CERTS Phase III: Synchronous Generator Report:

Capability and Compatibility of a Synchronous Generator when Installed in a CERTS Microgrid

Prepared By:

Chase Leibold

Surya Baktiono

David A Klapp

Prepared: April 2013

For: United States Department of Energy

Table of Contents:

Table of Contents: i
Table of Figures: ii
Table of Tables: v
1.0 Introduction 1
2.0 Definitions 2
3.0 The CERTS Microgrid Test Bed 4
4.0 Executive Summary 6
5.0 Test Results 7
5.1 Emergency Shutdown 7
5.2 Load Step Response of Generator B1 9
5.3 Voltage Regulation 18
5.4 Frequency vs. Real Power Droop Control 24
5.5 Voltage vs. Reactive Power Droop Control 36
5.6 Generator Black-Start Capacity 47
5.7 Load Step and Overload Response 51
5.8 P_{max} Control 70
5.9 Generator Voltage Dispatch Mismatch 80
5.10 Unbalanced Load Tests 86
5.11 Power Factor Tests 96
5.12 Harmonic Load Tests 103
6.0 Appendix 112
6.1 Marathon 2000EC Voltage Exciter 112
6.2 easYgen Controls Settings 113
6.3 Overview Controls Diagram 178

Table of Figures:

Figure 3.1 CERTS Microgrid Aerial Photo 5
Figure 3.2 CERTS Microgrid Overview Oneline 5
Figure 5.1.1: RMS Voltage and Current in Response to an Emergency Shutdown Command 8
Figure 5.2.1: Event AE, 0→100 kW, Meter B1, RMS Voltage and Current 13
Figure 5.2.2: Event AE, 0→100 kW, Meter B1, Waveform Voltage and Current 13
Figure 5.2.3: Event AE, 0→100 kW, Meter B1, Frequency 13
Figure 5.2.4: Event AE, 0→100 kW, Meter B1, Real Power 13
Figure 5.2.5: Event K, 100→120 kW, Meter B1, RMS Voltage and Current 15
Figure 5.2.6: Event K, 100→120 kW, Meter B1, Waveform Voltage and Current 15
Figure 5.2.7: Event K, 100→120 kW, Meter B1, Frequency 15
Figure 5.2.8: Event K, 100→120 kW, Meter B1, Real Power 15
Figure 5.2.9: Event AB, 80→0 kW, Meter B1, RMS Voltage and Current 17
Figure 5.2.10: Event AB, 80→0 kW, Meter B1, Waveform Voltage and Current 17
Figure 5.2.11: Event AB, 80→0 kW, Meter B1, Frequency 17
Figure 5.2.12: Event AB, 80→0 kW, Meter B1, Real Power 17
Figure 5.3.1: Event H, 504V, 60→95 kW, Meter B1, RMS Voltage and Current 21
Figure 5.3.2: Event H, 504V, 60→95 kW, Meter B1, Waveform Voltage and Current 21
Figure 5.3.3: Event H, 504V, 60→95 kW, Meter B1, Frequency 21
Figure 5.3.4: Event H, 504V, 60→95 kW, Meter B1, Real Power 21
Figure 5.3.5: Steady State Error (%) vs Real Power (kW) 22
Figure 5.3.6: Generator Start-up, Meter B1, RMS Voltag 23
Figure 5.3.7: Generator Start-up, Meter B1, Waveform Voltage and Current 23
Figure 5.3.8: Generator Start-up, Meter B1, Frequency 23
Figure 5.3.9: Generator Start-up, Meter B1, Real Power 23
Figure 5.4.1: Frequency vs. Real Power Control Comparison 27
Figure 5.4.2: Event F, 95 kW, Meter B1, RMS Voltage and Current 28
Figure 5.4.3: Event F, 95 kW, Meter B1, Waveform Voltage and Current 28
Figure 5.4.4: Event F, 95 kW, Meter B1, Frequency 28
Figure 5.4.5: Event F, 95 kW, Meter B1, Real Power 28
Figure 5.4.6: Event F, 95 kW, Meter B1, Reactive Power 29
Figure 5.4.7: Event A, 0 kW Meter B1, RMS Voltage and Current 30
Figure 5.4.8: Event A, 0 kW, Meter B1, Frequency 30
Figure 5.4.9: Event B, 20 kW, Meter B1, RMS Voltage and Current 30
Figure 5.4.10: Event B, 20 kW, Meter B1, Frequency 30
Figure 5.4.11: Event C, 40 kW, Meter B1, RMS Voltage and Current 31
Figure 5.4.12: Event C, 40 kW, Meter B1, Frequency 31
Figure 5.4.13: Event D, 60 kW, Meter B1, RMS Voltage and Current 31
Figure 5.4.14: Event D, 60 kW, Meter B1, Frequency 31
Figure 5.4.15: Event E, 80 kW, Meter B1, RMS Voltage and Current 32
Figure 5.4.16: Event E, 80kW, Meter B1, Frequency 32
Figure 5.4.17: Event G, 0 kW, Meter B1, RMS Voltage and Current 32
Figure 5.4.18: Event G, 0 kW, Meter B1, Frequency 32
Figure 5.4.19: Event H, 20 kW, Meter B1, RMS Voltage and Current 33
Figure 5.4.20: Event H, 20 kW, Meter B1, Frequency 33
Figure 5.4.21: Event I, 40 kW, Meter B1, RMS Voltage and Current 33
Figure 5.4.22: Event I, 40 kW, Meter B1, Frequency 33
Figure 5.4.23: Event J, 60 kW, Meter B1, RMS Voltage and Current 34
Figure 5.4.24: Event J, 60 kW, Meter B1, Frequency 34
Figure 5.4.25: Event K, 80 kW, Meter B1, RMS Voltage and Current 34
Figure 5.4.26: Event K, 80 kW, Meter B1, Frequency 34
Figure 5.4.27: Event L, 95 kW, Meter B1, RMS Voltage and Current 35
Figure 5.4.28: Event L, 95 kW, Meter B1, Frequency 35
Figure 5.5.1: Measured and Target Voltage for V/Q Droop Function 38
Figure 5.5.2: Event D, 60 kvar, Meter B1, RMS Voltage 39

Figure 5.5.3: Event D, 60 kvar, Meter B1, Waveform Voltage and Current 39
Figure 5.5.4: Event D, 60 kvar, Meter B1, Frequency....39
Figure 5.5.5: Event D, 60 kvar, Meter B1, Real Power....39
Figure 5.5.6: Event D, 60 kvar, Meter B1, Reactive Power 40
Figure 5.5.7: Event A, 0 kvar, Meter B1, RMS Voltage and Current 41
Figure 5.5.8: Event A, 0 kvar, Meter B1, Reactive Power 41
Figure 5.5.9: Event B, 20 kvar, Meter B1, RMS Voltage and Current....41
Figure 5.5.10: Event B, 20 kvar, Meter B1, Reactive Power 41
Figure 5.5.11: Event C, 40 kvar, Meter B1, RMS Voltage and Current....42
Figure 5.5.12: Event C, 40 kvar, Meter B1, Reactive Power 42
Figure 5.5.13: Event E, 0 kvar, Meter B1, RMS Voltage and Current....42
Figure 5.5.14: Event E, 0 kvar, Meter B1, Reactive Power....42
Figure 5.5.15: Event F, 20 kvar, Meter B1, RMS Voltage and Current 43
Figure 5.5.16: Event F, 20 kvar, Meter B1, Reactive Power....43
Figure 5.5.17: Event G, 40 kvar, Meter B1, RMS Voltage and Current 43
Figure 5.5.18: Event G, 40 kvar, Meter B1, Reactive Power 43
Figure 5.5.19: Event H, 60 kvar, Meter B1, RMS Voltage and Current 44
Figure 5.5.20: Event H, 60 kvar, Meter B1, Reactive Power 44
Figure 5.5.21: Event I, 0 kvar, Meter B1, RMS Voltage and Current....44
Figure 5.5.22: Event I, 0 kvar, Meter B1, Reactive Power....44
Figure 5.5.23: Event J, 20 kvar, Meter B1, RMS Voltage and Current....45
Figure 5.5.24: Event J, 20 kvar, Meter B1, Reactive Power....45
Figure 5.5.25: Event K, 40 kvar, Meter B1, RMS Voltage and Current 45
Figure 5.5.26: Event K, 40 kvar, Meter B1, Reactive Power 45
Figure 5.5.27: Event L, 60 kvar, Meter B1, RMS Voltage and Current....46
Figure 5.5.28: Event L, 60 kvar, Meter B1, Reactive Powe 46
Figure 5.6.1: Event D, 115 kVA, Meter B1, RMS Voltage and Current....49
Figure 5.6.2: Event D, 115 kVA, Meter B1, Waveform Voltage and Current 49
Figure 5.6.3: Event D, 115 kVA, Meter B1, Frequency....49
Figure 5.6.4: Event D, 115 kVA, Meter B1, Real Power 49
Figure 5.6.5: Event D, 115 kVA, Meter B1, Reactive Power....50
Figure 5.7.1: Event DY, 20→100 kW w/ Load Relief, Meter B1, RMS Voltage and Current 66
Figure 5.7.2: Event DY, 20→100 kW w/ Load Relief, Meter B1, Waveform Voltage and Current....66
Figure 5.7.3: Event DY, 20→100 kW w/ Load Relief, Meter B1, Frequency 66
Figure 5.7.4: Event DY, 20→100 kW w/ Load Relief, Meter B1, Real Power....66
Figure 5.7.5: Event EB, 20→100 kW w/o Load Relief, Meter B1, RMS Voltage and Current....67
Figure 5.7.6: Event EB, 20→100 kW w/o Load Relief, Meter B1, Waveform Voltage and Current 67
Figure 5.7.7: Event EB, 20→100 kW w/o Load Relief, Meter B1, Frequency....67
Figure 5.7.8: Event EB, 20→100 kW w/o Load Relief, Meter B1, Real Power 67
Figure 5.8.1: Event D, 50→70 kW, Meter B1, RMS Voltage and Current....73
Figure 5.8.2: Event D, 50→70 kW, Meter B1, Waveform Voltage and Current 73
Figure 5.8.3: Event D, 50→70 kW, Meter B1, Frequency....73
Figure 5.8.4: Event D, 50→70 kW, Meter B1, Real Power 73
Figure 5.8.5: Event I, 50→100 kW, Meter B1, RMS Voltage and Current 75
Figure 5.8.6: Event I, 50→100 kW, Meter B1, Waveform Voltage and Current....75
Figure 5.8.7: Event I, 50→100 kW, Meter B1, Frequency 75
Figure 5.8.8: Event I, 50→100 kW, Meter B1, Real Power....75
Figure 5.8.9: Event I, 50→100 kW, Meter A2, RMS Voltage and Current 76
Figure 5.8.10: Event I, 50→100 kW, Meter A2, Waveform Voltage and Current....76
Figure 5.8.11: Event I, 50→100 kW, Meter A2, Frequency 76
Figure 5.8.12: Event I, 50→100 kW, Meter A2, Real Power....76
Figure 5.8.13: Event J, 100→50 kW, Meter B1, RMS Voltage and Current 78
Figure 5.8.14: Event J, 100→50 kW, Meter B1, Waveform Voltage and Current....78
Figure 5.8.15: Event J, 100→50 kW, Meter B1, Frequency 78
Figure 5.8.16: Event J, 100→50 kW, Meter B1, Real Power....78
Figure 5.8.17: Event J, 100→50 kW, Meter A2, RMS Voltage and Current....79

Figure 5.8.18: Event J, 100→50 kW, Meter A2, Waveform Voltage and Current 79
Figure 5.8.19: Event J, 100→50 kW, Meter A2, Frequency 79
Figure 5.8.20: Event J, 100→50 kW, Meter A2, Real Power 79
Figure 5.9.1: Event T, B1 100%, A1 105%, 120 kvar, Meter B1, RMS Voltage and Current 84
Figure 5.9.2: Event T, B1 100%, A1 105%, 120 kvar, Meter A1, RMS Voltage and Current 84
Figure 5.9.3: Event T, B1 100%, A1 105%, 120 kvar, Meter B1, Reactive Power 84
Figure 5.9.4: Event T, B1 100%, A1 105%, 120 kvar, Meter A1, Reactive Power 84
Figure 5.9.5: Event T, B1 100%, A1 105%, 120 kvar, Meter B1, Waveform Voltage and Current 85
Figure 5.9.6: Event T, B1 100%, A1 105%, 120 kvar, Meter A1, Waveform Voltage and Current 85
Figure 5.9.7: Event T, B1 100%, A1 105%, 120 kvar, Meter LM3, Reactive Power 85
Figure 5.9.8: Event T, B1 100%, A1 105%, 120 kvar, Meter LM5, Reactive Power 85
Figure 5.10.1: Event A, Unbalance Loading, Load Meter 3, RMS Voltage and Current 89
Figure 5.10.2: Event A, Unbalanced Loading, Load Meter 3, Real Power 89
Figure 5.10.3: Event A, Unbalanced Loading, Load Meter 3, Waveform Voltage and Current 89
Figure 5.10.4: Event A, Unbalance Loading, Load Meter 3, RMS Voltage and Current (Zoomed) 89
Figure 5.10.5: Event A, Unbalance Loading, Meter B1, Reactive Power 90
Figure 5.10.6: Event A, Unbalanced Loading, Meter A1, Reactive Power 90
Figure 5.10.7: Event A, Unbalance Loading, Meter B1, Real Power 92
Figure 5.10.8: Event A, Unbalanced Loading, Meter A1, Real Power 92
Figure 5.10.9: Event A, Unbalanced Loading, Load Meter 3, Frequency 92
Figure 5.10.10: Event M, Balanced Load w/ Motor Start, Load Meter 3, RMS Voltage and Current 94
Figure 5.10.11: Event M, Balanced Load w/ Motor Start, Load Meter 3, Frequency 94
Figure 5.10.12: Event M, Balanced Load w/ Motor Start, Load Meter 3, Real Power 94
Figure 5.10.13: Event M, Balanced Load w/ Motor Start, Load Meter 3, Reactive Power 94
Figure 5.10.14: Event M, Unbalance Loading, Load Meter 3, RMS Voltage and Current 95
Figure 5.11.1: Event B, 0.75→0.60 pf, Meter B1, RMS Voltage and Current 99
Figure 5.11.2: Event B, 0.75→0.60 pf, Meter B1, Frequency 99
Figure 5.11.3: Event B, 0.75→0.60 pf, Meter B1, Real Power 99
Figure 5.11.4: Event B, 0.75→0.60 pf, Meter B1, Reactive Power 99
Figure 5.11.5: Event B, 0.75→0.60 pf, Meter A1, RMS Voltage and Current 100
Figure 5.11.6: Event B, 0.75→0.60 pf, Meter A1, Frequency 100
Figure 5.11.7: Event B, 0.75→0.60 pf, Meter A1, Real Power 100
Figure 5.11.8: Event B, 0.75→0.60 pf, Meter A1, Reactive Power 100
Figure 5.11.9: Event B, 0.75→0.60 pf, Meter A2, RMS Voltage and Current 101
Figure 5.11.10: Event B, 0.75→0.60 pf, Meter A2, Frequency 101
Figure 5.11.11: Event B, 0.75→0.60 pf, Meter A2, Real Power 101
Figure 5.11.12: Event B, 0.75→0.60 pf, Meter A2, Reactive Power 101
Figure 5.11.13: Event F, 0.75→0.60 pf, Meter B1, RMS Voltage and Current 102
Figure 5.11.14: Event F, 0.75→0.60 pf, Meter B1, Frequency 102
Figure 5.11.15: Event F, 0.75→0.60 pf, Meter B1, Real Power 102
Figure 5.11.16: Event F, 0.75→0.60 pf, Meter B1, Reactive Power 102
Figure 5.12.1: Event I, Single Source, 15kW Harmonic, Meter B1, RMS Voltage and Current 107
Figure 5.12.2: Event I, Single Source, 15kW Harmonic, Meter B1, Waveform Voltage and Current 107
Figure 5.12.3: Event I, Single Source, 15kW Harmonic, Meter B1, Real Power 107
Figure 5.12.4: Event I, Single Source, 15kW Harmonic, Meter B1, Reactive Power 107
Figure 5.12.5: Event G, Three Sources, 15kW Harmonic, Meter B1, RMS Voltage and Current 109
Figure 5.12.6: Event G, Three Sources, 15kW Harmonic, Meter B1, Waveform Voltage and Current 109
Figure 5.12.7: Event G, Three Sources, 15kW Harmonic, Meter B1, Real Power 109
Figure 5.12.8: Event G, Three Sources, 15kW Harmonic, Meter B1, Reactive Power 109
Figure 5.12.9: Event G, Three Sources, 15kW Harmonic, Meter A1, RMS Voltage and Current 110
Figure 5.12.10: Event G, Three Sources, 15kW Harmonic, Meter A1, Waveform Voltage and Current 110
Figure 5.12.11: Event G, Three Sources, 15kW Harmonic, Meter A1, Real Power 110
Figure 5.12.12: Event G, Three Sources, 15kW Harmonic, Meter A1, Reactive Power 110
Figure 5.12.13: Event G, Three Sources, 15kW Harmonic, Meter A2, RMS Voltage and Current 111
Figure 5.12.14: Event G, Three Sources, 15kW Harmonic, Meter A2, Waveform Voltage and Current 111
Figure 5.12.15: Event G, Three Sources, 15kW Harmonic, Meter A2, Real Power 111

Figure 5.12.16: Event G, Three Sources, 15kW Harmonic, Meter A2, Reactive Power.....111

Table of Tables:

Table 5.1.1: Emergency Shutdown Test Settings 7
Table 5.1.2: Emergency Shutdown Test Results 7
Table 5.2.1: Generator B1 Test Settings.....10
Table 5.2.2: Generator B1 Test Results.....11
Table 5.3.1: Voltage Regulation Test Settings 19
Table 5.3.2: Initial Voltage Regulation Test Results.....19
Table 5.4.1: Frequency vs. Real Power Droop Control Test Settings 25
Table 5.4.2: Frequency vs. Real Power Steady State Measurements 26
Table 5.5.1: Voltage vs. Reactive Power Droop Control Test Settings.....37
Table 5.5.2: Voltage vs. Reactive Power Droop Control Test Results.....37
Table 5.6.1: Generator Black Start Capacity Settings 48
Table 5.6.2: Generator Black Start Capacity Results 48
Table 5.7.1: Load Step and Stalling Response Characteristic Test Settings.....56
Table 5.7.2: Load Step and Stalling Response Characteristic Test Results.....64
Table 5.8.1: Pmax Controller Test Settings.....71
Table 5.8.2: Pmax Controller Test Results.....72
Table 5.9.1: Voltage Dispatch Mismatch Test Settings: B1 Voltage: 95%, A1 Voltage 100% 81
Table 5.9.2: Voltage Dispatch Mismatch Test Settings: B1 Voltage: 105%, A1 Voltage 100% 81
Table 5.9.3: Voltage Dispatch Mismatch Test Settings: B1 Voltage: 100%, A1 Voltage: 95% 81
Table 5.9.4: Voltage Dispatch Mismatch Test Settings: B1 Voltage: 100%, A1 Voltage: 105% 81
Table 5.9.5: Voltage Dispatch Mismatch Test Results: B1 Voltage: 95%, A1 Voltage 100% 82
Table 5.9.6: Voltage Dispatch Mismatch Test Results: B1 Voltage: 105%, A1 Voltage 100% 82
Table 5.9.7: Voltage Dispatch Mismatch Test Results: B1 Voltage: 100%, A1 Voltage: 95% 82
Table 5.9.8: Voltage Dispatch Mismatch Test Results: B1 Voltage: 100%, A1 Voltage: 105% 82
Table 5.10.1: Motor Start Tests, Weak Grid, Unbalanced Load with 0.9 Power Factor 87
Table 5.10.2: Unbalance Unload Test Results.....88
Table 5.11.1: Power Factor Test Settings.....97
Table 5.11.2: Power Factor Test Results.....98
Table 5.12.1: Harmonic Load Tests with Motor Starts Test Settings.....104
Table 5.12.2: Harmonic Load Tests with Motor Start, Results Table 105

1.0 Introduction

This document is a report on the testing performed on a 100 kW synchronous generator connected to the CERTS Microgrid, located at American Electric Power's Walnut Test Site. The testing was designed to investigate a synchronous generator's compatibility with the existing CERTS Microgrid Test Bed, its equipment and controls.

2.0 Definitions

- ***Distributed Energy Resource:*** Stand-alone equipment capable of sourcing or sinking electrical power into an electrical bus. Examples include: diesel/electric generators, battery storage systems, photovoltaic panels (solar panels), wind turbines, etc. ***Also referred to as: DER.***

- ***Difficult Loads:*** There are a number special loads utilized to stress the microgrid DER equipment. These loads include a 10 HP motor dynamometer exclusively in Load Bank 3, a harmonic current load which can be connected to any of the Load Banks 3 – 6, and large 'team' loads which have capacities requiring multiple DER to be successfully energized.

- ***easYgen:*** A generator controller designed and manufactured by Woodward, Inc. of Fort Collins, Colorado. This device is used as secondary generator controls to dispatch and govern generator B1 overall operation.

- ***Generator "A1":*** An 'Inverde 100', inverter based combined heat and power generator set assembled by Tecogen Inc. of Waltham, Massachusetts. The unit is fueled by natural gas and is rated to support 100 kW of electrical load and 700kBtu/hr of thermal load. The inverter on this unit allows it increased flexibility, as if frees the engine to operate over a wide range of rotational speeds (RPM), as opposed to a fixed speed.

- ***Generator "A2":*** An original prototype inverter based generator set assembled by Tecogen. The unit is fueled by natural gas and is rated to support 60 kW of electrical load. This unit is a prototype used as an intermediate step in the development of the CERTS Controls Algorithms.

- ***Generator "B1":*** A Synchronous generator set assembled by MTU Onsite Energy and controlled with a Woodward easYgen controller. The unit is fueled by natural gas, and is rated at 93 kW.

- ***Grid Connected:*** Mode when the microgrid is connected to the electrical grid through the grid interface switch enabling the exchange of real and reactive power with the local utility. ***Also referred to as: "Grid Tied".***

- ***Grid Connection Type:*** The CERTS Microgrid Test Bed contains a series inductance in the grid connection which can be bypassed as needed. When inserted it provides a weakly coupled grid connection simulating a distant, high impedance feeder connection. When bypassed it provides a strongly coupled grid connection simulating a close to substation, low impedance feeder connection. This adjustment is facilitated using series inductance "L11".

- ***Grid Disconnected:*** Mode when the microgrid is disconnected from the electrical grid at the utility interface switch. The microgrid is operating independently from the grid and is internally responsible for the power quality delivered to the load. ***Also referred to as: "Islanded".***

- ***Grid Interface Switch:*** The grid paralleling and protection switch used to connect and disconnect from the utility grid as necessary or desired. Within the CERTS Microgrid both a semiconductor and a mechanical version of this switch are available. Where the differences are important it is noted which switch was used, otherwise the response is similar with

either. The semiconductor switch was assembled by S&C. This consists of a Silicon Controlled Rectifier (SCR) based switch with input, output, and bypass breakers, paired with a custom DSP controller. The mechanical switch consists of an industrial power breaker with a Schweitzer Engineering Laboratories relay. In addition to isolating the microgrid during protection events specified in IEEE 1547, the grid interface switch also performs synchronized reconnection when the proper conditions are met. ***Also referred to as: "GIS"***

– ***Load Banks***: There are 4 load banks located within the CERTS Microgrid Test Bed: Load Bank 3, Load Bank 4, Load Bank 5, and Load Bank 6. Each is capable of consuming a maximum 95 kW of real load and 60 kvar of reactive (inductive) load. It should be noted that each load bank is constructed of wire wrapped resistors which vary in resistance as they heat up, causing the load bank to consume slightly less than dispatched real power, approximately 15%. Load Bank 3 is located in Zone 3, which also contains Generator A1. Load Bank 4 is located in Zone 4 which also contains Generator A2. Load Bank 5 is located in Zone 5 which also contains Generator B1. Finally Load Bank 6 is located outside of the protected zones of the microgrid, in Zone 6, and remains connected to the utility under all conditions. Load Bank 6 is used as a benchmark, against which the protected zone power quality is gauged. ***Also referred to as: LB3, LB4, LB5 and LB6.***

– ***Microgrid:*** A microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode.

3.0 The CERTS Microgrid Test Bed

The CERTS Walnut Test Bed is a facility in an extension of the American Electric Power Dolan Technology Center and is designed for the purpose of testing various microgrid and distributed generation components and concepts. The facility features several key pieces of equipment which enable testing to be performed on the microgrid safely and with repeatability. Key components include; varying types of Distributed Energy Resources (DER), a Grid Interface Switch (GIS) between the microgrid and utility connection, controllable loads used to mimic real world conditions, and an extensive data collection system. The test facility also supplies a low impedance electric utility connection with protective equipment, a high pressure natural gas supply, a cooling water supply and a security network for physical equipment protection.

Prior CERTS Microgrid Testing has examined homogenous inverter base generation interaction, various methods of microgrid protection, difficult and unsupportable load operation, power quality assessments, and semiconductor and mechanical grid interface switch functionality. This report covers testing performed on a directly coupled synchronous generator and its interactions within the CERTS Microgrid environment.

The current setup of the microgrid test bed features one prototype unit “A2”, one production inverter unit “A1” and a synchronous generator “B1”. The device specifications are listed below:

<u>Prototype Tecogen CERTS Generator “A2”</u>
Natural Gas V-8, 454 CID, Spark Ignition Engine
Woodward 8290 Governor
60kW Synchronous Generator, Air Cooled
Youtility CERTS Compatible Inverter and Exciter
480/277V, 100A, 60kW, 85kVA rated

<u>Tecogen Inverde 100 CHP Generator “A1”</u>
Natural Gas V-8, 454 CID, Spark Ignition Engine
Governor America Corp. SDG 700 Series Governor
125kW Permanent Magnet Generator, Water Cooled
Youtility CERTS Compatible Inverter
480/277V, 150A, 125kW, 125kVA
700 kBtu/hr Thermal

<u>MTU Synchronous Generator “B1”</u>
Natural Gas V-8, 8.1L Vortec, Spark Ignition Engine
E-Controls 128 EPR Governor
116 kVA Synchronous Generator, Air Cooled
Marathon DVR2000E Voltage Exciter
Woodward easYgen 3200 p2 Generator Controller
480/277V, 139A, 93kW, 116kVA

A CERTS compatible microgrid utilizes a set of control algorithms common to distributed energy resources which allows for system wide stability within rated conditions without a requirement for direct communications between devices. A low bandwidth, low

reliability, communications network can then be overlaid to optimize the operation of devices for various priorities such as fuel consumption, load demands, operating costs, etc. This type of network, peer-to-peer and plug and play creates no dependencies as in master-slave control architectures allowing for high system flexibility and reliability.

Figure 3.1 CERTS Microgrid Aerial Photo

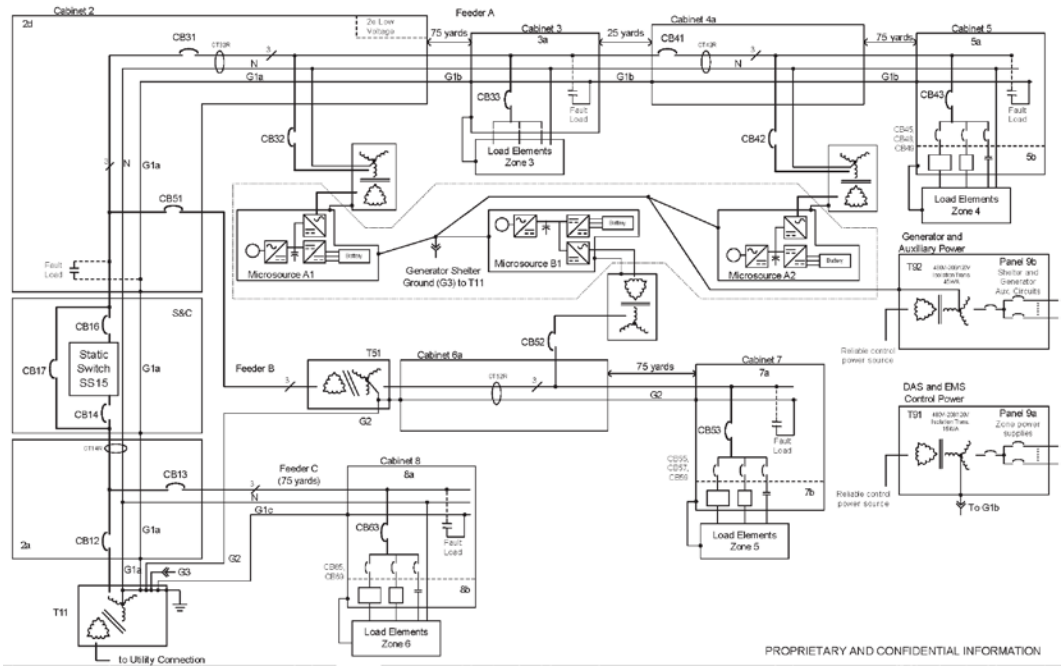


Figure 3.2 CERTS Microgrid Overview Oneline

4.0 Executive Summary

The sequences of tests that follow were designed to assess the compatibility and capabilities of a CERTS Controls equipped synchronous generator with other DER's connected to the CERTS Microgrid. Based on the results that follow, a synchronous generator is capable of operating within a CERTS Microgrid, although the generator would benefit from further refinement of its controls.

The generator exhibited its capabilities in test sequences such as 5.2: Load Step Response of Generator B1 and 5.7: Load Step and Overload Response. In these sequences, the generator's capabilities were examined such as its maximum power output and its stalling characteristic. Similarly, the generator's ability to collaborate with multiple generators was tested in sequences such as 5.9: Generator Voltage Dispatch Mismatch and 5.11: Power Factor Tests. In those tests, the synchronous generator exhibited its ability to collaborate with multiple generators to handle difficult and unusual load conditions.

Three important control features of the CERTS Microgrid are the Voltage vs Frequency Droop Control, Reactive Power vs Voltage Droop Control, and Pmax Controller. These specific functions are tested in sections 0 (page 24), 5.5 (page 36), and 5.8 (page 70). The synchronous machine successfully passed these tests by meeting the criterion set forth in each sequence.

The synchronous generator would benefit from limited improvements to its control system. Recommendations for improvements address issues discovered during testing and include a faster response time in order to avoid the shutdowns due to over-speed in sequence 5.7 and a band pass filter to address the 8 Hz oscillation observed during the multiple generator tests of sequences 5.10, 5.11, and 5.12.

While there are areas where the synchronous generator's performance could use improvement, its performance during the test sequences was generally acceptable. It was able to function satisfactorily during stand-alone operation and was able to collaborate with multiple generators in the CERTS Microgrid. Based on these results, the testing team is confident that a synchronous generator is fully capable operating as part of a CERTS Microgrid.

5.0 Test Results

5.1 *Emergency Shutdown*

Performance Goal

Verify proper operation of emergency shutdown command issued from a remote control station. The synchronous generator should completely shut down quickly at the remote issuance of an emergency shutdown command. This function should emulate the manual emergency stop located on the front of the generator unit.

Description of Procedure

Generator B1 was dispatched to 50 kW, 480$V_{l\text{-}l}$, 1% Frequency Droop, 5% Voltage Droop and operated islanded from the utility. The generator is started and connected to the 'islanded' microgrid electrical bus with a balanced load of 50 kW in LB5. Once the system has reached steady state an event is captured when the "Emergency Shutdown" command is issued from the remote control panel.

Test Settings

The easYgen Controller has the following settings:

Voltage Dispatch: 480V
Real Power Dispatch: 50 kW
Frequency Droop: 1%
Voltage Droop: 5%

The Voltage Exciter has the following settings:

Load Relief Setting: 58 Hz @ 3 pu V/Hz

Generator B1	GIS	Load Bank 5
50 kW	Open	50 kW

Table 5.1.1: Emergency Shutdown Test Settings

Test Results

Table 5.1.2 below summarizes system voltage behaviors prior to the remote emergency shutdown command issuance and the Generator response time.

Event LB5	GIS	Bus			Pass/Fail	Notes
		Voltage (Before)	Voltage (After)	Response Time		
Emergency Stopped	Open	275.6 V	0 V	0.17 s	Pass	None

Table 5.1.2: Emergency Shutdown Test Results

Analysis

At the issuance of the shutdown command, Generator B1 shut down in under 0.25 seconds and all microgrid protection breakers opened as expected. Figure 5.1.1 shows the voltage and current RMS waveforms of generator B1 as it responded to the shutdown command. The current waveforms show a rapid decay approaching zero immediately after the command was issued.

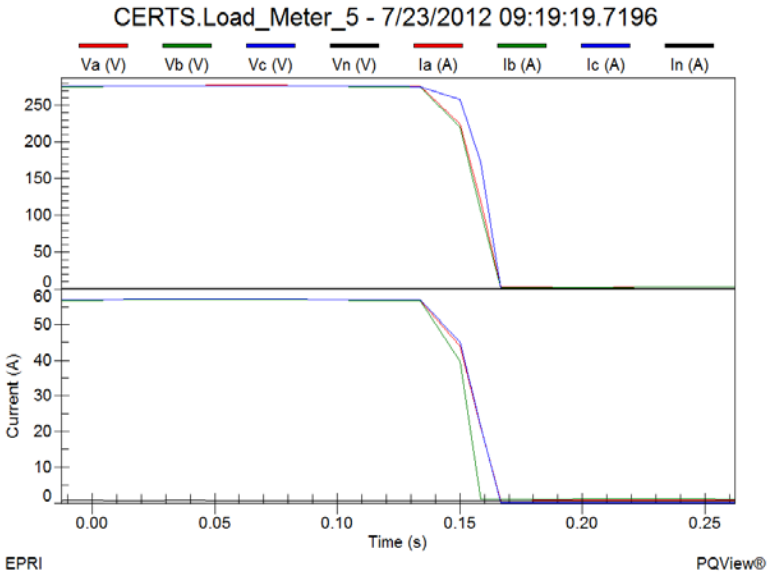


Figure 5.1.1: RMS Voltage and Current in Response to an Emergency Shutdown Command

5.2 *Load Step Response of Generator B1*

Performance Goal

Verify the generator's ability to respond to loads and load step changes of increasing magnitude. This test is designed to quantify the generator's load step capability throughout its operating range by stressing the generator at various operating points. The generator is tested with varying load steps under varying initial load conditions. A successful Pass criterion is the transition from one load point to another demonstrating stability in voltage and frequency. The generator should continue to carry the load in steady state unless prolonged overload occurs. Under overload conditions the generator should perform a protection trip and safely shutdown.

Description of Procedure

Generator B1 was dispatched to 50 kW, 480$V_{l\text{-}l}$, 1% Frequency Droop, 5% Voltage Droop and operated islanded from the utility. The under-frequency protection trip is set to 54 Hz @ 1 second and the over-frequency protection trip is set to 66 Hz @ 0.3 seconds. The generator is started and connected to the 'islanded' microgrid electrical bus, initially with no load present. Varying load steps are placed on the generator and each event is recorded. Each load step is then removed and the event is recorded again. For most tests, an initial load is also placed on the generator prior to the step load.

Test Settings

In the settings table below, initial loads are shown as fixed numbers (e.g. 50 kW), and the captured load step is shown with a transition increasing (e.g. 0→100 kW) or decreasing (e.g. 100→0 kW).

The easYgen Controller has the following settings:

- Voltage Dispatch: 480V
- Real Power Dispatch: 50 kW
- Frequency Droop: 1%
- Voltage Droop: 5%

The Voltage Exciter has the following settings:

- Load Relief Setting: 58 Hz @ 3 pu V/Hz

Test Event	Generator B1 Dispatch	GIS	Load Bank 3	Load Bank 4	Load Bank 5	Total Load Transition
A	50 kW	Open	0 kW	0 kW	0→20 kW	0→20 kW Load Step
B	50 kW	Open	0 kW	0 kW	20→0 kW	20→0 kW Load Step
C	50 kW	Open	20 kW	0 kW	0→20 kW	20→40 kW Load Step
D	50 kW	Open	20 kW	0 kW	20→0 kW	40→20 kW Load Step
E	50 kW	Open	40 kW	0 kW	0→20 kW	40→60 kW Load Step
F	50 kW	Open	40 kW	0 kW	20→0 kW	60→40 kW Load Step
G	50 kW	Open	60 kW	0 kW	0→20 kW	60→80 kW Load Step
H	50 kW	Open	60 kW	0 kW	20→0 kW	80→60 kW Load Step
I	50 kW	Open	80 kW	0 kW	0→20 kW	80→100 kW Load Step
J	50 kW	Open	80 kW	0 kW	20→0 kW	100→80 kW Load Step
K	50 kW	Open	80 kW	20 kW	0→20 kW	100→120 kW Load Step This load step is anticipated to cause a protection trip of the generator
L	50 kW	Open	80 kW	20 kW	20→0 kW	120→100 kW Load Step This load step may require bypass if generator is incapable of operation at initial conditions
M	50 kW	Open	0 kW	0 kW	0→40 kW	0→40 kW Load Step
N	50 kW	Open	0 kW	0 kW	40→0 kW	40→0 kW Load Step
O	50 kW	Open	20 kW	0 kW	0→40 kW	20→60 kW Load Step
P	50 kW	Open	20 kW	0 kW	40→0 kW	60→20 kW Load Step
Q	50 kW	Open	40 kW	0 kW	0→40 kW	40→80 kW Load Step
R	50 kW	Open	40 kW	0 kW	40→0 kW	80→40 kW Load Step
S	50 kW	Open	60 kW	0 kW	0→40 kW	60→100 kW Load Step
T	50 kW	Open	60 kW	0 kW	40→0 kW	100→60 kW Load Step
U	50 kW	Open	0 kW	0 kW	0→60 kW	0→60 kW Load Step
V	50 kW	Open	0 kW	0 kW	60→0 kW	60→0 kW Load Step
W	50 kW	Open	20 kW	0 kW	0→60 kW	20→80 kW Load Step
X	50 kW	Open	20 kW	0 kW	60→0 kW	80→20 kW Load Step
Y	50 kW	Open	40 kW	0 kW	0→60 kW	40→100 kW Load Step
Z	50 kW	Open	40 kW	0 kW	60→0 kW	100→40 kW Load Step
AA	50 kW	Open	0 kW	0 kW	0→80 kW	0→80 kW Load Step
AB	50 kW	Open	0 kW	0 kW	80→0 kW	80→0 kW Load Step
AC	50 kW	Open	20 kW	0 kW	0→80 kW	20→100 kW Load Step
AD	50 kW	Open	20 kW	0 kW	80→0 kW	100→20 kW Load Step
AE	50 kW	Open	0 kW	0 kW	0→100 kW	0→100 kW Load Step
AF	50 kW	Open	0 kW	0 kW	100→0 kW	100→0 kW Load Step

Table 5.2.1: Generator B1 Test Settings

Test Results

The results table below summarized the measured power, voltages, and frequencies of Generator B1.The voltages and frequencies were measured prior to and after the event occurred.

Test Event	Gen-set B1					Pass / Fail	Notes
	Real Power (P)	Voltage Avg (Prior)	Voltage Avg (After)	Frequency (Pre-Event)	Frequency (Post-Event)		
A	20.5 kW	277.1 V	276.6 V	59.98 Hz	60.05 Hz	Pass	
B	0.74 kW	276.5 V	276.8 V	60.05 Hz	60.05 Hz	Pass	
C	39.1 kW	277.7 V	276.6 V	59.98 Hz	60.03 Hz	Pass	
D	18.55 kW	276.4 V	276.6 V	60.3 Hz	60.03 Hz	Pass	
E	56.3 kW	276.6 V	276.5 V	59.8 Hz	60.04 Hz	Pass	
F	36 kW	276.4 V	277.4 V	60.3 Hz	60.1 Hz	Pass	
G	73.4 kW	276.5 V	276.4 V	59.41 Hz	60.04 Hz	Pass	
H	53.4 kW	276.6 V	276.5 V	59.78 Hz	60.04 Hz	Pass	
I	91.1 kW	276.2 V	276.3 V	59.69 Hz	60.05 Hz	Pass	
J	70.3 kW	276.5 V	276.3 V	60.28 Hz	60.04 Hz	Pass	
K	-	-	-	-	-	Pass	Generator B1 Shutdown from Protection Trip
L	-	-	-	-	-	NA	Skipped
M	39.7 kW	276.6 V	276.6 V	60.16 Hz	60.08 Hz	Pass	
N	.7 kW	276.4 V	276.8 V	60.19 Hz	60.03 Hz	Pass	
O	57.6 kW	276.73 V	276.5 V	59.54 Hz	60.03 Hz	Pass	
P	18.5 kW	276.4 V	276.7 V	60.32 Hz	60.04 Hz	Pass	
Q	75.2 kW	276.7 V	276.4 V	60.01 Hz	60.03 Hz	Pass	
R	36 kW	276.4 V	276.6 V	60.18 Hz	60.02 Hz	Pass	
S	92.8 kW	276.6 V	276.3 V	59.66 Hz	60.05 Hz	Pass	
T	53.2 kW	276.2 V	276.5 V	60.25 Hz	60.02 Hz	Pass	
U	58.2 kW	277 V	276.6 V	59.9 Hz	60.01 Hz	Pass	
V	.7 kW	275.6 V	277.9 V	60.02 Hz	60.3 Hz	Pass	
W	76.8 kW	276.6 V	277.3 V	60.04 Hz	59.9 Hz	Pass	
X	18.4 kW	276.4 V	276.7 V	59.98 Hz	60.05 Hz	Pass	
Y	93.9 kW	276.7 V	276.4 V	59.9 Hz	60.05 Hz	Pass	
Z	35.8 kW	276.4 V	276.6 V	60.1 Hz	60.02 Hz	Pass	
AA	76.8 kW	276.8 V	276.4 V	60.03 Hz	60.06 Hz	Pass	
AB	-	-	-	-	-	Fail	Generator B1 Shutdown from Over-Frequency Protection Trip.
AC	95.1 kW	276.6 V	276.3 V	59.8 Hz	60.03 Hz	Pass	
AD	-	-	-	-	-	Fail	Generator B1 Shutdown from Over-Frequency Protection Trip.
AE	91.8 kW	276.8 V	276.4 V	59.82 Hz	60.07 Hz	Pass	
AF	-	-	-	-	-	Fail	Generator B1 Shutdown from Over-Frequency Protection Trip.

Table 5.2.2: Generator B1 Test Results

Analysis

The generator successfully passed all loading steps from 0 to 100 kW and unloading steps from 60 to 0 kW with minimal impact to voltage and frequency. Figure 5.2.1 through Figure 5.2.4 represent the typical characteristics of a successful loading, Event AE, 0→100 kW, a full rated load step on the generator. The transition from no load to full load represents the most severe step the generator is expected to successfully pass, reaching steady state for both voltage and frequency in approximately 3 seconds.

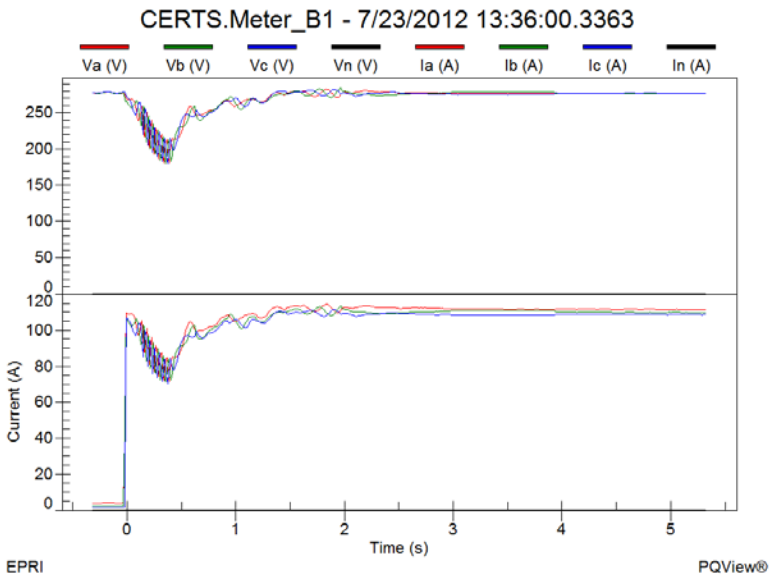


Figure 5.2.1: Event AE, 0→100 kW, Meter B1, RMS Voltage and Current

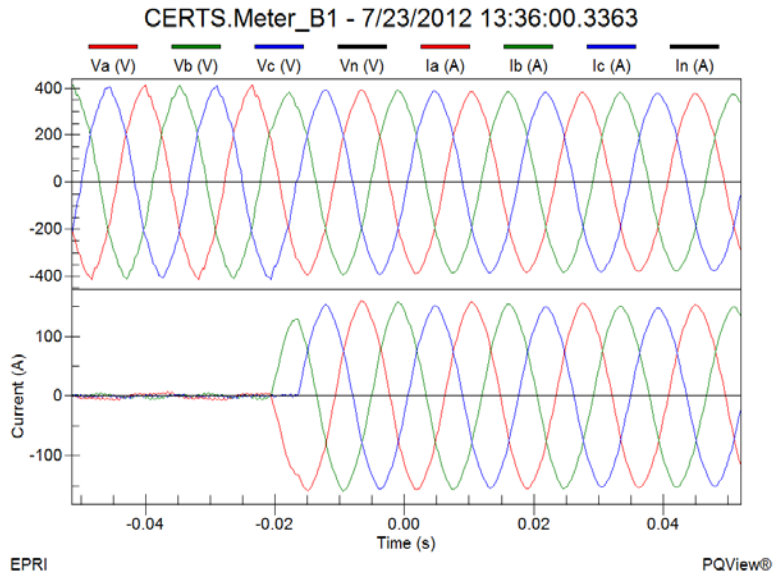


Figure 5.2.2: Event AE, 0→100 kW, Meter B1, Waveform Voltage and Current

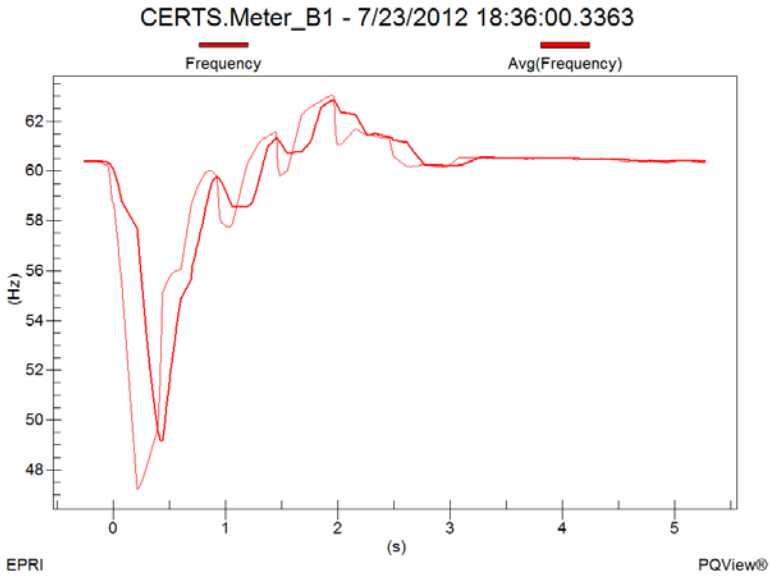


Figure 5.2.3: Event AE, 0→100 kW, Meter B1, Frequency

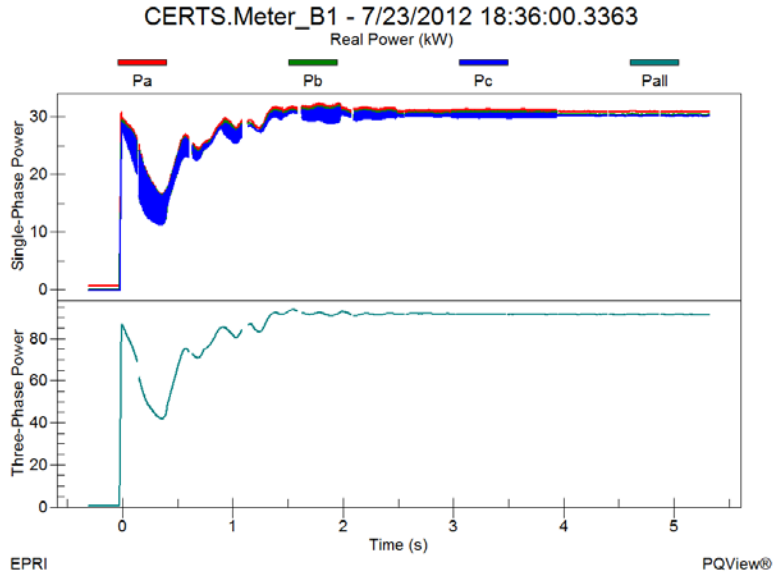


Figure 5.2.4: Event AE, 0→100 kW, Meter B1, Real Power

The overload test, Event K, 100→120 kW, was anticipated to result in a generator protection trip as the load was above the generators design rating. This test was performed to both establish the maximum successful load and to determine the process of shutdown to be expected under overload conditions. A load transition from 100 to 120 kW, 20% above the generators name plate rating was applied and the load application was captured.

Initially, at 0 seconds, the generator supplies the 120 kW demanded by the load. However the available mechanical power from the prime mover is exceeded and the electrical frequency begins to decrease. Additionally there is an interesting dynamic in the output voltage. Synchronous generators commonly include an overload protection in the voltage exciter; such that as the measured frequency drops below a predetermined point, the exciter under excites the generator to reduce the output voltage. This is done to reduce the effective real load on the generator in an attempt to prevent the generator from stalling or tripping from overload protection. Initially we suspected this was happening and therefore made adjustments to the voltage exciter to inhibit this function until a frequency of 40Hz was reach. The generator was retested with a similar result. Further investigation revealed that the Permanent Magnet Generator (PMG) powering the exciter was incapable of supplying the necessary voltage and power to maintain the excitation output to the rotor which therefore caused the generator voltage output to sag.

In affect the reduced generator voltage did reduce the real power demanded by the resistive load bank. Although the real power demanded by the load was below the generator rating by 0.5 seconds, the prime mover had already slowed to a point below which the full rated power could be carried. The generator frequency continued to decrease, following the horsepower curve of the prime mover. This continued until the electrical frequency fell below the under-frequency protection of less than 54 Hz for greater than 1 second is reached. At this point the generator performed a protection shutdown, properly protecting the generator from damage.

If an overload capacity is required one possible solution would be to utilize a de-rated generator which would keep some capacity in reserve for overload conditions. Another solution could be designing the prime mover to operate on the right side of its horsepower/torque curves peaks. This would allow for an increase in prime mover capacity as the unit slowed under load although it would also result in less fuel efficient operation. One final solution could be the incorporation of the voltage exciter overload protection. Provided the load type is a good match this would allow the bus voltage to be reduced in an attempt to reduce the real power consumed. While this is generally an undesirable operating condition it may be preferred over complete unit shutdown.

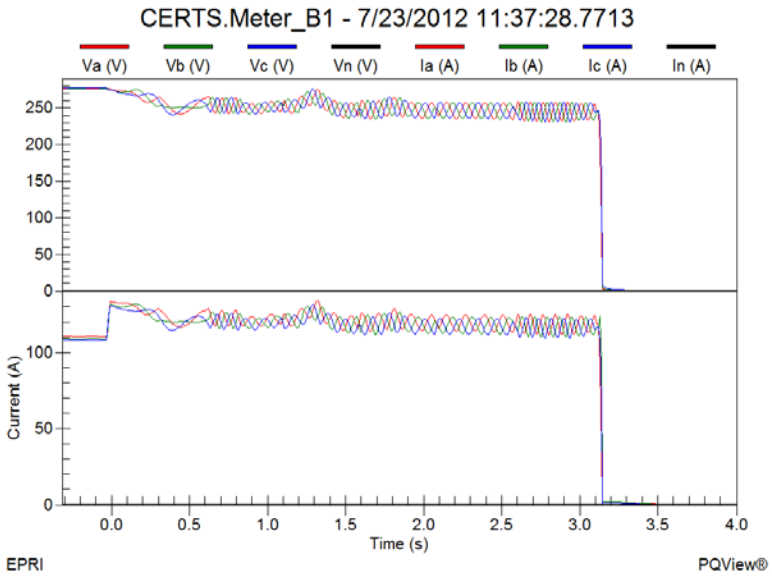


Figure 5.2.5: Event K, 100→120 kW, Meter B1, RMS Voltage and Current

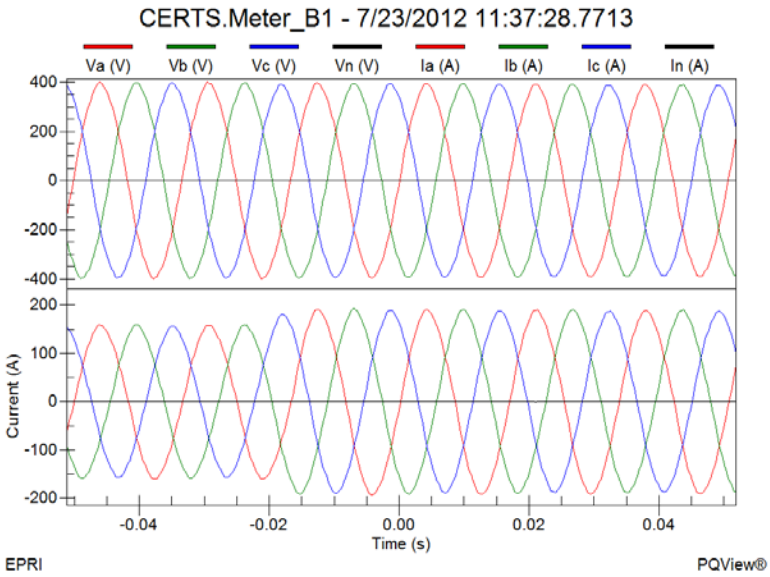


Figure 5.2.6: Event K, 100→120 kW, Meter B1, Waveform Voltage and Current

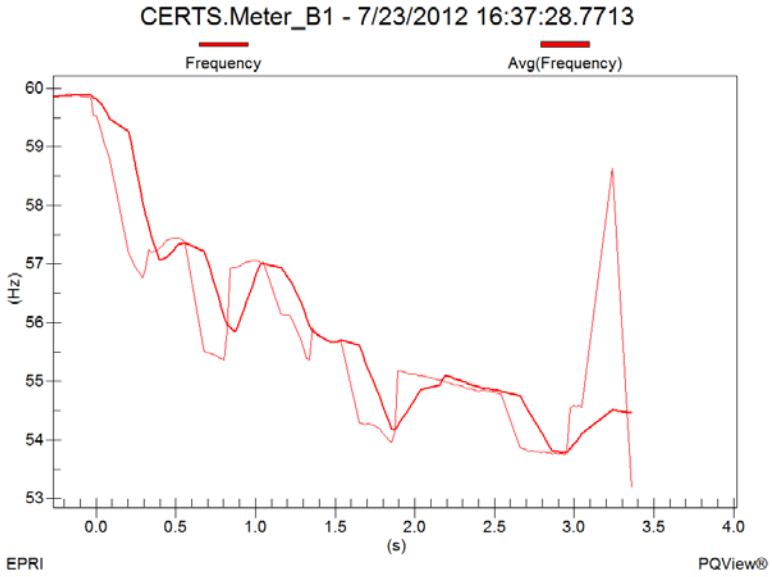


Figure 5.2.7: Event K, 100→120 kW, Meter B1, Frequency

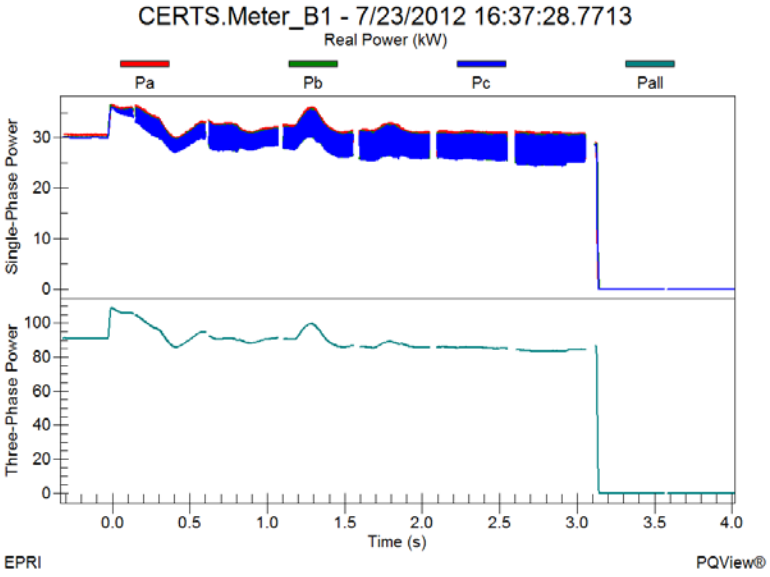


Figure 5.2.8: Event K, 100→120 kW, Meter B1, Real Power

The group of failed tests were due to large load rejections in the unloading tests; 80→0 kW, 100→20 kW, and 100→0 kW. Below, in Event AB, 80→0 kW, a load of 80 kW is rejected resulting in the generator electrical frequency and mechanical speed accelerating rapidly. The existing engine control unit responds too slowly to prevent the generator from reaching an over-frequency trip point when an 80 kW or greater load is rejected. Once the over-frequency protection trip is activated the easYgen control performed a protection shutdown.

There are a number of possible solutions. Preferably if the generator is capable of operation at these elevated speeds, the generation protection could be relaxed to allow for continued short term operation. This would prevent the protection shutdown of the generator and allow it to successfully ride thru the transient frequency condition before returning to nominal. Alternatively the generator engine control unit could be adjusted to more rapidly respond preventing the generator from reaching an unsafe operating speed.

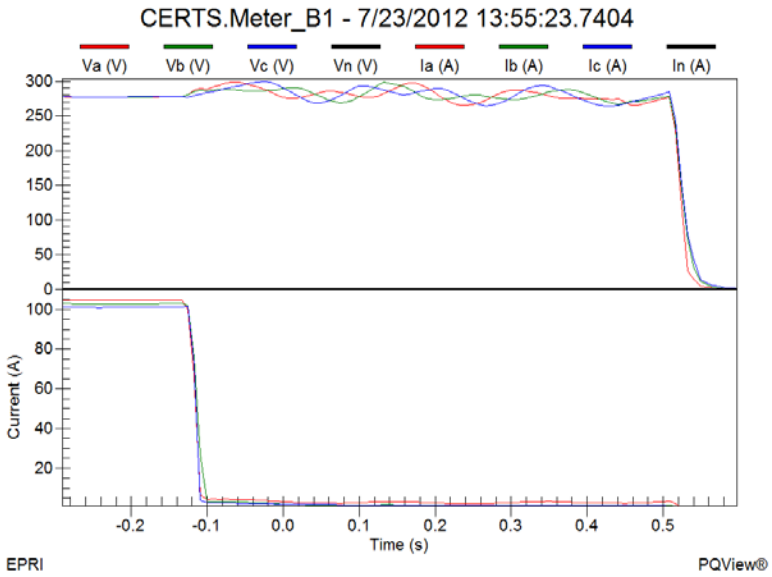


Figure 5.2.9: Event AB, 80→0 kW, Meter B1, RMS Voltage and Current

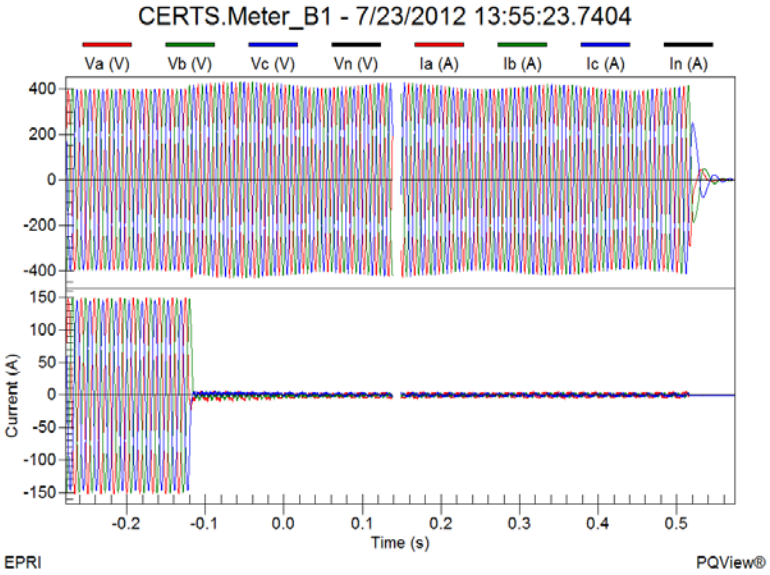


Figure 5.2.10: Event AB, 80→0 kW, Meter B1, Waveform Voltage and Current

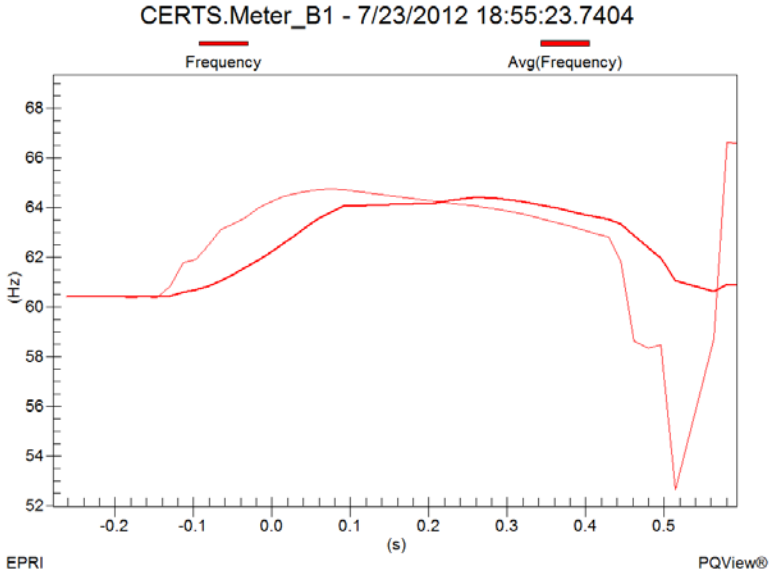


Figure 5.2.11: Event AB, 80→0 kW, Meter B1, Frequency

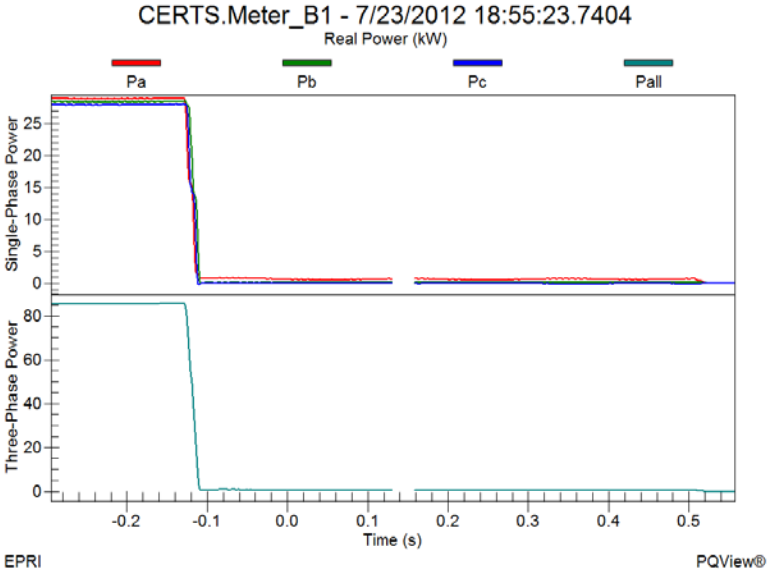


Figure 5.2.12: Event AB, 80→0 kW, Meter B1, Real Power

5.3 *Voltage Regulation*

Performance Goal

The intent of this testing is to ensure that the generator is capable of holding the correct output voltage throughout its operating range. It is also designed to determine whether the Frequency vs. Real Power and the Voltage vs. Reactive Power Controllers are properly decoupled. This section of testing is focused on two areas, the generator's steady state operation and its transient response in regard to voltage regulation. Voltage set points in generator B1 are varied between 95% to 105% of nominal voltage ($480V_{l\text{-}l}$). The loads have been deliberately chosen with no reactive power component to remove the effect of the Voltage vs. Reactive Power droop control which is tested in a later section. The generator should be capable of transitioning thru each load step with a transient in voltage no greater than 20% from nominal and lasting no longer than 0.5 seconds. In steady state the generator shall maintain the voltage within 0.5%, $2.5V_{l\text{-}l}$, of the set point voltage when the load has no reactive component. Additionally there should be little to no effect on the output voltage due to changes in the real power consumed on the microgrid bus.

Description of Procedure

Generator B1 was dispatched to 50 kW, 480 $V_{l\text{-}l}$, 1% Frequency Droop, 5% Voltage Droop and operated islanded from the utility. The generator is started and connected to the 'islanded' microgrid electrical bus, initially with no load present. An initial event was captured when the generator first connects to the microgrid bus, a no load reference case. Further events are captured as the load is increased in approximate 30kW steps until 95 kW is reached. Each set of load steps was repeated at voltage set points of nominal, 105% and 95% of nominal voltage.

Test Settings

The easYgen Controller has the following settings:

Voltage Dispatch: 480V
Real Power Dispatch: 50 kW
Frequency Droop: 1%
Voltage Droop: 5%

The Voltage Exciter has the following settings:

Load Relief Setting: 58 Hz @ 3 pu V/Hz

Test Event	Generator B1 (Dispatch = 50 kW)	GIS	Load Bank 5 (kW)
A	480 V	Open	0
B	480 V	Open	30
C	480 V	Open	60
D	480 V	Open	95
E	504 V	Open	0
F	504 V	Open	30
G	504 V	Open	60
H	504 V	Open	95
I	456 V	Open	0
J	456 V	Open	30
K	456 V	Open	60
L	456 V	Open	95

Table 5.3.1: Voltage Regulation Test Settings

Test Results

Test Event	Gen-set B1 Real Power Observed (kW)	Gen-set B1 Voltage (V)		Steady State Error (%)	Peak Voltage Deviation	Pass/Fail
		Target	Actual			
A	0	277	277.686	0.25%	N/A	Pass
B	29.5	277	277.6	0.22%	0.072	Pass
C	53.3	277	277.4	0.14%	0.074	Pass
D	85.1	277	277.2	0.07%	0.108	Pass
E	0	291	291.383	0.13%	N/A	Pass
F	31.9	291	291.4	0.14%	0.078	Pass
G	58.7	291	291.1	0.03%	0.082	Pass
H	93.9	291	290.9	0.03%	0.123	Pass
I	0	263	263.821	0.31%	N/A	Pass
J	26.4	263	263.8	0.30%	0.049	Pass
K	48.5	263	263.6	0.23%	0.069	Pass
L	78.1	263	263.4	0.15%	0.093	Pass

Table 5.3.2: Initial Voltage Regulation Test Results

Analysis

The generator voltage regulation was within the acceptance criteria. In Figure 5.3.1 through Figure 5.3.4 a typical event is detailed. Event H, 60→95 kW, a 35 kW load is stepped for a total of ~95 kW, is placed on the microgrid bus. In transient the voltage drops from an initial average of 291.3 $V_{l\text{-}n}$ (the 504 $V_{l\text{-}l}$ dispatch case) to an average of 243.5 $V_{l\text{-}n}$, a 16.4% voltage sag which lasts approximately 0.5 seconds. In steady state the voltage is 290.9 $V_{l\text{-}n}$, 0.03% of the target voltage.

Figure 5.3.5 shows the steady state error from the target voltage for each of the load steps and voltage dispatch levels. This information demonstrates a successful decoupling of the Frequency vs. Real Power and the Voltage vs. Reactive Power Controllers.

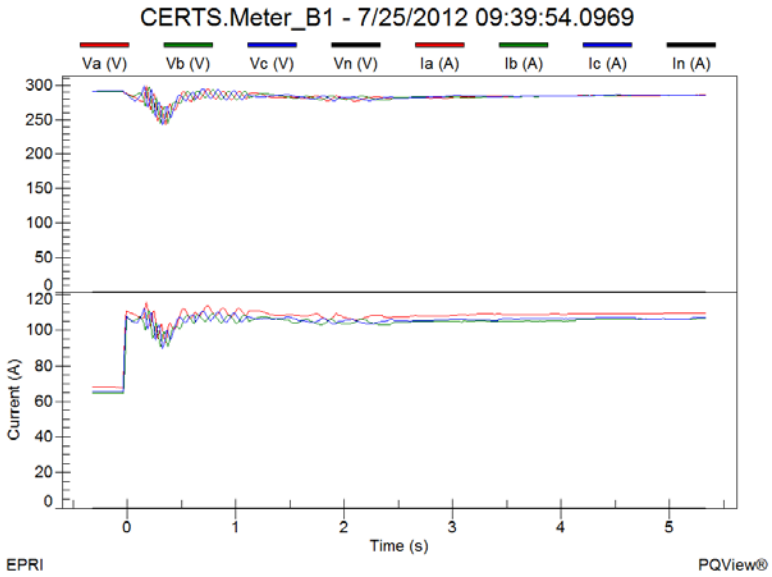


Figure 5.3.1: Event H, 504V, 60→95 kW, Meter B1, RMS Voltage and Current

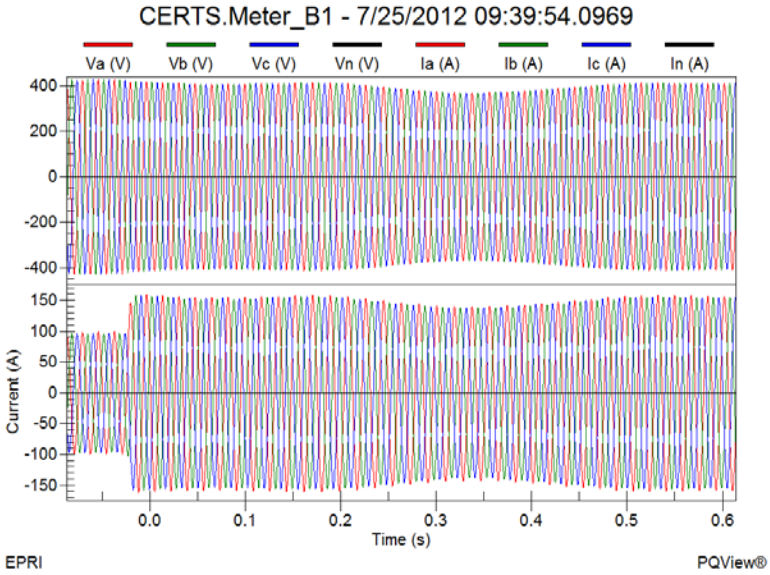


Figure 5.3.2: Event H, 504V, 60→95 kW, Meter B1, Waveform Voltage and Current

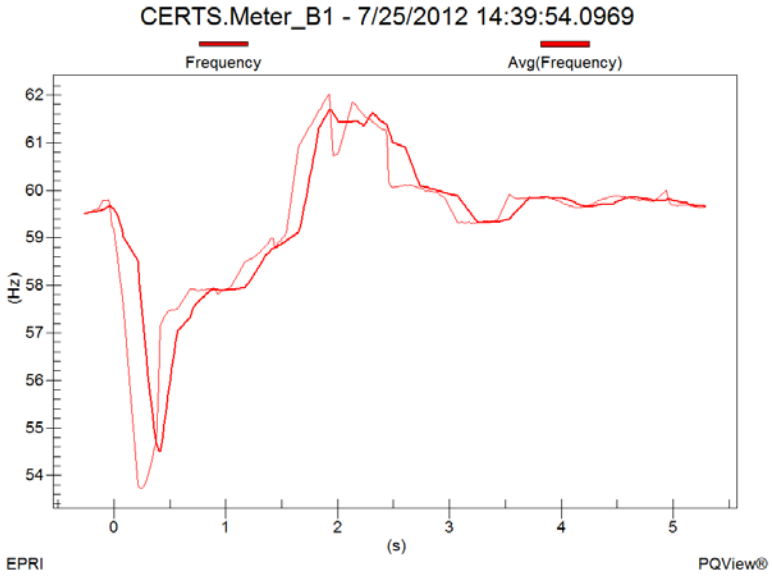


Figure 5.3.3: Event H, 504V, 60→95 kW, Meter B1, Frequency

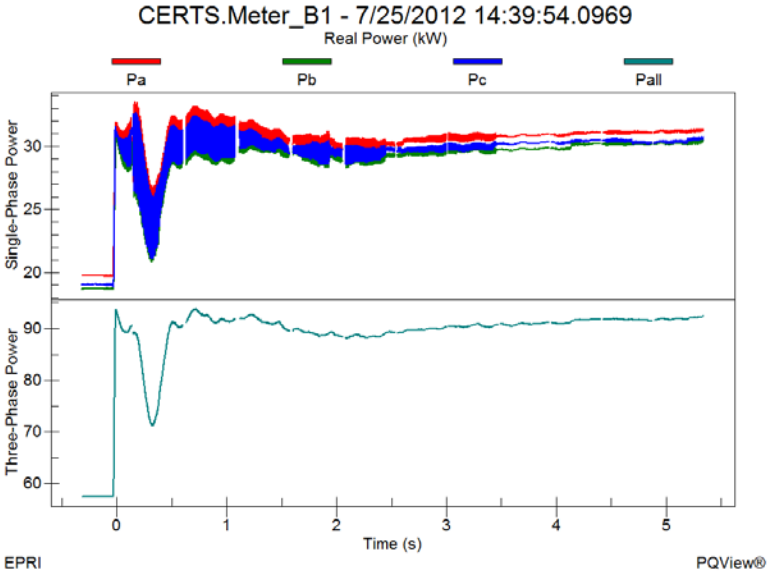


Figure 5.3.4: Event H, 504V, 60→95 kW, Meter B1, Real Power

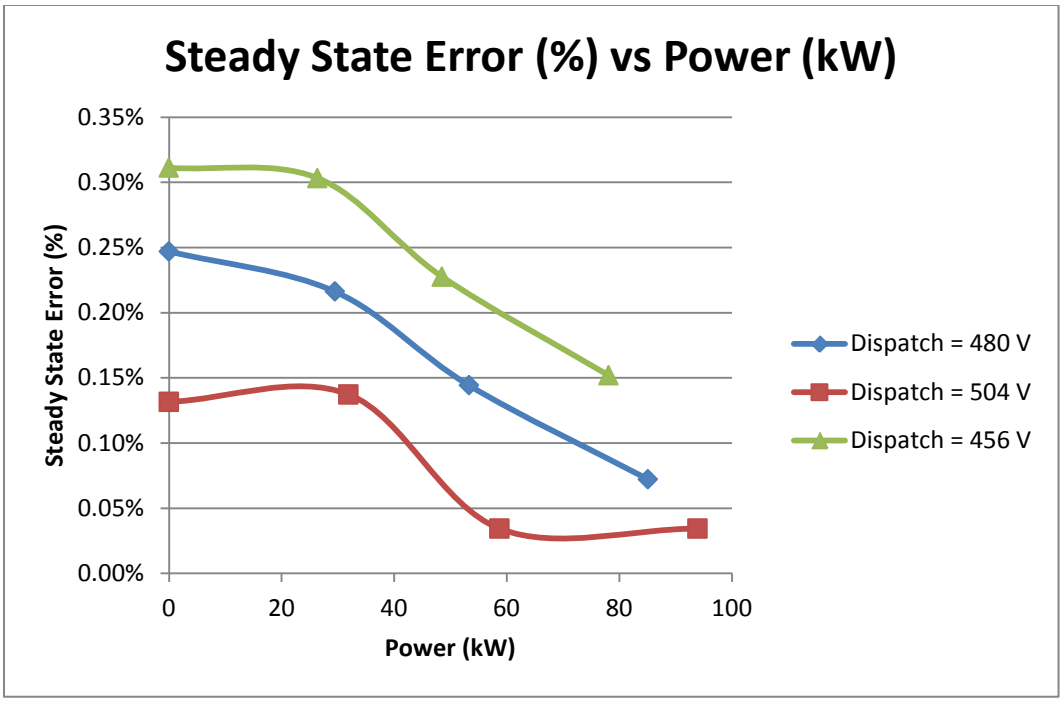


Figure 5.3.5: Steady State Error (%) vs Real Power (kW)

An interesting point was also found during this testing. When the generator is first started and connects to the microgrid bus the voltage takes approximately 15 seconds to reach the target voltage. The voltage deviation is approximately 3% or less for the 15 second period. From Figure 5.3.6, a voltage transient is measured when the generator connects to the bus. Then a gradual decay towards the target voltage is observed; $277V_{l\text{-}n}$ in this case. In Figure 5.3.7, both energizing voltage and a decaying inrush current, due to transformers connected to the microgrid bus, are observed.

