

AMPLIFIER, BOOSTER, AND REPEATER - BASIC ITEMS

This EAB reminder sheet is intended to institute uniform procedures for equipment authorizations of amplifier, booster, and repeater devices. This includes typical in-building radiation systems consisting at a minimum of one host unit and one or more remote units, used to improve service reliability inside buildings or other structures located within particular licensed service areas.

EXCERPTS AND DEFINITIONS FROM FCC RULES

Part 2 section 815 External radio frequency power amplifiers.

“(a) As used in this part, an external radio frequency power amplifier is any device which, (1) when used in conjunction with a radio transmitter as a signal source is capable of amplification of that signal, and (2) is not an integral part of a radio transmitter as manufactured.”

Part 22

22.377(e) “Transmitters used with in-building radiation systems must be installed such that, to the extent possible, they are readily accessible only to persons authorized by the licensee to access them.”

22.383 “Licensees may install and operate in-building radiation systems ...”

22.527 “Licensees may install and operate signal boosters ...”

22.99 “*Repeater*. A fixed transmitter that retransmits the signals of other stations.”

22.99 “*Cellular repeater*. In the Cellular Radiotelephone Service, a stationary transmitter or device that automatically re-radiates the transmissions of base transmitters at a particular cell site and mobile stations communicating with those base transmitters, with or without channel translation.”

22.99 “*Signal booster*. A stationary device that automatically reradiates signals from base transmitters without channel translation, for the purpose of improving the reliability of existing service by increasing the signal strength in dead spots.”

22.99 “*In-building radiation systems*. Supplementary systems comprising low power transmitters, receivers, indoor antennas and/or leaky coaxial cable radiators, designed to improve service reliability inside buildings or structures located within the service areas of stations in the Public Mobile Services.”

Part 90

90.219 – “Licensees authorized to operate radio systems in the frequency bands above 150 MHz may employ signal boosters at fixed locations ...”

90.7 “*Mobile repeater station*. A mobile station authorized to retransmit automatically on a mobile service frequency, communications to or from hand-carried transmitters.”

90.7 “*Signal booster*. A device at a fixed location which automatically receives, amplifies, and retransmits on a one-way or two-way basis, the signals received from base, fixed, mobile, and portable stations, with no change in frequency or authorized bandwidth. A signal booster may be either narrowband (Class A), in which case the booster amplifies only those discrete frequencies intended to be retransmitted, or broadband (Class B), in which case all signals within the pass-band of the signal booster filter are amplified.”

Part 24

No special definitions given – use Part 22 concepts.

FIBER-OPTIC AND OTHER SIMILAR RF DISTRIBUTION SYSTEMS

Fiber-optic distribution systems are a type of in-building radiation system that receives RF signals from an antenna, distributes the signal over fiber-optic cable, and then retransmits at another location for example within a building or tunnel. Most fiber-optic systems are signal boosters; however, some may be repeaters. These systems generally have two enclosures typically called host (or local or donor unit) and remote. Some systems may also have an optional expander box for fan-out to multiple remotes. The system transmits downlink signals from the remote unit to handsets, portables, or clients, and transmits uplink signals via from the host unit. Usually but not always the uplink goes through an intermediate amplifier to a “donor” antenna. Therefore both uplink and downlink must be tested, unless filing effectively documents how connection of uplink to donor antenna with or without an intermediate amplifier will be prevented, such as for always only a cabled connection to a base station. Fiber-optic systems are not amplifiers (AMP equipment class) – they are equipment class TNB or PCB. The same approval procedures also apply for multiple-enclosure systems connected by coax cable.

Synonyms and related terms: in-building radiation system, coverage enhancer, distributed antenna system, fiber-optic distribution system, converter, donor antenna

Typical in-building or distributed antenna systems can consist of five different components (enclosures), not counting antennas:

1) **host unit**

- a) transmits uplink to base station via antenna thru coax, **passive interface unit**, or **active interface unit** (amplifier)
- b) sends base-station downlink via fiber-optic or coax to **remote**
- c) receives handset uplink via fiber-optic or coax from **remote**
- d) optional connection to **expansion unit** via fiber-optic
- e) separate FCC ID from **remote**, unless electrically identical
- f) **non-transmitting host unit**
 - i) connects directly to a base station via coax cable but does not connect to antenna or amplifier
 - ii) Part 15 digital device subject to Verification, no FCC ID

2) **remote unit**

- a) receives base-station downlink via fiber-optic or coax from **host**, transmits via antenna to handsets
- b) returns handset uplink via fiber-optic or coax to **host**
- c) separate FCC ID from **remote**, unless electrically identical

3) **expansion unit**

- a) fiber-optic or coax from **host**
- b) fiber-optic or coax fan-out to **remote(s)**
- c) Part 15 digital device subject to Verification, no FCC ID

4) **passive interface unit**

- a) contains attenuators, splitters, combiners
- b) coax cable connection between **host** and base-station
- c) passive device, no FCC ID

5) **active interface unit**

- a) amplifies uplink signal from **host unit** for transmit by donor antenna
- b) attenuates downlink from donor antenna
- c) coax cable connection between **host** and **active interface unit**
- d) usually has separate FCC ID; in some cases could be combined/included with **host** as one enclosure

AMPLIFIER, BOOSTER, AND REPEATER REMINDER SHEET

GENERAL DEFINITIONS FOR CERTIFICATION PURPOSES

The following three general definitions follow from those stated in the Part 22, 24, and 90 rule sections as listed above. Two of the definitions replace previous EAB internal definitions given for booster, repeater and extender. The general term “extender” is the same as booster, but booster should be used rather than extender. The general term “translator” is the same as repeater, but repeater should be used rather than translator.

