Over-the-air (OTA) testing fundamentals

Reactive near-field region

Radiated near-field region (requires phase and magnitude measurement)

Far-field region (requires magnitude measurement only)

The Fraunhofer distance describes the boundary between the near field and far field:

\[ R_{FF} = \frac{2D^2}{\lambda} \]

The Fraunhofer distance presents the best compromise between a compact test setup, acceptable phase deviation and measurable null.

Parameters to consider for quiet zone size and quality:

- Size of achievable quiet zone depends on the taper value.
- The ripple value impacts measurement accuracy.

Near-field measurements:

- The test setup for near-field measurements is compact, but measurements are complex, time-consuming and have higher uncertainty.

Far-field measurements:

- Far-field measurements are fast and simple and provide higher measurement reliability, but path loss is higher and the test setup becomes larger with increasing DUT size and higher frequencies.

How to perform far-field measurements at near-field distances:

- Software-based near-field to far-field transformation
- Hardware-based near-field to far-field transformation

Most compact OTA test solutions for antenna and device testing

www.rohde-schwarz.com/5G
Over-the-air (OTA) testing fundamentals

How to perform far-field measurements at near-field distances

10 GHz the specific absorption rate (SAR) is

Reactive near-field region

Software based near-field to far-field transformation

Aperture size $D$

Complex wave: phase and magnitude measurement

Fourier transform: software based

Planar

Near-field (E-field) surface measurement methods

Spherical

...on their time dependencies.

This method is generally not suitable for metrics such as EVM and ACLR due

$x, y = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} E_{x,y} e^{jkr} \cdot r \, dx \, dy$

Radiated near-field region (requires phase and magnitude measurement)

Far-field region (requires magnitude measurement only)

Near-field definitions

measurements are complex, time-consuming and have higher

The test setup for near-field measurements is compact, but

radiators with $D > \lambda/2$: $NF$

$DR$

Distance (m)

Antenna aperture size $D$ (cm)

951 21 17 13 25

39 GHz

28 GHz

Planar wave distribution – indirect far-field (IFF)

Hardware-based near-field to far-field transformation

Complex near-field wave generated

Planar wave distribution: hardware-based

Plane wave, far-field received

1.8 m

22

E-field

Quiet zone

Quiet zone

Quiet zone

DUT

DUT

Reflector: compact antenna test range (CATR)

Lens Reflector

Typical near-field measurements for device characterization

❙ Peak equivalent isotropic radiated power (EIRP)

❙ Total radiated power (TRP)

10

15

0

5

951 21 17 13 25

DUT

DUT

39 GHz

Reflector: plane wave converter (PWC) Fresnel lens (Fourier optics)

1.0 m

1.0 m

Fraunhofer distance (m)

Typical far-field measurements for device characterization

❙ Block error rate (BLER)

Power

❙ Error vector magnitude (EVM)

Typical far-field measurements for device characterization

2D$^2/$D$^2/$4D$^2/$8D$^2$/

$R_{FFmin} = ND^2/\lambda$

$\phi (R+d)$

$\phi (R)$

$d$

$\pm D/2$

$–D/2$

$+$

$–30 \text{ dB}$

$–20 \text{ dB}$

$N = 4$

$N = 2$

$N = 1$

For more information: