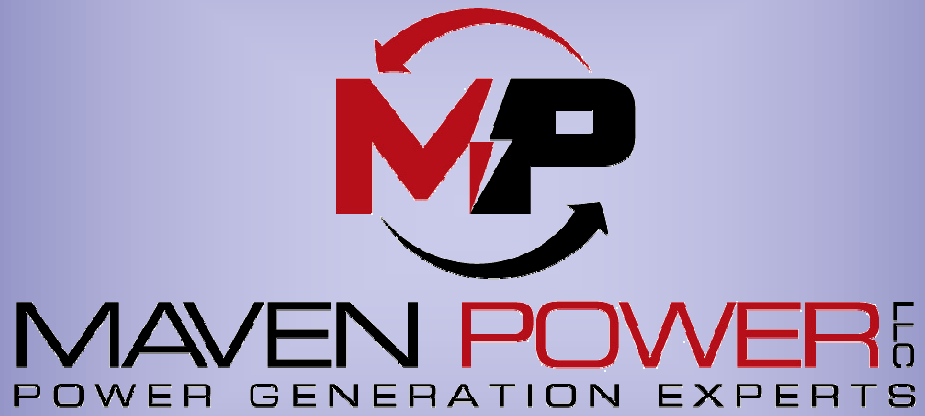
Interconnect Challenges in the Developing World's Distributed Generation Infancy



David C. Oehl, P.E.
President

Overview

- Introduction
- Project Background
- DG Plant Operation
- Challenges
  - Interconnection
  - Operational
  - Utility/Regulatory
- Results & Takeaways

Introduction

- Onsite & Distributed Generation
- Thermal Power Generation
- Engineering to Turn-key
  - Specialize in custom apps
  - Single source for integration
  - International expertise, challenging locations

