

# **Introduction to the Power Pallet Grid Tie System**

APL Workshop  
August 11, 2013  
Bear Kaufmann

# What a genset grid tie system entails

Synchronizing

Switching

Safeties

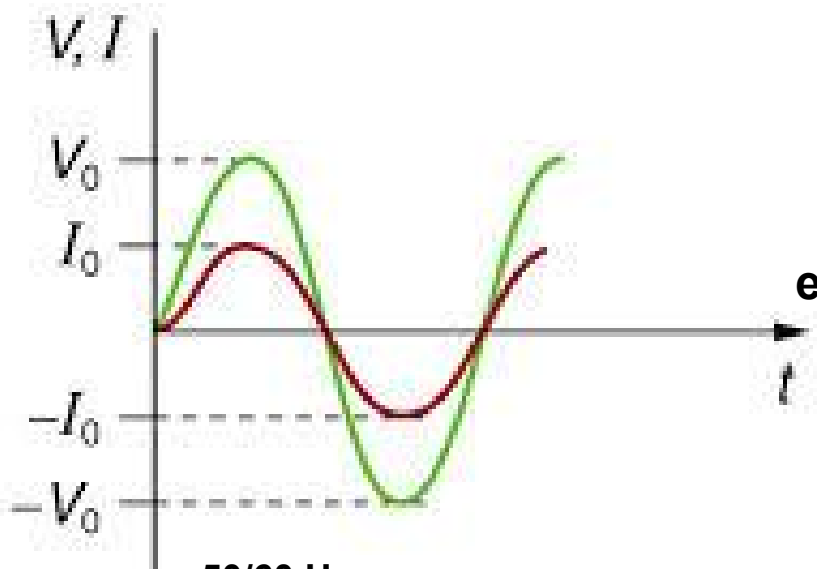
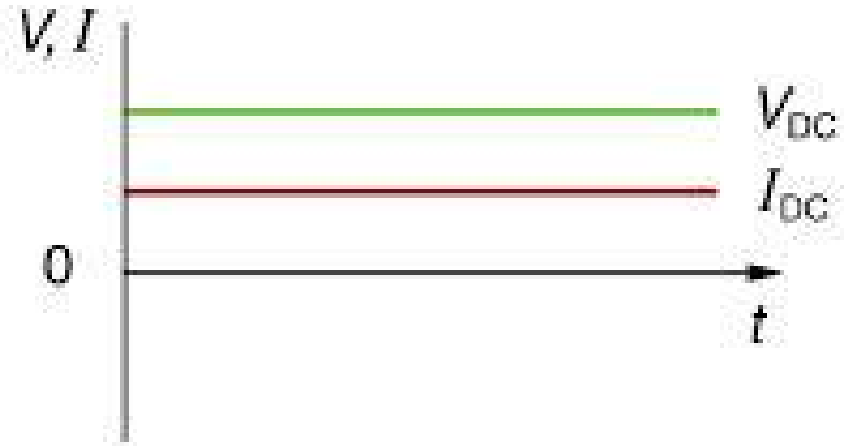
Wiring/Topology

