

Application Note

VIAVI

OneAdvisor-800

EMF Signal Analysis

VIAVI OneAdvisor-800 is the ideal field test solution for radio access networks, performing comprehensive tests for an effective maintenance and optimization of cell sites.

The radios deployed in cell sites must comply with the electro-magnetic field (EMF) emissions according to thresholds defined by government agencies and regulators responsible for public health and safety.

There are two main test methodologies to measure EMF in cell sites:

- Spectrum-based: measures all the power in the band where the signal of interest is transmitted.
- Beam-based: measures the power of 5G-NR beams and performs a power extrapolation to assess the total emission of 5G-NR radios.



OneAdvisor-800 EMF Analysis
(Spectrum and Beam)

Benefits of OneAdvisor-800 EMF Spectrum Analyzer

- Selectable spectrum or integrated power measurement modes
- Multi-trace analysis with average, maximum and minimum EMF power
- Configurable test time (1 to 60min)
- Automatic control of isotropic antenna

Benefits of OneAdvisor-800 EMF 5G-NR Analyzer

- Supports all 5G-NR numerologies
- Automatic beam search and PCI detection
- EMF power measurements per radio (PCI) including all possible beams in 5G-NR FR1
- Extrapolated EMF power assessment and power variation



OneAdvisor-800 EMF Analysis

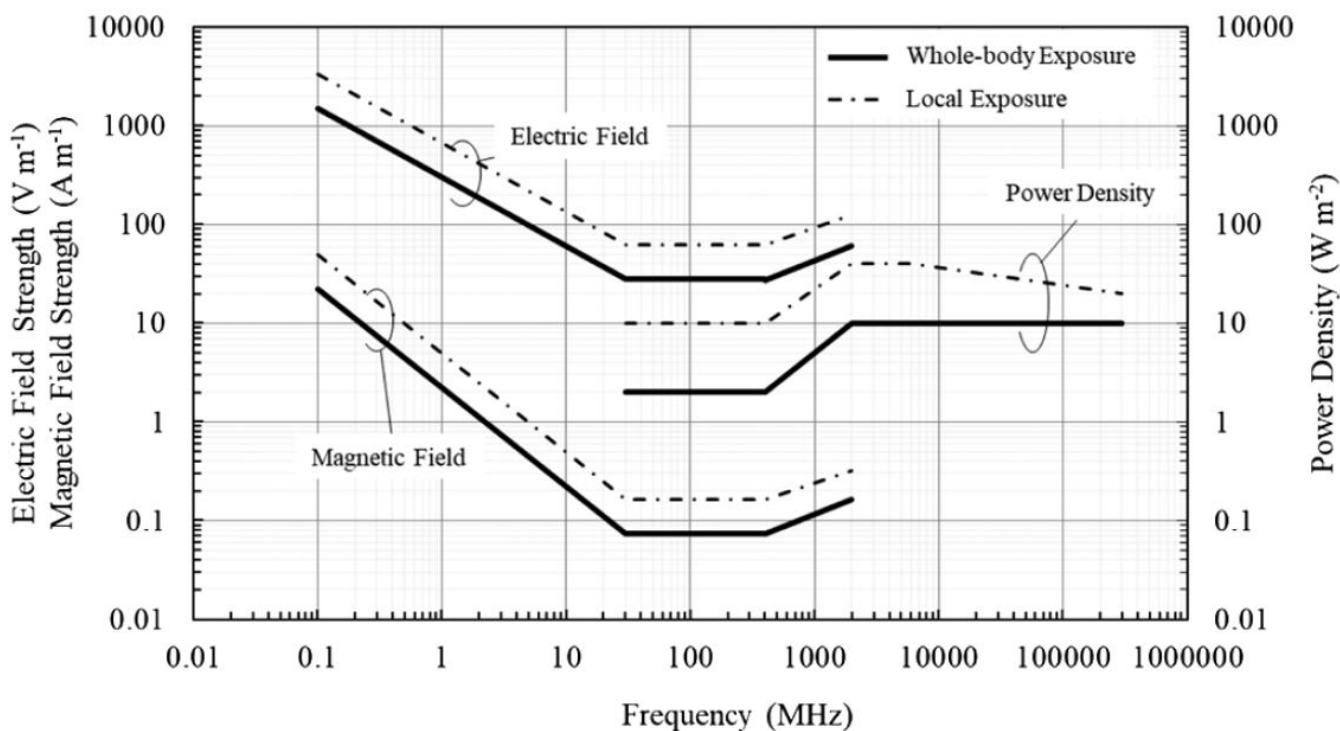
All-in-one 5G and LTE test solution offers the best total cost of ownership.

