Consorzio GSSH – Global Solution and Service for Healthcare
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# VERIFICA SULL'APPARECCHIATURA A RISONANZA MAGNETICA

## VERIFICA TENUTA DELLA GABBIA DI FARADAY

### D.M. 14/01/2021 del Ministero della Salute

| | |
|---|---|
| **Cliente** | GRANDE OSPEDALE METROPOLITANO BIANCHI MELACRINO MORELLI REGGIO CALABRIA |
| **Intervento presso** | **P.O RIUNITI- OSPEDALE BIANCHI MELACRINO-VIA PETRARA-89100 REGGIO CALABRIA** |
| **Impianto RM** | **PHILIPS ACHIEVA 1.5T** |
| **Configurazione** | **IT105393** |
| **Gabbia di Faraday** | **IMEDCO** |
| **Servizio eseguito per conto di** | **ALTHEA ITALIA SPA VIALE GUSTAVE ALEXANDRE EIFFEL 13-00148 ROMA** |
| **WO** | **WO-08779318** |
| **Data misura** | **29/11/2024** |

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# GENERALITA'

La presente relazione fornisce le misure effettuate per la verifica della corretta tenuta della gabbia di Faraday posta a protezione della Risonanza Magnetica.

# SCHERMATURA EMI/RFI (SALA ESAMI RMN)

L'obiettivo della gabbia di Faraday è di impedire, quanto più possibile, ai segnali RF presenti all'esterno di interferire con quelli utili per l'indagine diagnostica. Nel contempo la gabbia di Faraday consente di contenere parzialmente i rumori prodotti dai gradienti (vibrazioni prodotte nel range dell'udibile dovute a rapide variazioni di corrente all'interno delle bobine dei gradienti per la codifica spaziale) durante gli esami entro i limiti di legge.

Le zone più delicate in una schermatura per la RF sono:

- La porta di accesso al locale.
- La finestra visiva schermata e chiusa opportunamente (realizzata generalmente in doppio vetro con intelaiatura in rame e doppia rete in ottone schermante all'interno dei vetri).
- Le bocche d'accesso delle tubazioni per l'immissione o l'espulsione dell'aria, che devono rimanere sempre aperte, elettromagneticamente schermate mediante reti meccaniche a forma di favo d'alveare (Filtri Honey-Comb).
- Guide d'onda per la tubazione di evacuazione del gas criogeno (quench).
- Guide d'onda per i gas medicali quali il penetration panel (pannello di attraversamento filtri) per l'ingresso dei cavi di alimentazione elettrica (alimentazione magnete, luci di servizio, luci di riserva, prese di servizio, etc.)

# STRUMENTAZIONE UTILIZZATA

MBP SEMS: sistema di misura per la verifica dell'efficienza della tenuta degli ambienti schermati.

Composizione del sistema:

- Unità SEMS parte ricevente RX **S/N: 0151ISR08AP21**
- Unità SEMS parte trasmittente TX **S/N: 0151IST08AP21**
- Antenne biconiche
  - 2 antenne loop **S/N: 0151IL1A21MY21 – S/N: 0151IL1B21MY21**
  - 2 antenne a dipolo **S/N: 0061ID2AE4MY21 - S/N: 0061ID2BE4MY21**
- Antenne Rod
  - 2 RS232 / wireless
  - Treppiedi regolabili in altezza.

Quanto sopra adeguato alle esigenze di misura.