Dynamics

# Survey of Grid Tie Controller Options

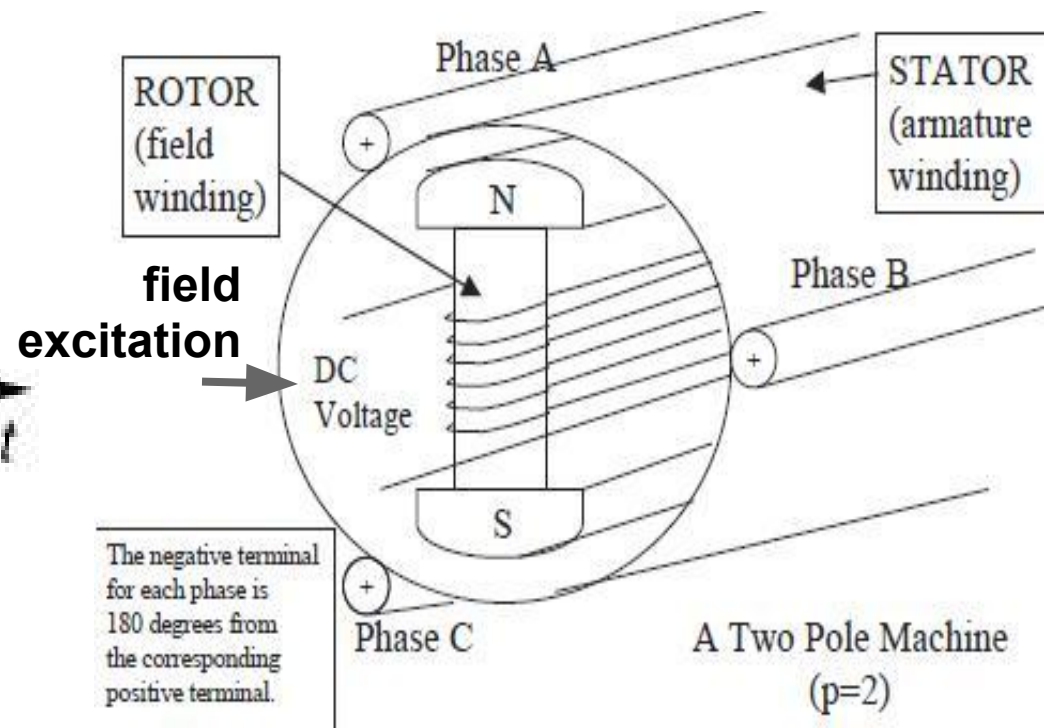
Vendor	Part	Generator Controls	Mains Export	Ethernet	J1939 (CAN)	Modbus	Load Balancing	With Interface	Internal PSU?
Woodward	easYgen 3100	1	1	0	1	1	1	0	1
	easYgen 3200	1	1	0	1	1	1	1	1
Heinzmann	Thesus DGM-02	1	1	0	1	1	0	0	0
SmartGen	HGM6510	1	1	0	1	1	1	1	1
ComAp	IG-NT BB	1	0	0	0	1	0	0	1
ComAp	InteliVision 5	0	0	0	0	0	0	1	0
ComAp	IGS-NT-LSM+PMS	0	1	0	0	0	1	0	0
ComAp	Total System	1	1	0	0	1	1	1	1
DeepSea	DSE-8620	1	1	0	1	1	0	1	1
	DSE-8610	1	1	0	1	1	1	1	1
	DSE-8660	0	1	1	1	1	1	1	1
Deif	AGC 242	1	0	0	1	1	1	1	1
	AGC 243	1	1	0	1	1	1	1	1
Baisler	DGC-2020	1	1	0	1	1	0	1	1
	LSM-2020	0	1	1	1	0	1	1	1

