UG-1077
eCAPH-9450
Multifunction Capacitor Bank Control

December 2018
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eCAP-9450 Multifunction Cap Bank Control
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Revisions

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1 General Information

1.1 Introduction

Based upon QEI's 6ACP6 platform, the eCAP-9450 provides three-phase, single-phase, 3-step, or 2-step capacitor bank control. It provides SCADA functionality via DNP or any other available byte-oriented server protocol available to the 6ACP6.

The eCAP-9450 accepts voltage and current inputs from either Line Post Sensors or PTs and CTs. Cap bank switching is based on either Voltage or kVAR, with a local Voltage override included, which has precedence over kVAR control. Neutral current detection is available.

An included +12Vdc power supply provides power for the 6ACP6 board and customer supplied radio. The 6ACP6 provides six relay outputs (rated at 20Amps/250VAC) arranged as 3 trip/close pairs for independent or ganged control of three cap bank switches.

Front panel switches are included for Phases A, B, C Open/Close, Auto, Manual, remote and Lock-out indication.

This user's guide describes the general operation of the eCAP-9450, including a description of the control mechanisms provided, operating modes, and general operating features.
1.2 Additional User Requirements

Since the eCAP-9450 is based on the QEI 6ACP6 AC Input Panel, the user should become thoroughly familiar with the 6ACP6 panel configuration and connections before attempting configuration and operation of the eCAP-9450.

The user should be thoroughly familiar with SCADA systems and their terminology, and be comfortable working with electric and electronic systems. Familiarity with computer operation, including Windows operating systems, is also required.

The following table lists other QEI documentation available to aid the user in familiarization with the eCAP-9450. Required documents are as follows:

<table>
<thead>
<tr>
<th>Document</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>UG-1076</td>
<td>6ACP6 User’s Guide</td>
</tr>
<tr>
<td>UG-1007</td>
<td>6PCP6 Power Supply</td>
</tr>
<tr>
<td>UM-2018</td>
<td>ConfigWiz 2.0 User’s Guide</td>
</tr>
<tr>
<td>UG-1020</td>
<td>6CTP2 Current Transformer Interface Panel User’s Guide</td>
</tr>
<tr>
<td>UG-1019</td>
<td>6PTP2 Potential Transformer Interface Panel User’s Guide</td>
</tr>
</tbody>
</table>
2 Specifications

2.1 Power:

Input power requirements:
3.0 Amp @ 120 VAC, 50/60 Hz nominal.

Radio Power:
The eCAP-9450 includes +13.8Vdc @ 2.5 Amp nominal power for radio equipment. Actual voltage level will be somewhat lower if running on battery backup.

Battery Backup:
The eCAP-9450 includes a 17Ah battery, providing up to 8 hours of operation during AC power failures. Actual operation time depends on various factors such as SCADA radio polling requirements.

2.2 Relay Contact Rating (Trip/Close Control Output Points):
20 Amps @ 240Vac

2.3 Communications:
One ethernet port 100BaseT copper for network communications (also used for eCAP-9450 configuration).
One isolated RS-232 serial port for radio communications.
Various SCADA communications protocols are available. See the 6ACP6 user guide UG-1076 and addendums for additional information.

2.4 Environmental:
Temperature: -30 °C to +70°C (-22F to 158F)
LCD Display 0 °C to +65°C (32 °F)
Humidity: 5% to 95% @ 70°C, non-condensing

2.5 Mechanical Physical Configurations, typical:
Cabinet Material: C. R. Steel
Rating: NEMA 4
Mounting: Wall or Pole-Top
Dimensions (HxW x D): 24.0” H x 20.0”W x 10.0”D
(610mm Hx 508mm Wx254mmD)
Weight: 80.0 lbs. (36.4 Kg.)
3 Connections

3.1 General Layout

This illustration shows the general layout of the sub-modules within the eCAP-9450. Note that the layout is slightly different depending on the model. Two different models are illustrated below.

The first model shown contains three trip/close control points. It accepts 3-phase current measurements from CTs (current transformers) and 3-phase voltage measurements from PTs (potential transformers).

The second model shown contains one trip/close control point. It accepts 3-phase current and voltage measurements from Line Post Sensors (LPS).

Typical Layout: 3 Trip/Close Control Points and 3-Phase CT/PT Inputs:
Typical Layout: 1 Trip/Close Control Point and 3-Phase LPS Inputs:
3.2 User Connections

3-Phase Measurement Inputs (Right Side Panel)

Per the layout drawings above, the 3-Phase measurement input connections to the eCAP-9450 are located on the right inside cabinet panel. Connections can come from either “PT”s (Potential Transformers) for Voltage measurements and “CT”s (Current Transformers) for current measurements, or from LPS sensors (Line Post Sensors).

PTs convert high levels of primary phase Voltage (such as 9.6KVrms) to 150Vrms. CTs convert high levels of primary phase current (such as 600 Amps) to 5 Amps.

Line Post Sensors convert high levels of Primary Phase Voltage (such as 9.6KVrms) and Current (such as 600 Amps) to lower level voltage signals (<10Vrms).

There is a different eCAP-9450 model depending on whether the line measurement inputs come from PTs/CTs or from LPS sensors. PT connections require QEI 6PTP2 interface boards, and CT connections require the QEI 6CTP2 interface board, both of which convert the PT and CT voltages down to low level signals usable by the 6ACP6 measurement platform. Consult the ordering information elsewhere in this manual to determine if you have the correct model.

**NOTE:** DO NOT connect PTs or CTs to eCAP-9450 LPS inputs, or damage may result.

Input AC Power, Output Control Points, Radio Power (Left Side Panel)

Per the layout drawings above, the Input AC Power connections, as well as the output control point connections (dry contact relay outputs) and the DC Radio Power connections (+13.8Vdc) are located on the left side cabinet panel.

Depending on the model, there is either one control point (a single trip/close pair of relays), or three control points (three trip/close relay pairs) available for control of the cap bank. Consult the ordering information elsewhere in this manual to determine if you have the correct model.

The illustrations on the following pages show the user connections on the right side and left side panels of the eCAP-9450, depending on the model.
Right Side Panel User Connections (CT / PT Input Measurement):

6PTP2

(3-PH CURR INPUTS)
(5A RMS MAX)

6PTP2

(3-PH VOLT INPUTS)
(150VRMS MAX)

(AUX VOLT INPUTS)
(150VRMS MAX)
<table>
<thead>
<tr>
<th>(6CTP2)</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TB1-1</td>
<td>CT High IA</td>
<td>6CTP2 -- CT Current High phase IA</td>
</tr>
<tr>
<td>TB1-2</td>
<td>CT Low IA</td>
<td>6CTP2 -- CT Current Low phase IA</td>
</tr>
<tr>
<td>TB1-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TB1-4</td>
<td>CT High IB</td>
<td>6CTP2 -- CT Current High phase IB</td>
</tr>
<tr>
<td>TB1-5</td>
<td>CT Low IB</td>
<td>6CTP2 -- CT Current Low phase IB</td>
</tr>
<tr>
<td>TB1-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TB1-7</td>
<td>CT High IC</td>
<td>6CTP2 -- CT Current High phase IC</td>
</tr>
<tr>
<td>TB1-8</td>
<td>CT Low IC</td>
<td>6CTP2 -- CT Current Low phase IC</td>
</tr>
<tr>
<td>TB1-9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(6PTP2)</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TB1-1</td>
<td>PT High VA</td>
<td>6PTP2 -- PT Voltage High V phase A</td>
</tr>
<tr>
<td>TB1-2</td>
<td>PT Neutral VA</td>
<td>6PTP2 -- PT Voltage Neutral V phase A</td>
</tr>
<tr>
<td>TB1-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TB1-4</td>
<td>PT High VB</td>
<td>6PTP2 -- PT Voltage High V phase B</td>
</tr>
<tr>
<td>TB1-5</td>
<td>PT Neutral VB</td>
<td>6PTP2 -- PT Voltage Neutral V phase B</td>
</tr>
<tr>
<td>TB1-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TB1-7</td>
<td>PT High VC</td>
<td>6PTP2 -- PT Voltage High V phase C</td>
</tr>
<tr>
<td>TB1-8</td>
<td>PT Neutral VC</td>
<td>6PTP2 -- PT Voltage Neutral V phase C</td>
</tr>
<tr>
<td>TB1-9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TB1-10</td>
<td>Earth</td>
<td>Earth Gnd Connection</td>
</tr>
</tbody>
</table>
Right Side Panel User Connections (LPS Input Measurement):

- CURRENT PHASE C LO
- CURRENT PHASE C HI
- CURRENT PHASE B LO
- CURRENT PHASE B HI
- CURRENT PHASE A LO
- CURRENT PHASE A HI
- VOLTAGE PHASE C LO
- VOLTAGE PHASE C HI
- VOLTAGE PHASE B LO
- VOLTAGE PHASE B HI
- VOLTAGE PHASE A LO
- VOLTAGE PHASE A HI

(3-PH CURR LPS INPUTS) (20VRMS MAX)

(AUX VOLT INPUTS) (150VRMS MAX)
Left Side Panel User Connections (3 Trip/Close Points):

- **LINE IN**
- **EARTH GND**
- **NEUTRAL IN**
- **N/C**
- **TRIP OUTPUT 0**
- **CLOSE OUTPUT 0**
- **TRIP OUTPUT 1**
- **CLOSE OUTPUT 1**
- **TRIP OUTPUT 2**
- **CLOSE OUTPUT 2**
- **N/C**
- **N/C**
- **RADIO PWR +12VDC**
- **DC COMMON**
Left Side Panel User Connections (1 Trip/Close Point):

Rear Panel User Connections (6ACP6 Status Inputs):
The eCAP-9450 includes 12 Status points (inputs) located on the 6ACP6 at TB1. Status input 0 is used by internal components, leaving 11 status inputs available for status connections from aux dry contacts of the cap bank switches.

<table>
<thead>
<tr>
<th>Location</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1 (6ACP6)</td>
<td>Status Point 0</td>
<td>Status Point 0 connection (Internal Use)</td>
</tr>
<tr>
<td>TB1-1</td>
<td>Status Point 1</td>
<td>Status Point 1 connection</td>
</tr>
<tr>
<td>TB1-2</td>
<td>Status Point 2</td>
<td>Status Point 2 connection</td>
</tr>
<tr>
<td>TB1-3</td>
<td>Status Point 3</td>
<td>Status Point 3 connection</td>
</tr>
<tr>
<td>TB1-4</td>
<td>Status Point 4</td>
<td>Status Point 4 connection</td>
</tr>
<tr>
<td>TB1-5</td>
<td>Status Point 5</td>
<td>Status Point 5 connection</td>
</tr>
<tr>
<td>TB1-6</td>
<td>Status Point 6</td>
<td>Status Point 6 connection</td>
</tr>
<tr>
<td>TB1-7</td>
<td>Status Point 7</td>
<td>Status Point 7 connection</td>
</tr>
<tr>
<td>TB1-8</td>
<td>Status Point 8</td>
<td>Status Point 8 connection</td>
</tr>
<tr>
<td>TB1-9</td>
<td>Status Point 9</td>
<td>Status Point 9 connection</td>
</tr>
<tr>
<td>TB1-10</td>
<td>Status Point 10</td>
<td>Status Point 10 connection</td>
</tr>
<tr>
<td>TB1-11</td>
<td>Status Point 11</td>
<td>Status Point 11 connection</td>
</tr>
<tr>
<td>TB1-12</td>
<td>N/C</td>
<td>Same connection as pin 14</td>
</tr>
<tr>
<td>TB1-13</td>
<td>N/C</td>
<td>Same connection as pin 13</td>
</tr>
<tr>
<td>TB1-14</td>
<td>Isolated +24V</td>
<td>See Illustration below:</td>
</tr>
<tr>
<td>TB1-15</td>
<td>Isolated +24V</td>
<td>See Illustration below:</td>
</tr>
</tbody>
</table>

The illustration shows typical status wiring connections:
+24V power from terminal 16 is internally connected to terminals 1-12. Note that the status inputs each require a dry contact between the actual status input on the 6ACP6 (TB1-2 through TB1-12), and the common of the isolated status power supply (6PCP6 TB2-5).

**6ACP6 Board Reference**

The 6ACP6 is the CPU board located on the rear panel of the cabinet. The 6ACP6 board contains the measurement circuitry for 3-Phase inputs, and the relay control outputs to switch the capacitor bank. It includes status inputs, a 100Base T copper network port (RJ45), and isolated RS232 port for a data radio.
6PCP6 Power Supply Reference

The 6PCP6 power supply module is located on the back wall of the cabinet. It provides DC power for the 6ACP6, radio, and other components of the eCAP-9450. It includes a battery charger and +24V isolated status power supply for cap bank status switches.
3.3 Interconnect Drawings:
3.4 Communications Connections

A panel located on the upper left hand wall of the cabinet provides a mounting location for a radio. The drawing below illustrates connecting a radio to the DB9M RS232 connector J8 (Port 14), and a PC laptop to the 100BaseTX Ethernet connector J12 on the 6ACP6 board.

The laptop is used for configuration of the eCAP-9450 via QEI Configwiz 2.0 Software. Communications parameters between the radio and the 6ACP6 are set via the Configwiz 2.0 software.
Radio connections are made to the 9-pin male connector J8 on the 6ACP6 (Port 14, DTE to radio). The pin out of the 9-pin connector is as follows:

<table>
<thead>
<tr>
<th>PIN</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-----</td>
<td>Data-carrier-detect</td>
</tr>
<tr>
<td>2</td>
<td>RXD</td>
<td>Data received by the eCAP-9450.</td>
</tr>
<tr>
<td>3</td>
<td>TXD</td>
<td>Data transmitted from the eCAP-9450.</td>
</tr>
<tr>
<td>4</td>
<td>-----</td>
<td>Data terminal ready</td>
</tr>
<tr>
<td>5</td>
<td>COM</td>
<td>Signal common ground.</td>
</tr>
<tr>
<td>6</td>
<td>-----</td>
<td>Not Used</td>
</tr>
<tr>
<td>7</td>
<td>RTS</td>
<td>Request to send (output).</td>
</tr>
<tr>
<td>8</td>
<td>CTS</td>
<td>Clear to send (input).</td>
</tr>
<tr>
<td>9</td>
<td>-----</td>
<td>Not Used</td>
</tr>
</tbody>
</table>
4 Front Panel

The eCAP-9450 contains the following front panel indicators and controls:

- Backlit LCD display shows live measurement values and configuration. It has four LEDs to indicate system status, and arrow keys for basic menu navigation.
- AUTO/MANUAL Toggle Switch places the eCAP-9450 in AUTO or MANUAL operation modes.
- Open/Close Toggle switches allow each individual capacitor to be tripped off-line (OPEN) or placed on-line (CLOSE).
- OPEN and CLOSE LEDs indicate the last operation performed on a per-phase basis.
- Other LEDs indicate specific operational modes: AUTO (LOCAL), REMOTE, MANUAL (LOCAL), or LOCKOUT.
4.1 Operation of Front Panel Switches and LEDs

AUTO/MANUAL Switch in AUTO (LOCAL) mode:

When the AUTO/MANUAL switch is placed in the AUTO position, the user configured local Automatic switching strategy (Algorithm) is in effect. (Yellow AUTO Led on), unless the unit has been sent a SCADA command to place it in REMOTE mode.

AUTO/MANUAL Switch in REMOTE mode:

When the AUTO/MANUAL switch is in AUTO position, the eCAP-9450 is placed in REMOTE mode via a SCADA command from the SCADA master station. (Note: DNP3 Output #5 Auto Enable).

Once placed in REMOTE mode, the AUTO Led turns off, and the Yellow REMOTE Led is on. In REMOTE mode, the eCAP-9450 is under SCADA control, and any local Automatic switching strategy (except for local overrides) is ignored.

AUTO/MANUAL Switch in MANUAL (LOCAL) mode:

When the AUTO/MANUAL switch is in MANUAL position, the three OPEN/CLOSE toggle switches are used to place each capacitor in either the OPEN (tripped off-line) or CLOSED (on-line) state. When the switch is in MANUAL mode, the eCAP-9450 ignores all SCADA commands, and ignores any local Automatic switching strategies.

In MANUAL mode, the Yellow MANUAL Led is on, and the Yellow AUTO and REMOTE Leds are off.

OPEN/CLOSE Switches:

There are three OPEN/CLOSE switches, one per phase. Each switch has a pair of Led indicators to indicate the last switch command performed. Red on = CLOSE, and Green on = OPEN. When an OPEN/CLOSE switch is operated in MANUAL mode, the associated Led will begin flashing to indicate a pending operation. The Led will flash faster several seconds before the operation occurs.

4.2 Open/Close LED Status Patterns

One LED ON, one LED OFF: This is the normal state. The state of the cap bank switch is shown by the illuminated LED.

One LED ON, the other LED flashing: This indicates that the switch is in the state indicated by the ON led, but an operation is pending to put the switch in the state indicated by the FLASHING led.

One LED flashing, the other LED OFF: Indicates that the switch should be in the position indicated by the flashing LED, but that a re-try operation is pending (to try again to put the switch in the correct position).

Both LED's off: The controller does not know the state of the switch (Switch-position feedback is not used and the unit has just been configured).

All Red LED's flashing fast, all Green LED's flashing slow: This condition indicates a failure in the main eCAP board, or the communications link between the main board and the front-panel has failed or the eCAP-9450 platform is not configured.
4.3 Additional Front Panel Switch Information

A 2-position Local/Remote Switch. When this switch is in the Local position, the unit is placed in Local Mode. This inhibits all cap bank switch operations from the Master Station and the Algorithmic control. In the Local position, only controls executed from this front-panel will succeed.

Putting the switch in the Local position also resets any lock-out condition that exists, so a locked out unit can be "unlocked" by momentarily switching to the Local position, and then returning it to the Auto position.

When the switch is in the Auto position, the controller will return to Automatic or Remote mode, as appropriate. Note that EVERY time a front-panel switch is operated, the Walk-Away delay is triggered, so the operator can put the unit into Auto mode without fear that an immediate operation will result.

**Momentary on-off-on switches, one for each Cap Bank switch:**

These switches can be used to initiate commands directly from the front panel, as follows:

Pushing the switch UP initiates a CLOSE operation on the associated bank. The red LED will begin flashing indicating that the control is pending. The LED flashes at a slow rate (approx. 1 flash/second) until 45 seconds before the control will be executed, at which point it begins to flash at a faster rate. Once the control is executed, the LED indicating the correct state will be lit solid.

If a local control is pending, it can be cancelled by operating the switch in the opposite direction once. The “pending” LED will go out, and the opposite LED will be lit solid.

If an operation is initiated to put the switch into the same state it's already in, the LED corresponding to the new state will flash in the same pattern as for a regular control, but the opposite LED will remain off.

If the LED's do not start flashing when an operation is initiated from the front panel, it means that the operation was rejected for one of the following reasons:

1. The unit is not in Local Mode
2. The requested operation is a CLOSE and the discharge time has not yet elapsed
3. Burnout protection is enabled and the line voltage is too low to operate the switch
4. Voltage Override is configured to be able to block local controls, and operating the control would violate the voltage override limits.
4.4 Front Panel LCD Display

The eCAP-9450 is equipped with a LCD display to allow the user to view measured values as well as navigate through various other menus options. The menu options and navigation are outlined in sections below.

System Status LEDs:

Four LEDs located to the left of the LCD display indicate the system status as follows:

- System Ok: Green LED Flashes on and off at a 1 second rate to indicate system operating normally.

- Power Loss: Red LED turns on to indicate that AC power is too high, too low, or lost. In this mode, AC input power is disconnected by the eCAP-9450, which is now running on battery power.

- Battery Test: Red LED turns on to indicate the battery test is running.

- Battery Fault: Red LED turns on to indicate that the battery test has failed.

LCD Display Navigation

Navigation through the LCD Display panel is accomplished through the use of the six menu navigation keys. The navigation key functionality is as follows:

<table>
<thead>
<tr>
<th>Navigation Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>&lt;</code> or <code>&gt;</code></td>
<td>(&lt;) will scroll through multiple pages (if available) of a single display selection. It may also be used to move the cursor to select particular digits when setting the time/date for example.</td>
</tr>
<tr>
<td><code>▲</code> or <code>▼</code></td>
<td>(▲) or (▼) may be used to navigate through menu options. It is also used to scroll through various display selections within a given section. It may also be used to increase/decrease the value of a selected digit when setting the time/date for example.</td>
</tr>
<tr>
<td><code>✓</code></td>
<td>(✓) is the enter key. It will open the selected display or perform the selected operation.</td>
</tr>
<tr>
<td><code>X</code></td>
<td>(X) will exit the current display and return to one menu level higher</td>
</tr>
</tbody>
</table>
Main Display

In its untouched state, the LCD display will scroll through a list of measured values. It will also display the latest event data and status of the battery test. With the press of the (✓) button on the front panel, the user can scroll through and choose from four menu options. The displayed values consist of the following:

**Measured Values:** These are scrolling values that consist of the following three phase measured and calculated values.

- Voltage (V)
- Current (A)
- Real Power (KW)
- Reactive Power (KVAR)
- Apparent Power (KVA)
- Power Factor

**Events:** The display will scroll through the last 50 events. The status point changes that are defined as events are user configurable through the use of ConfigWiz 2.0 in the Event Logger Server. The status point description, value and time of the event will be displayed. Refer to the Event Logger Server ConfigWiz 2.0 Addendum for configuration specific details.

**Battery Test Status:** The status of the most recent battery test will be displayed. It will consist of one of the following display lines:

- Batt Test Stopped: The battery test has been stopped by the user through the LCD Display.
- Batt Test in Progress: The battery is currently under test.
- Batt Test Failed: The battery failed testing. The battery voltage was below the expected value or when a load was applied to the battery, the voltage dropped below the knee point.
- Batt Test Not Allowed: The battery test is disabled through configuration.
- Batt Test Successful: The battery test was completed successfully.
Main Menu

The main menu consists of four menu options. The menu options are Measurements, Configuration, Events and Control. The menu options are described below.

**Measurements:** Displays the current values of measured analog and accumulator data.

**Configuration:** Contains the configured values for certain parameters as set up in ConfigWiz 2.0.

**Events:** A user may scroll through the last 50 recorded events.

**Control:** Allows for a user to set the time/date, start/stop a battery test and reset accumulator values.

Refer to the section on the particular menu selection for more details and navigation options.

Measurements

The measurement displays contain measured and calculated analog and accumulator data. The following diagram contains all of the available display screens and their values as well as navigation functionality. Refer to section 8.7 Data Points for descriptions of each point.
Configuration

The user is able to view operational parameters. These parameters are the same that are seen when configuring the eCAP-9450 with the ConfigWiz 2.0 software. The available parameters and navigation are shown below. Refer to Section 8.5
Configuration Parameters and Section 8.6 Measurement Parameters for detailed descriptions of each point.

Pressing (X) will exit the current display and return to one menu level higher.
Events

The previous 50 events may be viewed from the LCD Display. The display includes an event description, value and time of event. Navigation through the displayed events is shown below.

Control

Set Time/Date

The LCD Display allows the user to set the eCAP-9450 current time and date. This time is used for all system operations including the battery test and event logging. The navigation to the Set Time/Date display is shown below. The () or () buttons may be used to position the cursor over a value and () or () buttons may be used to change the value.
**Start Batt Test**

A user may manually start a battery test through the LCD display. A battery test may be initiated through the steps shown below. The status of the operation will be displayed following the request.

4.4.1.1 Stop Batt Test

A user may manually stop a battery test that is in progress through the LCD display. A battery test may be stopped through the steps shown below. The status of the operation will be displayed following the request.

4.4.1.2 Reset Accum

The accumulator values displayed on the LCD screen may be reset as shown below. The status of the operation will be displayed following the request. This operation will only reset the value of the accumulators shown on the LCD display and will not affect the values stored in memory.
5 Operational Description

5.1 Modes of Operation

The eCAP-9450 controller provides four basic modes of operation, to handle different capacitor configurations. The desired operational configuration is selected in software, using the ConfigWiz 2 configuration utility.

Single

As a single-phase controller, the eCAP-9450 monitors a single voltage and current input, and controls a single output switch. (In most systems, this single switch will insert or remove a 3-phase Capacitor Bank).

3-Phase

When configured as a 3-phase controller, the eCAP-9450 monitors 3 voltage and 3 current inputs. 3 Output Controls are utilized, which are intended to control 3 independent single-phase capacitor banks. Voltage and/or VARs control is done independently on each of the three phases. This configuration is particularly appropriate if line conditions make it likely that different phases will be operating with significantly different load conditions.

2-Stage

When configured as a 2-stage controller, the eCAP-9450 monitors a single input voltage and current. It controls two separate banks of capacitors, and will operate with either all banks removed, a single bank inserted, or both banks inserted, as the line conditions dictate. This mode provides more precise line control, since there are two stages of regulation provided.

3-Stage

When configured as a 3-Stage controller, the unit operates identically to 2-stage operation, except that a total of 3 cap banks will be controlled.

5.2 Operating States

The eCAP-9450 has 5 basic operational states. These are:

Local:

Insertion or Removal of the cap banks is done only through the switches provided on the front-panel. Operations from the master-station will not be executed, nor will any algorithmic operations be done. This mode of operation provides protection for the Field Engineer during equipment installation or service. Local operation provides several protection mechanisms, including a Walk-Away delay (which prevents immediate switch operation, giving the operator a chance to distance himself from the banks before operation) and enforcement of minimum capacitor discharge times, preventing accidental re-insertion of a cap bank before it has completely discharged.
Additionally, the eCAP-9450 provides a configurable option that can prevent the operator from inserting or removing cap banks when this would create undesirable line conditions (such as under-voltage or over-voltage) or when such operations might damage the switch itself (burnout protection).

Remote:
Insertion or Removal of the cap banks is done exclusively by commands from the Master-Station, using an appropriate SCADA protocol. In the same manner as Local control, the eCAP can be configured to block controls from the master-station if those controls would create undesirable line conditions (under-voltage or over-voltage, burn-out protection, etc.) and will ALWAYS block controls if the capacitor discharge delays or the walk-away delays have not been satisfied.

Comm Fail:
The eCAP-9450 can be configured to be controlled from a master-station, but revert to automatic control in the event that communications to the master station fail. If the eCAP does not receive a valid message from the master-station for a period of five minutes, the automatic-control algorithm will be activated. Control will revert to the master-station as soon as communications are re-established.

Auto:
The eCAP-9450 will function in fully automatic mode. This mode is well suited for applications where there is no communications link between the eCAP and a master-station, or where the master-station is used only to monitor conditions, leaving line regulation and control up to the eCAP.

It should be noted that a pseudo-control is available to the Master-Station which allows Auto mode to be enabled or disabled remotely.

Lockout:
The controller has detected a failure, either in the algorithm’s ability to regulate the line conditions or in the Cap-Bank hardware. All control operations to the Cap Bank switches are blocked until the lockout is reset, either from the Master-station or from the local front-panel.

5.3 Control Algorithms
The insertion or removal of Cap Banks is controlled by a multi-tiered series of algorithms. These algorithms are designed to:

a) Provide effective use of the Cap Banks to improve line conditions.
b) Prevent undesirable line conditions in unusual cases.
c) Prevent damage to the Cap Banks and associated Switches.
d) Detect cases where the configured parameters are inappropriate for the actual situation, or where equipment has failed, and “lock-out” the system in a desired state.

Automatic Control
The fundamental purpose of the eCAP-9450 is to utilize switchable
capacitor banks to control either the line voltage, or the line VARS. This control is
done as follows:

Voltage Control should be selected when the cap banks are intended to be used in a
voltage-regulation scheme. In this mode, the controller compares the actual line
voltage with upper and lower thresholds. If the voltage is too low, the banks are
inserted. If it is too high, they are removed.

VARs control should be selected when the cap banks are intended to be used in a
power-factor-correction scheme. The controller compares the VARs on the line with
programmed upper and lower thresholds. If the load impedance is too      inductive,
the banks are inserted. If the load impedance is too capacitive the banks are
removed.

Timing restrictions and other control is provided, to keep the algorithm operating in a
stable manner. These include a Transient delay, to prevent short-duration transients
from incorrectly triggering an action, an Anti-Hunt delay to prevent      “oscillation”
(where the bank is repeatedly inserted and removed) and a retry delay. See the
configuration section for a detailed description of these parameters.

Voltage Override

Voltage Override enhances the basic algorithm by adding additional control of the
cap banks to prevent driving the line into undesirable conditions. The Voltage
Override function is optional, and can be either enabled or disabled through
configuration. To configure Voltage Override, Upper and Lower voltage levels are
specified. These levels should reflect the maximum and minimum voltages allowable
on the line (with some margin, as desired).

Voltage Override actually performs two similar, but independent functions. First, it
INHIBITS insertion or removal of the banks if doing so is likely to cause the line
voltages to reach undesirable levels. Second, it FORCES the banks in or out if
undesirable levels exist on the line, in order to restore more desirable voltage levels.
Both Inhibit and Force operations are intended to achieve the same goals, but there
are some significant differences between these two functions.

Voltage Override Force

Voltage Override Force is active ONLY when the controller is in Automatic mode. It
operates nearly identically to the standard Voltage Control algorithm, with the
following exceptions:

1. Voltage Override Forcing uses a faster response time than the normal
   Voltage Regulation algorithm, since the Anti-Hunt delay is ignored. This can
   provide a fast response to high-voltage (or low-voltage) conditions without
   compromising the stability of the line control process as a whole.

2. VO Forcing also complements the VARs control algorithm, removing or
   inserting the banks in order to regulate the line voltage regardless of the
   VARs level.

Voltage Override Inhibit

Voltage Override Inhibit prevents operations from occurring when such operations
are likely to drive the line voltage outside the specified limits.
For example, when using a VARS control algorithm, line conditions might exist where the load is heavily inductive, yet the line voltage is still relatively high. Insertion of a cap bank under these conditions could cause excessively high voltage levels.

When using Voltage control, Voltage Override provides faster response times to more extreme line conditions, by bypassing the Anti-Hunt delay.

**Burnout Protection**

Some types of Cap Bank switches can fail if they are powered by the line voltage, and the voltage is lower than the minimum operational value. To prevent damage to the switch, a Burnout Protection feature is provided that blocks all cap-bank switch operations until the line voltage reaches an acceptable level.

**Neutral Current Sensing**

The eCAP-9450 is equipped with three auxiliary inputs which can be used to detect unusual current levels in the common connection of the capacitor bank, and take appropriate action. It should be noted that the term "Neutral Current" in this context refers specifically to current flow between the common connection point of the capacitor bank and the system ground. The characteristics of this current may vary depending on the type of cap-bank used.

Cap banks connected across the line in a Delta configuration have a body which is isolated from both capacitor terminals. In this configuration, virtually no current should be flowing in the common neutral connection, since any significant current would indicate an internal short between the capacitor itself and the case.

Cap Banks connected in a Wye configuration usually have only a single connection to the line, with the case being the other capacitor connection. In this case, more significant current may flow on the neutral path, due to a combination of nominal differences in actual capacitance values and possible voltage asymmetry on the line, and thresholds should accordingly be set to higher levels to prevent unintentional fault triggers.

When the eCAP detects a neutral fault condition, it removes the Cap Banks (it can be configured to force them inserted instead for some particular applications, but this is not the standard configuration). If desired the controller will wait for a programmable interval, and then attempt to re-insert the caps to test whether the condition has cleared.

The re-insertion test can be repeated for a number of attempts. If the condition clears, the unit will resume normal operation. If the condition does not clear, the unit will enter the lockout state, and will have to be reset either locally or from the master-station.

**Bank and Switch Wear Protection**

**Hunting and Retries**

If the eCAP is not properly configured, or the cap bank is not sized properly for the line loads, (Or the bank fuses are blown) the controller may not be able to regulate the line conditions effectively. This can manifest itself in two different ways:
1. If the bank is oversized (or the limits are configured improperly) inserting the bank may "overcorrect" the problem, causing the controller to decide to remove the bank, causing the voltage to drop again, and so on, creating an oscillating cycle. Continued operation in this mode would create wear and tear on the Cap Banks and switches (and would most likely create worse line regulation than doing nothing). The controller can detect this condition, and a) limit the rate at which the bank is inserted and removed, and b) if the condition persists, lockout the bank until the problem can be investigated and resolved.

2. If the switches that insert and remove the Cap Banks get "stuck", or the fuses to the bank are blown, attempts to insert (for example) the bank will have no effect. The controller, detecting that the voltage is still low, will try to re-insert the bank, and so on. Although for many types of switches this behavior is totally benign, it can produce wear on other switch types. For this reason, both the rate of these "redundant" operations as well as the total number of attempts can be limited.

**Algorithmic Hierarchy**

The eCAP-9450 simultaneously runs a number of different algorithms in order to determine whether to insert or remove the cap bank(s). There may be times, therefore, when two different algorithms conflict (For example, when Power-Factor regulation wants to insert the caps, but Voltage Override wants to remove them), or where different settings in the controller can be contradictory (i.e. setting Lockout Retry Time smaller than Discharge Delay). In the event of a conflict the following hierarchy will be enforced:

1. The Discharge Delay has the highest priority. It will always be obeyed regardless of the conditions.

2. The Walk-Away timer also is ALWAYS obeyed regardless of the conditions.

3. If Burnout Protection is enabled and the voltage is below the burnout threshold, no control operations will be performed, regardless of the source.

4. Neutral-Sensing - If a neutral fault is detected, all other algorithmic processing is blocked. The system will perform retries (if configured) in order to resolve the issue, but other automatic control functions will be suspended until the condition is cleared. If the controller enters the Lockout state, all controls will be blocked until the lockout is reset, either from the front-panel or from the Master-station.

5. Voltage Override has priority over the Automatic Volts/VARs regulation

6. Automatic Control has the lowest priority, and will only operate controls if all higher-priority conditions are clear.

**5.4 Data Collection**

The data collection parameters may be configured by the user. This is configurable through the use of ConfigWiz 2.0 and the Event Logger Server. Please refer to the ePAQ-9450 ConfigWiz 2.0 Addendum for specific configuration details.

The eCAP-9450 has mass memory for the storage of analog measurement parameters, The measurement parameters are stored in two different interval sizes.
Three variables can be chosen through and recorded every 5 minutes. Four unbalance phase variables can also be chosen to be recorded every 15 minutes. The give number of variables for both the 5 minute and 15 minute intervals provide for a minimum of 40 days of history. The user may select more or less than number of variables described above. The number of variables selected will affect the number of days stored in history.

Event data may also be logged and time stamped. This data is available to be downloaded from the Web Access Server. The eCAP-9450 will store up to the last 300 events. The events that will be recorded include Open/Close operations, alarms, lockout conditions and diagnostic statuses. These points will also include a reason for that event occurring. Changes in the Auto/Manual and Remote/Local front panel switch are also logged although they do not include a reason as these changes can only be made from the front panel.

