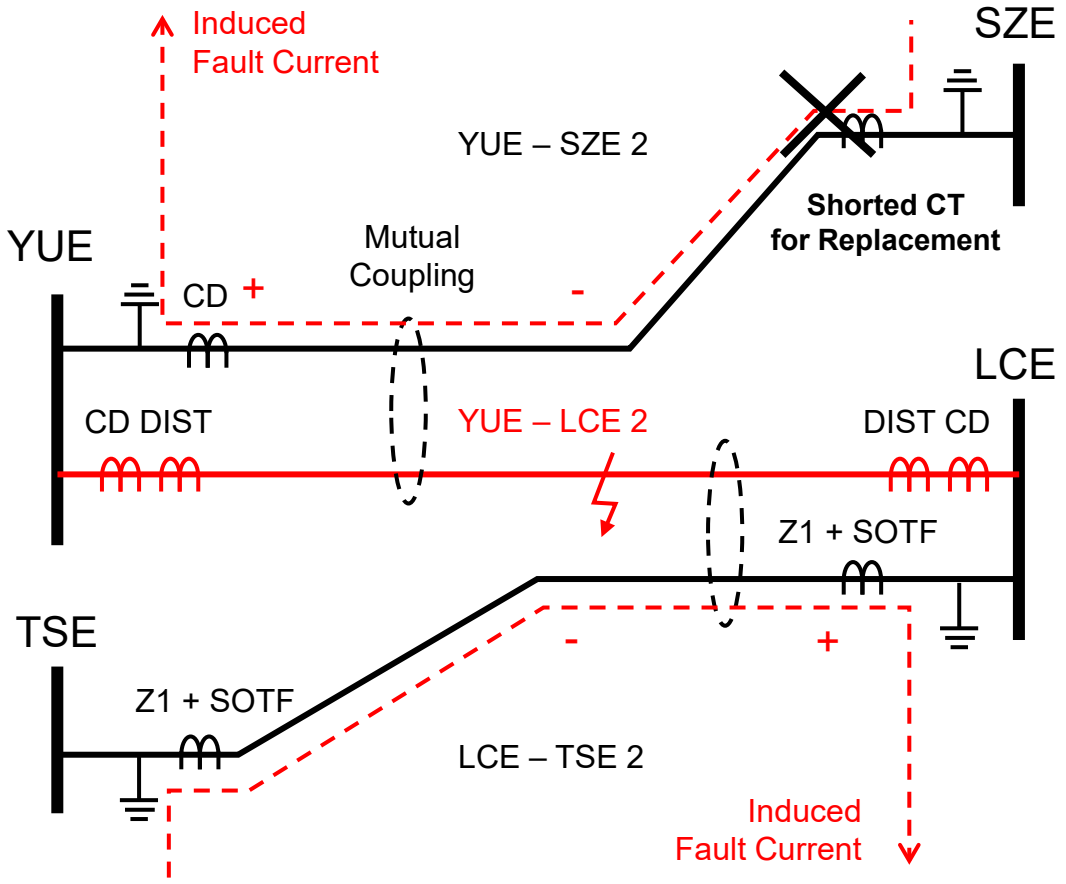
YUE – LCE 2 Fault on 20240331

Background

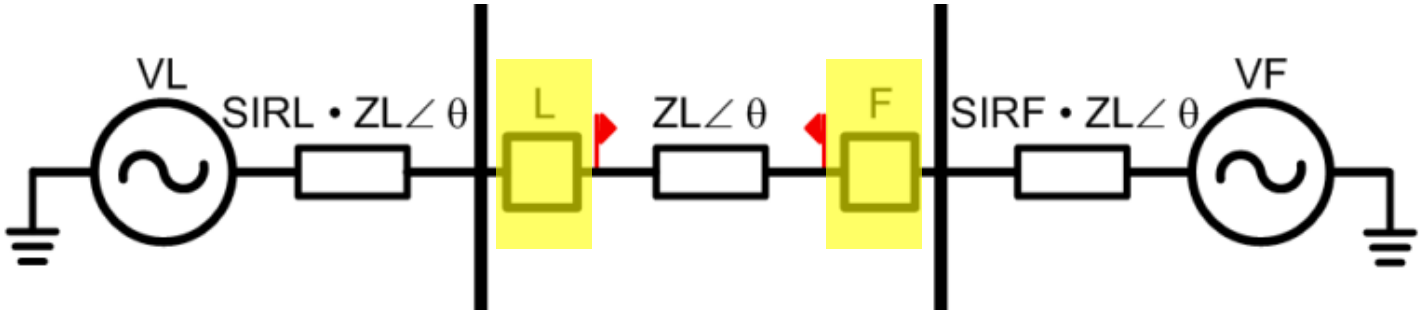
- **YUE – LCE 2** was faulted on 2024-03-31 12:28 (IDR: 1393314-1) due to hill fire. CD (L3 – E) and DIST at both ends are activated to isolated the fault.
- During the fault, CD (L1 – E, L2 – E) for **YUE – SZE 2** at YUE side was activated with measured current 0.8A.
    - It was found that YUE – SZE 2 was switched out, isolated and earthed for OHL and CT replacement. CT was shorted and isolated at SZE side, so CD can only observe the induced fault current at YUE side as differential.
- During the fault, DIST (SOTF element and Z1, typed RCS902H) for **LCE – TSE 2** at both side was activated.
    - It was found that LCE – TSE 2 was switched out, isolated and earthed for HVIC application. The induced fault current operated ZMCF element and Z1 possibly with induced voltage to the relay, even with VT MCB switched off.
    - Note –

