Application Note

Anritsu
envision : ensure

Anritsu ElectroMagnetic Field (EMF) Measurement System

Introduction

Anritsu's ElectroMagnetic Field (EMF) Measurement System is designed to measure radiation compliance with various national and international standards for personal safety set by governmental regulatory authorities, see figure 1. This application note will outline optimal methods for setting up the Anritsu EMF system (option 444), taking measurements and insuring compliance with various radiation standards.

The EMF system employs several types of measurements. These include broadband "spectrum analyzer" modes where total field strength is measured across the frequency band of interest. Additionally, demodulated measurements for LTE, TD-LTE and W-CDMA signals can be measured for health and safety impact. The advantage of performing demodulated measurements is the ability to extrapolate the measurements to assume a fully loaded channel. This provides the ability to take EMF measurements assuming a "worst case" scenario.

Figure 1. Technician conducting EMF measurements at cell site

EMF Measurement System Setup

There are two overall steps to complete for instrument setup. These include setting the timing parameters of the measurement as well as the instrument setup.

Instrument Setup – Limit Lines

In setting up the instrument to perform EMF testing, there are only two parameters to address: limit lines and units. The EMF system preforms radiation testing, logging the results periodically during the measurement. If pass/fail notifications are required, limit lines need to be set up across the frequency band. In many cases for broadband measurements, these limit lines will change according to frequency (see figure 2). Even though both upper and lower limit lines can be used, in most cases upper limits are required for EMF. The user can also save limit lines to memory for reuse at a later time. Anritsu also provides an ICNIRP limit which can automatically be implemented. ICNIRP (International Commission on Non-Ionizing Radiation Protection) is an international body which provides guidance to government regulators for radiation protection.

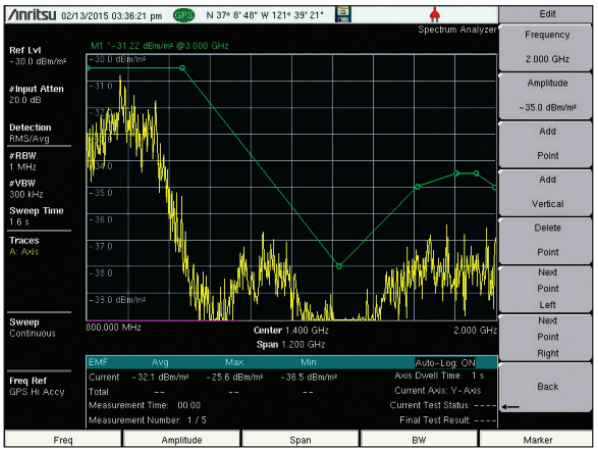

Figure 2. Wideband EMF measurement with limit line

Instrument Setup – Units

Units of measurements are usually specified by regulators for comparisons to the standard. In most cases either V/m or dBm/m^2 can be used. If the incorrect units are used in any measurement, they can be easily corrected on the saved log files using mathematical formulas to translate one unit to another.

Instrument Setup – Spectrum Analyzer Parameters

Other parameters that need to be considered include the following.

- Frequency – Set Start/Stop frequencies for band of interest
- Preamp – If so equipped in the spectrum analyzer, turning on the preamplifier can be helpful in viewing low level signals
- Reference Level – Set automatically by the EMF system firmware. However, user may want to adjust as needed.
- Attenuation – Generally set to off, given low-level signals typically being measured

Timing

Timing parameters are listed under the 'Automated Measurements' menu in the EMF system. The first timing issue to address is axis dwell time. Isotropic antennas are actually three antennas in one, each antenna pointed in a different direction to measure the total field strength coming from all directions. Dwell time refers to the length of time each antenna is active, before switching to the next antenna. After all three antennas conduct measurements, an RMS value is calculated to provide total field strength for that measurement. See figure 3 for Antenna Configuration illustration. By default, axis dwell time is set at one second.

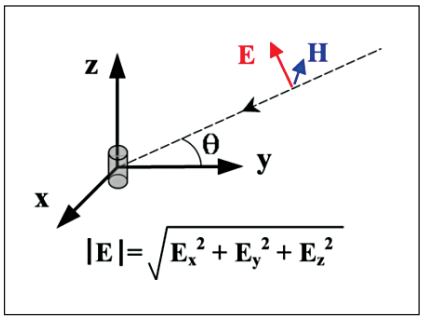

Figure 3. Antenna Configuration. Total measurement given by formula shown

The second timing parameter refers to the measurement itself. To adhere to international standards, measurement times are broken down into smaller time periods. Typically, each measurement "block" is set to six minutes. If the average value of radiation violates the limit over the block period, the test is considered a 'Fail'. Depending on the amount of testing required, a series of blocks will be measured as part of the overall EMF test. To set up a 3 hour test using 6 minute measurement blocks, set the 'Measurement Time' to 6 and the 'Number of Measurements' to 30.

