populated by **NO_LEVEL** as QuasiPeak will be measured only for a few frequencies (the ones which value is above the limit-margin). Warning: the expected number of steps (given by the selected span and RBW) must be in the range [50, 500e3]. If this range is not respected, SFD=ERR 5 is replied.

SSFDS	In addition to the SSFD command, the ER9000 has the SSFDS instruction. This command accepts the frequency step parameter (step > 0). When using, instead, the SSFD command, the ER9000 choses, automatically, the best step for the RBW in use, as an optimization. In that case, the true step is sent by the receiver at the beginning of the sweep data. The syntax is the same as per the SSFD command. Example: **#SSFDS 9e3;150e3;50;SPQ;2000;26;10;OFF;ON;100;1***
SSSW	This setting command actuates some generic settings for the Sweep Mode. **#SSSW PLM;TGS;TGT;TGF*** Arguments are as follows: • **PLM** = Pulse Limiter which can be either **On** or **OFF**. • **TGS** = Built-In Generator which can be either **On** or **OFF**. • **TGT** = Built-In Generator tracking mode which can be only **OFF** in Sweep mode. • **TGF** = tuning frequency for the Built-In Generator when is not tracking (STGT OFF). The string can be in exponential form and should be expressed in Hz. Frequency should range between 10 Hz and 30 MHz inclusive. Example: **#SSSW ON;OFF;OFF;0*** which activates the Pulse Limiter and switches off all of the internal generators.
SSTP	This setting command stops abruptly a running sweep in Analyzer mode. The reply is always **STP=OK,** which acknowledges the command has been granted
STAT b	This setting command sets MinAtt to the value indicated by (b) which range from 0dB to the maximum available attenuation and must be in step of 5dB. The reply is **TAT=OK** which acknowledges the command has been granted or **TAT=SERR** if the command has been ignored. **Note: In Sweep mode the Attenuator is always forced to AUTO** Example: **#STAT 10***
STGF f	This setting command sets the tuning frequency for the Built-In CW signal generator when it is not tracking (STGT OFF**).** The string (f) can be in exponential form and should be expressed in Hz. Frequency should range between 10 Hz and 30 MHz inclusive. The reply is **TGF=OK** which acknowledges the command has been granted or **TGF=SERR** if the command has been ignored. Example: **#STGF 150e3*** Sets the tuning frequency, for Built-In CW generator, to 150 kHz.

STGL l	This setting command sets the output level of the built-in CW generator. The string (l) should be expressed in dBµV. Level should range between 60 and 90 inclusive. The reply is **TGL=OK** which acknowledges the command has been granted or **TGL=SERR** if the command has been ignored. Example: **#STGL 85.5*** which sets the output level of the built-in generator to 85.5 dBµV.
STGS a	This setting command switches the built-in generator; according to the parameter (a) which can be either **On** or **OFF**. The reply is **TGS=OK** which acknowledges the command has been granted or **TGS=SERR** if the command has been ignored. Example: **#STGS ON*** which switches the internal generator on.
STGT t	This setting command changes the built-in CW generator Tracking mode; according to the parameter (t) which can be either **On** or **OFF**. When tracking mode is ON the built-in generator is tuned on the same receiver frequency. When tracking mode is OFF the built-in generator is tuned at the frequency previously set by STGF command. The reply is **TGT=OK** which acknowledges the command has been granted or **TGT=SERR** if the command has been ignored. Example: **#STGT ON*** which activates the tracking mode for the internal CW generator.
SUPP n	This setting command **#SUPP n*** outputs on the User Port bit by bit the argument n . Each Pin has its own contribution according to its index as follows: OUT0= 2^0 OUT1= 2^1 OUT2= 2^2 OUT3= 2^3 Thus, the argument sent is the sum of each weighted contribution. The reply is **UPP=OK** which acknowledges the command has been granted or **UPP=SERR** if the command has been ignored (IE argument >15). Example**: #SUPP 5*** will set: • user port pins OUT0 and OUT2 to high level • user port pins OUT1 and OUT3 to low level

7.6.3 Analyzer Reply	The PMM ER9000 replies to the command "**SAGO**" sending back an array of bytes which contains all the information needed to draw a sweep.