      ZMCF at RCS902H requires no DTL OC setting, not blocked by VTS (reset 10s after CB opened), and rely on only impedance measurement.

      Z1 at RCS902H is not blocked by VTS in logic, only guarded by fault detector logic.

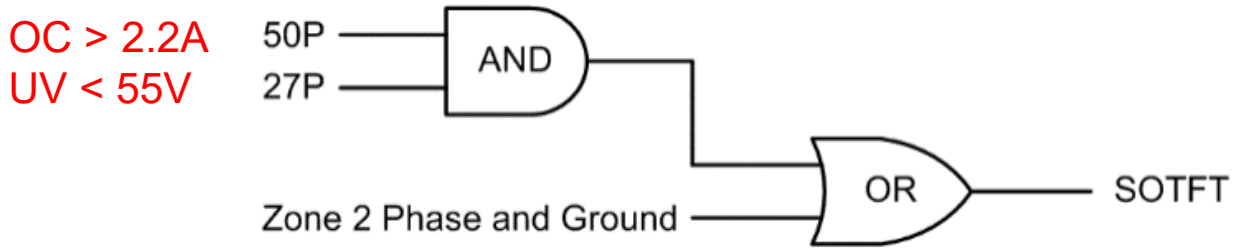


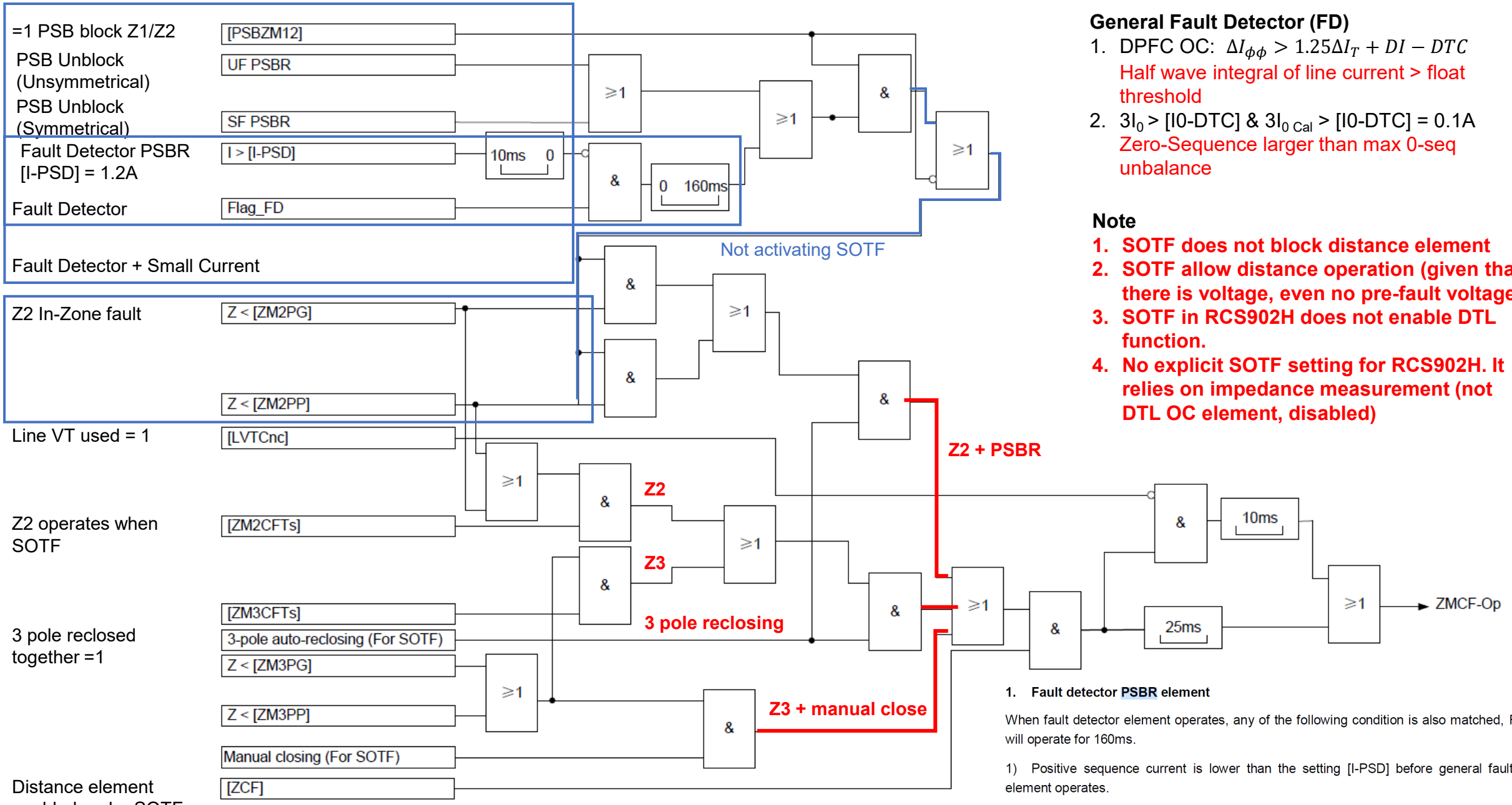
Switch Onto Fault (SOTF) -



1. CB (L) closes first, and CB (F) closes then.
2. No voltage is available to relay before close of CB (L).
3. If CB (L) closes into a close-in three phase fault, no usable polarizing voltage is available, and directional / distance element will not be enabled.

- To achieve dependability for **close-in three phase fault** (possibly with **high SIR**) such that **susceptible on-fault voltage** ($V_F \approx 0$) is available, SOTF (a DTL OC element, I_{SET} = **2.2A** for 400kV Fdr, typed SEL) is employed.
- Major problem is on auto-reclosing, where voltage memory is already expired.





General Fault Detector (FD)

1. DPFC OC: $\Delta I_{\phi\phi} > 1.25\Delta I_T + DI - DTC$
   Half wave integral of line current > float threshold
2. $3I_0$ > [I0-DTC] & $3I_{0\ Cal}$ > [I0-DTC] = 0.1A
   Zero-Sequence larger than max 0-seq unbalance

Note

1. **SOTF does not block distance element**
2. **SOTF allow distance operation (given that there is voltage, even no pre-fault voltage).**
3. **SOTF in RCS902H does not enable DTL function.**
