LIMITATIONS

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1 Introduction
Loop Automation is a Distribution System Automation (DSA) scheme that will automatically restore supply to fault free sections of a network if they have been disconnected because of a fault in another section of the network. Loop Automation can also restore the normal network configuration automatically after the faulted section has been repaired.

The distributed intelligence embedded in the Reclosers operates the scheme without communications or operator intervention by using the built-in voltage detection of the Centurion Reclosers. No additional equipment is required for Loop Automation. As a result Utilities, with or without SCADA communications, can easily introduce Loop Automation into most network configurations.

Centurion Reclosers equipped with CAPM4 controllers require a firmware upgrade for Loop Automation. External CVTs may also be required. Please consult with your Siemens PT&D, Inc. representative.

Please note:
- It is important to read this manual in conjunction with the Installation-Operation-Maintenance manual or other applicable technical manuals.
- References to Operator Control Panel display pages appear as {DISPLAY GROUP – PAGE TITLE: Text}.

2 How to Use this Manual
This manual is prepared in four main parts as follows:
- Part 1 – Understanding Loop Automation. This part gives the basic concepts and principles that are essential reading to understand Loop Automation.
- Part 2 – Configuring a Loop Automation Scheme. This part explains more about how Loop Automation works and gives the method for working out the settings to ensure correct operation.
- Part 3 – Loop Automation In Service. This part provides recommendations for installing and testing Loop Automation as well as advice on operational procedures.
- Appendices - Network Examples. This part contains examples of Loop Automation. This is a very useful extension to the manual that should be studied to gain further understanding of Loop Automation.

WARNING

As with any arrangement where automatic operation takes place, a danger exists that maintenance personnel may attempt to isolate a section of the network without realizing that supply to the section may be automatically restored via an alternate supply path.

It is therefore essential that Supply Authority personnel be fully trained in the operation and maintenance of the Loop Automation systems prior to their use on Distribution systems.

It is strongly recommended that each Recloser that is part of Loop Automation be supplied with a clearly visible external label, warning that the Recloser is part of a Loop Automation scheme and further that the Recloser could automatically trip or close at any time.

1 SCADA Supervisory Control and Data Acquisition system
3 About this Manual

3.1 Aim of the Manual

This manual describes the operation of Loop Automation and how Centurion Reclosers are configured to implement this scheme. This manual is intended for use by the following:

- Linepersons.
- System Administrators.
- Network Supervisors.

While every care has been taken in preparation of this manual, no responsibility is taken for loss or damage incurred by the purchaser or user due to any error or omission in this document.

3.2 Controller Version Covered by this Manual

This manual applies to CAPM4&5 based controllers. When switched on, the Operator Control Panel briefly displays the CAPM type. If “CAPM4” or “CAPM5” is not displayed, this manual does not apply; please contact your Siemens PT&D, Inc. representative to obtain the correct manual.

3.3 Software Version Covered by this Manual

The electronic controller incorporates a software based microprocessor. The firmware version and configuration (see Section 3.4 below) determine the functionality of the controller.

To confirm that this manual applies to the software/configuration loaded in the controller it is necessary to display the Software Capability list on the Operator Control Panel. The list is found on the \{SYSTEM STATUS – CAPABILITY\} page (advice on using the Operator Control Panel is provided in the equipment specific technical manual).

Press the Select key and use the arrow keys to view the capability list. This manual applies if the capability declarations include the following message:

<table>
<thead>
<tr>
<th>Firmware</th>
<th>026-12.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configuration</td>
<td>10087</td>
</tr>
</tbody>
</table>

When contacting Customer Service for technical support, please have both the version number and the configuration number readily available at the time of the call. Without this information, the Customer Service representative will be unable to provide a meaningful level of support.

3.5 Year 2000 Compliance Statement

This software complies with rules 1, 2, 3 and 4 of the British Standards Institute Year 2000 Conformity Requirement (DISC PD2000-1 A Definition of Year 2000 Conformity Requirements). A copy of this statement can be found on the Siemens PT&D, Inc. (www.siemenstd.com).

If this message does not appear, please contact your local Siemens PT&D, Inc. representative.

3.4 Software Identification System

The software loaded into the controller has two important identification numbers:

- The Firmware Version that has the form XXX-XX.XX. This identifies the exact firmware version loaded into non-volatile program memory.
- The Configuration Number with the form XXXXX. This identifies the configuration loaded into the database that controls the device functionality. For example, a configuration determines whether text on the MJ-R Operator panel is displayed in English or another language.
Part 1 – Understanding Loop Automation

4 What Loop Automation Does

Loop Automation reconfigures a network to return supply to fault free sections that have lost supply due to a fault condition on another section of the network.

4.1 Types of Recloser

Loop Automation relies on the team of Reclosers in the network being correctly configured as either a:

- **Feeder Recloser** (or Sectionalizer Recloser) - this Recloser is positioned close to the substation.
- **Tie Recloser** - used as the open point where two feeders meet and is the normally open point in the network.
- **Mid-Point Recloser** - this Recloser is positioned anywhere on the network between a Feeder and Tie Recloser.

4.2 Fault Isolation and Network Re-Configuration

Consider the example network shown at Figure 1, Loop Automation Network. Note that it shows a fault condition on Section B.

With Loop Automation enabled, the following operational sequence is initiated:

- Overcurrent protection trips the Feeder Recloser on the upstream side of the fault. This is just the normal protection, not a Loop Automation function.
- The Feeder Recloser may trip and auto-reclose several times in an attempt to clear the fault. It is only after the auto-reclose sequence has finished and the Recloser is locked out (end of sequence) that the Loop Automation operation starts.
- Loop Automation then closes the Tie Recloser.
- The Mid-Point Recloser trips under protection due to the fault on section B and goes directly to lockout without an auto-reclose.
- This action isolates section B and reconfigures the network to provide supply to section C.

In this example, the Feeder Recloser that trips due to the fault; the Tie Recloser detects the loss of supply in section C and closes automatically. The Mid-Point Recloser also detected the same loss of supply and tripped 1-shot to lockout when the Tie Recloser closed onto the fault.

The distributed algorithm that controls the operation of these Reclosers is further explained in Section 5.

4.3 Auto-Restoration Option

The process of isolating the faulted section and reconfiguring the network to supply power to the unfaulted sections is the first capability of Loop Automation.

Loop Automation can also auto-restore the original network configuration when the fault on section B is removed. It does this by:

- Detecting that section B has been re-energized by the lineperson who will have closed either the Feeder or Mid-Point Recloser after repairing the fault.
- Automatically closing the remaining open point (either the Mid-Point or Feeder Recloser) to close the network loop.
- Automatically opening the Tie Recloser.
- The normal configuration is now restored.

Note that this auto-restore capability is an option. If the network cannot be run as a closed loop then auto-restore cannot be used and must be turned off.

The distributed algorithm that controls this auto-restore capability is further explained in Section 5.

5 Understanding Isolation & Re-Configuration

5.1 Overview

The basic rules of Loop Automation which cause Isolation and Re-configuration are as follows:

Rule A: A Feeder Recloser trips when it loses supply.
Rule B: A Mid-point Recloser changes to the ‘B’ Protection Group and changes to single-shot mode for a short time when it loses supply.
Rule C: A Tie Recloser closes when it detects the supply to one side of the network has been lost and that it still has supply available on the other side.

These simple rules are used to isolate and reconfigure the network for all possible faults. The following sections show how these rules are utilized. Note that the above rules are simplifications; – the full rules are given in Appendix A.

5.2 Faults in Other Sections of the Network

What happens for faults in other sections of the network? Each scenario is explored below using the
network example as shown in Figure 1: Example of Loop Automation Network.

5.2.1 Fault In Section A
In this scenario, the Circuit Breaker (CB) at the zone-substation will open and supply will be lost to the Feeder Recloser which will then be tripped by Loop Automation (Rule A).

Supply is also lost to the Mid-Point Recloser causing it to change to the ‘B’ protection group and go to single shot mode (Rule B).

Similarly, supply is also lost to the Tie Recloser that now closes (Rule C) and restores supply to the un-faulted B and C sections.

Note: This time the tie Recloser does not close onto a fault. Instead, after a delay the Mid-Point Recloser will time out of single shot mode and be ready to auto-reclose if new faults don’t develop on section B.

5.2.2 Protection Groups
Note: After the isolation and reconfiguration process, the Mid-Point Recloser operates on the group ‘B’ settings. The B settings must also be set up in advance to allow proper co-ordination when the network is fed from the “reverse” direction.

How does the Tie Recloser select settings to activate? The Tie Recloser selects settings automatically based on the side of the tie Recloser detected as having lost supply. If a load side loss is detected, the group ‘A’ settings are activated. If a source side loss is detected, the group ‘B’ settings are activated.

5.2.3 Fault in Section C
In this scenario the Mid-Point Recloser trips to lockout due to the fault; the Tie Recloser senses the loss of supply and closes onto the fault (Rule C). Prior to closing, the Tie Recloser automatically reverts to single shot mode and trips & locks at fault closing.

Note: In this example, the fault was located on the last section of line before the open point. Therefore, Loop Automation cannot restore supply to this section.

5.2.4 Faults in Sections D and E
Isolation and reconfiguration in sections A and C are similar to C and D. It is suggested that the reader methodically work through each section in turn with the Rules to verify correct operation with and without a mid-point Recloser.

5.3 Purpose of Feeder Recloser
It is logical to ask the question “what is the purpose of the Feeder Recloser, or “why couldn’t a Mid-Point Recloser “ have been used?

The answer is the Feeder Recloser is always closest to the source of supply and must never feed power in the reverse direction. The intent of Rule A is to insure the feeder opens to isolate the source to prevent reverse feed of the source after Loop Automation reconfigures the circuit.

On the other hand a Mid-Point Recloser has different rules allowing it to feed power in both directions. As a result, a Loop network is not required to have a Mid-Point Recloser but must always have a Feeder Recloser.

Ideally, the Recloser Feeder Recloser should be located in the zone substation for maximum coverage of the network by the Loop Automation scheme.

5.4 Asymmetric Tie Recloser Operation
In some networks, it may not be desirable to reconfigure the network on both sides of the tie point. To accommodate this, the tie Recloser has an optional “Tie Restore One Way” setting. When selected, the tie Recloser automatically restores supply, but only in the event the load side supply is lost. An example is given in Section 7.

5.5 Loss of Supply to the Zone Substation
Supply can be lost to the zone substation due to a transformer fault or a transmission network fault. In these cases both Feeder Reclosers trip. (Section A fault-Rule A). Also, since the fault was caused by a loss of supply to both feeders, Loop Automation will not close the Tie Recloser (Rule C).

Loop Automation does not normally close the Feeder Reclosers when supply is restored. However, with Auto-Restore, the Feeder Reclosers can be configured to close after supply restoration (Section 6 - Rule D).

5.6 Loop Automation Timeout
Loop Automation is triggered by supply voltage being lost or restored on the power lines. Loss of power also occurs during a normal auto-reclose sequence.

Therefore, to prevent Loop Automation from operating during normal auto-reclose sequences, a sufficient delay must elapse before Loop Automation algorithms initiate. This user-selected time delay should greater than the longest auto-reclose sequence and is called the Loop Automation Timeout.

