ElectroMagnetic Field Measurements
EMF Option 444
Anritsu’s ElectroMagnetic Field (EMF) Measurements are designed to measure radiation compliance with various national standards for personal safety set by governmental regulatory authorities. Many countries have mandated EMF safety testing in areas where cellular or other high power transmission antennas are located. The EMF option is primarily targeted to both cellular operators and government regulators. Additionally, contractors and small service companies perform building inspections and field surveys to monitor radiation exposure intensities in areas situated near transmission antennas.

Anritsu’s EMF Measurements are designed to be easy to use, while providing the user with numerous automated features which will enable them to do their job quickly and more efficiently. ElectroMagnetic field measurements (EMF, Option 444) are available on the following Anritsu Spectrum Master™, Cell Master™ and LMR Master™ products: MS2711E, MS2712E, MS2713E, MS2720T, MT8212E, MT8213E and S412E. Firmware version 1.56 or later is required for the MS2711E/12E/13E and MT8212E/13E. For the MS2720T and S412E firmware version 1.12 or later is required.

EMF Option (444) provides the capability to measure electromagnetic field radiation when used in conjunction with an Anritsu isotropic antenna. Automated measurements can be taken using user-definable time intervals.

**EMF Measurements Key Features and Benefits**

- Limit lines that are user-settable at various power levels across the spectrum
- Limits can be saved for recall at a later time
- Axis dwell time is user-settable (time that each axis [X, Y, and Z] measures radiation before switching to next axis)
- Pass/Fail indicators on screen for immediate feedback on test results
- Automatic save feature for easy storage of measurement results to internal memory (auto-logging) or USB stick
- Results provided for maximum, minimum, average of all measurements conducted
- Clear display of measurement status, measurement time, number of measurements taken, and most other user settings
- Measurement time is user-configurable
- Pre-amp standard for measurements of low-level signals (optional for MS2711E)

Available field strength units include the following: (S412E Supports Spectrum Analyzer and LTE Modes ONLY)

- Spectrum Analyzer Mode: dBm/m², dBm/V/m, dBuV/m, V/m, W/m², dBW/m², A/m, dBA/m, W/cm²
- LTE and TD-LTE Mode: dBm/m², V/m, W/m²
- W-CDMA Mode: dBm/m², V/m, W/m², % of Limit (V/m), % of Limit (W/m²)

For wideband radiation measurements, the EMF option operates in Spectrum Analyzer mode. Total radiation from all sources can be measured over the frequency band desired. The EMF option will also conduct radiation measurements of demodulated signals in specific frequency bands. In this way, measurements can be extrapolated assuming a fully-loaded traffic channel in order to present a worst-case analysis. Option 444 will work with demodulated signals of the following types: (S412E Supports LTE ONLY)

- W-CDMA
- LTE
- TD-LTE

If the user desires to measure EMF with a demodulated signal, the appropriate demodulation option also will need to be purchased. Additionally, Option 9 (demodulation) will need to be purchased if not offered as standard with the Spectrum Analyzer being used.

Customers with Spectrum Analyzers purchased previously may upgrade their units with the EMF Option 444. If EMF demodulation measurements are required, the appropriate demodulation option will also need to be purchased and installed.
Isotropic Antenna

In order to conduct EMF measurements, an Anritsu isotropic antenna is required. Anritsu offers three isotropic antennas covering a frequency range from 9 kHz to 6 GHz. These antennas along with their corresponding frequency ranges are shown below.

- 9 kHz to 300 MHz  H-Field Isotropic Antenna (Anritsu part number: 2000-1800-R)
- 30 MHz to 3 GHz  E-Field Isotropic Antenna (Anritsu part number: 2000-1792-R)
- 700 MHz to 6 GHz  E-Field Isotropic Antenna (Anritsu part number: 2000-1791-R)

Each antenna contains a tri-axis sensor with an integrated RF switch device, microcontroller and memory. Each of the three sensors is situated orthogonally inside the antenna housing to transmit and receive a spherical radiation pattern. In this way, all radiation at the antenna’s geographical position is measured, regardless of direction of arrival.

