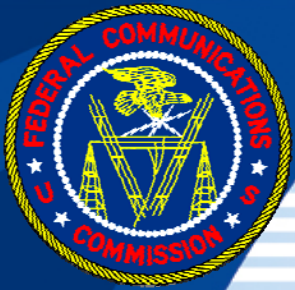




IEEE 802.11ac and Pre-ac Device Emissions Testing Draft Guidance

See Draft KDB Publication # 644545

TCB Workshop
April 24, 2012
Steve Martin



Permit But Ask (PBA)

- 802.11ac and pre-ac devices are on the PBA list
 - Capable of transmitting simultaneously in more than one Part-15 band in 5-6 GHz (among the 4 U-NII bands and one 15.247 band)

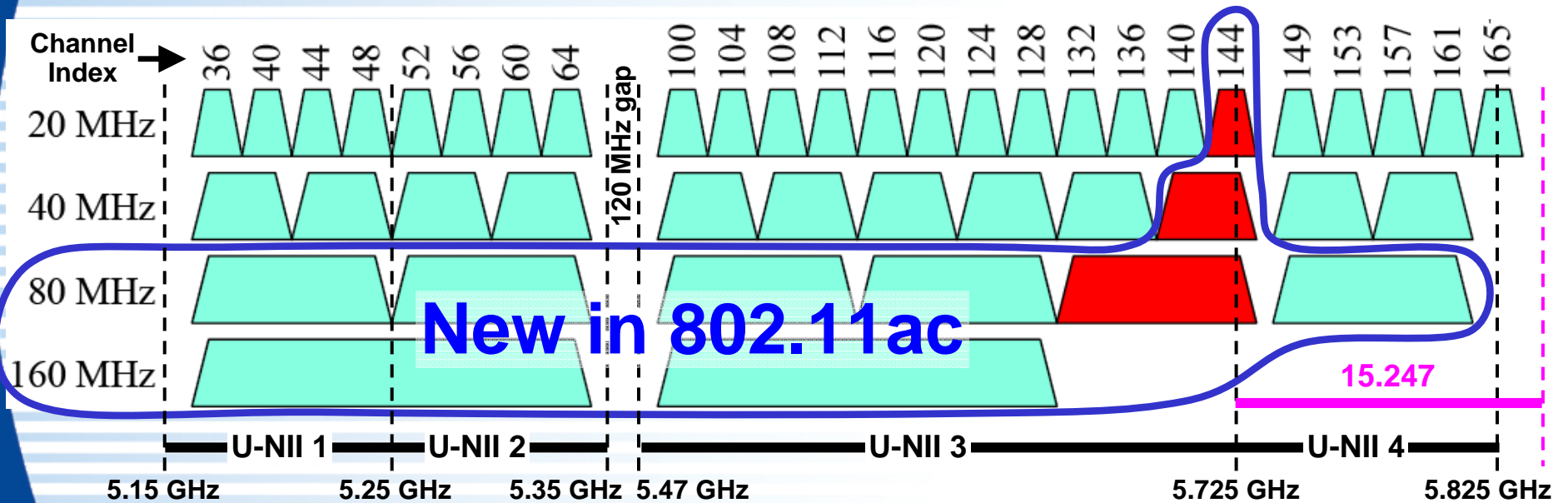
This presentation deals only with emissions testing. Consult with the FCC regarding SAR issues as well.



What's New in 802.11ac Emissions?

(All changes limited to 5-6 GHz bands)

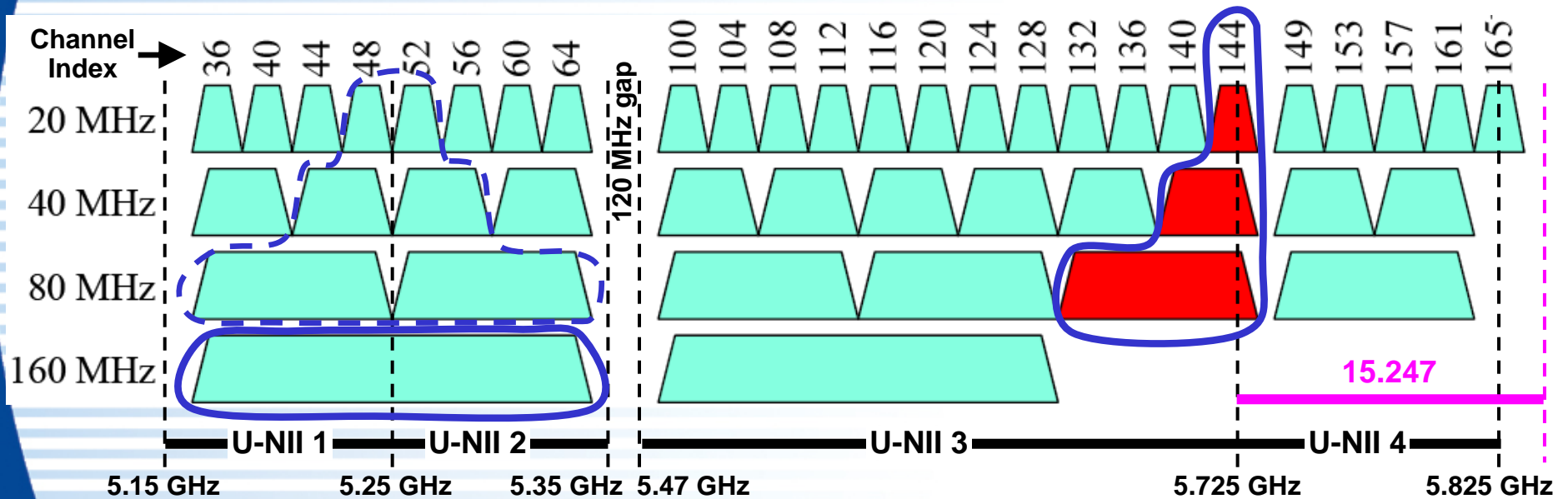
- 80 MHz and optional 160 MHz channel bandwidths
 - Optional non-contiguous spectra (80 + 80 MHz)
 - Channels straddling adjacent bands (shown in red)
 - Up to 256-QAM
 - Up to 8 MIMO outputs
- } Use existing guidance





Simultaneous Operation in Multiple 5-6 GHz Bands

- Band straddling channels
- 80 + 80 MHz mode (non-adjacent 80-MHz channels)
- Emission bandwidth may cross band boundary ^[15.215(c)+15.403(i)]
 - Below 5.25 GHz requires indoor operation only
- Multiple 802.11 implementations in one device

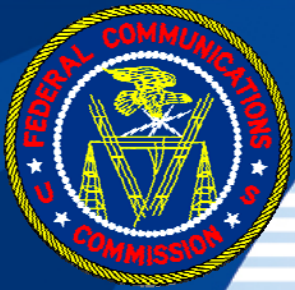




Operational Requirements for U-NII Bands

Operational requirements for each band must be satisfied whether transmitting in one band or multiple bands simultaneously

- U-NII 1 (5.15-5.25 GHz) → Indoor operation – 15.407(e)
- U-NII 2 (5.25-5.35 GHz) → DFS and TPC – 15.407(h)
- U-NII 3 (5.47-5.725 GHz) → DFS and TPC – 15.407(h)
and KDB pub 443999
*“Interim Plans to Approve UNII
Devices Operating in the 5470
– 5725 MHz Band with Radar
Detection and DFS
Capabilities”*
- U-NII 4 (5.725-5.825 GHz) → None



Which Rule Section Applies Above 5.725 GHz?