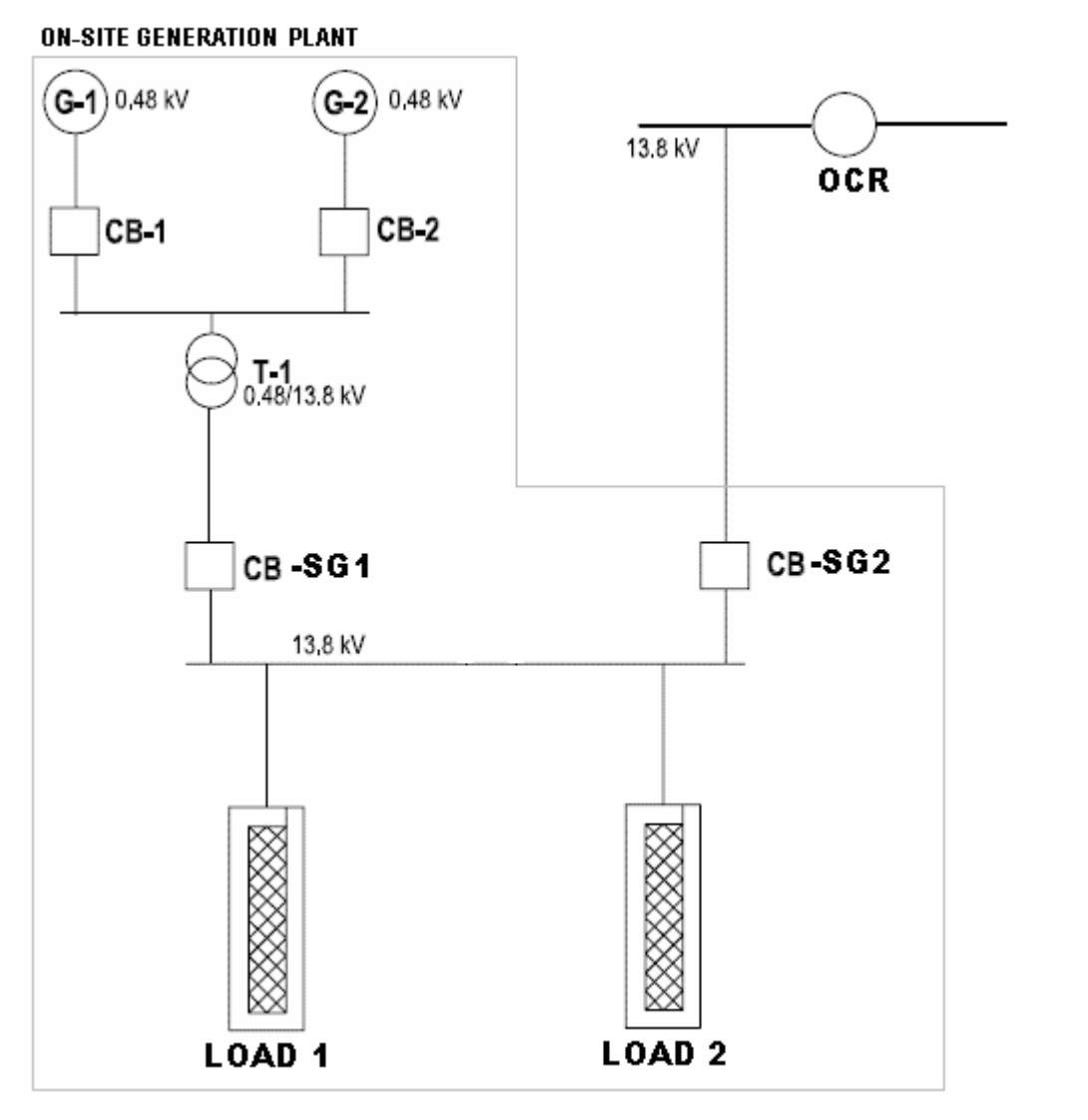
Introduction

- Equipment
- Fuel systems
- Electrical & distribution
- Design & integration
- Project management
- O & M
- Automation

Project Background

- 2.5MWe On-site Generation
- Natural gas-fired
- Utility new to DG
- Integration effort
- Industrial, general use feeder