After supply is lost the feeder and Mid-Point Reclosers must obey rules A and B (Refer page 4) before the tie Recloser closes under Rule C. The Loop Automation Timeout is set for a longer period in the Tie Recloser than the other Reclosers to achieve this coordination. The Loop Automation Timeout may typically be set to 30 seconds in the Feeder and Mid-Point Reclosers and 40 seconds in the Tie Recloser.

Part 2 of this manual gives a detailed procedure for configuring these timers.
6 Understanding Auto-Restoration

6.1 Overview

The Auto-Restore feature closes the Feeder and Mid-Point Reclosers and opens the Tie Recloser to restore the normal network configuration after a fault condition has been cleared. The basic rules of Auto-Restore are as follows:

Rule D: A Feeder Recloser closes when its source supply is restored if Loop Automation caused the condition, or when it has supply restored to both sides.

Rule E: A Mid-point Recloser closes when it has supply restored to both sides.

Rule F: A Tie Recloser trips when it detects a 50% reduction or a direction reversal in the power flowing through it.

These simple rules will restore the network to its normal operating configuration after a faulted section has been repaired; the following sections explain how this works.

Note that the above rules are simplifications – the full rules are given in Appendix A.

6.2 Auto-Restoration Examples

To gain an understanding of how Auto-Restoration works for the network fault conditions discussed earlier, consider each of the following scenarios while referring to the network drawn below each example.

6.2.1 Auto-Restore from Fault in Section A

In this scenario, the fault condition initiated Loop Automation and supply is now restored through the closed Tie Recloser to Section C up to the open Feeder Recloser. The Mid-Point Recloser remained closed and the substation CB has tripped.

When the lineperson physically clears the fault condition and closes the substation CB, the Feeder Recloser will sense supply to both sides and close (Rule D).

Figure 2: Auto-Restoration - Section A

With the Feeder Recloser now closed, the zone substation would take up a substantial proportion of the feeder load. The Tie Recloser would therefore detect a significant drop in power flow and would trip (Rule F), restoring the normal network configuration. Because Loop Automation remained ON at the Tie there is no need to manually re-arm Loop Automation at that Recloser.

6.2.2 Auto-Restore from Fault in Section B

In this scenario, the fault condition initiates Loop Automation. Supply is restored through the closed Tie Recloser to Section C up to the open Mid-Point Recloser. The Feeder Recloser is also now open.

When the lineperson physically clears the fault condition, re-arms Loop Automation and closes the Feeder Recloser, the Mid-Point Recloser will sense supply to both sides and close (Rule E). Alternatively, the lineperson may clear the fault condition and then close the Mid-Point Recloser. The Feeder Recloser will then sense supply at both sides and close (Rule D).

Figure 3: Auto-Restoration - Section B

The Tie Recloser detects either a 50% reduction or directional change of power flow through it and trips (Rule F) to restore the network to normal configuration.

6.2.3 Auto-Restore on Fault Condition in Section C

In this scenario, the fault condition initiates Loop Automation when supply is lost to Section C. The Mid-Point Recloser is now open. The Tie Recloser goes to single shot mode, closes, and trips 1 shot to lockout.

When the lineperson physically clears the fault condition and closes the substation CB, the Feeder Recloser will sense supply to both sides and close (Rule D).

Figure 4: Auto-Restoration - Section C
The Tie Recloser detects supply on both sides and remains open. The lineperson must then re-arm Loop Automation at the Tie Recloser.

7 Supply Auto-Changeover

7.1 Overview
In addition to improving the quality of supply in a network, Loop Automation can also be used to provide a secure supply to a critical load (e.g., a hospital) by implementing an Auto-Changeover (ACO) scheme.

7.2 Description
The following figure shows two Reclosers, one normally open (Tie Recloser) and the other normally closed (Feeder Recloser).

![Figure 5: Loop Automation used with a Critical Load](image)

Note that when using Loop Automation as an Auto-Changeover scheme, the Tie Recloser must be configured to “Tie Restore One Way” so that it will not close to back-feed the alternative supply if it is lost.

- For this to work correctly, the bushings on the side marked "A" must be configured as the Source Side and the bushings on the side marked "B" as the load side.

At Loss of Supply:

- When the Feeder Recloser detects a loss of supply it trips (Rule A) and the Tie Recloser closes (Rule C), restoring supply to the critical load from the alternate source. This can only happen if the alternate supply is available.

If Auto-Restore is enabled:

- The Feeder Recloser will close (Rule D) when the normal power supply returns.

- The Tie Recloser will trip provided that the power flow through the tie reduces by 50% or more (Rule F).

8 “Lockout” and “End of Sequence”

For a Recloser without any automation facilities enabled, a permanent fault will cause the Recloser to go through a sequence of trip and reclose operations, finally ending up with the Recloser in the open “Lockout” condition. The Recloser will not close while in this state without operator intervention.

Where automation facilities are enabled it is possible that, even though a Recloser has gone through its reclose sequence to “Lockout”, the automation logic may command a close at some later time.

In this instance, the Recloser state cannot be described as "Lockout" as the word "Lockout" implies that the Recloser will not perform any further automatic operations until an operator intervenes. Instead of "Lockout" the term "End of Sequence" is used. For the Loop Automation scheme, lockout and end of sequence operate as follows:

- The normal ‘Lockout’ event is generated if no automation logic is enabled in the Recloser that could cause an automatic close at some time in the future. Consequently, the {SYSTEM STATUS – OPERATOR SETTINGS} page will display the “Lockout” status.

- An ‘End of Sequence’ event is generated instead of lockout if automation logic could at some time in the future generate an automatic close.

In this case {SYSTEM STATUS – OPERATOR SETTINGS} page shows a blank field instead of displaying the Lockout status.

- If the automation system changes state so that it will not cause any future closes then the ‘Lockout’ event is generated.

The {SYSTEM STATUS – OPERATOR SETTINGS} page then displays the “LOCKOUT” status.

Note: If "Break before Make" functionality is mandatory (i.e., out-of-phase supplies) Loop Automation cannot be used for Auto-Changeover. Consult Siemens PT&D, Inc. for separate ACO firmware designed for this requirement.
Part 2 – Configuring a Loop Automation Scheme

9 Introduction
Loop Automation itself is not difficult to configure, as it is simply a matter of setting the ACR type (Feeder, Mid-Point or Tie), the loop automation time, and deciding if Auto-Restore is required.

However, it must be strongly emphasized that Loop Automation relies on the basic protection being set correctly so that the ACR nearest the fault trips to lockout. If this is not the case then Loop Automation will not operate as expected.

The following topics are discussed in this part of the manual:

- Loop Automation Timing.
- Procedure to determine the Loop Automation Settings.
- Parameters affecting Loop Automation.
- Configuring Loop Automation at the Operator Control Panel.
- Configuring Loop Automation using the CSS-Centurion System Software

10 Loop Automation Timing

10.1 Overview
Reclosers in Loop Automation schemes are primarily protection devices that trip for faults and attempt a number of reclose operations as defined by the user. Loop Automation only comes into effect after a user set time has elapsed following the detection of a loss of power. This allows Reclosers to go through their normal protection sequence. For this reason, Loop Automation is not intended to initiate until the Recloser reaches then end of its protection sequence.

Loop Automation, therefore, should only take effect after there is no possibility of the supply being restored by an auto-reclose from a Recloser. To ensure that this occurs the “Loop Automation Time” must have a setting greater than the longest auto-reclose sequence possible, plus a safety margin of several seconds. It is then permissible for Loop Automation to attempt reconfiguration of the network to restore supply to as much of the un-faulted network as possible.

It is important to set the Tie Recloser Loop Automation Time for a longer duration than the Feeder and Mid-Point Reclosers to insure the Tie Recloser does not close before the other devices are ready.

As a result, it is necessary to predetermine the timing between the various stages of the isolation and reconfiguration sequences.

10.2 Example Timing Diagram
Figure 6 shows the timing of the Loop Automation algorithm. The following factors should to be taken into consideration while studying the diagram:

- The diagram shows a fault condition that reduced system voltage and caused an upstream Circuit Breaker (CB) to trip. The diagram shows the operation of the Loop Automation Timers in each Recloser (Feeder, Mid-Point and Tie).
- The Loop Automation timer is actually started by the Source Supply ON/OFF events that are delayed by the Supply Timeout.
- All applicable Loop Automation Reclosers will see the same loss of supply and consequently, will start their Loop Automation Timers at the same time.
- The upstream CB recloses once and locks out. The Source Supply event in the controller is delayed by the Supply Timeout time. Once the "Source Supply OFF" event occurs the Loop Automation timer starts.
- In this example, the first time the Loop Automation timer starts it is reset before timing out by the Source Supply ON event which occurs during the reclose.
- However, after the upstream CB goes to “Lockout” the Loop Automation Timer successfully times out and triggers the loop automation action. In the case of a Mid-Point Recloser the action is to change settings to Group B and to set Single-Shot mode. For a Feeder Recloser, the action is to trip.
- In the example the system voltage is restored after a further interval when the Tie Recloser closes. This illustrates that the Tie ACR must have a longer Loop Automation time than the Feeder and Mid-Point ACRs. This interval is called the co-ordination time.

Refer also to Appendix B that shows a number of examples and provides additional information such as event records. These examples should also be studied until they are fully understood.
NOTE: A different fault may reduce system voltage to zero.
In that case, the loop automation timer does not reset and start again as shown above.
11 Procedure to Determine the Loop Automation Settings

11.1 Overview
There are four steps in the process of determining the required Loop Automation settings for a network:
1. Sketch the network and identify each ACR.
2. Decide the global settings to be applied.
3. Determine the protection requirements for devices in all network configurations.
4. Determine the role, direction and timings of each device.

This section explains those steps and provides a working example of a network and how to determine the settings required.

When carrying out these steps it is strongly recommended that you record the settings on the template provided at Appendix C as well as enter them into the Centurion System Software (CSS) configuration files. As you work through the procedure, refer also to Section 12 for a detailed explanation of each of the parameters.

11.2 Procedure

Step 1:
Sketch the network and identify each of the ACRs.
Record general notes e.g.:
- ACR 4 is normally open.
- The dotted line feeder will supply the solid line feeder back to ACR 1 automatically.
- Solid line feeder will supply the dotted line feeder back to ACR 5 automatically.
- There is no auto-restore on ACR 2, 3 or 4 so restoration of normal configuration must be carried out manually after the fault condition is removed.
- Auto-restore is ON for ACR 1 and 5 so that if source supply is lost and they 1 trip, they will also close automatically when supply is restored.