The gradual decay towards the target voltage is potentially due to integral windup in either the primary or secondary controls; however further testing is required to determine the exact cause. One possible solution would be to delay the connection of the generator to the microgrid bus by approximately 15 seconds; allowing the voltage to reach its target value. Presently we do not believe this condition will cause operational problems with or without a connection delay.

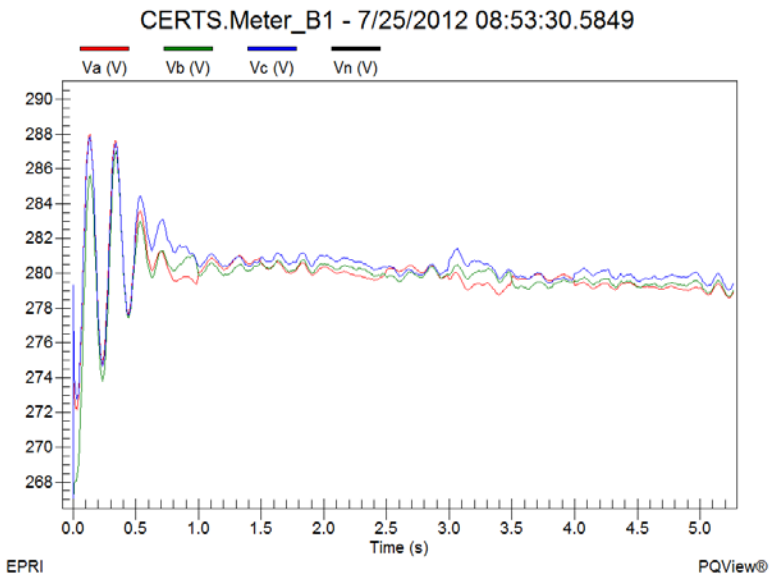


Figure 5.3.6: Generator Start-up, Meter B1, RMS Voltag

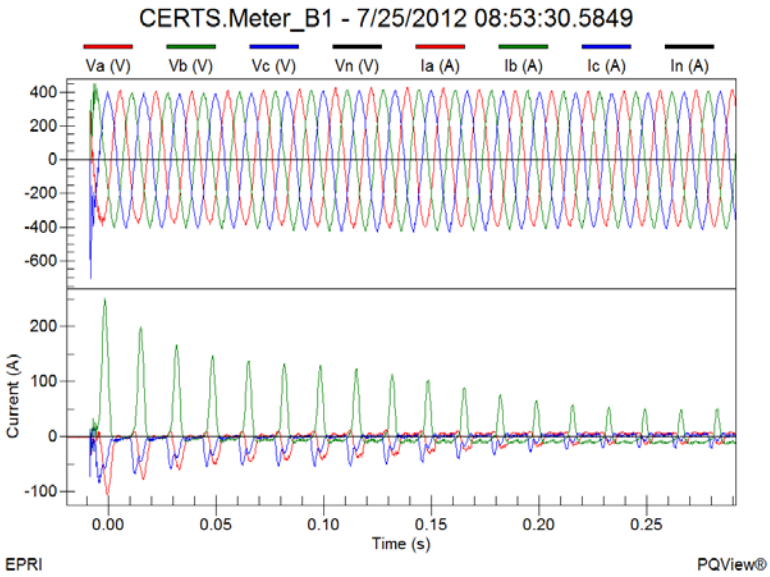


Figure 5.3.7: Generator Start-up, Meter B1, Waveform Voltage and Current

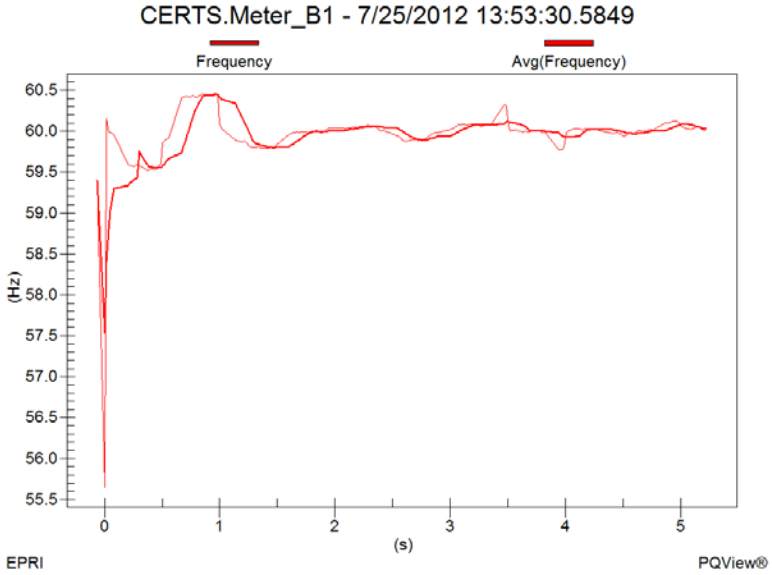


Figure 5.3.8: Generator Start-up, Meter B1, Frequency

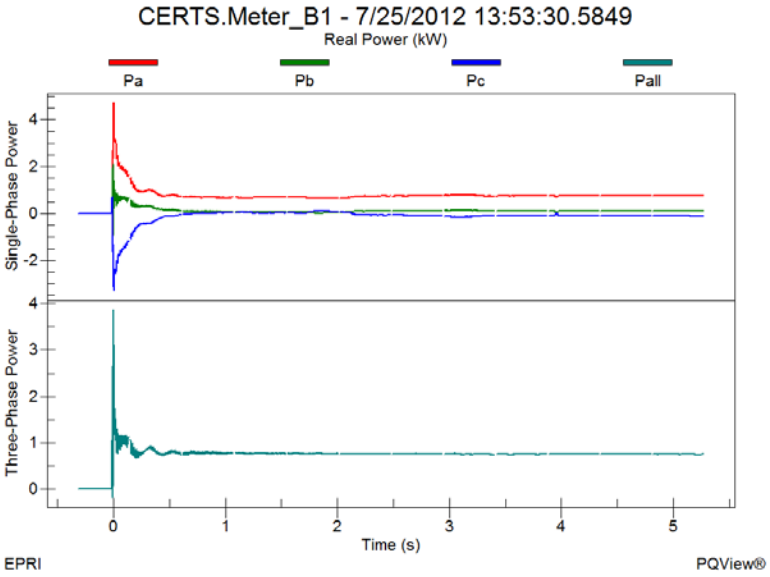


Figure 5.3.9: Generator Start-up, Meter B1, Real Power

5.4 *Frequency vs. Real Power Droop Control*

Performance Goal

The intent of this testing is to ensure proper implementation of the Frequency vs. Real Power Droop Control within the generator secondary easYgen controls. This section of tests is focused on two areas; the generator steady state operation and its transient response in regard to frequency and real power. In steady state the generator should demonstrate the relationship in Equation 5.1. This generator's response should have a rise/fall time of 1 second or less, an overshoot of not more than 10%, a settling time of 4 seconds, and a steady state error of less than 0.2 Hz of the predicted point.

$F'_{set} = F_{set} - \left[P_{\text{real}} * \left(F_{rated} * droop\ factor\right) / P_{\text{rated}}\right]$	F'_{set} = Target Frequency F_{set} = Desired Frequency P_{real} = Real Power Output F_{rated} = Rated Frequency droop factor = Desired Droop Percentage P_{rated} = Generator Rated Real Power

Equation 5.1: Real Power vs. Frequency Droop

Description of Procedure

Generator B1 is initially dispatched to 0 kW, 480 V, 1% Frequency Droop, 5% Voltage Droop and operated islanded from the utility. The generator is started and connected to the 'islanded' microgrid electrical bus, initially with no load present. An initial event was captured when the generator first connects to the microgrid bus, a no load reference case. Further events are captured as the load is increased in approximate 20 kW steps until 95 kW is reached. Each set of load steps is repeated at real power dispatch set points of 0 kW and 93 kW.

Test Settings

The easYgen Controller has the following settings:

Voltage Dispatch: 480V
Real Power Dispatch: Varies
Frequency Droop: 1%
Voltage Droop: 5%

The Voltage Exciter has the following settings:

Load Relief Setting: 58 Hz @ 3 pu V/Hz

Test Event	Generator B1	GIS	Load Bank 5
A	0 kW	Open	0 kW
B	0 kW	Open	20 kW
C	0 kW	Open	40 kW
D	0 kW	Open	60 kW
E	0 kW	Open	80 kW
F	0 kW	Open	95 kW
G	93 kW	Open	0 kW
H	93 kW	Open	20 kW
I	93 kW	Open	40 kW
J	93 kW	Open	60 kW
K	93 kW	Open	80 kW
L	93 kW	Open	95 kW

Table 5.4.1: Frequency vs. Real Power Droop Control Test Settings

Test Results

The measured power and frequency as well as the expected calculated droop frequency are summarized in the following tables:

	Gen-set B1 Real Power (kW)	Gen-set B1 Frequency (Hz)				
Test Event	**Measured**	**Target**	**Measured**	**Frequency Error**	**Standard Deviation**	**Pass/Fail**
A	**0.95**	**59.994**	**60.011**	**0.03%**	**0.033**	**Pass**
B	**19.95**	**59.871**	**59.981**	**0.18%**	**0.052**	**Pass**
C	**37.52**	**59.758**	**59.877**	**0.20%**	**0.113**	**Pass**
D	**54.73**	**59.647**	**59.766**	**0.20%**	**0.096**	**Pass**
E	**71.70**	**59.537**	**59.670**	**0.22%**	**0.106**	**Pass**
F	**84.99**	**59.452**	**59.568**	**0.19%**	**0.060**	**Pass**
G	**1.73**	**60.589**	**60.642**	**0.09%**	**0.043**	**Pass**
H	**19.93**	**60.471**	**60.578**	**0.18%**	**0.058**	**Pass**
I	**37.44**	**60.358**	**60.480**	**0.20%**	**0.093**	**Pass**
J	**54.61**	**60.248**	**60.380**	**0.22%**	**0.073**	**Pass**
K	**71.77**	**60.137**	**60.274**	**0.23%**	**0.081**	**Pass**
L	**85.11**	**60.051**	**60.173**	**0.20%**	**0.061**	**Pass**

Table 5.4.2: Frequency vs. Real Power Steady State Measurements

Analysis

The Frequency vs. Real Power Controller performed within the acceptance criteria. Figure 5.4.1 compares the measured frequencies and real power at two different real power dispatch points, 0 kW and 93 kW. The target steady state droop slope was 1% and was measured at 0.87%. The transient response to a typical event, Event F, 80→95 kW, is detailed in Figure 5.4.2 through Figure 5.4.6. In Figure 5.4.2 the load step event reaches steady state the voltage in approximately 1 second. In Figure 5.4.3 the voltage transition is rapid and the waveform remains sinusoidal. From Figure 5.4.4 the frequency reaches steady state shortly after the 1 second mark and in Figure 5.4.5 real power is delivered evenly on all three phases. The steady state error in the Frequency vs. Real Power Control Droop could be corrected by adjusting the target droop to 1.15% for a desired 1% effective droop.

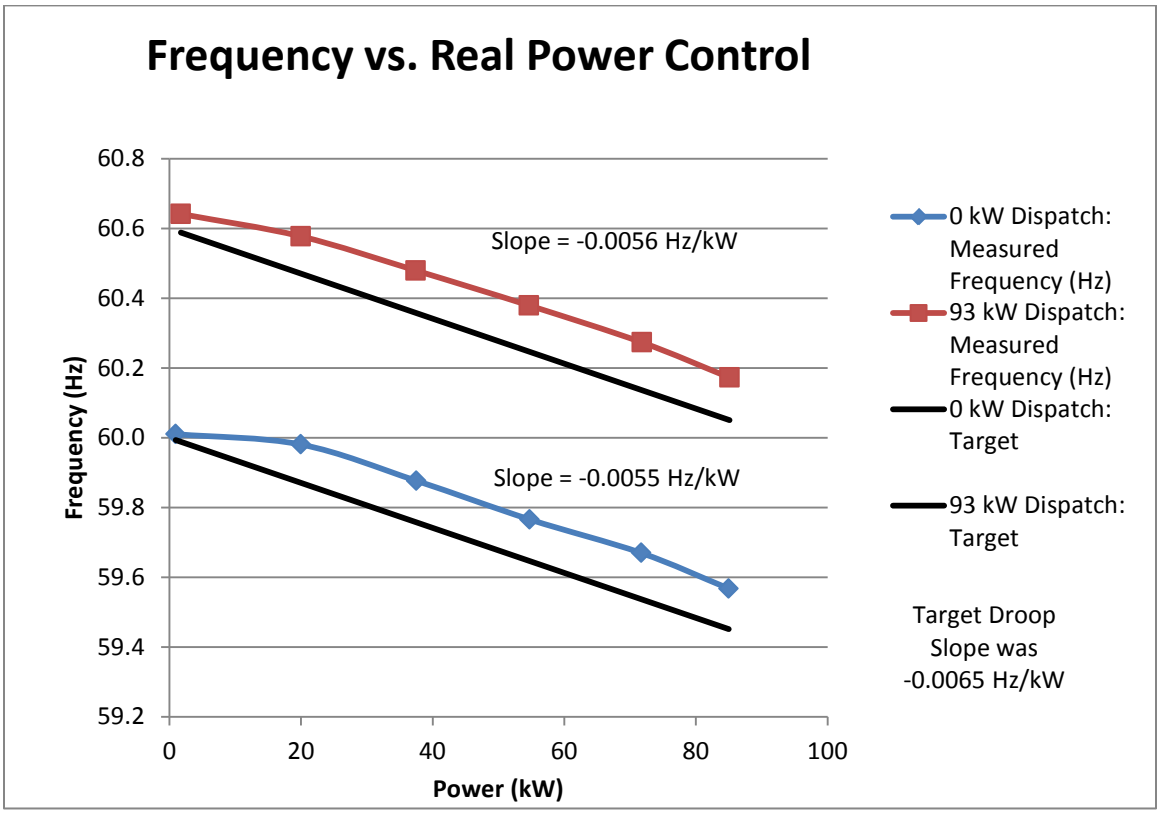


Figure 5.4.1: Frequency vs. Real Power Control Comparison

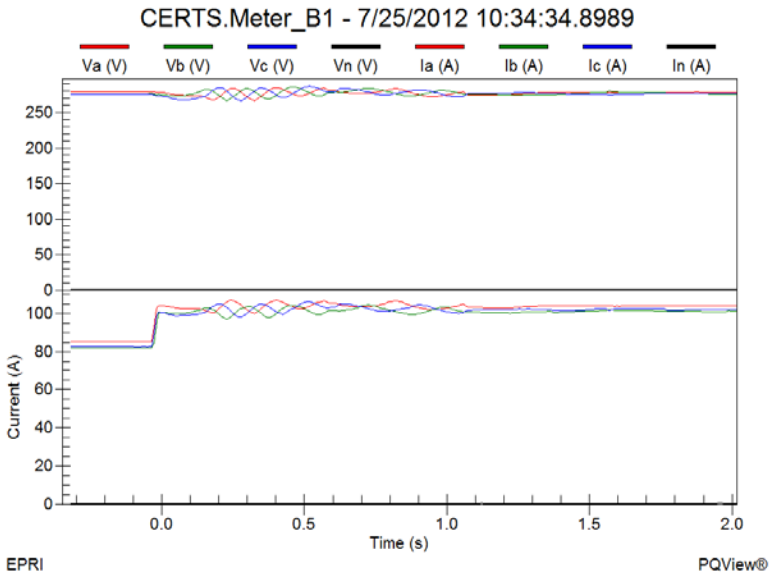


Figure 5.4.2: Event F, 95 kW, Meter B1, RMS Voltage and Current

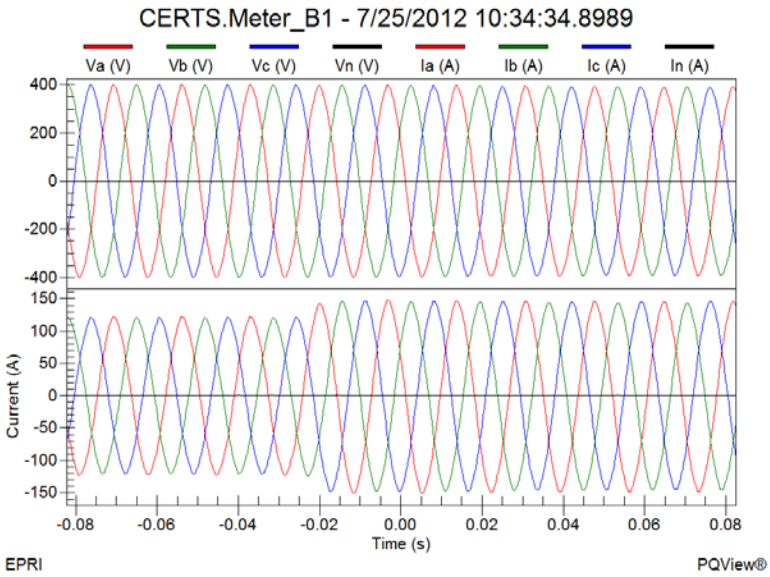


Figure 5.4.3: Event F, 95 kW, Meter B1, Waveform Voltage and Current

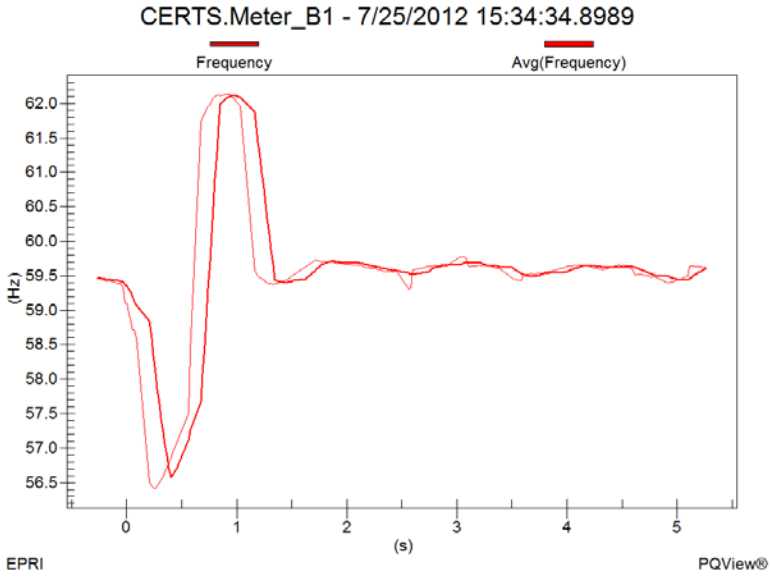


Figure 5.4.4: Event F, 95 kW, Meter B1, Frequency

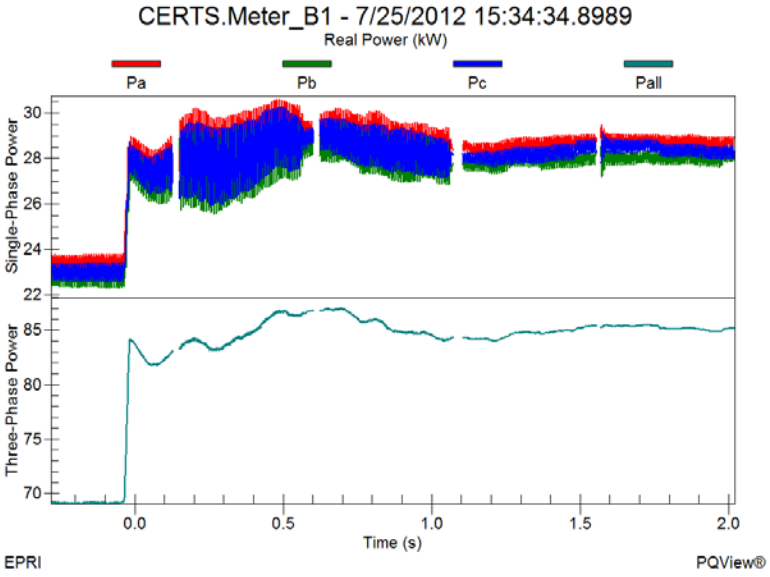


Figure 5.4.5: Event F, 95 kW, Meter B1, Real Power

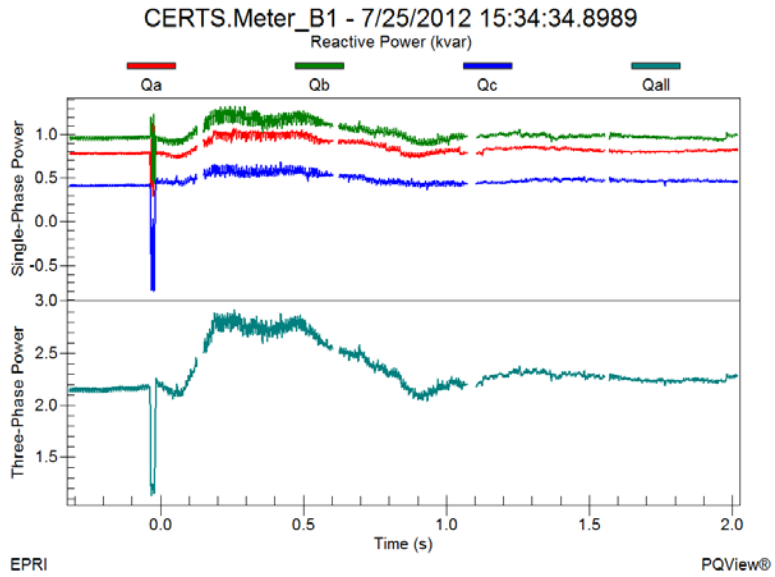


Figure 5.4.6: Event F, 95 kW, Meter B1, Reactive Power

Figure 5.4.7 through Figure 5.4.28 have been included for comparisons to prior results collected from other CERTS compatible sources, and are generally for informational use.

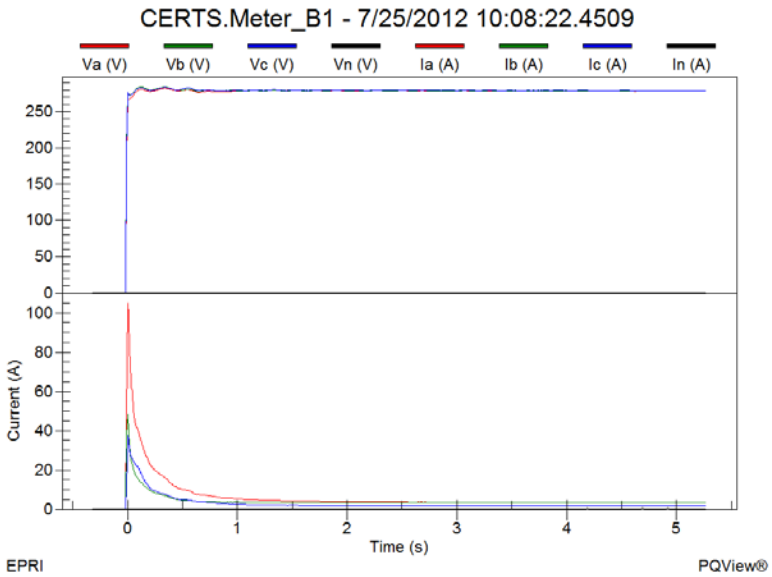


Figure 5.4.7: Event A, 0 kW Meter B1, RMS Voltage and Current

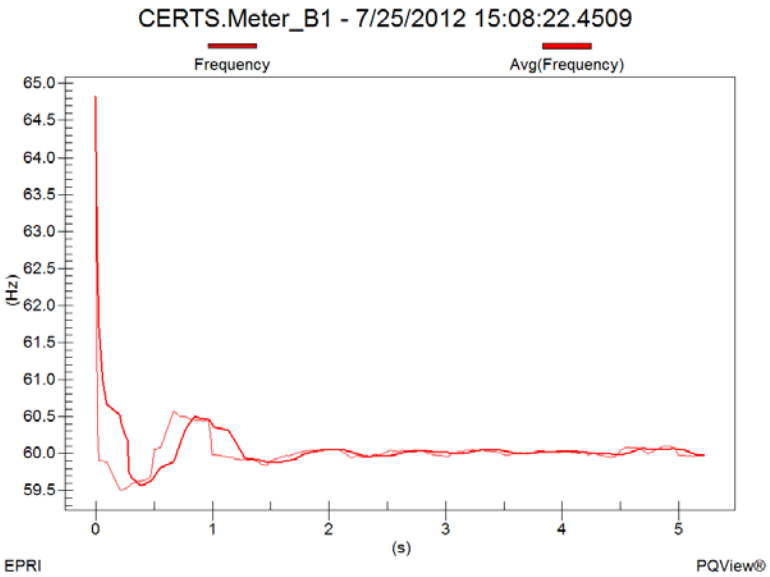


Figure 5.4.8: Event A, 0 kW, Meter B1, Frequency

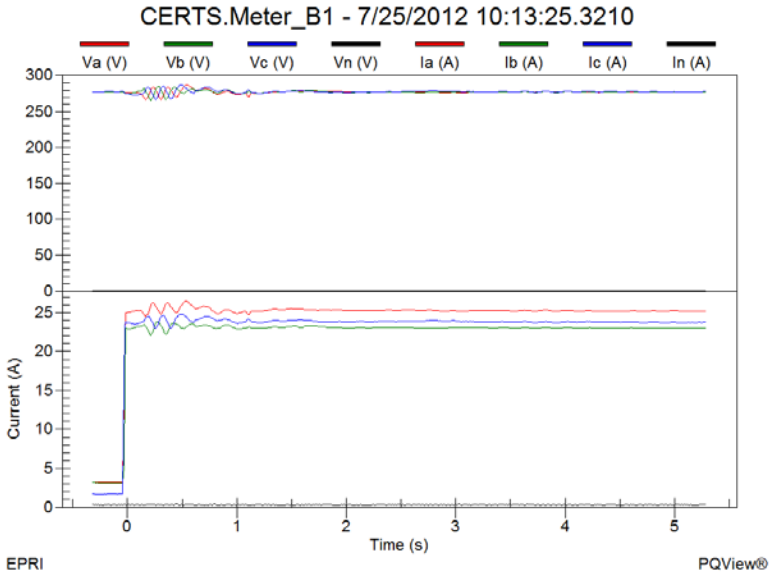


Figure 5.4.9: Event B, 20 kW, Meter B1, RMS Voltage and Current

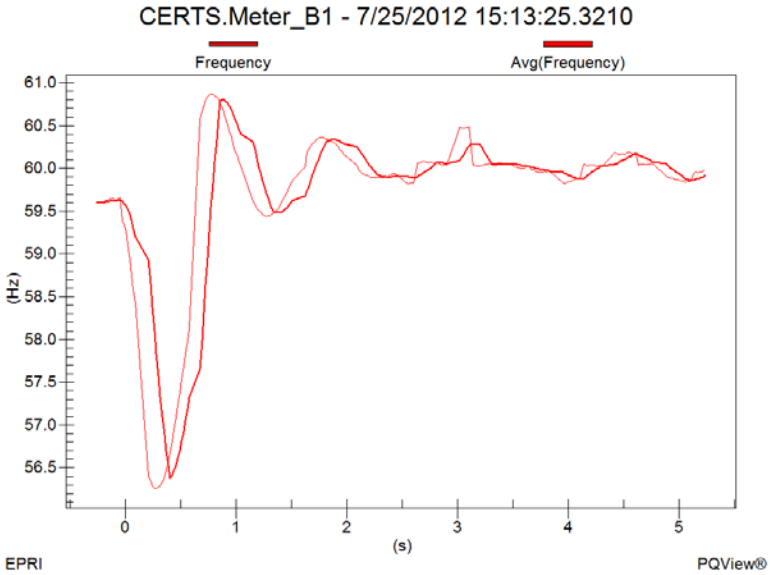


Figure 5.4.10: Event B, 20 kW, Meter B1, Frequency

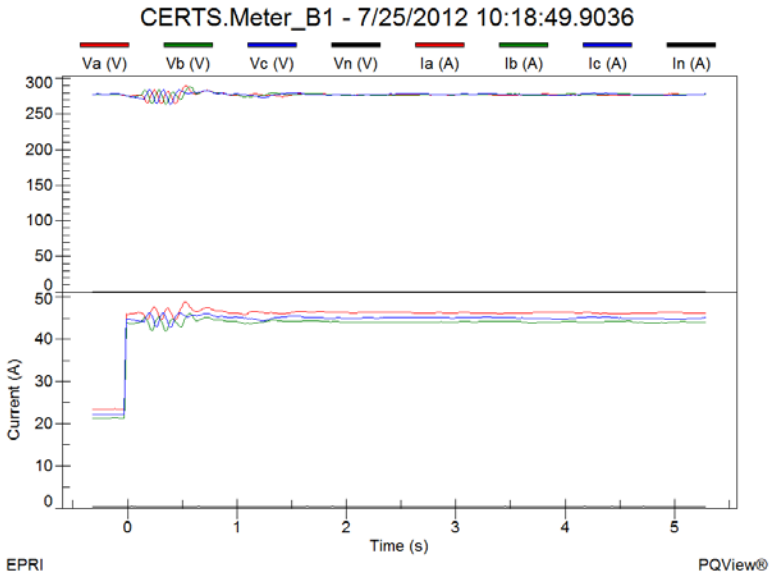


Figure 5.4.11: Event C, 40 kW, Meter B1, RMS Voltage and Current

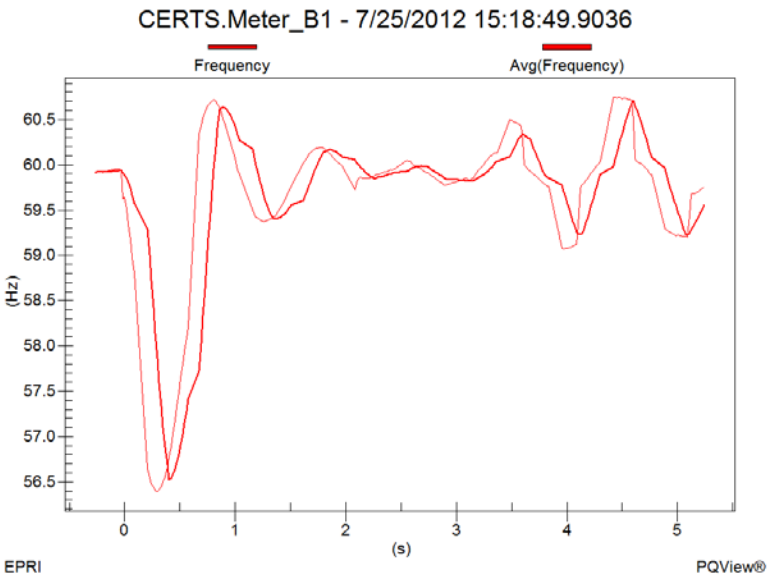


Figure 5.4.12: Event C, 40 kW, Meter B1, Frequency

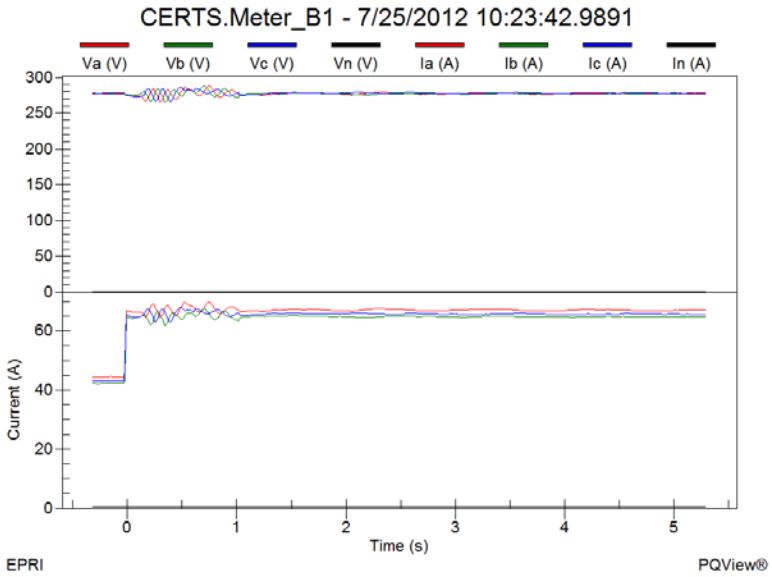


Figure 5.4.13: Event D, 60 kW, Meter B1, RMS Voltage and Current

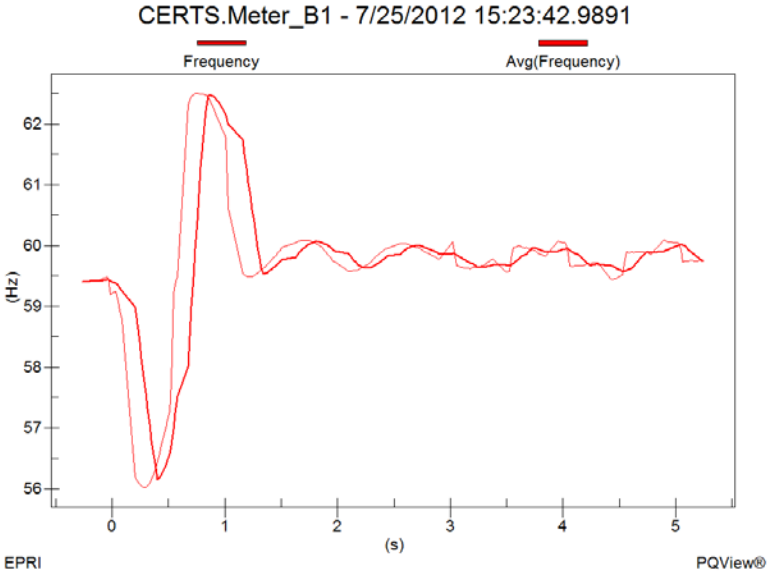


Figure 5.4.14: Event D, 60 kW, Meter B1, Frequency

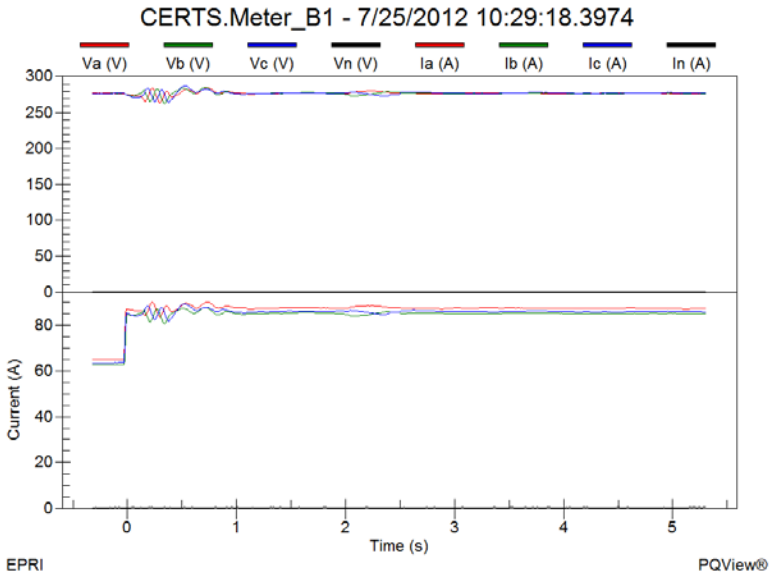


Figure 5.4.15: Event E, 80 kW, Meter B1, RMS Voltage and Current

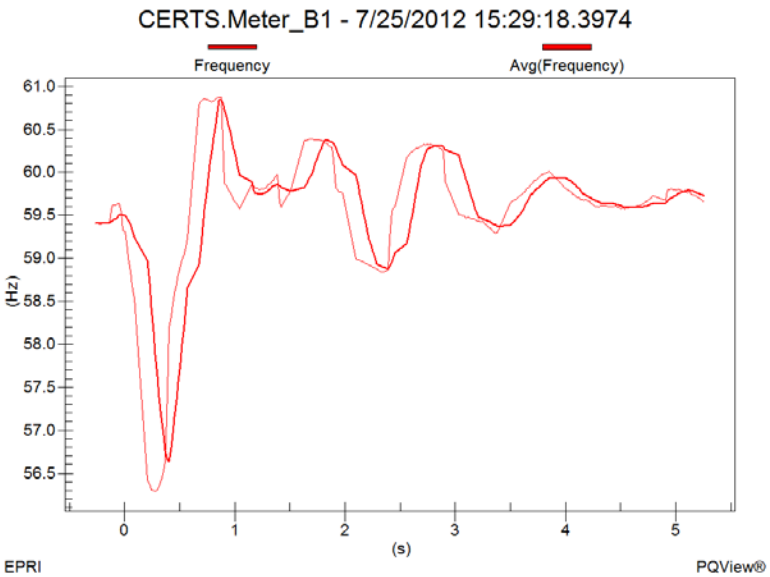


Figure 5.4.16: Event E, 80kW, Meter B1, Frequency

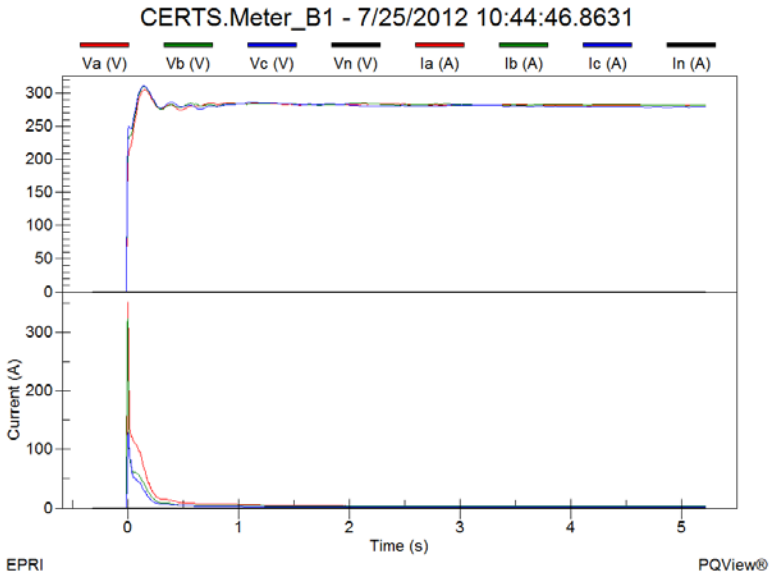


Figure 5.4.17: Event G, 0 kW, Meter B1, RMS Voltage and Current

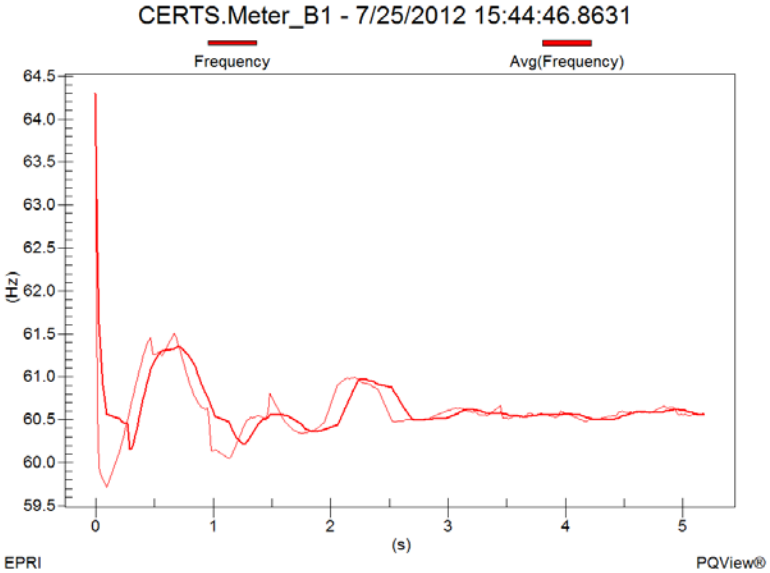


Figure 5.4.18: Event G, 0 kW, Meter B1, Frequency

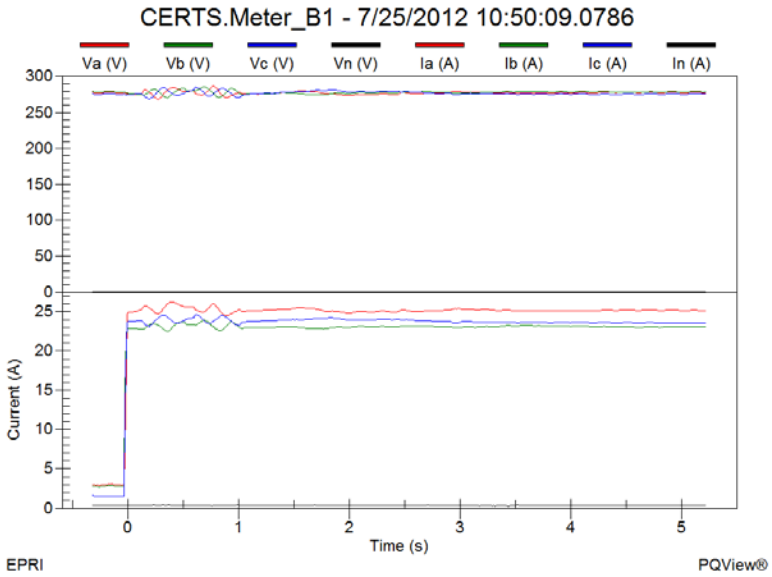


Figure 5.4.19: Event H, 20 kW, Meter B1, RMS Voltage and Current

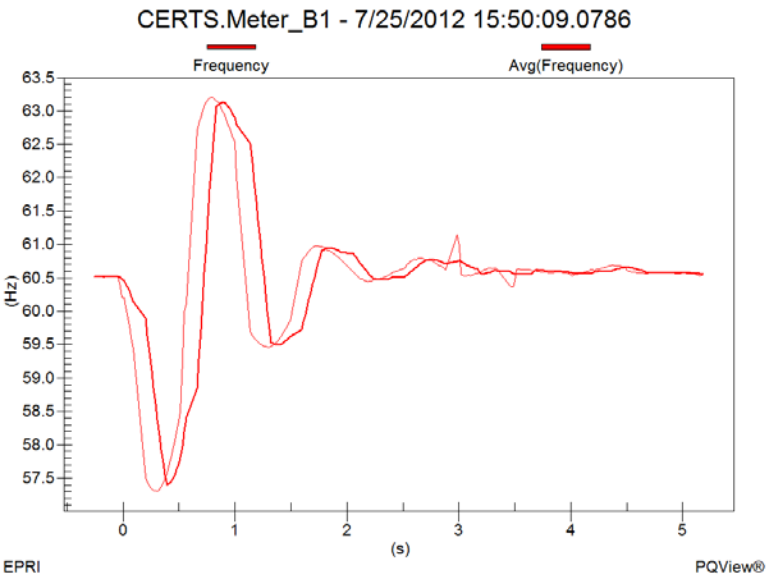


Figure 5.4.20: Event H, 20 kW, Meter B1, Frequency

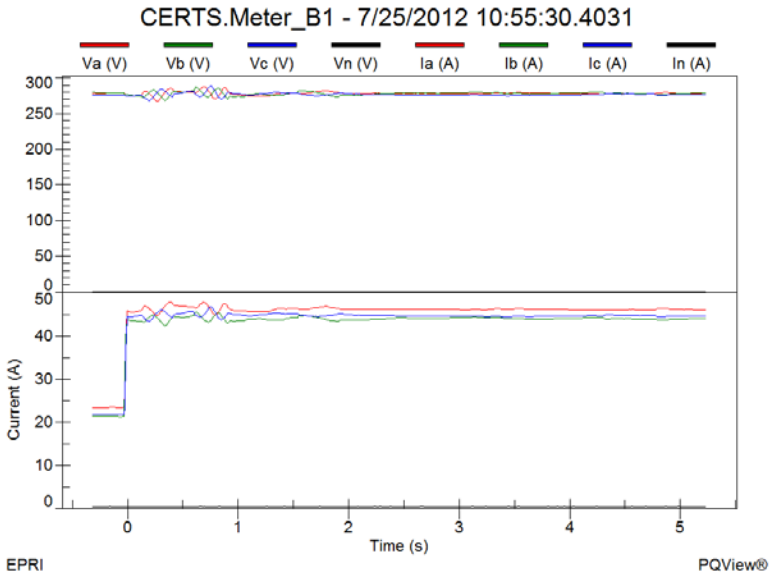


Figure 5.4.21: Event I, 40 kW, Meter B1, RMS Voltage and Current

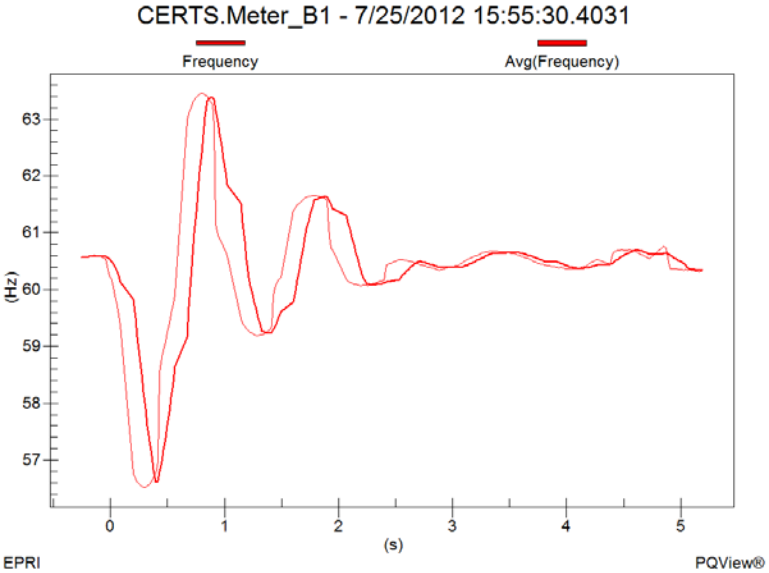


Figure 5.4.22: Event I, 40 kW, Meter B1, Frequency

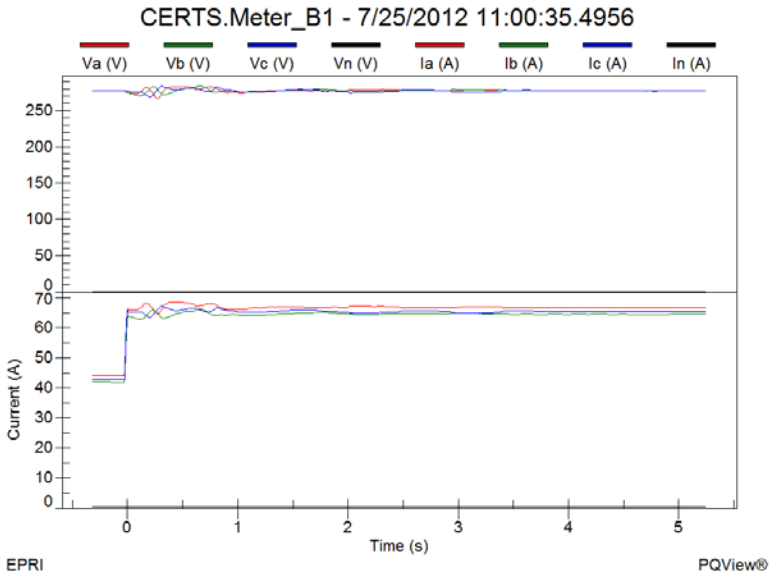


Figure 5.4.23: Event J, 60 kW, Meter B1, RMS Voltage and Current

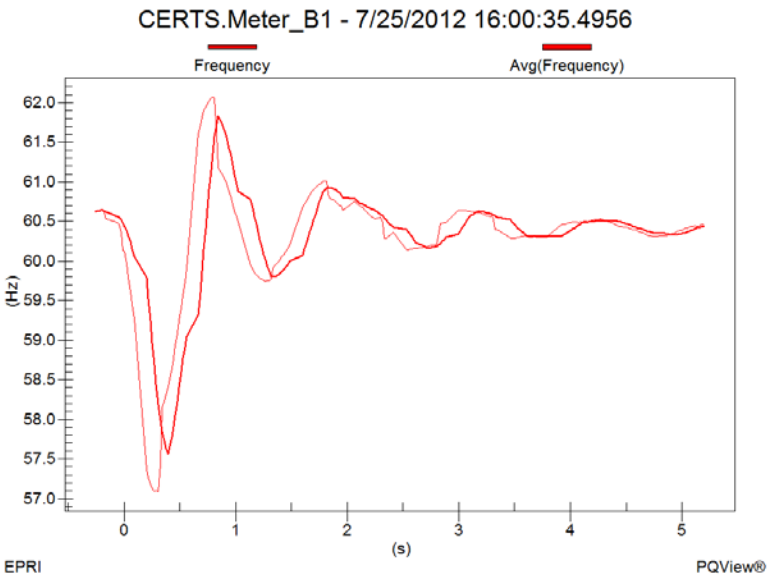


Figure 5.4.24: Event J, 60 kW, Meter B1, Frequency

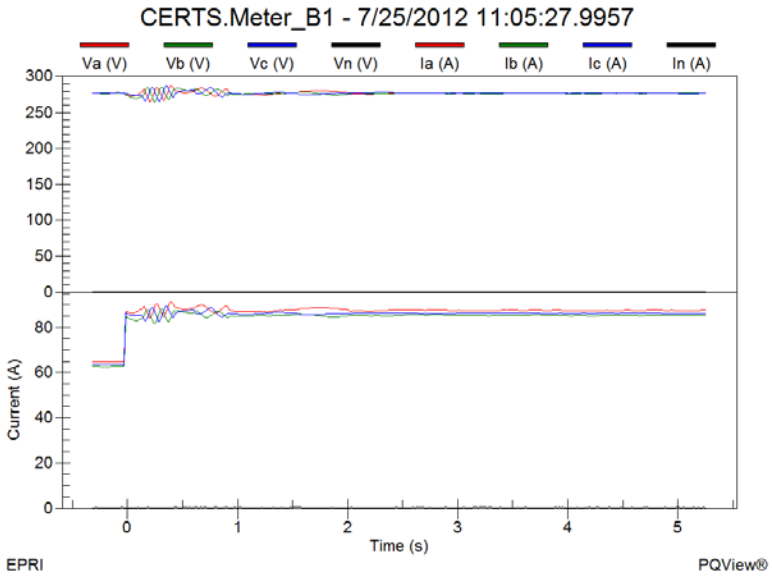


Figure 5.4.25: Event K, 80 kW, Meter B1, RMS Voltage and Current

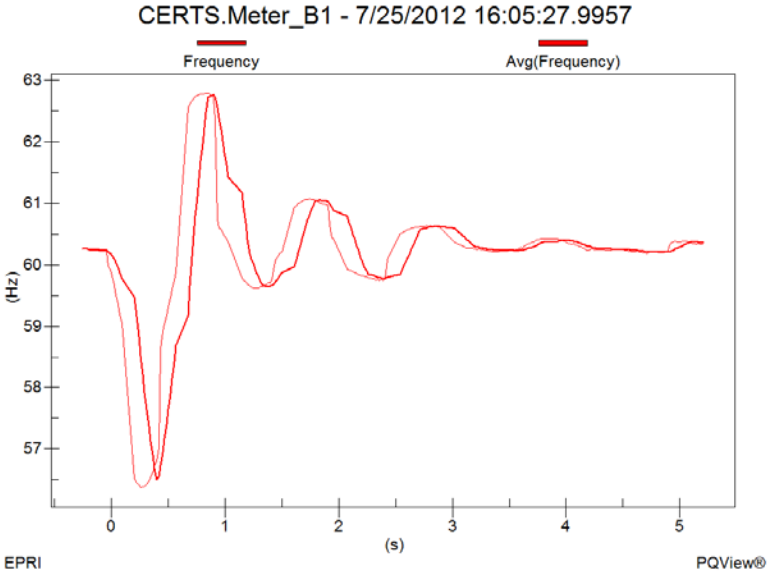


Figure 5.4.26: Event K, 80 kW, Meter B1, Frequency

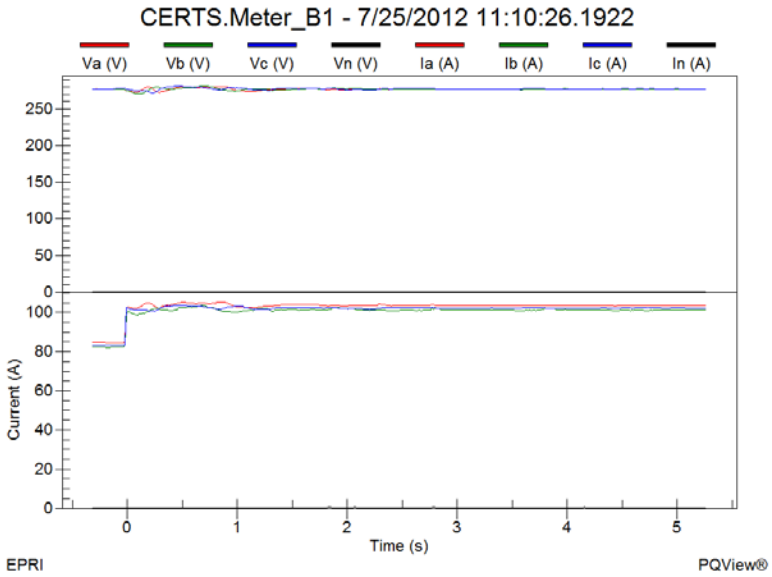


Figure 5.4.27: Event L, 95 kW, Meter B1, RMS Voltage and Current

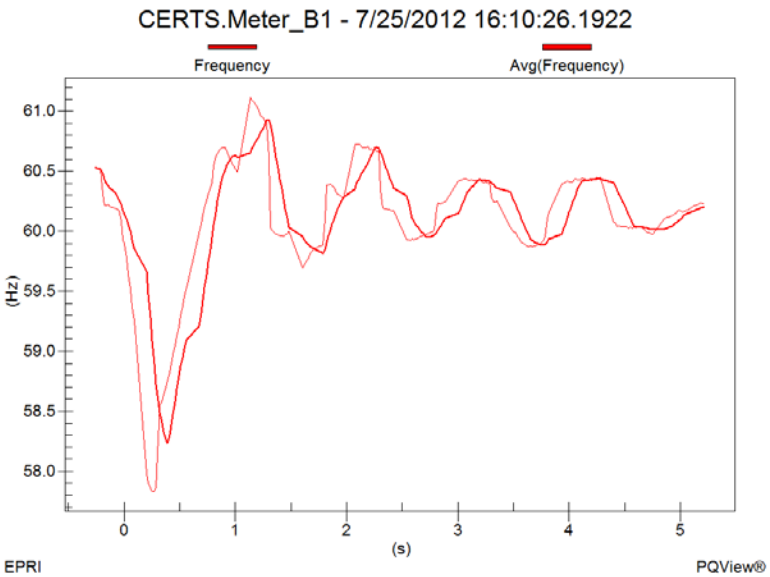


Figure 5.4.28: Event L, 95 kW, Meter B1, Frequency

5.5 *Voltage vs. Reactive Power Droop Control*

Performance Goal

The intent of this testing is to ensure proper implementation of the Voltage vs. Reactive Power Droop Control within the generator secondary easYgen controls. The Voltage vs. Reactive Power Droop Control is intended to enable multiple generating sources on a common bus to actively manage bus voltage and reactive power flow between them. Each DER measures the reactive flow into or out of its terminals and adjusts its set point output voltage according to a droop slope, minimizing excessive reactive power flows between source equipment yet allowing for a flexible output voltage amongst sources. This section of tests is focused on two areas: the generator steady state operation and its transient response in regard to voltage and reactive power. In steady state the generator should demonstrate the relationship in Equation 5.2. In transient, the generator should have a rise/fall time of 1 second or less, an overshoot of not more than 10 %, a settling time of 4 seconds, and a steady state error of less than 2 %.

$V'_{set} = V_{set} - \left[Q_{reative} * \left(V_{rated} * droop\ factor\right) / Q_{rated}\right]$	V'_{set} = Target Voltage V_{set} = Desired Voltage $Q_{reative}$ = Reactive Power Output V_{rated} = Rated Voltage droop factor = Desired Droop Percentage Q_{rated} = Generator Rated Reactive Power

Equation 5.2: Voltage vs. Reactive Power Droop

Description of Procedure

Generator B1 is initially dispatched to 0 kW, 480V_{l-l}, 1 % Frequency Droop, 5 % Voltage Droop and operated islanded from the utility. The generator is started and connected to the 'islanded' microgrid electrical bus, initially with no load present. An initial event was captured when the generator first connects to the microgrid bus, a no load reference case. Further events are captured as the load is increased in steps of approximately 20 kvar each until a total of 60 kvar is reached. Each set of load steps is repeated at voltage dispatch set points of nominal (480 V_{l-l}, 277V_{l-n}), 105% (504 V_{l-l}, 291V_{l-n}) and 95% (456 V_{l-l}, 263V_{l-n}) of nominal voltage.

Test Settings

The easYgen Controller has the following settings:

- Voltage Dispatch: Varies
- Real Power Dispatch: 50 kW
- Frequency Droop: 1%
- Voltage Droop: 5%

The Voltage Exciter has the following settings:

- Load Relief Setting: 58 Hz @ 3 pu V/Hz

Test Event	Generator B1	GIS	Load Bank 5 (kvar)
A	Dispatch = 0 kW Voltage = 480 V_{LL}	Open	0
B	Dispatch = 0 kW Voltage = 480 V_{LL}	Open	20
C	Dispatch = 0 kW Voltage = 480 V_{LL}	Open	40
D	Dispatch = 0 kW Voltage = 480 V_{LL}	Open	60
E	Dispatch = 0 kW Voltage = 504 V_{LL}	Open	0
F	Dispatch = 0 kW Voltage = 504 V_{LL}	Open	20
G	Dispatch = 0 kW Voltage = 504 V_{LL}	Open	40
H	Dispatch = 0 kW Voltage = 504 V_{LL}	Open	60
I	Dispatch = 0 kW Voltage = 456 V_{LL}	Open	0
J	Dispatch = 0 kW Voltage = 456 V_{LL}	Open	20
K	Dispatch = 0 kW Voltage = 456 V_{LL}	Open	40
L	Dispatch = 0 kW Voltage = 456 V_{LL}	Open	60

Table 5.5.1: Voltage vs. Reactive Power Droop Control Test Settings

Test Results

Test Event	Load Bank 5 (kvar)	Generator B1 Voltage (V)		Voltage Error	Standard Deviation	Pass/Fail
	Measured	Target	Measured			
A	0.00	277.00	278.93	0.70%	0.43	Pass
B	19.26	274.33	274.89	0.20%	0.26	Pass
C	39.16	271.58	272.07	0.18%	0.35	Pass
D	56.97	269.11	269.39	0.10%	0.38	Pass
E	0.02	291.00	292.50	0.54%	0.36	Pass
F	21.34	288.04	288.51	0.17%	0.25	Pass
G	43.40	284.99	284.78	0.07%	0.32	Pass
H	63.09	282.26	282.47	0.08%	0.37	Pass
I	0.00	263.00	265.60	0.94%	0.53	Pass
J	17.56	260.57	261.75	0.43%	0.26	Pass
K	35.72	258.05	259.16	0.40%	0.38	Pass
L	51.89	255.81	256.78	0.35%	0.37	Pass

Table 5.5.2: Voltage vs. Reactive Power Droop Control Test Results

Analysis

The Voltage vs. Reactive Power Controller performed within the acceptance criteria. Figure 5.5.1 compares the measured voltage and reactive power at three different voltage dispatch points, nominal (480 V_{l-l}, 277V_{l-n}), 105% (504 V_{l-l}, 291V_{l-n}) and 95% (456 V_{l-l}, 263V_{l-n}).The target steady state droop slope was 5% and was measured at 5.93%. The transient response to a typical event, Event D, 40→60 kvar, a 20 kvar transition, is detailed in Figure 5.5.2 through Figure 5.5.6. In Figure 5.5.2 the load step event reaches steady state voltage in approximately 0.5 seconds. In Figure 5.5.3 the voltage transition is rapid and the waveform remains sinusoidal. Energizing currents flow for approximately 5 cycles when the inductance is switched in, as would be expected. From Figure 5.5.4 the frequency reaches steady state shortly after the 2.5 second mark and in Figure 5.4.5 the real power delivered remains marginal. Figure 5.5.6 shows the reactive power step which reaches stability with the voltage at approximately 0.5 seconds. The steady state error in the Voltage vs Reactive Power Droop Control could be corrected by adjusting the target droop to 4.22% for a desired 5% effective droop.

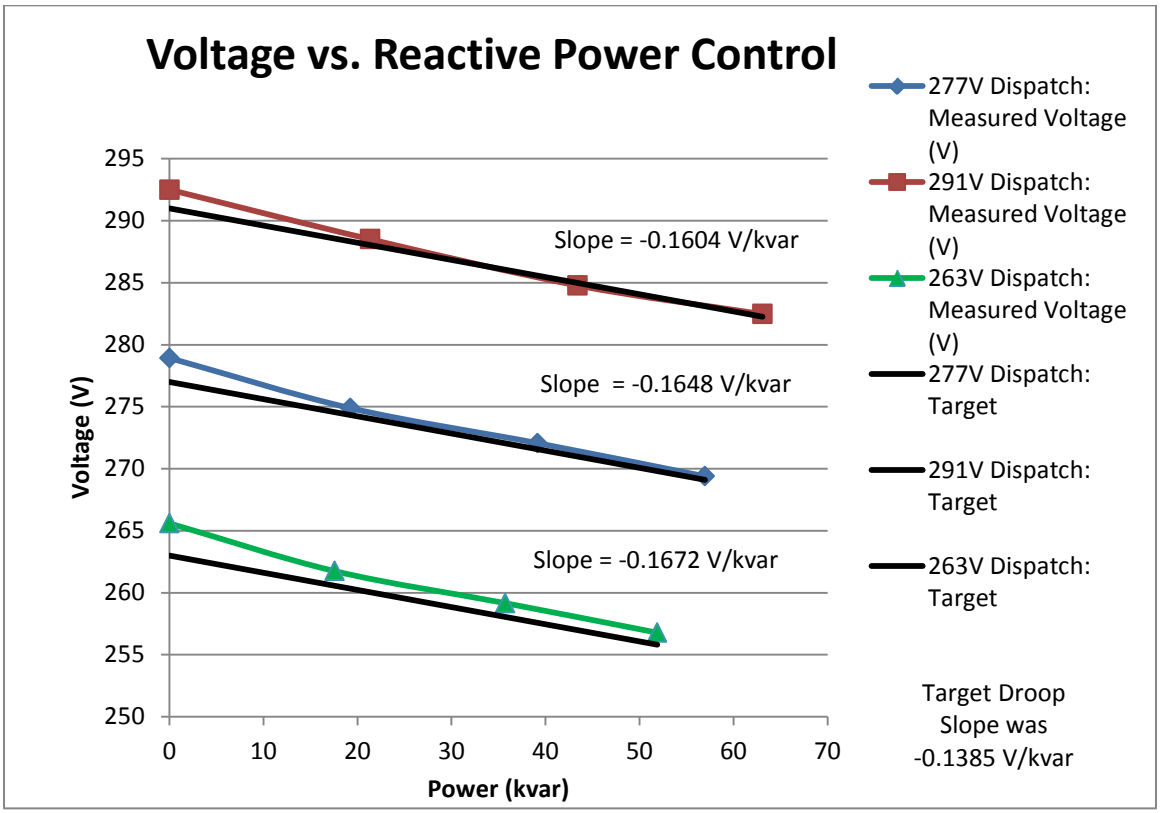


Figure 5.5.1: Measured and Target Voltage for V/Q Droop Function

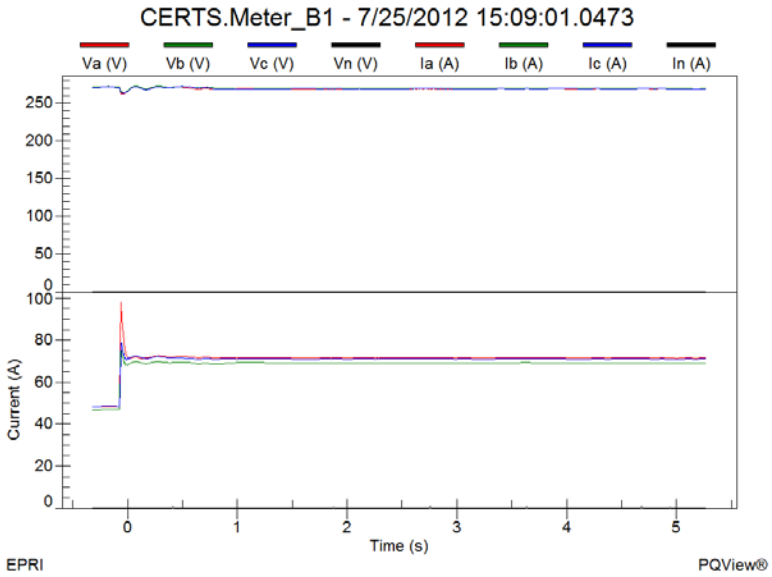


Figure 5.5.2: Event D, 60 kvar, Meter B1, RMS Voltage

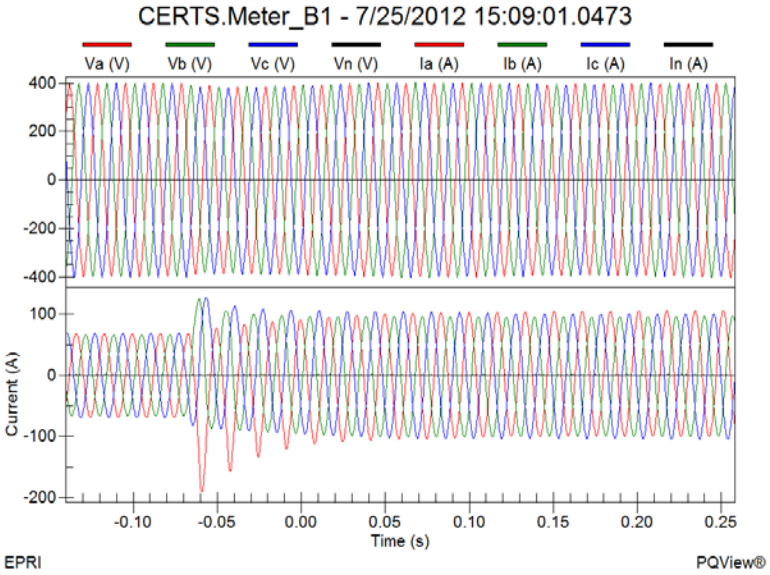


Figure 5.5.3: Event D, 60 kvar, Meter B1, Waveform Voltage and Current

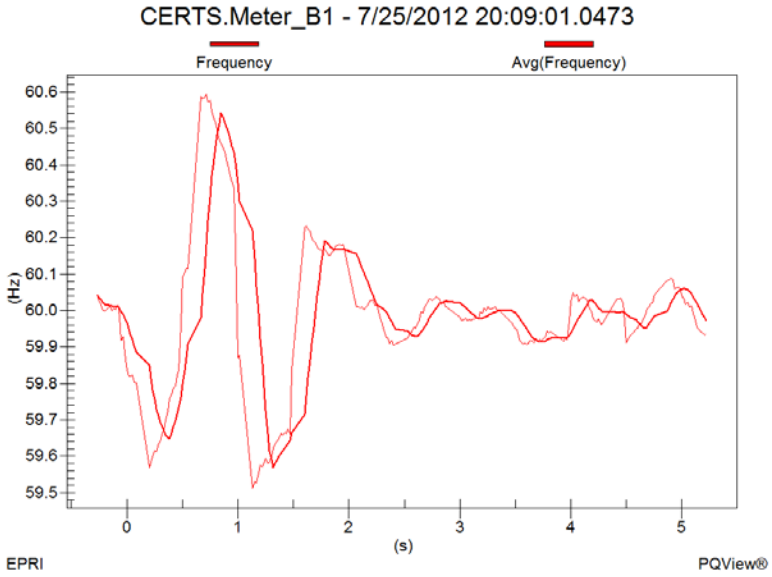


Figure 5.5.4: Event D, 60 kvar, Meter B1, Frequency

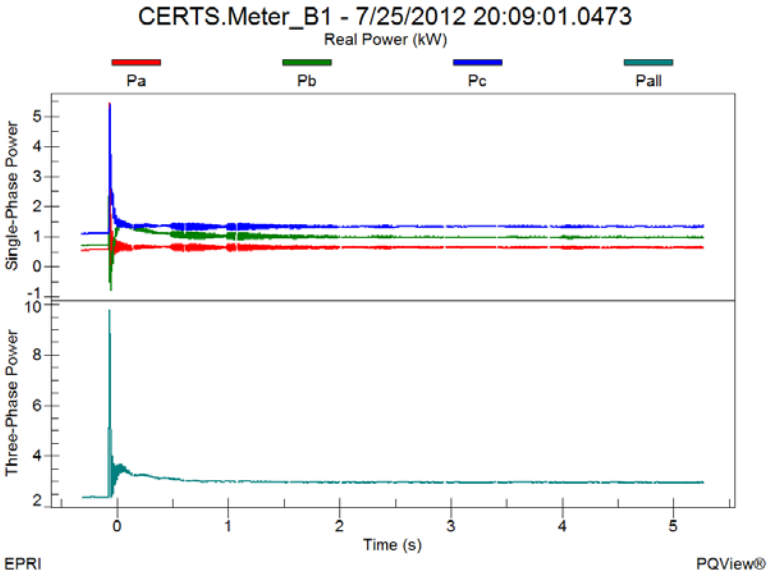


Figure 5.5.5: Event D, 60 kvar, Meter B1, Real Power

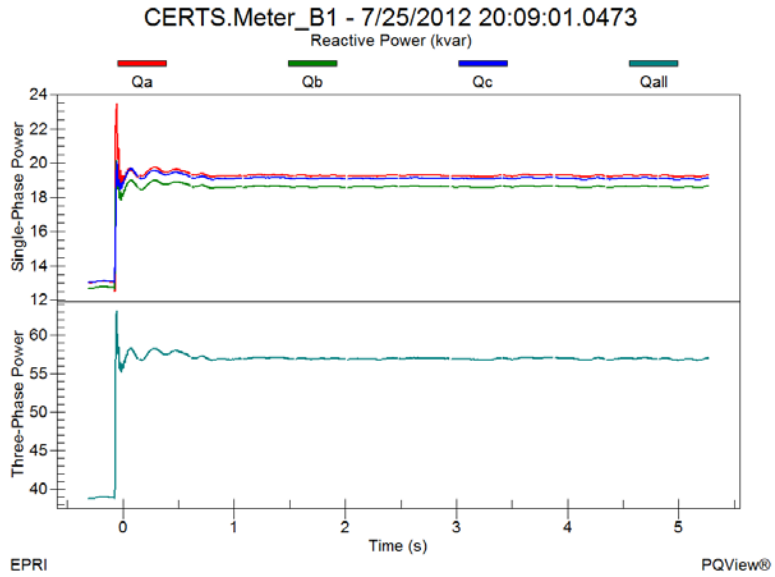


Figure 5.5.6: Event D, 60 kvar, Meter B1, Reactive Power

Figure 5.5.7 through Figure 5.5.28 have been included for comparisons to prior results collected from other CERTS compatible sources, and are generally for informational use.

