Operation

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Qualified Persons

⚠ WARNING

The equipment covered by this publication must be installed, operated, and maintained by qualified persons who are knowledgeable in the installation, operation, and maintenance of overhead electric power distribution equipment along with the associated hazards. A qualified person is one who is trained and competent in:

- The skills and techniques necessary to distinguish exposed live parts from nonlive parts of electrical equipment
- The skills and techniques necessary to determine the proper approach distances corresponding to the voltages to which the qualified person will be exposed
- The proper use of the special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools for working on or near exposed energized parts of electrical equipment

These instructions are intended only for such qualified persons. They are not intended to be a substitute for adequate training and experience in safety procedures for this type of equipment.

Read this Instruction Sheet

NOTICE

Read this instruction sheet thoroughly and carefully before installing or operating S&C 5800 Series Automatic Switch Controls. Familiarize yourself with the Safety Information on page 4. The latest version of this publication is available online in PDF format at **sandc.com/en/support/product-literature/**.

Retain this Instruction Sheet

This instruction sheet is a permanent part of your 5800 Series Automatic Switch Control. Designate a location where you can easily retrieve and refer to this publication.

Proper Application

⚠ WARNING

The equipment in this publication must be selected for a specific application. The application must be within the ratings furnished for the selected equipment.

Special Warranty Provisions

The standard warranty contained in S&C's standard conditions of sale, as set forth in Price Sheets 150 and 181, applies to the S&C 5800 Series Automatic Switch Control, except that the first paragraph of the said warranty is replaced by the following:

(1) General: The seller warrants to the immediate purchaser or end user for a period of 10 years from the date of shipment that the equipment delivered will be of the kind and quality specified in the contract description and will be free of defects of workmanship and material. Should any failure to conform to this warranty appear under proper and normal use within 10 years after the date of shipment, the seller agrees, upon prompt notification thereof and confirmation that the equipment has been stored, installed, operated, inspected, and maintained in accordance with the recommendations of the seller and standard industry practice, to correct the nonconformity either by repairing any damaged or defective parts of the equipment or (at the seller's option) by shipment of necessary replacement parts. The seller's warranty does not apply to any equipment that has been disassembled, repaired, or altered by anyone other than the seller. This limited warranty is granted only to the immediate purchaser or, if the equipment is purchased by a third party for installation in third-party equipment, the end user of the equipment. The seller's duty to perform under any warranty may be delayed, at the seller's sole option, until the seller has been paid in full for all goods purchased by the immediate purchaser. No such delay shall extend the warranty period.

Replacement parts provided by the seller or repairs performed by the seller under the warranty for the original equipment will be covered by the above special warranty provision for its duration. Replacement parts purchased separately will be covered by the above special warranty provision.

For equipment/services packages, the seller warrants for a period of one year after commissioning that the 5800 Series Automatic Switch Control will provide automatic fault-isolation and system reconfiguration per agreed-upon service levels. The remedy shall be additional system analysis and reconfiguration of the IntelliTeam II Automatic Restoration System until the desired result is achieved.

Warranty of the S&C 5800 Series Automatic Switch Control is contingent upon the installation, configuration, and use of the control or software in accordance with S&C's applicable instruction sheets.

This warranty does not apply to major components not of S&C manufacture, such as batteries and communication devices. However, S&C will assign to the immediate purchaser or end user all manufacturer's warranties that apply to such major components.

Warranty of equipment/services packages is contingent upon receipt of adequate information on the user's distribution system, sufficiently detailed to prepare a technical analysis. The seller is not liable if an act of nature or parties beyond S&C's control negatively affect performance of equipment/services packages; for example, new construction that impedes radio communication, or changes to the distribution system that impact protection systems, available fault currents, or system-loading characteristics.

Understanding Safety-Alert Messages

Several types of safety-alert messages may appear throughout this instruction sheet and on labels attached to the 5800 Series Automatic Switch Control. Familiarize yourself with these types of messages and the importance of these various signal words:

⚠ DANGER

"DANGER" identifies the most serious and immediate hazards that *will likely* result in serious personal injury or death if instructions, including recommended precautions, are not followed.

⚠ WARNING

"WARNING" identifies hazards or unsafe practices that *can* result in serious personal injury or death if instructions, including recommended precautions, are not followed.

⚠ CAUTION

"CAUTION" identifies hazards or unsafe practices that *can* result in minor personal injury if instructions, including recommended precautions, are not followed.

NOTICE

"NOTICE" identifies important procedures or requirements that *can* result in product or property damage if instructions are not followed.

Following Safety Instructions

If you do not understand any portion of this instruction sheet and need assistance, contact your nearest S&C Sales Office or S&C Authorized Distributor. Their telephone numbers are listed on S&C's website **sandc.com**, or call S&C Headquarters at (773) 338-1000; in Canada, call S&C Electric Canada Ltd. at (416) 249-9171.

NOTICE

Read this instruction sheet thoroughly and carefully before installing or operating your S&C 5800 Series Automatic Switch Control.

Replacement Instructions and Labels

If you need additional copies of this instruction sheet, contact your nearest S&C Sales Office, S&C Authorized Distributor, S&C Headquarters, or S&C Electric Canada Ltd.

It is important that any missing, damaged, or faded labels on the equipment be replaced immediately. Replacement labels are available by contacting your nearest S&C Sales Office, S&C Authorized Distributor, S&C Headquarters, or S&C Electric Canada Ltd.

Applicable Software

These instructions were prepared for use with the IntelliTeam II Automatic Restoration System and 5800 Series Control software: SNCD2B1X Rev. 2.39, PADD2B1X Rev. 2.39, and VISD2B1X Rev. 2.39.

The software-revision number is on the *Troubleshooting>Control & Switch Information* screen. For questions regarding the applicability of information in this instruction sheet to future product releases, please contact S&C Electric Company.

NOTICE

All switch controls in the IntelliTeam II system must use the same software revision.

Revision 2.39 must be installed only in 5800 Series Switch Controls manufactured after January 1, 2005, or in older controls that have had the four-layer processor board (006-001053-01 or 006-001053-02) retrofitted. Using revision 2.39 with the earlier two-layer boards may result in memory corruption. If assistance is needed or the equipment requires upgrade, please contact S&C Electric Company.

⚠ WARNING

These instructions do not replace the need for utility operation standards. Any conflict between the information in this document and utility practices should be reviewed by appropriate utility personnel and a decision made as to the correct procedures to follow.

Serious risk of personal injury or death may result from contact with electric distribution equipment when electrical isolation and grounding procedures are not followed. The equipment described in this document must be operated and maintained by qualified persons who are thoroughly trained and understand any hazards that may be involved. This document is written only for such qualified persons and is not a substitute for adequate training and experience in safety procedures for accessing high-voltage equipment.

S&C 5800 Series Controls are connected to switchgear operating at primary voltage levels. High voltage may be present in the wiring to the switch control or in the switch control itself during certain switchgear wiring or grounding system failures, or because of a problem with the switch control itself. For this reason, access to switch controls should be treated with the same safety precautions that would be applied when accessing other high-voltage lines and equipment. Follow all locally approved safety procedures when working on or around this control.

Before attempting to access an existing switch installation, check carefully for visible or audible signs of electrical or physical malfunction (do this before touching or operating the switch control or any other part of the installation). These warning signs include smoke, fire, open fuses, crackling noises, loud buzzing, etc. If a malfunction is suspected, treat all components of the installation, including the switch control and associated mounting hardware, as if they were elevated to primary (high) voltage.

Whenever you manually reconfigure the circuit (for example, during repairs), follow your company's operating procedures to disable automatic operation of the switch control. This will prevent any unexpected operation.

Switch Control Modules

The switch control electronics modules are described below and shown in Figure 1.

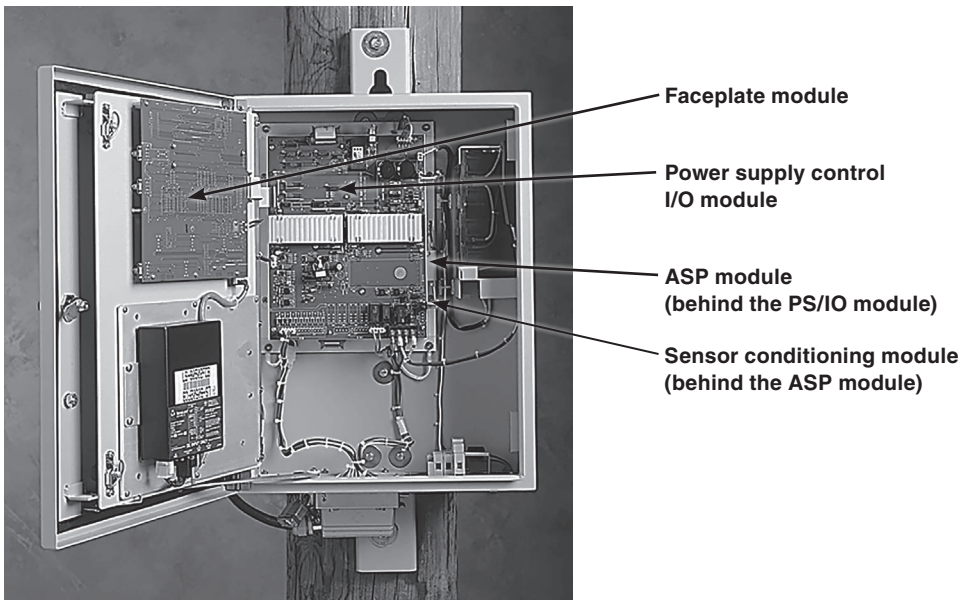


Figure 1. Location of switch control modules.

Faceplate module—The printed circuit board is attached to the back of the faceplate. It includes all the electronics and switches for the faceplate and the 5800 control microprocessor.

Power supply/control I/O module (PS/IO)—This is the source for all low-voltage power used by the switch control and any associated communications equipment. It also supplies power for the digital interface contacts. The PS/IO module performs data acquisition, control, and basic communication interface functions. For more about the power management system, see the "Power Supply/Control I/O Module" section on page 13.

ASP module—This is responsible for waveform processing and is located behind the power supply/control I/O module.

Sensor conditioning module—This conditions ac waveforms to standard low-voltage ac levels and provides analog I/O interfacing. The module is located behind the PS/IO and ASP modules.

Faceplate

The faceplate LCD screen, LEDs, and switches allow monitoring and control of the line switch(es) and the switch control. See Figure 2 on page 7.

To extend battery carryover time, the switch control turns off power to the faceplate LCD screen and LEDs when the enclosure door or low-voltage cabinet door is closed.

Faceplate LEDs

OVERCURRENT FAULT LED

This LED is lit when the switch control detects an overcurrent condition.

The LED is off when the following are true:

- Three-phase line voltage is sensed, the switch is closed, and 45 minutes have elapsed
- The faceplate REMOTE/LOCAL switch is operated
- The REMOTE/LOCAL switch is set to **Remote** mode and the OVERCURRENT FAULT indicator is cleared by a SCADA command

Note: When the switch control is reinitialized by IntelliLink software, the LED goes off, regardless of whether the conditions above are met.

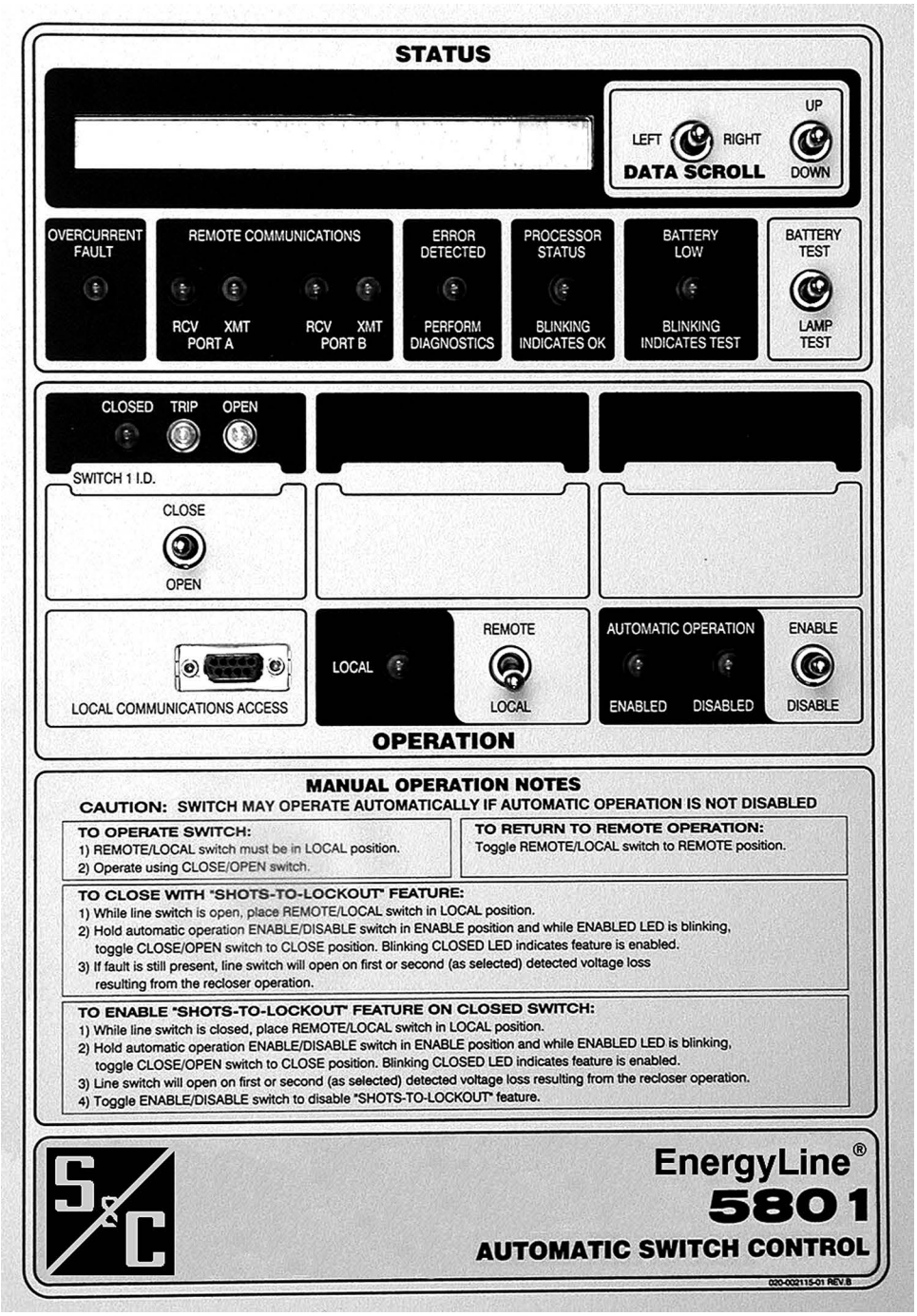


Figure 2. The 5801 Automatic Switch Control faceplate.

