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Part 96
3.5 GHz CBRS Band
EUD EIRP Discussion

June 22, 2016

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Part 90 vs. Part 96 - Power & Antenna Limits

Fixed/Base & Mobile/Portable vs. CBSD & End User Device

§90.1321 Power and antenna limits.

(a) Base and fixed stations are limited to 25 watts/25 MHz equivalent isotropically radiated power (EIRP). In any event, the peak EIRP power density shall not exceed 1 Watt in any one-megahertz slice of spectrum.

(b) In addition to the provisions in paragraph (a) of this section, transmitters operating in the 3650-3700 MHz band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers provided the emissions comply with the following:

(1) Different information must be transmitted to each receiver.

(2) If the transmitter employs an antenna system that emits multiple directional beams but does not emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device, *i.e.*, the sum of the power supplied to all antennas, antenna elements, staves, etc. and summed across all carriers or frequency channels, shall not exceed the limit specified in paragraph (a) of this section, as applicable. The directional antenna gain shall be computed as follows:

(i) The directional gain, in dBi, shall be calculated as the sum of 10 log (number of array elements or staves) plus the directional gain, in dBi, of the individual element or stave having the highest gain.

(ii) A lower value for the directional gain than that calculated in paragraph (b)(2)(i) of this section will be accepted if sufficient evidence is presented, *e.g.*, due to shading of the array or coherence loss in the beam-forming.

(3) If a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels and if transmitted beams overlap, the power shall be reduced to ensure that the aggregate power from the overlapping beams does not exceed the limit specified in paragraph (b)(2) of this section. In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the limit specified in paragraph (b)(2) of this section by more than 8 dB.

(4) Transmitters that emit a single directional beam shall operate under the provisions of paragraph (b)(2) of this section.

(c) Mobile and portable stations are limited to 1 watt/25 MHz EIRP. In any event, the peak EIRP density shall not exceed 40 milliwatts in any one-megahertz slice of spectrum.

96.41 – General Radio Requirements

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(b) *Power Limits*: Unless otherwise specified in this subsection, the maximum EIRP and maximum Power Spectral Density (PSD) of any CBSD and End User Device must comply with the limits shown in the table below:

Device	Maximum EIRP (dBm/10 megahertz)	Maximum PSD (dBm/MHz)
End User Device	23	n/a
Category A CBSD	30	20
Category B CBSD*	47	37

* Category B CBSDs will only be authorized for use after an ESC is approved and commercially deployed consistent with sections 96.15 and 96.67.

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Part 90 vs. Part 96 - Power & Antenna Limits

EUD EIRP - Fixed Wireless Needs

- Current FCC Part 96 End User Device Maximum EIRP envisions use of the ~ 0 dBi unity gain antennas typical of Smart Phone type devices
  - Systems typically designed for edge of cell data rates in 1's of Mbps at edge of cell
- Operators are very interested in the opportunity to operate Fixed Wireless broadband type applications in the CBRS band as was done in the legacy Part 90 3.65 GHz band
  - This will require data rates in 10's of Mbps at edge of cell
- Good SINR required to deliver usable downlink data rates
  - Nominal target 15 dB SINR at edge of cell
- High gain directional CPE's typically used in other bands (such as B41 and B42) to deliver fixed wireless access

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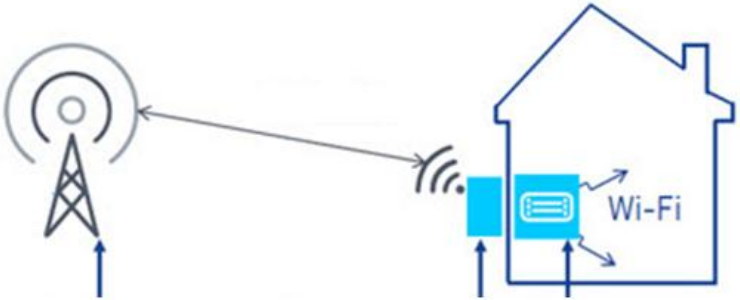
Part 90 vs. Part 96 - Power & Antenna Limits

