Generator Third-Harmonic Protection Explained

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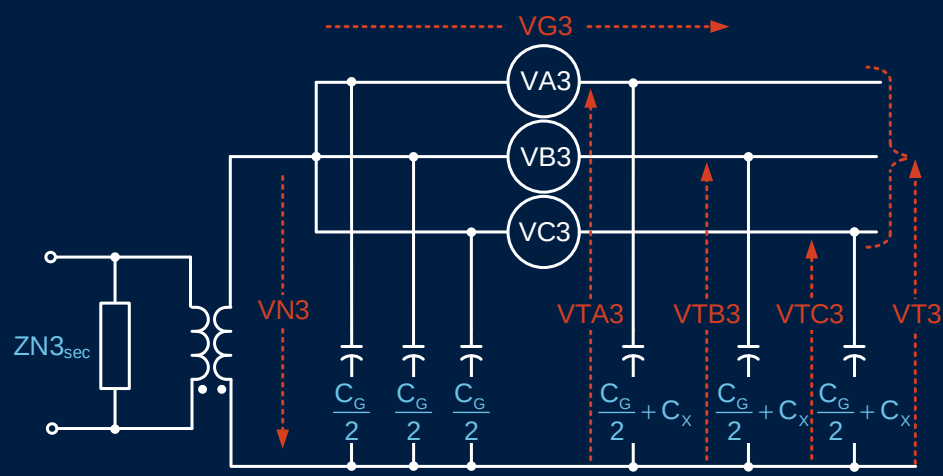
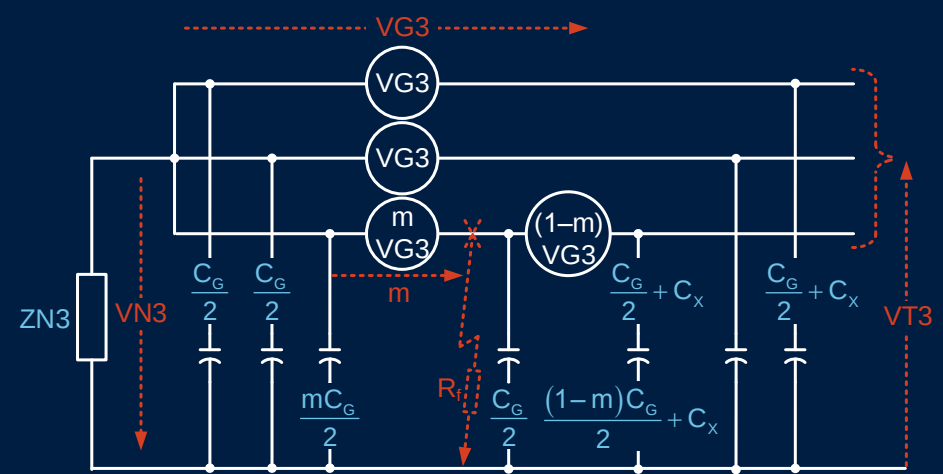
Overview

- Third-harmonic schemes
- Security and settings
- Sensitivity and coverage

Third-Harmonic Circuit

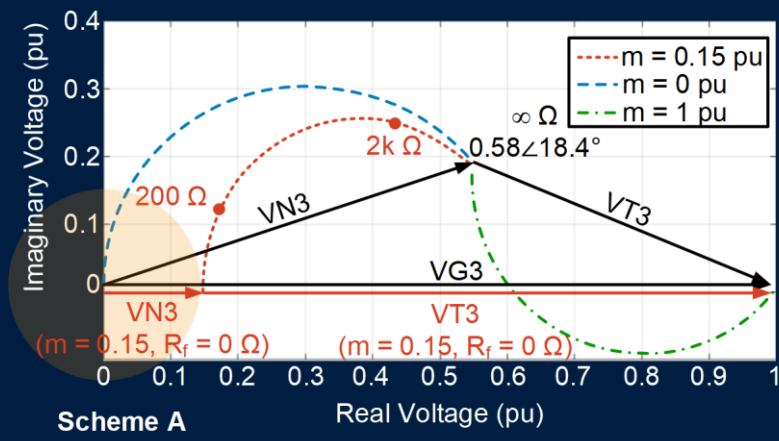


Third-Harmonic Circuit
Ground Fault



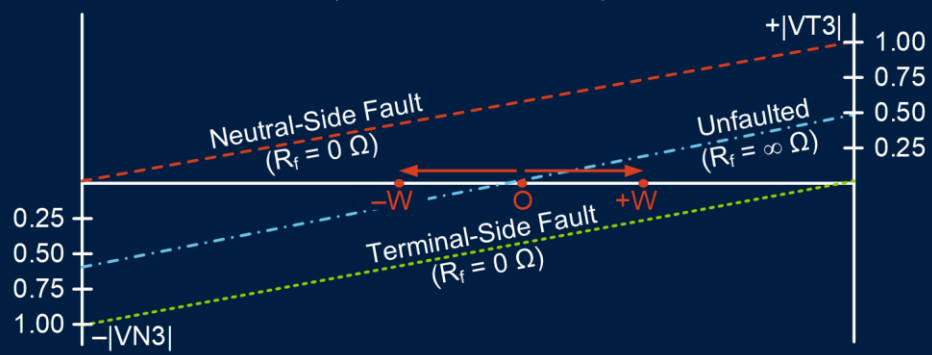
Scheme A

$$\text{Scheme A} = \frac{|VN3|}{|VN3 + VT3|} < PKPA$$



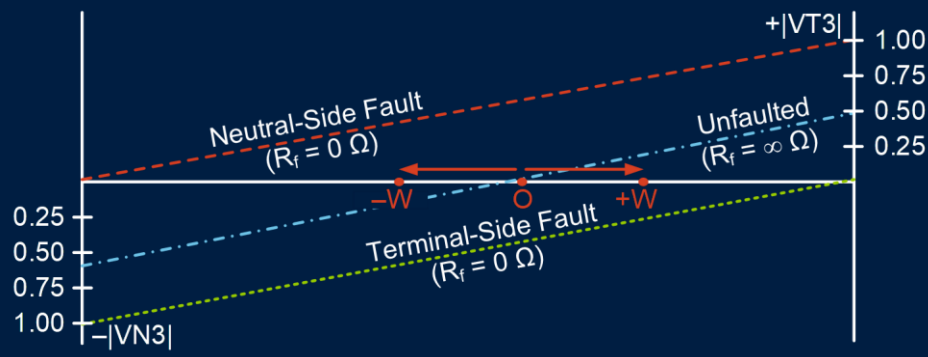
Scheme B

$$\text{Scheme B} = \left|RAT \bullet |VT3| - |VN3|\right| > PKPB$$



Schemes B, C, and D

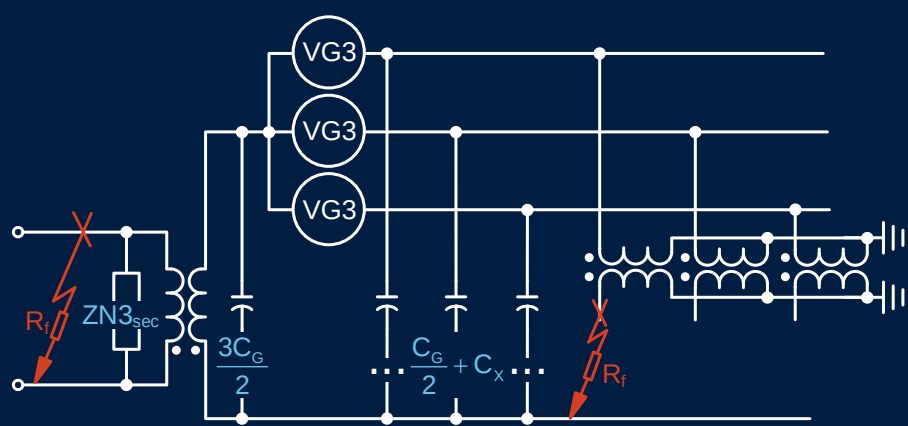
$$\text{Scheme B} = \left|\text{RAT} \bullet |\text{VT3}| - |\text{VN3}|\right| > \text{PKPB}$$



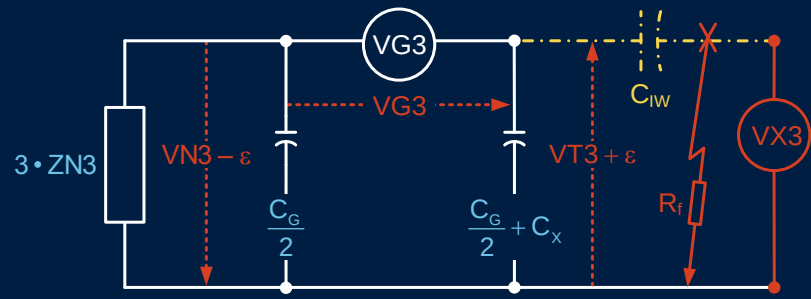
$$\text{Scheme C} = \frac{|\text{VT3}|}{|\text{VN3}|} > \text{PKPC}$$

