

SEL-7000

Fully Integrated Substation Monitoring and Control System

User's Guide

SEL Systems and Services Division

20040413



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Section 1: Introduction

Manual Overview

This document provides the necessary information to understand and operate an SEL-7000 System. It includes the following sections:

- **Section 1: Introduction.** Explains the contents of this document.
- **Section 2: System Overview.** Summarizes the capabilities of the SEL-7000.
- **Section 3: Basic HMI Operations.** Provides a step-by-step description of the basic operations of the SEL-7000, including the following topics:
 - How to navigate the local HMI.
 - How to log on to the local HMI.
 - How to trip and close a breaker from the local HMI and the relay front panels.
 - How to apply and remove tags from the local HMI and the relay front panels.
 - How to enable or disable controls from the local HMI and the relay front panels.
 - How to diagnose a breaker trip from the local HMI and the relay front panels.
 - Basic troubleshooting hints.
- **Section 4: Equipment Used in the SEL-7000.** Provides a brief description of the equipment used and the functions they provide.

References

The following list contains other SEL references with additional information about topics associated with the SEL-7000:

- SEL-7000 Instruction Manual
- SEL Application Guide 2002-07 “SEL-7000 Integrated Substation Control, Automation, Monitoring, and Protection System”
- SEL-7000 Drawing Package, including:
 - AC schematics
 - DC schematics

- Communication cabling diagram
- Wiring diagrams
- Panel layouts
- Logic diagrams
- SEL-2032 Instruction Manual
- SEL Relay Reference Manuals and User's Guides for the relays used in the SEL-7000
- SEL-2100 Instruction Manual
- SEL Application Guide AG2002-05 "Securing SEL Ethernet Products with VPN Technology"
- SEL Application Guide AG2002-01 "TrafficWerks SEL Fast Message I/O Server Configuration"
- SEL Application Guide AG2001-12 "Implementing MIRRORRED BITS™ Technology Over Various Communication Media"
- SEL Application Guide AG2001-06 "Avoiding Magnetic Induction Issues in Communications Cabling"
- SEL Application Guide AG2000-08 "Applying the SEL-5040 Power System Report Manager"
- SEL Application Guide AG99-01 "Using Contact Inputs to Detect DC Grounds"
- Operation Manual, Model 1084 A/B/C GPS Satellite-Controlled Clock, Arbiter Systems, Inc.
- Owner's Manual, Davis Weather Monitor II
- Installation Manual, Standard and Industrial Anemometer
- Specification Sheet, Davis Weather Monitor II
- Product Manual, Teltone Substation Line Sharing Switch (SLSS)
- User's Guide, WonderWare FactorySuite InTouch
- Reference Guide, WonderWare FactorySuite InTouch

Acronyms

There are a number of acronyms found throughout this document:

- HMI—Human Machine Interface
- SCADA—Supervisory Control and Data Acquisition
- MOD—Motor Operated Disconnect
- CSW—Circuit Switcher
- IED—Intelligent Electronic Device
- SER—Sequential Event Recorder

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Section 2: System Overview

Introduction

This section summarizes the capabilities of the SEL-7000 Integrated Substation System. For further information regarding these topics, refer to the SEL-7000 Instruction Manual, the SEL-7000 schematics, and the SEL-7000 logic diagrams.

System Description

The SEL-7000 is a fully integrated substation system for protection, automation, control, and management of event reports, settings, and station SER data. Communication to all the IEDs in a substation allows us to take full advantage of multifunction devices like protective relays and to reduce duplication of functions within the station. This significantly reduces the number of components necessary in a substation and therefore reduces cost, reduces maintenance expenses, and increases reliability.

Figure 2.1 shows the flow of information in the SEL-7000. You can follow the data flow from the substation equipment to the IEDs and then on to the communications processor. The communications processor provides measurement data to the station computer (local HMI) and to the customer's SCADA system.

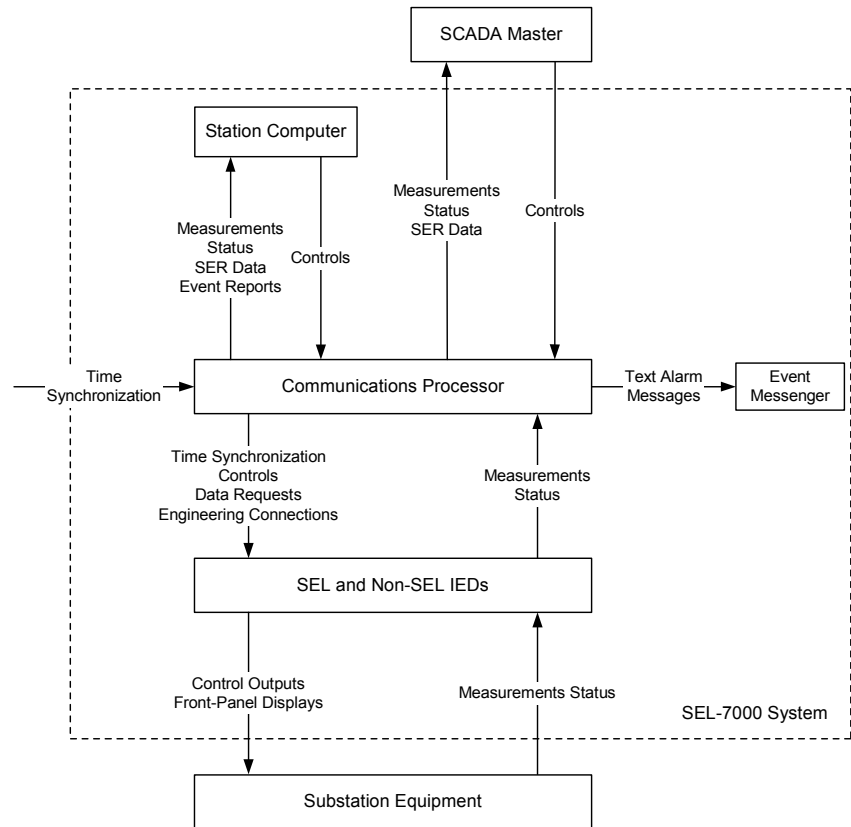


Figure 2.1: System Information Flow Diagram

The following list includes definitions for the types of information cited in Figure 2.1:

- **Measurements.** Analog process values (current, voltage, power).
- **Status.** Discrete indications (circuit breaker open/closed).
- **Controls.** Operator-initiated actions with substation equipment (circuit breaker open/close).
- **SER Data.** Sequential event recorder data, time-stamped information reflecting changes in the state of individual points within the substation (e.g., Circuit Breaker Open Indication, 7/31/2002 9:00:05.234).
- **Event Reports.** Analog waveform captures collected by the protective relays, including both prefault and post-fault data (SEL event files viewable with SEL-5601 Software).
- **Time Synchronization.** IRIG-B signal providing 1-ms resolution time synchronization, from a GPS receiver located in the station.
- **Engineering Data.** File-based reports, diagnostic data, and IED settings that are exchanged with the relay.

Communications Architecture

Figure 2.2 shows the communications architecture of the SEL-7000. Communications processors consolidate measurement data and system status from station IEDs and provide a pass-through point for controls from the local HMI or the remote SCADA system. The communications processors also provide a pass-through point for engineering access (through both Ethernet and dial-up modem services) and for automated relay event record collection (via the SEL-5040 Power System Report Manager Software). The communications processors also distribute IRIG-B time synchronization to all the SEL relays.

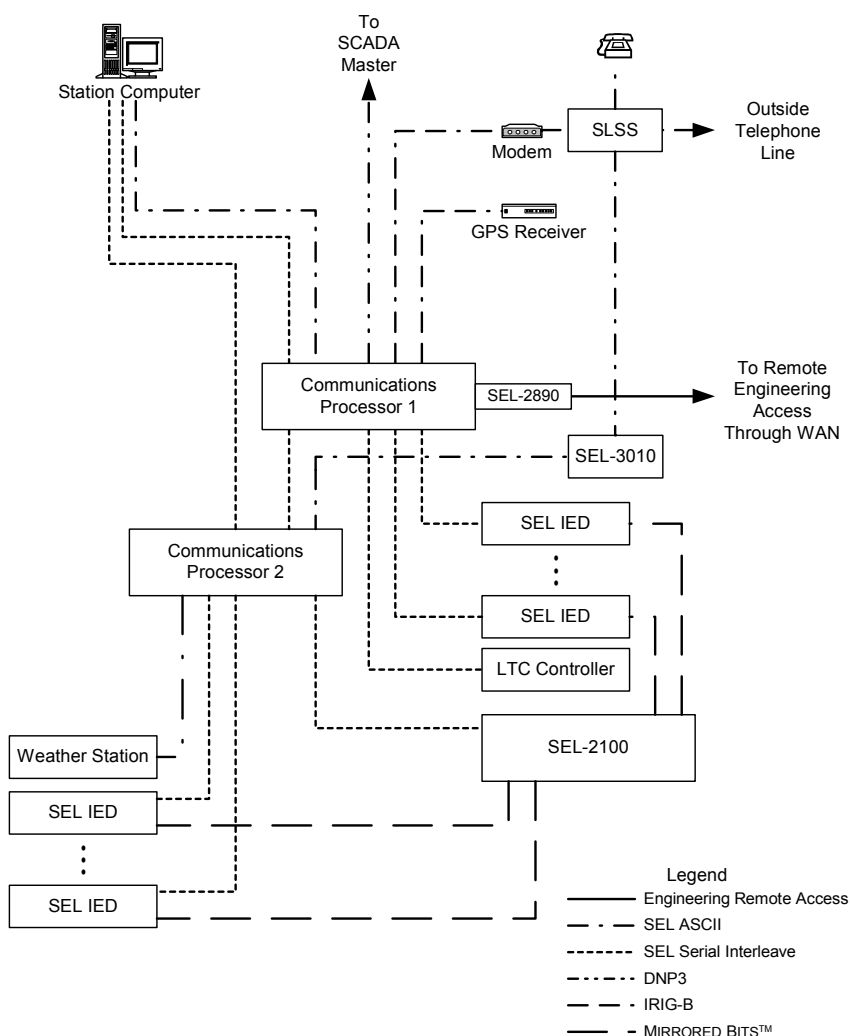


Figure 2.2: Communications Architecture

Sources of Operator Control

In the SEL-7000 design, there are several possible sources of operator control:

- **Remote SCADA control.** A remote control interface through a SCADA master system or an HMI located offsite.
- **Local HMI control.** The primary local interface for visualization and control via the HMI located on the substation computer. The HMI has the ability to block remote (SCADA) control.
- **Local panel control.** Front-panel pushbuttons located on the front of the SEL-351 and SEL-421 Relays. The pushbuttons are enabled only when communication with the local HMI control is lost.
- **Local maintenance control.** The SEL-351S and SEL-421 have prewired inputs that can be configured to block all other forms of trip or close control (remote SCADA, local HMI, or local panel). This is often desirable when manually operating a breaker in the substation yard.

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Section 3: Basic HMI Operations

Introduction

This section demonstrates on a step-by-step basis how to use the SEL-7000 Integrated Substation System Human Machine Interface (HMI) residing on the rack-mounted PC. It does not explain how to apply or set any of the settings on the IEDs in the SEL-7000. It covers the following topics:

- Navigating the HMI screens
- Logging on to the system
- Observing and controlling breakers
- Setting and clearing tags
- Enabling and disabling controls
- Diagnosing a breaker trip
- Troubleshooting

Navigating the HMI Screens

The header bar, the main screen, and the alarm bar screens are used to describe how to navigate through the HMI.

Header Bar

The header bar appears at the top of all screens in the HMI. Use the header bar to navigate between the various screens in the HMI (see Figure 3.1). Click one of the buttons to view one of the screens. The main screen will then change to the selected screen.

If a button appears dimmed, the button is currently disabled and the screen cannot be accessed. To enable the button, you must either log on to the system or close a pop-up window before you can click the button. To log on to the system, refer to *Logging on to the SEL-7000 on page 3.3*.

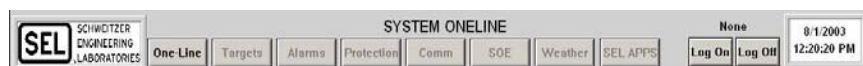


Figure 3.1: Header Bar

Main Screen

The main screen of the HMI displays the information for the button selected from the header bar. The main screen is the space on the screen between the header bar (Figure 3.1) and the alarm bar (Figure 3.5).

If you have not previously logged on, the **System Online** screen will appear in the main screen, as shown in Figure 3.2. Once you are logged on, clicking one of the buttons from the header bar will open the selected screen.

To select an icon or button, move your mouse over the icon or button until a box appears around it. Click the icon or button to initiate the task.

If you have logged off, certain buttons or icons on the screen will not be available.

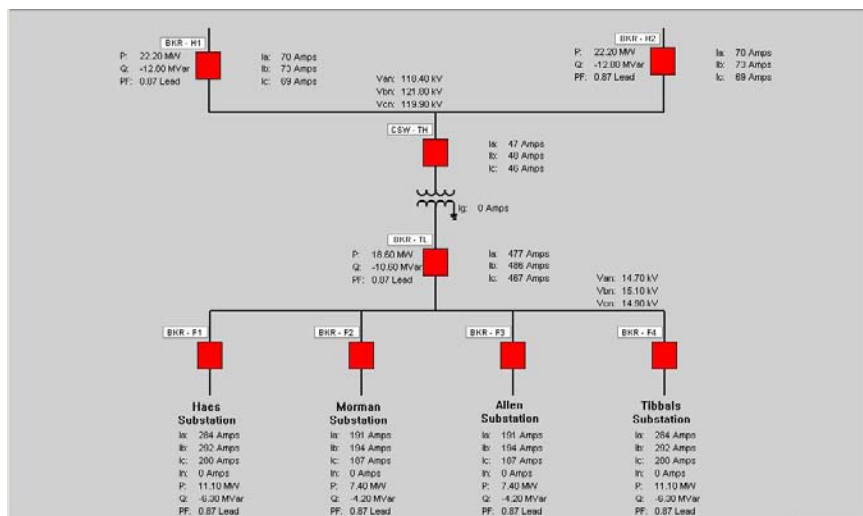


Figure 3.2: System Online

Click the breaker symbol (the colored box underneath the breaker name shown in Figure 3.3) to view the detail screen of the selected breaker. The breaker symbol can be selected only if you are logged on to the system (see *Logging on to the SEL-7000* on page 3.3). Once you are logged on, click the breaker symbol to view a detailed screen for that breaker.



Figure 3.3: Breaker Symbol

There are four conditions for the breaker symbol:

- A red symbol indicates that the breaker is closed.
- A green symbol indicates that the breaker is open.
- If a BF appears when the breaker symbol is red or green, this means that a breaker failure has occurred.
- A blue (cyan) symbol appears when communication is lost. Click the **Comm** button on the header bar (Figure 3.1) to view the status of all communications links in the SEL-7000.

Click the transformer symbol (Figure 3.4) to view the detail screen for the transformer.



Figure 3.4: Transformer Symbol

Alarm Bar

The alarm bar displays the current system alarms (see Figure 3.5). The data shows the latest four unacknowledged alarms in chronological order. Click the **ACK** button to acknowledge any alarms on the alarm bar. Unacknowledged alarms are displayed in red. Unacknowledged alarms that have returned to normal are displayed in blue.

The **ACK** button is disabled if you are not logged on (see *Logging on to the SEL-7000 on page 3.3*). For more information on the alarm bar and acknowledging an event, refer to *Diagnosing a Breaker Trip on page 3.36*.

Date	Time	Description	Value	Group	Provider	
Aug 01 2003	12:18:46.003 PM	Trans. Line 2 SEL-421-1 Alarm	Normal	BreakerH2	\nTouch	
Aug 01 2003	12:18:46.003 PM	Trans. Line 2 SEL-421-1 TC2	Alarm	BreakerH2	\nTouch	
Aug 01 2003	12:18:46.003 PM	Trans. Line 2 Breaker A Contact	Closed	BreakerH2	\nTouch	
Aug 01 2003	12:18:46.003 PM	Trans. Line 2 Reclose	Enabled	BreakerH2	\nTouch	

ACK

Figure 3.5: Alarm Bar

Logging on to the SEL-7000

This section provides instructions for logging on to the SEL-7000 HMI screen. If you are not properly logged on, the HMI buttons appear dimmed, as shown in Figure 3.6. You will also not be able to leave this screen and/or gain access to various tags and detail screens. Tags are discussed in *Applying and Removing Tags on page 3.9*.

A view-only log on level will not allow the user to issue any commands (open/close breaker, apply/remove tags, etc.). See the SEL-7000 Instruction Manual for a detailed explanation of the different password-protected access levels available to the user.

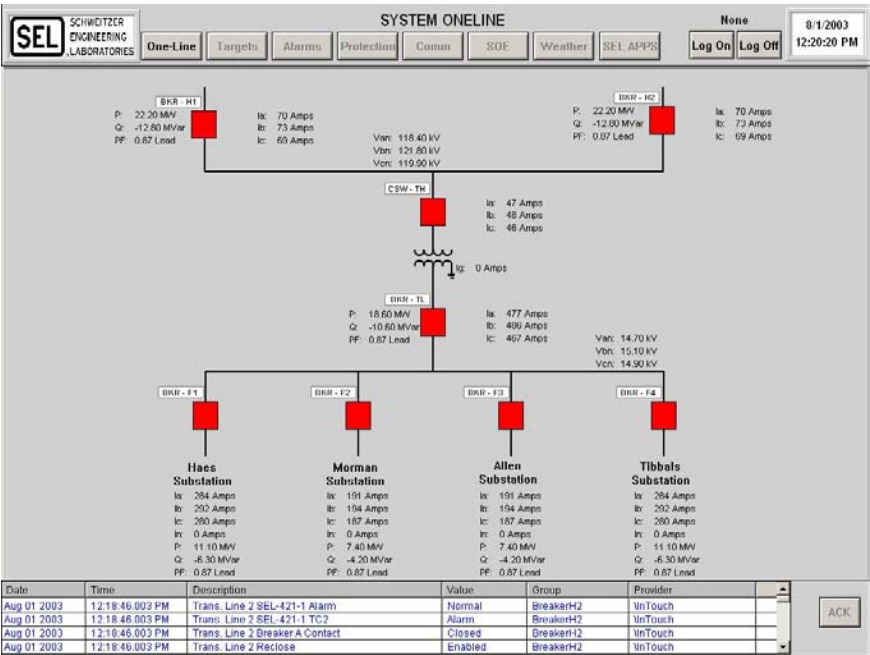



Figure 3.6: SEL-7000 System Not Logged On

Perform the following steps to log on to the SEL-7000 HMI:

- Step 1.** Click the  button from the header bar, as shown in Figure 3.1.
- The log on pop-up screen will appear, as shown in Figure 3.7.