Radios in cell sites transmit electric and magnetic waves over the air, in the case of 5G-NR radios the frequency of those waves are classified in two different frequency ranges:

- Frequency range 1 (FR1): 410 MHz to 7,125 MHz
- Frequency range 2 (FR2): 25,250 MHz to 52,600 MHz

The radiation levels in those frequency ranges do not cause any molecular change (ionization), therefore it is referred as non-ionizing radiation, and is typically measured as the energy of the electromagnetic field (EMF) in a certain area or volts per meter (V/m); also, it can be represented as power density or power flow per unit area in terms of watts per square meter (W/m²).

Several organizations including the Institute of Electrical and Electronics Engineers (IEEE), and the International Commission on Non-Ionizing Radiation Protection (ICNIRP), have issued recommendations for human exposure to RF electromagnetic fields, which protect effects associated with heating.



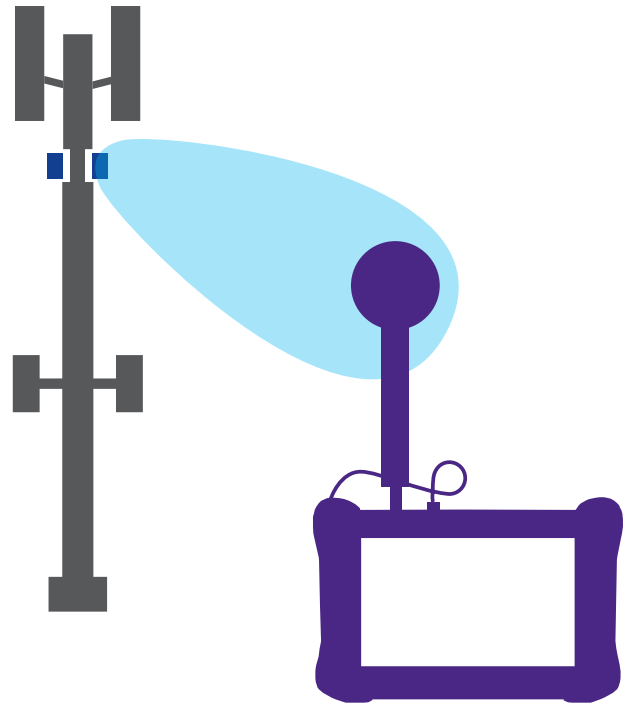
ICNIRP Levels for general public exposures (average time of ≥6 min, from 100 kHz to 300 GHz)

