Phase-Loss Isolation

Overview

The **Phase-Loss Isolation** (PLI) feature of the IntelliTeam® SG Automatic Restoration System uses both IntelliTeam SG system peer-to-peer communication between team members and voltage sensing at the controls to provide detection of loss of voltage on one or two phases and isolate the problem section when overcurrent elements do not trip. A common application for this feature is to detect and isolate a broken conductor.

The **Phase-Loss Isolation** function is different than the **Phase-Loss Sectionalizing** function. **Phase-loss Sectionalizing** is the conventional automatic-sectionalizing feature that, when enabled, opens the switch to protect downstream 3-phase load from being single-phased because of an upstream open conductor or blown fuse. **Phase-Loss Sectionalizing** is part of the switch control logic whereas the **Phase-Loss Isolation** function is part of the IntelliTeam SG system application logic.

The IntelliTeam SG system operates based on the connectivity of each feeder in the IntelliTeam SG system. By combining connectivity information with the voltage sensing at each control, IntelliTeam SG system software provides phase-loss isolation. For this feature to function properly, all controls must be configured with IntelliTeam Designer to use **Phase-Loss Isolation** mode and have their individual **Phase-Loss Sectionalizing** function enabled. See Figures 1 and 2 on page 3 for configuration examples.

Phase-Loss Sectionalizing

The **Phase-Loss Isolation** feature is used primarily for overhead circuits, but it is also supported in Vista® Underground Distribution Switchgear with S&C 6802 Automatic Switch Controls and PME/PMH Pad-Mounted Switchgear with S&C 6802/3 controls, which are commonly used in mixed systems that include both overhead and underground line segments.

The **Phase-Loss Isolation** feature requires the sectionalizing/interrupting devices to have their **Phase-Loss Sectionalizing** feature enabled. Sectionalizing must be configured properly for phase-loss isolation to take action because the core phase-loss sectionalizing logic must detect the voltage loss and perform timing to fully qualify the phase-loss condition.

When the sectionalizing/interrupting device is a third-party device installed with an IntelliNode™ Interface Module, the **Phase-Loss Sectionalizing** function must be enabled in the IntelliNode module. To properly configure an IntelliNode module for phase-loss isolation with the IntelliTeam SG system, you must have the **Extended VLoss and Single Phase VLoss** setting in the **Enabled** state and the **Extended VLoss and Single Ph. VLoss Protection Type** setpoint set to the **Extended 1Ph and 3Ph VLoss** setting as shown in Figure 3 on page 4.

Phase-loss sectionalizing instructions for the IntelliNode module are in Instruction Sheet 1043-530, "S&C IntelliNode™ Interface Module: *Setup*." IntelliRupter® fault interrupter phase-loss sectionalizing instructions are in Instruction Sheet 766-530, "S&C IntelliRupter® PulseCloser® Fault Interrupter: *Setup*," and 6800 Series Automatic Switch Control phase-loss sectionalizing instructions are in Instruction Sheet 1045-530, "S&C 6800 Series Automatic Switch Controls: *Setup*." It's important to configure all devices in the circuit with similar phase-loss sectionalizing timing. The IntelliTeam SG restoration system's distributed intelligence architecture can tolerate some mis-coordination of voltage-element timing, but significant mis-coordination will cause unexpected results.

When the **Phase-Loss Sectionalizing** mode is not enabled, the device cannot take part in a **Phase-Loss Isolation** operation. For example, a downstream switch that experiences a phase-loss trip cannot complete the phase-loss isolation event, when the source switch's **Phase-Loss Sectionalizing** mode is in the **Disabled** state. This is because it is impossible for the IntelliTeam SG system to know that switch was experiencing a phase-loss condition.

There are additional considerations when configuring phase-loss sectionalizing for an IntelliRupter fault interrupter and phase-loss protection for 6800 Series Automatic Switch Controls because their phase-loss schemes can be configured so they will only operate when the IntelliTeam SG system is in the **Ready** state.

