



TCB Workshop

Carrier Current Systems (CCS) and Broadband over Power Line (BPL)

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Slide 1



Definitions

➤ 15.3(f) Carrier current system

- ▶ A system, or part of a system, that transmits radio frequency energy by conduction over the electric power lines ... [to be] received by conduction ... (unintentional radiator) or ... radiation... (intentional radiator).

➤ 15.3(t) Power line carrier systems

- ▶ ... carrier current system used by an electric power utility entity on transmission lines for protective relaying, telemetry, etc. for general supervision of the power system... The system does not include those electric lines which connect the distribution substation to the customer or house wiring. [15.113 specifies frequency band 9 – 490 kHz]

Does “Carrier current system” definition include use of the lines between the substation and the customer?

Definition is broad enough to include BPL access systems

CCS Current Rules (Continued)



Measurement Standards

➤ In situ

- ▶ 15.31(d) ...for...carrier current systems..., measurements...shall be performed at a minimum of three installations that can be demonstrated to be representative of typical installation sites.

➤ Distance

- ▶ 15.31(f) The distance specified corresponds to the horizontal distance between the measurement antenna and the closest point of the equipment under test, support equipment or interconnecting cables...defined by an imaginary straight line periphery

➤ Distance Extrapolation

- ▶ 15.31(f)(1) [At ≥ 30 MHz: use 20 dB/decade]
- ▶ 15.31(f)(2) [At < 30 MHz]: ...an attempt should be made to avoid making measurements in the near field... Pending the development of an appropriate measurement procedure ...[measure the] extrapolation factor... or [use] 40 dB/decade

May 19-21, 2004

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Slide 3

Should we include power lines as part of system? **Yes**

Should we use horizontal distance or slant range for distance scaling?

Use slant range to power line or device—whichever is closer

Should we specify a minimum distance to reduce extrapolation error at 40 dB/decade? **Near field/far field boundary: $\lambda/2\pi$ (48 m at 1 MHz; 1.6 m at 30 MHz)**

Specify nominal horizontal measurement distance: 10-30m (F<30 MHz) & 10m (F>30MHz)



Frequency Range of Radiated Measurements

- 15.33(b)(1)...for an unintentional radiator, including a digital device, the spectrum shall be investigated from the lowest radio frequency signal generated or used in the device, without going below [9 kHz], up to the frequency shown in the following table:
 - ▶ [1000 MHz if highest frequency generated or used is 1.705 - 108 MHz]

Equipment Authorization of Unintentional Radiators

- 15.101(a) [Verification]

CCS Current Rules (Continued)



AC-Line Conducted Limits

- **15.107(a) & (b). Conducted limits on Class B and Class A digital devices.**
- **15.107(c) The limits ... in ... paragraphs (a) and (b) shall not apply to carrier current systems operating as unintentional radiators on frequencies below 30 MHz... these carrier current systems shall be subject to the following standards:**
 - ▶ (1) ...systems in 535-1705 kHz band...intended to be received using a standard AM broadcast receiver: no limit on conducted emissions.
 - ▶ (2) For all other carrier current systems: 1000 uV within the frequency band 535-1705 kHz, as measured using a 50 μ H/50 ohms LISN.

CCS Current Rules (Continued)



Radiated Emission Limits

➤ Operating Frequency >30 MHz

- ▶ 15.109(a) [Class B limits specified at 3 m]
- ▶ 15.109(b) [Class A limits specified at 10 m]
- ▶ 15.109(g) [As alternative to (a) or (b)]

➤ Operating Frequency <30 MHz

- ▶ 15.107(c)(3) Carrier current systems operating below 30 MHz are also subject to the radiated emission limits in Section 15.109(e).
- ▶ 15.109(e) Carrier current systems used as unintentional radiators...and that operate in the frequency range of 9 kHz to 30 MHz[?]....shall comply with... 15.209 for the frequency range of 9 kHz to 30 MHz.
- ▶ 15.209(a) [Limits specified at 300 m for 9 – 490 kHz and 30 m for 490 kHz to 30 MHz



Other Standards

ANSI C63.4—Methods of Measurement ... (Low Voltage Equipment)

- 16 radials at 22.5 degree intervals
- Receive antenna height
 - ▶ Adjust to maximize response
 - ▶ 1 m for loop antennas (<30 MHz) & 1-4 m for electric field antennas (>30 MHz)
 - ▶ For on-site measurements see IEEE Std 139-1988

IEEE Std 139-1988—Measurement of ... ISM...