One Line Diagram



2.5MWe Onsite Generation

MAVEN POWER LLC
POWER GENERATION EXPERTS

15kV Switchgear

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SG-1

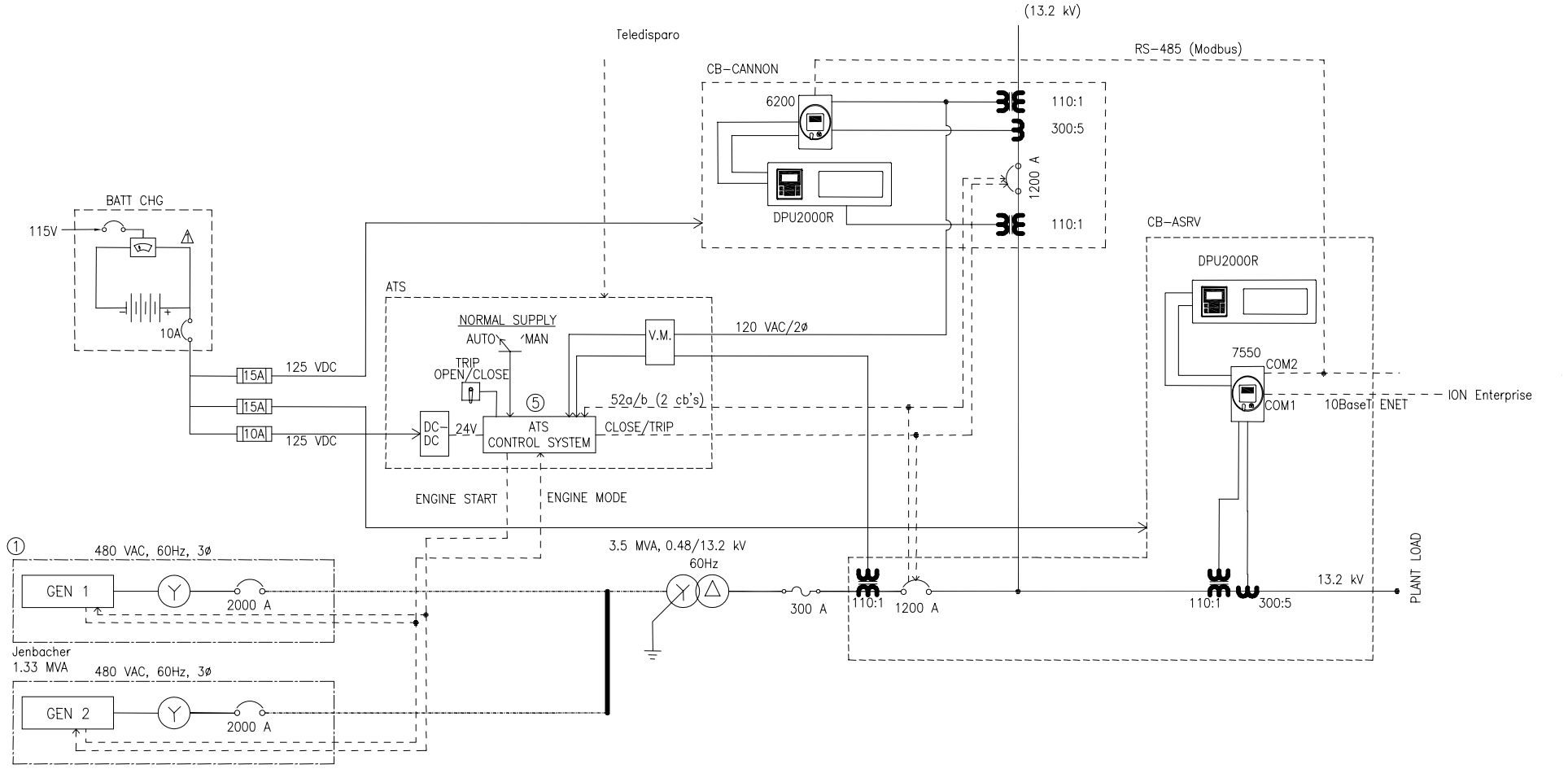
SG-2

Automatic Source Transfer Control

Plant Operation

- Grid parallel w/ power import
- Automatic source transfer switching
- Generator operation at base load
- Islanding operation upon loss of normal supply