The RF switch, microcontroller, and memory inside the antenna are controlled by firmware in the Spectrum Analyzer via a USB cable. The microcontroller operates the RF switch, controlling which probe is active. Once all three probes are switched, a composite RMS calculation is made. The memory inside the antenna is used to store parameters associated with that particular antenna. This includes serial number, date of compliance testing, antenna frequency range, and antenna factors.

Each isotropic antenna is characterized over its entire frequency range. The antenna factors are stored in the antenna’s memory and automatically downloaded into the Spectrum Analyzer once the antenna USB cable is inserted.
**EMF Measurements on Demodulated Signals**

Users may purchase the EMF option in order to make radiation power measurements in Spectrum Analyzer mode. These are power measurements for either narrowband or wideband field strength measurements across the frequency range of the Spectrum Analyzer and isotropic antenna being used. Additionally, EMF testing can be conducted on demodulated signals in various cellular channels. This includes the LTE, TD-LTE, and W-CDMA standards.

To measure demodulated W-CDMA signals, Option 35 is required for the MS2712E/13E and MT8212E/13E platforms. For MS2720T, Option 81 is required for W-CDMA. Option 9 is also required for the MS2712E/13E and MS2720T platforms for W-CDMA demodulation capability. The field strength of the pilot channel (P-CPICH) is measured for all such signals present. Results are then displayed for each individual scrambling code as well as for total power levels for all measurements combined. Additionally, the analog signal strength across the channel is measured and displayed for comparison. In order to present a “worst case” result, extrapolation factors can be automatically calculated and displayed where a fully loaded traffic channel is assumed.

![Sample Display of W-CDMA Measurement](image-url)
For LTE and TD-LTE, options 546 and 556 respectively are required for the MS2712E/13E and MT8212E/13E platforms. Option B3 is required for either LTE or TD-LTE on the MS2720T platform. Option 9 is also required for the MS2712E/13E and MS2720T platforms for LTE or TD-LTE demodulation capability. For LTE only, options 31 and 546 are required for the S412E. Primary Synchronization Signals (P-SS), Secondary Synchronization Signals (S-SS), and Reference Signals (RS) are measured and displayed based on each Cell ID received. In addition, the total radiation field resulting from all cell site signals combined is calculated and displayed. The analog signal strength across the channel is also measured and displayed for comparison. In order to present a “worst case” result, extrapolation factors can be automatically calculated and displayed where a fully loaded traffic channel is assumed. See the picture below for a sample display of an LTE EMF measurement. The display for the TD-LTE EMF measurement is identical.
Isotropic Antenna Specifications
The 2000-1800-R isotropic antenna is a tri-axis H-Field sensor with an integrated RF switch. The RF switch is controlled by the analyzer via a USB port.

Each antenna comes with a Certificate of Compliance and supporting test data.

**Electrical Characteristics (2000-1800-R)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000-1800-R</td>
<td>H-Field sensor</td>
</tr>
<tr>
<td>Sensor Type</td>
<td>Three Axis sensor with scanned axes</td>
</tr>
<tr>
<td>Frequency Range</td>
<td>9 kHz to 300 MHz</td>
</tr>
<tr>
<td>1 dB Compression Point at Output</td>
<td>118 dBµV typical</td>
</tr>
<tr>
<td>Decoupling of the axis</td>
<td>&gt; 20 dB typical</td>
</tr>
<tr>
<td>VSWR</td>
<td>&lt; 1.5 (20 kHz - 50 MHz) typical</td>
</tr>
<tr>
<td>RF Connector</td>
<td>N-Connector Male, 50 Ω</td>
</tr>
<tr>
<td>Supply and Control</td>
<td>USB</td>
</tr>
</tbody>
</table>

![VSWR at N-Connector](image1.png)

![Electric Antenna Factor](image2.png)

VSWR (typical)

Antenna Factors (typical)