EMF Spectrum Analysis

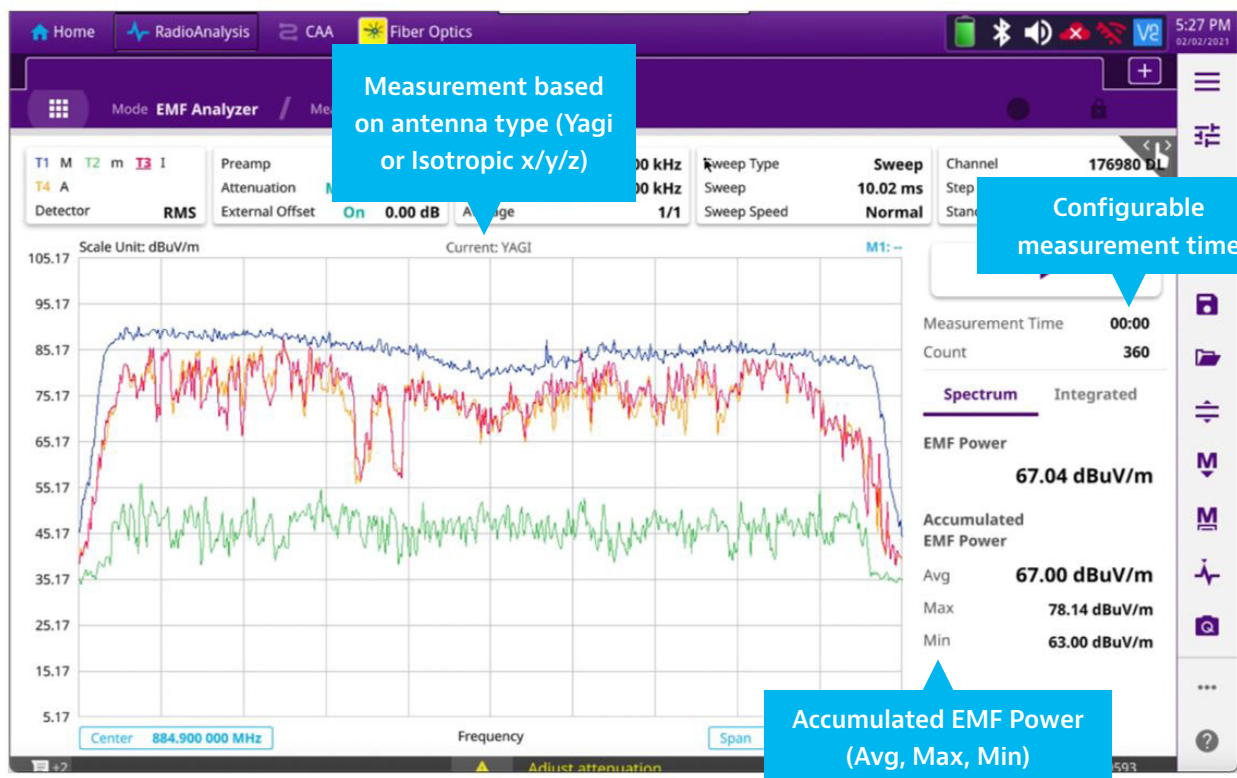
OneAdvisor-800 with EMF Spectrum Analysis measures all the radiation power in a defined frequency band, integrating all the power received in a configurable test time, from 1 to 60 minutes.

The EMF Spectrum Analysis is applicable for most RF signals, particularly for cellular signals with frequency division duplex (FDD).

EMF Spectrum Analysis can be conducted with an isotropic antenna, performing a 3-axis power measurement controlled by the OneAdvisor-800, or with a directional antenna.



OneAdvisor-800 EMF Spectrum Analysis



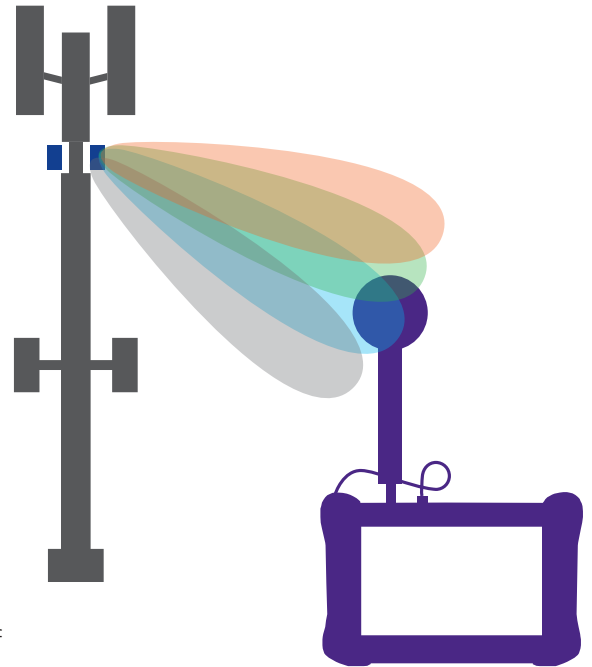
OneAdvisor-800 EMF Spectrum Analysis

EMF 5G-NR Signal Analysis

OneAdvisor-800 with EMF 5G-NR Signal Analysis measures all the radiation power in a defined frequency band, identifying the radio identity (PCI) and integrating all the power received from 5G-NR beams at a configurable test time, from 1 to 60 minutes.

OneAdvisor-800 EMF 5G-NR Signal Analysis is the most accurate methodology to test emissions from 5G-NR radios covering all possible numerologies defined by 3 GPP.

