Capstone Project Results

Frequency Stability of Different GFM-GFL Ratios in High Penetration Grids

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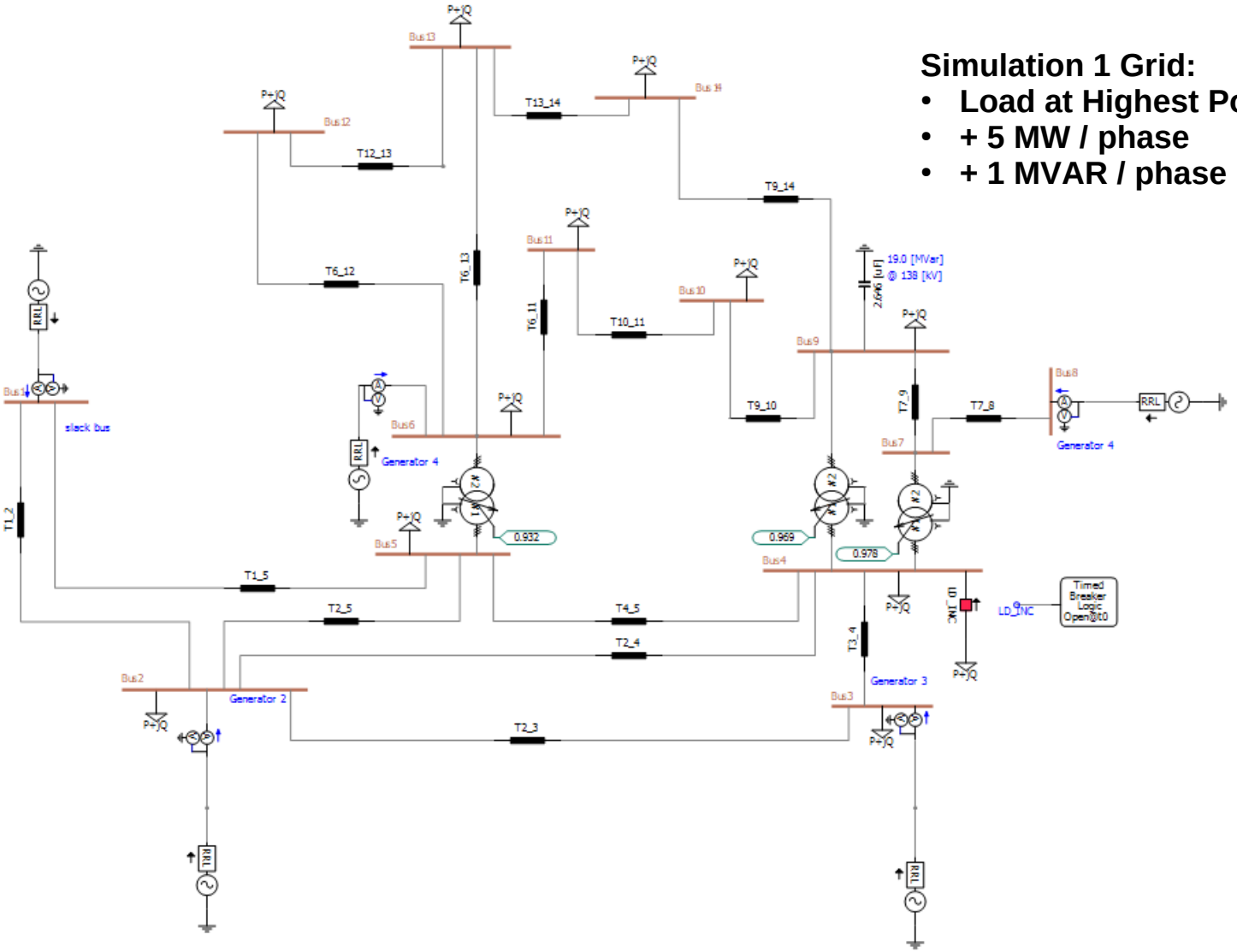
Simulations Done

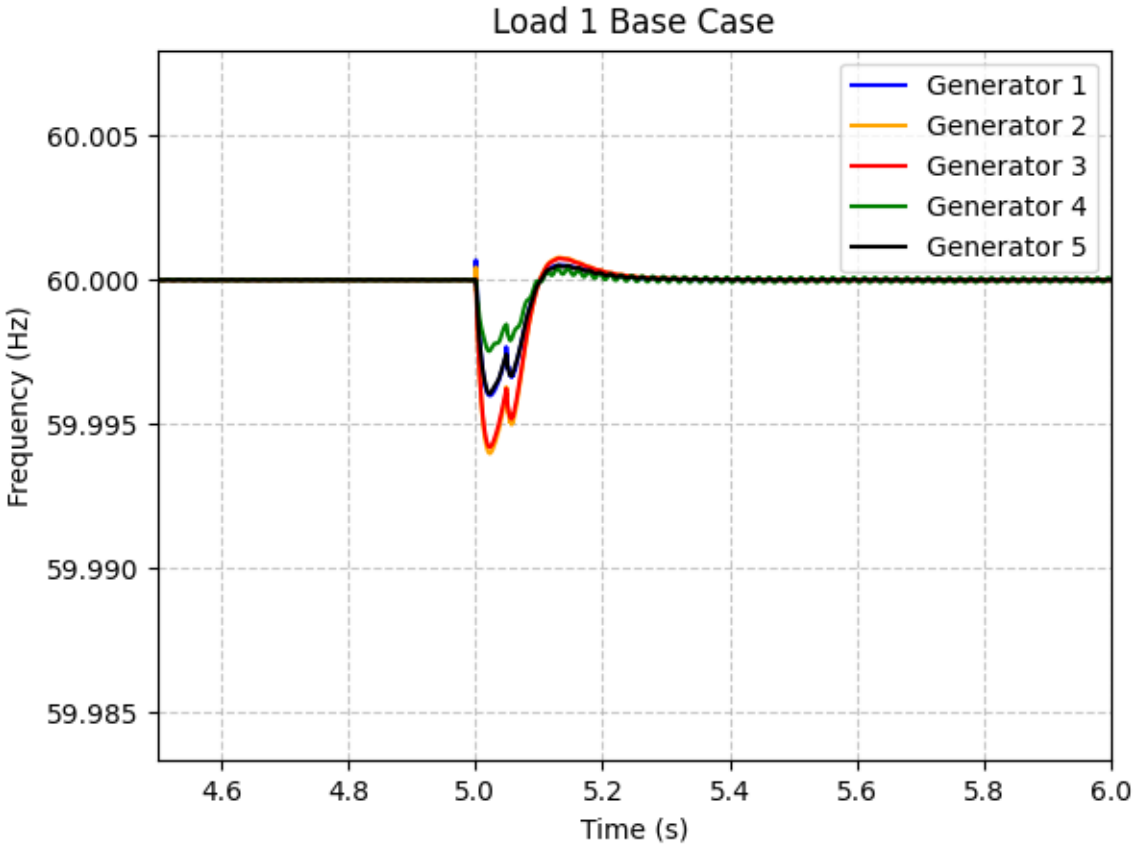
- Simulation 1:
  - Load at High Power Bus
- Simulation 2:
  - Load at Remote Bus
- Simulation 3:
  - Simple Fault
- Simulation 4:
  - Symmetric Fault
- Simulation 5:
  - Simple Fault at Highest Power Flow Transmission Line

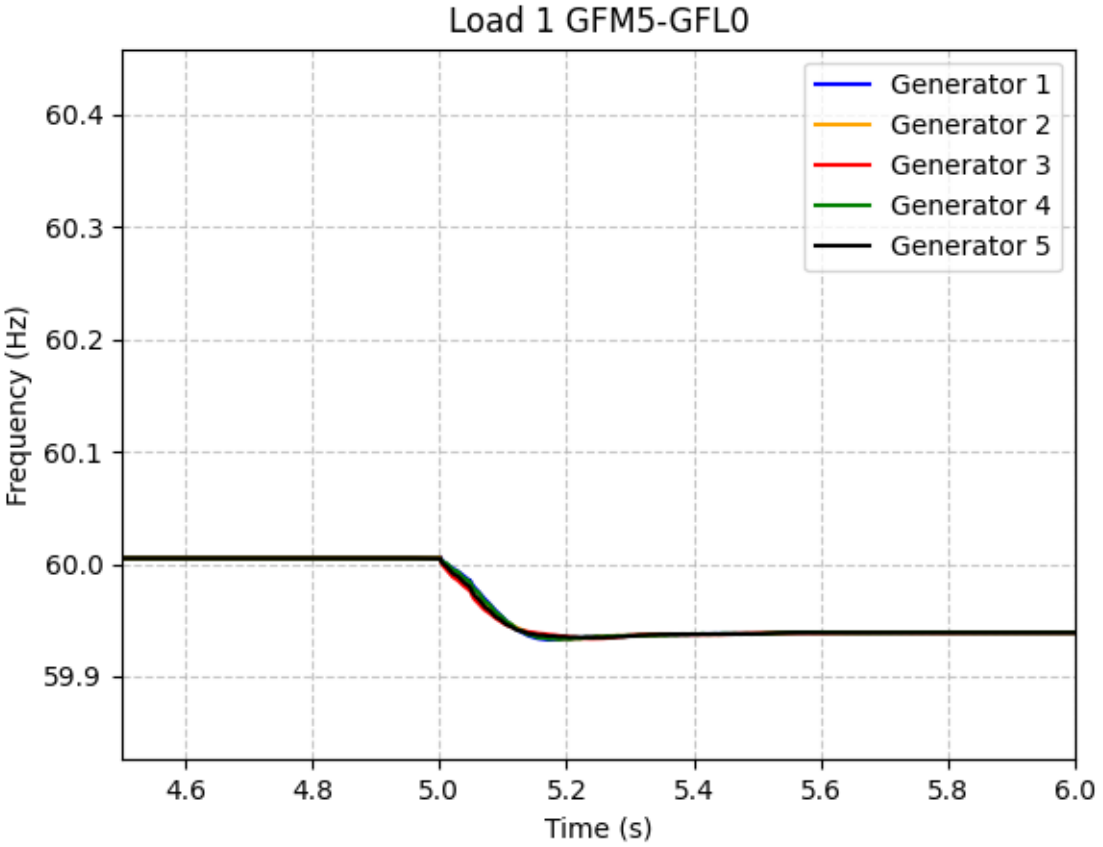
Simulation 1 Grid:

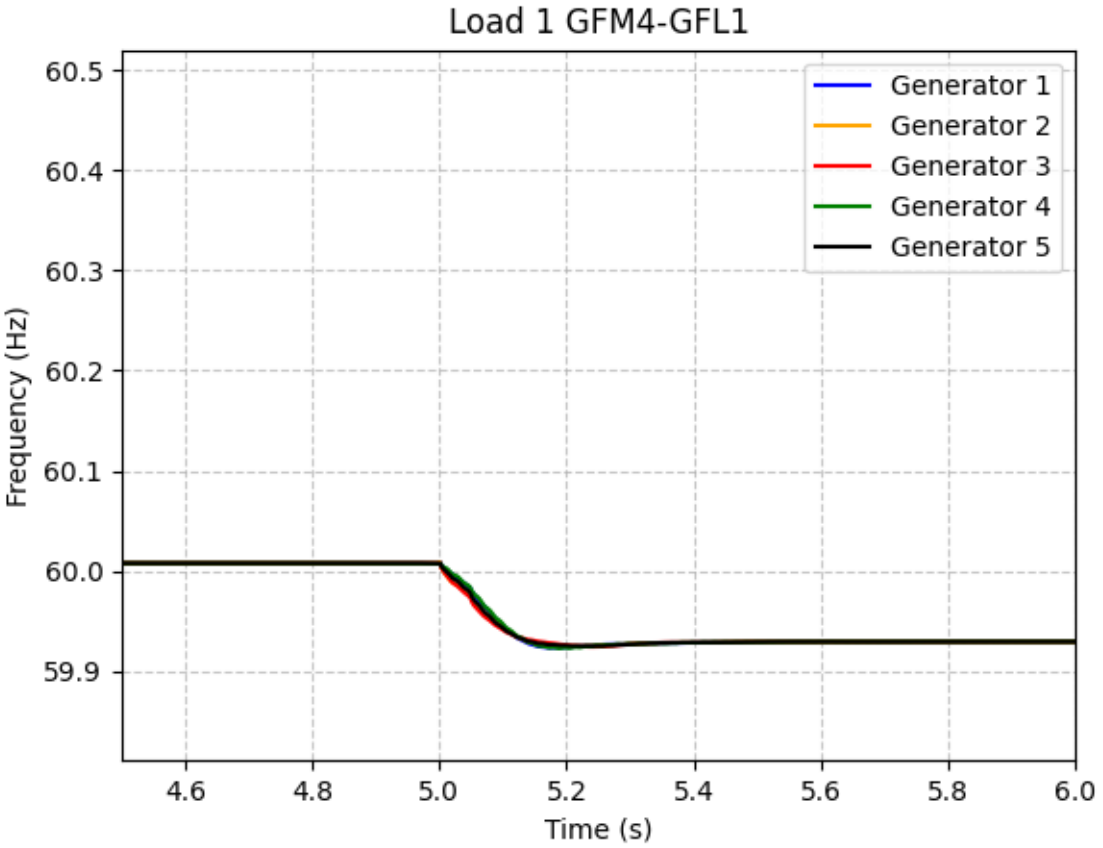
- **Load at Highest Power Bus**
- **+ 5 MW / phase**
- **+ 1 MVAR / phase**

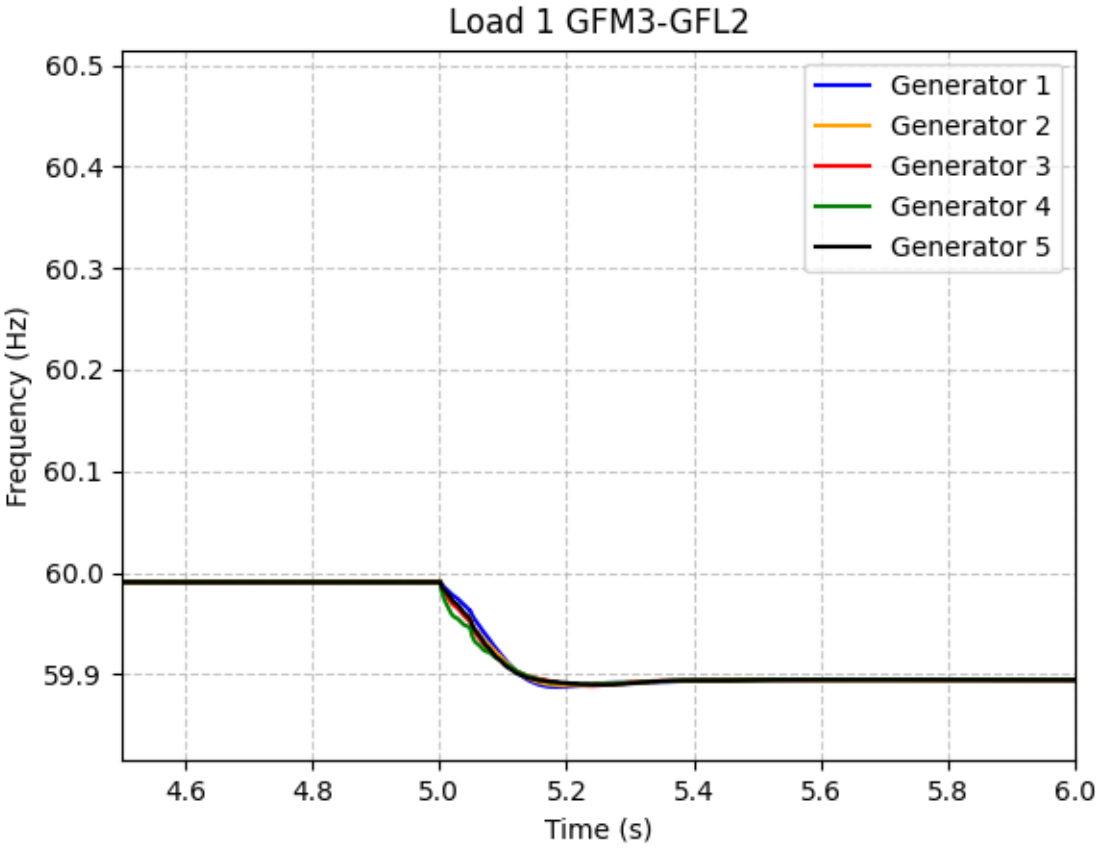


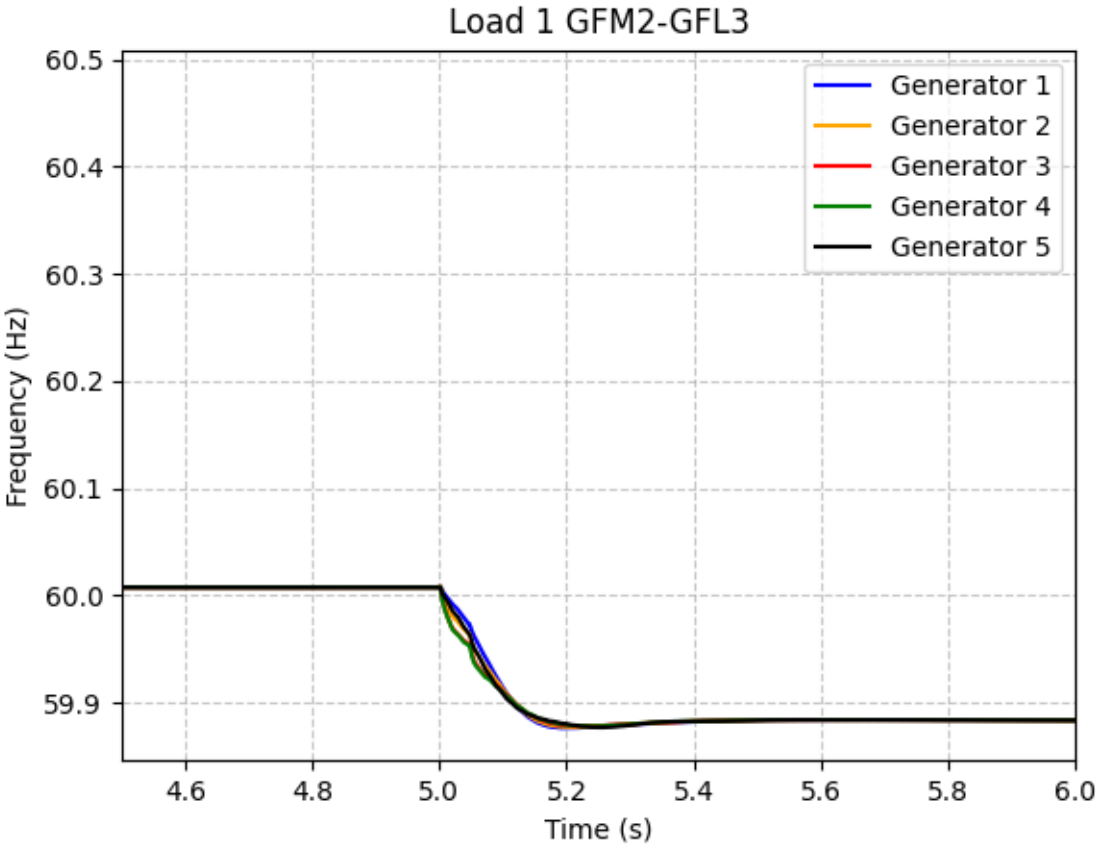
ALL LOAD Simulations	Base Case	GFM5-GFL0	GFM4-GFL1	GFM3-GFL2	GFM2-GFL3	GFM1-GFL4
Generator 1	Ideal	GFM	GFM	GFM	GFM	GFM
Generator 2	Ideal	GFM	GFL	GFL	GFL	GFL
Generator 3	Ideal	GFM	GFM	GFM	GFL	GFL
Generator 4	Ideal	GFM	GFM	GFL	GFL	GFL
Generator 5	Ideal	GFM	GFM	GFM	GFM	GFL

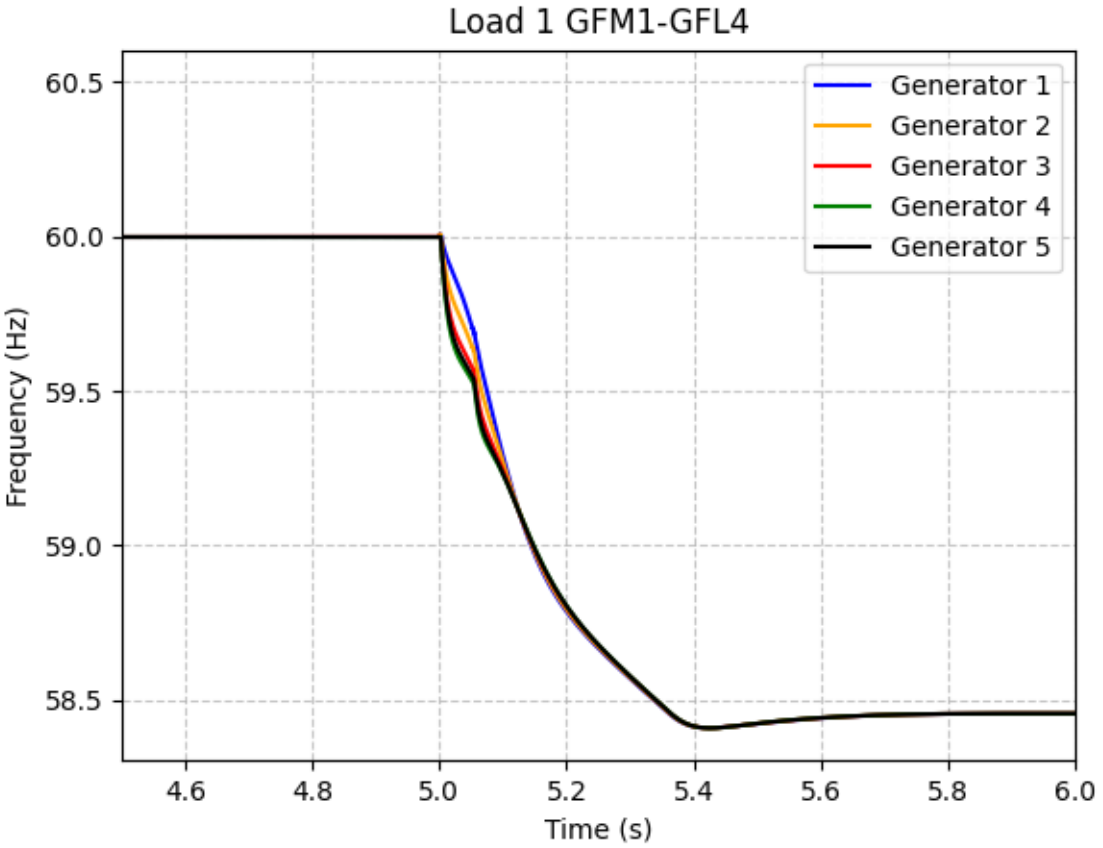

Load 1 Base Case
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
60.005
60.000
59.995
59.990
59.985
Frequency (Hz)
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

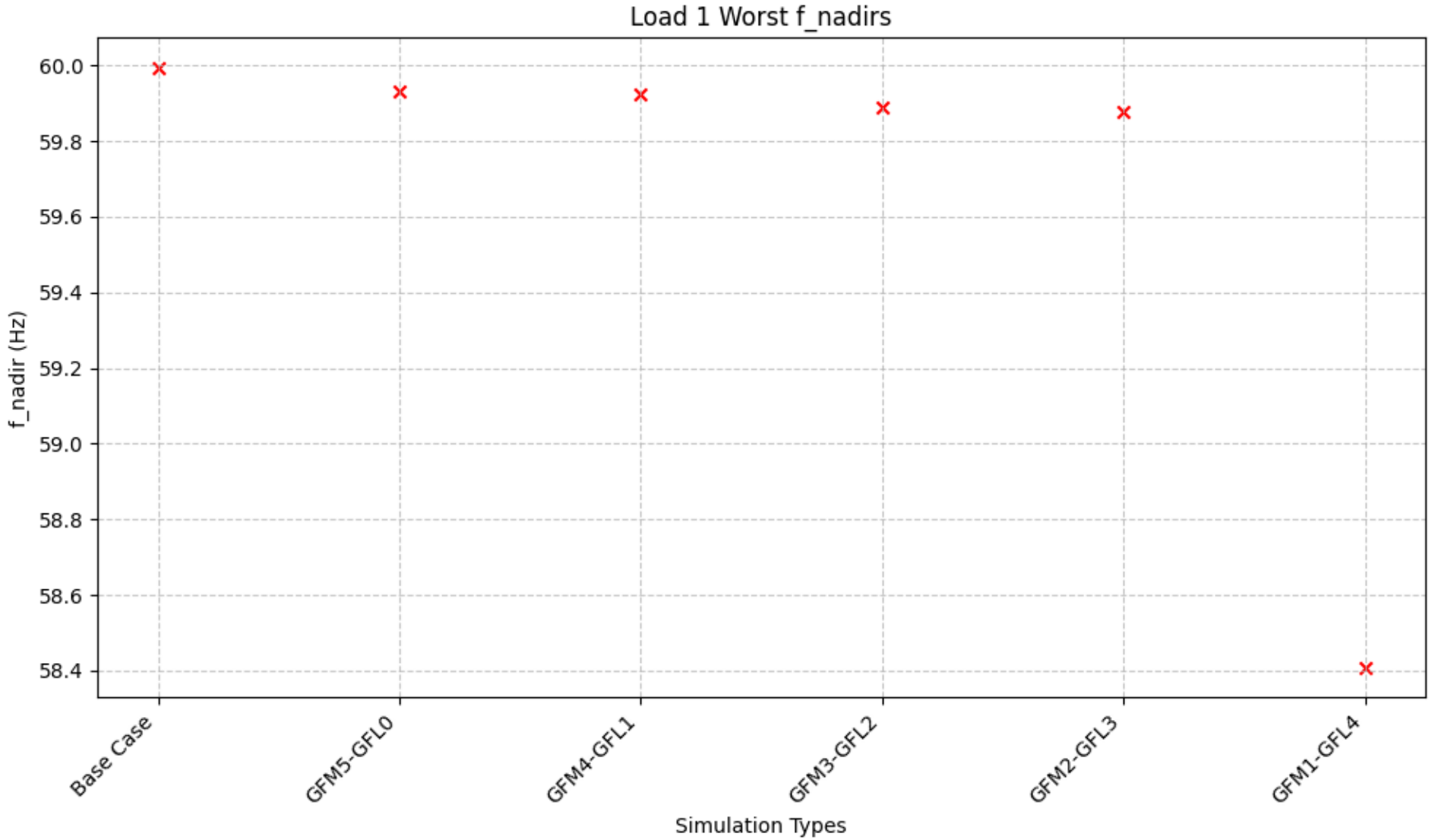

Load 1 GFM5-GFL0
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
60.4
60.3
60.2
60.1
60.0
59.9
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