# AC/DC Power



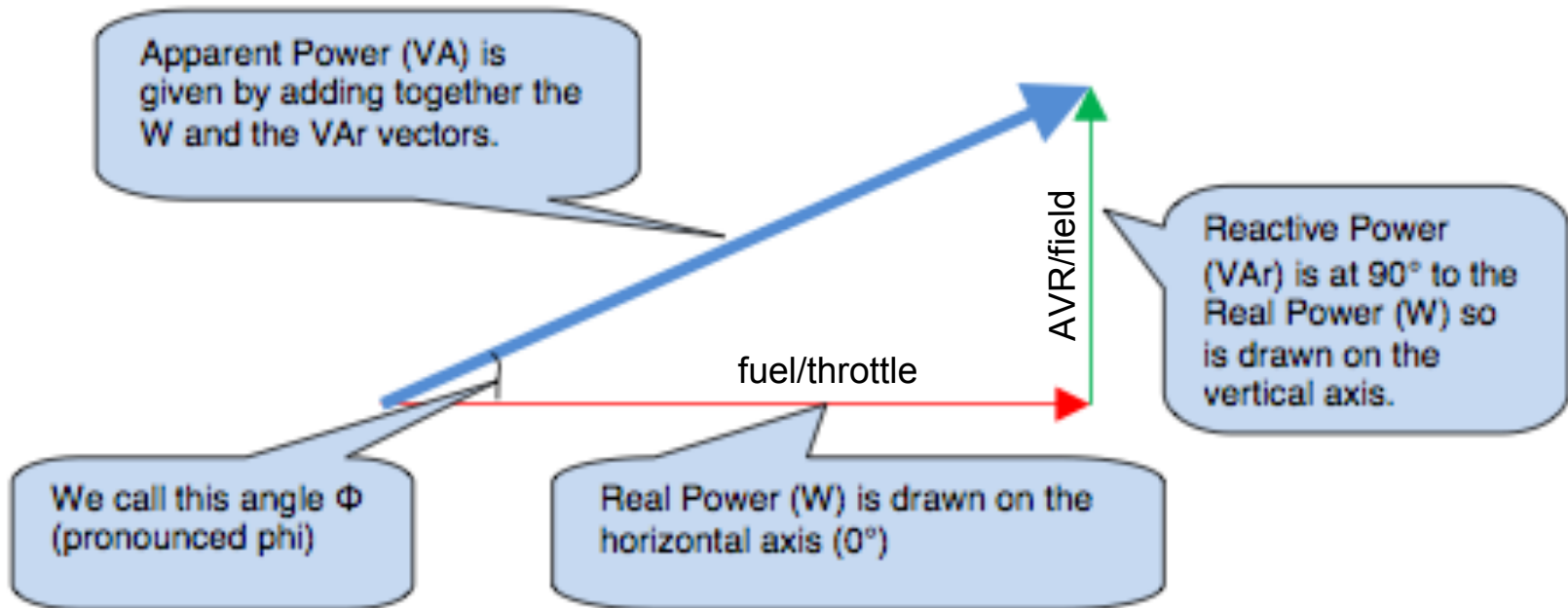
50/60 Hz  
120V/230V...

## Simplified Synchronous Generator

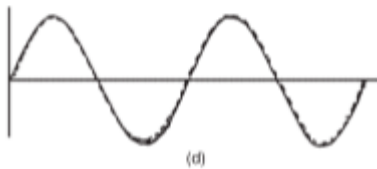
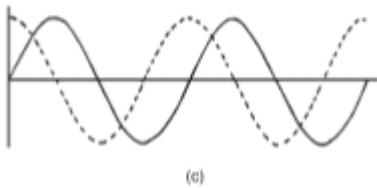
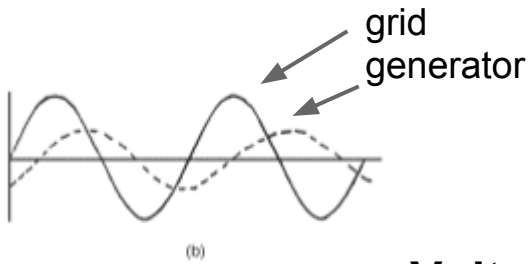
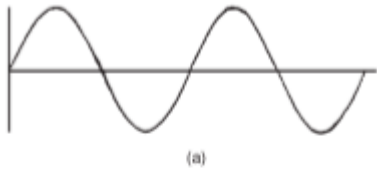


# Power

<b>VA = Volts * Amps</b>	Apparent Power, Resistive
<b>VAr = Volts * Reactive Amps</b>	Reactive Power, Capacitive/Inductive Load Not useful, wasted, added current. No direct fuel impact.
<b>W = V * A * Power Factor</b>	Real Power, Engine sees real power and fuel