EMF Signal Analysis can be conducted with an isotropic antenna, performing a 3-axis power measurement controlled by the OneAdvisor-800, or a directional antenna.

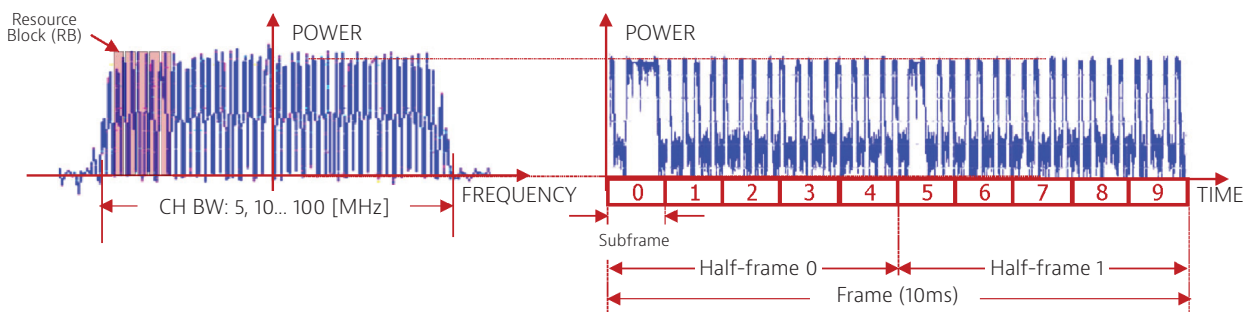


OneAdvisor-800 EMF 5G-NR Signal Analysis

5G Overview

5G New Radio (NR) has been defined to provide an improved set of services and applications, incorporating additional flexibility and functionality than LTE including the following:

- Channel bandwidth: flexibility for wider channel bandwidth configurations; for example, for frequency range 1 (FR1) defined by 3 GPP from 410 MHz to 7125 MHz the transmission bandwidth can have a range of 5 MHz to 100 MHz.
- OFDMA structure numerology: the signal frequency components or sub-carriers can be configured at different bandwidths including 15 KHz, 30 KHz, or 60 KHz with a corresponding multiplier in time to allocate the number of symbols per frame.
- Beamforming: ability to generate and shape multiple beams based on phase and amplitude to direct radiated power to the user's serving area.



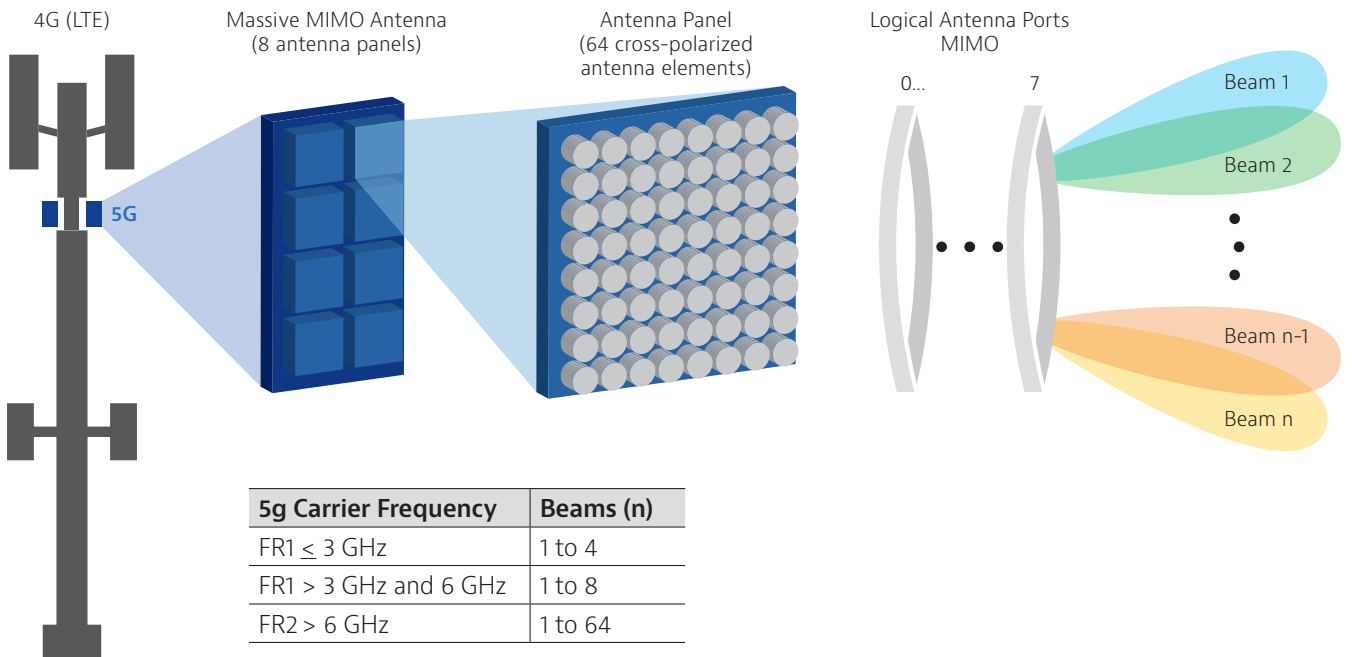
2FR1: 450 MHz TO 7.1 GHz (RB)														
μ	Δf	5	10	15	20	25	30	40	50	60	70	80	90	100
0	15	25	52	79	106	133	160	216	270					
1	30	11	24	38	51	65	78	106	133	162	189	217	245	273
2	60		11	18	24	31	38	51	65	79	93	107	121	135