To use the **Phase-Loss Isolation** feature with IntelliRupter fault interrupters, the IntelliRupter fault interrupter **Single-Phase Protection and Sectionalizing** element can be set to either **Yes** or **IntelliTeam SG** mode and the **Trip on Single Phase Voltage** element should be set to the **No** state. See Figure 1 on page 3. For either setting, when IntelliTeam operation is enabled and in the **Ready** state, the **Inform** mode will be in effect. See the "Inform Mode" section on page 5.

However, when the IntelliTeam system is not in the **Ready** state and the **Sectionalizing** element is set to the **Yes** state, the **Sectionalizing** element will trip based only on its native settings. But, when the IntelliRupter **Sectionalizing** element is set to the **IntelliTeam SG** mode, the element can only trip when the IntelliTeam system is in the **Ready** state. When the IntelliTeam system is not in the **Ready** state and the **Sectionalizing** element is set to the **IntelliTeam SG** mode, the element will not respond.

The 6800 series control's **Phase-Loss Protection** feature works in the same manner as the **Phase-Loss Sectionalizing** element works on the IntelliRupter fault interrupter. The same rules apply for whether the 6800 series control's **Phase-Loss Protection** feature is set to the **Yes** or **IntelliTeam SG** mode and whether the IntelliTeam system is in the **Ready** state, as described for the IntelliRupter fault interrupter. See Figure 2 on page 3.

Application of the **Phase-Loss Isolation** feature on systems with mixed control types requires additional consideration of how the voltage elements will respond to system events. The 6800 series controls and the IntelliNode modules use the voltage magnitude of individual phases to detect single-phase loss-of-voltage problems. This is a simple element and is easy to set up, but it may miss detecting an event when voltage on the problem phase is supported by phase-to-phase loads or transformers. On the other hand, IntelliRupter fault interrupters use all six voltage sensors, negative-sequence and zero-sequence elements to detect single-phase loss-of-voltage problems.

The elements can be more difficult to set up, but this is a more dependable method of detecting a single-phase voltage problem. Therefore, when using the **Phase-Loss Isolation** feature on a system with different controls and with phase-to-phase connected loads or transformers, configure the **Time-to-Trip** setpoint to be the same in all devices, and the IntelliTeam SG system will select the best switches to open or close.

