AHRI Standard 110

2016 Standard for

Air-conditioning, Heating and Refrigerating Equipment Nameplate Voltages

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IMPORTANT

SAFETY RECOMMENDATIONS

It is strongly recommended that the product be designed, constructed, assembled and installed in accordance with nationally recognized safety requirements appropriate for products covered by this standard.

AHRI, as a manufacturers' trade association, uses its best efforts to develop standards employing state-of-the-art and accepted industry practices. However, AHRI does not certify or guarantee safety of any products, components or systems designed, tested, rated, installed or operated in accordance with these standards or that any tests conducted under its standards will be non-hazardous or free from risk.

Note:

This standard supersedes ANSI/AHRI Standard 110-2012.

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AIR-CONDITIONING, HEATING AND REFRIGERATING EQUIPMENT NAMEPLATE VOLTAGES

Section 1. Purpose

1.1 *Purpose.* The purpose of this standard is to establish, for air-conditioning, heating and refrigerating equipment: definitions; voltage rating requirements; equipment performance requirements; and conformance conditions.

1.1.1 *Intent.* This standard is intended for the guidance of the industry, including manufacturers, engineers, installers, contractors, and users.

1.1.2 *Review and Amendment.* This standard is subject to review and amendment as technology advances.

1.2 The provisions herein are recommendations intended for implementation only through reference by other authoritative documents.

Section 2. Scope

2.1 *Scope.* This standard applies to 50 Hz and 60 Hz electrical voltage ratings and operating limits as applied to air-conditioning, heating and refrigerating equipment, heat pumps, and electric furnaces as well as components.

2.1.1 *Exclusions.* Voltages less than 100V AC are not included in this standard.

Section 3. Definitions

All terms in this document will follow the standard industry definitions in the *ASHRAE Terminology* website (https://www.ashrae.org/resources--publications/free-resources/ashrae-terminology) unless otherwise defined in this section.

3.1 *Delta*. A three-phase transformer coil configuration that is commonly abbreviated by the Greek letter Δ.

3.2 *"Shall" or "Should."* "Shall" or "should" shall be interpreted as follows:

3.3.1 *Shall*. Where "shall" or "shall not" is used for a provision specified, that provision is mandatory if compliance with the standard is claimed.

3.3.2 *Should*. "Should" is used to indicate provisions which are not mandatory but which are desirable as good practice.

3.3 *Voltages.*

3.3.1 *Equipment Nameplate Voltage Rating*. The nominal Utilization Voltage marked on the equipment nameplate by the manufacturer (Tables 1 and 2).

3.3.2 *Low Voltage*. The Nominal System Voltage with the range between 100V and 1kV AC according to ANSI C84.1.

3.3.3 *Medium Voltage*. The Nominal System Voltage with the range between 1kV and 35kV AC according to IEEE 1585.

Note: For the purposes of this standard, 1kV is included under Medium Voltage.

3.3.4 *Nominal System Voltage*. A nominal value assigned to the electric power supply system for the purpose of conveniently designating its voltage class.

3.3.5 *Service Voltage*. The voltage at the point where the electric systems of the supplier and the user are connected.

3.3.6 *Utilization Voltage*. The voltage at the line terminals of the utilization equipment.

3.4 *Three-phase Systems*.

3.4.1 *Wye*. A three-phase transformer coil configuration that is commonly abbreviated by the letter Y. If a neutral conductor is supplied then it is connected to the center point of the transformer (see Figure 1).

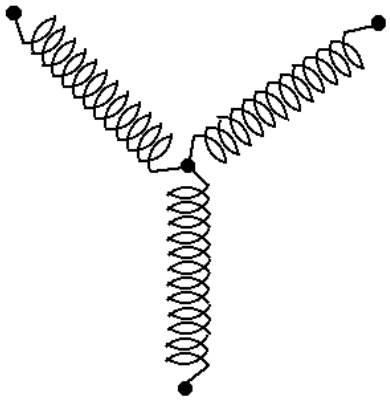

Figure 1. Three-phase Three-wire Voltage Source Ungrounded - Wye

3.4.2 *Three-phase Four-wire System*. A symmetrical voltage source which provides a grounded neutral conductor for connection of loads. The phase-to-neutral voltage amplitudes are 0.577 times the phase-to-phase amplitudes. Four-wire systems in Table 1 are designated by the phase-to-phase voltage, followed by the letter Y, which defines the transformer coil configuration, a slant line, and the phase-to-neutral voltage (see Figure 2).

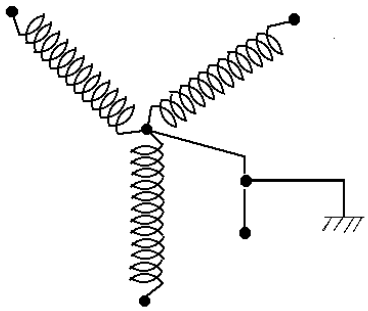

Figure 2. Three-phase Four-wire Voltage Source

3.4.3 *Three-phase Three-wire System*. A voltage source which only provides three phase conductors to the loads. The source may be derived from symmetrical, grounded or ungrounded transformer connections (see Figure 3).

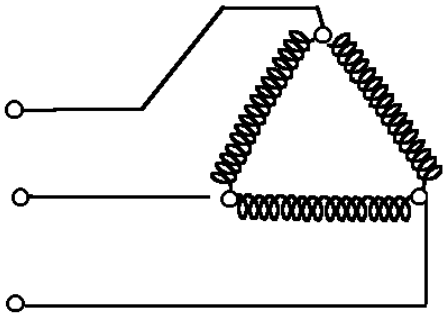

Figure 3. Three-phase Three-wire Voltage Source - Delta

3.4.4 *Corner-grounded System*. An asymmetrical three-wire voltage source in which one conductor is grounded. For the remaining phases the phase-to-neutral voltage amplitudes and the phase-to-phase amplitudes are the same (see Figure 4).

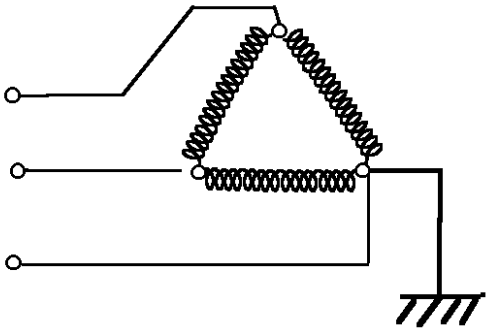

Figure 4. Corner-grounded Voltage Source

3.4.5 *High-leg System*. An asymmetrical three-wire voltage source in which a center-tap of one transformer coil is grounded. The phase-to-neutral voltage amplitude of two phases is 0.5 times the phase-to-phase amplitude. The high leg phase amplitude is 0.865 times the phase-to-phase amplitudes (see Figure 5).

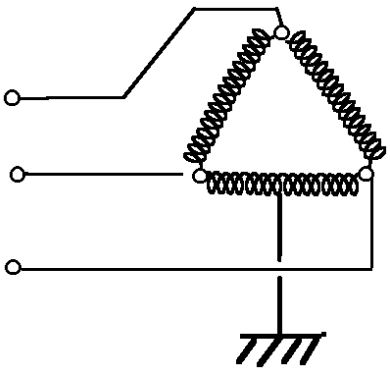

Figure 5. High-leg Voltage Source

Section 4. Voltage Rating Requirements

4.1 *Standard System Voltage Relationships.* Tables 1, 2, and 3 present the basic relationships between standard Nominal System Voltages and Utilization Voltages for air-conditioning, heating and refrigeration equipment and components. (Data derived from ANSI C84.1).

4.2 *Application of Voltage Ranges.* (See ANSI C84.1).

4.2.1 *Range A-Service Voltage*. Electric supply systems are designed and operated so that most Service Voltages are within the limits specified for this range. The occurrence of Service Voltages outside of these limits should be infrequent and should be handled as a special occurrence.

4.2.2 *Range A-Utilization Voltage.* User systems are to be designed and thus must operate acceptably between the minimum and maximum Utilization Voltage Range A.

Utilization equipment shall be designed and rated to give acceptable performance throughout this range, per the applicable AHRI Standard.

4.2.3 *Range B-Service and Utilization Voltages.* This range includes Voltages above and below Range A limits that necessarily result from practical design and operating conditions on supply or user systems or both. Although such conditions are a part of practical operations, they are typically limited in extent, frequency and duration. When they occur, corrective measures are typically undertaken within a reasonable time to improve Voltages to meet Range A requirements.

Insofar as practical, utilization equipment shall be designed to give acceptable performance in the extremes of this range of Utilization Voltage, although not necessarily equal performance as in Range A.

4.2.3.1 *Exception.* For 208V systems only, motor driven equipment shall be designed to start and operate satisfactorily under rated load conditions at the extremes of Range B, but not necessarily under maximum load conditions. For rated and maximum load conditions, see the industry standards for the product concerned.

It must be recognized that, because of conditions beyond the control of the supplier or user, or both, there will be infrequent and limited periods when sustained Voltages outside of Range B limits will occur. Utilization equipment may not operate satisfactorily under these conditions, and protective devices may operate to protect the equipment. When Voltages occur outside the limits of Range B, prompt corrective action is recommended. The urgency for such action will depend upon many factors, such as the location and nature of load or circuits involved, and the magnitude and duration of the deviation beyond Range B limits.