FR2: 24.25 GHz to 52.6 GHz (RB)					
μ	Δf	50	100	200	400
2	60	66	132	264	
3	120	32	66	132	264

5G-NR Signal Data Structure and Numerology

5G-NR Beamforming

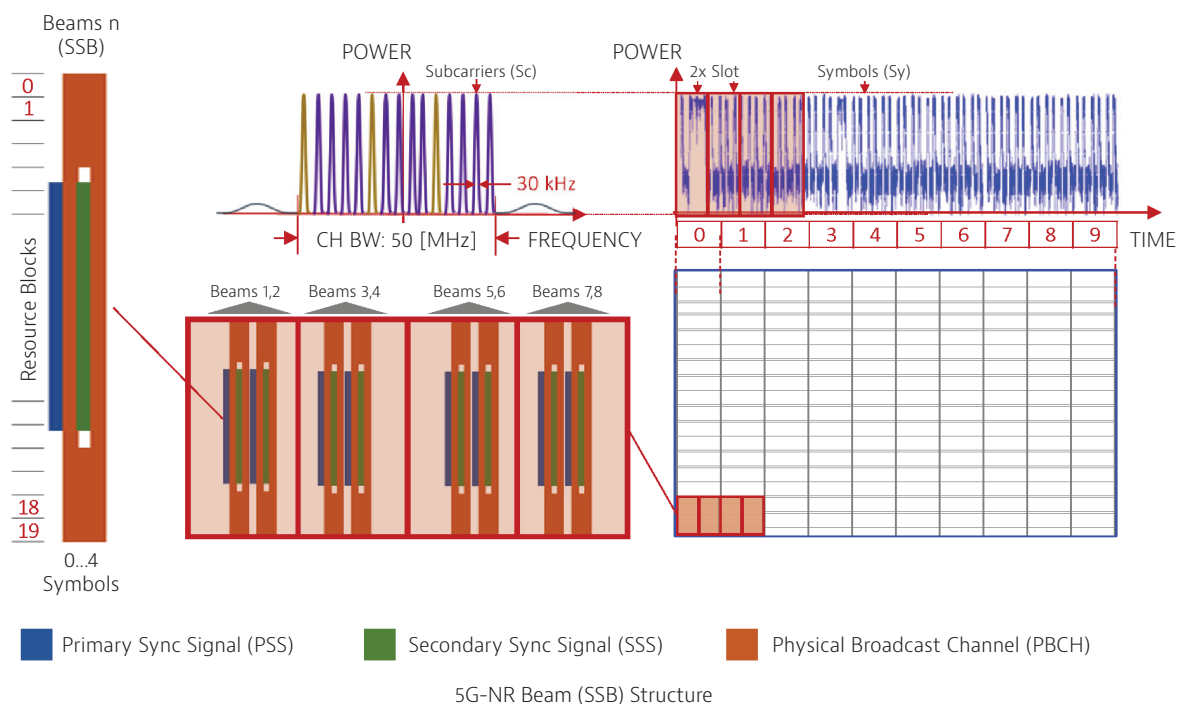
Beamforming is a distinctive property of 5G-NR with which multiple beams can be transmitted to user's equipment (UE) either mobile phones or customer premise equipment, to increase bandwidth and it is possible by increasing the number of antenna elements in the cell.