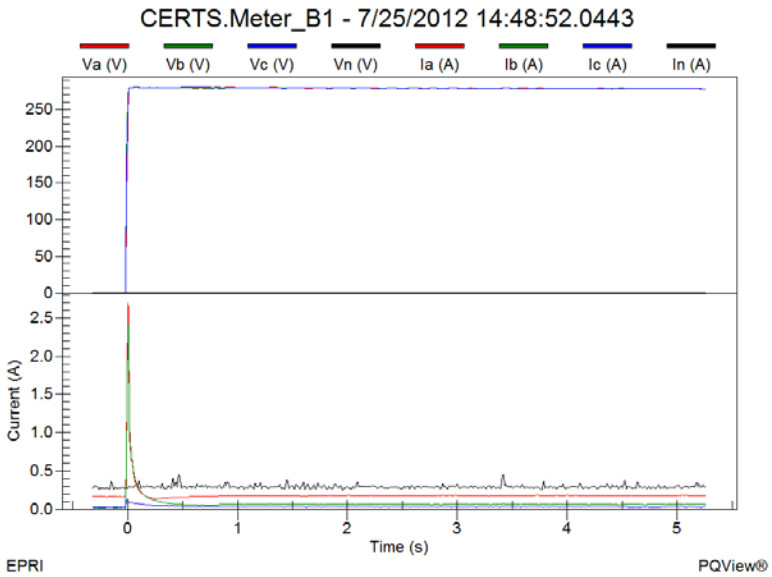


Figure 5.5.7: Event A, 0 kvar, Meter B1, RMS Voltage and Current

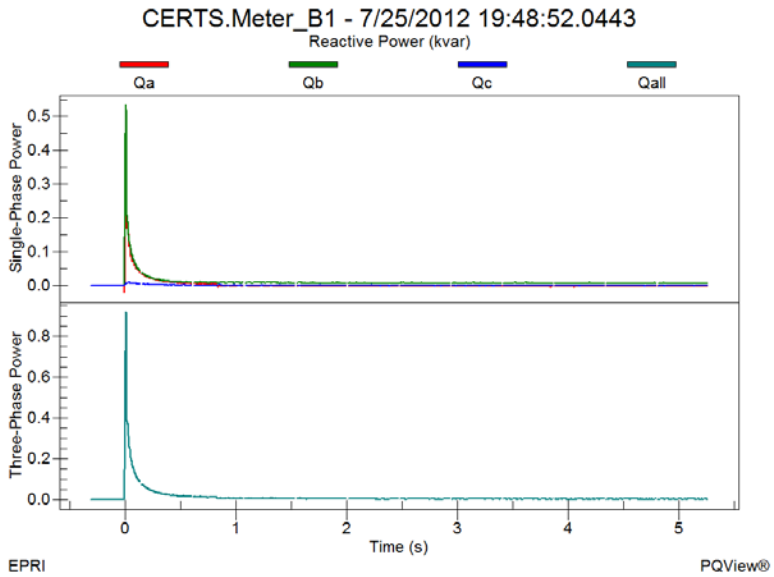


Figure 5.5.8: Event A, 0 kvar, Meter B1, Reactive Power

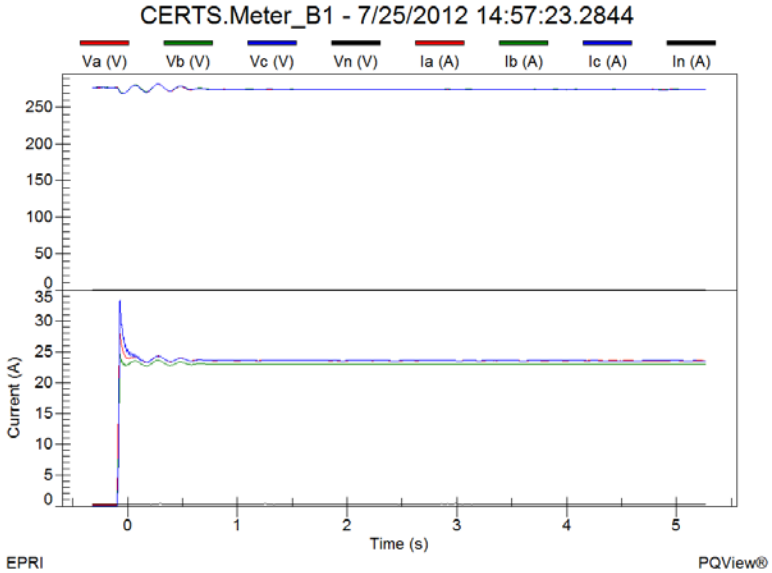


Figure 5.5.9: Event B, 20 kvar, Meter B1, RMS Voltage and Current

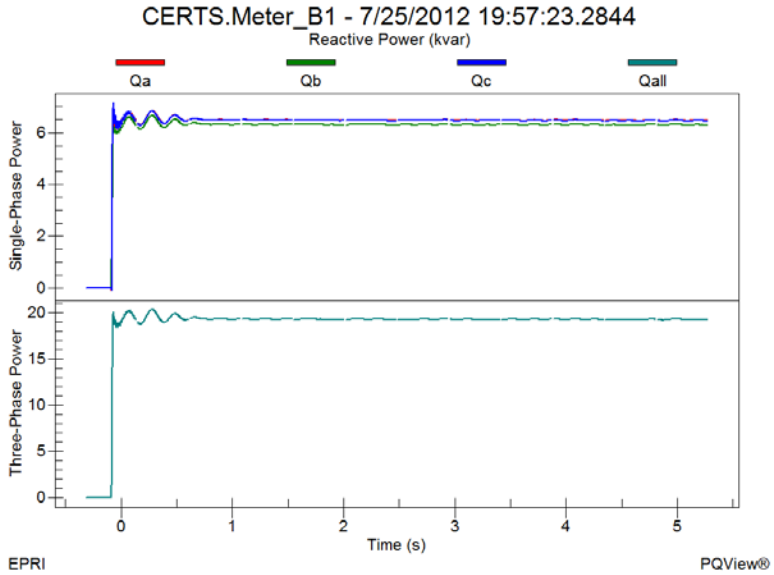


Figure 5.5.10: Event B, 20 kvar, Meter B1, Reactive Power

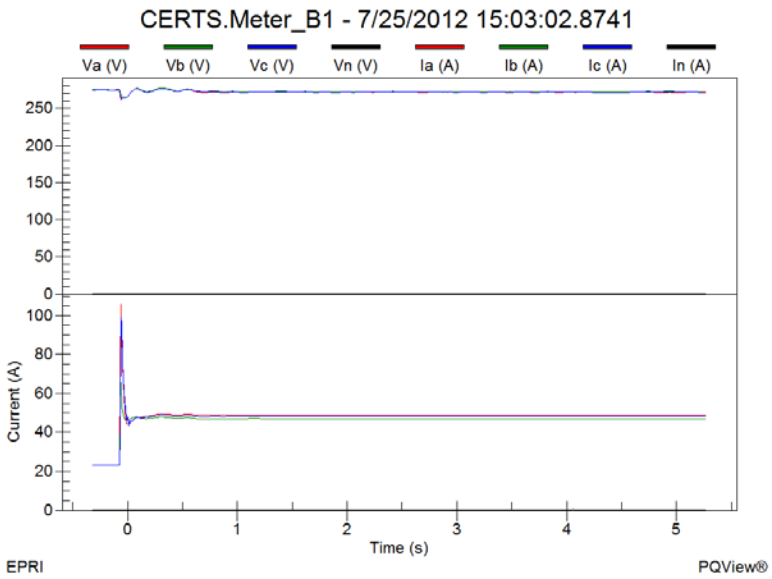


Figure 5.5.11: Event C, 40 kvar, Meter B1, RMS Voltage and Current

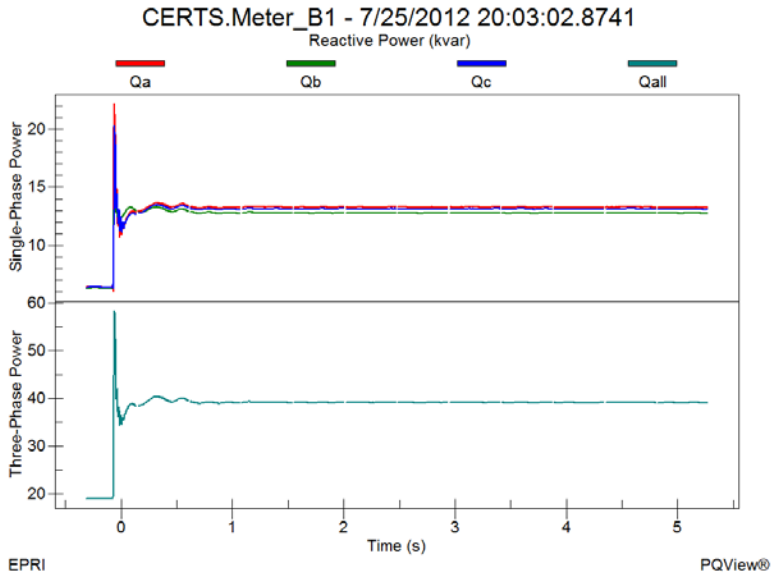


Figure 5.5.12: Event C, 40 kvar, Meter B1, Reactive Power

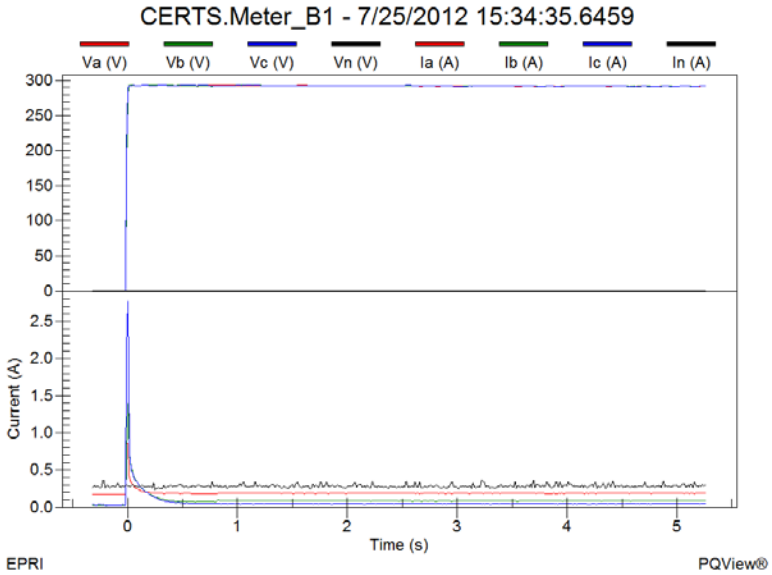


Figure 5.5.13: Event E, 0 kvar, Meter B1, RMS Voltage and Current

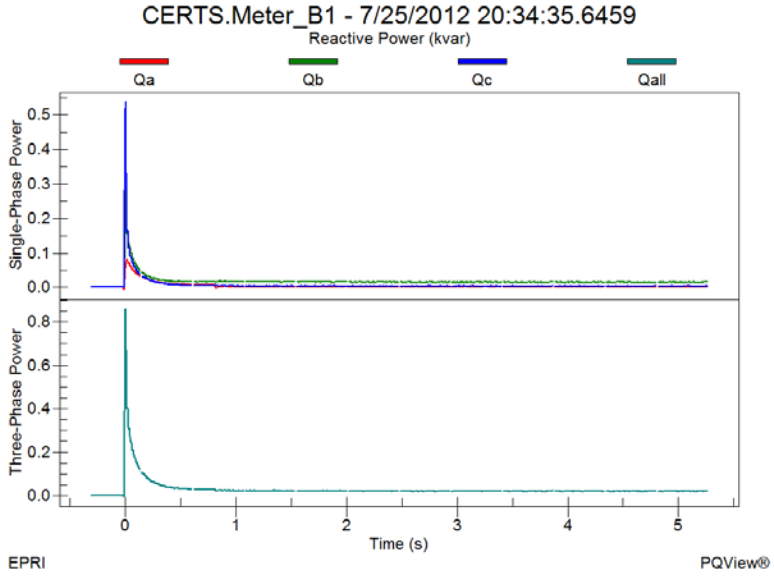


Figure 5.5.14: Event E, 0 kvar, Meter B1, Reactive Power

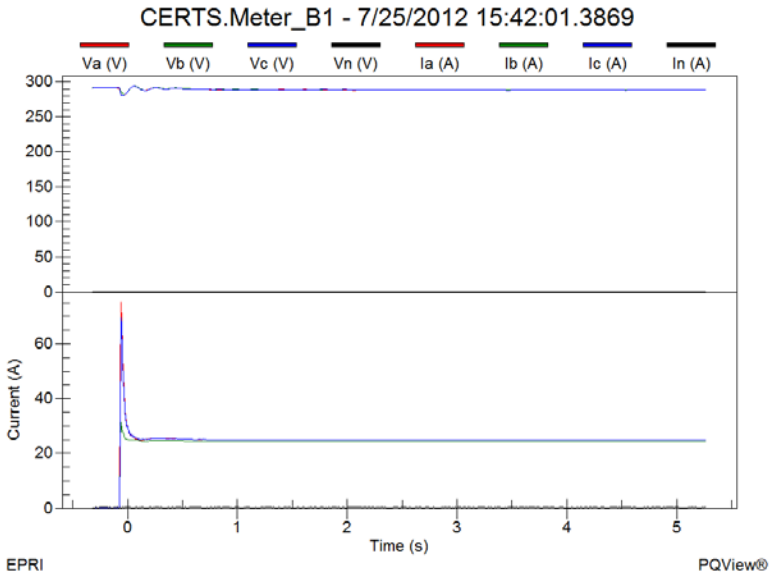


Figure 5.5.15: Event F, 20 kvar, Meter B1, RMS Voltage and Current

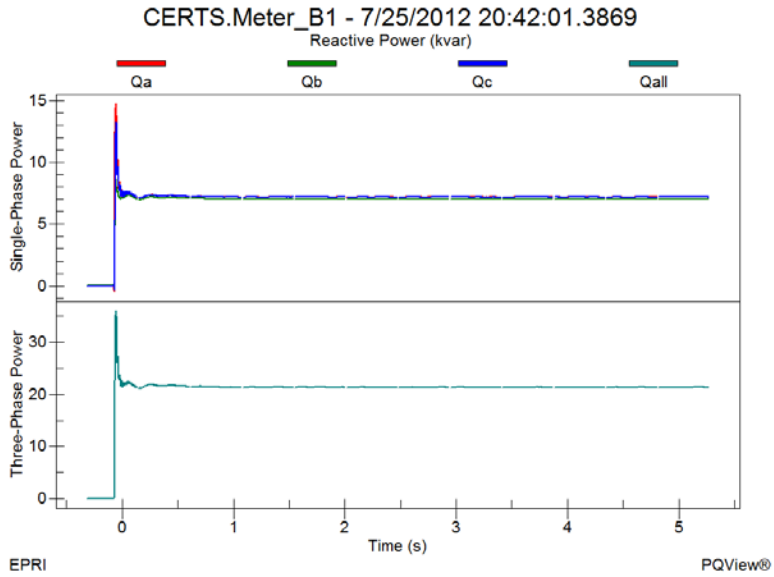


Figure 5.5.16: Event F, 20 kvar, Meter B1, Reactive Power

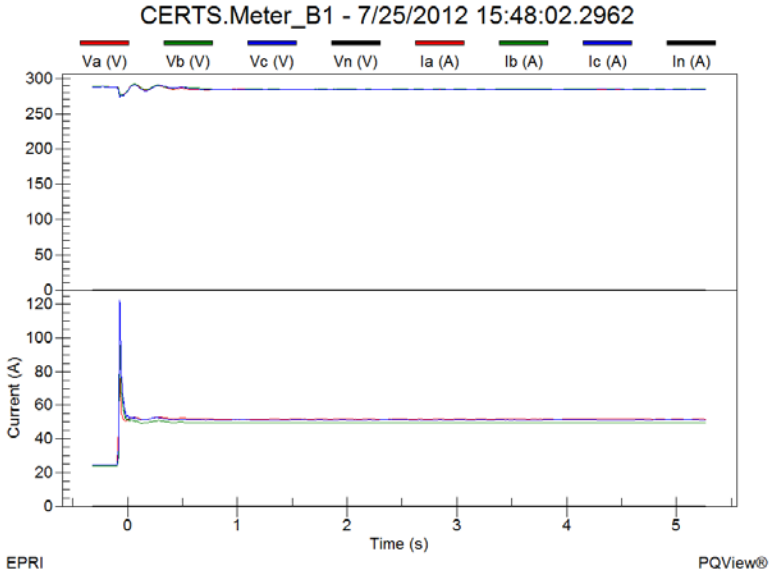


Figure 5.5.17: Event G, 40 kvar, Meter B1, RMS Voltage and Current

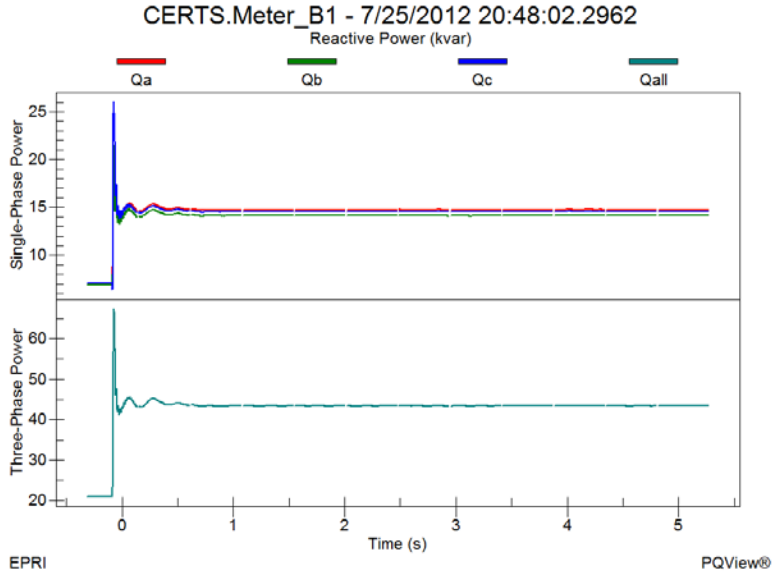


Figure 5.5.18: Event G, 40 kvar, Meter B1, Reactive Power

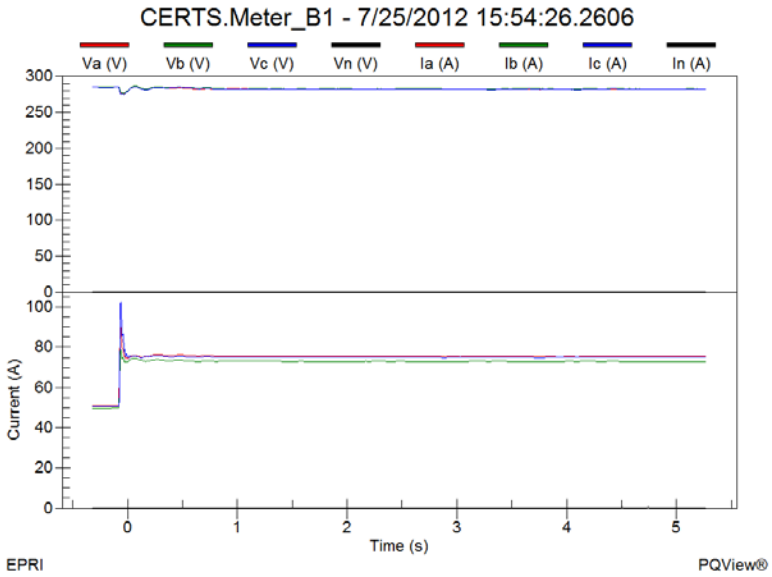


Figure 5.5.19: Event H, 60 kvar, Meter B1, RMS Voltage and Current

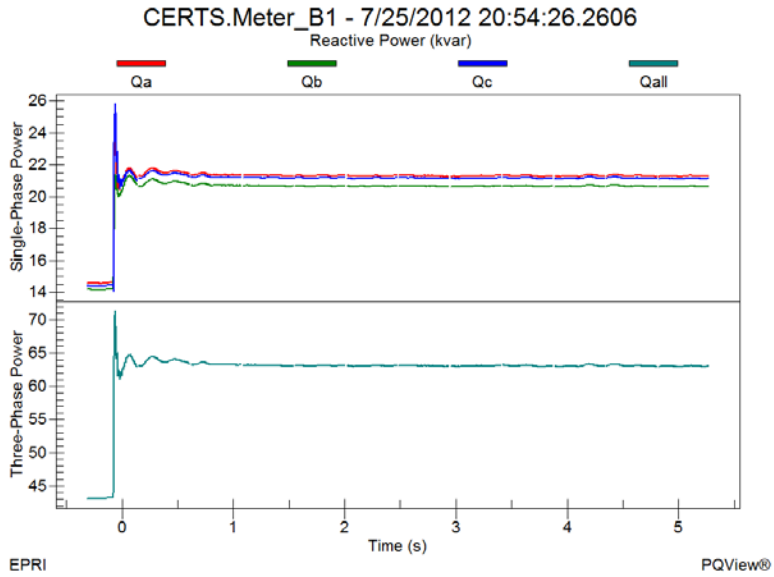


Figure 5.5.20: Event H, 60 kvar, Meter B1, Reactive Power

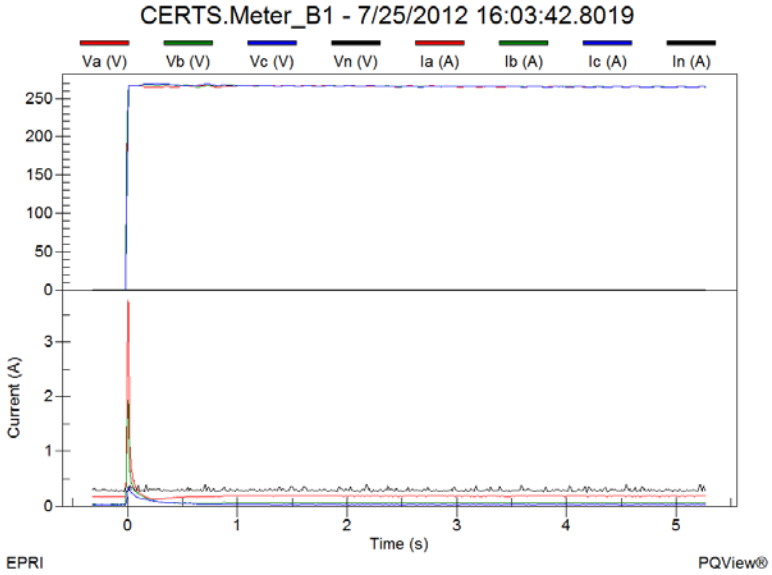


Figure 5.5.21: Event I, 0 kvar, Meter B1, RMS Voltage and Current

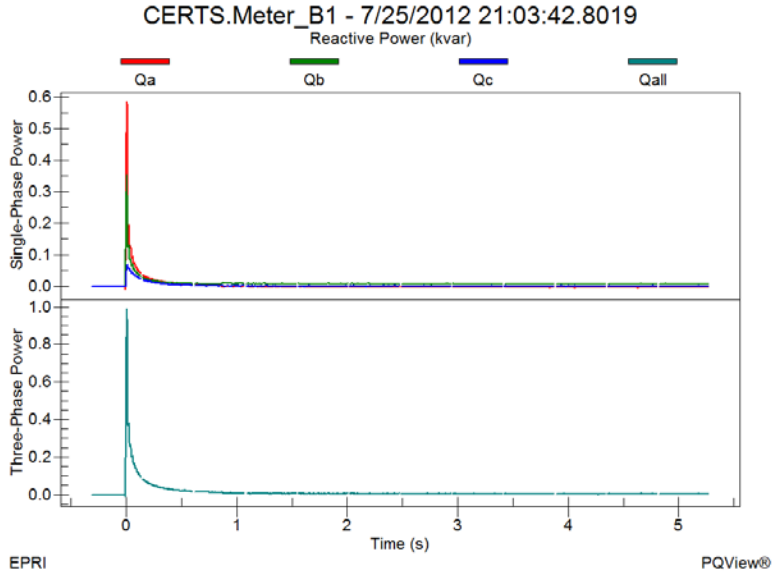


Figure 5.5.22: Event I, 0 kvar, Meter B1, Reactive Power

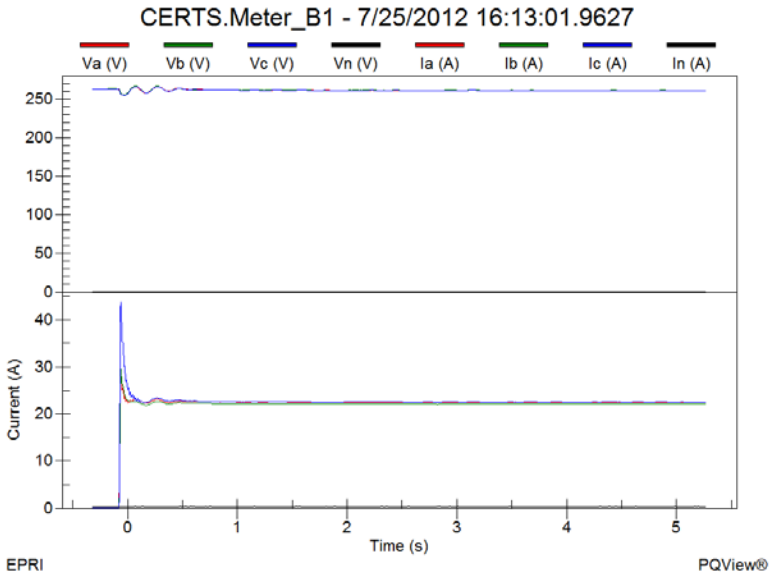


Figure 5.5.23: Event J, 20 kvar, Meter B1, RMS Voltage and Current

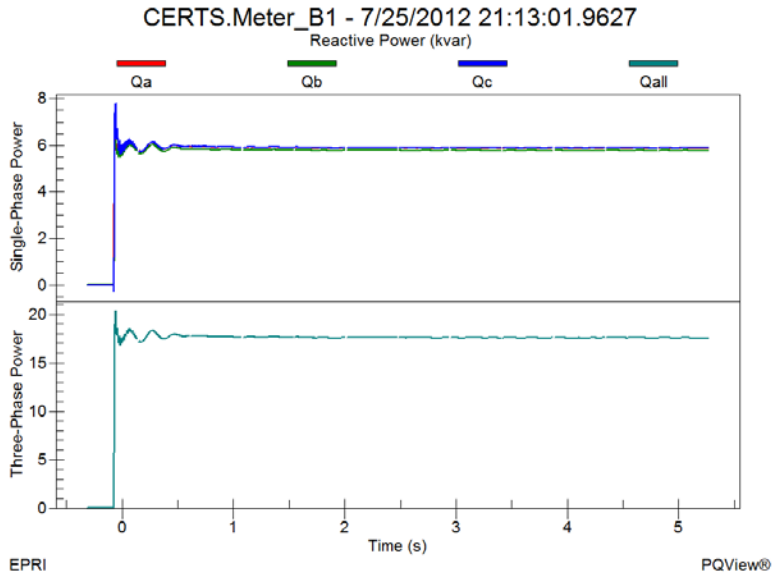


Figure 5.5.24: Event J, 20 kvar, Meter B1, Reactive Power

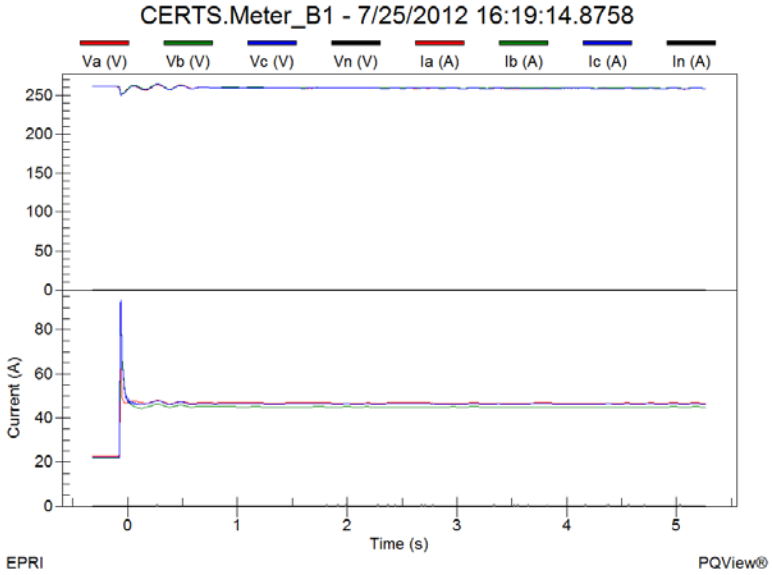


Figure 5.5.25: Event K, 40 kvar, Meter B1, RMS Voltage and Current

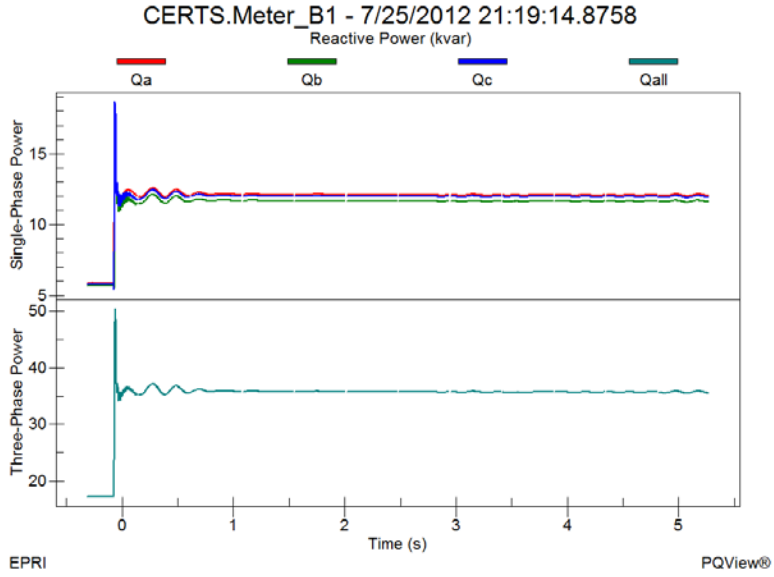


Figure 5.5.26: Event K, 40 kvar, Meter B1, Reactive Power

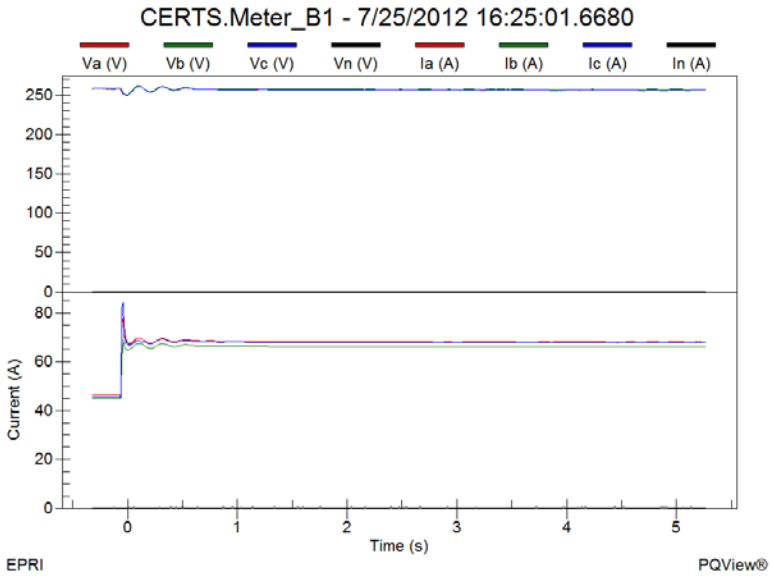


Figure 5.5.27: Event L, 60 kvar, Meter B1, RMS Voltage and Current

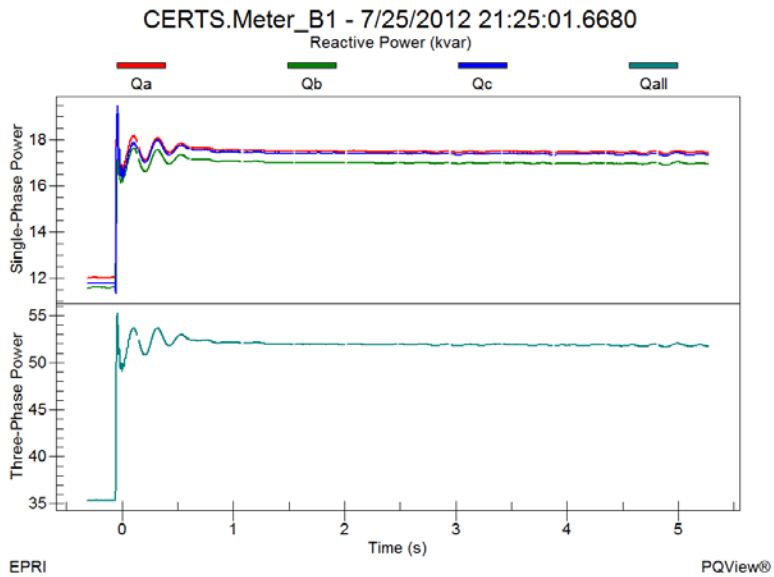


Figure 5.5.28: Event L, 60 kvar, Meter B1, Reactive Powe r

5.6 *Generator Black-Start Capacity*

Performance Goal

The intent of this testing is to ensure the generator is capable of black starting a significant load within its ratings. Black start capabilities are important when energizing a facility from a de-energized condition. While facility load types differ, commonly motor and transformer based loads will require a significant real and reactive power draw for a short period of time when initially energized. This is also an important quality when many small DER are linked together, which must operate in a coordinated fashion, to carry loads beyond any single unit's ratings. The generator should be capable of black starting a load to the full rated continuous kVA rating of the generator without protection trips or shutdown.

Description of Procedure

Generator B1 was dispatched to 0 kW, $480V_{l\text{-}l}$, 1% Frequency Droop, 5% Voltage Droop and operated islanded from the utility. The specified load is applied to the de-energized microgrid bus and the generator is then started. An event recording is captured when the generator connects to the microgrid bus, energizing the load. The test was repeated with increasing loads up to 115 kVA, as specified in Table 5.6.1.

Test Settings

The easYgen Controller has the following settings:

Voltage Dispatch: 480V
Real Power Dispatch: 0 kW
Frequency Droop: 1%
Voltage Droop: 5%

The Voltage Exciter has the following settings:

Load Relief Setting: 58 Hz @ 3 pu V/Hz

Test Event	GIS	Load Bank 5	Notes
A	Open	30 kW + j10 kvar	~30 kVA
B	Open	55 kW + j20 kvar	~60 kVA
C	Open	80 kW + j40 kvar	~90 kVA
D	Open	95 kW + j60 kvar	~115 kVA

Table 5.6.1: Generator Black Start Capacity Settings

Test Results

Test Event	Gen-set B1						Pass/Fail
	Real Power (kW)	Reactive Power (kvar)	Frequency Transient %	Voltage Transient %	Frequency @ 10sec (Hz)	Voltage (V)	
A	30.46	10.34	12	11.4	59.98	276.46	Pass
B	53.90	19.83	14.8	19	59.88	275.33	Pass
C	73.37	40.12	19.7	26.9	59.84	271.98	Pass
D	86.00	56.85	22.2	32.8	59.84	268.63	Pass

Table 5.6.2: Generator Black Start Capacity Results

Analysis

The Synchronous Generator B1 was able to successfully black-start all test loads totaling 103 kVA and less. The voltage and frequency transients damped to steady state in less than 3 seconds. Following the initial sag, the system recovered to nominal operating values with little oscillation. Under the most strenuous case the voltage sagged to 180 V_{rms} and the frequency sagged to a low of approximately 46 Hz. Although smaller voltage and frequency sags are desirable, the synchronous generator is capable of supplying generation from a black-start. Event D, 115 kVa, illustrated in Figure 5.6.1 through Figure 5.6.5 demonstrates a characteristic operation. One potential solution to reduce the voltage and frequency sag is to implement a soft-start system, applying load to the generator gradually instead of instantly.

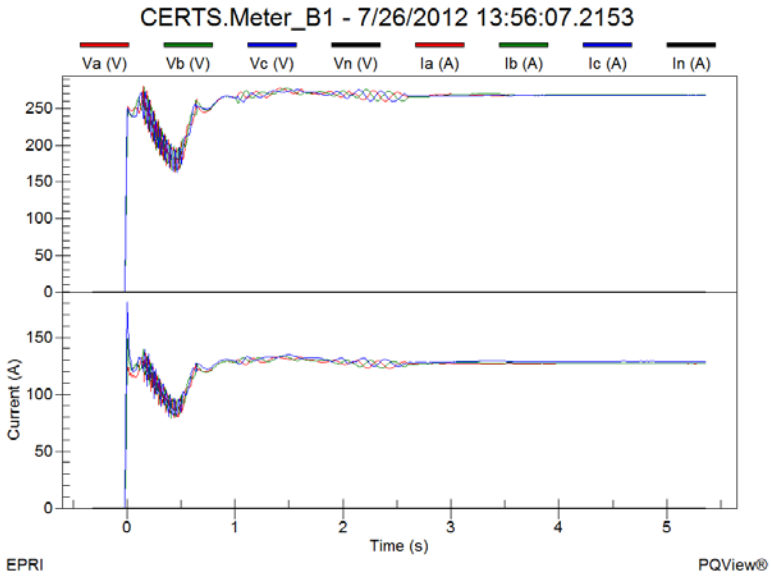


Figure 5.6.1: Event D, 115 kVA, Meter B1, RMS Voltage and Current

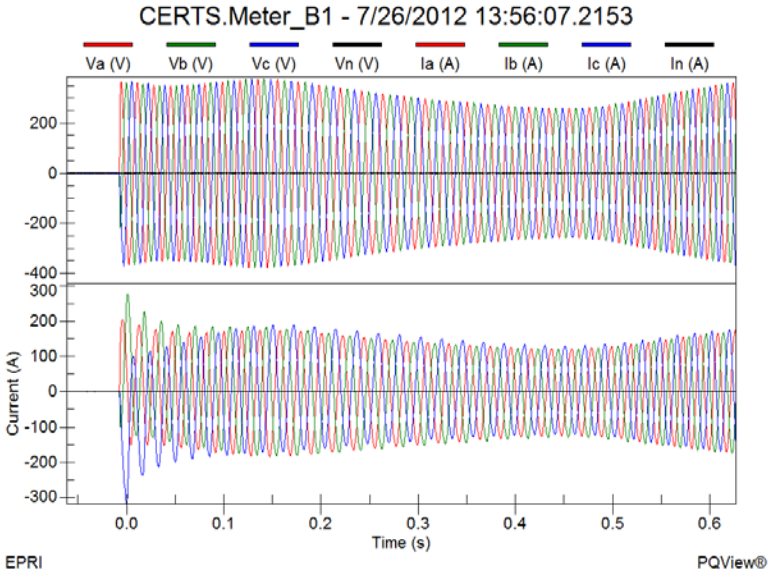


Figure 5.6.2: Event D, 115 kVA, Meter B1, Waveform Voltage and Current

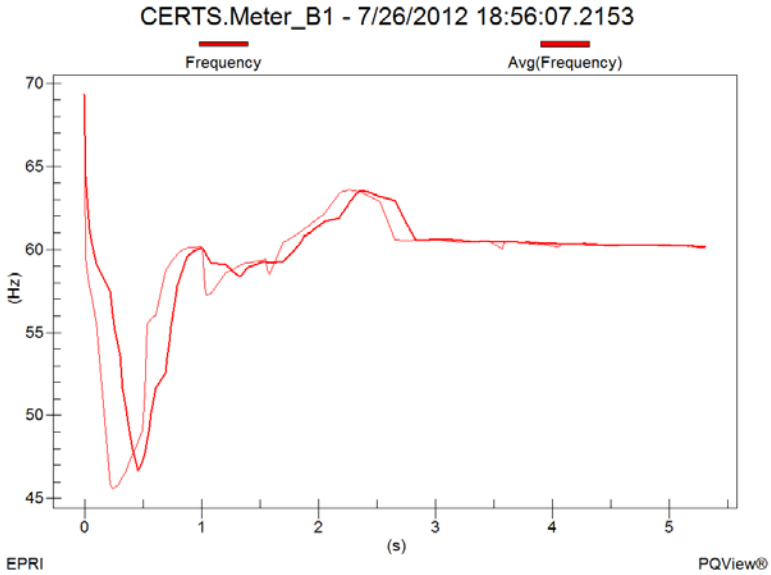


Figure 5.6.3: Event D, 115 kVA, Meter B1, Frequency

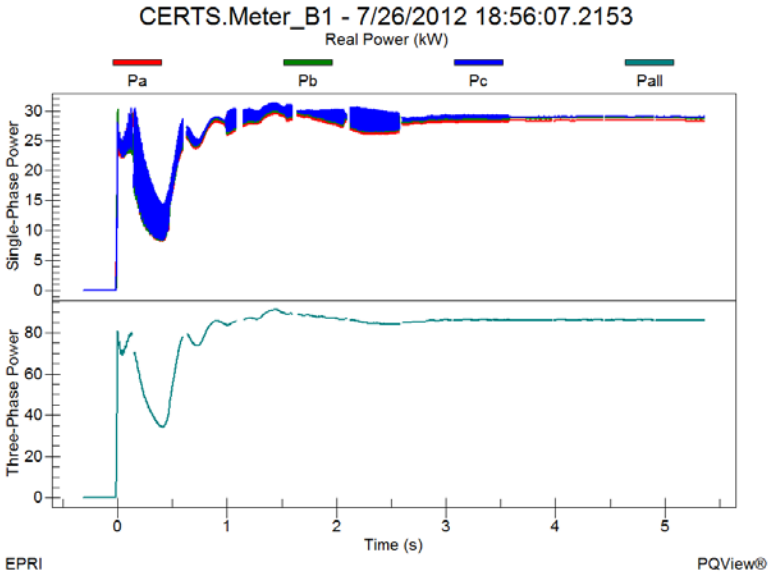


Figure 5.6.4: Event D, 115 kVA, Meter B1, Real Power

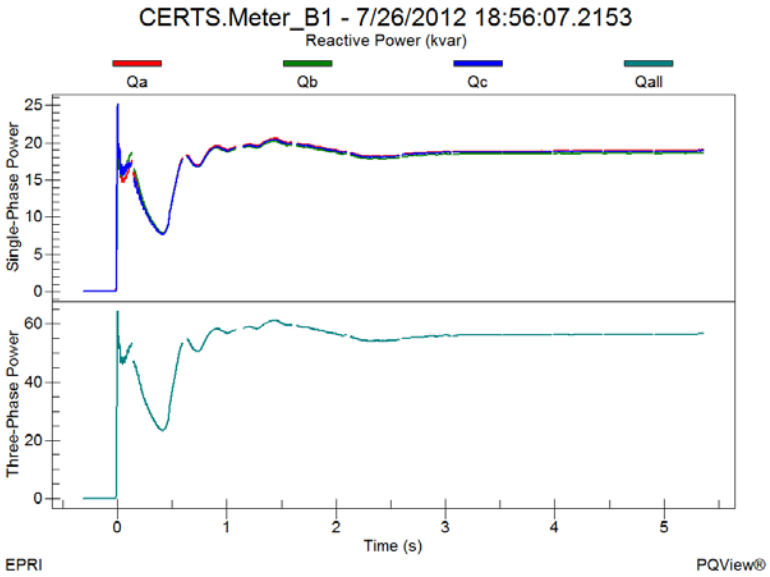


Figure 5.6.5: Event D, 115 kVA, Meter B1, Reactive Power

5.7 *Load Step and Overload Response*

Performance Goal

The intent of this testing is to determine the load step response and overload characteristics of the generator. This testing is completed in four sections below with adjustments made to the generator controls for each section. The generator is first tested in its stock, from manufacturer, configuration which does not contain the CERTS controls algorithms, but does contain an overload mechanism, referred to as 'Load Relief'. This 'Load Relief' function is designed to under-excite and therefore reduce the output voltage when a significant under-frequency condition is measured. Generally this has the effect of lowering the real power consumed by the load or causes some portion of the load to trip off-line due to under-voltage protection.

This technique is utilized in an attempt to return from an overload condition before the generator shuts down due to an internal protection trip. This type of operation is recognized as 'last resort' type of function and is not a desirable area of continuous operation. This technique is being examined as it is commonly employed in synchronous generating equipment and its compatibility with the CERTS P_{max} functionality is to be gauged. Finally, although the test settings describe the 'Load Relief' function as enabled or disabled, in detail this is not accurate. The 'Load Relief' function in the Marathon DVR 2000E, installed on this generator, does not allow a complete disabling of its operation. Instead its range of influence can be controlled. An 'enabled' 'Load Relief' has settings of 58 Hz @ 3 pu V/Hz, whereas a 'disabled' 'Load Relief' has settings of 40Hz @ 1 pu V/Hz, the limit of its available range.

The generator should continue to maintain stability when the load is within the generator's ratings. When the load exceeds the generator's ratings, depending on the settings for the specific tests, various overload mechanisms may operate in an attempt to return from the overload condition. It is recognized that although the overload functions may operate it may not be possible to return from an overload condition. As such the generator is considered to have passed the test provided an attempted overload correction occurs or it reaches a significantly low frequency at which secondary protection would normally be configured to trip. Additional information is provided whether or not the overload function achieves a return from an overload condition.

Description of Procedure

Generator B1 was dispatched to 50 kW, 480$V_{l\text{-}l}$, 1% Frequency Droop, 5% Voltage Droop and operated islanded from the utility. The generator is started and connected to the 'islanded' microgrid electrical bus, initially with no load present. Varying load steps are placed on the generator and each event is recorded. Each load step load is then removed and the event is recorded again. For most tests, an initial load is also placed on the generator prior to the step load. This testing includes loads above the rating of the generator to test its overload response. In addition to the varying initial and step loads, the CERTS and Load Relief controls functions were enabled and disabled in four possible combinations. These settings are summarized in Table 5.7.1.

Test Settings

The easYgen Controller has the following settings when enabled:

Voltage Dispatch: 480V
Real Power Dispatch: 50 kW
Frequency Droop: 1%
Voltage Droop: 5%

The easYgen Controller has the following settings when disabled:

Voltage Dispatch: Ignored
Real Power Dispatch: Ignored
Frequency Droop: Ignored
Voltage Droop: Ignored

The Voltage Exciter has the following settings when enabled:

Load Relief Setting; 58 Hz @ 3 pu V/Hz

The Voltage Exciter has the following settings when disabled:

Load Relief Setting; 40 Hz @ 1 pu V/Hz

Orange highlighted load transitions contain overload conditions. During this course of testing some of the normal protection shutdowns for under-frequency and under-voltage were disabled to allow for a complete capture of the dynamic event. This is not an advisable mode of operation and was only performed by qualified personnel for the purposes of this research. Over-frequency and over-voltage protection trips remained enabled.

Test Events	Load Relief	CERTS Control	Gen-set B1	Load Bank 3	Load Bank 4	Load Bank 5	Total Load Transition
A	✓		50 kW	0 kW	0 kW	0→20 kW	0→20 kW
B	✓	✓	50 kW	0 kW	0 kW	0→20 kW	0→20 kW
C		✓	50 kW	0 kW	0 kW	0→20 kW	0→20 kW
D			50 kW	0 kW	0 kW	0→20 kW	0→20 kW
E	✓		50 kW	0 kW	0 kW	20→0 kW	20→0 kW
F	✓	✓	50 kW	0 kW	0 kW	20→0 kW	20→0 kW
G		✓	50 kW	0 kW	0 kW	20→0 kW	20→0 kW
H			50 kW	0 kW	0 kW	20→0 kW	20→0 kW
I	✓		50 kW	20 kW	0 kW	0→20 kW	20→40 kW
J	✓	✓	50 kW	20 kW	0 kW	0→20 kW	20→40 kW
K		✓	50 kW	20 kW	0 kW	0→20 kW	20→40 kW
L			50 kW	20 kW	0 kW	0→20 kW	20→40 kW
M	✓		50 kW	20 kW	0 kW	20→0 kW	40→20 kW
N	✓	✓	50 kW	20 kW	0 kW	20→0 kW	40→20 kW
O		✓	50 kW	20 kW	0 kW	20→0 kW	40→20 kW
P			50 kW	20 kW	0 kW	20→0 kW	40→20 kW
Q	✓		50 kW	40 kW	0 kW	0→20 kW	40→60 kW
R	✓	✓	50 kW	40 kW	0 kW	0→20 kW	40→60 kW
S		✓	50 kW	40 kW	0 kW	0→20 kW	40→60 kW
T			50 kW	40 kW	0 kW	0→20 kW	40→60 kW
U	✓		50 kW	40 kW	0 kW	20→0 kW	60→40 kW
V	✓	✓	50 kW	40 kW	0 kW	20→0 kW	60→40 kW

Test Events	Load Relief	CERTS Control	Gen-set B1	Load Bank 3	Load Bank 4	Load Bank 5	Total Load Transition
W		✓	50 kW	40 kW	0 kW	20→0 kW	60→40 kW
X			50 kW	40 kW	0 kW	20→0 kW	60→40 kW
Y	✓		50 kW	60 kW	0 kW	0→20 kW	60→80 kW
Z	✓	✓	50 kW	60 kW	0 kW	0→20 kW	60→80 kW
AA		✓	50 kW	60 kW	0 kW	0→20 kW	60→80 kW
AB			50 kW	60 kW	0 kW	0→20 kW	60→80 kW
AC	✓		50 kW	60 kW	0 kW	20→0 kW	80→60 kW
AD	✓	✓	50 kW	60 kW	0 kW	20→0 kW	80→60 kW
AE		✓	50 kW	60 kW	0 kW	20→0 kW	80→60 kW
AF			50 kW	60 kW	0 kW	20→0 kW	80→60 kW
AG	✓		50 kW	80 kW	0 kW	0→20 kW	80→100 kW
AH	✓	✓	50 kW	80 kW	0 kW	0→20 kW	80→100 kW
AI		✓	50 kW	80 kW	0 kW	0→20 kW	80→100 kW
AJ			50 kW	80 kW	0 kW	0→20 kW	80→100 kW
AK	✓		50 kW	80 kW	0 kW	20→0 kW	100→80 kW
AL	✓	✓	50 kW	80 kW	0 kW	20→0 kW	100→80 kW
AM		✓	50 kW	80 kW	0 kW	20→0 kW	100→80 kW
AN			50 kW	80 kW	0 kW	20→0 kW	100→80 kW
AO	✓		50 kW	80 kW	20 kW	0→20 kW	100→120 kW
AP	✓	✓	50 kW	80 kW	20 kW	0→20 kW	100→120 kW
AQ		✓	50 kW	80 kW	20 kW	0→20 kW	100→120 kW
AR			50 kW	80 kW	20 kW	0→20 kW	100→120 kW
AS	✓		50 kW	80 kW	20 kW	20→0 kW	120→100 kW
AT	✓	✓	50 kW	80 kW	20 kW	20→0 kW	120→100 kW
AU		✓	50 kW	80 kW	20 kW	20→0 kW	120→100 kW
AV			50 kW	80 kW	20 kW	20→0 kW	120→100 kW
AW	✓		50 kW	0 kW	0 kW	0→40 kW	0→40 kW
AX	✓	✓	50 kW	0 kW	0 kW	0→40 kW	0→40 kW
AY		✓	50 kW	0 kW	0 kW	0→40 kW	0→40 kW
AZ			50 kW	0 kW	0 kW	0→40 kW	0→40 kW
BA	✓		50 kW	0 kW	0 kW	40→0 kW	40→0 kW
BB	✓	✓	50 kW	0 kW	0 kW	40→0 kW	40→0 kW
BC		✓	50 kW	0 kW	0 kW	40→0 kW	40→0 kW
BD			50 kW	0 kW	0 kW	40→0 kW	40→0 kW
BE	✓		50 kW	20 kW	0 kW	0→40 kW	20→60 kW
BF	✓	✓	50 kW	20 kW	0 kW	0→40 kW	20→60 kW
BG		✓	50 kW	20 kW	0 kW	0→40 kW	20→60 kW
BH			50 kW	20 kW	0 kW	0→40 kW	20→60 kW
BI	✓		50 kW	20 kW	0 kW	40→0 kW	60→20 kW
BJ	✓	✓	50 kW	20 kW	0 kW	40→0 kW	60→20 kW

Test Events	Load Relief	CERTS Control	Gen-set B1	Load Bank 3	Load Bank 4	Load Bank 5	Total Load Transition
BK		✓	50 kW	20 kW	0 kW	40→0 kW	60→20 kW
BL			50 kW	20 kW	0 kW	40→0 kW	60→20 kW
BM	✓		50 kW	40 kW	0 kW	0→40 kW	40→80 kW
BN	✓	✓	50 kW	40 kW	0 kW	0→40 kW	40→80 kW
BO		✓	50 kW	40 kW	0 kW	0→40 kW	40→80 kW
BP			50 kW	40 kW	0 kW	0→40 kW	40→80 kW
BQ	✓		50 kW	40 kW	0 kW	40→0 kW	80→40 kW
BR	✓	✓	50 kW	40 kW	0 kW	40→0 kW	80→40 kW
BS		✓	50 kW	40 kW	0 kW	40→0 kW	80→40 kW
BT			50 kW	40 kW	0 kW	40→0 kW	80→40 kW
BU	✓		50 kW	60 kW	0 kW	0→40 kW	60→100 kW
BV	✓	✓	50 kW	60 kW	0 kW	0→40 kW	60→100 kW
BW		✓	50 kW	60 kW	0 kW	0→40 kW	60→100 kW
BX			50 kW	60 kW	0 kW	0→40 kW	60→100 kW
BY	✓		50 kW	60 kW	0 kW	40→0 kW	100→60 kW
BZ	✓	✓	50 kW	60 kW	0 kW	40→0 kW	100→60 kW
CA		✓	50 kW	60 kW	0 kW	40→0 kW	100→60 kW
CB			50 kW	60 kW	0 kW	40→0 kW	100→60 kW
CC	✓		50 kW	80 kW	0 kW	0→40 kW	80→120 kW
CD	✓	✓	50 kW	80 kW	0 kW	0→40 kW	80→120 kW
CE		✓	50 kW	80 kW	0 kW	0→40 kW	80→120 kW
CF			50 kW	80 kW	0 kW	0→40 kW	80→120 kW
CG	✓		50 kW	80 kW	0 kW	40→0 kW	120→80 kW
CH	✓	✓	50 kW	80 kW	0 kW	40→0 kW	120→80 kW
CI		✓	50 kW	80 kW	0 kW	40→0 kW	120→80 kW
CJ			50 kW	80 kW	0 kW	40→0 kW	120→80 kW
CK	✓		50 kW	0 kW	0 kW	0→60 kW	0→60 kW
CL	✓	✓	50 kW	0 kW	0 kW	0→60 kW	0→60 kW
CM		✓	50 kW	0 kW	0 kW	0→60 kW	0→60 kW
CN			50 kW	0 kW	0 kW	0→60 kW	0→60 kW
CO	✓		50 kW	0 kW	0 kW	60→0 kW	60→0 kW
CP	✓	✓	50 kW	0 kW	0 kW	60→0 kW	60→0 kW
CQ		✓	50 kW	0 kW	0 kW	60→0 kW	60→0 kW
CR			50 kW	0 kW	0 kW	60→0 kW	60→0 kW
CS	✓		50 kW	20 kW	0 kW	0→60 kW	20→80 kW
CT	✓	✓	50 kW	20 kW	0 kW	0→60 kW	20→80 kW
CU		✓	50 kW	20 kW	0 kW	0→60 kW	20→80 kW
CV			50 kW	20 kW	0 kW	0→60 kW	20→80 kW
CW	✓		50 kW	20 kW	0 kW	60→0 kW	80→20 kW
CX	✓	✓	50 kW	20 kW	0 kW	60→0 kW	80→20 kW

Test Events	Load Relief	CERTS Control	Gen-set B1	Load Bank 3	Load Bank 4	Load Bank 5	Total Load Transition
CY		✓	50 kW	20 kW	0 kW	60→0 kW	80→20 kW
CZ			50 kW	20 kW	0 kW	60→0 kW	80→20 kW
DA	✓		50 kW	40 kW	0 kW	0→60 kW	40→100 kW
DB	✓	✓	50 kW	40 kW	0 kW	0→60 kW	40→100 kW
DC		✓	50 kW	40 kW	0 kW	0→60 kW	40→100 kW
DD			50 kW	40 kW	0 kW	0→60 kW	40→100 kW
DE	✓		50 kW	40 kW	0 kW	60→0 kW	100→40 kW
DF	✓	✓	50 kW	40 kW	0 kW	60→0 kW	100→40 kW
DG		✓	50 kW	40 kW	0 kW	60→0 kW	100→40 kW
DH			50 kW	40 kW	0 kW	60→0 kW	100→40 kW
DI	✓		50 kW	60 kW	0 kW	0→60 kW	60→120 kW
DJ	✓	✓	50 kW	60 kW	0 kW	0→60 kW	60→120 kW
DK		✓	50 kW	60 kW	0 kW	0→60 kW	60→120 kW
DL			50 kW	60 kW	0 kW	0→60 kW	60→120 kW
DM	✓		50 kW	60 kW	0 kW	60→0 kW	120→60 kW
DN	✓	✓	50 kW	60 kW	0 kW	60→0 kW	120→60 kW
DO		✓	50 kW	60 kW	0 kW	60→0 kW	120→60 kW
DP			50 kW	60 kW	0 kW	60→0 kW	120→60 kW
DQ	✓		50 kW	0 kW	0 kW	0→80 kW	0→80 kW
DR	✓	✓	50 kW	0 kW	0 kW	0→80 kW	0→80 kW
DS		✓	50 kW	0 kW	0 kW	0→80 kW	0→80 kW
DT			50 kW	0 kW	0 kW	0→80 kW	0→80 kW
DU	✓		50 kW	0 kW	0 kW	80→0 kW	80→0 kW
DV	✓	✓	50 kW	0 kW	0 kW	80→0 kW	80→0 kW
DW		✓	50 kW	0 kW	0 kW	80→0 kW	80→0 kW
DX			50 kW	0 kW	0 kW	80→0 kW	80→0 kW
DY	✓		50 kW	20 kW	0 kW	0→80 kW	20→100 kW
DZ	✓	✓	50 kW	20 kW	0 kW	0→80 kW	20→100 kW
EA		✓	50 kW	20 kW	0 kW	0→80 kW	20→100 kW
EB			50 kW	20 kW	0 kW	0→80 kW	20→100 kW
EC	✓		50 kW	20 kW	0 kW	80→0 kW	100→20 kW
ED	✓	✓	50 kW	20 kW	0 kW	80→0 kW	100→20 kW
EE		✓	50 kW	20 kW	0 kW	80→0 kW	100→20 kW
EF			50 kW	20 kW	0 kW	80→0 kW	100→20 kW
EG	✓		50 kW	40 kW	0 kW	0→80 kW	40→120 kW
EH	✓	✓	50 kW	40 kW	0 kW	0→80 kW	40→120 kW
EI		✓	50 kW	40 kW	0 kW	0→80 kW	40→120 kW
EJ			50 kW	40 kW	0 kW	0→80 kW	40→120 kW
EK	✓		50 kW	40 kW	0 kW	80→0 kW	120→40 kW
EL	✓	✓	50 kW	40 kW	0 kW	80→0 kW	120→40 kW

Test Events	Load Relief	CERTS Control	Gen-set B1	Load Bank 3	Load Bank 4	Load Bank 5	Total Load Transition
EM		✓	50 kW	40 kW	0 kW	80→0 kW	120→40 kW
EN			50 kW	40 kW	0 kW	80→0 kW	120→40 kW
EO	✓		50 kW	0 kW	20 kW	0→95 kW	0→95 kW
EP	✓	✓	50 kW	0 kW	20 kW	0→95 kW	0→95 kW
EQ		✓	50 kW	0 kW	20 kW	0→95 kW	0→95 kW
ER			50 kW	0 kW	20 kW	0→95 kW	0→95 kW
ES	✓		50 kW	0 kW	20 kW	95→0 kW	95→0 kW
ET	✓	✓	50 kW	0 kW	20 kW	95→0 kW	95→0 kW
EU		✓	50 kW	0 kW	20 kW	95→0 kW	95→0 kW
EV			50 kW	0 kW	20 kW	95→0 kW	95→0 kW
EW	✓		50 kW	20 kW	0 kW	0→95 kW	20→115 kW
EX	✓	✓	50 kW	20 kW	0 kW	0→95 kW	20→115 kW
EY		✓	50 kW	20 kW	0 kW	0→95 kW	20→115 kW
EZ			50 kW	20 kW	0 kW	0→95 kW	20→115 kW
FA	✓		50 kW	20 kW	0 kW	95→0 kW	115→20 kW
FB	✓	✓	50 kW	20 kW	0 kW	95→0 kW	115→20 kW
FC		✓	50 kW	20 kW	0 kW	95→0 kW	115→20 kW
FD			50 kW	20 kW	0 kW	95→0 kW	115→20 kW

Table 5.7.1: Load Step and Stalling Response Characteristic Test Settings

Test Results

Test Event	Pre Event			Post Event			Pass/Fail	Notes
	Voltage (V)	Frequency (Hz)	Power (kW)	Voltage (V)	Frequency (Hz)	Power (kW)		
A	276.783	59.9779	0.70376	276.526	59.9706	20.0802	Pass	
B	277.843	60.3557	0.78117	277.684	60.2729	20.1331	Pass	
C	277.761	60.3193	0.74532	277.626	60.2872	20.1647	Pass	
D	276.653	60.055	0.7592	276.455	59.9251	20.1272	Pass	
E	276.638	60.0086	18.3081	276.783	60.1013	0.70559	Pass	
F	277.664	60.0986	18.4859	277.82	60.1929	0.7463	Pass	
G	277.652	60.2193	18.4219	277.778	60.2241	0.74692	Pass	
H	276.393	60.1029	18.3138	276.699	60.0829	0.71657	Pass	
I	276.551	59.8807	19.9994	276.573	60.0336	39.0355	Pass	
J	277.64	60.2393	20.0381	277.528	60.1888	39.2339	Pass	
K	277.527	60.2414	19.9468	277.504	60.2534	39.1132	Pass	
L	276.411	59.8343	18.3388	276.458	60.0273	37.5835	Pass	
M	276.58	60.6364	35.8476	276.64	60.0724	18.258	Pass	
N	277.591	60.1507	36.2186	277.414	60.1229	18.4353	Pass	
O	277.301	60.1714	36.0261	277.589	60.126	18.402	Pass	
P	276.571	60.2329	35.8674	276.591	60.0738	18.2329	Pass	
Q	276.581	59.8093	37.0091	276.511	59.9751	56.141	Pass	
R	277.507	59.7507	37.4544	277.6	59.7516	56.9829	Pass	
S	277.345	60.265	37.17	277.36	60.07	56.3213	Pass	
T	276.473	60.0579	36.6678	276.461	59.9685	55.7616	Pass	
U	276.548	60.2357	53.2856	276.587	60.0629	35.6068	Pass	
V	277.239	59.425	53.5528	277.452	59.6204	35.866	Pass	
W	277.275	59.8771	53.3725	277.482	59.976	35.7264	Pass	
X	276.39	59.9693	53.2496	276.58	60.0427	35.6323	Pass	
Y	276.455	59.4014	54.2182	276.373	60.0376	73.3289	Pass	
Z	277.191	59.4936	53.5523	277.16	60.0306	72.8387	Pass	
AA	277.3	59.7229	54.4026	277.184	59.996	73.5102	Pass	
AB	276.407	59.8986	53.044	276.356	60.0452	72.2479	Pass	
AC	276.377	59.9664	70.4538	276.485	60.0195	52.8409	Pass	
AD	277.354	60.315	70.7243	277.333	59.8676	52.9989	Pass	
AE	276.973	59.8814	70.5678	277.291	59.8771	53.0013	Pass	
AF	276.272	59.5807	70.4193	276.509	60.0328	52.8492	Pass	
AG	276.347	59.8614	70.4227	276.279	60.0503	90.3076	Pass	
AH	277.067	59.83	70.0364	277.073	59.8605	90.1736	Pass	
AI	277.201	60.0107	70.8195	277.042	59.995	90.7283	Pass	
AJ	276.41	60.1093	69.2058	276.289	60.0649	88.9928	Pass	
AK	276.297	60.2057	86.9766	276.367	60.0965	69.859	Pass	
AL	277.028	59.9521	87.2542	277.105	59.7997	70.0432	Pass	

Test Event	Pre Event			Post Event			Pass/Fail	Notes
	Voltage (V)	Frequency (Hz)	Power (kW)	Voltage (V)	Frequency (Hz)	Power (kW)		
AM	277.094	59.8521	87.3188	277.13	59.8211	70.1	Pass	
AN	276.383	60.4107	87.0035	276.419	60.056	69.8145	Pass	
AO	276.263	59.7336	88.333	256.477	56.6724	92.2704	Pass	Shutdown from Under-frequency and Under-speed.
AP	276.849	59.419	91.589	245.812	54.1081	86.3806	Pass	Under-Frequency and Under-Voltage Trips Removed.
AQ	277.035	60.32	84.7657	179.644	48.2682	21.194	Pass	Under-Frequency and Under-Voltage Trips Removed.
AR	276.347	60.148	84.6493	179.441	45.9092	21.0457	Pass	Under-Frequency and Under-Voltage Trips Removed.
AS	-	-	-	-	-	-	N/A	Test Skipped.
AT	-	-	-	-	-	-	N/A	Test Skipped.
AU	177.673	27.6948	20.3615	204.238	32.0611	26.9229	Pass	Test Event begins with generator overloaded. Test Event results in a continuous operation state which would cause a protection trip if enabled.
AV	132.841	30.1028	26.0667	166.127	33.6878	32.9422	Pass	Test Event begins with generator overloaded. Test Event results in a continuous operation state which would cause a protection trip if enabled.
AW	276.846	60.105	0.78521	276.565	59.9856	39.2063	Pass	
AX	277.841	60.2521	0.7411	278.381	60.2461	39.6897	Pass	
AY	277.87	60.3079	0.75286	277.768	60.3328	39.3735	Pass	
AZ	276.747	60.0629	0.69157	276.465	59.9929	39.3569	Pass	
BA	276.598	60.1093	35.5804	276.84	60.1116	0.73259	Pass	
BB	277.564	60.0307	36.0011	278.273	60.1238	0.72743	Pass	
BC	277.811	60.5607	36.0633	277.843	60.0972	0.7152	Pass	
BD	276.533	60.3836	35.9807	276.798	60.1019	0.68343	Pass	
BE	276.667	59.5407	20.0227	276.54	59.9855	57.7527	Pass	
BF	277.643	60.1329	20.2225	277.74	60.279	58.5012	Pass	

Test Event	Pre Event			Post Event			Pass/Fail	Notes
	Voltage (V)	Frequency (Hz)	Power (kW)	Voltage (V)	Frequency (Hz)	Power (kW)		
BG	277.653	60.0793	18.4581	277.241	60.224	56.6692	Pass	
BH	276.676	59.9729	18.5232	276.445	60.0183	56.8796	Pass	
BI	276.49	60.1664	53.2821	276.663	60.1076	18.3798	Pass	
BJ	277.297	60.0971	53.3659	277.58	59.9908	18.3685	Pass	
BK	277.834	59.9857	53.6261	277.583	60.0494	18.3406	Pass	
BL	276.4	59.9664	53.5015	276.607	60.0516	18.3379	Pass	
BM	276.69	60.055	37.3226	276.428	60.0244	75.021	Pass	
BN	277.505	59.9714	37.4333	276.93	60.1399	75.1498	Pass	
BO	277.626	60.2764	36.1495	276.982	60.1167	74.0934	Pass	
BP	276.59	60.0543	36.1774	276.344	60.064	74.7457	Pass	
BQ	276.457	60.1764	70.7009	276.604	60.068	35.6876	Pass	
BR	277.278	60.175	70.9041	277.414	59.9004	35.8175	Pass	
BS	277.441	59.93	71.0405	277.641	59.9247	35.8222	Pass	
BT	276.321	60.4293	71.0233	276.521	60.0559	35.8001	Pass	
BU	276.457	59.625	53.5368	276.28	60.0683	91.8996	Pass	
BV	277.203	59.8657	53.9673	275.761	60.1729	91.6471	Pass	
BW	277.369	60.2629	52.5519	206.366	47.5318	30.1397	Fail	Test Event results in a continuous operation state which would cause a protection trip if enabled.
BX	276.449	59.8464	52.4698	277.017	59.8489	91.6056	Pass	
BY	276.319	60.2143	87.3077	276.497	60.0709	52.9063	Pass	
BZ	276.981	59.6314	87.6466	277.16	59.6897	53.0243	Pass	
CA	199.873	46.8757	26.0907	275.66	58.895	50.4834	N/A	Test performed incorrectly. Disregard.
CB	276.318	60.19	87.4289	276.495	60.0784	52.8636	Pass	
CC	-	-	-	-	-	-	N/A	Test Skipped.
CD	277.008	59.8621	70.7335	249.345	54.2236	86.3841	Pass	Test Event results in a continuous operation state which would cause a protection trip if enabled.
CE	276.938	59.955	70.0503	172.92	45.2525	19.3556	Pass	Test Event results in a continuous operation state which would cause a protection trip if enabled.
CF	276.299	58.1395	69.0956	174.154	28.5726	19.4875	Pass	Test Event results

Test Event	Pre Event			Post Event			Pass/Fail	Notes
	Voltage (V)	Frequency (Hz)	Power (kW)	Voltage (V)	Frequency (Hz)	Power (kW)		
								in a continuous operation state which would cause a protection trip if enabled.
CG	-	-	-	-	-	-	N/A	Test Skipped
CH	247.57	54.0114	84.0437	290.154	60.9359	76.9916	Pass	Test Event begins with generator overloaded. Test Event results in a continuous operation state which would cause a protection trip if enabled.
CI	174.155	30.3654	20.0977	231.817	36.044	34.2245	Pass	Test Event begins with generator overloaded. Test Event results in a continuous operation state which would cause a protection trip if enabled.
CJ	175.191	26.9421	20.1637	233.37	35.8005	34.3234	Pass	Test Event begins with generator overloaded. Test Event results in a continuous operation state which would cause a protection trip if enabled.
CK	276.863	59.9657	0.72178	276.534	59.9693	57.3577	Pass	
CL	277.87	60.3643	0.71317	278.004	60.4088	57.0424	Pass	
CM	277.743	59.9757	0.69269	277.777	60.3978	58.6651	Pass	
CN	276.81	60.01	0.71747	276.48	59.9871	57.8028	Pass	
CO	276.523	59.9964	52.8712	276.881	60.096	0.71844	Pass	
CP	277.059	60.4814	52.943	278.127	59.9708	0.72562	Pass	
CQ	277.326	60.175	53.5526	277.782	59.9427	0.69195	Pass	
CR	276.629	59.8757	52.9881	276.823	60.1229	0.68637	Pass	
CS	276.698	60.0229	19.5966	276.432	60.0651	76.0083	Pass	
CT	277.651	59.8686	20.157	276.45	60.3245	76.0708	Pass	
CU	277.674	60.1943	18.4964	276.373	60.4456	75.1628	Pass	
CV	276.643	59.7993	18.352	276.409	60.058	74.9114	Pass	

Test Event	Pre Event			Post Event			Pass/Fail	Notes
	Voltage (V)	Frequency (Hz)	Power (kW)	Voltage (V)	Frequency (Hz)	Power (kW)		
CW	276.379	59.965	70.4036	276.685	60.0935	18.3346	Pass	
CX	277.173	59.9921	70.7988	277.649	59.8955	18.5173	Pass	
CY	276.986	59.96	70.7375	278.156	59.865	18.4656	Pass	
CZ	276.394	60.11	70.4289	276.65	60.1077	18.2729	Pass	
DA	276.692	59.9707	36.7781	276.339	60.0626	93.4638	Pass	
DB	277.338	60.2314	37.0653	273.446	60.2376	91.5705	Pass	
DC	277.331	59.9964	37.3431	192.979	45.5	23.961	Fail	
DD	276.56	60.1129	35.3108	198.703	47.075	26.0807	Fail	
DE	276.324	60.0714	87.0554	276.615	60.0693	35.5776	Pass	
DF	277.392	59.8457	87.7867	276.971	59.7653	35.6934	Pass	
DG	195.418	69.0671	24.5568	-	-	-	N/A	Test performed incorrectly. Disregard.
DH	198.327	51.0211	26.006	-	-	-	N/A	Test performed incorrectly. Disregard.
DI	-	-	-	-	-	-	N/A	Test Skipped.
DJ	277.35	59.835	54.1434	250.161	54.4819	88.244	Pass	Test Event results in a continuous operation state which would cause a protection trip if enabled.
DK	277.627	60.9261	53.7184	170.899	28.8889	18.7164	Pass	Test Event results in a continuous operation state which would cause a protection trip if enabled.
DL	276.446	60.0579	52.1643	173.815	45.145	19.7529	Pass	Test Event results in a continuous operation state which would cause a protection trip if enabled.
DM	-	-	-	-	-	-	N/A	Test Skipped
DN	248.026	53.8121	88.5397	-	-	-	Pass	Test Event begins with generator overloaded. Shutdown from Over-frequency and Over-speed.
DO	174.013	45.41	19.7863	275.707	56.1483	50.1316	Pass	Test Event begins with generator overloaded. Test

Test Event	Pre Event			Post Event			Pass/Fail	Notes
	Voltage (V)	Frequency (Hz)	Power (kW)	Voltage (V)	Frequency (Hz)	Power (kW)		
								Event results in a continuous operation state which would cause a protection trip if enabled.
DP	175.225	30.5603	20.3079	280.175	43.5335	45.7835	Pass	Test Event begins with generator overloaded. Test Event results in a continuous operation state which would cause a protection trip if enabled.
DQ	276.848	60.0379	0.7136	276.471	60.0016	75.6317	Pass	
DR	277.877	59.4571	0.79676	273.433	60.0719	75.3127	Pass	
DS	277.88	59.4214	0.75164	274.703	60.6902	75.5537	Pass	
DT	276.883	60.09	0.68353	276.403	60.0924	73.7108	Pass	
DU	276.359	59.9936	69.7726	-	-	-	Fail	Shutdown Over-frequency and Over-speed.
DV	277.1	60.1036	70.6532	278.18	59.5488	0.75342	Pass	
DW	277.404	60.0071	70.6351	278.998	59.8605	0.71636	Pass	
DX	276.332	59.9193	69.7242	276.826	60.0694	0.68306	Pass	
DY	276.717	59.8329	18.0249	276.347	60.0594	93.6602	Pass	
DZ	277.739	59.3064	19.8598	270.9	60.0878	91.3227	Pass	
EA	277.591	59.8779	18.2608	196.383	46.665	25.1478	Fail	
EB	276.597	59.8343	18.2014	197.635	47.81	25.6863	Fail	
EC	276.265	60.5379	86.8388	-	-	-	Fail	Shutdown Over-frequency and Over-speed.
ED	277.348	59.4971	87.9698	278.657	59.4642	18.6699	Pass	
EE	198.833	48.7071	26.1753	-	-	-	N/A	Test performed incorrectly. Disregard.
EF	196.225	56.8333	25.2744	-	-	-	N/A	Test performed incorrectly. Disregard.
EG	-	-	-	-	-	-	N/A	Test Skipped
EH	277.82	60.1507	37.2343	250.1	55.078	90.0735	Pass	Test Event results in a continuous operation state which would cause a protection trip if

Test Event	Pre Event			Post Event			Pass/Fail	Notes
	Voltage (V)	Frequency (Hz)	Power (kW)	Voltage (V)	Frequency (Hz)	Power (kW)		
								enabled.
EI	277.446	59.8364	35.4777	173.736	45.285	19.9444	Pass	Test Event results in a continuous operation state which would cause a protection trip if enabled.
EJ	276.447	60.1129	36.5723	172.825	45.965	19.8263	Pass	Test Event results in a continuous operation state which would cause a protection trip if enabled.
EK	-	-	-	-	-	-	N/A	Test Skipped.
EL	243.453	53.4936	84.1885	-	-	-	Pass	Test Event begins with generator overloaded. Shutdown from Over-frequency and Over-speed.
EM	174.374	46.7964	20.1583	-	-	-	Pass	Test Event begins with generator overloaded. Shutdown from Over-frequency and Over-speed.
EN	173.7	55.5431	19.9848	-	-	-	Pass	Test Event begins with generator overloaded. Shutdown from Over-frequency and Over-speed.
EO	276.867	59.8207	0.76045	276.357	60.0292	91.3796	Pass	
EP	277.839	60.2243	0.69879	272.257	60.5601	89.2536	Pass	
EQ	277.808	59.4621	0.74042	201.218	46.185	26.7919	Fail	
ER	276.799	59.755	0.73392	200.66	48.59	26.534	Fail	
ES	276.369	59.9407	84.4996	-	-	-	Fail	Shutdown Over-frequency and Over-speed.
ET	277.066	60.2007	85.404	-	-	-	Fail	Shutdown Over-frequency and Over-speed.
EU	276.966	59.6043	87.6828	278.302	59.666	0.71017	Pass	
EV	202.938	50.5986	27.2663	-	-	-	N/A	Test performed incorrectly. Disregard.

Test Event	Pre Event			Post Event			Pass/Fail	Notes
	Voltage (V)	Frequency (Hz)	Power (kW)	Voltage (V)	Frequency (Hz)	Power (kW)		
EW	-	-	-	-	-	-	N/A	Test Skipped.
EX	277.702	60.1871	19.7633	256.882	56.4754	94.3689	Pass	Test Event results in a continuous operation state which would cause a protection trip if enabled.
EY	277.402	59.9943	18.3231	176.352	45.13	20.5697	Pass	Test Event results in a continuous operation state which would cause a protection trip if enabled.
EZ	276.618	60.0764	18.8897	176.899	45.29	20.9794	Pass	Test Event results in a continuous operation state which would cause a protection trip if enabled.
FA	-	-	-	-	-	-	N/A	Test Skipped
FB	247.478	53.6871	83.8511	-	-	-	Pass	Test Event begins with generator overloaded. Shutdown from Over-frequency and Over-speed.
FC	178.289	55.6814	21.2946	-	-	-	Pass	Test Event begins with generator overloaded. Shutdown from Over-frequency and Over-speed.
FD	177.319	59.745	21.0387	-	-	-	Pass	Test Event begins with generator overloaded. Shutdown from Over-frequency and Over-speed.

Table 5.7.2: Load Step and Stalling Response Characteristic Test Results

Analysis

From the test results the ‘CERTS Control’ functions appear to have little to no effect on the load step and overload response of the generator in either the enabled or disabled state. All of the overload conditions led to operation at reduced voltages and frequencies low enough to cause protection trips of the generator. Additionally the large load rejection tests demonstrate that the generator increases in speed/frequency rapidly during load rejection. If the generating equipment is capable of operating under these conditions relaxing the over-speed and over-frequency protection trips would allow the generator the additional time necessary to return to nominal.

The ‘Load Relief’ function had a noticeable difference on whether or not the generator was successfully able to load step 40 kW or greater to its full rated load. As the generator approaches the maximum mechanical power available from the prime mover, the engine speed and therefore the electrical frequency falls significantly. When the load relief is enabled it reduces the output voltage during the transient, causing the load to be more gradually applied to the generator. This results in a brief under-voltage condition during the loading event affecting power quality, however it does allow the generator to continue carrying the load where it would have shutdown otherwise. Examples of this effect can be seen by comparing Events DY, 20→100 kW w/ Load Relief, and EB, 20→100 kW w/o Load Relief, detailed below in Figure 5.7.1 through Figure 5.7.8.

Event DY, 20→100 kW w/ Load Relief, begins as with the generator supporting approximately 20 kW of load. An additional 80kW is added to the microgrid bus. The electrical frequency drops to 48 Hz and the ‘Load Relief’ function of the voltage exciter reduces the output voltage to prevent generator stall. The accompanying reduction in electrical load allows the prime mover to recover, increasing to the proper operating speed. As the frequency recovers so too does the voltage. With the assistance of the ‘Load Relief’ function the generator is successful in supporting the large load step.

Event EB, 20→100 kW w/o Load Relief, begins in a similar fashion with the generator supporting approximately 20 kW of load. The additional 80 kW is added to the microgrid bus. The electrical frequency again drops below 50 Hz however because the voltage remains fixed the electrical load does not reduce. Even at full throttle the prime mover is incapable of recovering to the proper operational speed. Eventually the electrical frequency falls below the ‘disabled’ 40 Hz threshold and the voltage exciter does reduce the output voltage. The electrical frequency and voltage continue to drop until the electrical power consumed matches the available mechanical power of the prime mover. The generator would continue at this reduced operation point indefinitely if not tripped offline. Generally a protection trip would be required as the reduced output voltage could cause damage to connected loads and the reduced operating speed of the prime mover is accompanied by side effects like reduced oil pressure which could lead to mechanical failure.

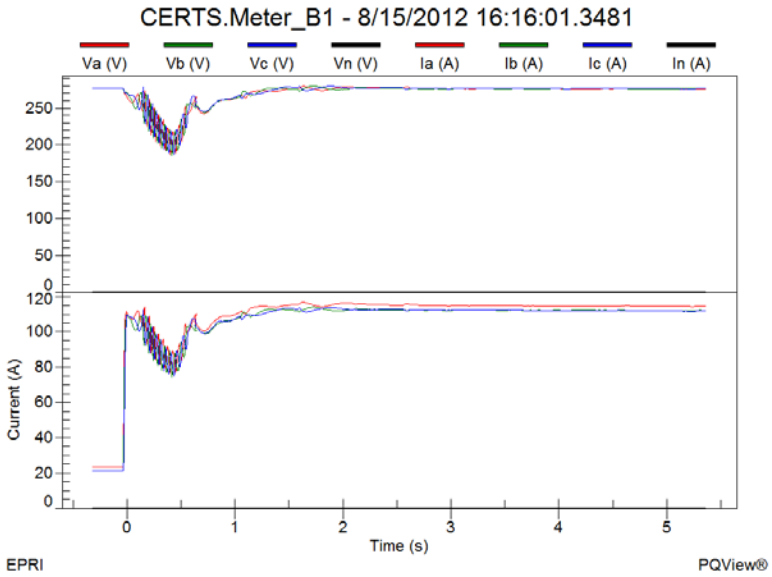


Figure 5.7.1: Event DY, 20→100 kW w/ Load Relief, Meter B1, RMS Voltage and Current

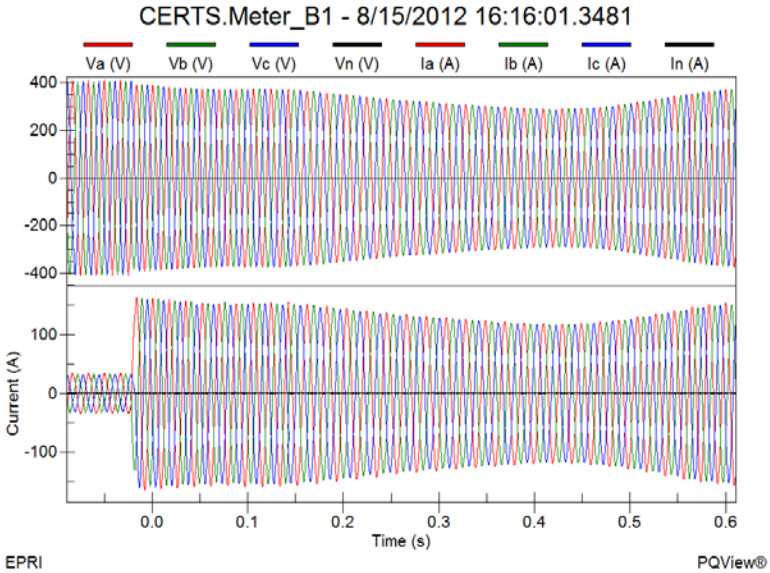


Figure 5.7.2: Event DY, 20→100 kW w/ Load Relief, Meter B1, Waveform Voltage and Current

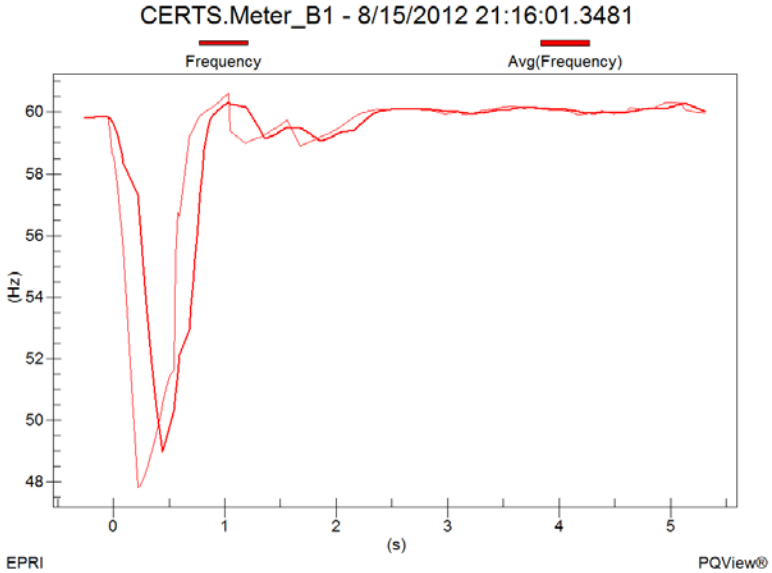


Figure 5.7.3: Event DY, 20→100 kW w/ Load Relief, Meter B1, Frequency

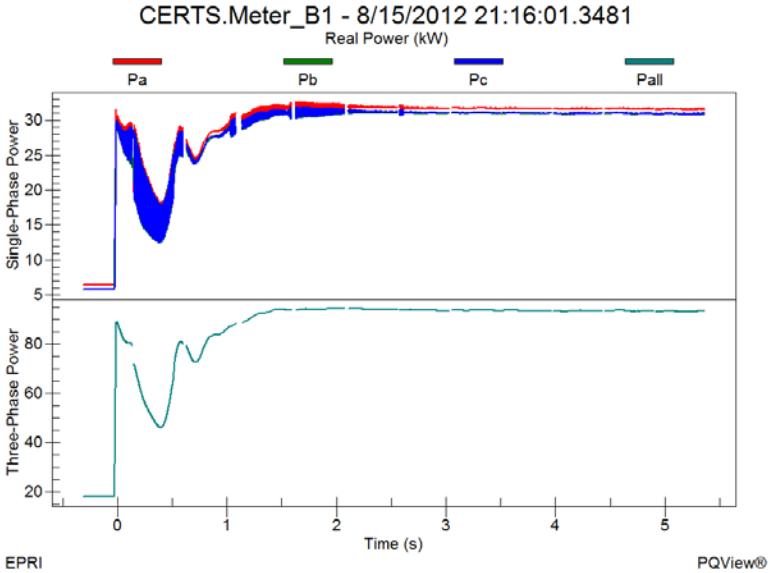


Figure 5.7.4: Event DY, 20→100 kW w/ Load Relief, Meter B1, Real Power

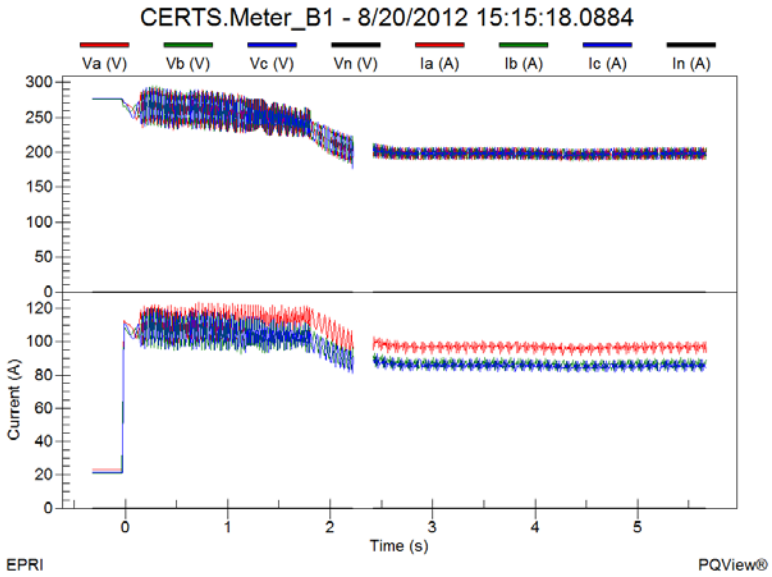


Figure 5.7.5: Event EB, 20→100 kW w/o Load Relief, Meter B1, RMS Voltage and Current

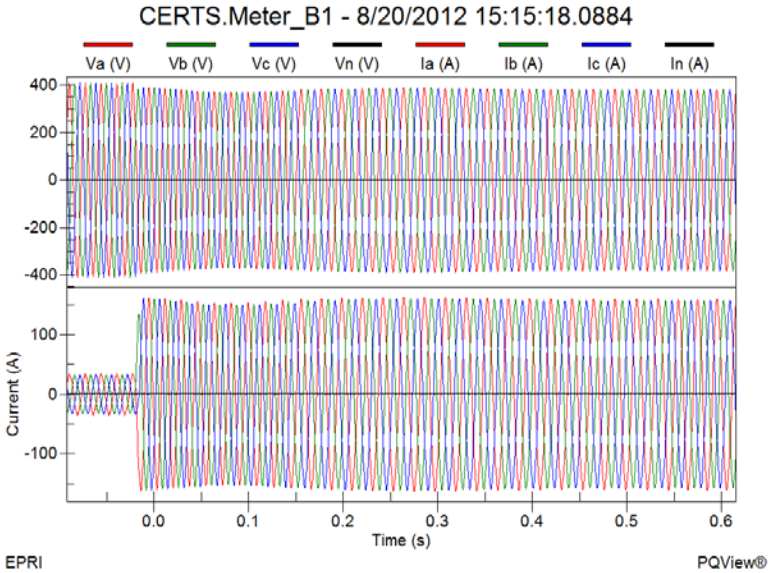


Figure 5.7.6: Event EB, 20→100 kW w/o Load Relief, Meter B1, Waveform Voltage and Current

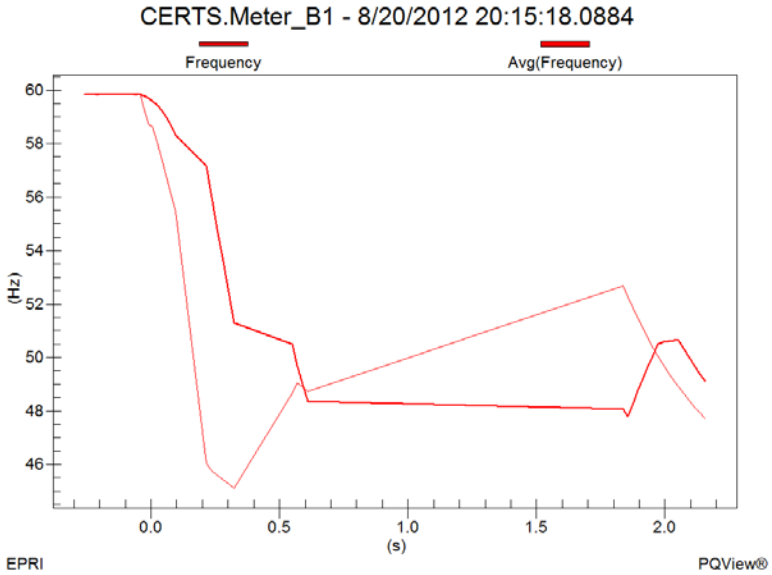


Figure 5.7.7: Event EB, 20→100 kW w/o Load Relief, Meter B1, Frequency

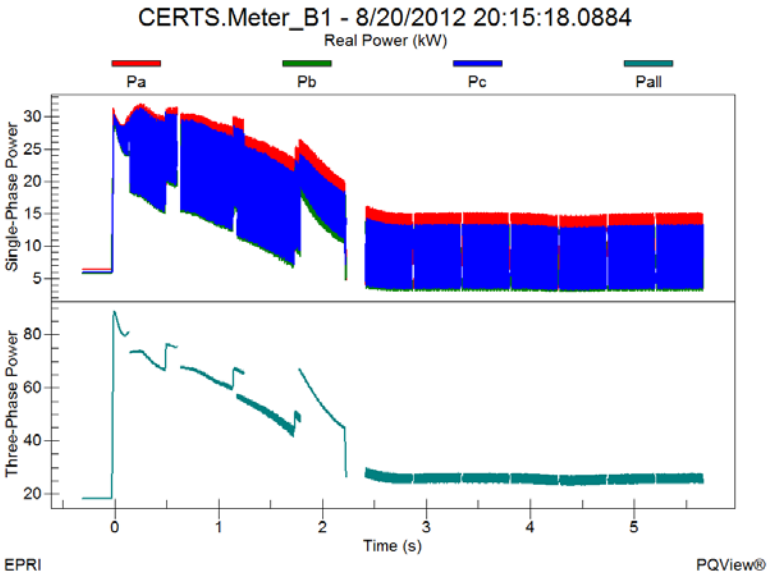


Figure 5.7.8: Event EB, 20→100 kW w/o Load Relief, Meter B1, Real Power

Part of this test sequence was designed to record the generators stalling characteristic when subjected to a load which exceeded its rated power output for other parallel research activities. It was hypothesized that the mechanical limit of the natural gas engine would be reached and the engine would stall completely. For this testing, the under-voltage, under-speed and under-frequency protection trips were disabled. During the course of testing an additional interaction was uncovered. When a load, sufficiently large to hypothetically stall the engine, was applied, the generator did not stall but rather the terminal voltage dramatically reduced and the generator settled to a rotational speed of approximately 900 rpm or 30 Hz.

Initially it was believed this was linked to the 'Load Relief' function of the voltage exciter alone; however in some tests the voltage reduction effect was noticed at frequencies above the 'Load Relief' set point. Upon further investigation the voltage reduction appears to be a function of two components. The first was the 'Load Relief' function as described earlier. The second appears to be linked to the permanent magnet generator (PMG) which provides power to the voltage exciter and subsequently the rotor field. The voltage exciter draws the necessary power and voltage from the PMG to excite the rotor of the larger generator. The PMG's voltage and power ratings are also dynamically affected by the speed of the prime mover shaft to which it's mounted.

It is believed that the following sequence of events occurs during an overload event:

1. Excessive electrical load is applied to the generator and the speed of the prime mover begins to reduce.
2. The engine throttle is fully opened but the electrical load exceeds that of the prime movers design.
3. The increased electrical load requires additional voltage and power from the voltage exciter, and therefore the PMG, to maintain the output voltage of the generator.
4. The prime mover continues to reduce in speed following its power vs. speed curve.
5. At some point the PMG output voltage into the exciter falls below the voltage necessary to drive the voltage exciter's output as desired.
6. Additionally at or near the 'Load Relief' set point frequency the voltage exciter intentionally begins to reduce the excitation voltage.
7. This reduction in speed/frequency continues until the generator set reaches a steady-state point where the available mechanical power from the prime mover matches that of the reduced electrical power required of the load.
8. The generator remains in this final state until it is manually shutdown or the load is relieved.

This effect can be seen in the voltages collected in Figure 5.7.1 and Figure 5.7.5 as well as the frequencies collected in Figure 5.7.3 and Figure 5.7.7. Examining the voltage in Figure 5.7.1 where the Load Relief function is enabled, the generator output voltage sags quickly upon the sudden reduction in frequency shown in Figure 5.7.3. This reduction in voltage recovers as the frequency recovers lasting approximately 1 second after the load is applied. In contrast the

voltage in Figure 5.7.5 is held nearly fixed declining only slightly until 1.75 seconds have elapsed. Then a more sudden reduction occurs attributed to the reduced capabilities of the PMG. Again this downward slide continues until a steady state point is reached.

5.8 P_{max} Control

Performance Goal

The intent of this testing is to ensure proper implementation of the CERTS P_{max} function within the generator secondary easYgen controls. The P_{max} function serves a critical role in adjusting the generators output when an overload condition occurs. This function maintains a stable operating environment when a generating resource is operating at the limit of its capabilities. The P_{max} function must operate quickly to shift the overload condition from the generator to other available resources before a protection trip occurs and before power quality on the microgrid bus is negatively affected. The generator should demonstrate a predictable adjustment in frequency when an operating condition is present which loads the generator to its P_{max} limit. When connected with multiple CERTS sources the Synchronous generator should also make these adjustments fast enough to prevent a shut down due to a protection trip. To successfully pass this testing the generator should demonstrate both criteria.

Description of Procedure

This test was performed by artificially setting the P_{max} set point lower than the generator's real power rating. The generator is then loaded to a level greater than the P_{max} set point causing the P_{max} function to activate. By doing this it is possible to separate the response of the P_{max} function from that of the actual physical dynamics of the generator itself. This test was performed with generators B1 and A2 and with the microgrid in islanded mode. Generator B1 was dispatched to 50 kW, 480V_{l-l}, 1% Frequency Droop, 5% Voltage Droop and Generator A2 was dispatched to 10 kW, 277V_{l-n}, 0.01Hz/kW Frequency Droop, and 0.24V/kvar Voltage Droop. P_{max} was lowered to 60 kW on both generators for the duration of this test, and the following settings were used in the easYgen Controller for P_{max}; Proportional Gain = 10, Integral Gain = 2.5, & Derivative Gain = 0.01.

The generators are started and allowed to reach steady state at which time a 50 kW load is applied in LB 5. An event, the addition of a further 50 kW in LB 3, is captured, bringing the total load to approximately 100 kW and activating the P_{max} function in Generator B1.

During this course of testing some of the normal protection shutdowns for under-frequency and under-voltage were disabled to allow for a complete capture of the dynamic event. This is not an advisable mode of operation and was only performed by qualified personnel for the purposes of this research. Over-frequency and over-voltage protection trips remained enabled.

Test Settings

The easYgen Controller of Generator B1 has the following settings:

Voltage Dispatch: 480V
Real Power Dispatch: 50 kW
Frequency Droop: 1%
Voltage Droop: 5%

The Voltage Exciter of Generator B1 has the following settings:

Load Relief Setting: 40 Hz @ 1 pu V/Hz

The Controller of Generator A2 has the following settings:

Voltage Dispatch: 277V
Real Power Dispatch: 10 kW
Frequency Droop: -0.01 Hz/kW
Voltage Droop: 0.24 V/kvar

The P_{max} settings of Generator A2 are factory set and unknown at this time.

Test Event	Generator B1		Generator A2	Load Bank 3	Load Bank 5	Total Transition Load
A	**Pdispatch = 50 kW** **P_{max} = 60 kW**	**UF Trip = Disabled** **Pmax gains = Kp = 10, Ki = 2.5, Kd =0.01**	**Offline**	**0 kW**	**50→70 kW**	**50→70 kW**
B	**Pdispatch = 50 kW** **P_{max} = 50 kW**	**UF Trip = Disabled** **Pmax gains = Kp = 10, Ki = 2.5, Kd =0.01**	**Offline**	**0 kW**	**70→50 kW**	**70→50 kW**
C	**Pdispatch = 50 kW** **P_{max} = 93 kW**	**UF Trip = 57 Hz @ 5 sec, 54Hz @ 1 sec** **Pmax gains = Kp = 10.0, Ki = 2.5, Kd =0.01**	**Offline**	**0→50 kW**	**50 kW**	**50→100 kW**
D	**Pdispatch = 50 kW** **P_{max} = 50 kW**	**UF Trip = Disabled** **Pmax gains = Kp = 5.0, Ki = 5.0, Kd =0.01**	**Offline**	**0 kW**	**50→70 kW**	**50→70 kW**
E	**Pdispatch = 50 kW** **P_{max} = 50 kW**	**UF Trip = Disabled** **Pmax gains = Kp = 5.0, Ki = 5.0, Kd =0.01**	**Offline**	**0 kW**	**70→50 kW**	**70→50 kW**
F	**Pdispatch = 50 kW** **P_{max} = 93 kW**	**UF Trip = 57 Hz @ 5 sec, 54Hz @ 1 sec** **Pmax gains = Kp = 5.0, Ki = 5.0, Kd =0.01**	**Offline**	**0→50 kW**	**50 kW**	**50→100 kW**
G	**Pdispatch = 50 kW** **P_{max} = 60 kW**	**UF Trip = 57 Hz @ 5 sec, 54Hz @ 1 sec** **Pmax gains = Kp = 10.0, Ki = 2.5, Kd =0.01**	**Pdispatch = 10 kW** **P_{max} = 60 kW**	**0→50 kW**	**50 kW**	**50→100 kW**
H	**Pdispatch = 50 kW** **P_{max} = 60 kW**	**UF Trip = 57 Hz @ 5 sec, 54Hz @ 1 sec** **Pmax gains = Kp = 10.0, Ki = 2.5, Kd =0.01**	**Pdispatch = 10 kW** **P_{max} = 60 kW**	**50→0 kW**	**50 kW**	**100→50 kW**
I	**Pdispatch = 50 kW** **P_{max} = 60 kW**	**UF Trip = 57 Hz @ 5 sec, 54Hz @ 1 sec** **Pmax gains = Kp = 5.0, Ki = 5.0, Kd =0.01**	**Pdispatch = 10 kW** **P_{max} = 60 kW**	**0→50 kW**	**50 kW**	**50→100 kW**
J	**Pdispatch = 50 kW** **P_{max} = 60 kW**	**UF Trip = 57 Hz @ 5 sec, 54Hz @ 1 sec** **Pmax gains = Kp = 5.0, Ki = 5.0, Kd =0.01**	**Pdispatch = 10 kW** **P_{max} = 60 kW**	**50→0 kW**	**50 kW**	**100→50 kW**

Table 5.8.1: Pmax Controller Test Settings

Test Results

Test Event	Pre Event				Post Event				Pass / Fail	Notes
	Generator B1	Generator A2	Generator B1		Generator B1	Generator A2	Generator B1			
	Real Power (kW)	Real Power (kW)	Voltage (V)	Frequency (Hz)	Real Power (kW)	Real Power (kW)	Voltage (V)	Frequency (Hz)		
A	47.89	0.00	277.91	60.20	65.86	0.00	277.24	56.11	Pass	
B	63.27	0.00	277.27	56.15	46.42	0.00	277.37	58.18	Pass	
C	46.52	0.00	277.66	59.73	-	-	-	-	Pass	Generator B1 Shutdown from Over-Frequency Protection Trip.
D	46.40	0.00	277.44	59.93	64.90	0.00	277.16	55.83	Pass	
E	47.18	0.00	279.74	59.19	46.29	0.00	277.34	58.31	Pass	
F	48.95	0.00	277.55	59.60	-	-	-	-	Pass	Generator B1 Shutdown from Over-Frequency Protection Trip.
G	41.62	4.53	276.80	60.04	60.32	35.29	276.58	59.78	Pass	
H	57.70	33.90	276.38	60.17	31.48	14.80	276.89	59.95	Pass	
I	41.63	4.64	277.09	59.89	60.09	34.90	276.54	59.78	Pass	
J	60.76	30.98	276.34	59.81	60.17	-13.91	277.25	60.70	Fail	

Table 5.8.2: Pmax Controller Test Results

Analysis

The Synchronous Generator B1's P_{max} controller functioned within the acceptance criteria. During stand-alone operation, when the load exceeded the P_{max} set point, the generator responded with a continual reduction in frequency until an under-frequency protection did or would have tripped, had it not been disabled. During multiple source operation the Synchronous Generator B1 reduced its frequency appropriately to hold its steady state power output to the P_{max} limit set point.

In Figure 5.8.1 through Figure 5.8.4 a P_{max} overload event, Event D, 50→70 kW, is demonstrated with the synchronous generator standalone on the isolated microgrid bus. In this test case the Under-frequency Trip has been disabled, which is not a generally recommended operational setup and should only be performed by qualified individuals. When the load is applied the P_{max} controller drops the frequency at an approximate 1 Hz/second rate. This continues until 56 Hz is reached and the frequency stabilizes. The prime mover engine control unit does not accept speed set points below 56 Hz regardless of the P_{max} controller output. The synchronous generator unit would continue to operate at this frequency until the load falls below the P_{max} set point or the unit is manually shutdown, generally it would be tripped offline by an Under-frequency protection trip.

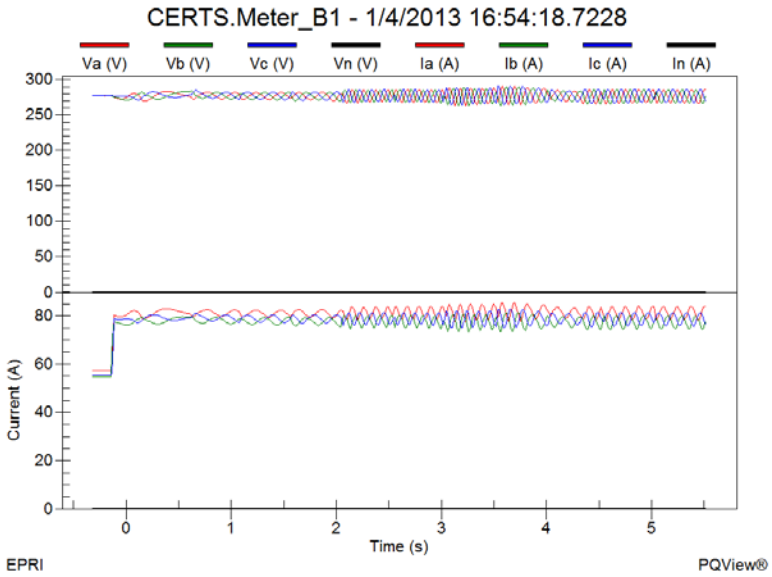


Figure 5.8.1: Event D, 50→70 kW, Meter B1, RMS Voltage and Current

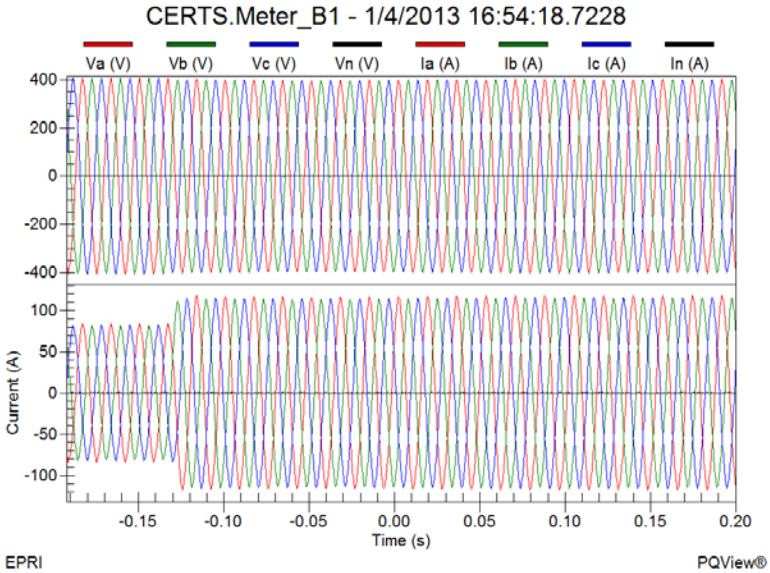


Figure 5.8.2: Event D, 50→70 kW, Meter B1, Waveform Voltage and Current

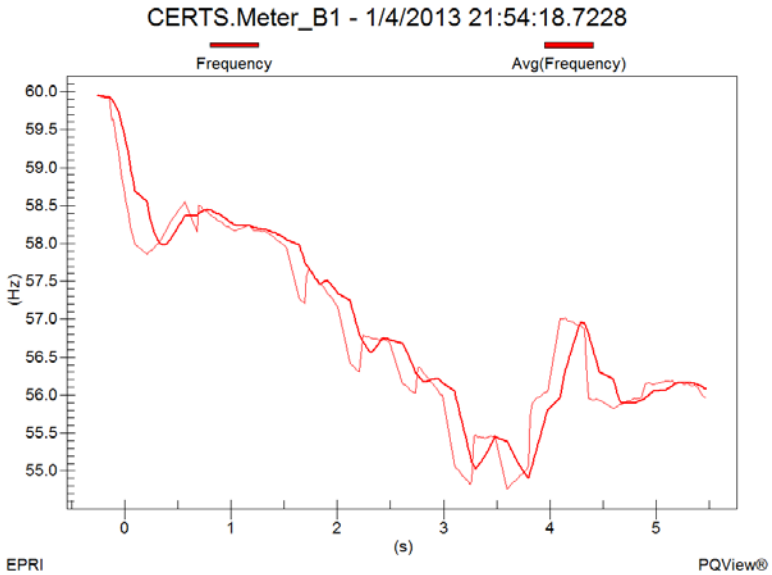


Figure 5.8.3: Event D, 50→70 kW, Meter B1, Frequency

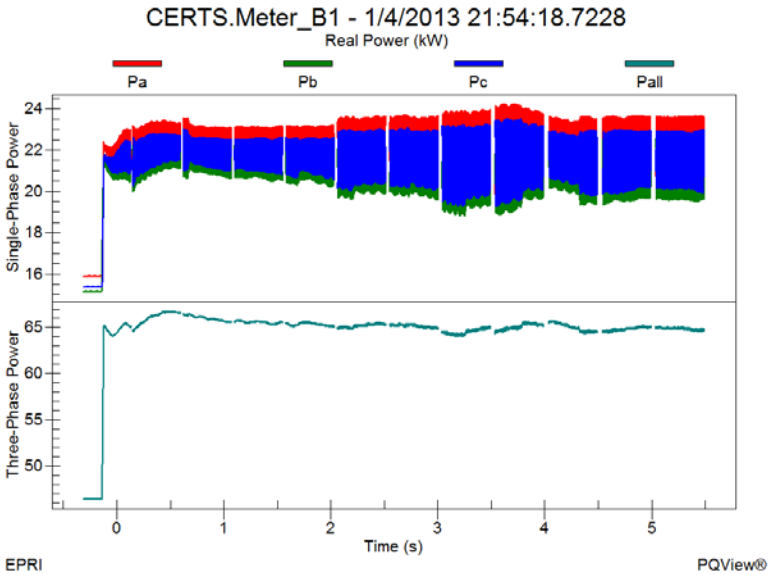


Figure 5.8.4: Event D, 50→70 kW, Meter B1, Real Power

In Figure 5.8.5 through Figure 5.8.12 an increasing load step event, Event I, 50→100 kW, is demonstrated. The total microgrid bus load is stepped from approximately 50 kW to 100 kW, a 50 kW transition. The Synchronous Generator B1 is producing approximately 40 kW, and the Prototype Unit A2 is producing approximately 5 kW before the event. When the load is added, the additional power flows from both sources nearly equal in the beginning. As seen in Figure 5.8.8 and Figure 5.8.12. In this period the inertia of the synchronous unit's rotor and prime mover and the virtual inertia of the prototype unit's inverter are approximately equal allowing for a nearly identical power split. Because the synchronous generator is now above its P_{max} set point and because it has delay associated with its mechanical operation the generator's rotor slows causing a dynamic adjustment to the power flow.

The real power from the synchronous unit falls off quickly even though throttle is added to compensate. The entirety of the load step is now carried by the prototype unit, in fact pushing it briefly above its P_{max} set point. Both the prototype unit's P_{max} controls and the Synchronous unit's droop controls begin to adjust, first bringing the prototype unit out of its overload and then further to find the new continuous operation point. Finally, approximately 2 seconds after the load step, the P_{max} controller within the synchronous generator operates again as the unit reaches the P_{max} set point, effectively holding the real power output to the set point.

The units will continue to operate at this new operating point with any further increases in load being drawn from the prototype unit in steady state, effectively making the total capacity of the sources available to the microgrid bus without adjusting the unit's dispatch. One important observation is that there must be equal or greater overload capability within the low inertia sources like to the prototype unit. This is required to carry the load for a long enough period of time until the high inertia sources can respond and return the system to an allowable continuous operation point. An additional point of interest is that to voltage supplied to the load experiences very little disturbance, as demonstrated in Figure 5.8.6 and Figure 5.8.10, far less than if the bus were supplied by the synchronous generator alone.

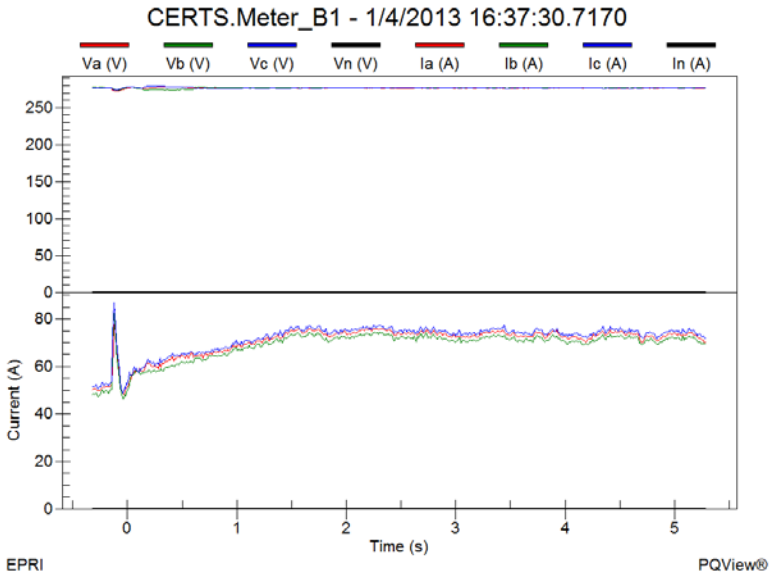


Figure 5.8.5: Event I, 50→100 kW, Meter B1, RMS Voltage and Current

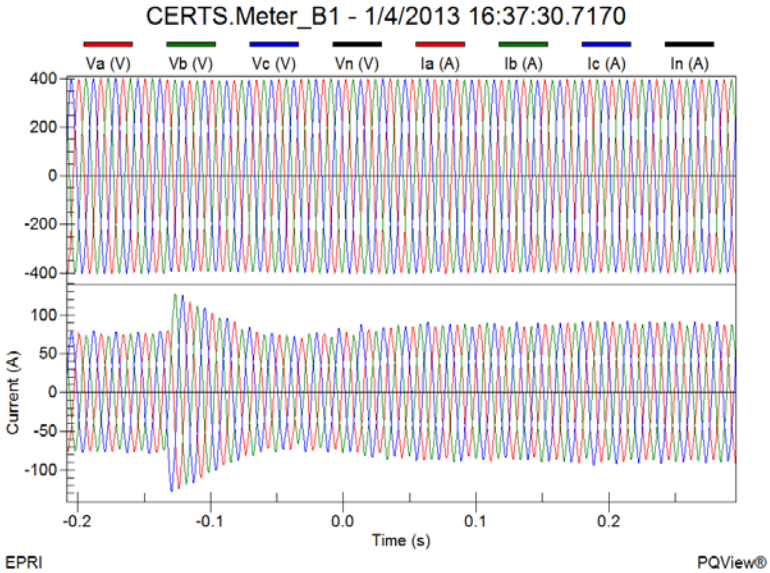


Figure 5.8.6: Event I, 50→100 kW, Meter B1, Waveform Voltage and Current

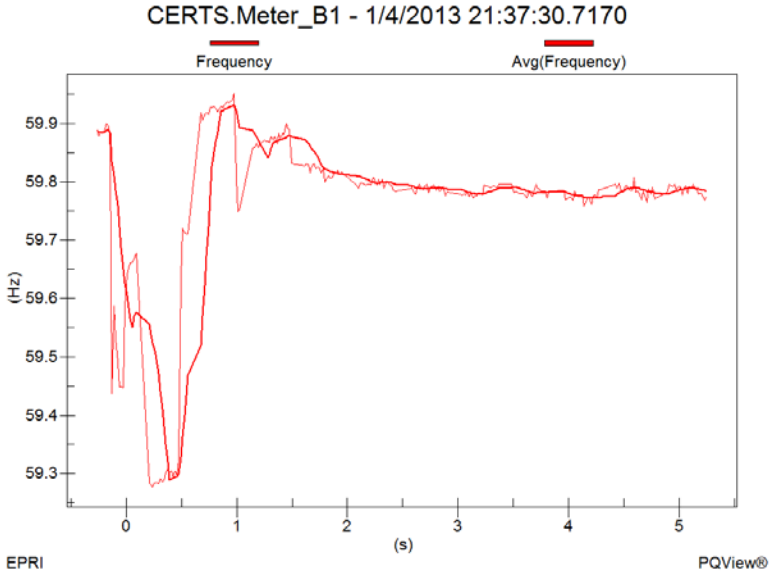


Figure 5.8.7: Event I, 50→100 kW, Meter B1, Frequency

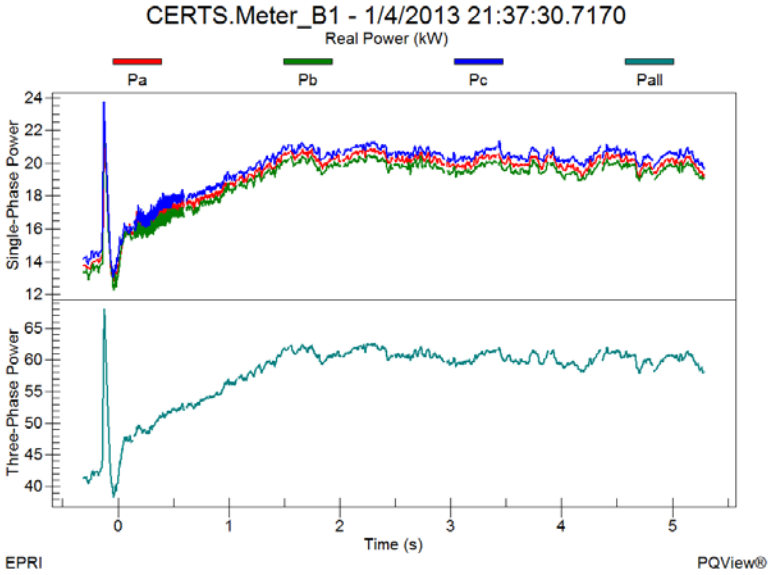


Figure 5.8.8: Event I, 50→100 kW, Meter B1, Real Power

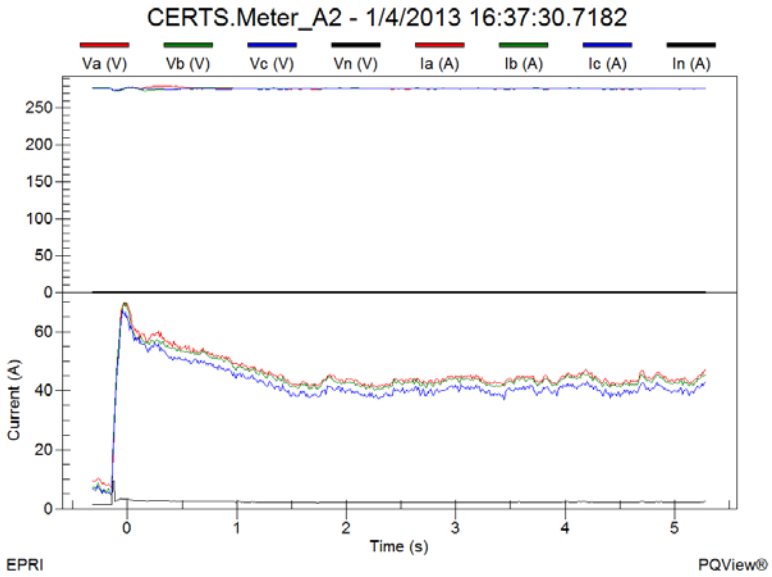


Figure 5.8.9: Event I, 50→100 kW, Meter A2, RMS Voltage and Current

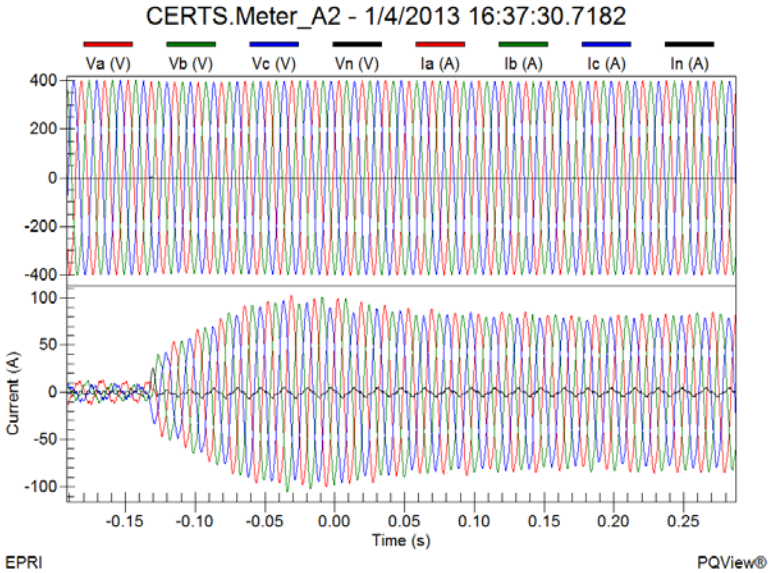


Figure 5.8.10: Event I, 50→100 kW, Meter A2, Waveform Voltage and Current

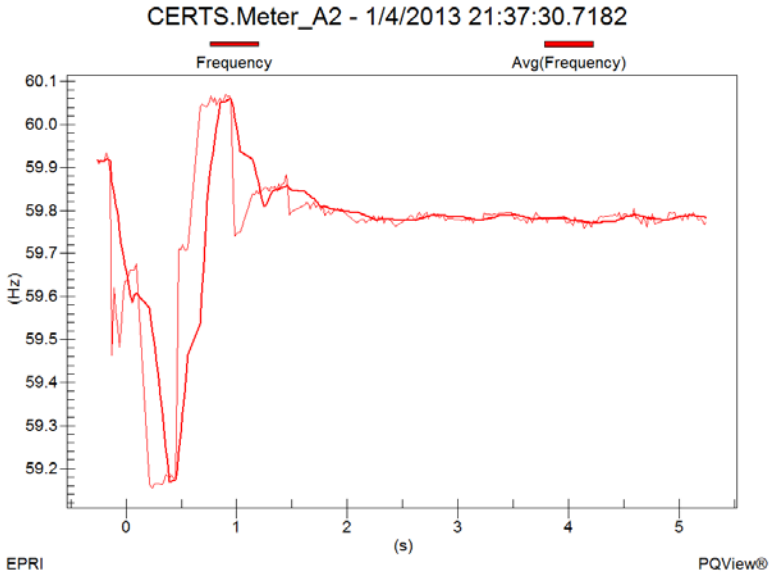


Figure 5.8.11: Event I, 50→100 kW, Meter A2, Frequency

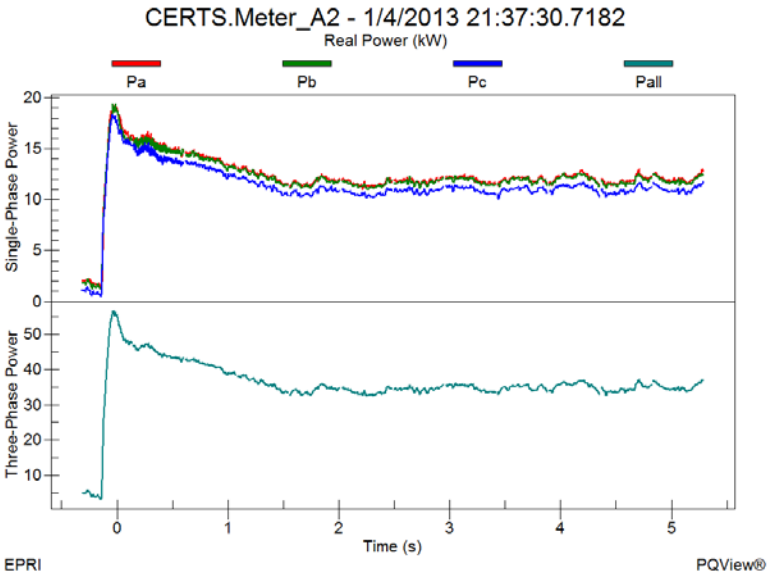


Figure 5.8.12: Event I, 50→100 kW, Meter A2, Real Power

In Figure 5.8.13 through Figure 5.8.20, Event J, 100→50 kW, a failure to return from a P_{max} overload condition is documented. The expected outcome of this test is, as the total electrical load on the microgrid bus is reduced, the power delivered by each generator should also reduce. When steady state is reached both generators should be operating within the ratings of each unit and the frequency should be that predicted by the Real Power vs. Frequency Droop Slope. In this case when the electrical load is reduced on the microgrid bus the power delivered by both generators reduces initially as expected. Then the real power delivered from the synchronous generator returns to near the P_{max} set point. The real power delivered from the inverter based unit falls below its P_{min} set point. At this point the P_{min} controller of the invert based unit should raise the output electrical frequency until the under-load is removed. Instead the system reaches a new stable operating point, with the frequency slightly elevated, and the inverter based unit sinking real power from the microgrid electrical bus. It is possible that the system reached the proper stable operating point at some time later than the collected data presented. If this condition were to continue indefinitely it is likely that the inverter based unit would shut down due to a protection trip. Presently we believe the cause to be linked to a low gain value within the P_{min} controller of the inverter based unit.

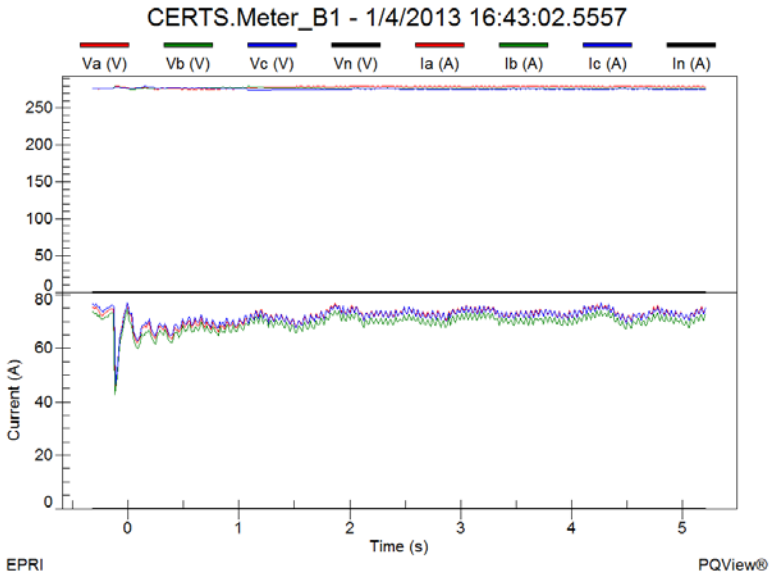


Figure 5.8.13: Event J, 100→50 kW, Meter B1, RMS Voltage and Current

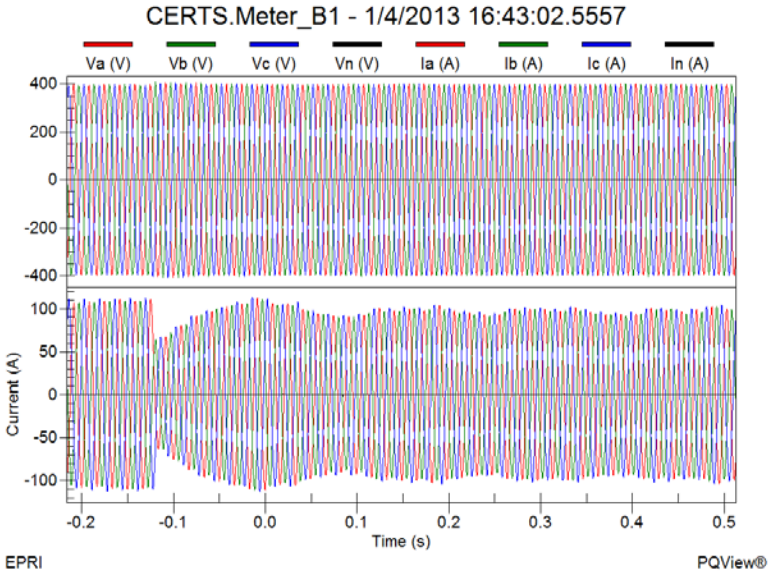


Figure 5.8.14: Event J, 100→50 kW, Meter B1, Waveform Voltage and Current

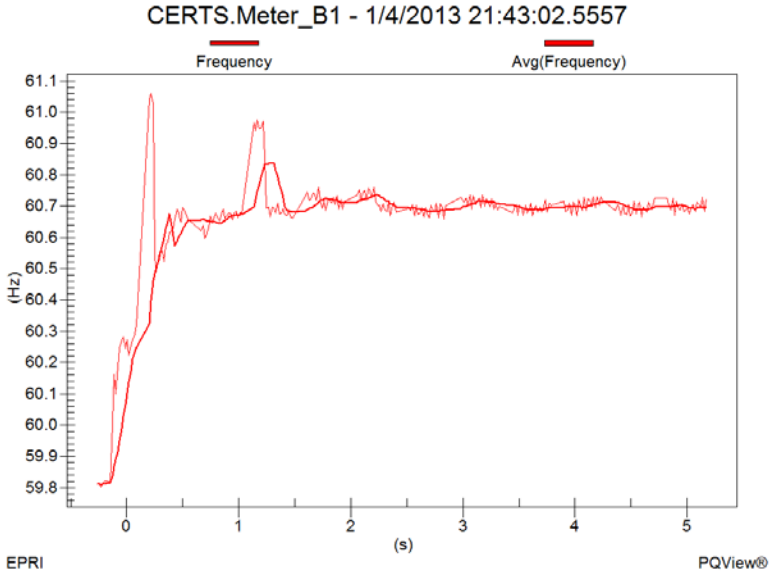


Figure 5.8.15: Event J, 100→50 kW, Meter B1, Frequency

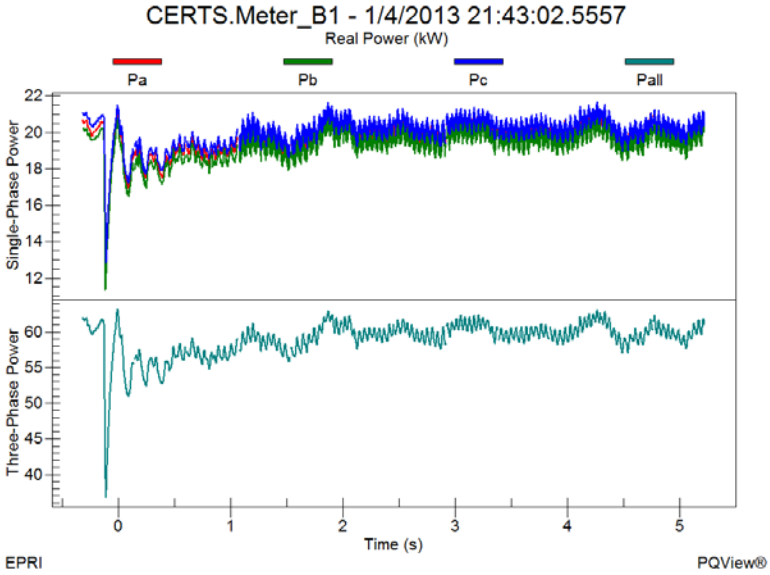


Figure 5.8.16: Event J, 100→50 kW, Meter B1, Real Power

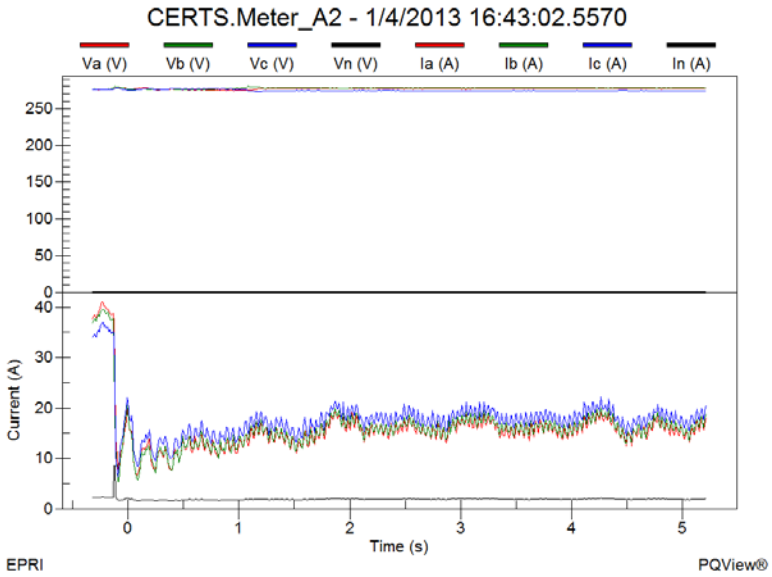


Figure 5.8.17: Event J, 100→50 kW, Meter A2, RMS Voltage and Current

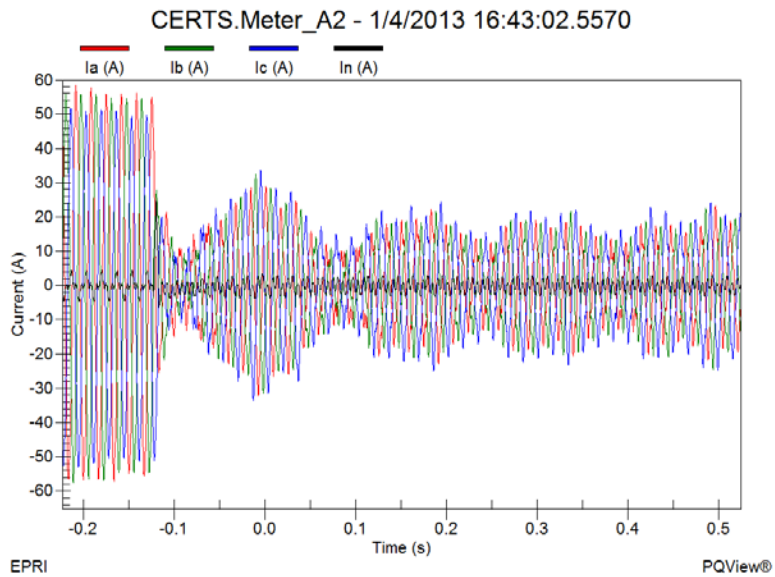


Figure 5.8.18: Event J, 100→50 kW, Meter A2, Waveform Voltage and Current

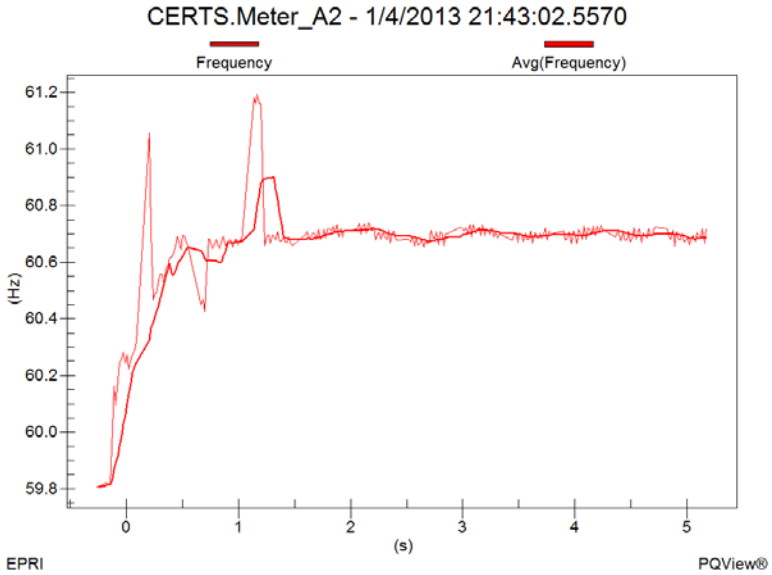


Figure 5.8.19: Event J, 100→50 kW, Meter A2, Frequency

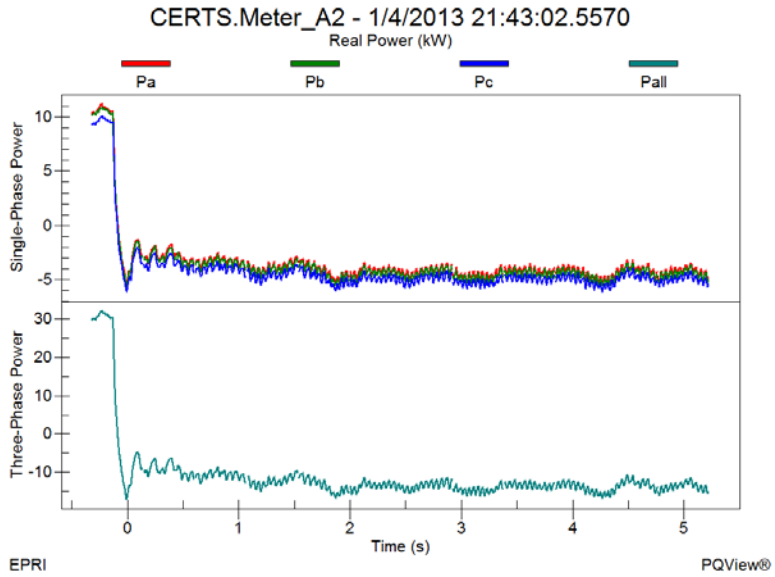


Figure 5.8.20: Event J, 100→50 kW, Meter A2, Real Power

5.9 *Generator Voltage Dispatch Mismatch*

Performance Goal

The intent of this testing is to ensure stable operation when operating with multiple generating sources connected to the microgrid electrical bus. This test stresses the application of the Voltage vs. Reactive Power Controller in a multisource environment, and whether the inverter based and synchronously coupled generators are compatible. Generating assets will commonly have differences in their dispatch voltages, their voltage drop in response to various loads, and time varying interconnection voltages when grid tied. The Voltage vs. Reactive Power control allows each generating asset to make tuning adjustments to the voltage set point in order to reduce reactive power flows between sources. The generators should continue to maintain stability, with predictable changes to output voltage, through various adjustments in voltage set point of multiple sources. A pass criterion for this test is acceptable reactive power flow from the generator with no protection trips.

Description of Procedure

Generator B1 is dispatched to 20 kW, 465$V_{l\text{-}l}$ (95% of nominal), 1% Frequency Droop, 17% Voltage Droop and Generator A1 was dispatched to 20 kW, 277$V_{l\text{-}n}$, 0.006Hz/kW Frequency Droop, and 0.47V/kvar Voltage Droop. The generators are started and connected to the 'islanded' microgrid electrical bus, initially with no load present. An initial event was captured when the generator first connects to the microgrid bus, a no load reference case. Varying reactive load steps are placed on the microgrid bus and each event is recorded. For some tests, an initial load is also placed on the generator prior to the step load. The loads are adjusted as in Table 5.9.1through Table 5.9.4. As each load is adjusted an event capture is taken. The voltage set points of each generator are adjusted for varying mismatch combinations of 95%, 100%, and 105% of nominal voltage and the test then repeated.

Test Settings

The easYgen Controller of Generator B1 has the following settings:

- Voltage Dispatch: Varies
- Real Power Dispatch: 20 kW
- Frequency Droop: 1%
- Voltage Droop: 17%

The Voltage Exciter of Generator B1 has the following settings:

- Load Relief Setting: 40 Hz @ 1 pu V/Hz

The Controller of Generator A1 has the following settings:

- Voltage Dispatch: Varies
- Real Power Dispatch: 20 kW
- Frequency Droop: -0.006 Hz/kW
- Voltage Droop: 0.47 V/kvar

Test Event	Generator B1	Generator A1	GIS	Load Bank 3	Load Bank 5
A	V_{l-l} = 465 V	V_{l-n} = 277 V	Open	0 kW 0 kvar	0 kW 0 kvar
B	V_{l-l} = 465 V	V_{l-n} = 277 V	Open	0 kW 0 kvar	0 kW 0→30 kvar
C	V_{l-l} = 465 V	V_{l-n} = 277 V	Open	0 kW 0 kvar	0 kW 30→60 kvar
D	V_{l-l} = 465 V	V_{l-n} = 277 V	Open	0 kW 0→30 kvar	0 kW 60 kvar
E	V_{l-l} = 465 V	V_{l-n} = 277 V	Open	0 kW 30→60 kvar	0 kW 60 kvar

Table 5.9.1: Voltage Dispatch Mismatch Test Settings: B1 Voltage: 95%, A1 Voltage 100%

Test Event	Generator B1	Generator A1	GIS	Load Bank 3	Load Bank 5
F	V_{l-l} = 504 V	V_{l-n} = 277 V	Open	0 kW 0 kvar	0 kW 0 kvar
G	V_{l-l} = 504 V	V_{l-n} = 277 V	Open	0 kW 0 kvar	0 kW 0→30 kvar
H	V_{l-l} = 504 V	V_{l-n} = 277 V	Open	0 kW 0 kvar	0 kW 30→60 kvar
I	V_{l-l} = 504 V	V_{l-n} = 277 V	Open	0 kW 0→30 kvar	0 kW 60 kvar
J	V_{l-l} = 504 V	V_{l-n} = 277 V	Open	0 kW 30→60 kvar	0 kW 60 kvar

Table 5.9.2: Voltage Dispatch Mismatch Test Settings: B1 Voltage: 105%, A1 Voltage 100%

Test Event	Generator B1	Generator A1	GIS	Load Bank 3	Load Bank 5
K	V_{l-l} = 480 V	V_{l-l} = 268 V	Open	0 kW 0 kvar	0 kW 0 kvar
L	V_{l-l} = 480 V	V_{l-l} = 268 V	Open	0 kW 0 kvar	0 kW 0→30 kvar
M	V_{l-l} = 480 V	V_{l-l} = 268 V	Open	0 kW 0 kvar	0 kW 30→60 kvar
N	V_{l-l} = 480 V	V_{l-l} = 268 V	Open	0 kW 0→30 kvar	0 kW 60 kvar
O	V_{l-l} = 480 V	V_{l-l} = 268 V	Open	0 kW 30→60 kvar	0 kW 60 kvar

Table 5.9.3: Voltage Dispatch Mismatch Test Settings: B1 Voltage: 100%, A1 Voltage: 95%

Test Event	Generator B1	Generator A1	GIS	Load Bank 3	Load Bank 5
P	V_{l-l} = 480 V	V_{l-l} = 291 V	Open	0 kW 0 kvar	0 kW 0 kvar
Q	V_{l-l} = 480 V	V_{l-l} = 291 V	Open	0 kW 0 kvar	0 kW 0→30 kvar
R	V_{l-l} = 480 V	V_{l-l} = 291 V	Open	0 kW 0 kvar	0 kW 30→60 kvar
S	V_{l-l} = 480 V	V_{l-l} = 291 V	Open	0 kW 0→30 kvar	0 kW 60 kvar
T	V_{l-l} = 480 V	V_{l-l} = 291 V	Open	0 kW 30→60 kvar	0 kW 60 kvar

Table 5.9.4: Voltage Dispatch Mismatch Test Settings: B1 Voltage: 100%, A1 Voltage: 105%

Test Results

Event	B1 Measured Voltage (V)	A1 Measured Voltage (V)	B1 Reactive Power (kvar)	A1 Reactive Power (kvar)	LM3 Reactive Power (kvar)	LM5 Reactive Power (kvar)	Pass / Fail
A	268.90	268.98	-11.10	10.60	0.32	0.00	Pass
B	261.54	261.65	14.58	24.15	0.31	39.47	Pass
C	255.35	255.49	19.71	31.10	0.29	51.54	Pass
D	249.76	249.84	35.45	37.03	24.39	49.21	Pass
E	243.59	243.63	48.83	43.32	46.45	46.77	Pass

Table 5.9.5: Voltage Dispatch Mismatch Test Results: B1 Voltage: 95%, A1 Voltage 100%

Event	B1 Measured Voltage (V)	A1 Measured Voltage (V)	B1 Reactive Power (kvar)	A1 Reactive Power (kvar)	LM3 Reactive Power (kvar)	LM5 Reactive Power (kvar)	Pass / Fail
F	284.61	284.64	13.92	-14.29	0.35	0.01	Pass
G	275.49	275.54	43.08	0.14	0.34	43.86	Pass
H	269.60	269.68	47.55	9.43	0.33	57.67	Pass
I	264.15	264.18	62.44	19.04	27.34	55.22	Pass
J	253.92	253.92	67.65	32.72	50.92	50.92	Pass

Table 5.9.6: Voltage Dispatch Mismatch Test Results: B1 Voltage: 105%, A1 Voltage 100%

Event	B1 Measured Voltage (V)	A1 Measured Voltage (V)	B1 Reactive Power (kvar)	A1 Reactive Power (kvar)	LM3 Reactive Power (kvar)	LM5 Reactive Power (kvar)	Pass / Fail
K	265.93	265.95	5.77	-6.37	0.32	0.00	Pass
L	258.18	258.23	31.75	5.71	0.30	38.37	Pass
M	252.47	252.55	33.91	15.40	0.29	50.19	Pass
N	247.11	247.12	45.83	24.77	23.82	51.07	Pass
O	236.65	236.65	50.92	35.62	43.72	44.00	Pass

Table 5.9.7: Voltage Dispatch Mismatch Test Results: B1 Voltage: 100%, A1 Voltage: 95%

Event	B1 Measured Voltage (V)	A1 Measured Voltage (V)	B1 Reactive Power (kvar)	A1 Reactive Power (kvar)	LM3 Reactive Power (kvar)	LM5 Reactive Power (kvar)	Pass / Fail
P	282.63	282.74	-10.29	9.91	0.33	0.01	Pass
Q	274.11	274.25	18.27	24.51	0.33	43.38	Pass
R	267.35	267.50	23.55	32.49	0.33	56.65	Pass
S	261.32	261.41	40.52	39.21	26.78	53.98	Pass
T	254.40	254.43	54.37	46.43	50.77	51.07	Pass

Table 5.9.8: Voltage Dispatch Mismatch Test Results: B1 Voltage: 100%, A1 Voltage: 105%

Analysis

This test sequence stressed the synchronous generator's (B1) ability to operate in conjunction with another generator (A1) in the presence of a voltage mismatch between the two sources. In this section all test results were within the acceptance criteria. The Voltage vs. Reactive Power controller functioned as expected resulting in acceptable voltage response and reactive power flow between sources for the various reactive loads.

In Figure 5.9.1 through Figure 5.9.8, a typical load step event, Event T, Generator B1 dispatched at nominal voltage and Generator A1 at 105% of nominal, with a 120 kvar load, is demonstrated. When the additional reactive load is added to the microgrid bus additional reactive power flows from both generators initially. Then the reactive flow of the inverter based unit returns to a value similar to that prior to the load step. The synchronous generator provides the necessary reactive power. Next Voltage vs. Reactive Power controllers in both sources readjust their output voltages to arrive at stable operational point. Interestingly the initial expectation was that the majority of the reactive power would flow from the inverter, both due to speed of response from the inverter as well as the lower impedance to the stepped reactive load. The most likely cause of this behavior is different Voltage vs. Reactive Power droop slopes between each unit however the system responded appropriately and reached the acceptable steady state conditions.

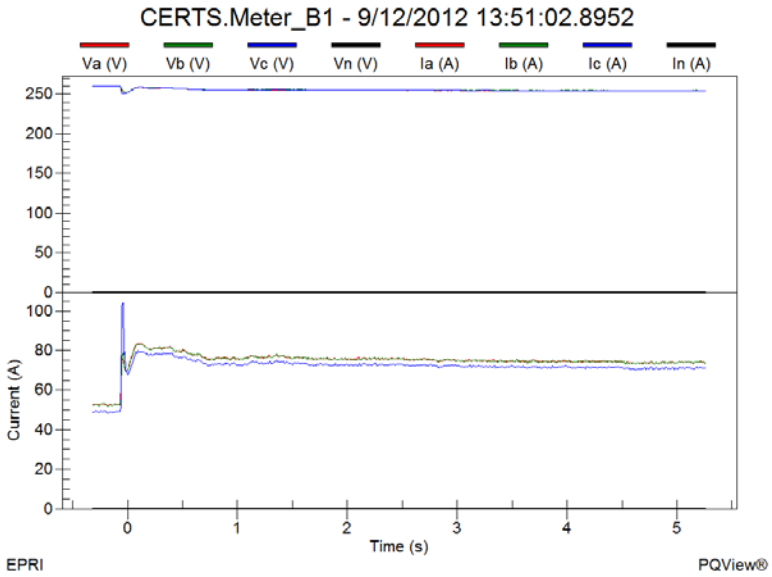


Figure 5.9.1: Event T, B1 100%, A1 105%, 120 kvar, Meter B1, RMS Voltage and Current

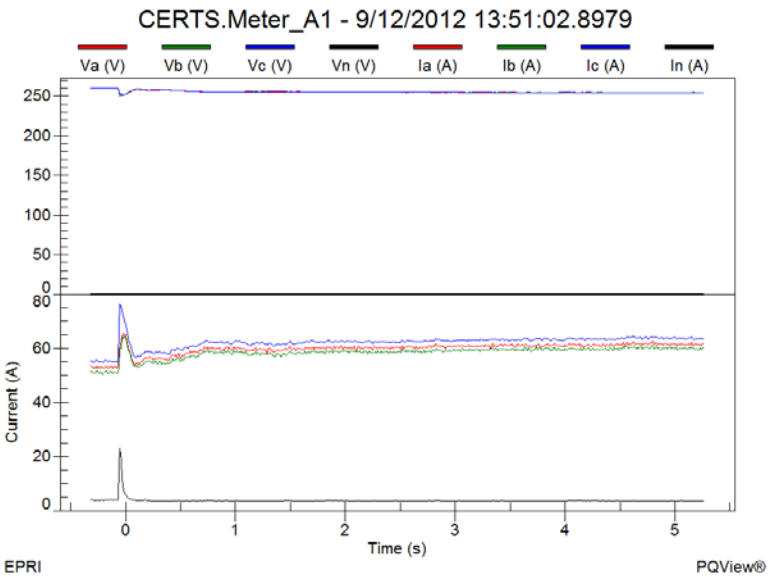


Figure 5.9.2: Event T, B1 100%, A1 105%, 120 kvar, Meter A1, RMS Voltage and Current

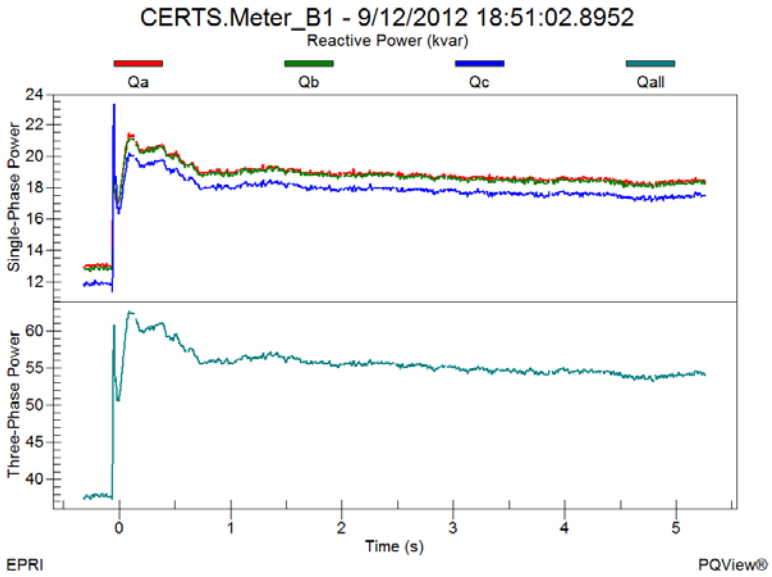


Figure 5.9.3: Event T, B1 100%, A1 105%, 120 kvar, Meter B1, Reactive Power

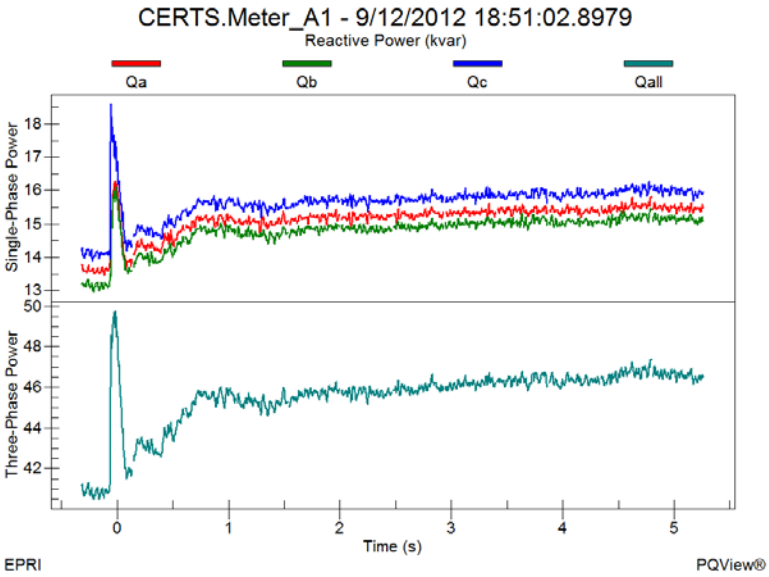


Figure 5.9.4: Event T, B1 100%, A1 105%, 120 kvar, Meter A1, Reactive Power

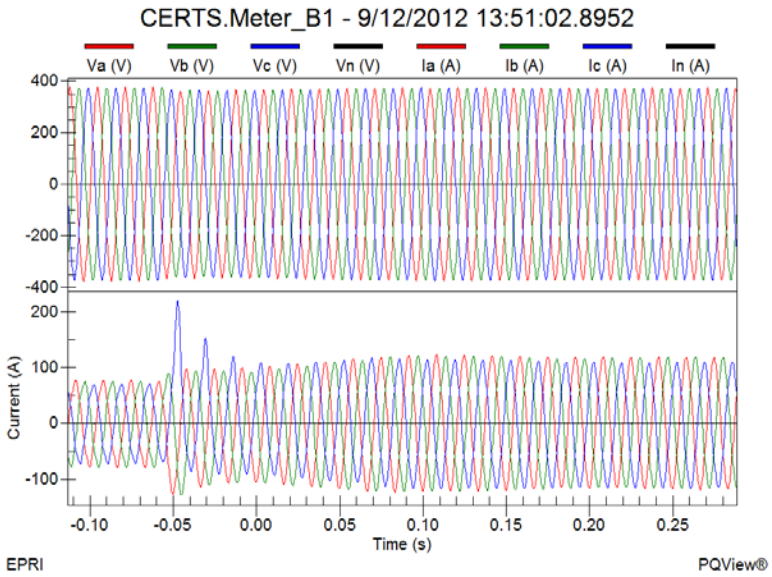


Figure 5.9.5: Event T, B1 100%, A1 105%, 120 kvar, Meter B1, Waveform Voltage and Current

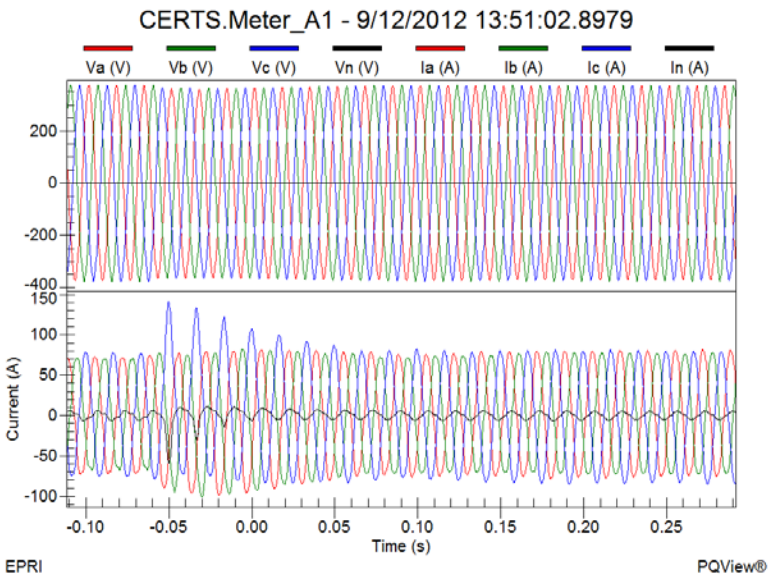


Figure 5.9.6: Event T, B1 100%, A1 105%, 120 kvar, Meter A1, Waveform Voltage and Current

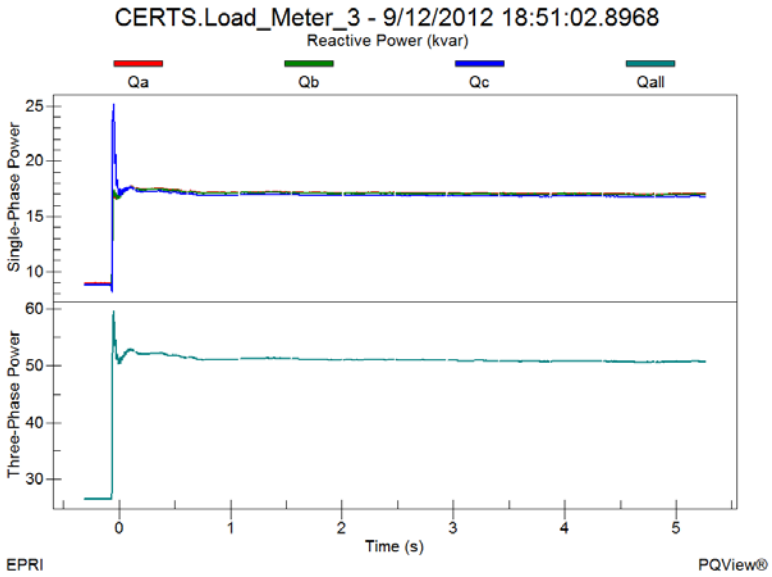


Figure 5.9.7: Event T, B1 100%, A1 105%, 120 kvar, Meter LM3, Reactive Power

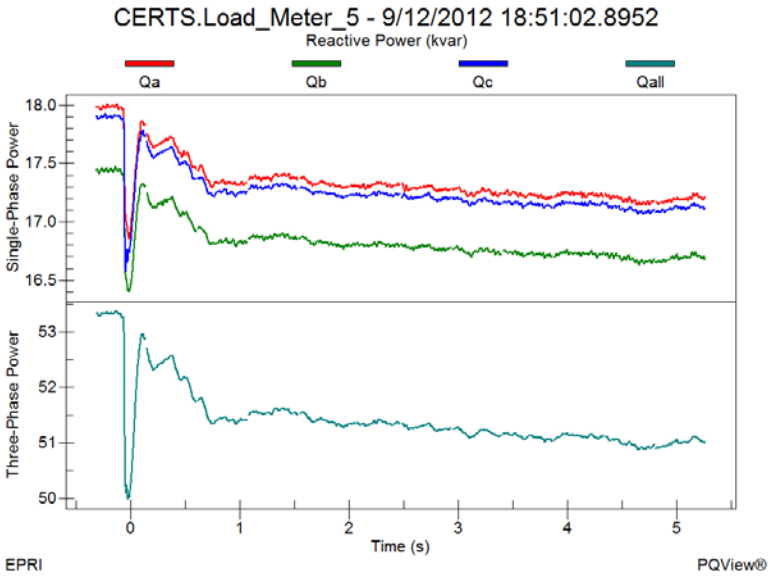


Figure 5.9.8: Event T, B1 100%, A1 105%, 120 kvar, Meter LM5, Reactive Power

5.10 *Unbalanced Load Tests*

Performance Goal

The intent of this testing is to ensure stable operation when the generating sources are serving unbalanced loads with and without motor starts. Unbalanced load conditions are very common in electrical systems, therefore operating successfully within this type of environment is important to broad acceptance. The generators should continue to operate together, providing power stably, with predictable changes to frequency, while serving a highly unbalanced load. A pass criterion for this test is acceptable steady state voltage and frequency while serving both balanced and unbalanced loads.

