DYNAMIC LOAD BALANCER for THREE PHASE POWER

Unbalanced loading of 3 phase electrical lines causes generation & distribution inefficiencies (i.e. greater fuel consumption), potential power outages, and shortens operational life of equipment. Traditionally, load balancing is static with varied success. Dynamic load balancing would reduce engineering effort and ensure consistently balanced loads increasing efficiency, reducing outages, and increasing MTBF.

The Problem

- Power generation and distribution - typically 3 phase
  - Best performance at unbalance < 3%
- Power consumption - loads are typically single phase
  - Loads are manually assigned to phases
    - Difficult to achieve accurate balance
    - No ability to adjust for load dynamics
- Negative impacts of unbalance
  - Energy loss within generation & transmission
  - Available capacity limited by most heavily loaded phase
  - Increased heating of generators and motors
  - Vibration and mechanical stress on generators
  - Potential drop out of switching gear (self-protect)

Potential Solutions

- Classic Solution is an Uninterruptible Power Supply (UPS)
  - Excellent static and dynamic balancing
  - Significant power loss, large, single point off failure
- Better Solution is the Parallel Phase Balancer (PPB)
  - Very high efficiency, very good static and dynamic balancing, small and lightweight, no single point of failure
  - Reduces demand on generation and distribution

	Manual	UPS	PPB
Realized Static Line Unbalance	Typ >>5%	<3%	<3%
Dynamic Unbalance Response	None	Excellent	Very Good
Power Efficiency	100%	~80% - 85%	>98%
Impact to Size & Weight	NA	Large	Small
Impact to Reliability & Availability	NA	Large	Small

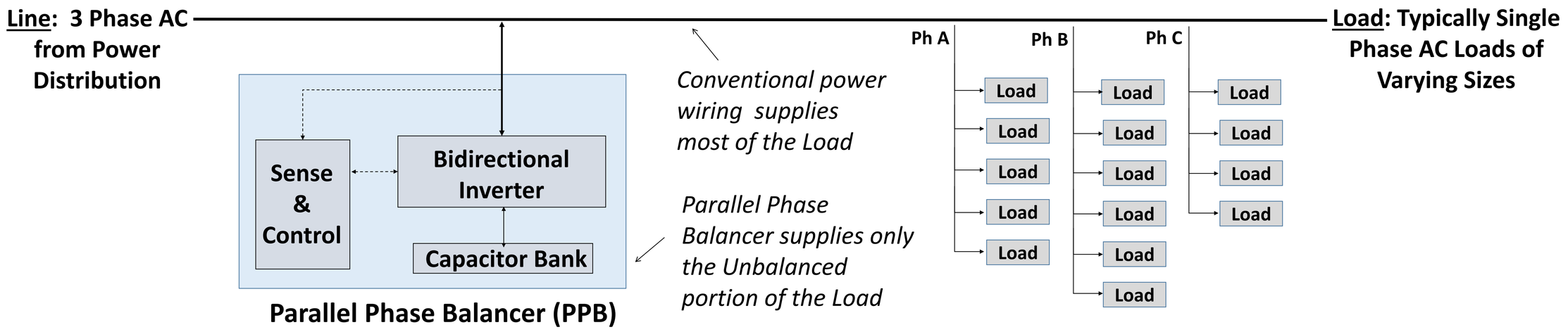
A BETTER SOLUTION – THE PARALLEL PHASE BALANCER

PPB Operation

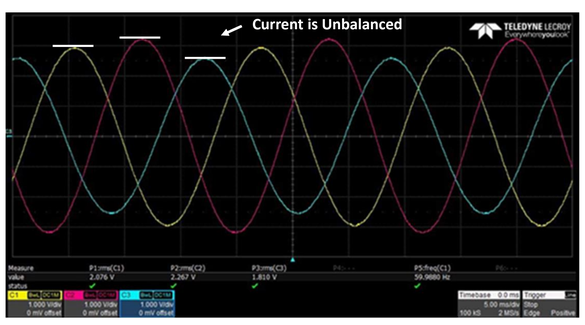
- PPB is connected in parallel with the power Line
- Preferred location is Load end to minimize generation & transmission losses
- PPB pulls extra current from lightly loaded Line Phases, injects it onto more heavily loaded Load Phases
  - Uses FET based Bidirectional Inverter w/associated Capacitor Bank
  - Closed loop microcontroller adjusts PPB operation dynamically
  - Only Unbalanced portion of the Load is processed
    - Most load power flows through standard wiring
    - Yields high efficiency, small size & weight, high reliability, fault tolerance

Typical Applications

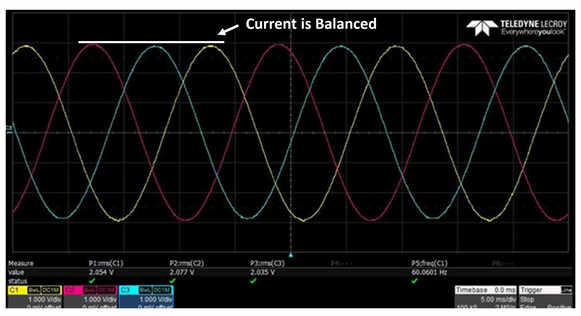
- Applications that have “finite” power sources, typically “off-grid” full or part time
  - Ships and submarines (present application)
  - Expeditionary units
  - Forward bases
  - Micro-grids
  - Other systems powered by mobile generators
- Scalable and adaptable to application specifics



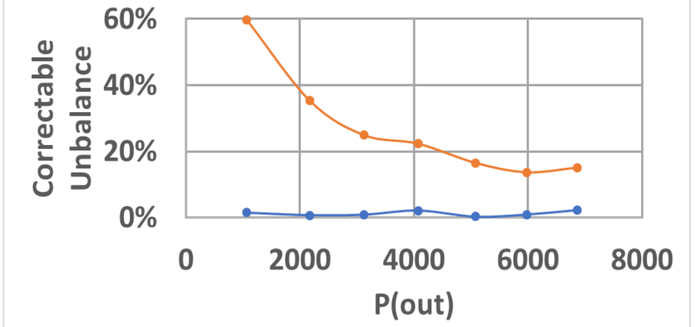
TYPICAL PARALLEL PHASE BALANCER IMPLEMENTATION – 19”RACK MOUNT, 1U

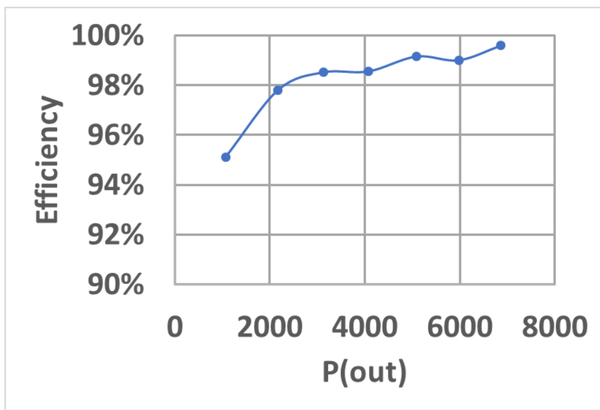


Line Currents @ 4 kW - Balancer Off
22.34% Unbalance



Line Currents @ 4kW - Balancer On
2.14% Unbalance





Key Characteristics

- 8 kW rated capacity
- 3 Ph In / 3 Ph Out
- >98% efficient
- Load unbalance correction
  - > 20% @ 4 kW load
  - > 12% @ 8 kW load

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