Multiple-Output Devices (e.g., MIMO) with Cross-Polarized Antennas

See KDB Publication # 662911 D02 for details (Formerly KDB Draft Publication 689094)

TCB Workshop October 2011

Steve Martin
FCC / OET
Laboratory Division
Two attachments to KDB Publication 662911. Both apply to unlicensed and licensed devices.

- **# 662911 D01** (Published April 2011)
  - Conducted output emission measurements
  - Modified October 2011 to reference new attachment D02

- **# 662911 D02** (Published October 2011)
  - Conducted and radiated emission measurements for devices driving cross-polarized antennas
  - Formerly KDB Draft Publication 689094
The Reason for D02:
Inconsistency between conducted and radiated tests of devices with cross-polarized antennas

- Conducted measurement procedure in 662911 D01 requires summing emissions across the outputs.

But,

- Radiated measurement with a linearly polarized antenna might see only one transmitter (Tx) output at a time.
New Interpretation

Where a rule specifies a **conducted limit** (power or PSD):
- Limit applies to total emission. Sum the power or power spectral density (PSD) across outputs or across polarizations

Where a rule specifies a **radiated limit** (EIRP, ERP, or field strength):
- Limit applies to the maximum emission that would be observed by a linearly polarized measurement antenna unless the rule specifies otherwise.

*Interpretation depends on how the limit is expressed (radiated or conducted) rather than on how it is measured (radiated or conducted)*
Implementation

Conducted limits (e.g., 15.247, 15.407, 90Y)
- Perform conducted emissions tests
  - Sum the power or PSD across the outputs
- Or, perform radiated emissions tests (if necessary due to integral antennas)
  - Measure radiated emissions with vertical and horizontal polarizations
  - Convert each to power or PSD
  - Sum the power or PSD across the polarizations
    • Note that this was not in the draft KDB. Comments are welcome.

A rule that reduces the conducted limit as antenna gain is increased creates a cap on EIRP. But the limit is still a conducted limit.
Radiated limits (e.g., EIRP or ERP in Parts 27C or 90Z)

Unless otherwise specified, the limit applies to the maximum emission that would be observed by a linearly polarized measurement antenna.

- Perform radiated emissions tests
  - Horizontally and vertically polarized measurements must individually comply with the limit

- Or, perform conducted emissions tests as follows:
  - Measure conducted output power or PSD for each Tx chain.
  - Compute EIRP or ERP of each Tx chain individually.
  - Apply the limit as follows:
    - Apply the limit to each of the two EIRPs or ERPs individually if:
      1. Tx output signals are uncorrelated per KDB Publication 662911; or,
      2. One Tx output is a 90-degree phase-shifted replica of the other and the antenna phase centers are co-located.
    - Apply the limit to the sum of the two EIRPs or ERPs if
      - Tx output signals are correlated per KDB Publication 662911 and (2) does not apply.
Examples with two outputs driving cross-polarized linear antennas

15.247: 1 watt conducted power limit if antenna gain < 6 dBi
- Limit is reached if each output is at 0.5 watts

90Y: 1 watt/MHz peak EIRP power density limit
- For outputs that are *uncorrelated* per KDB 662911, limit is reached if peak conducted emission + antenna gain = 1 watt/MHz for each output.
- For outputs that are *correlated* per KDB 662911, limit is reached if peak conducted emission + antenna gain = 0.5 watt/MHz for each output.