- Two principles based on 15.215(c)
 - A spectrally contiguous transmission must be under only one rule section
 - All simultaneous transmissions above 5.725 GHz must be under only one rule section—either 15.247 or 15.407 (but not both)

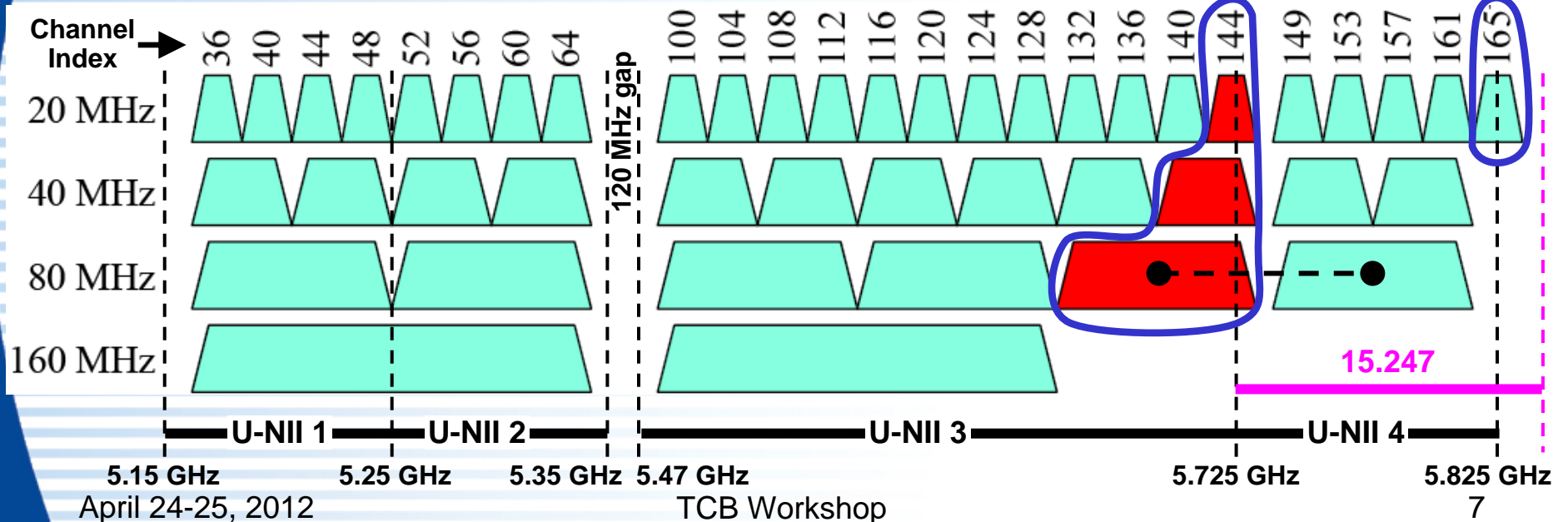


Which Rule Section Applies Above 5.725 GHz?

- Use only 15.247 when transmitting on channel 165
- Use only 15.407 when transmitting on a channel that crosses 5.725 GHz
 - E.g., 80+80MHz on upper 2 channels
- Otherwise, you choose either 15.247 or 15.407 (but not both)

Require 15.407 for all transmissions above 5.725 GHz

Require 15.247 for all transmissions above 5.725 GHz





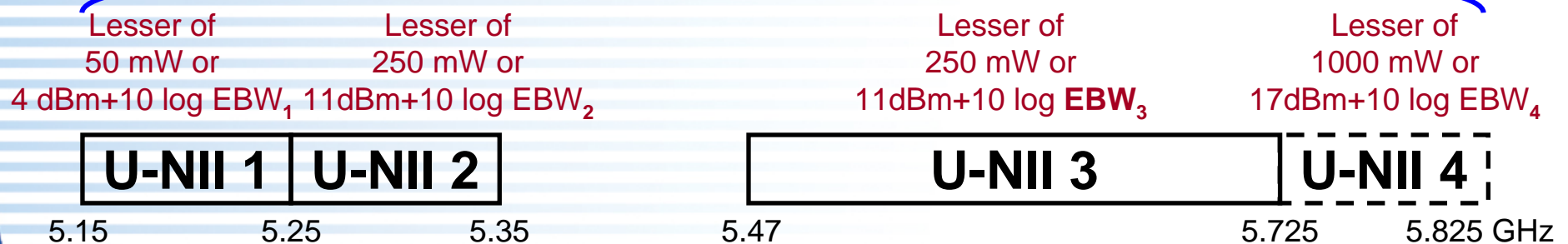
U-NII In-Band Power Limits For Simultaneous Multi-Band Operation