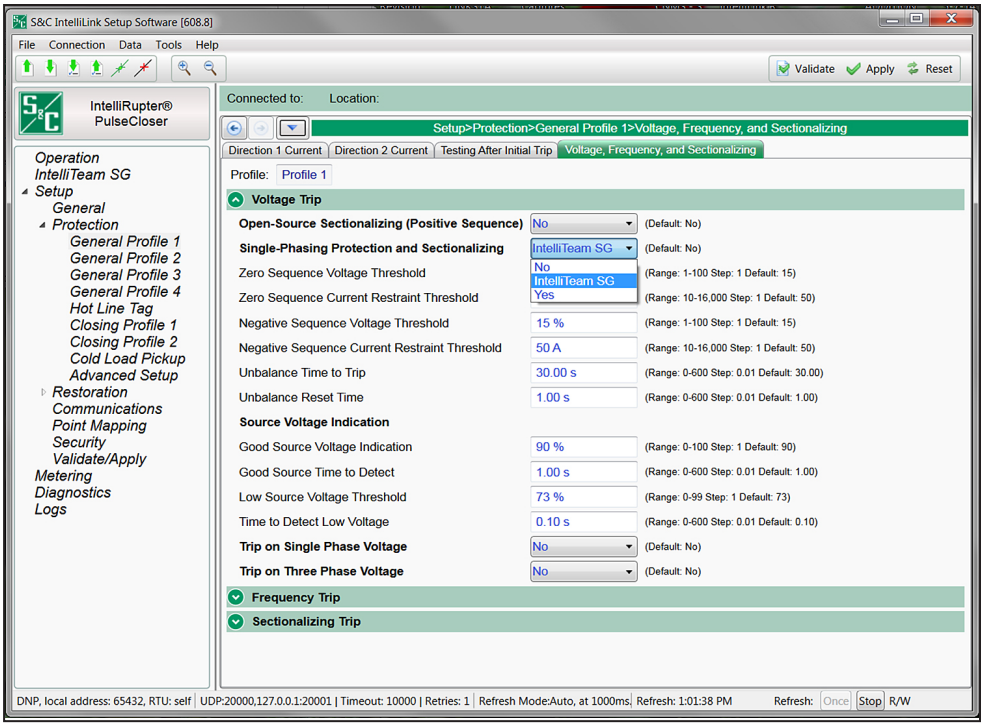

Figure 1. The IntelliRupter fault interrupter Phase-Loss Sectionalizing settings.

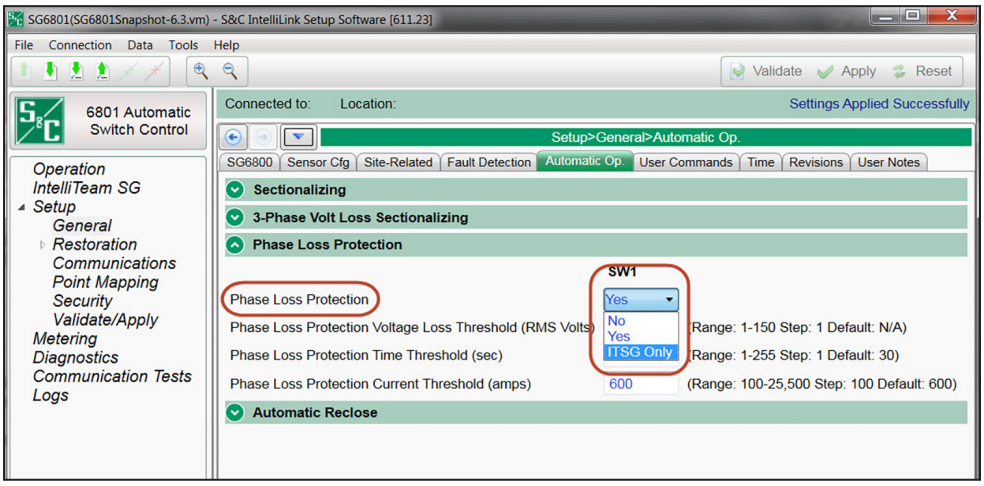

Figure 2. The 6800 series control Phase-Loss Protection settings.