Typically, the user should first send the PMM ER9000 all the setting commands to insure the receiver is correctly set on the wanted parameters and then read the reply.

Just as an example, the user could send the following commands:

7.6.3.1 Reply example

#SAAT -1*	Set Attenuator Automatic mode
#SAPA Off*	Switch Preamplifier OFF
#SPLM a*	Switch Pulse Limiter OFF
#SAFF 150e3,30e6*	Sets the Start frequency to 150kHz and Stop frequency to 30MHz
#SAHT 2*	Sets the hold time to 2 ms
#SADT 2*	Sets the detector to AVG
....	More Command
....	More Command
#SAGO *	Start Sweep in Analyzer Mode

☞ NOTE

The PMMER9000 replies by sending a 48 bytes header followed by a variable size array of integer (the size depends on frequency settings) as follows:

HEADER		
ID Byte	Value	Meaning
1	A	The first 8 Bytes are just a fixed header and acknowledge the command
2	G	
3	O	
4	=	
5	O	
6	K	
7	0x13 (CR)	
8	0x10 (LF)	
9	Start Frequency	Little Endian 32 bit Float figure representing the start frequency of sweep
10		
11		
12		
13	Stop Frequency	Little Endian 32 bit Float figure representing the Stop frequency of sweep
14		
15		
16		
17	Step Frequency	Little Endian 32 bit Float figure representing the step frequency of sweep
18		
19		
20		
21 … 26	Reserved …	…
27	Attenuator	Little Endian 16 bit integer representing the attenuator used
28		
29 … 48	Reserved ….	…

********** **End of Header** ********** (continued) From here all figures represent the level referred to the tuned frequency And are expressed in **hundredth of dBm**		
49 50	Level Fstart	Little Endian 16 bit integer representing the level referred to start frequency.
51 52	Level Fstart +Fstep	Little Endian 16 bit integer representing the level referred to start frequency plus step frequency
51 52	Level Fstart +2*Fstep	Little Endian 16 bit integer representing the level referred to start frequency plus 2 * step frequency
....	....	....
....	....	....
nn nn+1	Level Fstop	Little Endian 16 bit integer representing the level referred to Stop frequency

NOTE

The number of levels replied is calculated by the formula 1+(Fstop-Fstart)/Fstep. However, because of the different approximation in managing floating point figures, please note that the number of received levels may slightly differ specially with big difference in (Fstop-Fstart).

It is always possible to terminate a sweep before its natural end by sending the command SSTP.

7.7 Sweep Mode commands sequence example

This is the sequence used by the PMM Emission Suite when a scantable is run, in the "conducted" range (Band B from 0.15 to 30 MHz).

Example

Command sent	Reply received	Description
#?IDN*		Queries information about model, release and date of the firmware
	IDN=ER9000-FW - Opt.1 - 0.52 21/21	It is a ER9000/01 with its FW
		It is used to check congruencies, frequency limits, and all the related characteristics
#?MAA*		Queries the maximum available attenuation
	MAA= 55	Maximum available attenuation is 55 dB
#?BWL*		Queries the RBW filters list
	#ER&BWL 0; 3 MHz*#ER&BWL 1; 2 MHz*#ER&BWL 2; 1 MHz*#ER&BWL 3; 500 kHz*#ER&BWL 4; 300 kHz*#ER&BWL 5; 200 kHz*#ER&BWL 6; 100 kHz*#ER&BWL 7; 50 kHz*#ER&BWL 8; 30 kHz*#ER&BWL 9; 20 kHz*#ER&BWL 10; 10 kHz*#ER&BWL 11; 5 kHz*#ER&BWL 12; 3 kHz*#ER&BWL 13; 2 kHz*#ER&BWL 14; 1 kHz*#ER&BWL 15; 500 Hz*#ER&BWL 16; 300 Hz*#ER&BWL 17; 200 Hz*#ER&BWL 18; 100 Hz*#ER&BWL 19; 50 Hz*#ER&BWL 20; 30 Hz*#ER&BWL 21; 20 Hz*#ER&BWL 22; 10 Hz*#ER&BWL 23; 1 MHz-C*#ER&BWL 24; 120 kHz-C*#ER&BWL 25; 9 kHz-C*#ER&BWL 26; 200 Hz-C*#ER&BWL END*	Available RBW filters list

#?S/N*		Queries the serial number
	S/N=000WE91102	Serial number
#S3PRC*		Switches to Conducted frequency range (A and B bands)
	3PR=OK	ack
#?CRA*		Queries if RMS-AVG optional detector is active
	CRA=OK	RMS-AVG active
#SCFA -1*		Correction factors, if present, deactivated
	CFA=OK (OFF)	Important. Could be previously stored and activated.
#SSSW OFF;OFF;OFF;1000e3*		Sets the Pulse Limiter OFF
	SSW=OK	ack
#SSFD 150000;30000000;5000;P;1.9;25;10;OFF;ON;0;*		Sweep command
	Binary data reply	Measurements data
#?UHT*		Queries the hold time
	UHT=1.9ms	Applied hold time

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8 - Click Mode Operating Instructions (PMM CA0010 Option)

8.1 Introduction

The **CLICK mode** allows the User to make in a fast, easy and fully automatic way a difficult test like the Discontinuous Disturbances measurement, as defined by current CISPR standards.

8.2 Click Mode option

To enable the Click mode you need the optional PMM CA0010 Click Analyzer.

🖙 NOTE

For further information about Click Analysis and Generation software installation and use, please refer to the "PMM CA0010 User's Manual".

🖙 NOTE

When the Click option has been successfully installed, the PMM Click Analysis software can be run to take measurements.

8.3 Enter the Click Mode

To enter **Click Mode**, run the PMM CA0010 Click Analysis software and follow the instructions contained in the CA0010 User's Manual.

The main window will be the **IDLE** function, which allows a preliminary, free running evaluation, at the selected frequency and level.

To increase test productivity the PMM ER9000 has some very unique features: it allows skipping as many as 2 steps, as it may predict how many clicks would overcome the Lq limit and may also advice the User if the next step would fail.

🖙 NOTE

PMM ER9000 works as a simultaneous 4 channels click meter.

8.4 Introduction to the discontinuous disturbance (click) measurement

Mechanical or electronic switching procedures - e.g. those due to thermostats or program controls – may unintentionally generate broadband discontinuous disturbances with a repetition rate lower than 1 Hz.

Indeed, CISPR 16-2-1 and CISPR 14-1 define a discontinuous disturbance, also called "click", as a disturbance the amplitude of which exceeds the quasi-peak limit of continuous disturbance, the duration of which is not longer than 200 ms and which is separated from a subsequent disturbance by at least 200 ms. The durations are determined from the signal which exceeds the IF reference level of the measuring receiver.

A click may also contain a number of impulses; in which case the relevant time is that from the beginning of the first to the end of the last impulse.

The test procedures and the test setup for click measurement are indicated in CISPR 16-2-1 and in CISPR 14-1 standards.

It basically consists in the measurement of the number of clicks exceeding a certain level determined as function of the click number and duration.

The PMM ER9000 has a better then 500µs time resolution, as requested by the standard.

Moreover, several "exceptions" shall be dealt with by the click analyzer in order to make the test as per the standard.