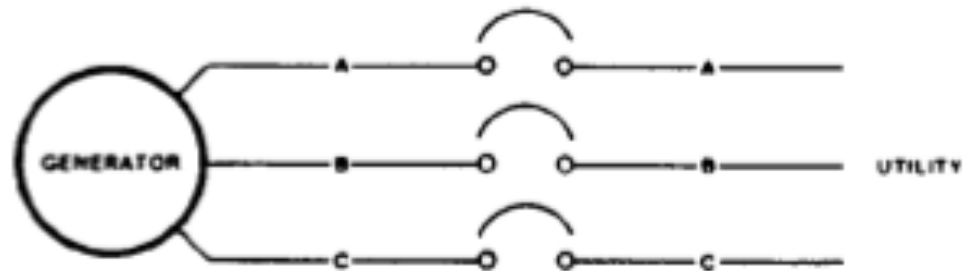
# Grid Tie: Steps to Syncing



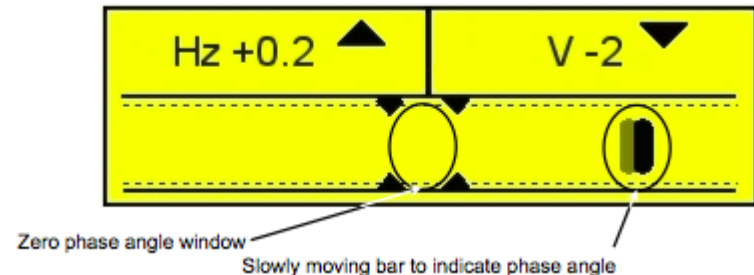
**Voltage Match**  
**Frequency Match**  
**Phase Match**

## States:

- **Available** -> sync command ->
- **Synchronizing** -> close contact ->
- **On Grid/Load Control** -> break contact ->
- **Available/Shutdown**



