ANSI/AHRI Standard 110-2024 (SI/I-P)

Air-conditioning, Heating and Refrigerating Equipment Nameplate Voltages

Approved American National Standard

ANSI

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IMPORTANT

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ICS Code: 29.020

Note:

This standard supersedes AHRI Standard 110-2016.

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Intent

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

Review and Amendment

This standard is subject to review and amendment as technology advances.

2024 Edition

This edition of AHRI Standard 110, *Air-conditioning, Heating, and Refrigerating Equipment Nameplate Voltages*, was prepared by the Electrical Standards Technical Committee (STC). The standard was approved by the Multi-sector Standards Subcommittee (SSC) on 19 February 2024. This standard was approved as an American National Standard (ANS) on 21 March 2024.

Origin and Development of AHRI Standard 110

The initial publication was ARI Standard 110-1990, *Air-Conditioning and Refrigerating Equipment Nameplate Voltages*. Subsequent revisions were:

ARI Standard 110-1997, *Air-Conditioning and Refrigerating Equipment Nameplate Voltages*

ANSI/AHRI Standard 110-2002, *Air-Conditioning, Heating and Refrigerating Equipment Nameplate Voltages*

ANSI/AHRI Standard 110-2012, *Air-Conditioning, Heating and Refrigerating Equipment Nameplate Voltages*

AHRI Standard 110-2016, *Air-Conditioning, Heating and Refrigerating Equipment Nameplate Voltages*

Summary of Changes

ANSI/AHRI Standard 110-2024 (SI/I-P) contains the following update(s) to the previous edition:

- Update references to current versions
- Reaffirm that the standard remains applicable in 50 hertz countries

Committee Personnel

Electrical Standards Technical Committee

Company/Organization	Participant	Voting Role
Voting Organizations		
ebm-papst Inc.	Armin Hauer, Chair	Primary
Carrier Corporation	Ismail Agirman	Primary
Daikin Applied Americas Inc.	Joe Schoen	Primary
Hussmann Corporation	Ron Shebik	Primary
Lennox International Inc.	Ravi Gurunarayana	Primary
Mitsubishi Electric Cooling & Heating	Jeremy Tidd	Primary
	Alvaro Araque	Alternate
Nidec Motor Corporation	Tim Albers	Primary
Trane Technologies	Vijaya Chauhan	Primary
Nonvoting Organizations		
Daikin Manufacturing Company, L.P.	Daisuke Oshimi	Nonvoter
	Dominic Poon	Nonvoter
Maria Woodbury		AHRI Staff Liaison

Electrical Standards Technical Committee Scope:

The Electrical Standards Technical Committee (STC) is responsible for the development and maintenance of AHRI standards and guidelines pertaining to electrical voltage rating and operating limit requirements for air-conditioning and refrigerating equipment.

Multi-sector Standards Subcommittee

Company/Organization	Participant	Voting Role
Voting Organizations		
Copeland	Jennifer Butsch, Chair	Primary
Carrier Corporation	Scott MacBain	Primary
Daikin Comfort Technologies Manufacturing, L.P.	Jeff Whitelaw	Primary
Danfoss	Brian Dail	Primary
Parker Hannifin Corporation	John Withouse	Primary
The Chemours Company FC, LLC	Esther Rosenberg	Primary
Karl Best		AHRI Staff Liaison

Multi-sector Standards Subcommittee Scope:

The scope of the Multi-sector Standards Subcommittee (SSC) is standards and guidelines related to components that are part of and methods that are for end products from any AHRI product sector. (The definition of and list of products associated with each sector are found on AHRI's website.)

These lists represent the membership at the time the Standards Technical Committee (STC) and Standards Subcommittee (SSC) were balloted on the final text of this edition. Since that time, changes in the membership may have occurred. Membership on these committees shall not in and of itself constitute an endorsement by the committee members or their employers of any document developed by the committee on which the member serves.

Multi-sector Standards Consensus Body

Participant	Interest Category Classification
Mike Devine Tecumseh Products Company	Component Manufacturer
Henry Ernst Daikin Applied Americas Inc.	Product Manufacturer
Caroline Henley UL Solutions	Testing Laboratory
Paul Lindahl SPX Cooling Technologies, Inc.	Product Manufacturer
W. Vance Payne National Institute of Standards & Technology	Testing Laboratory
Karl Peterman Swegon North America Inc.	Product Manufacturer
Charles Plourde-LeBlanc Nortek Air Solutions, LLC	Product Manufacturer
Greg Woyczynski Association of Home Appliance Manufacturers	General Interest

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AIR-CONDITIONING, HEATING, AND REFRIGERATING EQUIPMENT NAMEPLATE VOLTAGES

Section 1. Purpose

This standard establishes definitions, voltage rating requirements, and equipment performance requirements for air-conditioning, heating, and refrigerating (AHR) equipment.

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.

2.2 Exclusions

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

Section 3. Definitions

All terms in this document shall follow the standard industry definitions in the ASHRAE Terminology website unless otherwise defined in this section.

3.1 Expression of Provisions

Terms that provide clear distinctions between requirements, recommendations, permissions, options, and capabilities.

3.1.1 "Can" or "cannot"

Express an option or capability.

3.1.2 "May"

Signifies a permission expressed by the document.

3.1.3 "Must"

Indication of unavoidable situations and does not mean that an external constraint referred to is a requirement of the document.

3.1.4 "Shall" or "shall not"

Indication of mandatory requirements to strictly conform to the standard and where deviation is not permitted.

3.1.5 "Should" or "should not"

Indication of recommendations rather than requirements. In the negative form, a recommendation is the expression of potential choices or courses of action that is not preferred but not prohibited.

3.2 Standard Specific Definitions

3.2.1 Delta

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

3.2.2 Rating Conditions

Any set of operating conditions where a single level of performance results and causes only that level of performance to occur.

3.2.3 Standard Rating

A rating based on tests performed at *standard rating conditions*.

3.2.4 Standard Rating Conditions

Rating conditions used as the basis of comparison for performance characteristics.

3.2.5 Three-phase Systems

3.2.5.1 Corner-grounded System

An asymmetrical three-wire voltage source with one grounded conductor. For the remaining phases, the phase-to-neutral voltage amplitudes and the phase-to-phase amplitudes are the same (see Figure 4).

3.2.5.2 Three-phase Three-wire System, Wye (Y)

A symmetrical three-phase transformer coil configuration that is commonly abbreviated by the letter Y. When supplied, a neutral conductor is connected to the center point of the transformer (see Figure 1).

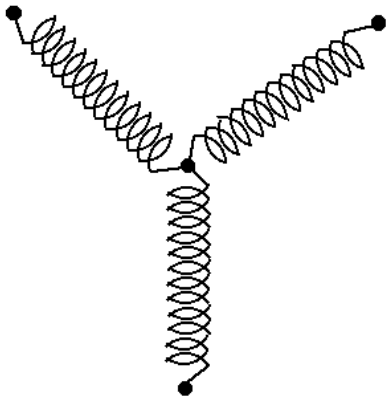

Figure 1 Three-phase Three-wire Voltage Source Ungrounded - Wye

3.2.5.3 Three-phase Four-wire System, Wye (Y)

A symmetrical voltage source that 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, and this defines the transformer coil configuration, a slant line, and the phase-to-neutral voltage (see Figure 2).

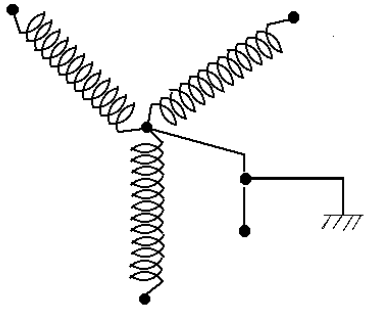

Figure 2 Three-phase Four-wire Voltage Source

3.2.5.4 Three-phase Three-wire System

A symmetrical voltage source that only provides three phase conductors to the loads. The source can be derived from symmetrical, grounded, or ungrounded transformer connections (see Figure 3).

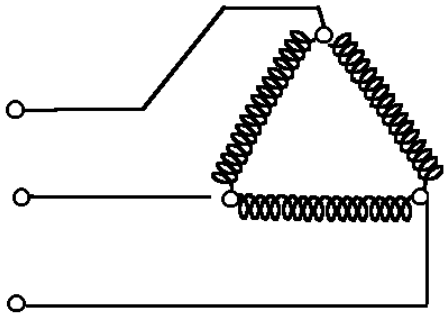

Figure 3 Three-phase Three-wire Voltage Source - Delta

3.2.5.5 Corner-grounded System

An asymmetrical three-wire voltage source with one grounded conductor. For the remaining phases, the phase-to-neutral voltage amplitudes and the phase-to-phase amplitudes are the same (see Figure 4).

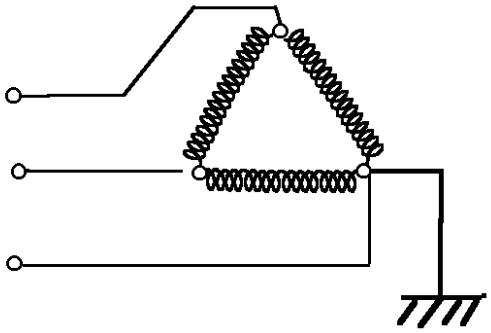

Figure 4 Corner-grounded Voltage Source

3.2.5.6 High-leg System

An asymmetrical three-wire voltage source where 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).