External radio frequency power amplifier (ERFPA) - any device which, (1) when used in conjunction with a radio transmitter signal source, is capable of amplification of that signal, and (2) is not an integral part of a radio transmitter as manufactured. The EAS equipment class AMP is used only for an ERFPA device inserted between a transmitter (TNB/PCB) and an antenna (has only one antenna port)

Booster is a device that automatically reradiates signals from base transmitters without channel translation, for the purpose of improving the reliability of existing service by increasing the signal strength in dead spots. An “in-building radiation system” is a signal booster. These devices are not intended to extend the size of coverage from the originating base station. A booster can be either single or multiple channels.

Repeater is a device that retransmits the signals of other stations. Repeaters are different from boosters in that they can include frequency translation and can extend coverage beyond the design of the original base station. A repeater is typically single channel but can also be multiple channels.

ERFPA (AMP) and boosters/repeaters (TNB/PCB) can generally be authorized for all rule parts except 15 and 18.

Tests should be done with each typical signal. e.g., for F3E emissions use 2500 Hz with 2.5 or 5 kHz deviation. Use of CW signal for some tests is acceptable in lieu of actual emission, in some cases when CW signal gives worst case.

REMINDER SHEET ITEMS

[] Form 731 entries –

- For ERFPA as defined above
 - In one enclosure
 - Equipment Class – AMP
 - List AMP in frequency tolerance field of Form 731
 - List emission designators without necessary bandwidth (e.g., F3E, F1D)
 - In two enclosures
 - Does not exist (if it does, use same entries as for one enclosure)
- For Booster as defined above
 - In one enclosure
 - Equipment Class – TNB or PCB
 - List AMP in frequency tolerance field of Form 731
 - List emission designators without necessary bandwidth (e.g., F3E, F1D)
 - List in comments field the word “booster”
 - In two enclosures (host/remote)
 - Two separate FCC IDs/applications
 - Equipment Class – TNB or PCB
 - List AMP in frequency tolerance field of Form 731
 - List emission designators without necessary bandwidth (e.g., F3E, F1D)
 - List in comments field the words “Part of booster system used with FCC ID: xxxyyy.” (Where xxxyyy is FCC ID of other TNB or PCB in system).

- For Repeater as defined above
 - In one enclosure
 - Equipment Class – TNB or PCB
 - List AMP in frequency tolerance field of Form 731 if device contains no frequency translation; otherwise, measure frequency tolerance and list.
 - List in comments field the word “repeater”
 - In two enclosures (host/remote)
 - Two separate FCC IDs/applications
 - Equipment Class – TNB or PCB
 - List AMP in frequency tolerance field of Form 731 if device contains no frequency translation; otherwise, measure frequency tolerance and list.
 - List in comments field the words “Part of repeater system used with FCC ID: xxxyyy.” (Where xxxyyy is FCC ID of other TNB or PCB in system).
- [] Applicable rule part(s) –
 - Specific rule part(s) the device will be used with. Verify applicable emission masks etc and if booster rules apply.
 - Check to see if frequency and device is licensable in applicable rule part.
- [] Booster rules – Include exhibit or correspondence showing applicant was informed that boosters must meet all criteria stated in Sections 90.219 and 22.383 for related booster/in-building operations.
- [] Single or multiple FCC IDs – One FCC ID per transmitter enclosure or rack, not per system.
- [] Form 731 line items – All transmitters in the device (uplink/downlink) should be listed and tested.
- [] System operation – When transmitter requires other devices in a system, select Form 731 “Part of system...” checkbox. List FCC IDs of other components. Test with system components if needed. Usually applies for fiber-optic systems. Control of power level is one implication.
- [] Radiated spurs (enclosure) – Use of CW signal (low, mid. and high freq.) is acceptable rather than all modulations
- [] Conducted spurs – Test all modulation types [TDMA, CDMA, and FM (covers GSM and F1D)] at low, mid. and high frequency
- [] Intermodulation –Test all modulation types [TDMA, CDMA, and FM (covers GSM and F1D)]
 - CW signal rather than typical signal is acceptable (for FM).
 - At maximum drive level, for each modulation: one test with three tones, or two tests (high-, low-band edge) with two tones
 - Limit usually is -13dBm conducted.
 - Not needed for Single Channel systems.
 - Combination of modulation types not needed.
- [] Occupied bandwidth – Use RBW 300 Hz or 1% RBW. The spectral shape of the output should look similar to input for all modulations.
- [] Output power –
 - Power on Form 731 should be clearly understood as either composite of multi-channels or per carrier. If power is composite include in comments field: "Power output listed is composite for multi-channel operation."
 - Check that the input drive level is at maximum input rating and maximum gain settings for all tests. Check both uplink and downlink input levels. See manual or brochures/technical description for maximum rating. May need to check FCC identifier of transmitter used for tests.
 - Confirm device cannot operate in saturation. Are there means to control maximum power and to assure linear operation (use in system configuration may be necessary)? How is saturation or over-modulation prevented for pulsed signal inputs?
 - Meets power limits of 90.219 for Part 90 booster operations.
- [] Out of Band Rejection – Test for rejection of out of band signals. Filter freq. response plots are acceptable.