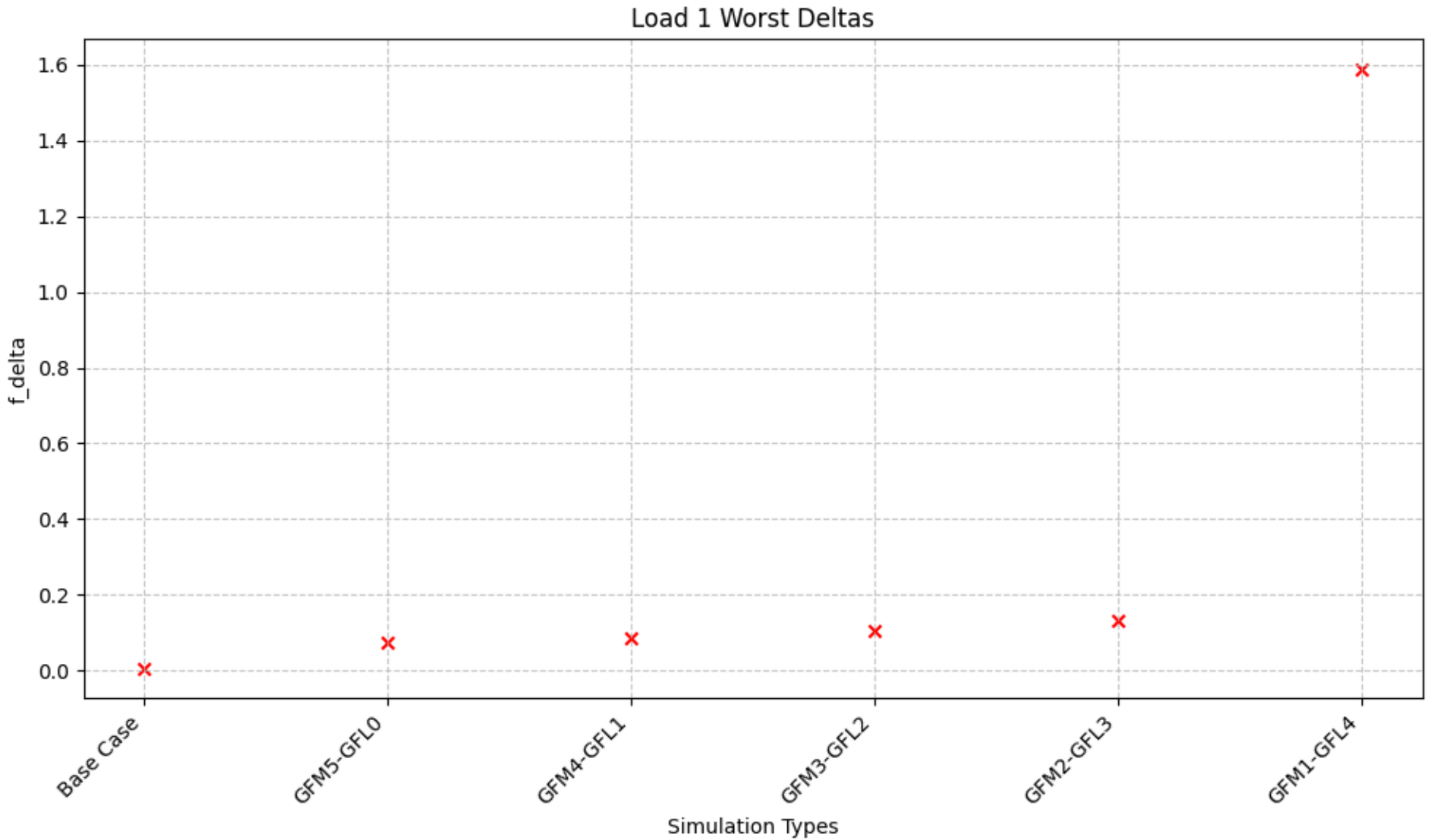

Load 1 GFM4-GFL1
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
60.5
60.4
60.3
60.2
60.1
60.0
59.9
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

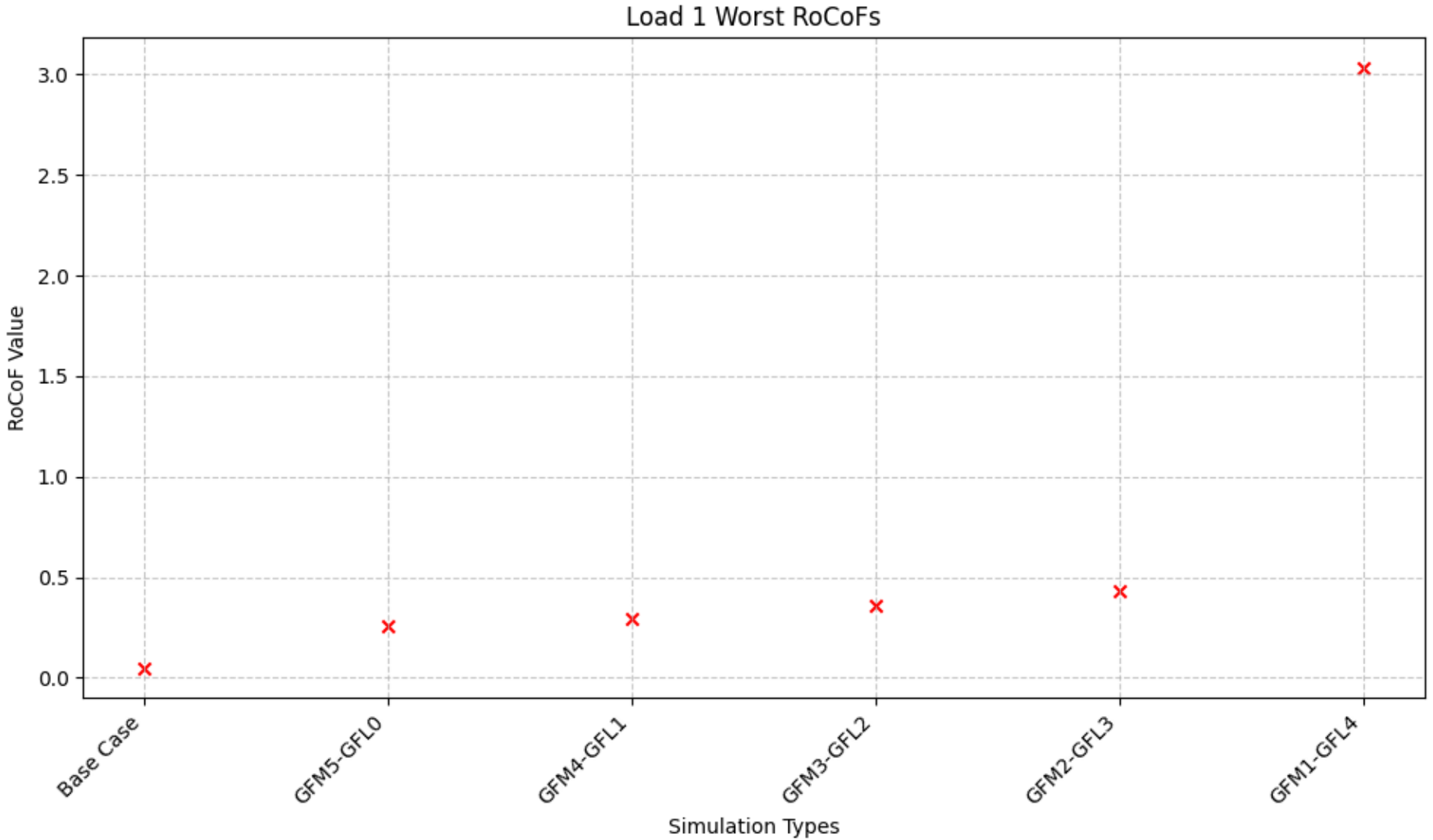

Load 1 GFM3-GFL2
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
60.5
60.4
60.3
60.2
60.1
60.0
59.9
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)


Load 1 GFM2-GFL3
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
60.5
60.4
60.3
60.2
60.1
60.0
59.9
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

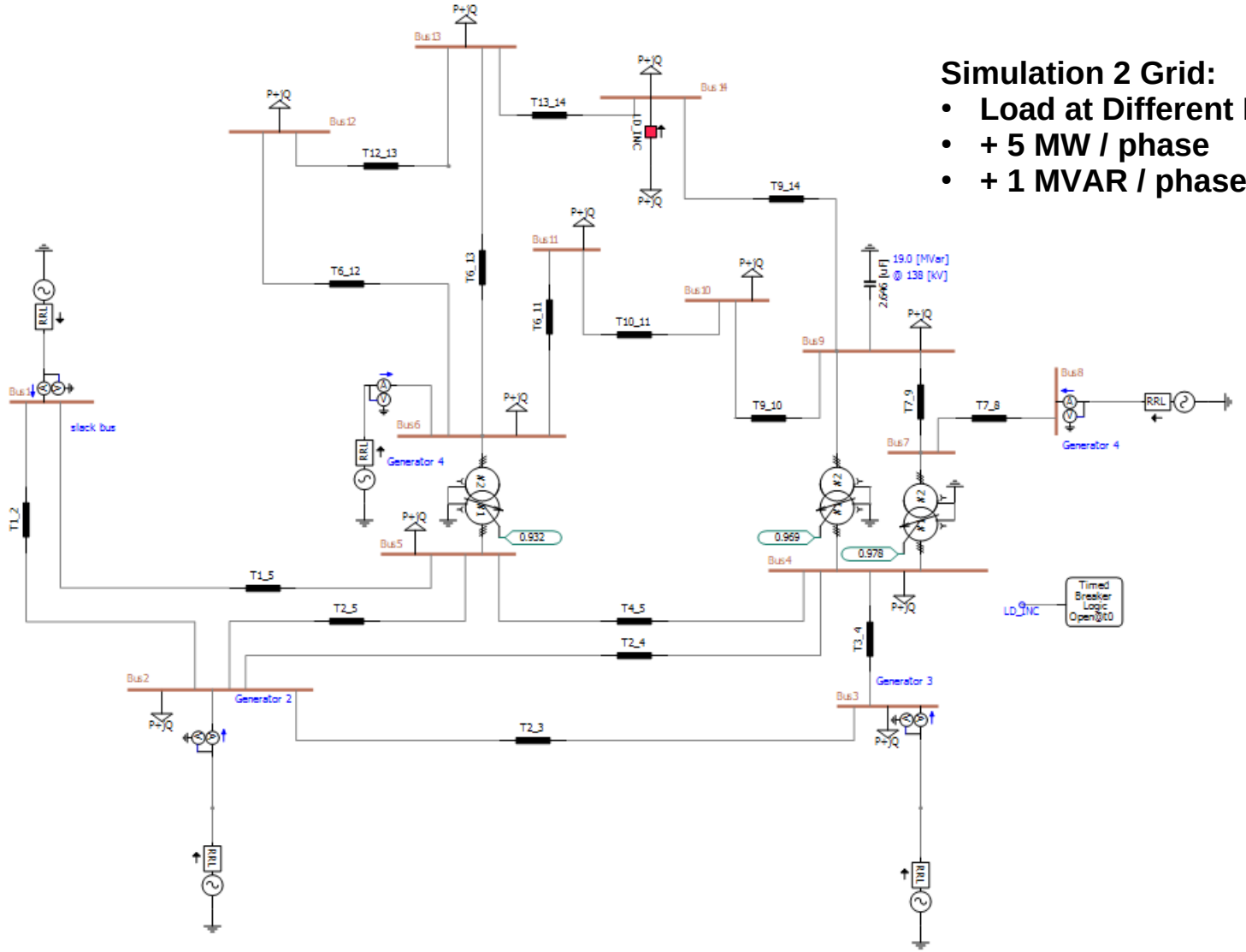

Load 1 GFM1-GFL4
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
60.5
60.0
59.5
59.0
58.5
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)


Load 1 Worst f_nadirs
f_nadir (Hz)
60.0
59.8
59.6
59.4
59.2
59.0
58.8
58.6
58.4
Base Case
GFM5-GFL0
GFM4-GFL1
GFM3-GFL2
GFM2-GFL3
GFM1-GFL4
Simulation Types


Load 1 Worst Deltas
f_delta
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Base Case
GFM5-GFL0
GFM4-GFL1
GFM3-GFL2
GFM2-GFL3
GFM1-GFL4
Simulation Types

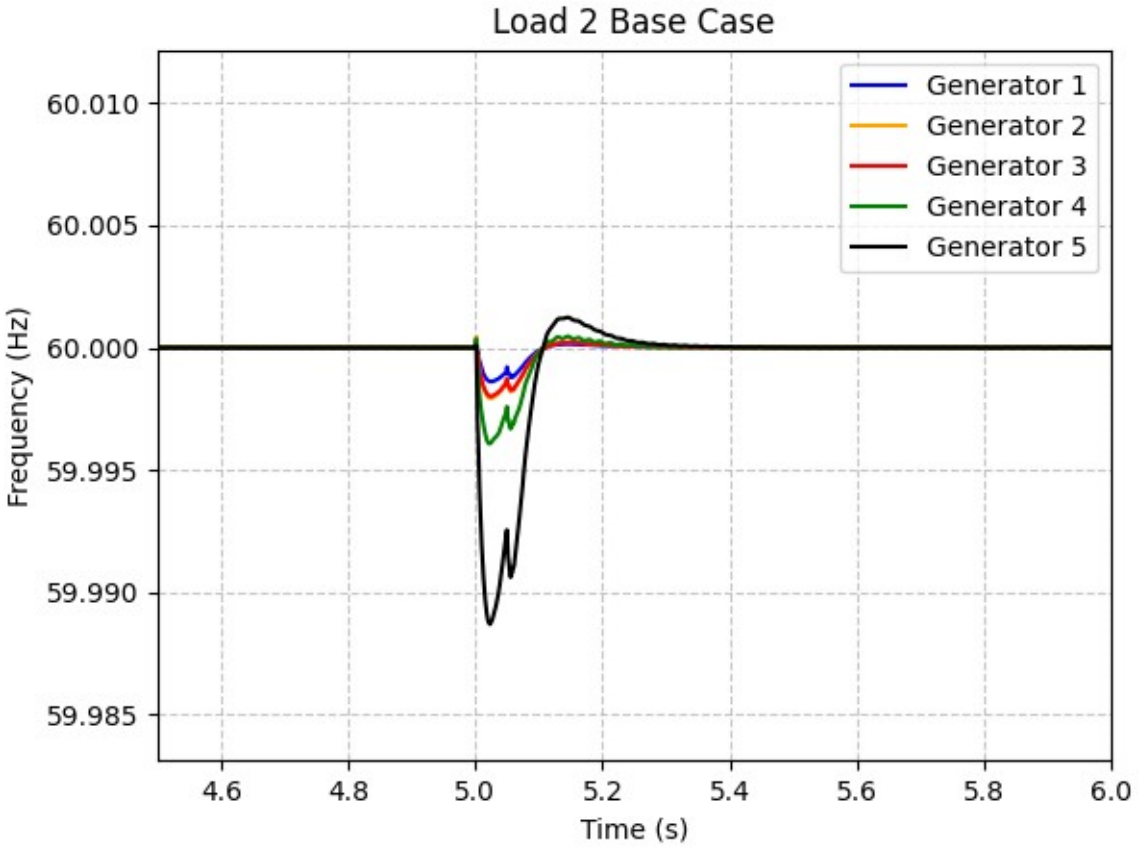

Load 1 Worst RoCoFs
RoCoF Value
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Base Case
GFM5-GFL0
GFM4-GFL1
GFM3-GFL2
GFM2-GFL3
GFM1-GFL4
Simulation Types

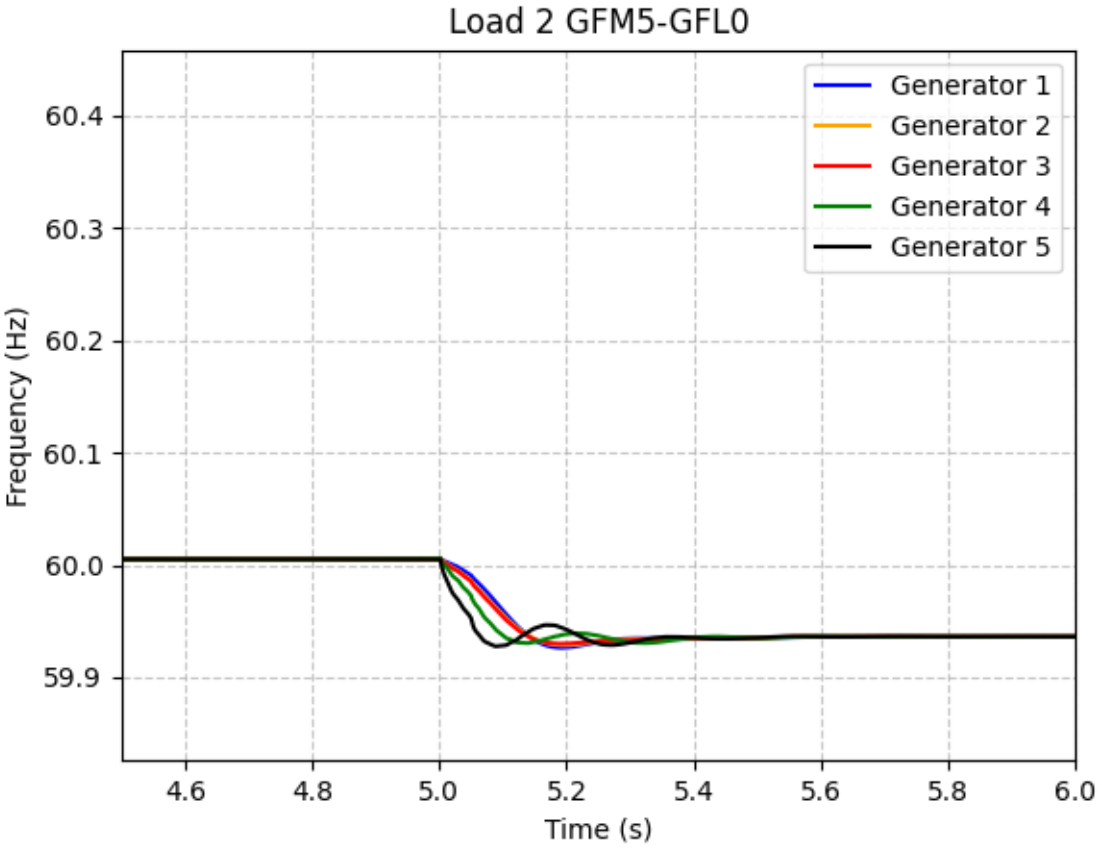
Load1	Worst F_nadir	Worst Delta	Worst RoCoF
Base Case	59.9940	0.0060	0.0491
GFM5-GFL0	59.9325	0.0726	0.2545
GFM4-GFL1	59.9231	0.0848	0.2949
GFM3-GFL2	59.8874	0.1033	0.3600
GFM2-GFL3	59.8763	0.1314	0.4337
GFM1-GFL4	58.4093	1.5886	3.0336

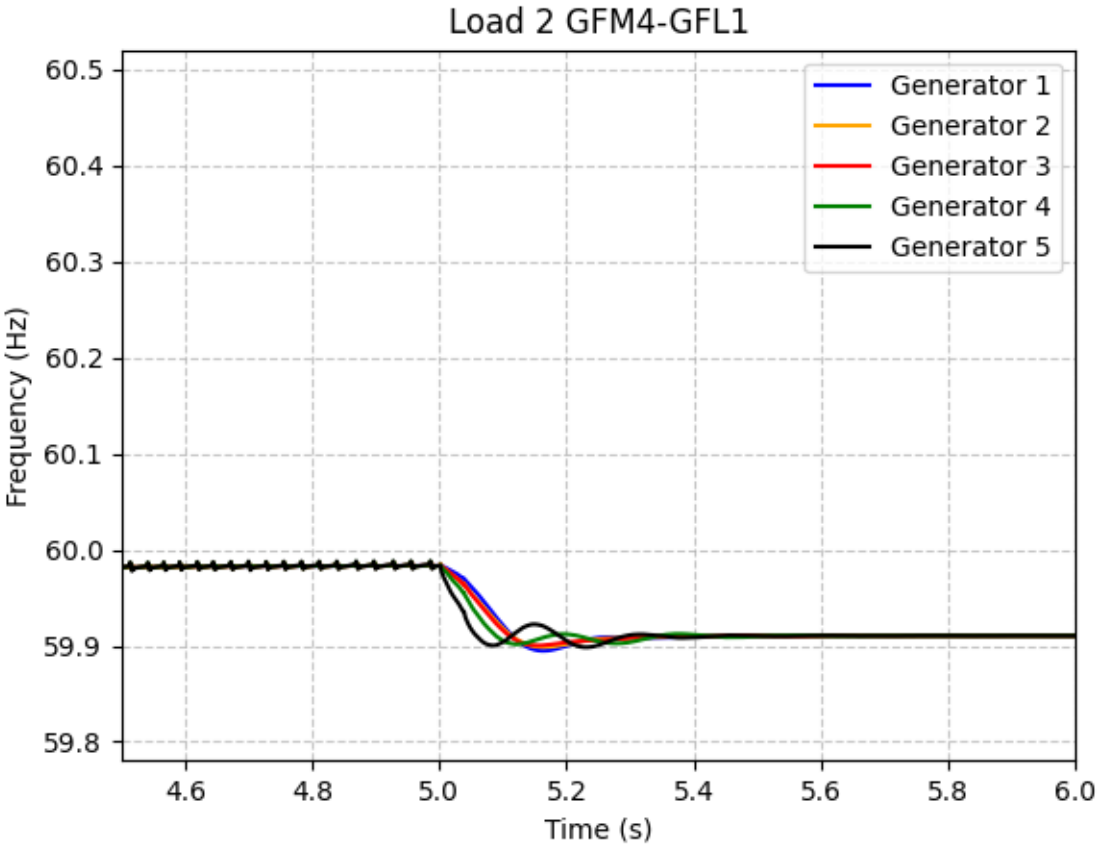


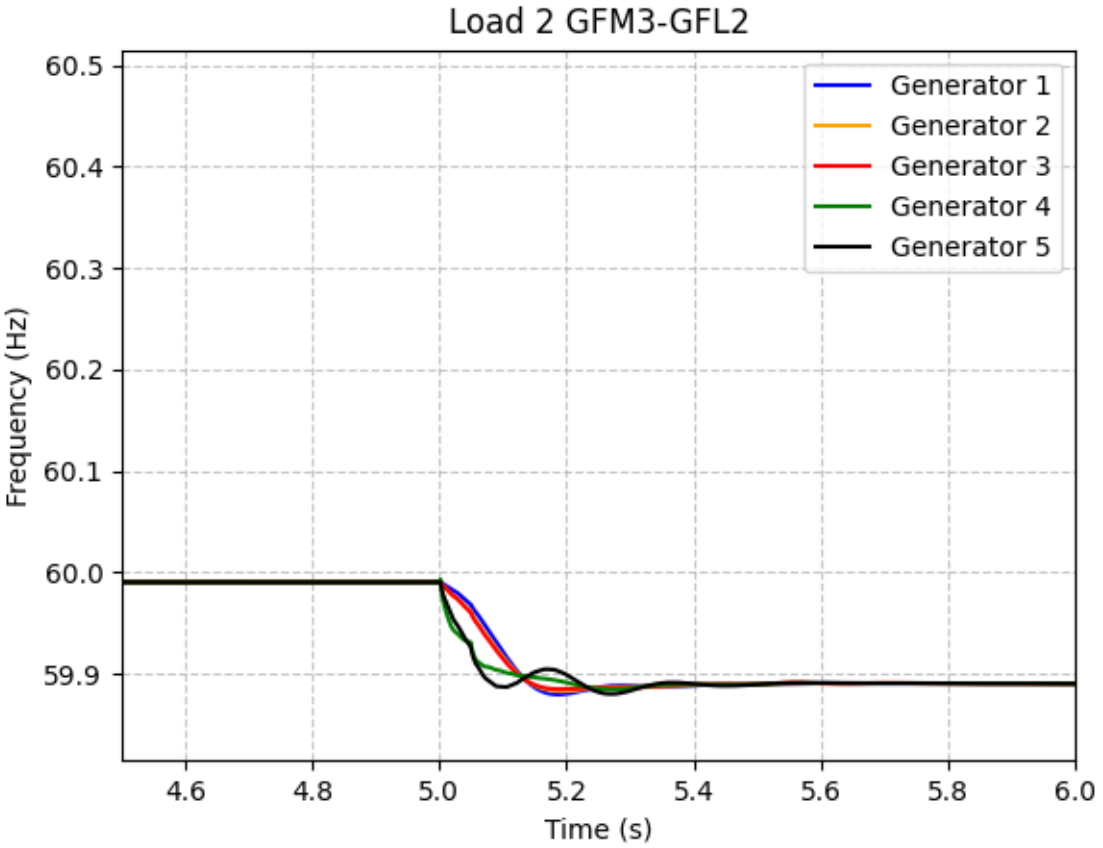
Simulation 2 Grid:

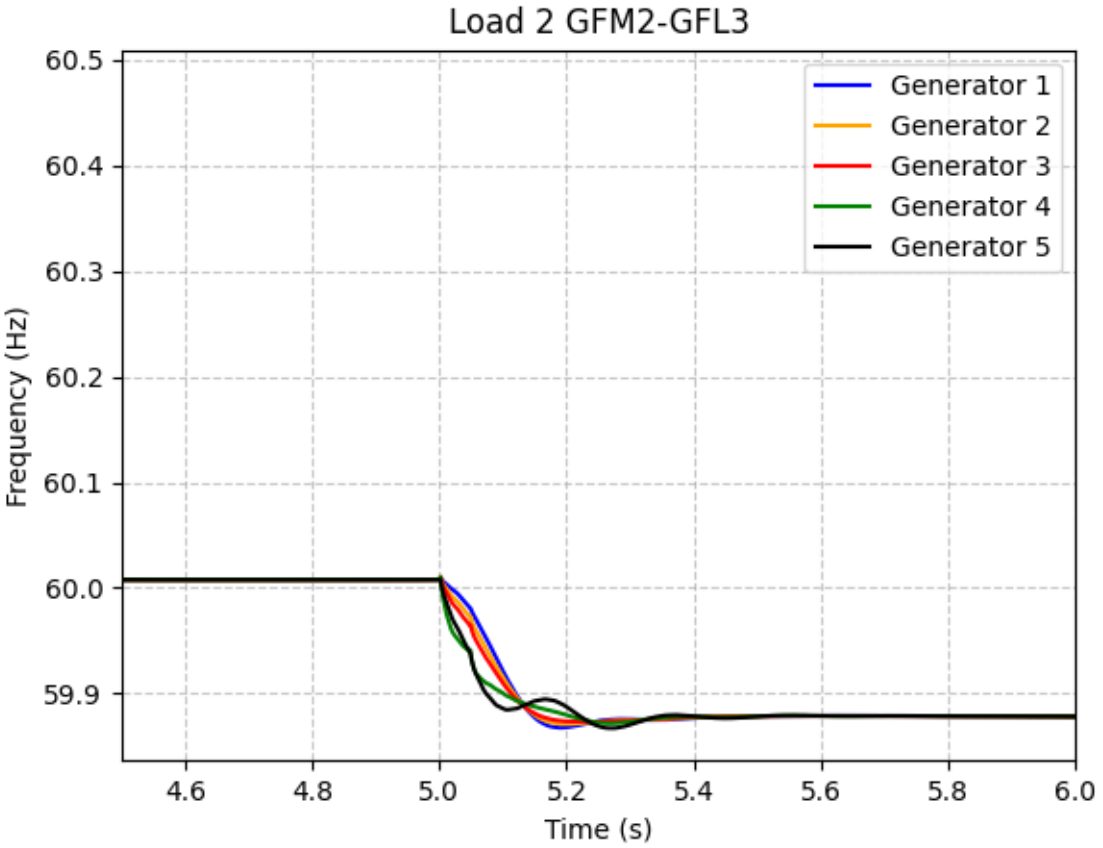
- **Load at Different Location**
- **+ 5 MW / phase**
- **+ 1 MVAR / phase**

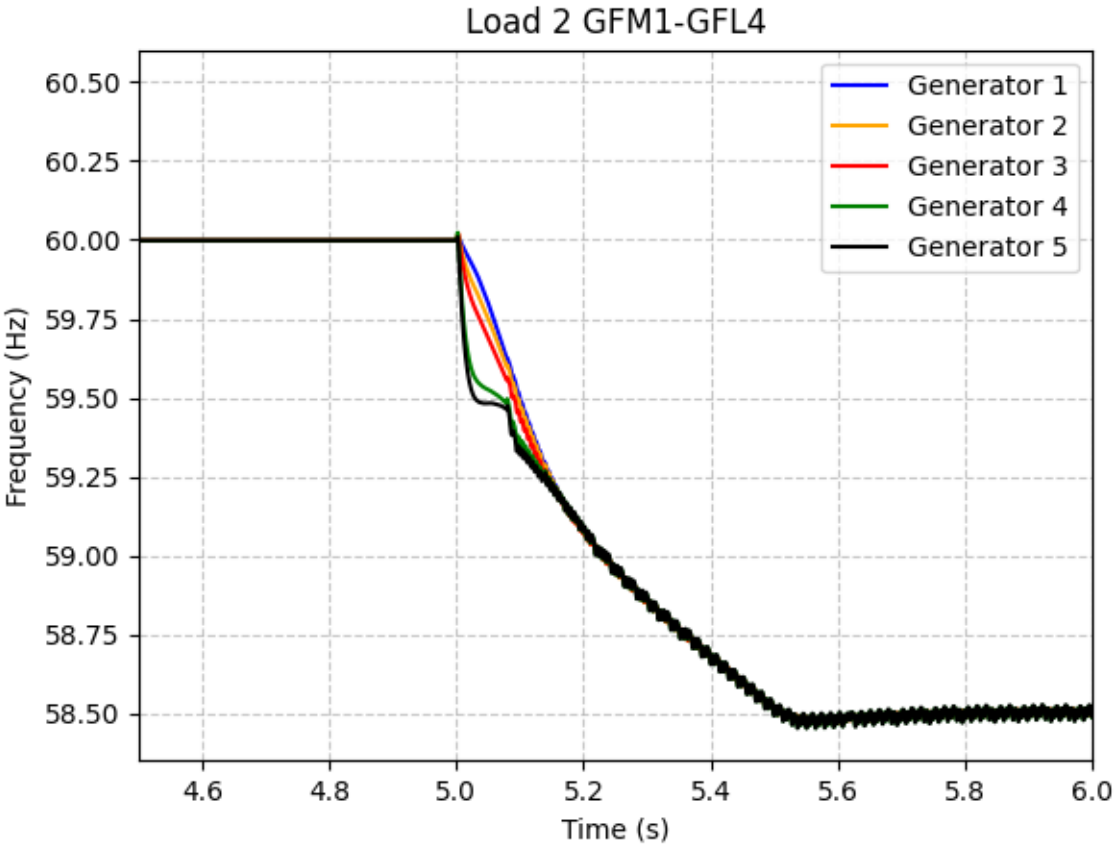

Load 2 Base Case
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
60.010
60.005
60.000
59.995
59.990
59.985
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

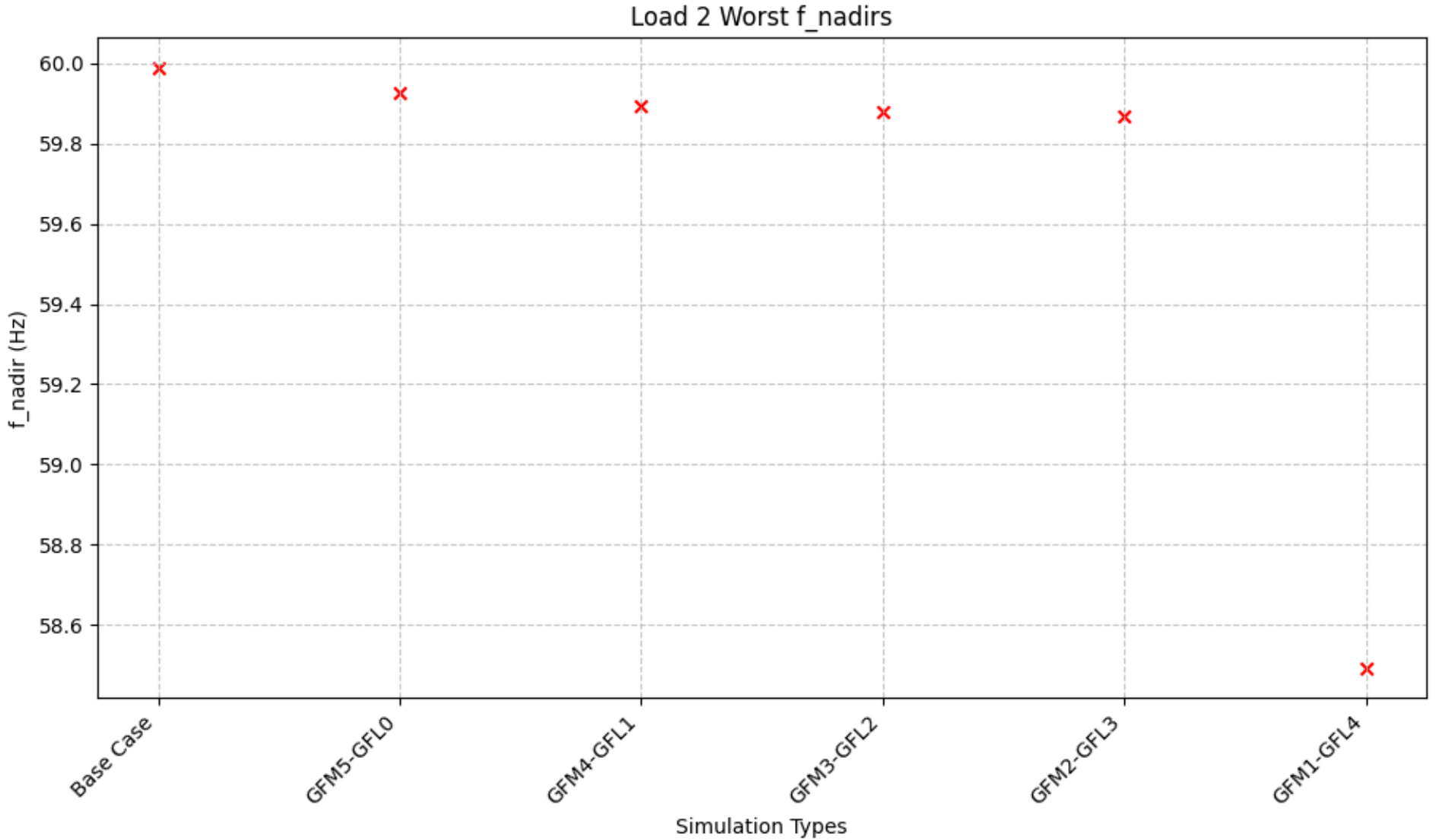

Load 2 GFM5-GFL0
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
60.4
60.3
60.2
60.1
60.0
59.9
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

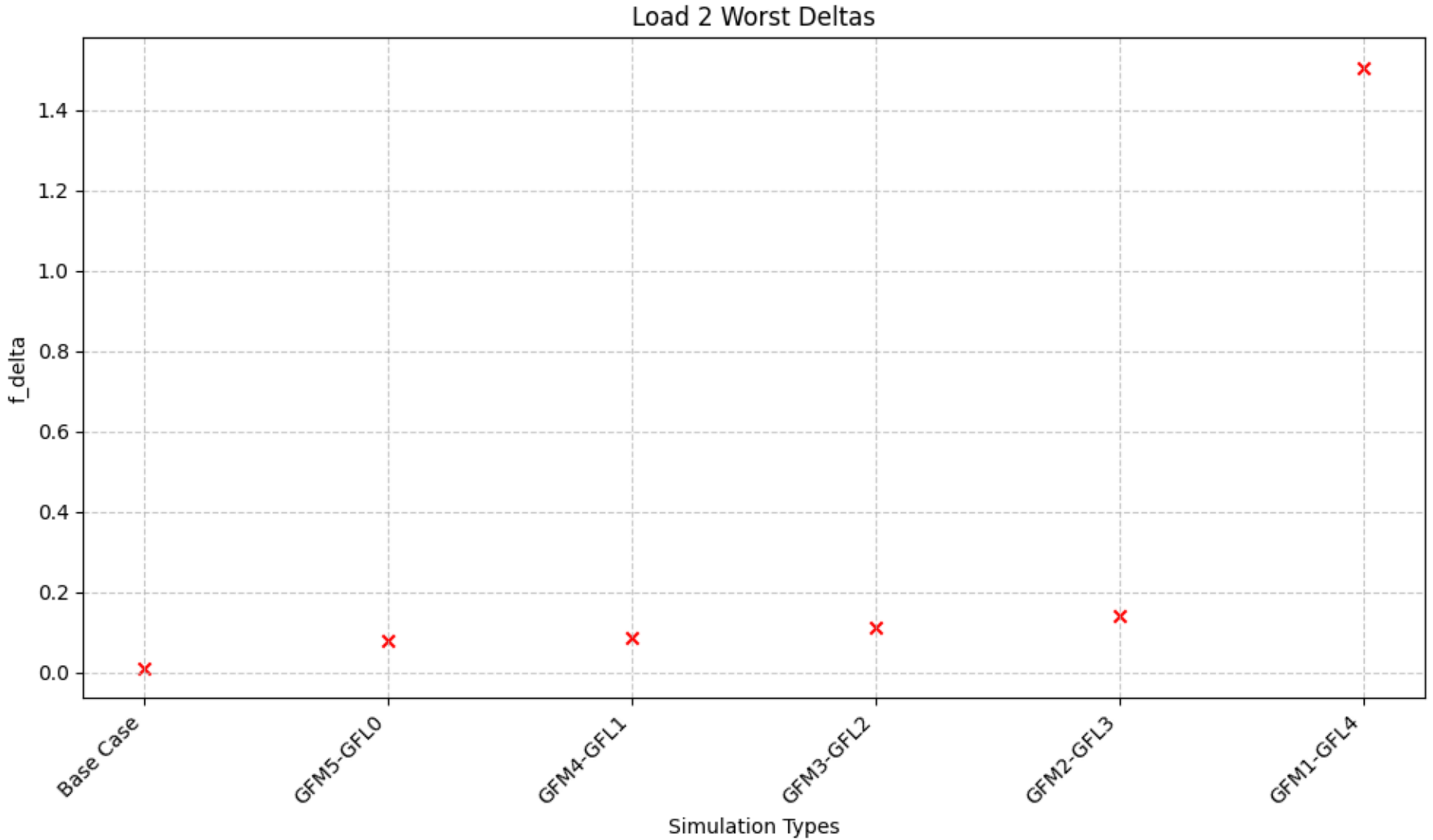

Load 2 GFM4-GFL1
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
60.5
60.4
60.3
60.2
60.1
60.0
59.9
59.8
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

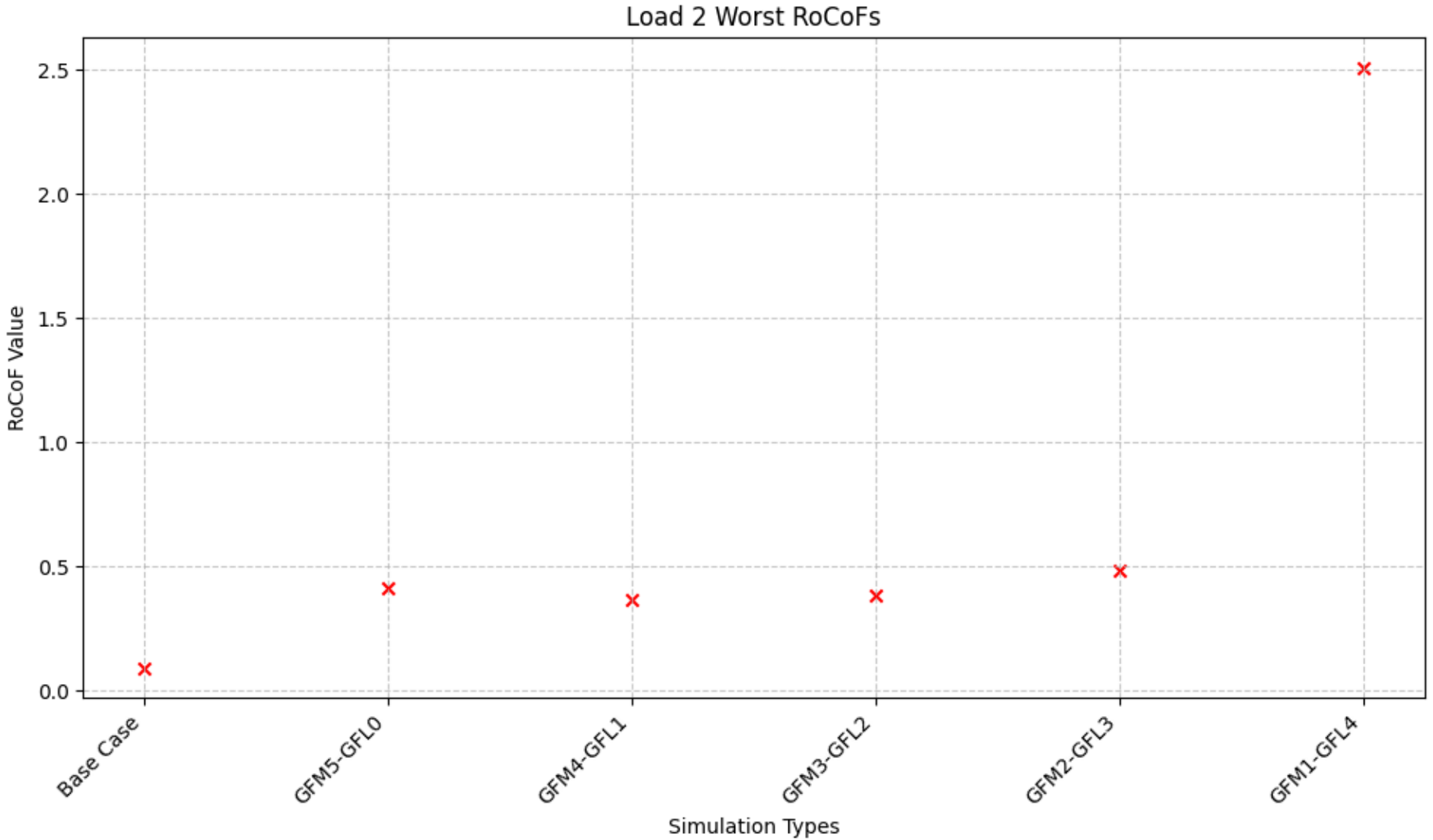

Load 2 GFM3-GFL2
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
60.5
60.4
60.3
60.2
60.1
60.0
59.9
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)


Load 2 GFM2-GFL3
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
60.5
60.4
60.3
60.2
60.1
60.0
59.9
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

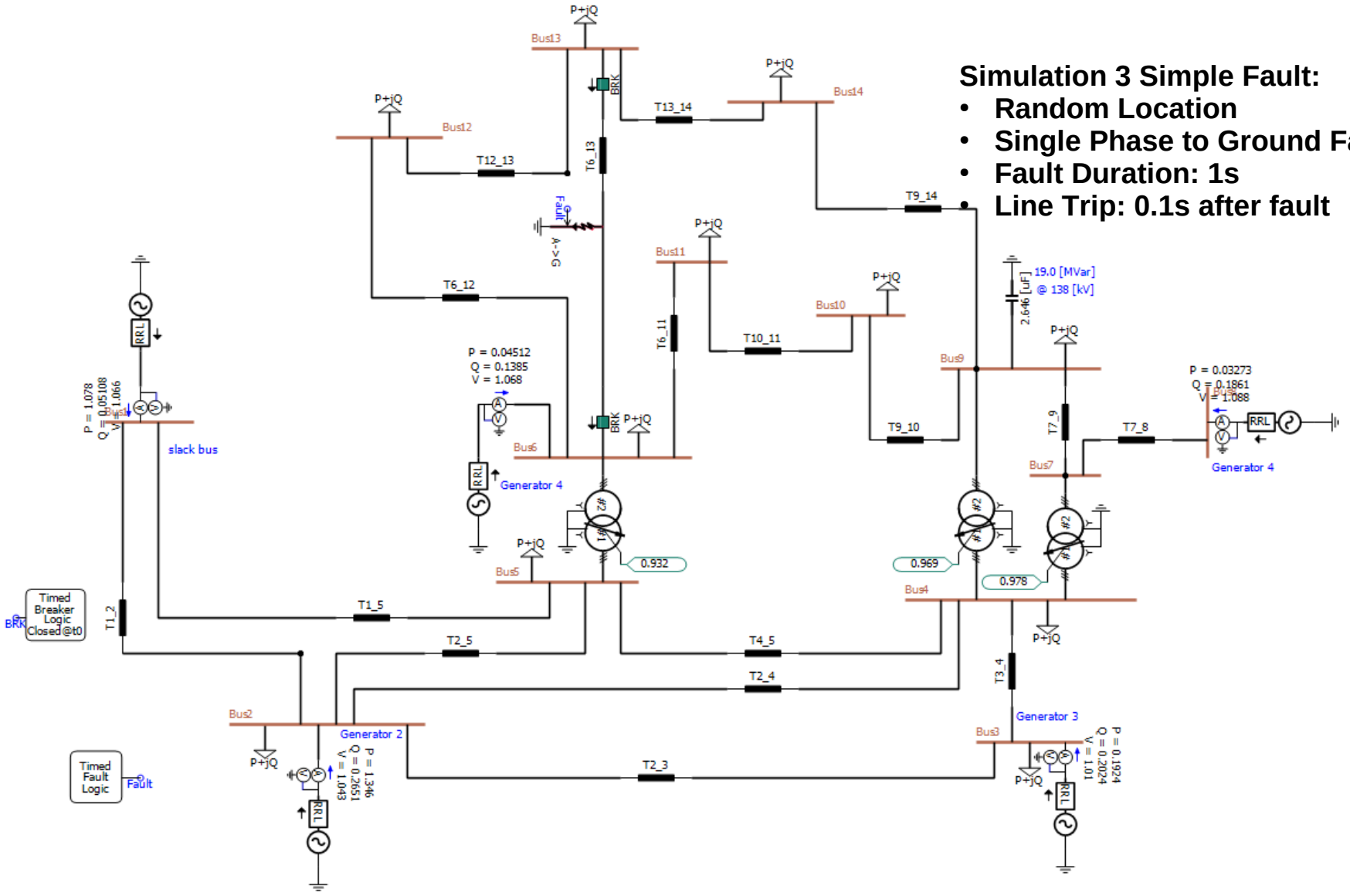

Load 2 GFM1-GFL4
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
60.50
60.25
60.00
59.75
59.50
59.25
59.00
58.75
58.50
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)


Load 2 Worst f_nadirs
f_nadir (Hz)
60.0
59.8
59.6
59.4
59.2
59.0
58.8
58.6
Base Case
GFM5-GFL0
GFM4-GFL1
GFM3-GFL2
GFM2-GFL3
GFM1-GFL4
Simulation Types

