

Electrical Service Types and Voltages

This application note describes various types of utility electrical services and supply voltages. The nominal system supply voltages listed below can vary by $\pm 10\%$ or more. Measuring the phase-to-phase and phase-to-line voltages in the field is highly recommended to confirm the type of electrical service.

Classification of Electrical Services

Alternating current (AC) electric power distribution systems can be classified by the following properties:

- Frequency: 50 Hz or 60 Hz
- Number of phases: single or three phase
- Number of wires: 2, 3, or 4 (not counting the safety ground)
- Neutral present:
 - Wye connected systems have a neutral
 - Delta connected systems typically do not have a neutral
- Voltage levels:
 - Low Voltage: 600 volts or less
 - Medium Voltage: 601 volts to about 34,500 volts
 - High Voltage: 46,000 volts and up

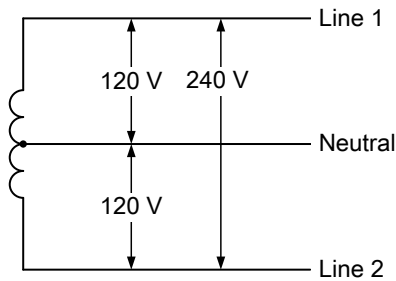
Wye, Line-to-Neutral Voltage	Wye or Delta, Line-to-Line Voltage
120	208
120	240
230	400
240	415
277	480
347	600

- Line-to-line voltages are typically 1.732 times the phase-to-neutral voltages.
- In a symmetrical three-phase electrical system, the phase-to-neutral voltages should be equal if the load is balanced.

Common Electrical Services and Loads

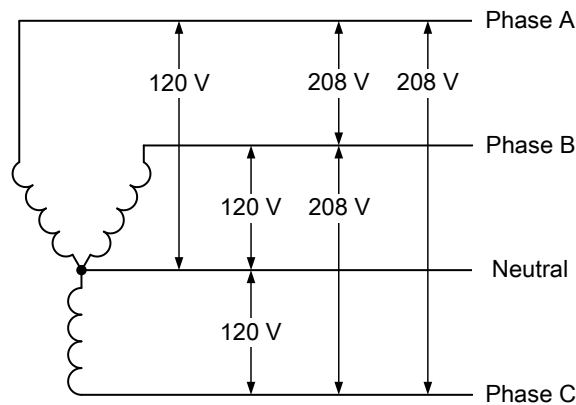
In the following drawings, the coil symbols represent the secondary winding of a utility service transformer or other step down transformer. Electrical code regulations in most jurisdictions require that the neutral conductor be bonded (connected) to the earth safety ground at the electrical service entrance.

Single Phase Three Wire



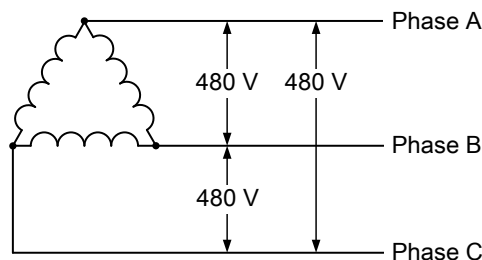
Also known as an Edison system, split-phase or center-tapped neutral, this is the most common residential service in North America. Line 1 to neutral and Line 2 to neutral are used to power 120 volt lighting and plug loads. Line 1 to Line 2 is used to power 240 volt single phase loads such as a water heater, electric range, or air conditioner.

Three Phase Four Wire Wye



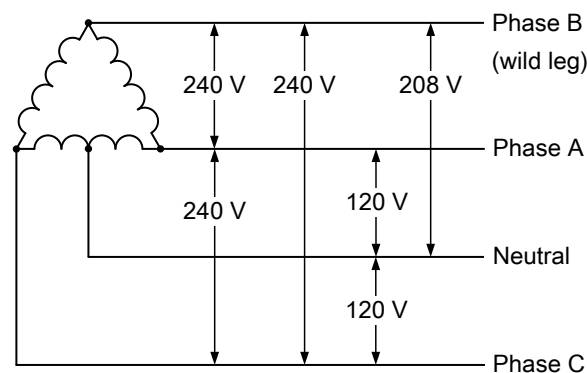
The most common commercial building electric service in North America is the 120/208 volt wye, which is used to power 120 volt plug loads, lighting, and smaller HVAC systems. In larger facilities the voltage is 277/480 volt and used to power single phase 277 volt lighting and larger HVAC loads. In western Canada 347/600 volt is common.

Three Phase Three Wire Delta



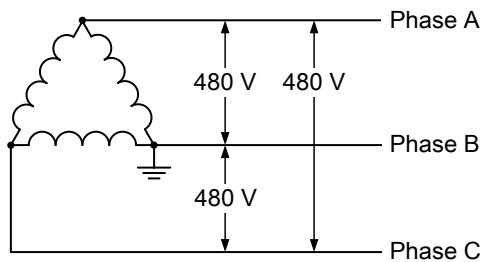
Used primarily in industrial facilities to provide power for three-phase motor loads, and in utility power distribution applications. Nominal service voltages of 240, 400, 480, 600 volts and higher are typical.

Three Phase Four Wire Delta



Also known as a high-leg or wild-leg delta system. Used in older facilities with mostly three-phase motor loads and some 120 volt single-phase lighting and plug loads. Similar to the Three Phase Three Wire Delta discussed above but with a center-tap on one of the transformer winding to create a neutral for 120 volt single-phase loads. Single-phase loads are connected to either phase A or C and to neutral. Phase B, the high or wild leg, is not used as the voltage to neutral is 208 volt.

Three Phase Two Wire Corner-Grounded Delta



Used to reduce wiring costs by using a service cable with only two insulated conductors rather than the three insulated conductors used in a convention three phase service entrance.

International Electrical Distribution Systems

Description	L-N Vac	L-L Vac	Countries
Single Phase, 2-Wire 120 V with neutral	120		US
Single Phase, 2-Wire 230 V with neutral	230		EU, Others
Single Phase, 2-Wire 208 V (no neutral)		208	US
Single Phase, 2-Wire 240 V (no neutral)		240	US
Single Phase, 3-Wire 120/240 V	120	240	US
3-Phase, 3-Wire 208 V Delta (no neutral)		208	US
3-Phase, 3-Wire 230 V Delta (no neutral)		230	Norway
3-Phase, 3-Wire 400 V Delta (no neutral)		400	EU, Others
3-Phase, 3-Wire 480 V Delta (no neutral)		480	US
3-Phase, 3-Wire 600 V Delta (no neutral)		600	US, Canada
3-Phase, 4-Wire 208Y/120 V	120	208	US
3-Phase, 4-Wire 400Y/230 V	230	400	EU, Others
3-Phase, 4-Wire 415Y/240 V	230	415	Australia
3-Phase, 4-Wire 480Y/277 V	277	480	US
3-Phase, 4-Wire 600Y/347 V	347	600	US, Canada
3-Phase 4-Wire Delta 120/208/240	120/208	240	US
3-Phase 4-Wire Delta 240/415/480	240/415	480	US