- Receive antenna height and radials
 - ▶ “Repeat the measurements at enough locations around, and, if possible, above the EUT”

FCC/OET MP-5 (1986)—Measurements of ... ISM Equipment

- Receive antenna height
 - ▶ **Loop** antenna: “height ... **around 2 meters**” but not in a null.
 - ▶ For a **dipole** or equivalent antenna: height **1-4 m at distances ≤ 10 m; 2-6 m at distances > 10 m**
- Radials separated by ≤ 20 degrees if possible

TCBs must audit a certain number of devices based on the number of grants issued.

Report cases of non-compliance to the Commission at rfabina@fcc.gov.

Summary of Existing Rules for BPL



- **BPL devices are “carrier current systems”** [15.3(f)]
- **Part 15 interference requirements**
 - ▶ Must not cause harmful interference
 - ▶ Must accept interference from other devices
- **Emission limits**
 - ▶ AC-Line Conducted limits [15.107]
 - ▶ Devices operating < 30 MHz: 1000 uV in 535 – 1705 MHz
 - ▶ Devices operating > 30 MHz: Same as digital device limits
 - 150 kHz – 30 MHz
 - ▶ Radiated limits
 - ▶ < 30 MHz Intentional radiator limits [15.209]
 - 1.705-30 MHz: 30 uV/m at 30 m)
 - ▶ > 30 MHz Unintentional radiator limits [15.109]
 - 30-88 MHz: 90 uV/m at 10 m (Class A); 100 uV/m at 3 m (Class B); etc.
- **Field strength measurements are “in situ”**
 - ▶ Minimum of 3 installations that are “representative of typical installation sites”

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Slide 8

BPL Notice of Proposed Rule Making (NPRM)



- **NPRM Proposals** (ET Docket Number 04-37)
 - ▶ New rules for Access Broadband over Power Line (BPL) Systems
 - ▶ New measurement guidelines for all BPL
- **Proposed rules and guidelines may be modified based on comments received from the public**
- **Dates**
 - ▶ NPRM released Feb 23, 2004
 - ▶ Comments due May 3, 2004 (1131 comments received)
 - ▶ Reply comments due Jun 1, 2004
- **Subsequent process**
 - ▶ Report and Order
 - ▶ Specifies the new rules
 - ▶ Specifies effective date and application to existing devices

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Slide 9

Scope of BPL NPRM



➤ In-house BPL

- ▶ No change to existing rules
- ▶ New measurement guidelines

➤ Access BPL

*Definition: A carrier current system that transmits radio frequency energy by conduction **over electric power lines owned, operated, or controlled by an electric service provider.** The electric power lines may be aerial (overhead) or underground*

- ▶ Existing rules remain in place
 - ▶ Clarifies that conducted limits do not apply to access BPL
 - ▶ Clarifies that Class B radiated limits apply to all low-voltage lines
- ▶ New rules added to support interference mitigation
- ▶ ~~New measurement guidelines~~

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Slide 10

New Rules Proposed by BPL NPRM



➤ New requirements for access BPL devices

- ▶ Incorporate adaptive interference mitigation techniques such as dynamic or remote reduction in power and adjustment in operating frequencies in order to avoid site-specific, localized use of the same spectrum by licensed services
- ▶ Incorporate shut down feature to deactivate units found to cause harmful interference

➤ New requirement for operators of access BPL devices

- ▶ Notification requirement: Supply information to publicly accessible database
 - ▶ Installation locations
 - ▶ Frequency bands of operation
 - ▶ Type of modulation used

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Slide 11

Summary of Measurement Guidelines Proposed by BPL NPRM



➤ All BPL

- EUT operated at maximum power and maximum duty factor
- Antenna type and height
 - < 30 MHz: magnetic loop antenna at 1 meter height
 - > 30 MHz: electric field sensing antenna scanned from 1 to 4 meters height
 - NPRM seeks comments on higher antenna heights or use of correction factors for emissions from overhead lines
- Measurement distance: 10 meters horizontal distance
 - Extrapolate to distance specified in rule. Use slant range from overhead power line for extrapolation