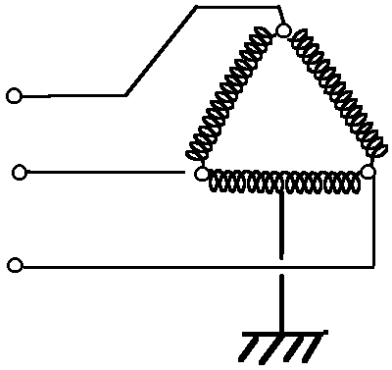

Figure 5 High-leg Voltage Source

3.2.6 Voltage

The electric potential or potential difference.

3.2.6.1 Equipment Nameplate Voltage Rating

The nominal *utilization voltage* marked on the equipment nameplate by the manufacturer (see Table 1 and Table 2).

3.2.6.2 Low Voltage

The *nominal system voltage* with a range between 100 V and 1 kV AC according to ANSI C84.1.

3.2.6.3 Medium Voltage

The *nominal system voltage* with a range between 1 kV and 35 kV AC according to IEEE 1585.

Note: *Medium voltage* includes 1 kV for the purposes of this standard.

3.2.6.4 Nominal System Voltage

A nominal value assigned to the electric power supply system for the classification by *voltage*.

3.2.6.5 Service Voltage

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

3.2.6.6 Utilization Equipment

Electrically powered air-conditioning, heating, and refrigeration equipment.

3.2.6.7 Utilization Voltage

The *voltage* at the line terminals of the *utilization equipment*.

Section 4. Test Requirements

This standard does not have any applicable test requirements.

Section 5. Rating Requirements

This standard does not have any applicable rating requirements.

Section 6. Minimum Data Requirements for Published Ratings

This standard does not establish requirements for published ratings.

Section 7. Conformance Conditions

This standard does not establish conformance conditions.

Section 8. Voltage Rating Requirements

8.1 Standard System Voltage Relationships

Table 1, Table 2, and Table 3 present the basic relationships between standard *nominal system voltages* and *utilization voltages* for air-conditioning, heating, and refrigeration equipment and components. The data is derived from ANSI C84.1.

8.2 Application of Voltage Ranges

See ANSI C84.1.

8.2.1 Range A-Service Voltage

Electric supply systems are designed and operated so that *service voltages* are within the limits specified for this range.

Note: The occurrence of *service voltages* can be outside of these limits and should be handled as a special occurrence.

8.2.2 Range A-Utilization Voltage

User systems shall be designed to operate between the minimum and maximum *utilization voltage* Range A.

Utilization equipment shall be designed and rated to give performance throughout this range, in accordance with the applicable AHRI standard.

8.2.3 Range B-Service and Utilization Voltages

This range includes *voltages* above and below Range A limits that necessarily result from design and operating conditions on supply or user systems or both. These conditions that are a part of operations can be limited in extent, frequency, and duration. When these conditions occur, corrective measures are undertaken to improve *voltages* to meet Range A requirements.

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

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.

Because of conditions beyond the control of the supplier or user, or both, there can be periods when sustained *voltages* outside of Range B limits occur. *Utilization equipment* can operate incorrectly under these conditions, and protective devices can operate to protect the equipment.

Note: When *voltages* occur outside the limits of Range B, corrective action should be taken. The urgency for such action depends upon factors, such as the location and nature of load or circuits involved, and the magnitude and duration of the deviation beyond Range B limits.

8.2.4 Equipment Nameplate Voltage Ratings

AHR equipment having more than one *equipment nameplate voltage rating*, where permitted to be connected to these *voltages* without individual adjustment, shall have the *voltages* separated by a hyphen.

- 208-230V example: The equipment can be operated at these *utilization voltages* or at *voltages* between these values without individually adjusting for the difference between the values.

As of April 2023, motors covered by US CFR Title 10, Chapter II, Subchapter D, Part 431 Subpart B shall meet required efficiency levels for every *voltage* listed on an electric motor nameplate. Additionally, this affects electric motors rated as 230 V nameplate nominal *voltage* with an incremental 208 V marking, including a “Usable at” marking.

AHR equipment having more than one *equipment nameplate voltage rating*, that 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.

- 230/460V example: The equipment can 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. See Table 1.

Table 1 Low Voltage 60 Hz Systems in the USA

Nominal System Voltage, V	Equipment Nameplate Voltage Rating, 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	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:

- Motors can be guaranteed to operate and to deliver their full power at the rated frequency and within ±10% of their motor nameplate voltage rating. US single-phase AHR components that are dual voltage rated (such as 208-230) can carry a minus 5% voltage allowance from the lower voltage rating of 208 volts.