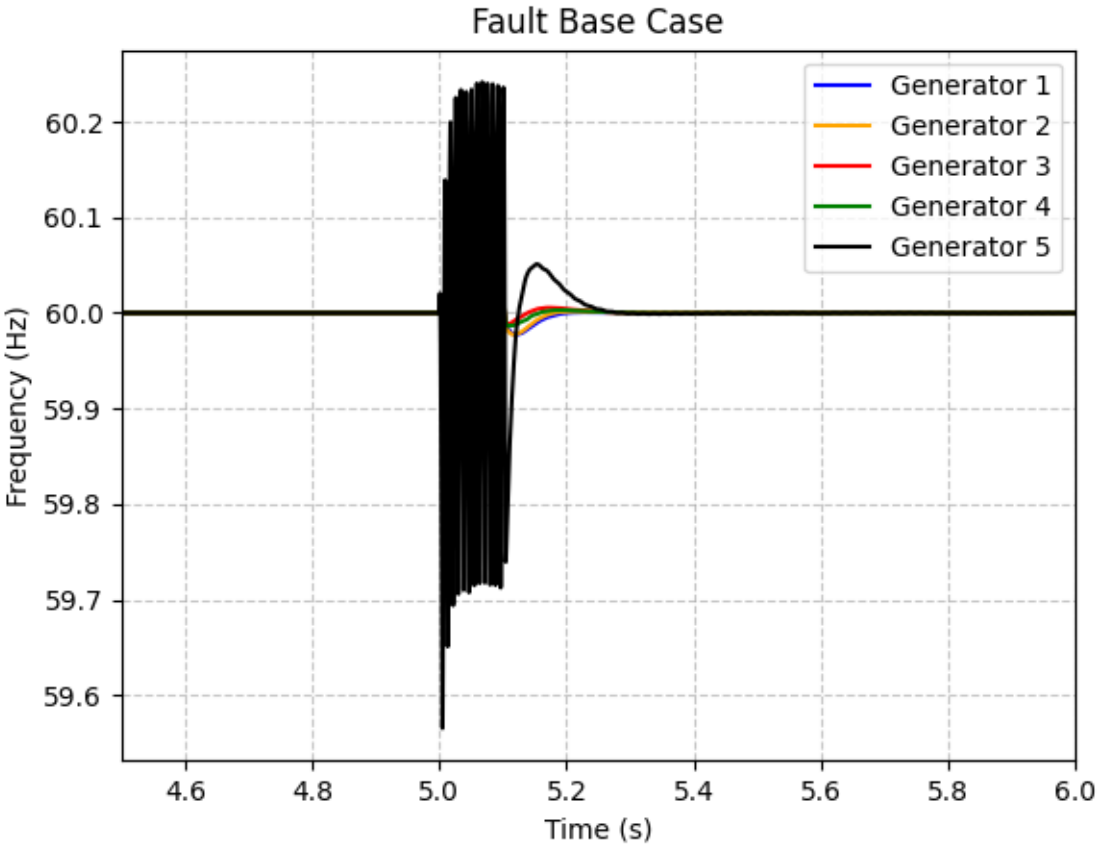

Load 2 Worst Deltas
f_delta
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Base Case
GFM5-GFL0
GFM4-GFL1
GFM3-GFL2
GFM2-GFL3
GFM1-GFL4
Simulation Types

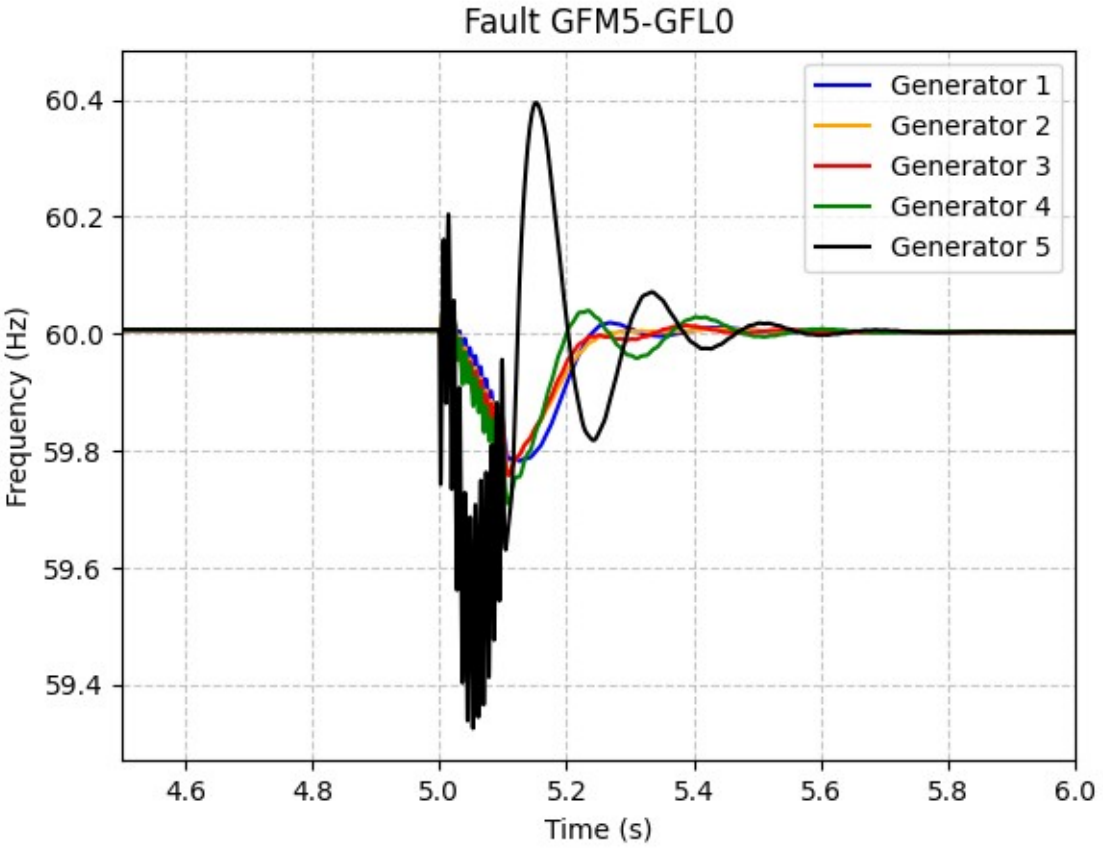

Load 2 Worst RoCoFs
RoCoF Value
2.5
2.0
1.5
1.0
0.5
0.0
Base Case
GFM5-GFL0
GFM4-GFL1
GFM3-GFL2
GFM2-GFL3
GFM1-GFL4
Simulation Types

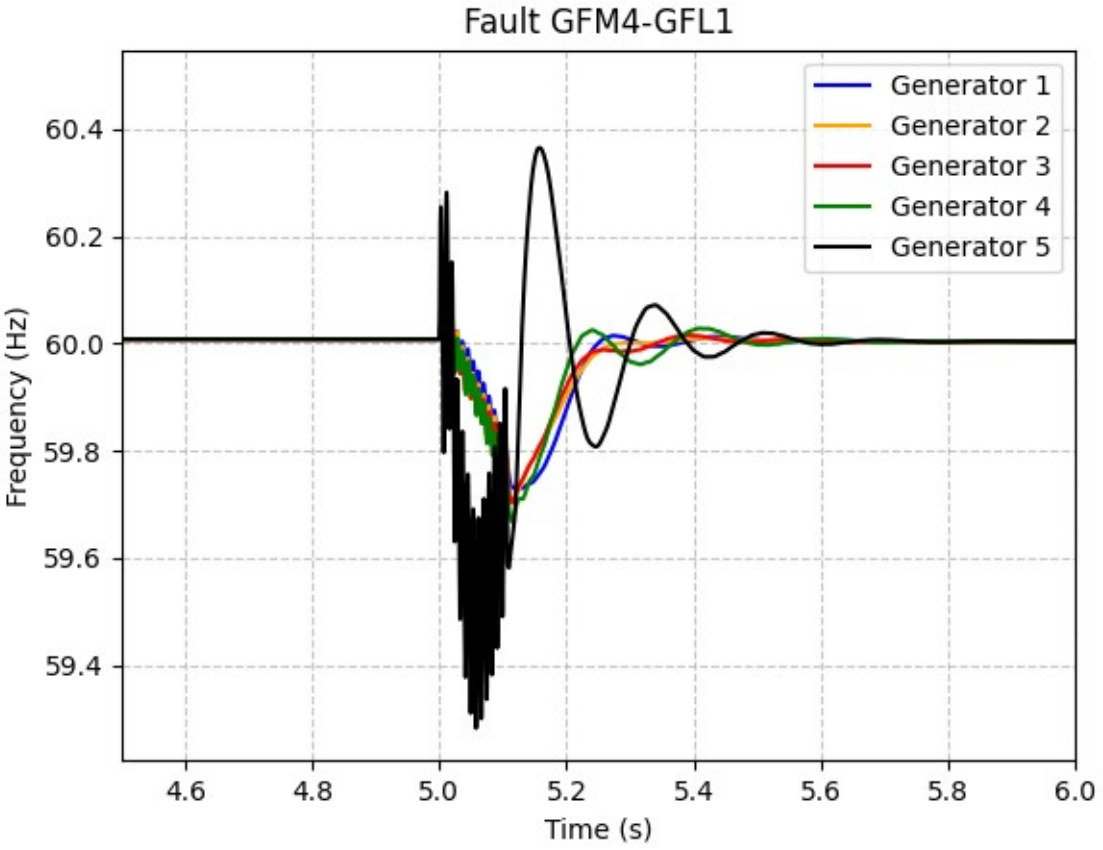
Load2	Worst F_nadir	Worst Delta	Worst RoCoF
Base Case	59.9887	0.0113	0.0920
GFM5-GFL0	59.9263	0.0788	0.4101
GFM4-GFL1	59.8947	0.0875	0.3635
GFM3-GFL2	59.8794	0.1107	0.3850
GFM2-GFL3	59.8671	0.1405	0.4830
GFM1-GFL4	58.4935	1.5045	2.5085

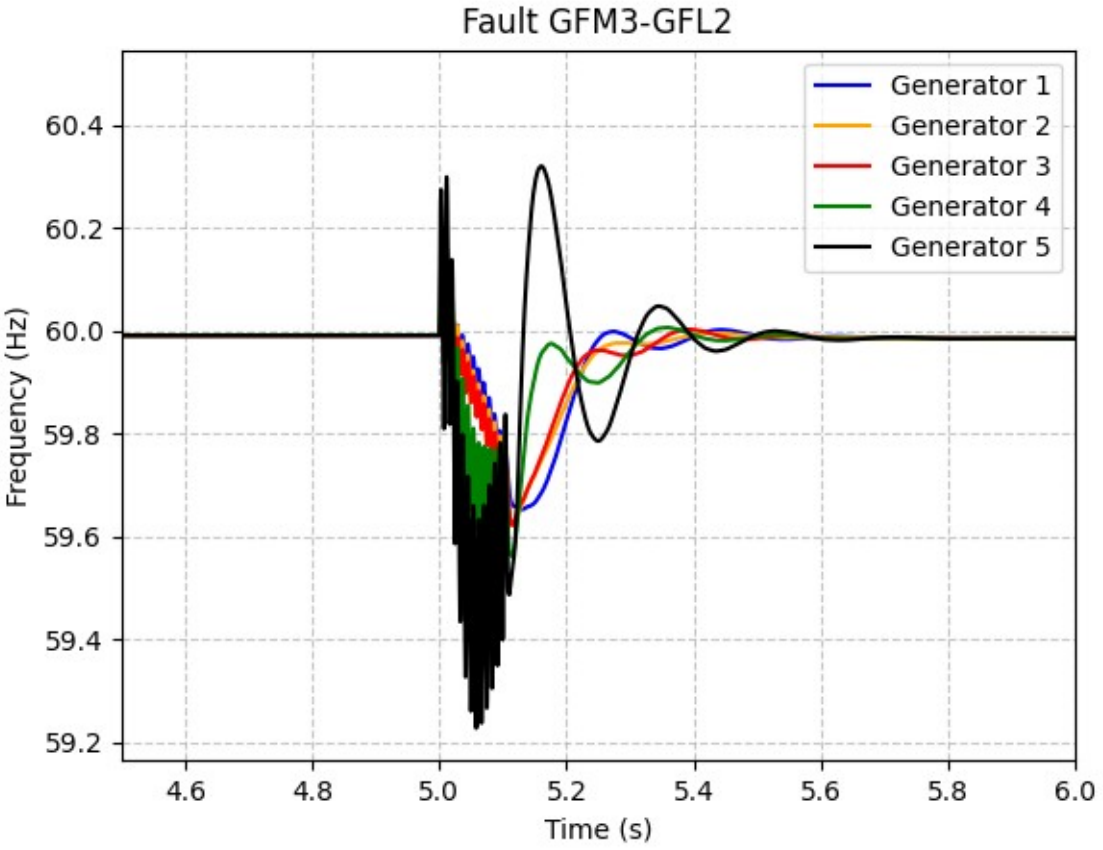

Simulation 3 Simple Fault:
• Random Location
• Single Phase to Ground Fault
• Fault Duration: 1s
• Line Trip: 0.1s after fault
Bus13
Bus14
Bus12
Bus11
Bus10
Bus9
Bus8
Bus7
Bus6
Bus5
Bus4
Bus3
Bus2
Bus1
T13_14
T12_13
T6_13
T9_14
T6_12
T6_11
T10_11
T9_10
T7_9
T7_8
T1_5
T1_2
T2_5
T4_5
T2_4
T3_4
T2_3
FAULT
A->G
BRK
RRL
P+jQ
slack bus
Generator 2
Generator 3
Generator 4
P = 0.04512
Q = 0.1385
V = 1.068
P = 1.078
Q = 0.05108
V = 1.066
P = 1.346
Q = 0.2651
V = 1.043
P = 0.1924
Q = 0.2024
V = 1.01
P = 0.03273
Q = 0.1861
V = 1.088
19.0 [MVar]
@ 138 [kV]
2.646 [uF]
0.932
0.969
0.978
Timed Breaker Logic Closed@t0
Timed Fault Logic
Fault

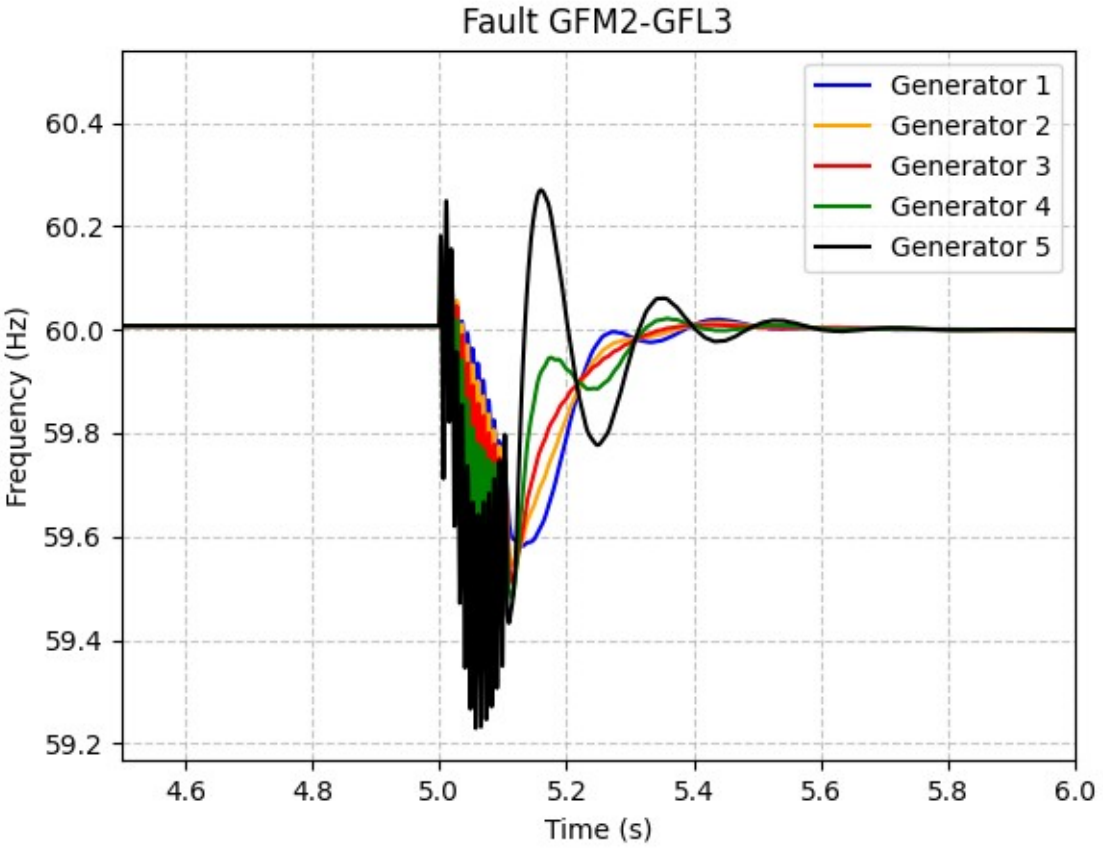
ALL FAULTS SIMULATIONS	Base Case	GFM5-GFL0	GFM4-GFL1	GFM3-GFL2	GFM2-GFL3	GFM1-GFL4	N-GFM2-GFM3 (Fault next to GFL)	N-GFM3-GFM2	N-GFM4-GFM1
Generator 1	Ideal	GFM	GFM	GFM	GFM	GFM	GFM	GFM	GFM
Generator2	Ideal	GFM	GFL	GFL	GFL	GFL	GFL	GFL	GFM
Generator 3	Ideal	GFM	GFM	GFM	GFL	GFL	GFM	GFM	GFM
Generator 4	Ideal	GFM	GFM	GFL	GFL	GFL	GFL	GFM	GFM
Generator 5	Ideal	GFM	GFM	GFM	GFM	GFL	GFL	GFL	GFL

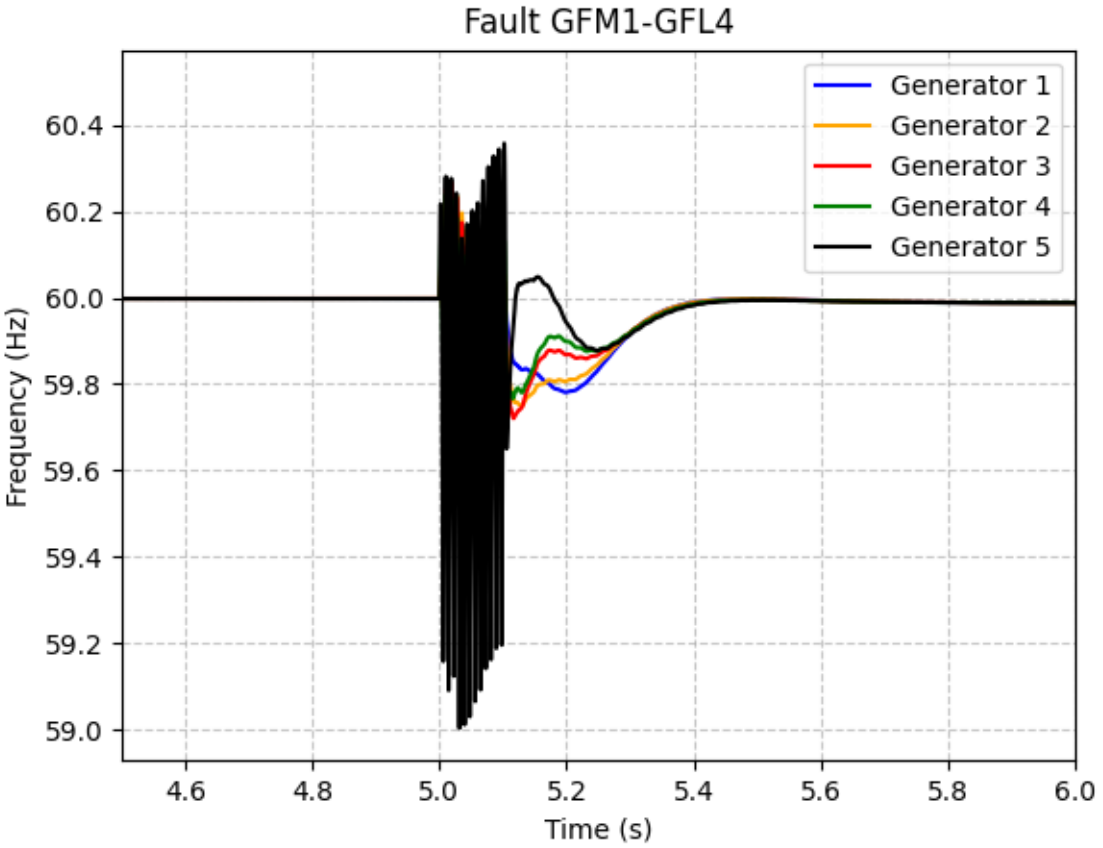

Fault Base Case
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
60.2
60.1
60.0
59.9
59.8
59.7
59.6
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

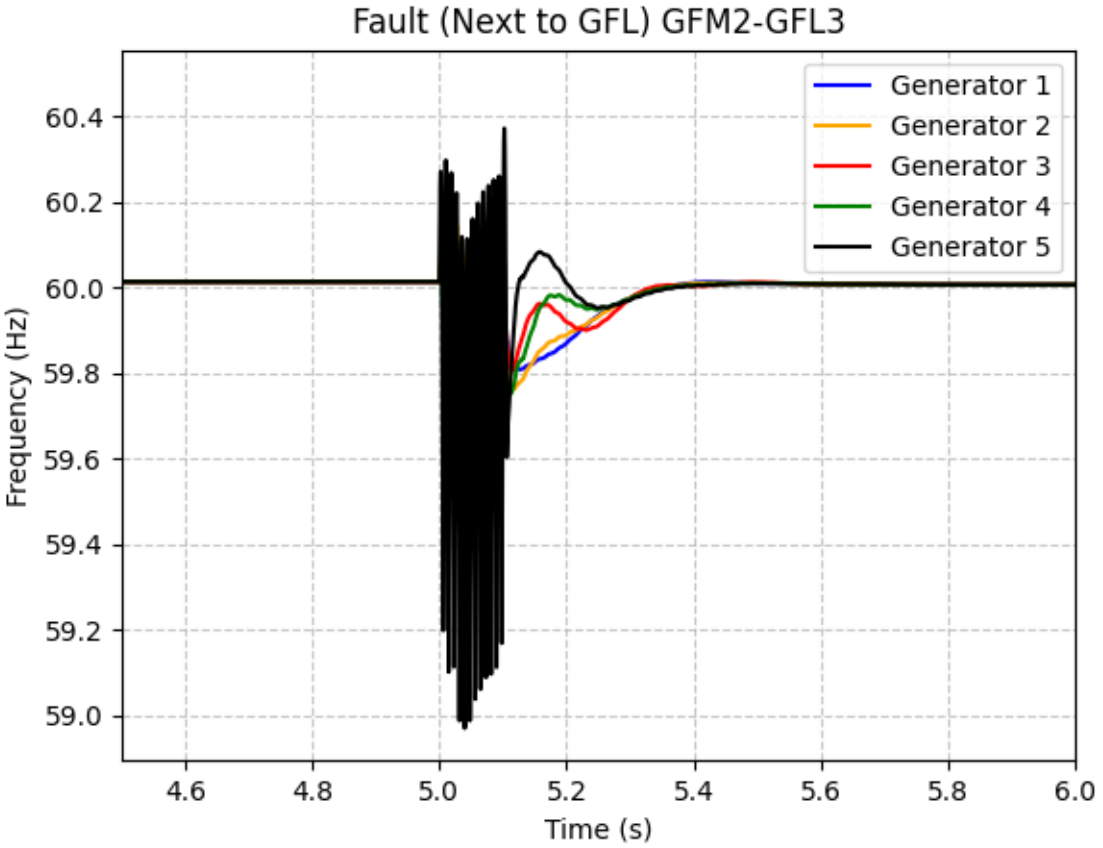

Fault GFM5-GFL0
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
60.4
60.2
60.0
59.8
59.6
59.4
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

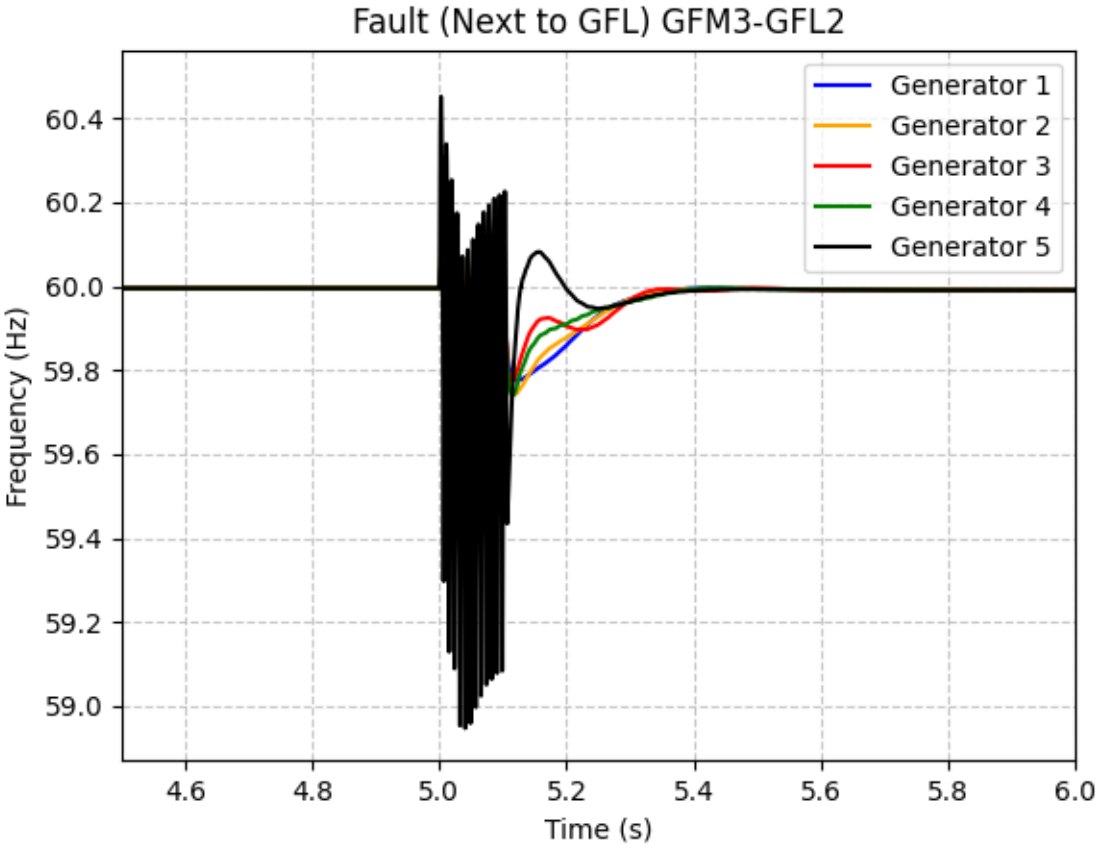

Fault GFM4-GFL1
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
60.4
60.2
60.0
59.8
59.6
59.4
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

