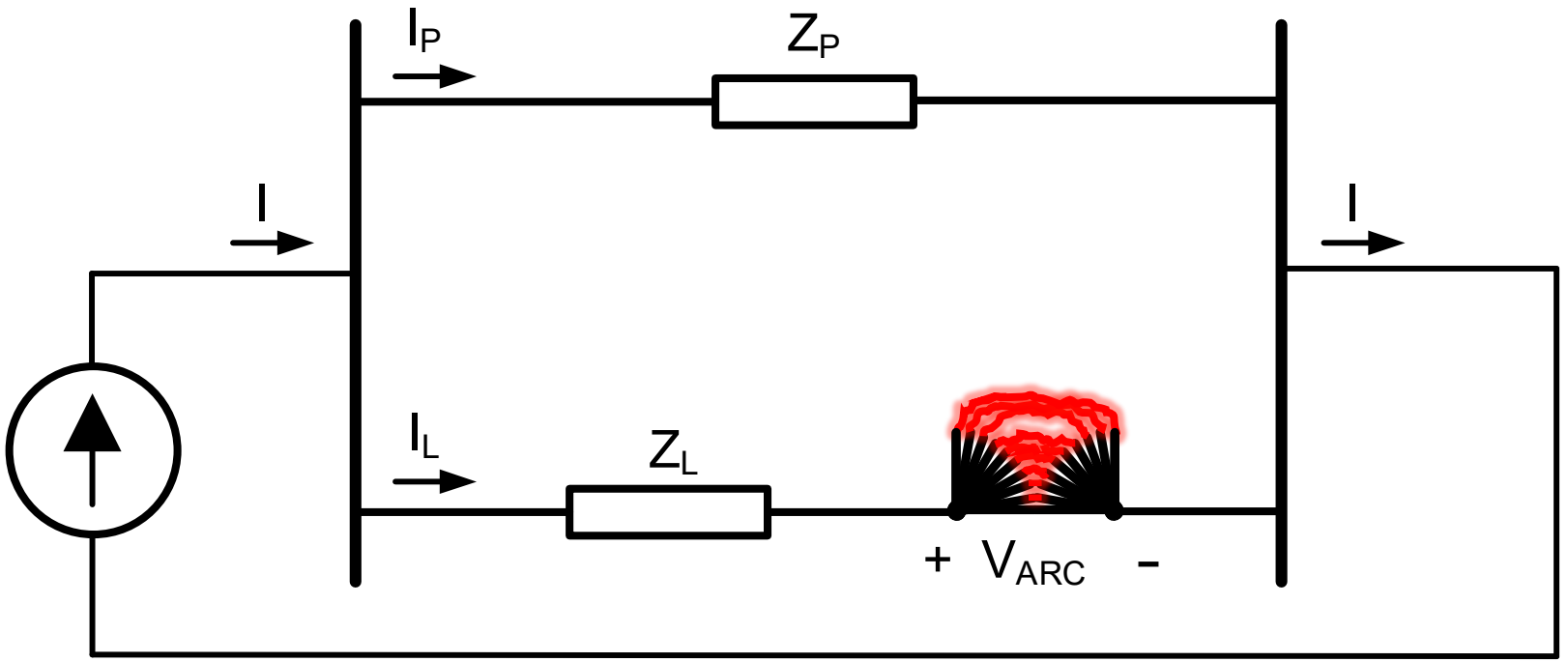
Novel Methods for Detecting Conductor Breaks in Power Lines

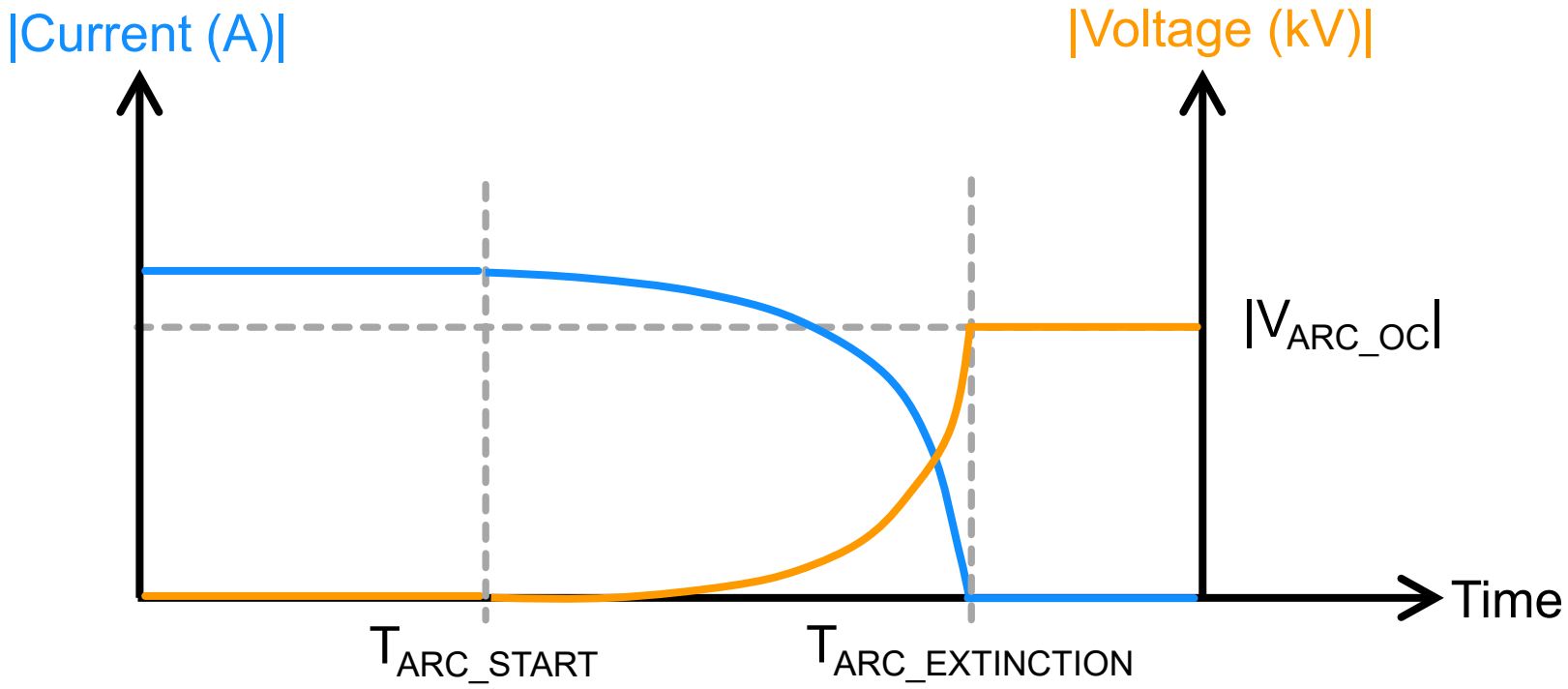
Kanchanrao Dase, James Colwell, and Shreenivas Pai
Schweitzer Engineering Laboratories, Inc.