U-NII maximum conducted output power must comply with:

- Individual band limits – Based on portion of EBW in the band
- Limit on aggregate power – Based on aggregate EBW

Total power < Highest limit among occupied* U-NII bands
based on $EBW_1 + EBW_2 + EBW_3 + EBW_4$

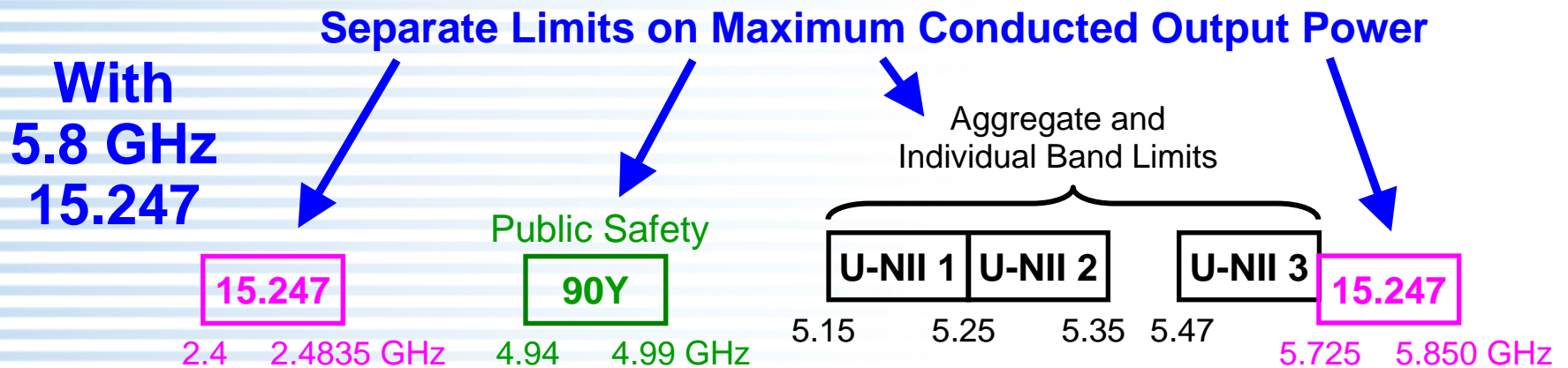
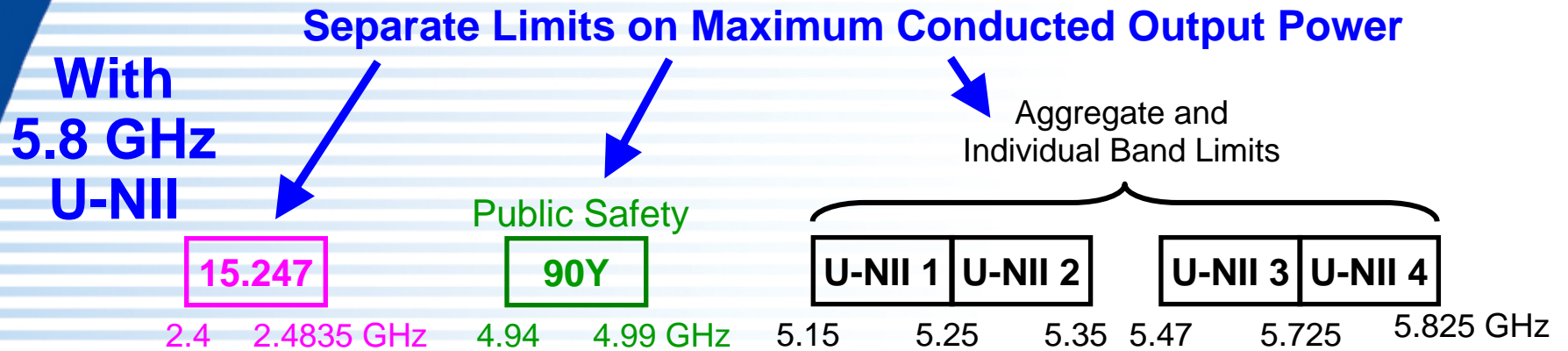
(*Omit U-NII 4 and EBW_4 from calculation when 15.247 is used above 5.725 GHz)