REMOTE COMMUNICATION RCV/XMT LEDs

These LEDs blink when the switch control sends or receives signals through communication equipment installed in the control enclosure. There are separate LED sets for Port A and Port B.

RCV LED—This LED blinks when the switch control detects an incoming character. Activity occurs only when communication equipment is installed, properly connected, and receiving power.

XMT LED—This LED blinks when the switch control sends one or more characters. The XMT LED blinks any time a transmit is attempted, regardless of whether communication equipment is installed.

ERROR DETECTED LED

This LED is lit when the switch control detects any of the following conditions:

- **Battery charger overvoltage—**If the charger attempts to overcharge the battery, the switch control turns the charger off and turns on the LED.
- **Open/close contacts are not mutually exclusive—**The switch-position contacts are either both open or both closed.
- **Temperature sensor failure—**The temperature sensor (on the PS/IO module) reads abnormally high or low, which is generally caused by an open or shorted circuit.
- **Transfer operations blocked—**If the switch control is unable to perform a **Load-Transfer** or a **Return-to-Normal** operation for any reason, or it knows another team member is in this condition, the LED is lit.
- **Switch error (5801) –** There is a switch error, such as open visual-disconnect contacts (Scada-Mate® Switch) or low pressure (Joslyn switch).
- **Switch in Local mode (5802/5803) –** The switch control senses that one of the switches is in **Local** mode (the manual mode for the switch, selected in the low-voltage cabinet).

PROCESSOR STATUS LED

This LED blinks once per second when the switch control has power and control software is running normally.

BATTERY LOW LED

This LED is off when the battery system is working normally and the battery is charged.

The LED is lit when the battery power level drops below the **Battery Voltage Low** setpoint on the *Troubleshooting>Battery System* screen. This LED is normally lit when the control is operating on battery power and the normal battery carryover period is nearly over. If this LED is lit when ac power is on and the battery normally would contain an adequate charge, the battery may be defective.

The LED blinks during any battery test. The control automatically runs a battery test at scheduled intervals. In addition, a SCADA command or the faceplate BATTERY TEST/LAMP TEST switch can be used to start a battery test at any time. See the "BATTERY TEST/LAMP TEST Switch" section on page 9 for more details.

Note: When replacing a defective battery, it is necessary to immediately initiate a battery test to update the battery status.

CLOSED LED

This red LED is lit when the line switch is closed. The LED indicates the sensed position of the line switch based on the state of the closed status input from the switch. It also blinks while the **Shots-to-Lockout** mode is enabled. Each CLOSED LED provides information about one line switch.

TRIP LED

This yellow LED is lit when the control trips open the line switch using automatic logic (sectionalizing, phase-loss protection, etc.). It is off when the switch is closed. For a normally-open switch, the LED also turns off when the REMOTE/LOCAL switch is toggled between settings. Each TRIP LED provides information about one line switch.

If the switch tripped because of phase-loss protection and the **Phase Loss Protection with Automatic Reclose** mode is enabled, the LED blinks while waiting to reclose the switch. For the normally open switch, the LED also goes off when the REMOTE/ LOCAL switch is toggled between settings.

Note: If the switch control is reinitialized with IntelliLink software, the LED turns off, regardless of whether the switch is closed.

OPEN LED

This green LED is lit when the line switch is open. The LED indicates the sensed position of the line switch based on the state of the open status input from the switch. Each OPEN LED provides information about one line switch.

LOCAL LED

This LED is lit when remote (SCADA) operation of the switch control is blocked and local operation is allowed. The LED is off when local operation is blocked and remote operation is allowed.

AUTOMATIC OPERATION ENABLED LED

This LED is lit when automatic operation of the switch control is enabled.

⚠ CAUTION

When **Automatic Operation** mode is enabled, the automatic control logic may trip the switch regardless of the state of the REMOTE/LOCAL switch.

AUTOMATIC OPERATION DISABLED LED

This LED is lit when automatic operation of the switch control is disabled.

The Faceplate Switches

The faceplate includes the following switches:

DATA SCROLL Switches

Use these switches to scroll LCD screen data into view. For more information, see the "Faceplate LCD Screen" section on page 10, Table 1 on page 11, and Table 2 on page 12.

BATTERY TEST/LAMP TEST switch

Toggle this switch up to start a battery test. The test lasts approximately 30 seconds if the control is operating on battery power or approximately 3 minutes if the control is operating on ac power. The BATTERY LOW LED blinks during the test. See the "Power Supply/Control I/O Module section" on page 13 for more information.

Hold this switch down to test the LEDs on the faceplate; all LEDs should blink.

CLOSE/OPEN switch

Toggle this switch up to transmit a **Close** command to the line switch. Toggle this switch down to transmit an **Open** command to the switch. It is also used for enabling the **Shots-to-Lockout** feature. See the "Shots-to-Lockout Feature" section on page 22. Each CLOSE/OPEN switch operates one line switch.

Note: If the REMOTE/LOCAL switch is in the **Remote** position, toggling a CLOSE/OPEN switch has no effect.

REMOTE/LOCAL switch

Toggle this switch up to enable remote (SCADA) control of the line switch(es) and disable commands from the faceplate CLOSE/OPEN switches and the Automatic Operation ENABLE/DISABLE switch.

Toggle this switch down to disable remote (SCADA) operation of the line switch(es) and enable commands from the faceplate CLOSE/OPEN switch(es) and Automatic Operation ENABLE/DISABLE switch. The LOCAL LED is lit when this switch is set to the **Local** state.

Note: To disable **Automatic Operation** mode and have full local control of the switch(es), toggle the faceplate Automatic Operation ENABLE/DISABLE switch to the **Disable** mode. When **Automatic Operation** mode is disabled on the *Setup>Automatic Operation* screen (for both switches, if applicable), toggling the ENABLE/DISABLE switch has no effect.

ENABLE/DISABLE switch

Toggle this switch up to enable **Automatic Operation** mode for the control and the team. Toggle this switch down to disable **Automatic Operation** mode. This switch affects automatic operation of both line switches, if applicable. It is also used to enable the **Shots-to-Lockout** feature. See the "Shots-to-Lockout Feature" section on page 22.

Note: When **Automatic Operation** mode is disabled on the *Setup>Automatic Operation* screen (for both switches, if applicable), toggling this switch has no effect.

Note: When the ENABLE/DISABLE switch is toggled to the **Disable** state, the teams associated with that switch to go into the **Not Ready** or **Stop Transfer** state. Other teams on the same circuit will remain in the **Ready** state.

Faceplate LCD Screen

The LCD screen allows quick access to key information at the switch control installation site. The LCD displays several categories of information:

Team Status Info—This is the RTU address, team ID, and the **Ready—Fault—Alarm** state for each team where this control is a member. **Ready** state indicates the team is ready to take action (even if a transfer event has already taken place) and there are no errors, faults, battery problems, or team communication problems present. **Fault** state indicates this team is isolating a faulted line segment. This information is also displayed on the *Team Operation* screen.

Real-time Data—This is the total operation count, present phase and ground current levels, line voltage, reverse current conditions, phase angles, and total kvar flows for both feeders, if applicable. This information is also displayed on the *Setup>Site-Related* screen.

Auto Operation (Switch 1 and Switch 2, if applicable)—This shows the automatic operation features enabled and the present value of the automatic operation setpoints. These values are also displayed on the *Setup>Automatic Operation* screens.

Fault Events—This is the date, time, event, switch control interpretation, and action for the 62 most recent protection-related fault events. These fault messages are coded versions of the messages displayed on the *Overcurrent Fault>Fault Events* screen. See the "Fault Events Log" section on page 28 for an explanation of each code.

Fault Magnitudes—This is the date, time, phase, peak magnitude, and duration for the 16 (5801) or 32 (5802/5803) most recent overcurrent-fault events. This information is also displayed on the *Overcurrent Fault>Fault Magnitudes* screen.

Maintenance—This shows the software version installed in the switch control, assorted battery-status information, and the present cabinet temperature. The software version is also displayed on the *Troubleshooting>Control & Switch Information* screen. The battery and temperature information are also displayed on the *Troubleshooting>Battery System* screen.

Fault Settings—This is the present value for each of the fault-detection setpoints for Switch 1 and Switch 2, if applicable. These values are also displayed on the *Setup>Fault Detection* screen.

The 2 x 40 character LCD screen always displays one field from a large data page. See Table 1 on page 11 and Table 2 on page 12.

The DATA SCROLL switches are used to scroll each field into view:

- To move left or right across the page (from one category to another category), toggle the LEFT/RIGHT switch.
- To move up or down between fields within a category, toggle the UP/DOWN switch.
- The Fault Events and Fault Magnitude logs are circular buffers. The most recent event is normally displayed on the LCD screen. To see the second-most-recent event, toggle the UP/DOWN switch up.

Table 1. LCD Data Page for S&C 5801 Control with IntelliTeam II Functionality

CATEGORY							
FIELDS	**1. Team Status Information**	**2. Real-Time Data**	**3. Auto Operation**	**4. Fault Events①**	**5. Fault Magnitude**	**6. Maintenance**	**7. Fault Settings**
	Team Name Team Status: Ready/Fault/ Alarm Status Real-Time Load Real Capacity	Operations Counter Line Current (amps) Ground Current (Amps) Live Voltage (Volts) Phase Angle (Degrees) Reverse Current (Active or None) Line kvars	Automatic Operation Features Enabled Sectionalizer Reset and Extended Voltage Loss Time Successful Reclose Reset Time Fault Current Required before First/All Voltage Loss(es) Recloser Counts to Trip Number of Shots Required for Lockout Shots-To-Lockout Time Threshold (Tenths) Phase Loss Protection Voltage Loss Threshold Phase Loss Protection Time Threshold Phase Loss Protection Current Threshold Automatic Reclose Time Threshold	Most Recent Oldest 3rd Most Recent 2nd Most Recent	Most Recent Oldest 3rd Most Recent 2nd Most Recent	Software Version Ac Power/ Battery Status Battery Low/ Bad Setpoints Battery Voltage w/o Surface Charge Predicted Voltage Under Load Power Supply Voltage/Battery Impedance Cabinet Temperature	Phase Fault Detected Current Level (Amps) Ground Fault Detected Current Level (Amps) Phase Fault Duration Time Threshold (msec) Ground Fault Duration Time Threshold (msec) Phase Current Inrush Restraint Time (msec) Ground Current Inrush Restraint Time (msec) Phase Current Inrush Restraint Multiplier Ground Current Inrush Restraint Multiplier

① For an explanation of the codes used in the Fault Events column, see the "Fault Events Log" section on page 28.

Table 2. LCD Data Page for S&C 5802/5803 Control with IntelliTeam II Functionality

CATEGORY								
FIELDS	**1. Team Status Information**	**2. Real-Time Data**	**3. Switch 1 Auto Operation**	**4. Switch 2 Auto Operation**	**5. Fault Events①**	**6. Fault Magnitude**	**7. Maintenance**	**8. Fault Settings**
	Team Name Team Status: Ready/Fault/ Alarm Status Real-Time Load Real Capacity	Close/Open Status [Sw 1, 2, 3] Operations Counter [Sw 1, 2, 3] Switch 1 Line Current Switch 2 Line Current Switch 3 Line Current Ground Current [Sw 1, 2, 3] Switch 1 Line Voltage Switch 2 Line Voltage Switch 1 Phase Angle Switch 2 Phase Angle Switch 1 Reverse Current (Active or None) Switch 2 Reverse Current (Active or None) Switch 1 Line kvars Switch 2 Line kvars	Automatic Operation Features Enabled Sectionalizer Reset + Extended Voltage Loss Time Successful Reclose Rest Time Fault Current before First/All Voltage Loss(es) Recloser Counts to Trip Number of Shots Required for Lockout Shots-To-Lockout Time Threshold (Tenths) Phase Loss Protection Voltage Loss Threshold Phase Loss Protection Time Threshold Phase Loss Protection Current Threshold Automatic Reclose Time Threshold	Automatic Operation Features Enabled Sectionalizer Reset + Extended Voltage Loss Time Successful Reclose Rest Time Fault Current before First/All Voltage Loss(es) Recloser Counts to Trip Number of Shots Required for Lockout Shots-To-Lockout Time Threshold (Tenths) Phase Loss Protection Voltage Loss Threshold Phase Loss Protection Time Threshold Phase Loss Protection Current Threshold Automatic Reclose Time Threshold	Most Recent Oldest 3rd Most Recent 2nd Most Recent	Most Recent Oldest 3rd Most Recent 2nd Most Recent	Software Version Ac Power/ Battery Status Battery Low/ Bad Setpoints Battery Voltage w/o Surface Charge Predicted Voltage Under Load Power Supply Voltage/ Battery Impedance Cabinet Temperature Fault Interrupter Status	Phase Fault Detected Current Level (Amps) [Sw. 1, 2] Ground Fault Detected Current Level (Amps) [Sw. 1, 2] Phase Fault Duration Time Threshold (msec) [Sw. 1, 2] Ground Fault Duration Time Threshold (msec) [Sw. 1, 2] Phase Current Inrush Restraint Time (msec) [Sw. 1, 2] Ground Current Inrush Restraint Time (msec) [Sw. 1, 2] Phase Current Inrush Restraint Multiplier [Sw. 1, 2] Ground Current Inrush Restraint Multiplier [Sw. 1, 2]

① For an explanation of the codes used in the Fault Events column, see the “Fault Events Log” section on page 28.

Power Supply/Control I/O Module

The power supply/control I/O (PS/IO) module is a highly efficient, computer-controlled, uninterrupted power-supply system specifically designed to meet the specialized power requirements of automated electric-power distribution equipment.

The PS/IO module provides steady-state current flow for switch control operation, pulsed current flow for communications equipment, and occasional large current surges for line-switch operation. It also provides 12 Vdc, battery charging (24 or 36 Vdc), and other dc voltages from a single 24- or 36-Vdc source. This design provides superior battery lifetime and carryover compared to systems that "center tap" a 24- or 36-Vdc system to supply their 12-Vdc requirements or that use multiple, non-interchangeable batteries.

The PS/IO module supplies accurate, temperature-compensated charging voltages with current-limiting and other safety mechanisms to maximize battery carryover and minimize the possibility of battery off-gassing or explosion. This system meets or exceeds ANSI surge-withstand and dielectric specifications, including ANSI C62.41 - 1992 6KV3KA surge and C37.90a 2.5kV 125 MHz ring wave and 5-kV fast transient waveform specifications.

The power-management system consists of the PS/IO module and a Hawker/Gates 24-Vdc or 36-Vdc battery. When ac power is available, the PS/IO module converts the ac power to dc and uses the dc power to run the switch control, charge the battery, and operate the communication equipment. It draws on the battery only for the current needed to operate the switch. When external ac power is not available, the PS/IO module uses power from the sensors instead, if applicable. When both external ac power and power from the sensors is not available, the PS/IO module draws on the stored battery power for all switch control operations.

The power-management system can be monitored from the switch control faceplate with IntelliLink software or from the SCADA master station.

Power Supply/Control I/O module LEDs

The PS/IO module LEDs provide information about the state of the battery and ac power.

AC ON LED

This LED is lit when the switch control has a power source, either external ac or sensor power. It is located on the middle left of the module.

Note: The ac-line fuse is not intended for field replacement. Replacing a blown fuse may result in further damage.

CHG ON LED

This LED is lit when the battery charger is connected to the battery, the AC ON LED is lit, and the battery charger and battery are within the proper voltage range (20-30.5 volts for 24-Vdc batteries, 30-45.75 volts for 36-Vdc batteries). It is located on the middle left of the module.

BAT ON LED

This LED is lit when the battery is connected to the 24-Vdc or 36-Vdc power-supply bus. It is located on the bottom right of the module.

ANALOG PWR LED

This LED is lit when power is being supplied to the analog processors. It is located on the top middle of the module.

Battery Management

The battery-management system makes sure the switch control can operate the line switch with the available battery capacity and provide advanced warning of a weak battery, before the switch cannot be operated. Battery capacity is affected by several variables, including age, temperature, load cycling, and loading.

The switch control continuously monitors the battery voltage. It tests the battery at regular, scheduled intervals. The interval depends on the power conditions:

- During battery discharge, the test is run hourly.
- After a power outage, the test is run every two hours for 24 hours to monitor the battery status while the battery is recharged.

- After 24 hours of continuous operation on ac power (or power from the sensors, if applicable), the test is run once a day.

Note: The BATTERY TEST/LAMP TEST switch or a SCADA command to manually test the battery can be used at any time.

During the battery test, the switch control applies various loads to the battery to determine how it will perform under load. These tests include:

- **Actual battery voltage—**This determines the true open-circuit battery voltage.
- **Battery impedance—**This determines the internal impedance of the battery.
- **Calculated voltage under load—**This determines the minimum voltage predicted during switch operation. When the switch control is operating on battery power, the control reevaluates the **Calculated Voltage Under Load** value continuously. Otherwise, it evaluates this value only during battery-test cycles.

Based on the results of the above monitoring and tests, the switch control may take the following actions:

- If the battery **Calculated Voltage Under Load** value drops below the **Battery Low** setpoint, the switch control displays a "Battery Low" message and illuminates the faceplate BATTERY LOW LED. At voltages below this value, switch operation is still possible but only for a limited time.
- When the **Calculated Voltage Under Load** value drops below the **Battery Bad** setpoint, the switch control sets the **Battery Bad** status indication for the SCADA operator and displays a "Battery Bad" message on certain IntelliLink screens. The switch will not reliably operate at voltages below this value.
- If the battery steady-state voltage drops below 22.0 volts (for a 24-Vdc battery) or 33.0 volts (for a 36-Vdc battery) while the switch control is operating on battery power, the switch control automatically disconnects all loads to prevent deep discharge. Power is restored to loads when ac power (or sensor power, if applicable) is restored or the battery is replaced.
- If the battery voltage falls outside the proper range (20-30.5 volts for 24-Vdc batteries, 30-45.75 volts for 36-Vdc batteries) while the switch control is operating on ac power (or sensor power, if applicable), the switch control disconnects the battery from the system and turns off the BAT ON LED on the power supply/control I/O module.

Because the battery supplies the wetting voltage of switch-status contacts, disconnecting the battery will also generate alarms. Based on field experience, a weak battery may fail the battery test in very cold temperatures but pass when the ambient temperature rises. If a **Battery Low** or **Battery Bad** alarm occurs, schedule the battery for replacement. In warmer climates or seasons, if a battery test indicates a **Battery Low** condition, the battery may last a week or two longer.

Battery Care and Maintenance

Typical battery life for 5800 Series controls is five to seven years. The battery should be replaced when capacity is reduced to 80% of capacity when new. Increased temperature accelerates battery aging, so installations in warmer climates will have a shorter battery life.

5800 Series controls automatically test and record battery capacity. Battery replacement is the only routine maintenance required. Yearly site inspection of the BATTERY LOW LED and the physical condition of the battery is recommended for non-communicating controls. More frequent inspection should be scheduled for older batteries, and the battery replaced every five years. Communicating controls report **Battery Low** status to SCADA when capacity is near 80%, though the battery will still power the switch operator.

The following suggestions can improve battery life:

- Store batteries at room temperature. To maximize battery life, store all gel-cell batteries at or below room temperature. When in service, the battery will probably be exposed to higher temperatures that will affect its lifetime.

- Keep stored batteries charged. Gel-cell batteries are generally designed with a 6-month maximum shelf life. This means they can survive sitting on the shelf without being recharged and without incurring substantial damage for 6 months. When they must be stored for a longer period, periodical recharging is critical. When recharged every month, the batteries can be stored for years without significant damage. To recharge a battery, connect it to the switch control or to an independent battery charger, such as the S&C BC-8-24 battery charging system.

  The best approach is maintaining the smallest inventory possible and rotating the inventory, removing the oldest batteries first.
- Use batteries known to be good. Do not install used batteries in battery-backed equipment unless they have been properly tested. The cost of a service call to replace a bad battery is usually higher than the cost of a new battery. Although a battery might be good enough to provide temporary standby power, the line switch has a brief but large power requirement that may exceed the ability of a weak battery to rapidly deliver necessary current.
- Avoid installing the control enclosure in a sunny location. When possible, install the switch control in a shady area. Because batteries are not efficient in a hot environment, do everything possible to minimize the peak operating temperature.

Switch Control Software

5800 Series switch controls are entirely software-driven. Each control is shipped with control software, IntelliLink Setup Software, and the setup manager software.

Control software is installed in the factory. This software manages the minute-by-minute functioning of the team member. It continually monitors:

- Voltage and current on the feeder
- Incoming SCADA commands
- The position of the faceplate switches
- The condition of the battery
- Ambient air temperature inside the control enclosure
- The internal switch control clock/calendar
- The software setpoint values
- Fault and voltage-loss information already stored in the control
- Various other setpoints and data values as needed

Based on this information, the control software decides how to respond to a possible overcurrent fault, a change in voltage, a command from the faceplate or SCADA master station, and other conditions.

The control software, setpoint configurations, and historical data are all stored in non-volatile memory. This memory survives power interruptions, including the complete failure of the battery system. The memory chip has a minimum 10-year shelf life, without power.

IntelliLink® Setup Software

IntelliLink Setup Software runs on computers using the Windows operating system. It communicates with a control connected by cable at the switch control site. IntelliLink software can:

- Enter installation-dependent operating parameters (setpoints), such as the network address, automatic operation features, etc.
- Monitor real-time data, such as the present line voltage and current
- Examine the performance and operating history of an installed switch control
- Transfer all configuration, operating, and historical data from the switch control to a report file on the computer
- Download new control software into the switch control
- Troubleshoot assorted types of switch control installation problems

SCADA Communications Equipment

The S&C IntelliTeam II Automatic Restoration System uses the DNP 3.0 protocol for team communication. A SCADA system using the DNP protocol can remotely monitor, control, and change setpoints for all IntelliTeam II switch controls.

The communication hardware (radio, modem, etc.) is mounted inside the switch control enclosure on the universal communication mounting plate on the back of the faceplate. This shortens connection lengths and provides better reliability.

See the applicable DNP Points List and Implementation instruction sheet and the communication equipment documentation for more information.

Optional IntelliLink® Remote Setup Software

S&C IntelliLink Remote Setup Software is used to access S&C automation products by using the DNP 3.0 protocol remotely from any computer connected to the DNP network. One can configure controls, access historical and real-time data, and troubleshoot equipment as though connected directly to the faceplate of the control communicated with. To activate IntelliLink Remote software, purchase a software license key from S&C Electric Company. A temporary key is available at no charge for evaluation. Follow these steps to use the IntelliLink Remote software:

STEP 1. Connect the computer to an S&C automation control or a headend radio. Use the SCADA port (Port A) on the control with a DB9 to 6-pin IDC cable.

STEP 2. Start the IntelliLink Setup Software if it is not already running.

STEP 3. In the IntelliLink menu, select the **Tools** and **Options** entries.

STEP 4. In the **Communications** tab of the Options dialog box, select the **DNP** entry as the protocol.

STEP 5. Configure the **Connection Type** setpoint. When connecting directly to a 5800 Series Switch Control, IntelliTeam Interface Module, or a headend radio, select the **Serial** option.

STEP 6. When using the **Serial** option, enter the following:

- **(a) Port—**This is the computer port where the DNP communications cable is connected.
- **(b) Baud Rate—**This is the baud rate between the switch control, or IntelliNode™ Interface Module, and the directly connected communications device (radio, fiber-optic transceiver, etc.).

STEP 7. **Use Default Timeout—**Check this box to use the default timeout value. Setting the timeout value manually is recommended:

- **(a) Timeout—**This is the timeout duration (in milliseconds) for communication.
- **(b) Retries—**This is the number of times the control will try to connect with the remote device.
- **(c) Our Address—**This is the DNP address associated with the computer or the master station address. Set this unique value according to utility standard practice.
- **(d) Dest. Address—**This is the DNP/RTU address of the destination control. To communicate with the locally connected control, when its DNP/RTU address is unknown, configure this as "SELF."

STEP 8. Click on the **Connect** button. When the connection is established, the IntelliLink screens can be viewed as though connected directly to the remote switch control or Interface Module.

STEP 9. Repeat steps 7 and 8 for each switch control, or IntelliNode Interface Module, to be viewed.

Operation Overview

This section explains how the switch control components work together to detect and respond to overcurrent faults and voltage outages.

Signal Processing

The switch control includes separate electronic paths to accommodate the different requirements for peak versus normal current measurements. For normal current measurements, full scale is 800 amps RMS. For peak measurements, full scale varies with the switch type. For S&C switches, the value is approximately 4000 amps RMS and depends on the switch model. See Table 4 on page 18.

Peak detection focuses on speed, with several samples taken for each sinusoidal peak and instantaneous analysis of the incoming data. Measurement of normal current is slower and includes a finer degree of accuracy.

The control reports current, voltage, and phase-related data in units of amperes, volts, and kvars. The rated accuracy of these measurements is based on the combined accuracy of all control components (exclusive of the sensor and sensor cable, but inclusive of all sensor-conditioning components). The control uses the switch-calibration data and the phase-angle offset values to correct all ac waveform data sampled from the switch sensors.

Using the jumpers included with the control, configure it for wye or delta distribution-line applications. Based on the selected configuration and certain setpoint values, the control normalizes voltages to nominal 120- or 240-Vac values.

RMS AC Waveform Analysis

The control uses RMS detectors, with accuracy to the 100th 60-Hz harmonic, to produce true RMS amplitude data for current, neutral current, and voltage waveforms. This is particularly important when measuring neutral current because the harmonic distortion effects of any single phase are multiplied in the summing of the phases.

Because there is some response latency associated with this circuitry, voltage and current changes that occur within a few tenths of a second are sensed as a single, steady value.

For real-time, steady-state monitoring and data-logging, the control collects data at 0.2-second intervals. It averages eight samples and reports the 1.6-second averaged value. This results in a net response time of 1.6 seconds.

The switch control uses the 1.6-second averaged values for the real-time display, reporting via SCADA communication, and data-logging. Daily high and low values are logged for the current day and the preceding seven days.

Waveform Analysis for a Power System with Delta-connected Customer Transformers

The control treats power systems with delta-connected customer transformers as a special case.

When the line switch has three voltage sensors and the sensor conditioning module is configured with a delta jumper, the control reproduces the delta voltage waveform before any transducer functions are performed. This is useful for comparing the measured voltage against that seen by customers served by phase-to-phase connected transformers. For S&C voltage sensors, this configuration is necessary for accurate phase-to-phase voltage measurements because these sensors measure phase-to-neutral voltages even in a delta distribution system.

For switches with one voltage transformer for voltage sensing and control power, and three CVMI current sensors, the sensor-conditioning module must always be configured with the wye jumper. Voltage sensing and reporting are determined by the way the voltage transformer is connected: phase to phase (delta) or phase to neutral (wye).

Voltage Sensing for S&C Switches

The 5800 Series control software supports 15-kV, 25-kV, and 34.5-kV S&C switches.

The nominal voltage-sensor ratios for the line switch(es), with corresponding maximum voltage levels, are shown in the Table 4 on page 18.

Table 4. Maximum Voltage Levels Supported in S&C Switches

S&C Switch Model	S&C Nominal Voltage Sensor Ratio	Maximum Phase-to-Phase Voltage (Delta Jumper)	Maximum Phase-to-Phase Voltage (Wye Jumper)
15 kV	1386:1	20.0 kV	15.0 kV
25 kV	2440:1	27.3 kV	20.4 kV
34.5 kV	3389:1	38.7 kV	29.0 kV

The maximum voltage levels represent the highest voltage measurements supported by the control software. The maximum voltage levels in Table 4 are based on nominal sensor ratios. Actual maximum voltages may vary slightly based on the S&C sensor-calibration information supplied with each switch. For the physical information and electrical specifications for each switch, see the applicable S&C literature. When support for higher voltage levels is required, contact S&C Electric Company.

The third column of the table shows the maximum voltage levels supported for installations configured for phase-to-phase (delta) voltage reporting. These installations require a delta-configured sensor conditioning module.

The fourth column of the table shows the maximum voltage levels supported for installations configured for phase-to-ground (wye) voltage reporting. These installations require a wye-configured sensor conditioning module.

Accurate voltage reporting requires proper setpoint configuration. This includes entering the actual sensor ratios supplied by S&C for each sensor. It also includes selection of a voltage-reporting method (phase to phase or phase to neutral) consistent with customer transformers on the feeder and their associated step-down ratios.

Phase Angle Measurements

The switch control uses a highly accurate, proprietary, zero-crossing detection scheme (that is not tricked by multiple zero-crossings of noisy or harmonic-contaminated signals) to measure the phase angles between the voltage and current waveforms on each phase.

The switch control samples the phase-angle reading every 0.2 seconds, then averages eight samples and reports the 1.6-second averaged value. Phase-angle measurements are reported on a 0-360 degree range.

Enter **Phase-Angle Offset** values to compensate for both sensor-dependent and installation-dependent phase-angle characteristics.

Overcurrent Fault & Voltage Loss Detection

Overcurrent faults are measured with a combination of peak-current detection hardware for phase faults and true RMS amplitude-detection hardware for harmonic-sensitive neutral-current faults.

To determine whether an overcurrent fault exists, the control compares sensed current to setpoint values for current level and fault duration. The **Current Level** setpoint can be specified in 10-amp RMS increments for phase faults and 1-amp RMS increments for ground faults.

The **Fault Duration Time Threshold** setpoint can be specified in 6.25-millisecond (approximately 1/3-cycle) increments for phase faults and 50-millisecond increments for ground faults.

This scheme allows the software to measure fault current with a scaling appropriate to the higher amplitude signals encountered with faults and to detect the peaks of narrow spikes caused by CT saturation that trick many digital-sampling schemes.

Phase-Overcurrent Detection

Phase-overcurrent conditions are sensed using a combination of analog and digital techniques. The switch control provides fault detection with a resolution of 1/3 cycle and peak values of approximately 4000 amps RMS. Overcurrent measurements are accurate to 0.5% of full scale, excluding sensors. For information about scaling beyond 4000 amps, contact S&C Electric Company.

Note: S&C 5802/5803 controls monitor each feeder independently and respond to changes on that feeder regardless of the condition of the other pad-mounted switch and feeder.

To detect phase overcurrent faults:

(a) The switch control monitors the current on all three phases and compares it to the **Phase Fault Detection Current Level** setpoint.

(b) When at least one peak overcurrent sample is above the setpoint every 18.75 milliseconds (a window of time slightly longer than one cycle), the control registers an overcurrent condition (a potential or pending fault) on that phase.

(c) When the overcurrent condition is registered, the control starts the **Phase Fault Duration Time Threshold** timer.

(d) When the overcurrent condition is present continuously for the duration of the timer, the control labels it a **Phase Overcurrent Fault** condition and responds accordingly.

If, during any 18.75-millisecond window, overcurrent is not detected, the control considers the **Phase Overcurrent Fault** condition to be no longer present and takes appropriate action.

(e) When a recognized **Phase Overcurrent Fault** condition ends (after the timer expires), the software records the maximum RMS current measured during the fault and the fault duration. Any fault lasting longer than 6.82 minutes is recorded as 6.82 minutes (409.6 seconds).

Ground Overcurrent Detection

The switch control hardware measures ground current as an analog vector sum of the three individually sensed phase currents. This analog signal is measured by a true RMS-detecting circuit, yielding a very accurate, harmonic-independent measure of the true RMS current integrated over several cycles. Because of this multi-cycle integration, there is some delay in the response time through the hardware. This delay is inversely proportional to the magnitude of the change in ground current. The larger the change in ground current, the faster the circuit responds. The net result is very similar to the time-current characteristics of a protective relay.

The software samples the true RMS-detection hardware on 50-millisecond intervals. On each interval, the current is compared to the **Ground Fault Detection Current Level** setpoint. When the current exceeds the setpoint and this condition persists continuously for a period of time specified by the **Ground Fault Duration Time Threshold** setpoint, an **Overcurrent Fault Condition** state is indicated and appropriate action taken.

Because the registration of an overcurrent fault condition is affected by the relationship between the minimum fault-current detection level and the RMS detector rise and fall times, a family of time-current characteristic curves is generated. See the graph in Figure 11 on page 20 of Instruction Sheet 1042-531, "S&C 5800 Series Automatic Switch Controls with IntelliTeam® II Automatic Restoration System: *Setup*." Each of these curves corresponds to a single setting of the **Ground Fault Detection Current Level** setpoint. The points on each curve represent the minimum amount of time the ground current must be present to register a fault. For example, when the **Ground Fault Detection Current Level** setpoint is 150 amps, a 500-amp ground current must be present for approximately 42 milliseconds before the control registers a fault.

The minimum registration time for this example is less than the 50-millisecond software sampling interval. Therefore, short-duration, high-magnitude ground overcurrent faults can be detected by using low-magnitude overcurrent thresholds.

Voltage-Loss Detection

The control checks the voltage on all three phases at 50-millisecond intervals. Any voltage drop below the **Loss of Voltage Threshold** setpoint is considered a voltage outage.

Inrush Restraint

The **Inrush Restraint** feature prevents phase- or ground-overcurrent conditions that can occur during outage restoration (hot- or cold-load pickup) from falsely indicating a fault condition. It also applies when the switch is closed from the faceplate or via SCADA while power is present. The **Current Inrush Restraint Multiplier** feature enables the switch control to differentiate between moderate overcurrents (caused by cold-load pickup) and

large overcurrents (caused by a fault condition) during the inrush restraint period. See the "Inrush and Load-Pickup Restraint" section on page 25 of Instruction Sheet 1042-531, "S&C 5800 Series Automatic Switch Controls with IntelliTeam® II Automatic Restoration System: *Setup*," for additional information.

Inrush restraint is applied as follows:

(a) During a voltage outage, the switch control continuously monitors the switch status, the RMS voltage sensors, and the phase-overcurrent detectors for any indication the outage has ended.

(b) When voltage rises above the **Loss of Voltage Threshold** setpoint on any phase or overcurrent is detected on any phase, the switch control checks the switch position.

(c) If the switch is closed, the switch control starts the **Phase Current Inrush Restraint** timer and the **Ground Current Inrush Restraint** timer.

(d) If both **Current Inrush Restraint Multiplier** setpoints are in **Time Block** mode, the control ignores all overcurrent conditions until the **Inrush Restraint** timers expire.

If one or both **Current Inrush Restraint Multiplier** setpoints is in something other than **Time Block** mode, the control considers any overcurrent condition that exceeds the specified multiplier value to be an overcurrent fault. See the "Phase Overcurrent Detection" section on page 18 and the "Ground Overcurrent Detection" section on page 19 for details.

(e) After the **Inrush Restraint** timers expire, the switch control responds to overcurrent conditions in the normal manner.

Note: No inrush restraint occurs when the **Inrush Restraint** setpoints are set to 0.

Switch Control Response to Overcurrent and Voltage Loss Events

The control response to an overcurrent condition or voltage loss depends on the settings in effect when the event occurs. For example, the values selected for the **Fault Detection Current Level** and **Fault Duration Time Threshold** setpoints determine whether the control recognizes an overcurrent event as a fault condition. The **Automatic Operation** features enabled and the position of the faceplate automatic operation ENABLE/DISABLE switch determine what the control will do when a recognized fault condition occurs.

Overcurrent Data Logging

The control keeps a record of each recognized event, the assumed cause of the event, and any action taken. It logs all events, regardless of the position of the Automatic Operation ENABLE/DISABLE switch and the REMOTE/LOCAL switch.

The control maintains separate chronological logs of event data. Information is stored in these logs in a circular fashion; the newest entry always overwrites the oldest. The control logs each event with millisecond timestamping and 6.25-millisecond resolution.

The first log is a sequence-of-events buffer. Each record in this log represents one fault event. For example, an overcurrent condition followed by voltage loss and/or a fault-related action taken by the control, "the line switch opened because of a phase-imbalance condition." The information in this log is displayed on the *Overcurrent Fault>Fault Events* screen and the LCD screen.

The second log contains the magnitude and duration information for each fault event. The recorded magnitude is the maximum RMS current amplitude encountered during the fault event. The duration is recorded in units of milliseconds, with 6.25-millisecond resolution and a maximum recordable fault duration of 409 seconds (6 minutes, 49 seconds). The information in this log is displayed on the *Overcurrent Fault>Fault Magnitudes* screen and the LCD screen.

Note: Because of the delayed rise and fall times of the hardware, the logged time for detection of ground-overcurrent faults may be delayed relative to the logged time for phase-overcurrent faults caused by the same event. In addition, the accuracy of recorded duration times for ground-overcurrent events is affected by the 50-millisecond sampling interval and hardware rise and fall times. The peak magnitude of ground overcurrent is also affected by the amount of time the event is present. Accurate magnitude recording requires the condition to be present for approximately 400 milliseconds. See Instruction sheet 1042-531, "S&C 5800 Series Automatic Switch Controls with IntelliTeam® II Automatic Restoration System: *Setup*," for more information.

Automatic Operation

The 5800 Series switch control can perform several automatic operations: line sectionalizing, phase-imbalance protection, phase-imbalance protection with automatic reclose, and one- or two-shot lockout of a faulted circuit.

Note: For any of the automatic operation features to work correctly, an appropriate value for the **Loss of Voltage Threshold** setpoint must be entered. See the "Loss of Voltage Threshold" section on page 15 of Instruction Sheet 1042-531, "S&C 5800 Series Automatic Switch Controls with IntelliTeam® II Automatic Restoration System: *Setup*," for more information.

Line Sectionalizing

The switch control can sectionalize a distribution circuit based on detected fault current and voltage fluctuations associated with source-side recloser operation.

Note: The S&C 5802/5803 control monitors each feeder independently and responds to changes on specific feeders regardless of the condition of the other pad-mounted switch and feeder.

When **Sectionalizing** mode is enabled, the control uses the following logic to determine when to trip open the switch:

(a) The control continuously monitors all sensed voltage phases and compares the voltage to the **Loss of Voltage Threshold** setpoint.

(b) When the voltage drops below the setpoint on all sensed phases, the control starts the **Sectionalizer Reset and Extended Voltage Loss Time** timer. In addition, the control sets the counter of recloser operations to "1."

If a phase- or ground-overcurrent fault was present within 0.6 seconds prior to the detected loss of voltage, the control assumes the voltage loss was caused by a source-side breaker or recloser opening in response to a load-side overcurrent fault.

If an overcurrent fault was not detected prior to the loss of voltage, the control assumes the voltage loss was caused by a source-side breaker or recloser opening in response to a source-side overcurrent fault.

(c) The control continues to monitor voltage levels. It adds one count to the counter for each time the source-side device opens.

(d) If the **Successful Reclose Reset Time** setpoint is greater than zero, the **Reset on Successful Reclose** mode is also active. If voltage returns on all sensed phases (above the **Loss of VoltageThreshold** setpoint), current is below the fault-detection threshold, and this condition persists without interruption for longer than the **Successful Reclose ResetTime** timer, the sectionalizing counts and memory timer are reset and sectionalizing is canceled.

(e) If the **Sectionalizer Reset and Extended Voltage Loss Time** timer expires before the counter reaches the appropriate **Recloser Counts to Trip** setpoint, the control resets the counter to zero. Later voltage losses are considered part of a different reclose sequence. However, if three-phase voltage is not present when the timer expires, an **Extended Voltage Loss** condition exists and the control opens the switch.

When the counter reaches the setpoint value before the timer expires and the problem was a load-side fault, the control trips open the switch.

Note: When the **Fault Current Required Before First/All Voltage Loss(es)** setpoint is "All," the switch will not trip open unless all voltage losses were preceded by fault current. However, it may still operate based on the **Recloser Counts to Trip, Voltage Loss Only** setpoint. See Instruction Sheet 1042-531, "S&C 5800 Series Automatic Switch Controls with IntelliTeam® II Automatic Restoration System: *Setup*," for more information.

If the counter reaches the setpoint value before the timer expires and the problem was a source-side fault, the control notes the events but does not trip open the switch.

Follow these steps to enable line sectionalizing:

STEP 1. In the **Features Enabled** field on the *Setup>Automatic Operation* screen, select a combination that includes **Sectionalizing** mode.

STEP 2. If desired, at the *Setup>Automatic Operation* screen, set the **Successful Reclose Reset Time** setpoint to coordinate with the reclosers.

STEP 3. Use either the faceplate automatic operation ENABLE/DISABLE switch or a SCADA command to enable **Automatic Operation** mode for the control.

Phase-Loss Protection

When the **Phase-Loss Protection** mode is enabled, the switch control trips open the switch in response to a persistent phase-imbalance condition to prevent damage to customer equipment. The control uses the following logic to determine when to trip open the switch:

(a) When the control detects a loss of voltage on one or two phases, it starts the **Phase Loss Protection Time Threshold** timer.

(b) If the voltage loss persists and true RMS current remains below the **Phase Loss Protection Current Threshold** setpoint until the timer expires, the switch control trips open the switch.

If voltage returns before the timer expires, the switch control terminates the timing operation.

If voltage returns on one phase before the timer expires but is then lost on another phase, the switch control restarts the timer.

Follow these steps to enable the **Phase Loss Protection** mode:

STEP 1. In the **Features Enabled** field on the *Setup>Automatic Operation* screen, select a combination that includes the **Phase Loss Protection** mode.

STEP 2. At the *Setup>Automatic Operation* screen, enter values for the **Phase Loss Protection Time Threshold** and the **Phase Loss Protection Current Threshold** setpoints. Also enter the **Phase Loss Protection Voltage Loss Threshold** setpoint; otherwise, the control uses the **Loss of Voltage Threshold** setpoint on the *Setup>Site-Related* screen. See Instruction Sheet 1042-531, "S&C 5800 Series Automatic Switch Controls with IntelliTeam® II Automatic Restoration System: *Setup*," for more information.

⚠ CAUTION

Select a conservative value for the **Phase Loss Protection Current Threshold** setpoint, one clearly below the loadbreak rating of the line switch.

STEP 3. Use either the faceplate Automatic Operation ENABLE/DISABLE switch or a SCADA command to enable the **Automatic Operation** mode.

Shots-to-Lockout Feature

The **Shots-to-Lockout** feature allows the field technician or SCADA operator to test a potentially faulted line. When the circuit is then de-energized by a source-side protective device (recloser, breaker, etc.) and the control sees the transition from voltage present to loss of voltage, the control opens the switch immediately. This allows the faulted line segment to be isolated and prevents the source-side device from reclosing into a fault multiple times.

Note: When the source-side device opens and recloses very quickly, sensors on the load side of the switch may not have enough time to sense both the voltage increase (when the switch closes) and the voltage loss (when the source-side device opens) before the sourceside device recloses. Under these conditions, the control cannot carry out **Shots-to-Lockout** mode, except during a transfer event. For best results, the sensors should always be installed on the source side.

During a transfer event, the IntelliTeam system uses **Shots-to-Lockout** mode every time it automatically closes a switch to restore load. However, depending on the location of voltage sensors, it may not know whether voltage has been restored up to the switch. For this reason, when the IntelliTeam system does not see a transition from voltage present to loss of voltage, it still trips open the switch following the **Shots-to-Lockout Time Threshold** if no voltage is present. Be sure to coordinate this timing with the breaker at the source. For more information about switch control response time, see the "Loss of Voltage Threshold (RMS Volts)" section on page 15 in Instruction Sheet 1042-531, "S&C 5800 Series Automatic Switch Controls with IntelliTeam® II Automatic Restoration System: *Setup*."

⚠ CAUTION

It is very important to coordinate the end of the **Shots-to-Lockout** timer and source-breaker operation. Operation of the breaker at the same time the switch opens could result in failure of the switch.

When the line switch is closed, **Shots-to-Lockout** mode can also be enabled. This feature is useful for extending shots-to-lockout functionality to a load-side manual switch. The feature is enabled indefinitely (latched), until disabled by toggling the faceplate REMOTE/LOCAL switch to the **Remote** mode.

When **Shots-to-Lockout** mode is enabled:

(a) When the line switch is open: If the switch is closed into a fault and the source-side protective device (recloser, circuit breaker, etc.) detects the fault, the source-side device opens and voltage is lost on all phases.

When the line switch is closed: If a load-side manual switch on the circuit closes into a fault and the source-side protective device (recloser, circuit breaker, etc.) detects the fault, the source-side device opens and voltage is lost on all phases.

(b) The control recognizes the source-side device opened. If the **Number of Shots Required for Lockout** sepoint is "1," the control trips open the switch right away. If it is set to "2," the control waits until the source-side device recloses and opens a second time. Then, the control trips open the switch. If the **Overcurrent Required before Shots-to-Lockout Operation** setpoint is also enabled, the control only opens the switch when the three-phase voltage loss was preceded by an overcurrent event.

Setting the **Number of Shots to Lockout** setpoint to "2" prevents the control from trying to open the switch at the same time as the source-side device is performing an instantaneous reclose. When the **Overcurrent Required before Shots-to-Lockout Operation** setpoint is also enabled, the relationship between the detection of overcurrent and voltage losses follows the **Fault Current Required before First/All Voltage Loss(es)** setpoint.

(c) The switch remains open until it is closed with a SCADA command or manually from the switch control faceplate.

Local Shots-to-Lockout

To perform the **Shots-to-Lockout** command from the control faceplate:

STEP 1. On Page 1 of the *Setup>Automatic Operation* screen, make sure:

- The **Features Enabled** setpoint is set to an option that includes **Sectionalizing** mode.
- The **Number of Shots Required for Lockout** setpoint is set to the appropriate number for this control.
- The **Shots-To-Lockout Time Threshold** setpoint contains a value larger than zero.
- The **Overcurrent Required Before Shots-to-Lockout Operation** setpoint is set to the appropriate value for this switch control.

STEP 2. Set the faceplate REMOTE/LOCAL switch to **Local** mode.

STEP 3. Hold the faceplate Automatic Operation ENABLE/DISABLE switch in the **Enable** position. This will cause the ENABLED LED to blink while the switch is held.

STEP 4. While holding the ENABLE/DISABLE switch in the **Enable** position, toggle the CLOSE/OPEN faceplate switch (for the tested circuit) to the **Close** position. This will cause the CLOSED LED for the selected switch to blink. If the line switch is open, this action closes the switch.

STEP 5. Release the ENABLE/DISABLE switch.

If the line switch was previously open, the **Lockout** mode remains in effect (and the CLOSED LED continues to blink) for the duration of the **Shots-To-Lockout Time Threshold** timer. If the appropriate number of voltage losses is detected during this time, the control trips open the switch.

If the line switch was already closed, the **Lockout** mode remains in effect (and the CLOSED LED continues to blink) indefinitely. To disable it, toggle the REMOTE/LOCAL switch to **Remote** mode.

Remote Shots-to-Lockout

The **Shots-to-Lockout** command can be issued by a SCADA master station. See the appropriate DNP Implementation instruction sheet for more information. However, **Latched Shots-to-Lockout** mode is not available remotely.

Note: To use **Remote Shots-to-Lockout** mode, the control faceplate REMOTE/LOCAL switch must be set to **Remote** mode and the Automatic Operation ENABLE/DISABLE switch set to **Enable** mode.

Automatic Load Transfer

The IntelliTeam II system defines a team as two or more switch controls that protect a given line segment by transferring load to an alternate source. A switch control may be a member of one or more teams.

After completing its sectionalizing and/or phase-loss logic, the switch control can reclose its switch to transfer load to an adjacent distribution circuit or to restore service to load on the source side of the fault. To do this, the switch control uses information it receives from other team members.

Team members use an independent software agent, called the coach, to distribute data and coordinate operation. The coach visits each team member within a prescribed time period, carrying with it an ID number and incrementing visit counter. When it arrives at a team member that has already seen that ID and visit counter, the coach assumes it is a duplicate and dies.

If a team member does not hear from the coach within a prescribed period, the team member generates a new coach. The new coach has an ID one number higher than the last visiting coach and a visit counter set at zero. The new coach determines the state of the team line segment and takes any necessary action. If an arriving coach finds a new coach with a higher ID has visited, the arriving coach, with the lower ID, dies.

At the beginning of an event, any team member witnessing the event will tell all the other team members and the coach. The transmission includes a sequence number, nature of the event, and which team member made the report. All members continually monitor for this report.

- If the report requires local team restoration, the coach visits the other normally closed team members to verify they are now open. It then follows the alternate source sequence list and visits team members that could become an alternate source.
- If the report requires service restoration for the adjacent team, the coach immediately moves to its team member that is also a member of the adjacent team.

When an event begins, load averaging is stopped, so the load value prior to the event will be used for reconfiguration negotiation.

Loading Restrictions

As a default, the team decides whether to restore a line segment based only on the available capacity of the feeder, updated as the reconfiguration progresses, and any restrictions placed on a line segment due to wire size, switch capacity, or other limiting factors.

This method won't prevent circuit overloading when non-continuous line segments (a bifurcated circuit) assume their loading information is correct and both close simultaneously to restore independent loads.

When a line segment cannot handle any overloading at all, set the **Contract Required** setpoint on the *Setup>Team* screen to "Yes" for any team. When team members encounter a line segment in a restoration path that requires a contract, they communicate with all subsequent line segments in the direction of the alternate source to ensure the alternate source will not be overloaded. This slows down the reconfiguration process. For more information, see the "Contracts" section on page 25.

The number of line segments that a team can pick up is restricted by using the **Line-Segment Limit** setpoint on the *Setup>Team* screen. For example, "Add 1" inhibits any other line segments from being restored through a member after it restores its first line segment.

With the value set to "N/A," the team can pick up as many line segments as capacity will allow. The line-segment limit may be configured in any or all teams but it is a global value for all members in that team. The limit is continuously propagated outward from the source segment as the coach travels from team member to team member. As the limit propagates outward, limits with a lower configured count take precedence and are then propagated further.

When the coach arrives at the team member for the switch it would like to close, it looks for the coach from the adjacent team. If it's not already there, the first coach calls, and the second coach will move to the shared team member. Both coaches can now decide whether to close the switch based on available capacity, contracts for resources, and other restrictions. As switches close, the IntelliTeam II system updates available capacity on the feeders used to restore service. When a transfer with a known load value occurs, it resets the loading data to reflect the new value. This updates information more quickly than 2-minute load averaging.

As load is restored, some team members may want to begin the **Return-to-Normal** process for their team(s). But **Return-to-Normal** mode is blocked by the two-coach rule: a coach that knows its team is not being fed from its normal source will not allow an adjacent team coach to start the **Return-to-Normal** process.

When a team is in the reconfigured state and the alternate source has a new event, the team can look for a new alternate source, if available, to supply its line segment.

A normally open switch in a source/substation location must have the voltage sensors on the substation side. Otherwise, transfer operations will not work correctly. If this is an existing installation, with voltage sensors on the wrong side and they cannot be moved, contact S&C for more information.

Follow these steps to enable the **Automatic Load Transfer** mode:

STEP 1. Set the **Team Logic** setpoint on the *Setup>Team* screen to the **Enabled** state for each team if applicable.

STEP 2. Use either the faceplate Automatic Operation ENABLE/DISABLE switch or a SCADA command to enable **Automatic Operation** mode for the switch control.

Contracts

A large IntelliTeam II system may have feeder reconfiguration occurring simultaneously at more than one location. To prevent circuit overloading, the system uses contracts to ensure it will not pick up more line segments than the circuit can supply. Contracts travel across teams to safely secure resources needed to energize the line segment.

As the IntelliTeam II system transfers load to an alternate source, a contract is required when the **Line-Segment Limit** setpoint has been enabled or if a **Line-Segment Limit** condition has been propagated from the source. A contract is generally not required unless the line segment being energized will be directly or indirectly fed from an alternate source. For example, a source/substation switch never requires a contract to close, but a tie switch will always require a contract to close.

Every team member has a contract agent. Unlike the coach, contract agents are static and only the contract is communicated. The contract agent obtains contracts and maintains outstanding contracts.

A contract is required when:

(a) During a transfer event, the coach of the requesting line segment asks a team member to close an alternate-source switch to energize the segment.

(b) A team member contacts the coach of the alternate-source line segment to verify circuit resources.

(c) When a team member finds the line-segment limit has not yet been exceeded, it issues a request to the local contract agent. While the contract agent works to obtain a contract, both the requesting coach and the alternate-source coach must remain at this team member (except to satisfy the visit timer). The team member also waits while the contract is being obtained.

(d) The contract agent prepares and sends the contract to the agent of the team member presently the source for the alternate-source line segment. The requesting agent waits for the contract to be returned.

(e) The receiving contract agent checks the requested-resource availability. If there is not enough excess capacity, the agent updates the contract to decline the request and returns the contract to its sender. If sufficient excess capacity is available at this team member, the contract agent adds its ID to the routing list and forwards the contract to the next team member in the direction of the absolute source.

(f) When the contract reaches the source/substation-switch agent, the agent checks for available excess capacity. If the contract request exceeds excess capacity the agent declines the contract and returns the contract directly to the originating contract agent.

(g) When circuit resources are sufficient, the contract agent accepts the contract, lists its ID as the granting contract agent, increments its local count of line segments that have been transferred, and keeps a copy.

(h) Following the contract-routing table, the accepted contract returns, through each previous contract agent, back to the originating agent. If the contract was declined, it goes directly to the originating contract agent.

(i) If the contract was declined, the requesting agent reports to its team member the transfer is not allowed and dissolves the contract. If the contract was accepted, the agent reports the transfer may continue and the agent saves the contract.

An accepted contract must be maintained and carries an associated maintenance timer. The requesting contract agent or an intermediate agent can initiate contract maintenance. If the timer expires, the agent sends a maintenance message along the contract route to verify the existence of the contract and reset the maintenance timer.

The requesting contract agent may also dissolve the contract when a manual switching operation energizes the line segment from another source, a local **Return-to-Normal** operation occurs or a second event occurs that causes additional circuit reconfiguration. To dissolve the contract, the requesting agent sends a message down the contract route. Each contract agent then dissolves the contract and decrements the local line-segment count.

Return to Normal

Following a reconfiguration event and subsequent repair and restoration of the faulted line section, team members can return to their normal state. When the **Return-to-Normal** timers expire, the coaches begin the process of returning each team to its normal configuration. The **Return-to-Normal** process begins at the team closest to the normal source and works outward. A closed transition **Return-to-Normal** mode must notify the normal tie switch before it continues.

Each team member may be configured for an open or closed transition. Teams with no tie switches allow their members to follow the needs of adjacent teams:

- A load switch between teams where an open transition is required will remain closed. It relays the Return-to-Normal request, becomes deenergized, and returns a go-ahead message before finally being reenergized from the normal source.
- The team member at a tie switch will automatically open the switch after a prescribed timeout. This ensures a circuit parallel will not be left in place indefinitely.

Follow these steps to enable the **Return-to-Normal** mode:

STEP 1. Set the **Rtn-to-Norm** setpoints on the *Setup>Team* screen to the **Open** or **Closed** state for each team member, in each team if applicable. See Instruction Sheet 1042-531, "S&C 5800 Series Automatic Switch Control with IntelliTeam® II Automatic Restoration System: *Setup*," for more information.

STEP 2. Use either the faceplate Automatic Operation ENABLE/DISABLE switch or a SCADA command to enable the switch control **Automatic Operation** mode.

Prohibit Restoration

This feature disables team automatic restoration (automatic closing of switches) in case of emergency or for circuit anomalies where restoration would be undesirable. The feature is enabled and disabled by SCADA (with DNP Control Point #8 for Scada-Mate® Switching Systems and Control Point #11 for pad-mounted gear) and also on the *Prohibit Restoration* screen. See Figure 3 on page 27. The **Prohibit Restoration** command affects all teams associated with the switch control receiving the command.

The **Prohibit Restoration** command will NOT prevent auto-sectionalizing logic from acting on fault conditions to open the switch. When a team is not in **Ready-to-Transfer** state (such as the **Prohibit Restoration** state) the auto-sectionalizing logic reverts to standard sectionalizing logic. Standard sectionalizing logic does not include sectionalizing on three-phase voltage loss or an extended three-phase voltage loss. To stop all automatic operation, send the DNP **Disable Automatic** command to each switch individually.

Indications that a team is in the **Prohibit Restoration** state are:

- The *Team Operation* screen indicates "ProRes" in the **Internal Error** field for each switch in which it is active and will indicate "ALARM" in the **Ready Status** field.
- The LCD screen will indicate "ALARM" instead of "READY" for that team.
- A DNP Status Point will be set (Point #34 for Scada-Mate Switching Systems and Point #49 for pad-mounted gear).

Prohibit Restoration Screen

The *Prohibit Restoration* screen is accessed through the **Operation** menu Misc. Operation entry. To change the state of **Prohibit Restoration** mode from this screen, click on either the **Disable** or **Enable** text button. A dialog box will open to verify your choice, or cancel the action.

When **Prohibit Restoration** mode is active, view the *Troubleshooting>Event Status* screens to determine whether this was the result of a SCADA command or a Prohibit Restoration Timer action. See Instruction Sheet 1042-551, "S&C 5800 Series Automatic Switch Control with IntelliTeam® II Automatic Restoration System: *Troubleshooting*," for more information.

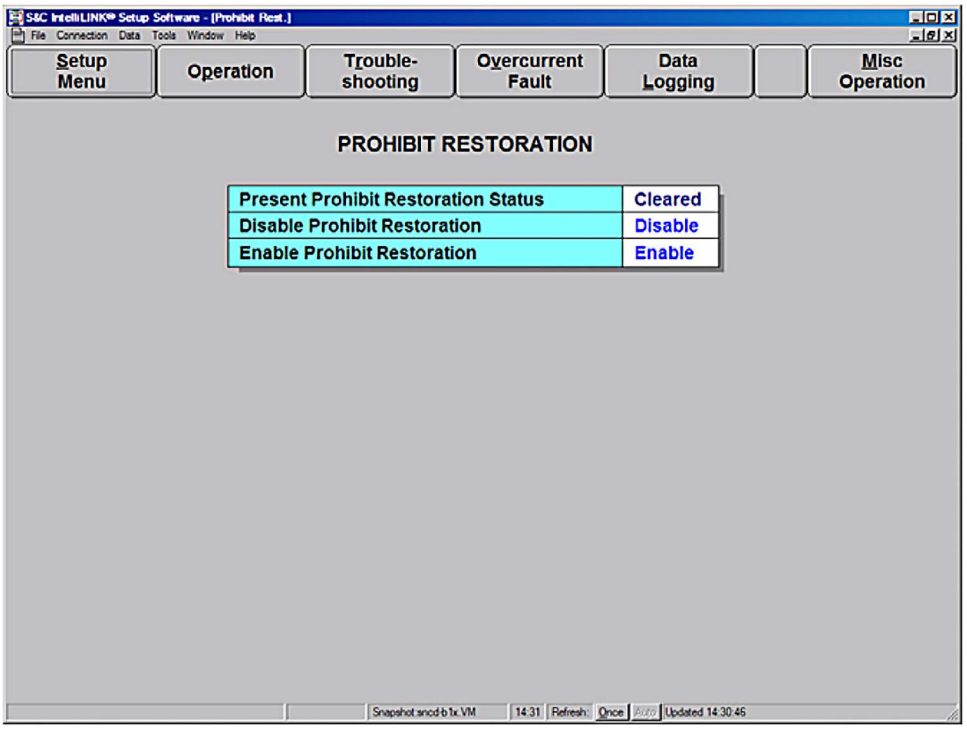


Figure 3. The *Miscellaneous Operation>Prohibit Restoration* screen.

Prohibit Restoration mode also may be enabled automatically through use of the **Prohibit Restoration Timer** setpoint on the *Setup>Team* screen. Enabling this feature automatically with the timer is useful when a predetermined time limit for the team to perform restoration is needed. If restoration has not occurred within this time limit, all restoration activity will be halted and the team will remain in an alarm state until **Prohibit Restoration** mode is cleared.

Fault Events Log

When a line switch has been tripped (opened automatically) by the switch control, information on the *Overcurrent Fault* screens can help determine the cause of this action.

Click the **Overcurrent Fault** button on any screen to open the *Overcurrent Fault Menu* screen, and then click on the **Fault Events** button.

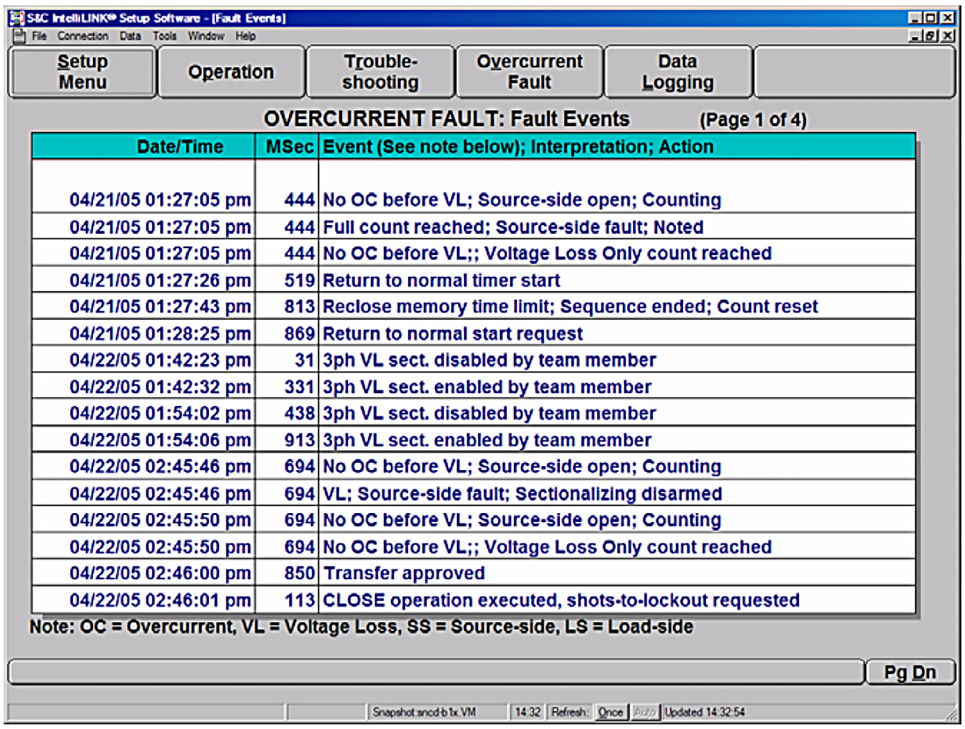


Figure 4. The *Overcurrent Fault>Fault Events* screen.

The *Overcurrent Fault>Fault Events* screen shows a chronological list of fault-related events for the switch(es). The record for each event includes time, switch number (if applicable), type of event, the switch control interpretation of the event, and the action taken. See Figure 4.

This log has four pages of stored data. When the log is full, each new event overwrites the oldest event in the log. To find the most recent event, look for the message with a timestamp older than the time for the message above it.

This screen has two columns:

Date/Time and MSec

This is the time (to the nearest 6.25 milliseconds) the event was logged. The control logs the event after the fault event and all described actions have completed.

Event

The event message describes the event, the assumption the control made about the event, and the action(s) taken. The number code on the LCD screen is shown in square brackets (for Switch 1 and Switch 2 respectively, if applicable) on the line below the name that appears on the IntelliLink software screen. Code 0 means there was no event.

Note: For the S&C 5802/5803 control, each event message is specific to one switch/circuit and is preceded by either "Sw1:" for Switch 1, or "Sw2:" for Switch 2. When both circuits are affected, such as a voltage loss, the message appears twice.

Phase A OC; Fault current sensed & cleared; Noted [1], [2]

The switch control detected an overcurrent fault on Phase A. That overcurrent fault has ended. The switch control is waiting to see whether voltage will be lost on all three phases. When all voltage is lost, the control will begin timing for a possible reclose operation.

The switch control displays similar messages for **Phase B**, **Phase C**, and **Ground Overcurrent** conditions.

Phase B OC; Fault current sensed & cleared; Noted [3], [4]

See the "Phase A OC; Fault current sensed & cleared; Noted [1], [2]" entry.

Phase C OC; Fault current sensed & cleared; Noted [5], [6]

See the "Phase A OC; Fault current sensed & cleared; Noted [1], [2]" entry.

Ground OC; Fault current sensed & cleared; Noted [7], [8]

See the "Phase A OC; Fault current sensed & cleared; Noted [1], [2]" entry.

OC then voltage o.k.; Load-side protective open; Noted [9], [21]

The switch control detected an overcurrent fault. This condition was not followed within 0.6 seconds by a loss of voltage on the same phase. The control assumed that a load-side fault occurred, but the condition was cleared on the load side by a fuse, recloser, etc.

No timer, or other action, is started for this type of event.

OC then VL; Source-side protective open; Counting [10], [22]

The switch control detected an overcurrent fault, which was followed within 0.6 seconds by a loss of voltage on all phases. The control assumed a load-side fault occurred and the condition was cleared on the source side by a three-phase device (breaker, interrupter, or recloser). The control added one count to the **Recloser Operations** counter.

Reclose memory time limit; Sequence ended; Count reset [11], [23]

The **Sectionalizer Reset** timer expired. The control will consider future events to be part of a different event sequence.

The switch control always displays this message when the timer expires.

VL; Source-side fault; Sectionalizing disarmed [12], [24]

The switch control detected a three-phase voltage loss but no overcurrent fault condition. The control assumed a source-side fault occurred and the condition was cleared on the source side by a three-phase device (breaker, interrupter, or recloser). The control started the **Sectionalizer Reset** timer and set the value in the **Recloser Operations** counter to "1." Because the fault was on the source side, the control will not trip open the switch because of recloser counts with fault current detected, but it will open the switch if the **Recloser Counts to Trip, Voltage Loss Only** count is reached.

VL; Load-side fault; Sectionalizing armed [13], [25]

The switch control previously detected a phase- or ground-overcurrent fault followed within 0.6 seconds by three-phase voltage loss. The control assumed the present voltage loss was associated with the previous load-side fault and the condition was again cleared on the source side by a three-phase device (breaker, interrupter, or recloser). The control incremented the **Recloser Operations** counter.

Full count reached; Source-side fault; Noted [14], [26]

The full count was reached on the **Recloser Operations** counter. Because the first voltage loss in the sequence was not preceded by an overcurrent fault, the control took no sectionalizing action on the **Recloser Counts to Trip, Fault Current Detected** count.

Full count reached; Load-side fault; Noted [15], [27]

The full count was reached on the **Recloser Operations** counter. Because the first voltage loss in the sequence was preceded by an overcurrent fault (as well as all subsequent voltage losses, if the **Fault Current Required Before First/All Voltage Loss(es)** mode is set to "All"), the control will take the appropriate sectionalizing action.

Full count reached with sectional. disabled; Noted [16], [28]

The full count was reached on the **Recloser Operations** counter. Because **Sectionalizing** mode was disabled, the control did not trip open the switch.

To identify the exact events that led to this action, review earlier log messages.

Full count reached; Open operation executed [17], [29]

The full count was reached on the **Recloser Operations** counter and the control tripped open the switch.

To identify the exact events that led to this action, review earlier log messages.

No OC before VL; Source-side open; Counting [18], [30]

The switch control detected a three-phase voltage outage that was not preceded by an overcurrent fault. The control assumed a source-side fault occurred and the condition was cleared by a source-side device. The control added one count to the **Recloser Operations** counter.

OC then VL; Source-side fuse blown for load-side fault [19], [31]

The switch control detected a phase- or ground-overcurrent fault. This was followed within 0.6 seconds by a loss of voltage on the same phase without all other phases losing voltage. The control assumed a load-side fault occurred and the condition was cleared on the source side by a fuse or single-phase recloser.

No OC then VL; Source-side (SS) fuse blown - SS fault [20], [32]

The switch control detected a loss of voltage on one or two phases that was not preceded by an overcurrent fault. The control assumed a source-side fault occurred and the condition was cleared on the source side by a fuse or a single-phase recloser.

CLOSE operation executed, shots-to-lockout requested [33], [35]

In response to an **Automatic-Transfer** command, or a SCADA or faceplate **Shots-To-Lockout** command, the control closed the switch and started the **Shots-To-Lockout** timer.

If voltage is restored on any phase and then lost on all three phases before the timer expires, the control will trip open the switch. If **Overcurrent Required before Shots-To- Lockout Operation** mode is enabled, the control also detected overcurrent.

Lockout close completed with VL after - OPEN executed [34], [36]

The operator issued a **Shots-to-Lockout** command. The control detected the appropriate number of three-phase voltage losses within the specified **Shots-to-Lockout Time** interval, so it tripped open the switch. When **Overcurrent Required before Shots-To-Lockout Operation** mode is enabled, the control also detected overcurrent. When the **Number of Shots Required for Lockout** setpoint is "2," the relationship between the detection of overcurrent and voltage losses follows the **Fault Current Required before First/All Voltage Loss(es)** setpoint.

Persistent phase imbalance; OPEN executed [37], [137]

The switch control detected a loss of voltage on one or two (but not all three) phases. The imbalance continued for the duration of the **Phase Loss Protection Time Threshold** timer. Because this loss occurred while the **Phase Loss Protection** and **Automatic Operation** modes were both enabled, the control tripped open the switch.

Phase imbalance w. reclose enabled; Waiting [38], [138]

The switch control detected a phase imbalance while **Automatic Reclose** mode was enabled. The control tripped open the line switch and is now waiting for three-phase voltage to return.

When full voltage returns, the control will start the **Automatic Reclose** timer. When voltage is continuously present for the full duration of the timer, the control will reclose the switch.

Switch closed; Operator action; Reclose canceled [39] or [41], [139] or [141]

While the switch control was waiting for three-phase voltage to return with **Automatic-Reclose** mode enabled, the operator manually closed the line switch (from the faceplate or via SCADA command). The operator action canceled the pending **Automatic-Reclose** operation.

Voltage OK after imbalance; Voltage restored; Waiting [40], [140]

After the switch control tripped open the switch because of a phase imbalance, three-phase voltage returned. Because **Automatic Reclose** mode was enabled, the control started the **Automatic-Reclose** timer. The control is waiting for the timer to expire.

When the **Automatic Reclose Time Threshold** setpoint value is reached, the control will close the switch.

Imbalance corrected w. reclose enabled; CLOSE executed [42], [142]

After the switch control tripped open the switch because of a phase imbalance, three-phase voltage was restored and remained present for the duration of the **Automatic Reclose** timer. Because **Automatic Reclose** mode was enabled, the control closed the switch.

No OC before VL; Voltage Loss Only count reached [43], [143]

The switch control detected a three-phase voltage outage that was not preceded by an overcurrent fault. **Sectionalizing on Voltage Loss Only** mode is enabled, and the **Recloser Counts to Trip, Voltage Loss Only** setpoint has been reached.

Open operation executed on Voltage Loss Only [44], [144]

Sectionalizing on Voltage Loss Only mode is enabled, and the **Recloser Counts to Trip, Voltage Loss Only** setpoint has been reached. The control opened the switch.

Sectionalizing disabled on Voltage Loss Only; None [45], [145]

The necessary criteria for **Sectionalizing on Voltage Loss Only** mode have been reached, but the mode is disabled. Neither a count of voltage losses nor an extended voltage loss will cause an operation.

Reclose memory time limit; Extended Volt Loss; OPEN [46], [146]

The **Reclose Memory Time Limit** period expired without restoration of voltage on any phase. This is an **Extended Voltage-Loss** condition and the control opened the switch.

Fault Interrupter tripped; Load side isolated Fault Interrupter closed; Load restored

A fault interrupter position of the Vista switchgear operated to either isolate a fault, or has been closed to restore load. This is a single indication representing all fault-interrupter positions on the Vista switchgear. A message indicating a trip event will be displayed only after the first interrupter has opened, and the closed indication will not be displayed until all interrupters are closed.

Shots-to-lockout latched on [83]

The operator enabled the **Shots-to-Lockout** mode on a closed switch. The control will open the switch if the detected three-phase voltage count equals the **Number of Shots Required for Lockout** setpoint.

Successful reclose; Sequence ended; Count reset [84]

The **Successful-Reclose Reset Time** timer has expired. The control will consider future events to be part of a different event sequence.

The control always displays this message when the timer expires.

For more details on any of the following event messages, see the *Troubleshooting>Team Event Log* screens.

Seeking alternate source [100]

The team is looking for an alternate source during a transfer event, based on the **Alternate-Source Sequence** and the **Normal Function** modes of the switches within the team, both entered on the *Setup>Team* screen.

Switch closed successfully [101]

A team switch/position closed successfully.

Switch close failure [102]

A team switch/position failed to close or remain closed. The switch may have already been closed, **Automatic Operation** mode may have been disabled at this team member, or the switch may have reopened during the **Shots-to-Lockout Time Period** setpoint.

Transfer approved [103]

The **Transfer Operation** requested by a team using the alternate source-switch previously determined was approved by the adjacent teams.