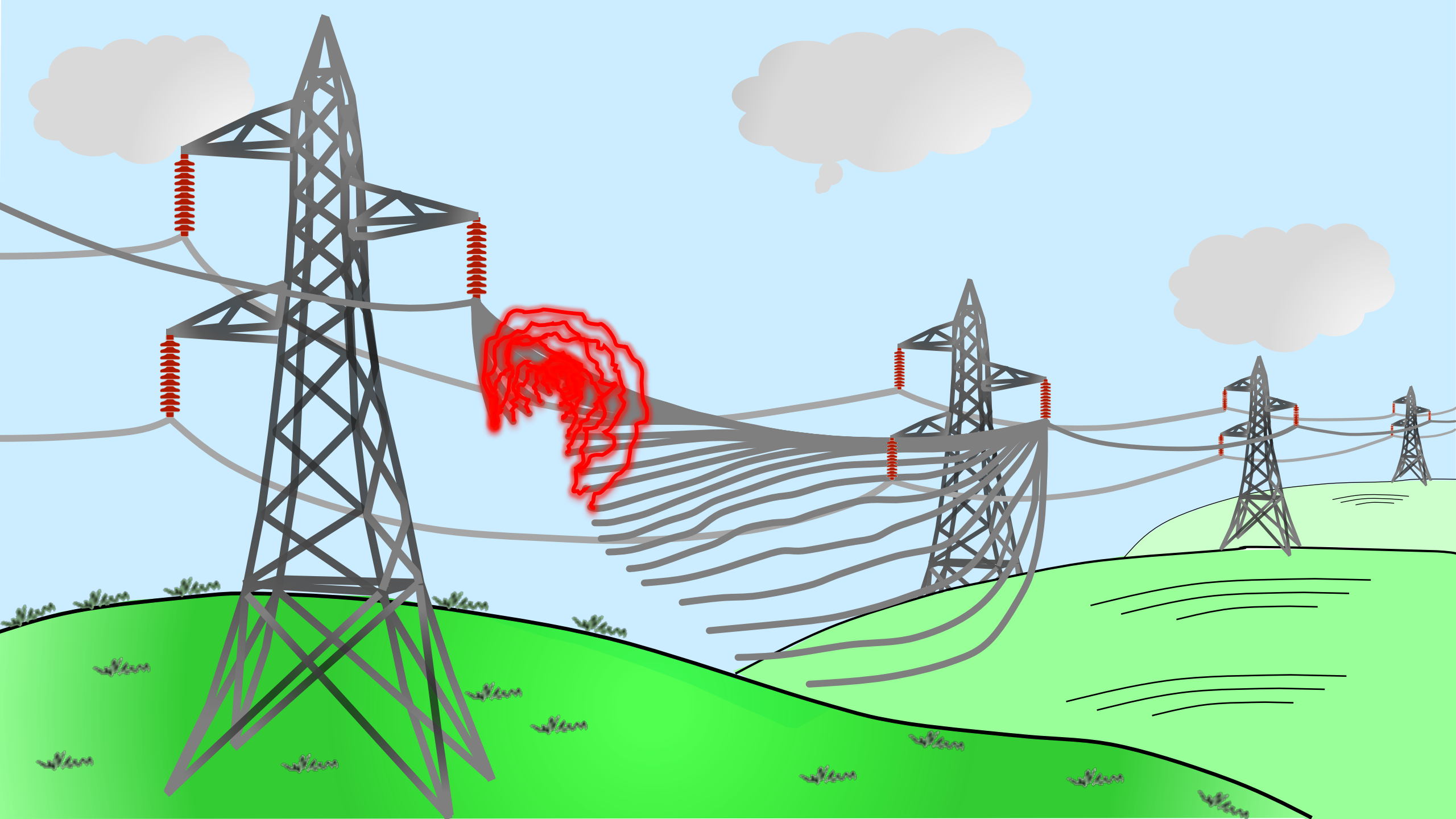
Series arcing through disconnect switch



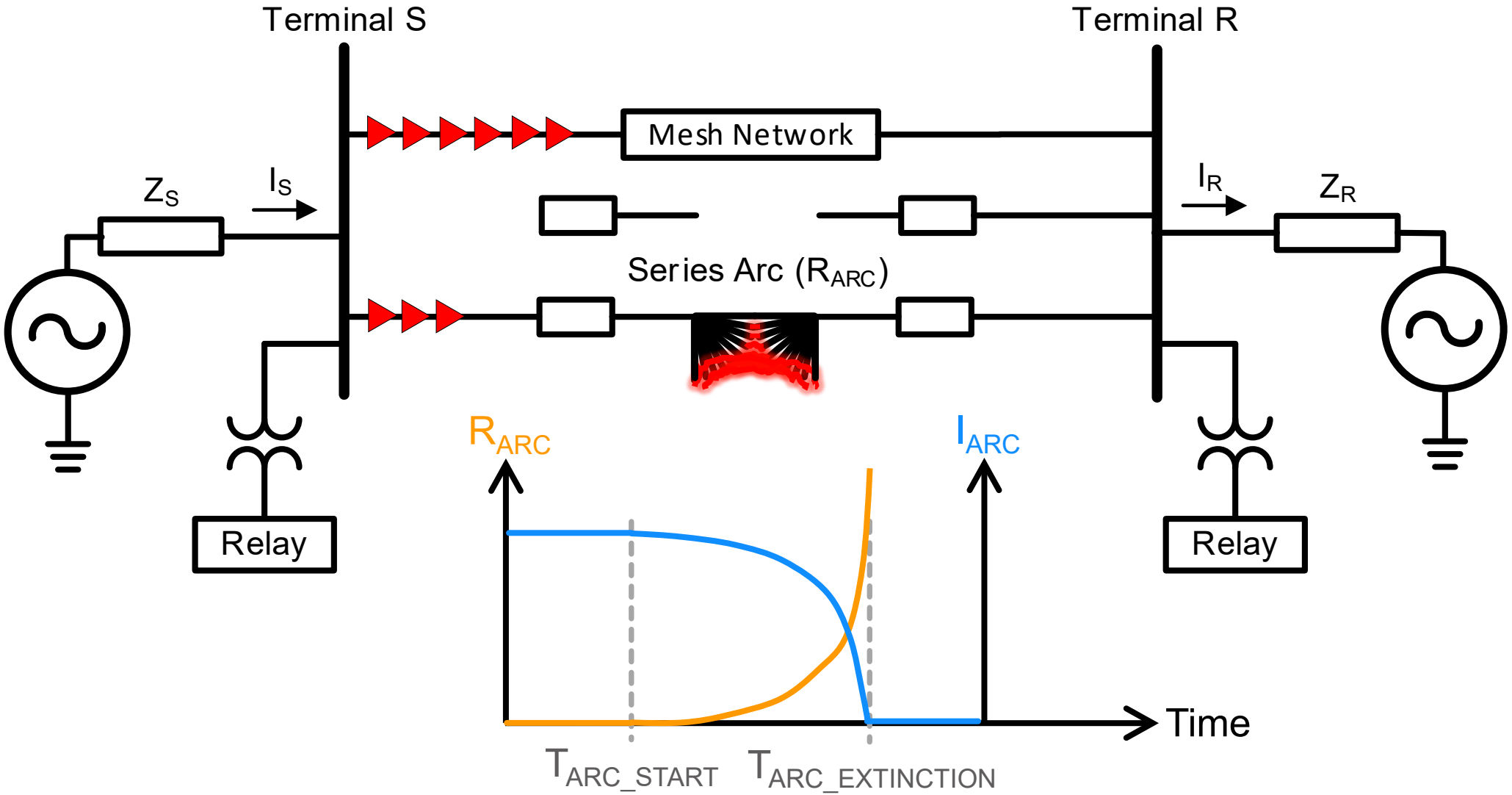
$$V_{ARC\_OC} = I_P \bullet Z_P = I \bullet Z_P$$