Table 1. Low Voltage 60 Hz Systems in the USA[2]

Nominal System Voltage, V	Nameplate Voltage Marking, V	Voltage Range A[1]				Voltage Range B[1]			
		Maximum, V	Minimum, V			Maximum, V	Minimum, V		
		Utilization and Service Voltage	Service Voltage	Utilization Voltage for Lighting and Power Circuits Servicing Cord-plug Connected Equipment	Utilization Voltage (All Other)	Utilization and Service Voltage	Service Voltage	Utilization Voltage for Lighting and Power Circuits Servicing Cord-plug Connected Equipment	Utilization Voltage (All Other)
120	115	126	114	110	108	127	110	106	104
208 or 240	208/230 (200/230)	252	197	Not Applicable	187	254	191	Not Applicable	180
208	208 (200)	228	197	191	187	228	191	184	180
240	230	252	228	220	216	254	220	212	208
277	265	291	263	254	249	293	254	245	240
480	460	504	456	440	432	508	440	424	416
600	575	630	570	550	540	635	550	530	520

Notes:

1) Power systems exist whose operating characteristics deviate from the voltage range limits of this table. It shall not be construed that nameplate voltage rated equipment, suitable for application to such systems and deviating from the values appearing in this table, be produced.

2) Motors are usually guaranteed to operate satisfactorily and to deliver their full power at the rated frequency and at a voltage 10% above or below their rating, or at the rated Voltage. Some U.S. single-phase HVAC components that are dual-voltage rated (e.g., 208/230-1-60) may carry a minus 5% voltage allowance from the lower Voltage rating of 208 volts.
Equipment having more than one marked rated Voltage, which is permitted to be connected to these Voltages without individual adjustment, should have the Voltages separated by a hyphen.
Example: 208-230V; The equipment may be operated at these Utilization Voltages or at Voltages between these values without individually adjusting for the difference between them.
Equipment having more than one marked rated Voltage, which requires rewiring or other adjustments made by the installer to the equipment to permit connection to these Voltages, shall have the Voltages separated by an oblique stroke.
Example: 208/230V; The equipment may be operated at these Utilization Voltages only if the installer makes the proper wiring or adjustment to the equipment for each voltage as specified by the manufacturer.

4.3 *Medium Voltages for 60Hz USA Systems Only*. For the standard Nominal System Voltages for 60Hz units for USA systems only, see Table 2.

Table 2. Medium Voltage 60 Hz Systems in the USA

Nominal System Voltage, V	Nameplate Voltage Marking, V	Voltage Range A			Voltage Range B		
		Maximum	Minimum		Maximum	Minimum	
		Utilization and Service Voltage	Service Voltage, V	Utilization Voltage[1], V	Utilization and Service Voltage, V	Service Voltage, V	Utilization Voltage[1], V
Nominal System Voltage Does not Apply for the Medium Voltage Range.	2340	2520	2340	2160	2540	2280	2080
	4050/2340	4370Y/2520	4050Y/2340	3740Y/2160	4400Y/2540	3950Y/2280	3600Y/2080
	4050	4370	4050	3740	4400	3950	3600
	4680	5040	4680	4320	5080	4560	4160
	6730	7240	6730	6210	7260	6560	5940
	8110/4680	8730Y/5040	8110Y/4680	-	8800Y/5080	7900Y/4560	-
	11700/6760	12600Y/7270	11700Y/6760	-	12700Y/7330	11400Y/6580	-
	12160/7020	1309Y/7560	12160Y/7020	-	13200Y/7620	11850Y/6840	-
	12870/7430	13860Y/8000	12870Y/7430	-	13970Y/8070	12504Y/7240	-
	13460/7770	14490Y/8370	13460Y/7770	-	14520Y/8380	13110Y/7570	-
	13460	14490	13460	12420	14520	13110	11880
	20260/11700	21820Y/12600	20260Y/11700	-	22000Y/12700	19740Y/11400	-
	22290/12870	-	22290Y/12870	-	-	21720Y/12540	-
	22430	-	22430	-	-	21850	-
				-		23690Y/13680	-
							-

1) Utilization equipment does not generally operate directly at these Voltages. For equipment supplied through transformers, refer to limits for nominal system voltage of transformer output.

4.4 *Nominal Voltages for 50Hz and 60Hz Non-USA Systems Only*. For the standard Nominal System Voltages for 50Hz and 60Hz units for non U.S.A. systems only, see Table 3.