Conducting the EMF Measurement

There are various methods for conducting EMF measurements, some of which are specified by government regulatory authorities. Some basic criteria include the following.

- Be sure to turn off any wireless devices such as smartphones, WiFi or other devices that may emit radiation.
- Do not keep any metal objects near the antenna. This includes laptops, rings or other metallic objects.
- Hold the antenna and instrument in an upright position. It is also advisable to hold the instrument/antenna at a height of 1.8 meters (6 feet) as part of the measurement. 1.8 meters (6 feet) is typically the height of a person's head standing in an upright position. To facilitate measurements in a practical way, the user may choose to use a wooden tripod. The tripod should be wooden to avoid interference with the measurement.
- Typically, measurements are taken at 10-12 locations surrounding the transmitter. This helps to insure an accurate assessment of the radiation field.

Given the problems of multi-path, it is advisable to take measurements in at least several locations surrounding the periphery of the transmitter. In this way you may be able to locate “hot spots” or areas where the radiation occurs at particularly high levels. The area to be covered for your measurements would typically be as close as a person would be allowed to stand in the vicinity of a transmitter. For example, certain transmitters may be fenced off or located in areas inaccessible to most people. These areas would not require testing to the limits set for the general population.

The ICNIRP specifies two limits for radiation safety. This includes limits for the general population and those whose occupation includes working in close proximity to transmitters. For this case, limit lines for radiation are higher. See figure 4 for radiation thresholds set by the ICNIRP.

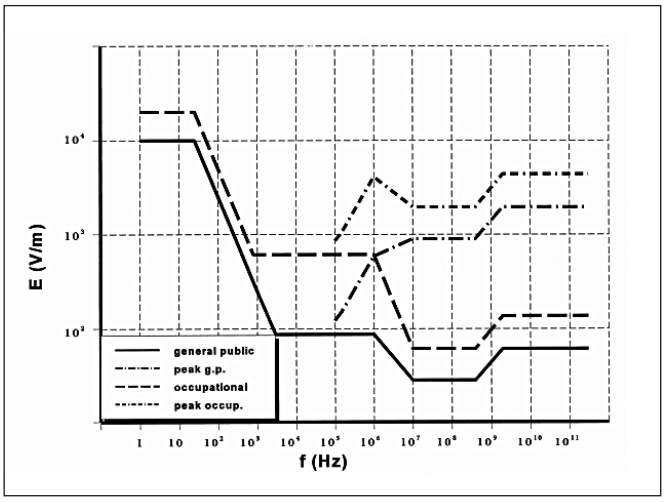

Figure 4. ICNIRP reference levels for EMF exposure

Results

Screenshots for measurements in spectrum analyzer mode (wideband), LTE and W-CDMA are shown below in Figures 5, 6, and 7.

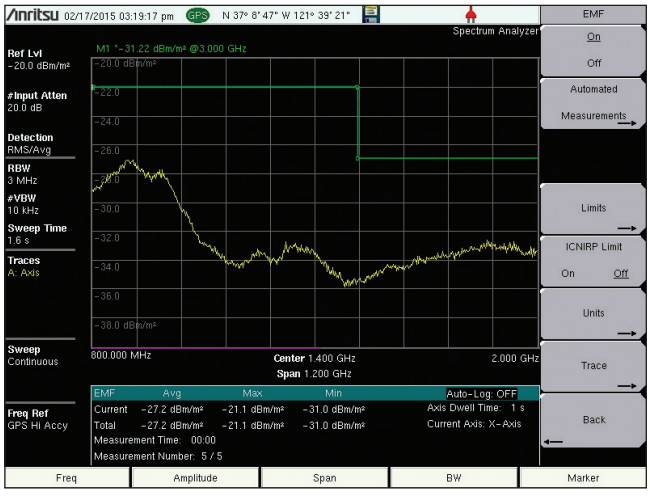

Figure 5. EMF result display in spectrum analyzer mode (broadband field strength measurements)