5.5 Exports

Event Log

The user can export an event log in a .csv file format. The .csv file contains a location descriptor, point name, time of the event and the value or condition of the event.

ConfigWiz 2.0

The user also has the ability to export the configuration of the eCAP-9450 to a .csv file. This file provides the configuration parameters set up in ConfigWiz 2.0. This export may be used to document the configuration file and recreate it if necessary. A user also has the option to export the entire configuration or may choose to export by type which includes SCADA, Communication and Measurement.

ConfigWiz 2.0 & PLCC

A user may also export a .csv file of the PLCC logic that is implemented in the control of the capacitor bank. PLCC is user configurable and includes Boolean logic and basic mathematical formulas for data manipulation. A PLCC routine is also used to check the status of the backup batteries.

5.6 Battery Test

The eCAP-9450 implements a PLCC (Programmable Logic and Communication Control) routine to test the status of the capacitor bank’s backup batteries. The battery self-test checks to make sure the batteries are capable of providing at least 30 minutes of autonomy in the absence of mains power. The self-test may be enable or disabled in the configuration. A user can also perform a forced battery test, this can be done via the front panel.
If during the battery test it is detected that there is not sufficient battery power as required for the normal operation of the capacitor bank, the eCAP-9450 will switch back to mains power. This switch will occur immediately, despite the remaining amount of time in the battery test timer. This will cause an alarm indication to appear on the front panel, the alarm status point and the alarm will also be recorded in the event logger (if configured).
6 Installation Information

6.1 Mechanical / Mounting

Cabinet dimensions are as shown. Mounting flange locations are as shown. Wiring access holes or cut outs should be generally located at the bottom of the cabinet.

1. DIMENSIONS SHOWN IN INCHES.
2. MATERIAL- #14 GA STEEL (.0747 THICK).
3. FINISH- TEXTURED GRAY (POWDER COATS) PPS-5693, TEXTURED.
4. QUARTER TURN LATCH ACCOMODATES UP TO 3/8" LOCK HOSP.
7 Ordering Information

**eCAP-9450**  MULTI-FUNCTION CAPACITOR CONTROLLER  40-058168-XXX

The eCAP-9450 is part of the QEI family of Automatic Capacitor Controls. It includes QEI’s 6ACP6 platform. A special client in the 6ACP6 provides three-phase, single-phase, 3-step or 2-step capacitor bank control. The eCAP-9450 provides SCADA functionality via DNP or any other available byte-oriented server protocol available to the 6ACP6. The standard 6ACP6 DRT client is also included.

The eCAP-9450 includes a graphical LCD display and keypad for front panel configuration of all settings, and real-time display of measurements.

The eCAP-9450 accepts voltage and current inputs from either line post sensors or PTs and CTs. Capacitor switching is based on either Voltage or kVAR, with a local Voltage Override included, which has precedence over kVAR control. Neutral current detection is available.

Power input options are 120Vac/220Vac/240Vac/125Vdc. The unit includes +12Vdc power for customer-supplied radio. Battery backup is an available option (battery backup option also includes battery test functions).

The 6ACP6 provides six relay outputs (rated 10Amps/250VAC) arranged as 3 trip/close pairs for independent control of three cap bank switches.

Front Panel switches are included for Phase A Open/Close, Phase B Open/Close, Phase C Open/Close, and Auto/Manual. Front Panel LEDs are included for Open/Close, Auto, Manual, Remote, and Lock-out indication.

The eCAP-9450 is housed in a 24”H x 20”W x 10”D enclosure (NEMA 4).

ORDERING INFORMATION

eCAP-9450-XXX

QEI P/N 40-058168-XXX

-001= 6CTP2-1 / 6PTP2-1, 3 CTL POINTS, W/BATT
-002= LPS, 1 CONTROL POINT, W/BATT
-003= 6CTP2-1 / 6PTP2-1, 3 CTL POINTS, W/O BATT
-004= LPS, 1 CONTROL POINT, W/O BATT
-005= 6CTP2-1 / 6PTP2-1, 3 CTL POINTS, W/BATT, W/NCT
-006= LPS, 1 CONTROL POINT, W/BATT, W/NCT
-007= 6CTP2-1 / 6PTP2-1, 3 CTL POINTS, W/O BATT, W/NCT
-008= LPS, 1 CONTROL POINT, W/O BATT W/NCT
7.1 Data Points

The eCAP-9450 provides a wide range of data points for remote monitoring problem detection, and master-station control and re-configuration. Some data points (Line voltages and currents, watts and VARs) are likely to be useful permanently as part of the Master-station database.

Other points, which provide more detailed information about the Cap Controller’s operational state, may be particularly useful when a bank is initially installed and ignored later when the controller’s proper configuration has been verified.

The ConfigWiz 2.0 utility can be used to select points to be sent to the master-station, giving you complete control over the data transmitted.

However, the eCAP does not require a master-station communications link to function properly, and will operate just fine as a remote stand alone controller.

Refer to section Data Points for a full list and description of the data points provided.

7.2 General Information on Data Formats and Options

Delay Times:

For delay times, the default is that the times are specified in minutes. However, due to the wide range of possible values that may be needed, the following syntax can be used:

- Adding a ’d’ or ’D’ after the value specifies that the time is in days
- Adding an ’h’ or ’H’ after the value specifies that the time is in hours
- Adding an ’s’ or ’S’ after the value specifies that the time is in seconds.
- Adding an ’m’ or ’M’ after the value, indicates that the time is in minutes.

If no suffix is added, the value is interpreted in Minutes. The suffix can be, but does not have to be, separated with a space. "10M" is considered identical to "10 m"

Configuration and Measurement Parameters

There are two areas of configuration for the Cap Controller parameters.

When you double-click on the icon for this field device, you will see a number of different tabs which provide configuration for the Cap Controller algorithmic parameters.

However, before configuring these specific parameters, you should first configure parameters relating to the underlying measurement system that provides the data on which the controller operates. These parameters can be accessed by selecting the "Client" box at the lower-left of the Configuration screen. For purposes of illustration, the configuration parameters are shown before the measurement parameters (below).
7.3 Configuration Parameters

The eCAP-9450 provides a wide variety of features, allowing it to be customized for many different specific application requirements. To configure the Cap Controller, you must first add a "CapCon" Client (IED) to the RTU file you are creating.

1. In ConfigWiz 2.0, select the IEDs tab. Then double click “CapCon” or drag it to the RTU tree to add it to the configuration.

![Add New Elements](image)

The CapCon_Client should appear in the RTU tree as shown below.

![RTU Tree](image)

2. Left-Click on **CapCon#1** or right click and select Property Display. The following screen appears:
“Auto” Tab

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
<th>Valid Entries</th>
<th>Default Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algorithm</td>
<td>This field determines the mode of the controller, as follows:</td>
<td>Volts, VARs</td>
<td>Volts</td>
</tr>
<tr>
<td></td>
<td>Volts - The controller switches based on voltage, performing a voltage-regulation function.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>VArS - The controller switches based on VArS, performing a power-factor correction function.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hi Volt Thresh</td>
<td>If Voltage Control is configured, this parameter sets the High Voltage level (in engineering units). This is the voltage level at which the cap bank would be removed under Automatic control. The suffix 'k' or 'm' is allowed, to specify Kilo (1000’s) or Mega (1,000,000’s) as appropriate</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>Lo Volt Thresh</td>
<td>If Voltage Control is configured, this parameter sets the Low Voltage level (in engineering units). This is the voltage level at which the cap bank would be inserted under Automatic control.</td>
<td>115</td>
<td></td>
</tr>
<tr>
<td>Hi Var Thresh</td>
<td>If VARs control is configured, this parameter sets the VARs threshold which causes removal of the caps. The suffix 'k' or 'm' is allowed, to specify Kilo or Mega, as</td>
<td>-1k</td>
<td></td>
</tr>
</tbody>
</table>
Lo Var Thresh  For VARs control, the threshold which causes the Cap Bank to be inserted.  -550k

Retry Delay  After the controller performs an insertion or removal operation, it continues to monitor the line conditions. If, after an insertion, the line conditions continue to indicate a low voltage, the controller will re-try the insertion operation (and likewise, for a removal). This action can help clear a "stuck switch" or other temporary failure of the switch to open or close. The retry delay specifies the amount of time to wait between these "retry" attempts. (The total number of retries can also be limited - refer to "Multi-Trip Limit" and "Multi-Close Limit" in the "Lockout" tab.)  30m

Anti Hunt Delay  If Insertion of the Cap Bank causes the voltage (or VARs) to go beyond the Removal level, and vice-versa, the Cap Controller could oscillate, or "Hunt" continuously. This parameter specifies a delay (with an optional "s" "m" or "h" suffix) that blocks rapid cycles of insertion and removal. Once the bank is inserted, it will not be removed (by the control algorithm) for the amount of time specified; once removed, it will not be re-inserted for this time. The total number of hunt operations can also be limited, refer to the "Hunt Limit" parameter in the "Lockout" tab.)  1H

Cap Bank Size  This parameter is used to specify the total size (in VARs) of the cap bank(s). This parameter is only used to determine whether the VARS changed as expected after an insertion or removal (in order to set or clear the DVar Error status points). It is not used for any operational purposes.  300K

"Burnout" Tab
<table>
<thead>
<tr>
<th>Field Name</th>
<th>Description</th>
<th>Valid Entries</th>
<th>Default Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burnout Enable</td>
<td>Set to &quot;Yes&quot; to enable Burnout Protection (and therefore prevent operation of the switch if the line voltage is too low). Set to &quot;No&quot; to disable this feature.</td>
<td>Yes, No</td>
<td>No</td>
</tr>
<tr>
<td>Burnout Thresh</td>
<td>Specifies the voltage below which the switch will not be operated.</td>
<td>20 Char.</td>
<td>95.0</td>
</tr>
</tbody>
</table>
### “General” Tab

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Description</th>
<th>Valid Entries</th>
<th>Default Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Specifies the type of the controller, as one of the following: 1-Phase, 3-Phase, 2-Step, or 3-Step</td>
<td>1-Phase</td>
<td>1-Phase</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3-Phase</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2-Step</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3-Step</td>
<td></td>
</tr>
<tr>
<td>Operating Mode</td>
<td>This field configures when the Voltage or VARs control algorithm is active, as follows:</td>
<td>Disable</td>
<td>Disable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CommFail</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disable - Algorithm is not enabled.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CommFail - Algorithm is active when communications to the Master-Station have failed (No messages received within the last five minutes).</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enabled - Algorithm is always enabled.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switch Feedback</td>
<td>Set this field to &quot;Yes&quot; if the position of the Cap Bank switch can be sensed using Status Input 0 (or inputs 0 through 2 as applicable for the Type).</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Remove At Power up</td>
<td>If set to &quot;Yes&quot; the controller will remove all banks whenever the controller is powered up, in an attempt to improve the conditions for power restoration.</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>
If set to "No" this is not done.

**Discharge Delay**
In accordance with industry standards, once a Cap Bank has been removed from the line; it may NOT be inserted until it has had the time to discharge completely. The discharge delay applies to ALL types of operations (Local, Remote, or Automatic) and is also triggered when the controller first powers up. This value can be set to either 5 minutes or 10 minutes, and should be set to the appropriate value for the Capacitors being used. The Discharge delay can NOT be disabled.

**Transient Delay**
Because line conditions can include short-term transients (for example, during the startup of large loads) the controller does not immediately react to changes on the line. This parameter specifies the amount of time that the condition must exist for, before an operation is initiated. The suffixes S, M, H or D can be added to specify Seconds, Minutes, Hours or Days, respectively.

