EMC Measurement Roundtable

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ERP/EIRP MEASUREMENTS

ERP/EIRP Measurements

- The guidance provided in KDB publication 412172 regarding determining ERP/EIRP assumes that the measurements were performed in the far field of the radiating antenna.
- This guidance may not be applicable in near field situations.

DTS MEASUREMENTS

DTS Measurements

- Two corrections to KDB 558074 regarding compliance measurements performed on DTS transmitters operating under the 15.247 rules.
  - Eliminate requirement 11.2(e) that the number of measurement points be ≥ span/RBW.
  - Clarify that 13.0 Band edge measurements are specific to measurements performed at a restricted band edge

MEDICAL BODY AREA NETWORKS

Medical Body Area Networks

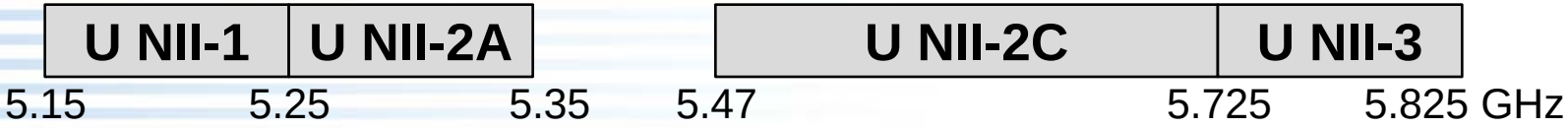
- Compliance measurement guidance for Medical Body Area Networks (MBANs) operating in the 2360-2400 MHz frequency bands is forthcoming.

UNII & 802.11 MEASUREMENTS

Clarification of U-NII Requirements in 802.11ac KDB # 644545 D01

"Guidance for IEEE 802.11ac and Pre-ac Device Emissions Testing"

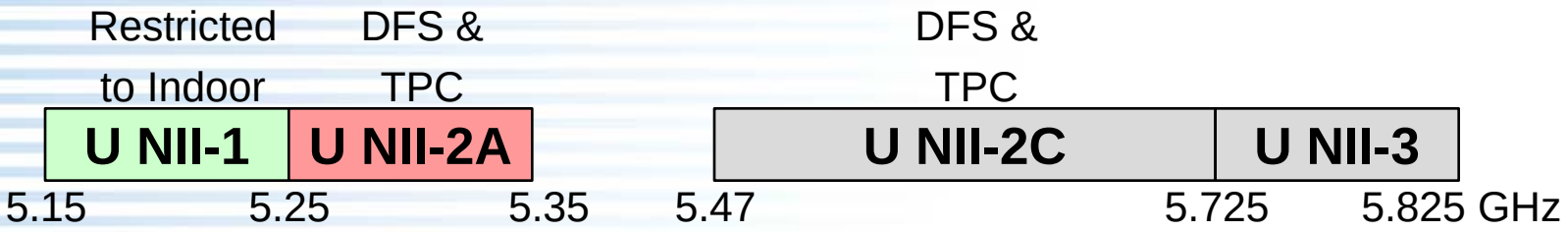
- **Change U-NII band designations** to match 2013 U-NII NPRM (FCC 13-22):



- **Clarify application of U-NII operational requirements and out-of-band limits**
  - KDB 644545 D01 does not change the rules!

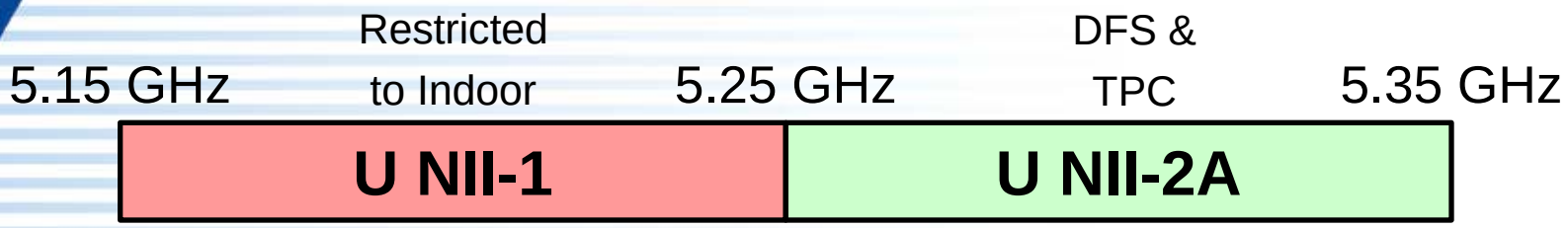
U-NII Operational Requirements and Out-of-Band Limits

- **Operational requirements**



- **Out-of-band limits** of 15.407(b) apply outside of current band(s) of operation
  - E.g., when a transmission is contained within one U-NII band, the out-of-band limits apply everywhere outside of that band, even if the device is capable of operating in other U-NII bands
- The only exceptions ➔ 15.407(b)(1) and (2)

Exceptions



- 15.407(b)(1) When operating in U NII-1:
  - The out-of-band limits apply outside of 5.15 - 5.35 GHz. (i.e., the out-of-band limits do not apply within U NII 2A).
  - Interpretation: If the 20-dB bandwidth extends into U NII-2, then DFS/TPC are required.
- 15.407(b)(2) When operating in U NII-2A, the device must satisfy:
  - The out-of-band limits (EIRP < -27 dBm/MHz) in U NII-1, ***or***
  - The operational requirements (indoor operation) of UNII 1

802.11ac KDB 644545 D01

- KDB 644545 D01 (802.11ac Guidance)
  - *C)1) A device is considered to operate in any U-NII bands that contain a portion of the 20-dB bandwidth…* [15.215(c)].[2]
    - [2] … ***Note that in most cases emissions outside the band(s) of operation must comply with the out-of-band emission limits, which are generally more stringent than a 20 dB attenuation…***
  - *G) Unwanted emissions (out-of-band and spurious)*
    - *2) For any given transmission, the out-of-band and spurious emissions limits apply outside of the frequency bands of operation for that transmission except as noted in section a), below. This means, for example, that the* ***U-NII out-of-band emission limit applies within any U-NII band in which the device is not currently transmitting.***
      - *a) …Sections 15.407(b)(1) and (b)(2) of the rules include exceptions…*
- Planned revision to C)1)
  - Will clarify that the 20-dB bandwidth is of consequence only for extremely low power devices or for defining operation in U-NII 1, where:
    - The device is permitted to exceed -27 dBm/MHz EIRP in U-NII 2A
    - DFS and TPC will not be required if 20 dB bandwidth is contained within U-NII 1

MIMO MEASUREMENTS

Planned Addition to MIMO KDB Publication # 662911 D01

"Emissions Testing of Transmitters with Multiple Outputs in the Same Band"

KDB 662911 D01 Outline

- How to sum emission measurements across output ports
- How to compute directional gain (including array gain)
  - Correlated and completely uncorrelated signals
  - Basic methodology: equal-gain antennas driven at equal power levels.
  - Special cases
    - …
    - Two cross-polarized antennas
    - New ➔ **Multiple antennas with two (or three) orthogonal polarizations**

KDB 662911 D01 Multiple Orthogonal Antennas

- If
  - The system has multiple transmit antennas; and
  - All antennas have orientations that are fixed relative to one another; and
  - Each antenna has one of two (or three) polarizations all of which are mutually orthogonal (i.e., cross polarized);
- Then
  - Compute directional gain for each polarization separately.
  - Total directional gain = gain for the maximum of the two (or three) polarizations

Example

- Device antennas
  - 3 vertical
  - 2 horizontal, co-polarized (i.e., in-line or parallel)

  Device need not be fixed, but antenna orientations must be fixed relative to one another so that if the device is tilted, orthogonality between the polarizations is maintained.
- Directional gain computation

  Use KDB 662911 D01 guidance to compute:
  - Total directional gain of the 3 vertical antennas
  - Total directional gain of the 2 horizontal antennas

  Antenna gain of the device = higher of the two total gains

ET Docket No. 07-113, Adopted Aug. 9, 2013

MILLIMETER WAVE MEASUREMENTS

Changes

- Limits are EIRP in 57-64 GHz band instead of power density at 3 meters
- Added provisions for higher power outdoor point to point communication
- Power limit for outdoor transmitters based on antenna gain. EIRP 82 dBm minus 2 dB for every dB that antenna gain is less than 51 dBi
- Eliminated requirement for transmitter identification

KDB Publication 200443 MMW Measurement Procedure

- Revised with new attachment 200443 DO2 RF Detector Method v01
- Provides guidance for making measurements under Sections 15.255 & 15.257
- Both sections require measurement of fundamental power using RF detector with video bandwidth greater than 10 MHz (Not 10 MHz RBW on spectrum analyzer)

Fundamental RF Detector Power Measurement

- Apply signal to RF diode detector mounted in appropriate wave guide
- Observe detected video signal on 50 ohm input of digital storage oscilloscope (DSO)
- Based on output capacitance of diode detector and 50 ohms, determine video bandwidth
- If video bandwidth is greater than 10 MHz, a low pass filter may be used to reduce the video bandwidth to 10 MHz.

Fundamental Power Measurement (cont)

- If signal not continuous, adjust trigger and sweep time to display highest level transmission time
- Record peak and average levels
- Substitute calibrated CW signal generator for test antenna
- Adjust amplitude of signal generator so amplitude on DSO equals recorded peak & average

Fundamental Power Measurement (cont)

- Calculate field strength

$$F.S. = P + 107 + AF$$

where:

F.S. is field strength in dBuV/m
P is substitution power
AF is antenna factor of test antenna

Fundamental Power Measurement (cont)

- If measurement performed in far field

$$d = 2D^2/\lambda$$

where:

D is largest dimension of EUT transmit antenna

λ is wavelength

then

$$EIRP = F.S. + 20Log(d) – 104.8$$

Fundamental Power Measurement (cont)

- If measurement performed in near field, EIRP may be determined using far field equivalent to near field F.S. if EUT transmit antenna characteristics are known.
- Otherwise, far field equivalent must be estimated. If measurement made at less than 0.1 of far field boundary, assume it was made at 0.1 and extrapolate to far field at 20 dB/decade. If between 0.1 and far field boundary, extrapolate to far field at 20 dB/decade. Calculate EIRP using far field value.

Correction to 200443 Attachment

Footnote 2 web address should be

http://www.phys.hawaii.edu/~anita/new/papers/militaryHandbook/antnrfld.pdf

QUESTIONS?