To better understand the click measurement process – automatically made by PMM ER9000 - it could be useful also to know few more definitions:

- *switching operation*: one opening or closing of a switch or contact;
- *minimum observation time T*: the minimum time necessary when counting clicks (or switching operations) to provide firm evidence for the statistical interpretation of the number of click (or switching operations) per time unit;
- *click rate N*: number of clicks or switching operations within one minute (this figure is being used to determine the click limit);
- *Click limit Lq*: the relevant limit L for continuous disturbance for the measurement with the quasi-peak detector, increased by a certain value (offset) determined from the click rate N. The click limit applies to the disturbance assessed according to the upper quartile method;
- *Upper quartile method*: a quarter of the number of the clicks registered during the observation time T is allowed to exceed the click limit Lq. In the case of switching operations a quarter of the number of switching operations registered during the observation time T is allowed to produce clicks exceeding the click limit Lq.
- *short click 1*: a disturbance not longer than 10 ms;
- *short click 2 (E3)*: a disturbance between 10 ms and 20 ms;
- *click*: a disturbance longer than 10 ms and not longer than 200 ms;
- *other than click*: a discontinuous disturbance longer than 200 ms.

With reference to the mentioned standards, a schematic process flow of the measurement is the following:

- Determination of the click rate *N*
- Pass/fail decision if instantaneous switching and if N>=30
- Check conformity to definitions
- Apply Exceptions (whenever applicable)
- Calculate Limit Quartile
- Measurement using Upper Quartile Method
- Pass/fail using Upper Quartile criterion
- Repeat for next frequency

As PMM ER9000 manages all these steps in a completely automatic way, a detailed step by step description is here given before to describe each command and function.

8.4.1 Determination of the click rate

The first step of the measuring process is to determine the click rate N in the minimum observation time. This is done measuring the time needed to count up to 40 clicks or 40 switching operations; the maximum time allowed is anyway 2 hours (120 minutes), unless the cycle is determined by a program, which needs additional time to be terminated.

Therefore, if the equipment has a cycle and in this cycle less than 40 clicks appear, then the cycle shall be repeated until 40 clicks are counted or until the observation time is 2 hours.

If the equipment has a cycle and in this cycle more than 40 clicks appear, the observation time is anyway determined by the cycle.

When the minimum observation time has been defined, it is possible to calculate the click rate N using the simple relationship:

$$N = \frac{n_1}{T}$$

where n_1 is the number of clicks measured and T is the minimum observation time.

However, in certain conditions – see CISPR 14-1 for further reference – the click rate N should be calculated using a different approach:

$$N = \frac{n_2 \cdot f}{T}$$

where n_2 is the number of switching operations and f is a factor dictated in the standard. Such a factor can be taken into account for automatic calculations if its value is properly set in the main setup page.

The click rate must be determined at two frequencies: 150 kHz (Step 1) and 500 kHz (Step 3).

8.4.2 Preliminary Conformity and Exceptions

Once the number of clicks – or switching operations – has been determined, then some preliminary controls can be made to verify if the rate is greater than 30 (fail conditions); if the measured clicks are conforming to the definition of the standard; if there are exceptions applicable.

Thanks to its digital architecture, PMM ER9000 can easily record and store all the relevant parameters, keeping trace of all the events occurring during the test and allowing the User to post-process all these data; PMM ER9000 will also notify immediately the test results to the User.

8.4.2.1 Old and New exceptions

The "Click" test also requires verifying if exceptions E1 to E4 are applicable. While E1 and E2 are "old" exceptions, easy to deal with, the new E3 and, in particular, E4 are calling for a new hardware structure: an old click analyzer is no longer compliant.

E3 is an additional counter, does not require additional memory and implies only minor changes in the test flow, thus can be implemented in a relatively easy way.

E4 is very demanding in terms of hardware requirements: a memory for storing each disturbance duration and interval is required in order to post-elaborate them, and it is mandatory to provide all the data in the test report. Moreover, as the application of E4 is conditional to the final click rate N - which in turn may prevent using E4 – the test flow significantly changes.