Step 2:
Decide the following global settings (refer also to Section 12 for explanation of parameters):

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live Terminal Voltage</td>
<td>V = 2000V</td>
</tr>
<tr>
<td>Supply Timeout</td>
<td>ST = 1 second</td>
</tr>
<tr>
<td>Co-ordination Time</td>
<td>T1 = 10 second</td>
</tr>
<tr>
<td>Single shot time</td>
<td>SS = 2 x T1 (SS = 20 sec)</td>
</tr>
<tr>
<td>Maximum Sequence Time</td>
<td>T2 = 30 sec</td>
</tr>
<tr>
<td>Auto-changeover Time</td>
<td>AT = T1 + T2 (AT = 40 sec)</td>
</tr>
</tbody>
</table>

Step 3:
Determine the protection requirements for all devices in all network configurations:
- Mid-point ACR’s will need two protection groups for feeding from either side.
- The Tie ACR will also require two protection groups if set to Restore Both Ways.
- When setting the protection groups, ensure that the maximum sequence time is met for all faults that can cause loss of supply events.
Step 4:
Determine the following for each device:
- Deployed as either a Feeder, Mid-Point or Tie Recloser.
- Direction of power flow in the normal network configuration.
- Auto-restoration Unavailable/ON/OFF.
- Loss of Phase / Loop Automation Linked or Unlinked.
- Loop Automation (LA) time:
  - Feeder or Mid-Point - LA time = \( T2 + T1 \)
  - Tie - LA time = (2 \times T1) + T2

11.3 Example Setting Record
The following record shows the range of information recorded while preparing a network for Loop Automation configuration.

<table>
<thead>
<tr>
<th>GLOBAL PARAMETERS</th>
<th>LOOP AUTOMATION TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Live Terminal Voltage</strong> 2000V</td>
<td>Feeder and Mid-Point ACR: LA Time = T1 + T2</td>
</tr>
<tr>
<td><strong>Supply Timeout (ST)</strong> 10 sec</td>
<td>= 40 seconds</td>
</tr>
<tr>
<td><strong>Co-ordination time (T1)</strong> 10 sec</td>
<td>Tie ACR: LA Time = (2 \times T1) + T2</td>
</tr>
<tr>
<td><strong>Single Shot Reset Time</strong> 20 sec</td>
<td>= 50 seconds</td>
</tr>
<tr>
<td><strong>Auto-changeover (T1 + T2)</strong> 40 sec</td>
<td></td>
</tr>
<tr>
<td><strong>Loop Automation Available</strong></td>
<td></td>
</tr>
<tr>
<td><strong>LOOP/Loop Automation UnLinked</strong> No</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ACR NO:</th>
<th>TYPE</th>
<th>SER</th>
<th>SER NO:</th>
<th>LOCATION</th>
<th>DIRECTION</th>
<th>LA TIME (sec)</th>
<th>AUTO-RESTORE AVAILABLE</th>
<th>AUTO-RESTORE ON-OFF</th>
<th>TIE RESTORE ONE/TWO WAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Feeder</td>
<td>N</td>
<td>ACR 7077</td>
<td>Whites Rd</td>
<td>Source 1</td>
<td>40</td>
<td>Available</td>
<td>ON</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>Mid-point</td>
<td>U</td>
<td>ACR 7092</td>
<td>Lytton Rd North</td>
<td>Source 1</td>
<td>40</td>
<td>Not Available</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>3</td>
<td>Mid-point</td>
<td>U</td>
<td>ACR 6999</td>
<td>Lytton Rd West</td>
<td>Source 2</td>
<td>50</td>
<td>Not Available</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>4</td>
<td>Tie</td>
<td>N</td>
<td>ACR 7078</td>
<td>Fisherman Island</td>
<td>Source 2</td>
<td>40</td>
<td>Not Available</td>
<td>N/A</td>
<td>BOTH</td>
</tr>
<tr>
<td>5</td>
<td>Feeder</td>
<td>N</td>
<td>ACR 7091</td>
<td>Hemnant Substation</td>
<td>Source 2</td>
<td>40</td>
<td>Available</td>
<td>ON</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Figure 8: Setting Sheet

**NOTE:** The information included within this example has no relevance to an existing network and is included for example purposes only.
### 12 Parameters Affecting Loop Automation

#### 12.1 Overview

Loop Automation incorporates a number of parameters that must be correctly configured to ensure correct operation. These parameters may be set using either the Operator Control Panel, (refer Section 13) or by CSS.

#### 12.2 Description of Parameters

All the parameters on the Loop Automation setting sheet are explained below while some others are further explained in the equipment specific technical manual.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live Terminal Voltage.</td>
<td>Determines the voltage level at which a terminal is considered to be “live”. This value is used to generate Load/Source ON/OFF events that trigger Loop Automation. Must be the same value in all Reclosers. Typical value is 2000V. Refer to equipment technical manual for further information. (System Status 4: “LIVE” if &gt; 2000V).</td>
</tr>
<tr>
<td>Supply Timeout. (ST)</td>
<td>Determines the time between detecting a change of terminal live/dead status and generating the “Supply On/Off” event. It is this event that triggers the start of the Loop Automation timer and should be set to the same value in all Reclosers. The value of this parameter is set by utility practices. A value of 0.5 to 5.0 seconds is typical. Refer to equipment technical manual for further information. (System Status 4: Supply Timeout 5.0s).</td>
</tr>
<tr>
<td>Coordination Time. (T1)</td>
<td>There has to be a delay between the actions of each the Loop Automation devices. For example, the Mid-Point ACR must change its protection group before the Tie ACR closes. This is the coordination time. Typical time is 10 seconds, minimum recommended time is 5.0 seconds.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Single Shot Reset Time.</td>
<td>The single-shot facility is used by Loop Automation to force one shot to lockout in the Mid-Point and Tie ACR prior to the Tie closing onto a faulted feeder.</td>
</tr>
<tr>
<td>(2 x T1)</td>
<td>Single-Shot timer must be set longer than the Loop Automation coordination time (T1), twice as long is recommended.</td>
</tr>
<tr>
<td></td>
<td>{Protection Setting 2: SS Reset Time 1s}.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Sequence Time.</td>
<td>Loop Automation should only take control after there is no further possibility of the supply being restored by an auto-reclose from another Recloser. Therefore the Loop Automation Time must be longer than the maximum time required for the Recloser to trip to lockout. This is called the Maximum Sequence Time.</td>
</tr>
<tr>
<td>(T2)</td>
<td>The protection settings and the expected fault levels determine Maximum Sequence time. It must include the time to trip and the dead time for each reclose in the sequence. To limit the trip time it may be desirable to set a maximum time to trip setting (refer to equipment manual for protection parameters).</td>
</tr>
<tr>
<td></td>
<td>For example, a typical reclose sequence has an instantaneous trip, a 1 second dead time followed by a second inverse time trip with a max time of 5 seconds. This establishes the Maximum Sequence Time to be around 6 seconds.</td>
</tr>
<tr>
<td></td>
<td>If there is the possibility of low level faults with long trip times (perhaps on fused tap lines) then these can take longer than the Maximum Sequence Time provided that they do not reduce the system voltage to a level where Loss of Supply events occur.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto Changeover Time.</td>
<td>Determines the period of time that power (greater than 50 kW) must flow in the reversed direction before an automatic change of protection group takes place.</td>
</tr>
<tr>
<td>(T1 + T2)</td>
<td>Used in the Mid-point Recloser to change protection settings when restoring the normal configuration. It is also used when power flows to the alternate source in a closed Tie Recloser and Loop Automation is turned off.</td>
</tr>
<tr>
<td></td>
<td>In a Loop Automation scheme this must be long enough to allow an auto-reclose sequence to finish. Therefore it must be longer than the Maximum Sequence Time (T2).</td>
</tr>
<tr>
<td></td>
<td>A time of T2 plus the Coordination Time is recommended.</td>
</tr>
<tr>
<td></td>
<td>Consult your switchgear manual for further information.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Live Load Blocking. ON/OFF    | This setting takes priority over Loop Automation closing and should be turned OFF when Loop Automation is used. Consult your equipment technical manual for further information.  
  *Factory default is “OFF”* |
| Loop Automation. Available/Not Available. | Enables or disables the entire Loop Automation facility. When set to “Not Available”, the Loop Automation pages are hidden in Software version 24-00.00 and later. This must be set to Available in all ACR's used in the Loop Automation scheme.  
  *Factory default is “Not Available”* |
| ACR No:                       | This field identifies the device within the network. For documentation purposes only.                                                         |
| Type.                         | Determines whether the ACR operates as a Feeder, Mid-Point or Tie Recloser.  
  *Range: Feeder ACR, Mid-point ACR, Tie ACR.*  
  *Factory default is “Tie ACR”.* |
<p>| Series.                       | This field records the style of ACR as Centurion Recloser or U-Series. For documentation purposes only.                                      |
| Name (serial No:)             | This field records the plant name and/or serial number for the device. For documentation purposes only.                                      |
| Location.                     | This field records the location of the device. For documentation purposes only.                                                             |
| Direction.                    | Designates which terminals of the ACR are the source and load sides in normal configuration. For the Feeder Recloser this is only important if auto-restore is used. For the Mid-Point ACR this affects the selection of the protection group |</p>
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
</table>
| Direction       | which is set automatically by the direction of the power flow when the Tie is closed. Therefore if the direction parameter is not right the wrong protection group will be in service. For the Tie ACR this affects the protection group selection as for the Mid-Point and, in addition will affect the Tie Restore One Way direction, if set wrong then the Tie will operate for loss of supply on the wrong side. This parameter can only be set after field installation when the installation details are known.  
*Range:* Source 1 or 2 - Load 2 or 1 in the N-Series and  
Source I or X - Load X or I in the Centurion Recloser  
*Factory Defaults is:* Source I - Load X |
| Loop Auto Time. (LA) | Determines the delay after a Supply On/Off event before the Loop Automation program takes action. The same timeout value is used both when supply is lost and during Auto Restore operation.  
*Range:* 3 to 1800 seconds  
*Factory Default is* “30 seconds” |
| Auto Restore Available. | Enables or disables the Auto Restore facility. This is a security feature and ensures the Auto Restore features cannot be turned on unless this field is first set to “Auto Restore Available”.  
Note that the network must be able to operate closed up if Auto Restore is used.  
*Range:* Available, Not Available  
*Factory default is* “Auto Restore Not Available” |
| Auto Restore ON/OFF. | Turns on the Auto Restore features. Note that for the Centurion Recloser additional external voltage sensors must be fitted to units that require Auto-Restore.  
*Range:* Auto Restore On, Auto Restore Off  
*Factory default is* “Auto Restore Off” |
| Tie Restore. | Only applies to Tie ACR. This field is only displayed if “Recloser Type” is set to Tie ACR. This field sets whether a Tie ACR reconfigures supply in both directions, or just from Source to Load. Set Tie Restore Both Ways if you want to restore symmetrically across the tie Recloser.  
*Range:* One Way, Both Ways. |
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factory default is “Tie Restore One Way”-registration removed</td>
<td></td>
</tr>
<tr>
<td>Loop Automation ON/OFF.</td>
<td>Turns ON or OFF the Loop Automation function.</td>
</tr>
<tr>
<td></td>
<td><em>Factory default is “Loop Automation Off”</em></td>
</tr>
<tr>
<td>LOP/Loop Unlinked</td>
<td>Advises that Loss of Phase and Loop Automation are not linked together.</td>
</tr>
<tr>
<td></td>
<td>Loss of Phase and Loop Automation operate independently.</td>
</tr>
<tr>
<td></td>
<td>This field is “display only” when Loop Automation is not available.</td>
</tr>
<tr>
<td></td>
<td><em>Factory default is “LOP/Loop Unlinked”</em></td>
</tr>
<tr>
<td>LOP/Loop Linked</td>
<td>This password protected field may be set only when Loop Automation is made available.</td>
</tr>
<tr>
<td></td>
<td>Loss of Phase protection will now turn on and off automatically with Loop Automation.</td>
</tr>
<tr>
<td></td>
<td><em>Factory default is “LOP/Loop Unlinked”</em></td>
</tr>
</tbody>
</table>
13 Entering the Loop Automation Parameters

13.1 Overview

The Loop Automation Availability and Configuration pages are located in the System Status display group in the Operator Control Panel:

- Loop Automation is made available at \{SYSTEM STATUS – Options 2\}
- Loop Automation is configured at \{SYSTEM STATUS – Loop Automation Configuration\}.