1. Power systems exist whose operating characteristics deviate from the voltage range limits of Table 1.

8.3 Medium Voltages for 60 Hz USA Systems Only

For the standard *nominal system voltages* for 60 Hz units for USA systems only, see Table 2.

Table 2 Medium Voltage 60 Hz Systems in the USA

Nominal System Voltage	Equipment Nameplate Voltage Rating, 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	—

Notes:

- *Utilization equipment* does not always operate directly at these *voltages*. For equipment supplied through transformers, refer to limits for *nominal system voltage* of transformer output.

1. For three-phase four-wire systems, the first number is phase to phase voltage and the second number is phase to neutral voltage.

8.4 Nominal Voltages for 50 Hz and 60 Hz Non-USA Systems Only

For the standard *nominal system voltages* for 50 Hz and 60 Hz units for non-USA systems only, see Table 3.

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

Systems	Nominal Frequency, Hz	V[1]				
		Highest Supply or Utilization Voltage	Equipment Nameplate Voltage Rating, V	Nominal Voltage	Lowest Supply Voltage	Lowest Utilization Voltage
Three-phase four-wire or three-phase three-wire systems	50	254	230	230	208	198
		254/440	230/400	230/400	208/360	198/344
		440/759	400/690	400/690 or 380/660	360/621	344/593
		1100	1000	1000	900	860
	60	132/229	120/208	120/208	108/187	103/179
		264	240	240, 200, or 220	216	206
		254/440	230/400	230/400	208/360	198/344
		305/528	277/480	277/480	249/432	238/413
		528	480	480	432	413
		382/660	347/600	347/600	312/540	298/516
		660	600	600	540	516
Single-phase three-wire systems	50	132/264	120/240	120/240 or 100/200	108/216	103/206
	60	132/264	120/240	120/240	108/216	103/206

Notes:

- Table 3 lists common power systems used throughout the world.

1. For three-phase four-wire systems, the first number is phase to neutral voltage and the second number is phase to phase voltage.

8.5 Three Phase Systems with Nominal Voltage Above 1 kV and Not Exceeding 35 kV at 50 Hz and 60 Hz

For three phase systems with nominal *voltage* above 1 kV and not exceeding 35 kV at 50 Hz and 60 Hz in the USA only, see Table 4, derived from Table 3 of IEC 60038.

Table 4 Three Phase Systems with Nominal Voltage Above 1 kV and not Exceeding 35 kV at 50 Hz and 60 Hz for Non-USA Systems Only

Highest Voltage for Equipment, kV	Nominal System Voltage, kV		Equipment Nameplate Voltage Rating, kV
3.6	3.3	3	3.3
7.2	6.6	6	6.6
12.0	11.0	10	11.0
17.5	—	15	15.0
24.0	22.0	20	22.0
36.0	33.0	30	33.0
40.5	—	35	35.0

In any one country, the ratio between two adjacent nominal *voltages* shall be not less than two.

The highest *voltage* and the lowest *voltage* should not differ by more than ± 10% from the nominal *voltage* of the system.

Section 9. Equipment Performance 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.

APPENDIX A. REFERENCES – NORMATIVE

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

A.1. ANSI C84.1-2020, *Electrical Power Systems and Equipment — Voltage Ratings (60 Hz)*, 2020, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA.

A.2. ASHRAE Terminology. ASHRAE. Accessed September 9, 2022. https://www.ashrae.org/technical-resources/free-resources/ashrae-terminology.

A.3. IEC Standard 60038:2009+Amd1:2021 CSV, *IEC standard voltages*, 2021, International Electrotechnical Commission, 3, rue de Varembe, P.O. Box 131, 1211 Geneva 20, Switzerland.

A.4. IEEE 1585-2002 (Reaffirmed 2007), *Guide for the Functional Specification of Medium Voltages (1-35kV) Electronic Series Devices for Compensation of Voltage Fluctuations*, 2007, Institute of Electrical and Electronics Engineers, 3 Park Avenue, 17th Floor New York, NY 10016, USA.

APPENDIX B. REFERENCES – INFORMATIVE

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

B.1. *ASHRAE Handbook—HVAC Systems and Equipment*, 2020, ASHRAE, 180 Technology Parkway, Peachtree Corners, GA 30092, USA.

B.2. *ASHRAE Handbook—HVAC Applications Chapter 57 Electrical Considerations*, 2019, ASHRAE, 180 Technology Parkway, Peachtree Corners, GA 30092, USA.