Series arcing through disconnect switch

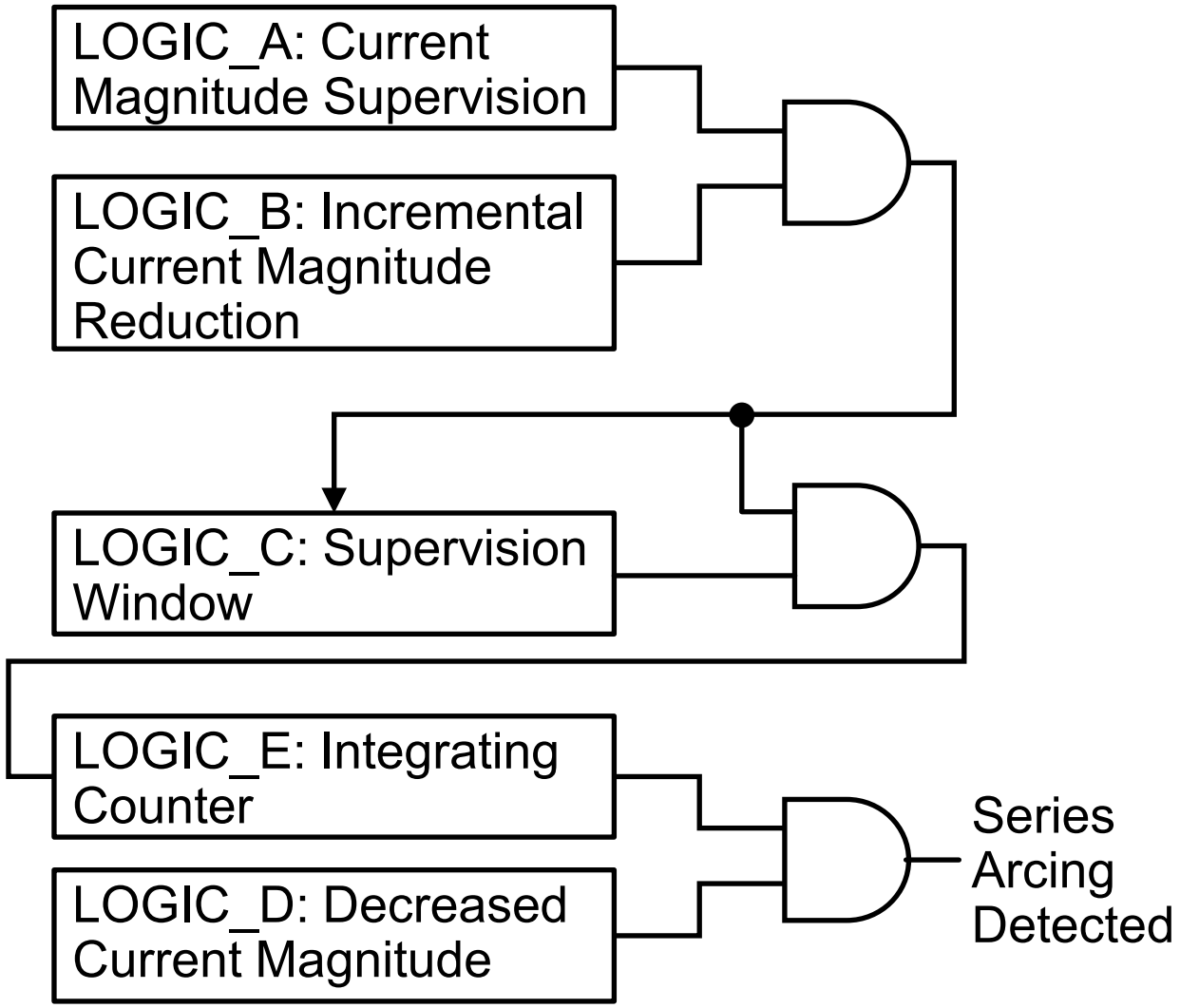


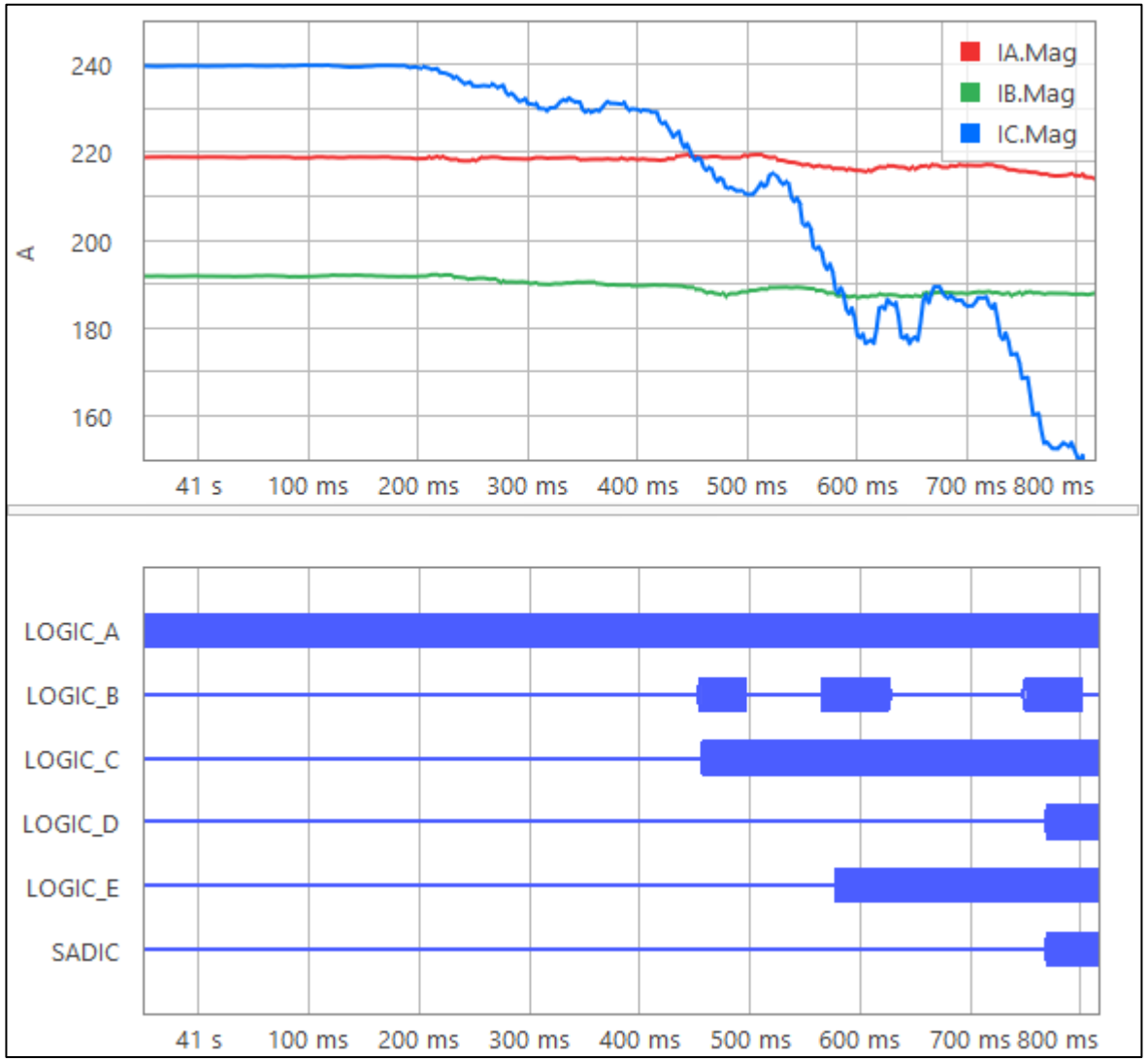


Series arcing in a power line