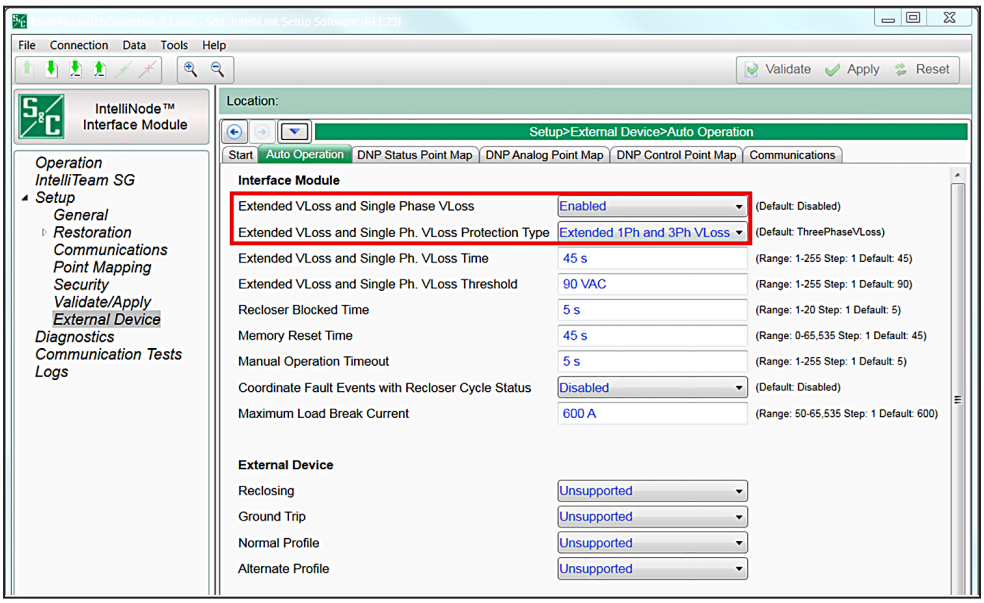

Figure 3. The IntelliNode Interface Module Phase-Loss Protection settings.

Inform Mode

When using the IntelliTeam SG **Phase-Loss Isolation** function with the **Rapid Self-Healing** (RSH) function, the **Phase-Loss Sectionalizing** element operates in the **Inform** mode instead of tripping and locking out the device on its own. The **Phase-Loss Sectionalizing** feature will tell the IntelliTeam SG system when it detects an event and then waits for the IntelliTeam SG system to supervise the operation.

The **Inform** mode is active when the IntelliTeam SG system **Phase-Loss Isolation** feature and the device's **Phase-Loss Sectionalizing** mode are both in the **Enabled** state and the **Rapid Self-Healing** feature is also in the **Enabled** state. When **Inform** mode is active, instead of opening on single-phase sectionalizing logic, all controls will inform the IntelliTeam SG system about the condition, and the IntelliTeam SG system will locate and isolate the problem section. All other downstream controls that are not involved with the phase-isolation event will remain closed and will wait for the IntelliTeam SG system with the **Rapid Self-Healing** feature in the **Enabled** state to restore all unaffected line segments.

The **Inform** mode is not used when the **Phase-Loss Isolation** feature is in the **Enabled** state and the **Rapid Self-Healing** feature is in the **Disabled** state. Configured this way, all switches will open for the phase-loss event (per their **Phase-Loss Sectionalizing** settings) and when all switches are open the IntelliTeam SG system will restore teams up to the place where the phase-loss event occurred.

Note: The **Inform** mode is always used at an open switch regardless of the state of the **Rapid Self-Healing** feature or the configured options for the **Phase-Loss Isolation** feature. The reason for this is the IntelliTeam SG system needs to initiate phase-loss isolation when there is an open conductor in the line segment directly adjacent to the open switch. In this situation, the only switch that may see the phase-loss condition is the open switch (if there are voltage sensors on that side). Normal phase-loss isolation logic can't do anything, because the switch is already open. With the **Inform** mode enabled at the normally open switch, the IntelliTeam SG system will request that the switch logic report the phase-loss condition, so the **Phase-Loss Isolation** feature will open the source switch to isolate the phase-loss section.

Note: While **Inform** mode, when active and enabled, prevents the **Phase-Loss Sectionalizing** logic from opening a switch, regardless of the time it takes to complete phase-loss isolation, it has no affect on other forms of protection or sectionalizing logic. The switch may still be opened by switch logic for those other reasons. If this occurs, the IntelliTeam SG system logic will assess the state of the system to determine what is needed to isolate the problem area and restore teams around it.

Enabling Phase-Loss Isolation

Devices with gold IntelliTeam SG system licenses can be configured for phase-loss isolation. A validation error will occur when a bronze license is used.

Follow these steps to configure a device to participate in phase-loss isolation:

STEP 1. Enable the **Phase-Loss Isolation** feature with IntelliTeam Designer software by clicking the **Team Attributes** tab, highlighted in Figure 4.

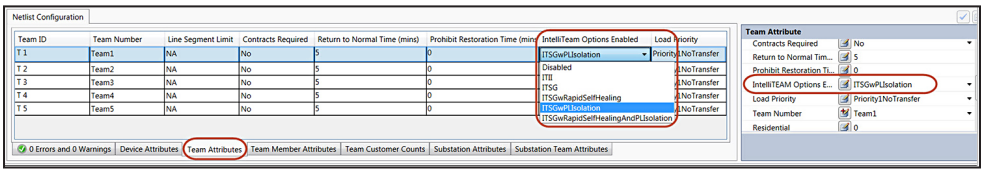

Figure 4. Use the Team Attributes tab to enable the Phase-Loss Isolation feature.