Reduce all limits per 15.407 if antenna gain > 6 dBi



In-Band Power Limits For Simultaneous Multi-Band Operation

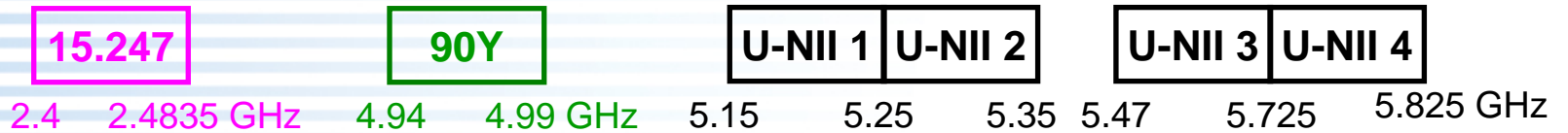




In-Band Power Spectral Density (PSD) Limits For Simultaneous Multi-Band Operation

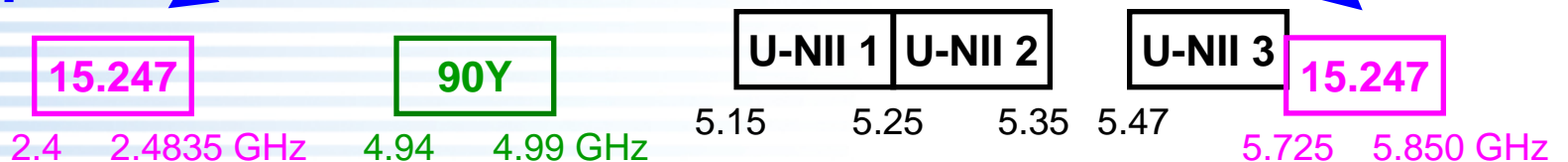
With 5.8 GHz U-NII

Separate Limits on PSD



With 5.8 GHz 15.247

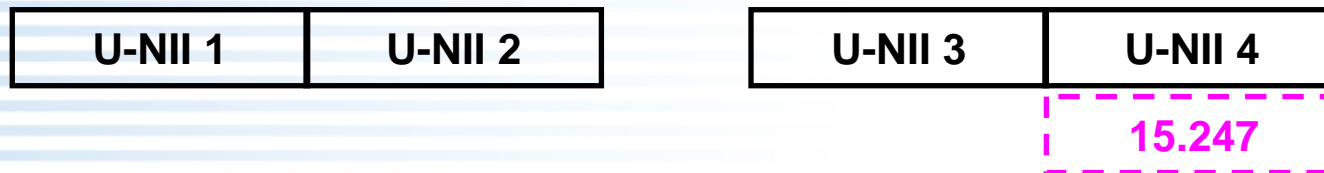
Separate Limits on PSD





Out-of-Band and Spurious Emissions

- Which out-of-band and spurious limits apply? [15.31(k)]
 - 15.247 transmissions → 15.247(d)
 - U-NII transmissions → 15.407(b)
(-27 and -17 dBm/MHz limits are peak max-hold)
 - Composite 15.247 and U-NII transmissions → Higher of 15.247(d) and 15.407(b)
- Where do the limits apply?
 - “Outside of the frequency bands of operation” [15.407(b)] except as noted in 15.407(b)(1) and (2) for U-NII bands 1 and 2.
 - U-NII bands of operation are determined by 26-dB emission bandwidths [15.215(c) and 15.403(i)]

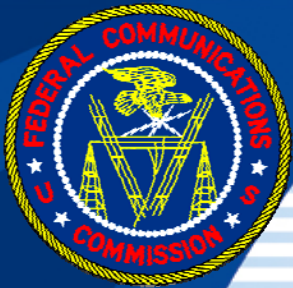




Applicable Rules

- 2.4 – 2.4835 GHz **15.247**
- 4.94 – 4.99 GHz (public safety) **Part 90** Subparts B, I, Y, and emission mask (l) or (m) from 90.210. Maximum channel width = 20 MHz

- 5 GHz operations:
 - 5.15 – 5.25 GHz (U-NII 1) **15.407**
 - 5.25 – 5.35 GHz (U-NII 2) **15.407**
 - 5.47 – 5.725 GHz (U-NII 3) **15.407**
 - > 5.725 GHz (U-NII 4 & DTS) **15.247** or **15.407**, as specified in this KDB. (A device may use both rule sections for operations above 5.725 GHz—but not simultaneously.)