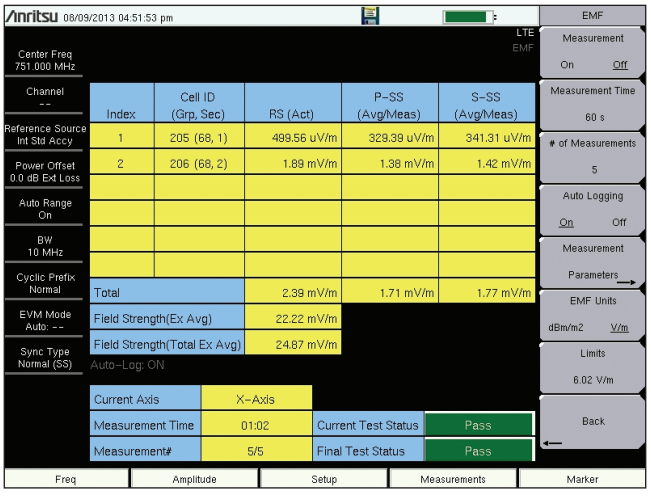

Figure 6. EMF result display for W-CDMA measurements

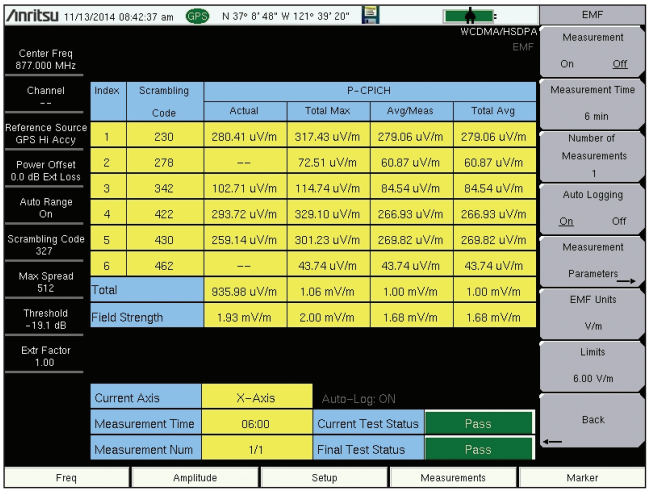

Figure 7. EMF result display for LTE measurements (similar to TD-LTE)

Displayed Measurements

The user has the option for displaying measurement parameters in a variety of formats. These include the following:

- Actual – Current measurement displayed at the time measurement is conducted
- Total Min – The minimum value taken over a measurement period
- Total Max – The maximum value taken over a measurement period
- Avg/Meas – The average value of the measurement parameter for a given measurement period
- Total Avg – The "average of averages". Each measurement period is averaged. The Total Avg calculates the average value for all measurement periods.

Extrapolation Factor

For EMF demodulated measurements (W-CDMA, LTE, TD-LTE), an extrapolation factor calculation can be engaged. This enables the analyzer to calculate the "worst case" scenario for radiation measurements by assuming that the traffic channels are fully loaded. Calculations are made and displayed based on this worst case analysis.

Pass/Fail

The limit check is done at the end of a measurement period. The limit line, if selected, is applied against the Avg trace. At the end of the measurement time and if the trace exceeds the selected limit, a fail is recorded. The Current Test Status on the screen is updated to FAIL. The Final Test Result is also updated to FAIL. If the Average Isotropic Result does not cross the limit line, the Current Test Status is updated to PASS. If all measurements pass, the Final Test Result is updated to PASS.

EMF measurement data is automatically stored in the instrument’s memory. Data is saved in CSV format, suitable for post-processing in Excel™ or other spreadsheet utility. Saved data includes all measurements taken as a function of frequency, demodulation parameters (for W-CDMA, LTE and TD-LTE), GPS positioning (when GPS is used), and Pass/Fail characteristics measured against limit lines set by the user.

The Anritsu EMF system is designed to be fully automated and simple to use. Most measurements are easily accessible under two menus. The display also features continual updates of measurement status, with Pass/Fail indicators indicating the success (or failure) of testing in real-time.

Notes

Notes

Notes

Anritsu envision : ensure

• 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.
Praça Amadeu Amaral, 27 - 1 Andar
01327-010 - Bela Vista - São Paulo - SP - Brazil
Phone: +55-11-3283-2511
Fax: +55-11-3288-6940

• Mexico
Anritsu Company, S.A. de C.V.
Av. Ejército Nacional No. 579 Piso 9, Col. Granada
11520 México, D.F., México
Phone: +52-55-1101-2370
Fax: +52-55-5254-3147

• 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 Québec, Bâtiment Iris 1-Silic 612,
91140 Villebon-sur-Yvette, 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 München, Germany
Phone: +49-89-442308-0
Fax: +49-89-442308-55

• Italy
Anritsu S.r.l.
Via Elio Vittorini 129 00144 Roma, Italy
Phone: +39-6-509-9711
Fax: +39-6-502-2425

• Sweden
Anritsu AB
Kistagången 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, bld. 1, 7th floor.
Russia, 125009, Moscow
Phone: +7-495-363-1694
Fax: +7-495-935-8962

• 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

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

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

• 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: +81-46-296-1221
Fax: +81-46-296-1238

• Korea
Anritsu Corporation, Ltd.
5FL, 235 Pangyoyeok-ro, Bundang-gu, Seongnam-si,
Gyeonggi-do, 463-400 Korea
Phone: +82-31-696-7750
Fax: +82-31-696-7751

• 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

Anritsu utilizes recycled paper and environmentally conscious inks and toner.

11410-00852, Rev. B Printed in United States 2015-03