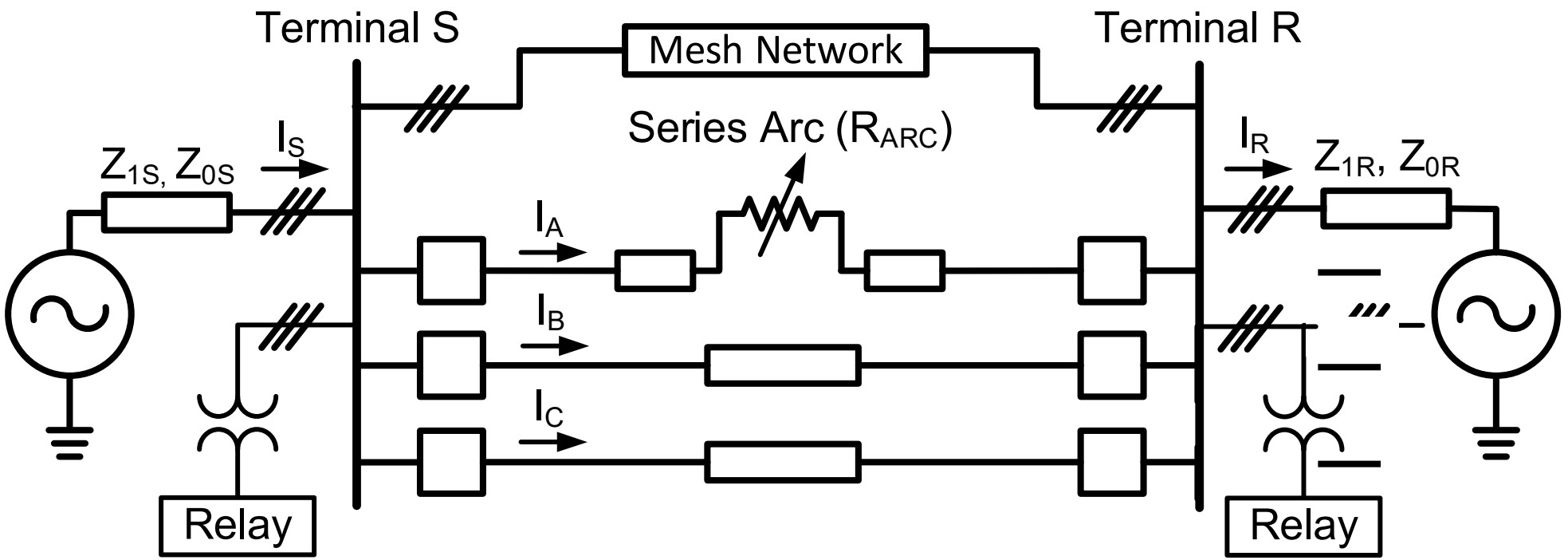


Detecting series arc through current reduction



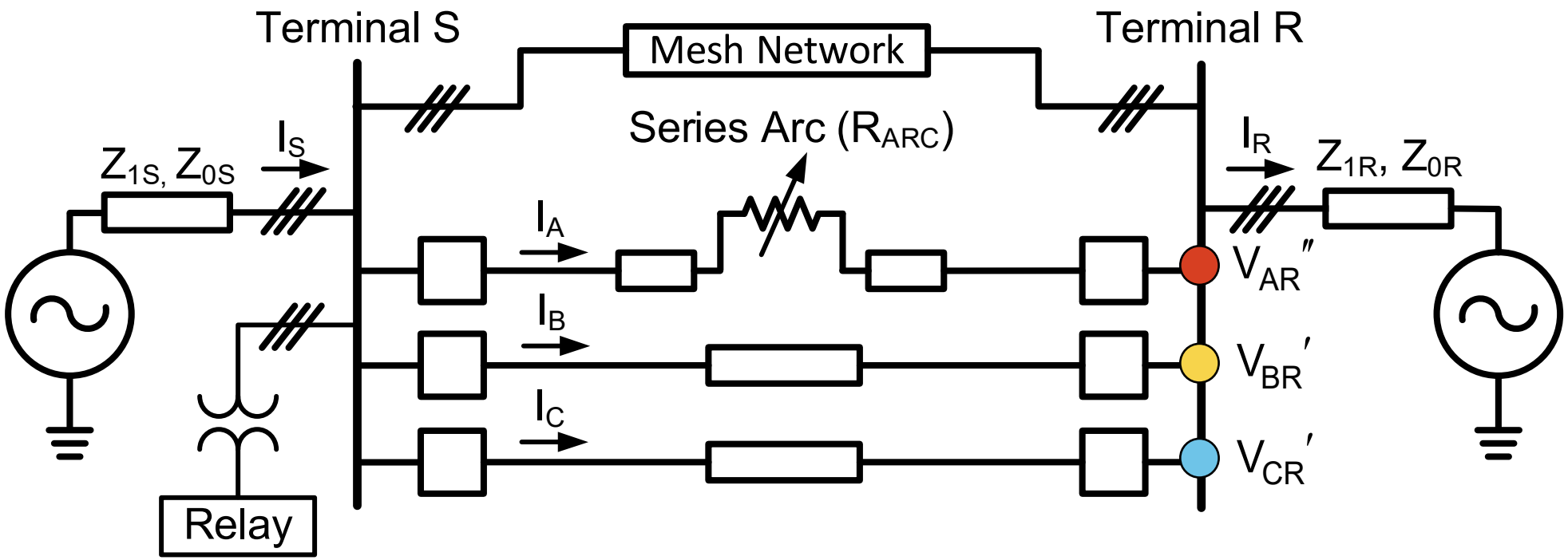


Double-ended approach of estimating phase resistance