Only new analysers specifically designed – like the PMM ER9000 - can successfully meet the requirements of the standard and be compliant with the new Click test criteria.

8.4.3 Calculate Limit Quartile

When the click rate N is determined it is possible to calculate the click limit Lq by increasing the relevant limit (quasi-peak) L for continuous disturbances with:

- ✆ 44 dB for N<0,2, or
- ✆ 20 log (30/N) dB for 0,2<N<30

Therefore

$$L_q = L + 20 \cdot Log \frac{30}{N}$$

8.4.4 Measurement vs. Lq limit

Now the test can be done at the 4 fixed frequencies dictated by the standard: 150 kHz, 500 kHz, 1.4 MHz, 30 MHz, and the results compared with the limit Lq.
If less than 25% of the clicks measured exceeds the limit Lq, then the test is positive, otherwise it fails.
The PMM ER9000 can now produce an extensive report with all the relevant data.

8.5 Start

As soon as the Setup has been done, it is possible to start the test.
First of all the analyzer will determine the click rate N, and – if all the conditions apply – after that the analyzer will immediately continue measuring the number of clicks exceeding the upper quartile limit L_q.
Simply select **Start**: the PMM ER9000 will automatically take care of all the necessary steps, reporting at the end of the test all the relevant results.

During the test, the evolution of the measurements can be continuously controlled in the Data and Details windows, where all the info are duly provided.
At any time, it is possible to **Stop** the measure or to **Pause** it.

The PMM ER9000 does the determination of the click rate at the two frequencies of 150 kHz and 500 kHz or at all the four frequencies, depending on the Operator's choice.

NOTE

The PMM ER9000 does the determination of the click rate at the two frequencies of 150 kHz and 500 kHz or at all the four frequencies, depending on the Operator's choice.

8.5.1 RUN 2
After the Run 1 is completed, the **Run 2** begins automatically, carrying out the measurements vs Lq limit, or, in other words, performing the heart of the test itself.

Among the parameters, on the display it is reported the max clicks number allowed (25% of the clicks measured during Step 1).

☞ **NOTE**
In certain conditions, the analyzer may judge the input attenuation is not adequate (for example, when the limit is recalculated following up the Lq value): in that case, a message appears, requiring additional attenuation.

In most cases, it is enough to touch **OK** to adjust the input attenuation to the optimum value and continue the test.

☞ **NOTE**
The total amount of available internal attenuation is 45 dB but the CA0010 is also equipped with supplementary attenuators so that a very high dynamic range can be accomplished.

NOTICE
Please remember that the maximum input signal allowed is 7 V (137 dBμV), and that a click test may result in a potentially dangerous condition for the input stage of the receiver.
Before to apply an unknown signal to PMM ER9000 receiver, use an oscilloscope or a wide band RF voltmeter to measure it.
If needed, set a proper threshold and consequently input attenuator.

8.5.2 Stop and Pause
If Stop has been selected during a measurement, the test can then be aborted or it is possible to go immediately to the next step.

If Paused, the test can be resumed at any convenient time.

8.6 Report

After a Click test the PMM ER9000 reports all the relevant data.
Due to the complexity of the test and to the various conditions that may happen during the measurement, several reports may be issued.

8.6.1 Fail during determination of the click rate N

In case a test failed condition is recorded during the determination of the click rate N during the first Run, the report will show the situation. In this case there is no need to go on testing that specific frequency/frequencies.

8.6.2 Report after a successful test with less than 5 instantaneous switching at one frequency

If the determination of the click rate N shows that at a given frequency there are less than 5 instantaneous switching operations, there is no need of any further test at that frequency or frequencies (the investigation frequencies are 150 kHz for the interval from 150 to 500 kHz, and 500 kHz for the interval from 500 kHz to 30 MHz).

