NTIA Report 08-450

POTENTIAL INTERFERENCE FROM BROADBAND OVER POWER LINE (BPL) SYSTEMS TO FEDERAL GOVERNMENT RADIOCOMMUNICATION SYSTEMS AT 1.7 - 80 MHz

Phase 2 Study

VOLUME I

technical report

U.S. DEPARTMENT OF COMMERCE • National Telecommunications and Information Administration

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PREFACE

This report contains two volumes. Volume I presents the main text and Volume II contains appendixes that provide additional technical supporting information that is summarized in Volume I.

EXECUTIVE SUMMARY

On October 14, 2004, the Federal Communications Commission (Commission or FCC) adopted a Report and Order that defined new Part 15 rules for Access Broadband over Power Line (BPL) systems. The National Telecommunications and Information Administration (NTIA) contributed to the Commission's work by providing analysis to support recommendations for refinements in the rules and measurement guidelines in comments and staff correspondence filed in response to the Commission's earlier BPL Notice of Proposed Rulemaking (NPRM). The NTIA Phase 2 study of Access BPL systems expands on its earlier Phase 1 study by providing additional modeling results and analyses to evaluate the effectiveness of the FCC's rules and measurement guidelines in minimizing the potential for harmful interference to federal radiocommunication systems under worst-case conditions.

NTIA's simulations of overhead Medium Voltage (MV) power lines show that aspects of the measurement guidelines addressed in the BPL Report and Order, such as measurement distance, locations, height and height correction factor, and antenna type, effectively estimate the peak electric field strength that might be experienced in the vicinity of the Access BPL energized power line. These simulations employ the Numerical Electromagnetic Code (NEC) software package to model a variety of power line configurations. NTIA investigated the Commission's new methodology for extrapolating field strength limits when measurements must be made at distances other than those specified in the rules. NTIA's simulations confirm that the extrapolation methodology provides a reasonable approximation of the predicted rate of field strength roll-off with distance in close proximity to the BPL device and its associated power lines.

The FCC's rules include special mechanisms for minimizing the likelihood of harmful interference to critical federal radiocommunication systems in addition to the baseline protection afforded by field strength limits, prohibition of harmful interference from Access BPL systems, and compliance measurement provisions. These special protection provisions have the following forms: geographic consultation areas, wherein BPL deployments at any frequency in those areas must be preceded by consultations between BPL operators and nearby radio operators; excluded bands, in which certain frequencies are not to be used by BPL in any geographic area; and small geographic exclusion zones, wherein BPL emissions are forbidden at specified frequencies. NTIA's analysis shows that, at the distances corresponding to these protection areas, BPL emissions are expected to result in only small increases in the noise floor of protected communications receivers, or power flux density levels that fall below the interference protection requirement for sensitive radioastronomy or over-the-horizon radar receivers.

This Phase 2 report illustrates the application of the rules and measurement guidelines in a case study. Using the NEC software package, NTIA created an elaborate power line model that approximates an existing overhead Access BPL power line structure. After applying the emissions limits and methodology from the BPL measurement guidelines, NTIA analyzed the noise floor increase expected in nearby receivers as a result of BPL operations. In addition, NTIA used this power line model to

analyze the BPL emission levels that might be seen at more distant receivers. The results of the case study are consistent with NTIA's earlier analyses using simple power line models.

NTIA's Comments in response to the BPL NPRM included a preliminary analysis of the aggregation of overhead Access BPL emissions via ionospheric propagation in the 1.7 to 30 MHz frequency range. That analysis has been further refined in this report to include NEC simulations of both an elaborate overhead power line model and an underground power line model, and the adopted BPL measurement guidelines were employed to ensure compliance with Part 15 rules. As in the earlier analysis, the Voice of America Coverage Analysis Program (VOACAP) High Frequency (HF) propagation software package was used for predicting the propagation of radiated BPL emissions. Ionospheric propagation was analyzed using these overhead and underground models over a wide range of conditions. The results of this analysis show that a widespread deployment of Access BPL systems throughout the United States is not expected to pose a problem for federal radiocommunication systems operating in the 1.7 to 30 MHz band.

In summary, the Phase 2 study analyses expanded on the scope of NTIA's earlier analyses and applied the Commission's adopted rules and measurement guidelines for Access BPL systems. The results of these analyses confirm that these Access BPL rules, measurement guidelines, and special protection provisions will limit the interference risks for federal radiocommunication systems.

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GLOSSARY

AWG	American Wire Gauge
BPL	Broadband over Power Line(s)
BW	Bandwidth
CISPR	International Special Committee on Radio Interference
CONUS	Continental United States
COTHEN	Customs Over The Horizon Enforcement Network
dB	Decibel
dBi	Decibel referenced to an isotropic radiator
dBm	Decibel referenced to 1 milliwatt
dBμV	Decibel referenced to 1 microvolt
dBW	Decibels referenced to 1 Watt
E	Electric Field Strength
EMC	Electromagnetic Compatibility
EUT	Equipment Under Test
FCC	Federal Communications Commission
G	Gain
GHz	Gigahertz
H	Magnetic Field Strength
HF	High Frequency
Hz	Hertz
I	Interference Power
ICAO	International Civil Aviation Organization
IRAC	Interdepartment Radio Advisory Committee
ITM	Irregular Terrain Model
ITS	Institute for Telecommunication Sciences
ITU	International Telecommunication Union
ITU-R	International Telecommunication Union Radiocommunication Sector
kHz	Kilohertz
km	Kilometer
LV	Low Voltage
m	Meter
MHz	Megahertz
mm	millimeter
mS	Siemens/meter
ms	Millisecond
MV	Medium Voltage
N	Noise Power
NEC	Numerical Electromagnetic Code
NOI	Notice of Inquiry
NPRM	Notice of Proposed Rulemaking
NTIA	National Telecommunications and Information Administration
OR	Off-Route

OTH	Over the Horizon
PFD	Power Flux Density
PLC	Power Line Communications
PLT	Power Line Telecommunications
R	Route
RF	Radio Frequency
RMS	Root Mean Square
RSMS	Radio Spectrum Measurement System
S	Signal Power
SNR	Signal-to-Noise Ratio
SSB	Single Sideband
SSN	Smoothed Sunspot Number
URD	Underground Residential Distribution
US&P	United States and Possessions
UTC	Universal Coordinated Time
VHF	Very High Frequency
VLA	Very Large Array
VOA	Voice of America
VOACAP	Voice of America Coverage Analysis Program
W	Watt
μA	Microampere
μV	Microvolt