STEP 2. Select the device by clicking the appropriate Team ID entry in the left column.

STEP 3. In the Team Attribute editor on the right, select either **ITSGwPLIsolation** or **ITSGwRapidSelf-HealingAndPLIsolation** option from the list provided for the **IntelliTeam Options Enabled** setting, or select it in the IntelliTeam Options Enabled column in the **Team Attributes** tab.

Table 1 on page 7 shows all configurations of the applicable **Phase-Loss Isolation** settings in the IntelliTeam SG system application, the **Phase-Loss Sectionalizing** settings of the IntelliRupter fault interrupter and 6800 series controls, and resulting behavior.

Legends for Table 1:

PL Sect: **No/Yes/IT-SG Only** state of the **Phase-Loss Sectionalizing** feature (control settings)

IT-SG: **Off/On** state of the IntelliTeam SG system (IntelliTeam system settings)

PLI: **Off/On** state of the **Phase-Loss Isolation** feature (IntelliTeam system settings)

w/RSH: **Off/On** state of the **Phase-Loss Isolation with Rapid Self-Healing** feature (IntelliTeam system settings)

Ready: **Yes/No** state of the team **Ready** state (IntelliTeam system state)

Table 1. Phase-Loss Isolation and Phase-Loss Sectionalizing 6800 Series Control Settings

PL Sect	IT-SG	PLI	w/RSH	Ready	Result
No	—	—	—	—	Switch will not open based on phase-loss sectionalizing or PLI
Yes	No	—	—	—	Switch will always open based on qualified loss of voltage for phase-loss sectionalizing
Yes	Yes	No	—	—	Switch will always open based on qualified loss of voltage for phase-loss sectionalizing
Yes	Yes	Yes	No	Yes	Switch always opens on qualified loss of voltage for phase-loss sectionalizing; performs PLI as necessary to isolate the broken conductor
Yes	Yes	Yes	No	No	Switch always opens on qualified loss of voltage for phase-loss sectionalizing; no PLI performed
Yes	Yes	Yes	Yes	Yes	Switch qualifies voltage loss for phase-loss sectionalizing but does not open (**Inform Mode** active); performs PLI to open source and load switches of the broken-conductor team only
Yes	Yes	Yes	Yes	No	Switch always opens on qualified loss of voltage for phase-loss sectionalizing (**Inform Mode** not active); no PLI performed
IT-SG	No	—	—	—	Switch does not use phase-loss sectionalizing logic
IT-SG	Yes	No	—	Yes	Switch opens on qualified loss of voltage for phase-loss sectionalizing; no PLI performed
IT-SG	Yes	No	—	No	Switch does not use phase-loss sectionalizing logic
IT-SG	Yes	Yes	No	Yes	Switch opens on qualified loss of voltage for phase-loss sectionalizing, performs PLI as necessary to isolate the broken conductor
IT-SG	Yes	Yes	No	No	Switch does not use phase-loss sectionalizing logic; no PLI performed
IT-SG	Yes	Yes	Yes	Yes	Switch qualifies loss of voltage for phase-loss sectionalizing but does not open (**Inform Mode** active); performs PLI to open source and load switches of the broken-conductor team only
IT-SG	Yes	Yes	Yes	No	Switch does not use phase-loss sectionalizing logic; no PLI performed

Table 2 on page 9 shows all configurations of the applicable **Phase-Loss Isolation** settings in the IntelliTeam SG system application, the **Phase-Loss Sectionalizing** settings of the IntelliNode Interface Module, and resulting behavior.