4. **No explicit SOTF setting for RCS902H. It relies on impedance measurement (not DTL OC element, disabled)**

1. Fault detector PSBR element

When fault detector element operates, any of the following condition is also matched, FD PSBR will operate for 160ms.

1) Positive sequence current is lower than the setting [I-PSD] before general fault detector element operates.

2) Positive sequence current is higher than the setting [I-PSD] before general fault detector element operates, but the duration is less than 10ms.

10. SOTF Test

SOTF is enabled when all poles are dead for 50ms.

SOTF is turned OFF when line is energised with 3-ph voltages healthy for about 400ms.

	TRIP LED	LCD	ALARM LED
SOTF Trip ☐ Press Reset Button. ☐ Simulate CB open (energise binary input BkrOff) for 20s (SOTF is enabled in 50ms). ☐ VTS and ALARM LED reset in 10s. ☐ Simulate close on to fault (de-energise binary input BkrOff and apply a Z2 fault with no pre-fault volt at the same time). ☐ Stop injection after 1.5s	☐ ON	☐ ZMCF-OP (SOTF Trip) ☐ ZM2-OP ☐ ZM3-OP ☐ FAULT LOCATION	☐ ON (after injection stopped.)
No SOTF Trip ☐ Press Reset Button. ☐ Simulate CB open (energise binary input BkrOff) for 20s (SOTF is enabled in 50ms). ☐ VTS and ALARM LED reset in 10s. ☐ Simulate CB close (de-energise binary input BkrOff) and apply 3-ph healthy volt for 1s (SOTF is disabled in 0.4s). ☐ Apply a Z2 fault. ☐ Stop injection after 1.5s.	☐ ON	☐ ZM2-OP ☐ ZM3-OP ☐ FAULT LOCATION	☐ ON (after injection stopped.)