# MODALITA' DELLA VERIFICA

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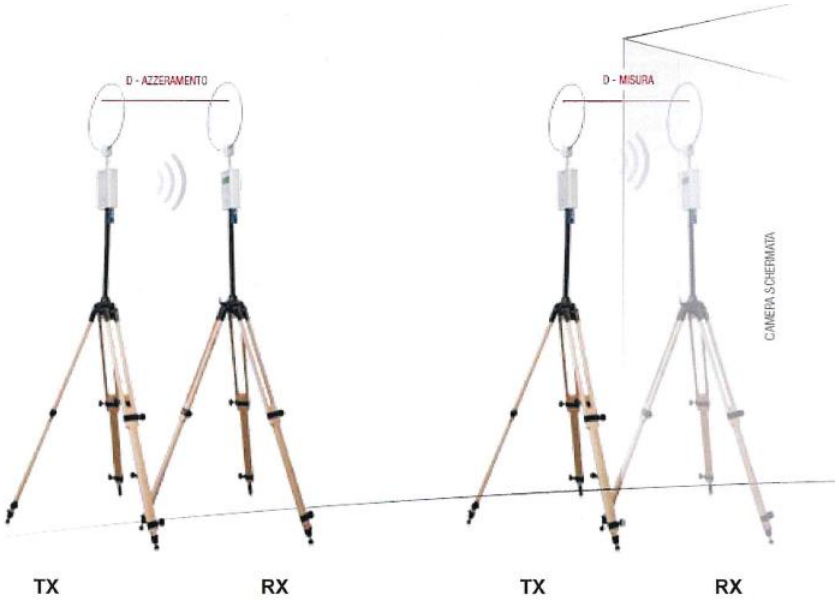
## Prima Fase: “AZZERAMENTO”

L’unità trasmittente TX genera un segnale a RF che viene irradiato attraverso l’adeguata antenna. Ad una distanza prefissata viene posizionato il ricevitore RX che per mezzo di un’analoga antenna riceve il segnale e ne misura il livello in dB.

## Seconda Fase: “MISURA”

L’unità ricevente RX viene posizionata all’interno dell’ambiente da misurare, mantenendo la stessa distanza dall’unità TX iniziale, ottenendo così una riduzione del segnale misurato.

Dalla differenza delle due misurazioni si ottiene il risultato voluto, cioè l’attenuazione dell’ambiente.



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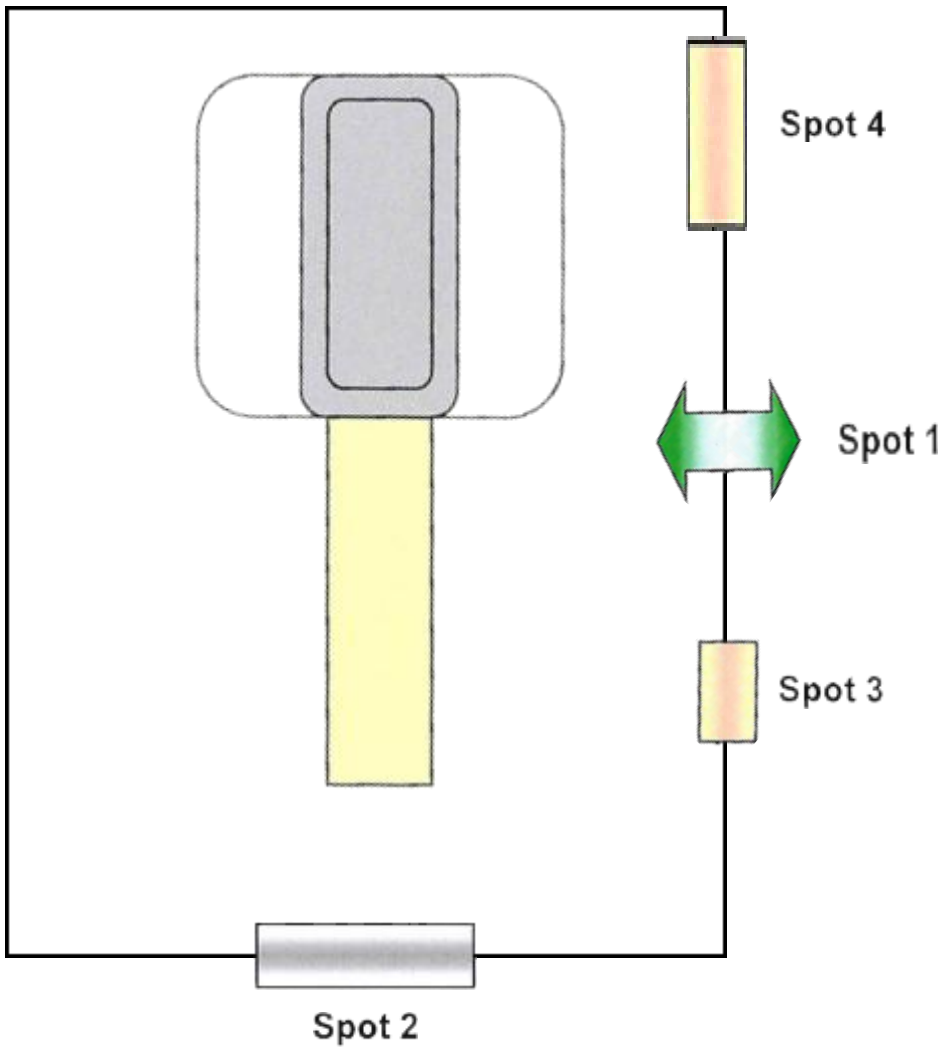
# DESCRIZIONE DELL'IMPIANTO E DEL SITO