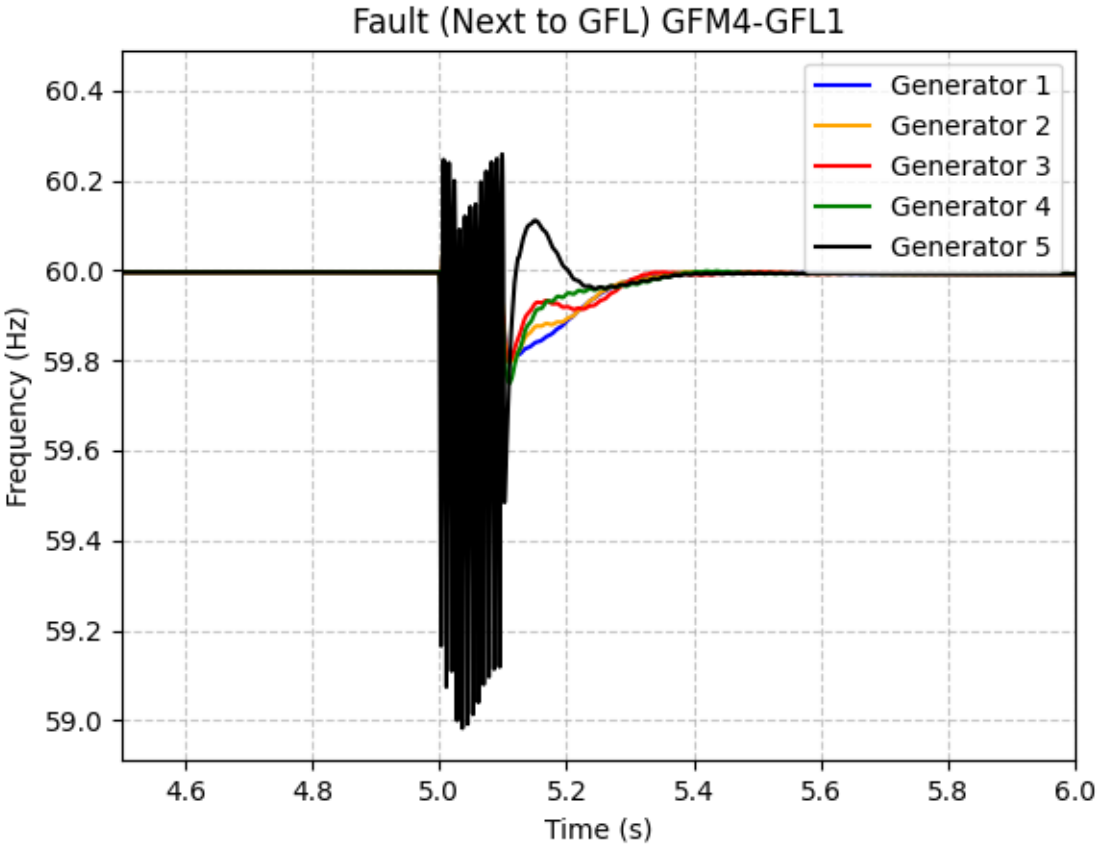

Fault GFM3-GFL2
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
60.4
60.2
60.0
59.8
59.6
59.4
59.2
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

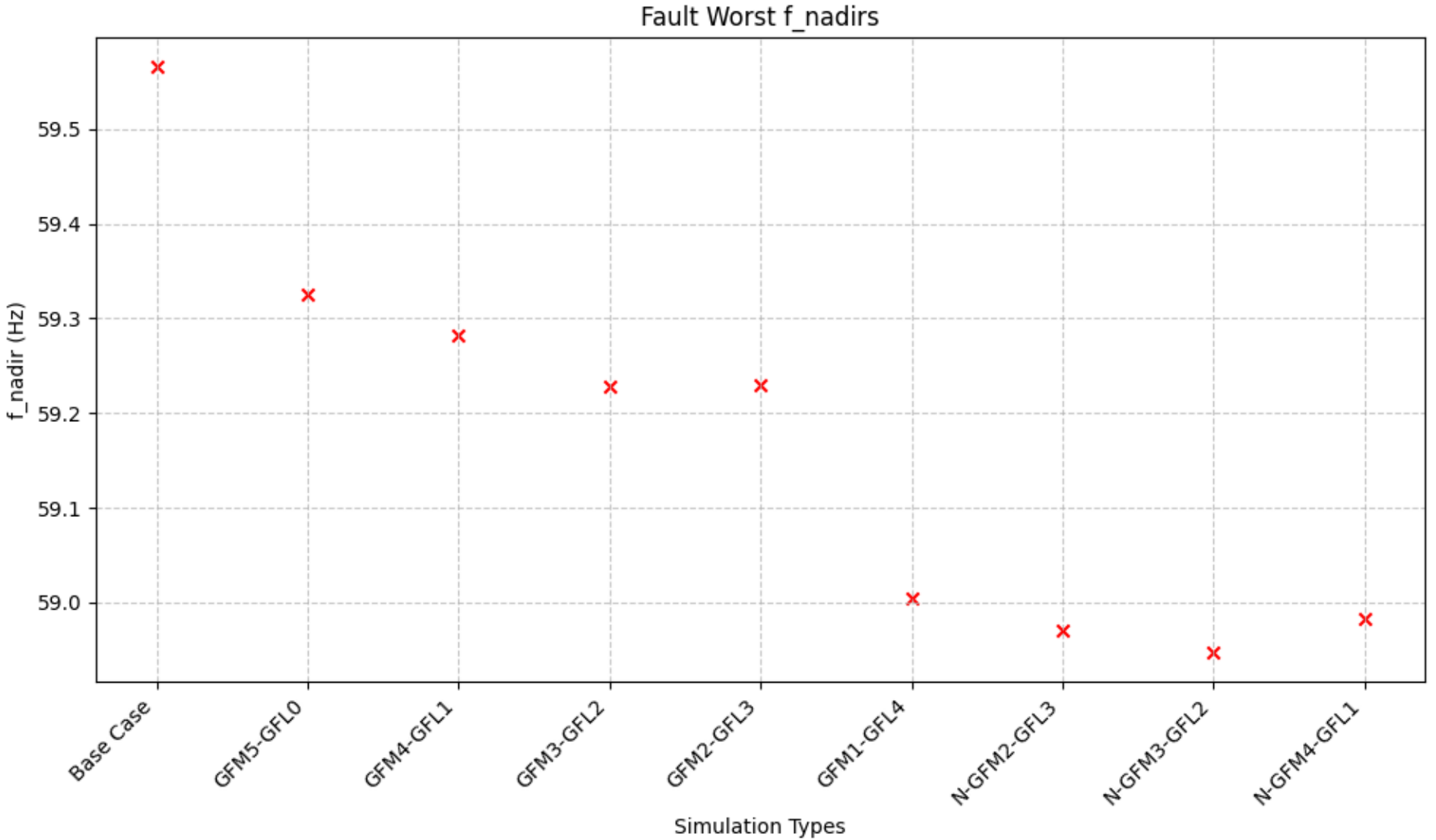

Fault GFM2-GFL3
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
60.4
60.2
60.0
59.8
59.6
59.4
59.2
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

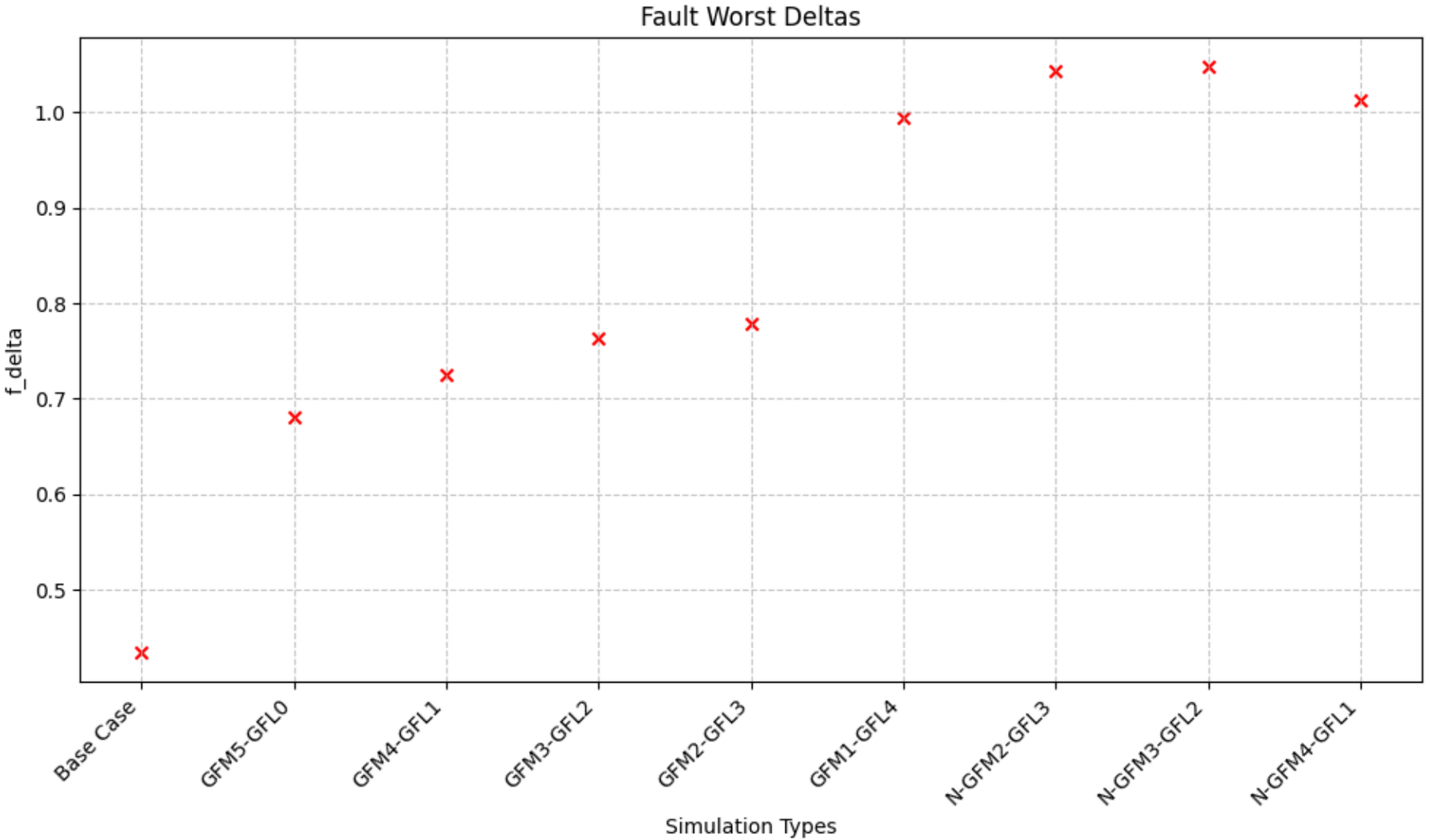

Fault GFM1-GFL4
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
60.4
60.2
60.0
59.8
59.6
59.4
59.2
59.0
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

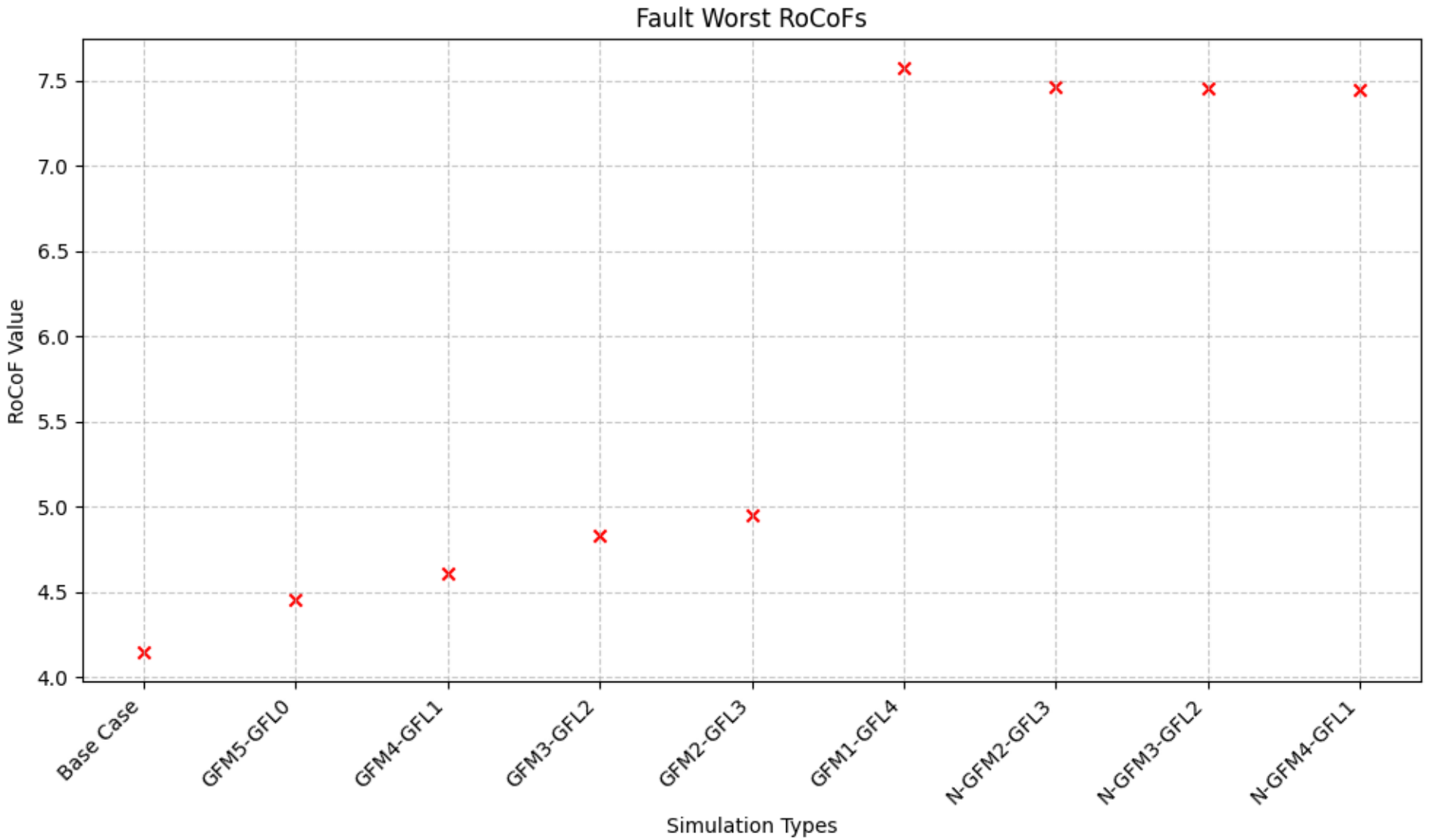

Fault (Next to GFL) GFM2-GFL3
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
60.4
60.2
60.0
59.8
59.6
59.4
59.2
59.0
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)


Fault (Next to GFL) GFM3-GFL2
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
60.4
60.2
60.0
59.8
59.6
59.4
59.2
59.0
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

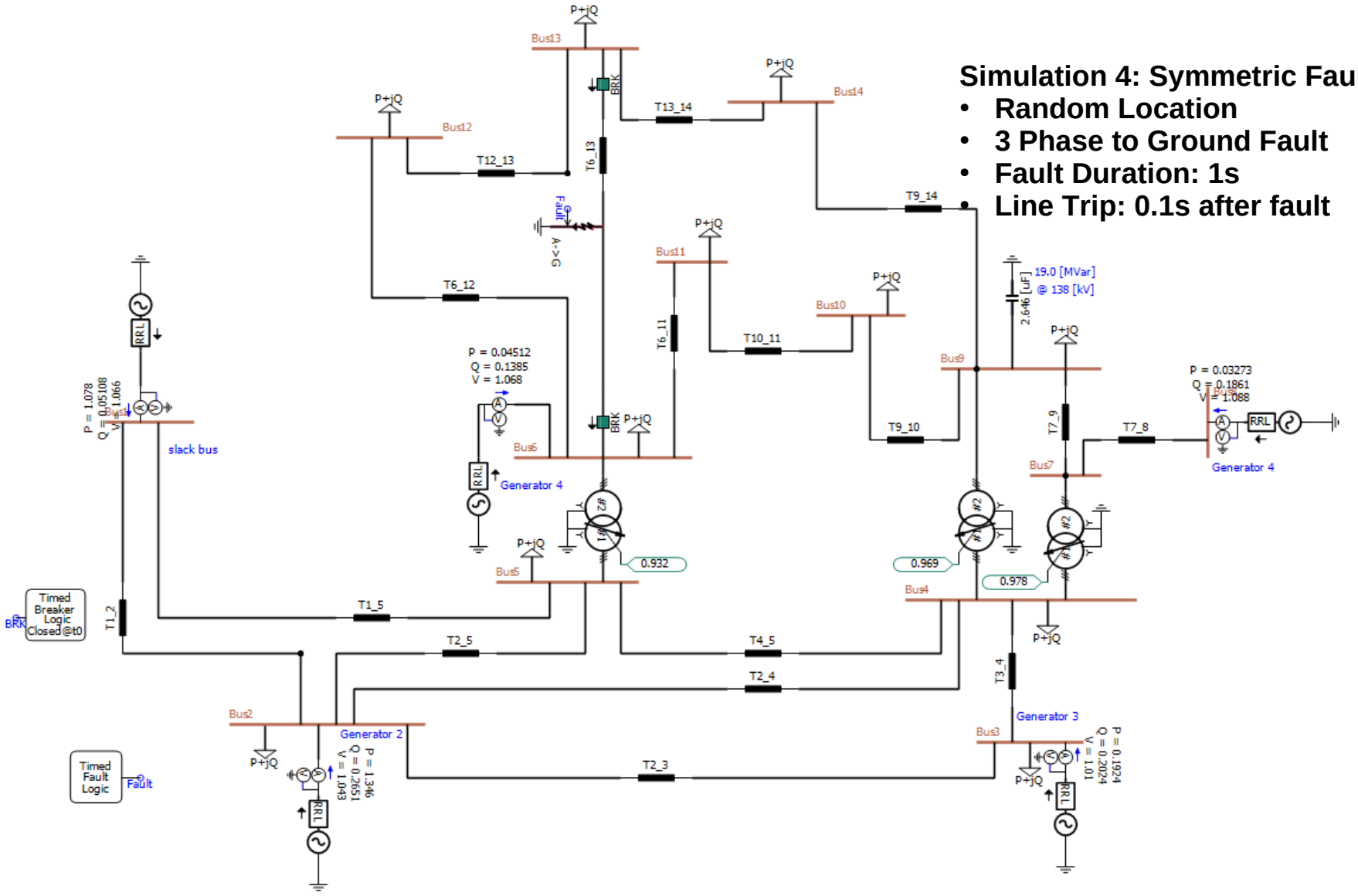

Fault (Next to GFL) GFM4-GFL1
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
60.4
60.2
60.0
59.8
59.6
59.4
59.2
59.0
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

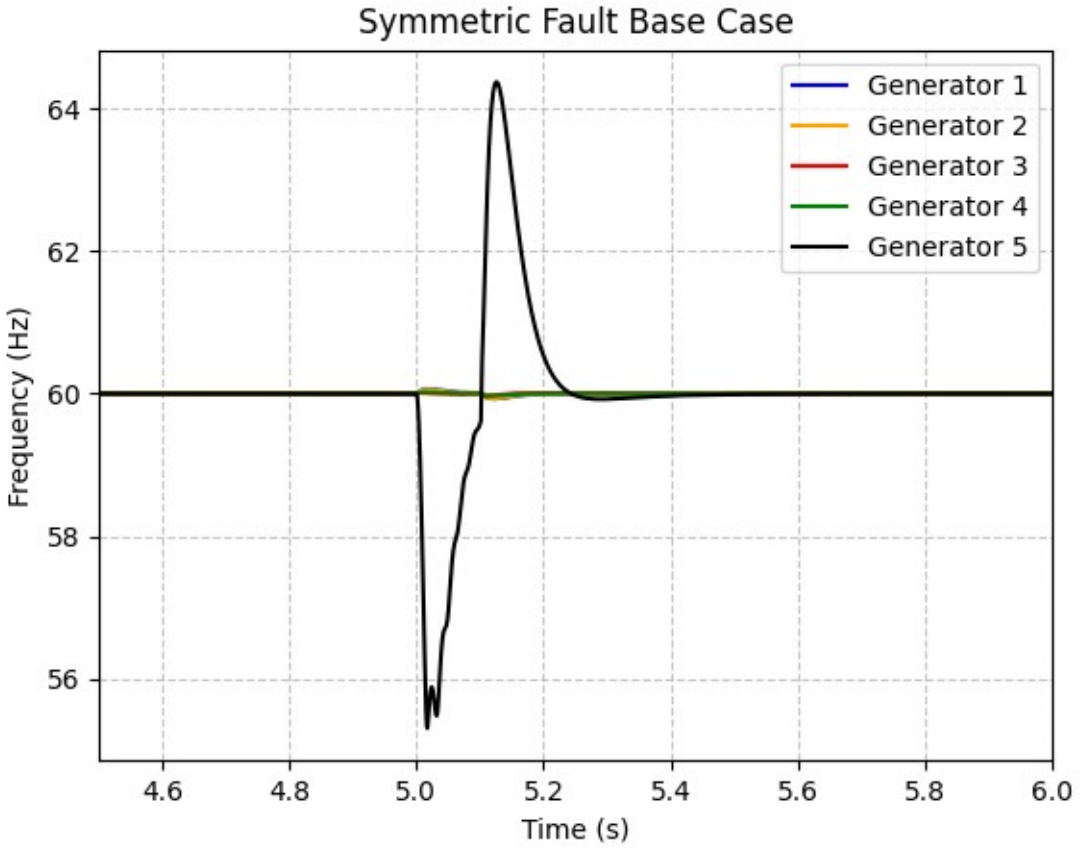

Fault Worst f_nadirs
f_nadir (Hz)
59.5
59.4
59.3
59.2
59.1
59.0
Base Case
GFM5-GFL0
GFM4-GFL1
GFM3-GFL2
GFM2-GFL3
GFM1-GFL4
N-GFM2-GFL3
N-GFM3-GFL2
N-GFM4-GFL1
Simulation Types