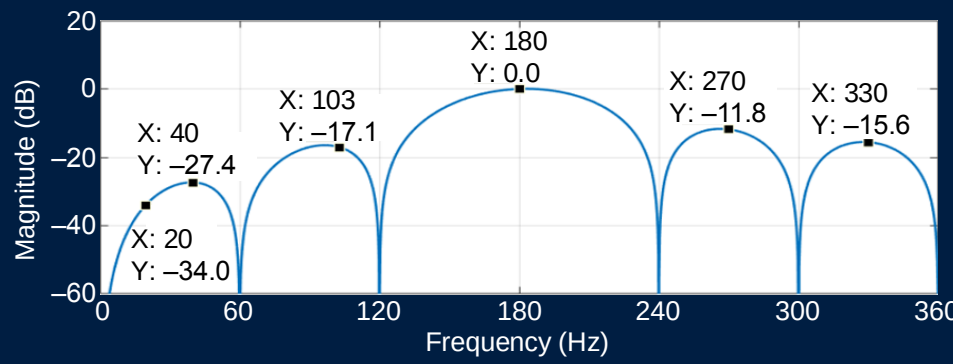
$$\text{Scheme D} = \left|\text{RAT} \bullet \text{VT3} - \text{VN3}\right| > \text{PKPD} \bullet |\text{VN3}|$$

Security
PT Secondary Faults

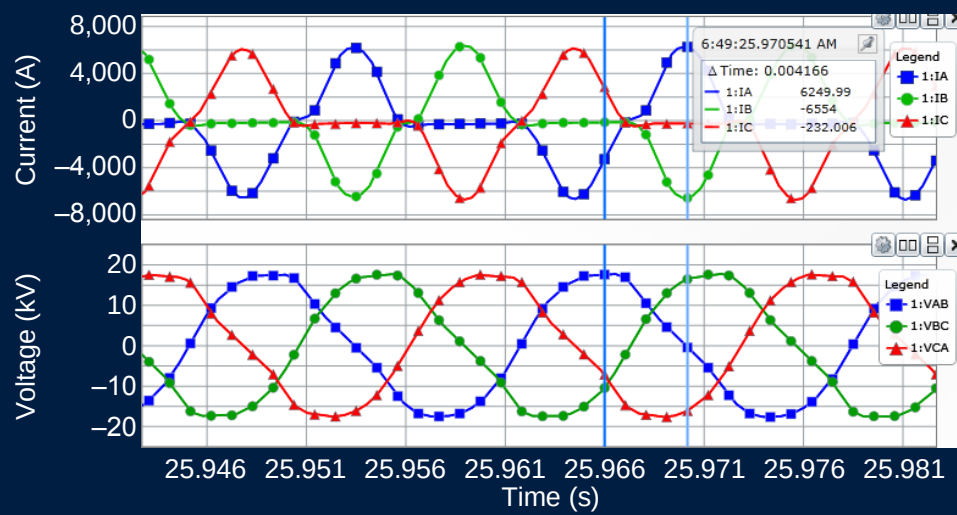


Security
System Events

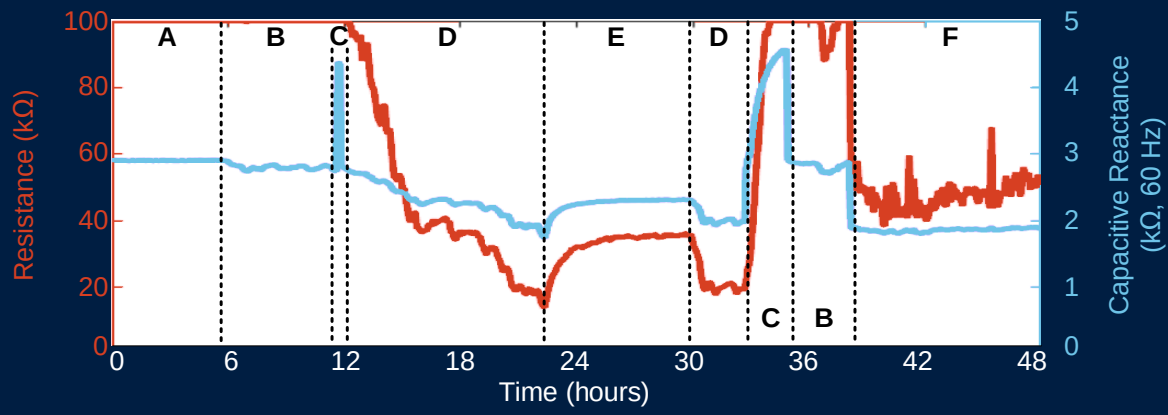




Security
GSU Events

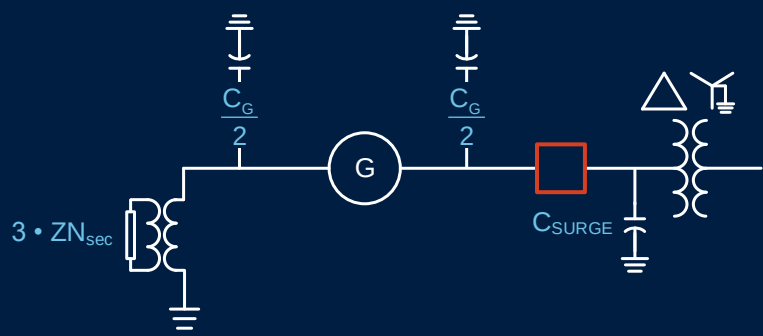


Security
Variation of Stator Ground Capacitance



A: Light Load
B: Heavy Load
C: Offline
D: Heavy Load (Cooling Off)
E: Light Load (Cooling Off)
F: Two Units Paralleled