**RM:** PHILIPS
**Modello:** ACHIEVA 1.5T
**Configurazione: IT105213**
**Produttore gabbia RF:** IMEDCO
**Planimetria:**




## RISULTATI DELLE MISURE

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Per quanto attiene la tenuta della gabbia di Faraday si è reputato opportuno effettuare le misure nei punti caratteristici in relazione alla tipologia dell'ambiente trovato e alla frequenza di risonanza ed a quelle nell'intervallo definito dalle norme MIL; relativamente ai punti caratteristici si ha che le zone più significative soggette al controllo periodico sono sicuramente costituite dalle porte, dalla visiva e dal penetration Panel.

Lo scopo della presente tabella è quello di fornire il risultato delle misure relative all'efficienza della schermatura per la gabbia di Faraday, indicando i valori di attenuazione riscontrati alle diverse frequenze:

**Punti di misura e relativi valori:**
Spot 1 PORTA
Spot 2 VISIVA
Spot 3 PANNELLO LATERALE MAGNETE

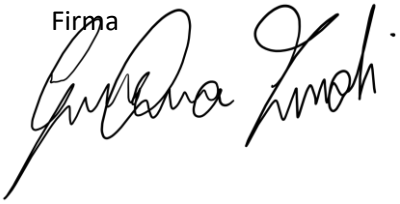
Spot 4 PENETRATION PANEL

| Antenne | Frequenza (MHz) | Spot 1 (dB) | Spot 2 (dB) | Spot 3 (dB) | Spot 4 (dB) | Spot 5 (dB) | Spot 6 (dB) |
|---|---|---|---|---|---|---|---|
| Campo (H) | **10** | **67,8** | **84,7** | **97,5** | **97,6** | | |
| Campo (E) | 63.85 | 59,2 | 60,2 | 76,9 | 98,7 | | |
| Campo (E) | **63.86** | **60,6** | **89,1** | **99,3** | **98,4** | | |
| Campo (E) | 63.87 | 74,6 | 93,1 | 109 | 115 | | |
| Campo (P) | **100** | **61,6** | **89,2** | **107** | **90** | | |

| Media | | | |
|---|---|---|---|
| (MHz) | **10** | **63.86** | **100** |
| (dB) | 86,9 | 86,85 | 86,95 |

Valore accettabile per misure eseguite alla frequenza di risonanza della macchina >75 Db
Valore accettabile per misure eseguite alle alte frequenze >70 Db
Valore ottimale per misure eseguite alla frequenza di risonanza della macchina >85 Db
Valore ottimale per misure eseguite alle altre frequenze >80 Db
Strumento utilizzato:
Misure eseguite secondo norme MIL-STD 285 e IEEE STD 299-1997 e come specifiche Philips.

Tecnico
Gianluca Trimarchi
Firma



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# ALLEGATI

## CERTIFICATO CALIBRAZIONE STRUMENTAZIONE UTILIZZATA CON PERIODICITA' ANNUALE

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# CERTIFICATE OF CALIBRATION