Fixed PTMP Wireless Applications – Last Mile Internet Access

Common Existing Part 90 Deployment



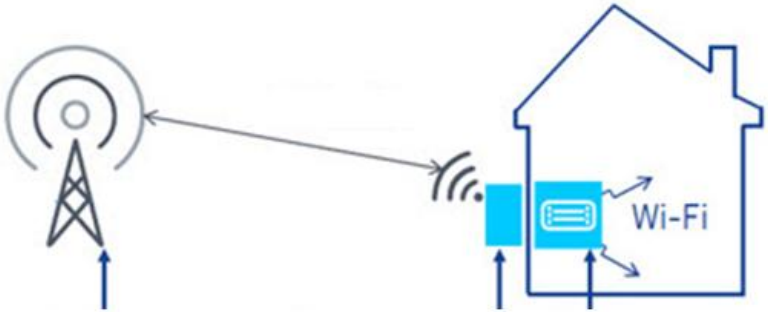
High Gain
Directional Antennas
up to 1 watt/ MHz
(i.e. 10 watts EIRP
@ 10 MHz Channel)

Outdoor
High Gain
Directional Antenna
up to 1 watt/ MHz
(i.e. 10 watts EIRP
@ 10 MHz Channel)

Indoor POE
Router with Wifi

Fixed User Device Symmetric with Base Power Limits

New Part 96



High Gain
Directional Antennas
up to 5 watt/ MHz
(i.e. 50 watts EIRP
@ 10 MHz Channel)

Outdoor
Unity Gain
Directional Antenna
up to 0.2 watt/ MHz
(i.e. 0.2 watts EIRP
@ 10 MHz Channel)

Indoor POE
Router with Wifi

Higher Base Limits, but no Passive Gains on User Device Unless it Has Connectivity Back to SAS

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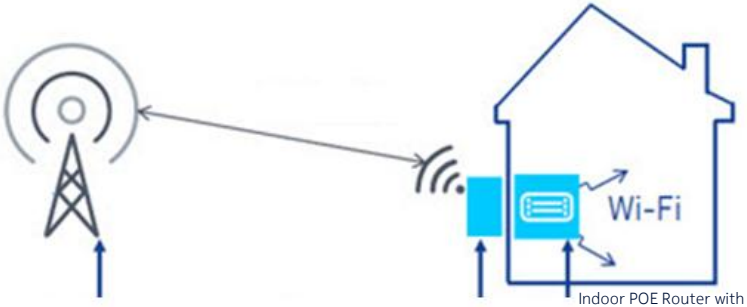
Part 96 vs. Part 90 Power Limits – "Shifting of Gain/Power"

LTE Example - Max Coupling Loss = Link TX Power – Link RX Sensitivity

Part 90 vs. Part 96 = 8.4 dB delta

Part 90 Deployment



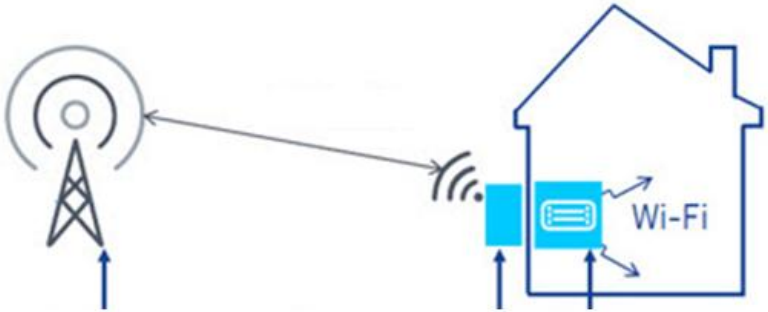
0.8 watts eNode B
11 dBi Directional Antenna
-102.7 RX Sensitivity @1 Mbps link target

0.2 watts eNode B
10 dBi Directional Antenna
-94.1 RX Sensitivity @1 Mbps link target

Indoor POE Router with Wifi

•UL: 23dBm + 10dBi – (-102.7dBm eNode B RX sensitivity) = 135.7dB for UL 1Mbps and MCS 6/27RBs.
•DL: With DL TX power 0.8 watt per BW 10Mhz, 29dBm + 11dBi – (-94.1dBm CPE RX sensitivity) = 134.1dB for DL 3.5Mbps and MCS 8/50RBs.