Security
Impedance Profile Change at Generator Terminal

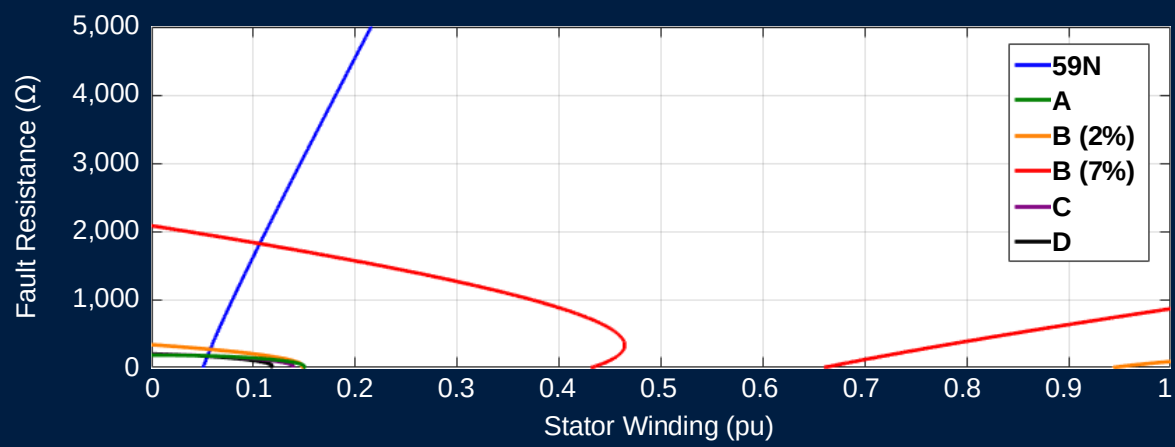


Security Settings

ε (pu of VG3)	Scheme A PKP	Scheme B PKP	Scheme C PKP	Scheme D PKP
0.00	0.58	0.00	1.00	0.00
0.10	0.48	0.20	1.41	0.43
0.20	0.38	0.40	2.04	1.08
0.28	0.30	0.56	2.87	1.92
0.43	0.15	0.88	6.79	5.85

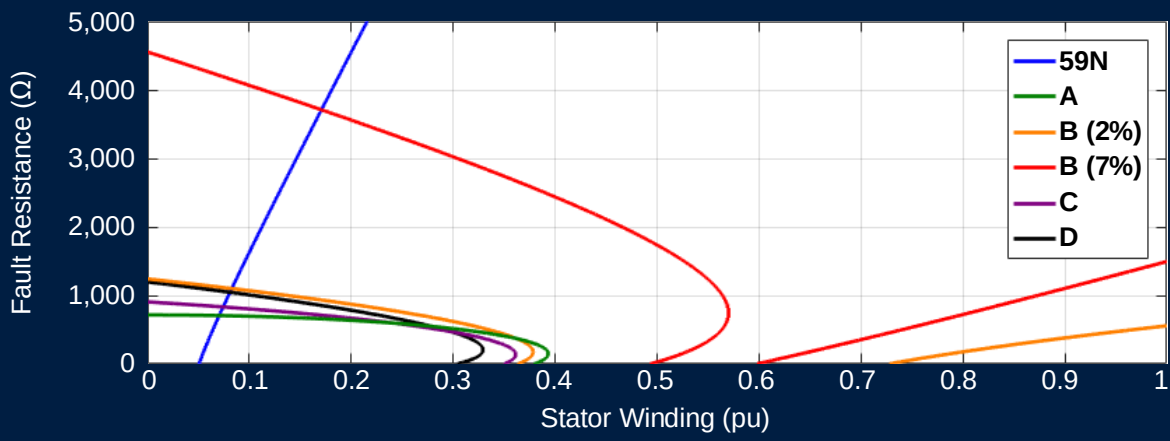
Sensitivity

Secure Settings (ε = 0.43 pu)



Sensitivity

Sensitive Settings (ε = 0.20 pu)



Conclusions

- Not all schemes are the same
- Schemes can be set with similar levels of security or sensitivity
- When set consistently, all schemes are adequate for secure tripping

Questions?