![Magnetic Antenna Factor](image3.png)

Magnetic Antenna Factor (typical)
**ElectroMagnetic Field Measurements**

**Mechanical Characteristics (2000-1800-R)**

| Color          | Body: B-39047 “Light Grey”  
|                | Handle: “Black”              |
| Weight         | 850 g                       |
| Environmental Conditions | -10 °C to +50 °C, IP54       |
| Mechanical compliancy | Operating: 7M3 (IEC 60721-3) |
| Dimensions     | 550 mm x 146 mm             |
Isotropic Antenna Specifications
The 2000-1792-R isotropic antenna is a tri-axis E-Field sensor with an integrated RF switch. The RF switch is controlled by the analyzer via a USB port.
Each antenna comes with a Certificate of Compliance and supporting test data.

Electrical Characteristics (2000-1792-R)

<table>
<thead>
<tr>
<th></th>
<th>2000-1792-R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor Type</td>
<td>E-Field sensor</td>
</tr>
<tr>
<td>Frequency Range</td>
<td>30 MHz to 3 GHz</td>
</tr>
</tbody>
</table>
| Typical 3D Isotropy      | $< \pm 1.5 \text{ dB} \ (300 \text{ MHz to } 1 \text{ GHz})$
                          | $< \pm 2.3 \text{ dB} \ (1 \text{ GHz to } 3 \text{ GHz})$ |
| Dynamic Range (with 1 kHz RBW) | 0.1 mV/m to 200 V/m (Typ)                      |
                          | 25 µV at 900 MHz                                 |
                          | 35 µV at 1800 MHz                                |
                          | 50 µV at 3000 MHz                                |
| Maximum Field Strength   | 500 V/m (destruction limit)                      |
| Switching Time           | $< 10 \mu\text{s}$                               |
| RF Connector             | N-Connector Male, 50 Ω                           |
| Supply and Control       | USB                                              |

VSWR (typical)

Antenna Factors (typical)
ElectroMagnetic Field Measurements

**Mechanical Characteristics (2000-1792-R)**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radome Material</td>
<td>ABS</td>
</tr>
<tr>
<td>Color</td>
<td>Body: B-39047 “Light Grey”</td>
</tr>
<tr>
<td></td>
<td>Handle: B-39042 “Dark Grey”</td>
</tr>
<tr>
<td>Weight</td>
<td>800 g</td>
</tr>
<tr>
<td>Climatic compliancy</td>
<td>Operating: 7K3 (IEC 60721-3)</td>
</tr>
<tr>
<td>Mechanical compliancy</td>
<td>Operating: 7M3 (IEC 60792-3)</td>
</tr>
<tr>
<td>Temperature Range (operating)</td>
<td>–25 °C, +70 °C</td>
</tr>
<tr>
<td>Humidity</td>
<td>100 % at +40 °C for up to 96 hours</td>
</tr>
<tr>
<td>Dimensions</td>
<td>Maximum Length: 450 mm ± 5 mm (with connector)</td>
</tr>
<tr>
<td></td>
<td>Maximum Width: 150 mm ± 1 mm</td>
</tr>
</tbody>
</table>

N-Connector Male, 50 Ω
Isotropic Antenna Specifications

The 2000-1791-R isotropic antenna is a tri-axis E-Field sensor with an integrated RF switch. The RF switch is controlled by the analyzer via a USB port.

Each antenna comes with a Certificate of Compliance and supporting test data.

Electrical Characteristics (2000-1791-R)

<table>
<thead>
<tr>
<th>2000-1791-R</th>
<th>E-Field sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor Type</td>
<td>Three Axis sensor with scanned axes</td>
</tr>
<tr>
<td>Frequency Range</td>
<td>700 MHz to 6 GHz</td>
</tr>
</tbody>
</table>
| Typical 3D Isotropy | \( \leq \pm 2 \text{ dB (0.7 GHz to 2 GHz)} \)
| | \( \leq \pm 2.5 \text{ dB (2 GHz to 3.6 GHz)} \)
| | \( \leq \pm 3.5 \text{ dB (3.6 GHz to 6 GHz)} \)
| Dynamic Range | 0.2 mV/m to 200 V/m (typical) |
| Maximum Field Strength | 500 V/m (destruction limit) |
| Switching Time | \(< 10 \mu\text{s}\) |
| RF Connector | N-Connector Male, 50 Ω |
| Supply and Control | USB |

VSWR (typical)  
Antenna Factors (typical)
# Mechanical Characteristics (2000-1791-R)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radome Material</td>
<td>ABS</td>
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<tr>
<td>Color</td>
<td>Body: B-39047 “Light Grey”</td>
</tr>
<tr>
<td></td>
<td>Handle: B-39042 “Dark Grey”</td>
</tr>
<tr>
<td>Weight</td>
<td>450 g</td>
</tr>
<tr>
<td>Climatic compliancy</td>
<td>Operating: 7K3 (IEC 60721-3)</td>
</tr>
<tr>
<td>Mechanical compliancy</td>
<td>Operating: 7M3 (IEC 60792-3)</td>
</tr>
<tr>
<td>Temperature Range (operating)</td>
<td>–25 °C, +70 °C</td>
</tr>
<tr>
<td>Humidity</td>
<td>100 % at +40 °C for up to 96 hours</td>
</tr>
<tr>
<td>Dimensions</td>
<td>Maximum Length</td>
</tr>
<tr>
<td></td>
<td>Maximum Width</td>
</tr>
<tr>
<td></td>
<td>320 mm ± 5 mm (with connector)</td>
</tr>
<tr>
<td></td>
<td>87 mm ± 1 mm</td>
</tr>
</tbody>
</table>

N-Connector Male, 50 Ω
### Required Instrument Options and Accessories

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS2711E-0444</td>
<td>EMF Option 444 for MS2711E</td>
</tr>
<tr>
<td>MS2712E-0444</td>
<td>EMF Option 444 for MS2712E</td>
</tr>
<tr>
<td>MS2713E-0444</td>
<td>EMF Option 444 for MS2713E</td>
</tr>
<tr>
<td>MS2720T-0444</td>
<td>EMF Option 444 for MS2720T</td>
</tr>
<tr>
<td>MTB212E-0444</td>
<td>EMF Option 444 for MTB212E</td>
</tr>
<tr>
<td>MTB213E-0444</td>
<td>EMF Option 444 for MTB213E</td>
</tr>
<tr>
<td>S412E-0444</td>
<td>EMF Option 444 for S412E</td>
</tr>
<tr>
<td>2000-1800-R</td>
<td>Isotropic Antenna, 9 kHz to 300 MHz, N Connector (male), 50 Ω</td>
</tr>
<tr>
<td>2000-1792-R</td>
<td>Isotropic Antenna, 30 MHz to 3 GHz, N Connector (male), 50 Ω</td>
</tr>
<tr>
<td>2000-1791-R</td>
<td>Isotropic Antenna, 700 MHz to 6 GHz N Connector (male), 50 Ω</td>
</tr>
<tr>
<td>200-1528-R</td>
<td>GPS Antenna, SMA(m) with 15 ft cable</td>
</tr>
</tbody>
</table>