Measurement Procedures

● Applicable procedures

- 15.247 general **KDB 558074**
- 15.407 (U-NII) general **KDB 789033**
- DFS and TPC **FCC 06-96 Appendix
and FCC KDB 443999**
- MIMO **KDB 662911**

● Adjustments to procedures

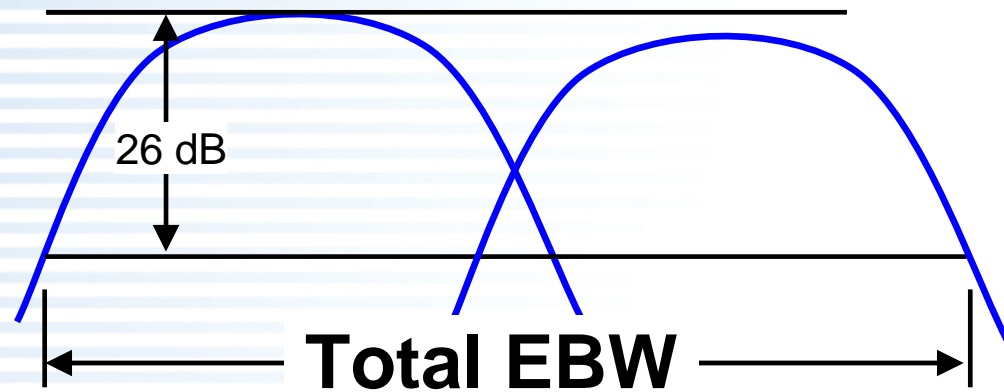
Emission bandwidth (EBW) and Maximum conducted output power

- Transmissions with non-contiguous spectra
- Transmissions spanning boundary between U-NII bands
 - EBW and power in each U-NII band
 - Total EBW and total power in occupied U-NII bands operating under U-NII rules