SIDEM
QUALITY AND REGULATORY
CONTROLLED COPY
07/07/2023

| | |
|---|---|
| **Item** | Shielding Effectiveness Measurement System<br>10.00 kHz - 128.00 MHz |
| **Manufacturer** | MPB S.R.L. |
| **Model** | SEMS LIGHT |
| **Serial number** | TX: 0151IST08AP21<br>RX: 0151ISR08AP21<br>L1P A: 0151IL1A21MY21<br>L1P B: 0151IL1B21MY21<br>D2 A: 0061ID2AE4MY21<br>D2 B: 0061ID2BE4MY21 |
| **Calibration procedure** | INTERNAL PROCEDURE SEMS-2002-STD |
| **Date(s) of measurements** | 2023-07-03 |
| **Date of emission** | 2023-07-03 |
| **Result of calibration** | MEASUREMENT RESULTS WITHIN SPECIFICATIONS |
| **Certificate number** | 23-S-13552 |

This document displays the procedure and the instrumental chain used to verify the compliance of the equipment under calibration to the technical characteristics required. The results shown in the next pages comes with the traceability chain of the laboratory and the related calibration certificates in their course of validity. Uncertainty declared in this document has been determined in compliance with the document EA-4/02 Expression of uncertainty of Measurement in Calibration and is expressed with a covering factor k=2, corresponding to a confidence level of about 95%.

Person in charge
Jan Bulli Wilkinson

Measurement operator
Ing. Marco Borrega

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## LABORATORY CHAIN OF TRACEABILITY

The following table shows the equipment used for this calibration procedure along with the reference list for traceability

| Equipment | Standard | Model | Calibration |
|---|---|---|---|
| Signal Generator | Frequency | Agilent N5183A | LAT 019 67260 |
| Function/Arbitrary Waveform Generator | Frequency | Rigol DG4202 | LAT 019 67271 |
| Multimeter | A.C. Voltage | Hewlett Packard 34401A | LAT 019 67280 |
| Power Sensor | R.F. Power | Agilent U2004A | LAT 019 67265 |
| Power Sensor | R.F. Power | Agilent U2004A | LAT 019 67268 |
| Power Sensor | R.F. Power | Agilent U2000A | LAT 019 67262 |
| Directional Cuopler | R.F. Power | Agilent 772D-001 | LAT 019 67275 |
| Directional Cuopler | R.F. Power | Werlatone C6110-10 | LAT 019 67278 |
| 20dB attenuator 7mm | Attenuation | Mini-Circuits BW-N20W5+ | LAT 019 67252 |
| 30dB attenuator 7mm | Attenuation | Mini-Circuits UNAT-30+ | LAT 019 67281 |
| 30dB attenuator 7mm | Attenuation | Mini-Circuits UNAT-30+ | LAT 019 67283 |
| 30dB attenuator 7mm | Attenuation | Mini-Circuits UNAT-30+ | LAT 019 67285 |
| 30dB attenuator 7mm | Attenuation | Mini-Circuits UNAT-30+ | LAT 019 67286 |
| Double Guide Horn Antenna | -- | ETS Lindgren 3116B | UKAS 2020010177-1 |
| Electric Field Probe | Electric Field | NARDA S.T.S. EP-603 | LAT 008 00605791E |

## CALIBRATION UNCERTAINTY

The uncertainty stated in this document does not take into account the long term stability of the monitor. For the purpose of this certificate the expanded uncertainties are given below.

| Domain | Uncertainty |
|---|---|
| RF Power | 6% |

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## MEASUREMENT CONDITIONS

All the instruments considered in the chain, comprising the equipment under calibration, were turned on at least 15 minutes (or the minimum warm up time stated in the manual, if present) to avoid any thermal drift.
The environmental conditions of temperature and relative humidity were monitored during the entire calibration procedure.

## CALIBRATION

**CalK Test:**
This test is conducted using the built-in procedure CalK aimed to certify the attenuation accuracy at: 30dB, 60dB and 90dB after zeroing on 30dB attenuator.
The result is PASS if the accuracy stays in the range of +/- 1dB below 30 MHz and 1.5dB above 30MHz, FAIL if it is out of these ranges.

| | PASS | FAIL |
|---|---|---|
| Calk | ✓ | |

**Frequency/Synchronism Stability Test Uncal 17m:**
This test is conducted zeroing on 30dB attenuator. Then, using unconnected mode, a full measure is taken adding a 60dB attenuator repeatedly for 17 minutes.
The result is PASS if, in the 17 minute period, the worst difference between the first and actual reading stays in the range of +/- 1.5dB while is FAIL if it is out of this range.

