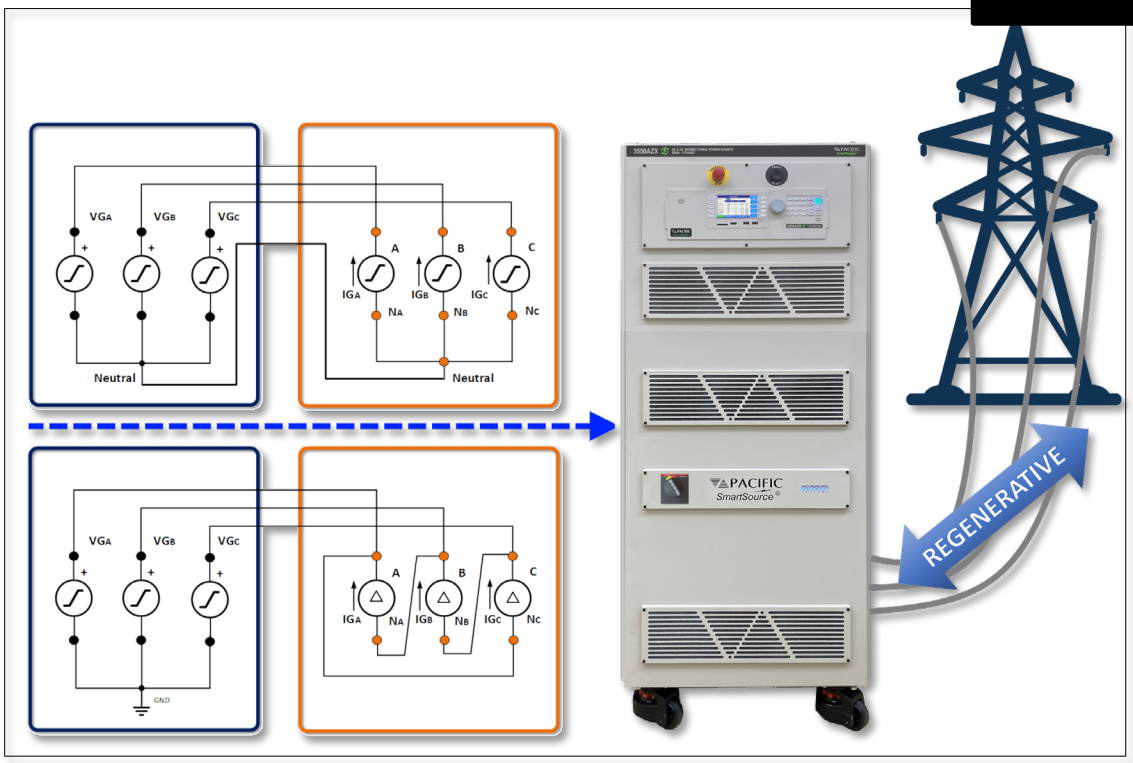
# AZX Output / Input Configuration Forms

**AGX SERIES**
**AZX SERIES**




## 1 AZX Series Output Configurations

The AZX Series Regenerative AC & DC power source / Load unit supports five output configurations in either Source or Load modes. These configurations are:

| Mode | Phase Mode | Applications |
|---|---|---|
| **FORM 1** | Single Phase Mode | Used for DC applications or Single-phase AC loads |
| **FORM 2** | Split Phase Mode | Used for Split Phase or Single-phase loads that require higher AC voltages |
| **FORM 3** | Three Phase Mode | Used for all three phase WYE or DELTA AC Loads. This mode simulates standard power grids. |
| **FORM 4** | Dual Outputs or Inputs | Provides two separate outputs (Source Mode) or separate inputs (AC Load Mode option). Independent Frequency. |
| **FORM 5** | Tripple Outputs or Inputs | Provides two separate outputs (Source Mode) or separate inputs (AC Load Mode option). Independent Frequency. |

These five output configuration modes are illustrated in the diagram shown in Figure 1.

By selecting FORM4 or FORM5, the user can set different frequency values for each of the two or three outputs. In source mode, this allows the AZX to function as two or three independent AC power sources, each having its own voltage, current limit, frequency, and phase setting.

In Electronic Load mode, FORM4 and FORM5 allow the load to be set to different Load modes such as Constant Current (CC), Constant Power (CP), Constant Impedance (CR) or Constant Voltage (CV) for each individual input.