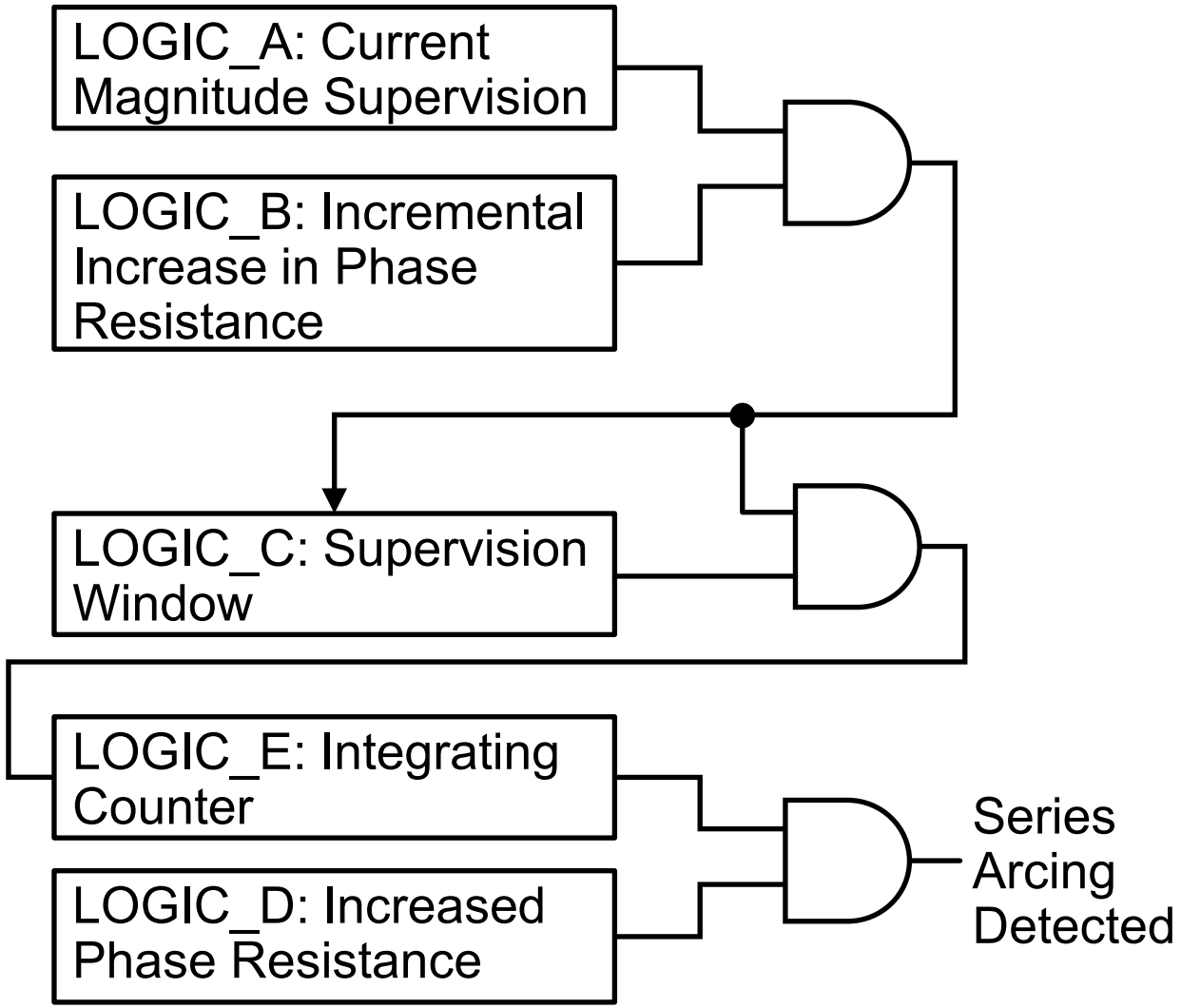


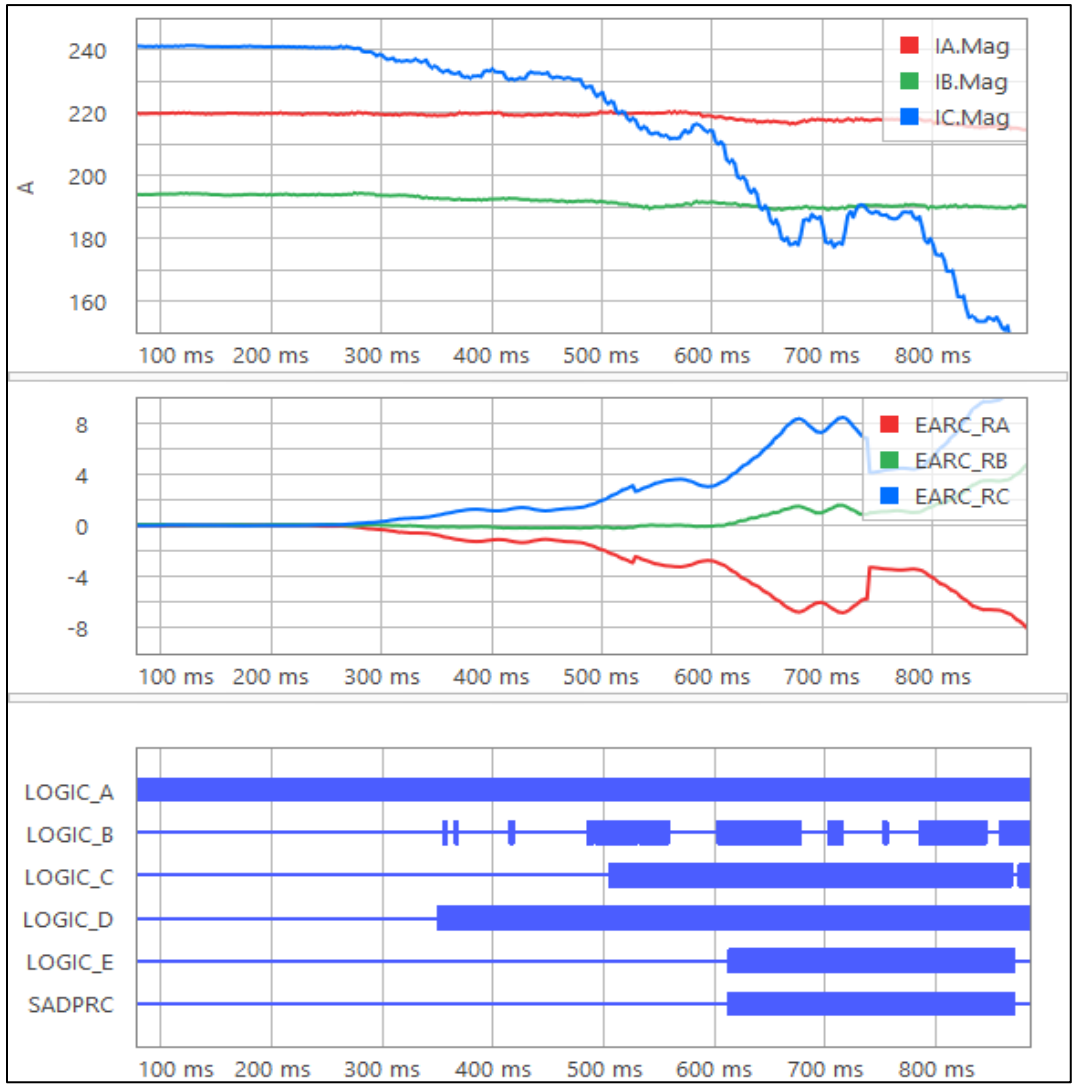
$$R_{A\_EST} = \mathrm{Real}\left(\frac{V_{AS} - V_{AR} - (I_B + I_C) \bullet Z_M}{I_A}\right)$$