Part 96 Deployment



4 watts eNode B
11 dBi Directional Antenna
-102.7 RX Sensitivity @1 Mbps link target

0.2 watts eNode B
0 dBi Antenna
-94.1 RX Sensitivity @1 Mbps link target

Indoor POE Router with Wifi

•UL: 23dBm – (-102.7dBm eNode B RX sensitivity) = 125.7dB for UL 1Mbps and MCS 6/27RBs.
•DL: With DL TX power 4w per BW 10Mhz, 36.0dBm + 11dBi – (-94.1dBm CPE RX sensitivity) = 141.1dB for DL 3.5Mbps and MCS 8/50RBs. Or you may see that the higher DL cell edge 5.1Mbps is achieved with 138.5dB max coupling loss.

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Part 90 vs. Part 96 - Power & Antenna Limits

Use of High Gain Antenna on User Device Requires Alternative Connection

3.5 GHz Report and Order, FCC FCC 15-47, the Commission found "that devices that need to operate at a higher EIRP than 23dBm will be considered to be CBSDs and subject to all CBSD requirements, including SAS registration." *3.5 R&O* at ¶ 244 *citing* 96.47(b)("Any device operated at higher power than specified for End User Devices in §96.41 will be classified as, and subject to, the operational requirements of a CBSD.").

Category B CBSD (which may operate at the highest power), it must, among other things:

(1) Be Professionally Installed
(2) Be Registered with the SAS
(3) Coordinate with the SAS
(4) And Meet security and Other Certification Requirements.

§96.39 (c) *Registration with SAS*. A CBSD must register with and be authorized by an SAS prior to its initial service transmission. The CBSD must provide the SAS upon its registration with its geographic location, antenna height above ground level (in meters), CBSD class (Category A/Category B), requested authorization status (Priority Access or General Authorized Access), FCC identification number, call sign, user contact information, air interface technology, unique manufacturer's serial number, sensing capabilities (if supported), and additional information on its deployment profile required by §§96.43 and 96.45. If any of this information changes, the CBSD shall update the SAS within 60 seconds of such change, except as otherwise set forth in this section. All information provided by the CBSD to the SAS must be true, complete, correct, and made in good faith.

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Part 96 vs. Part 90 Power Limits
Potential Reconsideration / Clarification?

3.5 GHz Report and Order, FCC FCC 15-47, the Commission stated "We do not agree with WISPA's assertion that End User Devices should be permitted to operate at power levels equal to CBSDs. Adopting such a rule would effectively authorize the deployment of innumerable higher power fixed and mobile devices in the band not subject to direct SAS authorization." ¶ 244

- Use of higher gain antenna on EUD has multiple benefits
  - Directly increases the signal strength received
  - Directional antenna pattern reduces interference seen from other base stations
  - Both effects increase SINR, boosting achievable data rates
- No Direct SAS coordination if high gain EUD under authorized SAS serving CBSD base station
  - Promote last mile fixed use in areas with no secondary internet connection
  - Provides existing Part 90 incumbents with similar service turn-up under new Part 96 rules
  - Indirect coordination/control authority with SAS Administrators though Serving CBSD Station
  - Removes burden of SAS Administrators coordinating with potentially thousands of fixed end user devices

- Unlikely Potential for increased interference to legacy systems
  - Interference environment primarily driven by CBSD downlink transmissions
  - High EIRP EUD could be connected to SAS to control output power in sensitive scenarios

- Implications of connecting EUD to SAS needs further examination
  - Message volume
  - Relationship of parameters controlled by CBSD and EUD
  - Non 3GPP Compliant (i.e. No existing chipsets to build around)
- Existing Part 96 rules would stifle fixed wireless deployments making the new band primarily mobile / nomadic use only

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