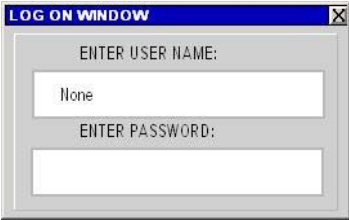


Figure 3.7: Log On Window

- Step 2.** Move the mouse to the left side of the text box under **ENTER USER NAME:** until a rectangular box appears in the text box (see Figure 3.8).

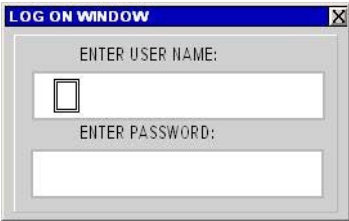


Figure 3.8: User Name Text Box

- Step 3.** Once the rectangular box appears, click it.
- Another text box will appear (see Figure 3.9).

Step 4. Enter the user name in the text box, followed by <Enter>.



Figure 3.9: Entering User Name

Step 5. Navigate the mouse to the left side of the text box under **ENTER PASSWORD:** until a rectangular box appears inside the text box.



Figure 3.10: Password Text Box

Step 6. Once the rectangular box appears, click it.
Another text box will appear (see Figure 3.11).


Step 7. Enter the correct password followed by <Enter>.

NOTE: The password will not be displayed.



Figure 3.11: Entering the Password

After you enter a valid user name and password, the log on window shown in Figure 3.11 will disappear and the buttons on the header bar will no longer be shaded.

Step 8. To log off the system, simply click the  button.

The buttons on the header bar will again be shaded. The main screen will go back to the **System Online** screen.

Tripping and Closing Breakers

The trip and close buttons on the HMI and front panels of the relays open and close the selected breaker.

HMI Trip

Perform the following steps to open a breaker through the HMI:

Step 1. Log on to the system (see *Logging on to the SEL-7000* on page 3.3).

Step 2. Click the **One-Line** button from the header bar (as shown in Figure 3.1) to display the **System Online** screen.

Step 3. Choose a breaker from the **System Online** screen that will be opened or closed:

- Transmission Line: BKR-H1 and BKR-H2
- Feeders: BKR-(F1–F4)
- High-Side Circuit Switcher: CSW-TH
- Low-Side Breaker: BKR-TL

Step 4. Move your mouse to the breaker symbol of the breaker for which you wish to view the detail screen.

Step 5. Once a square appears around the breaker symbol, click it.

A detail screen of the breaker will appear.

In the following example, Feeder Breaker 2 is used to demonstrate how to trip and close a breaker. For this example, the breaker will initially be closed, as shown in Figure 3.12.

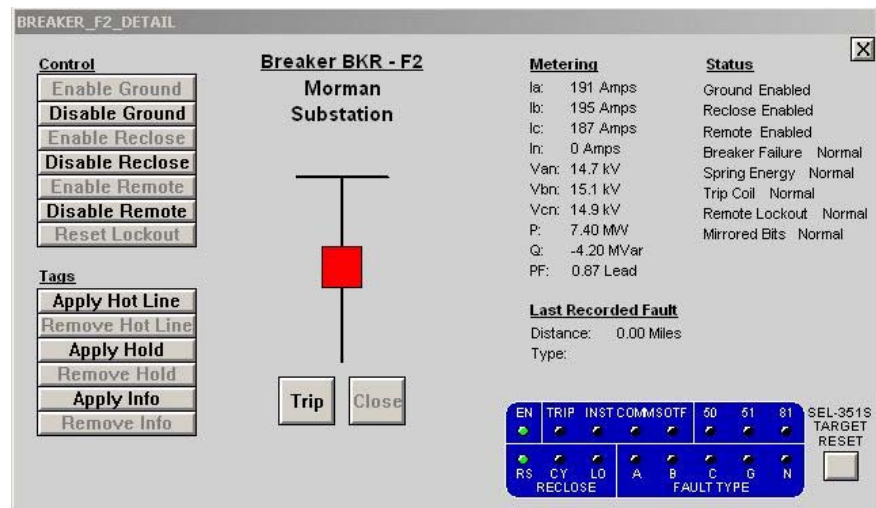




Figure 3.12: Breaker Feeder 2 With Breaker Closed

Step 6. To open the breaker, move your mouse over the  button until a box appears around it.

Step 7. Once the box appears, click the  button.

A green prompt window for the breaker will appear, as shown in Figure 3.13. When the prompt window is displayed, the detail screen will disappear from view. The **System Online** will then be visible to allow you to watch the state of the breaker change.

To cancel opening the breaker or to close the prompt window, click the  button. The open breaker prompt window will then disappear and you will return to the previous detail screen without opening the breaker.

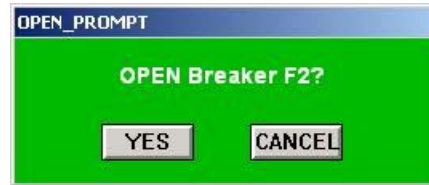





Figure 3.13: Open Breaker Prompt

Step 8. To open the breaker, click the  button.

Step 9. Once the breaker is open, click the  button to close the **OPEN_PROMPT** window. The following will occur:

- The breaker will appear in an abnormal state, as shown in Figure 3.14. An abnormal state occurs when there is an alarm associated with the breaker.
- The detail screen will reappear.
- The  button will be disabled.
- The breaker symbol will change from red to green if the control action was successful.

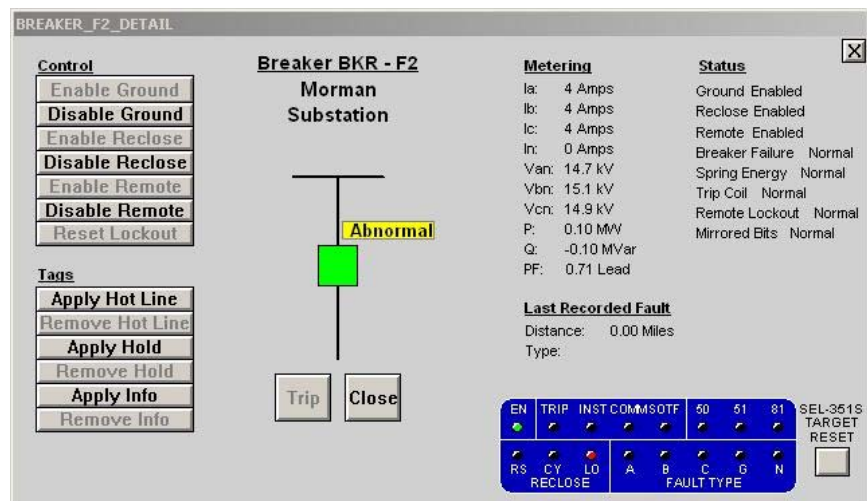


Figure 3.14: Breaker Feeder 2 With Breaker Open


HMI Close

Perform the following steps to close a breaker through the HMI:

Step 1. Ensure that the hot line or hold tag is disabled; the breaker will not close if either of these tags are enabled. To disable a tag, refer to *Applying and Removing Tags* on page 3.9.

Step 2. Once the tag is removed, click the  button on the detail screen.

A red close breaker window will appear, as shown in Figure 3.15. When the prompt window is displayed, the detail screen will disappear from view. The **System Online** will then be visible to allow the user to watch the state of the breaker change.

To cancel closing the breaker or to close the prompt window, click the  button. Once this button is clicked, the close breaker prompt window will disappear and you will return to the previous detail screen without closing the breaker.

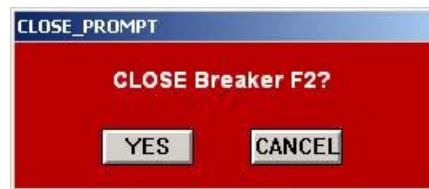







Figure 3.15: Close Breaker Prompt

Step 3. To close the breaker, click the  button. Once the button is clicked to confirm closing the breaker for the relay, the following will appear on the detail screen (Figure 3.12):

- The abnormal state may disappear.
- The detail screen will reappear.
- The  button will be disabled.
- The  button will be enabled.
- The breaker symbol will appear red if the control action was successful.

Step 4. Once the breaker is closed, click the  button to close the prompt window.

Step 5. To view the **System Online** screen, click the  button to close the detail screen.

Relay Front-Panel Trip

Front-panel operations are available only when the HMI is disabled, with the exception of the SEL-351S {TRIP} pushbuttons and the SEL-421 {BREAKER OPEN} pushbuttons.

To trip a breaker from the front panel of a relay, press the green {TRIP} pushbutton on the SEL-351S (Figure 3.16) or the {BREAKER OPEN} pushbutton on the SEL-421 (Figure 3.17). The breaker open LED will assert and the relay will be in a reclose lockout state.

Relay Front-Panel Close

If the HMI is enabled and you require the breaker closed, use the HMI to close the breaker. To close the breaker, first disable any blocking tags (see *Applying and Removing Tags* on page 3.9).

If the HMI is enabled, then the front-panel pushbuttons of the relays (including the **{CLOSE}** pushbutton) are locked. If the HMI is disabled or a communications cable is removed, the SEL-351S pushbuttons can be used once they have been unlocked by pressing the **{LOCK}** pushbutton for three seconds. If the HMI is disabled, the SEL-421 pushbuttons are automatically unlocked.

Once the hot line tag is disabled (if active), the targets are reset, and the front-panel pushbuttons are enabled. Use the **{BREAKER CLOSED}** pushbutton on the SEL-421 (Figure 3.17) or the red **{CLOSE}** pushbutton on the SEL-351S-6 (Figure 3.16) to close the breaker.

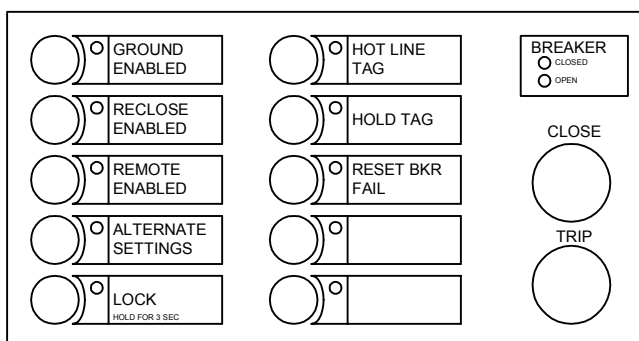


Figure 3.16: Pushbuttons for the SEL-351S

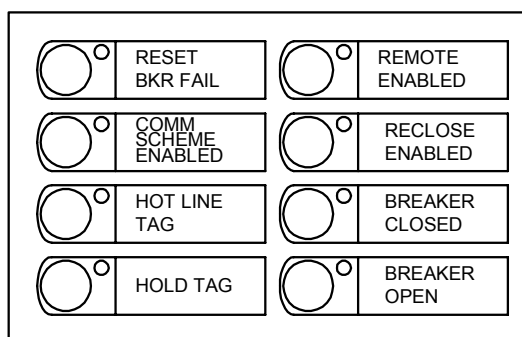


Figure 3.17: Pushbuttons for the SEL-421

Applying and Removing Tags

This subsection describes how to properly apply or remove the hot line, hold, and information tags through the SEL-7000 HMI or the front panel of the relays. The following is a list of the available devices that have an option to apply or remove tags:

- Transmission Line: BKR-H1 and BKR-H2
- Feeders: BKR-(F1 – F4)

- High-Side Circuit Switcher: CSW-TH
- Low-Side Breaker: BKR-TL

Tagging requirements are usually unique to every customer. For this reason, the tagging for most SEL-7000 Systems is fully customized for each customer. Contact SEL for further information on your unique tagging requirements.

Hot Line Tag

The hot line tag disables reclose functions in the SEL relays and blocks **CLOSE** commands from the remote SCADA system, the local HMI, and the front-panel pushbuttons. For relays configured with the reclose function, the relay goes to reclose lockout if this tag is enabled. Tag information is recorded in a Microsoft® Access database on the substation PC when a tag is set or removed. You can add further comments to this field when the tag is removed.

HMI Apply

Perform the following steps to apply a hot line tag through the HMI:

- Step 1.** Log on to the system (see *Logging on to the SEL-7000 on page 3.3*).
- Step 2.** Click the **One-Line** button from the header bar (Figure 3.1) to display the **System Online** screen.
- Step 3.** From the **System Online** screen, choose one of the following breakers to be tagged:
 - Transmission Line: BKR-H1 and BKR-H2
 - Feeders: BKR-(F1 – F4)
- Step 4.** Click the breaker symbol of the breaker for which you wish to apply a hot line tag.

The detail screen of the breaker will appear. On the left side of the detail screen is an option to either apply or remove a hot line tag.

The Transmission Line (BKR-H2) will be used to demonstrate how to properly apply and remove a hot line tag through the HMI. For this example, the breaker will initially have the hot line tag removed, as shown in Figure 3.18.

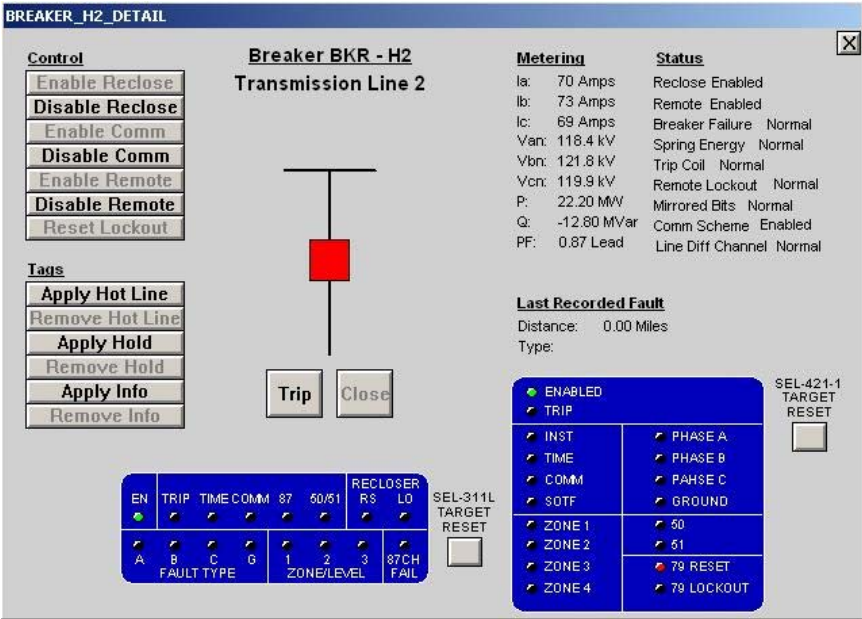


Figure 3.18: Breaker H2 With Hot Line Tag Removed

Step 5. Click the **Apply Hot Line** button.

The **Hot Line Tag** window for the breaker will appear (Figure 3.19).

To cancel the hot line tag application, click the **No** button or the **X** button. Once one of these options is selected, the **Hot Line Tag** window disappears and you will return to the previous detail screen.

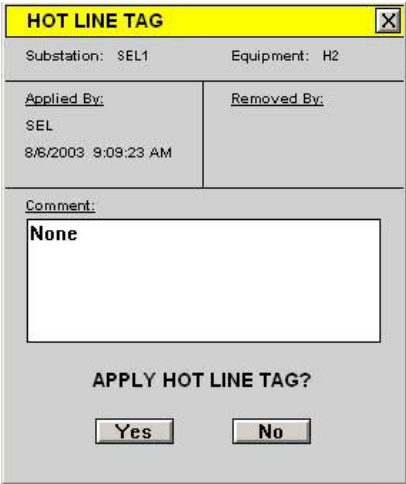


Figure 3.19: Apply Hot Line Tag Window


Table 3.1: Apply Hot Line Tag Window Description

Option	Description
Substation:	The name of the substation is automatically populated.
Equipment:	The name of the breaker to which the tag is applied is automatically populated.
Applied By:	The name of the operator who applied the tag and the date and time when it was applied is automatically populated.

Removed By:	The name of the operator who removed the tag and the date and time when it was removed is automatically populated.
Comment:	Fill this field with any important information; the maximum of allowable characters is 131.

Step 6. To apply the hot line tag, first enter your comment as to why the tag is being applied. This comment will be stored in the Microsoft Access tagging database. Then click the **Yes** button.

After the hot line tag is applied, the following will occur:

- The **Apply Hot Line** button will be disabled.
- The **Remove Hot Line** button will be enabled.
- The breaker will display an abnormal state. An abnormal state occurs whenever the properties associated with the breaker indicate an alarm condition.
- A yellow tag representing an enabled hot line tag will appear beside the breaker.
- The relay will now go to 79 (reclose) lockout.
- Reclose control will be disabled, as indicated by the  symbol.

