Guidance for Conducted Emissions Testing of Transmitters with Multiple Outputs in the Same Frequency Span (e.g., MIMO, Smart Antenna, etc)

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New Guidance—KDB Pub 662911

- Application
  - Conducted EMC compliance testing of transmitters with multiple outputs in the same frequency span (i.e., overlapping frequencies)
    - *E.g.*, MIMO, smart antenna, beamforming
- Two topics
  - (1) **How to combine emissions from multiple outputs**
    - Emission limits apply to sum of emissions from all outputs
  - (2) **How to include array gain in directional gain calculations** in rules where gain matters, *e.g.*,
    - Conducted in-band emission limits that vary with directional gain (*e.g.*, 15.247 & 15.407)
    - When conducted measurements + antenna gain are used for compliance with EIRP, ERP, or other in-band radiated limits

(1) Combining Emissions from Multiple Outputs

- **In-band power**
  - Measure power at each output and sum
- **In-band power spectral density (PSD)**

  Use <u>one</u> of the following methods:
  - Measure PSD at each output and sum the PSDs, <u>or</u>…
  - Measure PSD at each output and add *10 log(N)* [N = # of outputs]
    - This apportions the emission limit among the N outputs so each is permitted 1/NTH of the total limit
    - The *10 log(N)* term is not related to array gain calculations
- **Out-of-band and spurious emissions**

  Use <u>one</u> of the following methods:
  - Measure PSD at each output and sum the PSDs, <u>or</u>…
  - Measure PSD at each output and add 10 log(N) dB

  See the KDB regarding relative limits

- All sums are in linear power units.
- Use math—not a combiner! (This is a change from Apr 2010 presentation)
- Summing PSDs may require external calculations (*e.g.*, spreadsheet?)

(2) Including Array Gain in Directional Gain Calculations

- Method depends on correlation between Tx outputs
  - *"Correlated"*: Gain = antenna gain + 10 log(N)
  - *"Completely uncorrelated"*: Gain = antenna gain

  See designations of "correlated" in the KDB pub

- Special cases (see KDB pub)
  - Sectorized antenna systems
  - Cross-polarized antennas with N = 2
  - Unequal antenna gains with equal Tx powers

Test Reports

(1) Combining Emissions from Multiple Outputs

- Identify the method used

(2) Including Array Gain in Directional Gain Calculations

- Explain how directional gain (including array gain) was determined

- For signals claimed to be "completely uncorrelated", explain the basis for that classification in terms of the KDB guidance