### Related Instrument Options

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS2712E-0009</td>
<td>20 MHz Bandwidth Demodulation for MS2712E</td>
</tr>
<tr>
<td>MS2713E-0009</td>
<td>20 MHz Bandwidth Demodulation for MS2713E</td>
</tr>
<tr>
<td>MS2720T-0009</td>
<td>20 MHz Bandwidth Demodulation for MS2720T</td>
</tr>
<tr>
<td>MS2712E-0035</td>
<td>W-CDMA OTA Measurements for MS2712E*</td>
</tr>
<tr>
<td>MS2713E-0035</td>
<td>W-CDMA OTA Measurements for MS2713E*</td>
</tr>
<tr>
<td>MS2720T-0081</td>
<td>W-CDMA OTA Measurements for MS2720T*</td>
</tr>
<tr>
<td>MTB212E-0035</td>
<td>W-CDMA OTA Measurements for MTB212E</td>
</tr>
<tr>
<td>MTB213E-0035</td>
<td>W-CDMA OTA Measurements for MTB213E</td>
</tr>
<tr>
<td>MS2712E-0546</td>
<td>LTE OTA Measurements for MS2712E*</td>
</tr>
<tr>
<td>MS2713E-0546</td>
<td>LTE OTA Measurements for MS2713E*</td>
</tr>
<tr>
<td>MS2720T-0546</td>
<td>LTE OTA Measurements for MS2720T*</td>
</tr>
<tr>
<td>MTB212E-0546</td>
<td>LTE OTA Measurements for MTB212E</td>
</tr>
<tr>
<td>MTB213E-0546</td>
<td>LTE OTA Measurements for MTB213E</td>
</tr>
<tr>
<td>MS2712E-0556</td>
<td>TD-LTE OTA Measurements for MS2712E*</td>
</tr>
<tr>
<td>MS2713E-0556</td>
<td>TD-LTE OTA Measurements for MS2713E*</td>
</tr>
<tr>
<td>MS2720T-0883</td>
<td>TD-LTE OTA Measurements for MS2720T*</td>
</tr>
<tr>
<td>MTB212E-0556</td>
<td>TD-LTE OTA Measurements for MTB212E</td>
</tr>
<tr>
<td>MTB213E-0556</td>
<td>TD-LTE OTA Measurements for MTB213E</td>
</tr>
<tr>
<td>S412E-0006</td>
<td>6 GHz Coverage for S412E Spectrum Analyzer</td>
</tr>
<tr>
<td>S412E-0031</td>
<td>GPS Receiver for S412E (Requires suitable GPS Antenna)</td>
</tr>
<tr>
<td>S412E-0546</td>
<td>LTE OTA Measurement for S412E (Requires Option 31)</td>
</tr>
</tbody>
</table>

*requires Option 9, 20 MHz Bandwidth Demodulation
• United States
Anritsu Company
1155 East Collins Boulevard, Suite 100,
Richardson, TX, 75081 U.S.A.
Toll Free: 1-800-267-4878
Phone: +1-972-644-1777
Fax: +1-972-671-1877

• Canada
Anritsu Electronics Ltd.
700 Silver Seven Road, Suite 120,
Kanata, Ontario K2V 1C3, Canada
Phone: +1-613-591-2003
Fax: +1-613-591-1006

• Brazil
Anritsu Electrônica Ltda.
Prãa Amadeu Amaral, 27 – 1 Andar
01327-010 - Bela Vista - Sao Paulo - SP - Brazil
Phone: +55-11-3283-2511
Fax: +55-11-3288-6940

• United States
Anritsu Company
1155 East Collins Boulevard, Suite 100,
Richardson, TX, 75081 U.S.A.
Toll Free: 1-800-267-4878
Phone: +1-972-644-1777
Fax: +1-972-671-1877

• Canada
Anritsu Electronics Ltd.
700 Silver Seven Road, Suite 120,
Kanata, Ontario K2V 1C3, Canada
Phone: +1-613-591-2003
Fax: +1-613-591-1006

• Brazil
Anritsu Electrônica Ltda.
Prãa Amadeu Amaral, 27 – 1 Andar
01327-010 - Bela Vista - Sao Paulo - SP - Brazil
Phone: +55-11-3283-2511
Fax: +55-11-3288-6940

• Mexico
Anritsu Company, S.A. de C.V.
Av. Ejercito Nacional No. 579 Piso 9, Col. Granada
11520 México, D.F., México
Phone: +52-55-1101-2370
Fax: +55-55-2524-3147

• United Kingdom
Anritsu EMEA Ltd.
200 Capability Green, Luton, Bedfordshire LU1 3LU, U.K.
Phone: +44-1582-433280
Fax: +44-1582-731303