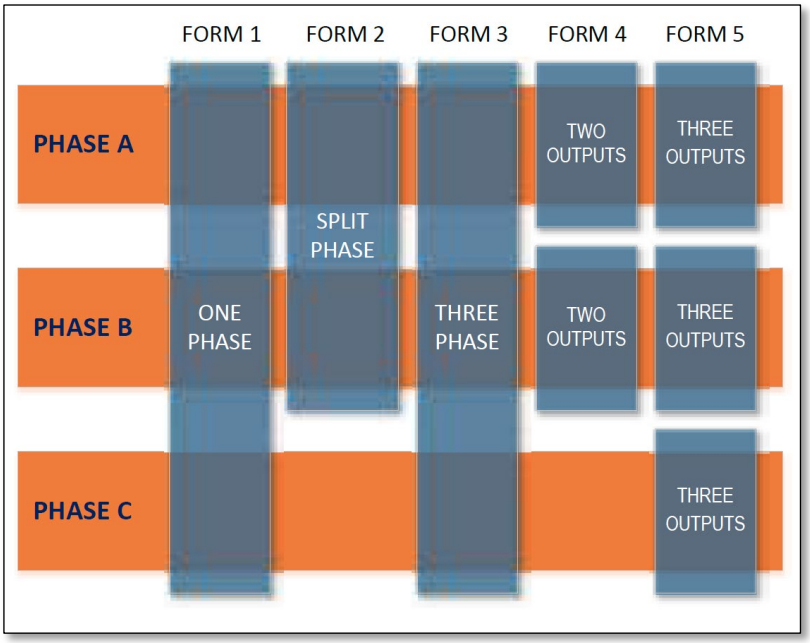



Figure 1-1: Illustration of FORM's 1 through 5

These additional output configurations in combination with isolated neutral connections allow for additional EUT support in both AC or DC Source mode as well as AC or DC Load mode of operation. This application note explains the various EUT configurations that can be tested using the AZX with W option.

## 2 Isolated Neutral Option W

The available "W" option (Alternate Output Wiring) removes the internal connection between the three output neutral terminals. This renders them galvanically isolated from each other. As a result, the neutrals for phases A, B and C can be at different voltage potentials with respect to chassis ground at all times.

This has some important application specific benefits as explained in subsequent paragraphs of this application note.

## 3 AZX Load Mode connection to a WYE / STAR AC Source

AC sources that have a WYE or STAR output configuration will have three phase connections and a neutral connection. These types of common AC source configurations can be directly connected to the AZX Electronic Load inputs, A, B, C and the common Neutral (NA, NB and NC are connected internally unless the "W" Option is configured on the AZX) as shown in the image below. Note that if the W Option is installed, the user must connect the three Neutral terminals on the AZX load input together for this test setup to function.

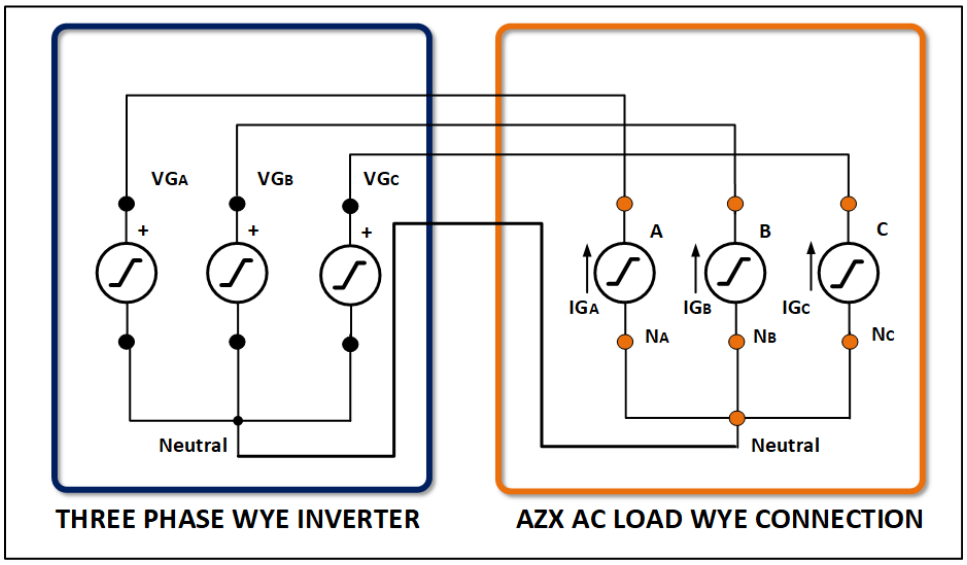
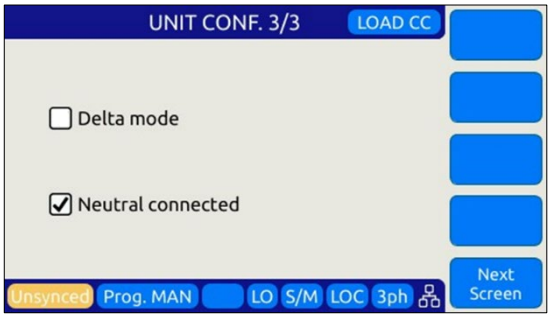