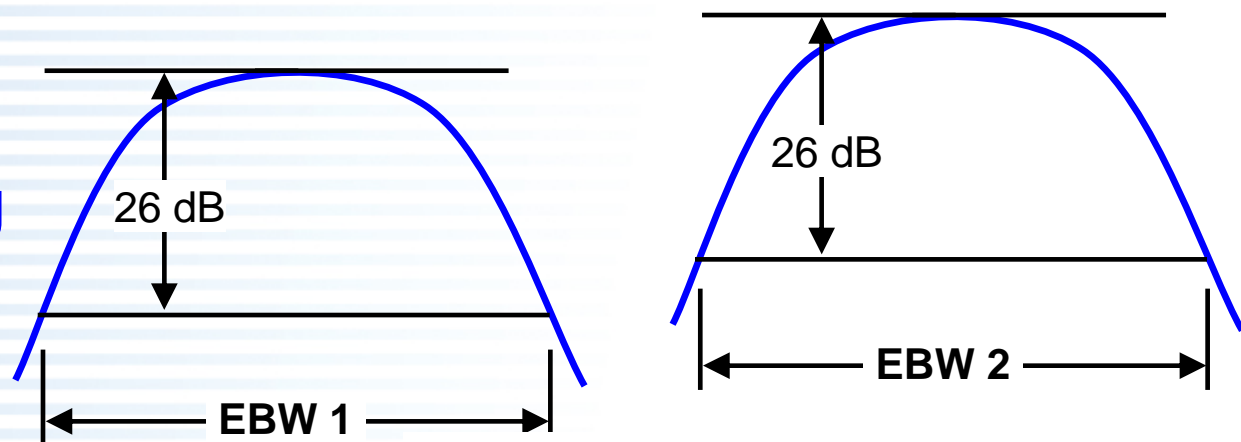


Emission Bandwidth (EBW) U-NII

Spectra with
overlapping
EBWs



Spectra with
non-overlapping
EBWs

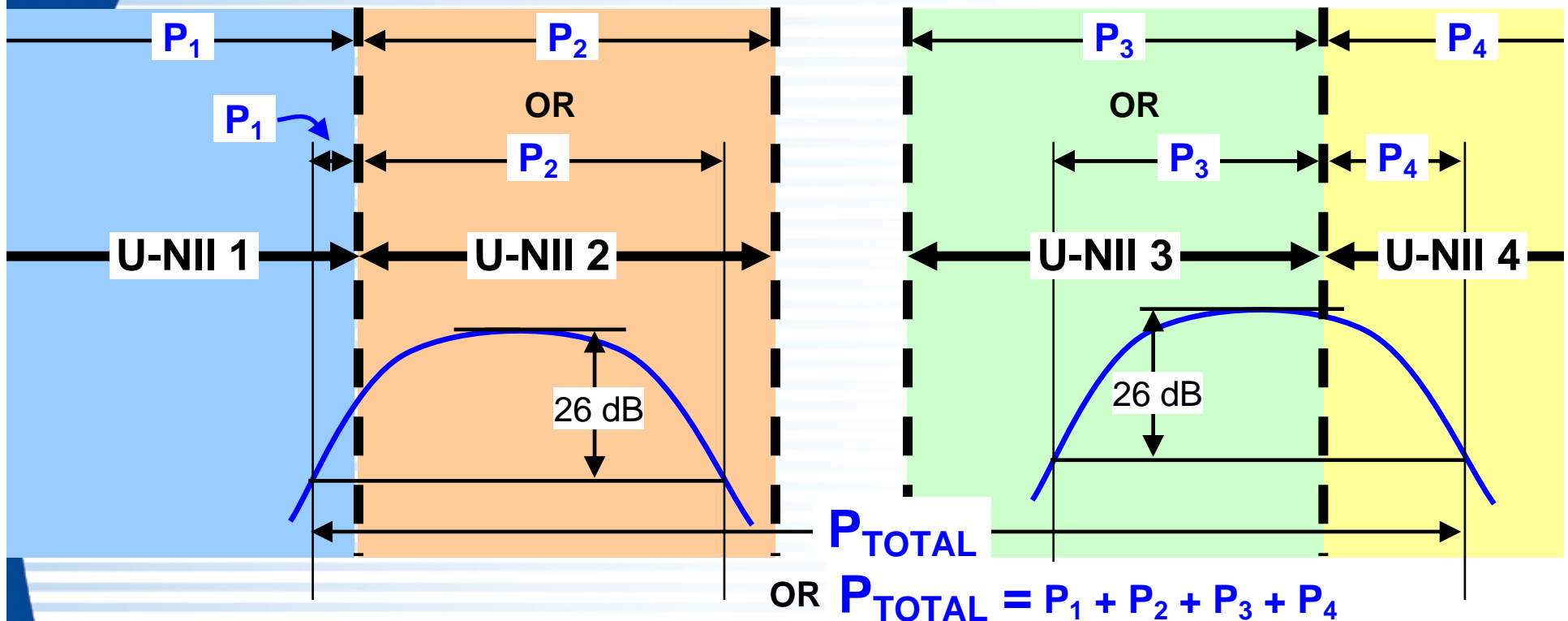


$$\text{Total EBW} = \text{EBW 1} + \text{EBW 2}$$

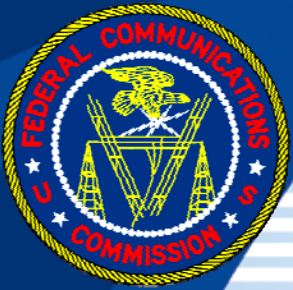


Maximum Conducted Output Power (U-NII) Examples

To measure conducted output power in each U-NII band, integrate over the band or over the 26-dB EBW within the band:



To measure total conducted output power, integrate over the outer span of -26 dB points or sum the band powers.



Questions and Answers

Draft KDB # 644545 has details
and is open for comments
through the KDB system

Thanks!