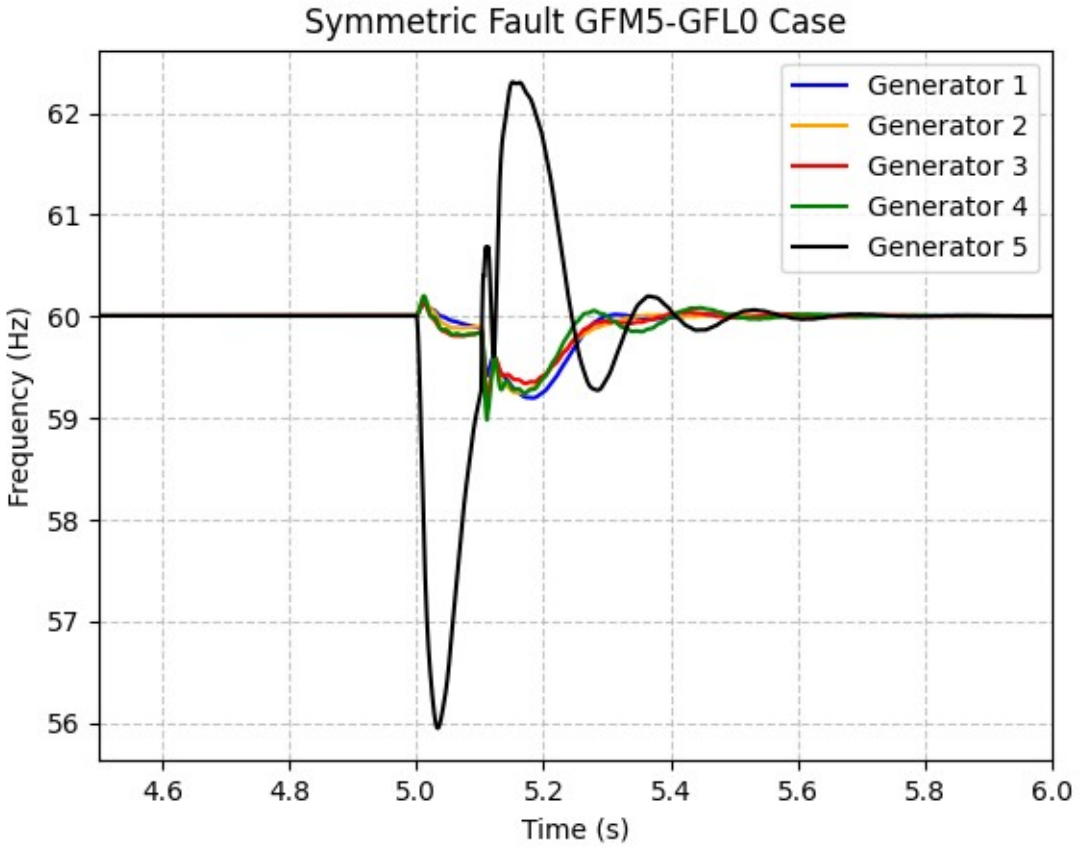

Fault Worst Deltas
f_delta
1.0
0.9
0.8
0.7
0.6
0.5
Base Case
GFM5-GFL0
GFM4-GFL1
GFM3-GFL2
GFM2-GFL3
GFM1-GFL4
N-GFM2-GFL3
N-GFM3-GFL2
N-GFM4-GFL1
Simulation Types

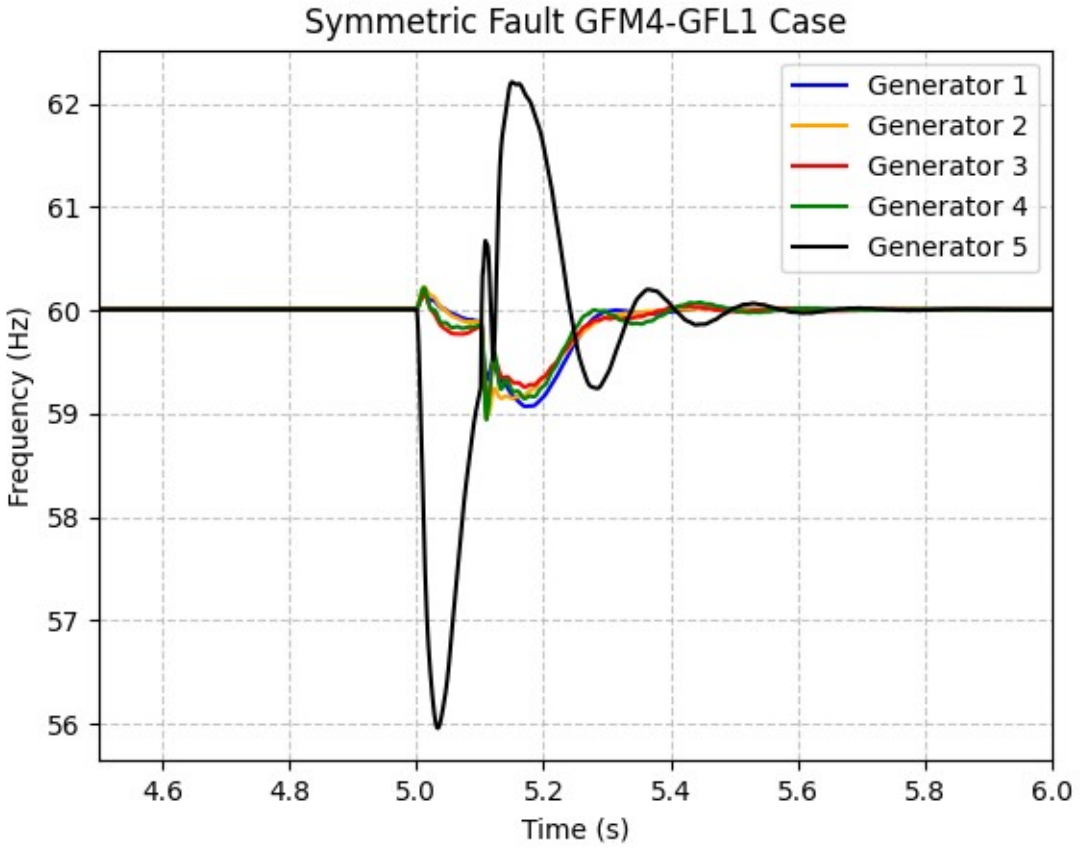

Fault Worst RoCoFs
RoCoF Value
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
Base Case
GFM5-GFL0
GFM4-GFL1
GFM3-GFL2
GFM2-GFL3
GFM1-GFL4
N-GFM2-GFL3
N-GFM3-GFL2
N-GFM4-GFL1
Simulation Types

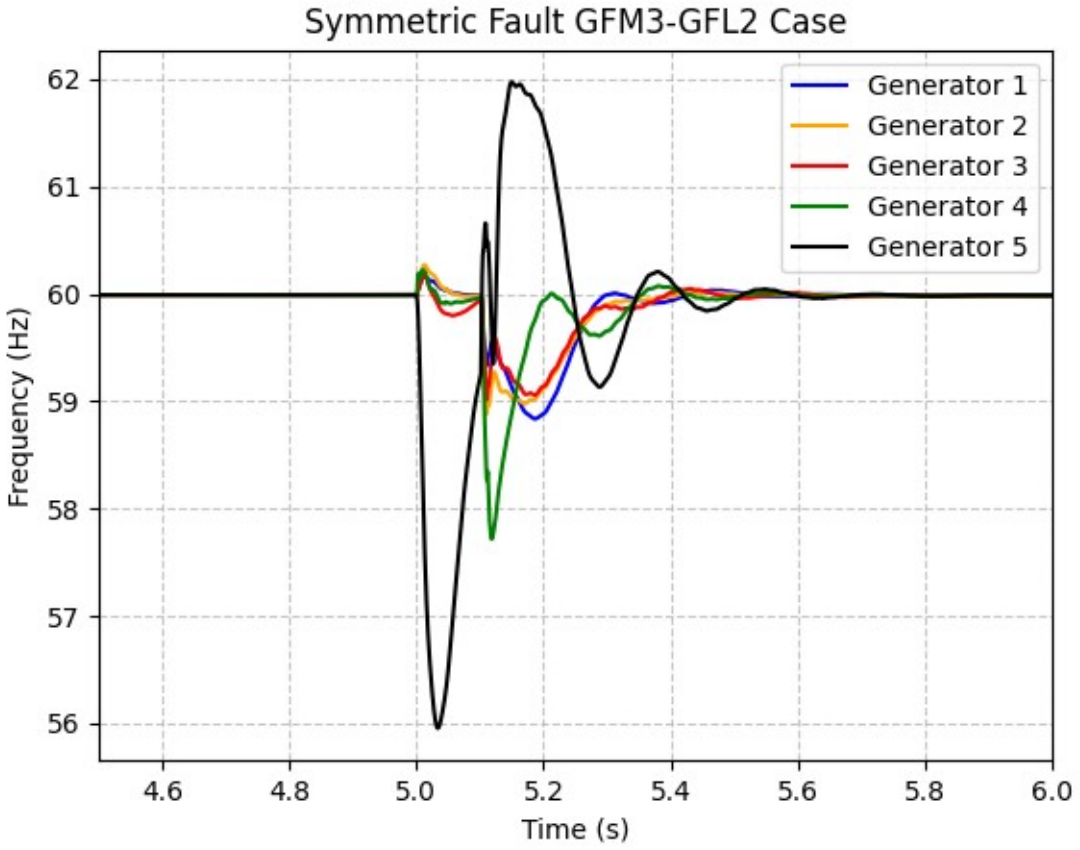
Simple Fault	Worst F_nadir	Worst Delta	Worst RoCoF
Base Case	59.5656	0.4344	4.1486
GFM5-GFL0	59.3261	0.6807	4.4590
GFM4-GFL1	59.2825	0.7254	4.6057
GFM3-GFL2	59.2277	0.7629	4.8348
GFM2-GFL3	59.2295	0.7780	4.9537
GFM1-GFL4	59.0038	0.9940	7.5735
N-GFM2-GFL3	58.9698	1.0431	7.4667
N-GFM3-GFL2	58.9474	1.0475	7.4611
N-GFM4-GFL1	58.9827	1.0131	7.4441

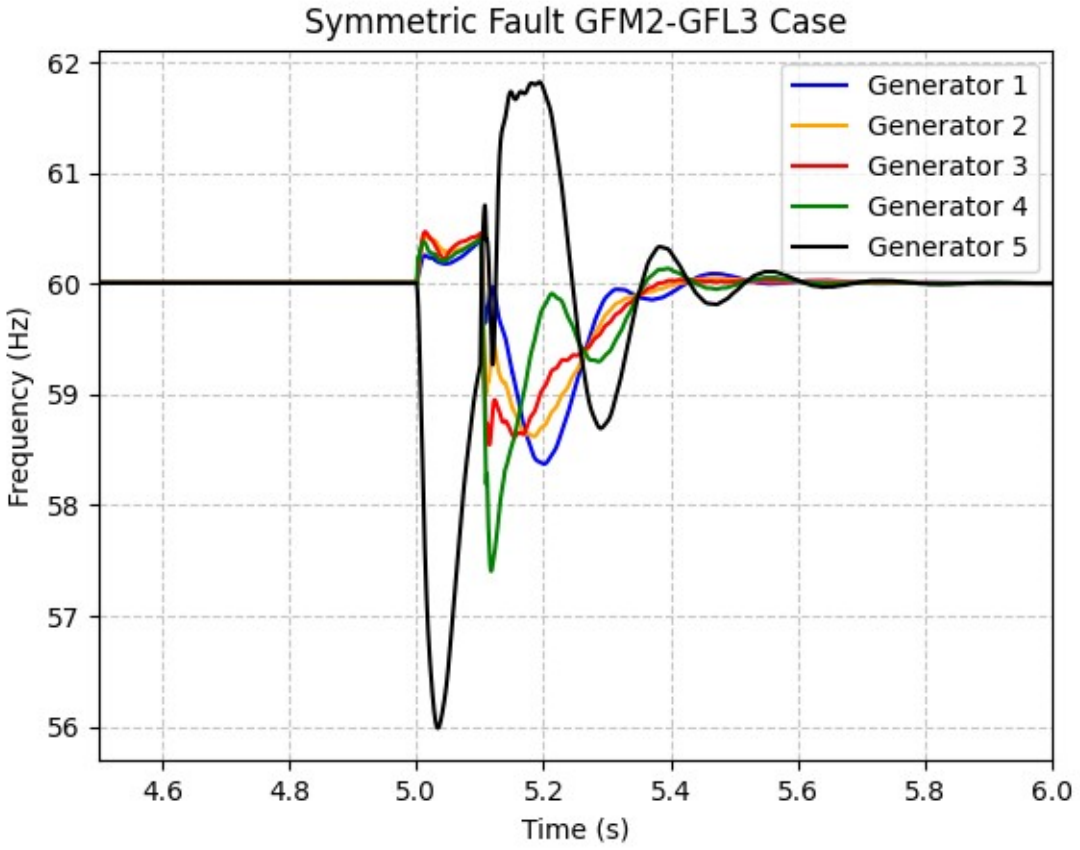

Simulation 4: Symmetric Fault:
• Random Location
• 3 Phase to Ground Fault
• Fault Duration: 1s
• Line Trip: 0.1s after fault
Bus13
Bus12
Bus14
Bus11
Bus10
Bus9
Bus8
Bus7
Bus6
Bus5
Bus4
Bus3
Bus2
Bus1
T13_14
T12_13
T6_13
T9_14
T6_12
T6_11
T10_11
T9_10
T7_9
T7_8
T1_2
T1_5
T2_5
T4_5
T2_4
T3_4
T2_3
P+jQ
BRK
Fault
A->G
RRL
slack bus
Generator 2
Generator 3
Generator 4
P = 1.078
Q = 0.05108
V = 1.066
P = 0.04512
Q = 0.1385
V = 1.068
P = 1.346
Q = 0.2651
V = 1.043
P = 0.1924
Q = 0.2024
V = 1.01
P = 0.03273
Q = 0.1861
V = 1.088
19.0 [MVar]
@ 138 [kV]
2.646 [uF]
0.932
0.969
0.978
Timed Breaker Logic Closed@t0
Timed Fault Logic

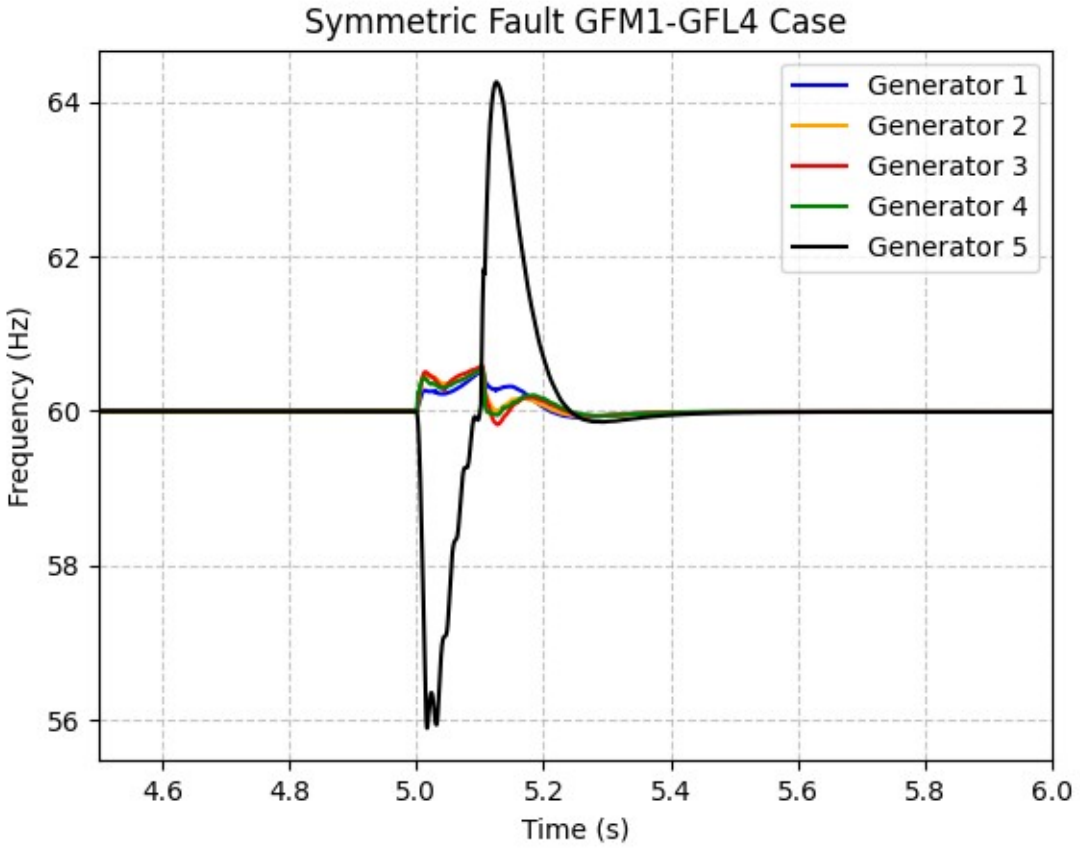

Symmetric Fault Base Case
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
64
62
60
58
56
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

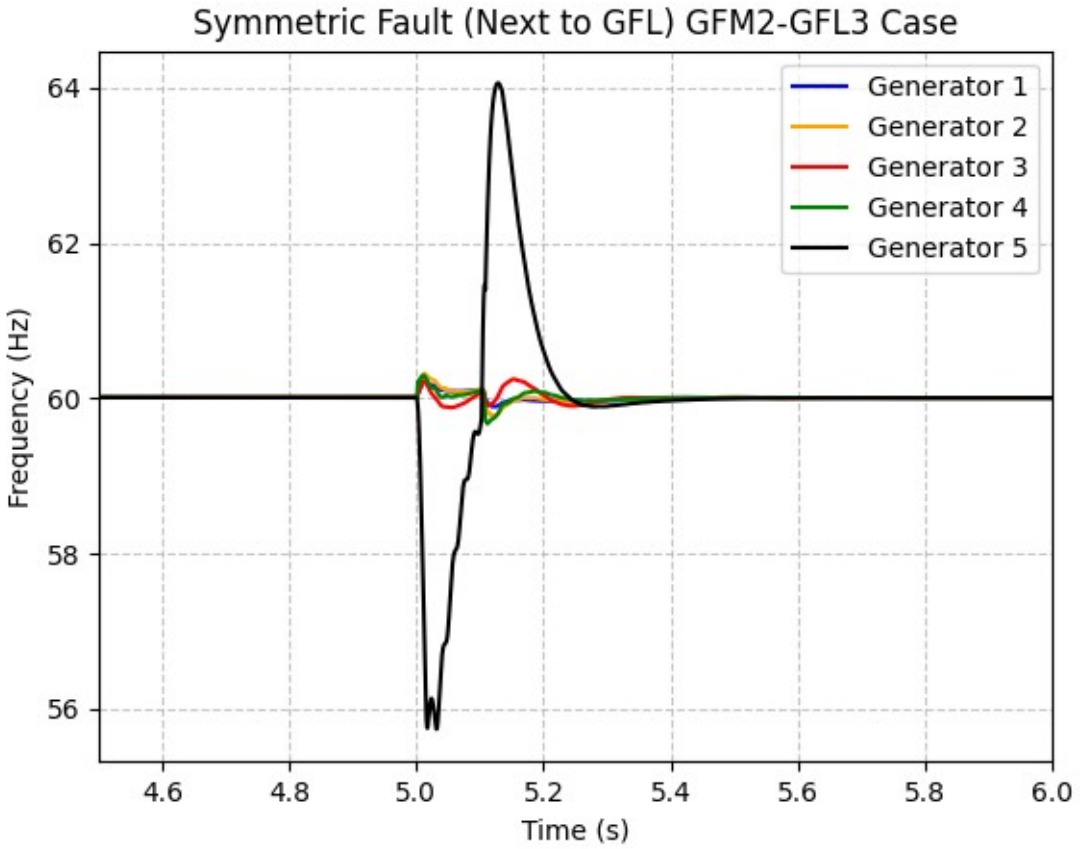

Symmetric Fault GFM5-GFL0 Case
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
62
61
60
59
58
57
56
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

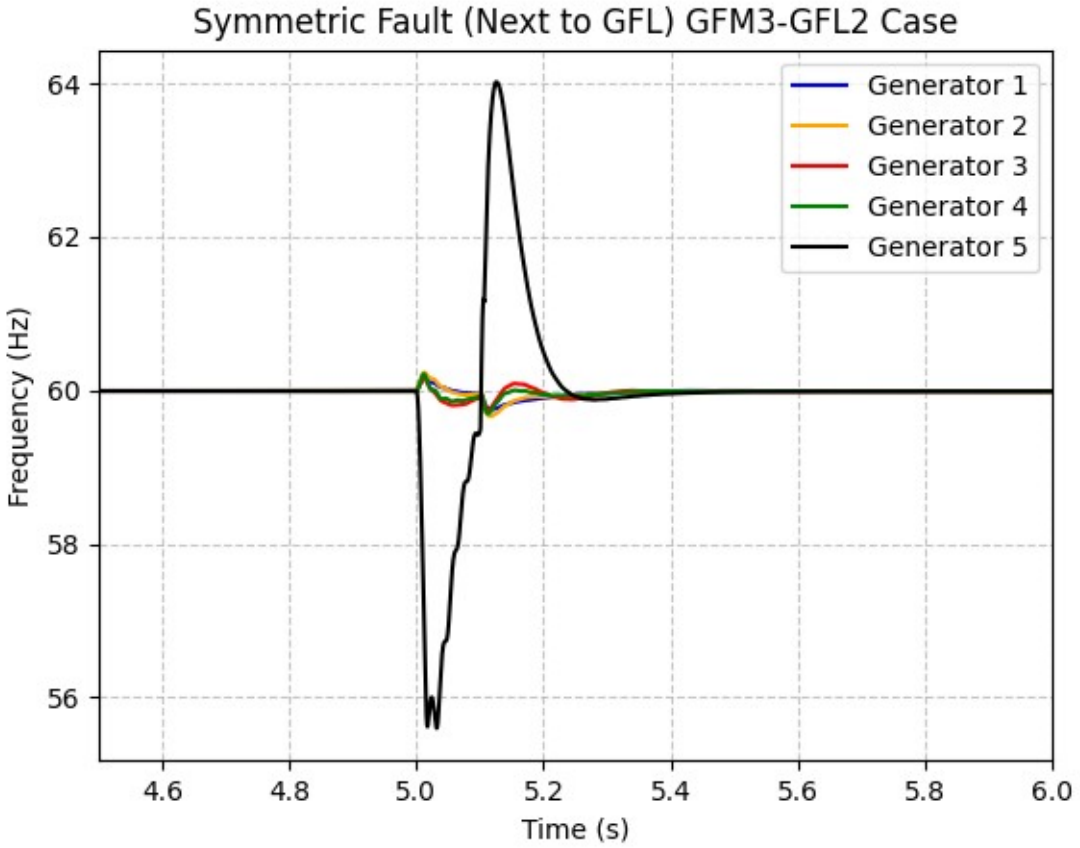

Symmetric Fault GFM4-GFL1 Case
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
62
61
60
59
58
57
56
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

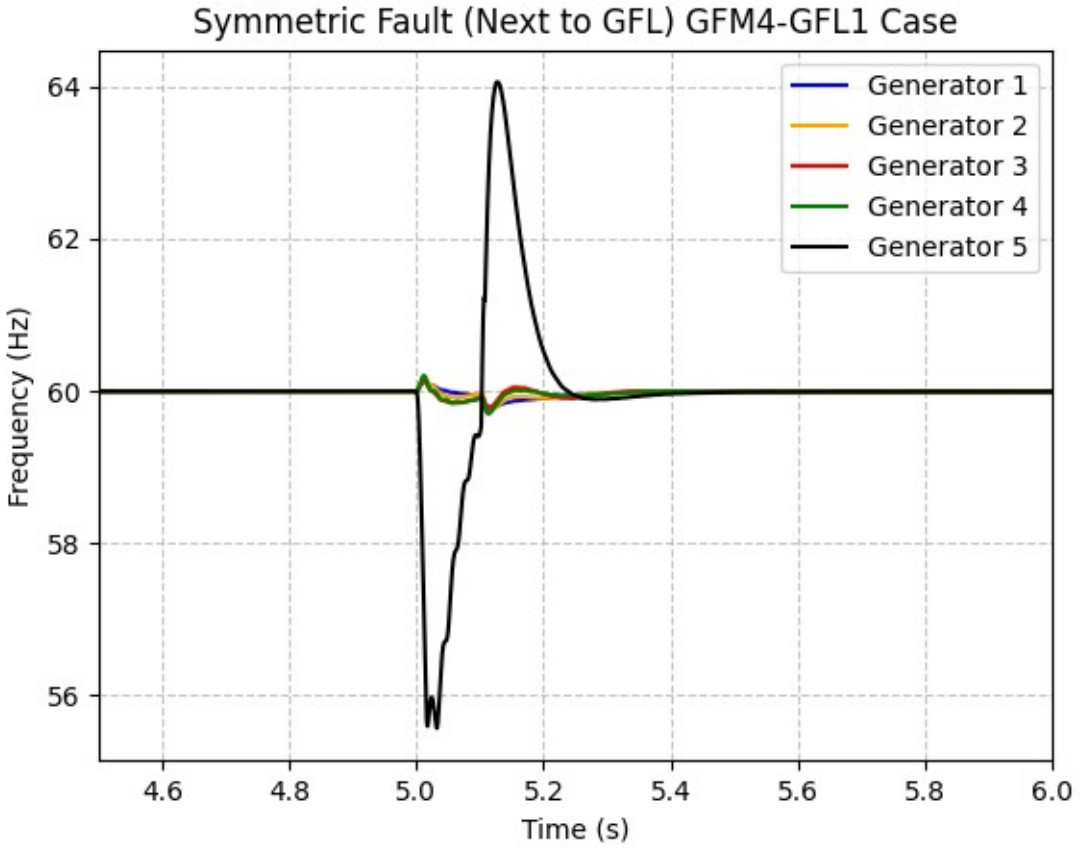

Symmetric Fault GFM3-GFL2 Case
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
62
61
60
59
58
57
56
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