| | PASS | FAIL |
|---|---|---|
| Uncal 17m | ✓ | |

**TX Absolute frequency accuracy Test:**
This test is conducted measuring the absolute frequency tuned on TX @96MHz..
The result is PASS is the accuracy is in the range of +/- 100Hz, FAIL if it is higher.

| | PASS | FAIL |
|---|---|---|
| Tx Pout @96MHz | ✓ | |

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**TX Absolute Power level accuracy Test:**

This test is conducted measuring the absolute Power level tuning the TX @96MHz..
The result is PASS is the accuracy the level stays in the interval 28.0dBm to 30.5dBm , FAIL if the level is out of this range.

| | PASS | FAIL |
|---|---|---|
| Tx Pout @96MHz | ✓ | |

**100dB Attenuation accuracy Test:**

This test is conducted first zeroing on 30dB attenuator and then measuring adding a 100dB attenuator.
The table reports the actual data at the respective frequencies:

| Frequency [MHz] | Reading [dB] |
|---|---|
| 0.0100 | 100.0000 |
| 0.1000 | 100.0000 |
| 1.0000 | 100.0000 |
| 12.0000 | 100.0000 |
| 24.0000 | 100.2000 |
| 48.0000 | 100.0000 |
| 64.0000 | 100.0000 |
| 96.0000 | 100.2000 |

**Dynamic Range Test:**

This test is conducted first zeroing on 30dB attenuator and then measuring with the TX OFF.
The result reflects the dynamic range available on the system
The table reports the actual data at the respective frequencies.

| Frequency [MHz] | Reading [dB] |
|---|---|
| 0.0100 | 128.6300 |
| 0.1000 | 129.4100 |
| 1.0000 | 137.4900 |
| 12.0000 | 139.2700 |
| 24.0000 | 137.4100 |
| 48.0000 | 142.1100 |
| 64.0000 | 139.6900 |
| 96.0000 | 130.6500 |

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## SYSTEM DYNAMICS

The SEMS uses different antennas to generate and receive the RF signal.
Those antennas, when connected to the system, must meet a certain standard of global gain to ensure that the net power at the receiver is high enough.
The following measurements shows the measurement dynamics inside an anechoic chamber; specifically for each pair of antennas:

**Loop Antennas L1/L2/L1-P/L2-P/L4-A/L2-A:**
the receiver and the transmitter are positioned at 60cm from each other and the L1/L2/L1-P/L2-P/L4-A/L2-Aantennas are connected respectively to the two units. The antennas are positioned so that they are on two vertical floors, absolutely parallel. The antenna connected to RX unit and the antenna connected to TX unit has the same distance from the plane where the two unit are positioned. When the system is properly positioned, the zeroing process is done; after the zeroing process a measurement is done in unconnected mode removing the Bluetooth keys, with TX unit turned off, to verify the exactly dynamic of the system with the loop antennas L1/L2/L1-P/L2-P/L4-A/L2-A.

**Biconical Antennas B1:**
the receiver and the transmitter are positioned at 60cm from each other and the B1 antennas are connected respectively to the two units. The antennas are positioned so that they are on two vertical floors, absolutely parallel. The antenna connected to RX unit and the antenna connected to TX unit has the same distance from the plane where the two unit are positioned. When the system is properly positioned, the zeroing process is done; after the zeroing process a measurement is done in unconnected mode removing the Bluetooth keys, with TX unit turned off, to verify the exactly dynamic of the system with the biconical antennas B1.

**Dipole Antennas D2/D1:**
the receiver and the transmitter are positioned at 150cm from each other and the D2/D1 antennas are connected respectively to the two units; the dipole antenna is connected to a TX unit by interposing a 10 dB attenuator. The antennas are positioned so that they are on two vertical floors, absolutely parallel. The antenna connected to RX unit and the antenna connected to TX unit has the same distance from the plane where the two unit are positioned. When the system is properly positioned, the zeroing process is done; after the zeroing process a measurement is done, for each extendeds elemnts of dipole antennas ( the elements extension is ever the same for the two antennas), in unconnected mode removing the Bluetooth keys, with TX unit turned off, to verify the exactly dynamic of the system with the dipole antennas D2/D1. We add 10dB, to the results obtained of the dynamic, to compensate the 10dB loss due to the attenuator present in the TX unit.