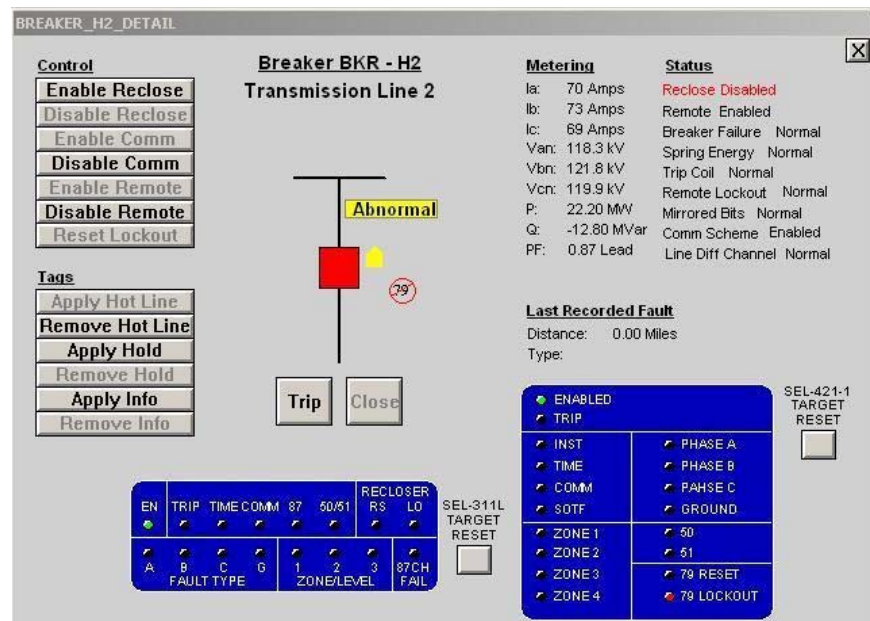


Figure 3.20: Breaker H2 With Hot Line Tag Applied

From the **System Online** screen, the following will indicate a hot line tag was applied:

- The breaker will display an abnormal state.
- A yellow tag representing an enabled hot line tag will appear beside the breaker.
- The alarm bar at the bottom of the screen will indicate that a hot line tag exists.
- The symbol for reclose will now display as disabled.

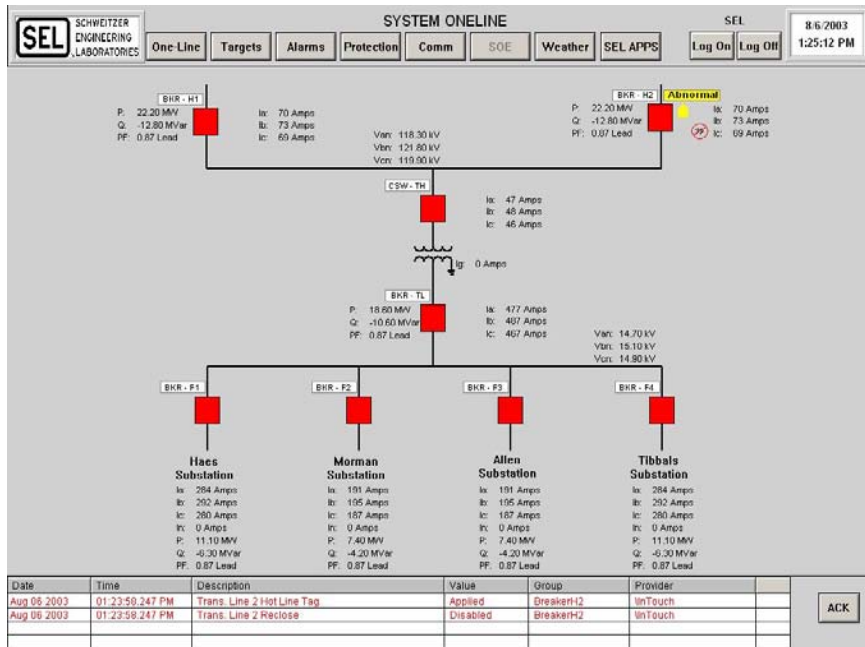


Figure 3.21: System Online Screen With Breaker H2 Hot Line Tag Applied

After a tag is applied, you can view the hot line tag from the detail screen or on the **System Online** screen by clicking the yellow hot line tag symbol. A **Hot Line Tag** window will appear, as shown in Figure 3.22. The **Hot Line Tag** window will look similar to an **Apply Hot Line Tag** window but there will not be an option to remove the tag. Viewing a tag does not make an entry in the tagging database.

HOT LINE TAG
✕

Substation: SEL1
Equipment: H2

Applied By:

SEL

8/6/2003 9:13:44 AM

Removed By:

Comment:

None

Figure 3.22: Hot Line Tag Window

HMI Remove

Perform the following steps to remove a hot line tag through the HMI:

- Step 1.** Ensure that you are logged on to the system (see *Logging on to the SEL-7000* on page 3.3).
- Step 2.** Click the **One-Line** button from the header bar.

Step 3. Click the breaker that has the hot line tag applied.

The detail screen for the breaker will then appear.

Step 4. Click the **Remove Hot Line** button.

The **Hot Line Tag** window will appear and the option to remove the tag will be available, as shown in Figure 3.23.

To cancel the removal of the tag, click the **No** button or the **X** button. You will return to the detail screen without removing the tag.

HOT LINE TAG	
Substation: SEL1	Equipment: H2
Applied By: SEL 9/6/2003 1:23:54 PM	Removed By:
Comment: None	
REMOVE HOT LINE TAG?	
Yes	No

Figure 3.23: Remove Hot Line Tag Window

Step 5. To remove the hot line tag, first append comments as to why you are removing this tag. This text will be stored in the tagging database. Then click the **Yes** button; the **Hot Line Tag** window will close and the hot line tag will be removed from the breaker.

After you remove the hot line tag, the following will occur (as in Figure 3.18):

- The hot line tag on the relay will be removed.
- The abnormal indication and the yellow hot line tag will be removed from the detail screen and the **System Online** screen.
- The alarm bar entry will disappear.
- The **Remove Hot Line** button will be disabled.
- The **Apply Hot Line** button will be enabled.

For more information on enabling reclose control, refer to *Enabling or Disabling Controls* on page 3.24.

Relay Front-Panel

If the HMI fails, the communications cable is disconnected, or the PC is disabled, you can use the relay front-panel pushbuttons to enable or disable the hot line tag, as shown in Figure 3.24. The SEL-351S Relays also require the pushbuttons to be unlocked. (See *Relay Front-Panel Close* on page 3.9 for instructions on unlocking front-panel pushbuttons.)

Press the **{HOT LINE TAG}** pushbutton on the relay front panel to enable or disable the tag. An illuminated LED will indicate the tag is enabled; the LED will be off when the tag is disabled.



Figure 3.24: Front-Panel Hot Line Tag Pushbutton

Similar to enabling the hot line tag from the HMI, if the **{HOT LINE TAG}** pushbutton is pressed, the relay will immediately disable reclose control for the breaker. After disabling the hot line tag, you can enable the reclose. For more information on enabling reclose control, refer to *Recloser Control on page 3.24*.

NOTE: Applying and removing the hot line tag from the relay front panel will not create entries in the tagging database.

Hold Tag

A hold tag is a clearance tag that indicates that equipment is de-energized and isolated for personal safety. This tag blocks the close in the relay. Tag information is collected when the tag is set. You can add further comments to this field when you remove the tag.

HMI Apply

Perform the following steps to apply a hold tag through the HMI:

- Step 1.** Log on to the system (see *Logging on to the SEL-7000 on page 3.3*).
- Step 2.** Click the **One-Line** button from the header bar, as shown in Figure 3.1. This will display the **System Online** screen.
- Step 3.** To apply or remove a hold tag, first choose one of the following breakers from the **System Online** screen:
 - Transmission Line: BKR-H1 and BKR-H2
 - Feeders: BKR-(F1 – F4)
 - High-Side Circuit Switcher: CSW-TH
 - Low-Side Breaker: BKR-TL
- Step 4.** Click the breaker symbol of the breaker for which you wish to apply the hold tag.

The detail screen of the breaker will appear.

On the left side of the detail screen is an option to either apply or remove a hold tag.

The High-Side Breaker (CSW-TH) will be used to demonstrate how to apply and remove a hold tag. For this example, the breaker will initially have the hold tag removed, as shown in Figure 3.25.

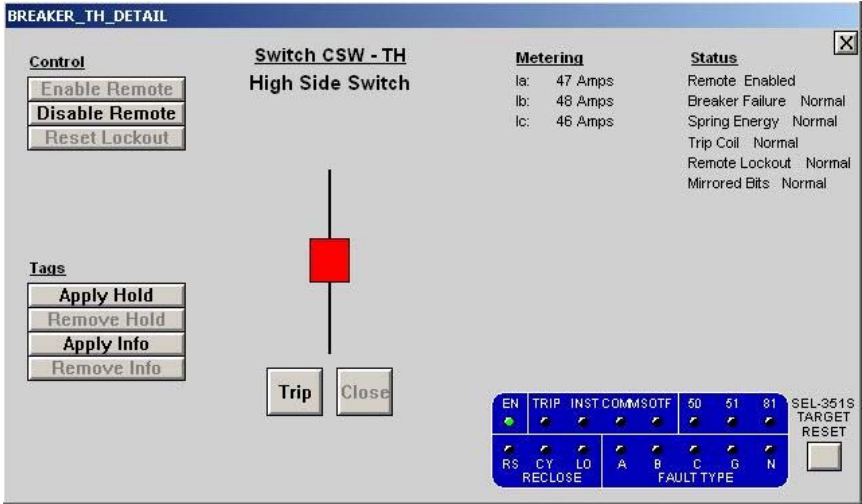


Figure 3.25: High-Side Switch With Hold Tag Removed

Step 5. Click the **Apply Hold** button.

The **Hold Tag** window for the breaker will appear, as in Figure 3.26.

To cancel the hold tag application, click the **No** button or the **X** button on the top right corner of the **Hold Tag** window. Once one of the options is selected, the **Hold Tag** window will disappear and you will return to the previous detail screen.



Figure 3.26: Apply Hold Tag Window

Table 3.2: Apply Hold Tag Window Description

Option	Description
Substation:	The name of the substation is automatically populated.
Equipment:	The name of the breaker to which the tag is applied is automatically populated.
Applied By:	The name of the operator who applied the tag and the date and time when it was applied is automatically populated.
Removed By:	The operator who removed the tag and the date and time when it was removed is automatically populated.
Comment:	Fill this field with important information; the maximum amount of allowable characters is 131.

Step 6. To apply the hold tag, enter your comments in the **Comment** field. These will be saved in the tagging database. Then click the **Yes** button. The **Hold Tag** window will disappear and you will return to the previous detail screen.

After the hold tag is applied, the following will appear on the detail screen (see Figure 3.27):

- A red tag representing an enabled hold tag will appear beside the breaker.
- The breaker will be in an abnormal state. An abnormal state occurs whenever the properties associated with the breaker indicate an alarm condition.
- The **Remove Hold** button will be enabled.
- The **Apply Hold** button will be disabled.

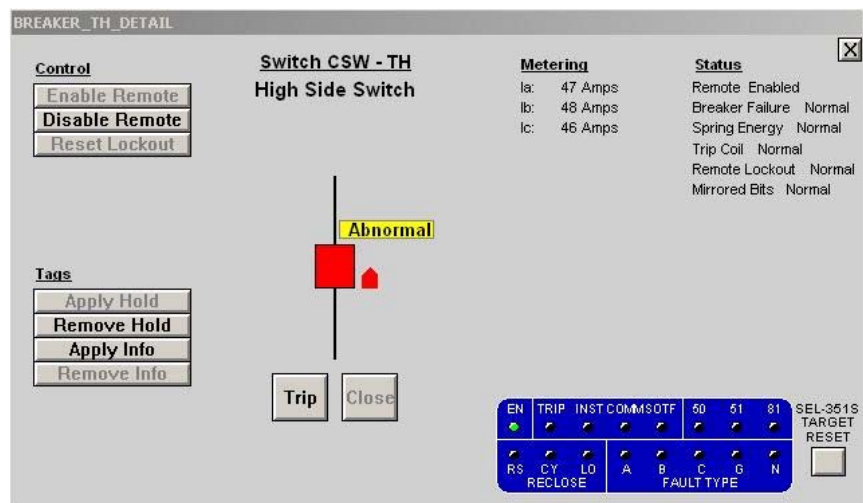


Figure 3.27: High-Side Switch With Hold Tag Applied

From the **System Online** screen, the following will indicate a hold tag was applied (see Figure 3.28):

- The device will go to an abnormal state.
- A red tag will appear beside the breaker.
- The alarm bar at the bottom of the screen will display the current status.

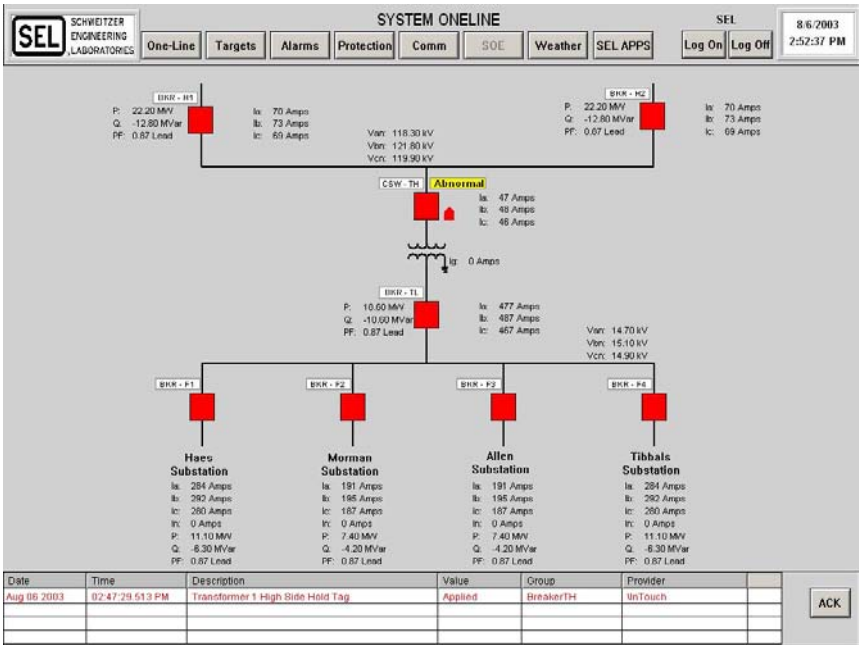


Figure 3.28: System Online Screen with High-Side Switch Hold Tag Applied

After a tag is applied, you can view the hold tag from the detail screen or on the **System Online** screen. To view the tag, click the red tag. The **Hold Tag** window will appear, as shown in Figure 3.29.

The **Hold Tag** window will look similar to an apply **Hold Tag** window but there will not be an option to remove the tag. Viewing a hold tag in this fashion does not create a database entry.

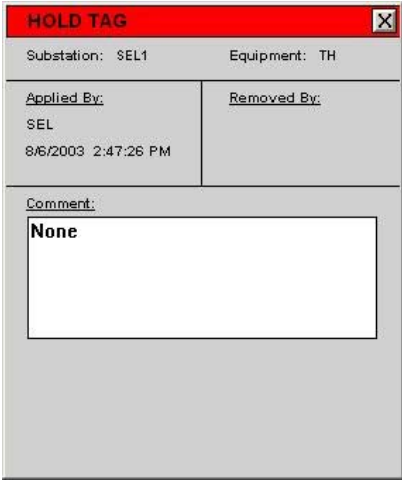


Figure 3.29: Hold Tag Window

HMI Remove

Perform the following steps to remove a hold tag through the HMI:

- Step 1.** Ensure that you are logged on to the system (see *Logging on to the SEL-7000* on page 3.3).
- Step 2.** Click the **One-Line** button from the header bar.

Step 3. Click the breaker that has the hold tag applied.

The detail screen will appear.

Step 4. Click the **Remove Hold** button.

The **Hold Tag** window will appear and the option to remove the tag will be enabled (see Figure 3.30).

To cancel the removal of the tag, click the **No** button or the **X** button. You will return to the detail screen without removing the tag.

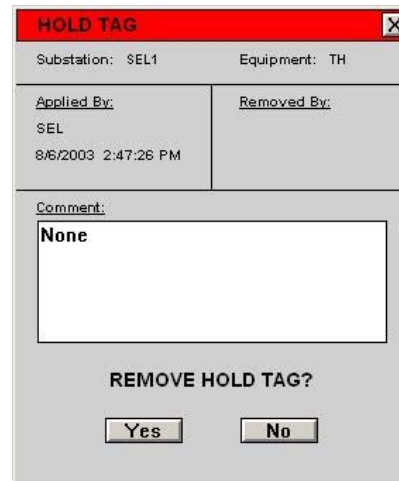


Figure 3.30: Remove Hold Tag Window

Step 5. To remove the hold tag, append comments and then click the **Yes** button. This will close the **Hold Tag** window and remove the hold tag from the breaker.

After you remove the hold tag, the following will occur (see Figure 3.25):

- The hold on the relay will be lifted.
- The abnormal indication and the red hold tag symbol will disappear from the detail screen and **System Online** screen.
- The alarm bar entry will disappear.
- The **Remove Hold** button from the detail screen will be disabled.
- The **Apply Hold** button will be enabled.

Relay Front-Panel

If the HMI fails or the PC is disabled, you can use the relay front-panel pushbuttons to enable or disable the hold tag (see Figure 3.31). The SEL-351S Relays also require that the front-panel pushbuttons be unlocked. (See *Relay Front-Panel Close* on page 3.9 for instructions on unlocking front-panel pushbuttons.) Press the **{HOLD TAG}** button on the front panel of the relay to enable or disable the tag. An illuminated LED will indicate the tag is enabled; the LED will be off when the tag is disabled.

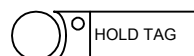


Figure 3.31: Front-Panel Hold Tag Button

NOTE: Applying and removing a hold tag from the relay front panel will not make entries in the tagging database.

Information Tag

The information tag is associated with a breaker and can be used to archive comments. The information tag does not perform any blocks or functional controls in the SEL relays.

HMI Apply

Perform the following steps to apply an information tag:

Step 1. Log on to the system (see *Logging on to the SEL-7000* on page 3.3).

Step 2. Click the **One-Line** button from the header bar, as shown in Figure 3.1. This will display the **System Online** screen.

Step 3. Choose one of the following breakers from the **System Online** screen:

- Transmission Line: BKR-H1 and BKR-H2
- Feeders: BKR-(F1 – F4)
- High-Side Circuit Switcher: CSW-TH
- Low-Side Breaker: BKR-TL

Step 4. Click the breaker symbol of the breaker for which you wish to apply an information tag.

The detail screen of the breaker will appear.

On the left side of the detail screen are several options, including options to either apply or remove an information tag. The dimmed buttons indicate that the option is not available.

The Low-Side Breaker (BKR-TL) will be used to demonstrate how to apply and remove an information tag. For this example, the breaker will initially have the information tag removed, as shown in Figure 3.32.

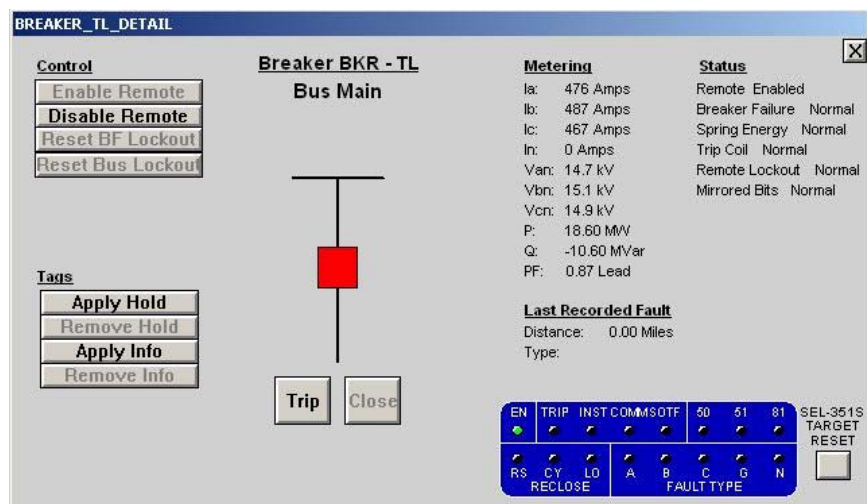


Figure 3.32: Breaker TL With Information Tag Removed

Step 5. Click the **Apply Info** button and the **Information Tag** window will appear, as shown in Figure 3.33.

To cancel the information tag application, click the **No** button or the **X** button on the top-right corner of the window. Once one of the options is selected, the **Information Tag** window will disappear and no information will be saved. You will then return to the previous breaker detail screen.

Figure 3.33: Apply Information Tag Window

Option	Description
Substation:	The name of the substation is automatically populated.
Equipment:	The name of the breaker to which the tag is applied is automatically populated.
Applied By:	The name of the operator who applied the tag and the date and time when it was applied is automatically populated.
Removed By:	The name of the operator who removed the tag and the date and time when it was removed is automatically populated.
Comment:	Fill this field with important information; the maximum amount of allowable characters is 131.

Step 6. To apply the information tag, enter your comments and then click the **Yes** button. The **Information Tag** window will then disappear and the information tag will be applied. You will then return to the previous detail screen.

The following will appear on the detail screen after you apply the information tag (see Figure 3.34):

- A white tag will appear beside the breaker.
- The breaker will be displayed as abnormal. An abnormal state occurs whenever the properties associated with the breaker indicate an alarm condition.

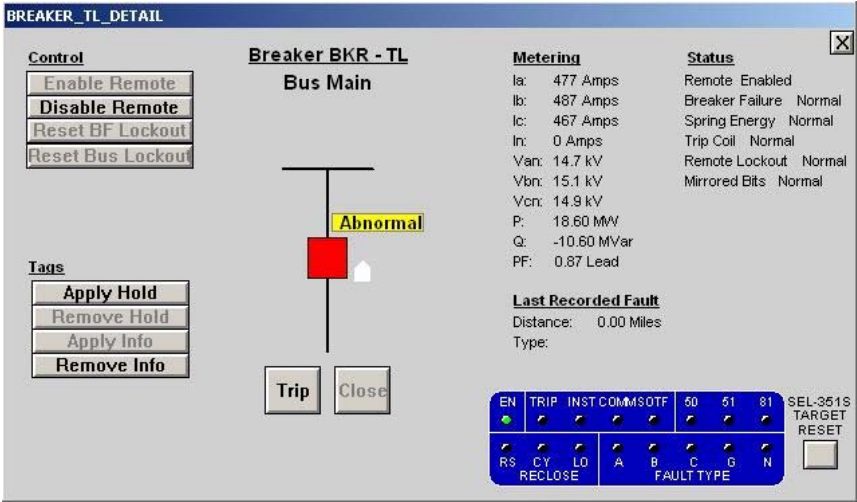


Figure 3.34: Breaker TL With Information Tag Applied

On the **System Online** screen, the following will indicate an information tag was applied (see Figure 3.35):

- A white tag will appear beside the breaker box.
- The breaker will be displayed as abnormal.
- The alarm bar will display the status of the information tag.

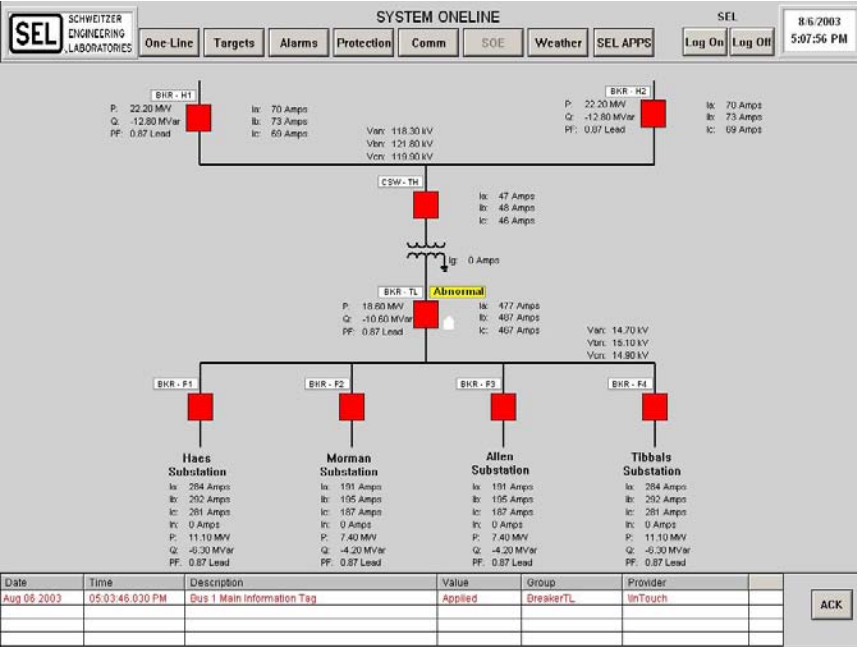


Figure 3.35: System Online Screen With Breaker TL Information Tag Applied

After a tag is applied, you can view the information tag from the detail screen or the **System Online** screen. To view the tag, click the white tag. The **Information Tag** window will appear, as shown in Figure 3.36.

The **Information Tag** window will look similar to an **Apply Information Tag** window but there will not be an option to remove the tag. Viewing an information tag in this fashion does not create a database entry.

INFORMATION TAG	
Substation: SEL1	Equipment: TL
Applied By: SEL 8/6/2003 5:03:42 PM	Removed By:
Comment: None	

Figure 3.36: Information Tag Window

HMI Remove

Perform the following steps to remove an information tag through the HMI:

Step 1. Ensure that you are logged on to the system (see *Logging on to the SEL-7000* on page 3.3).

Step 2. Click the **One-Line** button from the header bar.

Step 3. Click the breaker that has the information tag applied.

The detail screen will appear.

Step 4. Click the **Remove Info** button.

The information tag window will appear and the option to remove the tag will be available, as shown in Figure 3.37.



To cancel the removal of the tag, click the **No** button or the **X** button. You will return to the previous detail screen without removing the tag.

INFORMATION TAG	
Substation: SEL1	Equipment: TL
Applied By: SEL 8/6/2003 5:03:42 PM	Removed By:
Comment: None	
REMOVE INFORMATION TAG?	
Yes	No

Figure 3.37: Remove Information Tag Window

Step 5. To remove the tag, append comments and click the **Yes** button. This will close the information tag window and remove the information tag from the breaker.

After you have removed the information tag, the following will occur (see Figure 3.32):

- The abnormal indication and the white information tag will disappear from the detail screen and **System Online** screen.
- The alarm bar entry will disappear.
- The  button from the detail screen will be disabled.
- The  button will be enabled.

Relay Front-Panel

There are no options to enable or disable the information tags from the relay front panel.

Enabling or Disabling Controls

This subsection describes how to properly enable or disable the reclose control, ground relaying, remote control, and communications-assisted tripping scheme through the SEL-7000 HMI or the front panel of the relays. The following devices have controls that can be enabled or disabled:

- Transmission Line: BKR-H1 and BKR-H2
- Feeders: BKR-(F1 – F4)
- High-Side Circuit Switcher: CSW-TH
- Low-Side Breaker: BKR-TL

Recloser Control

This subsection describes how to enable and disable the reclose control from the SEL-7000 HMI and the front panels of the relays.

HMI Disable

Perform the following steps to disable controls through the HMI:

Step 1. Log on to the system (see *Logging on to the SEL-7000 on page 3.3*).

Step 2. Click the **One-Line** button from the header bar, as shown in Figure 3.1. This will display the **System Online** screen.

Step 3. Choose one of the following breakers from the **System Online** screen:

- Transmission Line: BKR-H1 and BKR-H2
- Feeders: BKR-(F1 – F4)

Step 4. Click the breaker symbol beneath the name of the breaker for which you wish to disable reclosing.

The detail screen of the breaker will appear. On the left side of the detail screen are options to enable or disable reclose control.

The Feeder 1 (BKR-F1) will be used to demonstrate how to disable and enable reclose control. For this example, the breaker will initially have the recloser control enabled, as shown in Figure 3.38.

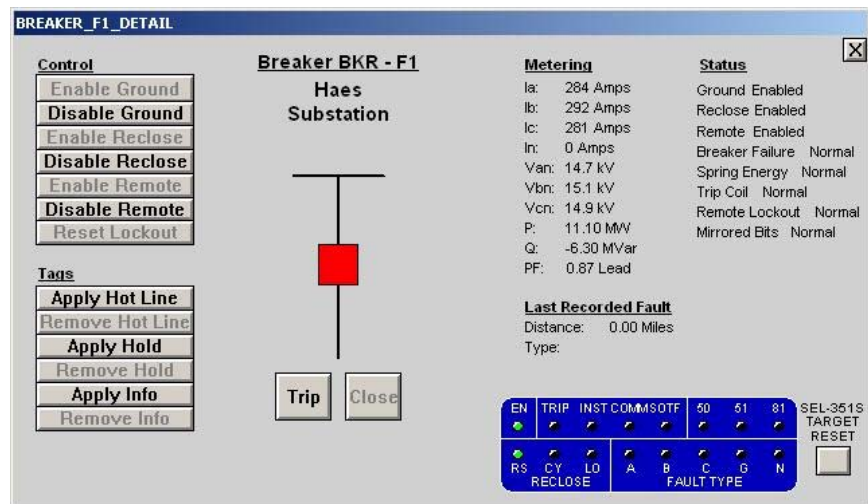


Figure 3.38: Breaker Feeder 1 With Reclose Enabled

Step 5. To disable reclose control, click the **Disable Reclose** button.

The breaker will have the reclose control disabled. Once the button is selected, the detail screen will appear with the following information (see Figure 3.39):

- The breaker will be displayed as abnormal. An abnormal state occurs whenever the properties associated with the breaker indicate an alarm state.
- The **Disable Reclose** button will be disabled.
- The **Enable Reclose** button will be enabled.
- The symbol for reclose will display as disabled.
- The text status of the reclose will be displayed in red as disabled.

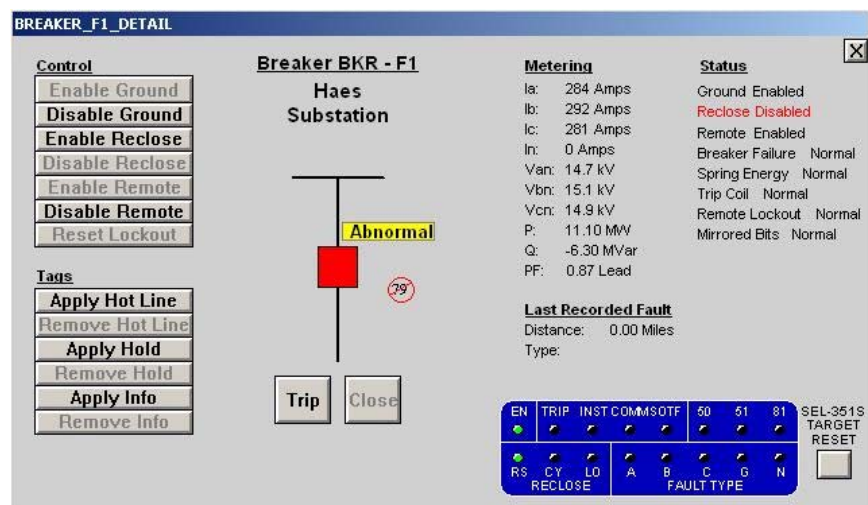


Figure 3.39: Breaker Feeder 1 With Reclose Disabled

On the **System Online** screen, the following will be displayed (see Figure 3.40):

- The alarm bar will display a message that the reclosing for the breaker is disabled.
- The symbol for reclose will now display as disabled.
- The breaker will be displayed as abnormal.

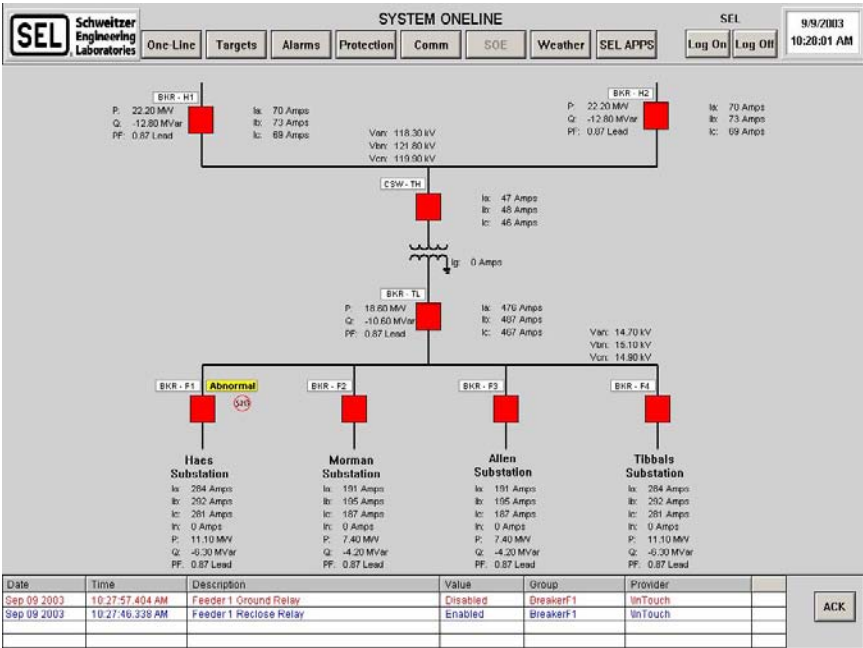


Figure 3.40: System Online Screen With Breaker Feeder 1 Reclose Control Enabled

HMI Enable

Perform the following steps to enable recloser control through the HMI:


- Step 1.** Ensure that you are logged on to the system (see *Logging on to the SEL-7000* on page 3.3).
- Step 2.** Click the **One-Line** button from the header bar.
- Step 3.** Click the breaker that has the reclose control disabled.
The detail screen will appear.
- Step 4.** Click the **Enable Reclose** button.

NOTE: If the hot line tag is enabled, the **Enable Reclose** button will be disabled. To disable the hot line tag, refer to *Applying and Removing Tags* on page 3.9.

The reclose control for the breaker will now be enabled.

After the reclose control is enabled, the following will occur (as shown in Figure 3.38):

- The abnormal indication will disappear from the detail screen and **System Online** screen.

- The  symbol for reclose disable will disappear on the detail screen and **System Online** screen.
- The alarm bar will display the reclose control as enabled.
- The **Enable Reclose** button will be disabled.
- The **Disable Reclose** button will be enabled.
- The text status of the reclose will be displayed in black as enabled.

Relay Front Panel

If the HMI is not available or the PC is disabled, you can use the relay front-panel pushbuttons, as shown in Figure 3.41. The SEL-351S Relays also require that the front-panel pushbuttons be unlocked. (See *Relay Front-Panel Close* on page 3.9 for instructions on unlocking front-panel pushbuttons.)

An illuminated LED will indicate the reclose function is enabled; the LED will be off when the reclose function is disabled. Pressing the **{RECLOSE ENABLED}** pushbutton toggles the reclose control between enabled and disabled.

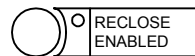


Figure 3.41: Front-Panel Reclose Enabled Pushbutton

If the hot line tag is enabled, the **{RECLOSE ENABLED}** pushbutton will not function. To disable the hot line tag, refer to *Applying and Removing Tags* on page 3.9.