Table 3. Standard Nominal System Voltages for 50Hz and 60Hz Systems (Non-USA Systems)[1]

Systems	Nominal Frequency, Hz	Voltage				
		Highest Supply or Utilization Voltage, V	Nominal Voltage, V	Lowest Supply Voltage, V	Lowest Utilization Voltage, V	Nameplate Voltage Marking, V
Three-phase Four-wire or Three-wire Systems[2]	50	254	230	208	198	230
		254/440	230/400	208/360	198/344	230/400
		440/759	400/690 or 380/660	360/621	344/593	400/690
		1100	1000	900	860	1000
	60	132/229	120/208	108/187	103/179	120/208
		264	240, 200, or 220	216	206	240
		254/440	230/400	208/360	198/344	230/400
		305/528	277/480	249/432	238/413	277/480
		528	480	432	413	480
		382/660	347/600	312/540	298/516	347/600
		660	600	540	516	600
Single-phase Three-wire Systems	50	132/264	120/240 or 100/200	108/216	103/206	120/240
	60	132/264	120/240	108/216	103/206	120/240

Notes:

1) There are many power systems throughout the world and this table lists the most common.

2) The first number is phase to neutral voltage and the second number is phase to phase voltage.

4.5 *AC Three Phase Systems with Nominal Voltage Above 1kV and Not Exceeding 35kV at 50Hz and 60Hz (For Non-USA Systems Only).* For AC three phase systems with nominal voltage above 1kV and not exceeding 35kV at 50Hz and 60Hz in the USA only, see Table 4, which was derived from IEC Standard 60038.

Table 4. AC Three Phase Systems with Nominal Voltage Above 1kV and not Exceeding 35kV at 50Hz and 60Hz (For Non-USA Systems Only)[1,2]

Highest Voltage Equipment, kV	Nominal System Voltage, kV		Nameplate Voltage Marking, kV
3.6[3]	3.3[3]	3[3]	3.3
7.2[3]	6.6[3]	6[3]	6.6
12	11	10	11
17.5	-	15	15
24	22	20	22
36[4]	33[4]	30[4]	33
40.5[4]	-	35[4]	35

Notes:
1) In any one country, the ratio between two adjacent nominal voltages shall be not less than two.
2) In a normal system, the highest voltage and the lowest voltage do not differ by more than approximately ±10% from the nominal voltage of the system.
3) These values shall not be used for new public distribution systems.
4) The unification of these values is under consideration.

Section 5. Equipment Performance Requirements

5.1 *Equipment Standard Rating Requirements.* Equipment standard rating tests, in accordance with equipment rating standards, shall be conducted at the Equipment Nameplate Voltage Rating. For all dual nameplate voltage equipment covered by this standard, any Standard Rating tests shall be performed at both Voltages or at the lower of the two Voltages if only a single Standard Rating is to be published.

Section 6. Conformance Conditions

6.1 *Conformance.* While conformance with this standard is voluntary, conformance shall not be claimed or implied for products or equipment within the standard's *Purpose* (Section 1) and *Scope* (Section 2) unless such product claims meet all of the requirements of the standard and all of the testing and rating requirements are measured and reported in complete compliance with the standard. Any product that has not met all the requirements of the standard shall not reference, state, or acknowledge the standard in any written, oral, or electronic communication.

APPENDIX A. REFERENCES - NORMATIVE

A1 Listed here are all standards, handbooks and other publications essential to the formation and implementation of the standards. All references in this appendix are considered as part of the standard.

A1.1 ANSI C84.1-2011, *Electrical Power Systems and Equipment - Voltage Ratings (60 Hz)*, 2011, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, U.S.A.

A1.2 *ASHRAE Terminology*, https://www.ashrae.org/resources--publications/free-resources/ashrae-terminology, 2016, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, GA 30329, U.S.A.

A1.3 IEC Standard 60038-2009, *IEC Standard Voltages*, 2009, International Electrotechnical Commission, 3, rue de Varembe, P.O. Box 131, 1211 Geneva 20, Switzerland.

A1.4 IEEE 1585-2002, Guide for the Functional Specification of Medium Voltages (1-35kV) Electronic Series Devices for Compensation of Voltage Fluctuations, 2002, Institute of Electrical and Electronics Engineers, 3 Park Avenue, 17th Floor New York, NY 10016.

APPENDIX B. REFERENCES - INFORMATIVE

B1 Listed here are all standards, handbooks, and other publications which may provide useful information and background but are not considered essential. References in this appendix are not considered part of the standard.

B1.1 *ASHRAE Handbook—HVAC Systems and Equipment, 2012*, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., 1791 Tullie Circle N.E., Atlanta, GA 30329, U.S.A.