Wherever the capital letter "P" appears next to a field in the following examples, a password must be entered prior to reconfiguring that field.

13.2 Making Loop Automation Available

From the Operator Settings page, press the ⇒ arrow key until the System Status Options 2 page appears. The fields provided at the \{SYSTEM STATUS – Options 2\} screen allow an engineer make the scheme available or not available and to link the scheme with another protection feature if required.

The options available are as follows:

- Loop Automation Available or Not Available.
- Loss of Phase protection and Loop Automation Linked or Unlinked.

<table>
<thead>
<tr>
<th>OPTIONS 2</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIRB Available</td>
<td>P</td>
</tr>
<tr>
<td>DIRB Not Available</td>
<td>P</td>
</tr>
<tr>
<td>Loop Auto Not Available</td>
<td>P</td>
</tr>
<tr>
<td>LOP/Loop Unlinked</td>
<td>P</td>
</tr>
<tr>
<td>LOP/Loop Linked</td>
<td>P</td>
</tr>
<tr>
<td>Dead Lockout OFF</td>
<td>P</td>
</tr>
<tr>
<td>Dead Lockout ON</td>
<td>P</td>
</tr>
</tbody>
</table>

Once all fields are configured, a typical display may be as follows:

13.3 Loop Automation Configuration Page

When \{SYSTEM STATUS – OPTIONS 2: Loop Automation Available\} is configured, continue to press the ⇒ arrow key until the Loop Automation Configuration page appears. The fields provided at the \{SYSTEM STATUS – Loop Automation Configuration\} screen allow an engineer to set up the main Loop Automation parameters. A number of other parameters will also need to be set up for the scheme to work correctly, refer to Section 12.

The parameters available are as follows:

- If the ACR is configured as either a Feeder, Mid-Point or Tie Recloser.
- If Auto Restoration is ON or OFF.
- If Auto Restoration is Available or Not Available.
- If Tie Restore is set One Way or Both Ways (Tie ACR option only).
- The Loop Automation Time.

\[1\] For firmware versions 26-00.00 and later, setting this field "Not Available" hides the Loop Automation Status and Configuration pages.

Siemens Power Transmission & Distribution, Inc.
## LOOP AUTOMATION CONFIGURATION

<table>
<thead>
<tr>
<th></th>
<th>Feeder ACR</th>
<th>Mid-point ACR</th>
<th>Tie ACR</th>
<th>Tie Restore One Way</th>
<th>Tie Restore Both Ways</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Auto Restore ON</td>
<td>Auto Restore OFF</td>
<td>Auto Restore Not Available</td>
<td>Auto Restore Available</td>
<td>Loop Auto Time 30s</td>
</tr>
</tbody>
</table>

Once all parameters are configured, a typical display may be as follows:

<table>
<thead>
<tr>
<th>Loop Automation Configuration</th>
<th>Feeder ACR</th>
<th>Auto Restore ON</th>
<th>Auto Restore Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tie Restore Both Ways</td>
<td></td>
<td></td>
<td>Loop Auto Time 30s</td>
</tr>
</tbody>
</table>
14 Centurion System Software

14.1 Overview
Centurion System Software (CSS) is a software package for controlling Centurion Reclosers a Personal Computer. Controller interface is via a local or remote serial port connection.
Loop Automation can be configured from CSS.

CAUTION

It is important to note that writing a CSS File to the CAPM automatically switches Loop Automation off. This prevents a saved configuration with Loop Automation set to “ON” from inadvertently switching Loop Automation “ON” when the file is loaded into the controller.

14.2 Creating a New Loop Automation File

Loop Automation is not available when opening a new file. CSS must be opened and then configured in OFF-LINE mode to create the file as follows:

- Select: OFF LINE.
- Select: Customise.
- Select: Select CAPM Capability and Protocol.
- Enter <SPTD> in password field.
- Select: OK.
- At the following screen, highlight Loop Automation and select Add- to transfer into the Selected Capability box (this action not required if a read file has been performed on a CAPM with Loop Automation already installed).
- Select: OK to exit this screen.

![Figure 9: CAPM4 Configure Capability and Protocols (Off Line)](image)
14.3 Configuring Loop Automation

- Select: Display.
- Select: Loop Automation.
- At the following screen, select the Available button.
- The required parameters for Loop Automation configuration may now be entered.

![Figure 10: CAPM4 Loop Automation Configuration (Off Line)](image)

![Figure 11: Example of CSS Loop Automation (On-Line)](image)
15 Introduction
Loop Automation is simple to use in service. The preparation sequence to be completed by the utility is as follows:

- Load the correct firmware version into each controller as necessary (consult Siemens PT&D, Inc. for firmware upgrade if required after shipment from SPT&D).
- Load the correct Loop Automation and protection settings into each controller. This can be done manually or preferably using CSS. It is advisable to use the setting sheet template at Appendix C to record the settings for future reference.
- Turn on Loop Automation at each controller.

WARNING
When switching to manually reconfigure Loop Automation networks, remember to de-activate Loop Automation on any Reclosers affected. If not turned off, automatic operation may occur due to Loop Automation.

After a network fault occurrence, Loop Automation may have operated to isolate the faulted section and restore supply to the un-faulted sections. This must be taken into account when analyzing the fault.

The following topics are discussed in this part of the manual:

- Operator Control Panel Displays.
- Switching Loop Automation ON.
- Switching Loop Automation OFF.
- Commissioning.
- Post-fault condition action.
16 Operator Control Panel Displays

16.1 Overview
Loop Automation adds two new pages into the System Status display group of the switchgear controller:
- The Loop Automation Status page - see below.
- The Loop Automation Configuration page – see Section 3.2
Loop Automation also displays messages on the title line of the Operator Control Panel and generates events in the event log.

16.2 Loop Automation Status Page
The Loop Automation Status page is the first page to appear when the Operator Control panel is turned on. The page shows:

- Whether Loop Automation is ON or OFF.
- If the ACR is configured as either a Feeder, Mid-Point or Tie Recloser.
- Loop Automation status messages on the bottom two lines of the display. These messages are displayed in plain English and are self-explanatory.
- Loop Automation may be turned ON or OFF by an operator by pressing the SELECT button and then pressing the ⇒ arrow. The ENTER button must be pressed to confirm the selection.
- The display advising the Type of ACR is an operator information message only.
- Note that this page is hidden if {SYSTEM STATUS – Loop Automation Configuration: Loop Auto Not Available} is set to Not Available.
- Access to each field:
  "O" means that Operator Access is possible.
  "D" means that this is a Display Field only.
  "P" means that this is a Password Protected field.

<table>
<thead>
<tr>
<th>Loop Automation Status</th>
<th>O</th>
<th>Feeder ACR</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop Automation ON</td>
<td>O</td>
<td>Mid-Point ACR</td>
<td></td>
</tr>
<tr>
<td>Loop Automation OFF</td>
<td></td>
<td>Tie ACR</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Loop Automation messages</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>e.g. 'Loop Automation Normal'</td>
<td></td>
</tr>
</tbody>
</table>

Once all parameters are configured, a typical display may be as follows:

<table>
<thead>
<tr>
<th>Loop Automation Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop Automation ON</td>
</tr>
<tr>
<td>Feeder ACR</td>
</tr>
<tr>
<td>Loop Automation Normal</td>
</tr>
</tbody>
</table>

16.3 Events Generated by Loop Automation

The following events may be logged as a result of the operation of Loop Automation.

<table>
<thead>
<tr>
<th>Event Text</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>End of Sequence.</td>
<td>Generated when a protection sequence has finished but Loop Automation may still cause an automatic close.</td>
</tr>
<tr>
<td>Lockout.</td>
<td>Generated when Loop Automation changes state so that an automatic close will not be generated (only applicable if an end of sequence event has been generated previously).</td>
</tr>
<tr>
<td>Loop Auto Close Req.</td>
<td>Loop Automation requests CLOSE.</td>
</tr>
<tr>
<td>Loop Auto OFF.</td>
<td>Loop Automation is turned OFF.</td>
</tr>
<tr>
<td>Loop Auto ON.</td>
<td>Loop Automation is turned ON.</td>
</tr>
<tr>
<td>Loop Auto Trip Req.</td>
<td>Loop Automation requests TRIP.</td>
</tr>
<tr>
<td>Prot Group A Active.</td>
<td>Loop Automation has changed the Protection Group setting from B to A.</td>
</tr>
<tr>
<td>Prot Group B Active.</td>
<td>Loop Automation has changed the Protection Group setting from A to B.</td>
</tr>
</tbody>
</table>
17 Turning On Loop Automation

17.1 Overview
Loop Automation is always turned on (made active) by a deliberate user action either from the Operator Control Panel status page, via CSS or remotely using a SCADA system.

17.2 Limitations
Loop Automation cannot be switched on if any of the following conditions exist:

- Loop Automation is set to "Not Available".
- The Trip or Close Isolate switches are set to isolate.
- The switch mechanism has failed.
- The switch is in Low Gas Lockout state.
- Switchgear data is invalid.
- Battery is abnormal.
- Trip/Close capacitor charging has failed.

The three types of Reclosers must be in their normal operating state before Loop Automation can be Switched on:

- Feeder Recloser Closed.
- Mid-point Recloser Closed.
- Tie Recloser Open.
18 Turning Off Loop Automation

18.1 Overview
Loop Automation can be switched off by a deliberate operator action, or automatically as detailed below. When Loop Automation is switched off the protection group selection defaults back to \{SYSTEM STATUS–OPERATOR SETTINGS: Protection Auto\} unless the operator has explicitly changed it to another setting.

18.2 User Actions which Turn Off Loop Automation

Loop Automation turns off when:

- An operator manually closes or trips the Recloser. This can be from any control point, including a local operator, SCADA system or the IOEX inputs.
- Changes are made to any protection or operator settings other than changing an active protection group.
- Changes are made to any of the existing ground fault, sensitive ground fault protection settings in any Protection Group.
- An operator changes any Loop Automation settings.