**Walkway Delay**
The amount of time after ANY change on the front-panel switches before an operation is permitted. If an operation is already pending and a new switch is pressed, this timer re-starts. This delay gives the operator a chance to move away to a safe distance before the operation occurs.

**Full Scale Volts**
Full Scale Voltage (engineering units) or ratio (i.e. 150.0, 300:1)

**Full Scale Amps**
Full Scale Amps(engineering units) or ratio (i.e. 100.0, 300:1)
“Lockout” Tab

The Lockout tab configures several parameters relating to aborting automatic Cap Bank insertion or Removal if certain conditions indicate that the bank has failed, or that the controller is misconfigured and is unable to properly regulate the line conditions.

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Description</th>
<th>Valid Entries</th>
<th>Default Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral Retries</td>
<td>If a Neutral fault is detected, and the Cap Bank is removed, the platform can try to re-insert the banks, to test if the condition has cleared. This parameter specifies the number of attempts to make before the bank is permanently locked out (Disables all automatic control until reset by the Master-Station or the Front Panel). If it set to 0, the unit will retry indefinitely, although this is not recommended.</td>
<td>-32,768 to 32,767</td>
<td>3</td>
</tr>
<tr>
<td>Neutral Retry Delay</td>
<td>This parameter configures the time to wait between attempts to re-insert the cap bank(s) after their removal due to neutral-fault detection. The h,m,ors prefixes are allowed, to specify hours, minutes, or seconds</td>
<td>20 Char</td>
<td>1H</td>
</tr>
<tr>
<td>Multi Trip Limit</td>
<td>The maximum number of consecutive Trips (removals) and Closes (insertions) that the controller will do. Note that although Hunt and Neutral conditions cause a &quot;permanent&quot; lockout, the Multi-Trip and Multi-Close conditions are only temporary &quot;lockouts&quot;. A Multi-Trip condition is cleared if the controller sees a line condition indicating the banks should be inserted (close); likewise a Multi Close condition is cleared by a line</td>
<td>-32,768 to 32,767</td>
<td>10</td>
</tr>
</tbody>
</table>
condition indicating removal of the banks (trip).

<table>
<thead>
<tr>
<th>Multi Close Limit</th>
<th>See Multi Trip Limit</th>
<th>-32,768 to 32,767</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunt Limit</td>
<td>The maximum number of back-to-back insertion/removal cycles before the unit is locked out. 0 means the unit will not lock out due to &quot;hunting&quot;.</td>
<td>-32,768 to 32,767</td>
</tr>
</tbody>
</table>

**“NeutralSense” Tab**

![CaptureFL Property Table](image)

Note: In this section, Neutral Sense refers to a sensor that measures the current from the common connection of the capacitor bank to the system neutral. This is a different parameter than the "Neutral Current" measured by Analog Point 6 (which reports the calculated phase imbalance on the line due to actual load imbalances).

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Description</th>
<th>Valid Entries</th>
<th>Default Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral Enable</td>
<td>Set to Yes if a neutral-current sensor is available, and you want to detect neutral-current fault conditions for bank removal. Setting this to &quot;No&quot; disables neutral-current-driven switch operations.</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Neutral Sensor</td>
<td>Indicates the input channel used for Neutral-Current sensing. Set as follows: Aux0 - Neutral Current sensor is on the Aux0 Input</td>
<td>Aux0, Aux1, Aux 2, Multi</td>
<td>Aux0</td>
</tr>
</tbody>
</table>
Aux1 - Neutral Current sensor is on the Aux1 Input

Aux2 - Neutral Current sensor is on the Aux2 Input

Multi - Independent Neutral Current Sensors for all 3 banks (2 banks for 2-stage) connected to Aux0-Aux2

<table>
<thead>
<tr>
<th><strong>Full Scale Neutral</strong></th>
<th>A full-scale value for the neutral sensor, in engineering units.</th>
<th>20 Char</th>
<th>20.0</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Neutral Transient Dly</strong></td>
<td>Similar to the Transient Delay for other measurements, this parameter controls the amount of time the neutral current must be above the threshold before a Neutral Fault Condition is said to exist.</td>
<td>21 Char</td>
<td>10s</td>
</tr>
<tr>
<td><strong>Neutral Thresh</strong></td>
<td>Threshold (in engineering units) of volts or amps above which a neutral fault is considered to exist. For 3-phase configurations, this value is only used if all 3 banks are in the same position (all inserted or all removed).</td>
<td>20 Char</td>
<td>10</td>
</tr>
<tr>
<td><strong>Unbal Neutral Thresh</strong></td>
<td>For 3-phase configurations only, this is a (usually higher!) threshold that is used for fault detection if some, but not all of the banks are inserted. Normally, if only some banks are in, a considerably higher neutral current is expected due to the imbalance of capacitance.</td>
<td>21 Char</td>
<td>15</td>
</tr>
<tr>
<td><strong>Neutral Fault Action</strong></td>
<td>In most systems, it is desired that detection of neutral current should cause the banks to be removed from the line. However, in certain systems, the opposite behavior is desired. Set this parameter as follows:</td>
<td>Open All, Close All</td>
<td>Open All</td>
</tr>
</tbody>
</table>

Open All (Default) - Remove all banks if fault is detected

Close All - Insert all banks if fault is detected.

“Voltage Override” Tab
### Field Name | Description                                                                                                                                                                                                 |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Override Enable</strong></td>
<td>Setting this parameter to &quot;Yes&quot; enables the Voltage Override algorithm (both Voltage override Inhibit and Voltage Override Force. Setting it to NO disables this feature (and all other parameters will be ignored).</td>
</tr>
<tr>
<td><strong>Hi Volt Limit</strong></td>
<td>The line voltage (in engineering units) above which the Cap Bank will be Removed by the Voltage Override Force function. Also used as a limit (along with the Band Width) for the Voltage Override Inhibit function - see &quot;Initial BW&quot; below.</td>
</tr>
<tr>
<td><strong>Lo Volt Limit</strong></td>
<td>The line voltage (in engineering units) below which the Cap Bank will be Inserted by the Voltage Override Force function.</td>
</tr>
<tr>
<td><strong>Initial BW</strong></td>
<td>Set this parameter to the expected voltage change (in engineering units) when the cap bank is inserted. This value is used to calculate the Voltage Override inhibit limits. If the Cap Bank is inserted, its removal will be prohibited if the voltage is less than (Lo Volt Limit + 1.25 * Initial BW). If the cap bank is out, insertion will be blocked if the voltage is higher than (Hi Volt Limit - 1.25*Initial BW).</td>
</tr>
<tr>
<td><strong>Adapt BW</strong></td>
<td>If set to &quot;Yes&quot;, the controller will monitor the change in line voltage every time a cap bank is inserted or removed. If the measured</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Valid Entries</th>
<th>Default Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Override Enable</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Hi Volt Limit</td>
<td>20 Char</td>
<td>128.0</td>
</tr>
<tr>
<td>Lo Volt Limit</td>
<td>20 Char</td>
<td>110</td>
</tr>
<tr>
<td>Initial BW</td>
<td>20 Char</td>
<td>3.5</td>
</tr>
<tr>
<td>Adapt BW</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
value is reasonable (between half and twice the "Initial BW" value, the controller will use a running average of this value to determine the Voltage Over-ride Inhibit limits. If set to "No" the controller will always use the configured "Initial BW" value.

<table>
<thead>
<tr>
<th>Override Remote</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

If set to "Yes", remote controls (from the Master Station) to insert or remove a cap bank will be rejected if they would violate the Voltage Override Inhibit limits. If set to "No" the Master-Station is allowed to insert or remove the cap banks even if the operation would violate the Voltage Override (VO) limits.

<table>
<thead>
<tr>
<th>Override Local</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

If set to "Yes", Local controls (from the Front Panel) to insert override move a cap bank will be ignored if they would violate the Voltage Override Inhibit limits. If set to "No" front-panel operations are executed even if the operation would violate the VO limits.

7.4 Measurement Parameters

The following configuration screens show configuration parameters relating to the underlying measurement system that provides the data on which the eCAP-9450 operates. These parameters are accessed by double clicking the "CapCon_Client" in the RTU Tree or by right clicking and selecting Property Display.

“Full Scale” Tab
The input sensing amplifiers for the eCAP-9450 operate at fixed gains. However, if the sensors you are using are less sensitive, and cannot provide a signal at the full level allowed by the appropriate amplifiers, you can specify the maximum gains allowed. The gains specified in this section will be applied at the lowest calculation level, and therefore can enhance the resolution of measurements. Note that if you are going to calibrate the unit using the XCAL feature, these gains need only be approximate; they will be calculated very accurately to provide optimal resolution and accuracy by the XCal procedure itself (see 6ACP6 user Guide).

All values in this tab are RMS Volts as measured at the input terminals to the eCAP-9450. The default values are also the maximum allowable values.

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Description</th>
<th>Valid Entries</th>
<th>Default Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volts Input FS</td>
<td>Maximum RMS volts from the 3 Line-Voltage Sensors.</td>
<td>0 to 7.58</td>
<td>7.58</td>
</tr>
<tr>
<td>Amps Input FS</td>
<td>Maximum RMS volts from the 3 Current Sensors.</td>
<td>0 to 20.47</td>
<td>20.47</td>
</tr>
<tr>
<td>Neutral Full Scale</td>
<td>Maximum RMS volts from the Neutral Current Sensor or sensors (also for any AUX inputs not used for Neutral-Current Sensing).</td>
<td>0 to 7.58</td>
<td>7.58</td>
</tr>
<tr>
<td>HW Amps Full Scale</td>
<td>Max Vac input to produce a full scale raw data value reading for current on the 6ACP6 at connectors TB5 or JP8.</td>
<td>0 to 20.47</td>
<td>20.47</td>
</tr>
<tr>
<td>HW Fault Amps FS</td>
<td>Max Vac input to produce a full scale raw data value reading for fault current on the 6ACP6 at connectors TB5 or JP8.</td>
<td>0 to 101.03</td>
<td>101.03</td>
</tr>
</tbody>
</table>

“Setpoints” Tab
Field Name | Description | Valid Entries | Default Values
--- | --- | --- | ---
Relay Close Time | Enter a time, in milliseconds, for the momentary closure of the on-board relays (6 Trip/Close pairs). Valid range is 0 to 65535. | 0 to 32,767 | 250

NOTE: This is a default value. Some protocols may allow different control durations to be specified by master-station control.

“Status” Tab

Field Name | Description | Valid Entries | Default Values
--- | --- | --- | ---
Status Debounce | Enter a time, in milliseconds, for de-bouncing of the 8 on-board status inputs. | 1 to 65,535 | 250

“Type” Tab
<table>
<thead>
<tr>
<th>Field Name</th>
<th>Description</th>
<th>Valid Entries</th>
<th>Default Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wye/Delta</td>
<td>Set to Wye if the voltage sensor(s) are connected to measure phase-to-neutral voltages. Set to Delta if the sensors measure phase-to-phase voltages.</td>
<td>Wye, Delta</td>
<td>Wye</td>
</tr>
<tr>
<td>VI Phase</td>
<td>Select “In Phase” or “Out of Phase” (I lags V by 90 degrees)</td>
<td>In Phase, Out of Phase</td>
<td>In Phase</td>
</tr>
<tr>
<td>Line Frequency</td>
<td>Select 60Hz or 50Hz as appropriate for the system</td>
<td>60 Hz, 50 Hz</td>
<td>60 Hz</td>
</tr>
<tr>
<td>VSensorCfg</td>
<td>The eCAP-9450 can operate with fewer than 3 voltage sensors; if a sensor is missing, an equivalent value can be computed from the other two phases. Set as:</td>
<td>3 Sensor, A Missing, B Missing, C Missing</td>
<td>A-B/C-B</td>
</tr>
</tbody>
</table>

- 3-Sensor: Sensors available on all three phases
- A (or AB) Missing: Sensors available for Vb (or Vbc) and Vc (or Vca) only
- B (or BC) Missing: Sensors available for Va (or Vab) and Vc (or Vca) only
- C (or CA) Missing: Sensors available for Va (or Vab) and Vb or Vbc) only
- A-B/C-B: Sensors available for Vab and Vcb (B-phase common)
If only two current sensors are available, the eCAP can calculate values for the third sensor based on the instantaneous sums.