Ground Relaying

This subsection describes how to enable and disable the ground relaying from the SEL-7000 HMI and the relay front panel.

HMI Disable

Perform the following steps to disable ground relaying from the HMI:

- Step 1.** Log on to the system (see *Logging on to the SEL-7000* on page 3.3).
- Step 2.** Click the **One-Line** button from the header bar, as shown in Figure 3.1.
This will display the **System Online** screen.
- Step 3.** Choose one of the following breakers from the **System Online** screen:
Feeders: BKR-(F1 – F4)
- Step 4.** Click the breaker symbol of the breaker for which you wish to view the detail screen.

The detail screen of the breaker will appear. On the left side of the detail screen are options to enable or disable ground relaying.

The Feeder 1 (BKR-F1) will be used to demonstrate how to disable and enable reclose control. For this example, the breaker will initially have the ground relaying enabled (see Figure 3.42).

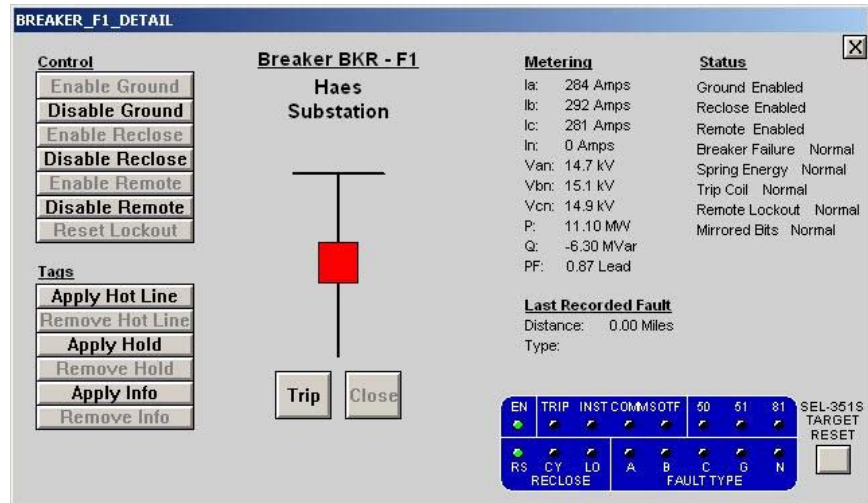



Figure 3.42: Breaker Feeder 1 With Ground Relaying Enabled

Step 5. To disable ground relaying, click the **Disable Ground** button.

The detail screen will appear with the following information (see Figure 3.43):

- The breaker will be displayed as abnormal. An abnormal state occurs whenever the properties associated with the breaker indicate an alarm state.
- The **Disable Ground** button will be disabled.
- The **Enable Ground** button will be enabled.
- The  symbol will appear.
- The text status will indicate **Ground Disabled** and will be displayed in red.

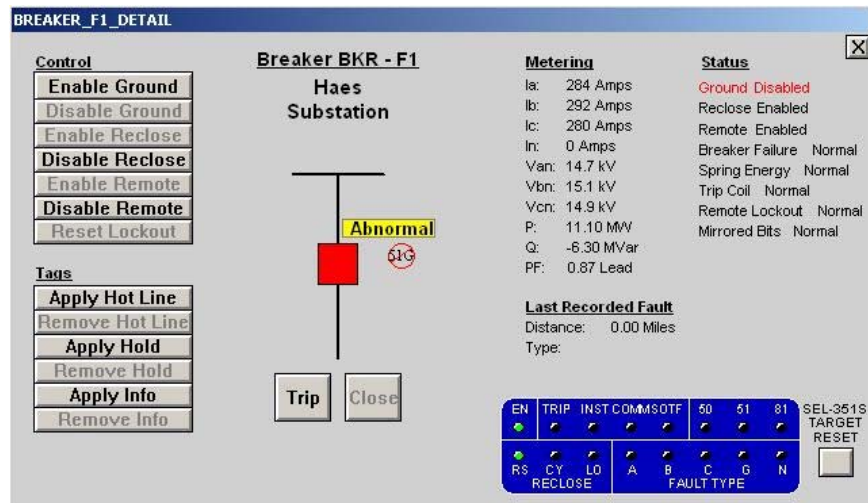



Figure 3.43: Breaker Feeder 1 With Ground Relaying Disabled

From the **System Online** screen, the following will be displayed (see Figure 3.44):

- The alarm bar displays a message that the ground relaying for the breaker is disabled.
- The  symbol will appear next to the breaker symbol.
- The breaker is displayed as abnormal.

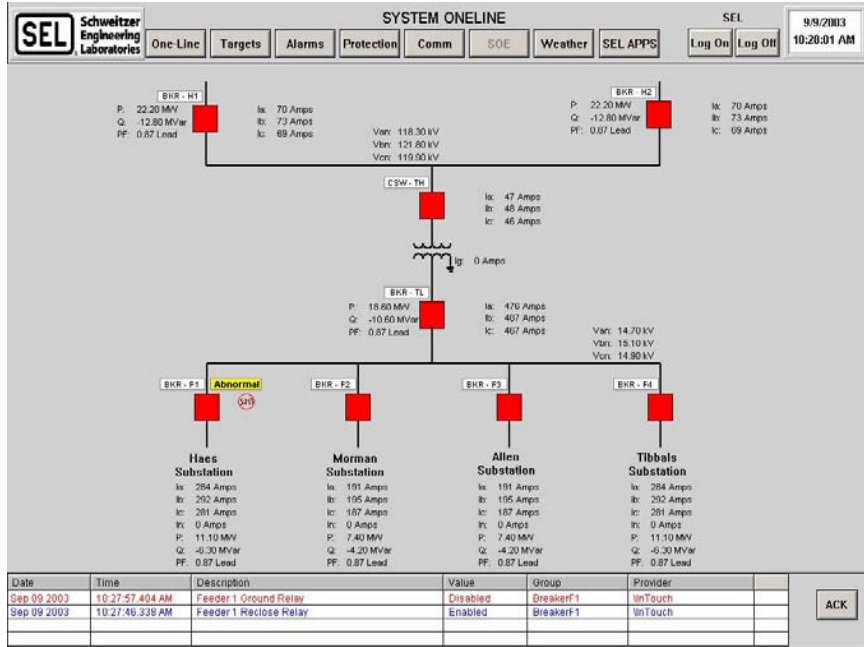


Figure 3.44: System Online Screen With Breaker Feeder 2 Ground Relaying Disabled

HMI Enable

Perform the following steps to enable ground relaying from the HMI:

Step 1. Ensure that you are logged on to the system (*Logging on to the SEL-7000 on page 3.3*).


Step 2. Click the **One-Line** button from the header bar.

Step 3. Click the breaker for which you wish to enable ground relaying.
The detail screen will appear.

Step 4. Click the **Enable Ground** button.

The ground relaying for the breaker will now be enabled.

After you enable the ground relaying, the following will occur (as shown in Figure 3.42):

- The abnormal indication will disappear from the detail screen and **System Online** screen.
- The  symbol will disappear on the detail screen and **System Online** screen.
- The alarm bar entry will disappear.

- The **Enable Ground** button will be disabled.
- The text status will indicate **Ground Enabled** and will be displayed in black.

Relay Front Panel

If the HMI is not available or the PC is disabled, you can use the relay front-panel pushbuttons to enable or disable the ground relaying (see Figure 3.45). The SEL-351S Relays also require that the front-panel pushbuttons be unlocked. (See *Relay Front-Panel Close* on page 3.9 for instructions on unlocking front-panel pushbuttons.)

An illuminated LED will indicate the ground is enabled; the LED will be off when the ground is disabled. Pressing the **{GROUND ENABLED}** pushbutton toggles the ground relaying between enabled and disabled.



Figure 3.45: Front-Panel Ground Enabled Pushbutton

Remote Control

This subsection describes how to enable and disable remote (SCADA) control from the HMI and the relay front panel. Remote control of the SEL-7000 is through the customer's SCADA system. Disabling remote control blocks SCADA trip and close of the breaker. Other control functions will still operate remotely.

HMI Disable

Perform the following steps to disable the remote control from the HMI:

- Step 1.** Log on to the system (see *Logging on to the SEL-7000* on page 3.3).
- Step 2.** Click the **One-Line** button from the header bar, as shown in Figure 3.1. This will display the **System Online** screen.
- Step 3.** Choose one of the following breakers from the **System Online** screen:
 - Transmission Line: BKR-(H1 – H2)
 - High-Side Circuit Switcher: CSW- TH
 - Low-Side Breaker: BKR- TH
 - Feeders: BKR-(F1 – F4)
- Step 4.** Click the breaker symbol of the breaker for which you wish to disable remote control.

The detail screen of the breaker will appear. On the left side of the detail screen are options to enable or disable remote control.

The Feeder 1 (BKR-F1) will be used to demonstrate how to disable and enable remote control. For this example, the breaker will initially have the remote control enabled (see Figure 3.46).

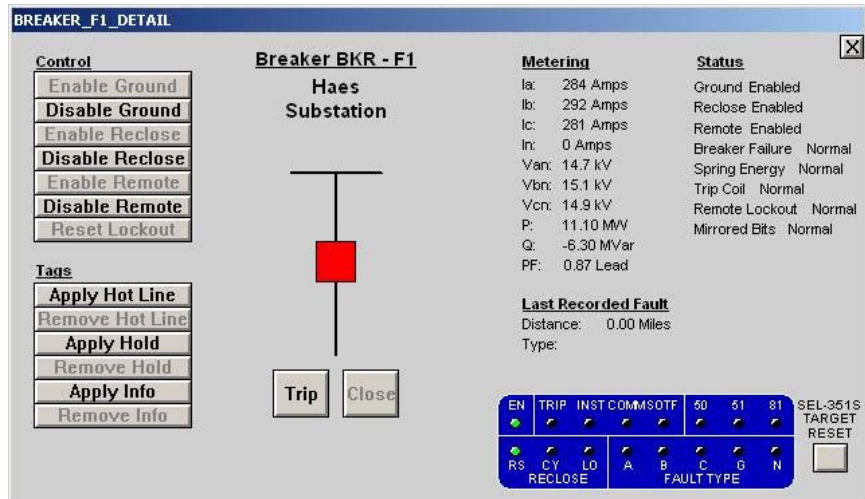


Figure 3.46: Breaker Feeder 1 With Remote Control Enabled

Step 5. To disable remote control, click the **Disable Remote** button and the breaker will have the remote control disabled.

Once remote control is disabled, the detail screen will appear with the following information (see Figure 3.47):

- The breaker will be displayed as abnormal. An abnormal state occurs whenever the properties associated with the breaker indicate an alarm state.
- The **Disable Remote** button will be disabled.
- The **Enable Remote** button will be enabled.
- The text status will indicate **Remote Disabled** and will be displayed in red.

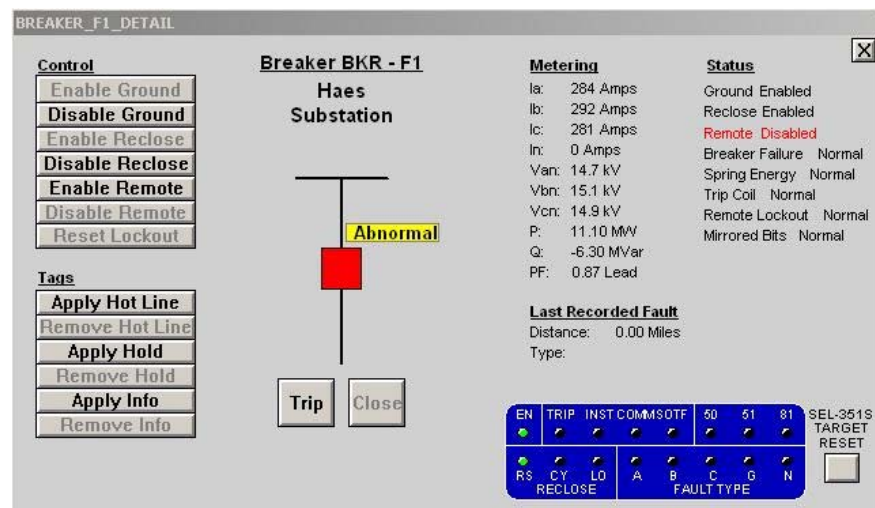


Figure 3.47: Breaker Feeder 1 With Remote Control Disabled

From the **System Online** screen, the following will be displayed (see Figure 3.48):

- The alarm bar will display a message that the remote control for the breaker is disabled.
- The breaker will be displayed as abnormal.

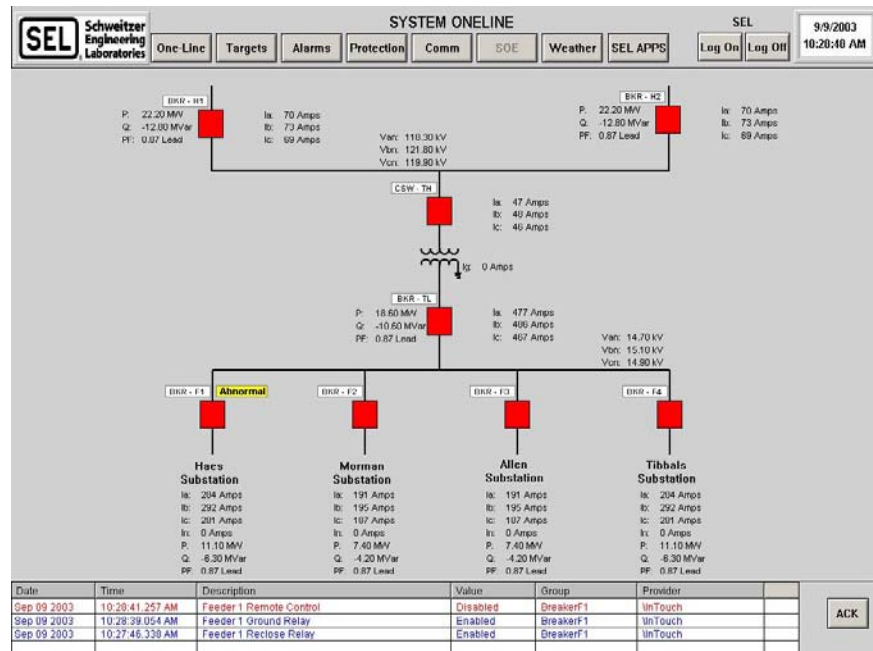


Figure 3.48: System Online Screen With Breaker Feeder 1 Remote Control Disabled

HMI Enable

Perform the following steps to enable remote control from the HMI:

- Step 1.** Ensure that you are logged on to the system (see *Logging on to the SEL-7000* on page 3.3).
- Step 2.** Click the **One-Line** button from the header bar.
- Step 3.** Click the breaker that has the remote control disabled.
The detail screen will appear.
- Step 4.** Click the **Enable Remote** button.

The remote control for the breaker will now be enabled.

After enabling the remote control, the following will occur (as shown in Figure 3.46):

- The abnormal indication will disappear from the detail screen and the **System Online** screen.
- The alarm bar entry will disappear.
- The **Enable Remote** button will be disabled.
- The **Disable Remote** button will be enabled.
- The text status will indicate **Remote Enabled** and will be displayed in black.

Relay Front Panel

If the HMI is not available or the PC is disabled, you can use the relay front-panel pushbuttons to enable or disable the remote (see Figure 3.49). The SEL-351S Relays also require that the front-panel pushbuttons be unlocked.

(See *Relay Front-Panel Close* on page 3.9 for instructions on unlocking front-panel pushbuttons.)

An illuminated LED indicates that remote control is enabled; the LED will be off when remote control is disabled. Pressing the **{REMOTE ENABLED}** pushbutton toggles the remote control between enabled and disabled.

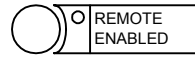


Figure 3.49: Front-Panel Remote Enabled Pushbutton

Communications-Assisted Tripping Scheme

This section describes how to enable and disable the communications-assisted tripping scheme on the transmission line breakers from the HMI or the relay front panel. Some examples of communications-assisted tripping schemes include Permissive Overreaching Transfer Trip (POTT), Directional Comparison Blocking (DCB), and differential comparison (in the SEL-311L).

HMI Disable

Perform the following steps to disable the communications-assisted tripping scheme through the HMI:

- Step 1.** Log on to the system (see *Logging on to the SEL-7000* on page 3.3).
- Step 2.** Click the **One-Line** button from the header bar, as shown in Figure 3.1.
This will display the **System Online** screen.
- Step 3.** Choose one of the following breakers from the **System Online** screen:
Transmission Line: BKR- (H1 – H2)
- Step 4.** Click the breaker symbol of the breaker for which you wish to disable communications-assisted tripping.

The detail screen of the breaker will appear. On the left side of the detail screen are options to enable or disable the communications-assisted tripping scheme.

The Transmission Line 2 (BKR-H2) will be used to demonstrate how to disable and enable the communications-assisted tripping scheme. For this example, the breaker will initially have the communications-assisted tripping scheme enabled, as shown in Figure 3.50.