18.3 Other Conditions which turn off Loop Automation

Loop Automation turns off when:

- The controller is powered up.
- The Recloser trips to the end of its sequence and Auto-Restore is off.
- Any of the action conditions detailed in Section 17 that would prevent turning on Loop Automation occur.
19 Commissioning

19.1 Overview
When Loop Automation is installed and configured it is possible to check its operation in the field on an energized feeder with the use of the Secondary Voltage Injection Interface Set (SVIIS). Note that the ACR will trip and close as the test progresses.

19.2 Feeder Preparation
Prepare each device as follows:
- A Feeder or Mid-Point ACR should be closed and bypassed at the start of the test to prevent customer interruption.
- A Tie ACR should be open at the start of the test and it must be acceptable for a Tie ACR to close.

19.3 Test Sequence
The test sequence is as follows:

1. Before bypassing a closed ACR check that the power flow is in the expected direction on the Measurement Page.
2. Bypass the ACR but leave it connected to the lines so that voltage signals are present. You may find that the ACR will now detect an earth fault because the bypass impedance is not perfectly balanced. In this case turn Earth Fault off.
3. Power down the Control Cubicle and connect the SVIIS between the control cubicle and the ACR. Set all the input switches on the SVIIS to “Switchgear”.
4. Power up the Control cubicle and check the System Status Live/Dead Display shows all terminals Live.
5. Turn the three switches on the SVIIS that correspond to the source side terminals to “Input” – this will cause the controller to think that source supply has been lost. Observe the event log and check that a Source Supply OFF event takes place at the expected time. Then turn the switches back to “Switchgear” and check that a Source Supply ON event takes place. Do the same for the other three switches and check that Load Supply OFF/ON event occur. This check has confirmed that the source and load have been configured correctly.
6. Now go to the Loop Automation status page and turn Loop Automation ON. Once again turn the three source side switches on the SVIIS to “Input” – this will cause the controller to think that source supply has been lost. Observe the Loop Automation status display and follow the messages on the screen. Check that the action and timing of Loop Automation is what you expect. In brief: a feeder ACR should Trip, a Tie ACR should close and a Mid-Point ACR should change protection group and go to single shot for a period.
7. Next, turn the switches back to “Switchgear”, this simulates the supply being restored. Observe the Loop Automation status display and follow the messages on the screen. Check that the action and timing of Loop Automation is what you expect. In brief: if auto-restore is ON then a feeder ACR should close and a tie/mid-point should not change.
8. For a closed Tie ACR check that the direction of power flow is as expected (it may not be easy to predict the direction of power flow).
9. To finish turn off Loop Automation, turn OFF the controller. Remove the SVIIS and put the ACRs into the required state. Turn ON the controller and remove any bypasses. Then turn Loop Automation ON.
20 After There Has Been A Fault

20.1 Overview
The first thing to do is to find and fix the fault. This will usually then be tested by closing one of the ACR’s on either side of the isolated section and seeing if it trips again. What happens next depends on the configuration of the Auto-Restore feature and its resulting effect on Loop Automation.

20.2 Not Using Auto-Restore
In this case the sequence of actions is:
- Locate and remove the fault condition.
- Close one of the open ACRs to test the faulted section. If the section is now un-faulted then restore the normal network configuration in the usual way, (for example close the other open ACRs and then open the tie ACR). This can be done either by visiting each device individually or by using a remote control system (SCADA).
- Turn on Loop Automation at each device when it has been switched to its normal state.

20.3 Using Auto-Restore
In this case the sequence of actions is:
- Locate and remove the fault condition.
- Close one of the open ACRs to test the faulted section. If the section is now unfaulted then after the Loop Automation Timeout the other open ACR will be closed automatically by Auto-Restore. Note that Loop Automation will still be ON at these ACRs.
- Turn ON Loop Automation at the ACR which was closed manually.
- Check that the tie ACR has been opened automatically by Auto-Restore (if Auto-Restore has been switched on at the tie) and that supply is present on both sides of the tie. If the tie has not opened it is probably because the change on load flow was insufficient to trigger the auto-restore. In this case open the tie manually, check supply is present on both sides and turn Loop Automation back on. If supply is not present on both sides then there is a network problem that needs to be investigated and fixed.

20.4 Analyzing What Happened
If the actions of Loop Automation are not as expected the likely cause is:
- One of the members of the scheme did not have Loop Automation switched on.
- The settings were incorrectly coordinated between the different members of the Loop Automation. In this case recheck the settings method given in Section 11.
- There was more than one fault on the network. In this case protection will have operated in the one of the devices to isolate the faulted section. There should not be any increased outages due to the actions of Loop Automation.

In all cases it is suggested to examine the examples in Appendix B to increase your understanding of Loop Automation.
Appendix A - Loop Automation Operating Rules

In the following tables the Sequence (Seq) column indicates if the rule is applied during Isolation and Reconfiguration (I), (Section 4.2), or during Auto-Restoration (R), (Section 4.3).

**A1 Feeder Recloser**

<table>
<thead>
<tr>
<th>RULE No:</th>
<th>ACR State</th>
<th>Auto Restore</th>
<th>Event</th>
<th>Action</th>
<th>Seq</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Closed</td>
<td>Off</td>
<td>Source Supply lost for longer than Loop Auto Time.</td>
<td>ACR Opens and Loop Automation is turned off.</td>
<td>I</td>
</tr>
<tr>
<td>2</td>
<td>Closed</td>
<td>On</td>
<td>Source Supply lost for longer than Loop Auto Time.</td>
<td>ACR Opens.</td>
<td>I</td>
</tr>
<tr>
<td>3</td>
<td>Closed</td>
<td>Off</td>
<td>Protection trip to Lockout.</td>
<td>ACR Opens and Loop Automation is turned off.</td>
<td>I</td>
</tr>
<tr>
<td>4</td>
<td>Closed</td>
<td>On</td>
<td>Protection trip to end of sequence.</td>
<td>ACR Opens and Loop Automation stays on.</td>
<td>I</td>
</tr>
<tr>
<td>5</td>
<td>Open</td>
<td>On</td>
<td>Source Supply is restored and ACR was initially tripped by Loop Automation.</td>
<td>ACR Closes.</td>
<td>R</td>
</tr>
<tr>
<td>6</td>
<td>Open</td>
<td>On</td>
<td>Supply is restored to both sides of ACR. Either at the source then load or load then source.</td>
<td>ACR Closes.</td>
<td>R</td>
</tr>
</tbody>
</table>

**A2 Mid-Point Recloser**

<table>
<thead>
<tr>
<th>RULE No:</th>
<th>ACR State</th>
<th>Auto Restore</th>
<th>Event</th>
<th>Action</th>
<th>Seq</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Closed</td>
<td>On or Off</td>
<td>Source Supply lost for longer than Loop Auto Time.</td>
<td>Switch to Protection B.</td>
<td>I</td>
</tr>
<tr>
<td>8</td>
<td>Closed</td>
<td>Off</td>
<td>Protection trip to Lockout.</td>
<td>ACR opens and Loop Automation is turned off.</td>
<td>I</td>
</tr>
<tr>
<td>9</td>
<td>Closed</td>
<td>On</td>
<td>Protection trip to end of sequence.</td>
<td>ACR opens and Loop Automation stays on.</td>
<td>I</td>
</tr>
<tr>
<td>10</td>
<td>Open</td>
<td>On</td>
<td>Supply is restored to both sides of ACR.</td>
<td>Switch to Protection A and close ACR.</td>
<td>R</td>
</tr>
</tbody>
</table>
### A3 Tie Recloser

<table>
<thead>
<tr>
<th>RULE No:</th>
<th>ACR State</th>
<th>Auto Restore</th>
<th>Restore Both Ways</th>
<th>Event</th>
<th>Action</th>
<th>Seq.</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Open</td>
<td>On or Off</td>
<td>On or Off</td>
<td>Supply to both sides is lost for longer than Loop Auto Time.</td>
<td>No Action.</td>
<td>I</td>
</tr>
<tr>
<td>12</td>
<td>Open</td>
<td>On</td>
<td>On or Off</td>
<td>Supply to load side is lost for longer than Loop Auto Time.</td>
<td>ACR Closes if alternative supply is present.</td>
<td>I</td>
</tr>
<tr>
<td>13</td>
<td>Open</td>
<td>Off</td>
<td>On or Off</td>
<td>Supply to load side is lost for longer than Loop Auto Time.</td>
<td>ACR Closes if alternative supply is present and turns Loop Automation off.</td>
<td>I</td>
</tr>
<tr>
<td>14</td>
<td>Open</td>
<td>On</td>
<td>On</td>
<td>Supply to source side is lost for longer than Loop Auto Time.</td>
<td>Activates Protection Group B and ACR Closes.</td>
<td>I</td>
</tr>
<tr>
<td>15</td>
<td>Open</td>
<td>Off</td>
<td>On</td>
<td>Supply to source side is lost for longer than Loop Auto Time.</td>
<td>Activates Protection Group B, ACR Closes and turns Loop Automation off.</td>
<td>I</td>
</tr>
<tr>
<td>16</td>
<td>Open</td>
<td>On or Off</td>
<td>Off</td>
<td>Supply to source side is lost for longer than Loop Auto Time.</td>
<td>No Action.</td>
<td>I</td>
</tr>
<tr>
<td>17</td>
<td>Closed</td>
<td>On</td>
<td>On or Off</td>
<td>Protection trip to lockout.</td>
<td>ACR opens and Loop Automation is turned off.</td>
<td>I</td>
</tr>
<tr>
<td>18</td>
<td>Closed</td>
<td>On</td>
<td>On or Off</td>
<td>Power flow changes by 50% or more for Loop Auto Time.</td>
<td>ACR opens. (If supply is subsequently lost to either side then ACR closes and Loop Automation turns off).</td>
<td>R</td>
</tr>
<tr>
<td>19</td>
<td>Closed</td>
<td>On</td>
<td>On or Off</td>
<td>Power flow changes by 50% or more but returns to previous level before Loop Auto Time expires.</td>
<td>ACR stays closed and Loop Automation is turned off.</td>
<td>R</td>
</tr>
</tbody>
</table>
Appendix B - Network Configuration Examples

Overview

The flexible nature of the Loop Automation scheme allows it to be used in a wide range of network configurations. A number of simple configuration examples have been included to demonstrate how the system will operate in different situations. These examples use different fault scenarios to illustrate the operation of Loop Automation.

In all of the examples, a normally open Tie Recloser is located at the end of the Feeder with an alternate source of supply behind it. The alternate supply may be another feeder supplied from the same substation, or from an entirely different substation.

Composition

The first two examples include an existing substation CB. Usually these cannot be programmed into the Loop Automation logic. Under these circumstances, there is a small limitation in the fault isolation sequence because the feeder section between the substation CB and the Feeder Recloser cannot be back-fed through the Tie Recloser. This limitation can be overcome by installing a Centurion Recloser in place of the substation CB. Arrows shown next to the Reclosers indicate the direction of positive power flow as configured in the Recloser controller. This defines the source side and load side of the Reclosers. The different configurations in the examples in this appendix describe:

- How permanent faults at various points along the feeder are isolated.
- How supply may be reconfigured to un-faulted feeder sections.
- The restoration sequences for each fault scenario. For each scenario the description first covers the case where {Loop Automation Configuration: Auto Restore} is ON and then covers the case where {Loop Automation Configuration: Auto Restore} is turned OFF.

Configuration

In all cases Loop Automation relies on the protection settings of the substation Circuit Breaker (CB) and Reclosers being coordinated correctly so that the CB or Recloser closest to the fault trips first. If this is not the case then Loop Automation will not be able to reconfigure supply to all un-faulted sections of the feeder. A Feeder Recloser can be used in place of a substation CB. This may permit substantial cost savings in some circumstances.

The Feeder Recloser is programmed to open when loss of supply is detected from the substation CB. This is necessary in order to prevent the substation being back-fed through the Tie Recloser from another source of supply. When supply is restored from the substation CB the Feeder CB can be configured to close automatically, restoring the normal configuration.

When loss of supply is detected on both sides of a Tie Recloser it will not close (to try to reconfigure supply). This is to cater for the case where both the main and alternate sources of supply have failed, e.g. where both supplies are fed from the same substation.
B1 Example Network One – Feeder, Mid-Point & Tie Reclosers

This example shows a Loop Automation scheme using Centurion Reclosers for the Feeder, Mid-Point and Tie. The substation has its own circuit breaker. In the normal state the substation CB, Feeder and Mid-point Reclosers are closed and the Tie is open with an alternative supply source behind it. The feeder sections are supplied through the substation CB, Feeder and Mid-point Reclosers up to the Tie point.

Default Settings for Examples:

Each of the fault isolation sequences are shown along with a sequence of events based on the event log.

Figure 12: Example One - Network Configuration

In order to show the relevant timings between Recloser event logs, it has been assumed in all the examples that:

- The initial fault occurred at 12:30:00.00 on 01/04/99.
- The Supply Timeout is set to 1 second.
- The \( \text{(Loop Automation Configuration: Loop Auto Time)} \) for the Feeder Recloser is set to 29 seconds.
- The \( \text{(Loop Automation Configuration: Loop Auto Time)} \) for the Mid-point Recloser is set to 29 seconds.
- The \( \text{(Loop Automation Configuration: Loop Auto Time)} \) for the Tie Recloser is set to 39 seconds.
B.1.1 Fault Condition Before the Feeder Recloser
Using the configuration shown at Figure 10 as a starting point, a fault condition occurs on the section of feeder between the substation CB and the Feeder Recloser.

Recloser Actions:

Step 1

![Figure 13: Fault occurs before Feeder Recloser]

Substation CB trips to lockout and isolates the fault from the supply source.

Step 2

![Figure 14: Feeder Recloser isolates fault]

30 seconds after the initial fault:
- The Feeder Recloser opens to isolate the fault from the alternate source of supply.
- The Mid-point Recloser changes to protection group “B” in preparation for a change in power flow direction.

Step 3

![Figure 15: Tie Recloser reconfigures supply]

40 seconds after the initial fault:
- The Tie Recloser closes restoring supply to the un-faulted sections of the feeder.
Sequence of Events:

<table>
<thead>
<tr>
<th>Feeder Recloser</th>
<th>Mid-Point Recloser</th>
<th>Tie Recloser</th>
</tr>
</thead>
<tbody>
<tr>
<td>01.00 Source Supply OFF</td>
<td>01.00 Source Supply OFF</td>
<td>01.00 Load Supply OFF</td>
</tr>
<tr>
<td>01.00 Load Supply OFF</td>
<td>01.00 Load Supply OFF</td>
<td>01.00 Load Supply OFF</td>
</tr>
<tr>
<td>30.00 Loop Auto Trip Req</td>
<td>30.00 Prot Group B Active</td>
<td>40.00 Loop Auto Close Req</td>
</tr>
<tr>
<td>30.00 Loop Auto OFF ¹</td>
<td></td>
<td>40.00 Loop Auto OFF ¹</td>
</tr>
<tr>
<td>41.10 Load Supply ON</td>
<td>41.10 Source Supply ON</td>
<td>41.10 Load Supply ON</td>
</tr>
<tr>
<td>Note 1: If Auto Restore is OFF</td>
<td>Note 1: If Auto Restore is OFF</td>
<td></td>
</tr>
</tbody>
</table>

Restoration Scenarios:

If \{**Loop Automation Configuration: Auto Restore**\} is set to “ON”:
- Lineperson clears fault.
- Lineperson closes substation CB.
- Feeder Recloser senses restoration of supply and closes automatically.
- Tie Recloser senses the change in power flow and opens.

With the Feeder Recloser now closed a substantial proportion of the feeder load would be taken up by the Zone Substation. The Tie Recloser would therefore detect a significant drop in power flow and trip, restoring the normal feeder configuration. Since Loop Automation remains On in the Tie Recloser the linesman would not need to travel to the Tie to re-arm Loop Automation.

If \{**Loop Automation Configuration: Auto Restore**\} is set to “OFF”:
- Lineperson clears fault.
- If supplies can be connected together, Linesman closes substation CB.
- Lineperson closes Feeder Recloser and re-arms Loop Automation.
- Lineperson opens Tie Recloser and re-arms Loop Automation in the Tie Recloser.
B.1.2 Fault Between Feeder Recloser and Mid-point Recloser

In this example a fault occurs on the section of the feeder between the Feeder Recloser and the Mid-point Recloser.

Recloser Actions:

Step 1:

The Feeder Recloser trips to end of sequence to isolate the fault from the supply source.

Figure 16: Fault between Feeder and Mid-point ACRs

Step 2:

30 seconds after the initial fault:
- The Mid-point Recloser changes to protection group ‘B’ in preparation for a change in power flow direction.
- 40 seconds after the initial fault:
  - The Tie Recloser closes to reconfigure supply to the feeder.

Figure 17: The Tie Recloser closes

Step 3:

The fault has not been cleared and the Mid-point Recloser trips to lockout to isolate the faulted feeder section.

No reclose operation takes place.

Supply is reconfigured to all the un-faulted sections of the feeder.

Figure 18: Mid-point Recloser trips to isolate fault
Sequence of Events:

<table>
<thead>
<tr>
<th>Feeder Recloser</th>
<th>Mid-point Recloser</th>
<th>Tie Recloser</th>
</tr>
</thead>
<tbody>
<tr>
<td>00.00 Pickup</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00.50 Prot Group A Active</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00.50 Phase Prot Trip</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00.50 Prot Trip 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00.60 B Max 1200 AMP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01.00 Automatic Reclose</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01.10 Pickup</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01.60 Prot Group A Active</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01.60 Phase Prot Trip</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01.60 Prot Trip 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01.70 B Max 1200 AMP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01.70 Lockout 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01.70 End of Sequence 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02.70 Load Supply OFF</td>
<td>02.70 Source Supply OFF</td>
<td>02.70 Load Supply OFF</td>
</tr>
<tr>
<td></td>
<td>02.70 Load Supply OFF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>31.60 Prot Group B Active</td>
<td></td>
</tr>
<tr>
<td></td>
<td>41.70 Pickup</td>
<td></td>
</tr>
<tr>
<td></td>
<td>42.20 Prot Group B Active</td>
<td></td>
</tr>
<tr>
<td></td>
<td>42.20 Phase Prot Trip</td>
<td></td>
</tr>
<tr>
<td></td>
<td>42.20 Single Shot</td>
<td></td>
</tr>
<tr>
<td></td>
<td>42.40 B Max 1050 AMP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>42.40 Lockout 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>42.40 End of Sequence 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>43.20 Load Supply ON</td>
<td></td>
</tr>
<tr>
<td>Note 1: If Auto Restore is OFF</td>
<td>Note 1: If Auto Restore is OFF</td>
<td>Note 1: If Auto Restore is OFF</td>
</tr>
<tr>
<td>Note 2: If Auto Restore is ON</td>
<td>Note 2: If Auto Restore is ON</td>
<td>Note 2: If Auto Restore is ON</td>
</tr>
</tbody>
</table>

Note 1: If Auto Restore is OFF
Note 2: If Auto Restore is ON

41.60 Loop Auto Close Req
41.60 Loop Auto OFF 1
41.70 Pickup

42.40 B Max 1050 AMP
42.70 Load Supply ON

43.20 Load Supply ON
Restoration Scenarios:

When \textbf{(Loop Automation Configuration: Auto Restore)} is turned ON:
- Lineperson clears fault.
- Lineperson closes Feeder Recloser and re-arms Loop Automation.
- Mid-point Recloser senses restoration of supply and closes automatically.
- Tie Recloser senses the change in power flow and opens.

When \textbf{(Loop Automation Configuration: Auto Restore)} is turned OFF:
- Lineperson clears fault.
- Lineperson closes Feeder Recloser and re-arms Loop Automation.
- Lineperson closes Mid-point Recloser and re-arms Loop Automation.
- Lineperson opens Tie Recloser and re-arms Loop Automation in the Tie Recloser.

\begin{center}
\textbf{WARNING}
\end{center}

Where the alternate supplies cannot be connected together the Lineperson must open the Tie Recloser before closing the Feeder Recloser.
B.1.3 Fault Beyond Mid-point Recloser

In this example a fault occurs on the section of feeder between the Mid-point and Tie Recloser.

Recloser Actions:

Step 1

![Figure 19: Fault occurs beyond Mid-point Recloser](image)

The Mid-point Recloser trips to end of sequence in order to isolate the fault from the supply source.

Step 2

![Figure 20: Tie Recloser closes onto the faulted section](image)

The Tie Recloser closes to reconfigure supply to the feeder 40 seconds after the initial fault.

Step 3

![Figure 21: Tie Recloser trips and locks out](image)

The Tie Recloser immediately trips and locks out because the fault has not been cleared.
## Sequence of Events:

<table>
<thead>
<tr>
<th>Feeder Recloser</th>
<th>Mid-Point Recloser</th>
<th>Tie Recloser</th>
</tr>
</thead>
<tbody>
<tr>
<td>00.00 Pickup</td>
<td>00.00 Pickup</td>
<td></td>
</tr>
<tr>
<td>00.60 B Max 900 AMP</td>
<td>00.50 Prot Group A Active</td>
<td>02.60 Load Supply OFF</td>
</tr>
<tr>
<td>01.10 Pickup</td>
<td>00.50 Phase Prot Trip</td>
<td>41.60 Loop Auto Close Req</td>
</tr>
<tr>
<td></td>
<td>00.50 Prot Trip 1</td>
<td>41.60 Loop Auto OFF</td>
</tr>
<tr>
<td></td>
<td>00.60 B Max 900 Amp</td>
<td>41.70 Pickup</td>
</tr>
<tr>
<td></td>
<td>01.00 Automatic Reclose</td>
<td>41.90 Prot Group A Active</td>
</tr>
<tr>
<td></td>
<td>01.60 Prot Group A Active</td>
<td>41.90 Phase Prot Trip</td>
</tr>
<tr>
<td></td>
<td>01.60 Phase Prot Trip</td>
<td>41.90 Prot Trip 1</td>
</tr>
<tr>
<td></td>
<td>01.60 Prot Trip 2</td>
<td>41.90 Lockout</td>
</tr>
<tr>
<td></td>
<td>01.70 End of Sequence&lt;sup&gt;1&lt;/sup&gt;</td>
<td>41.90 Loop Auto OFF&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>01.70 Lockout&lt;sup&gt;2&lt;/sup&gt;</td>
<td>42.00 B Max 850 AMP</td>
</tr>
<tr>
<td></td>
<td>01.70 B Max 900 AMP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>02.60 Load Supply OFF</td>
<td></td>
</tr>
</tbody>
</table>

**Note 1:** If Auto Restore is ON  
**Note 2:** If Auto Restore is OFF

## Restoration Scenarios:

Restoration is the same whether **Loop Automation Configuration: Auto Restore** is ON or OFF.

