PG&E SCADA
Communication Option

For Use With the S&C IntelliCAP PLUS®
Automatic Capacitor Control

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Contents

Notes:

Introduction

This supplement describes the hardware and software support for the PG&E SCADA communications protocol in the S&C IntelliCAP PLUS Single-Phase Programmable Capacitor Control.

Applicable Software

This document was prepared for use with software PCSP118S and PCVP118S. You can find the release date on the Setup disk's label and on the *PRODUCT INFORMATION* screen. For questions regarding the applicability of the information in this document to future software releases, please contact S&C Electric Company.

Document Conventions

The following conventions are used in this document:

BOLD UPPER CASE	Labels on faceplates and assemblies; switch positions.
Italic	Names of manuals, manual sections, and software screens.
"Quotes"	Names of fields on software screens.
<Brackets>	Names of computer keyboard keys.
Courier	Characters to be typed at the DOS prompt and commands issued by the SCADA master station.

Cautions

All Cautions are clearly marked with the notation ⚠ *CAUTION* ⚠. Please read all cautions carefully before attempting to install or operate this equipment.

⚠ *CAUTION* ⚠

The information in this document is meant only for qualified people who are properly trained for work with this type of equipment, and who understand the hazards that may be involved. The information in this document is not meant to be a substitute for training and experience in the safety procedures that are required for this type of equipment.

Communications Hardware

The IntelliCAP PLUS Capacitor Control is compatible with several communications hardware systems, including:

- UtiliNet®

- MDS

- CellNet®

- Cellular Telephones

- Fiber Optics

- Hayes™-compatible modems

- Phone Lines

Each communications hardware option can be factory- or field-installed. If the factory installs the communications hardware, the cables are connected before the Capacitor Control is shipped. For field installation, an installation guide comes with the manual or retrofit kit.

Communications Setup and Installation

Typically, S&C Electric Company provides Controls with the requested communications options already installed in the enclosure. You may be able to skip some of the following steps.

⚠ *CAUTION* ⚠

Do not enable communications by connecting dedicated phone lines, antennas, or fiber optic cables until this is called out in the instructions. If the device address is incorrect when communication is enabled, the Control could respond to master station communications intended for a different device. This could interfere with normal system operation.

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

A. *Installing the Hardware*

1. Plug the control into the meter base socket, if required. When the control is plugged into an energized meter base, all faceplate LEDs light momentarily. The LCD starts to scroll after a few seconds.

2. Remove the fuse on the faceplate.

3. Make sure that the **OPERATION MODE MANUAL** and **SCADA CONTROL LOCAL** LEDs are lit. If not, press the applicable **CHANGE** button.

Figure 1
Faceplate **SCADA PORT**

PG&E SCADA Communication Option
for the IntelliCAP PLUS Capacitor Control
    S&C Electric Company
Proprietary Information

Check to make sure no communications equipment is able to receive or transmit signals. If communications equipment is already installed, disconnect the power and communications **SCADA PORT** connector.

- For an external radio, disconnect the communications cable from the box receptacle on the bottom of the Capacitor Control.

- For all other communications options, disconnect the **SCADA PORT** connector on the faceplate (see Figure 1).

5. If you need to install the communications equipment in the enclosure, disconnect any current and/or neutral sensors and pull the Capacitor Control off the pole (See Figure 2). Install the radio or other device, following the installation guide. Replace the Capacitor Control on the pole and reconnect the current sensors.

◆NOTE: Do not connect the phone line, antenna, or fiber optic cable at this time.

6. When you are finished installing the communications hardware, replace the fuse.

Figure 2
Ground Lug, Sensor Input Connectors and optional
LED Neutral Current / Voltage Lockout Indicator

B. Setting the Correct Communications Address

1. Connect the Capacitor Control to an IBM®/PC-compatible computer, using the optical port on the side of the enclosure or to the DB9 connector on the front of the faceplate, labeled **LOCAL COMM. PORT** (See Figure 1).

2. Double-click the IntelliLINK icon 📇 in the open EnergyLine folder on the Windows desktop.

   If the EnergyLine folder is not open, open the Windows Start menu, then click Start > Programs > EnergyLine > IntelliLINK to start the software.

3. Wait while the IntelliLINK window appears and the IntelliLINK software attempts to open communications with the capacitor control.