8.7 Setup

Due to the complexity of the discontinuous disturbance test, this panel is rather complex, as many parameters shall be defined.
However, the PMM ER9000 has been designed to be extremely user-friendly and to take care in a fully automatic way of all the necessary steps of the test.

☞NOTE

Due to the fact that the Standard fixes the frequencies at which the test shall be done, these frequencies have been uniquely assigned by factory and the User cannot modify them; nevertheless it is possible to select an arbitrary Frequency Value for "Idle Mode" instead, useful for debugging purposes.

From the main Click Analysis window, select START and the main Setup panel will be displayed.
The User can navigate through the different parameters to set the desired values.

8.7.1 External attenuator

In case an external attenuator is used to protect the input of the analyzer, the value of this attenuator can be entered, in order to have the PMM ER9000 taking into account the value in all calculations of measured levels.
The way to enter the value of the attenuator is shown in the CA0010 User's Manual.

8.7.2 Limit

Three most used limits are built-in into the analyzer: CISPR 14, CISPR22 and CISPR11.
Either one can be selected simply by the drop down menu.
The limit will be loaded and all the calculations will be done with reference to the selected limit:

The Reference Standard for Click tests is always EN 55014-1 (or equivalent CISPR 14-1), which defines 4 different Limit Curves for Q-Peak according to Table 1, with following cross-correlation as for names assigned on ER9000 :

014-1 --> Limit in Column 2
014-2 --> Limit in Column 6
014-3 --> Limit in Column 8
014-4 --> Limit in Column 10

☞NOTE

Limit in Column 4 of Tab.1 is not used for Click test, as referred to Load and Auxiliary terminals.

8.7.3 Determination of N   As required by the standard, N may be determined either by counting the clicks, or by counting the switching operations.

Select **Clicks** if N has to be calculated on the number of clicks, or select **Sw.Op. current** to determine N on the number of switching operations, going up and down the list of the available options in terms of switched current: 10mA; 20 mA; 50 mA; 100mA; 200mA; 500mA; 1A; 2A and 5A. The current threshold value must be chosen in relation to the DUT declared consumption.

NOTE   **The internal LISN is able to autonomously measure the mains current drawn by the Device Under Test, when you need to count the switching operations.**

8.7.4 Factor f   The applicable standard may require a certain factor f to be used to calculate the click rate N. For example, table A2 of the CISPR14 gives the factor f for several products.
This factor depends on the nature of the EUT and shall be entered by the User in the normal way.

8.7.5 Stop on Fail   The Click test may be rather long, as the observation time and EUT cycle can take as long as 120 minutes.
In order to save time and increase productivity, the PMM ER9000 can stop the test as soon as a fail condition is achieved.
Two options are therefore available: stop immediately as the fail condition occurs (Right away) or anyway at the End of Step.
Please select the desired option.

8.7.6 Line   When using a PMM LISN, it's possible to select the Line on which to perform the test through the Setup Menu, just selecting the model and the specific desired line.

In case a 3rd party LISN would be used, just leave "NONE" in the menu.

8.8 Click option   The click option includes all the items described in the PMM CA0010 User's Manual, briefly listed here:

- CA0010 Click Analyzer from 150 kHz up to 30 MHz
- AC/DC Converter with plug adapters;
- Flexible black cover/accessories holding;
- LISN Mains Cable
- BNC-BNC coaxial cable 0,25 m length;
- DB9 male to DB9 male cable 0,25 m length for ER9000 connection;
- USB cable, 2m;
- Operating manual;
- Click Analysis and Click generation software
- Certificate of Compliance;
- Return for Repair Form.

For quick reference look at the following picture.

8.9 Test Set up

As required by the relevant standards, the discontinuous measurement (Click) test set up shall be the same adopted for continuous disturbances, therefore, usually, a LISN is used to sample the RF signal to be measured.

In case the internal LISN is to be used, it is the one contained in the PMM CA0010 Click Analyzer.