One Line Diagram



Challenges

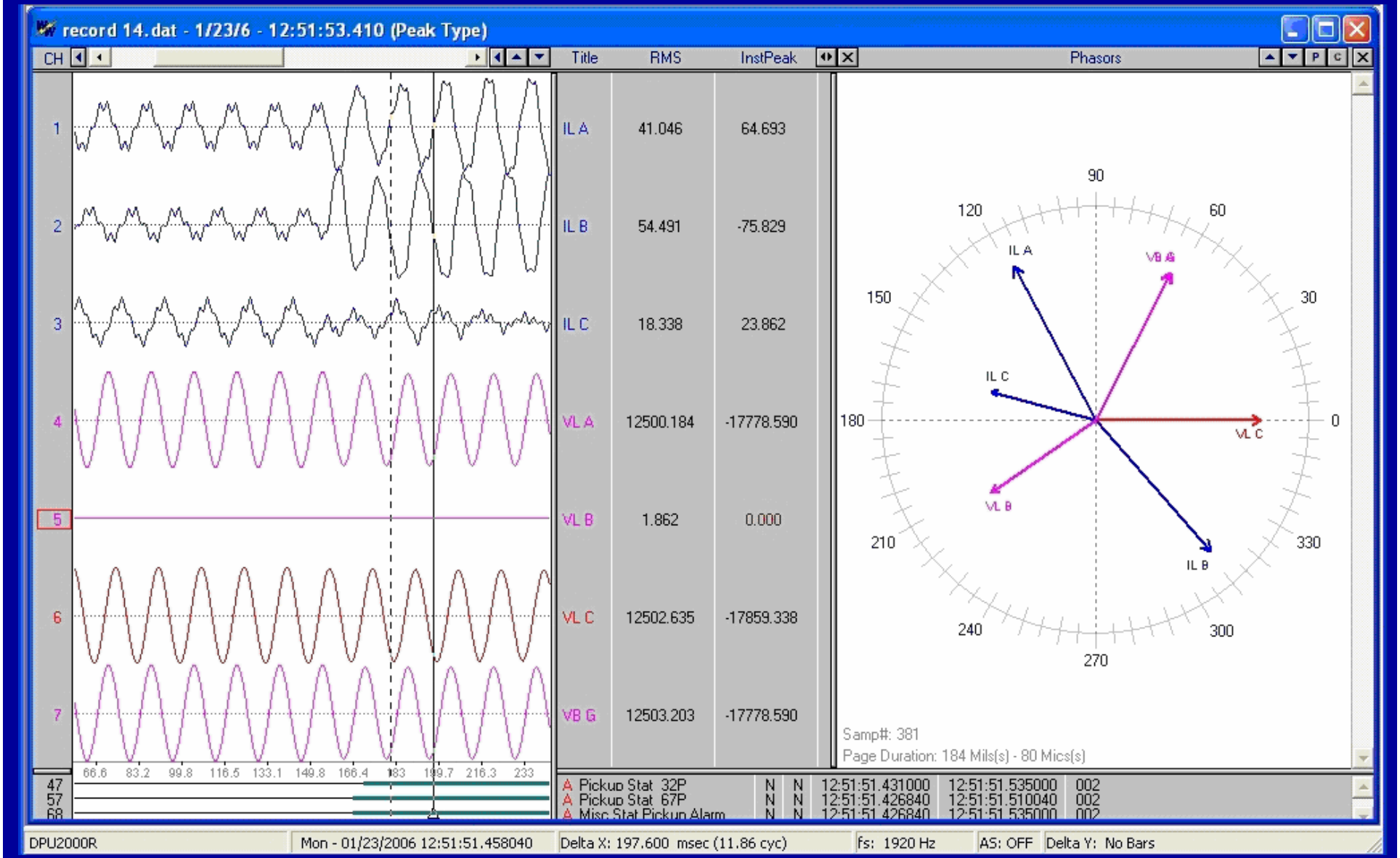
- Grid Instability
- Voltage Sag
- 5% drop for more than 5 cycles
- 15-20% of nominal not uncommon
- Resulting reverse power condition
- Load shedding
- Recloser Issues

Reverse Power

- Trips up to six times daily
- Anti-islanding required a main breaker trip (SG-1 or SG-2)
- Production interruptions
- Nominal phase current = 130A

SG2 Fault Recorder Data for Reverse Power (32R) Events				
Record	**Date**	**Time**	**Duration (cycles)**	**Current (A)**
1	21-Jan-06	5:34:07 AM	6.24	22
3	21-Jan-06	7:58:32 AM	3.46	40
5	21-Jan-06	10:12:55 AM	5.46	300
7	22-Jan-06	7:47:34 AM	6.21	45
12	22-Jan-06	9:23:37 PM	2.96	20
14	23-Jan-06	12:51:51 PM	6.21	45
16	24-Jan-06	4:34:39 AM	2.46	30
18	24-Jan-06	8:21:52 AM	2.96	15
		Average	4.50	cycles
		Max	6.24	cycles