When the IntelliLINK software establishes communications with the capacitor control, the *Operation* screen (Figure 3) opens.
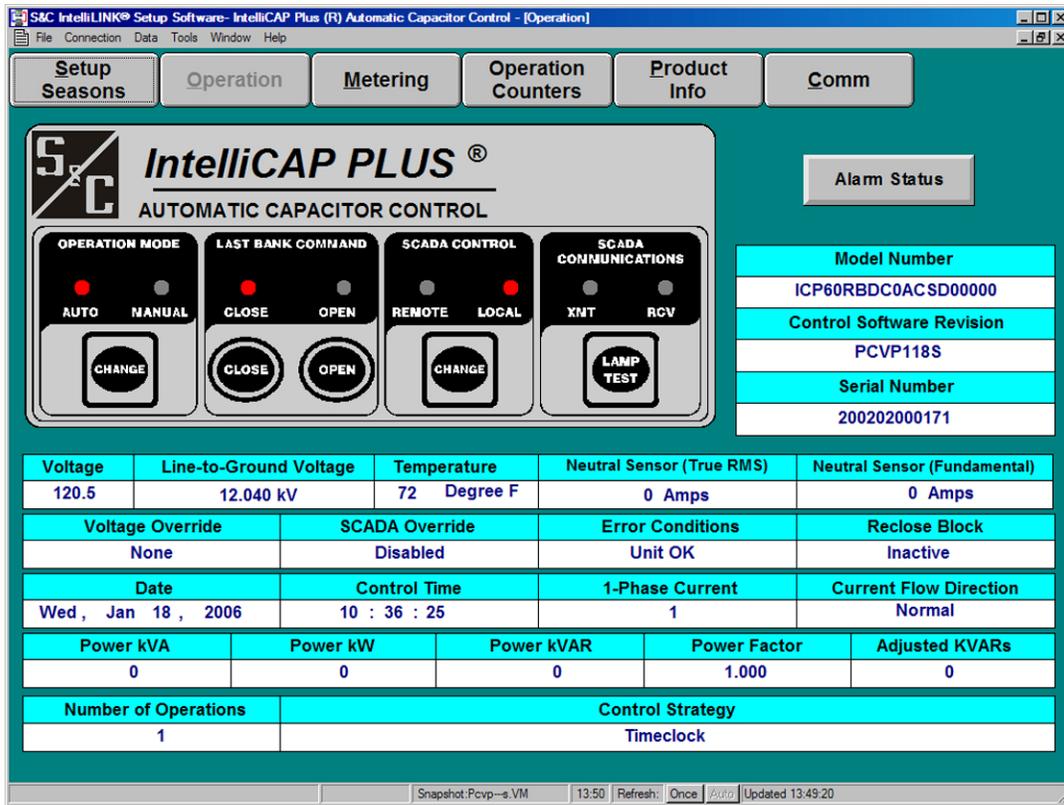
Figure 3
Operation Screen for the IntelliCAP PLUS IntelliLINK Software
(VAR with Neutral Current Version)

◆NOTE: If the IntelliLINK software does NOT establish communications with a functioning capacitor control, it displays the following dialog box.
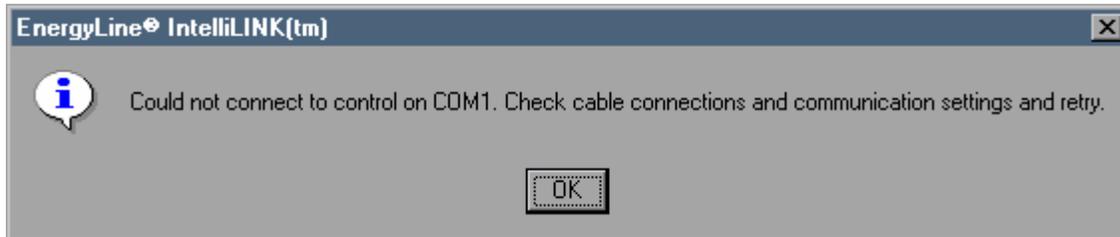
If this dialog box appears, or if the *Operation* screen opens but the software does not operate properly, see *Software Troubleshooting and Error Messages* in the *Troubleshooting* chapter.

4. On the *Operations* screen, select the **Comm** button to display Page 1 of the **Communications Setup** screen (see Figure 4).

5. Set the communications setpoints to the proper values.
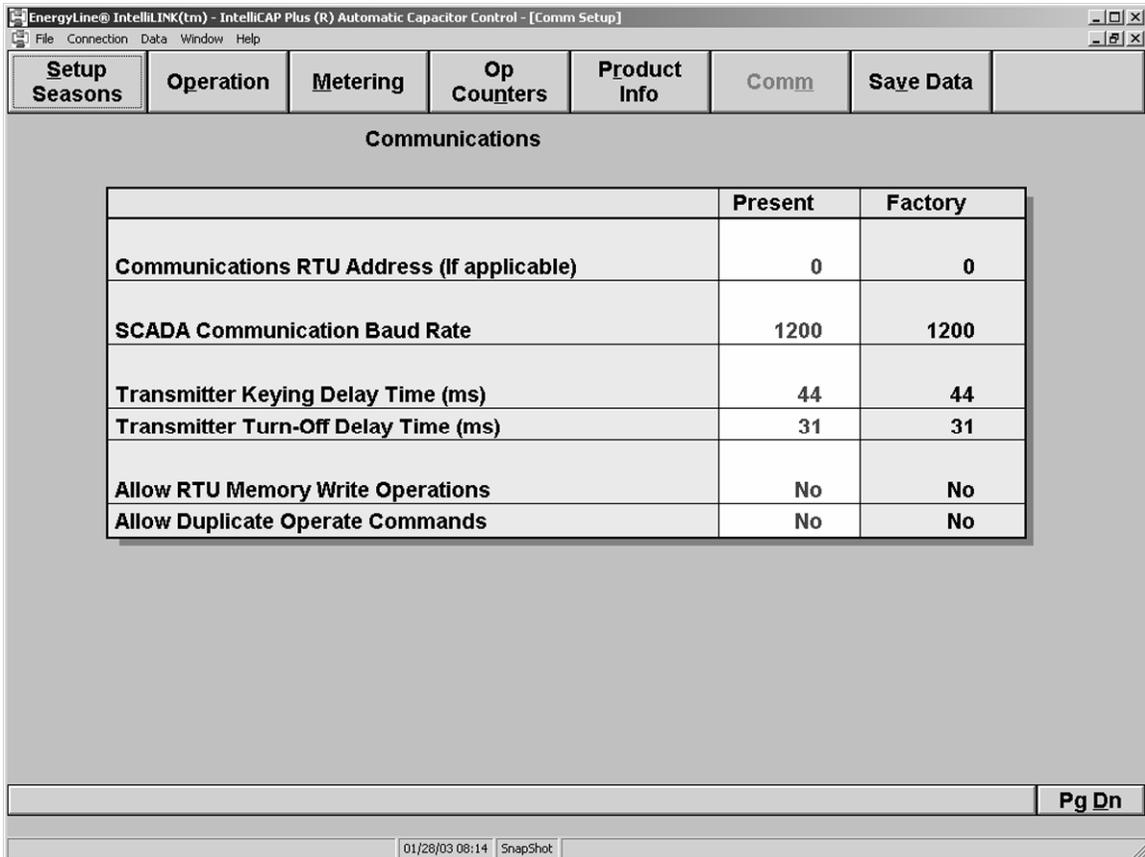
Figure 4
Page 1 of the Communications Setup Screen

6. This screen contains the following fields:

Communications RTU Address (if applicable).

Depending on the SCADA communications option installed in the control, this parameter sets the appropriate communications address.

◆NOTE: Be sure to set this address properly before physically connecting communications to ensure that the control does not respond to requests intended for another device.

SCADA Communication Baud Rate

This setpoint provides user selection of baud rate for the SCADA port. A number of baud rates from 300 to 9600 may be selected. Please make sure the selected baud rate matches the baud rate of the connected SCADA equipment (modem, radio, etc.). If configured improperly, SCADA communications will be inoperable.

Transmitter Keying Delay Time (ms)

This value specifies the amount of time that must elapse from the moment the transmitter is turned on until the data transmission begins.

Transmitter Turn-Off Delay Time (ms)

This value specifies the amount of time the transmitter should remain on after the second to last character transmission has begun.

Allow RTU Memory Write Operations

For security reasons, SCADA ordinal writes (Function 20h, Commands 30h and 31h) are by default disabled in the capacitor control. If you enable this feature to access some specific memory locations, you should also disable it when you are done. This prevents inadvertent changes to capacitor control parameters.

Allow Duplicate Operate Commands

Enabling this setpoint will allow the capacitor control to accept a duplicate Operate command for any given Select-Before-Operate sequence. While this is not covered by the PG&E SCADA protocol, this may be useful if your communications system is unreliable, and also is able to retry failed requests. For example, if a response to an Operate command failed to return to the master station, and a retry of the Operate was generated, if the duplicate Operate was received within the original Select timeout period, the capacitor control would respond as if the Operate had just occurred rather than with an error.

7. At page 1 of the **Communications Setup** screen, click the **Pg Dn** button to display Page 2 of the **Communications Setup** screen (Figure 5).

   This **TROUBLESHOOTING: Communications** screen shows a chronological listing of communications problems related to the PG&E protocol on port A.

   The log can hold 10 entries. Once the log is full, each new event over-writes the oldest event in the log. To find the most recent event, look for the message with a timestamp that is older than the time for the message above it.
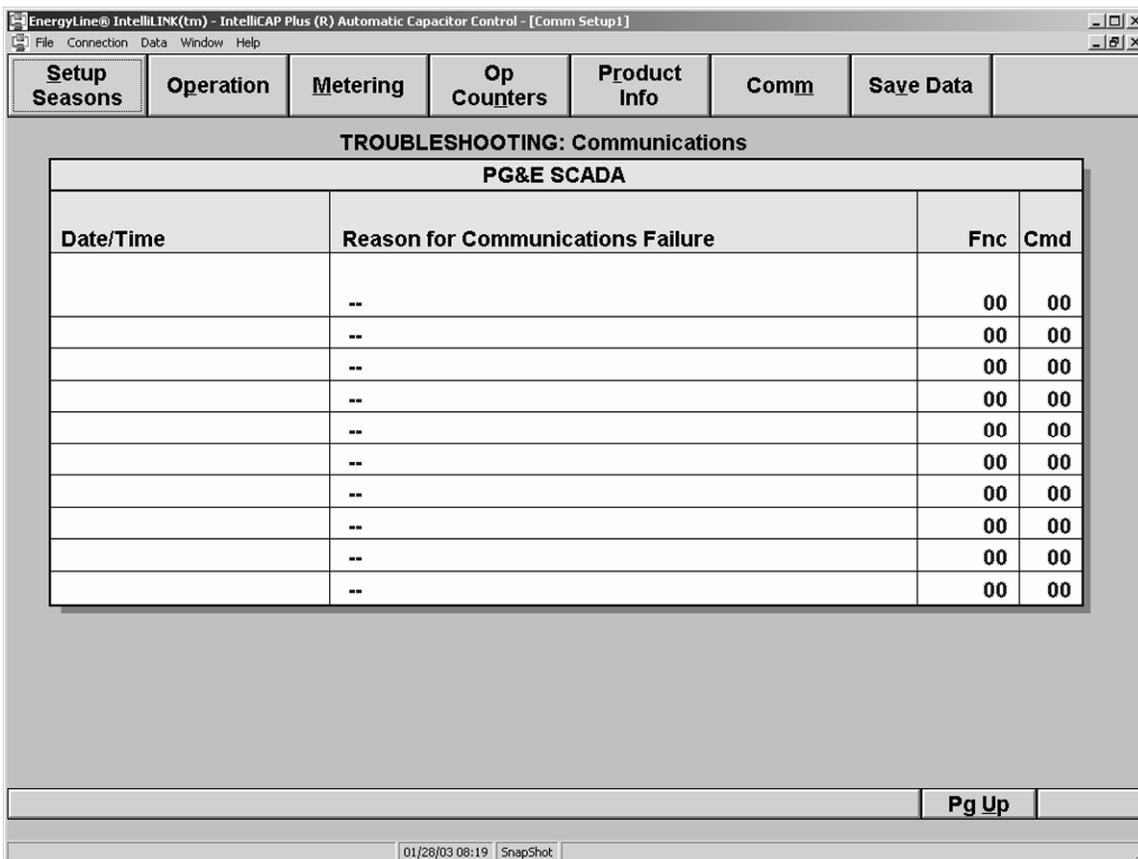
Figure 5
Page 2 of the Communications Setup Screen

Detailed parameter descriptions for this screen are:

Date/Time
This is the date and time when the event occurred.

Reason for Communications Failure
This is the reason that communications failed. If a message fails at the data link layer of PG&E SCADA, one of the following messages appears:
"Packet CRC Error"
"Internal: Bad UART interrupt"
"Packet size inconsistent with command"
"Packet size illegal"
"Packet size too small for this command"
"Packet contains bad characters/framing"

If a message fails at the application layer of PG&E SCADA, one of the following messages appears:
"Invalid function code or command received"

"Control requested on invalid channel"
"Channel not selected before operate"
"Control selection timed out"
"Control selection followed by non-operate"
"Control requested while in LOCAL mode"

Fnc
This is the PG&E SCADA function code for this communications failure. It can provide additional information about the packet received. (For more details, see PG&E SCADA protocol documentation.)

Cmd
This is the PG&E SCADA command code for this communications failure. It can provide additional information about the packet received. (For more details, see PG&E SCADA protocol documentation.)

8. Connect the **SCADA PORT** connector on the faceplate. For an external radio, connect the communications cable.

9. Replace the fuse.

10. For Automatic operation, (make sure Scada Control is in the local mode) hit the change button under Operation Mode to switch to Auto Mode For remote operation, hit the change button under Scada Control to switch to **REMOTE** when leaving the site.

⚠ *CAUTION* ⚠

When the Operation Mode is set to **AUTO**, automatic operation of the Capacitor Control resumes. Be aware that the Control can carry out commands from the automatic control logic. In addition, if Scada Control is in **REMOTE**, the Control can carry out commands from the SCADA master station.

PG&E SCADA Software Implementation

For accessing the IntelliCAP PLUS Capacitor Control, the master station should define the Control with the following I/O:

Status Points	15
Analog Input Points	28
Control Points	5

The points are defined in the tables below. Note that you can access all digital input points as either single-bit status or two-bit status values.

Status Points

Status Point #	Definition
1	Capacitor bank `Close` state. This bit is set if the capacitor bank is switched in.
2	Capacitor bank `Open` state. This bit is set if the capacitor bank is switched out.
3	**AUTO/MANUAL** operation mode. This bit is set when the control is in the **AUTO** position.
4	**REMOTE/LOCAL SCADA** control mode. This bit is set when the control is in the **REMOTE** position. When in the **LOCAL** mode, operation of the bank from the SCADA master station is blocked.
5	Voltage override alarm status. This bit is set when an over/under voltage condition is present.
6	Timeclock/temperature control mode. This bit is set if the Capacitor Control is operating in "Timeclock" control mode. NOTE: This point is not generally useful since there are several control strategies from which to choose.
7	Not Used.
8	Automatic control state. This bit is set if the bank is requested to be in circuit by the presently active control strategy. Unless the control logic has been overridden by a hardware manual override or by a voltage alarm condition, this corresponds to the present state of the bank, i.e. the bit is set if the bank is in circuit (closed).

Status Point #	Definition	
9	*VAR* *VAR with Neutral Sensor*	Reverse current. This bit is set if the Control has detected that the direction of current flow is reversed from the normal direction. This should only occur during emergency switching operations.
	Standard; Neutral Sensor	N.A.
10		Maintenance required. This bit is set when the Capacitor Control reaches the "Maximum Automatic Control Cycles Per Day"; when the Control detects a temperature sensor, voltage sensor, "Load Fuse Blown" error; or when there is a voltage bandwidth error. See the *Troubleshooting* chapter of the *User's Manual* for details.
11	*Neutral Sensor* *VAR with Neutral Sensor*	Neutral sensor lockout. This bit is set when the neutral current or voltage remains above the "Neutral Alarm Level" for a period of time specified by the "Current or Voltage Change Time Threshold." The Control performs corrective action, if enabled, and locks out if the condition has not been cleared. The alarm stays on unless manually reset. To reset, issue a "Reset NS Lockout" command. If neutral current or voltage flow still exists, the alarm will be reinitiated.
12	*Neutral Sensor* *VAR with Neutral Sensor*	Continuous neutral sensor alarm. This bit is set when the neutral current or voltage remains above the "Neutral Sensor Alarm Level" for a period of time specified by the "Neutral Current or Voltage Change Time Threshold." It is reset if the neutral value falls below the "Neutral Current or Voltage Alarm Level." If the neutral retry feature is enabled, this bit remains set prior to the retry. If the retry is unsuccessful, the neutral alarm bit remains set.
13		SCADA Override enabled. This bit is set when the SCADA Override feature is enabled in the setup software. This override strategy may or may not be controlling the bank state when enabled, depending on the state of other overrides and SCADA commands that have been issued.
14		Neutral Sensor Alarming. This bit is zero when Neutral Sensor Alarming

is based on fundamental RMS measurements, using only the 60 Hz component of the neutral voltage or neutral current. This bit is set when the total RMS measurement is the basis for this alarm.

15   Neutral Sensor Data Logging. This bit is zero when Neutral Sensor Data Logging is based on fundamental RMS measurements, using only the 60 Hz component of the neutral voltage or neutral current. This bit is set when the total RMS measurement is the value logged.

Analog Input Points

Analog Input Point #	Definition	
1	90% voltage reference standard. This is provided for the benefit of the protocol implementation to conform to the RTU standard. It is loaded as a constant.	
2	0% voltage reference standard. This is provided for the benefit of the protocol implementation to conform to the RTU standard. It is loaded as a constant with the value zero.	
3	The most recent temperature reading. This value is in units of °F or °C as selected in the IntelliLINK Setup Software.	
4	Most recent voltage measurement. Each count equals 0.1 Vac RMS.	
5	*VAR* *VAR with Neutral Sensor*	Phase angle. Each count equals one eighth of a degree, with an offset of 90°.
	Standard; Neutral Sensor	Returns a zero.
6	*VAR* *VAR with Neutral Sensor*	Three-phase kVARs. KVARs (Volt-amperes reactive) are calculated from the measured single phase voltage, current and phase angle times three. Each count equals 4 kVARs. A value of zero corresponds to 8188 kVARs leading.
	Standard; Neutral Sensor	Returns –8188.
7	*VAR* *VAR with Neutral*	Single-phase line current. Each count equals 1 ampere.

Sensor

Standard;	Returns a zero.
Neutral Sensor	

8   Three-phase kVA. The single-phase kVA is multiplied by three. Each count is 4 kVAs. NOTE: This analog does not apply to non-VAR versions.

Standard;	Returns a zero.
Neutral Sensor	

9   Three-phase kW. The single-phase kW is multiplied by three. Each count is 4 kWs. NOTE: This analog does not apply to non-VAR versions.

Standard;	Returns a Zero.
Neutral Sensor	

10 | *Neutral Sensor* | The most recent neutral current or voltage reading. |

Neutral Sensor	The most recent neutral current or voltage reading.
VAR with Neutral Sensor	Each count equals 1 ampere or volt.
Standard; VAR	Returns a zero.

11   Voltage, % total harmonic distortion (THD).

12   Voltage, % third harmonic distortion.

13   Voltage, % fifth harmonic distortion.

14   Voltage, % seventh harmonic distortion.

15   Current, % total harmonic distortion (THD).

Non-VAR units return zero.

16   Current, % third harmonic distortion.

Non-VAR units return zero.

17	Current, % fifth harmonic distortion.
	Non-VAR units return zero.
18	Current, % seventh harmonic distortion.
	Non-VAR units return zero.
19	Neutral, % total harmonic distortion (THD).
	Non-Neutral units return zero.
20	Neutral, % third harmonic distortion.
	Non-Neutral units return zero.
21	Neutral, % fifth harmonic distortion.
	Non-Neutral units return zero.
22	Neutral, % seventh harmonic distortion.
	Non-Neutral units return zero.
23	The time remaining in SCADA Override mode. If in timed mode, displays minutes remaining, if in latched mode, returns 4095.

24   Control Strategy. This is the presently configured control strategy in use. The possible values are:

    0 Temperature
    1 Timeclock
    2 Voltage Only
    3 Time-Biased Voltage
    4 Time-Biased Temperature
    5 Auto Off-Line Mode
    6 Auto On-Line Mode
    7 Current
    8 VAR
    9 Reverse Current Voltage Only
  10 Temperature Sensor Error, Voltage Only
  11 SCADA Override
  12 Timeclock with Temperature Override
  13 Current with Temperature Override
  14 VAR with Temperature Override

NOTE: Values 7, 8, 9, 13, and 14 do not apply to non-VAR versions.

25   The last switch in or out voltage delta. Each count is 0.1 Volt. This will be a signed value if the switch after voltage is less than the before switching voltage.

26   Neutral current or Neutral voltage, the data reported is the total harmonic RMS value. Each count equals 1 ampere for a control with neutral current sensing installed, or each count equals 1 Volt for a control with neutral voltage sensing installed.
NOTE: Versions without the Neutral option will return a 0 value.

27   Primary Line Voltage. Each count equals 10 Vac RMS.

28   Power Factor. The data reported is the cosine of the phase angle. Leading power factors are represented by negative numbers. Each count equals 0.001 with a 1000 offset (0 = -1.0, 1000 = 0.0, 2000 = 1.0).

Control Points

You can use the control points listed below to override the automatic operation of the capacitor bank.

Control
Point # Definition

1	Issue the Close/Open command to the switch. A Control-Select-Close command to this point switches the bank into the circuit. A Control-Select-Open command switches the bank out of the circuit. The command returns an error if the faceplate **REMOTE/LOCAL** switch is not in the **REMOTE** position.
2	Not Used.
3	Enable or disable "Automatic" operation. A Control-Select-Close command enables Automatic operation. A Control-Select-Open command disables Automatic operation (Manual Operation is enabled).
4	Enable or disable "SCADA Override" mode. A Control-Select-Close command enables SCADA Override. A Control-Select-Open command disables SCADA Override.
5	Reset NS Lockout. A Control-Select-Close command resets a Neutral Sensor Lockout condition.

The next several pages show sample scheduler (Figure 1), dbase (Figure 2), and display (Figure 3) files for PG&E's FVISION PC SCADA software. These files and all others necessary to run the program are provided on the Setup disk.

SCHEDULE.FOV – S&C IntelliCAP PLUS Automatic Capacitor Control - Basic Version

Prty	Offst	COM	M#	R#	CType	FCode	Cmmd	SSI	SSCt	2BSI	2BSCt	ANAI	ANACt	ANPI	ANPCt	PAII	PAICt	Ctrll	SNum	P1	P2	Descrip
1	0	1	0	00000	1	$00	$11	1	13	0	00	1	23	0	0	0	0	0	0	0	0	Digital/Analog Inputs
1	0	1	0	00000	2	$10	$11	0	0	0	00	0	0	0	0	0	0	1	0	0	0	Close Switch
1	0	1	0	00000	4	$10	$20	0	0	0	00	0	0	0	0	0	0	1	0	0	0	Bank in Circuit
1	0	1	0	00000	2	$10	$10	0	0	0	00	0	0	0	0	0	0	2	0	0	0	Open Switch
1	0	1	0	00000	4	$10	$20	0	0	0	00	0	0	0	0	0	0	2	0	0	0	Bank Out of Ckt.
1	0	1	0	00000	2	$10	$11	0	0	0	00	0	0	0	0	0	0	3	2	0	0	Enable Auto. Control
1	0	1	0	00000	4	$10	$20	0	0	0	00	0	0	0	0	0	0	3	0	0	0	Auto. Control Enabled
1	0	1	0	00000	2	$10	$10	0	0	0	00	0	0	0	0	0	0	4	2	0	0	Enable Manual Control
1	0	1	0	00000	4	$10	$20	0	0	0	00	0	0	0	0	0	0	4	0	0	0	Manual Control Enabled
1	0	1	0	00000	2	$10	$11	0	0	0	00	0	0	0	0	0	0	5	3	0	0	Enable Scada Override
1	0	1	0	00000	4	$10	$20	0	0	0	00	0	0	0	0	0	0	5	0	0	0	Scada Override Enabled
1	0	1	0	00000	2	$10	$10	0	0	0	00	0	0	0	0	0	0	6	3	0	0	Disable Scada Override
1	0	1	0	00000	4	$10	$20	0	0	0	00	0	0	0	0	0	0	6	0	0	0	Scada Override Disabled
1	0	1	0	00000	2	$10	$11	0	0	0	00	0	0	0	0	0	0	7	4	0	0	Reset Neutral Lockout Request
1	0	1	0	00000	4	$10	$20	0	0	0	00	0	0	0	0	0	0	7	0	0	0	Lockout Reset

