ULTIMATE SERVICE ASSOCIATES
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Generator 101 (Part 4) - 12-Wire Brushless Generator Voltages

1.0 Introduction

Power Generation is a multi-disciplined subject. A generator system is a sum of numerous parts requiring knowledge of many subjects including, but not limited to, electrical generation, engine mechanics, digital control, power distribution, principals of electricity, and switchgear control. This information sheet is Part 4 of a series addressing some electrical basics and terminology used in the generator system industry either as a buyer, specifier, user, technician or sales person. While these sheets will not qualify you as a mechanical or electrical engineer (who if consulted will provide more in-depth explanation) they provide a general overview for a 101 comprehension of the subject.

This information sheet discusses the terminology 12-wire brushless generator, the various voltage connections available, and the advantages of a 12-wire brushless generator to both manufacturer, supplier, and user.

PRINCIPAL 12-WIRE BRUSHLESS GENERATOR VOLTAGE CONNECTIONS

Figure 1

SERIES HIGH WYE

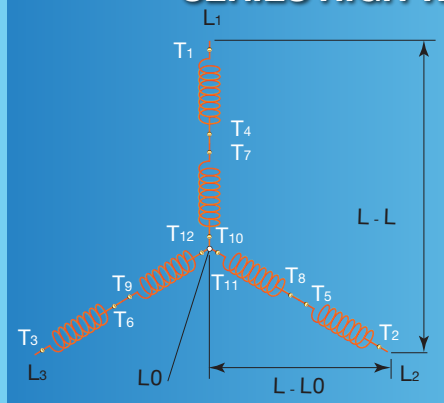

Figure 1A

Voltages Series High Wire		
Hz	L-L	L-L0
60	380	219
	416	240
	440	254
	460	266
	480	277

SERIES HIGH DELTA

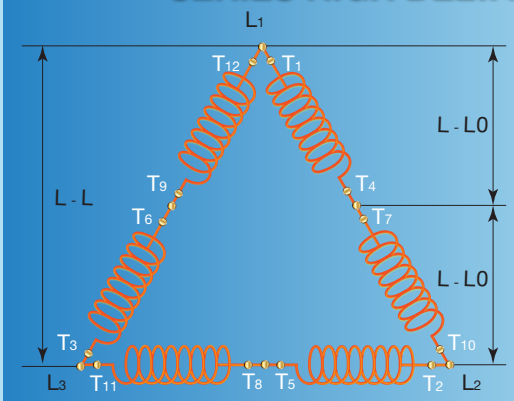

Figure 1C

Voltages Series High Delta		
Hz	L-L	L-L0
60	240	120
	277	139

PARALLEL LOW WYE

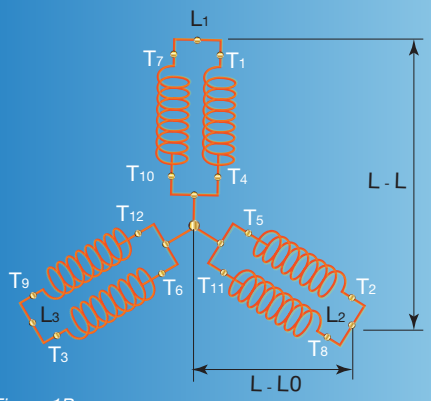

Figure 1B

Voltages Parallel Low Wire		
Hz	L-L	L-L0
60	190	110
	208	120
	220	127
	230	133
	240	139

PARALLEL LOW DELTA

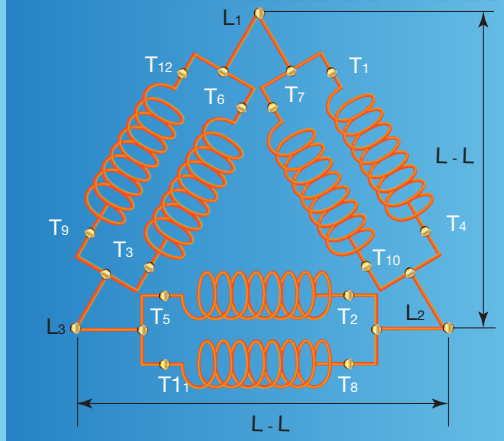

Figure 1D

Voltages Series Low Delta		
Hz	L-L	n/a
60	110	
	120	

To fulfill our commitment to be the leading network service provider in the Power Generation Industry, the USA, Inc. team maintains up-to-date technology and information standards on Power Industry changes, regulations and trends. As a service, our **Information Sheets** are circulated on a regular basis, to existing and potential Power Customers to maintain awareness of changes and developments in engineering standards, electrical codes, and technology impacting the Power Generation Industry.