Description of Procedure

Starting with test Event A, Generator B1 was dispatched to 45 kW, 480$V_{l\text{-}l}$, 1% Frequency Droop, 5% Voltage Droop and Generator A1 was dispatched to 45 kW, 277$V_{l\text{-}n}$, 0.006Hz/kW Frequency Droop, and 0.47V/kvar Voltage Droop. The generators are started and connected to the 'islanded' microgrid electrical bus, and an initial balanced load of 90 kW is added. Once the generators reached steady state, the load on Phase A was reduced from 30 kW to 10 kW and the event was recorded. After the test event is captured the loads are removed and the next test is performed. Each test differs slightly in the amount of unbalance and the inclusion of a dynamic motor starting event, according to Table 5.10.1. The motor start is used to trigger subsequent events for both grid connected and islanded conditions. The testing removes generation capacity from the microgrid bus progressively increasing the demands placed upon the remaining sources. Also for this testing an approximate power factor of 0.9 was chosen for all loads to better represent typical real world loadings.

Test Settings

The easYgen Controller of Generator B1 has the following settings:

- Voltage Dispatch: 480V
- Real Power Dispatch: Varies
- Frequency Droop: 1%
- Voltage Droop: 5%

The Voltage Exciter of Generator B1 has the following settings:

- Load Relief Setting: 40 Hz @ 1 pu V/Hz

The Controller of Generator A1 has the following settings:

- Voltage Dispatch: 277V
- Real Power Dispatch: Varies
- Frequency Droop: -0.006 Hz/kW
- Voltage Droop: 0.47 V/kvar

The Controller of Generator A2 has the following settings:

- Voltage Dispatch: 277V
- Real Power Dispatch: 30 kW
- Frequency Droop: -0.01 Hz/kW
- Voltage Droop: 0.24 V/kvar

Test Event	Generator B1	Generator A1	Generator A2	GIS	Motor Load	Load Bank 3	Load Bank 4	Load Bank 5	Load Bank 6
A	45 kW	45 kW	Off	Open	Off	ΦA: 30→10 kW ΦB: 30 kW ΦC: 30 kW	0 kW	0 kW	0 kW
B	40 kW	25 kW	30 kW	Closed	Off→ On	10 kW	ΦA: 10 kW ΦB: 15 kW ΦC: 15 kW	ΦA: 15 kW ΦB: 15 kW ΦC: 10 kW	ΦA: 15 kW ΦB: 30 kW ΦC: 15 kW
C	40 kW	25 kW	30 kW	Open	Off→ On	10 kW	ΦA: 10 kW ΦB: 15 kW ΦC: 15 kW	ΦA: 15 kW ΦB: 15 kW ΦC: 10 kW	ΦA: 15 kW ΦB: 30 kW ΦC: 15 kW
D	40 kW	25 kW	Off	Closed	Off→ On	10 kW	0 kW	ΦA: 15 kW ΦB: 15 kW ΦC: 10 kW	ΦA: 15 kW ΦB: 30 kW ΦC: 15 kW
E	40 kW	25 kW	Off	Open	Off→ On	10 kW	0 kW	ΦA: 15 kW ΦB: 15 kW ΦC: 10 kW	ΦA: 15 kW ΦB: 30 kW ΦC: 15 kW
F	40 kW	Off	Off	Closed	Off→ On	10 kW	0 kW	0 kW	ΦA: 15 kW ΦB: 30 kW ΦC: 15 kW
G	40 kW	Off	Off	Open	Off→ On	10 kW	0 kW	0 kW	ΦA: 15 kW ΦB: 30 kW ΦC: 15 kW
H	40 kW	25 kW	30 kW	Closed	Off→ On	20 kW	ΦA: 10 kW ΦB: 15 kW ΦC: 15 kW	ΦA: 15 kW ΦB: 15 kW ΦC: 10 kW	ΦA: 15 kW ΦB: 30 kW ΦC: 15 kW
I	40 kW	25 kW	30 kW	Open	Off→ On	20 kW	ΦA: 10 kW ΦB: 15 kW ΦC: 15 kW	ΦA: 15 kW ΦB: 15 kW ΦC: 10 kW	ΦA: 15 kW ΦB: 30 kW ΦC: 15 kW
J	40 kW	25 kW	Off	Closed	Off→ On	20 kW	0 kW	ΦA: 15 kW ΦB: 15 kW ΦC: 10 kW	ΦA: 15 kW ΦB: 30 kW ΦC: 15 kW
K	40 kW	25 kW	Off	Open	Off→ On	20 kW	0 kW	ΦA: 15 kW ΦB: 15 kW ΦC: 10 kW	ΦA: 15 kW ΦB: 30 kW ΦC: 15 kW
L	40 kW	Off	Off	Closed	Off→ On	20 kW	0 kW	0 kW	ΦA: 15 kW ΦB: 30 kW ΦC: 15 kW
M	40 kW	Off	Off	Open	Off→ On	20 kW	0 kW	0 kW	ΦA: 15 kW ΦB: 30 kW ΦC: 15 kW

Table 5.10.1: Motor Start Tests, Weak Grid, Unbalanced Load with 0.9 Power Factor

Test Results

Test Event	Load Bank 3		Real Power post event (kW)				Reactive Power post event (kvar)				Pass / Fail
	Voltage (V)	Frequency (Hz)	Generator B1	Generator A1	Generator A2	GIS	Generator B1	Generator A1	Generator A2	GIS	
A	273.59	60.04	34.07	28.67	0.00	0.06	-0.70	0.72	0.00	0.08	Pass
B	272.93	59.99	39.80	19.84	29.43	-5.92	40.97	3.76	2.45	6.27	Pass
C	271.17	60.01	37.71	17.12	27.57	0.06	41.11	6.82	5.67	0.08	Pass
D	275.03	59.99	40.00	19.69	0.00	-11.43	31.88	0.56	0.00	3.05	Pass
E	273.79	60.04	34.86	13.08	0.00	0.06	31.80	3.33	0.00	0.08	Pass
F	275.66	60.01	37.56	-0.51	0.00	-24.70	26.81	-1.54	0.00	-9.29	Pass
G	275.99	60.32	12.92	-0.52	0.00	0.06	17.59	-1.60	0.00	0.08	Pass
H	273.22	60.01	37.08	16.55	27.15	10.87	39.28	3.60	2.09	10.03	Pass
I	271.06	60.00	39.93	19.83	29.48	0.06	41.84	6.55	5.73	0.08	Pass
J	273.58	59.98	42.97	22.89	0.00	-10.79	42.14	2.88	0.00	-9.33	Pass
K	273.53	60.02	38.01	17.03	0.00	0.06	32.29	3.27	0.00	0.08	Pass
L	275.87	59.99	41.48	-0.51	0.00	-21.23	25.43	-1.48	0.00	-7.31	Pass
M	275.82	60.14	20.08	-0.51	0.00	0.06	18.04	-1.51	0.00	0.08	Pass

Table 5.10.2: Unbalance Unload Test Results

Analysis

The Synchronous Generator B1 functioned within the acceptance criteria demonstrating the ability to operate with multiple sources, both islanded and grid connected, serving unbalanced and motor starting loads. Table 5.10.2 contains the test results of the multi-generator unbalanced load and motor starts.In Figure 5.10.1 through Figure 5.10.9 below, Event A, a transition from balanced to unbalanced loading is demonstrated for an islanded microgrid bus. In Figure 5.10.1 and Figure 5.10.2, Load Bank 3 Phase A is reduced from approximately 30 kW to 10 kW. The voltage remains stable and falls only slightly as the generators arrive at the new steady state operating point in approximately 2 seconds. The voltage delivered to the load remains sinusoidal, Figure 5.10.3, with a minor separation of the phase voltages in magnitude, Figure 5.10.4.

The system's Reactive Power vs Voltage (Q/V) Droop Control enables the system to remain stable when there is a change in its reactive power flow. The droop control of each generator will independently adjust output voltage in response to reactive power delivered to arrive at equilibrium. Figure 5.10.5 and Figure 5.10.6 illustrate the reactive power of generators B1 and A1 respectively. From the graphs we observe generator B1 sinking reactive power and generator A1 sourcing reactive power. As a consequence of the Voltage vs. Reactive Power Control, generator B1 consequently lowers its output voltage and generator A1 raises its output voltage until the two reached equilibrium with minimal reactive power flow between them. The reactive power of each generator also shows a slight low frequency oscillation between sources, approximately 5 kvar @ 8 - 9 Hz, in both the balanced and unbalanced conditions. While this is does not present a major problem it could likely be improved by measurement filtering in the sources.

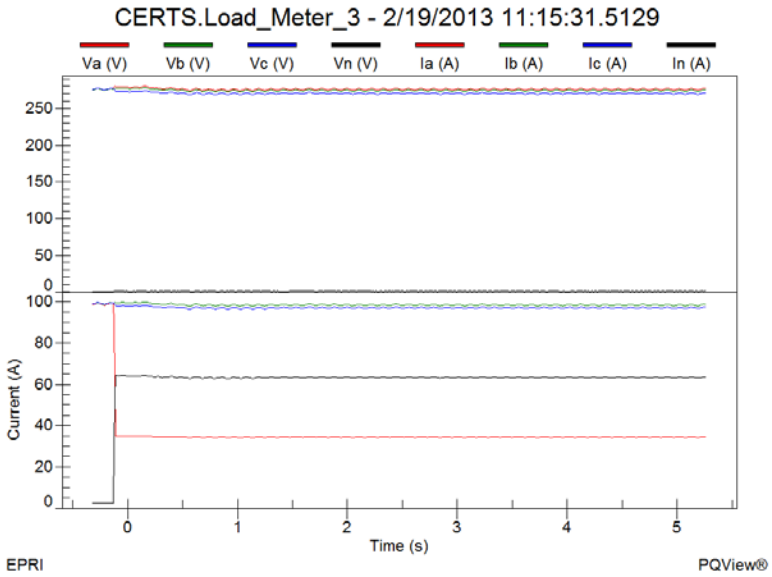


Figure 5.10.1: Event A, Unbalance Loading, Load Meter 3, RMS Voltage and Current

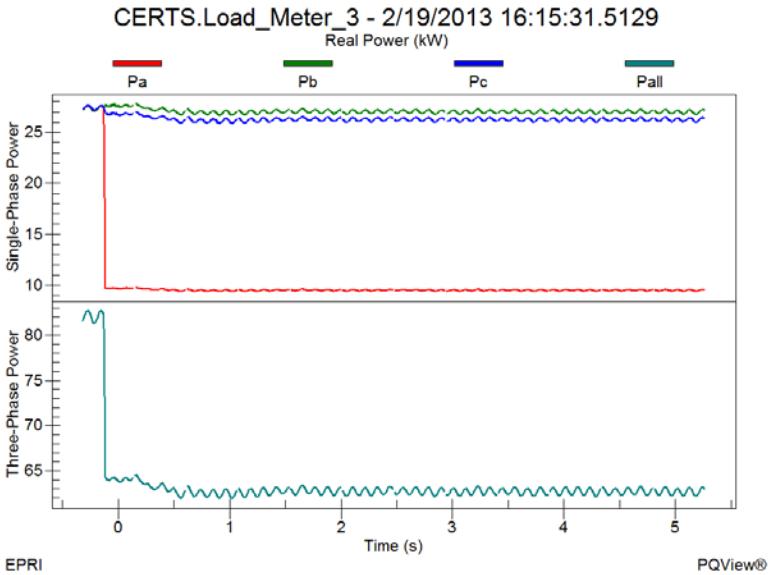


Figure 5.10.2: Event A, Unbalanced Loading, Load Meter 3, Real Power

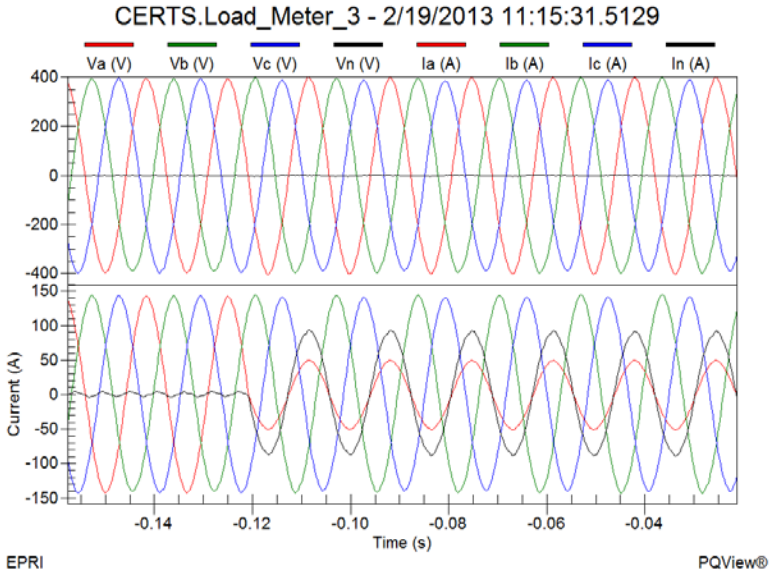


Figure 5.10.3: Event A, Unbalanced Loading, Load Meter 3, Waveform Voltage and Current

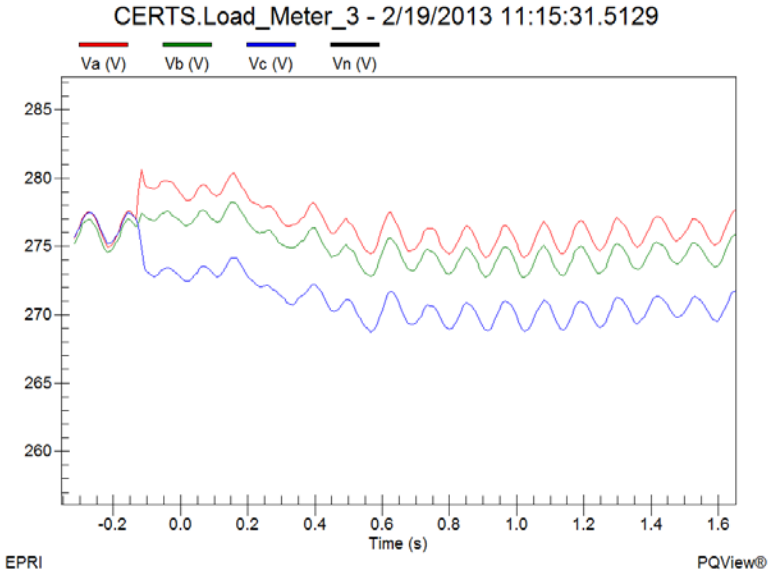


Figure 5.10.4: Event A, Unbalance Loading, Load Meter 3, RMS Voltage and Current (Zoomed)

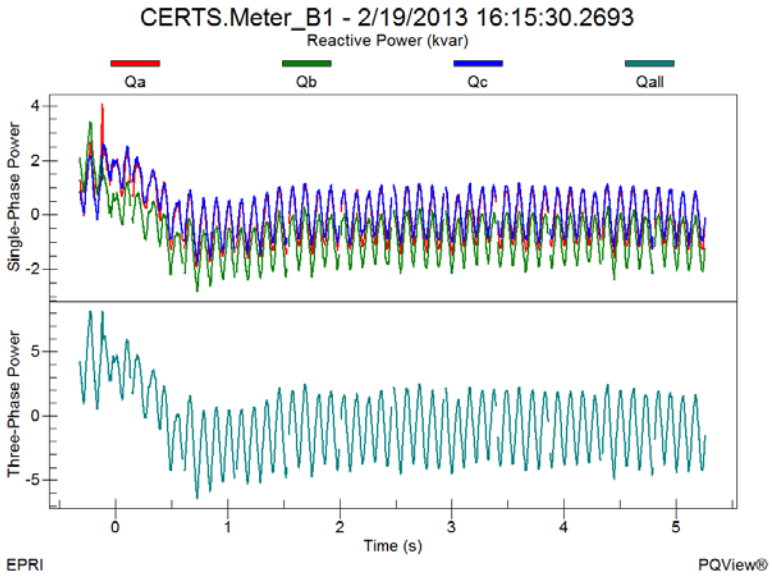


Figure 5.10.5: Event A, Unbalance Loading, Meter B1, Reactive Power

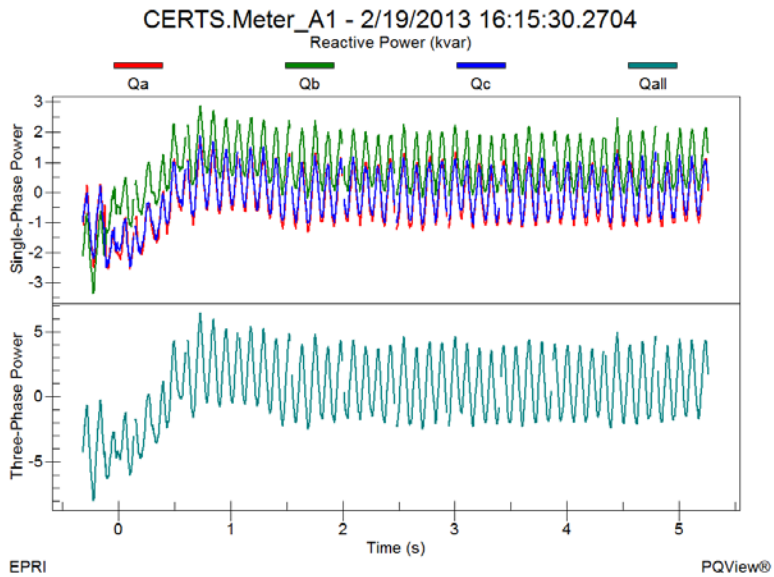


Figure 5.10.6: Event A, Unbalanced Loading, Meter A1, Reactive Power

Figure 5.10.7 and Figure 5.10.8 demonstrate an interesting but expected characteristic of a mixed synchronous and inverter based source system. Observing the real power output from the synchronous generator, the A phase power reduces however the B and C phase contributions increase, so that the total real power from the synchronous generator is unchanged initially. This is caused due to the reduction of A phase real power which also reduces the back torque on the synchronous rotor shaft. At this point, because the throttle response of the synchronous generator lags in time, the phase angle of the synchronous generator relative to the microgrid bus increases and the increased power in B and C phases is observed. As the two generators adjusts their operating points based on the Frequency vs. Real Power Droop Control, the individual phase real power contributions from both generators and the electrical bus frequency, Figure 5.10.9, arrive at the expected values. Interestingly this would not occur in an islanded, single sourced microgrid however the transient in frequency would be greater.

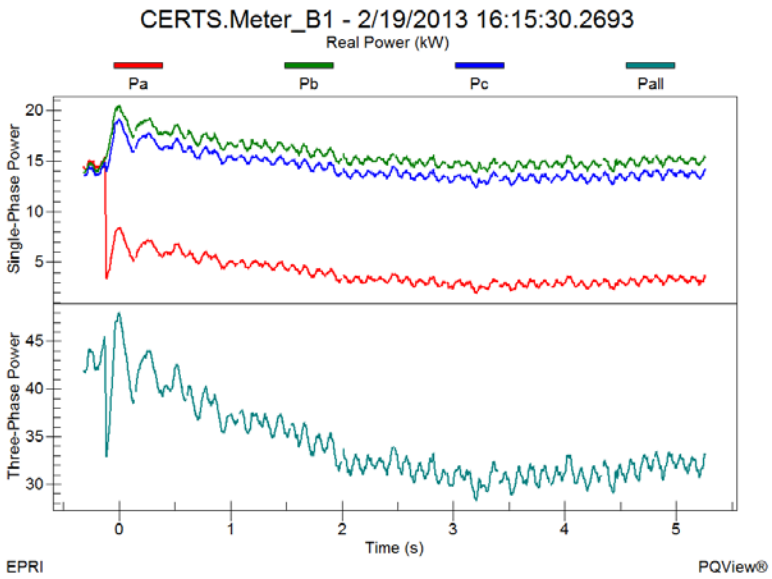


Figure 5.10.7: Event A, Unbalance Loading, Meter B1, Real Power

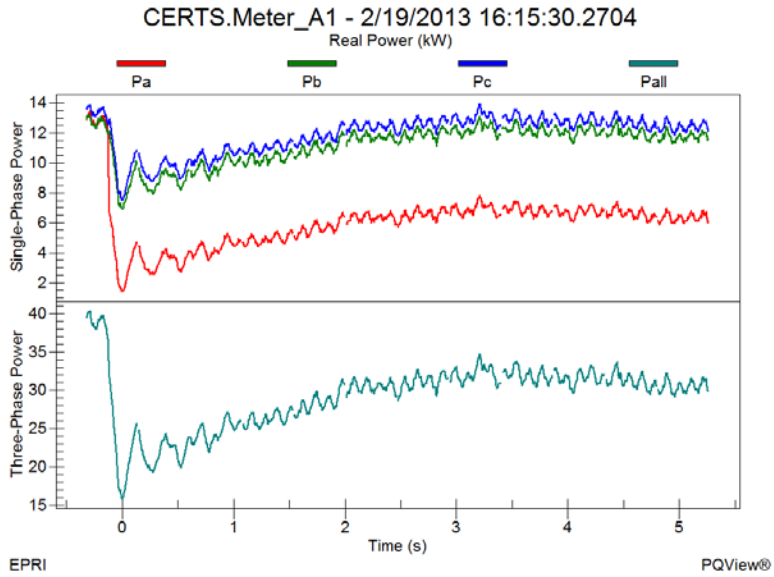


Figure 5.10.8: Event A, Unbalanced Loading, Meter A1, Real Power

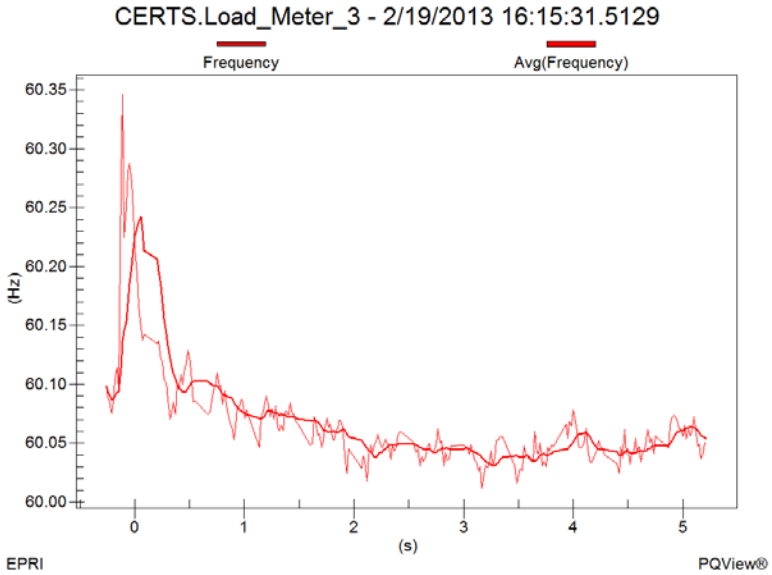


Figure 5.10.9: Event A, Unbalanced Loading, Load Meter 3, Frequency

Figure 5.10.10 through Figure 5.10.14 demonstrates the electrical behavior of synchronous generator B1 and Load Meter 3 in response to a motor starting event. Measurements were performed with different generator configurations as described in Table 5.10.1, Event B thru M above. The motor successfully started for each set of conditions during the test sequence. The motor consumed a large in-rush current, which the generator(s) were able to source. This large current was only momentary and the system settled to a steady state within 2 seconds. Afterwards, there were minimal voltage fluctuations.

A representative event, Event M, Balanced Load w/ Motor Start, is detailed below. During this event the synchronous generator is islanded as the sole source connected to the microgrid bus. An initial balanced load is present on the bus when the motor starting event is performed. The motor takes approximately 0.25 seconds to reach full operating speed as evidenced by the current transient in Figure 5.10.10. Oscillations in voltage damp out in approximately 2 seconds whereas oscillations in frequency require greater than 5 seconds to reach steady state, as in Figure 5.10.11. The real and reactive power required to start the 10 Hp motor are approximately 3.5 times the motors continuous ratings and are in line with expectations. Figure 5.10.14 shows the voltage and current waveforms during the event. The voltage remained undistorted although voltage magnitude was affected. The inrush current transient is also characteristic of an induction motor start. The frequency oscillations experienced can likely be improved by adjusting the control gains on the Frequency vs. Real Power Controller and possibly on the Engine Control Unit primary controls.

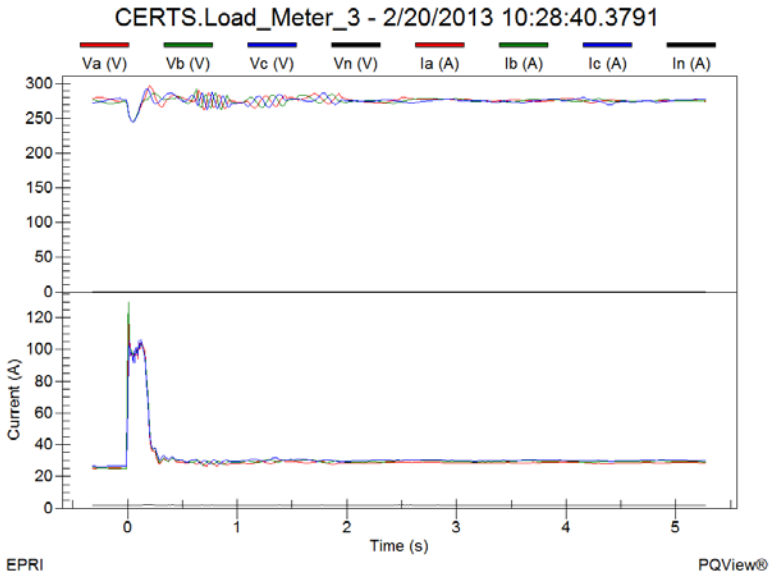


Figure 5.10.10: Event M, Balanced Load w/ Motor Start, Load Meter 3, RMS Voltage and Current

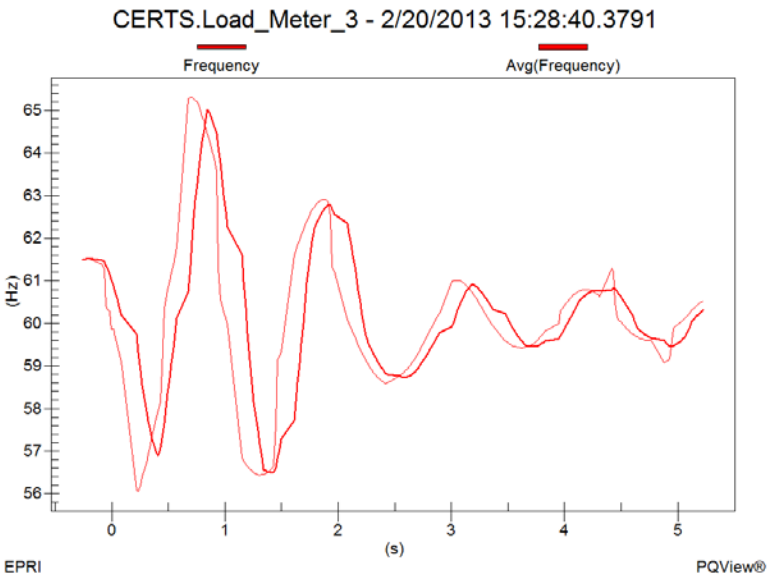


Figure 5.10.11: Event M, Balanced Load w/ Motor Start, Load Meter 3, Frequency

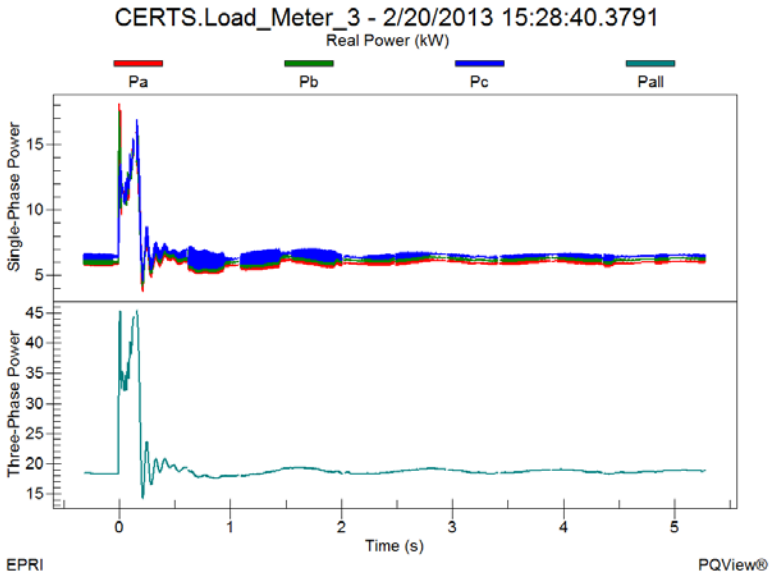


Figure 5.10.12: Event M, Balanced Load w/ Motor Start, Load Meter 3, Real Power

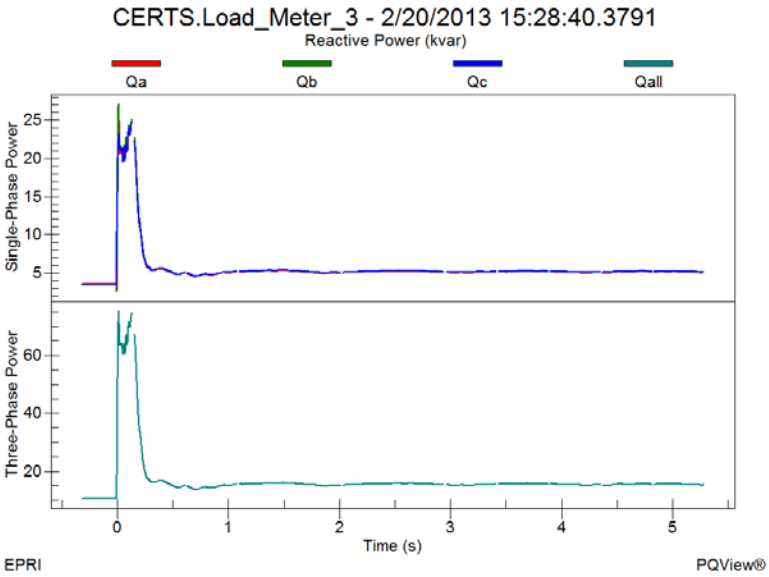


Figure 5.10.13: Event M, Balanced Load w/ Motor Start, Load Meter 3, Reactive Power

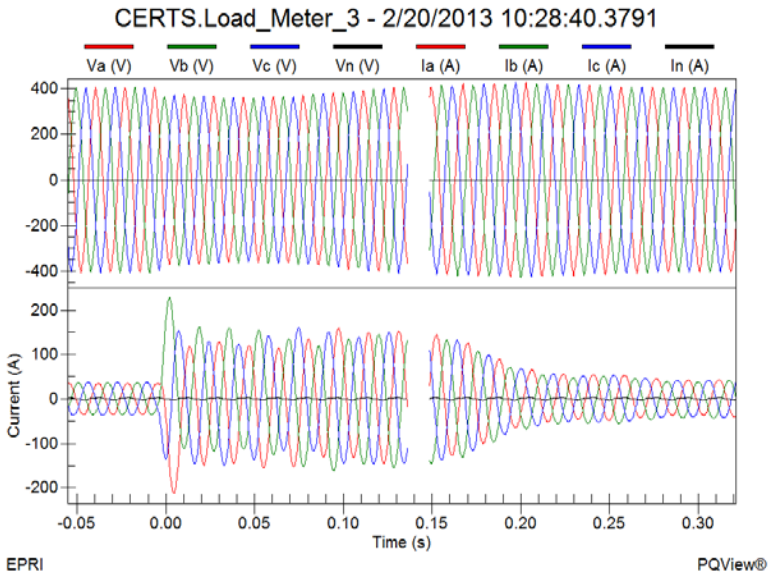


Figure 5.10.14: Event M, Unbalance Loading, Load Meter 3, RMS Voltage and Current

5.11 *Power Factor Tests*

Performance Goal

The intent of this testing is to ensure stable operation when the generating sources are serving loads with low power factor. Power factors other than unity are very common in electrical systems; therefore operating successfully within this type of environment is important to broad acceptance. This test sequence includes tests of the synchronous generator both individually and in conjunction with multiple generators. The generators should continue to operate together, providing stable power, with predictable changes to voltage and frequency, while serving low power factor loads. A pass criterion for this test is acceptable steady state voltage and frequency while serving low power factor loads.

Description of Procedure

The initial microgrid settings for this test sequence are tabulated in Table 5.11.1. Each setup begins with a nominal power factor of approximately 0.9, and with either a balanced or unbalanced load as specified in the table. The microgrid was allowed to reach steady state and then the power factor was reduced to approximately 0.75 and the event data recorded. The load bank's power factor was reduced again to 0.60 and the event data recorded.

During this test sequence, due to limitations in the load banks, the power factors specified in the test plan were approximated in execution. That is, the load banks are only adjustable in specified increments, and as a consequence the precise values required for the specified power factors were not realizable. For a load bank with 10 kW of real load, if a power factor of 0.60 is desired, a total reactive load of 13.33 kVA is necessary; however the closest available reactive load was 10 kvar which was utilized instead. Grey indicates the specific generator is offline and not contributing to the test. Similarly Greyed sections in the Test Results indicated no contribution from the generator although a results value may be present.

Test Settings

The easYgen Controller of Generator B1 has the following settings:
- Voltage Dispatch: 480V
- Frequency Droop: 1%
- Voltage Droop: 5%

The Voltage Exciter of Generator B1 has the following settings:
- Load Relief Setting: 40 Hz @ 1 pu V/Hz

The Controller of Generator A1 has the following settings:
- Voltage Dispatch: 277V
- Frequency Droop: -0.006 Hz/kW
- Voltage Droop: 0.47 V/kvar

The Controller of Generator A2 has the following settings:
- Voltage Dispatch: 277V
- Frequency Droop: -0.01 Hz/kW
- Voltage Droop: 0.24 V/kvar

Test Event	Generator B1	Generator A1	Generator A2	Load Bank 3	Load Bank 4	Load Bank 5	Notes
A	40 kW	25 kW	30 kW	10 kW, 20 kvar	40 kW, 30 kvar	40 kW, 40 kvar	Power Factor: 0.9→0.75
B	40 kW	25 kW	30 kW	10 kW, 20 kvar	40 kW, 45 kvar	40 kW. 40 kvar	Power Factor: 0.75→0.60
C	40 kW	25 kW	Off	10 kW, 10 kvar	0 kW, 0 kvar	40 kW, 40 kvar	Power Factor: 0.9→0.75
D	40 kW	25 kW	Off	10 kW, 10 kvar	0 kW, 0 kvar	40 kW, 40 kvar	Power Factor: 0.75→0.60
E	40 kW	Off	Off	10 kW, 10 kvar	ΦA: 10 kW, 6.6 kvar ΦB: 15 kW, 6.6 kvar ΦC: 15 kW, 6.6 kvar	40 kW, 40 kvar	Power Factor: 0.9→0.75
F	40 kW	Off	Off	10 kW, 20 kvar	ΦA: 10 kW, 13.3 kvar ΦB: 15 kW, 13.3 kvar ΦC: 15 kW, 13.3 kvar	40 kW, 40 kvar	Power Factor: 0.75→0.60
G	40 kW	25 kW	30 kW	10 kW	ΦA: 10 kW, 6.6 kvar ΦB: 15 kW, 6.6 kvar ΦC: 15 kW, 6.6 kvar	40 kW, 40 kvar	Power Factor: 0.9→0.75
H	40 kW	25 kW	30 kW	10 kW, 30 kvar	ΦA: 10 kW, 16.6 kvar ΦB: 15 kW, 16.6 kvar ΦC: 15 kW, 16.6 kvar	40 kW, 40 kvar	Power Factor: 0.75→0.60
I	40 kW	25 kW	Off	10 kW, 20 kvar	0 kW	ΦA: 15 kW, 13.3 kvar ΦB: 15 kW, 16.6 kvar ΦC: 10 kW, 16.6 kvar	Power Factor: 0.9→0.75
J	40 kW	25 kW	Off	10 kW, 30 kvar	0 kW	ΦA: 15 kW, 13.3 kvar ΦB: 15 kW, 16.6 kvar ΦC: 10 kW, 13.3 kvar	Power Factor: 0.75→0.60
K	40 kW	Off	Off	40 kW, 40 kvar	0 kW	40 kW	Power Factor: 0.9→0.75
L	40 kW	Off	Off	40 kW, 60 kvar	0 kW	40 kW	Power Factor: 0.75→0.60

Table 5.11.1: Power Factor Test Settings

Test Results

Test Event	Power Factor Change	Generator B1			Generator A1	Generator A2	Microgrid Bus	Pass/Fail
		Voltage	Frequency	Power Factor	Power Factor	Power Factor	Power Factor	
A	0.9→0.75	268.63	60.00	0.52	0.84	0.90	0.65	Pass
B	0.75→0.60	266.47	60.01	0.43	0.75	0.83	0.56	Pass
C	0.9→0.75	271.40	60.02	0.60	0.87	-0.72	0.66	Pass
D	0.75→0.60	271.94	60.04	0.63	0.87	-0.85	0.68	Pass
E	0.9→0.75	267.87	59.94	0.75	-0.33	0.42	0.74	Pass
F	0.75→0.60	263.77	59.74	0.65	-0.38	0.25	0.64	Pass
G	0.9→0.75	268.43	60.02	0.52	0.81	0.92	0.66	Pass
H	0.75→0.60	265.44	60.02	0.40	0.70	0.84	0.54	Pass
I	0.9→0.75	270.71	60.03	0.57	0.81	-0.76	0.61	Pass
J	0.75→0.60	270.08	60.03	0.51	0.81	-0.28	0.57	Pass
K	0.9→0.75	272.54	59.66	0.86	-0.33	-0.34	0.84	Pass
L	0.75→0.60	269.68	59.86	0.77	-0.34	-0.35	0.75	Pass

Table 5.11.2: Power Factor Test Results

Analysis

The synchronous generator successfully passed the power factor test sequence. The generator was able to operate with balanced and unbalanced loads of varying power factors. The four test events analyzed below are with both balanced and unbalanced loads with power factor of 0.75→0.60. Figure 5.11.1 through Figure 5.11.12 illustrates three generators and a balanced load. An oscillation in reactive power in all three sources of approximately 8 Hz was observed in Figure 5.11.4, Figure 5.11.8, and Figure 5.11.12.

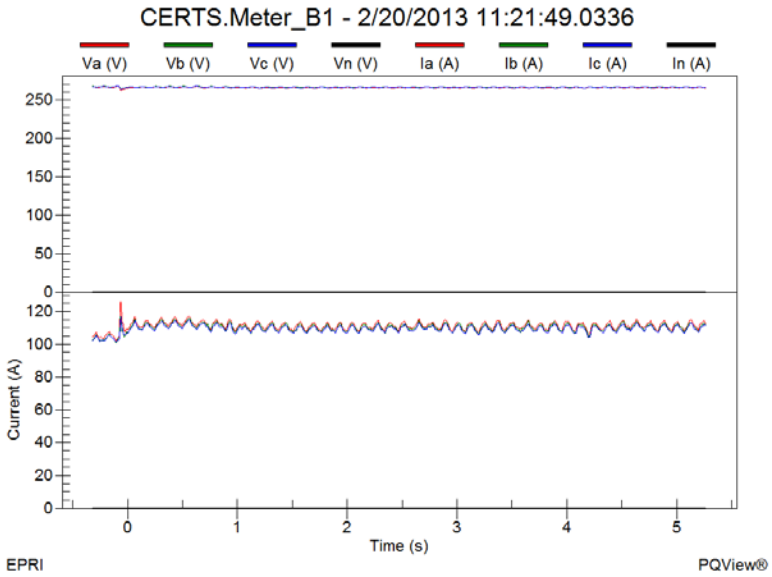


Figure 5.11.1: Event B, 0.75→0.60 pf, Meter B1, RMS Voltage and Current

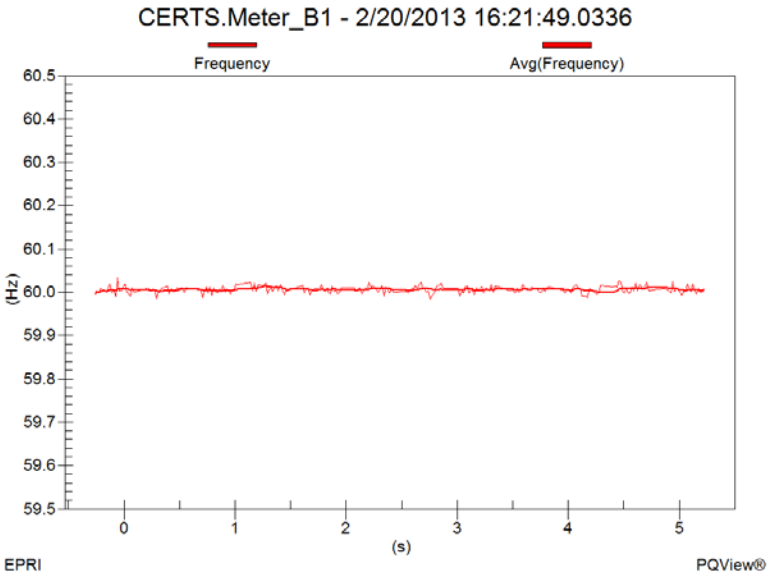


Figure 5.11.2: Event B, 0.75→0.60 pf, Meter B1, Frequency

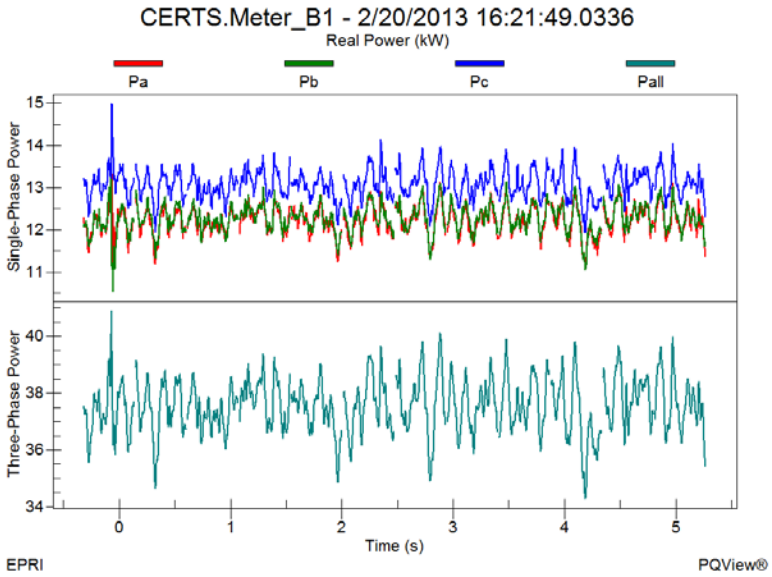


Figure 5.11.3: Event B, 0.75→0.60 pf, Meter B1, Real Power

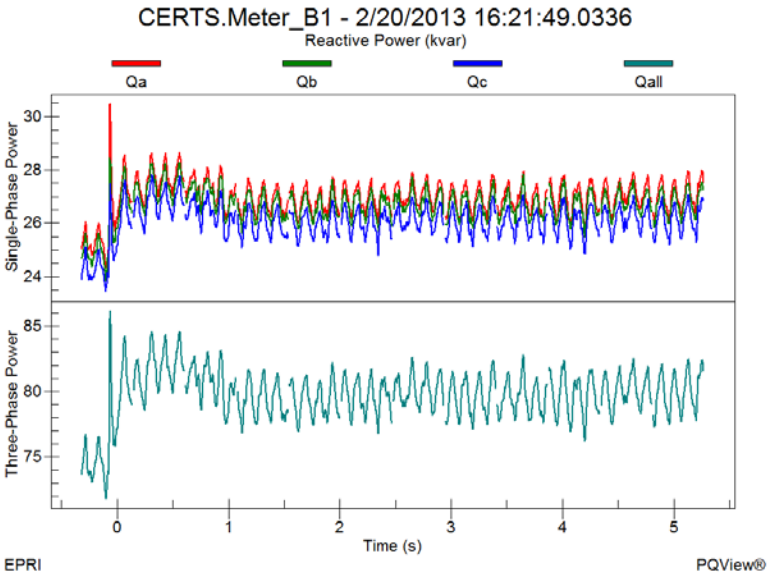


Figure 5.11.4: Event B, 0.75→0.60 pf, Meter B1, Reactive Power

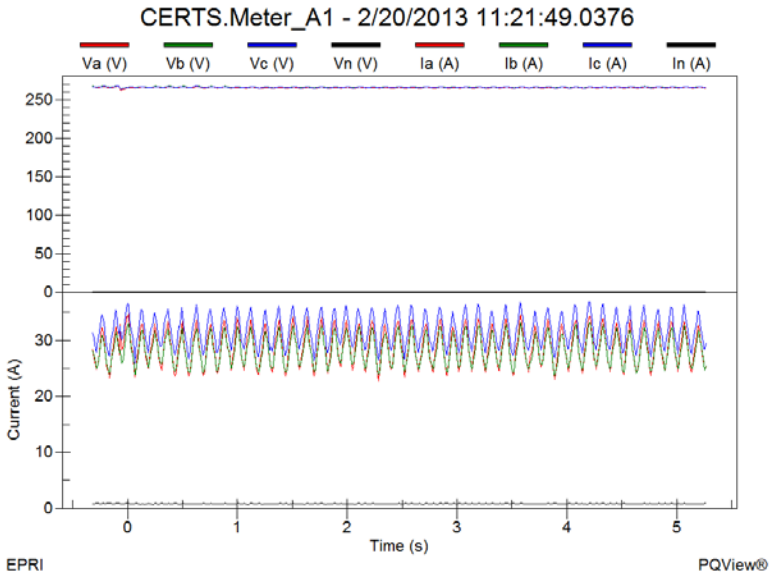


Figure 5.11.5: Event B, 0.75→0.60 pf, Meter A1, RMS Voltage and Current

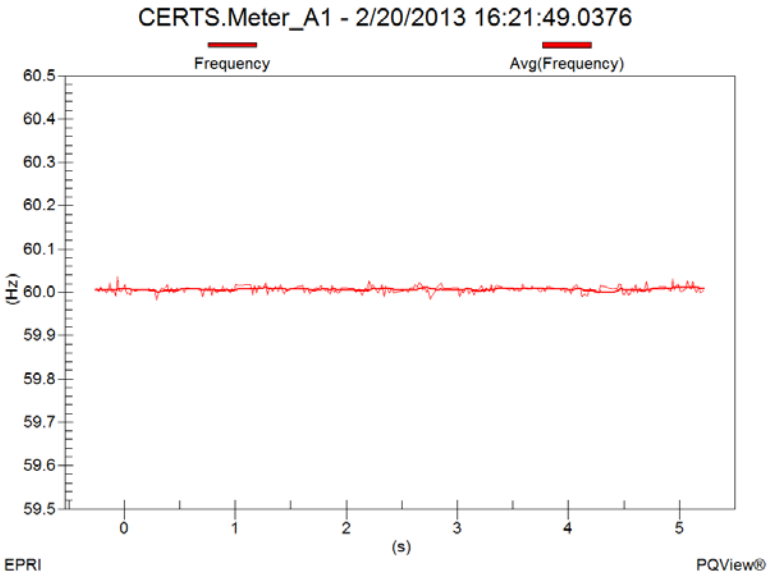


Figure 5.11.6: Event B, 0.75→0.60 pf, Meter A1, Frequency

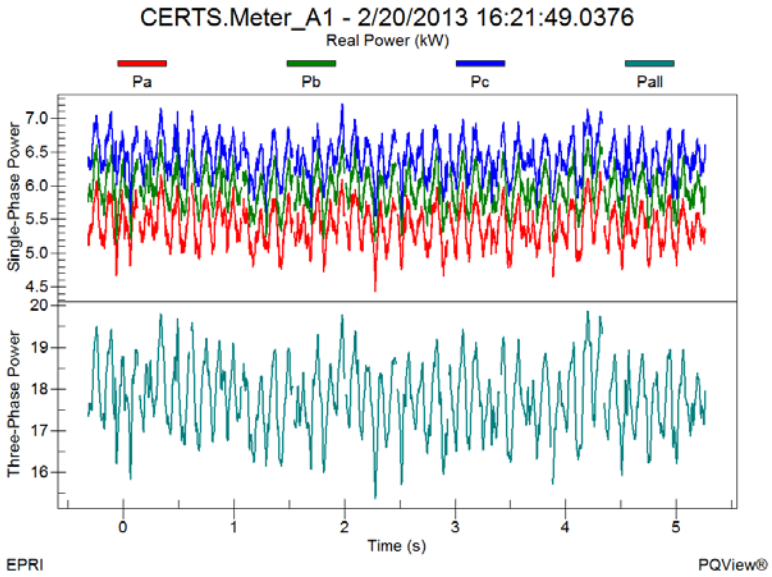


Figure 5.11.7: Event B, 0.75→0.60 pf, Meter A1, Real Power

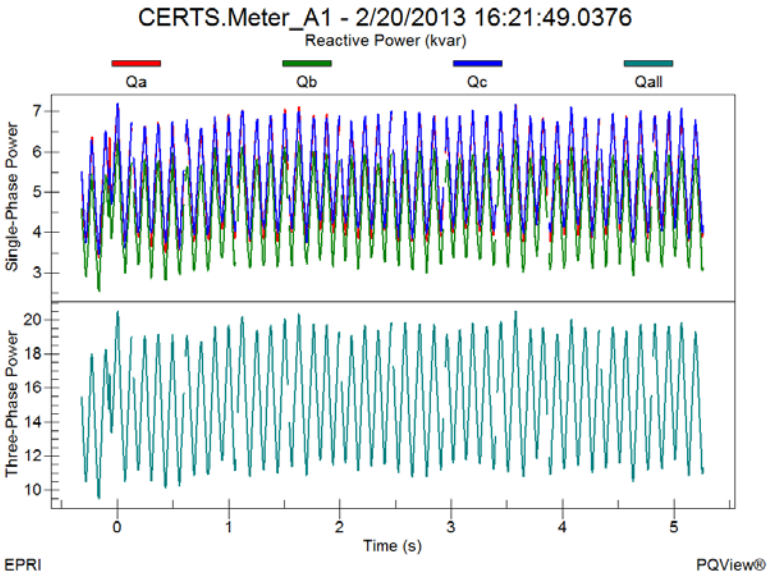


Figure 5.11.8: Event B, 0.75→0.60 pf, Meter A1, Reactive Power

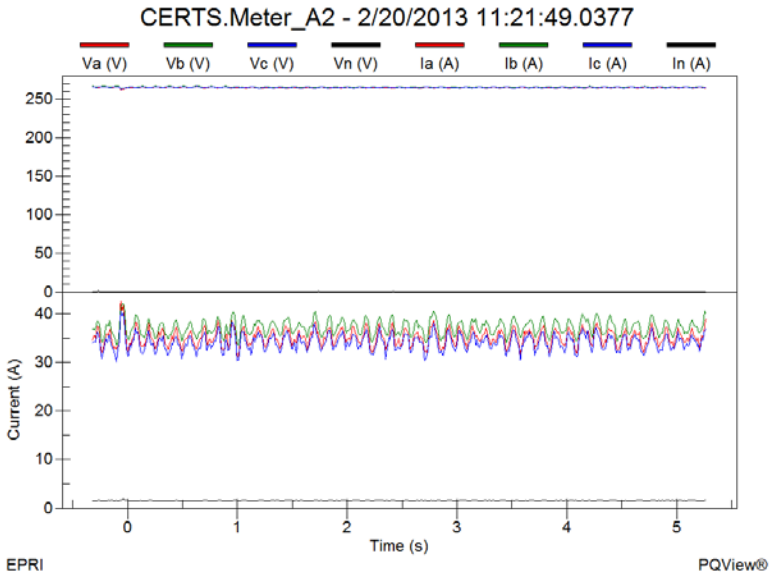


Figure 5.11.9: Event B, 0.75→0.60 pf, Meter A2, RMS Voltage and Current

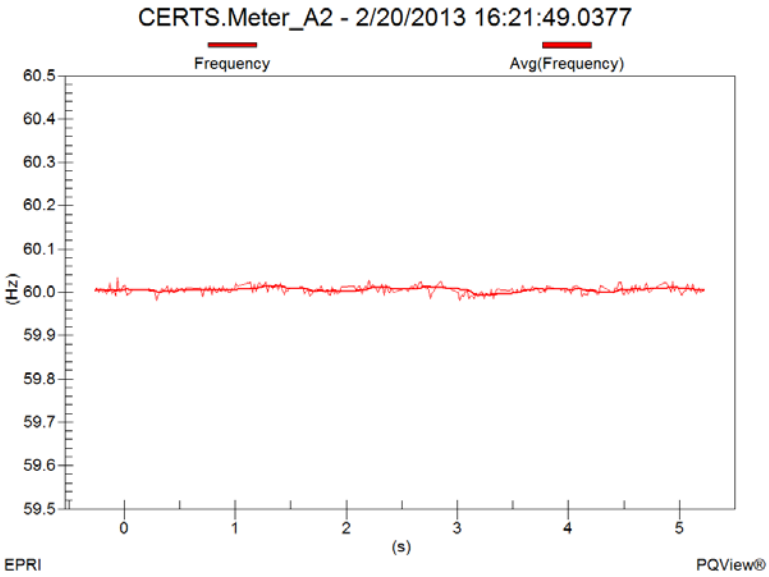


Figure 5.11.10: Event B, 0.75→0.60 pf, Meter A2, Frequency

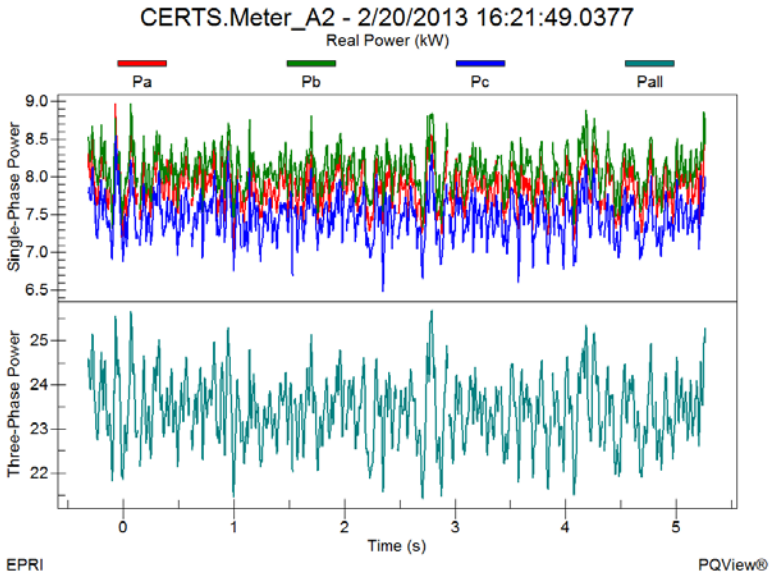


Figure 5.11.11: Event B, 0.75→0.60 pf, Meter A2, Real Power

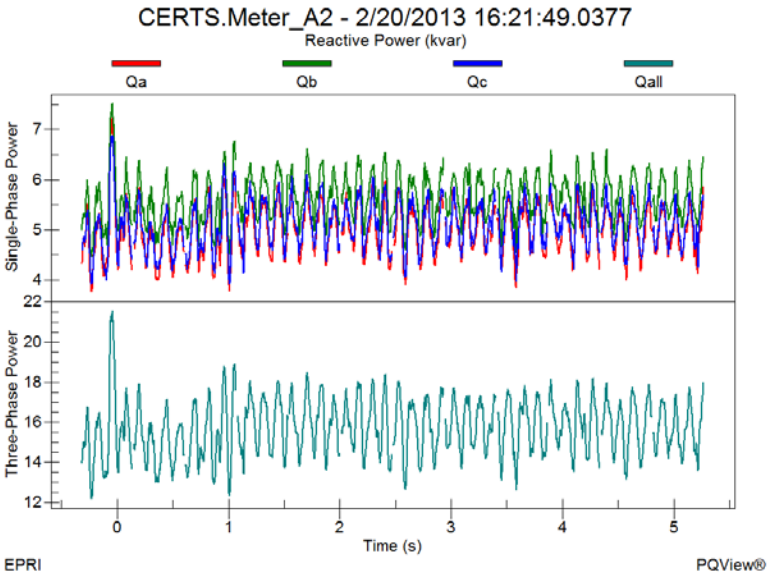


Figure 5.11.12: Event B, 0.75→0.60 pf, Meter A2, Reactive Power

Figure 5.11.13 through Figure 5.11.16 illustrates the most strenuous test in the power factor sequence, Event F, 0.75→0.60 pf. The synchronous generator operated alone with a near rated combined resistive and reactive load present. In this test voltage remains stable throughout. The event does have an effect on the frequency, initially causing a transient as in Figure 5.11.14, which requires longer than the sampled 5 seconds to reach stability. The event eventually results in stable operation without protection trip although an exact timing cannot be provided at this time. Further the event appears to cause an unusual affect in the measured real power, Figure 5.11.15. At this time we believe this to be an artifact between the measurement equipment and the analysis software tool. This is supported by the stable system voltage and the passive load elements used during the test.

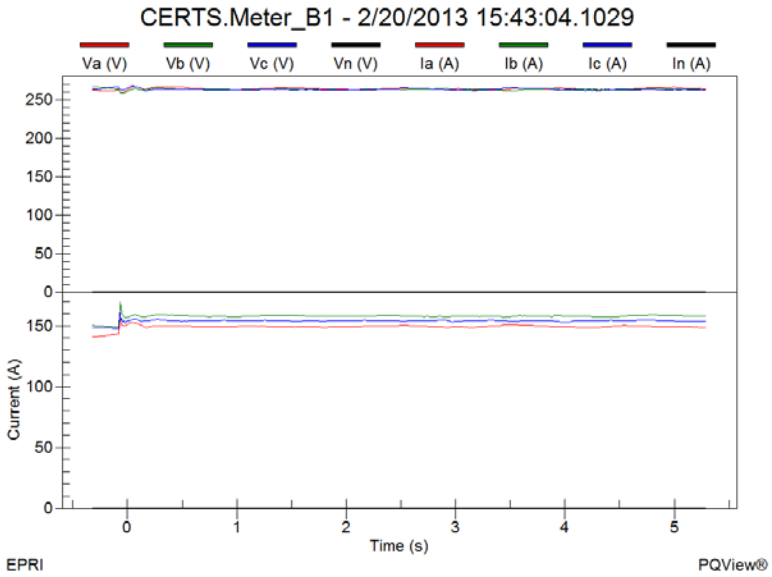


Figure 5.11.13: Event F, 0.75→0.60 pf, Meter B1, RMS Voltage and Current

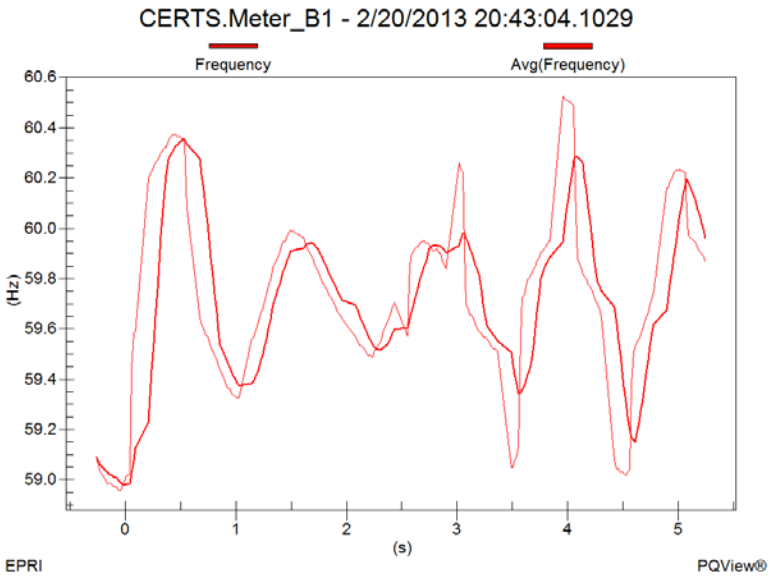


Figure 5.11.14: Event F, 0.75→0.60 pf, Meter B1, Frequency

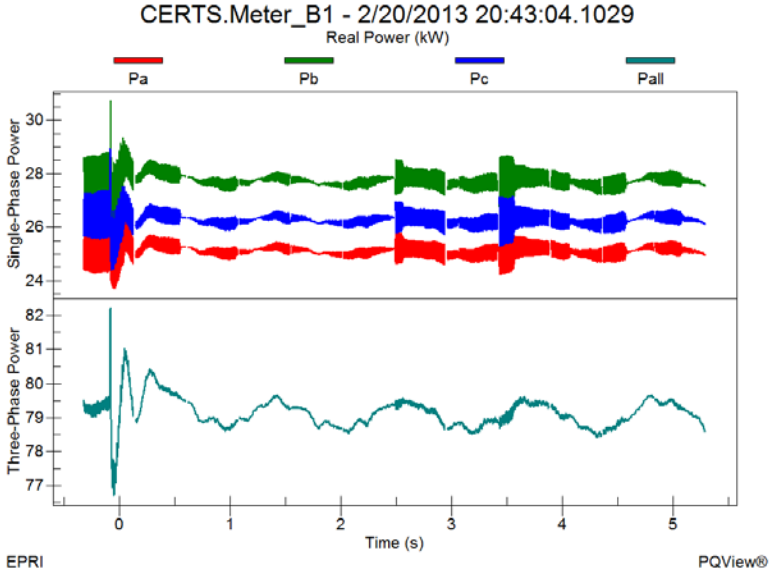


Figure 5.11.15: Event F, 0.75→0.60 pf, Meter B1, Real Power

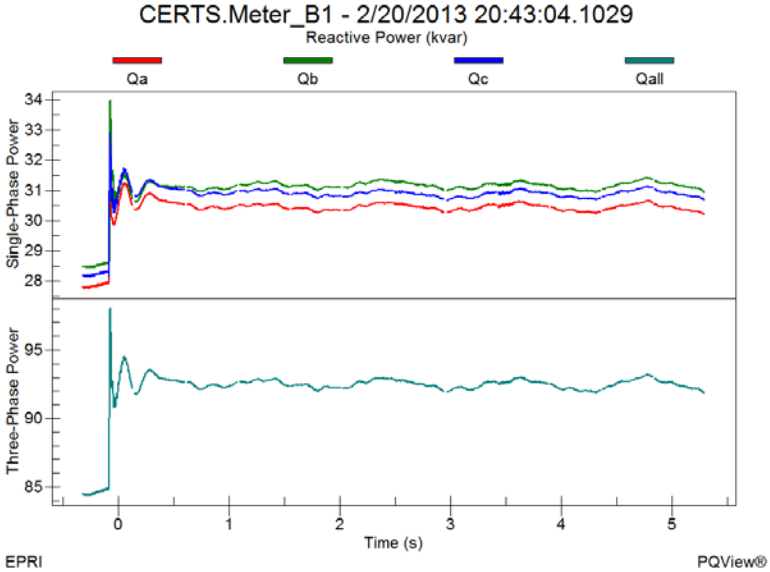


Figure 5.11.16: Event F, 0.75→0.60 pf, Meter B1, Reactive Power

5.12 *Harmonic Load Tests*

Performance Goal

The intent of this testing is to ensure stable operation when the generating sources are serving loads with significant harmonic content. Harmonic loads are becoming very common in electrical systems; therefore operating successfully within this type of environment is important to broad acceptance. This test sequence includes tests of the synchronous generator both individually and in conjunction with multiple generators. The generators should continue to operate together, providing stable power, with predictable changes to voltage and frequency, while serving harmonic loads. A pass criterion for this test is acceptable steady state voltage and frequency while serving harmonic loads.

Description of Procedure

The generators were dispatched according to Table 5.12.1, islanded from the utility. Next, the loads were applied to the microgrid bus including harmonic loads and adjusted to the desired power factor. With the system in a steady state, the 10 Hp motor start was performed and the event recorded. When the data finished recording, the next iteration was begun. Greyed tabular data indicates sources and loads which are not used in the test event even though results data may be present.

Test Settings

The easYgen Controller of Generator B1 has the following settings:

- Voltage Dispatch: 480V
- Real Power Dispatch: Varies
- Frequency Droop: 1%
- Voltage Droop: 5%

The Voltage Exciter of Generator B1 has the following settings:

- Load Relief Setting: 40 Hz @ 1 pu V/Hz

The Controller of Generator A1 has the following settings:

- Voltage Dispatch: 277V
- Real Power Dispatch: Varies
- Frequency Droop: -0.006 Hz/kW
- Voltage Droop: 0.47 V/kvar

The Controller of Generator A2 has the following settings:

- Voltage Dispatch: 277V
- Real Power Dispatch: 30 kW
- Frequency Droop: -0.01 Hz/kW
- Voltage Droop: 0.24 V/kvar

Test Event	Generator B1	Generator A1	Generator A2	Load Bank 3	Load Bank 4	Load Bank 5	Notes
A	40 kW	25 kW	30 kW	10 kW, 10 kvar, Motor Start, 5 kW Harmonic Load	40 kW, 20 kvar	40 kW, 20 kvar	LB 3: 10 Hp Motor Start
B	40 kW	25 kW	Off	10 kW, 10 kvar, Motor Start, 5 kW Harmonic Load	0 kW	40 kW, 20 kvar	LB 3: 10 Hp Motor Start
C	40 kW	Off	Off	10 kW, 10 kvar, Motor Start, 5 kW Harmonic Load	0 kW	0 kW	LB 3: 10 Hp Motor Start
D	40 kW	25 kW	30 kW	10 kW, 10 kvar, Motor Start, 10 kW Harmonic Load	40 kW, 20 kvar	40 kW, 20 kvar	LB 3: 10 Hp Motor Start
E	40 kW	25 kW	30 kW	10 kW, 10 kvar, Motor Start, 10 kW Harmonic Load	0 kW	40 kW, 20 kvar	LB 3: 10 Hp Motor Start
F	40 kW	Off	Off	10 kW, 10 kvar, Motor Start, 10 kW Harmonic Load	0 kW	0 kW	LB 3: 10 Hp Motor Start
G	40 kW	25 kW	30 kW	10 kW, 10 kvar, Motor Start, 15 kW Harmonic Load	40 kW, 20 kvar	40 kW, 20 kvar	LB 3: 10 Hp Motor Start
H	40 kW	25 kW	Off	10 kW, 10 kvar, Motor Start, 15 kW Harmonic Load	0 kW	40 kW, 20 kvar	LB 3: 10 Hp Motor Start
I	40 kW	Off	Off	10 kW, 10 kvar, Motor Start, 15 kW Harmonic Load	0 kW	0 kW	LB 3: 10 Hp Motor Start
J	40 kW	25 kW	30 kW	10 kW, 10 kvar, Motor Start	40 kW, 20 kvar	40 kW, 20 kvar, 5 kW Harmonic Load	LB 3: 10 Hp Motor Start
K	40 kW	25 kW	Off	10 kW, 10 kvar, Motor Start	40 kW, 20 kvar	40 kW, 20 kvar, 5 kW Harmonic Load	LB 3: 10 Hp Motor Start
L	40 kW	Off	Off	10 kW, 10 kvar, Motor Start	0 kW	0 kW, 10 kvar, 5 kW Harmonic Load	LB 3: 10 Hp Motor Start
M	40 kW	Off	30 kW	10 kW, 10 kvar, Motor Start	40 kW, 20 kvar	40 kW, 20 kvar, 10 kW Harmonic Load	LB 3: 10 Hp Motor Start
N	40 kW	25 kW	Off	10 kW, 10 kvar, Motor Start	0 kW	40 kW, 20 kvar, 10 kW Harmonic Load	LB 3: 10 Hp Motor Start
O	40 kW	Off	Off	10 kW, 10 kvar, Motor Start	0 kW	0 kW, 10 kW Harmonic Load	LB 3: 10 Hp Motor Start
P	40 kW	25 kW	30 kW	10 kW, 10 kvar, Motor Start	40 kW, 20 kvar	40 kW, 20 kvar, 15 kW Harmonic Load	LB 3: 10 Hp Motor Start
Q	40 kW	25 kW	Off	10 kW, 10 kvar, Motor Start	0 kW	40 kW, 20 kvar, 15 kW Harmonic Load	LB 3: 10 Hp Motor Start

Table 5.12.1: Harmonic Load Tests with Motor Starts Test Settings

Test Results

Test Event	Generator B1		Generator A1		Generator A2		Microgrid Bus		Notes	Pass / Fail
	Voltage Distortion (% THD)	Current Distortion (% THD)	Voltage Distortion (% THD)	Current Distortion (% THD)	Voltage Distortion (% THD)	Current Distortion (% THD)	Voltage Distortion (% THD)	Current Distortion (% THD)		
A	1.98	2.97	1.92	19.97	1.97	7.50	1.95	6.99	3 Sources, LB3 5 kW Harmonic Load	Pass
B	2.52	5.53	2.64	33.76	2.70	N/A	2.62	14.78	2 Sources, LB3 5 kW Harmonic Load	Pass
C	5.39	13.70	7.52	N/A	7.09	N/A	6.67	12.72	1 Source, LB3 5 kW Harmonic Load	Pass
D	2.76	3.61	2.77	26.52	2.94	9.53	2.82	6.56	3 Sources, LB3 10 kW Harmonic Load	Pass
E	2.91	5.47	2.87	69.00	3.02	14.24	2.93	9.69	3 Sources, LB3 10 kW Harmonic Load	Pass
F	6.32	19.59	4.21	N/A	6.75	N/A	5.76	20.67	1 Source, LB3 10 kW Harmonic Load	Pass
G	3.53	5.29	3.55	21.43	3.65	17.61	3.58	7.56	3 Sources, LB3 15 kW Harmonic Load	Pass
H	4.18	8.44	4.16	37.18	4.60	N/A	4.31	9.77	2 Sources, LB3 15 kW Harmonic Load	Pass
I	7.18	19.71	7.54	N/A	6.98	N/A	7.24	20.92	1 Source, LB3 15 kW Harmonic Load	Pass
J	2.03	3.37	2.02	16.27	1.94	12.66	2.00	5.39	3 Sources, LB5 5 kW Harmonic Load	Pass
K	2.35	3.80	2.35	14.66	2.30	N/A	2.33	13.92	2 Sources, LB5 5 kW Harmonic Load	Pass
L	6.20	12.42	4.58	N/A	4.61	N/A	5.13	12.11	1 Source, LB5 5 kW Harmonic Load	Pass
M	3.81	5.41	3.78	N/A	3.67	11.78	3.75	3.87	2 Sources, LB5 10 kW Harmonic Load	Pass
N	3.48	6.69	3.60	36.13	3.41	N/A	3.50	18.84	2 Sources, LB5 10 kW Harmonic Load	Pass
O	7.44	13.36	4.75	N/A	4.08	N/A	5.43	14.12	1 Source, LB5 10 kW Harmonic Load	Pass
P	3.33	4.40	3.45	27.80	3.16	10.08	3.31	11.55	3 Sources, LB5 15 kW Harmonic Load	Pass
Q	4.30	8.26	4.05	36.53	4.25	N/A	4.20	8.36	2 Sources, LB5 15 kW Harmonic Load	Pass

Table 5.12.2: Harmonic Load Tests with Motor Start, Results Table

Analysis

The microgrid sources as a whole performed well, meeting the acceptance criteria, with all source and harmonic load combinations resulting in continued stable operation in voltage and frequency. Table 5.12.2 contains the test results of the multi-generator harmonic loads and motor starts.

The sources were capable of feeding loads with total harmonic distortions in current as high as 20% with resulting worst case voltage distortion of approximately 7.4%. The worst case voltage distortion developed when the microgrid was being sourced by a single source with the maximum harmonic load added, as can be expected. The best case resulted from multiple sources serving the least amount of harmonic load.

In Figure 5.12.1 thru Figure 5.12.4 below, Event I, Single Source, 15kW Harmonic, the synchronous generator as the sole source, is supplying a 15kW harmonic load. Figure 5.12.2 illustrates the voltage and current waveforms during this event showing minor distortion in voltage and heavy distortion in current. Figure 5.12.3and Figure 5.12.4 show the real and reactive power flow due to the harmonic load and the motor start event.

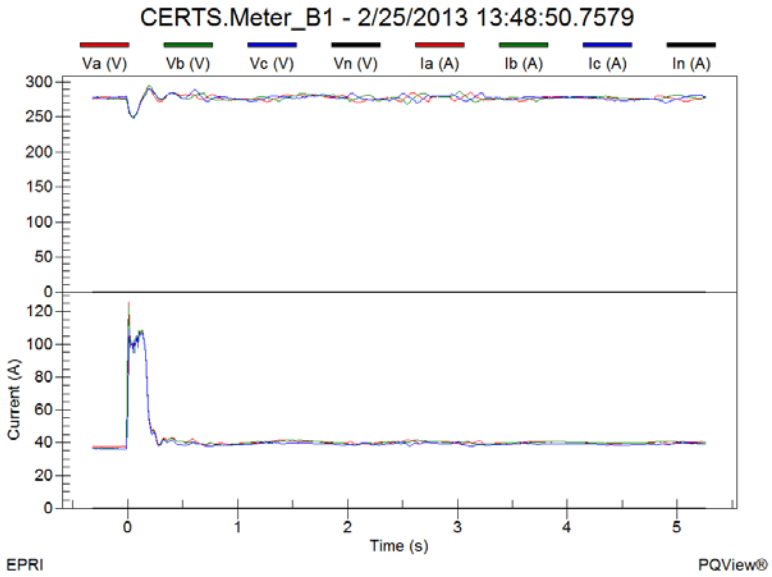


Figure 5.12.1: Event I, Single Source, 15kW Harmonic, Meter B1, RMS Voltage and Current

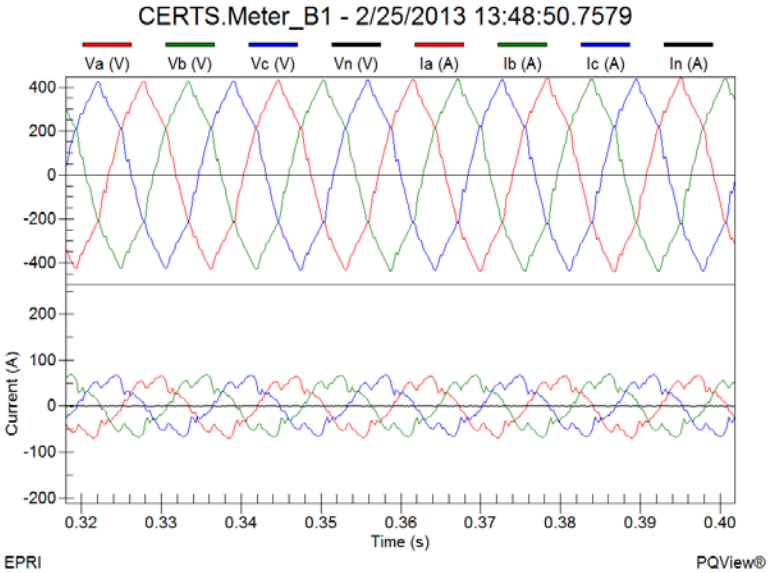


Figure 5.12.2: Event I, Single Source, 15kW Harmonic, Meter B1, Waveform Voltage and Current

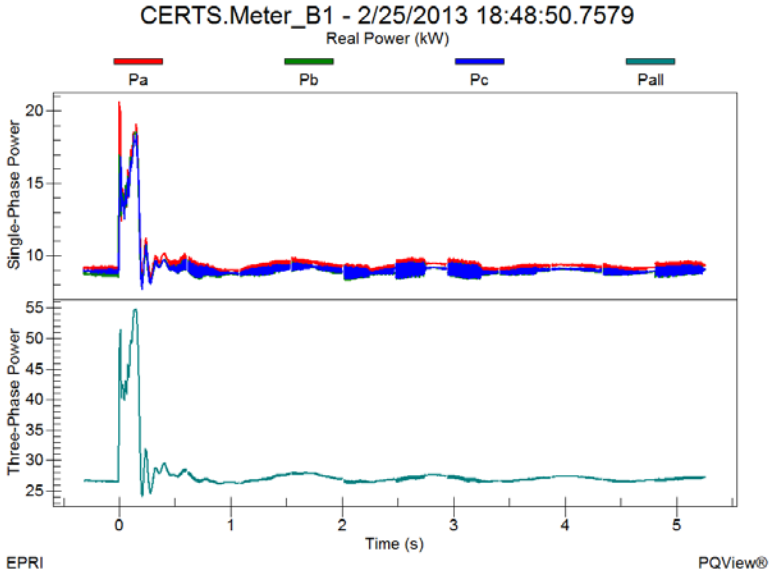


Figure 5.12.3: Event I, Single Source, 15kW Harmonic, Meter B1, Real Power

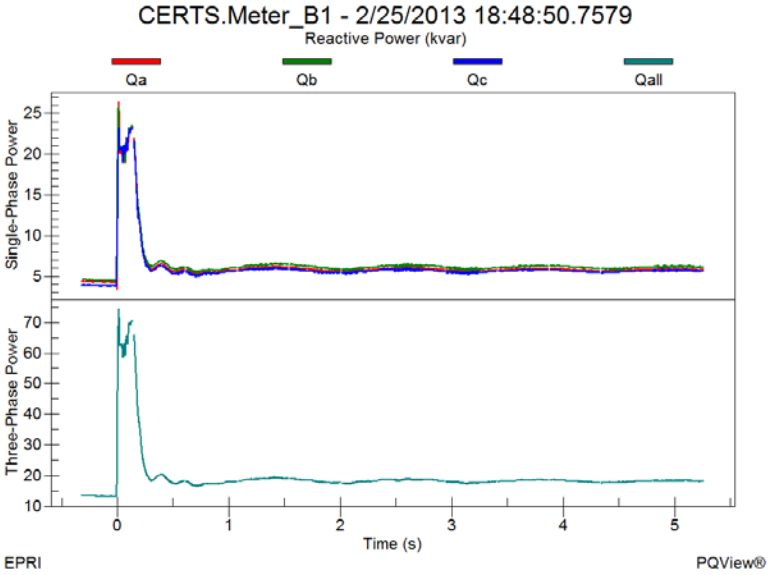


Figure 5.12.4: Event I, Single Source, 15kW Harmonic, Meter B1, Reactive Power

Event G below, Three Sources, 15kW Harmonic, demonstrates multiple sources supplying a heavily harmonic load as illustrated in Figure 5.12.5 thru Figure 5.12.16. From Figure 5.12.5, Figure 5.12.9, and Figure 5.12.13 the rms voltage and current show a slight voltage sag and a current surge during the motor start event. Figure 5.12.7, Figure 5.12.11, and Figure 5.12.15 demonstrate that all three units approximately share the real power burden of the motor start event. Figure 5.12.8, Figure 5.12.12, and Figure 5.12.16 demonstrates a similar sharing in reactive power for the motor start event.

Finally Figure 5.12.6, Figure 5.12.10, and Figure 5.12.14 illustrates an interesting point, the voltage waveforms remain nearly harmonic free however significant harmonics are present in the current supplied by both inverter based units, Generator A1 and Generator A2. Although the synchronous based generator is capable of sourcing harmonic currents as demonstrated in the Event I example above, when connected to mixed source systems the inverter based sources supply the majority of the harmonic current. The reason for this is most likely due to a lower apparent impedance of the inverter based sources to higher order frequencies than that of the synchronous unit. This has two important implications. First, in grid tied microgrids sourced by inverter based sources, local harmonic loads will likely be supplied by the local sources, reducing the demand for harmonic content from the utility. Second in microgrid environments with heavy harmonic loading, additional considerations may be necessary, such as the de-rating of inverter sources, to prevent unacceptable operating conditions on any one source type.

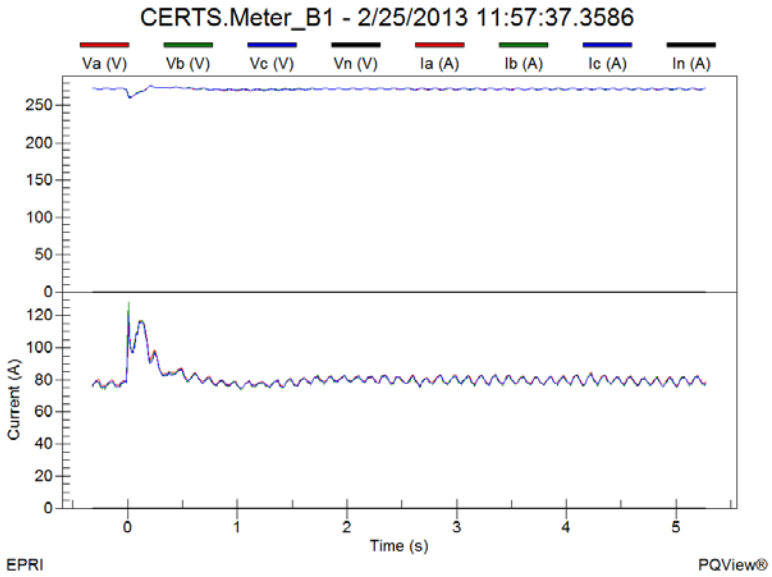


Figure 5.12.5: Event G, Three Sources, 15kW Harmonic, Meter B1, RMS Voltage and Current

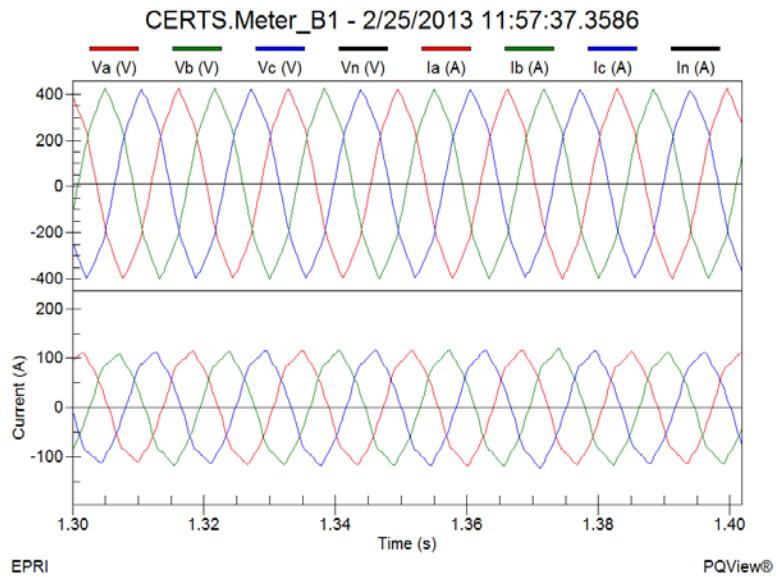


Figure 5.12.6: Event G, Three Sources, 15kW Harmonic, Meter B1, Waveform Voltage and Current

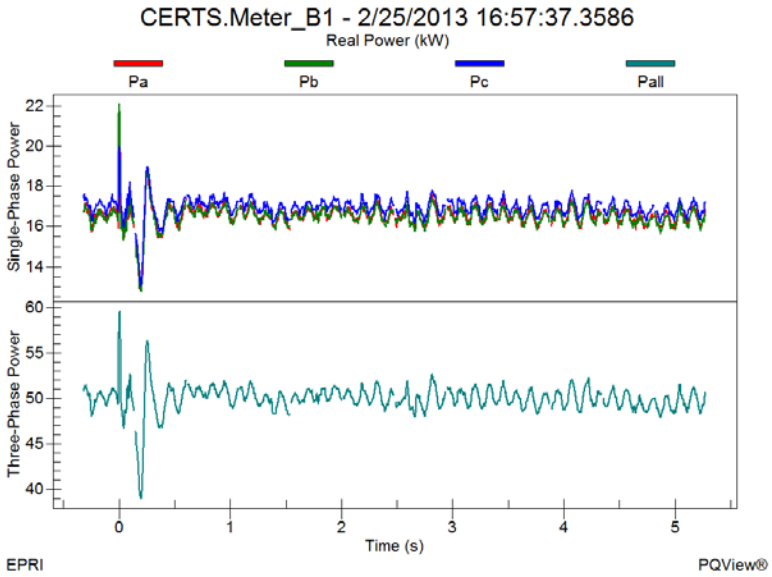


Figure 5.12.7: Event G, Three Sources, 15kW Harmonic, Meter B1, Real Power

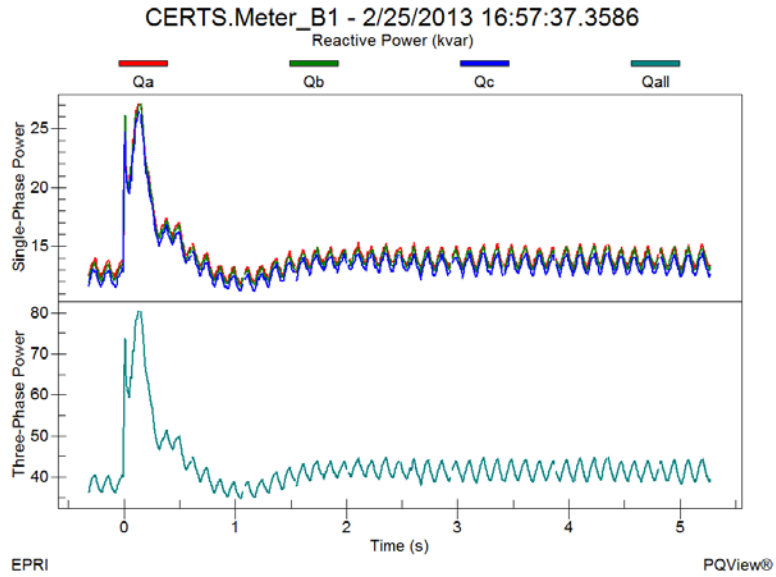


Figure 5.12.8: Event G, Three Sources, 15kW Harmonic, Meter B1, Reactive Power

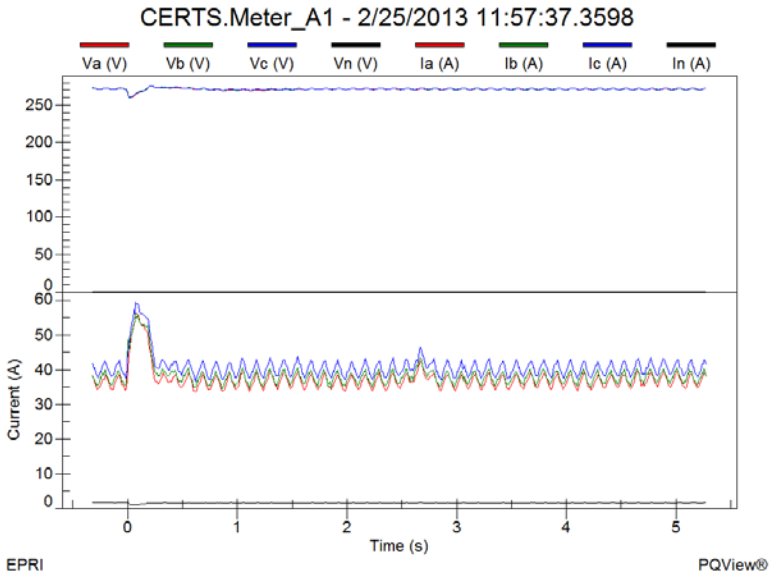


Figure 5.12.9: Event G, Three Sources, 15kW Harmonic, Meter A1, RMS Voltage and Current

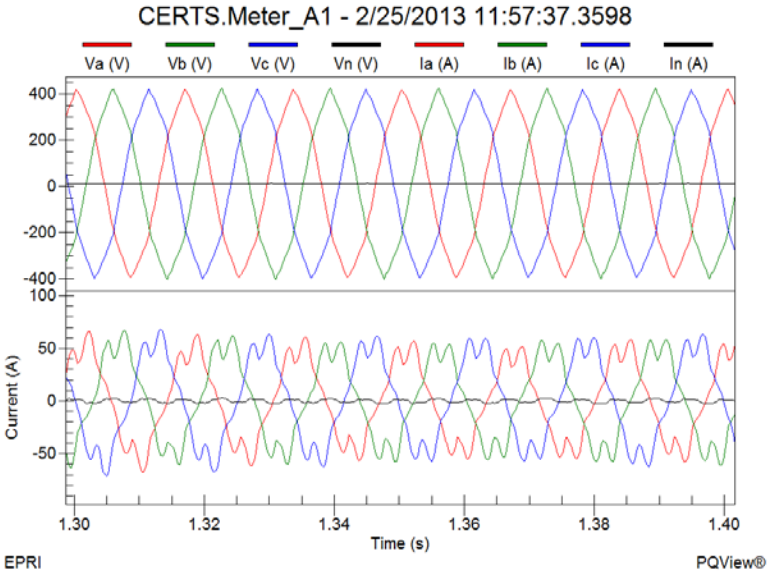


Figure 5.12.10: Event G, Three Sources, 15kW Harmonic, Meter A1, Waveform Voltage and Current

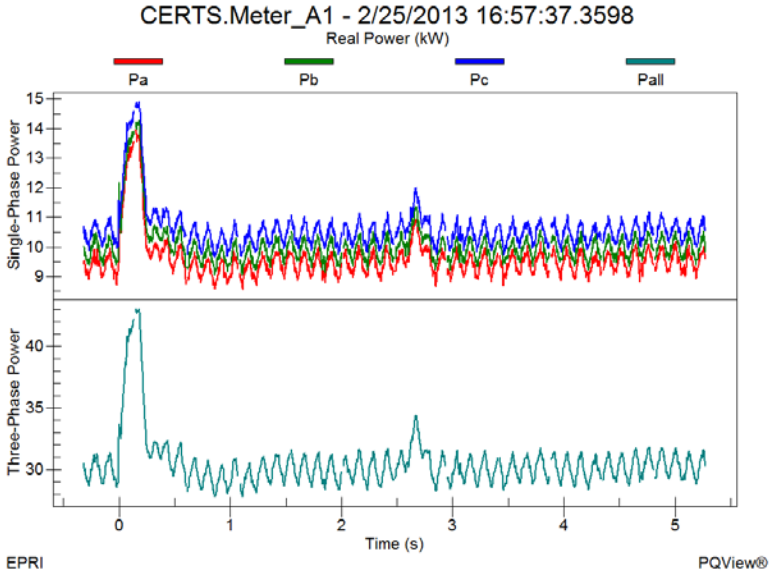


Figure 5.12.11: Event G, Three Sources, 15kW Harmonic, Meter A1, Real Power

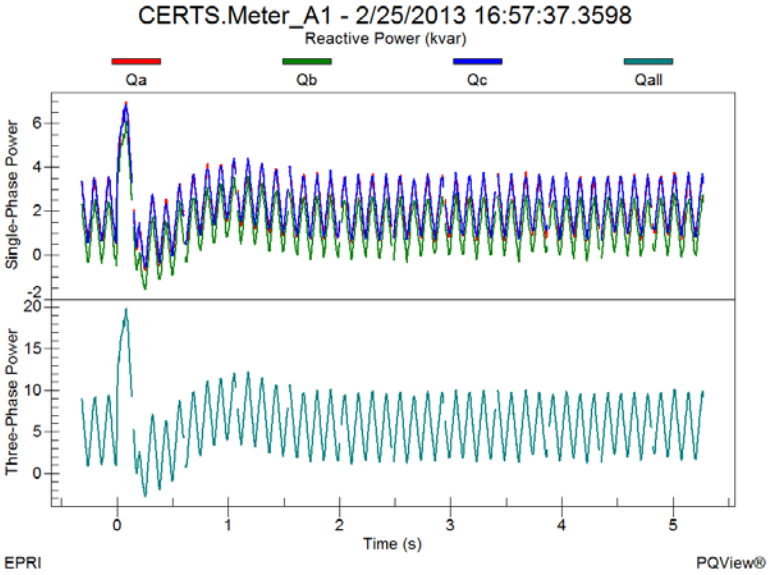


Figure 5.12.12: Event G, Three Sources, 15kW Harmonic, Meter A1, Reactive Power

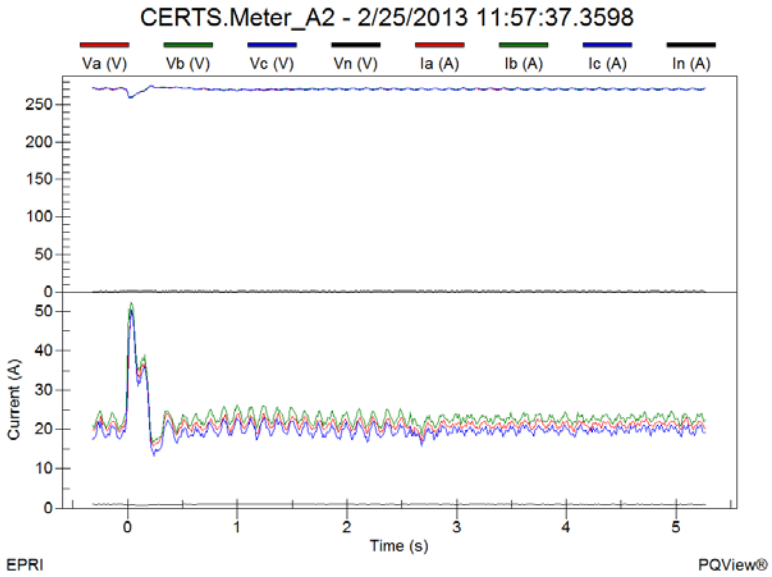


Figure 5.12.13: Event G, Three Sources, 15kW Harmonic, Meter A2, RMS Voltage and Current

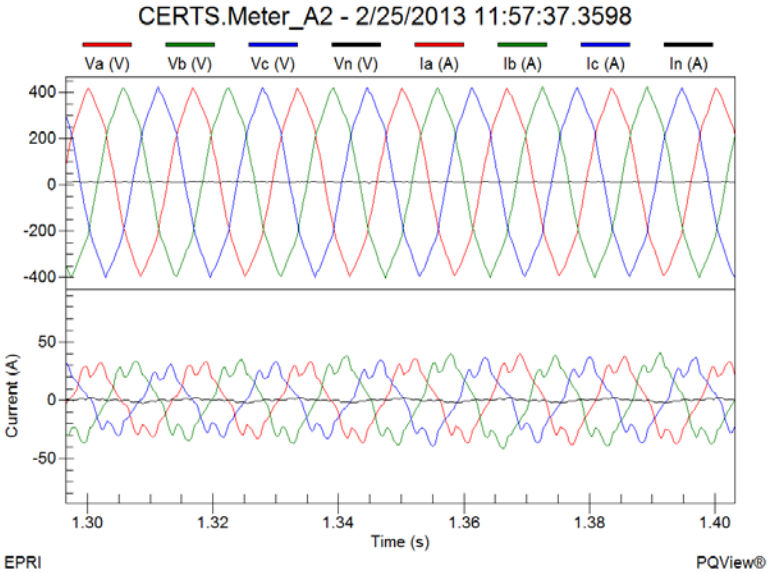


Figure 5.12.14: Event G, Three Sources, 15kW Harmonic, Meter A2, Waveform Voltage and Current

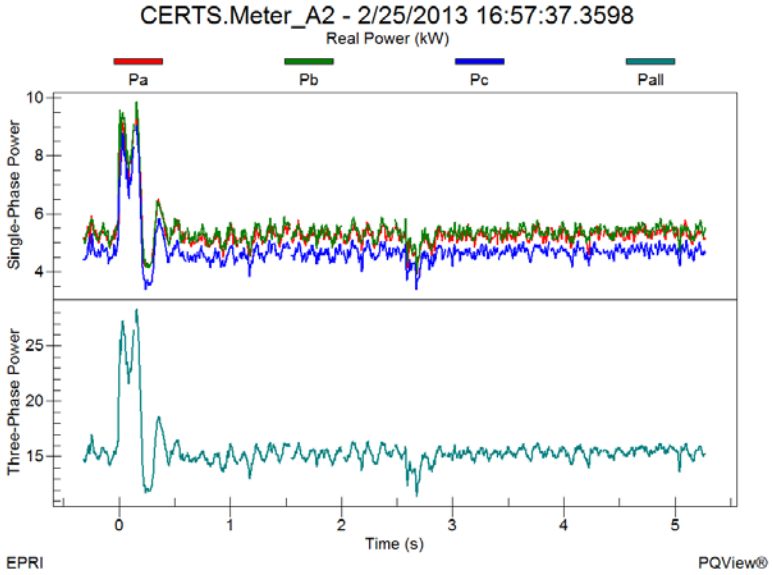


Figure 5.12.15: Event G, Three Sources, 15kW Harmonic, Meter A2, Real Power

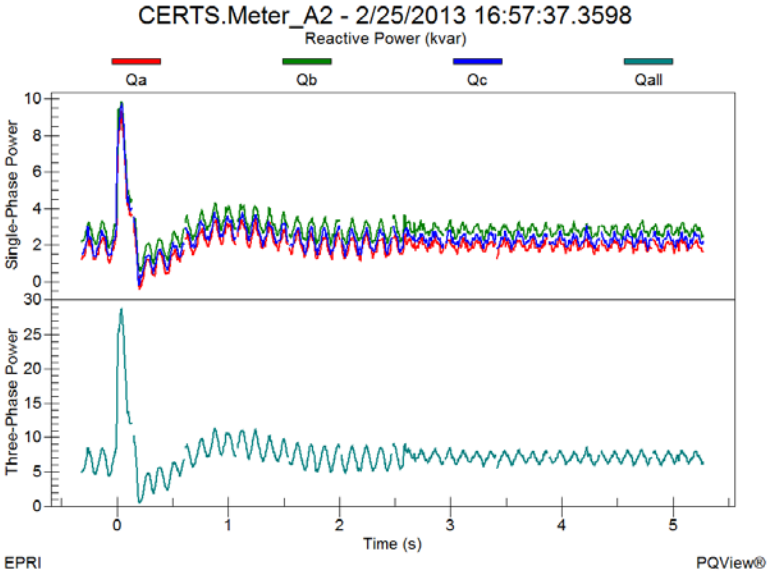


Figure 5.12.16: Event G, Three Sources, 15kW Harmonic, Meter A2, Reactive Power

6.0 Appendix

6.1 *Marathon 2000EC Voltage Exciter*

Configure: System Settings		Setting
Voltage Sensing		Three Phase
Version Numbers	DVR2000	2.16.05
Regulator Sensing Voltage		480.0V
Regulator Sensing Current		5A
Generator PT Ratio		1.00
Generator CT Ratio		1.0
Settings: Setpoint		
Automatic Voltage Regulator: AVR Setpoint		480.0V
Fine Voltage Adjustment: Band Setting		11.0%
Droop: Setpoint		0%
Field Current Regulator: FCR Setpoint		0.10A
Reactive Power Control : VAR Setpoint		0% of rated
Power Factor Control: PF Setpoint		1.000
Settings: Startup		
Startup Control: Gen Soft Start Time		3 Seconds
Underfrequency Setting: Corner Frequency		40.0Hz
Slope		1.00 V/Hz
Settings: Engine Unloading		
Unloading Activation: Frequency		9.0Hz
Unloading Activation: Rate		25.5Hz/25msec
Unloading Droop: Percentage		1%
Unloading Droop: Time		1 Second
Gain: Control Gain		
Stability Range		1
AVR/FCR: Proportional Gain Kp		400.00
AVR/FCR: Integral Gain Ki		1200.00
AVR/FCR: Derivative Gain Kd		15.00
AVR/FCR: AVR <= Loop Gain Kg => FCR		1.00 < = > 4.0
VAR/PF: PF Integral Gain Ki		5.00
VAR/PF: Integral Gain Ki		5.00
VAR/PF: VAR <= Loop Gain Kg => PF		2.50 < = > 3.00
OEL: Integral Gain Ki		150.00
OEL: Loop Gain Kg		1.00
Protection: Protection		
OEL: Current Level		6.150A
OEL: Alarm Time Delay		10 Second
Loss of Sensing Voltage		12 Second
Generator Overvoltage: Voltage Level		120%
Field Overvoltage: Voltage Level		80Vdc

6.2 *easYgen Controls Settings*

Easygen Settings.wset

Date:	9/18/2013 9:28			
Application:	5418-6387-NEW			
SID File Name:	5418-6387-NEW.sid			
System management		1702 Device number	1	
System management		1700 Language	English	
System management	**Configure display backlight**	4556 Configure display backlight	Key activat.	
System management	**Configure display backlight**	4557 Time until backlight shutdown	5	min
System management		14675 Black / white in color display	No	
System clock	**Daylight saving time**	4591 Daylight saving time	On	
System clock	**Daylight saving time**	4594 DST begin time	2	h
System clock	**Daylight saving time**	4598 DST begin weekday	Sunday	
System clock	**Daylight saving time**	4592 DST begin nth. weekday	2nd	
System clock	**Daylight saving time**	4593 DST begin month	3	
System clock	**Daylight saving time**	4597 DST end time	2	h
System clock	**Daylight saving time**	4599 DST end weekday	Sunday	
System clock	**Daylight saving time**	4595 DST end nth. weekday	1st	
System clock	**Daylight saving time**	4596 DST end month	11	
Configure counters		2550 Maintenance hours	0	h
Configure counters		2551 Maintenance days	0	d
Configure counters		2567 Code level for reset maint.	1	
Configure counters		15154 Operation hours source	Internal	
Configure counters	**Internal**	2573 Codelevel set operation hours	3	
Configure measurement		235 Generator type	Synchron	
Configure measurement		1750 System rated frequency	60Hz	
Configure measurement		1601 Engine rated speed	1800	rpm
Configure measurement		1766 Generator rated voltage	480	V
Configure measurement		1768 Mains rated voltage	480	V
Configure measurement		1781 Busbar 1 rated voltage	480	V
Configure measurement		1752 Gen. rated active power [kW]	93	
Configure measurement		1758 Gen. rated react. power [kvar]	100	
Configure measurement		1754 Generator rated current	175	A
Configure measurement		1748 Mains rated active power [kW]	300	
Configure measurement		1746 Mains rated react. pwr. [kvar]	300	
Configure measurement		1785 Mains rated current	400	A

Configure measurement		1858 1Ph2W voltage measuring	Phase - neutral	
Configure measurement		1859 1Ph2W phase rotation	CW	
Configure measurement		1851 Generator voltage measuring	3Ph 4W	
Configure measurement		1850 Generator current measuring	L1 L2 L3	
Configure measurement		1853 Mains voltage measuring	3Ph 4W	
Configure measurement		1854 Mains current input	Ground current	
Configure measurement		1852 Mains current measuring	Phase L1	
Configure measurement		1825 System rated active power[kW]	500	
Configure measurement		4103 Show mains data	No	
Configure measurement	**Transformer**	1801 Gen. PT primary rated voltage	480	V
Configure measurement	**Transformer**	1800 Gen. PT secondary rated volt.	480	V
Configure measurement	**Transformer**	1806 Gen. CT primary rated current	300	A/x
Configure measurement	**Transformer**	1810 Gnd. CT primary rated current	300	A/x
Configure measurement	**Transformer**	1813 Busb1 PT primary rated voltage	480	V
Configure measurement	**Transformer**	1812 Busb1 PT secondary rated volt.	480	V
Configure measurement	**Transformer**	1804 Mains PT primary rated voltage	480	V
Configure measurement	**Transformer**	1803 Mains PT secondary rated volt.	480	V
Configure measurement	**Transformer**	1807 Mains CT primary rated current	300	A/x
Configure measurement	**External mains active power**	2966 External mains active power	No	
Configure measurement	**External mains active power**	5780 Data source	06.01 Analog input 1	
Configure measurement	**External mains active power**	2967 Mains power meas. resolution	0.1kW	
Configure LogicsManager::Set timers		1652 Timer 1: Hour	8	h
Configure LogicsManager::Set timers		1651 Timer 1: Minute	0	min
Configure LogicsManager::Set timers		1650 Timer 1: Second	0	s
Configure LogicsManager::Set timers		1657 Timer 2: Hour	17	h
Configure LogicsManager::Set timers		1656 Timer 2: Minute	0	min
Configure LogicsManager::Set timers		1655 Timer 2: Second	0	s
Configure LogicsManager::Set timers		1663 Active day	1	
Configure LogicsManager::Set timers		1662 Active hour	12	h
Configure LogicsManager::Set timers		1661 Active minute	0	min
Configure LogicsManager::Set timers		1660 Active second	0	s
Configure LogicsManager::Set timers		1670 Monday active	No	
Configure LogicsManager::Set timers		1671 Tuesday active	No	
Configure LogicsManager::Set timers		1672 Wednesday active	No	
Configure LogicsManager::Set timers		1673 Thursday active	No	
Configure LogicsManager::Set timers		1674 Friday active	No	

Configure LogicsManager::Set timers	1675 Saturday active	No	
Configure LogicsManager::Set timers	1676 Sunday active	No	
Configure LogicsManager::Set timers	4117 Use ASA symbols	No	
Configure LogicsManager::Internal flags::1-6	12240 Flag 2	(00.02 LM: Flag 2 Or 09.03 Discrete input 3) And Not 00.01 LM: Flag 1	
	Delay ON	0	s
	Delay OFF	0	s
Configure LogicsManager::Internal flags::1-6	12230 Flag 1	(Not 09.02 Discrete input 2 Or 04.45 RemoteControl Bit 2) Or 01.09 Shutdown alarm	
	Delay ON	0	s
	Delay OFF	0	s
Configure LogicsManager::Internal flags::1-6	12250 Flag 3	(00.03 LM: Flag 3 Or 04.44 RemoteControl Bit 1) And Not 00.01 LM: Flag 1	
	Delay ON	0	s
	Delay OFF	0	s
Configure LogicsManager::Internal flags::1-6	12260 Flag 4	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
Configure LogicsManager::Internal flags::1-6	12270 Flag 5	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
Configure LogicsManager::Internal flags::1-6	12280 Flag 6	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
Configure LogicsManager::Internal flags::7-12	12290 Flag 7	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
Configure LogicsManager::Internal flags::7-12	12300 Flag 8	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
Configure LogicsManager::Internal flags::7-12	12910 Flag 9	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
Configure LogicsManager::Internal flags::7-12	12911 Flag 10	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s

Configure LogicsManager::Internal flags::7-12		12912 Flag 11	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure LogicsManager::Internal flags::7-12		12913 Flag 12	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure LogicsManager::Internal flags::13-16		12914 Flag 13	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure LogicsManager::Internal flags::13-16		12915 Flag 14	(15.03 Flexible limit 3 And 15.04 Flexible limit 4) Or 15.05 Flexible limit 5	
		Delay ON	0	s
		Delay OFF	0	s
Configure LogicsManager::Internal flags::13-16		12916 Flag 15	(04.18 Synchron. GCB active Or 02.21 Dead busbar1) And 02.05 Gen. volt./freq. ok	
		Delay ON	0	s
		Delay OFF	0	s
Configure LogicsManager::Internal flags::13-16		12917 Flag 16	(01.09 Shutdown alarm Or 00.37 LM: Flag 16) And Not 09.02 Discrete input 2	
		Delay ON	0	s
		Delay OFF	0	s
Configure application::Configure engine		3321 Start/Stop mode logic	Gas	
Configure application::Configure engine	**Diesel**	3308 Preglow time	5	s
Configure application::Configure engine	**Diesel**	3347 Preglow mode	Off	
Configure application::Configure engine	**Diesel**	3309 Preglow temperature threshold	0	°C
Configure application::Configure engine		3346 Preglow criterion	06.01 Analog input 1	
Configure application::Configure engine	**Gas**	3310 Ignition delay	1	s
Configure application::Configure engine	**Gas**	3311 Gas valve delay	0	s
Configure application::Configure engine	**Gas**	3312 Minimum speed for ignition	80	rpm
Configure application::Configure engine	**MPU**	1600 MPU input	On	
Configure application::Configure engine	**MPU**	15155 Engine speed source	ECU/J1939	
Configure application::Configure engine	**MPU**	1602 Fly wheel teeth	118	
Configure application::Configure engine		4057 Pre-excitation D+	Off	
Configure application::Configure engine		12970 MAN engine start	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure application::Configure engine		3302 Start attempts	3	

Configure application::Configure engine	4102 Start attempts critical mode	3	
Configure application::Configure engine	3306 Starter time	10	s
Configure application::Configure engine	3307 Start pause time	15	s
Configure application::Configure engine	3326 Stop time of engine	20	s
Configure application::Configure engine	3313 Firing speed	12	Hz
Configure application::Configure engine	3324 LogicsManager for firing speed	No	
Configure application::Configure engine	3315 Engine monitoring delay time	5	s
Configure application::Configure engine	3316 Cool down time	10	s
Configure application::Configure engine	3319 Cool down in STOP mode	No	
Configure application::Configure engine	3322 Cool down without breaker	No	
Configure application::Configure engine	3300 Auxiliary services prerun	3	s
Configure application::Configure engine	3301 Auxiliary services postrun	30	s
Configure application::Configure engine	12971 MAN engine stop	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
Configure application::Configure engine	12500 Firing speed	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure engine::Configure idle mode	12570 Auto idle mode	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure engine::Configure idle mode	12550 Constant idle run	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure engine::Configure idle mode	3328 Automatic idle time	30	s
::Configure engine::Configure idle mode	3329 During emergency / critical	No	
Configure application::Configure automatic run	12120 Start req in AUTO	(00.02 LM: Flag 2 Or 00.03 LM: Flag 3) And True	
	Delay ON	0	s
	Delay OFF	0.5	s
Configure application::Configure automatic run	12190 Stop req. in AUTO	(04.45 RemoteControl Bit 2 And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
Configure application::Configure automatic run	12540 Start w/o load	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
Configure application::Configure automatic run	5775 IOP Delayed unload. Alarm C,E	0	s

Configure application::Configure automatic run		1795 Startup in mode	STOP	
Configure application::Configure automatic run		12510 Operat. mode AUTO	(09.02 Discrete input 2 And True) And True	
		Delay ON	0.5	s
		Delay OFF	1.5	s
Configure application::Configure automatic run		12520 Operat. mode MAN	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure application::Configure automatic run		12530 Operat. mode STOP	(Not 09.02 Discrete input 2 Or 01.09 Shutdown alarm) And True	
		Delay ON	0	s
		Delay OFF	0.5	s
::Configure automatic run::Critical mode		4109 Critical mode postrun	600	s
::Configure automatic run::Critical mode		4100 Close GCB in critical mode	No	
::Configure automatic run::Critical mode		4105 Critical mode alarm class MAN	No	
::Configure automatic run::Critical mode		12220 Critical mode	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure application::Load dependent start/stop		12930 LD start stop	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure application::Load dependent start/stop		5752 Start stop mode	Reserve power	
Configure application::Load dependent start/stop		5753 Dead busbar start mode	All	
Configure application::Load dependent start/stop		5751 Base priority	5	
Configure application::Load dependent start/stop		5754 Fit size of engine	No	
Configure application::Load dependent start/stop		5755 Fit service hours	Off	
Configure application::Load dependent start/stop		5756 Changes of engines	Off	
Configure application::Load dependent start/stop		5759 Minimum running time	180	s
Configure application::Load dependent start/stop		12926 LDSS Priority 2	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure application::Load dependent start/stop		12925 LDSS Priority 3	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure application::Load dependent start/stop		12924 LDSS Priority 4	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
::Load dependent start/stop::IOP/MOP	**Start stop mode:: Reserve power**	5761 IOP Hysteresis	20	kW

::Load dependent start/stop::IOP/MOP	**Start stop mode:: Reserve power**	5760 IOP Reserve power	100	kW
::Load dependent start/stop::IOP/MOP	**Start stop mode:: Generator load**	5757 IOP Dynamic	Low	
::Load dependent start/stop::IOP/MOP	**Start stop mode:: Generator load**	5762 IOP Max. generator load	70	%
::Load dependent start/stop::IOP/MOP	**Start stop mode:: Generator load**	5763 IOP Min. generator load	30	%
::Load dependent start/stop::IOP/MOP		5764 IOP Add on delay	10	s
::Load dependent start/stop::IOP/MOP		5765 IOP Add on delay at rated load	3	s
::Load dependent start/stop::IOP/MOP		5766 IOP Add off delay	60	s
::Load dependent start/stop::IOP/MOP		5767 MOP Minimum load	10	kW
::Load dependent start/stop::IOP/MOP		5769 MOP Hysteresis	10	kW
::Load dependent start/stop::IOP/MOP	**Start stop mode:: Reserve power**	5768 MOP Reserve power	50	kW
::Load dependent start/stop::IOP/MOP	**Start stop mode:: Generator load**	5758 MOP Dynamic	Low	
::Load dependent start/stop::IOP/MOP	**Start stop mode:: Generator load**	5770 MOP Max. generator load	70	%
::Load dependent start/stop::IOP/MOP	**Start stop mode:: Generator load**	5771 MOP Min. generator load	30	%
::Load dependent start/stop::IOP/MOP		5772 MOP Add on delay	20	s
::Load dependent start/stop::IOP/MOP		5773 MOP Add on delay at rated load	5	s
::Load dependent start/stop::IOP/MOP		5774 MOP Add off delay	60	s
Configure application::Configure emergency run		4101 Break emerg. in critical mode	5	s
Configure application::Configure emergency run		2802 On/Off	Off	
Configure application::Configure emergency run		2800 Mains fail delay time	3	s
Configure application::Configure emergency run		3408 Emerg. start with MCB failure	No	
Configure application::Configure emergency run		12200 Inhibit emerg.run	(True And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure application::Configure breakers		3401 Application mode	GCB	
Configure application::Configure breakers		3411 Breaker transition mode	Parallel	
Configure application::Configure breakers		3400 Transfer time GCB<->MCB	1	s
Configure application::Configure breakers		5820 Dead bus detection max. volt.	10	%
Configure application::Configure breakers		3412 Breaker transition mode 1	Parallel	
Configure application::Configure breakers		12931 Transition mode 1	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure application::Configure breakers		3413 Breaker transition mode 2	Parallel	
Configure application::Configure breakers		12932 Transition mode 2	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s

::Configure breakers::Configure GCB		3403 GCB open relay	N.C.	
::Configure breakers::Configure GCB		3414 GCB close command	Impulse	
::Configure breakers::Configure GCB		3416 GCB time pulse	1	s
::Configure breakers::Configure GCB		5729 Synchronization GCB	Phase matching	
::Configure breakers::Configure GCB	**Synchronization**	5700 Voltage differential GCB	4	%
::Configure breakers::Configure GCB	**Synchronization**	5701 Pos. freq. differential GCB	0.25	Hz
::Configure breakers::Configure GCB	**Synchronization**	5702 Neg. freq. differential GCB	-0.25	Hz
::Configure breakers::Configure GCB	**Phase matching**	5703 Max. positive phase angle GCB	10	°
::Configure breakers::Configure GCB	**Phase matching**	5704 Max. negative phase angle GCB	-10	°
::Configure breakers::Configure GCB	**Phase matching**	5707 Phase matching GCB dwell time	1	s
::Configure breakers::Configure GCB		8825 Phase angle compensation GCB	Off	
::Configure breakers::Configure GCB		12976 GCB open in MAN	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
::Configure breakers::Configure GCB		3432 Dead bus closure GCB	On	
::Configure breakers::Configure GCB		5705 Closing time GCB	150	ms
::Configure breakers::Configure GCB		3415 Generator stable time	3	s
::Configure breakers::Configure GCB		3405 GCB auto unlock	No	
::Configure breakers::Configure GCB		12210 Undelay close GCB	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
::Configure breakers::Configure GCB		12977 GCB close in MAN	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
::Configure breakers::Configure MCB		3417 MCB time pulse	0.5	s
::Configure breakers::Configure MCB		5730 Synchronization MCB	Slip frequency	
::Configure breakers::Configure MCB	**Synchronization**	5710 Voltage differential MCB	5	%
::Configure breakers::Configure MCB	**Synchronization**	5711 Pos. freq. differential MCB	0.18	Hz
::Configure breakers::Configure MCB	**Synchronization**	5712 Neg. freq. differential MCB	-0.1	Hz
::Configure breakers::Configure MCB	**Phase matching**	5713 Max. positive phase angle MCB	7	°
::Configure breakers::Configure MCB	**Phase matching**	5714 Max. negative phase angle MCB	-7	°
::Configure breakers::Configure MCB	**Phase matching**	5717 Phase matching MCB dwell time	1	s
::Configure breakers::Configure MCB		8841 Phase angle compensation MCB	Off	
::Configure breakers::Configure MCB		12974 MCB open in MAN	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s

::Configure breakers::Configure MCB		3431 Dead bus closure MCB	Off	
::Configure breakers::Configure MCB		5715 Closing time MCB	150	ms
::Configure breakers::Configure MCB		3407 MCB auto unlock	No	
::Configure breakers::Configure MCB		12923 Enable MCB	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
::Configure breakers::Configure MCB		12975 MCB close in MAN	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
::Configure breakers::Configure Synchronization		5728 Synchronization mode	RUN	
::Configure breakers::Configure Synchronization		15157 Synchroscope autom. to front	On	
::Configure breakers::Configure Synchronization		12907 Syn. mode PERMIS.	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
::Configure breakers::Configure Synchronization		12906 Syn. mode CHECK	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
::Configure breakers::Configure Synchronization		12908 Syn. mode RUN	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure controller::Configure load share		1723 Segment number	1	
Configure controller::Configure load share		5568 Mode ext. load share gateway	0	
Configure controller::Configure load share		5747 Droop tracking	Off	
Configure controller::Configure load share		5748 Load sharing in droop mode	Off	
Configure controller::Configure load share		5531 Active power load share	Off	
Configure controller::Configure load share		5530 Active power load share factor	50	%
Configure controller::Configure load share		5631 Reactive power load share	Off	
Configure controller::Configure load share		5630 React. power load share factor	50	%
Configure controller::Configure frequency control		5507 Frequency control	PID analog	
Configure controller::Configure frequency control		5508 Freq. control initial state	49.7	%
Configure controller::Configure frequency control	**PID analog**	5510 Proportional gain	3.25	
Configure controller::Configure frequency control	**PID analog**	5511 Integral gain	10	
Configure controller::Configure frequency control	**PID analog**	5512 Derivative ratio	0.01	
Configure controller::Configure frequency control	**3pos controller**	5550 Deadband	0.02	Hz
Configure controller::Configure frequency control	**3pos controller**	5551 Time pulse minimum	0.05	s
Configure controller::Configure frequency control	**3pos controller**	5552 Gain factor	5	
Configure controller::Configure frequency control	**3pos controller**	5553 Expand deadband factor	1	
Configure controller::Configure frequency control	**3pos controller**	5554 Delay expand deadband	2	s

Configure controller::Configure frequency control		5518 Frequency setpoint 1 source	05.03 Interface freq.setp.	
Configure controller::Configure frequency control		5500 Int. freq. control setpoint 1	60	Hz
Configure controller::Configure frequency control		5519 Frequency setpoint 2 source	05.02 Internal freq.setp.2	
Configure controller::Configure frequency control		5501 Int. freq. control setpoint 2	60	Hz
Configure controller::Configure frequency control		5516 Start frequency control level	60	Hz
Configure controller::Configure frequency control		5517 Start frequency control delay	5	s
Configure controller::Configure frequency control		5503 Freq. control setpoint ramp	1	Hz/s
Configure controller::Configure frequency control		5504 Frequency control droop	1	%
Configure controller::Configure frequency control		5502 Slip frequency setpoint offset	0.05	Hz
Configure controller::Configure frequency control		5505 Phase matching gain	3	
Configure controller::Configure frequency control		5506 Phase matching df-start	0.05	Hz
Configure controller::Configure frequency control		12918 Setpoint 2 freq.	(False And False) And False	
		Delay ON	0	s
		Delay OFF	0	s
Configure controller::Configure frequency control		12904 Freq. droop act.	(True Or False) Or False	
		Delay ON	0	s
		Delay OFF	0	s
Configure controller::Configure load control		5525 Load control	PID analog	
Configure controller::Configure load control	**PID analog**	5513 Proportional gain	5	
Configure controller::Configure load control	**PID analog**	5514 Integral gain	5	
Configure controller::Configure load control	**PID analog**	5515 Derivative ratio	0.01	
Configure controller::Configure load control	**3pos controller**	5560 Deadband	1	%
Configure controller::Configure load control	**3pos controller**	5561 Time pulse minimum	0.05	s
Configure controller::Configure load control	**3pos controller**	5562 Gain factor	1	
Configure controller::Configure load control	**3pos controller**	5563 Expand deadband factor	1	
Configure controller::Configure load control	**3pos controller**	5564 Delay expand deadband	1	s
Configure controller::Configure load control		5539 Load setpoint 1 source	05.04 Internal pwr. setp.1	
Configure controller::Configure load control		5526 Load setpoint 1	Constant	
Configure controller::Configure load control		5520 Int. load control setpoint 1	93	kW
Configure controller::Configure load control		5540 Load setpoint 2 source	05.05 Internal pwr. setp.2	
Configure controller::Configure load control		5527 Load setpoint 2	Constant	
Configure controller::Configure load control		5521 Int. load control setpoint 2	0	kW
Configure controller::Configure load control		5522 Load control setpoint ramp	50	%/s
Configure controller::Configure load control		5523 Load control setpoint maximum	100	%
Configure controller::Configure load control		5524 Minimum gen. import/export	0	%
Configure controller::Configure load control		5532 Warm up load limit	100	%

Configure controller::Configure load control		5534 Warm up time	0	s
Configure controller::Configure load control		5533 Warm up mode	Time controlled	
Configure controller::Configure load control		5538 Engine warmup criterion	06.01 Analog input 1	
Configure controller::Configure load control		5546 Warm up threshold	80	°C
Configure controller::Configure load control		12919 Setp. 2 load	(15.02 Flexible limit 2 And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure controller::Configure load control		12940 F/P control	(15.01 Flexible limit 1 Or 15.02 Flexible limit 2) And 04.06 GCB closed	
		Delay ON	0	s
		Delay OFF	0	s
Configure controller::Derating of power		15142 J1939 derating	Off	
Configure controller::Derating of power		15146 Free derating	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure controller::Derating of power		15143 Start derating at	1000	
Configure controller::Derating of power		15144 Stop derating at	0	
Configure controller::Derating of power		15145 Max. power deviation	100	%
Configure controller::Derating of power		15147 Source free derating	06.01 Analog input 1	
Configure controller::f depending derating of power		5781 Function	Off	
Configure controller::f depending derating of power		5782 f start value	50.2	Hz
Configure controller::f depending derating of power		5783 f stop value	50.15	Hz
Configure controller::f depending derating of power		5784 f dep.derating	40	%/Hz
Configure controller::f depending derating of power		5785 Hold max. derating	Off	
Configure controller::Configure voltage control		5607 Voltage control	Off	
Configure controller::Configure voltage control		5608 Voltage control initial state	10	%
Configure controller::Configure voltage control	**PID analog**	5610 Proportional gain	18	
Configure controller::Configure voltage control	**PID analog**	5611 Integral gain	0.6	
Configure controller::Configure voltage control	**PID analog**	5612 Derivative ratio	0.04	
Configure controller::Configure voltage control	**3pos controller**	5650 Deadband	1	%
Configure controller::Configure voltage control	**3pos controller**	5651 Time pulse minimum	1	s
Configure controller::Configure voltage control	**3pos controller**	5652 Gain factor	5	
Configure controller::Configure voltage control	**3pos controller**	5653 Expand deadband factor	1	
Configure controller::Configure voltage control	**3pos controller**	5654 Delay expand deadband	2	s
Configure controller::Configure voltage control		5618 Voltage setpoint 1 source	05.09 Interface volt.setp.	
Configure controller::Configure voltage control		5600 Int.voltage control setpoint 1	480	V
Configure controller::Configure voltage control		5619 Voltage setpoint 2 source	05.08 Internal volt.setp.2	
Configure controller::Configure voltage control		5601 Int.voltage control setpoint 2	480	V

Configure controller::Configure voltage control		5616 Start value	50	%
Configure controller::Configure voltage control		5617 Start delay	1	s
Configure controller::Configure voltage control		5603 Voltage control setpoint ramp	5	%/s
Configure controller::Configure voltage control		5604 Voltage control droop	5	%
Configure controller::Configure voltage control		12920 Setp. 2 voltage	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure controller::Configure voltage control		12905 Volt. droop act.	(True And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure controller::Configure power factor control		5625 Power factor control	Off	
Configure controller::Configure power factor control	**PID analog**	5613 Proportional gain	0.7	
Configure controller::Configure power factor control	**PID analog**	5614 Integral gain	1.5	
Configure controller::Configure power factor control	**PID analog**	5615 Derivative ratio	0.01	
Configure controller::Configure power factor control	**3pos controller**	5660 Deadband	0.01	
Configure controller::Configure power factor control	**3pos controller**	5661 Time pulse minimum	0.05	s
Configure controller::Configure power factor control	**3pos controller**	5662 Gain factor	5	
Configure controller::Configure power factor control	**3pos controller**	5663 Expand deadband factor	1	
Configure controller::Configure power factor control	**3pos controller**	5664 Delay expand deadband	2	s
Configure controller::Configure power factor control		5638 Power Factor setpoint 1 source	05.10 Internal PF setp.1	
Configure controller::Configure power factor control		5620 Int. power factor setpoint 1	0.9	
Configure controller::Configure power factor control		5639 Power Factor setpoint 2 source	05.11 Internal PF setp.2	
Configure controller::Configure power factor control		5621 Int. power factor setpoint 2	1	
Configure controller::Configure power factor control		5622 React. pwr. ctrl setpoint ramp	1	%/s
Configure controller::Configure power factor control		12921 Setp.2 pwr.factor	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure controller::Configure power factor control		12941 V/Q control	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure controller::Power factor characteristic		5786 Power factor characteristic	PF(P)	
Configure controller::Power factor characteristic		5778 Point 1 voltage	98	%
Configure controller::Power factor characteristic		5779 Point 1 Q/S rated	0	
Configure controller::Power factor characteristic		5797 Point 2 voltage	106	%
Configure controller::Power factor characteristic		5798 Point 2 Q/S rated	0.31	
Configure controller::Power factor characteristic		5799 Q(V) response time	10	s
Configure controller::Power factor characteristic		5787 Point 1 power	0	kW
Configure controller::Power factor characteristic		5788 Point 1 cos phi	-0.95	
Configure controller::Power factor characteristic		5789 Point 2 power	200	kW

Configure controller::Power factor characteristic	5790 Point 2 cos phi	0.95	
Configure controller::Discrete raise/low function	12900 Discrete f/P +	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
Configure controller::Discrete raise/low function	12901 Discrete f/P -	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
Configure controller::Discrete raise/low function	12902 Discrete V/PF +	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
Configure controller::Discrete raise/low function	12903 Discrete V/PF -	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
Configure controller::PID1 control	16338 Description	PMin/Max PID	
Configure controller::PID1 control	5571 PID1 control	On	
Configure controller::PID1 control	5572 Proportional gain	10	
Configure controller::PID1 control	5573 Integral gain	0.45	
Configure controller::PID1 control	5574 Derivative ratio	0.001	
Configure controller::PID1 control	5575 Time pulse minimum	0.05	s
Configure controller::PID1 control	5576 Deadband	10	
Configure controller::PID1 control	5582 Sampling time	1	s
Configure controller::PID1 control	5692 Actuator run time	1	s
Configure controller::PID1 control	5577 PID1 control setpoint	06.01 Analog input 1	
Configure controller::PID1 control	5578 PID1 control actual value	01.24 Gen. total power	
Configure controller::PID1 control	5579 Int. PID1 control setpoint	10000	
Configure controller::PID1 control	5581 PID1 control initial state	60	%
Configure controller::PID1 control	5734 PID1 control PI band	1000	
Configure controller::PID1 control	5737 PID1 control setpoint ramp	1	
Configure controller::PID1 control	5740 Value format	0	
Configure controller::PID1 control	5580 PID1 ctrl.release	(True And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
Configure controller::PID2 control	16339 Description	Dispatch Control	
Configure controller::PID2 control	5584 PID2 control	On	
Configure controller::PID2 control	5585 Proportional gain	3.25	
Configure controller::PID2 control	5586 Integral gain	1	
Configure controller::PID2 control	5587 Derivative ratio	0.001	
Configure controller::PID2 control	5588 Time pulse minimum	0.05	s
Configure controller::PID2 control	5589 Deadband	1	
Configure controller::PID2 control	5595 Sampling time	1	s

Configure controller::PID2 control	5693 Actuator run time	4	s
Configure controller::PID2 control	5590 PID2 control setpoint	05.18 Used freq.setp.ramp	
Configure controller::PID2 control	5591 PID2 control actual value	05.17 Used freq.setp.	
Configure controller::PID2 control	5592 Int. PID2 control setpoint	0	
Configure controller::PID2 control	5594 PID2 control initial state	60	%
Configure controller::PID2 control	5735 PID2 control PI band	10	
Configure controller::PID2 control	5738 PID2 control setpoint ramp	10	
Configure controller::PID2 control	5741 Value format	0	
Configure controller::PID2 control	5593 PID2 ctrl.release	(True And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
Configure controller::PID3 control	16348 Description	Freq/Power Conversion	
Configure controller::PID3 control	5670 PID3 control	Off	
Configure controller::PID3 control	5671 Proportional gain	65	
Configure controller::PID3 control	5672 Integral gain	0.01	
Configure controller::PID3 control	5673 Derivative ratio	0.001	
Configure controller::PID3 control	5674 Time pulse minimum	0.05	s
Configure controller::PID3 control	5675 Deadband	1	
Configure controller::PID3 control	5681 Sampling time	1	s
Configure controller::PID3 control	5694 Actuator run time	0.1	s
Configure controller::PID3 control	5676 PID3 control setpoint	05.04 Internal pwr. setp.1	
Configure controller::PID3 control	5677 PID3 control actual value	05.27 Int. PID3 setpoint	
Configure controller::PID3 control	5678 Int. PID3 control setpoint	8000	
Configure controller::PID3 control	5680 PID3 control initial state	50	%
Configure controller::PID3 control	5736 PID3 control PI band	20000	
Configure controller::PID3 control	5739 PID3 control setpoint ramp	1000	
Configure controller::PID3 control	5742 Value format	0	
Configure controller::PID3 control	5679 PID3 ctrl.release	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure analog inputs::Displayed units	3630 Display pressure in	psi	
::Configure analog inputs::Displayed units	3631 Display temperature in	°F	
::Configure analog inputs::User defined table A	3560 X-value 1	0	%
::Configure analog inputs::User defined table A	3561 X-value 2	15	%
::Configure analog inputs::User defined table A	3562 X-value 3	17	%
::Configure analog inputs::User defined table A	3563 X-value 4	33	%
::Configure analog inputs::User defined table A	3564 X-value 5	34	%
::Configure analog inputs::User defined table A	3565 X-value 6	49	%

::Configure analog inputs::User defined table A		3566 X-value 7	58	%
::Configure analog inputs::User defined table A		3567 X-value 8	81	%
::Configure analog inputs::User defined table A		3568 X-value 9	100	%
::Configure analog inputs::User defined table A		3550 Y-value 1	100	
::Configure analog inputs::User defined table A		3551 Y-value 2	88	
::Configure analog inputs::User defined table A		3552 Y-value 3	75	
::Configure analog inputs::User defined table A		3553 Y-value 4	63	
::Configure analog inputs::User defined table A		3554 Y-value 5	50	
::Configure analog inputs::User defined table A		3555 Y-value 6	37	
::Configure analog inputs::User defined table A		3556 Y-value 7	25	
::Configure analog inputs::User defined table A		3557 Y-value 8	13	
::Configure analog inputs::User defined table A		3558 Y-value 9	0	
::Configure analog inputs::User defined table B		3610 X-value 1	4	%
::Configure analog inputs::User defined table B		3611 X-value 2	6	%
::Configure analog inputs::User defined table B		3612 X-value 3	8	%
::Configure analog inputs::User defined table B		3613 X-value 4	13	%
::Configure analog inputs::User defined table B		3614 X-value 5	16	%
::Configure analog inputs::User defined table B		3615 X-value 6	23	%
::Configure analog inputs::User defined table B		3616 X-value 7	28	%
::Configure analog inputs::User defined table B		3617 X-value 8	42	%
::Configure analog inputs::User defined table B		3618 X-value 9	58	%
::Configure analog inputs::User defined table B		3600 Y-value 1	2553	
::Configure analog inputs::User defined table B		3601 Y-value 2	2288	
::Configure analog inputs::User defined table B		3602 Y-value 3	2100	
::Configure analog inputs::User defined table B		3603 Y-value 4	1802	
::Configure analog inputs::User defined table B		3604 Y-value 5	1685	
::Configure analog inputs::User defined table B		3605 Y-value 6	1488	
::Configure analog inputs::User defined table B		3606 Y-value 7	1382	
::Configure analog inputs::User defined table B		3607 Y-value 8	1188	
::Configure analog inputs::User defined table B		3608 Y-value 9	1035	
::Configure analog inputs::Analog input 1		1025 Description		
::Configure analog inputs::Analog input 1		1000 Type	Off	
::Configure analog inputs::Analog input 1	**Linear**	1001 User defined min display value	0	
::Configure analog inputs::Analog input 1	**Linear**	1002 User defined max display value	6000	
::Configure analog inputs::Analog input 1	**Linear, Table A or Table B (Hardware range)**	1039 Sender value at display min.	0	%
::Configure analog inputs::Analog input 1	**Linear, Table A or Table B (Hardware range)**	1040 Sender value at display max.	100	%
::Configure analog inputs::Analog input 1		1020 Sender type	0 - 500 Ohm	
::Configure analog inputs::Analog input 1	**0 - 500 Ohm**	1046 Offset	0	Ohm
::Configure analog inputs::Analog input 1	**0 - 500 Ohm**	1041 Sender connection type	Two wire	

::Configure analog inputs::Analog input 1		10113 Filter time constant	Off	
::Configure analog inputs::Analog input 1	**Wire break**	1003 Monitoring wire break	High	
::Configure analog inputs::Analog input 1	**Wire break**	1004 Wire break alarm class	Control	
::Configure analog inputs::Analog input 1	**Wire break**	1005 Self acknowledge wire break	Yes	
::Configure analog inputs::Analog input 1	**Display**	1035 Value format	00.00Hz	
::Configure analog inputs::Analog input 1	**Display**	3632 Bargraph minimum	5800	
::Configure analog inputs::Analog input 1	**Display**	3633 Bargraph maximum	6200	
::Configure analog inputs::Analog input 2	**Linear**	1051 User defined min display value	100	
::Configure analog inputs::Analog input 2	**Linear**	1052 User defined max display value	0	
::Configure analog inputs::Analog input 2	**Linear, Table A or Table B (Hardware range)**	1089 Sender value at display min.	6	%
::Configure analog inputs::Analog input 2	**Linear, Table A or Table B (Hardware range)**	1090 Sender value at display max.	48	%
::Configure analog inputs::Analog input 2		1070 Sender type	0 - 500 Ohm	
::Configure analog inputs::Analog input 2	**0 - 500 Ohm**	1096 Offset	0	Ohm
::Configure analog inputs::Analog input 2	**0 - 500 Ohm**	1091 Sender connection type	Two wire	
::Configure analog inputs::Analog input 2		10114 Filter time constant	3	
::Configure analog inputs::Analog input 2		1075 Description	Fuel Level	
::Configure analog inputs::Analog input 2		1050 Type	Off	
::Configure analog inputs::Analog input 2	**Wire break**	1053 Monitoring wire break	High	
::Configure analog inputs::Analog input 2	**Wire break**	1054 Wire break alarm class	Class B	
::Configure analog inputs::Analog input 2	**Wire break**	1055 Self acknowledge wire break	Yes	
::Configure analog inputs::Analog input 2	**Display**	1085 Value format	0	
::Configure analog inputs::Analog input 2	**Display**	3634 Bargraph minimum	0	
::Configure analog inputs::Analog input 2	**Display**	3635 Bargraph maximum	100	
::Configure analog inputs::Analog input 3		1120 Sender type	0 - 500 Ohm	
::Configure analog inputs::Analog input 3	**0 - 500 Ohm**	1146 Offset	0	Ohm
::Configure analog inputs::Analog input 3	**0 - 500 Ohm**	1141 Sender connection type	Two wire	
::Configure analog inputs::Analog input 3		10116 Filter time constant	3	
::Configure analog inputs::Analog input 3		1125 Description	Coolant Temp	
::Configure analog inputs::Analog input 3		1100 Type	Off	
::Configure analog inputs::Analog input 3	**Linear**	1101 User defined min display value	0	
::Configure analog inputs::Analog input 3	**Linear**	1102 User defined max display value	1000	
::Configure analog inputs::Analog input 3	**Linear, Table A or Table B (Hardware range)**	1139 Sender value at display min.	0	%
::Configure analog inputs::Analog input 3	**Linear, Table A or Table B (Hardware range)**	1140 Sender value at display max.	100	%
::Configure analog inputs::Analog input 3	**Wire break**	1103 Monitoring wire break	Off	
::Configure analog inputs::Analog input 3	**Wire break**	1104 Wire break alarm class	Class B	

::Configure analog inputs::Analog input 3	**Wire break**	1105 Self acknowledge wire break	No	
::Configure analog inputs::Analog input 3	**Display**	1135 Value format	0	
::Configure analog inputs::Analog input 3	**Display**	3636 Bargraph minimum	0	
::Configure analog inputs::Analog input 3	**Display**	3637 Bargraph maximum	1000	
::Configure analog outputs::Analog output 1		5200 Data source	00.03 Speed bias	
::Configure analog outputs::Analog output 1		5201 Selected hardware type	Off	
::Configure analog outputs::Analog output 1	**User defined (Hardware range)**	5208 User defined min. output value	0	%
::Configure analog outputs::Analog output 1	**User defined (Hardware range)**	5209 User defined max. output value	100	%
::Configure analog outputs::Analog output 1		5204 Source value at minimal output	0	
::Configure analog outputs::Analog output 1		5206 Source value at maximum output	10000	
::Configure analog outputs::Analog output 1		5203 Filter time constant	Off	
::Configure analog outputs::Analog output 1		5202 PWM signal	Off	
::Configure analog outputs::Analog output 1		5210 PWM output level	10	V
::Configure analog outputs::Analog output 2		5214 Data source	00.02 Voltage bias	
::Configure analog outputs::Analog output 2		5215 Selected hardware type	±2.5V	
::Configure analog outputs::Analog output 2	**User defined (Hardware range)**	5222 User defined min. output value	0	%
::Configure analog outputs::Analog output 2	**User defined (Hardware range)**	5223 User defined max. output value	100	%
::Configure analog outputs::Analog output 2		5218 Source value at minimal output	0	
::Configure analog outputs::Analog output 2		5220 Source value at maximum output	10000	
::Configure analog outputs::Analog output 2		5217 Filter time constant	7	
::Configure analog outputs::Analog output 2		5216 PWM signal	Off	
::Configure analog outputs::Analog output 2		5224 PWM output level	10	V
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 1**	1400 Description	Emergency Stop	
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 1**	1200 Delay	0.08	s
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 1**	1201 Operation	N.C.	
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 1**	1202 Alarm class	Class F	
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 1**	1204 Self acknowledge	No	
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 1**	1203 Delayed by engine speed	No	
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 2**	1410 Description	Local Genset Enable	
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 2**	1220 Delay	0.08	s
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 2**	1221 Operation	N.O.	
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 2**	1222 Alarm class	Control	
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 2**	1224 Self acknowledge	Yes	
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 2**	1223 Delayed by engine speed	No	
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 3**	1420 Description	Local Start Request	
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 3**	1240 Delay	0.08	s
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 3**	1241 Operation	N.O.	
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 3**	1242 Alarm class	Control	

::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 3**	1244 Self acknowledge	Yes	
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 3**	1243 Delayed by engine speed	No	
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 4**	1430 Description	Protection Shutdown Request	
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 4**	1260 Delay	0.08	s
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 4**	1261 Operation	N.O.	
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 4**	1262 Alarm class	Class D	
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 4**	1264 Self acknowledge	Yes	
::Configure discrete inputs::Discrete inputs::1-4	**Discrete input 4**	1263 Delayed by engine speed	No	
::Configure discrete inputs::Discrete inputs::5-8	**Discrete input 5**	1440 Description	Discrete Inp. 5	
::Configure discrete inputs::Discrete inputs::5-8	**Discrete input 5**	1280 Delay	0.08	s
::Configure discrete inputs::Discrete inputs::5-8	**Discrete input 5**	1281 Operation	N.O.	
::Configure discrete inputs::Discrete inputs::5-8	**Discrete input 5**	1282 Alarm class	Control	
::Configure discrete inputs::Discrete inputs::5-8	**Discrete input 5**	1284 Self acknowledge	No	
::Configure discrete inputs::Discrete inputs::5-8	**Discrete input 5**	1283 Delayed by engine speed	No	
::Configure discrete inputs::Discrete inputs::5-8	**Discrete input 6**	1450 Description	Discrete Inp. 6	
::Configure discrete inputs::Discrete inputs::5-8	**Discrete input 6**	1300 Delay	0.08	s
::Configure discrete inputs::Discrete inputs::5-8	**Discrete input 6**	1301 Operation	N.O.	
::Configure discrete inputs::Discrete inputs::5-8	**Discrete input 6**	1302 Alarm class	Class F	
::Configure discrete inputs::Discrete inputs::5-8	**Discrete input 6**	1304 Self acknowledge	No	
::Configure discrete inputs::Discrete inputs::5-8	**Discrete input 6**	1303 Delayed by engine speed	No	
::Configure discrete inputs::Discrete inputs::5-8	**Discrete input 7**	1460 Description	Discrete Inp. 7	
::Configure discrete inputs::Discrete inputs::5-8	**Discrete input 7**	1320 Delay	0.08	s
::Configure discrete inputs::Discrete inputs::5-8	**Discrete input 7**	1321 Operation	N.O.	
::Configure discrete inputs::Discrete inputs::5-8	**Discrete input 7**	1322 Alarm class	Control	
::Configure discrete inputs::Discrete inputs::5-8	**Discrete input 7**	1324 Self acknowledge	Yes	
::Configure discrete inputs::Discrete inputs::5-8	**Discrete input 7**	1323 Delayed by engine speed	No	
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 9**	1480 Description	Discrete Inp. 9	
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 9**	1360 Delay	0.08	s
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 9**	1361 Operation	N.O.	
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 9**	1362 Alarm class	Class D	
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 9**	1364 Self acknowledge	No	
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 9**	1363 Delayed by engine speed	No	
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 10**	1488 Description	Low Coolant Level	
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 10**	1380 Delay	30	s
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 10**	1381 Operation	N.O.	
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 10**	1382 Alarm class	Class B	
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 10**	1384 Self acknowledge	Yes	
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 10**	1383 Delayed by engine speed	No	
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 11**	1496 Description	Discrete Inp. 11	
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 11**	1205 Delay	0.08	s
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 11**	1206 Operation	N.O.	
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 11**	1207 Alarm class	Class B	

::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 11**	1209 Self acknowledge	Yes	
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 11**	1208 Delayed by engine speed	No	
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 12**	1504 Description	Discrete Inp. 12	
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 12**	1225 Delay	0.08	s
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 12**	1226 Operation	N.O.	
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 12**	1227 Alarm class	Class B	
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 12**	1229 Self acknowledge	Yes	
::Configure discrete inputs::Discrete inputs::9-12	**Discrete input 12**	1228 Delayed by engine speed	No	

::Configure discrete outputs::Discrete outputs::1-6	12580 Ready for op. OFF	(False And False) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::Discrete outputs::1-6	12110 Relay 2	(03.28 Start/Gas And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::Discrete outputs::1-6	12310 Relay 3	(03.02 Starter And True) And True	
	Delay ON	0.5	s
	Delay OFF	0	s
::Configure discrete outputs::Discrete outputs::1-6	12320 Relay 4	(True And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::Discrete outputs::1-6	12130 Relay 5	(03.01 Auxiliary services Or 15.09 Flexible limit 9) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::Discrete outputs::1-6	12140 Relay 6	(04.20 Closing GCB active And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::Discrete outputs::7-12	12150 Relay 7	(04.19 Opening GCB active And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::Discrete outputs::7-12	12160 Relay 8	(04.06 GCB closed And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::Discrete outputs::7-12	12170 Relay 9	(False And True) And True	
	Delay ON	0	s

		Delay OFF	0	s
::Configure discrete outputs::Discrete outputs::7-12		12180 Relay 10	(03.05 Horn And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
::Configure discrete outputs::Discrete outputs::7-12		12560 Relay 11	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
::Configure discrete outputs::Discrete outputs::7-12		12590 Relay 12	(00.36 LM: Flag 15 And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
::Configure analog inputs::External analog input 1		16203 Description	Ext. AI 1	
::Configure analog inputs::External analog input 1		5851 Type	Off	
::Configure analog inputs::External analog input 1	**Linear**	5852 User defined min display value	0	
::Configure analog inputs::External analog input 1	**Linear**	5853 User defined max display value	1000	
::Configure analog inputs::External analog input 1	**Linear, Table A or Table B (Hardware range)**	5857 Sender value at display min.	0	%
::Configure analog inputs::External analog input 1	**Linear, Table A or Table B (Hardware range)**	5858 Sender value at display max.	100	%
::Configure analog inputs::External analog input 1		5856 Sender type	0 - 10V	
::Configure analog inputs::External analog input 1	**0 - 500 Ohm**	5859 Sender connection type	Two wire	
::Configure analog inputs::External analog input 1		5863 Filter time constant	3	
::Configure analog inputs::External analog input 1	**Wire break**	5854 Wire break alarm class	Class B	
::Configure analog inputs::External analog input 1	**Wire break**	5855 Self acknowledge wire break	No	
::Configure analog inputs::External analog input 1	**Display**	16204 Value format	0	
::Configure analog inputs::External analog input 1	**Display**	5861 Bargraph minimum	0	
::Configure analog inputs::External analog input 1	**Display**	5862 Bargraph maximum	1000	
::Configure analog inputs::External analog input 2		16213 Description	Ext. AI 2	
::Configure analog inputs::External analog input 2		5864 Type	Off	
::Configure analog inputs::External analog input 2	**Linear**	5865 User defined min display value	0	
::Configure analog inputs::External analog input 2	**Linear**	5866 User defined max display value	1000	
::Configure analog inputs::External analog input 2	**Linear, Table A or Table B (Hardware range)**	5870 Sender value at display min.	0	%
::Configure analog inputs::External analog input 2	**Linear, Table A or Table B (Hardware range)**	5871 Sender value at display max.	100	%
::Configure analog inputs::External analog input 2		5869 Sender type	0 - 10V	
::Configure analog inputs::External analog input 2	**0 - 500 Ohm**	5872 Sender connection type	Two wire	
::Configure analog inputs::External analog input 2		5876 Filter time constant	3	

::Configure analog inputs::External analog input 2	**Wire break**	5867 Wire break alarm class	Class B	
::Configure analog inputs::External analog input 2	**Wire break**	5868 Self acknowledge wire break	No	
::Configure analog inputs::External analog input 2	**Display**	16214 Value format	0	
::Configure analog inputs::External analog input 2	**Display**	5874 Bargraph minimum	0	
::Configure analog inputs::External analog input 2	**Display**	5875 Bargraph maximum	1000	
::Configure analog inputs::External analog input 3		16223 Description	Ext. AI 3	
::Configure analog inputs::External analog input 3		5877 Type	Off	
::Configure analog inputs::External analog input 3	**Linear**	5878 User defined min display value	0	
::Configure analog inputs::External analog input 3	**Linear**	5879 User defined max display value	1000	
::Configure analog inputs::External analog input 3	**Linear, Table A or Table B (Hardware range)**	5883 Sender value at display min.	0	%
::Configure analog inputs::External analog input 3	**Linear, Table A or Table B (Hardware range)**	5884 Sender value at display max.	100	%
::Configure analog inputs::External analog input 3		5882 Sender type	0 - 10V	
::Configure analog inputs::External analog input 3	**0 - 500 Ohm**	5885 Sender connection type	Two wire	
::Configure analog inputs::External analog input 3		5889 Filter time constant	3	
::Configure analog inputs::External analog input 3	**Wire break**	5880 Wire break alarm class	Class B	
::Configure analog inputs::External analog input 3	**Wire break**	5881 Self acknowledge wire break	No	
::Configure analog inputs::External analog input 3	**Display**	16224 Value format	0	
::Configure analog inputs::External analog input 3	**Display**	5887 Bargraph minimum	0	
::Configure analog inputs::External analog input 3	**Display**	5888 Bargraph maximum	1000	
::Configure analog inputs::External analog input 4		16233 Description	Ext. AI 4	
::Configure analog inputs::External analog input 4		5890 Type	Off	
::Configure analog inputs::External analog input 4	**Linear**	5891 User defined min display value	0	
::Configure analog inputs::External analog input 4	**Linear**	5892 User defined max display value	1000	
::Configure analog inputs::External analog input 4	**Linear, Table A or Table B (Hardware range)**	5896 Sender value at display min.	0	%
::Configure analog inputs::External analog input 4	**Linear, Table A or Table B (Hardware range)**	5897 Sender value at display max.	100	%
::Configure analog inputs::External analog input 4		5895 Sender type	0 - 10V	
::Configure analog inputs::External analog input 4	**0 - 500 Ohm**	5898 Sender connection type	Two wire	
::Configure analog inputs::External analog input 4		5902 Filter time constant	3	
::Configure analog inputs::External analog input 4	**Wire break**	5893 Wire break alarm class	Class B	
::Configure analog inputs::External analog input 4	**Wire break**	5894 Self acknowledge wire break	No	
::Configure analog inputs::External analog input 4	**Display**	16234 Value format	0	
::Configure analog inputs::External analog input 4	**Display**	5900 Bargraph minimum	0	
::Configure analog inputs::External analog input 4	**Display**	5901 Bargraph maximum	1000	
::Configure analog inputs::External analog input 5		16243 Description	Ext. AI 5	

::Configure analog inputs::External analog input 5		5903 Type	Off	
::Configure analog inputs::External analog input 5	**Linear**	5904 User defined min display value	0	
::Configure analog inputs::External analog input 5	**Linear**	5905 User defined max display value	1000	
::Configure analog inputs::External analog input 5	**Linear, Table A or Table B (Hardware range)**	5909 Sender value at display min.	0	%
::Configure analog inputs::External analog input 5	**Linear, Table A or Table B (Hardware range)**	5910 Sender value at display max.	100	%
::Configure analog inputs::External analog input 5		5908 Sender type	0 - 10V	
::Configure analog inputs::External analog input 5	**0 - 500 Ohm**	5911 Sender connection type	Two wire	
::Configure analog inputs::External analog input 5		5915 Filter time constant	3	
::Configure analog inputs::External analog input 5	**Wire break**	5906 Wire break alarm class	Class B	
::Configure analog inputs::External analog input 5	**Wire break**	5907 Self acknowledge wire break	No	
::Configure analog inputs::External analog input 5	**Display**	16244 Value format	0	
::Configure analog inputs::External analog input 5	**Display**	5913 Bargraph minimum	0	
::Configure analog inputs::External analog input 5	**Display**	5914 Bargraph maximum	1000	
::Configure analog inputs::External analog input 6		16253 Description	Ext. AI 6	
::Configure analog inputs::External analog input 6		5916 Type	Off	
::Configure analog inputs::External analog input 6	**Linear**	5917 User defined min display value	0	
::Configure analog inputs::External analog input 6	**Linear**	5918 User defined max display value	1000	
::Configure analog inputs::External analog input 6	**Linear, Table A or Table B (Hardware range)**	5922 Sender value at display min.	0	%
::Configure analog inputs::External analog input 6	**Linear, Table A or Table B (Hardware range)**	5923 Sender value at display max.	100	%
::Configure analog inputs::External analog input 6		5921 Sender type	0 - 10V	
::Configure analog inputs::External analog input 6	**0 - 500 Ohm**	5924 Sender connection type	Two wire	
::Configure analog inputs::External analog input 6		5928 Filter time constant	3	
::Configure analog inputs::External analog input 6	**Wire break**	5919 Wire break alarm class	Class B	
::Configure analog inputs::External analog input 6	**Wire break**	5920 Self acknowledge wire break	No	
::Configure analog inputs::External analog input 6	**Display**	16254 Value format	0	
::Configure analog inputs::External analog input 6	**Display**	5926 Bargraph minimum	0	
::Configure analog inputs::External analog input 6	**Display**	5927 Bargraph maximum	1000	
::Configure analog inputs::External analog input 7		16263 Description	Ext. AI 7	
::Configure analog inputs::External analog input 7		5929 Type	Off	
::Configure analog inputs::External analog input 7	**Linear**	5930 User defined min display value	0	
::Configure analog inputs::External analog input 7	**Linear**	5931 User defined max display value	1000	
::Configure analog inputs::External analog input 7	**Linear, Table A or Table B (Hardware range)**	5935 Sender value at display min.	0	%

::Configure analog inputs::External analog input 7	**Linear, Table A or Table B (Hardware range)**	5936 Sender value at display max.	100	%
::Configure analog inputs::External analog input 7		5934 Sender type	0 - 10V	
::Configure analog inputs::External analog input 7	**0 - 500 Ohm**	5937 Sender connection type	Two wire	
::Configure analog inputs::External analog input 7		5941 Filter time constant	3	
::Configure analog inputs::External analog input 7	**Wire break**	5932 Wire break alarm class	Class B	
::Configure analog inputs::External analog input 7	**Wire break**	5933 Self acknowledge wire break	No	
::Configure analog inputs::External analog input 7	**Display**	16264 Value format	0	
::Configure analog inputs::External analog input 7	**Display**	5939 Bargraph minimum	0	
::Configure analog inputs::External analog input 7	**Display**	5940 Bargraph maximum	1000	
::Configure analog inputs::External analog input 8		16273 Description	Ext. AI 8	
::Configure analog inputs::External analog input 8		5942 Type	Off	
::Configure analog inputs::External analog input 8	**Linear**	5943 User defined min display value	0	
::Configure analog inputs::External analog input 8	**Linear**	5944 User defined max display value	1000	
::Configure analog inputs::External analog input 8	**Linear, Table A or Table B (Hardware range)**	5948 Sender value at display min.	0	%
::Configure analog inputs::External analog input 8	**Linear, Table A or Table B (Hardware range)**	5949 Sender value at display max.	100	%
::Configure analog inputs::External analog input 8		5947 Sender type	0 - 10V	
::Configure analog inputs::External analog input 8	**0 - 500 Ohm**	5950 Sender connection type	Two wire	
::Configure analog inputs::External analog input 8		5954 Filter time constant	3	
::Configure analog inputs::External analog input 8	**Wire break**	5945 Wire break alarm class	Class B	
::Configure analog inputs::External analog input 8	**Wire break**	5946 Self acknowledge wire break	No	
::Configure analog inputs::External analog input 8	**Display**	16274 Value format	0	
::Configure analog inputs::External analog input 8	**Display**	5952 Bargraph minimum	0	
::Configure analog inputs::External analog input 8	**Display**	5953 Bargraph maximum	1000	
::Configure analog inputs::External analog input 9		16283 Description	Ext. AI 9	
::Configure analog inputs::External analog input 9		5955 Type	Off	
::Configure analog inputs::External analog input 9	**Linear**	5956 User defined min display value	0	
::Configure analog inputs::External analog input 9	**Linear**	5957 User defined max display value	1000	
::Configure analog inputs::External analog input 9	**Linear, Table A or Table B (Hardware range)**	5961 Sender value at display min.	0	%
::Configure analog inputs::External analog input 9	**Linear, Table A or Table B (Hardware range)**	5962 Sender value at display max.	100	%
::Configure analog inputs::External analog input 9		5960 Sender type	0 - 10V	
::Configure analog inputs::External analog input 9	**0 - 500 Ohm**	5963 Sender connection type	Two wire	
::Configure analog inputs::External analog input 9		5967 Filter time constant	3	
::Configure analog inputs::External analog input 9	**Wire break**	5958 Wire break alarm class	Class B	

::Configure analog inputs::External analog input 9	**Wire break**	5959 Self acknowledge wire break	No	
::Configure analog inputs::External analog input 9	**Display**	16284 Value format	0	
::Configure analog inputs::External analog input 9	**Display**	5965 Bargraph minimum	0	
::Configure analog inputs::External analog input 9	**Display**	5966 Bargraph maximum	1000	
::Configure analog inputs::External analog input 10		16293 Description	Ext. AI 10	
::Configure analog inputs::External analog input 10		5968 Type	Off	
::Configure analog inputs::External analog input 10	**Linear**	5969 User defined min display value	0	
::Configure analog inputs::External analog input 10	**Linear**	5970 User defined max display value	1000	
::Configure analog inputs::External analog input 10	**Linear, Table A or Table B (Hardware range)**	5974 Sender value at display min.	0	%
::Configure analog inputs::External analog input 10	**Linear, Table A or Table B (Hardware range)**	5975 Sender value at display max.	100	%
::Configure analog inputs::External analog input 10		5973 Sender type	0 - 10V	
::Configure analog inputs::External analog input 10	**0 - 500 Ohm**	5976 Sender connection type	Two wire	
::Configure analog inputs::External analog input 10		5980 Filter time constant	3	
::Configure analog inputs::External analog input 10	**Wire break**	5971 Wire break alarm class	Class B	
::Configure analog inputs::External analog input 10	**Wire break**	5972 Self acknowledge wire break	No	
::Configure analog inputs::External analog input 10	**Display**	16294 Value format	0	
::Configure analog inputs::External analog input 10	**Display**	5978 Bargraph minimum	0	
::Configure analog inputs::External analog input 10	**Display**	5979 Bargraph maximum	1000	
::Configure analog inputs::External analog input 11		16303 Description	Ext. AI 11	
::Configure analog inputs::External analog input 11		5981 Type	Off	
::Configure analog inputs::External analog input 11	**Linear**	5982 User defined min display value	0	
::Configure analog inputs::External analog input 11	**Linear**	5983 User defined max display value	1000	
::Configure analog inputs::External analog input 11	**Linear, Table A or Table B (Hardware range)**	5987 Sender value at display min.	0	%
::Configure analog inputs::External analog input 11	**Linear, Table A or Table B (Hardware range)**	5988 Sender value at display max.	100	%
::Configure analog inputs::External analog input 11		5986 Sender type	0 - 10V	
::Configure analog inputs::External analog input 11	**0 - 500 Ohm**	5989 Sender connection type	Two wire	
::Configure analog inputs::External analog input 11		5993 Filter time constant	3	
::Configure analog inputs::External analog input 11	**Wire break**	5984 Wire break alarm class	Class B	
::Configure analog inputs::External analog input 11	**Wire break**	5985 Self acknowledge wire break	No	
::Configure analog inputs::External analog input 11	**Display**	16304 Value format	0	
::Configure analog inputs::External analog input 11	**Display**	5991 Bargraph minimum	0	
::Configure analog inputs::External analog input 11	**Display**	5992 Bargraph maximum	1000	
::Configure analog inputs::External analog input 12		16313 Description	Ext. AI 12	
::Configure analog inputs::External analog input 12		6930 Type	Off	

::Configure analog inputs::External analog input 12	**Linear**	6931 User defined min display value	0	
::Configure analog inputs::External analog input 12	**Linear**	6932 User defined max display value	1000	
::Configure analog inputs::External analog input 12	**Linear, Table A or Table B (Hardware range)**	6936 Sender value at display min.	0	%
::Configure analog inputs::External analog input 12	**Linear, Table A or Table B (Hardware range)**	6937 Sender value at display max.	100	%
::Configure analog inputs::External analog input 12		6935 Sender type	0 - 10V	
::Configure analog inputs::External analog input 12	**0 - 500 Ohm**	6938 Sender connection type	Two wire	
::Configure analog inputs::External analog input 12		6942 Filter time constant	3	
::Configure analog inputs::External analog input 12	**Wire break**	6933 Wire break alarm class	Class B	
::Configure analog inputs::External analog input 12	**Wire break**	6934 Self acknowledge wire break	No	
::Configure analog inputs::External analog input 12	**Display**	16314 Value format	0	
::Configure analog inputs::External analog input 12	**Display**	6940 Bargraph minimum	0	
::Configure analog inputs::External analog input 12	**Display**	6941 Bargraph maximum	1000	
::Configure analog inputs::External analog input 13		16323 Description	Ext. AI 13	
::Configure analog inputs::External analog input 13		6943 Type	Off	
::Configure analog inputs::External analog input 13	**Linear**	6944 User defined min display value	0	
::Configure analog inputs::External analog input 13	**Linear**	6945 User defined max display value	1000	
::Configure analog inputs::External analog input 13	**Linear, Table A or Table B (Hardware range)**	6949 Sender value at display min.	0	%
::Configure analog inputs::External analog input 13	**Linear, Table A or Table B (Hardware range)**	6950 Sender value at display max.	100	%
::Configure analog inputs::External analog input 13		6948 Sender type	0 - 10V	
::Configure analog inputs::External analog input 13	**0 - 500 Ohm**	6951 Sender connection type	Two wire	
::Configure analog inputs::External analog input 13		6955 Filter time constant	3	
::Configure analog inputs::External analog input 13	**Wire break**	6946 Wire break alarm class	Class B	
::Configure analog inputs::External analog input 13	**Wire break**	6947 Self acknowledge wire break	No	
::Configure analog inputs::External analog input 13	**Display**	16324 Value format	0	
::Configure analog inputs::External analog input 13	**Display**	6953 Bargraph minimum	0	
::Configure analog inputs::External analog input 13	**Display**	6954 Bargraph maximum	1000	
::Configure analog inputs::External analog input 14		16333 Description	Ext. AI 14	
::Configure analog inputs::External analog input 14		6956 Type	Off	
::Configure analog inputs::External analog input 14	**Linear**	6957 User defined min display value	0	
::Configure analog inputs::External analog input 14	**Linear**	6958 User defined max display value	1000	
::Configure analog inputs::External analog input 14	**Linear, Table A or Table B (Hardware range)**	6962 Sender value at display min.	0	%

::Configure analog inputs::External analog input 14	**Linear, Table A or Table B (Hardware range)**	6963 Sender value at display max.	100	%
::Configure analog inputs::External analog input 14		6961 Sender type	0 - 10V	
::Configure analog inputs::External analog input 14	**0 - 500 Ohm**	6964 Sender connection type	Two wire	
::Configure analog inputs::External analog input 14		6968 Filter time constant	3	
::Configure analog inputs::External analog input 14	**Wire break**	6959 Wire break alarm class	Class B	
::Configure analog inputs::External analog input 14	**Wire break**	6960 Self acknowledge wire break	No	
::Configure analog inputs::External analog input 14	**Display**	16334 Value format	0	
::Configure analog inputs::External analog input 14	**Display**	6966 Bargraph minimum	0	
::Configure analog inputs::External analog input 14	**Display**	6967 Bargraph maximum	1000	
::Configure analog inputs::External analog input 15		16343 Description	Ext. AI 15	
::Configure analog inputs::External analog input 15		6969 Type	Off	
::Configure analog inputs::External analog input 15	**Linear**	6970 User defined min display value	0	
::Configure analog inputs::External analog input 15	**Linear**	6971 User defined max display value	1000	
::Configure analog inputs::External analog input 15	**Linear, Table A or Table B (Hardware range)**	6975 Sender value at display min.	0	%
::Configure analog inputs::External analog input 15	**Linear, Table A or Table B (Hardware range)**	6976 Sender value at display max.	100	%
::Configure analog inputs::External analog input 15		6974 Sender type	0 - 10V	
::Configure analog inputs::External analog input 15	**0 - 500 Ohm**	6977 Sender connection type	Two wire	
::Configure analog inputs::External analog input 15		6981 Filter time constant	3	
::Configure analog inputs::External analog input 15	**Wire break**	6972 Wire break alarm class	Class B	
::Configure analog inputs::External analog input 15	**Wire break**	6973 Self acknowledge wire break	No	
::Configure analog inputs::External analog input 15	**Display**	16344 Value format	0	
::Configure analog inputs::External analog input 15	**Display**	6979 Bargraph minimum	0	
::Configure analog inputs::External analog input 15	**Display**	6980 Bargraph maximum	1000	
::Configure analog inputs::External analog input 16		16353 Description	Ext. AI 16	
::Configure analog inputs::External analog input 16		6982 Type	Off	
::Configure analog inputs::External analog input 16	**Linear**	6983 User defined min display value	0	
::Configure analog inputs::External analog input 16	**Linear**	6984 User defined max display value	1000	
::Configure analog inputs::External analog input 16	**Linear, Table A or Table B (Hardware range)**	6988 Sender value at display min.	0	%
::Configure analog inputs::External analog input 16	**Linear, Table A or Table B (Hardware range)**	6989 Sender value at display max.	100	%
::Configure analog inputs::External analog input 16		6987 Sender type	0 - 10V	
::Configure analog inputs::External analog input 16	**0 - 500 Ohm**	6990 Sender connection type	Two wire	
::Configure analog inputs::External analog input 16		6994 Filter time constant	3	
::Configure analog inputs::External analog input 16	**Wire break**	6985 Wire break alarm class	Class B	

::Configure analog inputs::External analog input 16	**Wire break**	6986 Self acknowledge wire break	No	
::Configure analog inputs::External analog input 16	**Display**	16354 Value format	0	
::Configure analog inputs::External analog input 16	**Display**	6992 Bargraph minimum	0	
::Configure analog inputs::External analog input 16	**Display**	6993 Bargraph maximum	1000	
::Configure analog inputs::External analog output 1		10237 Data source	05.03 Interface freq.setp.	
::Configure analog inputs::External analog output 1		10238 Selected hardware type	User defined	
::Configure analog inputs::External analog output 1	**User defined (Hardware range)**	10242 User defined min. output value	0	%
::Configure analog inputs::External analog output 1	**User defined (Hardware range)**	10243 User defined max. output value	100	%
::Configure analog inputs::External analog output 1		10240 Source value at minimal output	0	
::Configure analog inputs::External analog output 1		10241 Source value at maximum output	16667	
::Configure analog inputs::External analog output 1		10239 Filter time constant	Off	
::Configure analog inputs::External analog output 2		10247 Data source	00.03 Speed bias	
::Configure analog inputs::External analog output 2		10248 Selected hardware type	0/4-20mA/0-10V	
::Configure analog inputs::External analog output 2	**User defined (Hardware range)**	10252 User defined min. output value	0	%
::Configure analog inputs::External analog output 2	**User defined (Hardware range)**	10253 User defined max. output value	100	%
::Configure analog inputs::External analog output 2		10250 Source value at minimal output	0	
::Configure analog inputs::External analog output 2		10251 Source value at maximum output	10000	
::Configure analog inputs::External analog output 2		10249 Filter time constant	Off	
::Configure analog inputs::External analog output 3		10257 Data source	00.03 Speed bias	
::Configure analog inputs::External analog output 3		10258 Selected hardware type	0/4-20mA/0-10V	
::Configure analog inputs::External analog output 3	**User defined (Hardware range)**	10262 User defined min. output value	0	%
::Configure analog inputs::External analog output 3	**User defined (Hardware range)**	10263 User defined max. output value	100	%
::Configure analog inputs::External analog output 3		10260 Source value at minimal output	0	
::Configure analog inputs::External analog output 3		10261 Source value at maximum output	10000	
::Configure analog inputs::External analog output 3		10259 Filter time constant	Off	
::Configure analog inputs::External analog output 4		10267 Data source	00.03 Speed bias	
::Configure analog inputs::External analog output 4		10268 Selected hardware type	0/4-20mA/0-10V	
::Configure analog inputs::External analog output 4	**User defined (Hardware range)**	10272 User defined min. output value	0	%
::Configure analog inputs::External analog output 4	**User defined (Hardware range)**	10273 User defined max. output value	100	%
::Configure analog inputs::External analog output 4		10270 Source value at minimal output	0	
::Configure analog inputs::External analog output 4		10271 Source value at maximum output	10000	
::Configure analog inputs::External analog output 4		10269 Filter time constant	Off	
::Configure discrete inputs::External DIs::1-4	**External discrete input 1**	16200 Description	Ext. DI 1	

::Configure discrete inputs::External DIs::1-4	**External discrete input 1**	16000 Delay	0.2	s
::Configure discrete inputs::External DIs::1-4	**External discrete input 1**	16001 Operation	N.O.	
::Configure discrete inputs::External DIs::1-4	**External discrete input 1**	16002 Alarm class	Control	
::Configure discrete inputs::External DIs::1-4	**External discrete input 1**	16004 Self acknowledge	No	
::Configure discrete inputs::External DIs::1-4	**External discrete input 1**	16003 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::1-4	**External discrete input 2**	16210 Description	Ext. DI 2	
::Configure discrete inputs::External DIs::1-4	**External discrete input 2**	16010 Delay	0.2	s
::Configure discrete inputs::External DIs::1-4	**External discrete input 2**	16011 Operation	N.O.	
::Configure discrete inputs::External DIs::1-4	**External discrete input 2**	16012 Alarm class	Control	
::Configure discrete inputs::External DIs::1-4	**External discrete input 2**	16014 Self acknowledge	No	
::Configure discrete inputs::External DIs::1-4	**External discrete input 2**	16013 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::1-4	**External discrete input 3**	16220 Description	Ext. DI 3	
::Configure discrete inputs::External DIs::1-4	**External discrete input 3**	16020 Delay	0.2	s
::Configure discrete inputs::External DIs::1-4	**External discrete input 3**	16021 Operation	N.O.	
::Configure discrete inputs::External DIs::1-4	**External discrete input 3**	16022 Alarm class	Control	
::Configure discrete inputs::External DIs::1-4	**External discrete input 3**	16024 Self acknowledge	No	
::Configure discrete inputs::External DIs::1-4	**External discrete input 3**	16023 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::1-4	**External discrete input 4**	16230 Description	Ext. DI 4	
::Configure discrete inputs::External DIs::1-4	**External discrete input 4**	16030 Delay	0.2	s
::Configure discrete inputs::External DIs::1-4	**External discrete input 4**	16031 Operation	N.O.	
::Configure discrete inputs::External DIs::1-4	**External discrete input 4**	16032 Alarm class	Control	
::Configure discrete inputs::External DIs::1-4	**External discrete input 4**	16034 Self acknowledge	No	
::Configure discrete inputs::External DIs::1-4	**External discrete input 4**	16033 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::5-8	**External discrete input 5**	16240 Description	Ext. DI 5	
::Configure discrete inputs::External DIs::5-8	**External discrete input 5**	16040 Delay	0.2	s
::Configure discrete inputs::External DIs::5-8	**External discrete input 5**	16041 Operation	N.O.	
::Configure discrete inputs::External DIs::5-8	**External discrete input 5**	16042 Alarm class	Control	
::Configure discrete inputs::External DIs::5-8	**External discrete input 5**	16044 Self acknowledge	No	

::Configure discrete inputs::External DIs::5-8	**External discrete input 5**	16043 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::5-8	**External discrete input 6**	16250 Description	Ext. DI 6	
::Configure discrete inputs::External DIs::5-8	**External discrete input 6**	16050 Delay	0.2	s
::Configure discrete inputs::External DIs::5-8	**External discrete input 6**	16051 Operation	N.O.	
::Configure discrete inputs::External DIs::5-8	**External discrete input 6**	16052 Alarm class	Control	
::Configure discrete inputs::External DIs::5-8	**External discrete input 6**	16054 Self acknowledge	No	
::Configure discrete inputs::External DIs::5-8	**External discrete input 6**	16053 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::5-8	**External discrete input 7**	16260 Description	Ext. DI 7	
::Configure discrete inputs::External DIs::5-8	**External discrete input 7**	16060 Delay	0.2	s
::Configure discrete inputs::External DIs::5-8	**External discrete input 7**	16061 Operation	N.O.	
::Configure discrete inputs::External DIs::5-8	**External discrete input 7**	16062 Alarm class	Control	
::Configure discrete inputs::External DIs::5-8	**External discrete input 7**	16064 Self acknowledge	No	
::Configure discrete inputs::External DIs::5-8	**External discrete input 7**	16063 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::5-8	**External discrete input 8**	16270 Description	Ext. DI 8	
::Configure discrete inputs::External DIs::5-8	**External discrete input 8**	16070 Delay	0.2	s
::Configure discrete inputs::External DIs::5-8	**External discrete input 8**	16071 Operation	N.O.	
::Configure discrete inputs::External DIs::5-8	**External discrete input 8**	16072 Alarm class	Control	
::Configure discrete inputs::External DIs::5-8	**External discrete input 8**	16074 Self acknowledge	No	
::Configure discrete inputs::External DIs::5-8	**External discrete input 8**	16073 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::9-12	**External discrete input 9**	16280 Description	Ext. DI 9	
::Configure discrete inputs::External DIs::9-12	**External discrete input 9**	16080 Delay	0.2	s
::Configure discrete inputs::External DIs::9-12	**External discrete input 9**	16081 Operation	N.O.	
::Configure discrete inputs::External DIs::9-12	**External discrete input 9**	16082 Alarm class	Control	
::Configure discrete inputs::External DIs::9-12	**External discrete input 9**	16084 Self acknowledge	No	
::Configure discrete inputs::External DIs::9-12	**External discrete input 9**	16083 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::9-12	**External discrete input 10**	16290 Description	Ext. DI 10	
::Configure discrete inputs::External DIs::9-12	**External discrete input 10**	16090 Delay	0.2	s
::Configure discrete inputs::External DIs::9-12	**External discrete input 10**	16091 Operation	N.O.	

::Configure discrete inputs::External DIs::9-12	**External discrete input 10**	16092 Alarm class	Control	
::Configure discrete inputs::External DIs::9-12	**External discrete input 10**	16094 Self acknowledge	No	
::Configure discrete inputs::External DIs::9-12	**External discrete input 10**	16093 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::9-12	**External discrete input 11**	16300 Description	Ext. DI 11	
::Configure discrete inputs::External DIs::9-12	**External discrete input 11**	16100 Delay	0.2	s
::Configure discrete inputs::External DIs::9-12	**External discrete input 11**	16101 Operation	N.O.	
::Configure discrete inputs::External DIs::9-12	**External discrete input 11**	16102 Alarm class	Control	
::Configure discrete inputs::External DIs::9-12	**External discrete input 11**	16104 Self acknowledge	No	
::Configure discrete inputs::External DIs::9-12	**External discrete input 11**	16103 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::9-12	**External discrete input 12**	16310 Description	Ext. DI 12	
::Configure discrete inputs::External DIs::9-12	**External discrete input 12**	16110 Delay	0.2	s
::Configure discrete inputs::External DIs::9-12	**External discrete input 12**	16111 Operation	N.O.	
::Configure discrete inputs::External DIs::9-12	**External discrete input 12**	16112 Alarm class	Control	
::Configure discrete inputs::External DIs::9-12	**External discrete input 12**	16114 Self acknowledge	No	
::Configure discrete inputs::External DIs::9-12	**External discrete input 12**	16113 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::13-16	**External discrete input 13**	16320 Description	Ext. DI 13	
::Configure discrete inputs::External DIs::13-16	**External discrete input 13**	16120 Delay	0.2	s
::Configure discrete inputs::External DIs::13-16	**External discrete input 13**	16121 Operation	N.O.	
::Configure discrete inputs::External DIs::13-16	**External discrete input 13**	16122 Alarm class	Control	
::Configure discrete inputs::External DIs::13-16	**External discrete input 13**	16124 Self acknowledge	No	
::Configure discrete inputs::External DIs::13-16	**External discrete input 13**	16123 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::13-16	**External discrete input 14**	16330 Description	Ext. DI 14	
::Configure discrete inputs::External DIs::13-16	**External discrete input 14**	16130 Delay	0.2	s
::Configure discrete inputs::External DIs::13-16	**External discrete input 14**	16131 Operation	N.O.	
::Configure discrete inputs::External DIs::13-16	**External discrete input 14**	16132 Alarm class	Control	
::Configure discrete inputs::External DIs::13-16	**External discrete input 14**	16134 Self acknowledge	No	
::Configure discrete inputs::External DIs::13-16	**External discrete input 14**	16133 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::13-16	**External discrete input 15**	16340 Description	Ext. DI 15	

::Configure discrete inputs::External DIs::13-16	**External discrete input 15**	16140 Delay	0.2	s
::Configure discrete inputs::External DIs::13-16	**External discrete input 15**	16141 Operation	N.O.	
::Configure discrete inputs::External DIs::13-16	**External discrete input 15**	16142 Alarm class	Control	
::Configure discrete inputs::External DIs::13-16	**External discrete input 15**	16144 Self acknowledge	No	
::Configure discrete inputs::External DIs::13-16	**External discrete input 15**	16143 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::13-16	**External discrete input 16**	16350 Description	Ext. DI 16	
::Configure discrete inputs::External DIs::13-16	**External discrete input 16**	16150 Delay	0.2	s
::Configure discrete inputs::External DIs::13-16	**External discrete input 16**	16151 Operation	N.O.	
::Configure discrete inputs::External DIs::13-16	**External discrete input 16**	16152 Alarm class	Control	
::Configure discrete inputs::External DIs::13-16	**External discrete input 16**	16154 Self acknowledge	No	
::Configure discrete inputs::External DIs::13-16	**External discrete input 16**	16153 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::17-20	**External discrete input 17**	16201 Description	Ext. DI 17	
::Configure discrete inputs::External DIs::17-20	**External discrete input 17**	16005 Delay	0.2	s
::Configure discrete inputs::External DIs::17-20	**External discrete input 17**	16006 Operation	N.O.	
::Configure discrete inputs::External DIs::17-20	**External discrete input 17**	16007 Alarm class	Control	
::Configure discrete inputs::External DIs::17-20	**External discrete input 17**	16009 Self acknowledge	No	
::Configure discrete inputs::External DIs::17-20	**External discrete input 17**	16008 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::17-20	**External discrete input 18**	16211 Description	Ext. DI 18	
::Configure discrete inputs::External DIs::17-20	**External discrete input 18**	16015 Delay	0.2	s
::Configure discrete inputs::External DIs::17-20	**External discrete input 18**	16016 Operation	N.O.	
::Configure discrete inputs::External DIs::17-20	**External discrete input 18**	16017 Alarm class	Control	
::Configure discrete inputs::External DIs::17-20	**External discrete input 18**	16019 Self acknowledge	No	
::Configure discrete inputs::External DIs::17-20	**External discrete input 18**	16018 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::17-20	**External discrete input 19**	16221 Description	Ext. DI 19	
::Configure discrete inputs::External DIs::17-20	**External discrete input 19**	16025 Delay	0.2	s
::Configure discrete inputs::External DIs::17-20	**External discrete input 19**	16026 Operation	N.O.	
::Configure discrete inputs::External DIs::17-20	**External discrete input 19**	16027 Alarm class	Control	
::Configure discrete inputs::External DIs::17-20	**External discrete input 19**	16029 Self acknowledge	No	

::Configure discrete inputs::External DIs::17-20	**External discrete input 19**	16028 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::17-20	**External discrete input 20**	16231 Description	Ext. DI 20	
::Configure discrete inputs::External DIs::17-20	**External discrete input 20**	16035 Delay	0.2	s
::Configure discrete inputs::External DIs::17-20	**External discrete input 20**	16036 Operation	N.O.	
::Configure discrete inputs::External DIs::17-20	**External discrete input 20**	16037 Alarm class	Control	
::Configure discrete inputs::External DIs::17-20	**External discrete input 20**	16039 Self acknowledge	No	
::Configure discrete inputs::External DIs::17-20	**External discrete input 20**	16038 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::21-24	**External discrete input 21**	16241 Description	Ext. DI 21	
::Configure discrete inputs::External DIs::21-24	**External discrete input 21**	16045 Delay	0.2	s
::Configure discrete inputs::External DIs::21-24	**External discrete input 21**	16046 Operation	N.O.	
::Configure discrete inputs::External DIs::21-24	**External discrete input 21**	16047 Alarm class	Control	
::Configure discrete inputs::External DIs::21-24	**External discrete input 21**	16049 Self acknowledge	No	
::Configure discrete inputs::External DIs::21-24	**External discrete input 21**	16048 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::21-24	**External discrete input 22**	16251 Description	Ext. DI 22	
::Configure discrete inputs::External DIs::21-24	**External discrete input 22**	16055 Delay	0.2	s
::Configure discrete inputs::External DIs::21-24	**External discrete input 22**	16056 Operation	N.O.	
::Configure discrete inputs::External DIs::21-24	**External discrete input 22**	16057 Alarm class	Control	
::Configure discrete inputs::External DIs::21-24	**External discrete input 22**	16059 Self acknowledge	No	
::Configure discrete inputs::External DIs::21-24	**External discrete input 22**	16058 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::21-24	**External discrete input 23**	16261 Description	Ext. DI 23	
::Configure discrete inputs::External DIs::21-24	**External discrete input 23**	16065 Delay	0.2	s
::Configure discrete inputs::External DIs::21-24	**External discrete input 23**	16066 Operation	N.O.	
::Configure discrete inputs::External DIs::21-24	**External discrete input 23**	16067 Alarm class	Control	
::Configure discrete inputs::External DIs::21-24	**External discrete input 23**	16069 Self acknowledge	No	
::Configure discrete inputs::External DIs::21-24	**External discrete input 23**	16068 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::21-24	**External discrete input 24**	16271 Description	Ext. DI 24	
::Configure discrete inputs::External DIs::21-24	**External discrete input 24**	16075 Delay	0.2	s
::Configure discrete inputs::External DIs::21-24	**External discrete input 24**	16076 Operation	N.O.	

::Configure discrete inputs::External DIs::21-24	**External discrete input 24**	16077 Alarm class	Control	
::Configure discrete inputs::External DIs::21-24	**External discrete input 24**	16079 Self acknowledge	No	
::Configure discrete inputs::External DIs::21-24	**External discrete input 24**	16078 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::25-28	**External discrete input 25**	16281 Description	Ext. DI 25	
::Configure discrete inputs::External DIs::25-28	**External discrete input 25**	16085 Delay	0.2	s
::Configure discrete inputs::External DIs::25-28	**External discrete input 25**	16086 Operation	N.O.	
::Configure discrete inputs::External DIs::25-28	**External discrete input 25**	16087 Alarm class	Control	
::Configure discrete inputs::External DIs::25-28	**External discrete input 25**	16089 Self acknowledge	No	
::Configure discrete inputs::External DIs::25-28	**External discrete input 25**	16088 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::25-28	**External discrete input 26**	16291 Description	Ext. DI 26	
::Configure discrete inputs::External DIs::25-28	**External discrete input 26**	16095 Delay	0.2	s
::Configure discrete inputs::External DIs::25-28	**External discrete input 26**	16096 Operation	N.O.	
::Configure discrete inputs::External DIs::25-28	**External discrete input 26**	16097 Alarm class	Control	
::Configure discrete inputs::External DIs::25-28	**External discrete input 26**	16099 Self acknowledge	No	
::Configure discrete inputs::External DIs::25-28	**External discrete input 26**	16098 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::25-28	**External discrete input 27**	16301 Description	Ext. DI 27	
::Configure discrete inputs::External DIs::25-28	**External discrete input 27**	16105 Delay	0.2	s
::Configure discrete inputs::External DIs::25-28	**External discrete input 27**	16106 Operation	N.O.	
::Configure discrete inputs::External DIs::25-28	**External discrete input 27**	16107 Alarm class	Control	
::Configure discrete inputs::External DIs::25-28	**External discrete input 27**	16109 Self acknowledge	No	
::Configure discrete inputs::External DIs::25-28	**External discrete input 27**	16108 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::25-28	**External discrete input 28**	16311 Description	Ext. DI 28	
::Configure discrete inputs::External DIs::25-28	**External discrete input 28**	16115 Delay	0.2	s
::Configure discrete inputs::External DIs::25-28	**External discrete input 28**	16116 Operation	N.O.	
::Configure discrete inputs::External DIs::25-28	**External discrete input 28**	16117 Alarm class	Control	
::Configure discrete inputs::External DIs::25-28	**External discrete input 28**	16119 Self acknowledge	No	
::Configure discrete inputs::External DIs::25-28	**External discrete input 28**	16118 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::29-32	**External discrete input 29**	16321 Description	Ext. DI 29	

::Configure discrete inputs::External DIs::29-32	**External discrete input 29**	16125 Delay	0.2	s
::Configure discrete inputs::External DIs::29-32	**External discrete input 29**	16126 Operation	N.O.	
::Configure discrete inputs::External DIs::29-32	**External discrete input 29**	16127 Alarm class	Control	
::Configure discrete inputs::External DIs::29-32	**External discrete input 29**	16129 Self acknowledge	No	
::Configure discrete inputs::External DIs::29-32	**External discrete input 29**	16128 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::29-32	**External discrete input 30**	16331 Description	Ext. DI 30	
::Configure discrete inputs::External DIs::29-32	**External discrete input 30**	16135 Delay	0.2	s
::Configure discrete inputs::External DIs::29-32	**External discrete input 30**	16136 Operation	N.O.	
::Configure discrete inputs::External DIs::29-32	**External discrete input 30**	16137 Alarm class	Control	
::Configure discrete inputs::External DIs::29-32	**External discrete input 30**	16139 Self acknowledge	No	
::Configure discrete inputs::External DIs::29-32	**External discrete input 30**	16138 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::29-32	**External discrete input 31**	16341 Description	Ext. DI 31	
::Configure discrete inputs::External DIs::29-32	**External discrete input 31**	16145 Delay	0.2	s
::Configure discrete inputs::External DIs::29-32	**External discrete input 31**	16146 Operation	N.O.	
::Configure discrete inputs::External DIs::29-32	**External discrete input 31**	16147 Alarm class	Control	
::Configure discrete inputs::External DIs::29-32	**External discrete input 31**	16149 Self acknowledge	No	
::Configure discrete inputs::External DIs::29-32	**External discrete input 31**	16148 Delayed by engine speed	No	
::Configure discrete inputs::External DIs::29-32	**External discrete input 32**	16351 Description	Ext. DI 32	
::Configure discrete inputs::External DIs::29-32	**External discrete input 32**	16155 Delay	0.2	s
::Configure discrete inputs::External DIs::29-32	**External discrete input 32**	16156 Operation	N.O.	
::Configure discrete inputs::External DIs::29-32	**External discrete input 32**	16157 Alarm class	Control	
::Configure discrete inputs::External DIs::29-32	**External discrete input 32**	16159 Self acknowledge	No	
::Configure discrete inputs::External DIs::29-32	**External discrete input 32**	16158 Delayed by engine speed	No	

::Configure discrete outputs::External DOs::1-4	12330 External DO 1	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::1-4	12340 External DO 2	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::1-4	12350 External DO 3	(False And True) And True	

	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::1-4	12360 External DO 4	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::5-8	12370 External DO 5	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::5-8	12380 External DO 6	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::5-8	12390 External DO 7	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::5-8	12400 External DO 8	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::9-12	12410 External DO 9	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::9-12	12420 External DO 10	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::9-12	12430 External DO 11	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::9-12	12440 External DO 12	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::13-16	12450 External DO 13	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::13-16	12460 External DO 14	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::13-16	12470 External DO 15	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s

::Configure discrete outputs::External DOs::13-16	12480 External DO 16	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::17-20	12331 External DO 17	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::17-20	12332 External DO 18	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::17-20	12333 External DO 19	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::17-20	12334 External DO 20	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::21-24	12335 External DO 21	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::21-24	12336 External DO 22	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::21-24	12337 External DO 23	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::21-24	12338 External DO 24	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::25-28	12339 External DO 25	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::25-28	12341 External DO 26	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::25-28	12342 External DO 27	(False And True) And True	
	Delay ON	0	s
	Delay OFF	0	s
::Configure discrete outputs::External DOs::25-28	12343 External DO 28	(False And True) And True	
	Delay ON	0	s

		Delay OFF	0	s
::Configure discrete outputs::External DOs::29-32		12344 External DO 29	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
::Configure discrete outputs::External DOs::29-32		12345 External DO 30	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
::Configure discrete outputs::External DOs::29-32		12346 External DO 31	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
::Configure discrete outputs::External DOs::29-32		12347 External DO 32	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure monitoring::Configure global settings		1756 Time until horn reset	3	s
Configure monitoring::Configure global settings		12490 Ext. acknowledge	(04.46 RemoteControl Bit 3 And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure monitoring::Generator::Operating V/f		5800 Upper voltage limit	120	%
Configure monitoring::Generator::Operating V/f		5801 Lower voltage limit	90	%
Configure monitoring::Generator::Operating V/f		5802 Upper frequency limit	110	%
Configure monitoring::Generator::Operating V/f		5803 Lower frequency limit	90	%
Configure monitoring::Generator::Frequency	**Overfrequency level 1**	1900 Monitoring	On	
Configure monitoring::Generator::Frequency	**Overfrequency level 1**	1904 Limit	105	%
Configure monitoring::Generator::Frequency	**Overfrequency level 1**	1905 Delay	2	s
Configure monitoring::Generator::Frequency	**Overfrequency level 1**	1901 Alarm class	Class D	
Configure monitoring::Generator::Frequency	**Overfrequency level 1**	1902 Self acknowledge	No	
Configure monitoring::Generator::Frequency	**Overfrequency level 1**	1903 Delayed by engine speed	No	
Configure monitoring::Generator::Frequency	**Underfrequency level 1**	1950 Monitoring	Off	
Configure monitoring::Generator::Frequency	**Underfrequency level 1**	1954 Limit	95	%
Configure monitoring::Generator::Frequency	**Underfrequency level 1**	1955 Delay	5	s
Configure monitoring::Generator::Frequency	**Underfrequency level 1**	1951 Alarm class	Class D	
Configure monitoring::Generator::Frequency	**Underfrequency level 1**	1952 Self acknowledge	No	
Configure monitoring::Generator::Frequency	**Underfrequency level 1**	1953 Delayed by engine speed	Yes	
Configure monitoring::Generator::Frequency	**Overfrequency level 2**	1906 Monitoring	On	
Configure monitoring::Generator::Frequency	**Overfrequency level 2**	1910 Limit	110	%

Configure monitoring::Generator::Frequency	**Overfrequency level 2**	1911 Delay	0.3	s
Configure monitoring::Generator::Frequency	**Overfrequency level 2**	1907 Alarm class	Class F	
Configure monitoring::Generator::Frequency	**Overfrequency level 2**	1908 Self acknowledge	No	
Configure monitoring::Generator::Frequency	**Overfrequency level 2**	1909 Delayed by engine speed	No	
Configure monitoring::Generator::Frequency	**Underfrequency level 2**	1956 Monitoring	Off	
Configure monitoring::Generator::Frequency	**Underfrequency level 2**	1960 Limit	90	%
Configure monitoring::Generator::Frequency	**Underfrequency level 2**	1961 Delay	1	s
Configure monitoring::Generator::Frequency	**Underfrequency level 2**	1957 Alarm class	Class F	
Configure monitoring::Generator::Frequency	**Underfrequency level 2**	1958 Self acknowledge	No	
Configure monitoring::Generator::Frequency	**Underfrequency level 2**	1959 Delayed by engine speed	Yes	
Configure monitoring::Generator::Voltage		1770 Generator voltage monitoring	Phase - neutral	
Configure monitoring::Generator::Voltage	**Overvoltage level 1**	2000 Monitoring	On	
Configure monitoring::Generator::Voltage	**Overvoltage level 1**	2004 Limit	108	%
Configure monitoring::Generator::Voltage	**Overvoltage level 1**	2005 Delay	5	s
Configure monitoring::Generator::Voltage	**Overvoltage level 1**	2001 Alarm class	Class B	
Configure monitoring::Generator::Voltage	**Overvoltage level 1**	2002 Self acknowledge	No	
Configure monitoring::Generator::Voltage	**Overvoltage level 1**	2003 Delayed by engine speed	No	
Configure monitoring::Generator::Voltage	**Undervoltage level 1**	2050 Monitoring	Off	
Configure monitoring::Generator::Voltage	**Undervoltage level 1**	2054 Limit	92	%
Configure monitoring::Generator::Voltage	**Undervoltage level 1**	2055 Delay	5	s
Configure monitoring::Generator::Voltage	**Undervoltage level 1**	2051 Alarm class	Class B	
Configure monitoring::Generator::Voltage	**Undervoltage level 1**	2052 Self acknowledge	No	
Configure monitoring::Generator::Voltage	**Undervoltage level 1**	2053 Delayed by engine speed	Yes	
Configure monitoring::Generator::Voltage	**Voltage asymmetry**	3900 Monitoring	On	
Configure monitoring::Generator::Voltage	**Voltage asymmetry**	3903 Limit	15	%
Configure monitoring::Generator::Voltage	**Voltage asymmetry**	3904 Delay	5	s
Configure monitoring::Generator::Voltage	**Overvoltage level 2**	2006 Monitoring	On	
Configure monitoring::Generator::Voltage	**Overvoltage level 2**	2010 Limit	112	%
Configure monitoring::Generator::Voltage	**Overvoltage level 2**	2011 Delay	0.3	s
Configure monitoring::Generator::Voltage	**Overvoltage level 2**	2007 Alarm class	Class F	
Configure monitoring::Generator::Voltage	**Overvoltage level 2**	2008 Self acknowledge	No	
Configure monitoring::Generator::Voltage	**Overvoltage level 2**	2009 Delayed by engine speed	No	
Configure monitoring::Generator::Voltage	**Undervoltage level 2**	2056 Monitoring	Off	
Configure monitoring::Generator::Voltage	**Undervoltage level 2**	2060 Limit	85	%
Configure monitoring::Generator::Voltage	**Undervoltage level 2**	2061 Delay	4	s
Configure monitoring::Generator::Voltage	**Undervoltage level 2**	2057 Alarm class	Class D	

Configure monitoring::Generator::Voltage	**Undervoltage level 2**	2058 Self acknowledge	No	
Configure monitoring::Generator::Voltage	**Undervoltage level 2**	2059 Delayed by engine speed	Yes	
Configure monitoring::Generator::Voltage	**Voltage asymmetry**	3901 Alarm class	Class D	
Configure monitoring::Generator::Voltage	**Voltage asymmetry**	3902 Self acknowledge	No	
Configure monitoring::Generator::Voltage	**Voltage asymmetry**	3905 Delayed by engine speed	Yes	
Configure monitoring::Generator::Current	**Overcurrent level 1**	2200 Monitoring	On	
Configure monitoring::Generator::Current	**Overcurrent level 1**	2204 Limit	110	%
Configure monitoring::Generator::Current	**Overcurrent level 1**	2205 Delay	15	s
Configure monitoring::Generator::Current	**Overcurrent level 1**	2201 Alarm class	Class D	
Configure monitoring::Generator::Current	**Overcurrent level 1**	2202 Self acknowledge	No	
Configure monitoring::Generator::Current	**Overcurrent level 3**	2212 Monitoring	On	
Configure monitoring::Generator::Current	**Overcurrent level 3**	2216 Limit	250	%
Configure monitoring::Generator::Current	**Overcurrent level 3**	2217 Delay	0.4	s
Configure monitoring::Generator::Current	**Overcurrent level 3**	2213 Alarm class	Class D	
Configure monitoring::Generator::Current	**Overcurrent level 3**	2214 Self acknowledge	No	
Configure monitoring::Generator::Current	**Overcurrent level 2**	2206 Monitoring	On	
Configure monitoring::Generator::Current	**Overcurrent level 2**	2210 Limit	150	%
Configure monitoring::Generator::Current	**Overcurrent level 2**	2211 Delay	1	s
Configure monitoring::Generator::Current	**Overcurrent level 2**	2207 Alarm class	Class D	
Configure monitoring::Generator::Current	**Overcurrent level 2**	2208 Self acknowledge	No	
Configure monitoring::Generator::Current	**Inverse time overcurrent**	4030 Monitoring	On	
Configure monitoring::Generator::Current	**Inverse time overcurrent**	4031 Alarm class	Class D	
Configure monitoring::Generator::Current	**Inverse time overcurrent**	4032 Self acknowledge	No	
Configure monitoring::Generator::Current	**Inverse time overcurrent**	4034 Inverse time characteristic	Normal	
Configure monitoring::Generator::Current	**Inverse time overcurrent**	4035 Inverse time overcurrent Tp=	1	s
Configure monitoring::Generator::Current	**Inverse time overcurrent**	4036 Inverse time overcurr. Ip=	100	%
Configure monitoring::Generator::Current	**Inverse time overcurrent**	4037 Inv. time overcurr. I-start=	115	%
Configure monitoring::Generator::Load/Power	**Reverse/reduced power level 1**	2250 Monitoring	Off	
Configure monitoring::Generator::Load/Power	**Reverse/reduced power level 1**	2254 Limit	-3	%
Configure monitoring::Generator::Load/Power	**Reverse/reduced power level 1**	2255 Delay	5	s
Configure monitoring::Generator::Load/Power	**Reverse/reduced power level 1**	2251 Alarm class	Class B	
Configure monitoring::Generator::Load/Power	**Reverse/reduced power level 1**	2252 Self acknowledge	No	
Configure monitoring::Generator::Load/Power	**Reverse/reduced power level 1**	2253 Delayed by engine speed	No	
Configure monitoring::Generator::Load/Power	**Unbalanced load level 1**	2400 Monitoring	On	
Configure monitoring::Generator::Load/Power	**Unbalanced load level 1**	2404 Limit	25	%

Configure monitoring::Generator::Load/Power	**Unbalanced load level 1**	2405 Delay	10	s
Configure monitoring::Generator::Load/Power	**Unbalanced load level 1**	2401 Alarm class	Class B	
Configure monitoring::Generator::Load/Power	**Unbalanced load level 1**	2402 Self acknowledge	No	
Configure monitoring::Generator::Load/Power	**Unbalanced load level 1**	2403 Delayed by engine speed	No	
Configure monitoring::Generator::Load/Power	**Reverse/reduced power level 2**	2256 Monitoring	Off	
Configure monitoring::Generator::Load/Power	**Reverse/reduced power level 2**	2260 Limit	-5	%
Configure monitoring::Generator::Load/Power	**Reverse/reduced power level 2**	2261 Delay	2.5	s
Configure monitoring::Generator::Load/Power	**Reverse/reduced power level 2**	2257 Alarm class	Class D	
Configure monitoring::Generator::Load/Power	**Reverse/reduced power level 2**	2258 Self acknowledge	No	
Configure monitoring::Generator::Load/Power	**Reverse/reduced power level 2**	2259 Delayed by engine speed	No	
Configure monitoring::Generator::Load/Power	**Unbalanced load level 2**	2406 Monitoring	On	
Configure monitoring::Generator::Load/Power	**Unbalanced load level 2**	2410 Limit	40	%
Configure monitoring::Generator::Load/Power	**Unbalanced load level 2**	2411 Delay	10	s
Configure monitoring::Generator::Load/Power	**Unbalanced load level 2**	2407 Alarm class	Class D	
Configure monitoring::Generator::Load/Power	**Unbalanced load level 2**	2408 Self acknowledge	No	
Configure monitoring::Generator::Load/Power	**Unbalanced load level 2**	2409 Delayed by engine speed	No	
Configure monitoring::Generator::IOP/MOP	**Overload IOP level 1**	2300 Monitoring	Off	
Configure monitoring::Generator::IOP/MOP	**Overload IOP level 1**	2304 Limit	105	%
Configure monitoring::Generator::IOP/MOP	**Overload IOP level 1**	2305 Delay	5	s
Configure monitoring::Generator::IOP/MOP	**Overload IOP level 1**	2301 Alarm class	Class B	
Configure monitoring::Generator::IOP/MOP	**Overload IOP level 1**	2302 Self acknowledge	No	
Configure monitoring::Generator::IOP/MOP	**Overload MOP level 1**	2350 Monitoring	Off	
Configure monitoring::Generator::IOP/MOP	**Overload MOP level 1**	2354 Limit	105	%
Configure monitoring::Generator::IOP/MOP	**Overload MOP level 1**	2355 Delay	5	s
Configure monitoring::Generator::IOP/MOP	**Overload MOP level 1**	2351 Alarm class	Class B	
Configure monitoring::Generator::IOP/MOP	**Overload MOP level 1**	2352 Self acknowledge	No	
Configure monitoring::Generator::IOP/MOP	**Overload IOP level 2**	2306 Monitoring	Off	
Configure monitoring::Generator::IOP/MOP	**Overload IOP level 2**	2310 Limit	110	%
Configure monitoring::Generator::IOP/MOP	**Overload IOP level 2**	2311 Delay	0.5	s
Configure monitoring::Generator::IOP/MOP	**Overload IOP level 2**	2307 Alarm class	Class D	
Configure monitoring::Generator::IOP/MOP	**Overload IOP level 2**	2308 Self acknowledge	No	

Configure monitoring::Generator::IOP/MOP	**Overload MOP level 2**	2356 Monitoring	Off	
Configure monitoring::Generator::IOP/MOP	**Overload MOP level 2**	2360 Limit	110	%
Configure monitoring::Generator::IOP/MOP	**Overload MOP level 2**	2361 Delay	0.5	s
Configure monitoring::Generator::IOP/MOP	**Overload MOP level 2**	2357 Alarm class	Class D	
Configure monitoring::Generator::IOP/MOP	**Overload MOP level 2**	2358 Self acknowledge	No	
Configure monitoring::Generator::Power factor	**Gen. lagging PF 1 exceeded**	2325 Monitoring	Off	
Configure monitoring::Generator::Power factor	**Gen. lagging PF 1 exceeded**	2329 Limit	0.6	
Configure monitoring::Generator::Power factor	**Gen. lagging PF 1 exceeded**	2330 Delay	30	s
Configure monitoring::Generator::Power factor	**Gen. lagging PF 1 exceeded**	2326 Alarm class	Class B	
Configure monitoring::Generator::Power factor	**Gen. lagging PF 1 exceeded**	2327 Self acknowledge	No	
Configure monitoring::Generator::Power factor	**Gen. lagging PF 1 exceeded**	2328 Delayed by engine speed	Yes	
Configure monitoring::Generator::Power factor	**Gen. leading PF 1 exceeded**	2375 Monitoring	Off	
Configure monitoring::Generator::Power factor	**Gen. leading PF 1 exceeded**	2379 Limit	-0.6	
Configure monitoring::Generator::Power factor	**Gen. leading PF 1 exceeded**	2380 Delay	30	s
Configure monitoring::Generator::Power factor	**Gen. leading PF 1 exceeded**	2376 Alarm class	Class B	
Configure monitoring::Generator::Power factor	**Gen. leading PF 1 exceeded**	2377 Self acknowledge	No	
Configure monitoring::Generator::Power factor	**Gen. leading PF 1 exceeded**	2378 Delayed by engine speed	Yes	
Configure monitoring::Generator::Power factor	**Gen. lagging PF 2 exceeded**	2331 Monitoring	Off	
Configure monitoring::Generator::Power factor	**Gen. lagging PF 2 exceeded**	2335 Limit	0.4	
Configure monitoring::Generator::Power factor	**Gen. lagging PF 2 exceeded**	2336 Delay	30	s
Configure monitoring::Generator::Power factor	**Gen. lagging PF 2 exceeded**	2332 Alarm class	Class B	
Configure monitoring::Generator::Power factor	**Gen. lagging PF 2 exceeded**	2333 Self acknowledge	No	
Configure monitoring::Generator::Power factor	**Gen. lagging PF 2 exceeded**	2334 Delayed by engine speed	Yes	
Configure monitoring::Generator::Power factor	**Gen. leading PF 1 exceeded**	2381 Monitoring	Off	
Configure monitoring::Generator::Power factor	**Gen. leading PF 1 exceeded**	2385 Limit	-0.4	
Configure monitoring::Generator::Power factor	**Gen. leading PF 1 exceeded**	2386 Delay	30	s
Configure monitoring::Generator::Power factor	**Gen. leading PF 1 exceeded**	2382 Alarm class	Class B	
Configure monitoring::Generator::Power factor	**Gen. leading PF 1 exceeded**	2383 Self acknowledge	No	
Configure monitoring::Generator::Power factor	**Gen. leading PF 1 exceeded**	2384 Delayed by engine speed	Yes	
Configure monitoring::Generator::Miscellaneous	**Ground fault level 1**	3250 Monitoring	On	

Configure monitoring::Generator::Miscellaneous	**Ground fault level 1**	3254 Limit	10	%
Configure monitoring::Generator::Miscellaneous	**Ground fault level 1**	3255 Delay	0.2	s
Configure monitoring::Generator::Miscellaneous	**Ground fault level 1**	3251 Alarm class	Class B	
Configure monitoring::Generator::Miscellaneous	**Ground fault level 1**	3252 Self acknowledge	No	
Configure monitoring::Generator::Miscellaneous	**Ground fault level 1**	3253 Delayed by engine speed	No	
Configure monitoring::Generator::Miscellaneous	**Generator phase rotation**	3950 Monitoring	On	
Configure monitoring::Generator::Miscellaneous	**Generator phase rotation**	3954 Generator phase rotation	CW	
Configure monitoring::Generator::Miscellaneous	**Generator phase rotation**	3951 Alarm class	Class D	
Configure monitoring::Generator::Miscellaneous	**Generator phase rotation**	3952 Self acknowledge	No	
Configure monitoring::Generator::Miscellaneous	**Generator phase rotation**	3953 Delayed by engine speed	No	
Configure monitoring::Generator::Miscellaneous	**Ground fault level 2**	3256 Monitoring	On	
Configure monitoring::Generator::Miscellaneous	**Ground fault level 2**	3260 Limit	30	%
Configure monitoring::Generator::Miscellaneous	**Ground fault level 2**	3261 Delay	0.1	s
Configure monitoring::Generator::Miscellaneous	**Ground fault level 2**	3257 Alarm class	Class F	
Configure monitoring::Generator::Miscellaneous	**Ground fault level 2**	3258 Self acknowledge	No	
Configure monitoring::Generator::Miscellaneous	**Ground fault level 2**	3259 Delayed by engine speed	No	
Configure monitoring::Engine::Engine speed	**Overspeed level 1**	2100 Monitoring	On	
Configure monitoring::Engine::Engine speed	**Overspeed level 1**	2104 Limit	1900	rpm
Configure monitoring::Engine::Engine speed	**Overspeed level 1**	2105 Delay	2	s
Configure monitoring::Engine::Engine speed	**Overspeed level 1**	2101 Alarm class	Class B	
Configure monitoring::Engine::Engine speed	**Overspeed level 1**	2102 Self acknowledge	No	
Configure monitoring::Engine::Engine speed	**Overspeed level 1**	2103 Delayed by engine speed	No	
Configure monitoring::Engine::Engine speed	**Underspeed level 1**	2150 Monitoring	Off	
Configure monitoring::Engine::Engine speed	**Underspeed level 1**	2154 Limit	1700	rpm
Configure monitoring::Engine::Engine speed	**Underspeed level 1**	2155 Delay	5	s
Configure monitoring::Engine::Engine speed	**Underspeed level 1**	2151 Alarm class	Class B	
Configure monitoring::Engine::Engine speed	**Underspeed level 1**	2152 Self acknowledge	No	
Configure monitoring::Engine::Engine speed	**Underspeed level 1**	2153 Delayed by engine speed	Yes	
Configure monitoring::Engine::Engine speed	**Speed detection**	2450 Monitoring	On	
Configure monitoring::Engine::Engine speed	**Speed detection**	2451 Alarm class	Class E	
Configure monitoring::Engine::Engine speed	**Speed detection**	2452 Self acknowledge	No	
Configure monitoring::Engine::Engine speed	**Overspeed level 2**	2106 Monitoring	On	
Configure monitoring::Engine::Engine speed	**Overspeed level 2**	2110 Limit	1980	rpm
Configure monitoring::Engine::Engine speed	**Overspeed level 2**	2111 Delay	0.3	s
Configure monitoring::Engine::Engine speed	**Overspeed level 2**	2107 Alarm class	Class F	
Configure monitoring::Engine::Engine speed	**Overspeed level 2**	2108 Self acknowledge	No	
Configure monitoring::Engine::Engine speed	**Overspeed level 2**	2109 Delayed by engine speed	No	
Configure monitoring::Engine::Engine speed	**Underspeed level 2**	2156 Monitoring	Off	
Configure monitoring::Engine::Engine speed	**Underspeed level 2**	2160 Limit	1600	rpm
Configure monitoring::Engine::Engine speed	**Underspeed level 2**	2161 Delay	1	s

Configure monitoring::Engine::Engine speed	**Underspeed level 2**	2157 Alarm class	Class F	
Configure monitoring::Engine::Engine speed	**Underspeed level 2**	2158 Self acknowledge	No	
Configure monitoring::Engine::Engine speed	**Underspeed level 2**	2159 Delayed by engine speed	Yes	
Configure monitoring::Engine::Engine speed	**Speed detection**	2454 Speed/frequency mismatch limit	5	Hz
Configure monitoring::Engine::Engine speed	**Speed detection**	2455 Delay	1	s
Configure monitoring::Engine::Engine speed	**Speed detection**	2453 Activation frequency	20	Hz
Configure monitoring::Engine::Mismatch	**Gen. active power mismatch**	2920 Monitoring	Off	
Configure monitoring::Engine::Mismatch	**Gen. active power mismatch**	2925 Limit	5	%
Configure monitoring::Engine::Mismatch	**Gen. active power mismatch**	2923 Delay	100	s
Configure monitoring::Engine::Mismatch	**Gen. active power mismatch**	2921 Alarm class	Class B	
Configure monitoring::Engine::Mismatch	**Gen. active power mismatch**	2922 Self acknowledge	No	
Configure monitoring::Engine::Mismatch	**Generator unloading mismatch**	3125 Unload limit	5	%
Configure monitoring::Engine::Mismatch	**Generator unloading mismatch**	3123 Delay	10	s
Configure monitoring::Engine::Mismatch	**Generator unloading mismatch**	3121 Alarm class	Class B	
Configure monitoring::Engine::Mismatch	**Generator unloading mismatch**	3122 Self acknowledge	No	
Configure monitoring::Engine::Mismatch	**Mains active power mismatch**	2930 Monitoring	Off	
Configure monitoring::Engine::Mismatch	**Mains active power mismatch**	2935 Limit	5	%
Configure monitoring::Engine::Mismatch	**Mains active power mismatch**	2933 Delay	30	s
Configure monitoring::Engine::Mismatch	**Mains active power mismatch**	2931 Alarm class	Class B	
Configure monitoring::Engine::Mismatch	**Mains active power mismatch**	2932 Self acknowledge	No	
Configure monitoring::Engine::Miscellaneous	**Start failure**	3303 Monitoring	On	
Configure monitoring::Engine::Miscellaneous	**Start failure**	3304 Alarm class	Class F	
Configure monitoring::Engine::Miscellaneous	**Start failure**	3305 Self acknowledge	No	
Configure monitoring::Engine::Miscellaneous	**Shutdown malfunction**	2500 Monitoring	On	
Configure monitoring::Engine::Miscellaneous	**Shutdown malfunction**	2503 Maximal stop delay	15	s
Configure monitoring::Engine::Miscellaneous	**Shutdown malfunction**	2501 Alarm class	Class F	
Configure monitoring::Engine::Miscellaneous	**Shutdown malfunction**	2502 Self acknowledge	No	
Configure monitoring::Engine::Miscellaneous	**Charge alternator (D+)**	4050 Monitoring	Off	
Configure monitoring::Engine::Miscellaneous	**Charge alternator (D+)**	4055 Delay	10	s
Configure monitoring::Engine::Miscellaneous	**Charge alternator (D+)**	4051 Alarm class	Class B	
Configure monitoring::Engine::Miscellaneous	**Charge alternator (D+)**	4052 Self acknowledge	No	
Configure monitoring::Engine::Miscellaneous	**Charge alternator (D+)**	4053 Delayed by engine speed	Yes	

Configure monitoring::Engine::Miscellaneous	**Unintended stop**	2650 Monitoring	On	
Configure monitoring::Engine::Miscellaneous	**Unintended stop**	2651 Alarm class	Class F	
Configure monitoring::Engine::Miscellaneous	**Unintended stop**	2657 Self acknowledge	No	
Configure monitoring::Engine::Miscellaneous	**Operating range failure**	2660 Monitoring	Off	
Configure monitoring::Engine::Miscellaneous	**Operating range failure**	2663 Delay	30	s
Configure monitoring::Engine::Miscellaneous	**Operating range failure**	2661 Alarm class	Class B	
Configure monitoring::Engine::Miscellaneous	**Operating range failure**	2662 Self acknowledge	No	
Configure monitoring::Mains::Operating V/f		5810 Upper voltage limit	110	%
Configure monitoring::Mains::Operating V/f		5814 Hysteresis upper voltage limit	2	%
Configure monitoring::Mains::Operating V/f		5811 Lower voltage limit	90	%
Configure monitoring::Mains::Operating V/f		5815 Hysteresis lower voltage limit	2	%
Configure monitoring::Mains::Operating V/f		5812 Upper frequency limit	110	%
Configure monitoring::Mains::Operating V/f		5816 Hyst. upper frequency limit	0.5	%
Configure monitoring::Mains::Operating V/f		5813 Lower frequency limit	90	%
Configure monitoring::Mains::Operating V/f		5817 Hyst. lower frequency limit	0.5	%
Configure monitoring::Mains::Decoupling		12922 Ext. mns.decoupl.	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure monitoring::Mains::Decoupling	**Mains decoupling**	3110 Mains decoupling	Off	
Configure monitoring::Mains::Decoupling	**Mains decoupling**	3113 Mns. decoupling feedback delay	0.4	s
Configure monitoring::Mains::Decoupling	**Mains decoupling**	3111 Alarm class	Class B	
Configure monitoring::Mains::Decoupling	**Mains decoupling**	3112 Self acknowledge	No	
Configure monitoring::Mains::Decoupling		8845 Mns.decoupling by overvolt.1	Off	
Configure monitoring::Mains::Decoupling		8844 Mns.decoupling by undervolt.1	Off	
Configure monitoring::Mains::Decoupling		8808 Mains decoupling volt.incr.	Off	
Configure monitoring::Mains::Decoupling		4989 Mns.decoupl.by time-dep.volt.	Off	
Configure monitoring::Mains::Decoupling		3296 Mains decoupling by QV	Off	
Configure monitoring::Mains::Decoupling		3297 Monitoring	Off	
Configure monitoring::Mains::Decoupling		3298 Monitoring mode	Multi	
Configure monitoring::Mains::Decoupling		1828 Voltage difference	4	%
Configure monitoring::Mains::Decoupling		1836 Frequency difference	1	%
Configure monitoring::Mains::Decoupling	**Missing member 4105**	5125 Alarm class	Class B	
Configure monitoring::Mains::Decoupling	**Missing member 4105**	5126 Self acknowledge	No	
Configure monitoring::Mains::Decoupling	**Change of frequency**	3058 Change of frequency	Off	
Configure monitoring::Mains::Decoupling	**Para.alignment 4105**	5131 Alarm class	Class B	
Configure monitoring::Mains::Decoupling	**Para.alignment 4105**	5132 Self acknowledge	No	

Configure monitoring::Mains::Decoupling	**Meas.difference 4105**	5137 Alarm class	Class B	
Configure monitoring::Mains::Decoupling	**Meas.difference 4105**	5138 Self acknowledge	No	
Configure monitoring::Mains::Frequency	**Overfrequency level 1**	2850 Monitoring	Off	
Configure monitoring::Mains::Frequency	**Overfrequency level 1**	2854 Limit	100.4	%
Configure monitoring::Mains::Frequency	**Overfrequency level 1**	2855 Delay	0.06	s
Configure monitoring::Mains::Frequency	**Overfrequency level 1**	2851 Alarm class	Class A	
Configure monitoring::Mains::Frequency	**Overfrequency level 1**	2852 Self acknowledge	Yes	
Configure monitoring::Mains::Frequency	**Overfrequency level 1**	2853 Delayed by engine speed	No	
Configure monitoring::Mains::Frequency	**Underfrequency level 1**	2900 Monitoring	Off	
Configure monitoring::Mains::Frequency	**Underfrequency level 1**	2904 Limit	99.6	%
Configure monitoring::Mains::Frequency	**Underfrequency level 1**	2905 Delay	1.5	s
Configure monitoring::Mains::Frequency	**Underfrequency level 1**	2901 Alarm class	Class A	
Configure monitoring::Mains::Frequency	**Underfrequency level 1**	2902 Self acknowledge	Yes	
Configure monitoring::Mains::Frequency	**Underfrequency level 1**	2903 Delayed by engine speed	No	
Configure monitoring::Mains::Frequency	**Overfrequency level 2**	2856 Monitoring	Off	
Configure monitoring::Mains::Frequency	**Overfrequency level 2**	2860 Limit	102	%
Configure monitoring::Mains::Frequency	**Overfrequency level 2**	2861 Delay	0.06	s
Configure monitoring::Mains::Frequency	**Overfrequency level 2**	2857 Alarm class	Class B	
Configure monitoring::Mains::Frequency	**Overfrequency level 2**	2858 Self acknowledge	Yes	
Configure monitoring::Mains::Frequency	**Overfrequency level 2**	2859 Delayed by engine speed	No	
Configure monitoring::Mains::Frequency	**Underfrequency level 2**	2906 Monitoring	Off	
Configure monitoring::Mains::Frequency	**Underfrequency level 2**	2910 Limit	98	%
Configure monitoring::Mains::Frequency	**Underfrequency level 2**	2911 Delay	0.06	s
Configure monitoring::Mains::Frequency	**Underfrequency level 2**	2907 Alarm class	Class B	
Configure monitoring::Mains::Frequency	**Underfrequency level 2**	2908 Self acknowledge	Yes	
Configure monitoring::Mains::Frequency	**Underfrequency level 2**	2909 Delayed by engine speed	No	
Configure monitoring::Mains::Voltage		1771 Mains voltage monitoring	Phase - phase	
Configure monitoring::Mains::Voltage	**Overvoltage level 1**	2950 Monitoring	Off	
Configure monitoring::Mains::Voltage	**Overvoltage level 1**	2954 Limit	108	%
Configure monitoring::Mains::Voltage	**Overvoltage level 1**	2955 Delay	1.5	s
Configure monitoring::Mains::Voltage	**Overvoltage level 1**	2951 Alarm class	Class A	
Configure monitoring::Mains::Voltage	**Overvoltage level 1**	2952 Self acknowledge	Yes	
Configure monitoring::Mains::Voltage	**Overvoltage level 1**	2953 Delayed by engine speed	No	
Configure monitoring::Mains::Voltage	**Undervoltage level**	3000 Monitoring	Off	

	1			
Configure monitoring::Mains::Voltage	**Undervoltage level 1**	3004 Limit	92	%
Configure monitoring::Mains::Voltage	**Undervoltage level 1**	3005 Delay	1.5	s
Configure monitoring::Mains::Voltage	**Undervoltage level 1**	3001 Alarm class	Class A	
Configure monitoring::Mains::Voltage	**Undervoltage level 1**	3002 Self acknowledge	Yes	
Configure monitoring::Mains::Voltage	**Undervoltage level 1**	3003 Delayed by engine speed	No	
Configure monitoring::Mains::Voltage		8806 Monitoring	Off	
Configure monitoring::Mains::Voltage		8807 Limit	110	%
Configure monitoring::Mains::Voltage		8831 Alarm class	Class B	
Configure monitoring::Mains::Voltage		8832 Self acknowledge	Yes	
Configure monitoring::Mains::Voltage		8833 Delayed by engine speed	No	
Configure monitoring::Mains::Voltage		8849 AND characteristics	Off	
Configure monitoring::Mains::Voltage	**Overvoltage level 2**	2956 Monitoring	Off	
Configure monitoring::Mains::Voltage	**Overvoltage level 2**	2960 Limit	110	%
Configure monitoring::Mains::Voltage	**Overvoltage level 2**	2961 Delay	0.06	s
Configure monitoring::Mains::Voltage	**Overvoltage level 2**	2957 Alarm class	Class B	
Configure monitoring::Mains::Voltage	**Overvoltage level 2**	2958 Self acknowledge	Yes	
Configure monitoring::Mains::Voltage	**Overvoltage level 2**	2959 Delayed by engine speed	No	
Configure monitoring::Mains::Voltage	**Undervoltage level 2**	3006 Monitoring	Off	
Configure monitoring::Mains::Voltage	**Undervoltage level 2**	3010 Limit	90	%
Configure monitoring::Mains::Voltage	**Undervoltage level 2**	3011 Delay	0.06	s
Configure monitoring::Mains::Voltage	**Undervoltage level 2**	3007 Alarm class	Class B	
Configure monitoring::Mains::Voltage	**Undervoltage level 2**	3008 Self acknowledge	Yes	
Configure monitoring::Mains::Voltage	**Undervoltage level 2**	3009 Delayed by engine speed	No	
Configure monitoring::Mains::Import/Export	**Mains export power 1**	3225 Monitoring	Off	
Configure monitoring::Mains::Import/Export	**Mains export power 1**	3229 Limit	80	%
Configure monitoring::Mains::Import/Export	**Mains export power 1**	3231 Hysteresis	0.01	%
Configure monitoring::Mains::Import/Export	**Mains export power 1**	3230 Delay	1	s
Configure monitoring::Mains::Import/Export	**Mains export power 1**	3226 Alarm class	Class A	
Configure monitoring::Mains::Import/Export	**Mains export power 1**	3227 Self acknowledge	Yes	
Configure monitoring::Mains::Import/Export	**Mains export power 1**	3228 Delayed by engine speed	No	
Configure monitoring::Mains::Import/Export	**Mains export power 1**	3232 Monitoring at	Overrun	
Configure monitoring::Mains::Import/Export	**Mains import power 1**	3200 Monitoring	Off	
Configure monitoring::Mains::Import/Export	**Mains import power 1**	3204 Limit	80	%
Configure monitoring::Mains::Import/Export	**Mains import power 1**	3213 Hysteresis	0.01	%
Configure monitoring::Mains::Import/Export	**Mains import power 1**	3205 Delay	1	s
Configure monitoring::Mains::Import/Export	**Mains import power 1**	3201 Alarm class	Class A	

Configure monitoring::Mains::Import/Export	**Mains import power 1**	3202 Self acknowledge	Yes	
Configure monitoring::Mains::Import/Export	**Mains import power 1**	3203 Delayed by engine speed	No	
Configure monitoring::Mains::Import/Export	**Mains import power 1**	3215 Monitoring at	Overrun	
Configure monitoring::Mains::Import/Export	**Mains export power 2**	3233 Monitoring	Off	
Configure monitoring::Mains::Import/Export	**Mains export power 2**	3237 Limit	100	%
Configure monitoring::Mains::Import/Export	**Mains export power 2**	3239 Hysteresis	0.01	%
Configure monitoring::Mains::Import/Export	**Mains export power 2**	3238 Delay	1	s
Configure monitoring::Mains::Import/Export	**Mains export power 2**	3234 Alarm class	Class B	
Configure monitoring::Mains::Import/Export	**Mains export power 2**	3235 Self acknowledge	No	
Configure monitoring::Mains::Import/Export	**Mains export power 2**	3236 Delayed by engine speed	No	
Configure monitoring::Mains::Import/Export	**Mains export power 2**	3240 Monitoring at	Overrun	
Configure monitoring::Mains::Import/Export	**Mains import power 2**	3206 Monitoring	Off	
Configure monitoring::Mains::Import/Export	**Mains import power 2**	3210 Limit	100	%
Configure monitoring::Mains::Import/Export	**Mains import power 2**	3214 Hysteresis	0.01	%
Configure monitoring::Mains::Import/Export	**Mains import power 2**	3211 Delay	1	s
Configure monitoring::Mains::Import/Export	**Mains import power 2**	3207 Alarm class	Class B	
Configure monitoring::Mains::Import/Export	**Mains import power 2**	3208 Self acknowledge	No	
Configure monitoring::Mains::Import/Export	**Mains import power 2**	3209 Delayed by engine speed	No	
Configure monitoring::Mains::Import/Export	**Mains import power 2**	3216 Monitoring at	Overrun	
Configure monitoring::Mains::Power factor	**Mains lagging PF 1 exceeded**	2975 Monitoring	Off	
Configure monitoring::Mains::Power factor	**Mains lagging PF 1 exceeded**	2978 Limit	0.9	
Configure monitoring::Mains::Power factor	**Mains lagging PF 1 exceeded**	2989 Hysteresis	0.02	
Configure monitoring::Mains::Power factor	**Mains lagging PF 1 exceeded**	2979 Delay	30	s
Configure monitoring::Mains::Power factor	**Mains lagging PF 1 exceeded**	2987 Alarm class	Class B	
Configure monitoring::Mains::Power factor	**Mains lagging PF 1 exceeded**	2976 Self acknowledge	No	
Configure monitoring::Mains::Power factor	**Mains lagging PF 1 exceeded**	2977 Delayed by engine speed	No	
Configure monitoring::Mains::Power factor	**Mains leading PF 1 exceeded**	3025 Monitoring	Off	
Configure monitoring::Mains::Power factor	**Mains leading PF 1 exceeded**	3028 Limit	-0.9	
Configure monitoring::Mains::Power factor	**Mains leading PF 1 exceeded**	3039 Hysteresis	0.02	
Configure monitoring::Mains::Power factor	**Mains leading PF 1 exceeded**	3029 Delay	10	s
Configure monitoring::Mains::Power factor	**Mains leading PF 1 exceeded**	3037 Alarm class	Class B	
Configure monitoring::Mains::Power factor	**Mains leading PF 1 exceeded**	3026 Self acknowledge	No	

Configure monitoring::Mains::Power factor	**Mains leading PF 1 exceeded**	3027 Delayed by engine speed	No	
Configure monitoring::Mains::Power factor	**Mains lagging PF 2 exceeded**	2980 Monitoring	Off	
Configure monitoring::Mains::Power factor	**Mains lagging PF 2 exceeded**	2983 Limit	0.8	
Configure monitoring::Mains::Power factor	**Mains lagging PF 2 exceeded**	2990 Hysteresis	0.02	
Configure monitoring::Mains::Power factor	**Mains lagging PF 2 exceeded**	2984 Delay	1	s
Configure monitoring::Mains::Power factor	**Mains lagging PF 2 exceeded**	2988 Alarm class	Class B	
Configure monitoring::Mains::Power factor	**Mains lagging PF 2 exceeded**	2981 Self acknowledge	No	
Configure monitoring::Mains::Power factor	**Mains lagging PF 2 exceeded**	2982 Delayed by engine speed	No	
Configure monitoring::Mains::Power factor	**Mains leading PF 2 exceeded**	3030 Monitoring	Off	
Configure monitoring::Mains::Power factor	**Mains leading PF 2 exceeded**	3033 Limit	-0.8	
Configure monitoring::Mains::Power factor	**Mains leading PF 2 exceeded**	3040 Hysteresis	0.02	
Configure monitoring::Mains::Power factor	**Mains leading PF 2 exceeded**	3034 Delay	1	s
Configure monitoring::Mains::Power factor	**Mains leading PF 2 exceeded**	3038 Alarm class	Class B	
Configure monitoring::Mains::Power factor	**Mains leading PF 2 exceeded**	3031 Self acknowledge	No	
Configure monitoring::Mains::Power factor	**Mains leading PF 2 exceeded**	3032 Delayed by engine speed	No	
Configure monitoring::Mains::Miscellaneous	**Mains phase rotation**	3970 Monitoring	On	
Configure monitoring::Mains::Miscellaneous	**Mains phase rotation**	3974 Mains phase rotation	CW	
Configure monitoring::Mains::Miscellaneous	**Mains phase rotation**	3971 Alarm class	Class B	
Configure monitoring::Mains::Miscellaneous	**Mains phase rotation**	3972 Self acknowledge	Yes	
Configure monitoring::Mains::Miscellaneous	**Mains phase rotation**	3973 Delayed by engine speed	No	
Configure monitoring::Mains::Miscellaneous		2801 Mains settling time	1	s
Configure monitoring::Time-dependent voltage		4950 Monitoring	Off	
Configure monitoring::Time-dependent voltage		4952 AND characteristics	Off	
Configure monitoring::Time-dependent voltage		4953 Monitoring at	Underrun	
Configure monitoring::Time-dependent voltage		4970 Init threshold	80	%
Configure monitoring::Time-dependent voltage		4978 Fallback threshold	90	%
Configure monitoring::Time-dependent voltage		4971 Point 1 voltage	45	%
Configure monitoring::Time-dependent voltage		4972 Point 2 voltage	45	%
Configure monitoring::Time-dependent voltage		4973 Point 3 voltage	70	%
Configure monitoring::Time-dependent voltage		4974 Point 4 voltage	70	%
Configure monitoring::Time-dependent voltage		4975 Point 5 voltage	90	%
Configure monitoring::Time-dependent voltage		4976 Point 6 voltage	90	%
Configure monitoring::Time-dependent voltage		4977 Point 7 voltage	90	%
Configure monitoring::Time-dependent voltage		4951 Alarm class	Class B	

Configure monitoring::Time-dependent voltage		4959 Self acknowledge	Yes	
Configure monitoring::Time-dependent voltage		4968 Fallback time	1	s
Configure monitoring::Time-dependent voltage		4961 Point 1 time	0	s
Configure monitoring::Time-dependent voltage		4962 Point 2 time	0.15	s
Configure monitoring::Time-dependent voltage		4963 Point 3 time	0.15	s
Configure monitoring::Time-dependent voltage		4964 Point 4 time	0.7	s
Configure monitoring::Time-dependent voltage		4965 Point 5 time	1.5	s
Configure monitoring::Time-dependent voltage		4966 Point 6 time	3	s
Configure monitoring::Time-dependent voltage		4967 Point 7 time	4	s
Configure monitoring::QV monitoring		3292 Monitoring	Off	
Configure monitoring::QV monitoring		3285 Limit undervoltage	85	%
Configure monitoring::QV monitoring		3287 Minimum current	10	%
Configure monitoring::QV monitoring		3291 Reactive power threshold	5	%
Configure monitoring::QV monitoring		3283 Delay step 1	0.5	s
Configure monitoring::QV monitoring		3284 Delay step 2	1.5	s
Configure monitoring::QV monitoring		3280 Alarm class	Class B	
Configure monitoring::QV monitoring		3293 Self acknowledge	Yes	
Configure monitoring::Breakers	**GCB**	2600 GCB monitoring	On	
Configure monitoring::Breakers	**GCB**	2601 GCB alarm class	Class C	
Configure monitoring::Breakers	**GCB**	3418 GCB maximum closing attemps	3	
Configure monitoring::Breakers	**GCB**	3420 GCB open monitoring	2	s
Configure monitoring::Breakers	**Synchronization GCB**	3060 Monitoring	On	
Configure monitoring::Breakers	**Synchronization GCB**	3063 Delay	180	s
Configure monitoring::Breakers	**Synchronization GCB**	3061 Alarm class	Class B	
Configure monitoring::Breakers	**Synchronization GCB**	3062 Self acknowledge	No	
Configure monitoring::Breakers	**MCB**	2620 MCB monitoring	Off	
Configure monitoring::Breakers	**MCB**	2621 MCB alarm class	Class B	
Configure monitoring::Breakers	**MCB**	3419 MCB maximum closing attemps	5	
Configure monitoring::Breakers	**MCB**	3421 MCB open monitoring	2	s
Configure monitoring::Breakers	**Synchronization MCB**	3070 Monitoring	Off	
Configure monitoring::Breakers	**Synchronization MCB**	3073 Delay	180	s
Configure monitoring::Breakers	**Synchronization MCB**	3071 Alarm class	Class B	
Configure monitoring::Breakers	**Synchronization MCB**	3072 Self acknowledge	No	
Configure monitoring::Breakers	**Gen. Busb. Mns. phase rotation**	2940 Monitoring	On	
Configure monitoring::Breakers	**Gen. Busb. Mns. phase rotation**	2941 Alarm class	Class F	
Configure monitoring::Breakers	**Gen. Busb. Mns. phase rotation**	2942 Self acknowledge	Yes	
Configure monitoring::Flexible limits::1-2	**Flexible limit 1**	4208 Description	P-max	
Configure monitoring::Flexible limits::1-2	**Flexible limit 1**	4200 Monitoring	On	

Configure monitoring::Flexible limits::1-2		4206 Monitored data source	01.24 Gen. total power	
Configure monitoring::Flexible limits::1-2	**Flexible limit 1**	4204 Monitoring at	Overrun	
Configure monitoring::Flexible limits::1-2	**Flexible limit 1**	4205 Limit	9350	
Configure monitoring::Flexible limits::1-2	**Flexible limit 1**	4216 Hysteresis	50	
Configure monitoring::Flexible limits::1-2	**Flexible limit 1**	4207 Delay	0.02	s
Configure monitoring::Flexible limits::1-2	**Flexible limit 1**	4201 Alarm class	Control	
Configure monitoring::Flexible limits::1-2	**Flexible limit 1**	4202 Self acknowledge	Yes	
Configure monitoring::Flexible limits::1-2	**Flexible limit 1**	4203 Delayed by engine speed	No	
Configure monitoring::Flexible limits::1-2	**Flexible limit 2**	4225 Description	P-min	
Configure monitoring::Flexible limits::1-2	**Flexible limit 2**	4217 Monitoring	On	
Configure monitoring::Flexible limits::1-2		4223 Monitored data source	01.24 Gen. total power	
Configure monitoring::Flexible limits::1-2	**Flexible limit 2**	4221 Monitoring at	Underrun	
Configure monitoring::Flexible limits::1-2	**Flexible limit 2**	4222 Limit	-50	
Configure monitoring::Flexible limits::1-2	**Flexible limit 2**	4233 Hysteresis	50	
Configure monitoring::Flexible limits::1-2	**Flexible limit 2**	4224 Delay	0.02	s
Configure monitoring::Flexible limits::1-2	**Flexible limit 2**	4218 Alarm class	Control	
Configure monitoring::Flexible limits::1-2	**Flexible limit 2**	4219 Self acknowledge	Yes	
Configure monitoring::Flexible limits::1-2	**Flexible limit 2**	4220 Delayed by engine speed	No	
Configure monitoring::Flexible limits::3-4	**Flexible limit 3**	4242 Description	Flex. limit 3	
Configure monitoring::Flexible limits::3-4	**Flexible limit 3**	4234 Monitoring	Off	
Configure monitoring::Flexible limits::3-4		4240 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::3-4	**Flexible limit 3**	4238 Monitoring at	Overrun	
Configure monitoring::Flexible limits::3-4	**Flexible limit 3**	4239 Limit	100	
Configure monitoring::Flexible limits::3-4	**Flexible limit 3**	4250 Hysteresis	1	
Configure monitoring::Flexible limits::3-4	**Flexible limit 3**	4241 Delay	1	s
Configure monitoring::Flexible limits::3-4	**Flexible limit 3**	4235 Alarm class	Control	
Configure monitoring::Flexible limits::3-4	**Flexible limit 3**	4236 Self acknowledge	Yes	
Configure monitoring::Flexible limits::3-4	**Flexible limit 3**	4237 Delayed by engine speed	No	
Configure monitoring::Flexible limits::3-4	**Flexible limit 4**	4259 Description	V-0	
Configure monitoring::Flexible limits::3-4	**Flexible limit 4**	4251 Monitoring	Off	
Configure monitoring::Flexible limits::3-4		4257 Monitored data source	01.20 Gen. power factor	
Configure monitoring::Flexible limits::3-4	**Flexible limit 4**	4255 Monitoring at	Overrun	
Configure monitoring::Flexible limits::3-4	**Flexible limit 4**	4256 Limit	0	
Configure monitoring::Flexible limits::3-4	**Flexible limit 4**	4267 Hysteresis	0	
Configure monitoring::Flexible limits::3-4	**Flexible limit 4**	4258 Delay	0.02	s
Configure monitoring::Flexible limits::3-4	**Flexible limit 4**	4252 Alarm class	Class A	
Configure monitoring::Flexible limits::3-4	**Flexible limit 4**	4253 Self acknowledge	Yes	
Configure monitoring::Flexible limits::3-4	**Flexible limit 4**	4254 Delayed by engine speed	Yes	
Configure monitoring::Flexible limits::5-6	**Flexible limit 5**	7108 Description	Flex. limit 5	
Configure monitoring::Flexible limits::5-6	**Flexible limit 5**	4270 Monitoring	Off	
Configure monitoring::Flexible limits::5-6		4276 Monitored data source	01.20 Gen. power factor	
Configure monitoring::Flexible limits::5-6	**Flexible limit 5**	4274 Monitoring at	Underrun	
Configure monitoring::Flexible limits::5-6	**Flexible limit 5**	4275 Limit	-700	

Configure monitoring::Flexible limits::5-6	**Flexible limit 5**	4278 Hysteresis	0	
Configure monitoring::Flexible limits::5-6	**Flexible limit 5**	4277 Delay	0.02	s
Configure monitoring::Flexible limits::5-6	**Flexible limit 5**	4271 Alarm class	Class A	
Configure monitoring::Flexible limits::5-6	**Flexible limit 5**	4272 Self acknowledge	Yes	
Configure monitoring::Flexible limits::5-6	**Flexible limit 5**	4273 Delayed by engine speed	Yes	
Configure monitoring::Flexible limits::5-6	**Flexible limit 6**	7116 Description	Flex. limit 6	
Configure monitoring::Flexible limits::5-6	**Flexible limit 6**	4280 Monitoring	Off	
Configure monitoring::Flexible limits::5-6		4286 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::5-6	**Flexible limit 6**	4284 Monitoring at	Overrun	
Configure monitoring::Flexible limits::5-6	**Flexible limit 6**	4285 Limit	100	
Configure monitoring::Flexible limits::5-6	**Flexible limit 6**	4288 Hysteresis	1	
Configure monitoring::Flexible limits::5-6	**Flexible limit 6**	4287 Delay	1	s
Configure monitoring::Flexible limits::5-6	**Flexible limit 6**	4281 Alarm class	Class B	
Configure monitoring::Flexible limits::5-6	**Flexible limit 6**	4282 Self acknowledge	No	
Configure monitoring::Flexible limits::5-6	**Flexible limit 6**	4283 Delayed by engine speed	No	
Configure monitoring::Flexible limits::7-8	**Flexible limit 7**	7124 Description	Flex. limit 7	
Configure monitoring::Flexible limits::7-8	**Flexible limit 7**	4290 Monitoring	Off	
Configure monitoring::Flexible limits::7-8		4296 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::7-8	**Flexible limit 7**	4294 Monitoring at	Overrun	
Configure monitoring::Flexible limits::7-8	**Flexible limit 7**	4295 Limit	100	
Configure monitoring::Flexible limits::7-8	**Flexible limit 7**	4298 Hysteresis	1	
Configure monitoring::Flexible limits::7-8	**Flexible limit 7**	4297 Delay	1	s
Configure monitoring::Flexible limits::7-8	**Flexible limit 7**	4291 Alarm class	Class B	
Configure monitoring::Flexible limits::7-8	**Flexible limit 7**	4292 Self acknowledge	No	
Configure monitoring::Flexible limits::7-8	**Flexible limit 7**	4293 Delayed by engine speed	No	
Configure monitoring::Flexible limits::7-8	**Flexible limit 8**	7132 Description	Flex. limit 8	
Configure monitoring::Flexible limits::7-8	**Flexible limit 8**	6000 Monitoring	Off	
Configure monitoring::Flexible limits::7-8		6006 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::7-8	**Flexible limit 8**	6004 Monitoring at	Overrun	
Configure monitoring::Flexible limits::7-8	**Flexible limit 8**	6005 Limit	100	
Configure monitoring::Flexible limits::7-8	**Flexible limit 8**	6008 Hysteresis	1	
Configure monitoring::Flexible limits::7-8	**Flexible limit 8**	6007 Delay	1	s
Configure monitoring::Flexible limits::7-8	**Flexible limit 8**	6001 Alarm class	Class B	
Configure monitoring::Flexible limits::7-8	**Flexible limit 8**	6002 Self acknowledge	No	
Configure monitoring::Flexible limits::7-8	**Flexible limit 8**	6003 Delayed by engine speed	No	
Configure monitoring::Flexible limits::9-10	**Flexible limit 9**	7140 Description	Cooling Pump - Engine Cooldown	
Configure monitoring::Flexible limits::9-10	**Flexible limit 9**	6010 Monitoring	On	
Configure monitoring::Flexible limits::9-10		6016 Monitored data source	07.15 110:Engine Coolant Temp	
Configure monitoring::Flexible limits::9-10	**Flexible limit 9**	6014 Monitoring at	Overrun	
Configure monitoring::Flexible limits::9-10	**Flexible limit 9**	6015 Limit	70	
Configure monitoring::Flexible limits::9-10	**Flexible limit 9**	6018 Hysteresis	5	
Configure monitoring::Flexible limits::9-10	**Flexible limit 9**	6017 Delay	1	s

Configure monitoring::Flexible limits::9-10	**Flexible limit 9**	6011 Alarm class	Control	
Configure monitoring::Flexible limits::9-10	**Flexible limit 9**	6012 Self acknowledge	No	
Configure monitoring::Flexible limits::9-10	**Flexible limit 9**	6013 Delayed by engine speed	No	
Configure monitoring::Flexible limits::9-10	**Flexible limit 10**	7148 Description	Flex. limit 10	
Configure monitoring::Flexible limits::9-10	**Flexible limit 10**	6020 Monitoring	Off	
Configure monitoring::Flexible limits::9-10		6026 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::9-10	**Flexible limit 10**	6024 Monitoring at	Overrun	
Configure monitoring::Flexible limits::9-10	**Flexible limit 10**	6025 Limit	100	
Configure monitoring::Flexible limits::9-10	**Flexible limit 10**	6028 Hysteresis	1	
Configure monitoring::Flexible limits::9-10	**Flexible limit 10**	6027 Delay	1	s
Configure monitoring::Flexible limits::9-10	**Flexible limit 10**	6021 Alarm class	Class B	
Configure monitoring::Flexible limits::9-10	**Flexible limit 10**	6022 Self acknowledge	No	
Configure monitoring::Flexible limits::9-10	**Flexible limit 10**	6023 Delayed by engine speed	No	
Configure monitoring::Flexible limits::11-12	**Flexible limit 11**	7156 Description	Flex. limit 11	
Configure monitoring::Flexible limits::11-12	**Flexible limit 11**	6030 Monitoring	Off	
Configure monitoring::Flexible limits::11-12		6036 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::11-12	**Flexible limit 11**	6034 Monitoring at	Overrun	
Configure monitoring::Flexible limits::11-12	**Flexible limit 11**	6035 Limit	100	
Configure monitoring::Flexible limits::11-12	**Flexible limit 11**	6038 Hysteresis	1	
Configure monitoring::Flexible limits::11-12	**Flexible limit 11**	6037 Delay	1	s
Configure monitoring::Flexible limits::11-12	**Flexible limit 11**	6031 Alarm class	Class B	
Configure monitoring::Flexible limits::11-12	**Flexible limit 11**	6032 Self acknowledge	No	
Configure monitoring::Flexible limits::11-12	**Flexible limit 11**	6033 Delayed by engine speed	No	
Configure monitoring::Flexible limits::11-12	**Flexible limit 12**	7164 Description	Flex. limit 12	
Configure monitoring::Flexible limits::11-12	**Flexible limit 12**	6040 Monitoring	Off	
Configure monitoring::Flexible limits::11-12		6046 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::11-12	**Flexible limit 12**	6044 Monitoring at	Overrun	
Configure monitoring::Flexible limits::11-12	**Flexible limit 12**	6045 Limit	100	
Configure monitoring::Flexible limits::11-12	**Flexible limit 12**	6048 Hysteresis	1	
Configure monitoring::Flexible limits::11-12	**Flexible limit 12**	6047 Delay	1	s
Configure monitoring::Flexible limits::11-12	**Flexible limit 12**	6041 Alarm class	Class B	
Configure monitoring::Flexible limits::11-12	**Flexible limit 12**	6042 Self acknowledge	No	
Configure monitoring::Flexible limits::11-12	**Flexible limit 12**	6043 Delayed by engine speed	No	
Configure monitoring::Flexible limits::13-14	**Flexible limit 13**	7172 Description	Flex. limit 13	
Configure monitoring::Flexible limits::13-14	**Flexible limit 13**	6050 Monitoring	Off	
Configure monitoring::Flexible limits::13-14		6056 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::13-14	**Flexible limit 13**	6054 Monitoring at	Overrun	
Configure monitoring::Flexible limits::13-14	**Flexible limit 13**	6055 Limit	100	
Configure monitoring::Flexible limits::13-14	**Flexible limit 13**	6058 Hysteresis	1	
Configure monitoring::Flexible limits::13-14	**Flexible limit 13**	6057 Delay	1	s
Configure monitoring::Flexible limits::13-14	**Flexible limit 13**	6051 Alarm class	Class B	
Configure monitoring::Flexible limits::13-14	**Flexible limit 13**	6052 Self acknowledge	No	
Configure monitoring::Flexible limits::13-14	**Flexible limit 13**	6053 Delayed by engine speed	No	

Configure monitoring::Flexible limits::13-14	**Flexible limit 14**	7180 Description	Flex. limit 14	
Configure monitoring::Flexible limits::13-14	**Flexible limit 14**	6060 Monitoring	Off	
Configure monitoring::Flexible limits::13-14		6066 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::13-14	**Flexible limit 14**	6064 Monitoring at	Overrun	
Configure monitoring::Flexible limits::13-14	**Flexible limit 14**	6065 Limit	100	
Configure monitoring::Flexible limits::13-14	**Flexible limit 14**	6068 Hysteresis	1	
Configure monitoring::Flexible limits::13-14	**Flexible limit 14**	6067 Delay	1	s
Configure monitoring::Flexible limits::13-14	**Flexible limit 14**	6061 Alarm class	Class B	
Configure monitoring::Flexible limits::13-14	**Flexible limit 14**	6062 Self acknowledge	No	
Configure monitoring::Flexible limits::13-14	**Flexible limit 14**	6063 Delayed by engine speed	No	
Configure monitoring::Flexible limits::15-16	**Flexible limit 15**	7188 Description	Flex. limit 15	
Configure monitoring::Flexible limits::15-16	**Flexible limit 15**	6070 Monitoring	Off	
Configure monitoring::Flexible limits::15-16		6076 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::15-16	**Flexible limit 15**	6074 Monitoring at	Overrun	
Configure monitoring::Flexible limits::15-16	**Flexible limit 15**	6075 Limit	100	
Configure monitoring::Flexible limits::15-16	**Flexible limit 15**	6078 Hysteresis	1	
Configure monitoring::Flexible limits::15-16	**Flexible limit 15**	6077 Delay	1	s
Configure monitoring::Flexible limits::15-16	**Flexible limit 15**	6071 Alarm class	Class B	
Configure monitoring::Flexible limits::15-16	**Flexible limit 15**	6072 Self acknowledge	No	
Configure monitoring::Flexible limits::15-16	**Flexible limit 15**	6073 Delayed by engine speed	No	
Configure monitoring::Flexible limits::15-16	**Flexible limit 16**	7196 Description	Flex. limit 16	
Configure monitoring::Flexible limits::15-16	**Flexible limit 16**	6080 Monitoring	Off	
Configure monitoring::Flexible limits::15-16		6086 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::15-16	**Flexible limit 16**	6084 Monitoring at	Overrun	
Configure monitoring::Flexible limits::15-16	**Flexible limit 16**	6085 Limit	100	
Configure monitoring::Flexible limits::15-16	**Flexible limit 16**	6088 Hysteresis	1	
Configure monitoring::Flexible limits::15-16	**Flexible limit 16**	6087 Delay	1	s
Configure monitoring::Flexible limits::15-16	**Flexible limit 16**	6081 Alarm class	Class B	
Configure monitoring::Flexible limits::15-16	**Flexible limit 16**	6082 Self acknowledge	No	
Configure monitoring::Flexible limits::15-16	**Flexible limit 16**	6083 Delayed by engine speed	No	
Configure monitoring::Flexible limits::17-18	**Flexible limit 17**	7204 Description	Flex. limit 17	
Configure monitoring::Flexible limits::17-18	**Flexible limit 17**	6090 Monitoring	Off	
Configure monitoring::Flexible limits::17-18		6096 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::17-18	**Flexible limit 17**	6094 Monitoring at	Overrun	
Configure monitoring::Flexible limits::17-18	**Flexible limit 17**	6095 Limit	100	
Configure monitoring::Flexible limits::17-18	**Flexible limit 17**	6098 Hysteresis	1	
Configure monitoring::Flexible limits::17-18	**Flexible limit 17**	6097 Delay	1	s
Configure monitoring::Flexible limits::17-18	**Flexible limit 17**	6091 Alarm class	Class B	
Configure monitoring::Flexible limits::17-18	**Flexible limit 17**	6092 Self acknowledge	No	
Configure monitoring::Flexible limits::17-18	**Flexible limit 17**	6093 Delayed by engine speed	No	
Configure monitoring::Flexible limits::17-18	**Flexible limit 18**	7212 Description	Flex. limit 18	
Configure monitoring::Flexible limits::17-18	**Flexible limit 18**	6100 Monitoring	Off	
Configure monitoring::Flexible limits::17-18		6106 Monitored data source	00.02 Voltage bias	

Configure monitoring::Flexible limits::17-18	**Flexible limit 18**	6104 Monitoring at	Overrun	
Configure monitoring::Flexible limits::17-18	**Flexible limit 18**	6105 Limit	100	
Configure monitoring::Flexible limits::17-18	**Flexible limit 18**	6108 Hysteresis	1	
Configure monitoring::Flexible limits::17-18	**Flexible limit 18**	6107 Delay	1	s
Configure monitoring::Flexible limits::17-18	**Flexible limit 18**	6101 Alarm class	Class B	
Configure monitoring::Flexible limits::17-18	**Flexible limit 18**	6102 Self acknowledge	No	
Configure monitoring::Flexible limits::17-18	**Flexible limit 18**	6103 Delayed by engine speed	No	
Configure monitoring::Flexible limits::19-20	**Flexible limit 19**	7220 Description	Flex. limit 19	
Configure monitoring::Flexible limits::19-20	**Flexible limit 19**	6110 Monitoring	Off	
Configure monitoring::Flexible limits::19-20		6116 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::19-20	**Flexible limit 19**	6114 Monitoring at	Overrun	
Configure monitoring::Flexible limits::19-20	**Flexible limit 19**	6115 Limit	100	
Configure monitoring::Flexible limits::19-20	**Flexible limit 19**	6118 Hysteresis	1	
Configure monitoring::Flexible limits::19-20	**Flexible limit 19**	6117 Delay	1	s
Configure monitoring::Flexible limits::19-20	**Flexible limit 19**	6111 Alarm class	Class B	
Configure monitoring::Flexible limits::19-20	**Flexible limit 19**	6112 Self acknowledge	No	
Configure monitoring::Flexible limits::19-20	**Flexible limit 19**	6113 Delayed by engine speed	No	
Configure monitoring::Flexible limits::19-20	**Flexible limit 20**	7228 Description	Flex. limit 20	
Configure monitoring::Flexible limits::19-20	**Flexible limit 20**	6120 Monitoring	Off	
Configure monitoring::Flexible limits::19-20		6126 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::19-20	**Flexible limit 20**	6124 Monitoring at	Overrun	
Configure monitoring::Flexible limits::19-20	**Flexible limit 20**	6125 Limit	100	
Configure monitoring::Flexible limits::19-20	**Flexible limit 20**	6128 Hysteresis	1	
Configure monitoring::Flexible limits::19-20	**Flexible limit 20**	6127 Delay	1	s
Configure monitoring::Flexible limits::19-20	**Flexible limit 20**	6121 Alarm class	Class B	
Configure monitoring::Flexible limits::19-20	**Flexible limit 20**	6122 Self acknowledge	No	
Configure monitoring::Flexible limits::19-20	**Flexible limit 20**	6123 Delayed by engine speed	No	
Configure monitoring::Flexible limits::21-22	**Flexible limit 21**	7236 Description	Flex. limit 21	
Configure monitoring::Flexible limits::21-22	**Flexible limit 21**	6130 Monitoring	Off	
Configure monitoring::Flexible limits::21-22		6136 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::21-22	**Flexible limit 21**	6134 Monitoring at	Overrun	
Configure monitoring::Flexible limits::21-22	**Flexible limit 21**	6135 Limit	100	
Configure monitoring::Flexible limits::21-22	**Flexible limit 21**	6138 Hysteresis	1	
Configure monitoring::Flexible limits::21-22	**Flexible limit 21**	6137 Delay	1	s
Configure monitoring::Flexible limits::21-22	**Flexible limit 21**	6131 Alarm class	Class B	
Configure monitoring::Flexible limits::21-22	**Flexible limit 21**	6132 Self acknowledge	No	
Configure monitoring::Flexible limits::21-22	**Flexible limit 21**	6133 Delayed by engine speed	No	
Configure monitoring::Flexible limits::21-22	**Flexible limit 22**	7244 Description	Flex. limit 22	
Configure monitoring::Flexible limits::21-22	**Flexible limit 22**	6140 Monitoring	Off	
Configure monitoring::Flexible limits::21-22		6146 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::21-22	**Flexible limit 22**	6144 Monitoring at	Overrun	
Configure monitoring::Flexible limits::21-22	**Flexible limit 22**	6145 Limit	100	
Configure monitoring::Flexible limits::21-22	**Flexible limit 22**	6148 Hysteresis	1	

Configure monitoring::Flexible limits::21-22	**Flexible limit 22**	6147 Delay	1	s
Configure monitoring::Flexible limits::21-22	**Flexible limit 22**	6141 Alarm class	Class B	
Configure monitoring::Flexible limits::21-22	**Flexible limit 22**	6142 Self acknowledge	No	
Configure monitoring::Flexible limits::21-22	**Flexible limit 22**	6143 Delayed by engine speed	No	
Configure monitoring::Flexible limits::23-24	**Flexible limit 23**	7252 Description	Flex. limit 23	
Configure monitoring::Flexible limits::23-24	**Flexible limit 23**	6150 Monitoring	Off	
Configure monitoring::Flexible limits::23-24		6156 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::23-24	**Flexible limit 23**	6154 Monitoring at	Overrun	
Configure monitoring::Flexible limits::23-24	**Flexible limit 23**	6155 Limit	100	
Configure monitoring::Flexible limits::23-24	**Flexible limit 23**	6158 Hysteresis	1	
Configure monitoring::Flexible limits::23-24	**Flexible limit 23**	6157 Delay	1	s
Configure monitoring::Flexible limits::23-24	**Flexible limit 23**	6151 Alarm class	Class B	
Configure monitoring::Flexible limits::23-24	**Flexible limit 23**	6152 Self acknowledge	No	
Configure monitoring::Flexible limits::23-24	**Flexible limit 23**	6153 Delayed by engine speed	No	
Configure monitoring::Flexible limits::23-24	**Flexible limit 24**	7260 Description	Flex. limit 24	
Configure monitoring::Flexible limits::23-24	**Flexible limit 24**	6160 Monitoring	Off	
Configure monitoring::Flexible limits::23-24		6166 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::23-24	**Flexible limit 24**	6164 Monitoring at	Overrun	
Configure monitoring::Flexible limits::23-24	**Flexible limit 24**	6165 Limit	100	
Configure monitoring::Flexible limits::23-24	**Flexible limit 24**	6168 Hysteresis	1	
Configure monitoring::Flexible limits::23-24	**Flexible limit 24**	6167 Delay	1	s
Configure monitoring::Flexible limits::23-24	**Flexible limit 24**	6161 Alarm class	Class B	
Configure monitoring::Flexible limits::23-24	**Flexible limit 24**	6162 Self acknowledge	No	
Configure monitoring::Flexible limits::23-24	**Flexible limit 24**	6163 Delayed by engine speed	No	
Configure monitoring::Flexible limits::25-26	**Flexible limit 25**	7268 Description	Flex. limit 25	
Configure monitoring::Flexible limits::25-26	**Flexible limit 25**	6170 Monitoring	Off	
Configure monitoring::Flexible limits::25-26		6176 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::25-26	**Flexible limit 25**	6174 Monitoring at	Overrun	
Configure monitoring::Flexible limits::25-26	**Flexible limit 25**	6175 Limit	100	
Configure monitoring::Flexible limits::25-26	**Flexible limit 25**	6178 Hysteresis	1	
Configure monitoring::Flexible limits::25-26	**Flexible limit 25**	6177 Delay	1	s
Configure monitoring::Flexible limits::25-26	**Flexible limit 25**	6171 Alarm class	Class B	
Configure monitoring::Flexible limits::25-26	**Flexible limit 25**	6172 Self acknowledge	No	
Configure monitoring::Flexible limits::25-26	**Flexible limit 25**	6173 Delayed by engine speed	No	
Configure monitoring::Flexible limits::25-26	**Flexible limit 26**	7276 Description	Flex. limit 26	
Configure monitoring::Flexible limits::25-26	**Flexible limit 26**	6180 Monitoring	Off	
Configure monitoring::Flexible limits::25-26		6186 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::25-26	**Flexible limit 26**	6184 Monitoring at	Overrun	
Configure monitoring::Flexible limits::25-26	**Flexible limit 26**	6185 Limit	100	
Configure monitoring::Flexible limits::25-26	**Flexible limit 26**	6188 Hysteresis	1	
Configure monitoring::Flexible limits::25-26	**Flexible limit 26**	6187 Delay	1	s
Configure monitoring::Flexible limits::25-26	**Flexible limit 26**	6181 Alarm class	Class B	
Configure monitoring::Flexible limits::25-26	**Flexible limit 26**	6182 Self acknowledge	No	

Configure monitoring::Flexible limits::25-26	**Flexible limit 26**	6183 Delayed by engine speed	No	
Configure monitoring::Flexible limits::27-28	**Flexible limit 27**	7284 Description	Flex. limit 27	
Configure monitoring::Flexible limits::27-28	**Flexible limit 27**	6190 Monitoring	Off	
Configure monitoring::Flexible limits::27-28		6196 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::27-28	**Flexible limit 27**	6194 Monitoring at	Overrun	
Configure monitoring::Flexible limits::27-28	**Flexible limit 27**	6195 Limit	100	
Configure monitoring::Flexible limits::27-28	**Flexible limit 27**	6198 Hysteresis	1	
Configure monitoring::Flexible limits::27-28	**Flexible limit 27**	6197 Delay	1	s
Configure monitoring::Flexible limits::27-28	**Flexible limit 27**	6191 Alarm class	Class B	
Configure monitoring::Flexible limits::27-28	**Flexible limit 27**	6192 Self acknowledge	No	
Configure monitoring::Flexible limits::27-28	**Flexible limit 27**	6193 Delayed by engine speed	No	
Configure monitoring::Flexible limits::27-28	**Flexible limit 28**	7292 Description	Flex. limit 28	
Configure monitoring::Flexible limits::27-28	**Flexible limit 28**	6200 Monitoring	Off	
Configure monitoring::Flexible limits::27-28		6206 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::27-28	**Flexible limit 28**	6204 Monitoring at	Overrun	
Configure monitoring::Flexible limits::27-28	**Flexible limit 28**	6205 Limit	100	
Configure monitoring::Flexible limits::27-28	**Flexible limit 28**	6208 Hysteresis	1	
Configure monitoring::Flexible limits::27-28	**Flexible limit 28**	6207 Delay	1	s
Configure monitoring::Flexible limits::27-28	**Flexible limit 28**	6201 Alarm class	Class B	
Configure monitoring::Flexible limits::27-28	**Flexible limit 28**	6202 Self acknowledge	No	
Configure monitoring::Flexible limits::27-28	**Flexible limit 28**	6203 Delayed by engine speed	No	
Configure monitoring::Flexible limits::29-30	**Flexible limit 29**	7300 Description	Flex. limit 29	
Configure monitoring::Flexible limits::29-30	**Flexible limit 29**	6210 Monitoring	Off	
Configure monitoring::Flexible limits::29-30		6216 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::29-30	**Flexible limit 29**	6214 Monitoring at	Overrun	
Configure monitoring::Flexible limits::29-30	**Flexible limit 29**	6215 Limit	100	
Configure monitoring::Flexible limits::29-30	**Flexible limit 29**	6218 Hysteresis	1	
Configure monitoring::Flexible limits::29-30	**Flexible limit 29**	6217 Delay	1	s
Configure monitoring::Flexible limits::29-30	**Flexible limit 29**	6211 Alarm class	Class B	
Configure monitoring::Flexible limits::29-30	**Flexible limit 29**	6212 Self acknowledge	No	
Configure monitoring::Flexible limits::29-30	**Flexible limit 29**	6213 Delayed by engine speed	No	
Configure monitoring::Flexible limits::29-30	**Flexible limit 30**	7308 Description	Flex. limit 30	
Configure monitoring::Flexible limits::29-30	**Flexible limit 30**	6220 Monitoring	Off	
Configure monitoring::Flexible limits::29-30		6226 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::29-30	**Flexible limit 30**	6224 Monitoring at	Overrun	
Configure monitoring::Flexible limits::29-30	**Flexible limit 30**	6225 Limit	100	
Configure monitoring::Flexible limits::29-30	**Flexible limit 30**	6228 Hysteresis	1	
Configure monitoring::Flexible limits::29-30	**Flexible limit 30**	6227 Delay	1	s
Configure monitoring::Flexible limits::29-30	**Flexible limit 30**	6221 Alarm class	Class B	
Configure monitoring::Flexible limits::29-30	**Flexible limit 30**	6222 Self acknowledge	No	
Configure monitoring::Flexible limits::29-30	**Flexible limit 30**	6223 Delayed by engine speed	No	
Configure monitoring::Flexible limits::31-32	**Flexible limit 31**	7316 Description	Flex. limit 31	
Configure monitoring::Flexible limits::31-32	**Flexible limit 31**	6230 Monitoring	Off	

Configure monitoring::Flexible limits::31-32		6236 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::31-32	**Flexible limit 31**	6234 Monitoring at	Overrun	
Configure monitoring::Flexible limits::31-32	**Flexible limit 31**	6235 Limit	100	
Configure monitoring::Flexible limits::31-32	**Flexible limit 31**	6238 Hysteresis	1	
Configure monitoring::Flexible limits::31-32	**Flexible limit 31**	6237 Delay	1	s
Configure monitoring::Flexible limits::31-32	**Flexible limit 31**	6231 Alarm class	Class B	
Configure monitoring::Flexible limits::31-32	**Flexible limit 31**	6232 Self acknowledge	No	
Configure monitoring::Flexible limits::31-32	**Flexible limit 31**	6233 Delayed by engine speed	No	
Configure monitoring::Flexible limits::31-32	**Flexible limit 32**	7324 Description	Flex. limit 32	
Configure monitoring::Flexible limits::31-32	**Flexible limit 32**	6240 Monitoring	Off	
Configure monitoring::Flexible limits::31-32		6246 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::31-32	**Flexible limit 32**	6244 Monitoring at	Overrun	
Configure monitoring::Flexible limits::31-32	**Flexible limit 32**	6245 Limit	100	
Configure monitoring::Flexible limits::31-32	**Flexible limit 32**	6248 Hysteresis	1	
Configure monitoring::Flexible limits::31-32	**Flexible limit 32**	6247 Delay	1	s
Configure monitoring::Flexible limits::31-32	**Flexible limit 32**	6241 Alarm class	Class B	
Configure monitoring::Flexible limits::31-32	**Flexible limit 32**	6242 Self acknowledge	No	
Configure monitoring::Flexible limits::31-32	**Flexible limit 32**	6243 Delayed by engine speed	No	
Configure monitoring::Flexible limits::33-34	**Flexible limit 33**	7332 Description	Flex. limit 33	
Configure monitoring::Flexible limits::33-34	**Flexible limit 33**	6250 Monitoring	Off	
Configure monitoring::Flexible limits::33-34		6256 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::33-34	**Flexible limit 33**	6254 Monitoring at	Overrun	
Configure monitoring::Flexible limits::33-34	**Flexible limit 33**	6255 Limit	100	
Configure monitoring::Flexible limits::33-34	**Flexible limit 33**	6258 Hysteresis	1	
Configure monitoring::Flexible limits::33-34	**Flexible limit 33**	6257 Delay	1	s
Configure monitoring::Flexible limits::33-34	**Flexible limit 33**	6251 Alarm class	Class B	
Configure monitoring::Flexible limits::33-34	**Flexible limit 33**	6252 Self acknowledge	No	
Configure monitoring::Flexible limits::33-34	**Flexible limit 33**	6253 Delayed by engine speed	No	
Configure monitoring::Flexible limits::33-34	**Flexible limit 34**	7340 Description	Flex. limit 34	
Configure monitoring::Flexible limits::33-34	**Flexible limit 34**	6260 Monitoring	Off	
Configure monitoring::Flexible limits::33-34		6266 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::33-34	**Flexible limit 34**	6264 Monitoring at	Overrun	
Configure monitoring::Flexible limits::33-34	**Flexible limit 34**	6265 Limit	100	
Configure monitoring::Flexible limits::33-34	**Flexible limit 34**	6268 Hysteresis	1	
Configure monitoring::Flexible limits::33-34	**Flexible limit 34**	6267 Delay	1	s
Configure monitoring::Flexible limits::33-34	**Flexible limit 34**	6261 Alarm class	Class B	
Configure monitoring::Flexible limits::33-34	**Flexible limit 34**	6262 Self acknowledge	No	
Configure monitoring::Flexible limits::33-34	**Flexible limit 34**	6263 Delayed by engine speed	No	
Configure monitoring::Flexible limits::35-36	**Flexible limit 35**	7348 Description	Flex. limit 35	
Configure monitoring::Flexible limits::35-36	**Flexible limit 35**	6270 Monitoring	Off	
Configure monitoring::Flexible limits::35-36		6276 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::35-36	**Flexible limit 35**	6274 Monitoring at	Overrun	
Configure monitoring::Flexible limits::35-36	**Flexible limit 35**	6275 Limit	100	

Configure monitoring::Flexible limits::35-36	**Flexible limit 35**	6278 Hysteresis	1	
Configure monitoring::Flexible limits::35-36	**Flexible limit 35**	6277 Delay	1	s
Configure monitoring::Flexible limits::35-36	**Flexible limit 35**	6271 Alarm class	Class B	
Configure monitoring::Flexible limits::35-36	**Flexible limit 35**	6272 Self acknowledge	No	
Configure monitoring::Flexible limits::35-36	**Flexible limit 35**	6273 Delayed by engine speed	No	
Configure monitoring::Flexible limits::35-36	**Flexible limit 36**	7356 Description	Flex. limit 36	
Configure monitoring::Flexible limits::35-36	**Flexible limit 36**	6280 Monitoring	Off	
Configure monitoring::Flexible limits::35-36		6286 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::35-36	**Flexible limit 36**	6284 Monitoring at	Overrun	
Configure monitoring::Flexible limits::35-36	**Flexible limit 36**	6285 Limit	100	
Configure monitoring::Flexible limits::35-36	**Flexible limit 36**	6288 Hysteresis	1	
Configure monitoring::Flexible limits::35-36	**Flexible limit 36**	6287 Delay	1	s
Configure monitoring::Flexible limits::35-36	**Flexible limit 36**	6281 Alarm class	Class B	
Configure monitoring::Flexible limits::35-36	**Flexible limit 36**	6282 Self acknowledge	No	
Configure monitoring::Flexible limits::35-36	**Flexible limit 36**	6283 Delayed by engine speed	No	
Configure monitoring::Flexible limits::37-38	**Flexible limit 37**	7364 Description	Flex. limit 37	
Configure monitoring::Flexible limits::37-38	**Flexible limit 37**	6290 Monitoring	Off	
Configure monitoring::Flexible limits::37-38		6296 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::37-38	**Flexible limit 37**	6294 Monitoring at	Overrun	
Configure monitoring::Flexible limits::37-38	**Flexible limit 37**	6295 Limit	100	
Configure monitoring::Flexible limits::37-38	**Flexible limit 37**	6298 Hysteresis	1	
Configure monitoring::Flexible limits::37-38	**Flexible limit 37**	6297 Delay	1	s
Configure monitoring::Flexible limits::37-38	**Flexible limit 37**	6291 Alarm class	Class B	
Configure monitoring::Flexible limits::37-38	**Flexible limit 37**	6292 Self acknowledge	No	
Configure monitoring::Flexible limits::37-38	**Flexible limit 37**	6293 Delayed by engine speed	No	
Configure monitoring::Flexible limits::37-38	**Flexible limit 38**	7372 Description	Flex. limit 38	
Configure monitoring::Flexible limits::37-38	**Flexible limit 38**	6300 Monitoring	Off	
Configure monitoring::Flexible limits::37-38		6306 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::37-38	**Flexible limit 38**	6304 Monitoring at	Overrun	
Configure monitoring::Flexible limits::37-38	**Flexible limit 38**	6305 Limit	100	
Configure monitoring::Flexible limits::37-38	**Flexible limit 38**	6308 Hysteresis	1	
Configure monitoring::Flexible limits::37-38	**Flexible limit 38**	6307 Delay	1	s
Configure monitoring::Flexible limits::37-38	**Flexible limit 38**	6301 Alarm class	Class B	
Configure monitoring::Flexible limits::37-38	**Flexible limit 38**	6302 Self acknowledge	No	
Configure monitoring::Flexible limits::37-38	**Flexible limit 38**	6303 Delayed by engine speed	No	
Configure monitoring::Flexible limits::39-40	**Flexible limit 39**	7380 Description	Flex. limit 39	
Configure monitoring::Flexible limits::39-40	**Flexible limit 39**	6310 Monitoring	Off	
Configure monitoring::Flexible limits::39-40		6316 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::39-40	**Flexible limit 39**	6314 Monitoring at	Overrun	
Configure monitoring::Flexible limits::39-40	**Flexible limit 39**	6315 Limit	100	
Configure monitoring::Flexible limits::39-40	**Flexible limit 39**	6318 Hysteresis	1	
Configure monitoring::Flexible limits::39-40	**Flexible limit 39**	6317 Delay	1	s
Configure monitoring::Flexible limits::39-40	**Flexible limit 39**	6311 Alarm class	Class B	

Configure monitoring::Flexible limits::39-40	**Flexible limit 39**	6312 Self acknowledge	No	
Configure monitoring::Flexible limits::39-40	**Flexible limit 39**	6313 Delayed by engine speed	No	
Configure monitoring::Flexible limits::39-40	**Flexible limit 40**	7388 Description	Flex. limit 40	
Configure monitoring::Flexible limits::39-40	**Flexible limit 40**	6320 Monitoring	Off	
Configure monitoring::Flexible limits::39-40		6326 Monitored data source	00.02 Voltage bias	
Configure monitoring::Flexible limits::39-40	**Flexible limit 40**	6324 Monitoring at	Overrun	
Configure monitoring::Flexible limits::39-40	**Flexible limit 40**	6325 Limit	100	
Configure monitoring::Flexible limits::39-40	**Flexible limit 40**	6328 Hysteresis	1	
Configure monitoring::Flexible limits::39-40	**Flexible limit 40**	6327 Delay	1	s
Configure monitoring::Flexible limits::39-40	**Flexible limit 40**	6321 Alarm class	Class B	
Configure monitoring::Flexible limits::39-40	**Flexible limit 40**	6322 Self acknowledge	No	
Configure monitoring::Flexible limits::39-40	**Flexible limit 40**	6323 Delayed by engine speed	No	
Configure monitoring::Multi-unit settings	**Multi-unit parameter alignment**	4070 Monitoring	Off	
Configure monitoring::Multi-unit settings	**Multi-unit parameter alignment**	4071 Alarm class	Class B	
Configure monitoring::Multi-unit settings	**Multi-unit missing members**	4060 Monitoring	Off	
Configure monitoring::Multi-unit settings	**Multi-unit missing members**	4063 Number of gens communicating	1	
Configure monitoring::Multi-unit settings	**Multi-unit missing members**	4061 Alarm class	Class B	
Configure monitoring::Multi-unit settings	**Multi-unit missing members**	4062 Self acknowledge	No	
Configure monitoring::Battery voltage	**Overvoltage level 1**	3450 Monitoring	On	
Configure monitoring::Battery voltage	**Overvoltage level 1**	3454 Limit	13.9	V
Configure monitoring::Battery voltage	**Overvoltage level 1**	3455 Delay	30	s
Configure monitoring::Battery voltage	**Overvoltage level 1**	3451 Alarm class	Class A	
Configure monitoring::Battery voltage	**Overvoltage level 1**	3452 Self acknowledge	No	
Configure monitoring::Battery voltage	**Overvoltage level 1**	3453 Delayed by engine speed	No	
Configure monitoring::Battery voltage	**Undervoltage level 1**	3500 Monitoring	On	
Configure monitoring::Battery voltage	**Undervoltage level 1**	3504 Limit	11	V
Configure monitoring::Battery voltage	**Undervoltage level 1**	3505 Delay	15	s
Configure monitoring::Battery voltage	**Undervoltage level 1**	3501 Alarm class	Class A	
Configure monitoring::Battery voltage	**Undervoltage level 1**	3502 Self acknowledge	No	
Configure monitoring::Battery voltage	**Undervoltage level 1**	3503 Delayed by engine speed	No	
Configure monitoring::Battery voltage	**Overvoltage level 2**	3456 Monitoring	On	
Configure monitoring::Battery voltage	**Overvoltage level 2**	3460 Limit	14.4	V
Configure monitoring::Battery voltage	**Overvoltage level 2**	3461 Delay	1	s
Configure monitoring::Battery voltage	**Overvoltage level 2**	3457 Alarm class	Class B	
Configure monitoring::Battery voltage	**Overvoltage level 2**	3458 Self acknowledge	No	
Configure monitoring::Battery voltage	**Overvoltage level 2**	3459 Delayed by engine speed	No	
Configure monitoring::Battery voltage	**Undervoltage level 2**	3506 Monitoring	On	

Configure monitoring::Battery voltage	**Undervoltage level 2**	3510 Limit	9	V
Configure monitoring::Battery voltage	**Undervoltage level 2**	3511 Delay	8	s
Configure monitoring::Battery voltage	**Undervoltage level 2**	3507 Alarm class	Class B	
Configure monitoring::Battery voltage	**Undervoltage level 2**	3508 Self acknowledge	No	
Configure monitoring::Battery voltage	**Undervoltage level 2**	3509 Delayed by engine speed	No	
Configure monitoring::CAN bus overload		3145 Monitoring	On	
Configure monitoring::CAN bus overload		3148 Delay	3	s
Configure monitoring::CAN bus overload		3146 Alarm class	Class C	
Configure monitoring::CAN bus overload		3147 Self acknowledge	No	
Configure monitoring::CAN interfaces	**Configure CAN interface 1**	3150 Monitoring	Off	
Configure monitoring::CAN interfaces	**Configure CAN interface 1**	3154 Delay	0.2	s
Configure monitoring::CAN interfaces	**Configure CAN interface 1**	3151 Alarm class	Class B	
Configure monitoring::CAN interfaces	**Configure CAN interface 1**	3152 Self acknowledge	Yes	
Configure monitoring::CAN interfaces	**Configure CAN interface 1**	3153 Delayed by engine speed	No	
Configure monitoring::CAN interfaces	**Configure CAN interface 2**	16187 Monitoring	Off	
Configure monitoring::CAN interfaces	**Configure CAN interface 2**	16186 Delay	0.2	s
Configure monitoring::CAN interfaces	**Configure CAN interface 2**	16188 Alarm class	Class B	
Configure monitoring::CAN interfaces	**Configure CAN interface 2**	16190 Self acknowledge	Yes	
Configure monitoring::CAN interfaces	**Configure CAN interface 2**	16189 Delayed by engine speed	No	
Configure monitoring::J1939 interface	**J1939 Red alarm**	15115 Monitoring	On	
Configure monitoring::J1939 interface	**J1939 Red alarm**	15119 Delay	0	s
Configure monitoring::J1939 interface	**J1939 Red alarm**	15116 Alarm class	Class F	
Configure monitoring::J1939 interface	**J1939 Red alarm**	15117 Self acknowledge	Yes	
Configure monitoring::J1939 interface	**J1939 Red alarm**	15118 Delayed by engine speed	No	
Configure monitoring::J1939 interface	**J1939 interface**	15110 Monitoring	On	
Configure monitoring::J1939 interface	**J1939 interface**	15114 Delay	3	s
Configure monitoring::J1939 interface	**J1939 interface**	15111 Alarm class	Class E	
Configure monitoring::J1939 interface	**J1939 interface**	15112 Self acknowledge	No	
Configure monitoring::J1939 interface	**J1939 interface**	15113 Delayed by engine speed	No	
Configure monitoring::J1939 interface	**J1939 Amber alarm**	15120 Monitoring	On	
Configure monitoring::J1939 interface	**J1939 Amber alarm**	15124 Delay	2	s
Configure monitoring::J1939 interface	**J1939 Amber alarm**	15121 Alarm class	Class B	
Configure monitoring::J1939 interface	**J1939 Amber alarm**	15122 Self acknowledge	No	
Configure monitoring::J1939 interface	**J1939 Amber alarm**	15123 Delayed by engine speed	No	
::Configure CAN interface 1		3156 Baudrate	250 kBd	
::Configure CAN interface 1	**CANopen interface**	8950 Node-ID CAN bus 1	1	

::Configure CAN interface 1	**CANopen interface**	8993 CANopen Master	Default Master	
::Configure CAN interface 1	**CANopen interface**	9120 Producer heartbeat time	2000	ms
::Configure CAN interface 1	**CANopen interface**	9100 COB-ID SYNC Message [decimal]	128	
::Configure CAN interface 1	**CANopen interface**	8940 Producer SYNC Message time	20	ms
::Configure CAN interface 1	**CANopen interface**	9101 COB-ID TIME Message [decimal]	3221225728	
::Configure CAN interface 1	**CANopen interface**	9102 Cycle of TIME sync. message	10	s
::Configure CAN interface 1	**Additional Server SDOs**	33040 2. Node ID	0	
::Configure CAN interface 1	**Additional Server SDOs**	33041 3. Node ID	0	
::Configure CAN interface 1	**Additional Server SDOs**	33042 4. Node ID	0	
::Configure CAN interface 1	**Additional Server SDOs**	33043 5. Node ID	0	
::Configure CAN interface 1::Load share interface		9923 Load share interface	Off	
::Configure CAN interface 1::Load share interface		9921 Transfer rate LS fast message	0.1	s
::Configure CAN interface 1::Load share interface		9920 Load share CAN-ID	5xx Hex	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 1**	9300 COB-ID [decimal]	2147483648	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 1**	9121 Event timer	2000	ms
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 1**	8970 Selected Data Protocol	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 1**	9910 Number of Mapped Objects	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 1**	9911 1. Mapped Object	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 1**	9912 2. Mapped Object	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 1**	9913 3. Mapped Object	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 1**	9914 4. Mapped Object	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 2**	9310 COB-ID [decimal]	2147483648	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 2**	9122 Event timer	2000	ms
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 2**	8971 Selected Data Protocol	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 2**	9915 Number of Mapped Objects	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 2**	9916 1. Mapped Object	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 2**	9917 2. Mapped Object	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 2**	9918 3. Mapped Object	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 2**	9919 4. Mapped Object	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 5**	33340 COB-ID [decimal]	2147483648	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 5**	9125 Event timer	2000	ms
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 5**	8974 Selected Data Protocol	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 5**	33870 Number of Mapped Objects	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 3**	9320 COB-ID [decimal]	2147483648	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 3**	9123 Event timer	2000	ms
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 3**	8972 Selected Data Protocol	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 3**	9905 Number of Mapped Objects	0	

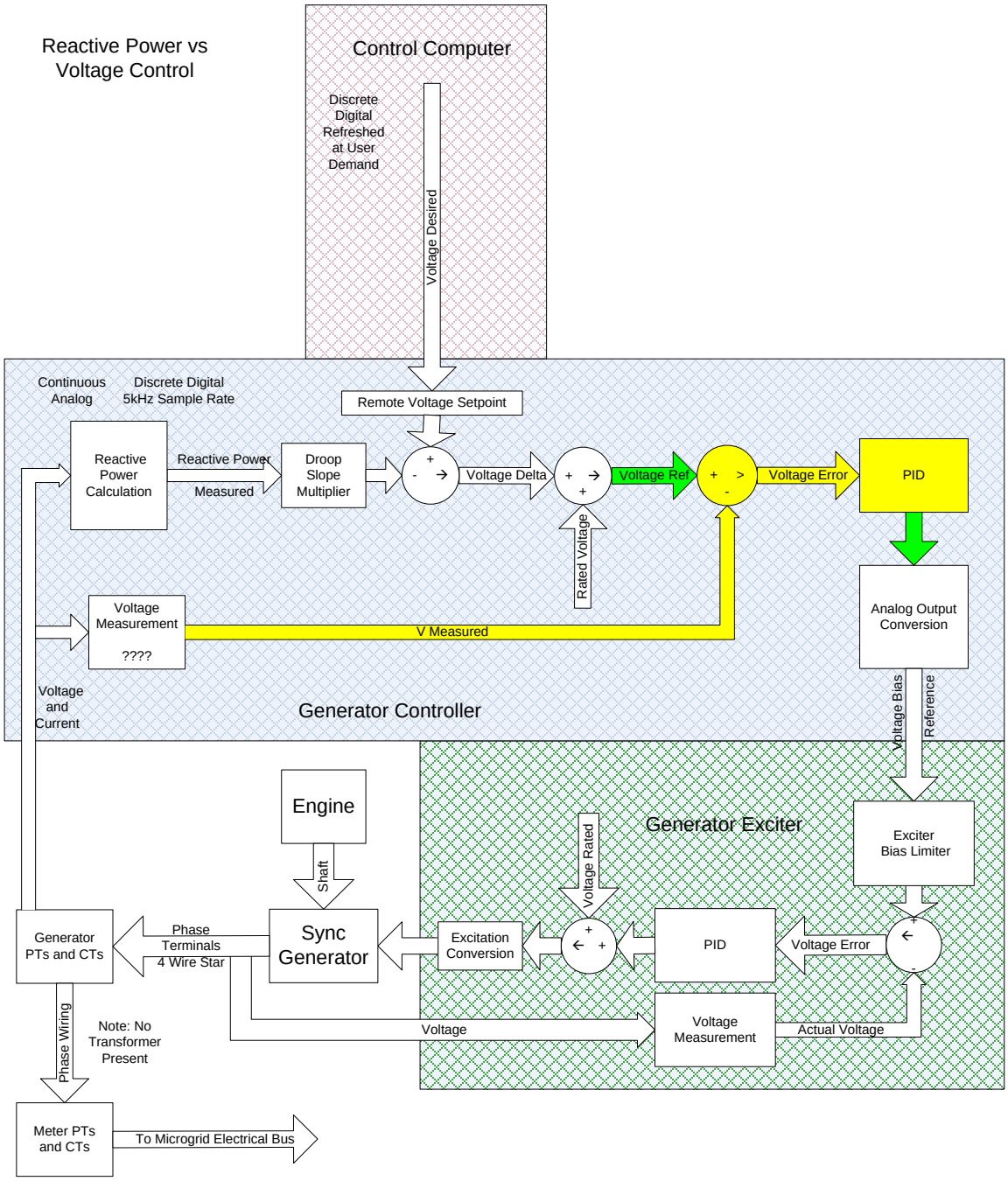
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 3**	9906 1. Mapped Object	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 3**	9907 2. Mapped Object	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 3**	9908 3. Mapped Object	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 3**	9909 4. Mapped Object	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 4**	33330 COB-ID [decimal]	2147483648	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 4**	9124 Event timer	2000	ms
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 4**	8973 Selected Data Protocol	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 4**	33865 Number of Mapped Objects	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 4**	33866 1. Mapped Object	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 4**	33867 2. Mapped Object	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 4**	33868 3. Mapped Object	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 4**	33869 4. Mapped Object	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 5**	33871 1. Mapped Object	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 5**	33872 2. Mapped Object	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 5**	33873 3. Mapped Object	0	
::Configure CAN interface 1::Receive PDOs::1-5	**Receive PDO 5**	33874 4. Mapped Object	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 1**	9600 COB-ID [decimal]	2147484033	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 1**	8962 Selected Data Protocol	5003	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 1**	9602 Transmission type	255	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 1**	9604 Event timer	20	ms
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 1**	9609 Number of Mapped Objects	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 1**	9605 1. Mapped Object	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 1**	9606 2. Mapped Object	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 1**	9607 3. Mapped Object	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 1**	9608 4. Mapped Object	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 2**	9610 COB-ID [decimal]	2147484102	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 2**	8963 Selected Data Protocol	5008	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 2**	9612 Transmission type	255	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 2**	9614 Event timer	20	ms
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 2**	9619 Number of Mapped Objects	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 2**	9615 1. Mapped Object	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 2**	9616 2. Mapped Object	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 2**	9617 3. Mapped Object	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 2**	9618 4. Mapped Object	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 5**	33640 COB-ID [decimal]	2147483648	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 5**	8966 Selected Data Protocol	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 5**	33642 Transmission type	255	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 5**	33644 Event timer	20	ms
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 3**	9620 COB-ID [decimal]	2147484358	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 3**	8964 Selected Data Protocol	5009	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 3**	9622 Transmission type	255	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 3**	9624 Event timer	20	ms

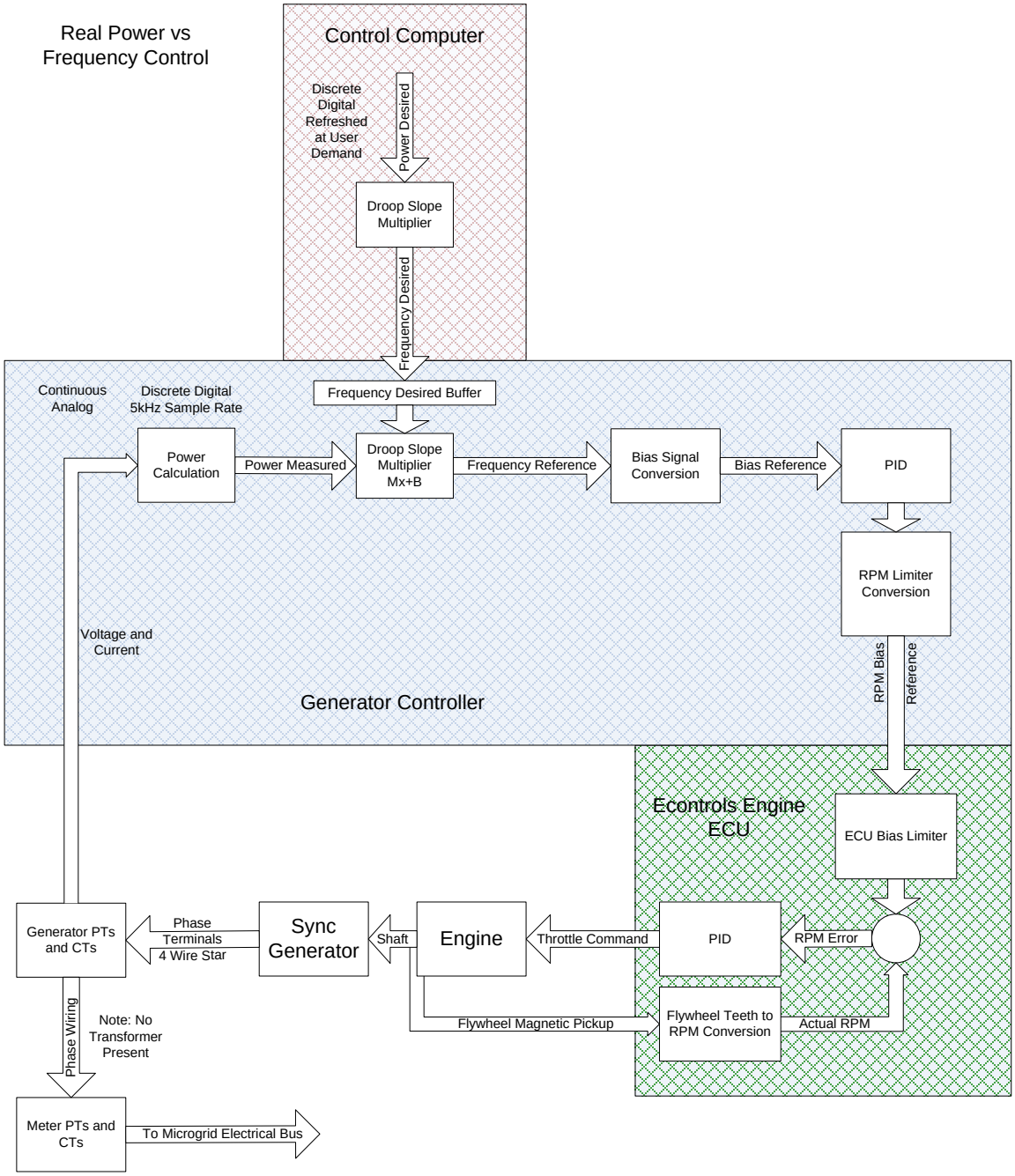
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 3**	9629 Number of Mapped Objects	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 3**	9625 1. Mapped Object	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 3**	9626 2. Mapped Object	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 3**	9627 3. Mapped Object	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 3**	9628 4. Mapped Object	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 4**	9630 COB-ID [decimal]	2147483648	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 4**	8965 Selected Data Protocol	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 4**	9632 Transmission type	255	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 4**	9634 Event timer	20	ms
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 4**	9639 Number of Mapped Objects	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 4**	9635 1. Mapped Object	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 4**	9636 2. Mapped Object	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 4**	9637 3. Mapped Object	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 4**	9638 4. Mapped Object	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 5**	33649 Number of Mapped Objects	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 5**	33645 1. Mapped Object	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 5**	33646 2. Mapped Object	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 5**	33647 3. Mapped Object	0	
::Configure CAN interface 1::Transmit PDOs::1-5	**Transmit PDO 5**	33648 4. Mapped Object	0	
::Configure CAN interface 2		3157 Baudrate	250 kBd	
::Configure CAN interface 2	**CANopen interface**	9940 This device	Node-ID 7	
::Configure CAN interface 2	**CANopen interface**	9930 IKD1 DI/DO 1..8	Off	
::Configure CAN interface 2	**CANopen interface**	9931 IKD2 DI/DO 9..16	Off	
::Configure CAN interface 2	**CANopen interface**	9932 IKD3 DI/DO 17..24	Off	
::Configure CAN interface 2	**CANopen interface**	9933 IKD4 DI/DO 25..32	Off	
::Configure CAN interface 2	**CANopen interface**	9934 Phoenix DI/DO 1..16	Off	
::Configure CAN interface 2	**CANopen interface**	9935 Phoenix DI/DO 17..32	Off	
::Configure CAN interface 2	**CANopen interface**	9936 Phoenix DI/DO 1..32	Off	
::Configure CAN interface 2	**CANopen interface**	9943 Phoenix 4AI 4AO	Off	
::Configure CAN interface 2	**CANopen interface**	9942 Phoenix 8AI 4AO	Off	
::Configure CAN interface 2	**CANopen interface**	9941 Phoenix 12AI 4AO	Off	
::Configure CAN interface 2	**CANopen interface**	9937 Phoenix 16AI 4AO	Off	
::Configure CAN interface 2	**CANopen interface**	9944 Phoenix 4AI 4AO DI/DO 1..32	Off	
::Configure CAN interface 2	**CANopen interface**	9945 Phoenix 8AI 4AO DI/DO 1..32	Off	
::Configure CAN interface 2	**CANopen interface**	9946 Phoenix 12AI 4AO DI/DO 1..32	Off	
::Configure CAN interface 2	**CANopen interface**	9938 Phoenix 16AI 4AO DI/DO 1..32	Off	
::Configure CAN interface 2	**CANopen interface**	9939 RP-3000	Node-ID 6	
::Configure CAN interface 2	**J1939 interface**	15102 Device type	Standard	
::Configure CAN interface 2	**J1939 interface**	15106 J1939 own address	234	
::Configure CAN interface 2	**J1939 interface**	15107 Engine control address	0	
::Configure CAN interface 2	**J1939 interface**	15103 SPN version	Version 2	

::Configure CAN interface 2	**J1939 interface**	15156 Logging DM1	On	
::Configure CAN interface 2	**J1939 interface**	15127 ECU remote controlled	Off	
::Configure CAN interface 2	**J1939 interface**	5537 Speed deviation ECU	120	rpm
Configure interfaces::Modbus protocol		3184 Modbus protocol number	5010	
Configure interfaces::Modbus protocol		3179 Detect a gap in a Modbus frame	Off	
Configure interfaces::Modbus protocol		3181 Power [W] exponent 10^x	2	
Configure interfaces::Modbus protocol		3182 Voltage [V] exponent 10^x	0	
Configure interfaces::Modbus protocol		3183 Current [A] exponent 10^x	0	
Configure interfaces::RS232: serial interface 1		3163 Baudrate	19.2 kBd	
Configure interfaces::RS232: serial interface 1		3161 Parity	No	
Configure interfaces::RS232: serial interface 1		3162 Stop bits	One	
Configure interfaces::RS232: serial interface 1		7900 Enable Modbus protocol	No	
Configure interfaces::RS232: serial interface 1	**Modbus Interface**	3185 Modbus slave ID	1	
Configure interfaces::RS232: serial interface 1	**Modbus Interface**	3186 Reply delay time	0	s
Configure interfaces::RS232: serial interface 1::Modem		4667 Delay for call retry	30	s
Configure interfaces::RS232: serial interface 1::Modem		4668 Max. number of call retries	30	
Configure interfaces::RS232: serial interface 1::Modem		12933 Unit1 call requ.	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure interfaces::RS232: serial interface 1::Modem		12934 Unit2 call requ.	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure interfaces::RS232: serial interface 1::Modem		12935 Unit3 call requ.	(False And True) And True	
		Delay ON	0	s
		Delay OFF	0	s
Configure interfaces::RS232: serial interface 1::Modem		4660 Modem initialization string		
Configure interfaces::RS232: serial interface 1::Modem	**Unit 1**	4661 Modem command string (1 of 2)	&g8000&c	
Configure interfaces::RS232: serial interface 1::Modem	**Unit 1**	4662 Modem command string (2 of 2)	test*test.com text to be sent&z	
Configure interfaces::RS232: serial interface 1::Modem	**Unit 2**	4663 Modem command string (1 of 2)	&gMobilephonenumber&c	
Configure interfaces::RS232: serial interface 1::Modem	**Unit 2**	4664 Modem command string (2 of 2)	text to be sent&z	
Configure interfaces::RS232: serial interface 1::Modem	**Unit 3**	4665 Modem command string (1 of 2)	at*af&c&pFaxnumber;	
Configure interfaces::RS232: serial interface 1::Modem	**Unit 3**	4666 Modem command string (2 of 2)	text to be sent&z	
Configure interfaces::RS485: serial interface 2		3170 Baudrate	56 kBd	
Configure interfaces::RS485: serial interface 2		3171 Parity	Even	
Configure interfaces::RS485: serial interface 2		3172 Stop bits	One	
Configure interfaces::RS485: serial interface 2		3173 Full-, halfduplex mode	Halfduplex	
Configure interfaces::RS485: serial interface 2		7908 Enable Modbus protocol	Yes	

Configure interfaces::RS485: serial interface 2	**Modbus Interface**	3188 Modbus slave ID	1	
Configure interfaces::RS485: serial interface 2	**Modbus Interface**	3189 Reply delay time	0.04	s

6.3 *Overview Controls Diagram*




Real Power vs
Frequency Control
Control Computer
Discrete
Digital
Refreshed
at User
Demand
Power Desired
Droop Slope
Multiplier
Frequency Desired
Continuous
Analog
Discrete Digital
5kHz Sample Rate
Frequency Desired Buffer
Power
Calculation
Power Measured
Droop Slope
Multiplier
Mx+B
Frequency Reference
Bias Signal
Conversion
Bias Reference
PID
RPM Limiter
Conversion
Voltage and
Current
RPM Bias
Reference
Generator Controller
Econtrols Engine
ECU
ECU Bias Limiter
Generator PTs
and CTs
Phase
Terminals
4 Wire Star
Sync
Generator
Shaft
Engine
Throttle Command
PID
RPM Error
Flywheel Magnetic Pickup
Flywheel Teeth to
RPM Conversion
Actual RPM
Phase Wiring
Note: No
Transformer
Present
Meter PTs and
CTs
To Microgrid Electrical Bus