Figure 2-1: AZX Load Connection to AC Source with WYE Output

This applies to three phases and the split phase without neutral connection in all the load modes.

Note that this AC Load setup is supported on all AZX units - with or without the "W" Option - as only a common neutral input is required.

Typical supported WYE/STAR Inverter output voltages for this configuration are:




| Grid Voltage | Regions | Supported |
|---|---|---|
| **120 VLN / 208 VLL** | US, Canada | ✓ |
| **220 VLN / 380 VLL** | Asia | ✓ |
| **230 VLN / 400 VLL** | Europe | ✓ |
| **277 VLN / 480 VLL** | US | ✓ |
| **346 VLN / 600 VLL** | Canada | ✓ |

## 4 AZX Load Mode connection to a Delta AC Source

When testing three phase AC sources with a DELTA output configuration on the other hand, there is no output neutral available to connect to the AZX Load neutral input(s). Connecting such a unit under test to only phases A, B and C of the AZX electronic load would leave the input neutral of the AZX floating, allowing it to float to any voltage level. This condition may result in an over voltage protection fault as the AZX load input voltage sense circuits are neutral referenced and thus the Line to Neutral input voltage measurement results may be off. If that happens, the AZX load will be unable to load the AC voltage source and will trip and over voltage error. This setup is reflected in the Figure below.

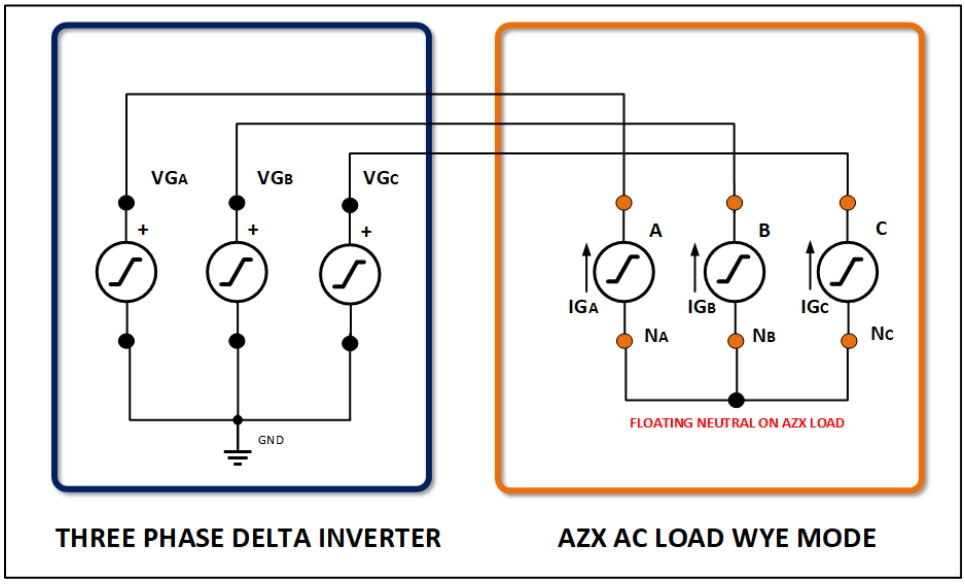
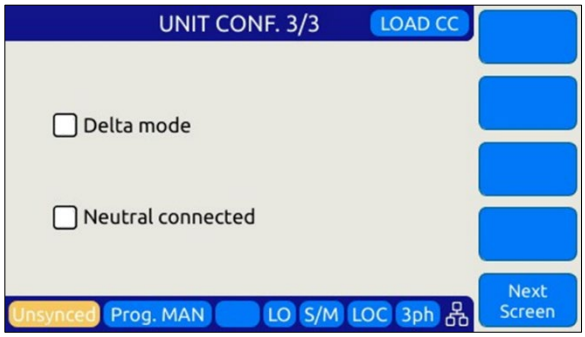