Please follow all the instructions illustrated in the CA0010 User's Manual to assemble the correct setup for your test.

to Mains
Network

(with proper
isolation
transformer)

To EUT supply
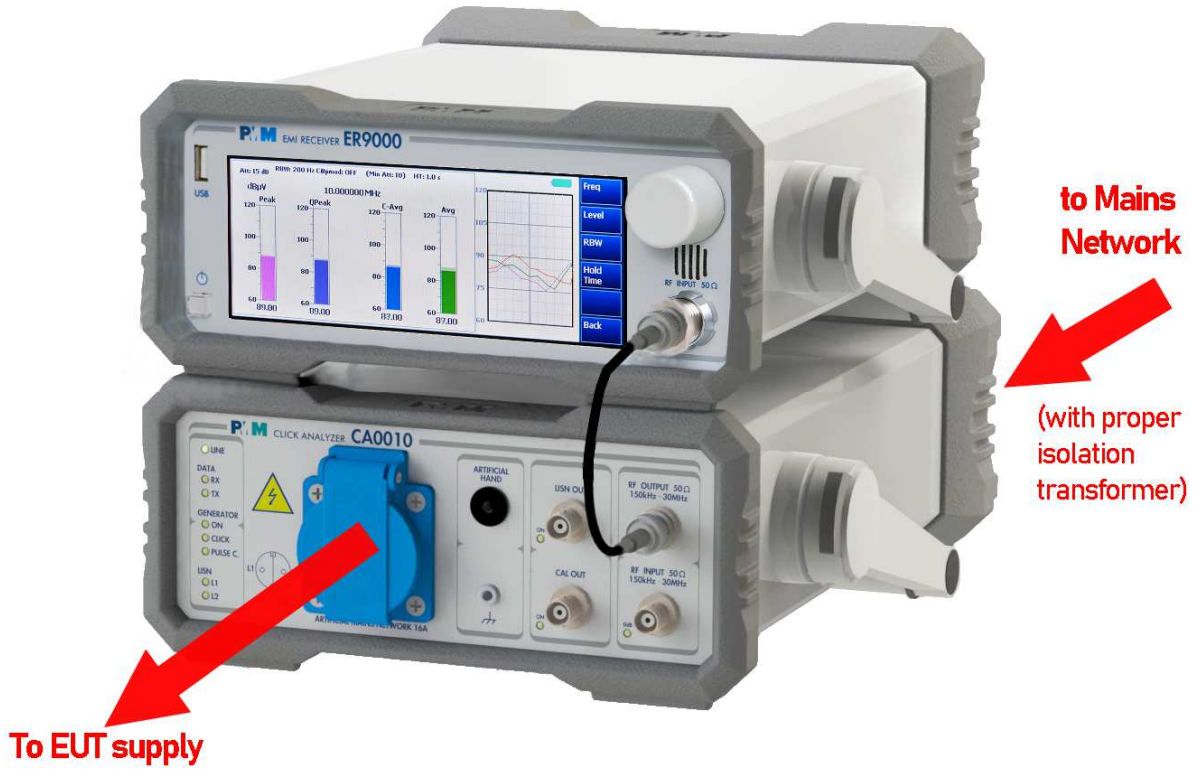
⚠ WARNING   **This is a Safety Class I apparatus and it is also equipped with a couple of protective/functional earth terminals, both on the rear and front panels. A good safety/functional ground connection should be provided before to operate the analyzer.**

Caro cliente

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

☐ Solo taratura   ☐ Riparazione   ☐ Riparazione & Taratura   ☐ Taratura SIT   ☐ Altro:
☐ Calibration only   ☐ Repair   ☐ Repair & Calibration   ☐ Certified Calibration   ☐ Other:

Ditta:
Company:

Indirizzo:
Address:

Persona da contattare: **Telefono:**
Technical contact person: *Phone n.*

Modello: **Numero di serie:**
Equipment model: *Serial n.*

☑ *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*: ☐ Continuous   ☐ 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: