ZERO-VOLTS RIDE THROUGH ON LOW-VOLTAGE DP POWER SYSTEMS

Sarah Whiteford
Power 1 Session
Dynamic Positioning Conference 2022

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SHORT CIRCUIT TESTING ON LV SYSTEMS

Some LV power distribution network equipment OEMs have successfully performed short circuit testing on their DP facilities in situ (Tjong, Barstad, Settemsdal, 2016), however this is the exception rather than the rule.

Today we will be reviewing the common methods of generating confidence in LV systems:

- Single Breaker ZVRT
- Dual Breaker ZVRT

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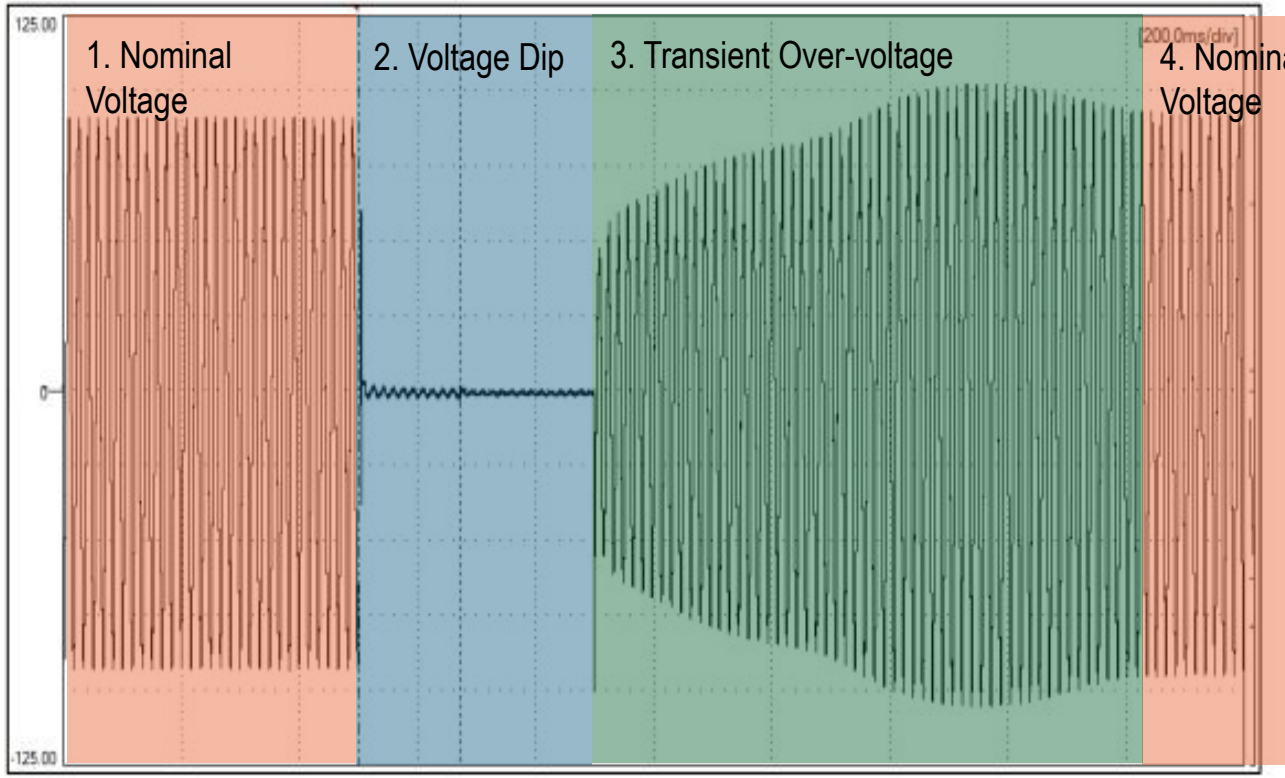
ZERO VOLTS RIDE THROUGH

Test period: From Fault Application to Fault clearance



Source: MTS TECHOP (D-07 - Rev1 - Jan21) p41 of 60

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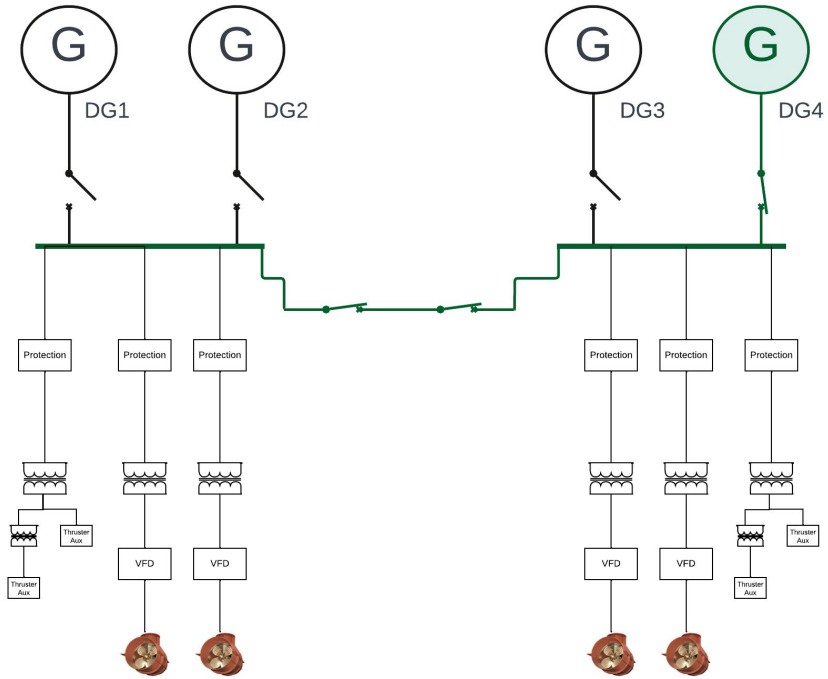
SINGLE BREAKER TESTS

	Before Test	Initiate Test	End Test
DG1	0	0	0
DG2	0	0	0
DG3	0	0	0
DG4	1	0	1
BT1	1	1	1



SINGLE BREAKER TESTS

Benefits:

1. Easy for OEM to support
2. Provides assurance when combined with external data capture

Drawbacks:

1. Layers of protections prevent opening and rapid reclosure
   a. may require disable or bypass
   b. risk the breaker can be closed onto a live bus
2. Mechanical activation times
   a. doubt regarding the duration of the test.
   b. test times are limited by the breaker
   c. difficult to synchronize data capture

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DUAL BREAKER TESTS

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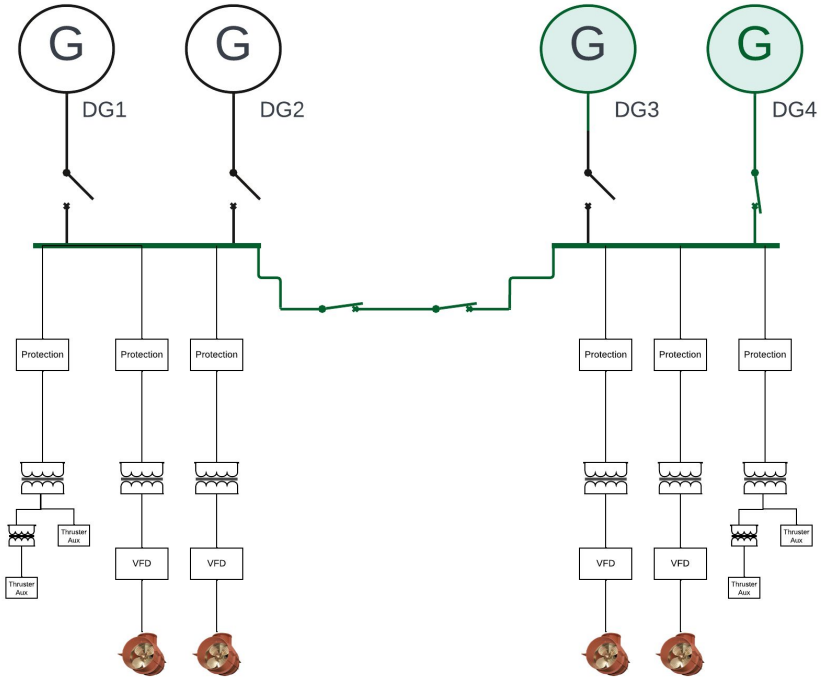

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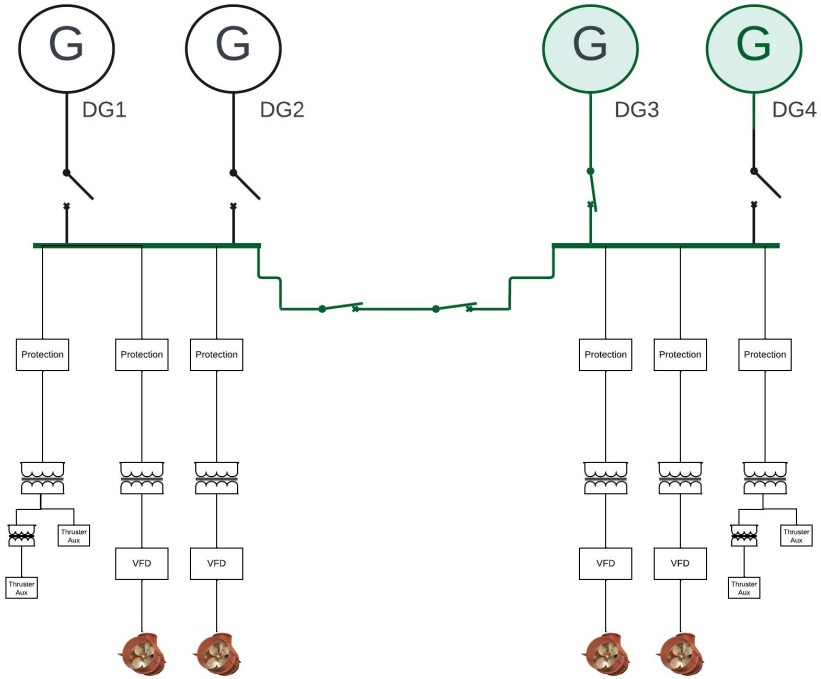

DUAL BREAKER TESTS

Benefits:

1. Inbuilt dead-bus interlocks,
2. Inbuilt data-capture,
3. Controllable test durations allowing repeatable results
4. Independent of the system's protections

Drawbacks:

1. **Not a "Silver Bullet":** requires a range of other tests to be completed, including
   a. Transient Over-voltage Ride Through,
   b. Earth Fault testing, and
   c. Primary Injection

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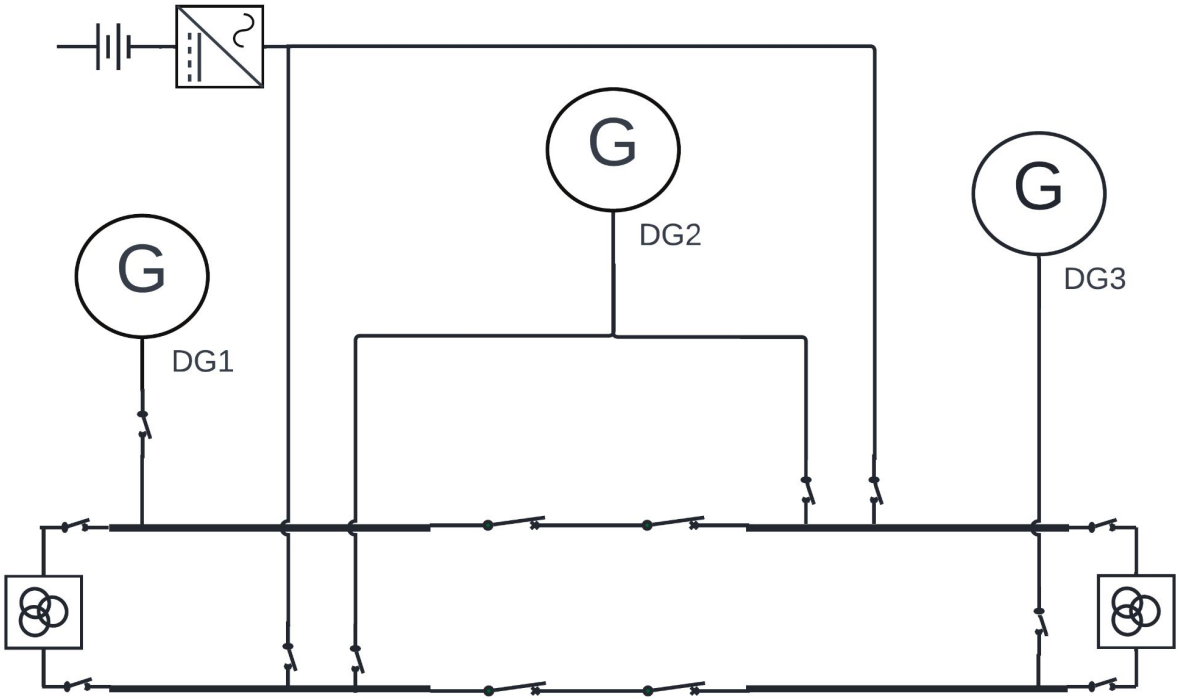
2022 CASE STUDY

2015 Build
Recent Hybridization

OEM onboard

Bus-tie opening time: 500ms

Acceptance criteria:
Ride through voltage reduction to at least 60% for 500ms without loss of DP Equipment



2022 CASE STUDY

Order of Events:

Dual Breaker 400ms test - **Fail**

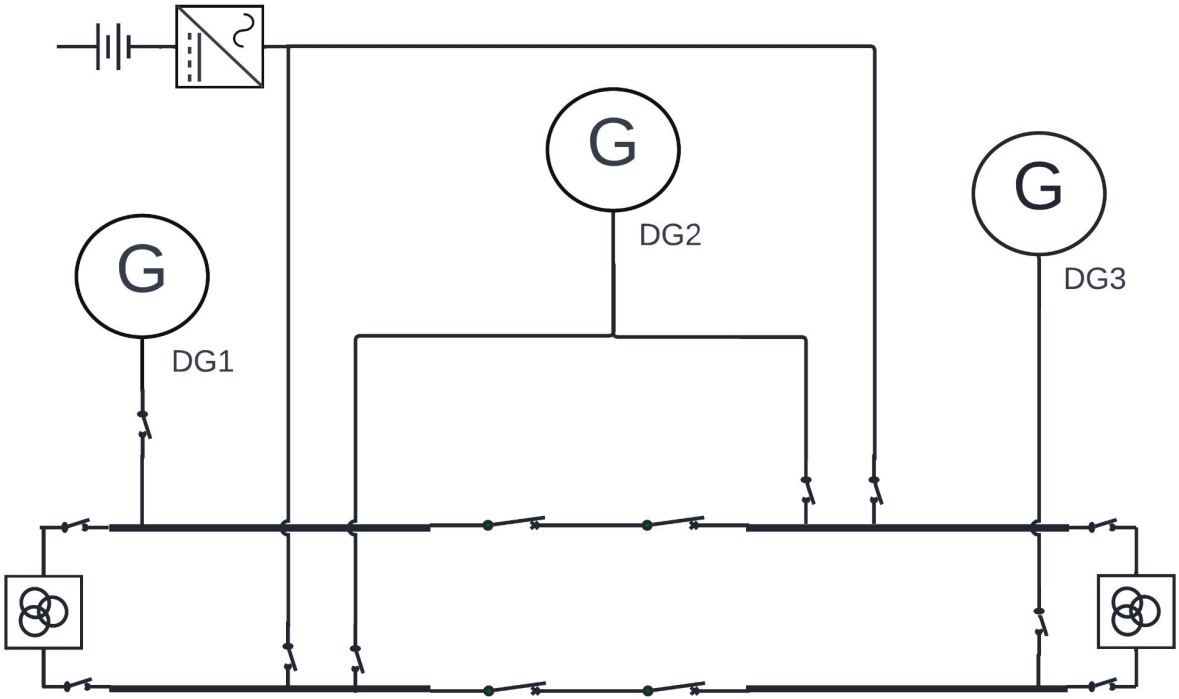
- Test was repeated with same result 3 times for troubleshooting

OEM Single Breaker tests were performed - **Pass**

*****Rectification works performed*****

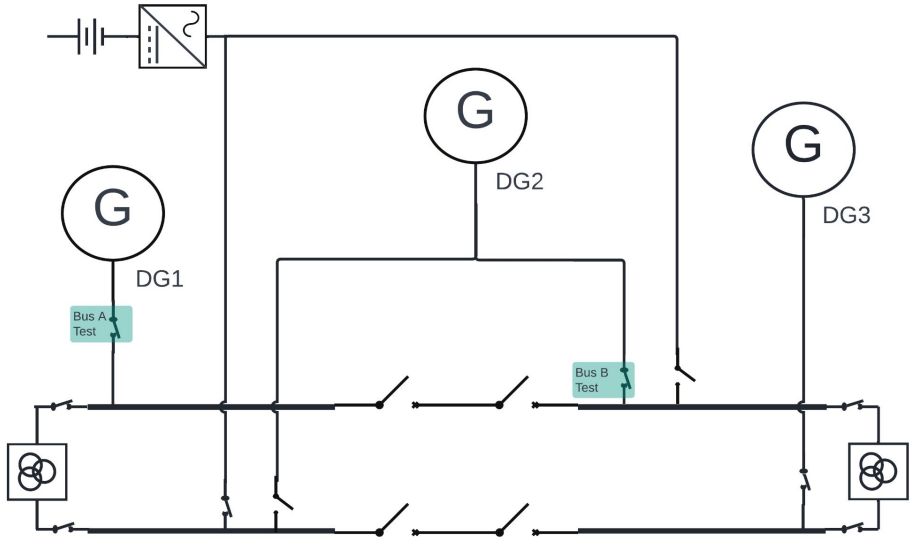
Dual Breaker 400ms test - **Pass**

Dual Breaker with transient over-voltage testing 850ms test - **Pass**



SINGLE BREAKER TESTING

Test ID	Bus Affected	Approx Duration	Duration @ <60% V	Duration @ <10% V	Result
1	A	0.157 s	0.125 s	0 s	**Pass**
2	A	0.232 s	0.192 s	0.073 s	**Pass**
3	B	0.67 s	0.63 s	0.50 s	**Fail**
4	B	0.145 s	0.111 s	0.031 s	**Pass**



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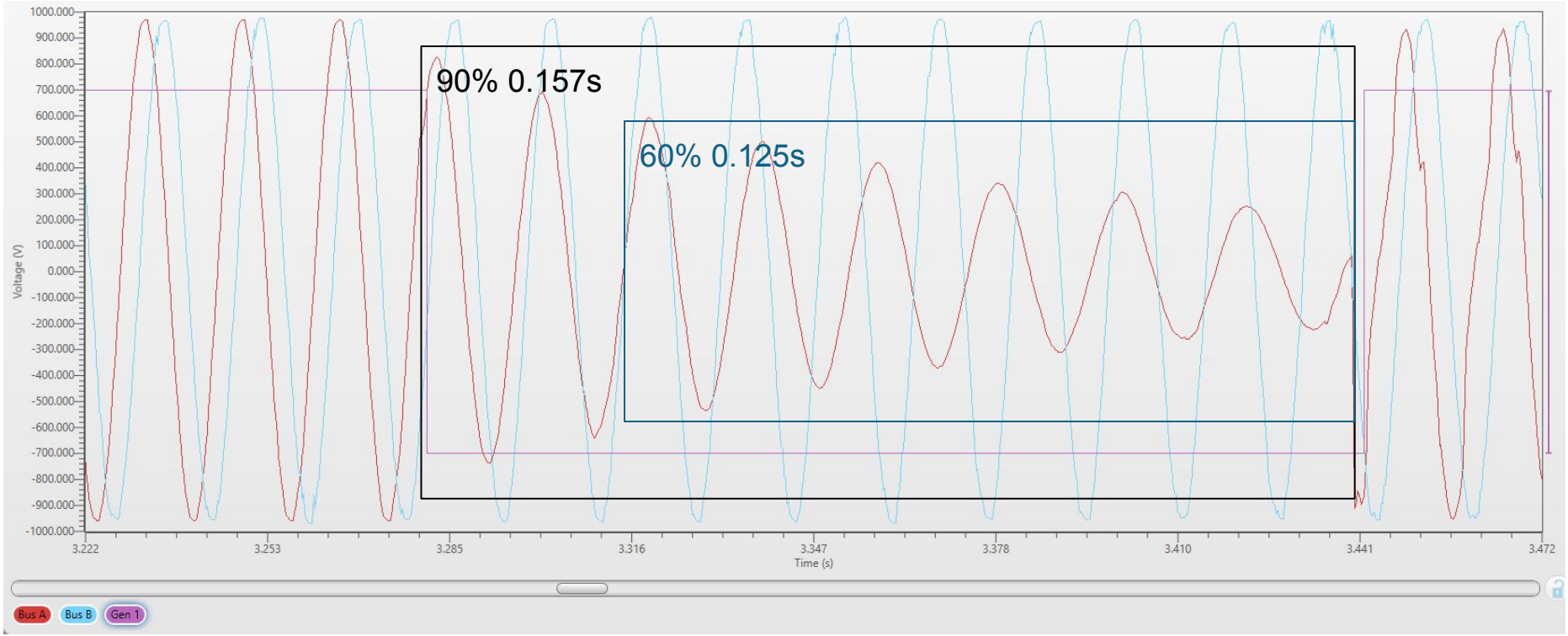

BUS A TEST 1

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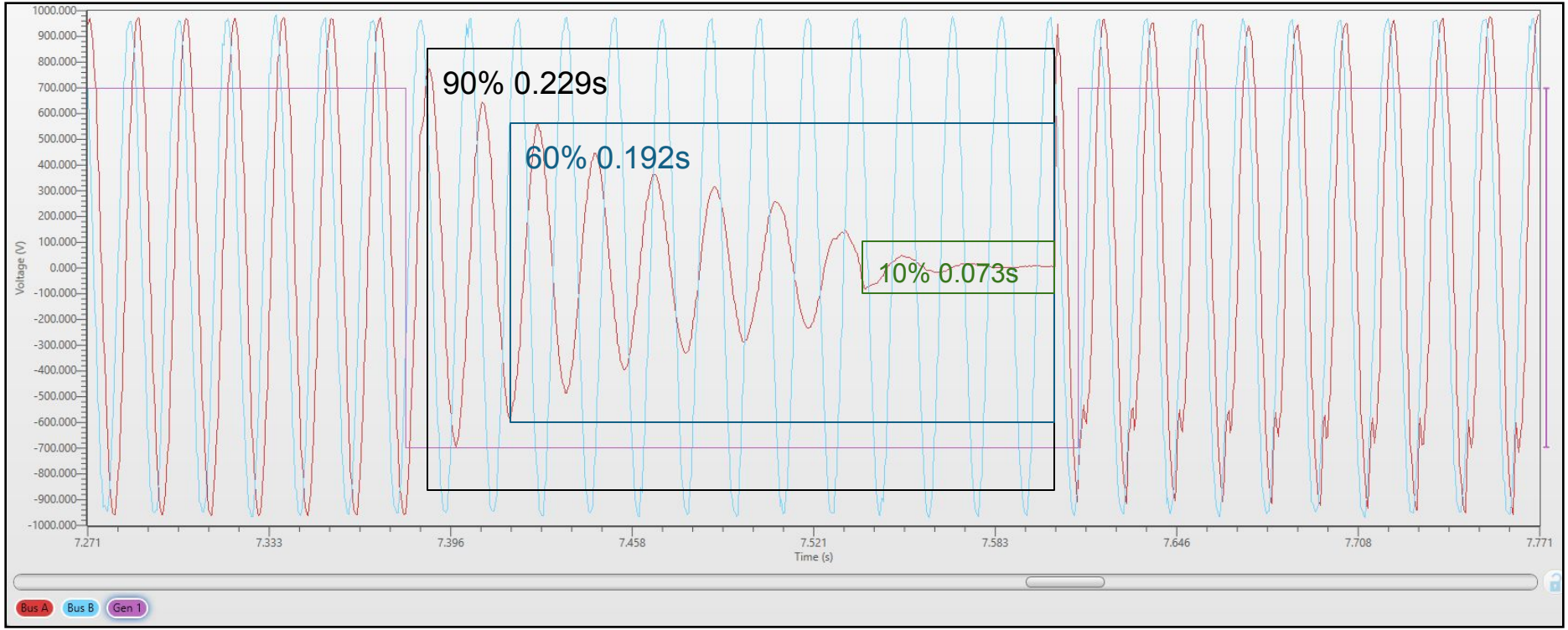

BUS A TEST 2

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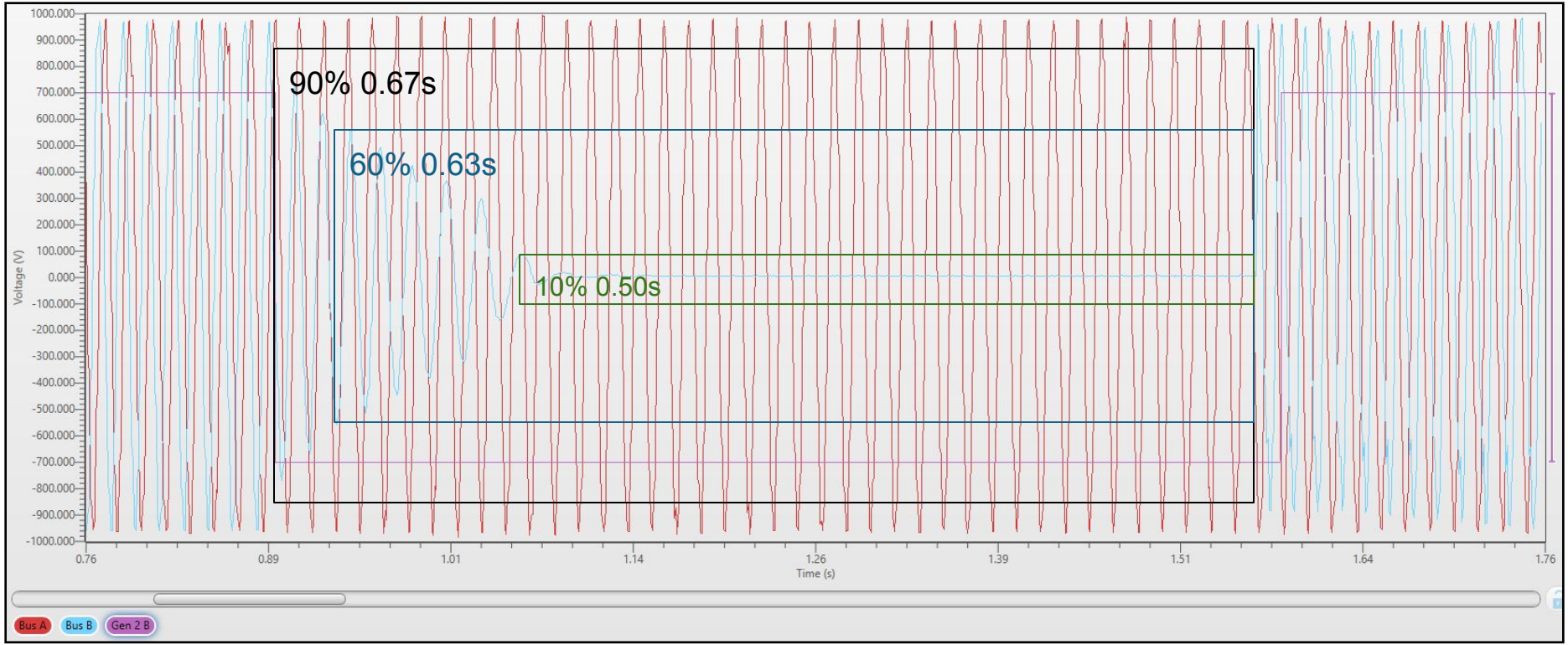

BUS B TEST 1

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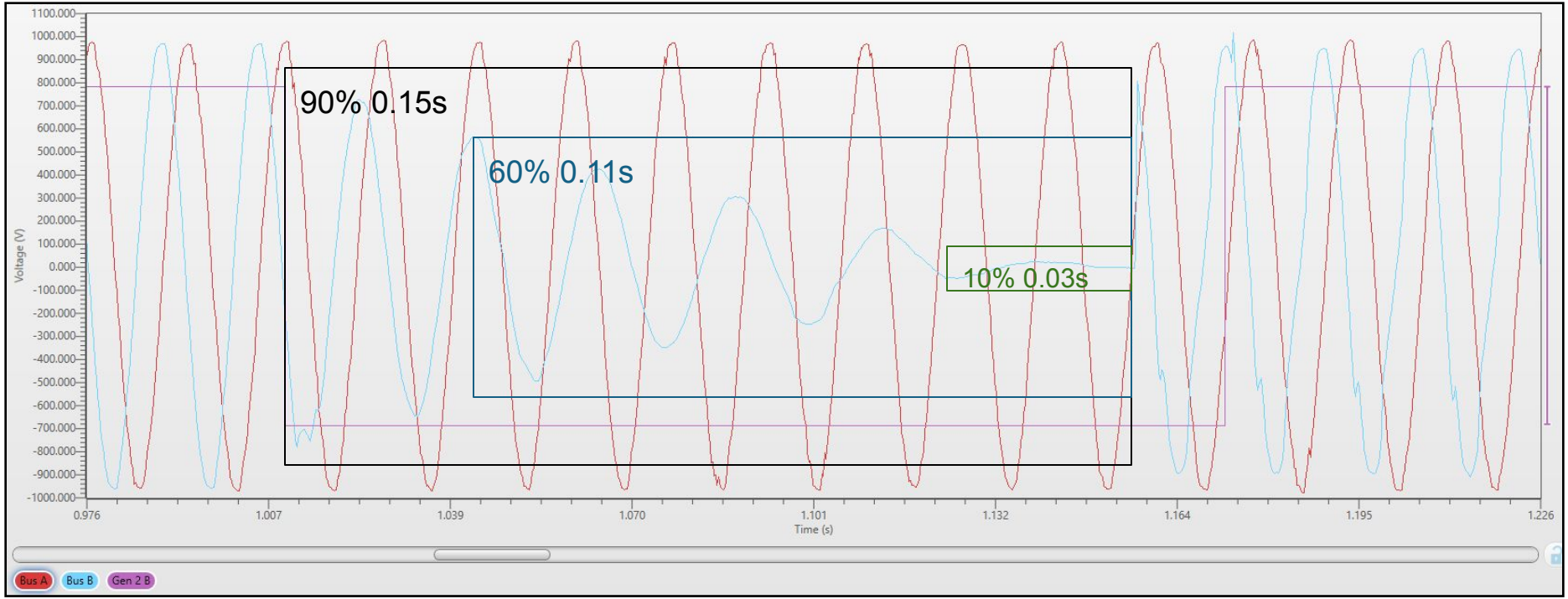

BUS B TEST 2

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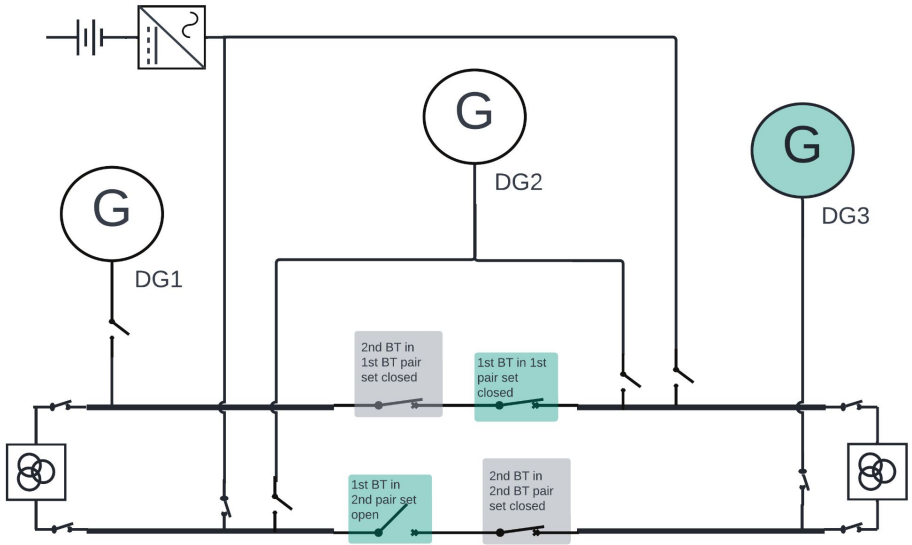
DUAL BREAKER TESTING

Test ID	Bus Affected	Approx Duration	Duration @ <60% V	Duration @ <10% V	Result
1	A	0.40 sec	0.33 sec	0.27 sec	**Pass**
2	A	0.85 sec	0.76 sec	0.59 sec	**Pass**
3	B	0.40 sec	0.34 sec	0.12 sec	**Pass**
4	B	0.87 sec	0.81 sec	0.61 sec	**Pass**



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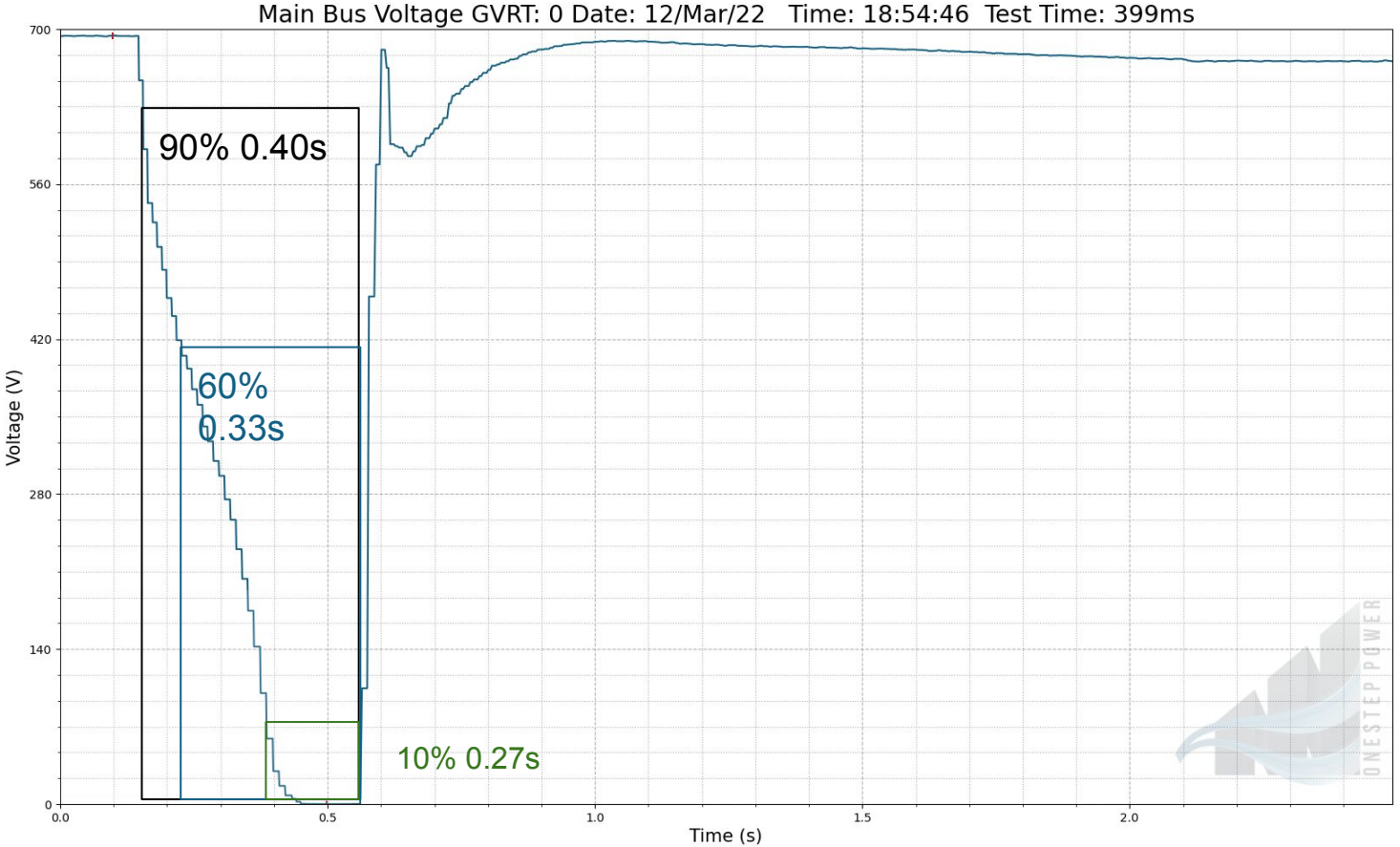

