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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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 one of the following methods:
- Measure PSD at each output and sum the PSDs, or...
- 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 $1/N^{TH}$ of the total limit
  - The $10 \log(N)$ term is not related to array gain calculations

Out-of-band and spurious emissions
Use one of the following methods:
- Measure PSD at each output and sum the PSDs, or...
- 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
(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