Figure 1
File SCHEDULE.FOV for S&C IntelliCAP PLUS Automatic Capacitor Control
(VAR with Neutral Current)

;DBASE.FOV – S&C IntelliCAP PLUS Automatic Capacitor Control - Neutral Current with VAR Option

;TYPE	INDEX	TAG	PREC	ROUTINE	P1	P2	P3	P4	P5	P6	P7-P10	DESCRIPTION
A	3	TEMP	72	S	0	4045	0	0				; Temperature Sensor
A	4	VOLTAGE	81	r	0	0	0	0	.1			; Voltage Sensor
A	5	PHASE	83	r	0	0	0	0	.125			; Corrected Phase Angle
A	6	KVARS	60	S	-8188	8192	0	0				; Calculated kVARs
A	7	CURRENT	40	S	0	4095	0	0				; Phase Current
A	9	KW	80	r	0	0	0	0	4			; Active Power
A	8	KVA	80	r	0	0	0	0	4			; Apparent power
A	10	NEUTSENS	60	r	0	0	0	0	1			; Neutral sensor Volts or Current
A	11	VOLTTHD	81	D	Open	Closed	0	0	3	4		; Cap. Bank Close Relay
A	12	CAPSIN	xx	D	Open	Closed	0	0	3	4		; Cap. Bank Close Relay
A	13	CAPSIN	xx	D	Open	Closed	0	0	3	4		; Cap. Bank Close Relay
A	14	CAPSIN	xx	D	Open	Closed	0	0	3	4		; Cap. Bank Close Relay
A	15	CAPSIN	xx	D	Open	Closed	0	0	3	4		; Cap. Bank Close Relay
A	16	CAPSIN	xx	D	Open	Closed	0	0	3	4		; Cap. Bank Close Relay
A	17	CAPSIN	xx	D	Open	Closed	0	0	3	4		; Cap. Bank Close Relay
A	18	CAPSIN	xx	D	Open	Closed	0	0	3	4		; Cap. Bank Close Relay
A	19	CAPSIN	xx	D	Open	Closed	0	0	3	4		; Cap. Bank Close Relay
A	20	CAPSIN	xx	D	Open	Closed	0	0	3	4		; Cap. Bank Close Relay
A	21	CAPSIN	xx	D	Open	Closed	0	0	3	4		; Cap. Bank Close Relay
A	22	CAPSIN	xx	D	Open	Closed	0	0	3	4		; Cap. Bank Close Relay
A	23	CAPSIN	xx	D	Open	Closed	0	0	3	4		; Cap. Bank Close Relay
D	1	CAPSIN	xx	D	Open	Closed	0	0	3	4		; Cap. Bank Close Relay
D	2	CAPSOUT	xx	D	Open	Closed	0	0	3	4		; Cap. Bank Open Relay
D	3	AUTO	xx	D	Manual	Auto	0	0	4	3		; Auto/Manual Switch
D	4	REMOTE	xx	D	Local	Remote	0	0	4	3		; Remote/Local Oper. Mode
D	5	V.OVER.	xx	D	Normal	Override	0	0	3	4		; Voltage Override
D	6	MODE	xx	D	Temp.	Time	0	0	3	3		; Time/Temperature Control
D	7	H.OVER	xx	D	Manual	Auto	0	0	3	4		; Softw. manual ctl.
D	8	AUTOMDE	xx	D	Open	Close	0	0	3	3		; Time/temp ctl state.
D	9	REVCRNT	xx	D	Normal	Reverse	0	0	3	3		; Reverse Current
D	10	MAINT.	xx	D	O.K.	Bad	0	0	3	3		; Maintenance Conditions
D	11	NCALARM	xx	D	OFF	ON	0	0	3	4		; Neutral Current Alarm
D	12	CNCALR	xx	D	OFF	ON	0	0	3	4		; Cont. Neutral Current Alarm
C	1	CLOSE	xx	C	CIN	0	0	0				; Manual Caps In Ckt.
C	2	OPEN	xx	C	COUT	0	0	0				; Manual Caps Out of Ckt.
C	3	AUTO	xx	C	AUTO	0	0	0				; Automatic Cap. Bank Control
C	4	MANUAL	xx	C	MANUAL	0	0	0				; Manual Cap. Bank Control