Figure 3-1: Incorrect AZX Load Connection to a DELTA AC Source

When the neutral is floating, or not connected, disable the Neutral connected option in the System Configuration 3/3 screen so that the AZX can control the neutral point to 0 and avoid an OVP error. See the 3rd UNIT CONFIGURATION screen shown to the right. The same setting can be made using the web browser interface, CONFIGURATION menu.




If there is no neutral connection (Neutral connected = unchecked), the Load will compensate the L-N voltage measurements to maintain a zero (virtual) neutral.

## 5 Delta AC Source Load Mode with Isolation Neutrals W Option

To directly support these types of Delta only AC sources, the "W" Option may be used if configured so the AZX in AC Load mode can better support a Delta input. This alternative connection method is shown in the image below.

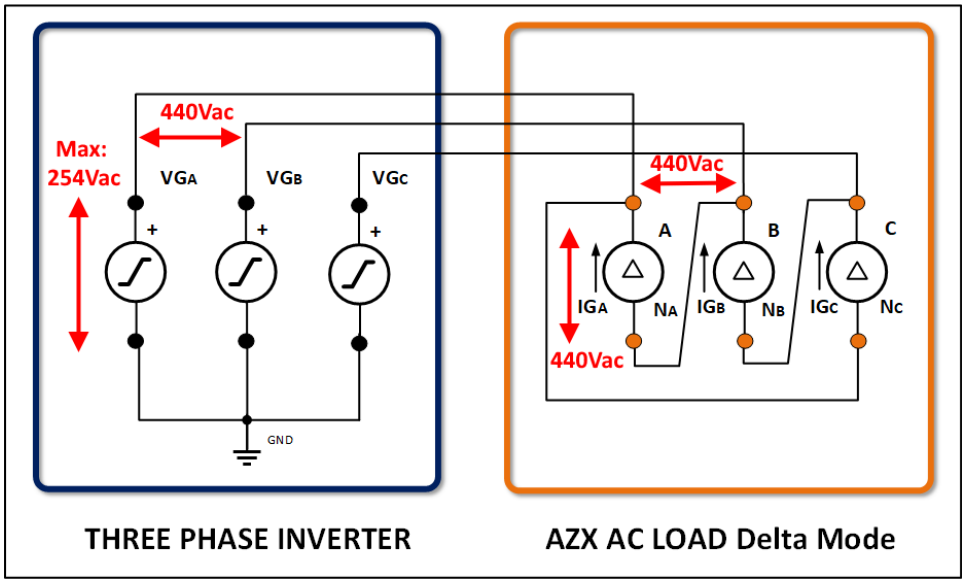
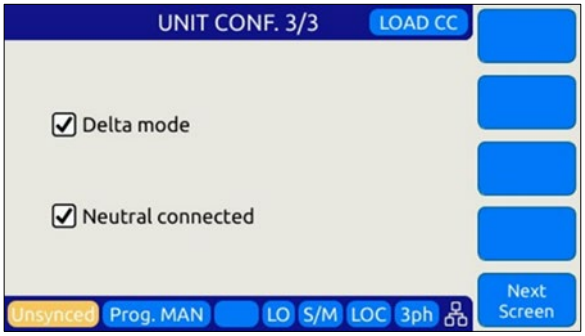



Figure 3-1: Alternative AZX Load with W option Connection to a DELTA AC Source

The only trade-off is that the maximum supported input voltage is reduced. In this mode of operation and configuration, the AZX AC load maximum supported AC input voltage is reduced from 440Vac to 254Vac. This restriction is caused by the fact that the voltage across each of the AZX load power stages will be √3 * VG (Generator Voltage). Since the maximum AC voltage for an AZX is 440Vac, the highest output voltage of the connected three phase inverter must be no more than 440 / √3 = 254Vac.