Single-ended approach of estimating phase resistance



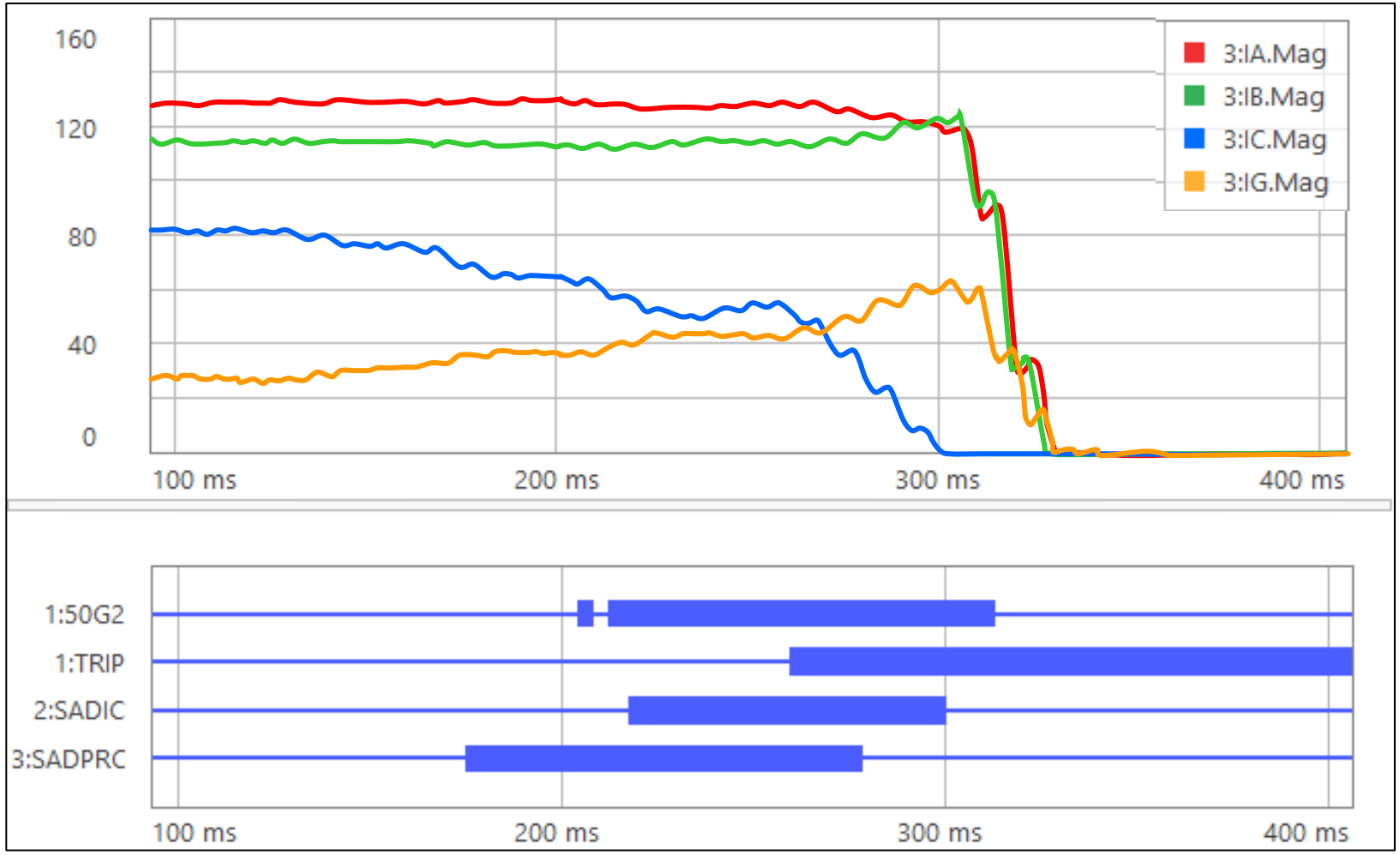
Detecting series arc through the estimation of phase resistance