2.0 What Does 12-wire Mean:

In a brushless generator configuration, the rotating part is the magnetic field, and the stator, the stationary part. With a brushless generator design, the electricity or electromotive force (EMF), is generated in the stator's armature coils, as covered in Information Sheet - Electricity 101 Part 3. The stator wiring, as the word indicates are stationary, with the rotor being the magnetic field.

2.1 Stator Wire Coils – In a standard brushless generator there are six copper coils wound into the stator. As the rotor with the magnetized coils rotates, its magnetic field generated in the rotor winding cuts across the coils wound into the stationary stator to induce an EMF into each of these coils. The coils of the stator are the source of the electric current being generated

2.2 Individual Coil Ends – Brushless generators are referred to as 12-wire reconnectable generators. To be more precise the number 12 refers to the end of each coil in the stator, hence 6-coils and with each coil end we have the number 12.

3.0 The Advantage of a 12-Wire Connectable:

As the electric power is generated in the stator's armature coils, and not the rotor, it is not necessary to use carbon brushes to pick up the electrical power from a rotor commutator to which the individual coils are connected, hence the term brushless. This provides generator manufacturers and operators with considerable advantages, including:

3.1 Greater Reliability - Brushless maintenance intervals are considerably expanded because brushes don't have to be inspected and replaced.

3.2 No Arcing between Brushes and Commutator - Arcing can produce radio interference and this is eliminated.

3.3 Several Voltage Options from One Generator - Unlike a carbon brush generator, where the commutator has to be engineered to give one particular voltage connection from the individual coils. A brushless generator produces its power in the 6 coils wound into the stator. As such, each 12-ends of the coil wires can be connected to give a variety of voltage options.

Having the ability to configure voltage output over a range enables manufacturers to produce a range of generators that meet a wide range of applications. Users such as generator rental companies can have their generator rental fleet equipped with voltage selector switches to set the voltage output to individual customer requirements.

4.0 Are There Other Wire Options than 12-Wire:

Generator suppliers also supply 4, 6, and 10-wire options.

5.0 Typical Voltage Configurations Available from a Brushless Generator:

The 12 terminals, one for each of the 6-coils in the armature, terminate in a terminal box located on the generator. Depending how these ends are connected will provide a range of voltage configurations that can be customized for various applications. The range of voltages is shown in ***Figure 1.***

Depending on how the terminals are connected provides a range of the most commonly used voltages used in industrial, commercial and residential applications. The voltage range is from 120 to 480 volts in various three- and single-phase options. In this sheet we cover the most common options. The power generation industry has given a name to the various configurations to how the terminals are connected. See charts in ***Figure 1.***

6.0 Coils Connected in Series or Parallel:

As discussed, the same electrical power (amperage and volts) is generated in the six armature coils wound into the stator. As indicated in ***Figure 1*** the coils are connected in pairs. Usually, the connection is in series with the two coils connected in line, or in parallel where the coils side by side have their terminals ends connected. The reasons for the two methods are:

6.1 Series - When connected in series end to end, double the voltage is generated. With this option there is less amperage output but increased voltage.

6.2 Parallel - In a parallel connection each pair of coils will produce a lower voltage, the same as generated in each coil but the amperage will increase.

7.0 Voltage Available by Connecting Pairs of Coils in Wye or Delta Configurations:

The two most common terms for connecting the coil terminals are Wye or Delta (Wye by some manufacturers and users is also referred to as Star). Each terminal end is assigned a reference, per ***Figure 1*** this sheet refers to T1 through to T12. The voltage available is dependent on whether the coils are connected in Wye or Delta configurations. Voltages are usually assigned a designation line to line (L to L) or line to neutral (L to L0). The following covers the two types of connections:

7.1 Series High Wye - In the Wye configuration, each pair of coils are connected in series with the end of each pair connected to the neutral point per ***Figure 1A***. The term High Wye is given because this is the arrangement line to line and line to neutral voltages will be the highest. This would be a common choice for installations having equipment that runs on a higher voltage which means less amperage and hence less copper.

7.2 Parallel Low Wye - As illustrated in ***Figure 1B*** each pair of coils are in parallel with their ends all connected at the neutral. This is now referred to as Low Wye because the voltage is lower. This voltage is more common in commercial and residential applications. Note in ***Figure 1B*** the lower L to L and L to L0 connections.

7.3 Series High Delta - As illustrated in ***Figure 1C*** each pair of coils are in series connected end to end, but this time in a delta configuration. Again, the high format relates to the higher voltage. It is also possible to have a single phase with a connection to the center tap, as indicated in ***Figure 1C*** where T4 and T7 connect with a link L - L0.

7.4 Series Low Delta - As illustrated in ***Figure 1D*** each pair of coils are connected in parallel; this provides the lower voltage delta configuration. Note all connections are L - L with no center tap available.

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