- Lineperson clears fault.
- Lineperson closes Mid-point Recloser and re-arms Loop Automation.
- Lineperson re-arms Loop Automation in the Tie Recloser.
B.1.4 Loss of Zone Substation Supply

In this example the substation loses its supply.

Recloser Actions:

Step 1

1 to 30 seconds after the zone substation supply is lost:

- The Mid-point Recloser changes to protection group “B” in preparation for a change in power flow direction.
- The Feeder Recloser opens in order to isolate the substation from the alternate source of supply.

Figure 22: Loss of supply

Step 2

The Tie Recloser closes 40 seconds after losing supply on its load side.

Supply is reconfigured to the Feeder Recloser from the alternate source.

At the end of the sequence supply is reconfigured to all sections of the feeder except for the section between the substation CB and Feeder Recloser.

Figure 23: Tie Recloser reconfigures supply
Sequence of Events:

<table>
<thead>
<tr>
<th>Feeder Recloser</th>
<th>Mid-Point Recloser</th>
<th>Tie Recloser</th>
</tr>
</thead>
<tbody>
<tr>
<td>01.00 Source Supply OFF</td>
<td>01.00 Source Supply OFF</td>
<td>01.00 Load Supply OFF</td>
</tr>
<tr>
<td>01.00 Load Supply OFF</td>
<td>01.00 Load Supply OFF</td>
<td></td>
</tr>
<tr>
<td>30.00 Loop Auto Trip Req</td>
<td>30.00 Prot Group B Active</td>
<td></td>
</tr>
<tr>
<td>41.00 Load Supply ON</td>
<td>41.00 Source Supply ON</td>
<td>40.00 Loop Auto Close Req</td>
</tr>
<tr>
<td></td>
<td>41.00 Load Supply ON</td>
<td>40.00 Loop Auto OFF¹</td>
</tr>
<tr>
<td></td>
<td></td>
<td>41.00 Load Supply ON</td>
</tr>
</tbody>
</table>

Restoration Scenarios:

If **Loop Automation Configuration: Auto Restore** is turned “ON”:

- Lineperson restores supply to the substation.
- The Feeder Recloser senses restoration of supply and closes automatically.
- Tie Recloser senses the change in power flow and opens.

If **Loop Automation Configuration: Auto Restore** is turned “OFF”:

- Lineperson restores supply to the substation.
- Lineperson closes Feeder Recloser and re-arms Loop Automation.
- Lineperson opens the Tie and re-arms Loop Automation.

**WARNING**

Where the alternate supplies cannot be connected together the Lineperson must open the Tie Recloser before closing the Feeder Recloser.
B2 Example Network Two – Substation CB, Feeder & Tie Reclosers
The second example is similar to the first, except there is no Mid-point Recloser in the network. In its normal state both the substation CB and Feeder Recloser are closed and the Tie is open with an alternate source of supply behind it.

**Figure 24: Example Two - Network Configuration**

Default Settings for Examples
Each of the fault isolation sequences are shown along with a sequence of events based on the event log. In order to show the relevant timings between Recloser event logs, it has been assumed in all the examples that:

- The initial fault occurred at 12:30:00.00 on 01/04/99.
- The Supply Timeout is set to 1 second.
- The **Loop Automation Configuration: Loop Auto Time** for the Feeder Recloser is set to 29 seconds.
- The **Loop Automation Configuration: Loop Auto Time** for the Tie Recloser is set to 39 seconds.
B.2.1 Fault Before Feeder Recloser

The following example shows Loop Automation operating when a fault occurs on the section of feeder between the substation CB and the Feeder Recloser.

**Recloser Actions:**

**Step 1**

![Fault occurs before Feeder Recloser](Image)

Substation CB trips to lockout to isolate the fault from the source of supply.

**Step 2**

![Feeder Recloser isolates the Fault](Image)

The Feeder Recloser opens 30 seconds after the initial fault isolating the fault from the alternate source of supply.

**Step 3**

![Supply is reconfigured](Image)

Supply is reconfigured to the un-faulted sections of the feeder by the Tie Recloser 40 seconds after the initial fault.

At the end of the sequence supply is reconfigured to the un-faulted sections of the feeder.

**Sequence of Events:**

Siemens Power Transmission & Distribution, Inc.
Restoration Scenarios:

If **{Loop Automation Configuration: Auto Restore}** is turned “ON”:

- Lineperson clears fault.
- Lineperson closes substation CB.
- Feeder Recloser senses restoration of supply and closes automatically.
- Tie Recloser senses the change in power flow and opens.

If **{Loop Automation Configuration: Auto Restore}** is turned “OFF”:

- Lineperson clears fault.
- Lineperson closes substation CB.
- Lineperson closes Feeder Recloser and re-arms Loop Automation.
- Lineperson opens Tie and re-arms Loop Automation.

---

**WARNING**

Where the alternate supplies cannot be connected together the Lineperson must open the Tie Recloser before closing the Feeder Recloser.
B.2.2 Fault Between Feeder and Tie Recloser

In this example a fault occurs between the Feeder and Tie Reclosers.

**Recloser Actions:**

**Step 1**

The Feeder Recloser trips to end of sequence and isolates the fault from the normal supply source.

![Figure 28: Fault between the Feeder and Tie Reclosers](image)

**Step 2**

The Tie closes 40 seconds after the initial fault to reconfigure supply to the feeder.

![Figure 29: Tie Recloser attempts to reconfigure the supply](image)

**Step 3**

The Tie trips and locks out because the fault has not been cleared.

![Figure 30: Tie Recloser trips and supply is not reconfigured](image)
Sequence of Events:

<table>
<thead>
<tr>
<th>Feeder Recloser</th>
<th>Tie Recloser</th>
</tr>
</thead>
<tbody>
<tr>
<td>00.0 Pickup</td>
<td>02.70 Load Supply OFF</td>
</tr>
<tr>
<td>00.50 Prot Group A Active</td>
<td></td>
</tr>
<tr>
<td>00.50 Phase Prot Trip</td>
<td></td>
</tr>
<tr>
<td>00.50 Prot Trip 1</td>
<td></td>
</tr>
<tr>
<td>00.60 B Max 1100 AMP</td>
<td></td>
</tr>
<tr>
<td>01.00 Automatic Reclose</td>
<td></td>
</tr>
<tr>
<td>01.10 Pickup</td>
<td></td>
</tr>
<tr>
<td>01.60 Prot Group A Active</td>
<td></td>
</tr>
<tr>
<td>01.60 Phase Prot Trip</td>
<td></td>
</tr>
<tr>
<td>01.60 Prot Trip 2</td>
<td></td>
</tr>
<tr>
<td>01.70 B Max 1100 AMP</td>
<td></td>
</tr>
<tr>
<td>01.70 End of Sequence</td>
<td></td>
</tr>
<tr>
<td>01.70 Lockout¹</td>
<td></td>
</tr>
<tr>
<td>02.70 Load Supply OFF²</td>
<td></td>
</tr>
<tr>
<td>41.60 Loop Auto Close Req</td>
<td></td>
</tr>
<tr>
<td>41.60 Loop Auto OFF¹</td>
<td></td>
</tr>
<tr>
<td>41.70 Pickup</td>
<td></td>
</tr>
<tr>
<td>41.90 Prot Group A Active</td>
<td></td>
</tr>
<tr>
<td>41.90 Phase Prot Trip</td>
<td></td>
</tr>
<tr>
<td>41.90 Prot Trip 1</td>
<td></td>
</tr>
<tr>
<td>41.90 Lockout</td>
<td></td>
</tr>
<tr>
<td>41.90 Loop Auto OFF²</td>
<td></td>
</tr>
<tr>
<td>42.00 B max 850 AMP</td>
<td></td>
</tr>
</tbody>
</table>

Note 1: If Auto Restore is ON
Note 2: If Auto Restore is OFF

Restoration Scenarios:

If **{Loop Automation Configuration: Auto Restore}** is turned “ON” or “OFF”:

- Lineperson clears fault.
- Lineperson closes Tie.
- Feeder Recloser senses restoration of supply and closes automatically.
- Lineperson opens Tie again and re-arms Loop Automation.
B3 Example Network Three – Feeder, Mid-point & Tie Reclosers

In this configuration, the substation CB has been replaced with a Centurion Recloser. This allows the user to backfeed the alternate source of supply right back to the substation Recloser if the substation loses supply. In normal operation, the Feeder and Mid-point Reclosers are normally closed and the Tie is open with an alternate source of supply behind it.

![Figure 31: Example Three - Network Configuration](image)

**Default Settings for Examples**

Each of the fault isolation sequences are shown along with a sequence of events based on the event log. In order to show the relevant timings between Recloser event logs, it has been assumed in all the examples that:

- The initial fault occurred at 12:30:00.00 on 01/04/99.
- The Supply Timeout is set to 1 second.
- The `{Loop Automation Configuration: Loop Auto Time}` for the Feeder Recloser is set to 29 seconds.
- The `{Loop Automation Configuration: Loop Auto Time}` for the Mid-point Recloser is set to 29 seconds.
- The `{Loop Automation Configuration: Loop Auto Time}` for the Tie Recloser is set to 39 seconds.
B.3.1 Fault Between Feeder and Mid-point Recloser

In this example a fault occurs between the Feeder and Mid-point Reclosers.

Recloser Actions:

Step 1

Fault is isolated from the normal source of supply when the Feeder Recloser trips to end of sequence.

Figure 32: Fault occurs before the Mid-point Recloser

Step 2:

The Mid-point Recloser changes to protection group "B" 30 seconds after the initial fault to allow for new protection grading when the power direction changes.

Figure 33: Mid-point Recloser changes to protection group ‘B’

Step 3:

The Tie closes onto the fault 40 seconds after the initial fault.
The Mid-point trips before the Tie Recloser, isolating the fault.