BUS A TEST 1: 400MS

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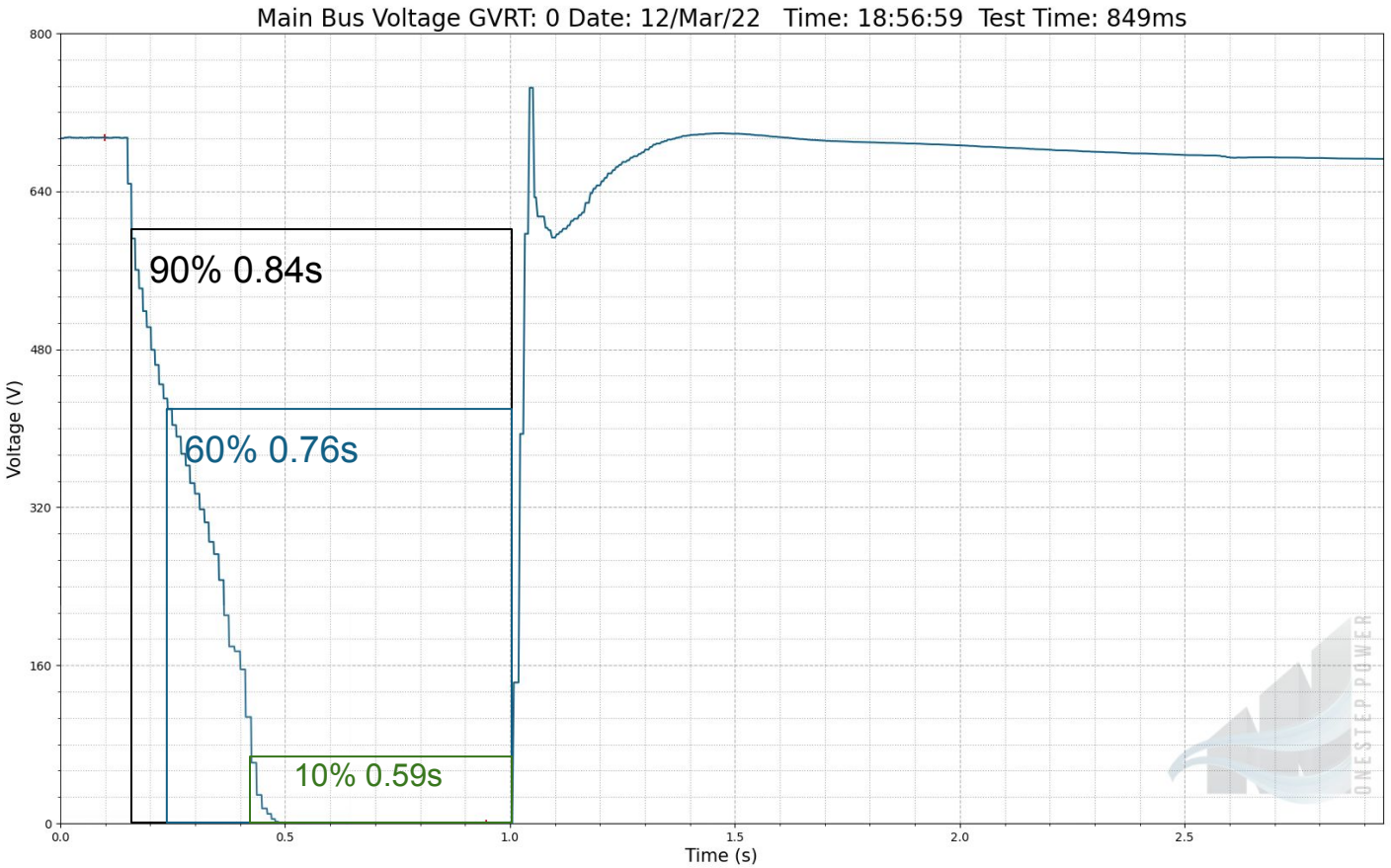
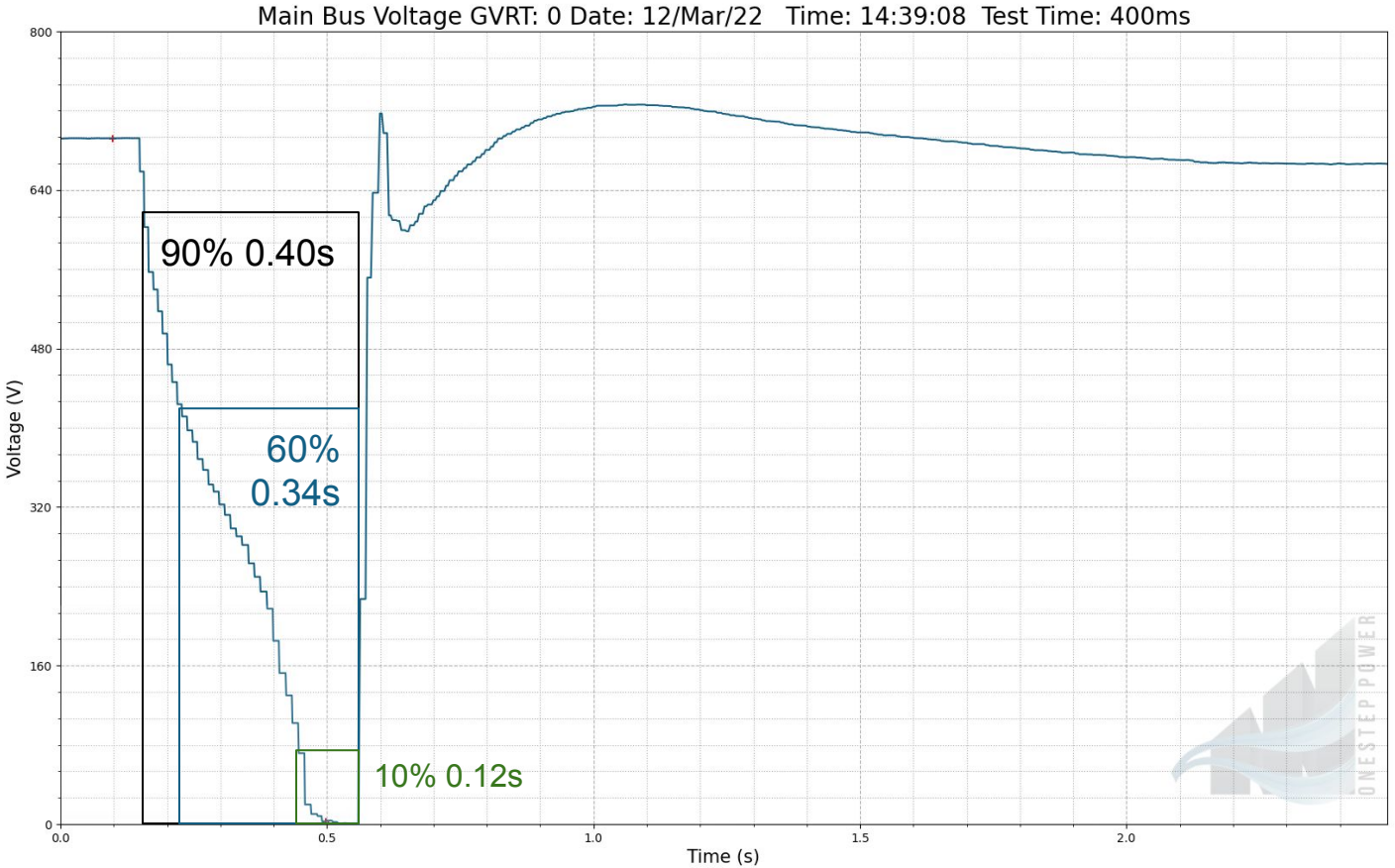
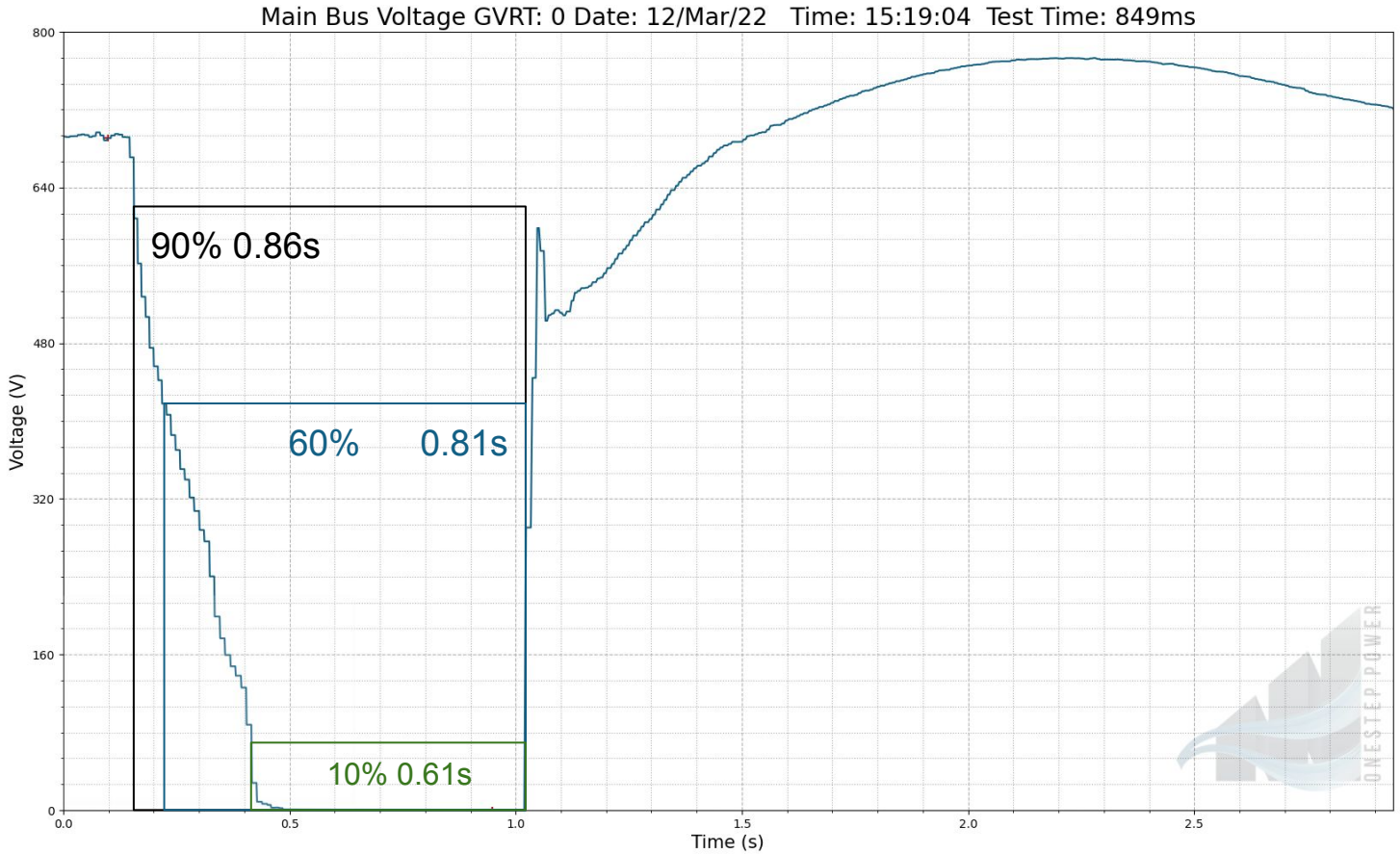


BUS A TEST 2: 850MS



BUS B TEST 1: 400MS



BUS B TEST 2: 850MS W GVRT

COMPARISON OF RESULTS

Manual manipulation

- ➔ Difficult to successfully test within the window with breaker protections
- ➔ Causes operator to aim to activate breaker as quickly as possible
- ➔ Successful tests without measurement may not reach low enough for long enough to validate ride through

Automated with data capture:

1. Immediate feedback regarding duration and magnitude of test
2. Repeatable durations
3. Interlock for dead-bus confirmation

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COMPREHENSIVE TESTING

1. *Protection setting audit (inc. version control)*
2. *Fuelling Testing*
3. *Excitation Testing*
4. *Over-Voltage Testing*
5. *Earth Fault Testing*
6. *Relay & Protective Device Testing*
7. *Current Sensing Testing*
8. *Load application & Rejection Testing*
9. *Phase Failure Testing*
10. *Blackout Recovery Testing*
11. *Harmonic Distortion Testing*
12. *Fault Ride Through Testing*

Image by David Mark from Pixabay

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THANK YOU

Come see a ZeroDIP demo at Booth #4

www.onesteppower.com

Sarah Whiteford | swhiteford@onesteppower.com | https://www.linkedin.com/in/sjwhiteford/

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