Legends for Table 2:

EVL/SVL:	**Enable/Disable** state of the **Extended Voltage Loss and Single Phase Voltage Loss** sectionalizing setting (IntelliNode module setting)
EVL/SVL Type:	**ThreePhaseVLoss** or **Extended 1Ph and 3Ph VLoss** state of the **Extended Voltage Loss and Single Phase Voltage Loss Protection Type** setting (IntelliNode module setting)
IT-SG:	**Off/On** state of the IntelliTeam SG system (IntelliTeam system settings)
PLI:	**Off/On** state of the **Phase-Loss Isolation** feature (IntelliTeam system settings)
w/RSH:	**Off/On** state of the **Phase-Loss Isolation with Rapid Self-Healing** feature (IntelliTeam system settings)
Ready:	**Yes/No** state of the team **Ready** state (IntelliTeam system state)

Table 2. Phase-Loss Isolation and Phase-Loss Sectionalizing IntelliNode Interface Module Settings

EVS/SVL	EVL/SVL Type	IT-SG	PLI	w/RSH	Ready	Result
Disabled	—	—	—	—	—	Switch will not open as all options are disabled
Enabled	3-P VL	No	—	—	—	Switch does not use phase-loss sectionalizing logic
Enabled	3-P VL	Yes	—	—	No	Switch does not use phase-loss sectionalizing logic
Enabled	3-P VL	Yes	—	—	Yes	Switch opens on qualified 3-phase voltage loss, no PLI performed
Enabled	3-P VL	Yes	Yes	No	No	Switch does not use phase-loss sectionalizing logic at all, no PLI performed (The setting of 3-P VL only is incompatible with PLI. This setting combination is not recommended.)
Enabled	3-P VL	Yes	Yes	No	Yes	Switch opens on qualified 3-phase voltage loss, no PLI performed (The setting of 3-P VL only is incompatible with PLI. This setting combination is not recommended.)
Enabled	3-P VL	Yes	Yes	Yes	No	Switch does not use phase-loss sectionalizing logic at all, no PLI performed (The setting of 3-P VL only is incompatible with PLI. This setting combination is not recommended.)
Enabled	3-P VL	Yes	Yes	Yes	Yes	Switch opens on qualified 3-phase voltage loss, no PLI performed (The setting of 3-P VL only is incompatible with PLI. This setting combination is not recommended.)
Enabled	3+1-P VL	—	—	—	—	Switch does not use phase-loss sectionalizing logic
Enabled	3+1-P VL	No	—	—	—	Switch does not use phase-loss sectionalizing logic
Enabled	3+1-P VL	Yes	—	—	No	Switch does not use phase-loss sectionalizing logic at all, no PLI performed
Enabled	3+1-P VL	Yes	—	—	Yes	Switch opens on qualified 3-phase or 1-phase voltage loss, no PLI performed
Enabled	3+1-P VL	Yes	Yes	No	No	Switch does not use phase-loss sectionalizing logic at all, no PLI performed
Enabled	3+1-P VL	Yes	Yes	No	Yes	Switch opens on qualified 3-phase voltage loss, or if it is a 1-phase voltage loss event, then switch opens on qualified 1-phase loss and then performs PLI as necessary to isolate the broken conductor
Enabled	3+1-P VL	Yes	Yes	Yes	No	Switch does not use phase-loss sectionalizing logic at all; no PLI performed
Enabled	3+1-P VL	Yes	Yes	Yes	Yes	Switch opens on qualified 3-phase voltage loss, or if it is a 1-phase voltage loss event, switch qualifies voltage loss for phase-loss sectionalizing but does not open (**Inform Mode** active); performs PLI to open source and load switches of the broken-conductor team only

Limitations

IntelliTeam system devices are normally installed with three voltage sensors. If any team member has been installed with only one voltage sensor, that team should not have the **Phase-Loss Isolation** feature set to the **Enabled** state. To use the **Phase-Loss Isolation** feature on teams that incorporate multi-switch devices and a common bus between the team members, three-phase voltage sensing is required at all team switch positions in the multi-switch device.