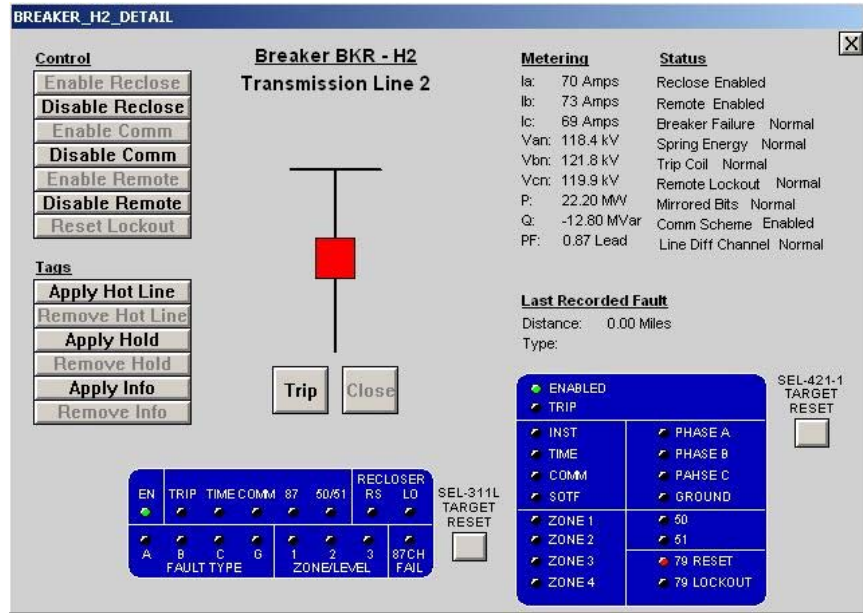


Figure 3.50: Breaker Transmission Line 2 Comm Scheme Enabled

Step 5. Click the **Disable Comm** button and the breaker will have the communications-assisted tripping scheme disabled. Once disabled, the detail screen will appear with the following information (see Figure 3.51):

- The breaker will be displayed as abnormal.
- The **Disable Comm** button will be disabled.
- The **Enable Comm** button will be enabled.
- The text status will indicate **Comm Scheme Disabled** and will be displayed in red.

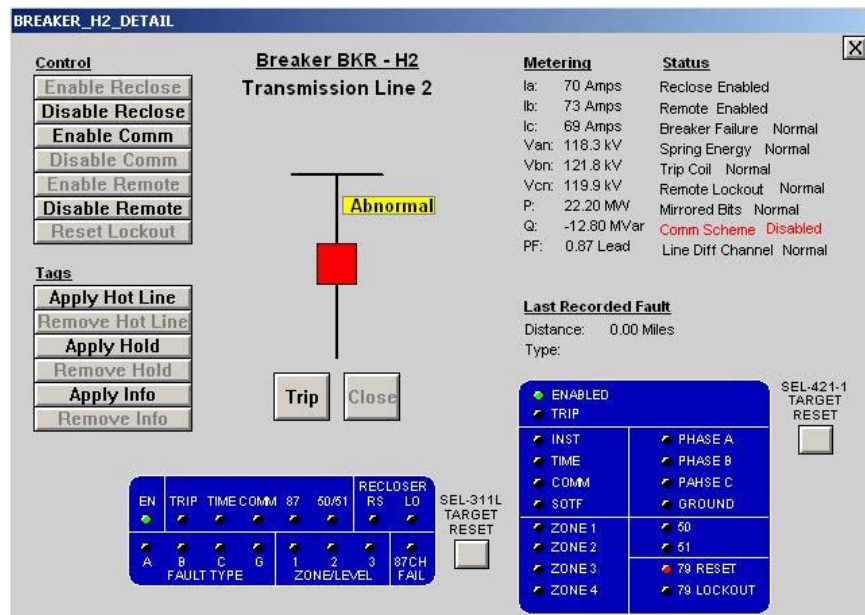


Figure 3.51: Breaker Transmission Line 2 Comm Scheme Disabled

From the **System Online** screen, the following will be displayed (see Figure 3.52):

- The alarm bar will display a message that the communications-assisted tripping scheme is disabled.
- The breaker will be displayed as abnormal.

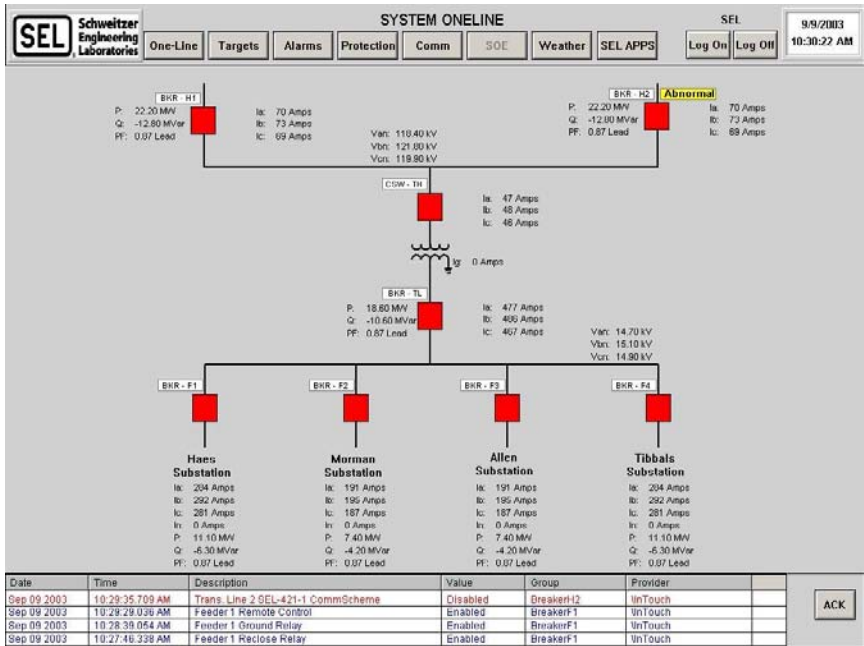


Figure 3.52: System Online With Breaker Transmission Line 2 Comm Scheme Disabled

HMI Enable

Perform the following steps to enable the communications-assisted tripping scheme through the HMI:

- Step 1.** Ensure that you are logged on to the system (see *Logging on to the SEL-7000* on page 3.3).
- Step 2.** Click the **One-Line** button from the header bar.
- Step 3.** Click the breaker that has the communications-assisted tripping scheme disabled.
The detail screen will appear.
- Step 4.** Click the **Enable Comm** button. The communications-assisted tripping scheme for the breaker will now be enabled.

After the communications-assisted tripping scheme is enabled, the following will occur (as shown in Figure 3.50):

- The abnormal indication will disappear from the detail screen and the **System Online** screen.
- The alarm bar indication will disappear.
- The **Enable Comm** button will be disabled.

- The **Disable Comm** button will be enabled.
- The text status will indicate **Comm Scheme Enabled** and will be displayed in black.

Relay Front Panel

If the HMI is not available or the PC is disabled, you can use the relay front-panel pushbuttons, as shown in Figure 3.53. To enable or disable the communications-assisted tripping scheme, press the **{COMM SCHEME ENABLED}** pushbutton. If the LED is illuminated, the communications-assisted tripping scheme is enabled; if the LED is off, the scheme is disabled.



Figure 3.53: Front-Panel Comm Scheme Enabled Pushbutton

Diagnosing a Breaker Trip

This section gives a brief overview of how to diagnose a breaker trip or a breaker failure trip, and how to properly clear a breaker trip or a breaker failure trip from either the HMI or the front panel of the SEL-351S or SEL-421 Relays.

Diagnosing a Trip from the HMI

You must first be logged on the system (see *Logging on to the SEL-7000 on page 3.3*). Once logged on to the system, use the **System Online**, **Relay Front Panel Targets Distribution**, **Alarm Summary**, and **Protection Overview** screens to determine what type of fault has occurred and to see the device(s) on which the fault occurred. Use the SEL-5040 System Report Manager and the SEL-5601 Event Waveform application software to analyze the data.

The following sections will describe what appears on each screen when a trip or a breaker failure occurs, and how to reset the trip or breaker failure from the HMI.

For this demonstration, Feeder 2 will be used to describe what happens when a fault occurs on the line or when breaker failure occurs, and what steps are required to clear the trip or breaker failure.

Diagnosing a Trip From the System Online Screen

The **System Online** screen will display the breaker on which the fault has occurred. A flashing red box and an abnormal state will indicate this, as shown in Figure 3.54. The alarm bar at the bottom of the screen informs you of which alarms were picked up because of the trip.

As soon as a trip has occurred on the system, the SEL-5040 will begin uploading the event report(s) from all of the affected relay(s) and saving the information on the PC. The alarm bar will indicate that the communication to the SEL relay is in transparent mode when the SEL-5040 is downloading the event information.

Once an event has been generated on one of the devices, the SEL-5040 will attempt to collect the information through the communications processor. For more information on how the SEL-5040 retrieves the information, refer to

Application Guide, AG2000-08, “Applying the SEL-5040 Power System Report Manager.” See the SEL-7000 Instruction Manual for in-depth coverage of the SEL-5040.

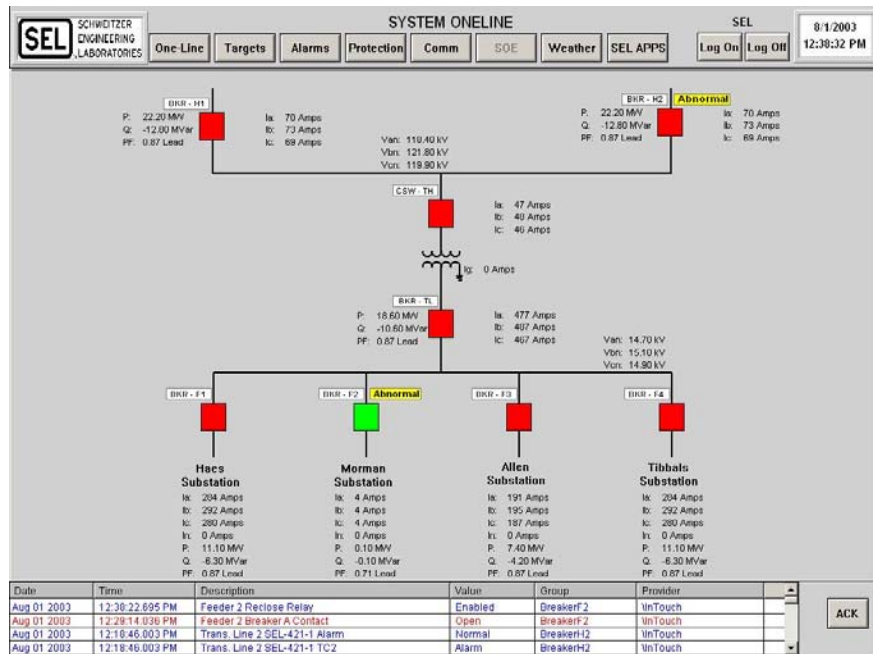


Figure 3.54: Fault on Breaker Feeder 2

If a breaker failure has occurred, a BF will appear inside the box, as shown in Feeder Breaker 2 in Figure 3.55.

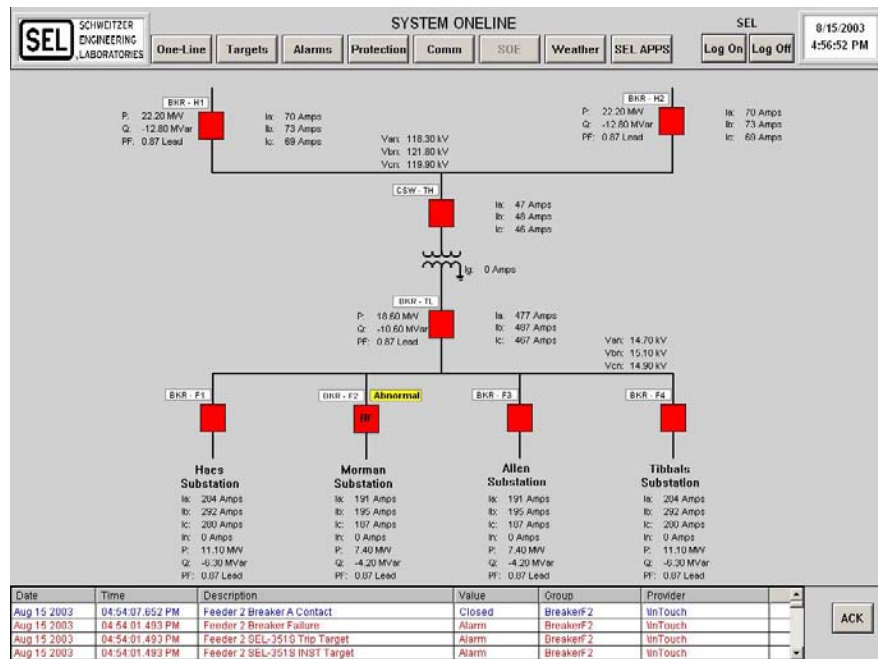


Figure 3.55: Breaker Failure on Breaker Feeder 2

Diagnosing a Trip From the Device Detail Screen

When a protection trip occurs on a feeder or transmission breaker, the breaker will go through one or more reclose cycles, eventually leaving the breaker

closed or open and locked out. The detail screen where the trip occurred will then display an abnormal state, the distance to the fault, the type of trip, and the front-panel targets of what were asserted on the front panel of the device. This is shown in Figure 3.56.

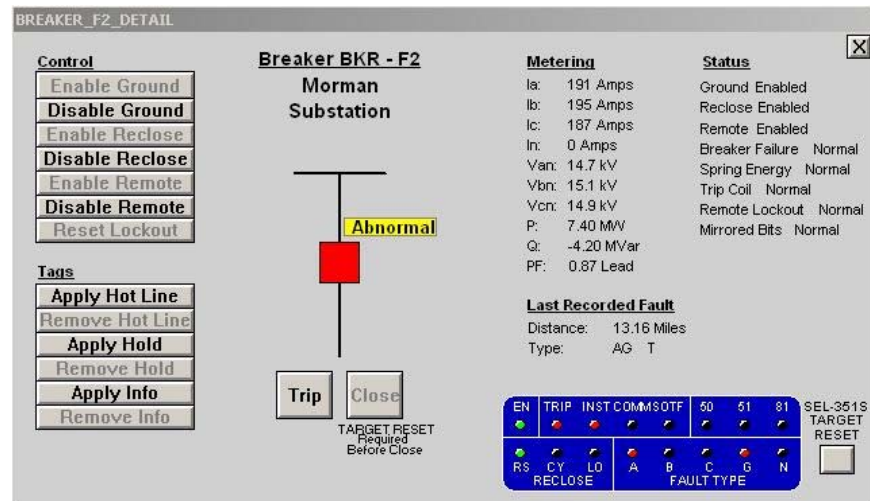


Figure 3.56: Fault on Breaker Feeder 2

If a breaker failure occurs, the **Reset Lockout** button is enabled, a **BF** is displayed inside the breaker box, and the status text of the breaker failure displays a **Trip** in red (see Figure 3.57).

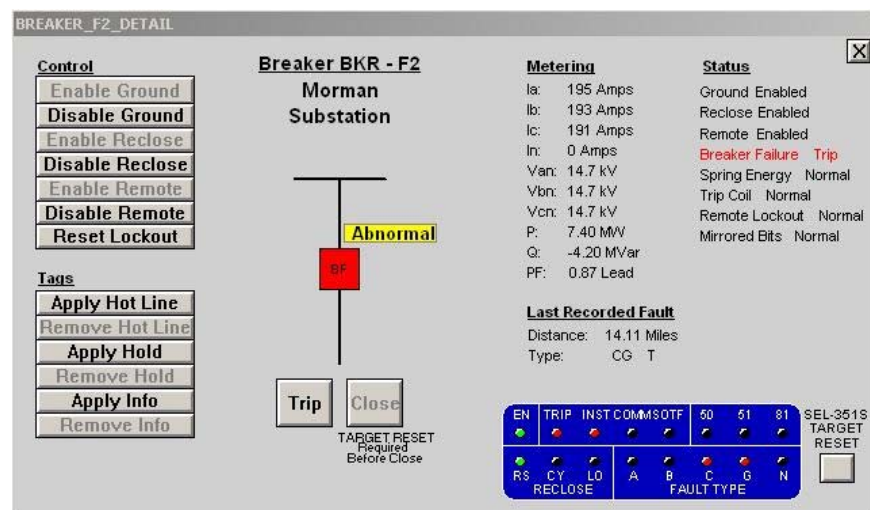


Figure 3.57: Breaker Failure Trip on Breaker Feeder 2

To clear the abnormal state and the front-panel LEDs, click the **Target Reset** button. The LEDs for the breaker will turn off and the **TARGET RESET** text next to the **Close** button will disappear. To clear the breaker failure state, click the **Reset Lockout** button. Once the button is clicked, the **BF** disappears, the **Reset Lockout** button dims, and the status of the breaker failure is returned to normal. Once the breaker failure lockout is cleared, it is possible to close the breakers affected by the lockout condition.

To manually close the breaker, click the **Target Reset** button. This will clear the targets on the selected device and the **Close** button will become available. Click the **Close** button to close the breaker. Refer to *Tripping and Closing Breakers* on page 3.6 for more information on how to close the breaker.

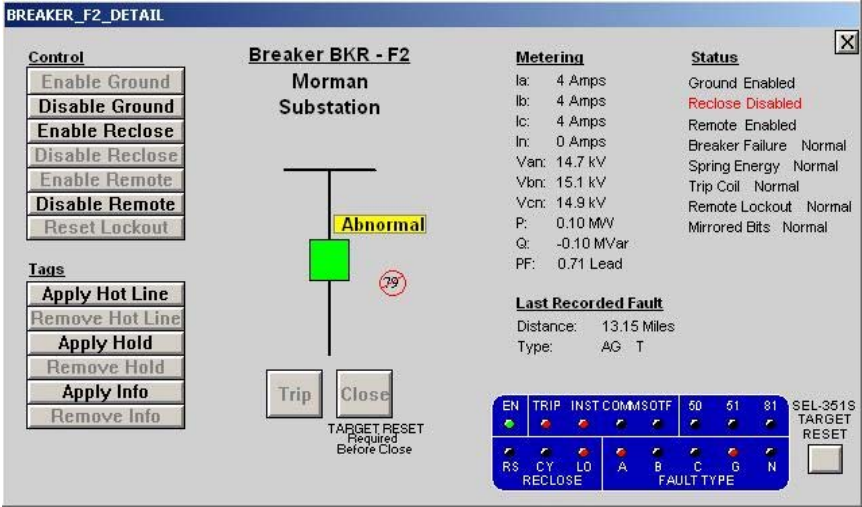


Figure 3.58: Breaker Open on Breaker Feeder 2

Diagnosing a Trip From the Relay Front Panel Target Screens

From the **Relay Front Panel Targets Distribution** screen, the HMI will show which relays were affected by the trip and which elements were asserted (see Figure 3.59). If the fault occurred on the transmission line, you must select the **Transmission** button to view the remaining relays. This opens the screen shown in Figure 3.60.