**Improper Syncing leads to damaging or destructive torque or power on generator and engine**

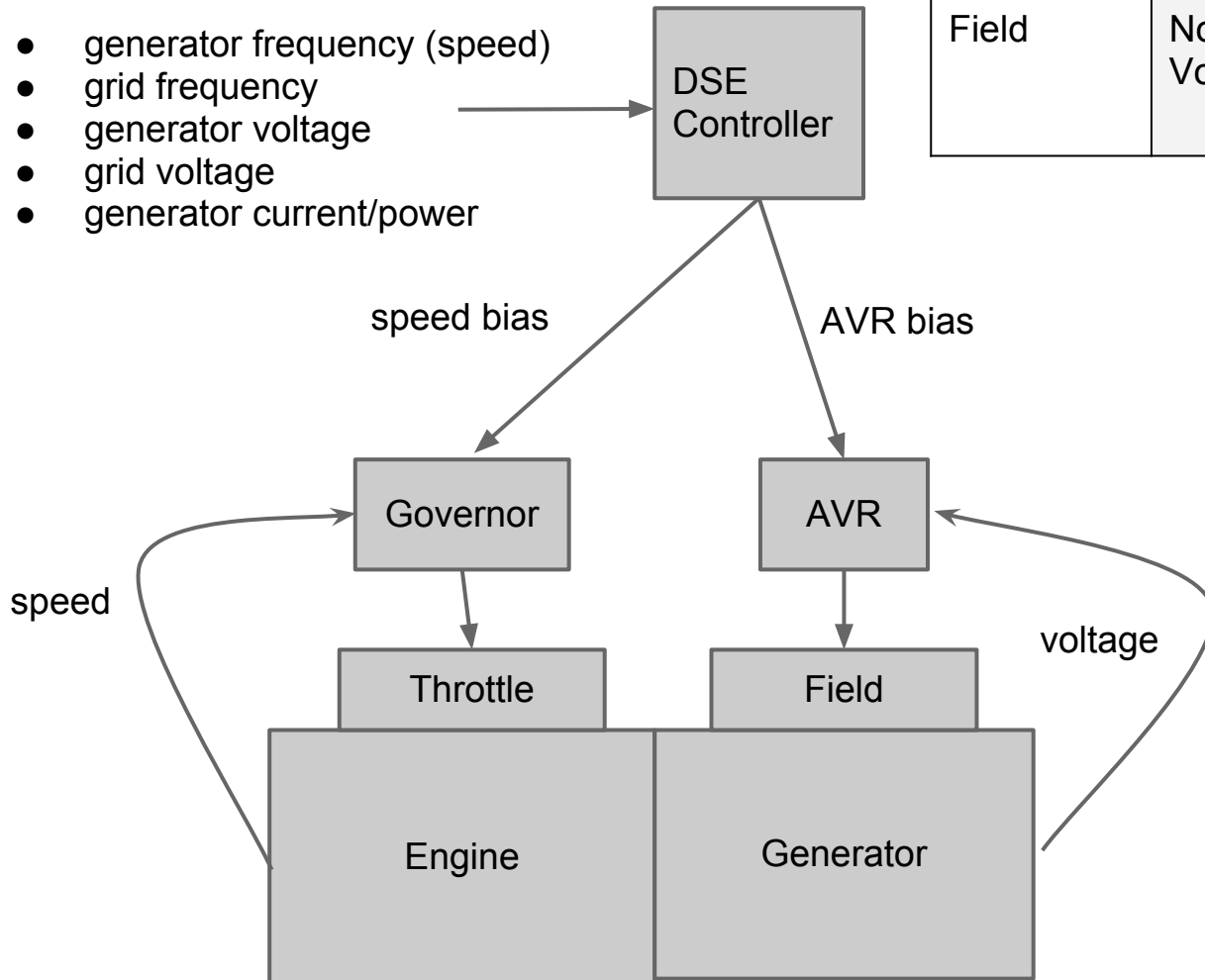


**DSE Synchronoscope**

# Controls

State	Available	Sync	On Grid
Governor	Setpoint	Frequency Match	Load Share Control
Field	Nominal Voltage	Voltage Match	Reactive Power Control

- generator frequency (speed)
- grid frequency
- generator voltage
- grid voltage
- generator current/power

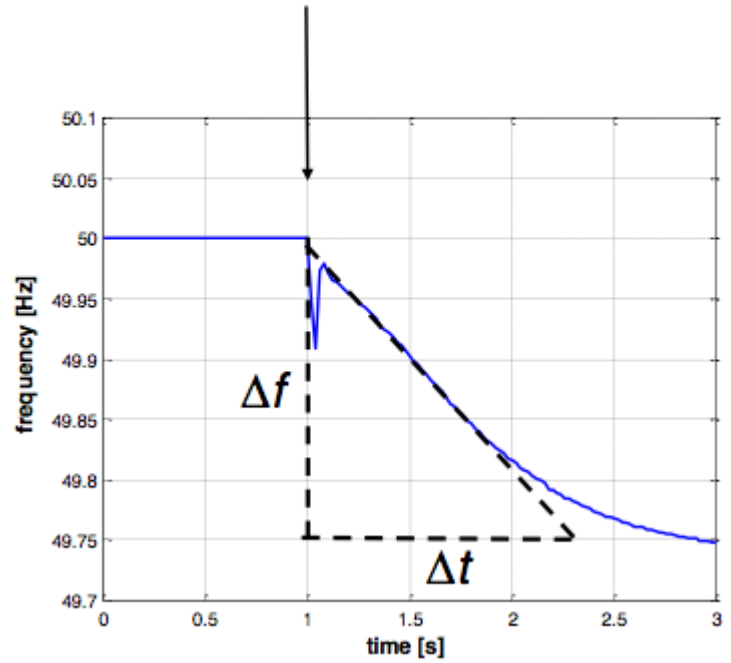


# Loss of Mains Protection

- Protect Generator
- Protect Line Workers
- Utility Requirement

DSE offers two methods:  
ROCOF (Rate of Change of Frequency - used by UK)  
Vector Shift (used in Europe)  
Other methods exist