1. With pre-fault voltage
2. Inject **Z2 fault** after 0.4s (disabled SOTF) not current injection only!!!

	L1E				L23	L31	L123
SOTF Trip Time (≈ 35ms)	ms	ms	ms	ms	ms	ms	ms

☐ All SOTF contacts = Close (< 0.5 Ω).

☐ All Any Trip contacts = Close (< 0.5 Ω).

1. Distance Element is NOT blocked during SOTF, including Z1.
2. VTS alarm reset in 10s after CB open.
3. Z2 injection requires voltage injection (but no pre-fault voltage, and voltage memory expires)

VTS -

DPFC Fault Detector (not used) will high set.
Distance Protection will be disabled ??
(not reflected in the logic diagram, can be activated.)
OC/ROC for VTS is disabled in CLP relay.

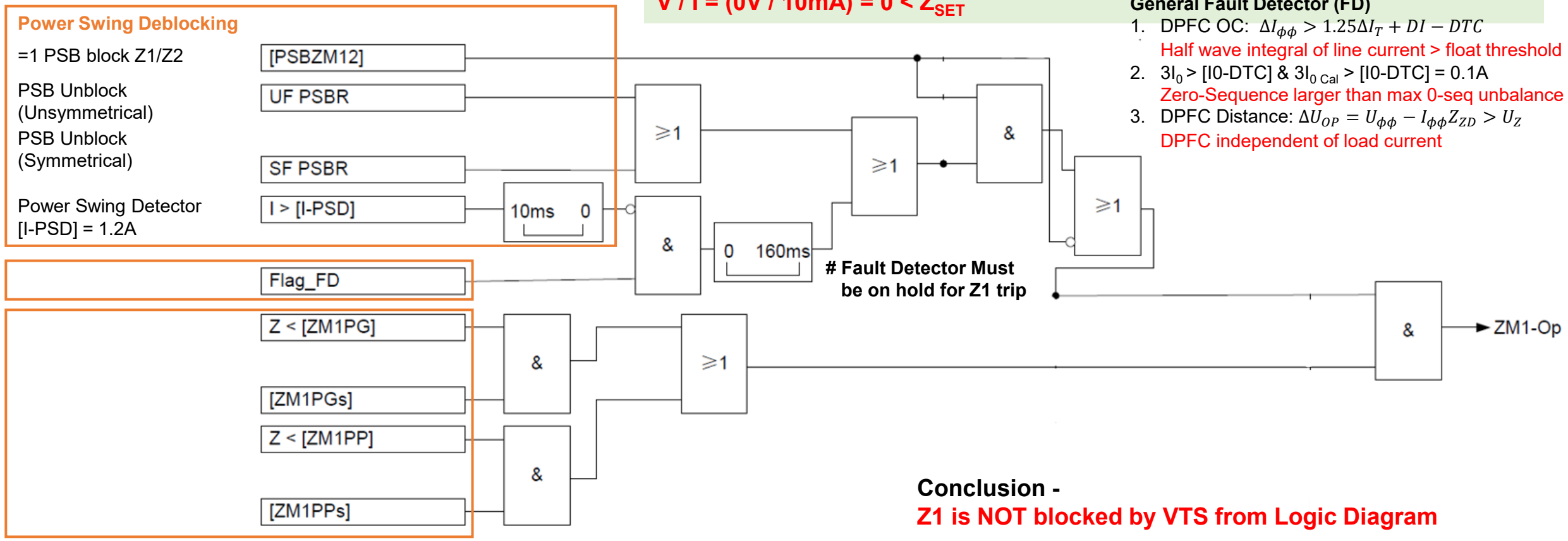
In case of VT circuit failure, direction judge for inverse-time zero-sequence overcurrent protection will withdraw, DPFC distance element will be reserved but the threshold will be increased to 1.5Un, distance protection will be disabled, overcurrent protection for VTS and zero-sequence overcurrent protection for VTS will be enabled if the logic setting [IVTSUFs] is set as "1".

Unanswered problem –
How to maintain stability of SOTF element with CB Open, VT Isolated (possibly with induced voltage) and with primary side earthed (CT with induced current)?

V / I = (0V / 10mA) = 0 < Z_{SET}

General Fault Detector (FD)

1. DPFC OC: $\Delta I_{\phi\phi} > 1.25\Delta I_T + DI - DTC$
   Half wave integral of line current > float threshold
2. $3I_0$ > [I0-DTC] & $3I_{0\,Cal}$ > [I0-DTC] = 0.1A
   Zero-Sequence larger than max 0-seq unbalance
3. DPFC Distance: $\Delta U_{OP} = U_{\phi\phi} - I_{\phi\phi} Z_{ZD} > U_Z$
   DPFC independent of load current



Conclusion -

Z1 is NOT blocked by VTS from Logic Diagram