### 7.5 Data Points

The eCAP-9450 provides a number of different data values which are accessible by the master-station. Some of these data points are intended to provide standard operational information, while others are intended primarily to determine whether the unit is configured appropriately, and whether the associated Cap Banks and Switches are functioning correctly.

In addition, Set Points and Control Points are provided which allow the Master-Station to enable or disable certain features remotely, and to fine-tune some operational parameters of the algorithms.

#### Status Points

<table>
<thead>
<tr>
<th>Point Name</th>
<th>Point_Desc</th>
<th>Name</th>
<th>Name</th>
<th>Alarm</th>
</tr>
</thead>
<tbody>
<tr>
<td>SwitchStateA</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>SwitchStateB</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>SwitchStateC</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>OpenFendingA</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>OpenFendingB</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>OpenFendingC</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>CloseFendingA</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>CloseFendingB</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>CloseFendingC</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>AutoMode</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>LocalMode</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>ValveOpenA</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>ValveOpenB</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>ValveOpenC</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>ValveClosedA</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>ValveClosedB</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>ValveClosedC</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>ValveFaultA</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>ValveFaultB</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>ValveFaultC</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>ValveActuatorA</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>ValveActuatorB</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>ValveActuatorC</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Status0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Status1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Status2</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Status3</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Status4</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Status5</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Status6</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Status7</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Status8</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Status9</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Status10</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Status11</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

0 Hdw I/O Pt.0 to 7 Hdw I/O Pt 7
These points reflect the current states of the 8 hardware status points on the eCAP-9450 platform. These status points are de-bounced using the Status Debounce time specified in the configuration file.

8 Switch State A to 10 Switch State C

These points indicate the state of the (up to) 3 switches used for insertion and removal of the Cap Banks. A '0' state indicates the cap bank is removed, a '1' state indicates it is inserted. In 3-Phase and 3-Stage configurations, all 3 points are active. For the "Single" configuration, only Switch State A is used; the other two will always be reported in the '0' state. Likewise, in the "2-Stage" configuration, Switch State C will always be '0'.

11 Open Pending A to 13 Open Pending C

These status points will be set to a '1' when the eCAP-9450 has detected conditions that will cause the associated Cap Bank to be removed, but the removal has not yet occurred. The switch operation may be delayed due to any of the following conditions:

1. The condition has not existed for the full Transient Delay interval.
2. The Walk-Away timer has not yet expired.
3. The operation is blocked by either the Anti-Hunt timer or the Retry Timer.

Even when these bits are asserted, it is not guaranteed that an operation will eventually result, since the underlying line conditions may return to normal levels before the associated delays have elapsed.

It should be noted that Remote controls from the Master-Station are NEVER delayed, they are either accepted (in which case the operation happens immediately) or they are rejected (in which case the master-station command is ignored and the operation is not performed).

14 Close Pending A to 16 Close Pending C

In a manner similar to the previous 3 status points, these points indicate when a cap bank insertion operation is pending. The operation may be delayed due to any of the above reasons, or additionally because the Discharge Delay criterion has not yet been met.

17 Auto Mode

This point is set to a '1' if the eCAP is in Automatic mode, and to a '0' if it is not.

18 Local Mode

This point is set to a '1' if the eCAP is in Local mode, and to a '0' if it is not.

19 Volt Over Ena

This point is set to a '1' if either part of the Voltage Override is enabled, and to a 0 if it is not. It will never be set if Voltage Override is disabled in the configuration file. If Voltage Override is enabled this point will be set (to a '1') under any of the following conditions:

1. The unit is in AUTO mode
2. The unit is in Remote Mode and Voltage Override is allowed to inhibit Remote Controls
3. The unit is in LOCAL Mode and Voltage Override is allowed to inhibit Local Controls
20 Burnout Ena
This status point is set to a '1' if the Burnout-Prevention algorithm is enabled and set to a 0 if it is disabled (either through configuration or through control by the Master-Station).

21 Neutral Fault
This status point is set whenever the measured Neutral Current is above the Neutral Threshold.

22 Lockout A to 24 Lockout C
These status points are set to a '1' if the associated switch has been locked out of operation either due to a neutral fault, or a Hunt Lockout, or if they are blocked by reaching the Multi-Trip or Multi-Close limit.

25 Feedback Error A to 27 Feedback Error C
If Switch Feedback issued, these bits indicate a discrepancy between the state of the feedback Status input and the expected state of the switch. This indicates either a stuck switch or a failure of the switch to operate.

29 Override Active A to 31 Override Active C
These bits are set when the voltage level is such that attempts to operate the switch (from it's current state to the opposite state) would be blocked due to the Voltage Override Inhibit function.

28 Burnout Active
This status point is set when the voltage level is low enough to activate the Burnout protection, and signals that switch operations will not be performed by the eCAP.

Analog Points
0 Phase A Voltage to 2 Phase C Voltage

The Voltage on each of the three input phases.
3 Phase A Current to 5 Phase C Current
The current on each of the three phases.

6 Neutral Current
The neutral current, as determined from the imbalance between the three individual phase currents.

7 Phase A Fault Current to 9 Phase C Fault Current
These points also report the current for each of the three input phases, but are sampled with an amplifier chain which is only one-fifth as sensitive as that used for the normal current measurements. This provides accurate current measurements at levels much higher than the normal operating conditions, for example during a fault.

10 Phase A Watts to 13 Total Circuit Watts
The power carried on each of the three phases, as well as the total circuit power.

14 Phase A VARs to 17 Total Circuit VARs
The VARs on each of the three phases, as well as the total circuit VARs.

18 Phase A VA to 21 Total VA
The VAs on each of the three phases, as well as the total circuit VA.

22 Phase A PF to 25 Average Circuit PF
The power factor, calculated for each individual phase and for the total feeder.

26 Internal Temperature
The eCAP-9450 contains an on-board temperature sensor, which measures the ambient temperature at the location. This value can be utilized in estimating expected loads due to heating or air-conditioning requirements.

27 DC 1 (Aux DC measurement input 2) to 28 DC 0 (Aux DC measurement input 1)
Provides the values of the two auxiliary DC inputs provided in the eCAP-9450.

29 Phase A Aux (Aux AC voltage input) to 31 Phase C Aux (Aux AC voltage input)
Provides the values of the three auxiliary AC inputs on the platform. If neutral current sensing is enabled, at least one of these inputs should be the neutral current measurement. Otherwise these inputs are available for general usage.

32 Hi Volt Thresh to 39 Burnout Thresh
These points reflect the values of various algorithmic thresholds, in master-station units. They provide feedback of all parameters which are settable from the Master-Station (using set points) and indicate the actual threshold value being used (whether this value comes from the initial configuration or was modified by a set point command). See section 3.4 for specific details.

40 DeltaV1 to 42 DeltaV3
These three points indicate the Delta-V value that is being used for the Voltage Override Inhibit function. They will reflect either the configured value, or the adapted value as appropriate.

43 LastDeltaV1 to 45 LastDeltaV3
These points indicate the measured change in voltage that resulted from the last operation performed. These values are updated on either an open operation or a close operation, and are nominally expected to be positive, since the value is computed as:

\[(\text{Voltage with Bank Inserted}) - (\text{Voltage with bank Removed})\].

Negative values can, however, be reported if the line voltage changes in the opposite direction from what is expected. These points are scaled in the same units as the main Voltage measurements (Analog Points 0-3).

Note that for 2-stage and 3-stage configurations, these parameters represent the voltage change for each of the STAGES (not for each of the phases!)

**46 LastDeltaVars1 to 48 LastDeltaVars3**

Similar to the Last Delta V points above, these points reflect the measured change in VARs after an insertion or removal, and are in the same units as the VARs measurements (Analog points 14-16)

**XX Voltage Imbalance**

The voltage imbalance is calculated using the following formula:

\[
\text{Voltage Imbalance} = \left(\frac{\text{Maximum Deviation of Single Phase from Average Voltage}}{\text{Average Voltage}}\right) \times 100
\]

**XX Current Imbalance**

The current imbalance is calculated using the following formula:

\[
\text{Current Imbalance} = \left(\frac{\text{Maximum Deviation of Single Phase from Average Current}}{\text{Average Current}}\right) \times 100
\]

**XX Three Phase Voltage Average**

The average of the voltage readings on all three phases.

**Accumulators**
0 Positive Watthours to 3 Negative Varhours

Watthour and VArhour accumulation.

4 Operations A to 6 Operations C

These accumulators increment each time the associated cap bank is removed from the line. Retry attempts are not counted. These accumulators can be reset using the "Reset Ops" control.

7 Multi Trip Count A to 9 Multi Trip Count C

These counters increment each time a redundant Trip operation is done on the corresponding point. The counters are cleared whenever the Multi-Op condition goes away.

10 Multi Close Count A to 12 Multi Close Count C

These counters increment each time a redundant Close operation is done on the corresponding point. The counters are cleared whenever the Multi-Op condition goes away.

13 Hunt Count A to 15 Hunt Count C

These counters increment each time a "hunting" condition is detected, and are cleared when either a) the hunt condition disappears or b) a Reset Lockout is done (either from the front-panel or the master-station).

16 DeltaV1Errs to 18 DeltaV3Errs

These counters increment every time the voltage change due to an operation (insertion or removal) is outside the range of 0.5 to 2.0 times the expected value. These accumulators can be reset using the "Reset Ops" control.
19 DeltaVar1Errs to 21 DeltaVar3Errs
These counters increment every time the VARs change due to an operation (insertion or removal) is outside the range of 0.5 to 2.0 times the expected value (the Cap Bank size). These accumulators can be reset using the "Reset Ops" control.

22 Events A to 24 Events C
These accumulators increment each time the associated cap bank is removed or inserted (Total switch operation attempts). Retry attempts are counted. These accumulators can be reset using the "Reset Ops" control.

Set Points

Once a Cap Controller has been installed in the field, it may be desirable to "Tweak" some of the operating limits and thresholds to improve performance. Therefore, Set Points are provided which allow the Master-Station to adjust these parameters.

These parameters will override the configured values. When they are updated by the Master-Station, the parameters are saved in battery-backed RAM and will persist even if the power to the unit is removed.

Each set point is "Echoed" back to the master-station through Analog Points 32 through 39, so their current values can be determined. These parameters are reset to the configured values when a new configuration file is written to the eCAP-9450.

All Set-Points are in the same units as the Phase A Volts analog point, except as noted below:

<table>
<thead>
<tr>
<th>Point Number</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Hi Volt Thresh</td>
</tr>
<tr>
<td>1</td>
<td>Lo Volt Thresh</td>
</tr>
<tr>
<td>2</td>
<td>Hi VAR Thresh</td>
</tr>
<tr>
<td>3</td>
<td>Lo VAR Thresh (units are the same as Phase A VARs)</td>
</tr>
<tr>
<td>4</td>
<td>Hi Volt Limit</td>
</tr>
<tr>
<td>5</td>
<td>Lo Volt Limit</td>
</tr>
</tbody>
</table>
Neutral Thresh (Units are the same as Phase A Aux)

Burnout Thresh

Refer to section Analog Points for point descriptions.