Reverse Power-Typical Observed Condition

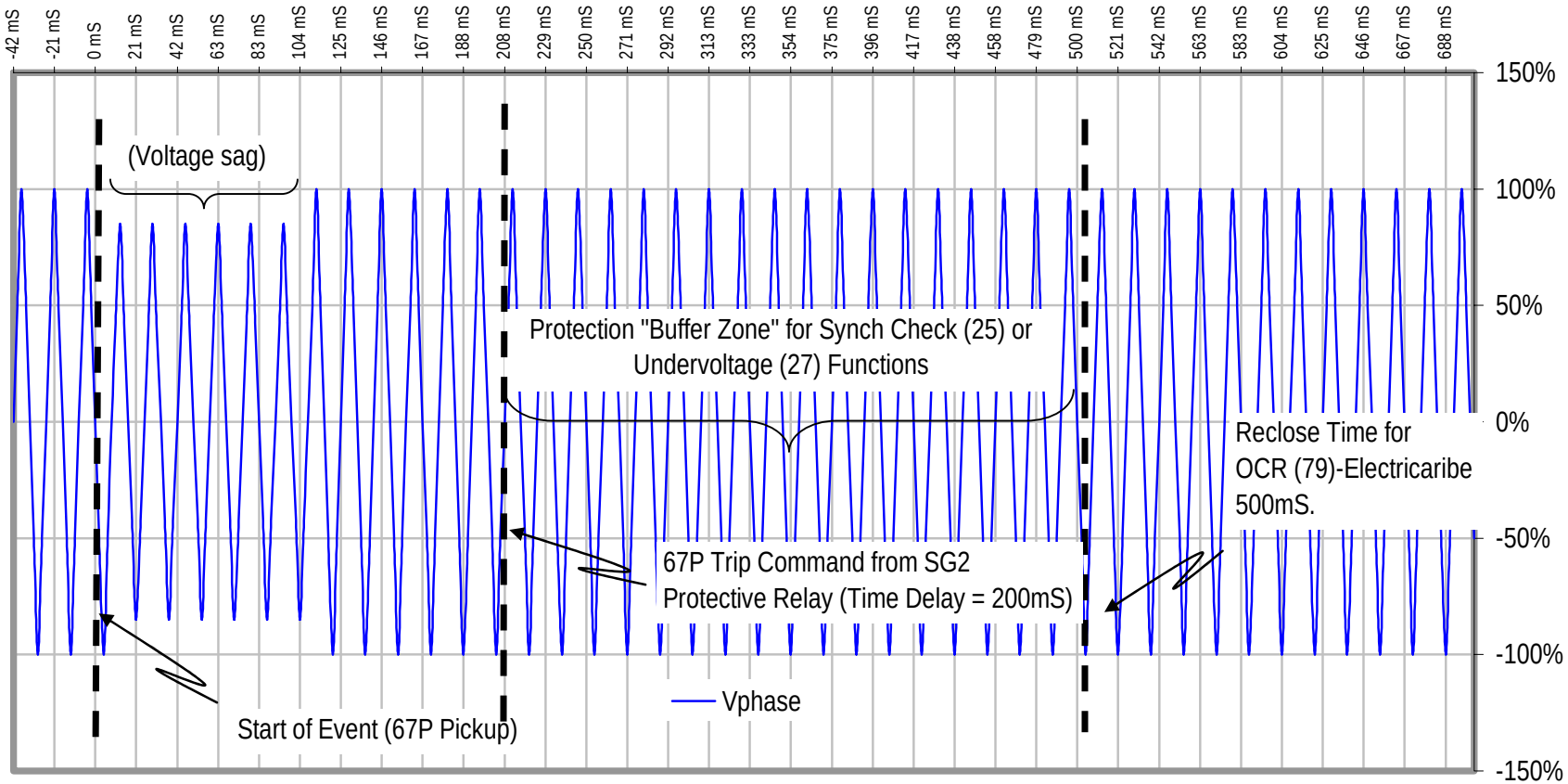


Recloser Issues

- No recloser lockout available
- Set to reclose automatically after 500mS
- No accommodation for 2nd source (DG)
- No effective way to distinguish between OCR operation and voltage sag-mandatory trip
- 32R protective function required
- 67P possible with recloser lockout

Recloser Timing

Typical Time Dynamics for Voltage Sags, Reverse Power and Recloser Functions at SG2



Ulitity Issues

- New to DG/Onsite Power
- Low internal empowerment, low motivation for DG support
- Proposal to install 25 (synch check) or 27 (undervoltage) monitoring system
- Regulatory body (FERC) limited authority

Takeaways

- Breaker arrangement critical
- Ability to ‘cross trip’ on voltage sag or reverse power condition
- Problem was transparent to end user (Maven Power’s Customer)
- Full solution a combinations of reverse power monitoring (67P) with recloser lockout.
- Simple, economical improvements by utility
  - Regular transformer maintenance
  - Line inspection & cleaning (rain)

Questions?

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