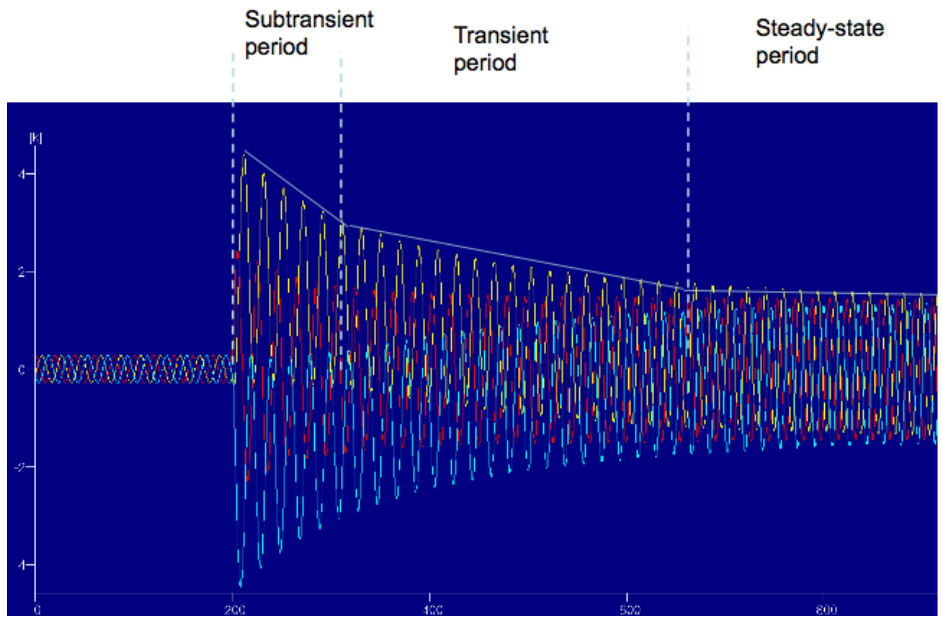
## ROCOF Loss of grid connection



$$ROCOF = \frac{\Delta f}{\Delta t}$$

Source: Booth 2011

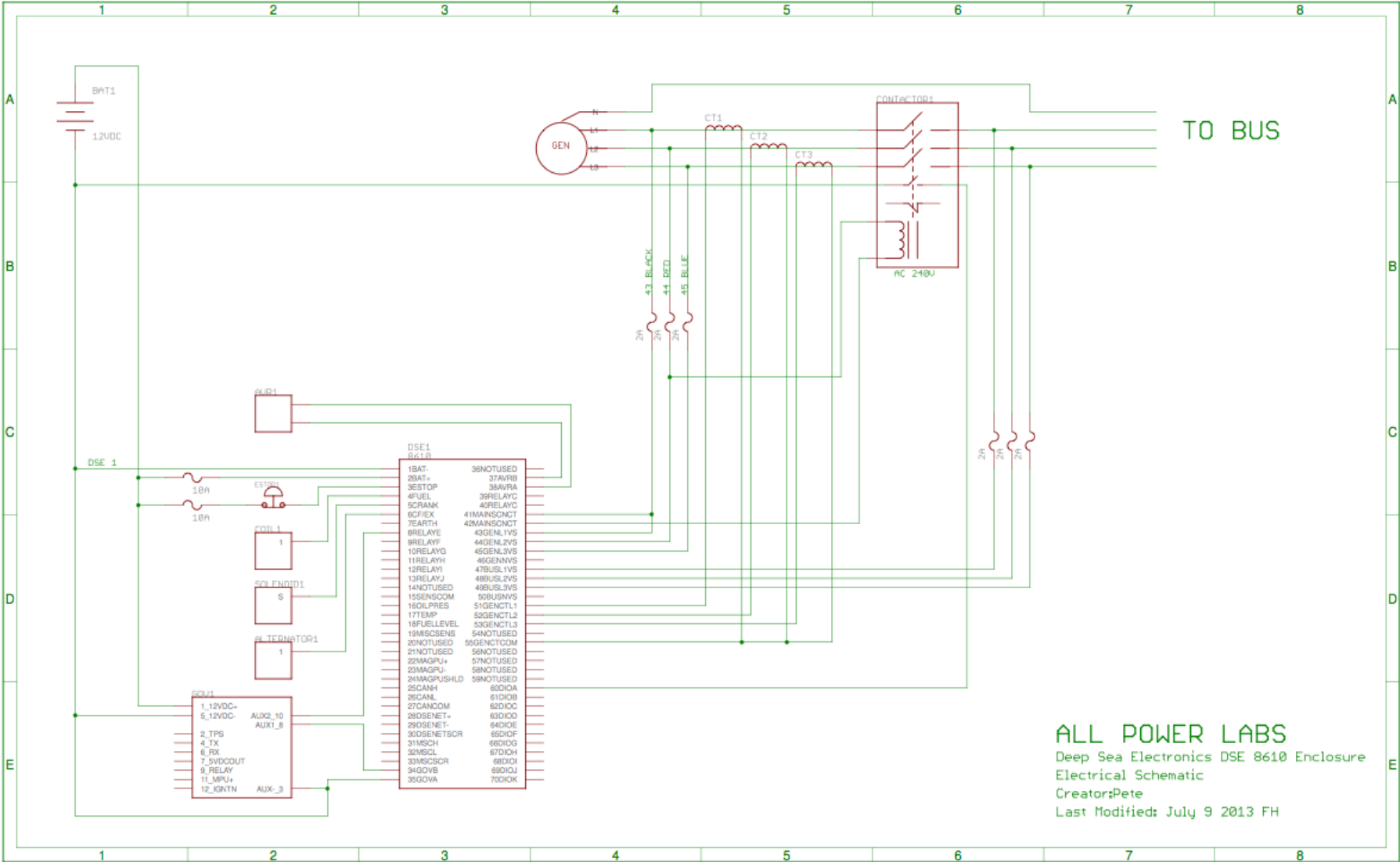
## Vector Shift



Very fast (cycle/subcycle) detection of load change.  
Standard settings (6-10°) require >30% change in VA to trip