Typical supported DELTA Inverter output voltages for this configuration are:

| Grid Voltage | Regions | Supported |
|---|---|---|
| **120 VLN / 208 VLL** | US, Canada | ✓ |
| **220 VLN / 380 VLL** | Asia | ✓ |
| **230 VLN / 400 VLL** | Europe | ✓ |

| Grid Voltage | Regions | Supported |
|---|---|---|
| **254 VLN / 440 VLL** | --- | Max. |
| **277 VLN / 480 VLL** | US | **No** |
| **346 VLN / 600 VLL** | Canada | **No** |

## 6 Phase Angle Settings in AC Load Mode

Note that phase angle programming in AC load mode in CC, CR or CP Modes is based on current phase angles, not voltage. As such, if the **SYNC** setting is enabled, the phase angle setting controls the shift between the voltage and the current for each phase, A, B and C.

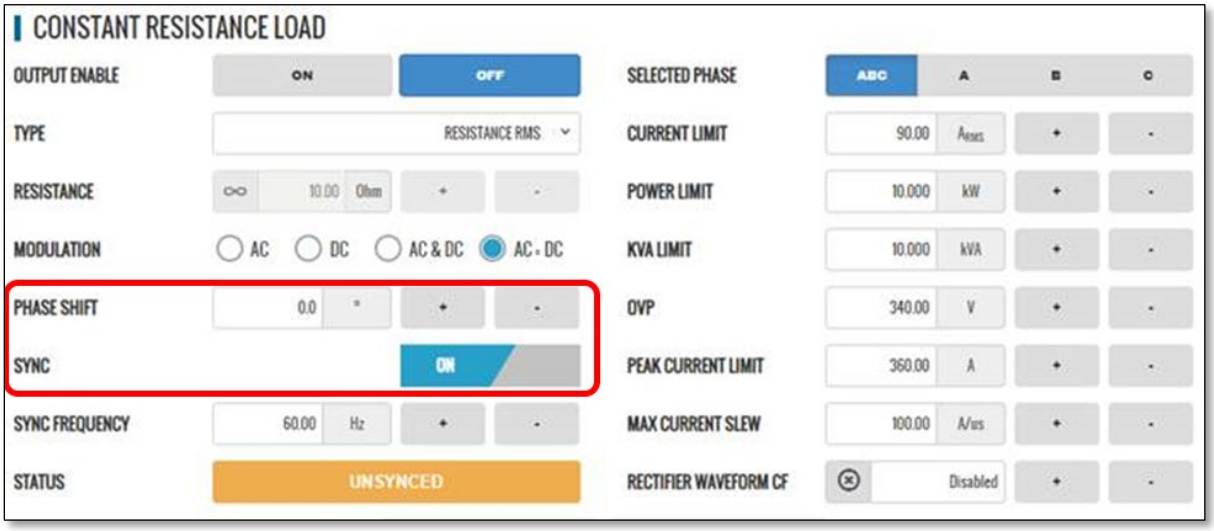



Figure 4-1: AZX AC Load Mode Phase Shift set to SYNC ON in web browser interface.

For example, in the AC load mode and constant resistance mode with SYNC set to **ON**, setting the phase angels to:

Phase A= 0°
Phase B= 120°
Phase C=240°

the AZX load will pushed back the current to phases B and C. Thus, the load will not be balanced. This is because the input voltages from the unit under test are likely 120 degrees apart.

To fix this, set all phase angle settings to 0°. At that setting, all three phases will be loaded correctly.

A zero on all phases produces voltages and current that are in sync for each phase.

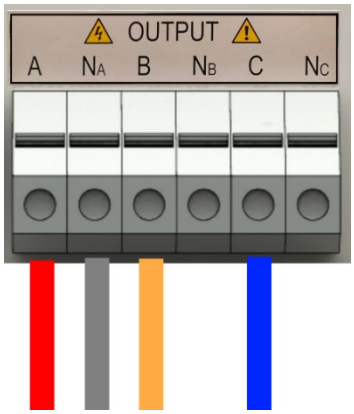
For a balanced three phase voltage it will produce current at 0 / 120 / 240 and will end up in a unity power factor load.

## 7 Operating modes and Output Connections AZX versus AZX-W

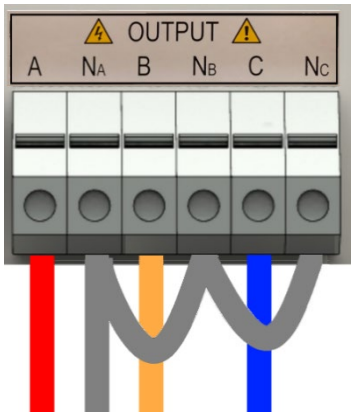
The standard AZX unit has 3 inverters (phases) in a Y (star) connection, i.e. all neutrals are shorted together with an internal shorting busbar. In voltage mode they function as three **voltage sources**, in current or load mode they function as three **current sources**.