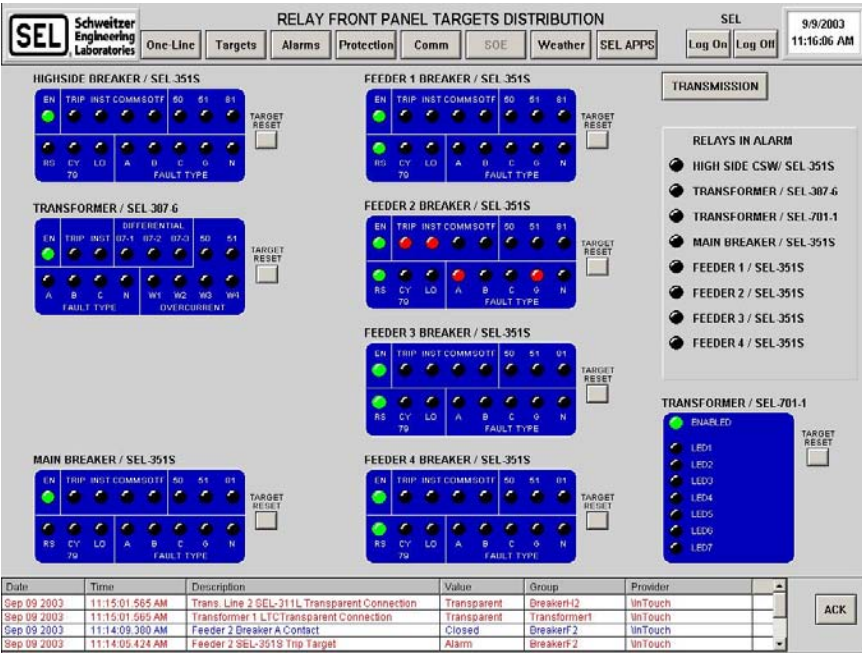


Figure 3.59: Relay Front Panel Targets Distribution Screen

The **Relays in Alarms** box indicates which relays are currently in an alarm state. An alarm state occurs on a relay when communication to that relay fails or the relay alarm output contact indicates a problem with the relay.

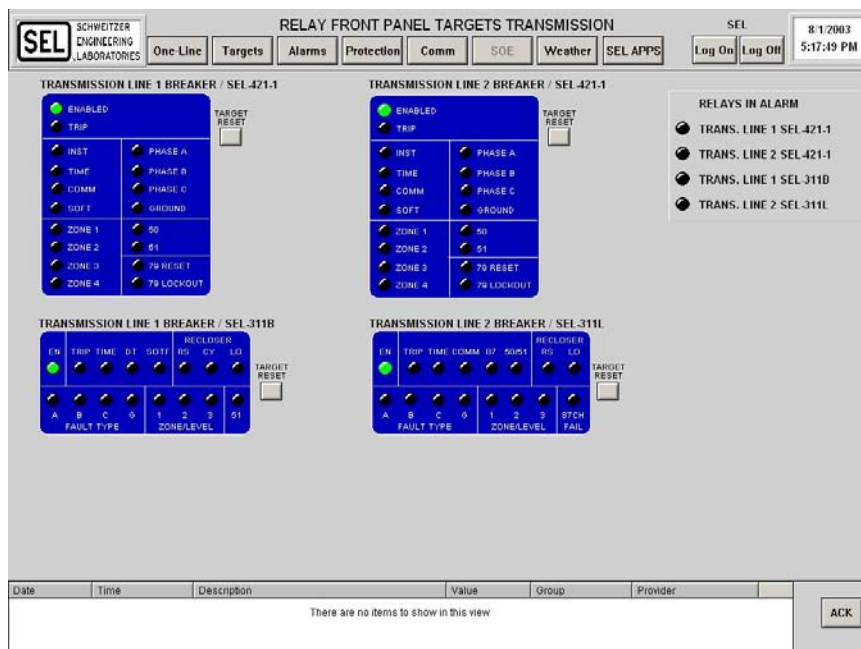


Figure 3.60: Relay Front Panel Targets Transmission Screen

Table 3.3 lists all the relay front-panel targets displayed on the **Relay Front Panel Targets Distribution** screen. For further information, refer to the selected relay instruction manual.

Table 3.3: Relay Front Panel Targets

LED Label	Description
EN	On when the unit is powered up and operating properly
TRIP	Indicates that a trip has occurred
INST	Instantaneous trip
COMM	Communications-assisted trip
SOTF	Switch-onto-fault trip
50	Instantaneous/definite-time overcurrent element generated trip
51	Time overcurrent element generated trip
81	Frequency element generated trip
A	Phase A involved in trip
B	Phase B involved in trip
C	Phase C involved in trip
G	Ground involved in trip
N	Neutral ground element generated trip
RS	Recloser in "Reset State." The relay is ready to start another reclose cycle.
CY	Recloser in "Cycle State." The relay is waiting on timer to reclose breaker.
LO	Recloser in "Lock-Out State." Reclosing is disabled.
W1	Winding 1 overcurrent asserted at, or 1 cycle after, rising edge of trip
W2	Winding 2 overcurrent asserted at, or 1 cycle after, rising edge of trip

W3	Winding 3 overcurrent asserted at, or 1 cycle after, rising edge of trip
W4	Winding 4 overcurrent asserted at, or 1 cycle after, rising edge of trip
87-1	Differential Element 1 asserted at, or 1 cycle after, rising edge of trip
87-2	Differential Element 2 asserted at, or 1 cycle after, rising edge of trip
87-3	Differential Element 3 asserted at, or 1 cycle after, rising edge of trip
ZONE 1	Zone/Level 1 Element picked up at the time of trip
ZONE 2	Zone/Level 2 Element picked up at the time of trip
ZONE 3	Zone/Level 3 Element picked up at the time of trip
ZONE 4	Zone/Level 4 Element picked up at the time of trip
87 CH FAIL	Line current differential channel failure
TIME	Time-delayed trip
DT	Direct trip

Diagnosing a Trip From the Alarm Screens

The **Alarm Summary** screen displays alarms that are active and/or unacknowledged. The **Alarm Summary** screen gives a description of all the alarms picked up and when that alarm occurred, as shown in Figure 3.61.

To view the entire history of all of the alarms, click the **Historical Alarms** button. A new window will then appear displaying a history of the alarms, as shown in Figure 3.62. The alarms displayed on this screen cannot be removed because they represent the historical database of all alarms maintained by the HMI.

You can view windows of this historical data by selecting the date range of the alarms you wish to view. Select the **Start Time** and **End Time** of the alarms you wish to view on the calendars in the upper-right corner of this screen. Click the **Refresh** button to update the historical alarms.

Once an alarm occurs, the message will initially be displayed in red as not acknowledged. If the alarm returns to its normal state but is not acknowledged, the alarm will appear blue. Once you acknowledge an alarm, the following will occur:

- For an alarm that has returned to its normal state, the message will disappear from the alarm bar and the **Alarm Summary** screen. It will remain in the **Alarm History** screen.
- For an active alarm, the message will remain in the **Alarm Summary** screen and in the **Alarm History** screen and will be removed from the alarm bar.

You can acknowledge alarms in several ways:

- The first method is to click the **ACK** button on the alarm bar. This will acknowledge only the alarms displayed currently on the alarm bar. The alarms acknowledged from the alarm bar will also acknowledge the alarms in the **Alarm Summary** screen and vice versa.
- The next method is to view the data in the **Alarm Summary** screen and select the **Ack Page** button. This will acknowledge the entire page of the **Alarm Summary** screen.

- The final method is to click the **Ack Selected** button on the **Alarm Summary** screen. Once this button is clicked, the highlighted alarm will be the only alarm acknowledged.

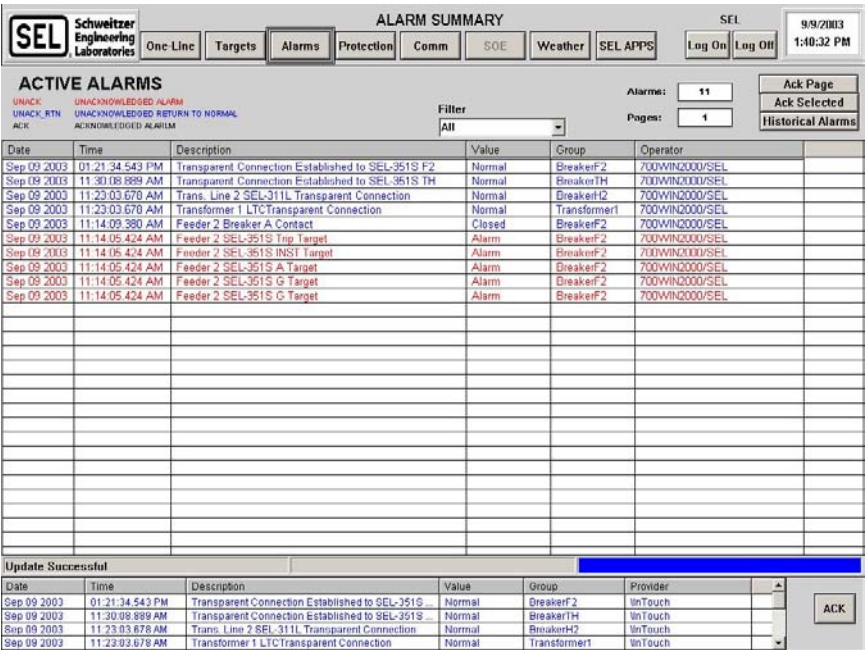


Figure 3.61: Alarm Summary Screen

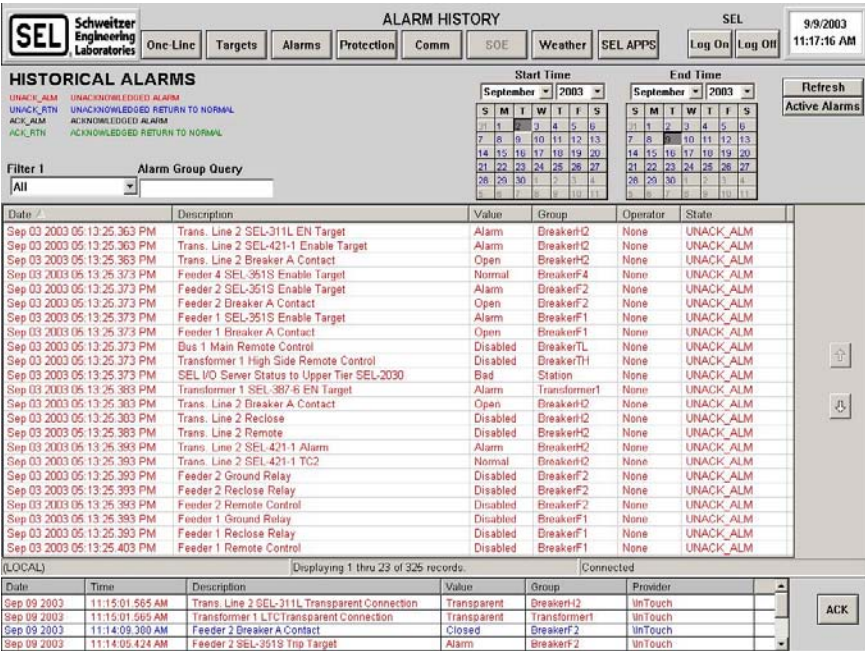


Figure 3.62: Alarm History Screen

Protection Overview Screen

The **Protection Overview** screen indicates with a flashing red circle which device had the trip. In this example, the SEL-351S Feeder 2 will appear different than the other devices, as shown in Figure 3.63.

Select a device and the HTML page to the right of the protection screen will give a brief description about the device. The HTML document briefly spells out the protection features provided by each component in the SEL-7000.

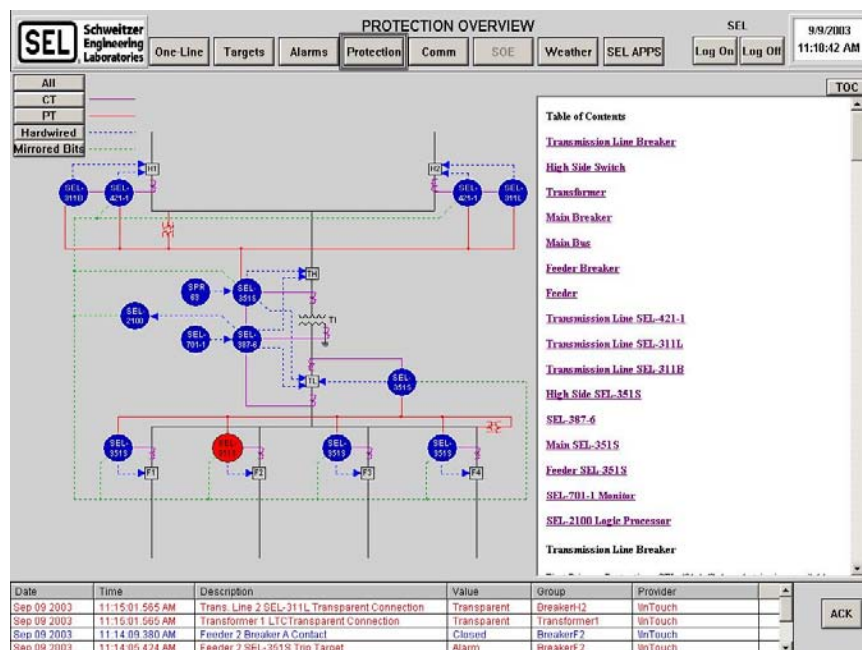


Figure 3.63: Protection Overview

SEL Applications

As soon as a trip occurs on any of the relays, a new event report is generated. The SEL-5040 will then retrieve the event from the relay. To view the event report, click the **SEL APPS** button on the HMI header bar. A new window then appears with buttons for various SEL software products. Click **CANCEL** to remove the window or click one of the other buttons to start an SEL application.

For a detailed explanation of any of the applications referred to in this section, see the SEL-7000 Instruction Manual.



Figure 3.64: SEL APPS Menu

Click the **SEL-5040** button to begin viewing and analyzing the recent event reports collected in the SEL-5040 (see Figure 3.65).

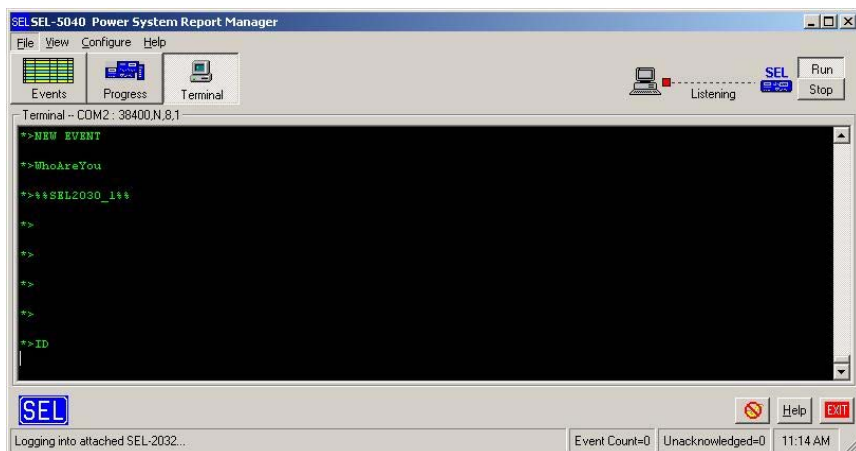


Figure 3.65: SEL-5040 Terminal Screen

After the SEL-5040 has retrieved the event reports, use the SEL-5601 Event Waveform Software to analyze the data. To immediately view the data with the SEL-5601, right-click the event and select **Show Waveform**, as shown in Figure 3.66.

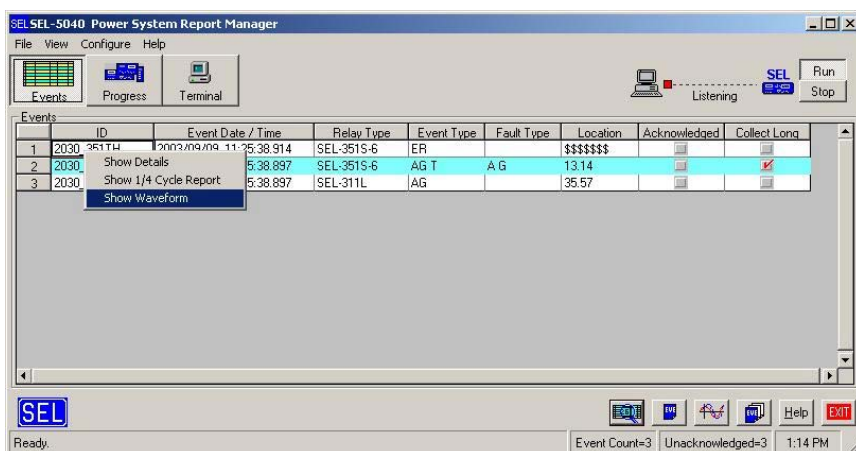


Figure 3.66: SEL-5040 Events Page

The **Event Waveform** program will then appear and the event report from the relay will then be generated into a waveform.