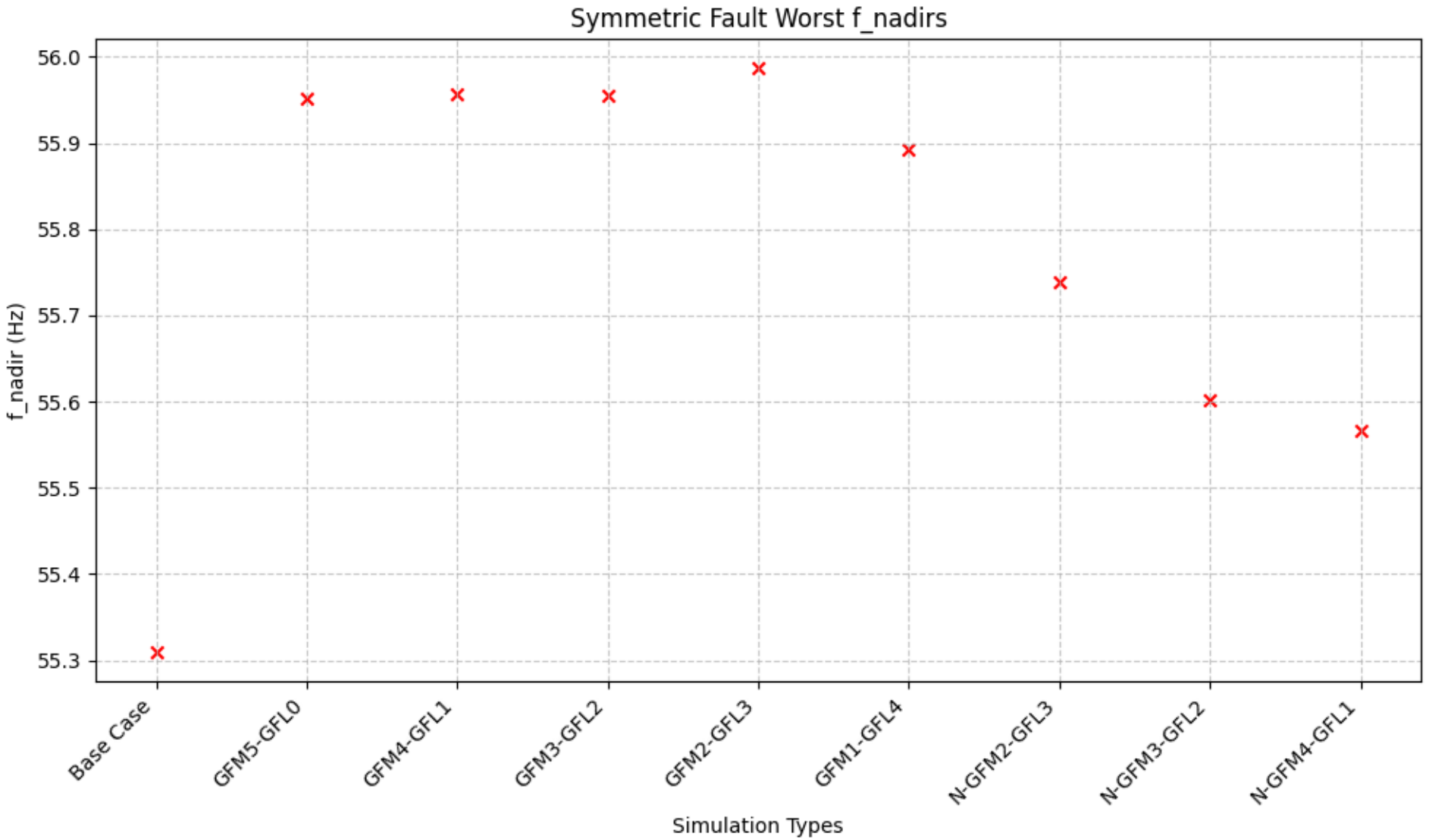

Symmetric Fault GFM2-GFL3 Case
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
Time (s)
62
61
60
59
58
57
56
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0

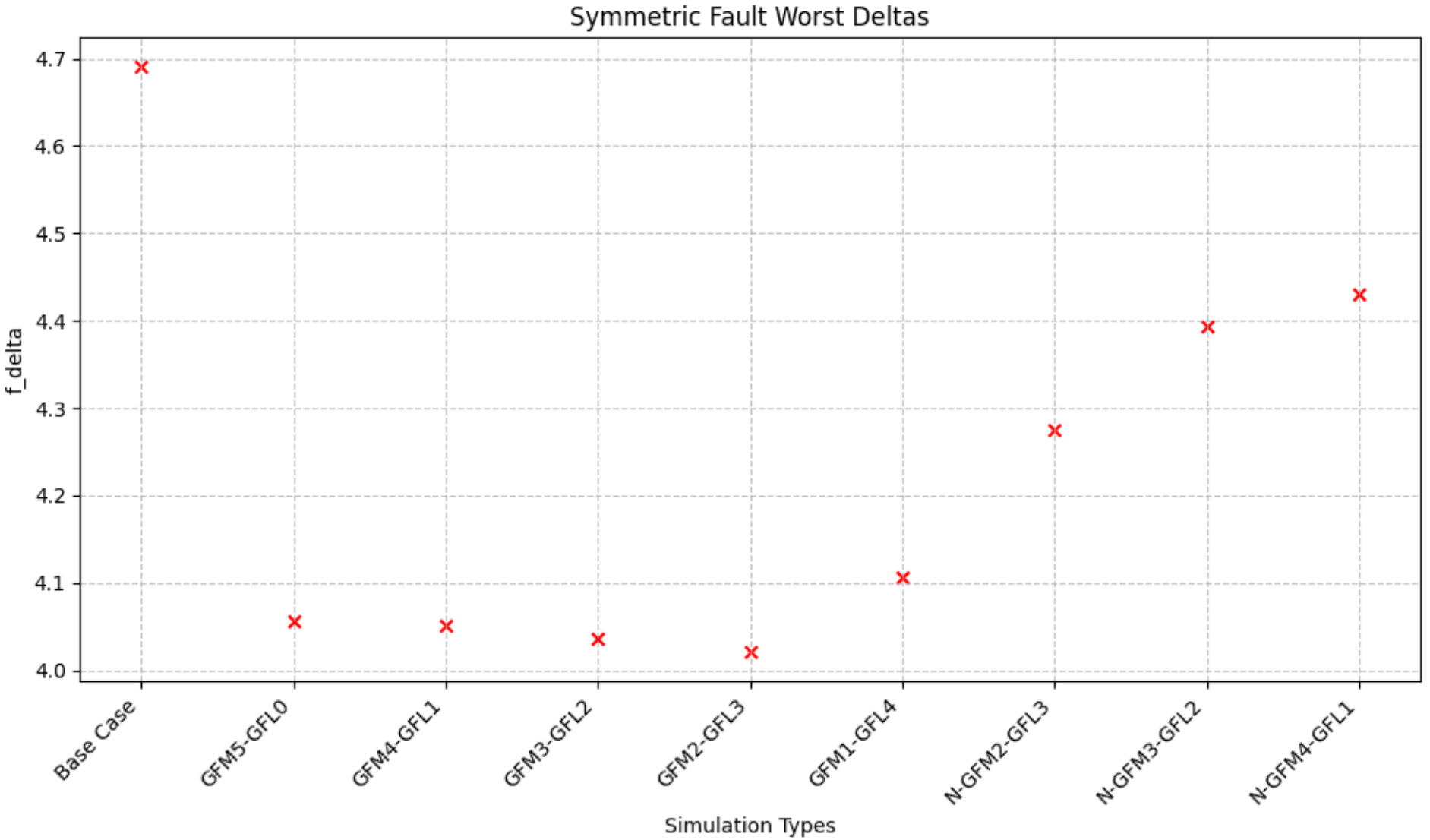

Symmetric Fault GFM1-GFL4 Case
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
64
62
60
58
56
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

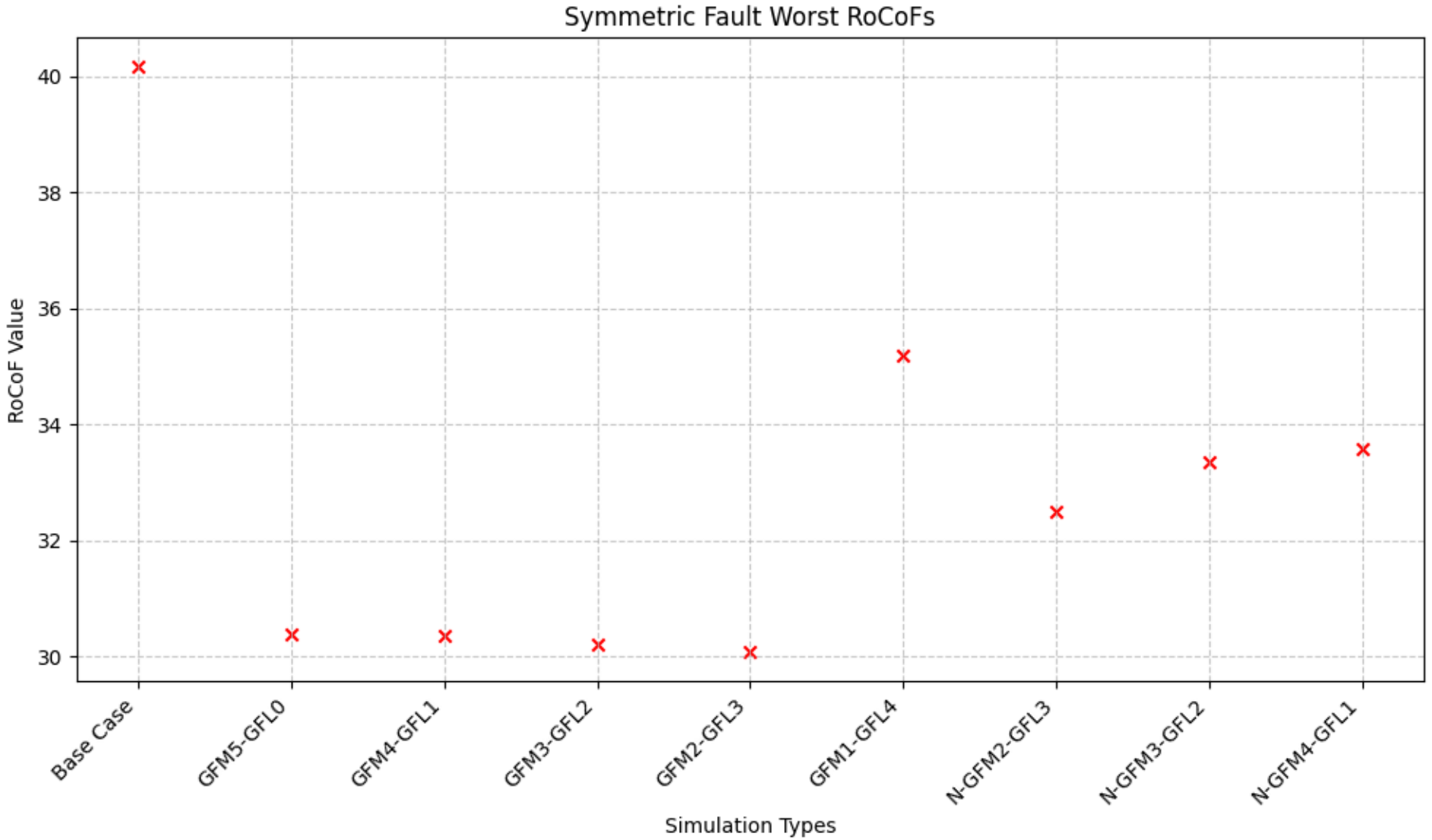

Symmetric Fault (Next to GFL) GFM2-GFL3 Case
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
64
62
60
58
56
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)


Symmetric Fault (Next to GFL) GFM3-GFL2 Case
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
64
62
60
58
56
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

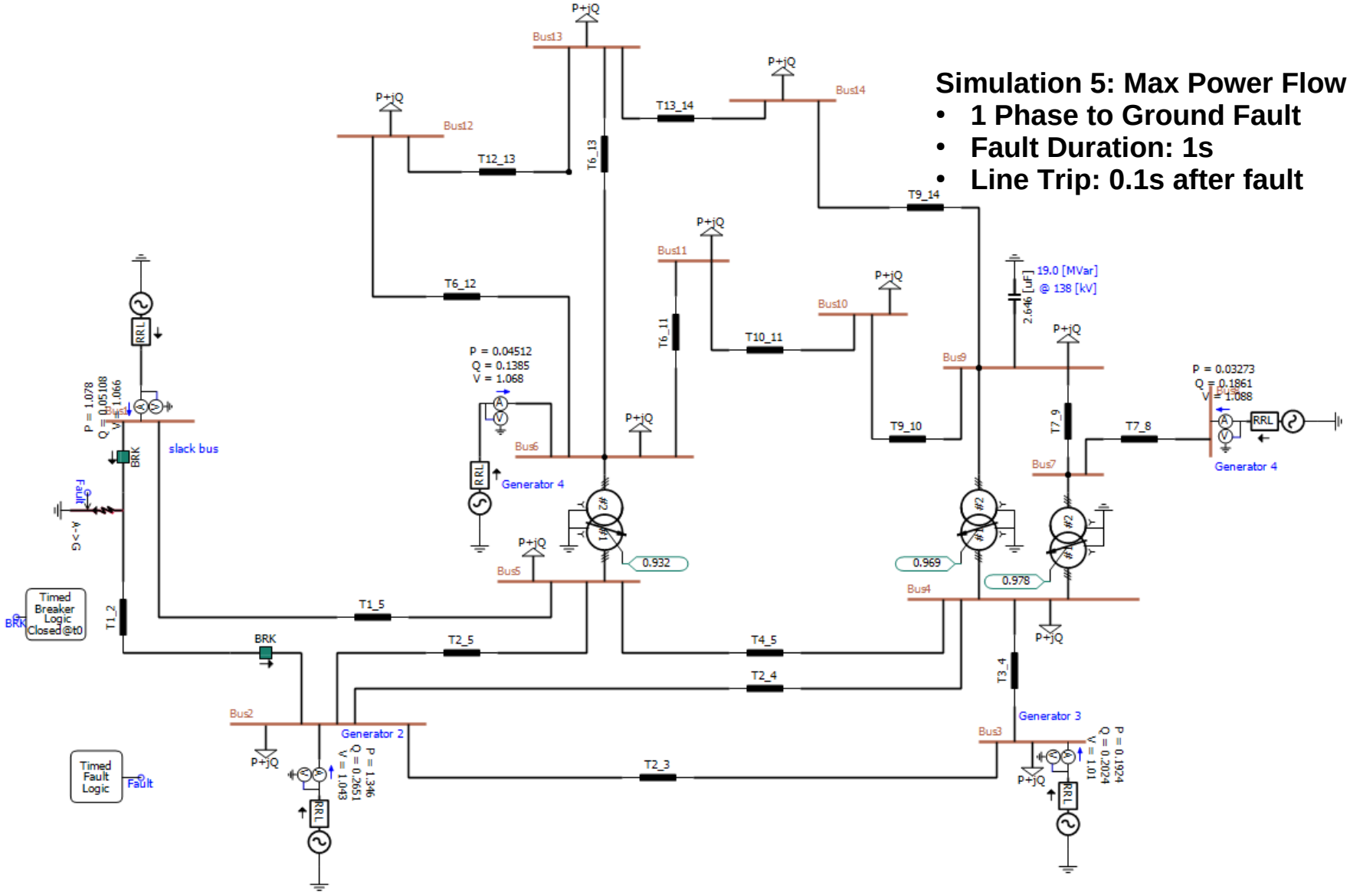

Symmetric Fault (Next to GFL) GFM4-GFL1 Case
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
64
62
60
58
56
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)


Symmetric Fault Worst f_nadirs
f_nadir (Hz)
56.0
55.9
55.8
55.7
55.6
55.5
55.4
55.3
Base Case
GFM5-GFL0
GFM4-GFL1
GFM3-GFL2
GFM2-GFL3
GFM1-GFL4
N-GFM2-GFL3
N-GFM3-GFL2
N-GFM4-GFL1
Simulation Types

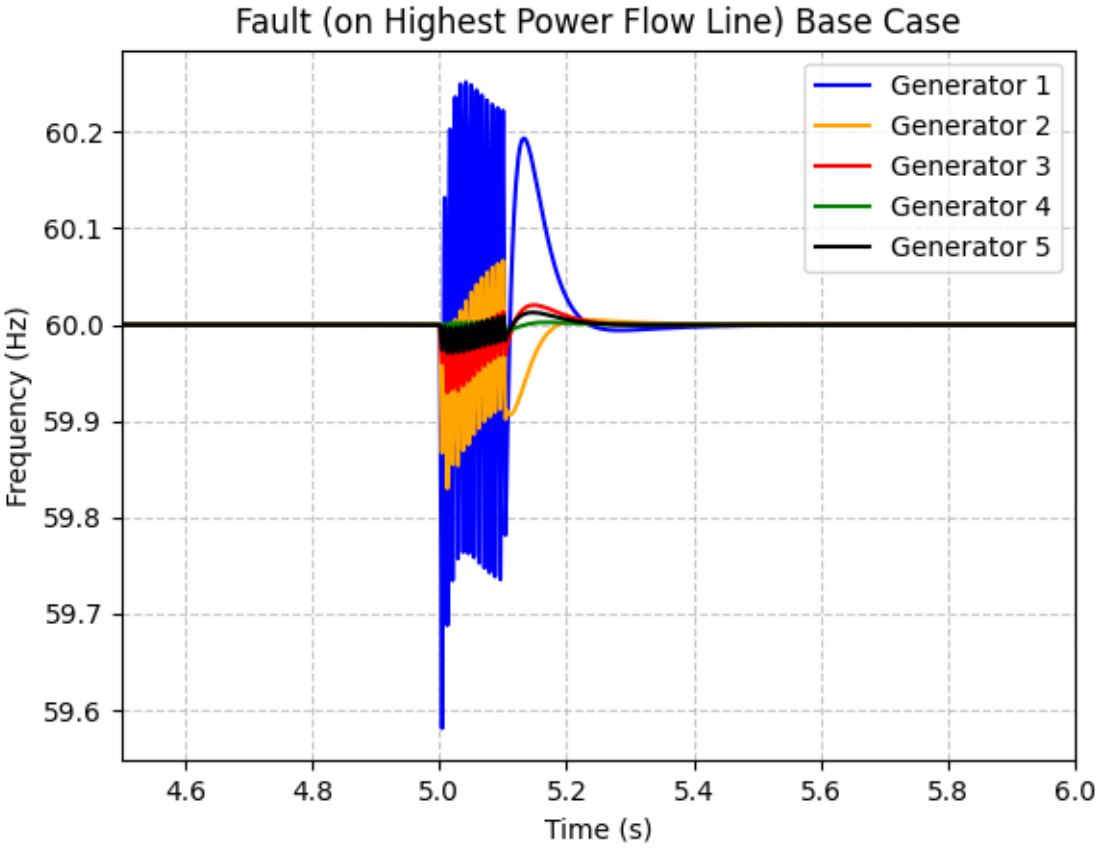

Symmetric Fault Worst Deltas
f_delta
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4.0
Base Case
GFM5-GFL0
GFM4-GFL1
GFM3-GFL2
GFM2-GFL3
GFM1-GFL4
N-GFM2-GFL3
N-GFM3-GFL2
N-GFM4-GFL1
Simulation Types

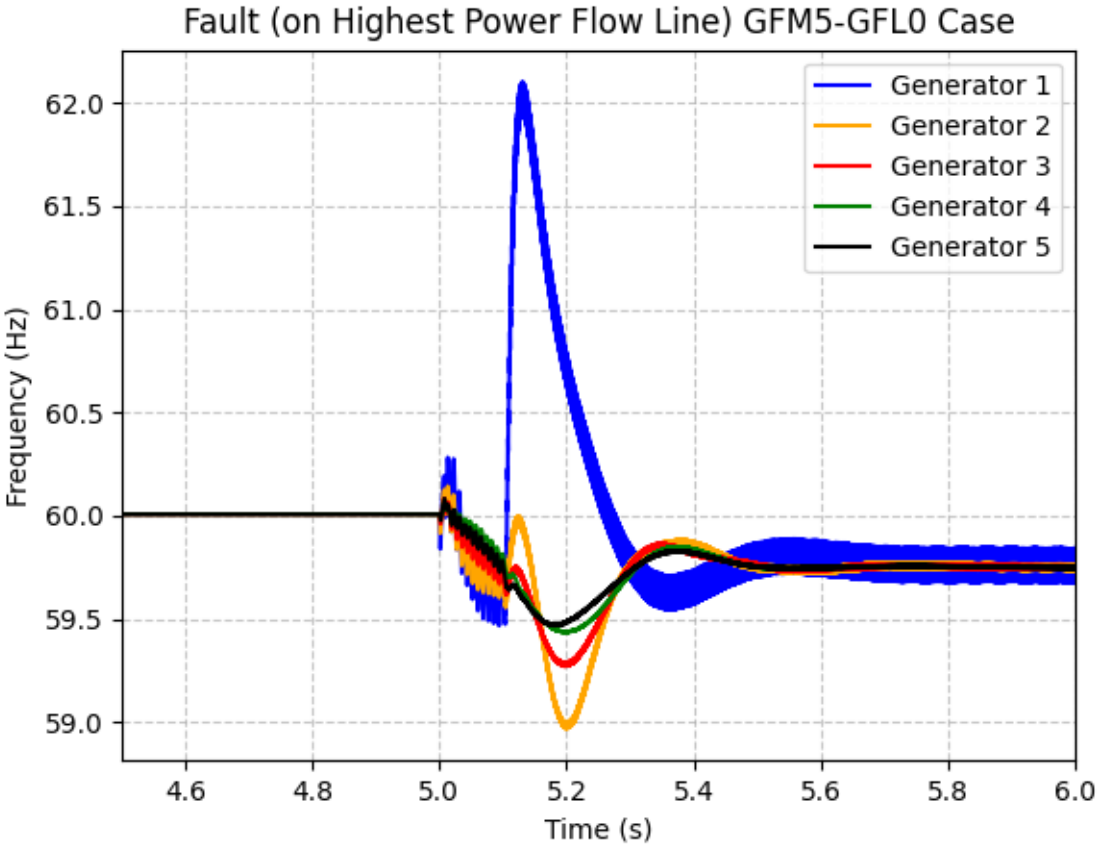

Symmetric Fault Worst RoCoFs
RoCoF Value
40
38
36
34
32
30
Base Case
GFM5-GFL0
GFM4-GFL1
GFM3-GFL2
GFM2-GFL3
GFM1-GFL4
N-GFM2-GFL3
N-GFM3-GFL2
N-GFM4-GFL1
Simulation Types

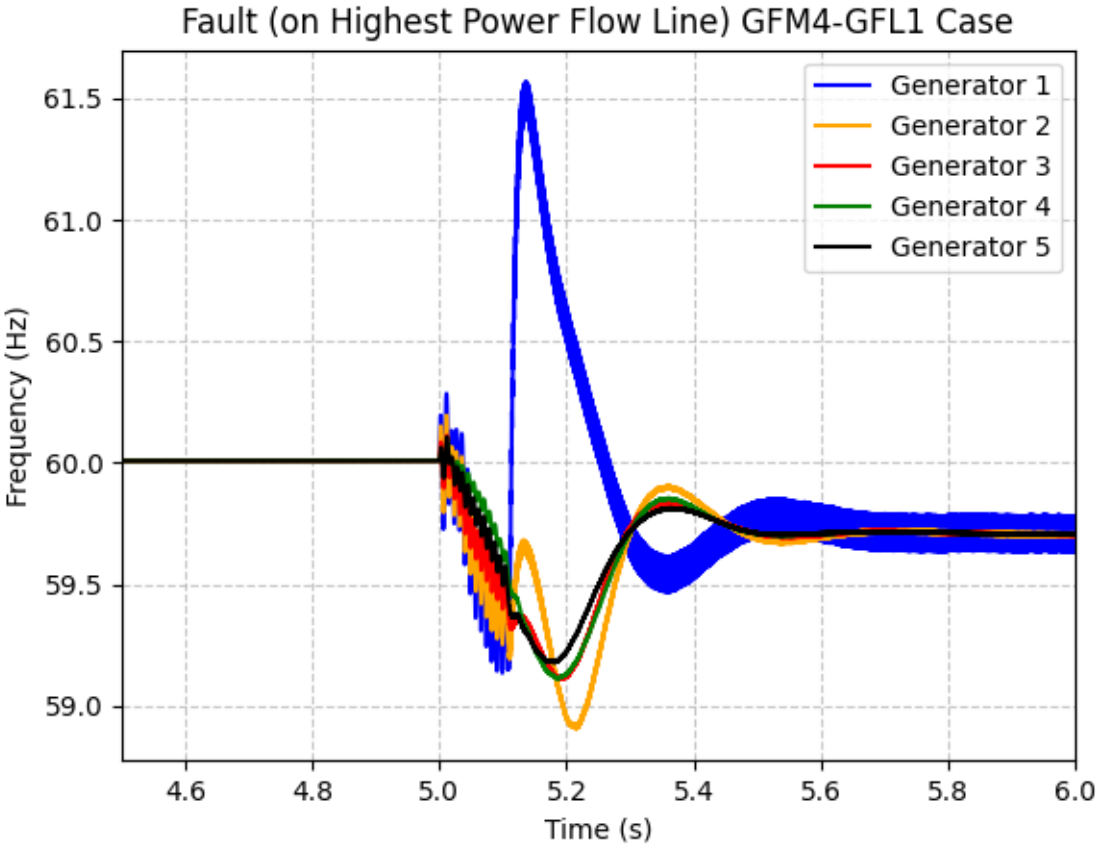
Symmetric Fault	Worst F_nadir	Worst Delta	Worst RoCoF
Base Case	55.3096	4.6904	40.1579
GFM5-GFL0	55.9510	4.0558	30.3920
GFM4-GFL1	55.9561	4.0518	30.3504
GFM3-GFL2	55.9545	4.0361	30.2105
GFM2-GFL3	55.9874	4.0211	30.0867
GFM1-GFL4	55.8919	4.1059	35.1988
N-GFM2-GFL3	55.7380	4.2749	32.4961
N-GFM3-GFL2	55.6009	4.3940	33.3510
N-GFM4-GFL1	55.5657	4.4302	33.5873