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Slide 12

Summary of Measurement Guidelines Proposed by BPL NPRM (continued)



➤ Access BPL

- 3 installations with overhead lines and 3 with underground lines
- Underground wiring
 - 16 radials around in-ground transformers
- Overhead wiring
 - Fixed distance from overhead line and various distances down line from coupler

➤ In-House BPL

- 3 installations
 - No metal siding or shielded wiring (e.g.: conduit, or BX electric cable)
 - Combination of buildings with overhead-lines and underground line
 - Install EUT on outside wall of building—ground floor or 1st floor
- Measurement locations
 - 16 radials around building
 - Fixed distance from overhead feed line and various distances from building connection
- Composite Device – BPL and computer peripheral

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Slide 13

CCS/BPL Measurement Details



- Determine peak emissions across the band
- Power average (100 sweeps) reduces the effects of ambients and noise - recommended
- 9 kHz RBW < 30 MHz and 100 kHz RBW > 30 MHz
- Antenna selection
 - Active Loop < 30 MHz
 - Increases measurement dynamic range
 - Greater risk of overload due to AM broadcast stations
 - Greater frequency range without switch setting
 - Passive Loop < 30 MHz
 - Less risk of overload
 - Can use external pre-selection filtering directly on the antenna
 - Bicon > 30 MHz
 - External Amplifiers – use engineering judgment
 - Low pass filter recommended to reduce FM & TV broadcast band effects

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Slide 14

Web Sites



- **FCC NPRM on BPL**
 - ▶ http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-04-29A1.pdf
- **Electronic Comments Filing System (ECFS)**
 - ▶ <http://www.fcc.gov/cgb/ecfs/>
 - ▶ Select "Search for Filed Comments"
 - ▶ Enter the following information on the form
 - ▶ Proceeding 04-37
 - ▶ Document Type
 - NP to retrieve the NPRM
 - CO to retrieve comments
 - RC to retrieve reply comments
- **CCS Measurement Principles**
 - ▶ http://hraunfoss.fcc.gov/eas_public/LSI_GET/52
- **NTIA Report**
 - ▶ <http://www.ntia.doc.gov/ntiahome/fccfilings/2004/bpl/index.html>

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Slide 15

Harmful Interference



- **Any emission, radiation or induction that endangers the functioning of a radio navigation service or of other safety services or seriously degrades, obstructs or repeatedly interrupts a radiocommunications service operating in accordance with this Chapter. [15.3(m)]**

Proposed Rule



- **Section 15.109 Radiated emission limits.**
 - ▶ (e) Carrier current systems, including BPL systems, used as unintentional radiators or other unintentional radiators that are designed to conduct their radio frequency emissions via connecting wires or cables and that operate in the frequency range of 9 kHz to 30 MHz, including devices that deliver the radio frequency energy to transducers, such as ultrasonic devices not covered under Part 18 of this Chapter, shall comply with the radiated emission limits for intentional radiators provided in Section 15.209 for the frequency range of 9 kHz to 30 MHz. As an alternative, carrier current systems used as unintentional radiators and operating in the frequency range of 525 kHz to 1705 kHz may comply with the radiated emission limits provided in Section 15.221(a). At frequencies above 30 MHz, the limits in paragraph (a), (b) or (i) of this Section, as appropriate, continue to apply. For all BPL systems, the requirements of this paragraph and paragraph (a) of this section shall also apply to the emissions from all low-voltage lines from the distribution transformer to all in-building wiring.

Proposed Rule (continued)



➤ **Section 15.109 Radiated emission limits.**

- ▶ (f) Access BPL systems shall incorporate adaptive interference mitigation techniques such as dynamic or remote reduction in power and adjustment in operating frequencies, in order for Access BPL installations to avoid site specific, localized use of the same spectrum by licensed services. Access BPL systems shall incorporate a shut down feature to deactivate units found to cause harmful interference.
- ▶ (g) Entities operating Access Broadband over Power Line systems shall supply to a Federal Communications Commission/National Telecommunications and Information Administration recognized industry operated entity, information on all existing, changes to existing and proposed Access BPL systems for inclusion in a data base. Such information shall include the installation locations, frequency bands of operation, and type of modulation used. No notification to the FCC is required.