**Rod Antennas R1/R2/R2 W:**
the receiver and the transmitter are positioned at 60cm from each other and the R1/R2/R2 W antennas, fully extended, are connected respectively to the two units; the rod antenna is connected to a TX unit by interposing a 10 dB attenuator. The antennas are positioned so that they are on two vertical floors, absolutely parallel. The antenna connected to RX unit and the antenna connected to TX unit has the same distance from the plane where the two unit are positioned. When the system is properly positioned, the zeroing process is done; after the zeroing process a measurement is done, in unconnected mode removing the Bluetooth keys, with TX unit turned off, to verify the exactly dynamic of the system with the rod antennas R1/R2/R2 W. We add 10dB, to the results obtained of the dynamic, to compensate the 10dB loss due to the attenuator present in the TX unit.

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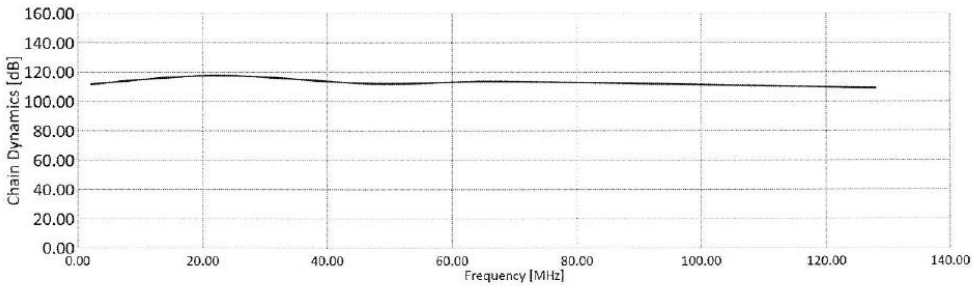
## HIGH FREQUENCY LOOP ANTENNAS (L1-P)

| Frequency [MHz] | Dynamics [dB] |
|---|---|
| 2.1000 | 111.7700 |
| 21.8400 | 117.6700 |
| 47.6700 | 112.2900 |
| 67.0900 | 113.7100 |
| 128.0000 | 109.1700 |



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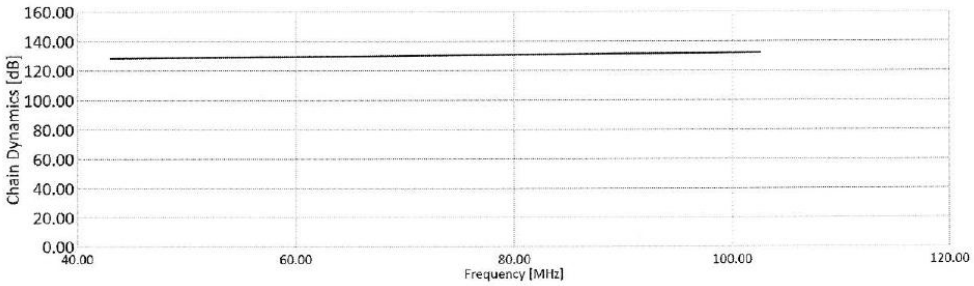
**DIPOLE ANTENNAS (D2)**

| Frequency [MHz] | Dynamics [dB] |
|---|---|
| 43.0000 | 128.3400 |
| 102.6200 | 132.1000 |



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## LINEARITY

The SEMS receiver uses a detector system that could suffer from linearity deviation.
The linearity test verifies the magnitude of error introduced by this deviation by having the kit measure different reference attenuators at different frequencies.
The following results shows, for each frequency and in absolute value, the worst point found.

| Frequency [MHz] | Worst Deviation [dB] |
|---|---|
| 0.0100 | 0.3000 |
| 0.0350 | 0.3000 |
| 0.1220 | 0.4000 |
| 0.4280 | 0.2000 |
| 1.5000 | 0.2000 |
| 5.2520 | 0.2000 |
| 18.3820 | 0.2000 |
| 64.3390 | 0.3000 |