

American National Standard

Requirements for Single Function Power-Line Carrier Transmitter/ Receiver Equipment

Approved 20 August 1997

American National Standards Institute

The Institute of Electrical and Electronics Engineers, Inc.
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AMERICAN NATIONAL STANDARD

REQUIREMENTS FOR SINGLE FUNCTION POWER-LINE CARRIER TRANSMITTER/RECEIVER EQUIPMENT

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American National Standard

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Foreword (This Foreword is not a part of American National Standard ANSI C93.5-1997)

This document was developed by Accredited Standards Committee C93, Power-Line-Carrier Equipment and Coupling Capacitor Voltage Transformers. During the development of the standard, the Committee considered input from a balanced group representing consumer, producer, and general-interest viewpoints, which it harmonized and integrated into the standard in its present, approved form.

Accredited Standards Committee C93 was established to coordinate, revise and update the existing documents into an effective group of American National Standards, including this standard for Single Function Power-Line Carrier Transmitter/Receiver Equipment. A separate standard will be developed to cover each type of equipment described in the Committee's Scope.

This is a new standard, *Requirements for Single Function Power-Line Carrier Transmitter/Receiver Equipment*, which includes technical definitions, performance ratings, testing methods, and manufacturing requirements for transmitter/receiver equipment. It is related to American National Standard *Power-Line Carrier Coupling Capacitor and Coupling Capacitor Voltage Transformers (CCVT)*, ANSI C93.1-1990, *Requirements for Power-Line Carrier Line Traps*, ANS C93.3-1994; *Requirements for Power-Line Carrier Line Tuning Equipment*, ANSI C93.4-1984.

Suggestions for improvement of this standard are welcome. They should be sent to Secretary, ASC C93, c/o NEMA, 1300 North 17th Street, Suite 1847, Rosslyn, VA 22209.

This standard was processed and approved for submission to ANSI by Accredited Standards Committee, C93, on Power-Line Carrier Equipment and Coupling Capacitor Voltage Transformers. Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the ASC C93 Committee had the following members:

Walter Seamon, Chairman
Christopher F. Merther, Secretary

<i>Organization Represented</i>	<i>Name of Representative</i>
Edison Electric Institute	Jim Benton Robert Morton G. Miller (Alt.)
Institute of Electrical & Electronic Engineers	Robert Morton Joseph Petruska
Manufacturers	Paolo Diamanti Chuck Peterson Roger Ray Jorge Ribeiro Miriam Sanders Walter Seamon
U.S. Dept. of Energy, Western Area Power Administration	Stan Friskney

This standard is dedicated to the memory of past Chairman of C93, Sig Bogdanowicz for his many contributions and dedicated service to this committee and other standards related to Power Line Carrier.

Requirements for single function power-line carrier transmitter/receiver equipment**1 Scope**

This standard applies to single function power-line carrier (PLC) transmitter/receiver equipment used to transfer information over power transmission circuits. This standard does not apply to transmitter/receiver equipment used over power distribution circuits for the purpose of load management or distribution automation.

2 Referenced American National Standards

This standard is intended for use in conjunction with the following American National Standards (ANS). When these standards are superseded by a revision approved by the American National Standards Institute (ANSI) the revision shall apply:

ANS C37.90.1-1989,	<i>ANSI/IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems</i>
ANS C37.90.2-1995	<i>ANSI/IEEE Standard For Withstand Capability of Relay Systems to Radiated Electromagnetic Interference From Transmitters</i>
ANS C37.98-1987,	<i>ANSI/IEEE Standard For Seismic Testing of Relays</i>
ANS C93.1-1990,	<i>Requirements for Power-Line Carrier Coupling Capacitors and Coupling Capacitor Voltage Transformers</i>
ANS C93.3-1994,	<i>Requirements for Power-Line Carrier Line Traps</i>
ANS C93.4-1984,	<i>Requirements for Power-Line Carrier Line Tuning Equipment</i>
ANSI/EIA 310-D-1992	<i>Racks, Panels, and Associated Equipment</i>
ANSI/IEEE 4-1978,	<i>ANSI/IEEE Standard Techniques for High-Voltage Testing</i>
ANSI/IEEE 100-1992,	<i>ANSI/IEEE Standard Dictionary of Electrical and Electronics Terms</i>
ANSI S1.4-1983,	<i>Specifications for Sound Level Meters</i>

3 Definitions

All definitions, except for terms specifically covered in this standard, shall be in accordance with ANSI/IEEE 100.