5G Massive MIMO and Beamforming

5G-NR cells transmitting at frequencies below 7 GHz can be equipped with antennas containing a few tenths of antenna elements, limiting the number of beams that can be generated, 3 GPP has defined a maximum of 4 coverage beams for frequencies up to 3 GHz, and a maximum of 8 for frequencies up to 7 GHz.

As transmission frequency increases, antenna elements get smaller, therefore 5G-NR cells transmitting at frequencies above 24 GHz can be equipped with antennas containing several hundreds of antenna elements capable of transmitting up to 64 coverage beams.



5G-NR coverage beams or Synchronization Signal and PBCH block (SSB) contain the following information required for devices to connect to the cell:

- a. Primary Synchronization Signal (PSS)
- b. Secondary Synchronization Signal (SSS)
- c. Physical Broadcast Channel (PBCH)

The UE's initiates its cell attachment by performing a cell search of beams or SSB's from which it will acquire synchronization and obtain the physical cell identity (PCI).

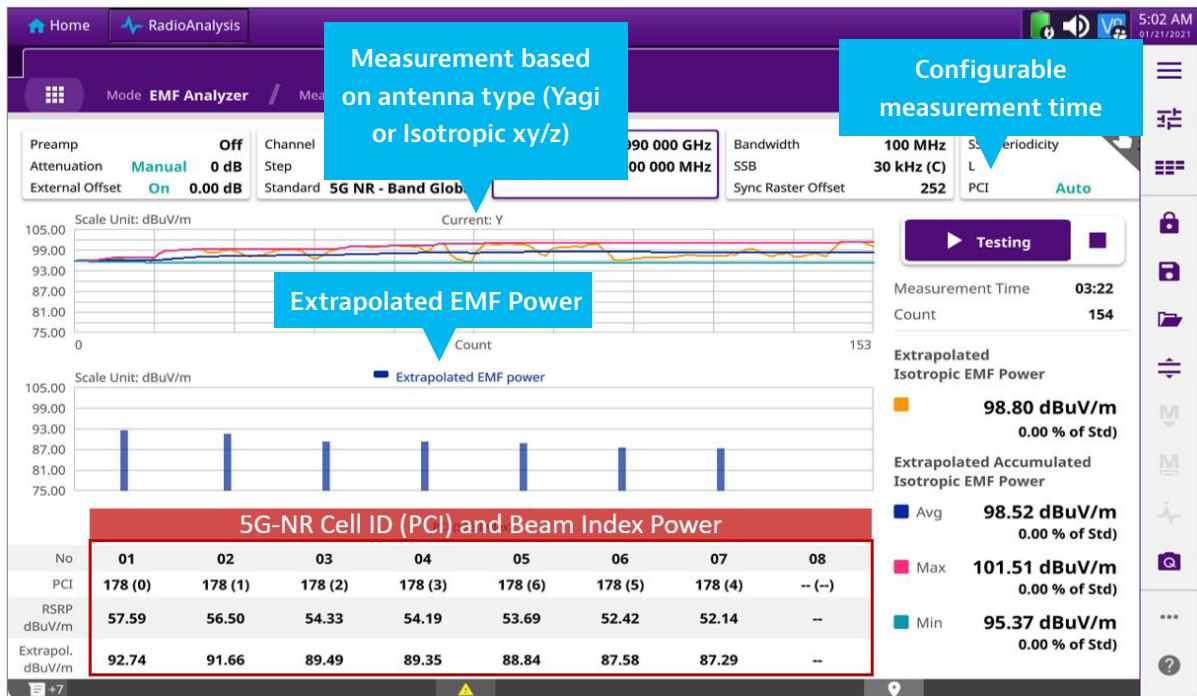
5G-NR EMF Signal Analysis

The flexibility of signal format provided by 5G-NR with different numerologies and beamforming makes EMF spectrum testing not viable to properly characterize the maximum level of EMF emissions, driving the need to perform 5G-NR signal analysis which demodulates the signal and obtains the physical cell identity (PCI), as well as the power level from all available beams. Individual beams are transmitted at a different time slots and might have a different power level, therefore it is required to measure the profile of each beam available and then extrapolate this power to obtain the total emitting power of a 5G-NR radio with traffic in all its resource blocks.

