

Single-Pole Tripping Applications using the GE 850R Recloser/Switch Control

August 26, 2020

Firmware versions: 2.6 and 2.7

Application

The GE 850R provides single-pole tripping and reclosing functions. The single-pole trip logic that is built into the 850R treats each phase separately and trips/closes each phase as a fault occurs. Some applications require the opening of more than one phase or opening and locking out all three phases. This application note describes operating for impending faults and opening multiple phases when in single-pole mode.

Picked-up-phase (impending faults) tripping logic

Figure 1 shows an example logic that performs two separate operations. Logic Section A trips any picked-up phase(s) when the relay has selected only one phase for tripping. Logic Section B trips three pole when the relay has two phases selected for tripping.

The logic in Logic Section A forces open any other phase that is picked up, in addition to the phase(s) initiating the trip. For example, if a fault occurs where two phases are involved because of an imbalance in the fault current, on one phase the time-overcurrent (TOC) element operates first. This is the tripping phase. The other phase, with a smaller operating current, is the picked-up phase - an impending fault. This logic clears both the tripping phase(s) as well as any picked-up phase(s) at the time of the initiating trip. It does not wait for the picked-up phase element to time out.

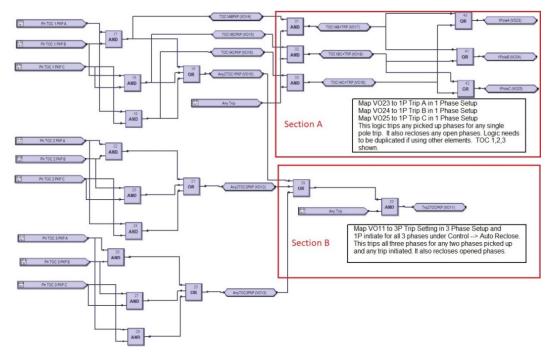


Figure 1. Picked-up-phase tripping logic



Figure 1 shows the use of TOC1, TOC2, and TOC3 elements. Duplicate this logic for additional tripping elements that are part of the scheme. Figure 2 and Figure 3 show the required settings in red to use Logic Section A (your virtual output numbers may differ).

| I Phase Setup // Quick Connect: Quick Connect Device: Setpoint | ts: System: Recloser Trip Close Logic 📃 💷 💌 |
|--|---|
| 😫 Save 😫 Bestore | |
| SETTING | PARAMETER |
| PhA Setup | |
| 1 Pole Trip Ph A Input 1 | Trip Bus 1 OP |
| 1 Pole Trip Ph A Input 2 | Virtual Output 23 On (1PoleA) |
| 1 Pole Trip Ph A Input 3 | Virtual Output 7 On (BKR1ManOPEN) |
| 1 Pole Close Ph A Input 1 | BKR1 Local Close (BKR1) |
| 1 Pole Close Ph A Input 2 | Off |
| 1 Pole Close Ph A Input 3 | Off |
| 1 Pole Phase A Block | Fixed Wakeup Time |
| | |
| PhB Setup | |
| 1 Pole Trip Ph B Input 1 | Trip Bus 2 OP |
| 1 Pole Trip Ph B Input 2 | Virtual Output 24 On (1PoleB) |
| 1 Pole Trip Ph B Input 3 | Virtual Output 7 On (BKR1ManOPEN) |
| 1 Pole Close Ph B Input 1 | BKR1 Local Close (BKR1) |
| 1 Pole Close Ph B Input 2 | Off |
| 1 Pole Close Ph B Input 3 | Off |
| 1 Pole Phase B Block | Fixed Wakeup Time |
| | |
| PhC Setup | |
| 1 Pole Trip Ph C Input 1 | Trip Bus 3 OP |
| 1 Pole Trip Ph C Input 2 | Virtual Output 25 On (1PoleC) |
| | Virtual Output 7 On (BKR1ManOPEN) |
| | BKR1 Local Close (BKR1) |
| 1 Pole Close Ph C Input 2 | Off |
| 1 Pole Close Ph C Input 3 | Off |
| | Fixed Wakeup Time |
| | Save Bestore Default SETTING PhA Setup 1 Pole Trip Ph A Input 1 1 Pole Trip Ph A Input 3 1 Pole Close Ph A Input 1 1 Pole Close Ph B Input 1 1 Pole Close Ph B Input 1 1 Pole Close Ph B Input 2 1 Pole Close Ph B Input 1 1 Pole Close Ph B Input 2 1 Pole Close Ph B Input 1 1 Pole Close Ph B Input 2 1 Pole Close Ph B Input 1 1 Pole Close Ph B Input 2 1 Pole Close Ph B Input 3 1 Pole Close Ph B Input 1 1 Pole Trip Ph C Input 1 1 Pole Trip Ph C Input 1 1 Pole Trip Ph C Input 1 1 Pole Close Ph C Input 2 |

Figure 2. 1 Phase Setup settings

| - Control | | |
|------------------------------|--|---|
| Setpoint Group | | |
| Local Control Mode | | |
| Breaker Control | Phase A Initiate // Quick Connect: C | uick Connect Device: Setpoints: Control: Au 🗖 💷 🔀 |
| Overhead Switch Control | | |
| Pole Discordance | 📑 Save 🔄 Restore 🔛 Defa | ult |
| ······ Virtual Input Control | Entre and a second seco | |
| ······ Trip Bus | SETTING | PARAMETER |
| Breaker Failure | External Initiate | Off |
| Synchrocheck 1 | Initiate IN1 | Trip Bus 1 OP |
| Synchrocheck 2 | Initiate IN2 | |
| Cold Load Pickup | | Virtual Output 23 On (1PoleA) |
| Auto Sectionalizer | Initiate IN3 | Off |
| Auto Reclose | Initiate IN4 | Off |
| AR Common Setup | Initiate IN5 | Off |
| Three Phase Setup | Initiate IN6 | Off |
| Phase A Setup | Initiate IN7 | Off |
| Phase B Setup | Initiate IN8 | Off |
| Phase C Setup | | |
| Three Phase Initiate | Initiate IN9 | Off |
| Phase A Initiate | Initiate IN10 | Off |
| Phase B Initiate | Initiate IN11 | Off |
| Phase C Initiate | Initiate IN12 | Off |
| Shot 1 | Initiate IN13 | Off |
| Shot 2 | Initiate IN14 | Off |
| Shot 3 | Initiate IN15 | Off |
| Shot 4 | Initiate IN 15 | UII |

Figure 3. Phase Initiate settings (set Phase B and Phase C similarly)

Opening three phases when in single-pole mode

Logic Section B opens all three phases for any two phases picked up in a single-pole-tripping scheme. This is a situation where leaving a single phase closed is not allowed. VO11 takes any two picked-up phases and any issued trip to operate a three-pole trip, based on the settings shown in red in Figure 4 and Figure 5 (your virtual output numbers may differ). For the Phase Initiate settings (Figure 5) be sure to set all three phases.



| Quick Connect |
|---------------------------|
| Quick Connect Device |
| Device Definition |
| Target Messages |
| Status |
| Metering |
| Quick Setup |
| Setpoints |
| Device |
| Custom Config |
| Real Time Clock |
| Security |
| Communications |
| Transient Recorder |
| Data Logger |
| Fault Report |
| Event Data |
| Flex States |
| Front Panel |
| Resetting |
| Installation |
| Clear Records |
| - System |
| Current Sensing |
| Voltage Sensing |
| Power Sensing |
| Power System |
| Recloser |
| Recloser Trip Close Logic |
| Common Setup |
| 3 Phase Setup |
| 1 Phase Setup |

- Control

| 3 Phase Set | tup // Quick Connect: Quick Co | nnect Device: Setpoints: System: 🗖 🔳 💌 |
|-------------|--------------------------------|--|
| Save | 🗃 Restore 🔡 Default | |
| - | | |

| SETTING | PARAMETER |
|----------------------|-----------------------------------|
| 3 Pole Trip Input 1 | Virtual Output 11 On (Trp2TOCPKP) |
| 3 Pole Trip Input 2 | Off |
| 3 Pole Trip Input 3 | Off |
| 3 Pole Close Input 1 | Off |
| 3 Pole Close Input 2 | Off |
| 3 Pole Close Input 3 | Off |
| 3 Pole Block | Fixed Wakeup Time |



| Setpoint Group Local Control Mode Breaker Control | | |
|---|--|--|
| Overhead Switch Control | | |
| Pole Discordance | | |
| Wirtual Input Control | 📓 Phase A Initiate // Quick Connect: C | Quick Connect Device: Setpoints: Control: Au 🗖 😐 🎫 |
| ······ Trip Bus | | |
| Breaker Failure | 🖹 Save 📄 Restore 🔛 Defa | ault |
| Synchrocheck 1 | SETTING | PARAMETER |
| Synchrocheck 2 | External Initiate | Off |
| Cold Load Pickup | Initiate IN1 | Trip Bus 1 OP |
| Auto Sectionalizer | Initiate IN2 | |
| Auto Reclose | | Virtual Output 11 On (Trp2TOCPKP) |
| AR Common Setup | Initiate IN3 | Off |
| Three Phase Setup | Initiate IN4 | Off |
| Phase A Setup | Initiate IN5 | Off |
| Phase B Setup | Initiate IN6 | Off |
| Phase C Setup | Initiate IN7 | Off |
| Three Phase Initiate | Initiate IN8 | Off |
| Phase A Initiate | Initiate IN9 | Off |
| Phase B Initiate | Initiate IN10 | Off |
| Phase C Initiate | Initiate IN11 | Off |
| Shot 1 | Initiate IN12 | Off |
| Shot 2 | Initiate IN13 | Off |
| Shot 2 Shot 3 | Initiate IN14 | Off |
| Shot 3 | Initiate IN15 | Off |

Figure 5. Three-pole, Phase Initiate settings (set Phase B and Phase C similarly)

Three-phase lockout

There might be a requirement that the single phases operate separately, but for an any phase lockout condition, all three phases open and lockout. You can set the 850R to open and lock out all three phases if there is a fault on a single phase that progresses to a lockout state. This can be used to prevent extended imbalance on three-phase loads. Most faults are temporary. Most three-phase loads can withstand brief, single-phase interruptions. However, these loads cannot withstand extended single-phase or two-phase power. When a feeder has single-phase and three-phase loads, this option provides continuity for single-phase loads on temporary faults and protects three-phase loads for permanent faults. For example, three-phase loads such as motors can be damaged when



one phase drops. For these loads, it is better to open all three phases at the time of a single-phase lockout. The setting shown in red in Figure 6 performs this operation.

| Setpoint Group Local Control Mode Breaker Control Overhead Switch Control Pole Discordance Virtual Input Control Trip Bus Breaker Failure Synchrocheck 1 SetTING PARAMETER Exaction Faibled Exaction Faibled |
|--|
| Breaker Control Overhead Switch Control Pole Discordance Virtual Input Control Trip Bus Breaker Failure Synchrocheck 1 SETTING PARAMETER |
| Overhead Switch Control Pole Discordance Vitual Input Control Trip Bus Breaker Failure Synchrocheck 1 SETTING PARAMETER |
| Pole Discordance Image: AR Common Setup // Quick Connect: Quick Connect Device: Setpoints: C Vitual Input Control Trip Bus Image: Breaker Failure Image: Save Synchrocheck 1 SETTING PARAMETER |
| Ortual Input Control Trip Bus ⊕ Breaker Failure Synchrocheck 1 SETTING PARAMETER |
| Trip Bus Save Default Breaker Failure Save Breatore Synchrocheck 1 SETTING PARAMETER |
| Breaker Failure Synchrocheck 1 SETTING PARAMETER PARAMETER |
| -Synchrocheck 1 SETTING PARAMETER |
| Contraction Contraction |
| Synchrocheck 2 |
| Lindblog |
| Cold Load Pickup AR Control Mode 1Ph |
| Auto Sectionalizer |
| All Phase LO Initiation Any Phase Lockout |
| Three Phase Setup Maximum Number Shots 2 |
| Phase A Setup Close Failure On |
| Phase B Setup Close Failure Time 2.000 s |
| Phase C Setup Manual Close Reset Off |
| Three Phase Initiate Manual Close Reset Time 5.000 s |
| Phase B limitate Incomplete Sequence Time 20.000 s |
| Phase C Initiate Reset Time 10.000 s |

Figure 6. All Phase Lockout Initiation setting

Ground blocking

For single-pole tripping applications it might be necessary to block the ground tripping elements during reclosing. In this case, consider the zero-sequence (3I_0) magnitude. An open phase causes imbalance, which increases 3I_0 current. A false operation could occur if 3I_0 magnitude rises above the setpoint for the neutral or ground elements. By factory default, programmable pushbutton PB 4 is mapped to Ground Trip Enable for all ground elements, as shown in Figure 7.

| 🖹 Save 🔛 Restore 🔛 | Default |
|--------------------|--------------------------|
| SETTING [GROUP 1] | PARAMETER |
| Ground TOC 1 | |
| Function | Disabled |
| Input | Phasor |
| Pickup | 1.000 x CT |
| Curve | IEEE Moderately Inverse |
| TDM | 1.00 |
| Reset | Instantaneous |
| Direction | Disabled |
| Block | PB 4 OFF (GndTrip Enbld) |
| Relays | Relay : Disabled |
| Events | Enabled |
| Targets | Self-Reset |

Figure 7. Factory default settings for Ground TOC1 Block

To retain pushbutton PB 4 functionality, as well as block the ground elements for any phase open, create the logic shown in Figure 8 and apply the settings shown in red in Figure 9 (your virtual output numbers may differ).

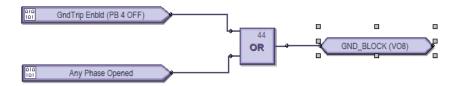


Figure 8. Ground-block logic



| Protection i⊐ Group 1 i⊐ Current | | |
|---|-----------------------------|--|
| Phase TOC Phase IOC Phase Directional OC Neutral TOC | Ground TOC // Quick Connect | : Quick Connect Device: Setpoints: Protection: |
| Neutral IOC | SETTING [GROUP 1] | PARAMETER |
| Neutral Directional OC | Ground TOC 1 | |
| Ground TOC | Function | Trip |
| Ground IOC | Input | Phasor |
| Ground Directional OC | Pickup | 0.500 x CT |
| Restricted Ground Fault | Curve | ANSI Very Inverse |
| Switch On To Fault | TDM | 1.00 |
| Negative Sequence TOC | Reset | Instantaneous |
| Negative Sequence IOC Negative Sequence Directional OC | Direction | Disabled |
| Broken Conductor | Block | Virtual Output 8 On (GND_BLOCK) |
| Load Encroachment | Relays | Relay : Disabled |
| Undercurrent | Events | Enabled |
| Themal Overload | Targets | Self-Reset |

Figure 9. Ground Block settings using pushbutton PB 4

If pushbutton PB 4 functionality is not needed, apply the Block settings shown in red in Figure 10.

| 📳 Ground TOC // Quick Connect: Quick Connect Device: Setpoints: Protection: 😑 💷 💌 | | |
|---|-------------------------|--|
| Save Restore | Default | |
| SETTING [GROUP 1] | PARAMETER | |
| Ground TOC 1 | | |
| Function | Trip | |
| Input | Phasor | |
| Pickup | 1.000 x CT | |
| Curve | IEEE Moderately Inverse | |
| TDM | 1.00 | |
| Reset | Instantaneous | |
| Direction | Disabled | |
| Block | Any Phase Opened | |
| Relays | Relay : Disabled | |
| Events | Enabled | |
| Targets | Self-Reset | |

Figure 10. Ground Block settings, no pushbutton-PB4 functionality

Summary

The application and settings in this application note are a guide to help you design your single-pole tripping schemes. If you want to include other functionality, please contact your technical support representative. Factory technical support can be reached at 1-800-547-8629, or email: <u>multilin.tech@ge.com</u>.