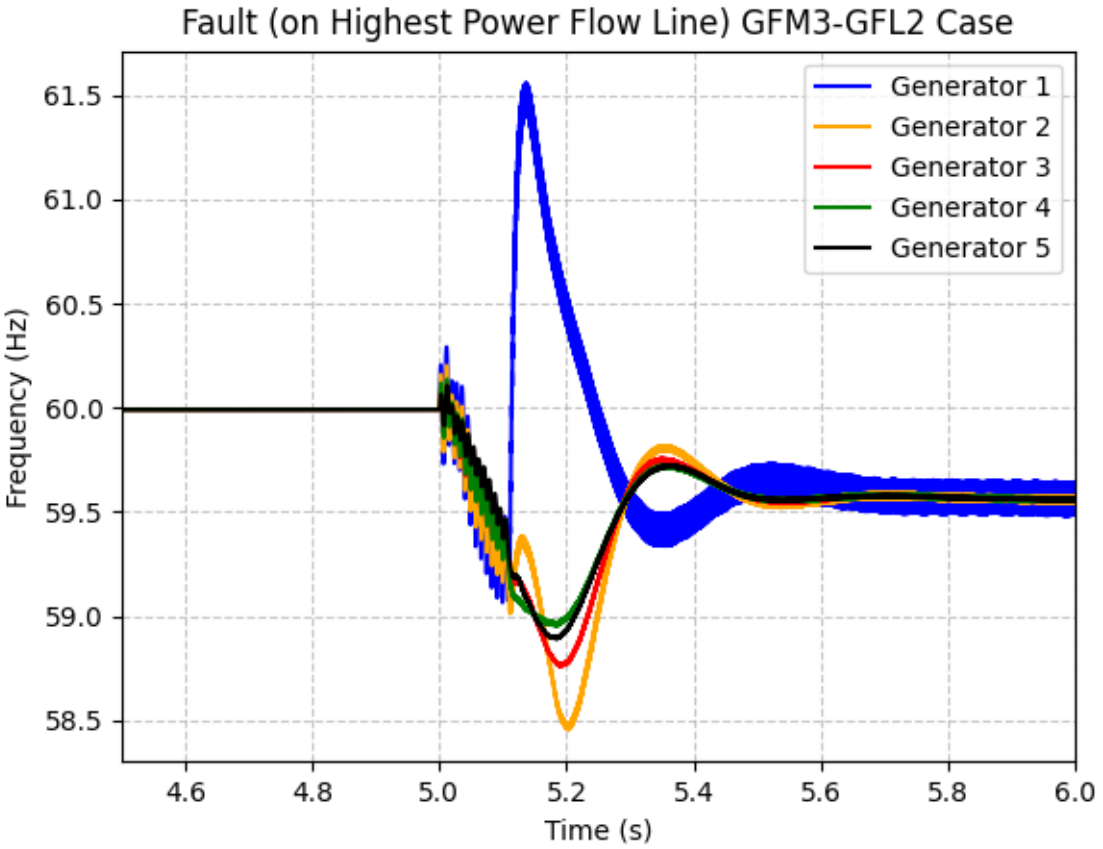

Simulation 5: Max Power Flow Fault
• 1 Phase to Ground Fault
• Fault Duration: 1s
• Line Trip: 0.1s after fault
Bus13
Bus14
Bus12
Bus11
Bus10
Bus9
Bus7
Bus6
Bus5
Bus4
Bus2
Bus3
T13_14
T12_13
T6_13
T9_14
T6_12
T6_11
T10_11
T9_10
T7_9
T7_8
T1_2
T1_5
T2_5
T4_5
T2_4
T3_4
T2_3
P+jQ
19.0 [MVar]
@ 138 [kV]
2.646 [uF]
P = 0.04512
Q = 0.1385
V = 1.068
P = 0.03273
Q = 0.1861
V = 1.088
P = 1.078
Q = 0.05108
V = 1.066
slack bus
Generator 4
Generator 2
Generator 3
0.932
0.969
0.978
BRK
Fault
A->G
Timed Breaker Logic Closed@t0
Timed Fault Logic
P = 1.346
Q = 0.2651
V = 1.043
P = 0.1924
Q = 0.2024
V = 1.01

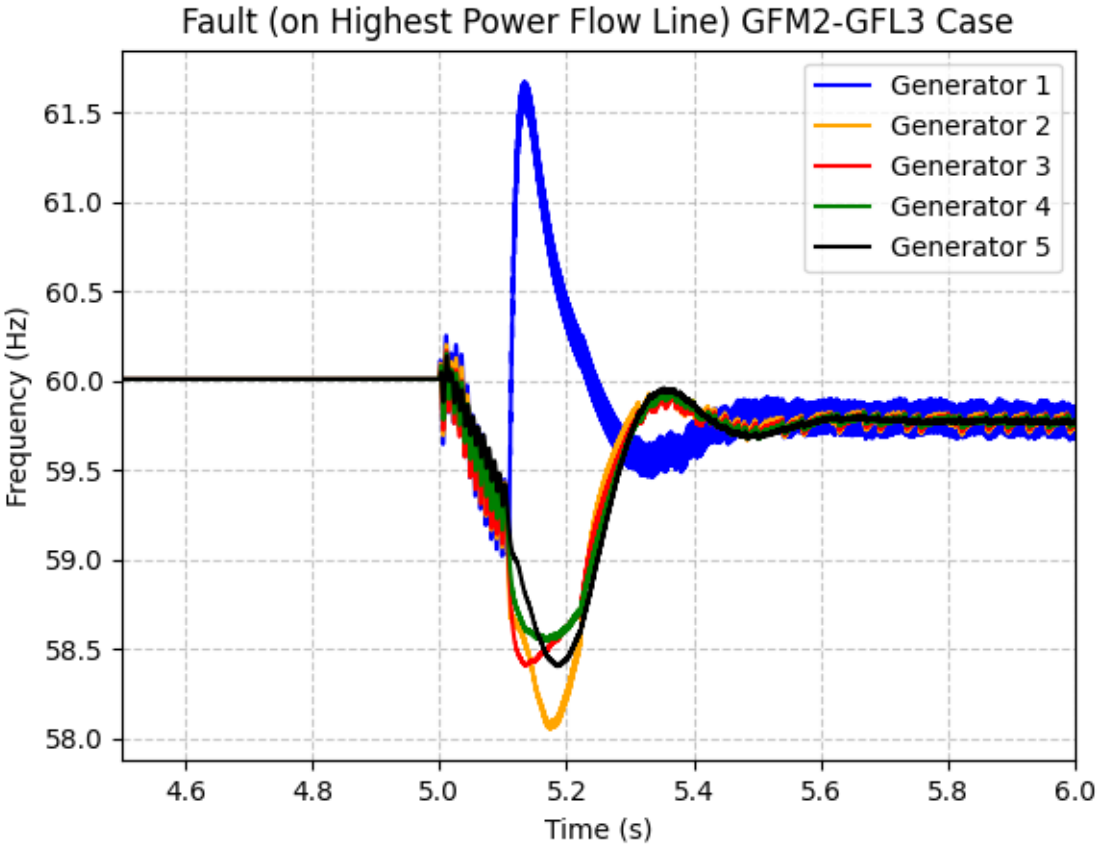
Fault at Highest Power Flow (Next GFM)	Base Case	GFM5-GFL0	GFM4-GFL1	GFM3-GFL2	GFM2-GFL3	GFM1-GFL4
Generator 1	Ideal	GFM	GFM	GFM	GFM	GFM
Generator 2	Ideal	GFM	GFL	GFL	GFL	GFL
Generator 3	Ideal	GFM	GFM	GFM	GFL	GFL
Generator 4	Ideal	GFM	GFM	GFL	GFL	GFL
Generator 5	Ideal	GFM	GFM	GFM	GFM	GFL

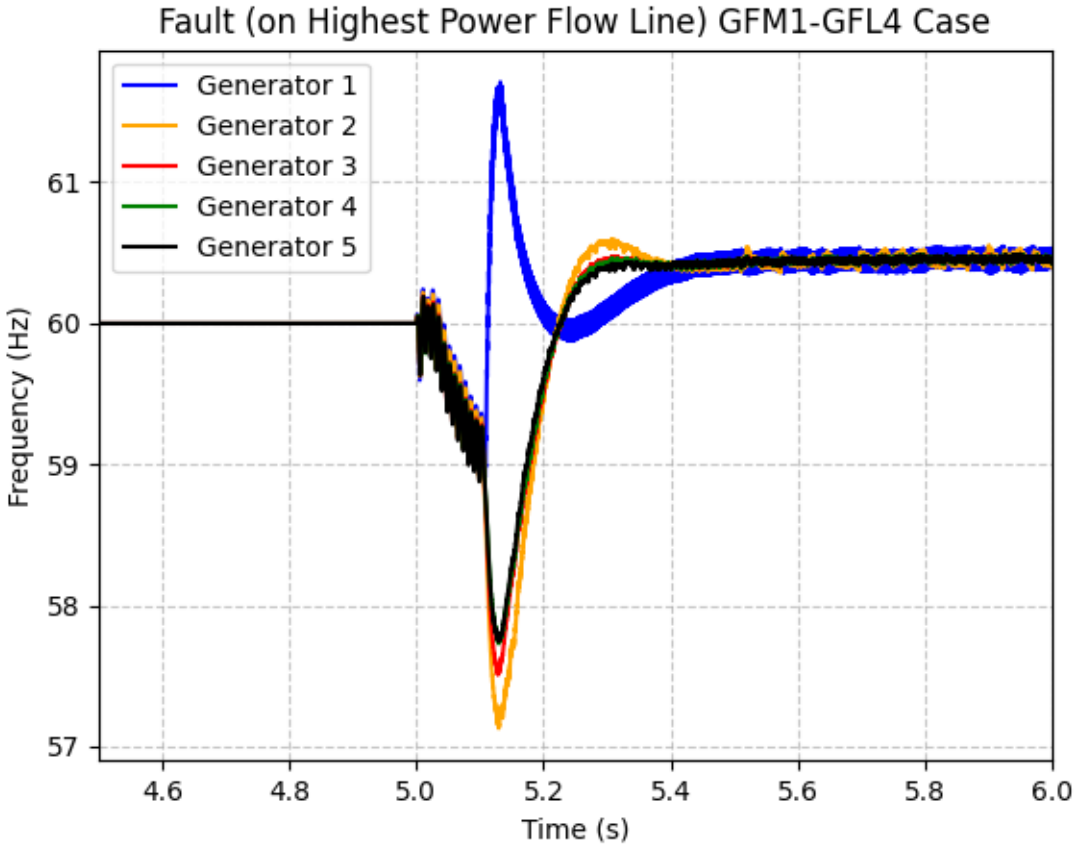

Fault (on Highest Power Flow Line) Base Case
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
60.2
60.1
60.0
59.9
59.8
59.7
59.6
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

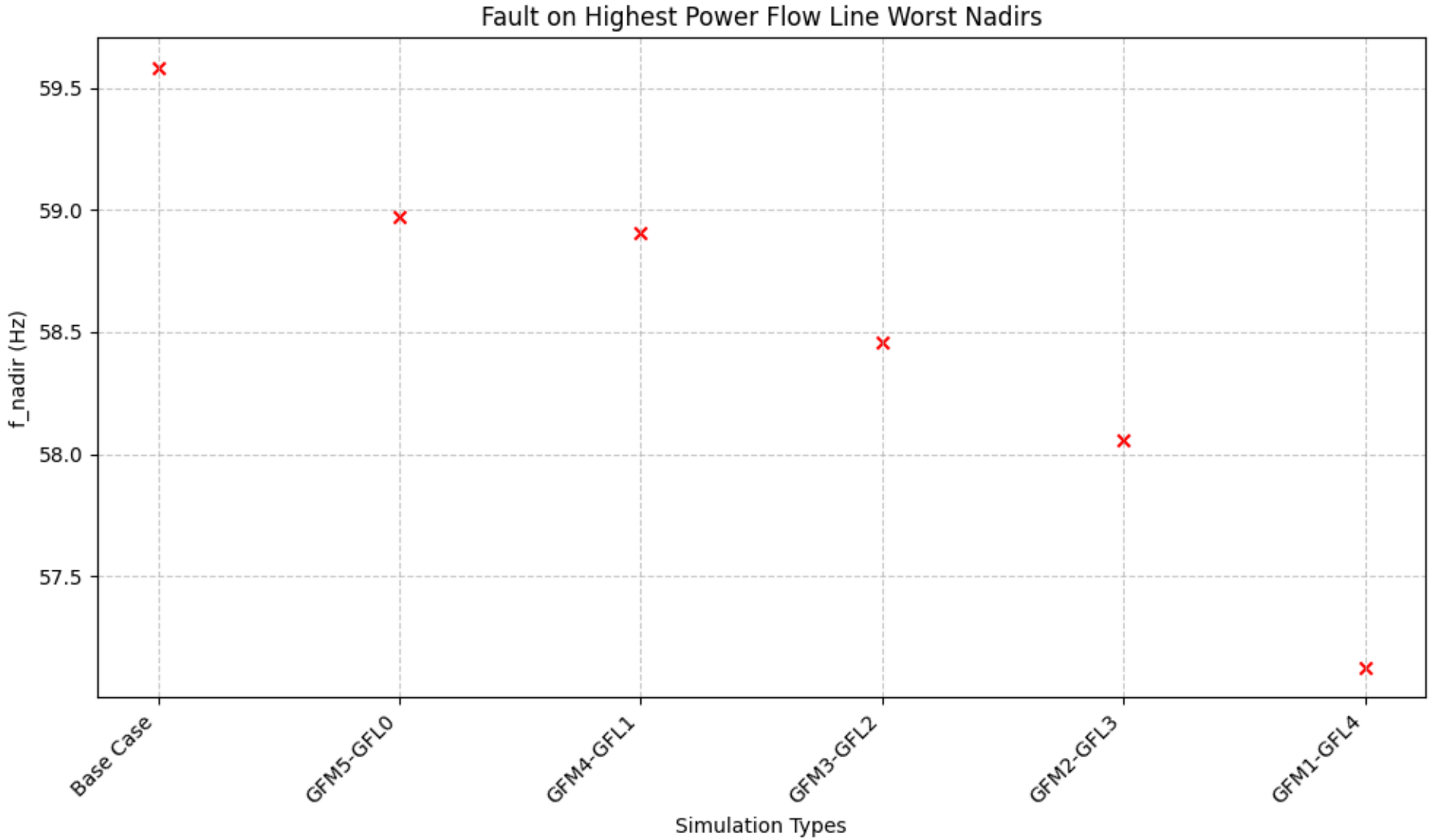

Fault (on Highest Power Flow Line) GFM5-GFL0 Case
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
62.0
61.5
61.0
60.5
60.0
59.5
59.0
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

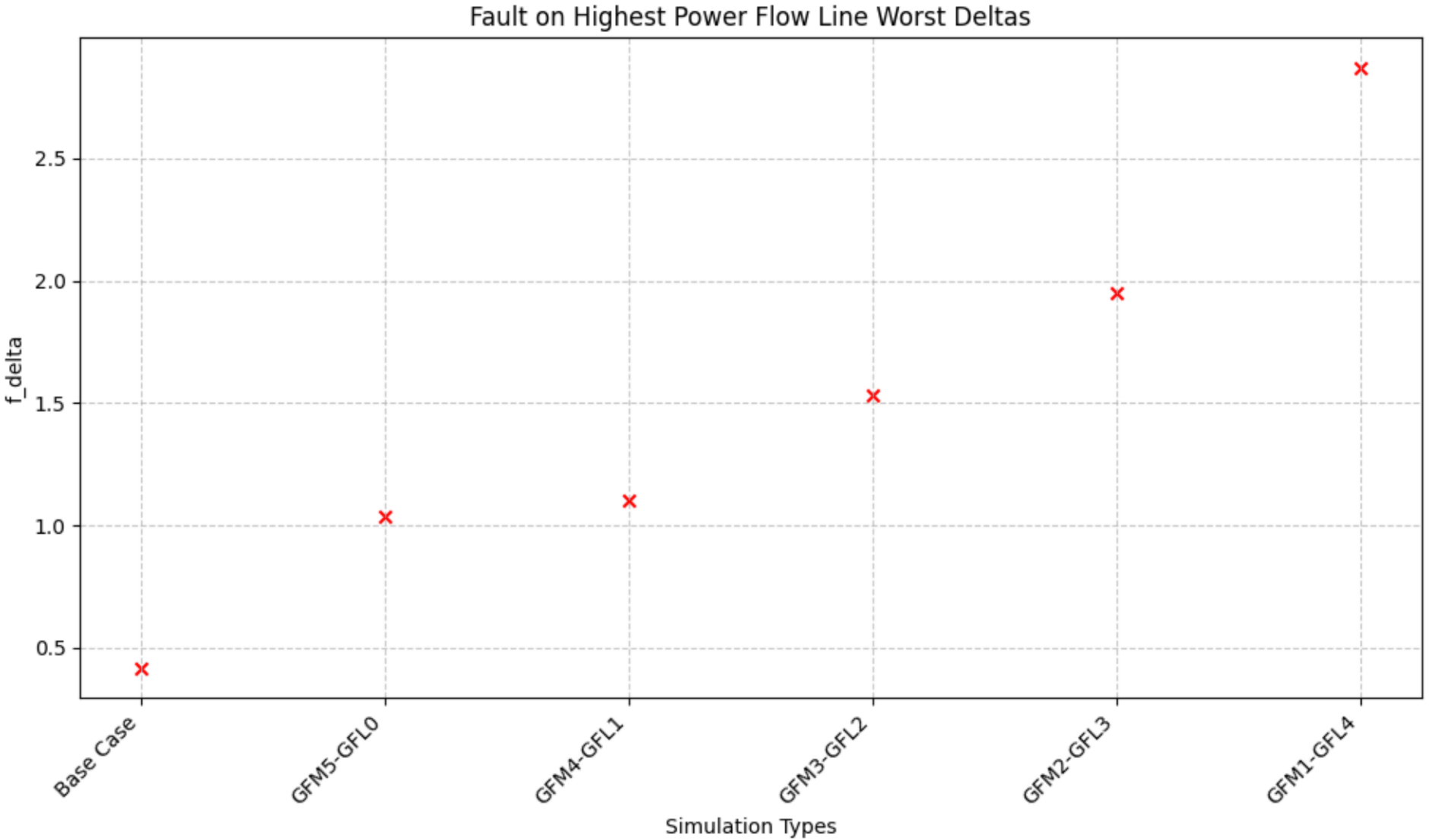

Fault (on Highest Power Flow Line) GFM4-GFL1 Case
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
61.5
61.0
60.5
60.0
59.5
59.0
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)

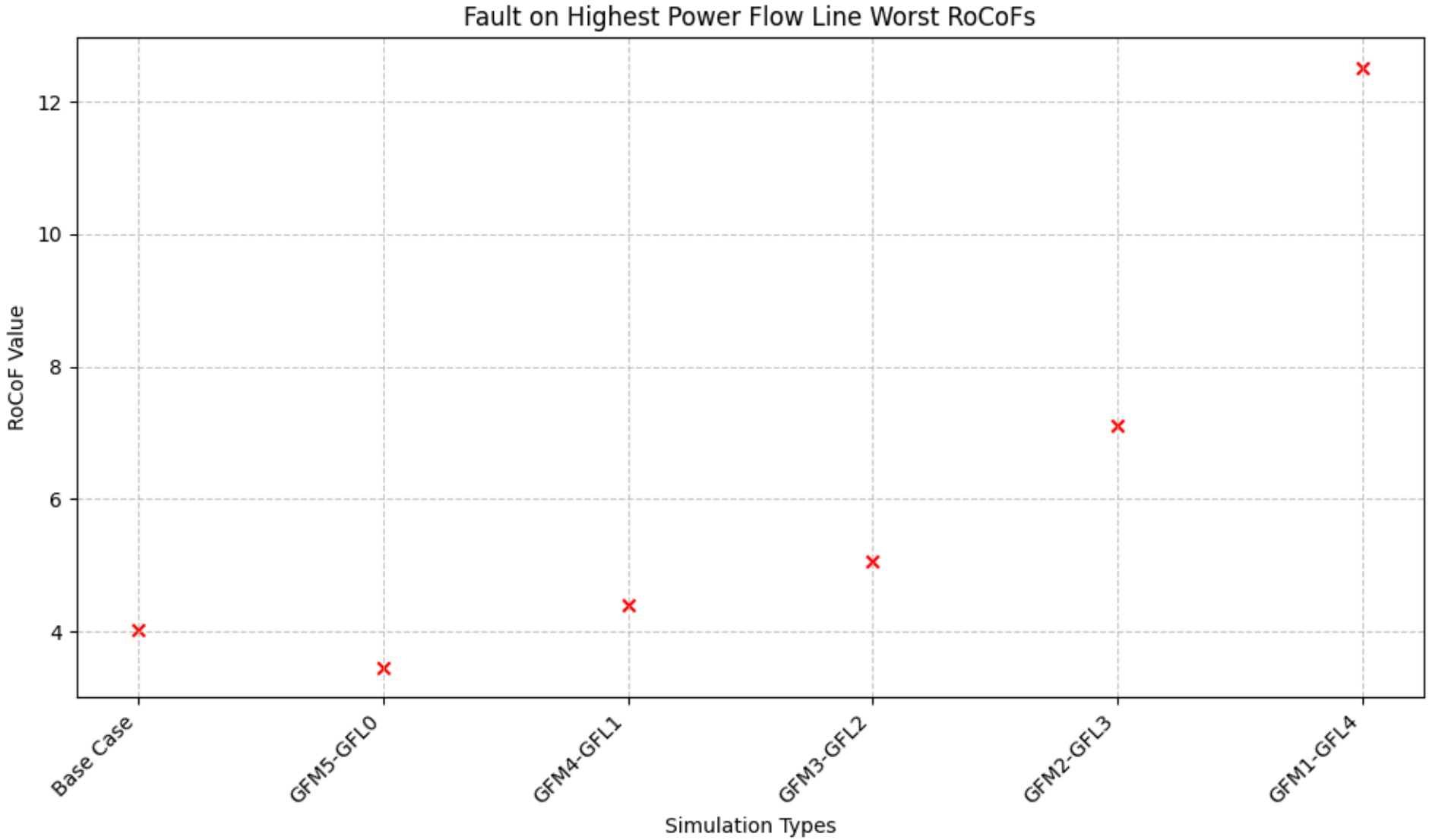

Fault (on Highest Power Flow Line) GFM3-GFL2 Case
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
61.5
61.0
60.5
60.0
59.5
59.0
58.5
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)


Fault (on Highest Power Flow Line) GFM2-GFL3 Case
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
61.5
61.0
60.5
60.0
59.5
59.0
58.5
58.0
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)


Fault (on Highest Power Flow Line) GFM1-GFL4 Case
Generator 1
Generator 2
Generator 3
Generator 4
Generator 5
Frequency (Hz)
61
60
59
58
57
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
Time (s)


Fault on Highest Power Flow Line Worst Nadirs
f_nadir (Hz)
59.5
59.0
58.5
58.0
57.5
Base Case
GFM5-GFL0
GFM4-GFL1
GFM3-GFL2
GFM2-GFL3
GFM1-GFL4
Simulation Types


Fault on Highest Power Flow Line Worst Deltas
f_delta
2.5
2.0
1.5
1.0
0.5
Base Case
GFM5-GFL0
GFM4-GFL1
GFM3-GFL2
GFM2-GFL3
GFM1-GFL4
Simulation Types


Fault on Highest Power Flow Line Worst RoCoFs
RoCoF Value
12
10
8
6
4
Base Case
GFM5-GFL0
GFM4-GFL1
GFM3-GFL2
GFM2-GFL3
GFM1-GFL4
Simulation Types

Fault at Highest Power Flow	Worst F_nadir	Worst Delta	Worst RoCoF
Base Case	59.5814	0.4186	4.0248
GFM5-GFL0	58.9703	1.0367	3.4607
GFM4-GFL1	58.9077	1.1003	4.3928
GFM3-GFL2	58.4587	1.5321	5.0632
GFM2-GFL3	58.0574	1.9504	7.1118
GFM1-GFL4	57.1289	2.8692	12.5101