Therefore, the OneAdvisor-800 5G-NR EMF signal analysis has the ability to analyze the 5G-NR signal from every radio (PCI) transmitting and the power level and index of each of its corresponding beams. And obtains the effective exposure level (EEL) by applying an extrapolation factor that considers the signal's characteristics including:

- Transmitting cells (i)
- Electric field of a beam from a cell ($E_{base,i}$)
- Full carrier transmission factor (R_{FBW})
- Time allocation factor ($R_{Pattern}$)
- Beam system type factor (R_{System})
- Multipath channel factor ($\alpha(\tau,\Delta)$)

$$\text{Where, EEL (Vm}^{-1}\text{)} = \sum_{i=1}^N \sqrt{\alpha(\tau,\Delta) E_{base,i}^2 R_{FBW} R_{Pattern} R_{System}}$$



Isotropic Antenna Specification

Parameter	Description
Antenna type	Isotropic E field
Frequency range	400 MHz to 6 GHz
Frequency correction factors	Stored in EEPROM
Transducer type	Isotropic transducer with 3 orthogonal dipole antennas, with RF absorbing boom
Polarization	Linear, tri-axial polarization selection by means of internal electronic solid state RF switch
Axis selection	By PC via USB axis selection SDSW-03 interface
Linear dynamic range	0.2mV/m to 200 V/m (1dB compression point)
Sensitivity	<0.3 mV/m (depend of RBW and noise quality of spectrum analyzer)
Max applicable field strength	300 V/m
Linear dynamic range	Up to 200V/m (1dB compression point)
Isotropic error on rms total electric field	±1.5 from 400 MHz to 1500 MHz
	±2.0 from 1500 MHz to 2000 MHz
	±2.5 from 2000 MHz to 3500 MHz
	±3.5 from 3500 MHz to 6000 MHz
Dimension	Antenna radome ø130mm, total length 390mm
Antenna Weight	0.6 kg
RF connector	N type Male, 50Ω
Protection class	IP 45
Temperature range	-20°C to +55°C
Humidity	Max 95% at 40°C without condensation
Recommended calibration interval	2 years

Ordering Information

Part Number	
ONA800A-SPO-A	OneAdvisor-800A Spectrum Analyzer 9 KHz to 6 GHz with Optical Hardware (CPRI) <ul style="list-style-type: none">• Bluetooth, Wi-Fi, Smart Access Anywhere• GPS connectivity w/GPS antenna• Realtime Spectrum Analysis 100 MHz• Interference Analysis and Gates Sweep Spectrum• Spectrum Route Map• Mag mount RF omni antenna SMA (f) 600 MHz to 6 GHz• GPS SMA mount antenna• External battery charger, additional battery, and cigarette lighter adapter
ONA-SP-EMFSA	EMF Spectrum Analysis
ONA-SP-EMFNR	EMF 5G-NR Signal Analysis
G700050381	Isotropic antenna (400 MHz to 6 GHz)

References

- Federal Communications Commission (FCC) – Radio Frequency Safety (www.fcc.gov)
- IEEE C95–1; Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
- International Commission on Non-Ionizing Radiation Protection (ICNIPR) guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz)
- 3 GPP TS 38.104; 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; NR; Base Station (BS) radio transmission and reception (Release 16)

For more information, visit our [OneAdvisor-800](#) page.



Contact Us **+1 844 GO VIAVI**
(+1 844 468 4284)

To reach the VIAVI office nearest you,
visit viasolutions.com/contact



Emitec Messtechnik AG
Birkenstrasse 47
6343 Rotkreuz

+41 41 748 60 10
info@emitec.ch
www.emitec-industrial.ch



Emitec Group   
#1 in Test & Measurement, worldwide.