Figure 2
File DBASE.FOV for S&C IntelliCAP PLUS Automatic Capacitor Control
(VAR with Neutral Current)

;S&C IntelliCAP PLUS Automatic Capacitor Control - Neutral Current Sensing with VAR Option
;DISPLAY 1 DATA FILE

;TYPE	INDEX	ROW	COL	PREC/SYM	COMMENT
A	4	16	30	51	; Voltage
A	3	17	30	50	; Temperature
A	8	18	30	50	; Neutral Current
A	6	16	61	80	; KVARs
A	7	17	61	80	; Current
A	5	18	61	83	; Power Angle
D	1	8	66	84	; Close Relay Contact
D	2	9	66	84	; Open Relay Contact
D	3	5	66	84	; Hardware Manual Override
D	4	6	66	84	; Remote SCADA enable Switch
D	5	12	66	84	; Voltage Override active
D	6	13	66	84	; Time/Temp. control type
D	7	10	66	84	; Software Manual Enable
D	8	14	66	84	; Timeclock state
D	9	20	66	84	; Reverse current
D	10	21	66	84	; Maintenance Conditions
D	11	20	36	84	; Neutral Current Alarm
D	12	21	36	84	; Continuous Neutral Current Alarm

Figure 3
File DISPLAY1.FOV for S&C IntelliCAP PLUS Automatic Capacitor Control
(VAR with Neutral Current)

PG&E Protocol Functions Implemented

The following PG&E SCADA communications protocol functions and commands have been implemented:

1. `Basic Scan`, Function Code $00, for all data types supported in the Capacitor Control. The "packed analog" form of encoding analog data is not supported.

2. `Scan Inclusive`, Function Code $01. As with the `Basic Scan` function, packed analog encoding is not supported.

3. `Scan-By-Table`, Function Code $0A. As with the `Basic Scan` function, packed analog encoding is not supported.

4. `Supervisory Control`, Function Code $10. The commands `Direct Digital Control`, `Direct Open`, `Direct Close`, and `High Resolution Proportional Control` are not supported.

5. The following Internal Control Function (Function Code $20) commands are implemented:

   - `Initialize RTU Configuration` (Standard Mode), Command Code $00.

   - `Accumulator Freeze`, Command Code $10.

   - `Accumulator Reset`, Command Code $11.

   - `Initialize Specified Status Counter`, Command Code $20.

   - `Initialize All Status Counters`, Command Code $21.

   - `Write to RTU Memory`, Command Code $30. (See section below for details.)

   - `Execute Write Memory`, Command Code $31. (See section below for details.)

Access to Setpoints and Data Logging Results Via PG&E Protocol

The implementation of PG&E SCADA also supports memory-mapped access to the entire collection of setup, real-time, and long term statistical and operating data. The complete memory map for the Capacitor Control is available from S&C.

The memory access feature of the protocol is used to transfer the data to the master station. The memory is accessed as ordinal number 5 (`RTU RAM memory`). Function 28, Command 30 (`Return RTU Configuration`) is used to read data from the

Control. Function 20, Commands 30 and 31 (`Write RTU Memory` and `Execute Write Memory`) are used to write to the setpoints.

To prevent incorrect or inadvertent writing to the Capacitor Control, a memory interlock has been implemented. Before memory write commands will be executed, you must make an initial write of the value integer 1 to location $04ED. When all writing operations are complete, set $04ED back to zero. For further information on this form of memory access, contact S&C.

Extended Error Code File Definitions

The codes assigned for inclusion in the "Error Code File" have been extended in this protocol implementation to provide additional detail on communications failures. The definitions of the additional codes are as follows:

Code (HEX)	Interpretation
F0	CRC error on incoming packet – Suspect bad reception if intermittent, otherwise check master station software.
F1	Bad interrupt (internal software error) – Notify S&C.
F2	Packet timeout during receipt – Intercharacter delay greater than 40 milliseconds – Suspect bad reception if intermittent, otherwise master station has excessive intercharacter delay.
F3	**REMOTE/LOCAL** switch in **LOCAL** position on Capacitor Control faceplate.
F4	Length of incoming packet inconsistent with packet type – Suspect bad reception if intermittent, otherwise check master station software.
F5	Illegal incoming packet length – Check master station software.
F6	Control operating mode inconsistent with command – Not in software manual mode when software manual operation requested – Use "manual" command, then retry request.
F7	Incoming packet does not have enough data in data field – Suspect bad reception if intermittent, otherwise check master station software.
F8	Ordinal read/write not supported.
F9	Memory pointer bad, no data to transfer – Check master station software.
FA	Character received with bad framing, parity, break rcvd, etc. – Probable bad reception or modem failure.