Figure 34: Tie Recloser reconfigures supply
### Sequence of Events:

<table>
<thead>
<tr>
<th>Feeder Recloser</th>
<th>Mid-Point Recloser</th>
<th>Tie Recloser</th>
</tr>
</thead>
<tbody>
<tr>
<td>00.00 Pickup</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00.50 Prot Group A Active</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00.50 Phase Prot Trip</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00.50 Prot Trip 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00.60 B Max 960 AMP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01.00 Automatic Reclose</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01.10 Pickup</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01.60 Prot Group A Active</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01.60 Phase Prot Trip</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01.60 Prot Trip 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01.70 B Max 960 AMP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01.70 End Of Sequence¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01.70 Lockout²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02.70 Load Supply OFF</td>
<td>02.70 Source Supply OFF</td>
<td>02.70 Load Supply OFF</td>
</tr>
<tr>
<td></td>
<td>02.70 Load Supply OFF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>31.60 Prot Group B Active</td>
<td></td>
</tr>
<tr>
<td></td>
<td>41.70 Pickup</td>
<td></td>
</tr>
<tr>
<td></td>
<td>42.20 Prot Group B Active</td>
<td></td>
</tr>
<tr>
<td></td>
<td>42.20 Phase Prot Trip</td>
<td></td>
</tr>
<tr>
<td></td>
<td>42.20 Prot Trip 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>42.40 B Max 730 AMP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>42.40 End of Sequence¹</td>
<td></td>
</tr>
<tr>
<td></td>
<td>42.40 Lockout²</td>
<td></td>
</tr>
<tr>
<td></td>
<td>42.70 Load Supply ON</td>
<td></td>
</tr>
<tr>
<td></td>
<td>41.60 Loop Auto Close Req</td>
<td>41.70 Pickup</td>
</tr>
<tr>
<td></td>
<td>41.60 Loop Auto OFF¹</td>
<td></td>
</tr>
<tr>
<td></td>
<td>42.40 B Max 730 AMP</td>
<td></td>
</tr>
</tbody>
</table>

Note 1: If Auto Restore is ON
Note 2: If Auto Restore is OFF

Note 1: If Auto Restore is ON
Note 2: If Auto Restore is OFF

Note 1: If Auto Restore is OFF
WARNING

Where the alternate supplies cannot be connected together the Lineperson must open the Tie Recloser before closing the Feeder Recloser.

Restoration Scenarios:

If {Loop Automation Configuration: Auto Restore} is turned “ON”:

- Lineperson clears fault.
- Lineperson closes Feeder Recloser at zone substation and re-arms Loop Automation.
- Mid-point senses restoration of supply and closes automatically.
- Tie Recloser senses the change in power flow and opens.

If {Loop Automation Configuration: Auto Restore} is “OFF”:

- Lineperson clears fault.
- Lineperson closes Feeder Recloser at the zone substation and re-arms Loop Automation.
- Lineperson closes Mid-point and re-arms Loop Automation.
- Lineperson opens Tie and re-arms Loop Automation in the Recloser.
B.3.2 Fault Between Mid-point and Tie Recloser
In this example a fault occurs between the Mid-point and Tie Reclosers.

Recloser Actions:

Step 1

Figure 35: Fault occurs beyond the Mid-point Recloser

Figure 36: Tie Recloser attempts to reconfigure the supply

Figure 37: Tie Recloser trips
### Sequence of Events:

<table>
<thead>
<tr>
<th>Feeder Recloser</th>
<th>Mid-Point Recloser</th>
<th>Tie Recloser</th>
</tr>
</thead>
<tbody>
<tr>
<td>00.00 Pickup</td>
<td>00.00 Pickup</td>
<td></td>
</tr>
<tr>
<td></td>
<td>00.50 Prot Group A Active</td>
<td></td>
</tr>
<tr>
<td></td>
<td>00.50 Phase Prot Trip</td>
<td></td>
</tr>
<tr>
<td>00.60 B Max 960 AMP</td>
<td>00.50 Prot Trip 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>00.60 B Max 730 AMP</td>
<td></td>
</tr>
<tr>
<td>01.10 Pickup</td>
<td>01.00 Automatic Reclose</td>
<td></td>
</tr>
<tr>
<td></td>
<td>01.10 Pickup</td>
<td></td>
</tr>
<tr>
<td></td>
<td>01.60 Prot Group A Active</td>
<td></td>
</tr>
<tr>
<td>01.70 B Max 960 AMP</td>
<td>01.60 Phase Prot Trip</td>
<td></td>
</tr>
<tr>
<td></td>
<td>01.60 Prot Trip 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>01.70 End of Sequence¹</td>
<td></td>
</tr>
<tr>
<td></td>
<td>01.70 Lockout²</td>
<td></td>
</tr>
<tr>
<td></td>
<td>01.70 B Max 900 AMP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>02.70 Load Supply OFF</td>
<td></td>
</tr>
</tbody>
</table>

**Note 1:** If Auto Restore is ON  
**Note 2:** If Auto Restore is OFF

<table>
<thead>
<tr>
<th>41.60 Loop Auto Off ¹</th>
<th>41.60 Loop Auto Off ²</th>
<th>42.00 B Max 730 AMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>41.70 Pickup</td>
<td>41.90 Lockout</td>
<td></td>
</tr>
<tr>
<td>41.90 Prot Group A Active</td>
<td>41.90 Single Shot</td>
<td></td>
</tr>
<tr>
<td>41.90 Phase Prot Trip</td>
<td>41.90 Loop Auto Off ²</td>
<td></td>
</tr>
<tr>
<td>42.00 B Max 730 AMP</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Restoration Scenarios:

Restoration is the same whether (Loop Automation Configuration: Auto Restore) is turned “ON” or “OFF”:
- Lineperson clears fault.
- Lineperson closes the Mid-point Recloser and re-arms Loop Automation.
- Lineperson re-arms Loop Automation in the Tie Recloser.
B.3.3 Loss of Zone Substation Supply

In this example the substation itself loses supply.

Recloser Actions:

Step 1

30 seconds after the zone substation loses its supply.
- The Mid-point changes to protection group “B” to provide correct grading when the power flow changes direction.
- The Feeder Recloser opens to isolate the substation from the alternate supply source.

Figure 38: Loss of Zone Substation supply

Step 2

The Tie closes 40 seconds after the initial fault restoring the supply to the feeder.
Supply is reconfigured to all sections of the feeder.

Figure 39: Tie Recloser reconfigures the supply
Sequence of Events:

<table>
<thead>
<tr>
<th>Feeder Recloser</th>
<th>Mid-Point Recloser</th>
<th>Tie Recloser</th>
</tr>
</thead>
<tbody>
<tr>
<td>01.00 Source Supply OFF</td>
<td>01.00 Pickup</td>
<td>01.00 Load Supply OFF</td>
</tr>
<tr>
<td>01.00 Load Supply OFF</td>
<td>01.00 Load Supply OFF</td>
<td></td>
</tr>
<tr>
<td>30.00 Loop Auto Trip Req</td>
<td>30.00 Prot Group B Active</td>
<td></td>
</tr>
<tr>
<td>41.00 Load Supply ON</td>
<td>41.00 Source Supply ON</td>
<td>41.00 Load Supply ON</td>
</tr>
<tr>
<td></td>
<td>41.00 Load Supply ON</td>
<td></td>
</tr>
</tbody>
</table>

Restoration Scenarios:

If **(Loop Automation Configuration: Auto Restore)** is turned “ON”:
- Linesman restores supply to the zone substation.
- The Feeder Recloser senses the restoration of supply and closes automatically.
- Tie Recloser senses the change in power flow and opens.

If **(Loop Automation Configuration: Auto Restore)** is turned “OFF”:
- Linesman restores supply to the zone substation.
- Linesman closes the Feeder Recloser and re-arms Loop Automation.
- Linesman opens the Tie and re-arms Loop Automation in the Recloser.

**WARNING**

Where the alternate supplies cannot be connected together the Lineperson must open the Tie Recloser before closing the Feeder Recloser.
B4 Example Network Four – Auto-Changeover

In this example, Loop Automation provides a secure supply to a critical load (e.g., Hospital). In the normal configuration, the Feeder Recloser is closed and the Tie is open with an alternate source of supply behind it.

![Network Configuration Diagram]

**Figure 40: Example Four - Network Configuration**

**Default Settings:**

Each of the fault isolation sequences are shown along with a sequence of events based on the event log. To show the relevant timings between Recloser event logs it has been assumed in the example that:

- The initial fault occurred at 12:30:00.00 on 01/04/99.
- The Supply Timeout is set to 1 second.
- The **(Loop Automation Configuration: Loop Auto Time)** for the Feeder Recloser is set to 29 seconds.
- The **(Loop Automation Configuration: Loop Auto Time)** for the Tie Recloser is set to 39 seconds.
B.4.1 Loss of Preferred Supply
The following example shows Loop Automation operating when the Feeder Recloser loses supply.

Recloser Actions:

Step 1

- The Feeder Recloser opens 30 seconds after the supply is lost, isolating the preferred supply from the alternate source of supply.

![Figure 41: Feeder Recloser isolates the Fault](image)

Step 2

- Supply is reconfigured to the critical load by the Tie Recloser 40 seconds after the initial fault.

![Figure 42: Supply is reconfigured](image)

Sequence of Events:

<table>
<thead>
<tr>
<th>Feeder Recloser</th>
<th>Tie Recloser</th>
</tr>
</thead>
<tbody>
<tr>
<td>01.00 Source Supply OFF</td>
<td>01.00 Load Supply OFF</td>
</tr>
<tr>
<td>01.00 Load Supply OFF</td>
<td></td>
</tr>
<tr>
<td>30.00 Loop Auto Trip Req</td>
<td>40.00 Loop Auto Close Req</td>
</tr>
<tr>
<td>40.00 Loop Auto OFF¹</td>
<td>40.00 Loop Auto OFF¹</td>
</tr>
<tr>
<td>41.00 Load Supply ON</td>
<td>41.00 Load Supply ON</td>
</tr>
<tr>
<td>Note 1: If Auto Restore is OFF</td>
<td></td>
</tr>
</tbody>
</table>
Restoration Scenarios:

If \( \text{Loop Automation Configuration: Auto Restore} \) is turned “ON”:
- Lineperson restores supply to Feeder Recloser.
- Feeder Recloser senses restoration of supply and closes automatically.
- Tie Recloser senses the change in power flow and opens.

If \( \text{Loop Automation Configuration: Auto Restore} \) is turned “OFF”:
- Lineperson restores supply to Feeder Recloser.
- Lineperson closes Feeder Recloser and re-arms Loop Automation.
- Lineperson opens Tie and re-arms Loop Automation.

WARNING

Where the alternate supplies cannot be connected together the Lineperson must open the Tie Recloser before closing the Feeder Recloser.
Appendix C - Settings Record
The following template shows the range of information required when preparing a network for Loop Automation configuration.
The template may be modified as required to suit individual requirements.

<table>
<thead>
<tr>
<th>GLOBAL PARAMETERS</th>
<th>LOOP AUTOMATION TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live Terminal Voltage</td>
<td>Supply Timeout (ST)</td>
</tr>
<tr>
<td>Co-ordination time (T1)</td>
<td>Single Shot Reset Time (2 x T1) = ............</td>
</tr>
<tr>
<td>Auto-changeover (T1 + T2)</td>
<td>Loop Automation</td>
</tr>
<tr>
<td>LOP/Loop Automation Unlinked</td>
<td>Auto-changeover</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ACR NO:</th>
<th>TYPE</th>
<th>SER NO:</th>
<th>LOCATION</th>
<th>DIRECTION</th>
<th>LA TIME (sec)</th>
<th>AUTO-RESTORE AVAILABLE</th>
<th>AUTO-RESTORE ON - OFF</th>
<th>TIE RESTORE ONE / TWO WAY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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