The W Option means this internal shorting busbar has been removed, so it converts the AZX to three independent (and thus floating) voltage or current sources, similar to having three batteries, which can be externally connected in Y (star), delta, or even in series."

Thus, a standard AZX is identical to an AZX -W with its three Neutral terminals shorted externally.




*Standard AZX Output*




*AZX with W Option Output*

With the AZX working in voltage mode, if the outputs are connected in delta mode it is equivalent to connecting three voltage sources in parallel, which is a problem since voltage sources that are connected in parallel will "fight" to control the voltage. This results in at least one of them tripping an overcurrent protection.

Delta connection of the AZX output is mostly meant to be used in load and current source mode. In general, voltage mode should be used with star (Y) connection of the outputs.

Something similar happens with a standard AZX (with star connection) in load (or current mode) with the neutral terminals **not** connected to the voltage source (unit under test). It´s equivalent to have current sources in parallel, which is not permissible as one phase will saturate its output trying to control the current.

To summarize:

- AZX in three phase voltage mode, output "should" be connected in star (Y), as the standard AZX.
- AZX in three phase current or load mode, output "should" have the Neutral connected to the voltage source or changed to delta connection (with W option).

With the AZX working as a load (or current source), these are the possible combinations:

- AZX (load) in star + UUT (voltage source) in star = WORKS (with neutral connection to the AZX)

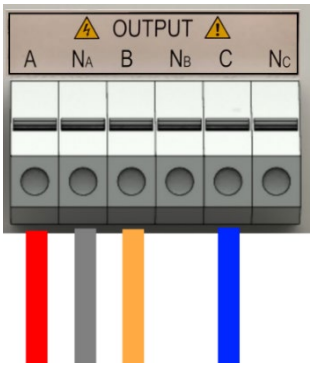
- AZX (load) in star + UUT (voltage source) in delta = DOES NOT WORK => need W option + delta connection in AZX
- AZX-W (load) in delta + UUT (voltage source) in delta = WORKS
- AZX-W (load) in delta + UUT (voltage source) in star (no neutral connection) = WORKS

One more important consideration is that the AZX in load mode is based on **current sources**. So even in "resistive" emulation mode, the output power stages work as current sources and don´t behave as actual resistors. So, they cannot have a current source connected to them as a unit under test. The unit under test **MUST** be a voltage source.

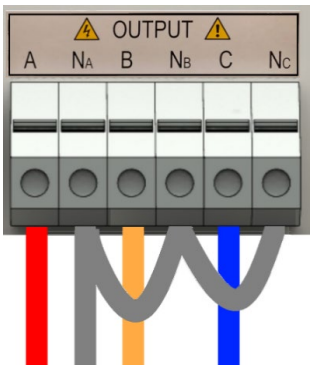
Using an AZX with W option, you can make a star or delta connection, but with a standard AZX, only a star connection is possible because all Neutrals are shorted together inside.

The following connections are supported:

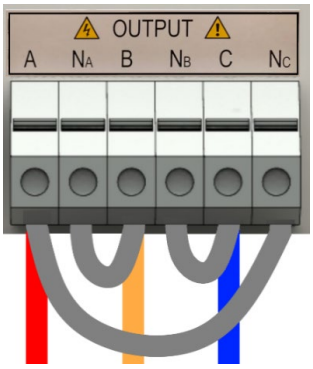
**Star output** with a standard AZX: Na, Nb, Nc neutrals shorted inside unit, connect only one neutral or all 3 neutrals, depending on the neutral current level. For balanced 3 phase loads, one neutral connection is usually sufficient:




**Star output with "Option W" AZX:** Na, Nb, Nc neutrals **MUST** be shorted outside unit, either at terminal block or at the load:




**Delta output** with "W Option" AZX: Note the required Phase to Neutrals connections shown.



## 8 Summary

This application note explains the purpose and applications for the “W” option which provides three isolated neutral output / input connections, one for each phase.

## 9 Customer Support

For application support, contact Pacific Power Source’s Customers Service - Toll Free US: +1 (800) 854-2433 / support@pacificpower.com or your local authorized Pacific Power Source distributor.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