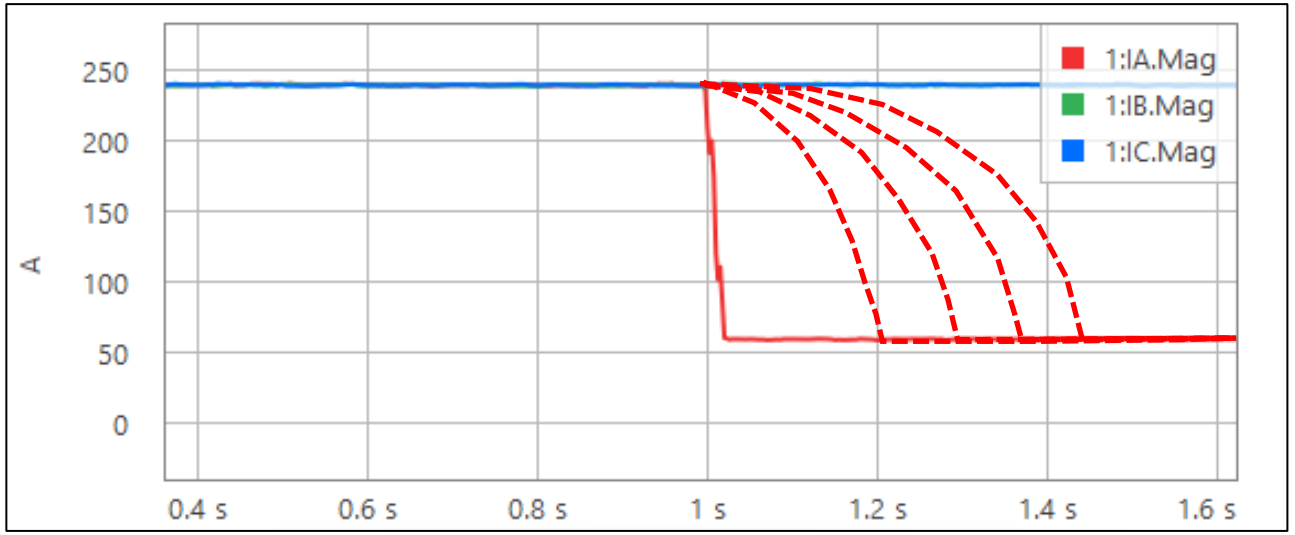
Benefits of the proposed methods

- Single-ended methods
- Early detection of broken conductor

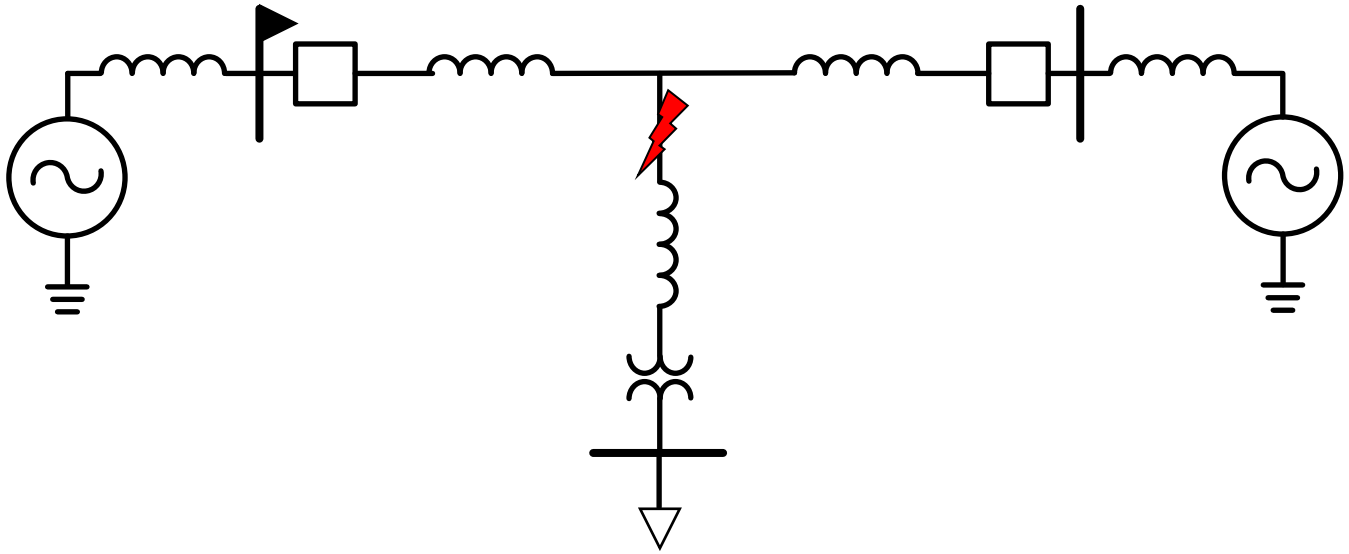


Benefits of the proposed methods

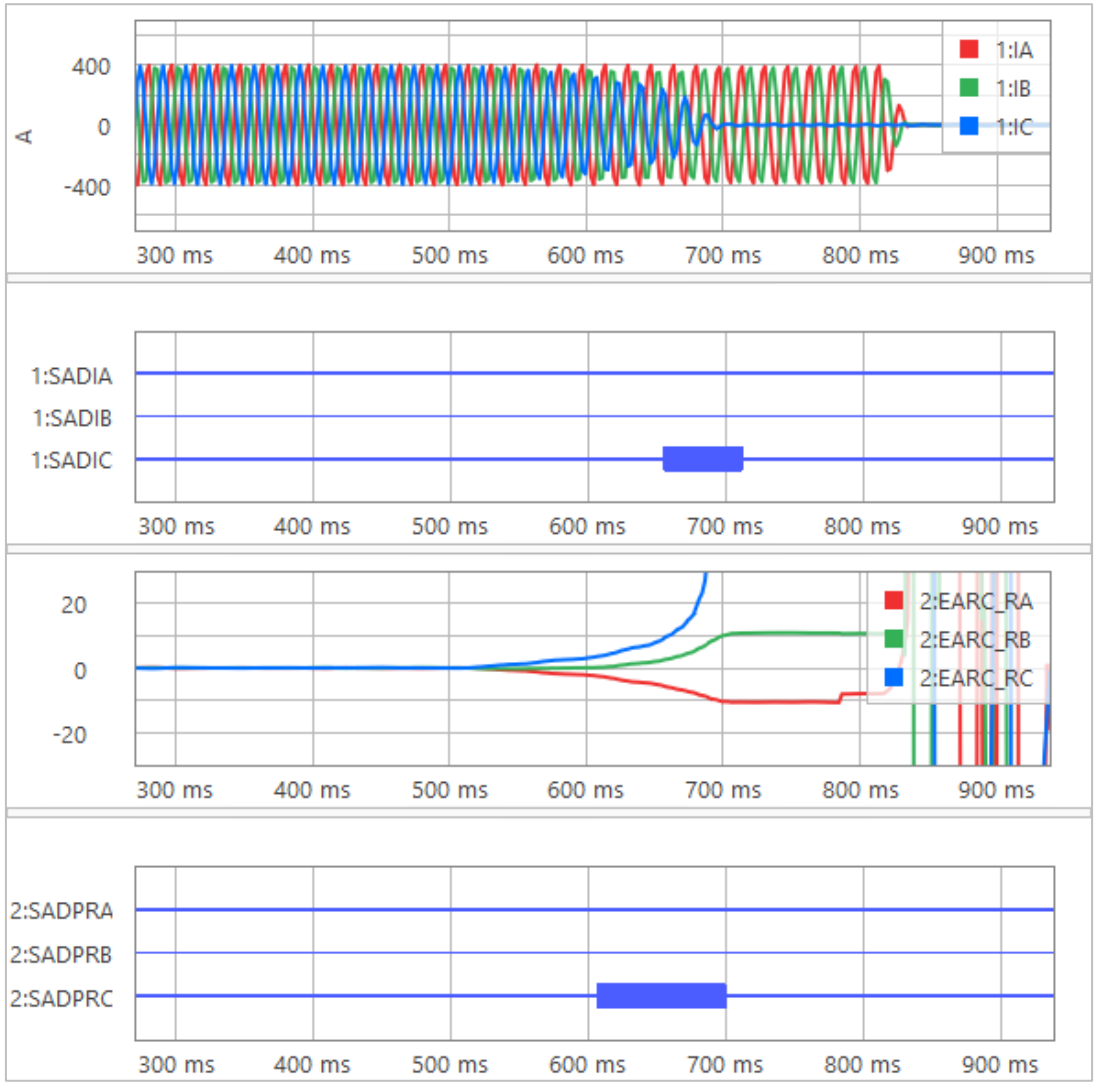
Loss-of-load detection



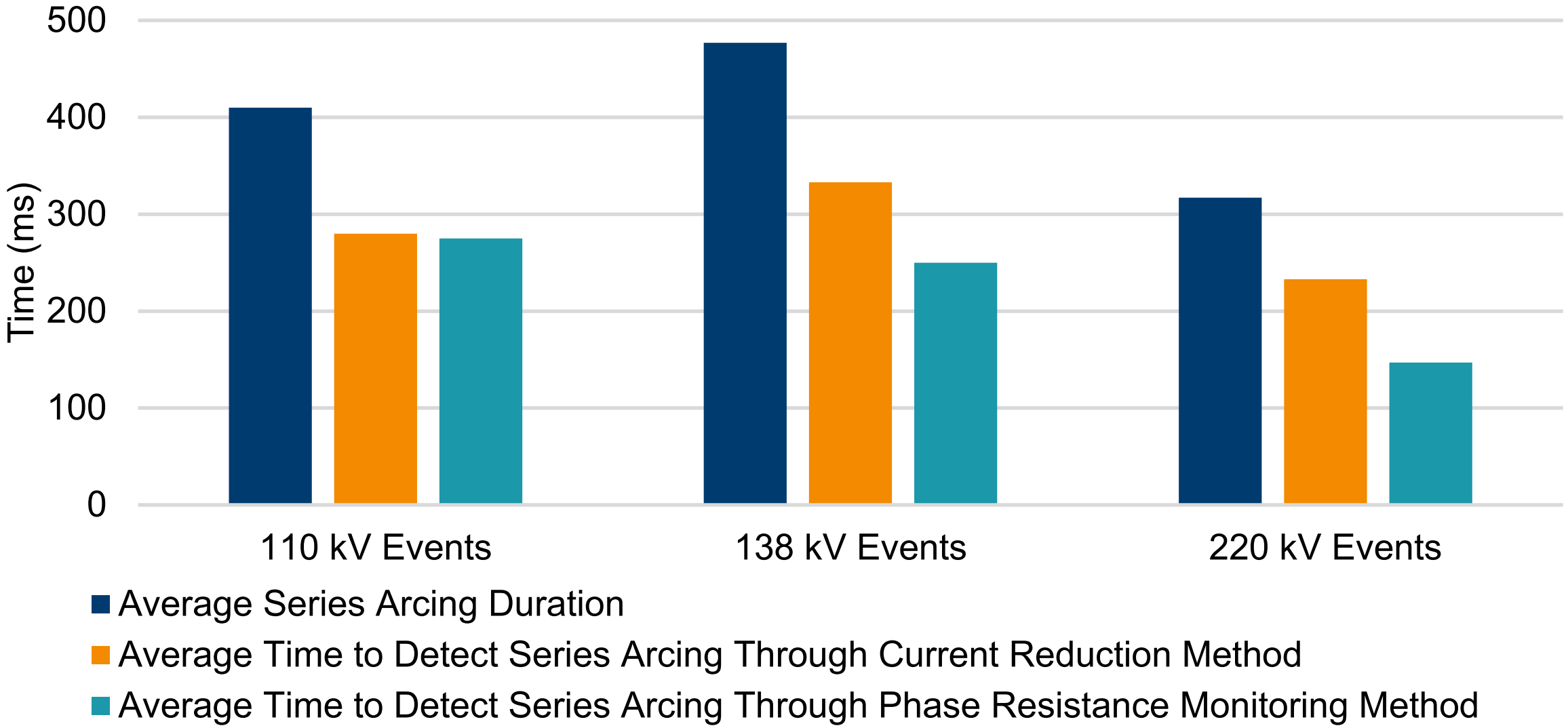
Detection of conductor breaks in tapped feeders



Validating the proposed methods through field events



Validating the proposed methods through field events



Performance analysis of other methods

Event	Terminal	Voltage Level (kV)	ΔV_{PH} (pu)	ΔV_0 (pu)	ΔV_2 (pu)	ΔZ (pu)
1	Local	220	–0.005	< 0.026	< 0.019	6
	Remote		0.001			135
2	Local	138	–0.018			151
	Remote		0.006			139
3	Local	110	–0.032			23
	Remote		0.011			23
4	NA	220	0.003			9
5	NA	138	–0.019			14

Conclusion

- Detection of broken conductors was successful by using the proposed single-ended methods
- The proposed methods can work for transmission, sub-transmission systems, tapped feeders, and distribution systems
- Field events have shown no significant change in voltage magnitudes before and after the conductor break
- Methods that rely on change in impedance may have less dependability for lines with significant charging current

Questions?