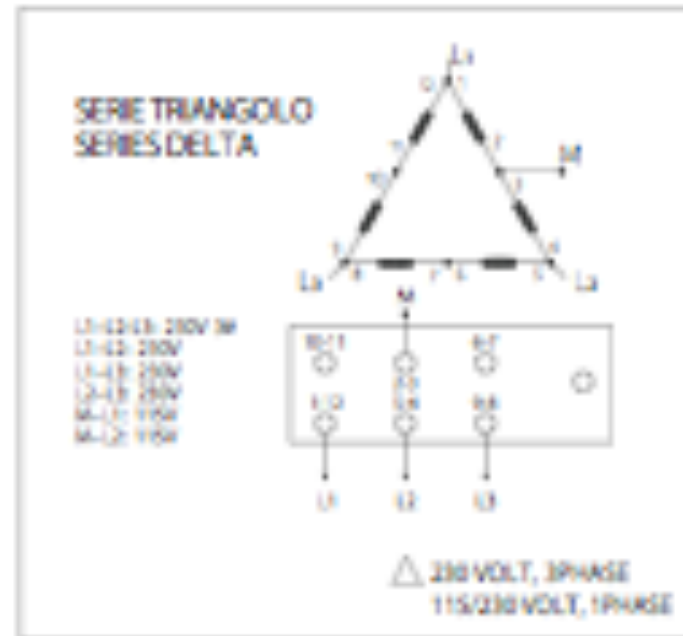
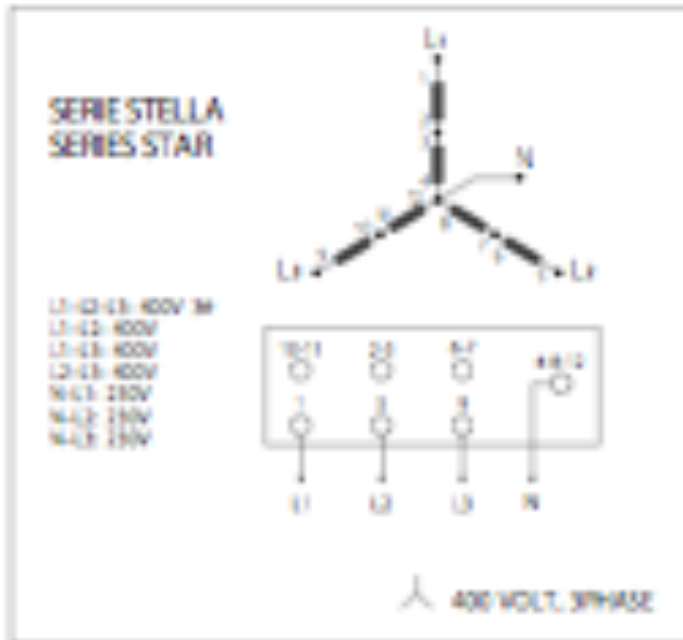
# Schematic



# Mains/Grid Supply

Likely form is either Star (Wye) or Delta  
50 or 60 Hz

Nominal Grid Voltage Varies and can be configured



# Features

## **Loss of Mains Detection** - Supported

Genset contactor control to bus. Vector Shift or ROCOF.