Transfer not approved [104]

The **Transfer Operation** requested by a team has been declined by the adjacent team. The requesting team must look for another alternate source or retry the operation on this alternate source if no other exists.

Switch opened successfully [105]

A team switch/position opened successfully.

Switch open failed [106]

A team switch/position was unable to open successfully.

Line segment faulted [107]

The line segment protected by a team is the location of the overcurrent fault on the circuit. The team will not attempt to restore service to this line segment.

Team Switch opened for transfer [108]

During a transfer event, a team opened one of its switches to allow the transfer operation to continue. This may occur when one or more switches within the team are not coordinated to open at the same time as the other switches.

Return to normal start request [109]

A team generated an event indicating that the **Return-to-Normal** timer has expired and that the **Return-to-Normal** process may start.

Return to normal disabled [110]

The **Return-to-Normal** process will not be carried out on a team because **Return to Normal** mode is disabled on the *Setup>Team* screen.

Return to normal timer start [111]

The **Return-to-Normal** timer was started by a team member.

RTN Start request received [112]

A team member received a request to start the **Return-to-Normal** process.

RTN process continuing [113]

The internal **Return-to-Normal** process for a team indicated a **Return-to-Normal** event could continue.

RTN process failed [114]

The internal **Return-to-Normal** process for a team indicated the Return-to-Normal event could not continue. This may be caused by a team member that has **Return-to-Normal** mode disabled or by the adjacent source team not yet being in its normal state.

Switch open to break extended parallel [115]

The team member at a tie switch automatically opened the switch after a prescribed time to ensure a circuit parallel was not left in place indefinitely.

Contract approved, close switch [116]

The team requested a contract, which then travelled to the granting agent, was approved, and came back. The switch has closed to energize the line segment.

Contract request declined [117]

The team requested a contract, which then travelled to the granting agent, but was declined.

Contract requested by team member [118]

A team member sent a contract request to its contract agent.

Contract dissolved by team member [119]

A team member dissolved an active contract.

3ph VL sectionalizing enabled by team member [120]

Three-Phase Voltage-Loss Sectionalizing mode has been enabled at this team member as a result of the team going into the **Ready-to-Transfer** state.

3ph VL sectionalizing disabled by team member [121]

Three-Phase Voltage-Loss Sectionalizing mode has been disabled at this team member as a result of a problem within the team, either at this team member or at one of the adjacent team members. Provided **Automatic Operation** mode has not been disabled at this team member, while in this state this team member will sectionalize using standard standalone sectionalizing logic. This requires the detection of an overcurrent condition prior to a three-phase voltage loss in order to arm the **Sectionalizer** mode.

3ph VL sectionalizing disabled by timer [122]

Three-Phase Voltage-Loss Sectionalizing mode has been disabled at this team member as a result of the expiration of a timer associated with team activity. If this timer is not updated during normal team operation, it is assumed the team is not operational, possibly due to a change in team configuration, and this team member should fall back to **Standard Standalone-Sectionalizing** mode.

Fault Magnitude and Duration

Click on the **Overcurrent Fault** button on any screen to open the *Overcurrent Fault Menu* screen. Then, click the **Fault Magnitudes** button.

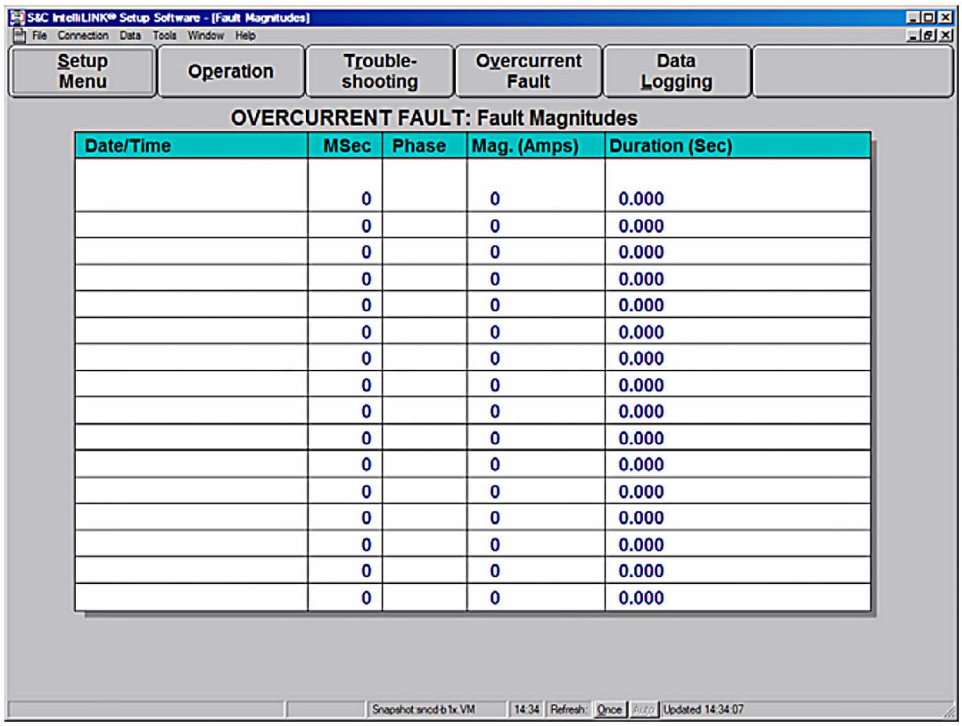


Figure 5. The *Overcurrent Fault>Fault Magnitudes* screen.

The *Overcurrent Fault>Fault Magnitudes* screen shows a chronological list of peak magnitude and duration data for overcurrent-fault events. The record for each event includes the date, time, phase, magnitude, and fault duration. See Figure 5.

The log can hold information for 16 events. When the log is full, each new event overwrites the oldest event in the log. To find the most recent event, look for the message with a time-stamp older than the time for the message above it.

The screen includes the following fields:

Date/Time – MSec

This is the time (to the nearest 6.25 milliseconds) when the event began. The control logs each event when it ends.

Phase

This is the phase and switch, if applicable, on which the overcurrent fault occurred (for example: A2, C1, or G2).

Mag. (Amps)

This is the peak (maximum) overcurrent-fault magnitude during the event, displayed as an RMS, asymmetric number.

Duration (Sec)

This is the duration of the overcurrent-fault event. The value is displayed in units of seconds, with resolution to the nearest 0.00625 seconds (6.25 milliseconds). The maximum recorded fault duration is 409.6 seconds (6.82 minutes). Any fault that lasts longer than that is recorded as 409.6 seconds.

Ac Power Outages

Click the **Overcurrent Fault** button on any screen to open the *Overcurrent Fault Menu* screen. Then, click on the **Power Outages** button.

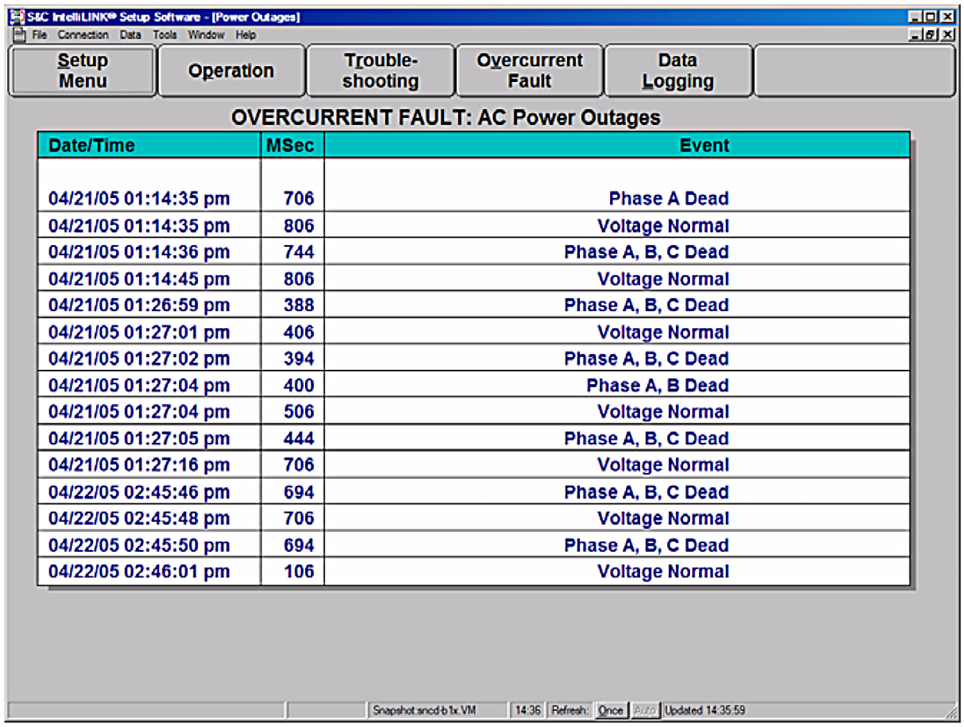


Figure 6. The *Overcurrent Fault>Ac Power Outages* screen.

The *Overcurrent Fault>Ac Power Outages* screen shows a chronological list of voltage outage events. The record for each event includes the date, time, and phase status for each event. See Figure 6. An event is recorded each time:

- Voltage drops below the **Loss-of-Voltage Threshold** setpoint on any phase. See the "Loss of Voltage Threshold (RMS Volts)" section on page 15 in Instruction Sheet 1042-531, "S&C 5800 Series Automatic Switch Control with IntelliTeam® II Automatic Restoration System: *Setup*," for more information.
- Voltage rises above the **Loss-of-Voltage Threshold** setpoint.

The log can hold information for 16 events. When the log is full, each new event overwrites the oldest event in the log. To find the most recent event, look for the message with a time-stamp older than the time for the message above it.

This screen includes the following fields:

Date/Time and MSec

This is the time (to the nearest 6.25 milliseconds) when the event began. This time is logged as soon as the event occurs.

Event

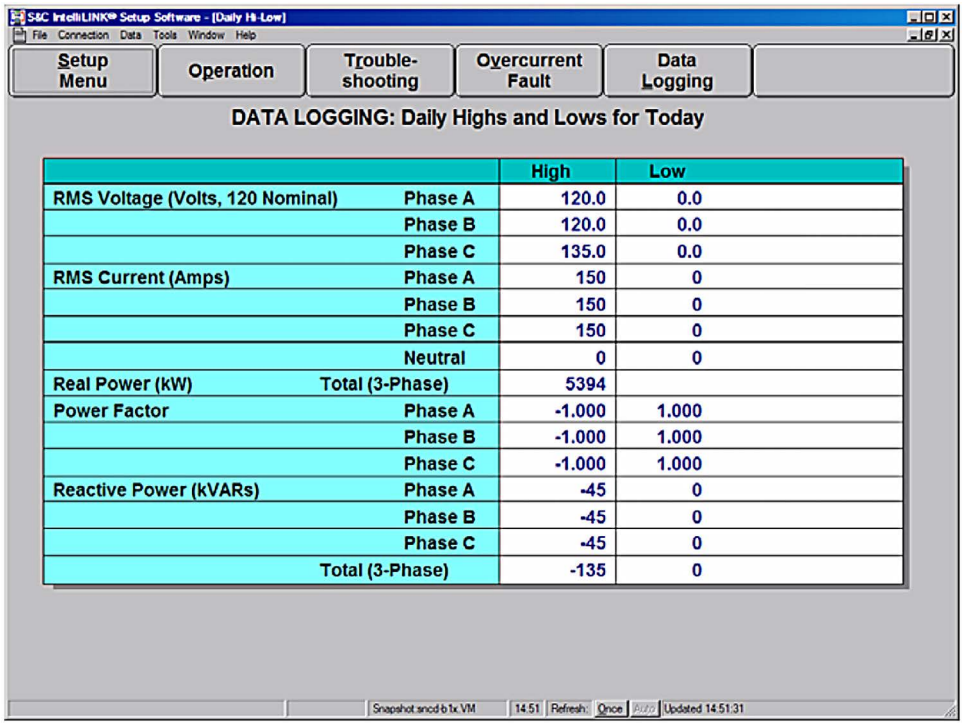
This is the phase and switch, if applicable, on which the voltage loss event occurred (for example: A2, C1, G2, or Control Power).

The switch control records a control power voltage loss event whenever the power supply/control I/O module detects loss of ac power and switches to battery backup power.

High/Low Values and Trend Data

The *Data Logging* screens show high and low values and trend data for voltage and current amplitude, phase, and related parameters. When a customer complains of a service outage or low voltage, the information on the *Data Logging* screens can help determine what happened and why it happened.

Click on the **Data Logging** button on any screen to open the *Data Logging Menu* screen. Then, click on the button for the time period that contains the day to be viewed. Then, if necessary, click on the **PgUp** and **PgDn** buttons to move to the correct day.



		High	Low
RMS Voltage (Volts, 120 Nominal)	Phase A	120.0	0.0
	Phase B	120.0	0.0
	Phase C	135.0	0.0
RMS Current (Amps)	Phase A	150	0
	Phase B	150	0
	Phase C	150	0
	Neutral	0	0
Real Power (kW)	Total (3-Phase)	5394	
Power Factor	Phase A	-1.000	1.000
	Phase B	-1.000	1.000
	Phase C	-1.000	1.000
Reactive Power (kVARs)	Phase A	-45	0
	Phase B	-45	0
	Phase C	-45	0
	Total (3-Phase)	-135	0

Figure 7. The *Data Logging>Daily Highs and Lows for Today* screen.

The *Data Logging>Daily Highs and Lows* screen shows the highest and lowest voltage and current, along with associated power factor, kvar, and kW values for each switch for a 24-hour period (12 midnight to 12 midnight). The high/low data for today and for each of the preceding seven days are presented. See Figure 7.

The switch control records the voltage on all three phases when any one phase is higher or lower than the previous high or low value recorded on any phase.

The control also records the current on all three phases, based on the average three-phase current. When a new daily high or low occurs, it records the power factor (per phase), kvars (per phase and total), and total kW at that time.

Each displayed value is the 1.6-second averaged value for that parameter. To obtain a 1.6-second averaged value, the control samples the data every 0.2 seconds. It then adds together eight consecutive samples and divides the total by 8.

Follow these steps to use the **Report** option to save the control software settings and stored data to the computer in a .CSV (comma-separated value) file. Keep the report as a permanent record and use the report information in spreadsheets or other programs.

STEP 1. Connect the computer to the control and start the IntelliLink software.

For details, see the "Starting IntelliLink Software" section in Instruction Sheet 1042-531, "S&C 5800 Series Automatic Switch Controls with IntelliTeam® II Automatic Restoration System: *Setup*."

STEP 2. At any IntelliLink screen, on the **Data** menu select the **Reports** option.

STEP 3. In the Report: Full Highlighted dialog box, click on the **OK** button.