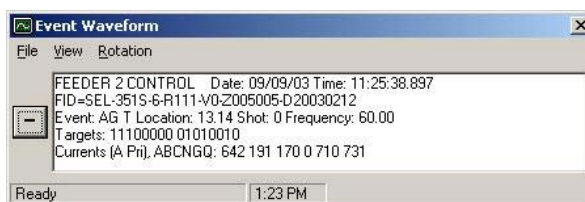


Figure 3.67: SEL-5601 Event Waveform Program

To view the graphic waveform of the event report, click the **View** menu bar of the SEL-5601. A drop-down menu will appear with the option to view the graph. Click this option and the graphical waveform for the event report will appear. Use the graph to view the analog quantities and the digital response from the event report of the trip, as shown in Figure 3.68.

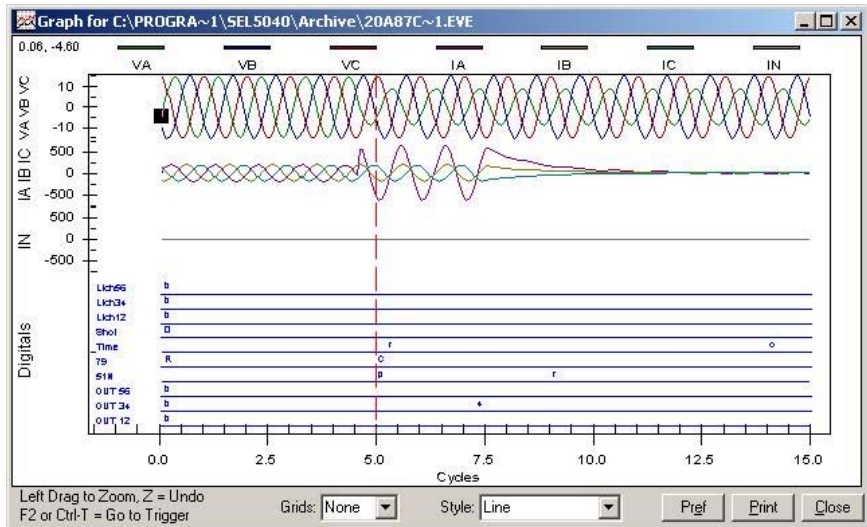


Figure 3.68: SEL-5601 Trip Waveform

To view the phasor diagram, click the **View** menu bar of the SEL-5601. A drop-down menu will appear with the option to view the phasor. Click this option and the **Phasor Diagram** for the event report will appear, as shown in Figure 3.69. Click the **Start** button and the SEL-5601 will play back the event on a moment-by-moment basis.

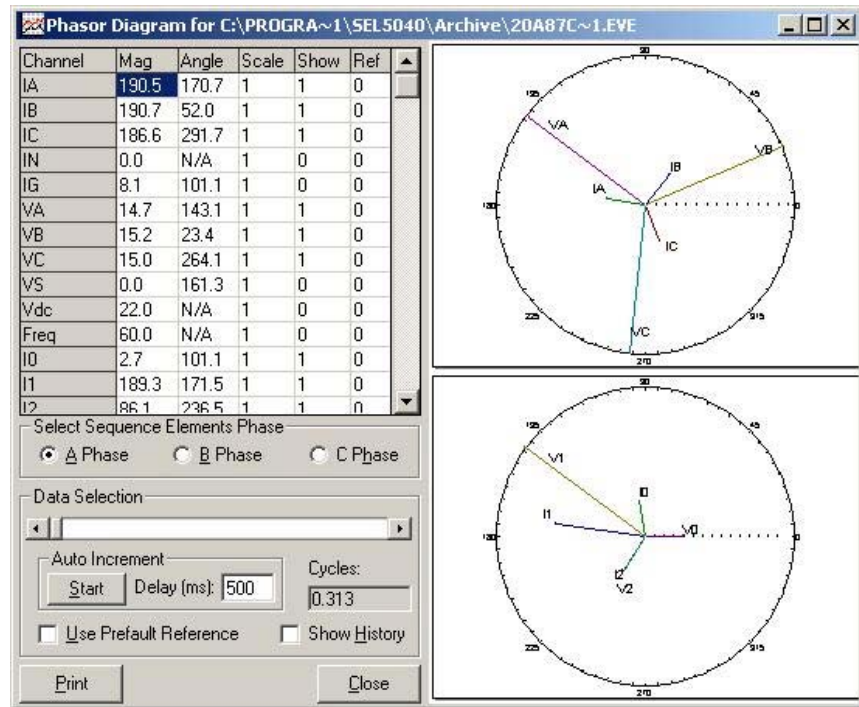


Figure 3.69: SEL-5601 Phasor Diagram

Use the **Harmonic Analysis** program to determine the number of harmonics that appear on a phase current or voltage, as shown in Figure 3.70. The **Harmonic Analysis** program can read only long event reports, which means that only 16 samples per cycle event reports from the relay are used for harmonic analysis.

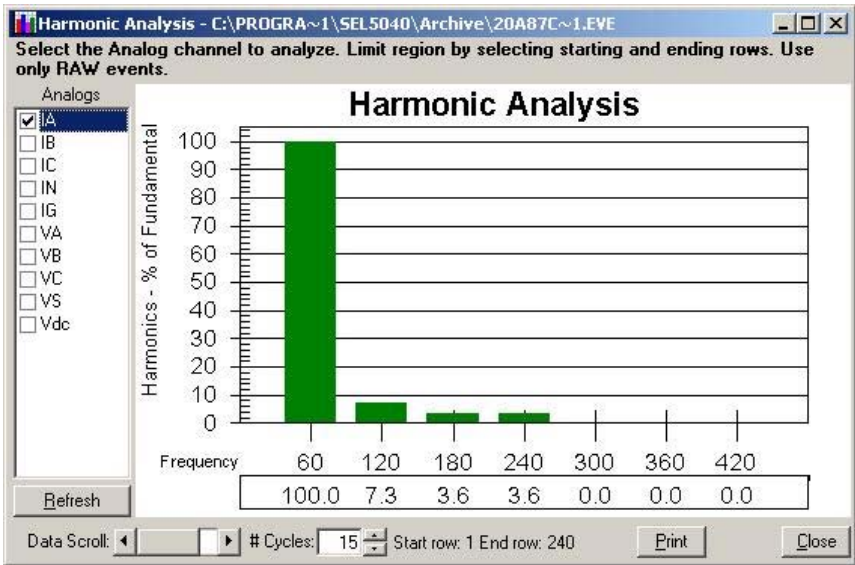


Figure 3.70: SEL-5601 Harmonic Analysis

Troubleshooting

Please see the appropriate instruction manual(s) for troubleshooting any of the electronic products supplied with the SEL-7000. The following is a summary of likely problems and their causes affecting the HMI:

Table 3.4: Troubleshooting the SEL-7000

Problem	Possible Cause
Cannot navigate any of the HMI pages.	You are not logged on to the system. See <i>Logging on to the SEL-7000</i> on page 3.3.
Cannot log on to the system.	Verify that the user name and password are valid. The password is case sensitive; ensure that <Caps Lock> is not activated.
One or more of the breakers is light blue (cyan) in color.	The HMI has detected a loss of communication with the relay, the SEL-2032, or with the I/O server.
The relays are connected, but no data are displayed.	The I/O server may be disabled; verify that the I/O server is running.
Unable to retrieve data for the SEL-5040.	Verify that the connections between the SEL-2032 and the device are available.
Alarms are never displayed on the alarm screen or the alarm bar.	The alarm DB logger is not set-up or running properly.
Cannot close the breaker from the HMI.	A hot line tag may be enabled. A trip may have occurred. You must perform a target reset before you can close the breaker after a trip. Communication to the relay may be down.

Cannot control anything from the SEL-351S-6 front panel.	<p>The front panels act only as a backup control in case the PC or HMI fail. The buttons on the SEL-351S-6 Relays are disabled until the HMI or PC fails.</p> <p>Additionally, the front-panel pushbuttons must be unlocked by pressing the {LOCK} pushbutton. A lit locked LED indicates that the pushbuttons are locked and disabled.</p>
Cannot control anything from the SEL-421 front panel.	<p>The front panels act only as a backup control in case the PC or HMI fail. The buttons on the SEL-421 Relays are disabled until the HMI or PC fails.</p>
Unable to manually close a breaker after a manual trip.	<p>If the HMI is enabled, all pushbuttons except manual trip are not available.</p> <p>To close a breaker, perform all operations on the HMI.</p>

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Section 4: Equipment Used in the SEL-7000

Introduction

This section provides a brief description of the major components used in the SEL-7000 and the functions they provide.

Equipment in the SEL-7000

Communications Processor

This product is used to link all substation Intelligent Electronic Devices (IEDs) into a single, low-cost, configurable contact point for SCADA and the local HMI. Boolean and arithmetic operators were used in the SEL-2032 to consolidate and manipulate information. SEL communications processors use the SEL fast-messaging protocol to communicate to SEL relays and logic processors. Settings are used to communicate to third-party IEDs, such as the Weather Monitor or the LTC. No protection functions are developed inside the communications processor; its main purpose is for automation, data acquisition, and control via the HMI and the customer's SCADA system.

The following list summarizes the functionality of the communications processor:

- Collecting measurements and status from all substation IEDs.
- Scaling, concentrating, and aggregating the collected data to provide a trim and meaningful dataset for the local HMI and remote SCADA systems.
- Providing a central access point for engineering connections to all substation IEDs. This access is available through the local HMI or remotely via a modem or an Ethernet connection.
- Monitoring and forwarding alarms from station IEDs.
- Distributing IRIG-B time-synchronization signals to all of the SEL relays.

SEL-351S-6 Protection and Breaker Control Relay

The SEL-351S-6 provides phase, negative-sequence, residual-ground, and neutral-ground overcurrent elements. It also contains directional elements, programmable US and IEC time-overcurrent curves, synchronism check, over- and undervoltage, and over- and underfrequency protection elements. This

product incorporates a large front-panel keyboard, a scrolling display panel, and ten programmable pushbuttons to replace unnecessary control switches and wiring at the breaker control panel.

For the SEL-7000, the SEL-351S-6 Relays provide protection and control for the feeders and the transformer high- and low-side (main) breakers.

SEL-2100 Protection Logic Processor

The SEL-2100 retrieves device status and remote system information using MIRRORING BITS™ communications. SELOGIC® control equations are used to create advanced protection and control. MIRRORING BITS communications is a very fast (4.16 ms or 8.3 ms, depending on the relay) and deterministic protocol allowing the user to dynamically control power system apparatus.

For the SEL-7000, the SEL-2100 distributes the breaker failure trip signals to appropriate relays, holds the lockouts for the transformer, and holds and distributes the low- and high-side fast bus tripping schemes. All lockouts are held in nonvolatile memory; they maintain their state during power loss.

SEL-387-6 Current Differential and Overcurrent Relay

The SEL-387 is used for protection, monitoring, and automation applications for important transformers, generators, and other power apparatus. Multiple percentage differential elements, in combination with phase- and sequence-overcurrent elements, provide comprehensive protection. SELOGIC control equations with SELOGIC variables, timers, latch bits, and remote control elements are used for customizing protection and control schemes.

For the SEL-7000, the SEL-387 provides the primary transformer differential protection. The SEL-387 sends the transformer lockout command to the SEL-2100, where it is latched into nonvolatile memory.

SEL-421 High-Speed Line Protection, Automation, and Control System

The SEL-421 is used for line protection, monitoring of substation equipment, and substation automation. Distance, directional, instantaneous, and time overcurrent, in combination with dual breaker and single-three-pole tripping, provide comprehensive line protection. Breaker wear monitoring, event reports, and sequence-of-event logging provide valuable equipment diagnostics. SELOGIC control equations with SELOGIC variables, timers, latch bits, and remote control elements are used for customizing protection and control schemes. The SEL-421 also comes with a recloser.

For the SEL-7000, the SEL-421 provides the primary transmission line protection. The buttons on the SEL-421 Relays are used for backup control in the unlikely event that the HMI interface is out of service. A directional comparison pilot protection scheme using MIRRORING BITS communications comes preconfigured in the SEL-7000.

SEL-311B Distance Relay With Recloser

Along with recloser capabilities, the SEL-311B has three zones of phase and ground MHO distance elements, definite-time directional negative-sequence and residual-ground overcurrent elements, torque-controlled phase instantaneous, definite-time elements, and single-phase overcurrent elements.

For the SEL-7000, the SEL-311B is used for transmission line protection and automation. The local HMI and remote SCADA system open and close the transmission breakers through the SEL-311B and SEL-311L Relays. All other automation related controls are directed towards the SEL-421 Relays.

SEL-311L Line Current Differential Relay

The SEL-311L is a single-pole tripping line current differential relay with step phase and ground distance backup time coordinated with Zone 1 and communications-assisted line protection. Instantaneous phase and ground distance tripping are automatically enabled for loss of first primary line protection and loss of line current differential communications channels. The directional and nondirectional time-overcurrent phase and ground tripping are used for backup protection.

For the SEL-7000, the SEL-311L is used for transmission line protection and automation. The local HMI and remote SCADA system open and close the transmission breakers through the SEL-311B and SEL-311L Relays. All other automation related controls are directed towards the SEL-421 Relays.

SEL-3010 Event Messenger

The SEL-3010 converts Serial ASCII Text to Speech. This is specifically for converting messages to audible speech on a telephone output. For example, when a transformer lockout occurs, the communications processor can be programmed to send a text message to the SEL-3010. The SEL-3010 then converts the message to speech and delivers it via a telephone call to a system operator. The recipient then uses the telephone keypad to acknowledge the alarm. The SEL-3010 is an optional device for the SEL-7000.

The SEL-3010 provides a method for alarms to be transmitted to operations staff without dependence on computers, SCADA systems, RTUs, or other equipment. High-priority alarms are delivered by telephone directly to the operations staff. The SEL-3010 contains a phone list of four numbers and automatically cycles through the phone list until the alarms are acknowledged. The communications processor can also be configured to enable and disable the SEL-3010 based on the time of day and day of week, so that alarms are not telephoned during the hours a station or command center is usually staffed.

SEL-2890 Ethernet Transceiver

The SEL-2890 provides economical Ethernet connectivity for engineering connections to the station IEDs. Over an Ethernet corporate network, the SEL-2890 connects the engineer to the substation without any need for modems, telephone lines, or telephone number lists. The SEL-2890 uses standard Telnet protocol communications to move serial data over the Ethernet, allowing software with serial port capabilities to communicate with station IEDs over the Ethernet network.

The SEL-2890 also contains a customizable HTML page that provides quick access to equipment or station status using a standard Internet browser. In addition, the SEL-2890 can send unsolicited messages as standard Internet emails, to alert engineers of important station status information.

HMI Computer

The SEL-7000 Human Machine Interface (HMI) resides on a 19" rack-mounted industrial PC. The specifications of this PC vary per the scope of the customer's project requirements. The monitor can be provided as a flat panel, a touch-screen flat-panel display, or a CRT.

The SEL-7000 HMI is an Intouch Wonderware HMI. Wonderware is a time-proven industrial interface program that has the flexibility and customer support necessary to meet all of our customers' requirements.

The TrafficWerks SEL Fast Message I/O Server driver resides on the HMI computer. It connects the HMI computer to the communications processor and performs three major functions:

1. The I/O driver provides measurement and status data from the communications processors to the local HMI.
2. The driver collects unsolicited SER data passed through the communications processor.
3. The driver processes Fast Operate commands sent by the Wonderware HMI to the communications processors.

Panel System

The SEL-7000 is built on a 19" rack painted in machine tool gray. All relays are rack-mounted. Fuse blocks, fuses, terminal blocks, panel lights, test switches, and single-ganger power receptacles all come prewired. Wire labels are used on all wire terminations. The racks for the SEL-7000 can be customized per the customer's requirements. The racks can be shipped separately or bolted together in one unit.

Arbiter Systems 1084B GPS Satellite-Controlled Clock

This satellite-controlled clock provides an unmodulated IRIG-B signal to the communications processors. The communications processors then pass this signal to the SEL relays for proper time synchronization of event records. This clock uses eight satellite receiver channels to provide coverage, regardless of the location of the substation. This clock is rated to ± 100 ns accuracy. The IRIG-B time signal is not propagated to the HMI for Wonderware Alarm Logging.

The SEL communications processors communicate to SEL relays via SEL "interleaved" communications. This method combines the IRIG-B signal with the other communications traffic to the relays, thus eliminating the coaxial cable network required by other time distribution methods.

Davis Weather Monitor II

The SEL-7000 uses this weather monitor to provide temperature, humidity, barometric pressure, wind speed/direction, highs/lows, and alarms. This information is sent to the communications processor and on to the HMI and SCADA. An optional rain gauge is available for this device. The Weather Monitor is a robust and economical source for weather information for the SCADA system.

Wilmore Series 1654 DC-AC Inverter

The SEL-7000 includes an inverter to supply ac power for critical loads that require the same battery backup capabilities as protective relays. The inverter commonly used is a 1000 VA, 120 Vac, 60 Hz device that runs off the station 130 Vdc battery system. This device normally inverts the dc battery voltage to an ac 120 Vrms output, switching over to bypass mode only if the dc battery power to the station is interrupted.

Teltone SLSS (Substation Line Sharing Switch)

The SEL-7000 uses the Teltone switch to reduce the number of phone lines required at the substation. It does this by sharing a single telephone line between eight telecom devices (phones, modems, SEL-3010, etc.). This device operates by routing calls to the appropriate device in the substation. It gives priority to telephone users (for safety concerns) and makes efficient use of a phone line system.

ABB FT-19R Flexitest Switch Assembly

The SEL-7000 uses test switches to isolate the CT, PT, and trip connections during the field commissioning and routine testing of the system. A transparent plastic cover that locks the switches in either the open or closed positions is included. This cover may be secured with a meter seal.