**Controls**

0 **Hdw Cont Pt.0** to 2 **Hdw Cont Pt.2**

These controls operate the momentary relays on the main eCAP board. A Trip will remove the associated cap bank from the line; a Close will insert the cap bank. Note that operations on THESE CONTROLS ONLY may be blocked by the eCAP controller for a number of reasons. They may include if the unit is in Local mode, or if the operation would violate algorithmic conditions.

The remainder of these controls are "Pseudo Controls" and are NOT blocked by the algorithmic conditions:

3 **Auto Enable**

A Close on this point enables the Automatic Voltage or VARs control algorithm. A Trip on this point disables the Automatic control.

4 **VO Enable**

A Close on this point enables the Voltage Override Force and Inhibit algorithm. A Trip on this point disables Voltage Override.

5 **Burnout Enable**

A Close on this point enables Burnout Protection; a Trip disables the Burnout Protection algorithm.

6 **Reset Lockout**

A close on this point will reset lockouts due to Neutral-Current faults, Anti-Hunt Lockout, or Multi-Op Lockout. A Trip on this point has no effect.

7 **Reset OpCntrs**

A Close on this point will reset the following accumulators to 0:

4 **Operations A**
5 Operations B
6 Operations C
16 DeltaV1Errs
17 DeltaV2Errs
18 DeltaV3Errs
19 DeltaVar1Errs
20 DeltaVar2Errs
21 DeltaVar3Errs
22 Events A
23 Events B
24 Events C

A Trip on this point has no effect.

8 Reset Delta V

A Close on this point will reset the Delta-Voltage used in the Voltage Override Inhibit algorithm back to the initial configured value. This can be used to reset the Delta-v value if it is configured to "Adapt" and the value has "strayed". A Trip on this point has no effect.

7.6 Test-Panel Functions

The eCAP-9450 is based on the 6ACP6 platform. Many diagnostic commands are available through the RS-232 Laptop port on the device. For a description of these commands and Test-Panel operation in general, please refer to document TP-802 6ACP6 Test Panel Users Guide.

The eCAP-9450 also adds an additional Test Panel command "CAPDATA", and obsoletes the "ENG" command, as described in the next sections.

CapData Screen

The Test-Panel has an additional command specifically designed to display the current state of all relevant operating parameters used in Cap Bank control, which can be very helpful in providing insight into the operation of the controller and its current state. To display this data, enter the command "CapData" to the test panel. The display will run continuously until a key is pressed at the terminal. An example of the CapData screen appears below.

```
Phase A Phase B Phase C | HiLimit: 128.00 Volts
124.73 Volts 124.75 Volts 124.75 Volts | HiThresh: 8.71 KVARs
28.05 KAMps 28.03 KAMps 28.00 KAMps | LoThresh: -398.61 KVARs
3.49 MWatt 3.49 MWatt 3.49 MWatt | LoLimit: 116.00 Volts
-163.36 KVARs -117.62 KVARs -108.91 KVARs | Burnout: 95.00 Volts
Normal Normal Normal |
| Neutral 115.14 VHI!!
State CLOSE CLOSECLOSE |
FeedBk N/A N/A N/A |
BlkBy |
Ops/Evnts 0/14 0/14 0/14 |
MultiT/C 0/0 0/0 0/0 |
| UnbalThres: 105.00
| Status: Runaway
```
Note that the screen is split into 5 sections, containing information about different functional aspects of the controller’s operation. These are organized as follows:

### Upper Left - Input Readings
Displays readings for the 3 input phases, scaled in engineering units. Note that the suffix M or K is added for Mega or Kilo, as appropriate. Also displays the state associated with the phase, as one of the following:

- **Burnout** - The voltage is below the Burnout-Protection Level
- **Lo Limit** - The voltage is below the Low Voltage-Override Level
- **Lo Thresh** - The voltage or VARS are below the insertion threshold
- **Normal** - Voltage/VARS are in the normal range
- **Hi Thresh** - Voltage or VARs are above the removal threshold
- **Hi Limit** - Voltage is above the High Voltage Override level

### Upper Right - Configured Thresholds
This area displays the configured values for the thresholds used in the algorithm, for reference purposes.

### Lower Left - Detailed Cap Controller State
For each of the three possible switches, the following information is displayed:

- **State**: OPEN if the bank is removed, CLOSE if it is inserted, ???if the controller does not know the current state of the Cap Bank.
- **FeedBk**: N/A if Switch Feedback is not present, otherwise OPEN or CLOSE as per the value of the associated status input point.
- **BlkdBy**: If an insertion or removal is pending, this field will display the reason why the operation has not already been done, as one of the following:
  - <blank> - If No operation is pending, this field is left blank
  - Burnout - Operation is blocked because the line voltage is below the Burnout Protection Threshold.
  - Low Over - An "Open" command is blocked because it would violate the "Low Voltage Override" condition, causing the line voltage to drop too low.
  - Hi Over - A "Close" command is blocked because it would violate the "High Voltage Override" condition, driving the voltage too high.
Hunt Time - An operation is temporarily blocked by the Anti-Hunt timer.
Mult Close - A Close operation is blocked because the controller has re-tried the operation for the maximum number of allowed retries.
Mult Trip - Similar to Multi-Close, but the operation is a TRIP.
Walk Away - Operation blocked because the Walk Away timer is active
Discharge - Operation blocked by the Cap Discharge Delay
Not Rem - Indicates that a Remote insertion or removal was attempted (from the Master-station) while the controller was not in the Remote mode.
Not Local - Indicates that a local (front-panel) operation was attempted while the unit was not in Local mode.
Lockout - Indicates that the bank is prevented from operating due to the Neutral Fault Sensing algorithm
Retry - Indicates a pending operation is blocked by the Retry timer.
Hunt Lock - Indicates the bank has been locked out due to excessive hunting.
VO Delay - Indicates the operation is prevented because the Voltage Override blocking condition has only been relieved within the past 45 seconds.

Ops/Evnts: Displays the number of Operations/Events for each switch
MultiT/C: Displays the Multi-Trip and Multi-Close counters for each switch
DV/VarErs: Displays the count of Delta-Volts and Delta-Vars Errors
Hunt: Displays the current Hunt count for each switch
Lockout: If the bank is locked out, this field shows the reason why, as one of the following:
    NFAULT - Locked out by Neutral-Fault Detection
    HUNT - Locked out by the Anti-Hunting algorithm
    MCLOSE - Blocked by the Multi-Close Limit
    MTRIP - Blocked by the Multi-Trip Limit
Dischg:
Retry:
Hunt:
Transnt: These fields display the current values of the Discharge-Delay timer, the Retry timer, the Hunt timer, and the Transient-Delay timer for each switch, in <minutes>:<Seconds> format. If the timer is not currently active, 0:00 is displayed.
DeltaV: Displays the current Delta-Volts value used in VO Blocking
LastDV: Displays the measured Delta-volts resulting from the last operation on each bank
LstDVar: Displays the measured Delta-VARS resulting from the last operation on each bank.

Middle Right - Neutral-Current Sensing
This area displays parameters relating to Neutral-Current detection. On the top 3 lines are displayed one, two or three current values (depending on the neutral-sensing configuration). These values may be followed by either "Hi!" indicating that the current is over the Balanced Threshold, or "VHI!!" if the current is over the Unbalanced Neutral threshold.

Immediately below these readings, the Balanced and Unbalanced threshold values are displayed, for reference.

The last line of this section displays the current status of the Neutral Fault Detection system, as one of the following:

- Disabled - Neutral-current Detection is not configured
- Ok - System is in normal state
- OVER - Neutral current is above the threshold level, but the transient delay has not yet expired.
- FAULT - The controller has removed the Cap Bank due to a neutral fault (but is still in the Retry Phase).
- Retry - The bank(s) have been re-inserted as part of the retry sequence.
- LOCKOUT - The bank is locked out due to Neutral-current faults.
- Local - The unit is in Local mode, Automatic operation not allowed.
- Walkaway - The Walk-away timer is active, delaying Neutral-Fault operations.
- Dischg - Insertion of the bank is blocked due to the Cap Discharge Delay

**Lower Right - General Information**

This area of the screen displays general configuration and status information not displayed elsewhere, as follows:

- Mode: Auto, Local, Remote, or Lockout
- Type: Single, 3-Phase, 2-Stage, or 3-Stage
- Algo: Volts or Vars.
- VOEna: YES if the Voltage Override function is enabled (by configuration), NO otherwise.
- BOEna: YES if Burnout Protection is configured, NO otherwise.
- WalkAwayTmr: Displays the time remaining on the Walk-Away timer, if it is currently active.

"ENG" Differences

The 6ACP6 platform test-panel provides an "Eng" command to specify the scale of engineering units for the platform. This command is not needed by the eCAP-9450, since the full-scale values are specified in the Cap Con configuration file instead. Values from the configuration file will override those specified using the "ENG" command.
8 Glossary

This section provides a list of the microcomputer and supervisory control terms that are used throughout this and associated User’s Manuals. Some of the terms have standard usage throughout the industry, while others are defined as expressly used by QEI. The glossary may be regarded as a definitive reference only within respect to the usage of the terms within this manual.

All words, abbreviations, and mnemonics are listed in alphabetical order.

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accumulation</td>
<td>A measurement whose raw value is generated by a pulse count and is presented in analog form.</td>
</tr>
<tr>
<td>Accumulator Point</td>
<td>A measurement point whose value is obtained by counting the number of contact closures appearing at a status input.</td>
</tr>
<tr>
<td>Activated Remote</td>
<td>An online remote station that is being polled for data by the master station and is responding to commands.</td>
</tr>
<tr>
<td>A/D or ADC</td>
<td>Analog-to-Digital, such as an A/D Converter.</td>
</tr>
<tr>
<td>A/D Converter</td>
<td>Analog-to-Digital Converter. A device that converts an analog input to a binary or BCD output.</td>
</tr>
<tr>
<td>Address</td>
<td>A location, either in hardware or within the program. Hardware addresses always consists of binary numbers while program addresses may be numbers or names.</td>
</tr>
<tr>
<td>Address Bus</td>
<td>A path for the transfer of several address bits in parallel.</td>
</tr>
<tr>
<td>Alarm</td>
<td>A condition, defined by the customer, that represents an unauthorized change of a status point; a measurement point with a value out of limits, or any other system condition that requires operator notification and acknowledgement.</td>
</tr>
<tr>
<td>Analog Point</td>
<td>A measurement point whose raw value is derived from a voltage or current received from a transducer or other device.</td>
</tr>
<tr>
<td>Aperture Time</td>
<td>A time span during which a selected point must be commanded. At all other times, the master station automatically refuses the control operation.</td>
</tr>
<tr>
<td>APPRS</td>
<td>Automatic peak-power reduction system. An optional SCADA program that provides for automatic voltage reduction at all remote stations as a function of the total demand as computed at the master station.</td>
</tr>
<tr>
<td>APPR Level</td>
<td>The number, entered via the control keyboard, around which the (optional) automatic peak-power reduction system is configured.</td>
</tr>
</tbody>
</table>
operates.

**ASCII**

See USASCII.

**Asynchronous**

Method of receiving serial data, without the use of transmitted clock pulses, in which synchronization is achieved by a start bit at the beginning of the word and a stop bit at the end of the word.

**Authorized Change**

Any change in the status of a system point that results from a command initiated by the operator.

**Binary**

The number system to the base 2. Binary characters are limited to the digits 0 and 1.

**BCD**

Binary Coded Decimal. The coded representation of a decimal number that expresses each decimal digit as a combination of binary numbers.

**BCH**

An acronym for Messrs. Bose-Chaudhuri and Hocquenhem, who developed a class of cyclic codes for maintaining the security of transmitted binary data.

**Bit**

A single binary digit.

**Bus**

One or more conductors used as a path over which information is transmitted from and received at several cards or locations.

**Byte**

A group of eight (8) binary digits (or bits) that are processed as a single unit. This is the minimum memory unit in the QEI system.