• France
Anritsu S.A.
12 avenue du Quã©bec, Batiment Iris 1-Silic 612,
91140 Vélizy-Villacoublay, France
Phone: +33-1-60-92-15-50
Fax: +33-1-64-46-10-65

• Germany
Anritsu GmbH
Nemetschek Haus, Konrad-Zuse-Platz 1
81829 Mûnchen, Germany
Phone: +49-89-442308-0
Fax: +49-89-442308-55

• Italy
Anritsu S.r.l.
Via Elio Vittorini 129, 00144 Roma Italy
Phone: +39-06-509-9711
Fax: +39-06-502-2425

• Sweden
Anritsu AB
Kistagångén 20B, 164 40 KISTA, Sweden
Phone: +46-8-534-707-00
Fax: +46-8-534-707-30

• Finland
Anritsu AB
Teknobulevardi 3-5, FI-01530 VANTAA, Finland
Phone: +358-20-741-8100
Fax: +358-20-741-8111

• Denmark
Anritsu A/S
Kay Fiskers Plads 9, 2300 Copenhagen S, Denmark
Phone: +45-7211-2200
Fax: +45-7211-2210

• Russia
Anritsu EMEA Ltd.
Representation Office in Russia
Tverskaya str. 16/2, bl 1. 7th floor.
Moscow, 125009, Russia
Phone: +7-495-363-1694
Fax: +7-495-935-8962

• Spain
Anritsu EMEA Ltd.
Representation Office in Spain
Edificio Cuzco IV, Pº. de la Castellana, 141, Pta. 8
28046, Madrid, Spain
Phone: +34-915-726-761
Fax: +34-915-726-621

• United Arab Emirates
Anritsu EMEA Ltd.
Dubai Liaison Office
P O Box 500413 - Dubai Internet City
Al Thuraya Building, Tower 1, Suite 701, 7th floor
Dubai, United Arab Emirates
Phone: +971-4-3670352
Fax: +971-4-3688460

• India
Anritsu India Pvt Ltd.
2nd & 3rd Floor, #837/1, Binnamangla 1st Stage,
Indiranagar, 100ft Road, Bangalore - 560038, India
Phone: +91-80-4058-1300
Fax: +91-80-4058-1301

• Singapore
Anritsu Pte. Ltd.
11 Chang Charn Road, #04-01, Shirio House
Singapore 159640
Phone: +65-6282-2400
Fax: +65-6282-2533

• P. R. China (Shanghai)
Anritsu (China) Co., Ltd.
27th Floor, Tower A,
New Caohejing International Business Center
No. 391 Gui Ping Road Shanghai, Xu Hui Di District,
Shanghai 200233, P.R. China
Phone: +86-21-6237-0898
Fax: +86-21-6237-0899

• P. R. China (Hong Kong)
Anritsu Company Ltd.
Unit 1006-7, 10/F., Greenfield Tower, Concordia Plaza,
No. 1 Science Museum Road, Tsim Sha Tsui East,
Kowloon, Hong Kong, P. R. China
Phone: +852-2301-4980
Fax: +852-2301-3545

• Japan
Anritsu Corporation
8-5, Tamura-cho, Atsugi-shi,
Kanagawa, 243-0016 Japan
Phone: +81-46-296-6509
Fax: +81-46-225-8359

• Korea
Anritsu Corporation, Ltd.
5FL, 235 Pangyoyeok-ro, Bundang-gu, Seongnam-si,
Gyeonggi-do, 463-400 Korea
Phone: +82-31-696-8771
Fax: +82-31-696-8771

• Australia
Anritsu Pty Ltd.
Unit 21/270 Ferntree Gully Road,
Notting Hill, Victoria 3168, Australia
Phone: +61-3-9558-8177
Fax: +61-3-9558-8255

• Taiwan
Anritsu Company Inc.
7F, No. 316, Sec. 1, Neihu Rd., Taipei 114, Taiwan
Phone: +886-2-8751-1816
Fax: +886-2-8751-1817

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