## **Export Control** – Supported

One or more 8610 units exporting fixed levels of power back to grid

## **No Break Transfer** – Not Supported

Allows genset to come online, synchronize with mains and automatically switch load to mains power without down time.

## **Islanding** – Not Supported

Allows system to switch to be independent of mains, powered by gensets if grid is down.

## **Load Sharing** – Supported (multi-8610, requires setup of MSC bus)

Allows multiple gensets on a single bus to evenly share loading. If synchronizing to a small grid with similarly sized gensets and no load sharing configured, genset loading dynamics may cause oscillations or uneven loading.

## **Close to Dead Bus** – Enabled (only)

The 8610 will close to a bus with a minimum (configurable) voltage without synchronizing. One of the key safeties required when grid goes down is to not re-energize the grid. An interlock or safety will be required for regulatory and technical safety reasons.

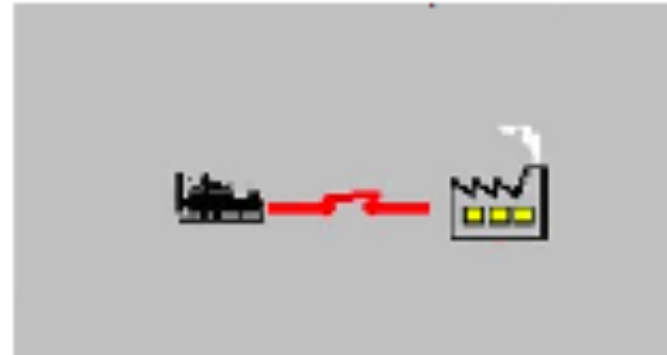
## **Earth Fault Detection**

Not included (but supported by 8610)

# Topologies

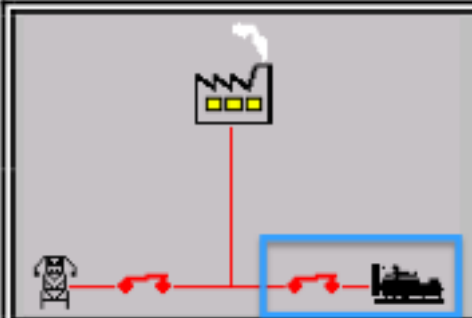
## Standard Power Pallet

## Grid Tie Power Pallet (using DSE 8610)



### 5.1.2 SINGLE SET FIXED EXPORT

A single set used solely to parallel with the mains. No control of the mains breaker is provided. If the mains breaker opens, the decision must be made if the set can be used to power the load (if the set is large enough). Upon mains return, the set breaker must be opened before the mains breaker can be closed.

	<b>Controller :</b>	8610 8710 7510 5510
	<b>Load Share options :</b>	<ul style="list-style-type: none"><li>Fixed export through <i>Mains parallel mode</i> operation of the DSE '10 controller.</li></ul>

**NOTE:** - It is recommended that the mains decoupling is enabled in the DSE module when paralleling a generating set with the mains. Additional equipment of this type is normally specified by the local electricity Supply Company to protect against the generator feeding the mains grid in the case of a mains failure. If in doubt, you should refer to your local Electricity Supply Company for advice.

# Grid Tie in Italy

[Paralleling Video](#)



# Useful References

Woodward Manual 26260 - Governing  
Fundamentals and Power Management

Loss of Mains Protection, C. Booth, University  
of Strathclyde

Deep Sea:

#057-047 Load Share System Design and  
Commissioning