Average Output Power: The power delivered by a transmitter into its normal load impedance at its fundamental radio frequency when no modulating signal is present. (For continuous sine wave output signals, transmitter average output power is given by $P = E I$, where E and I are rms values and the output terminals are connected to a nominal resistance load.)

A-weighted Sound Level: The value of a sound pressure signal after it has been passed through the A-weighted filter whose response is described in ANSI S1.4-1983, Specification for Sound Meters. A-weighted sound levels are expressed in decibels by the symbol dB(A).

Attenuation: A decrease in signal power in transmission from one point to another.

Blocking Frequency: For FSK channels used in an unblocking relay system, the blocking frequency functions as the guard frequency, and usually is transmitted to prevent the operation of protection equipment.

Blocking Signal: The signal transmitted by a power-line carrier set to prevent operation of the relay system during faults outside the protected zone.

Carrier-Frequency Range: The total frequency band used for power-line carrier service.

Carrier-Frequency Band: The frequency band used for a particular one-way PLC channel.

Center Frequency: The frequency which is midway between the two shift frequencies for FSK transmitters and receivers, sometimes called the channel frequency. Also for ON-OFF carrier sets, the frequency midway between the two band edge frequencies of the channel. (These frequencies are usually integer multiples of 0.5 kHz)

Channel Time: The time between applying a signal to the input of the transmitter and generating an output from the receiver with the transmitter and receiver connected back-to-back.

Dependability: The facet of reliability that is related to the degree of certainty that a relaying channel will operate correctly.

Dielectric Withstand Capability: The ability of insulating material and physical spacing to withstand specified overvoltages for a specified time without flashover or puncture.

Electromagnetic Compatibility (EMC): The capability of electronic equipment or systems to be operated in the intended operational electromagnetic environment at designed levels of efficiency.

Electromagnetic Interference (EMI), Conducted: Electromagnetic energy that may be carried out of or into equipment by conductors that are connected to equipment terminals.

Electromagnetic Interference (EMI), Radiated: Electromagnetic interference fields which may be radiated away from or upon the outside of the most exterior equipment cover, module, cabinet, enclosure, or housing.

Frequency Variance: Frequency variance is the permissible frequency error of the PLC channel. The error consists of the total of the setting error and the stability error.

Guard Frequency: The frequency normally transmitted by a PLC FSK system. The guard signal is used to monitor the PLC channel integrity. The reception of the guard signal prevents tripping of the relay system.

Intermodulation: The modulation of the components of complex waves by each other, as a result of which waves are produced that have frequencies equal to the sums and differences and integral multiples of the components of the original complex wave.

Limiter: A device whose output amplitude is substantially linear with regard to the input up to a predetermined value and substantially constant thereafter.

Methods of Modulation

Amplitude Modulation (AM): A method of modulation in which the amplitude of a carrier is caused to depart from its reference value by an amount proportional to the instantaneous value of the modulating wave.

Carrier ON-OFF Keying: A method of modulation in which the transmitter output signal is keyed either "ON" or "OFF."

Frequency Shift Keying (FSK): A method of modulation in which the transmitter is shifted among fixed frequencies.

Single Sideband (SSB): A method of amplitude modulation in which one sideband is transmitted and the other is suppressed. The carrier wave may be either transmitted or suppressed.

Minimum Frequency Spacing: The minimum allowable frequency difference between adjacent channel center frequencies. This spacing can refer to the same type of equipment, or to different types of equipment.

Noise

Impulse Noise: Noise characterized by transient disturbances separated in time by quiescent intervals.

White Noise: Noise, either random or impulse type, that has a flat frequency spectrum range of interest.

Noise Emissions: Any part of the radio-frequency output that is not a component of the desired output, as determined by the type of modulation and specified bandwidth limitations.

Nominal Impedance: The impedance for which an input or an output circuit has been designed.

Operate Time: The time between applying a signal to the input of the transmitter and generating an output from the receiver with the transmitter and receiver connected back-to-back with a solid state output circuit and no intentional time delay.

Rated Transmitter Power: The average output power for which a PLC terminal has been designed.

Receiver Sensitivity: The minimum input signal level required by a receiver to produce a specified output.

Return Loss (RL): A measure of the dissimilarity between two impedances, being equal to the number of decibels that correspond to the scalar value of the reciprocal of the reflection coefficient, and hence being expressed by the formula:

$$RL = 20 \log \left| \frac{Z_a + Z_b}{Z_a - Z_b} \right|$$

Where: RL is return loss in decibels
 Z_a and Z_b are the two impedances

Security: The facet of reliability that relates to the degree of certainty that a relaying channel will not operate incorrectly.