**Channel**

A unique communication link between the master station and one or more remote stations.

**C & I Point**

Control and Indication Point. Refers to a control point and its associated status point.

**Code**

Any set of rules for representing information. Two of the codes used in the QUICS protocol are USASCII and hexadecimal.

**Computed Value**

A measurement value created by performing mathematical operations upon data from one or more measurement points.

**Control Point**

A supervisory point that is capable of responding to an operator's command (i.e. close relay, open valve, etc.).

**CPU**

Central Processor Unit. The portion of the main processor board where instructions are executed and calculations are
performed.

**D/A or DAC**  
Digital-to-Analog, such as a D/A converter.

**D/A Converter**  
Digital-to Analog Converter. A device that converts a binary or BCD input to an analog output.

**Data**  
Changeable information, within the system, which represents

**Data Bus**  
A path for the transfer of several data bits in parallel.

**Deactivated Remote**  
An offline remote station that is not polled by the master station. However, the station remains operational with respect to its data-gathering functions and ability to respond to commands.

**Engineering Units**  
A quantity expressed in operator’s terms, such as megawatts, ponds per square inch, gallons per minute, etc.

**Firmware**  
Computer instructions that are stored in non-volatile memory and are retained even when no power is applied to the device.

**Flag**  
A single message bit that specifies the condition of a point, hardware device, or program operation.

**Flash**  
A type of non-volatile computer memory that can be electrically erased and reprogrammed such as in an EEPROM. It usually contains the computer program instructions needed for proper operation.

**Format**  
The specification for a transmitted or received message word, or for the internal organization of data.

**Freeze**  
To maintain an input value, such as that from a pulse accumulator, at its present magnitude, regardless of subsequent changes in the input.

**Full-Duplex**  
Traffic on a communication channel in which transmission is simultaneous in both directions as in a 4-wire circuit.

**Group Address**  
A number assigned to a block of local or remote supervisory status points.

**Half-Duplex**  
Traffic on a two-wire communication channel in which transmission is only in one direction at a time.

**Hardware**  
Any physical equipment, as opposed to documentation or software.
<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hardwired</strong></td>
<td>A connection made with a physical wire, as opposed to switching or program selection.</td>
</tr>
<tr>
<td><strong>Hexadecimal</strong></td>
<td>The number system to the base 16. Composed of the characters 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E and F.</td>
</tr>
<tr>
<td><strong>Hysteresis</strong></td>
<td>The difference between the value of an alarm limit and the value of the corresponding alarm return. The hysteresis zones on either side of the alarm limits prevent the oscillation of a signal about one of its limits from generating multiple alarms.</td>
</tr>
<tr>
<td><strong>Interface</strong></td>
<td>A hardware device that is placed between two other devices, or between a device and an operator, to make them compatible.</td>
</tr>
<tr>
<td><strong>Interrupt</strong></td>
<td>A signal that temporarily stops a microprocessor task and directs it to another task.</td>
</tr>
<tr>
<td><strong>I/O</strong></td>
<td>Input/Output. Generally refers to a microprocessor input or output device.</td>
</tr>
<tr>
<td><strong>LED</strong></td>
<td>Light Emitting Diode. A hardware device meant to indicate a binary state or condition by means of the presence or absence of light.</td>
</tr>
<tr>
<td><strong>Limits</strong></td>
<td>Boundaries placed upon the maximum and minimum permitted values of a measurement signal for the purpose of generating automatic alarm messages.</td>
</tr>
<tr>
<td><strong>Link</strong></td>
<td>Means either the physical means of communications between two devices or the firmware programmed into a processor panel in order to function in a predetermined manner.</td>
</tr>
<tr>
<td><strong>Lower Limit</strong></td>
<td>The boundary at which an alarm condition is initiated when an analog point is less than its minimum permissible value.</td>
</tr>
<tr>
<td><strong>Lower Limit Return</strong></td>
<td>The lower limit hysteresis level at which a lower limit alarm condition is removed.</td>
</tr>
<tr>
<td><strong>LSB</strong></td>
<td>Least Significant Bit.</td>
</tr>
<tr>
<td><strong>Machine Language</strong></td>
<td>The binary numbers that are interpreted as instructions by the computer.</td>
</tr>
<tr>
<td><strong>Measured Value</strong></td>
<td>The real-world magnitude, after scaling, obtained from an analog point.</td>
</tr>
<tr>
<td><strong>Measurement Point</strong></td>
<td>A supervisory remote point associated with either analog or digital data.</td>
</tr>
<tr>
<td><strong>Memory</strong></td>
<td>The physical locations where data (see RAM) and instructions (see Flash) are stored in the computer.</td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>MSB</strong></td>
<td>Most Significant Bit.</td>
</tr>
<tr>
<td><strong>Non-Volatile</strong></td>
<td>Refers to a memory device that does not lose its contents when power is removed from the device such as in an EEPROM or Flash.</td>
</tr>
<tr>
<td><strong>Offline</strong></td>
<td>The use of equipment without direct interaction with the computer program, e.g. a deactivated remote station.</td>
</tr>
<tr>
<td><strong>Offset</strong></td>
<td>A numerical value that compensates for any difference between the zero level of the raw value and the zero level of the engineering value.</td>
</tr>
<tr>
<td><strong>Online</strong></td>
<td>The use of equipment while under control of, or interacting with, the computer.</td>
</tr>
<tr>
<td><strong>PDM</strong></td>
<td>Pulse-Duration Measurement</td>
</tr>
<tr>
<td><strong>PDM Point</strong></td>
<td>A measurement point whose value is obtained by computing the duration of a contact closure and comparing that duration with previously established parameters.</td>
</tr>
<tr>
<td><strong>Point Address</strong></td>
<td>A number assigned to identify a unique status, measurement, control, or set point.</td>
</tr>
<tr>
<td><strong>Polling</strong></td>
<td>That mode of system operation in which the master station sequentially interrogates the remote stations to obtain data. Remote stations cannot initiate communications with the master in this mode.</td>
</tr>
<tr>
<td><strong>Queue</strong></td>
<td>A stored list of some sequence of events (SOE), such as system alarms or message word bits.</td>
</tr>
<tr>
<td><strong>RAM</strong></td>
<td>Random Access Memory. A solid-state memory device that can be both read and written into by the computer. RAMs are volatile memory that is used to store data.</td>
</tr>
<tr>
<td><strong>Raw Value</strong></td>
<td>A binary number that represents the digital quantity supplied to the computer from an A/D converter or other digital device.</td>
</tr>
<tr>
<td><strong>Read</strong></td>
<td>To copy or extract information, such as when the microprocessor receives information from an input device or memory location.</td>
</tr>
<tr>
<td><strong>Real-Time</strong></td>
<td>A mode of operation in which events are acted upon as soon as they occur, such as the system response to operator commands, or the event recorder response to</td>
</tr>
</tbody>
</table>
system changes.

**Reset**
To remove the data stored at the remote stations by replacing stored data with zeros.

**RS-232C**
Electronics Industry Association Standard for Interface between Data Terminal and Data Communications equipment employing serial binary data exchange.

**SCADA**
Supervisory Control and Data Acquisition. The TDMS-Plus Master Station and Remote Stations comprise such a SCADA system.

**Scaling**
The alteration of measurement data, either by hardware or by computer program, to convert the raw value into a corresponding engineering value.

**Scaling Resistor**
A component wired into the system to interface a current transducer to its corresponding analog-to-digital converter.

**Scratch-Pad Memory**
An area in RAM reserved for use by the CPU to avoid delays that would be encountered by inter-action with the main memory.

**Set Point**
A remote supervisory measurement point that can be preset to some digital or analog value by an operator command. The system may then establish an automatic operating level within a specified tolerance of the set point value.

**Software**
All the codes, listings, flow charts and other written information that define the computer program, as distinguished from the computer itself (i.e. hardware), and from the program instructions that are contained in the solid-state EEPROMs (firmware).

**Span**
The range between the maximum and minimum engineering values of a measurement.

**Stack**
An area of RAM reserved for the temporary storage of information during interrupts.

**State Alarm**
An alarm condition created by an unauthorized state. The alarm condition remains until the device returns to the authorized state (also called a status alarm).

**Station Address**
A number assigned to a remote station. No two stations on a common link (comm. line) may have the same address.

**Status Block**
A group of 16 consecutive status points.

**Status Point**
A supervisory point that provides two-state (binary) data.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subroutine</strong></td>
<td>A part of a program designed to perform a specific function and which may be utilized by the computer whenever that function is encountered in the program.</td>
</tr>
<tr>
<td><strong>Subsystem</strong></td>
<td>A complete station, such as master or remote, within a SCADA system.</td>
</tr>
<tr>
<td><strong>Supervisory Point</strong></td>
<td>Any unique, physical location that provides information to the system (i.e. a status or measurement point), or that responds to action by the system (i.e. a control or set point).</td>
</tr>
<tr>
<td><strong>Table</strong></td>
<td>An organized list of related items, each of which is identified either by its position on the list or by some pointer. Tables that provide program definitions are stored in EEPROM; data tables are stored in RAM.</td>
</tr>
<tr>
<td><strong>Telemetry</strong></td>
<td>The method of sensing and transmitting supervisory information from a remote station to the master station, or transmitting commands and set point information from the master to the remote. Generally analog or digital signals are used to represent information and these signals are modified to traverse the remote/master distance by suitable methods required by their transmission mediums.</td>
</tr>
<tr>
<td><strong>Transition Alarm</strong></td>
<td>An alarm condition created by a device in the act of changing state.</td>
</tr>
<tr>
<td><strong>Transducer</strong></td>
<td>A device, used at the measurement point, for converting the measured energy (electrical, mechanical, heat, etc.) into a current or a voltage.</td>
</tr>
<tr>
<td><strong>Turnaround Time</strong></td>
<td>The time required to reverse the direction of transmission in a half-duplex channel.</td>
</tr>
<tr>
<td><strong>Two’s Complement</strong></td>
<td>A binary number obtained by changing each original 0 to a 1, each 1 to a 0, and then adding 1 to the least significant bit (LSB).</td>
</tr>
<tr>
<td><strong>Unauthorized Change</strong></td>
<td>Any change in the status of a system point that is not due to a command initiated by the master station operator.</td>
</tr>
<tr>
<td><strong>Update</strong></td>
<td>To place more recent data from a supervisory point into computer memory, either at the remote or at the master station.</td>
</tr>
<tr>
<td><strong>Upper Limit</strong></td>
<td>The boundary at which an alarm condition is initiated when an analog point exceeds the maximum permissible value.</td>
</tr>
<tr>
<td><strong>Upper Limit Return</strong></td>
<td>The upper limit hysteresis level at which an upper limit alarm condition is removed.</td>
</tr>
<tr>
<td><strong>Upset</strong></td>
<td>A change in the state of a status point, or a specified change percentage change in the value of a measurement value.</td>
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<td>---------------</td>
<td>---------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>USASCII</strong></td>
<td>USA Standard Code for Information Interchange (usually abbreviated as ASCII). An eight-bit binary code for the representation of characters.</td>
</tr>
<tr>
<td><strong>Value</strong></td>
<td>The magnitude or state of a supervisory point. A status point has only two values, while a measurement point has some specific quantity that is usually specified in engineering units.</td>
</tr>
<tr>
<td><strong>Word</strong></td>
<td>A number of binary digits, grouped to be processed as a unit, in which each position in the group conveys certain specified information. Message words between master and remote contain 32 bits. Words used within the microprocessor (such as address or instruction words) are “byte size”, or 8 bits.</td>
</tr>
<tr>
<td><strong>Write</strong></td>
<td>To enter or provide information, such as when the computer places data in a RAM memory location or permits information to a peripheral device.</td>
</tr>
</tbody>
</table>