STEP 4. In the Save Report dialog box, specify a name and location to save this report. Then, click on the **Save** button.

When a location is not specified, the file is saved to the same directory as the program files for this team member. For example, the default location for SNCD-B1X report files is C:\ELine\SNCD-B1X\. The extension .CSV is added automatically.

When the report is complete, the message "Task completed" appears on the status line of the Writing Report dialog box.

STEP 5. Click on the **OK** button.

The software closes the dialog box and displays the *Report Menu* screen.

Saving a Configuration File

When two or more team members use a similar setup configuration and the same software version, the configuration from one team member can be saved and loaded into the others. The setpoints that are different for each team member then can be manually adjusted.

This process is also used to save the setpoint values on the *Setup>Team* screen and to load these setpoints into each team member to ensure the *Setup>Team* screen is identical for all members of the same team.

Follow these steps to save a setup configuration:

STEP 1. Determine which team member contains the configuration to be saved.

STEP 2. Connect the computer to the selected team member and start the IntelliLink software.

For more information, see the "Starting IntelliLink Software" section in Instruction Sheet 1042-531, "S&C 5800 Series Automatic Switch Controls with IntelliTeam® II Automatic Restoration System: *Setup*."

STEP 3. In the **File** menu, click on the **Save Setpoints** entry.

STEP 4. In the Select Setpoint Profile dialog box, choose the setpoint values to be saved.

To save the stand-alone setpoint values, click on the **PROFILE: Non-Team Setpoints** entry, and then click on the **OK** button.

To save team setpoint values, click on the PROFILE: Team x Setpoints entry for the desired team, and then click on the **OK** button.

To save all setpoint values (including values for teams not already configured), click on the Save Configuration Data entry, and then click on the **OK** button.

STEP 5. In the Save Setpoints dialog box, specify a name and location for this configuration .CFG file. Then, click on the **Save** button and click on the **OK** button.

Be sure to name team setpoint profiles logically. For example: Team2 for the Team 2 setpoints. When loading the setpoint profile into another team member, the IntelliLink software automatically places the profile into the *Setup>Team* screen with the matching team number.

When a location is not specified, the file is saved to the same directory as the program files for this for this team member. For example: the default location for SNCD-B1X report files is C:\ELine\SNCD-B1X\. The extension ".CFG" is added automatically.

Note: This process does not save the Physical Location information (on the *Setup>Miscellaneous* screen), the Communications RTU Address information (on the *Setup>Communications* screen), or the sensor configuration data (on the *Setup>Sensor Configuration* screen, if applicable).

Loading a Configuration File

Follow these steps to load a saved configuration into a team member:

STEP 1. If necessary, connect your computer to the team member where you want to load the saved configuration. Then, start the IntelliLink software.

For details, see the "Starting IntelliLink Software" section in Instruction Sheet 1042-531, "S&C 5800 Series Automatic Switch Controls with IntelliTeam® II Automatic Restoration System: *Setup*."

STEP 2. In the **File** menu, click on the Load Setpoints entry.

STEP 3. In the dialog box, select the .CFG file for the configuration to be loaded. Then, click on the **Open** button.

STEP 4. Enter all setpoint changes required for this team member.

For more information, see Instruction Sheet 1042-531, "S&C 5800 Series Automatic Switch Controls with IntelliTeam® II Automatic Restoration System: *Setup*."

Note: Be sure to enter the correct value for the Physical Location information (on the *Setup>Miscellaneous* screen), the Communications RTU Address information (on the *Setup>Communications* screen), or the sensor configuration data (on the *Setup>Sensor Configuration* screen, if applicable).

Viewing Screens Without Connecting to a Control

Follow these steps to view the IntelliLink screens and Help file without connecting to a team member or a snapshot:

STEP 1. Start the IntelliLink software on the computer.

STEP 2. During startup, click on the **Cancel** button to close the Connect dialog box. If the IntelliLink software is already running, click on the **Disconnect from the Connection** option. Then, in the **File** menu click on the **Close Screenset** option to clear the present screenset from memory.

STEP 3. In the **File** menu, click on the **Open Screenset** option.

STEP 4. In the Open Screenset dialog box, select the .WMN file whose name matches the version of the software for this control.

Using Snapshots

Operation and data-logging information can be saved in a snapshot (.VM) file. Snapshots are used to view data, generate reports, and save or change setpoint configurations, even when not connected to a switch control. To access the stored information, open the snapshot file instead of connecting to a physical control.

Save Settings and Data to a Snapshot File

Follow these steps to create a snapshot file:

STEP 1. Connect your computer to the switch control that has the information to be saved and start the IntelliLink software.

For details, see the "Starting IntelliLink Software" section in Instruction Sheet 1042-531, "S&C 5800 Series Automatic Switch Controls with IntelliTeam® II Automatic Restoration System: *Setup*." Skip this step if the computer is already connected to the control.

STEP 2. In the **File** menu, click on the **Save Snapshot** option.

STEP 3. In the dialog box, specify a file name and location for this snapshot and click on the **Save** button.

When a location is not specified, the file is saved to the same directory as the program files for this team member. For example, the default location for SNCD-B1X report files is C:\ELine\SNCD-B1X\. The extension .VM is added automatically.

View a Snapshot File

Follow these steps to connect to a snapshot file:

STEP 1. Start the IntelliLink software on your computer. During startup, click on the **Cancel** button to close the Connect dialog box.

If the IntelliLink software is already running, in the **Connection** menu click on the **Disconnect** option, and then in the File menu click on the **Close Screenset** option to clear the present screenset from memory.

STEP 2. From the **File** menu, click on the **Open Snapshot** option.

The Open Controller Data File dialog box opens.

STEP 3. Select the snapshot to view and click on the **Open** button.

STEP 4. When changing the configuration settings in the snapshot, in the Connect to File dialog box click on the **Yes** button. To avoid accidentally changing a setting, click on the **No** button.

The IntelliLink software opens and displays contents of the selected snapshot.

Save New Changes in a Snapshot File

All changes made to configuration settings in the snapshot are automatically saved to the disk immediately. There is no need to save changes in a separate operation.

Generate a Report From a Snapshot

Follow the same procedure when connected to a switch control. For details, see the "Generating Reports" section on page 37.

Creating a Configuration (.CFG) File From a Snapshot

Follow these steps to prepare a setpoint configuration file for team members in the field when there is no access to a comparable device.

STEP 1. Connect to the snapshot file.

For details, see the "View a Snapshot File" section on page 39.

STEP 2. Revise the configuration settings in the snapshot as necessary.

For more information, see Instruction Sheet 1042-531, "S&C 5800 Series Automatic Switch Controls with IntelliTeam® II Automatic Restoration System: *Setup*."

STEP 3. In the **File** menu, click on the **Save Snapshot** option.

STEP 4. In the dialog box, specify a file name and location for this snapshot and click on the **Save** button.

When a location is not specified, the file is saved to the same directory as the program files for this team member. For example, the default location for SNCD-B1X report files is C:\ELine\SNCD-B1X\. The extension .VM is added automatically.

Occasionally, the control software stored in the switch control must be updated. The Update program, installed with the IntelliLink software, easily replaces the old control software with the new version.

NOTICE

The setpoint values and historical data stored in the switch control may be lost during the update process. Before updating the control software, always generate all reports needed using the earlier IntelliLink and control software versions.

Follow these steps to update the control software:

STEP 1. Install the contents of the new setup disc on the computer.

For details, see the "Starting IntelliLink Software" section in Instruction Sheet 1042-531, "S&C 5800 Series Automatic Switch Controls with IntelliTeam® II Automatic Restoration System: *Setup*."

STEP 2. Connect the computer to the LOCAL ACCESS port on the switch control.

STEP 3. Start the Update program.

(a) In Windows, select the Start menu>Programs>EnergyLine>Update entry.

The Update Control Software dialog box opens. See Figure 8.

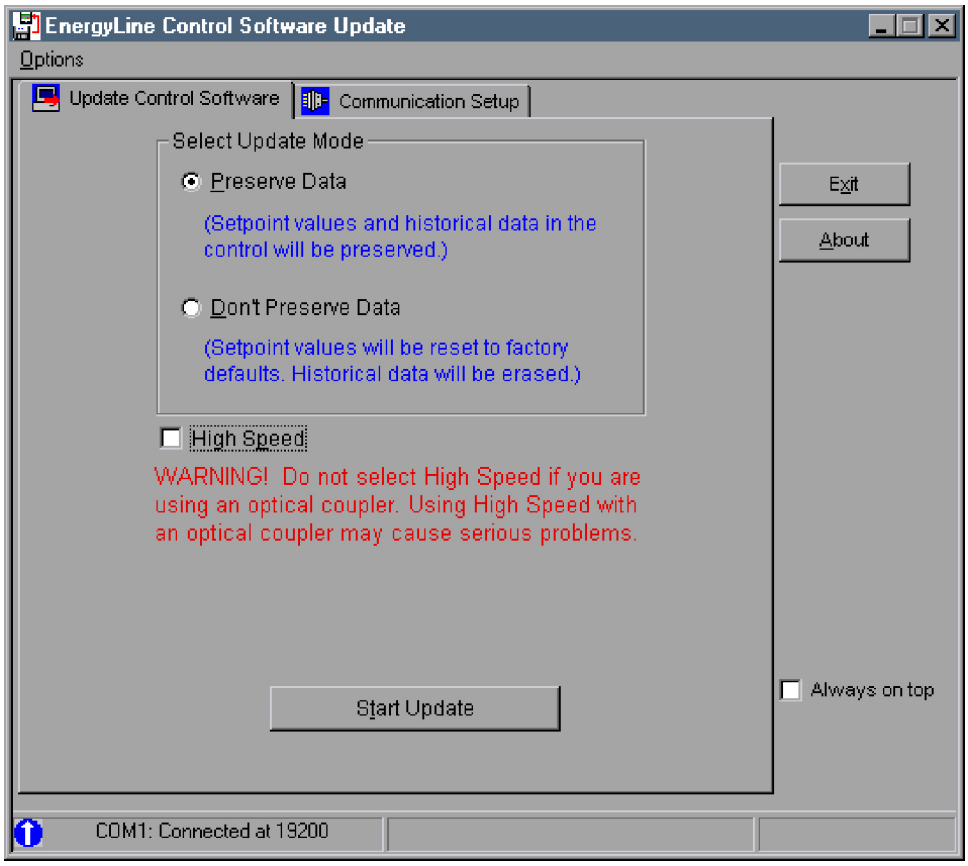


Figure 8. The Update Control Software dialog box.

(b) Select the desired options. Then, click on the **Start Update** button.

Note: When the switch control is not connected to the COM1 port on the computer, click on the **Communication Setup** tab, select the correct comm port, and click on the **Connect** button. Then, return to the **Update Control Software** tab and click on the **Start Update** button.

The update process takes about 15 minutes. The progress can be followed in the lower right corner of the dialog box. The window closes when the update is complete.

NOTICE

When the update process is cancelled after it starts, the software in the control is deactivated. If the process must be cancelled, start it again.

Note: An error message appears when the new downloaded software is not the same type as the software in the switch control. Review the software version in the switch control. Then, press the <Enter> key to abort the update process. When the correct software version has been downloaded, repeat the steps shown on page 41.

Updating Control Software with Battery Power Only

The switch control should be powered by both battery and ac control power (or battery and sensor power, if applicable) when updating the control software. When the control software must be updated at a location where no ac control power is available, follow these instructions to override the automatic **Shutdown** timer.

Protection System Logic

All control functions are directed by the CPU, including charging and monitoring the battery system. If the CPU program stops or hangs, the control will not function and the battery or circuits might be damaged. To indicate the CPU program is functioning properly, it sets a bit on the PS/IO board every few seconds. When that bit is not set for 60 seconds, the PS/IO board disconnects the battery and shuts down the control to prevent damage to the control circuits and the battery.

During the update process, the CPU is unable to function and cannot set the bit on the PS/IO board. The protection logic will disconnect the battery 60 seconds or less after the update process begins. When ac control power (or sensor power) is present, the control continues to operate without battery power and completes the software update. However, if ac control power (or sensor power) is not present, the control shuts down, terminating the software update. There is no damage to the control, and the update process can be restarted.

Manually Overriding the Battery-Disconnect Command

Control software can be updated using only battery power by manually sending a **Battery On** command to the PS/IO board. Do this by pressing the BAT ON switch every 30 seconds. The white momentary-contact switch is located on the PS/IO board. See Figure 9 on page 43.

Updating the control software takes about 15 minutes. However, maintaining battery power by pushing the BAT ON switch is generally easier than moving the control to a location with ac control power (or sensor power).

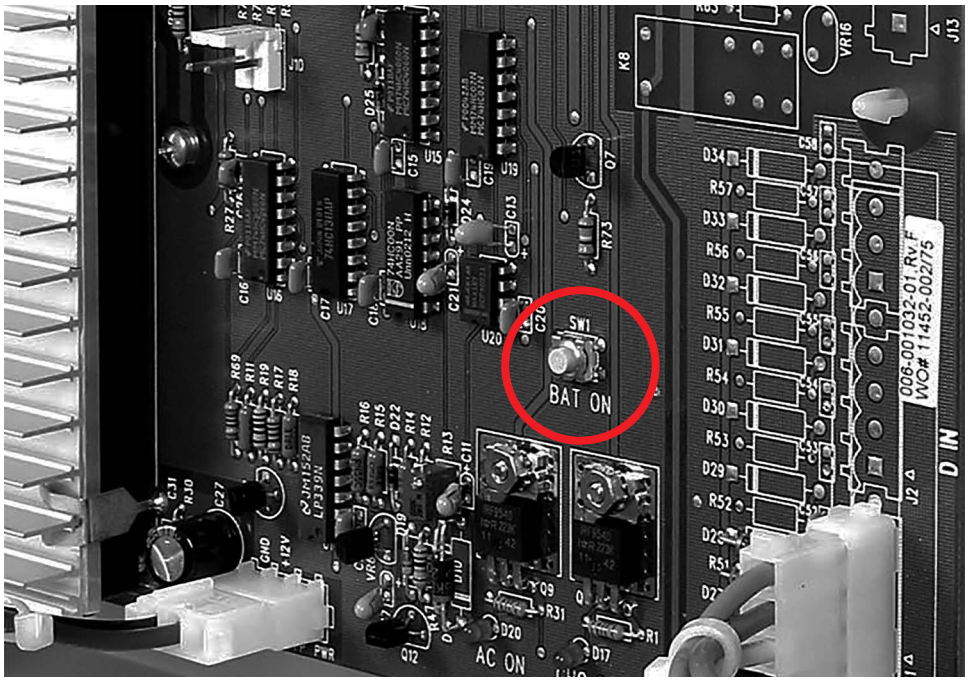


Figure 9. The BAT ON switch on the PS/IO board.