	<b>APPLICATION AND CONTROL OF CAPACITORS ON DISTRIBUTION LINES</b>		<b>039586</b>
	<b>Asset Type:</b> Electric Distribution	<b>Function:</b> Construction and Design	
<b>Issued by:</b> Derrick Mar (DSMN) <i>Derrick Mar</i>	<b>Date:</b> 06-29-12		
<b>Rev. #08:</b> This document replaces PG&E Document 039586, Rev. #07. For a description of the changes, see Page 8.			

**Purpose and Scope**

This document provides information for the application, ordering, and setting of capacitor controls. Some of the devices in this document include functionality that is currently not required including VAR control and the option to add a radio to a non-SCADA capacitor control to make it a SCADA capacitor control. These are included with the intention to prevent the potential more expensive cost of replacing units later when requirements change.

References	Location	Document
<a href="#">Cutouts, Fuses, and Disconnects for Overhead Distribution Lines</a>	<a href="#">OH: Cutouts and Fuses</a>	<a href="#">015225</a>
<a href="#">FRO-Installation of Fixed Capacitors on Overhead Distribution Lines</a>	<a href="#">FRO: Capacitors</a>	<a href="#">028424A</a>
<a href="#">Capacitors for Distribution Lines</a>	<a href="#">OH: Capacitors/EPM</a>	<a href="#">028425</a>
<a href="#">FRO-Installation of Automatically Switched Capacitors on Overhead Lines</a>	<a href="#">FRO: Capacitors</a>	<a href="#">032308A</a>
<a href="#">Guide for Application of Overhead SCADA and PDAC Systems</a>	<a href="#">TIL</a>	<a href="#">054421</a>
<a href="#">PG&amp;E Overhead SCADA and PDAC Installation</a>	<a href="#">OH: Switches</a>	<a href="#">054422</a>

**Programmable Capacitor Controls**

**Basic Electronic Control**

1. The electronic capacitor controls have more flexibility than analog or electromechanical controls. There are many varieties of these controls and features will change as the programming evolves. Consult the appropriate manufacturer’s manual for specific details of a particular model. However, the minimum features are:
  - A. Time, temperature, and voltage control in a single unit.
  - B. Voltage can be set to override time or temperature.
  - C. Switching is inhibited if an override condition would occur.
  - D. At least two seasonal settings (i.e., time with voltage override for summer, voltage for winter).
  - E. Automatic compensation for holidays and daylight savings.
  - F. Set points retained in non-volatile memory.
  - G. Data logging of readings and operations retained in non-volatile memory.
  - H. Closing delay from previous trip operation.

**VAR Option**

2. The var option includes input from a current sensor in addition to all the features of the basic control. This adds the capability of switching on a single-phase VAR reading. The control can be used with the standard Lindsey sensor (M240132).

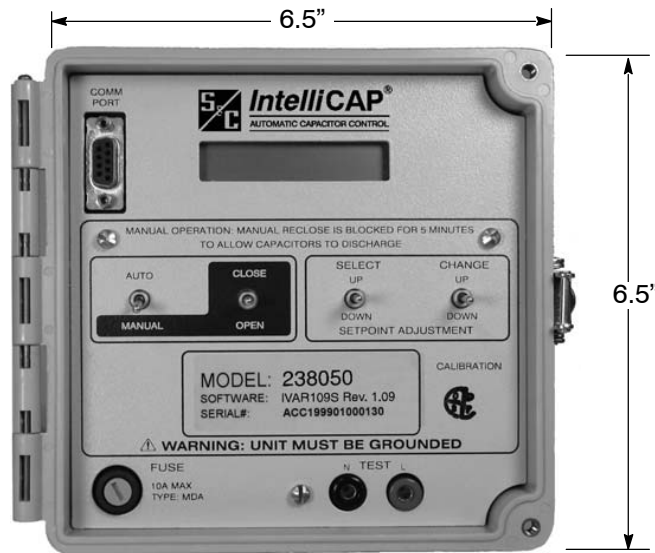
Table 1 compares the capacitors discussed in this document.

**Table 1 Capacitor Control Comparison**

	<b>S&amp;C Intellicap</b>	<b>HDE VarCom 1600</b>	<b>S&amp;C Intellicap Plus</b>
PG&E Material Code	M031530	M262786	See Table 2
SCADA Capable	No	Yes	Yes
SCADA Protocol	N/A	DNP 3.0	DNP 3.0 / 2179
<b>Faceplate</b>			
Faceplate Control	Toggle Switches	Dials	Push Buttons
Interface	No	RS-232 / USB	RS-232
<b>Dimensions/Weight</b>			
Height	6.5"	10.75"	14.5"
Width	6.5"	8.75"	9.5"
Depth	4.375"	5.5"	8.1"
Weight	4 lbs	8.5 lbs	8.25 lbs
<b>Control</b>			
Time	Yes	Yes	Yes
Temp	Yes	Yes	Yes
Voltage	Yes	Yes	Yes
VAR	No	No	Yes
Number of Schedules	2	4	4
<b>Data Logging</b>			
Intervals	1 - 60 minutes	5,000 Data Points at Programmable Intervals	1 - 60 minutes
Duration	2 - 120 days		2 - 120 days

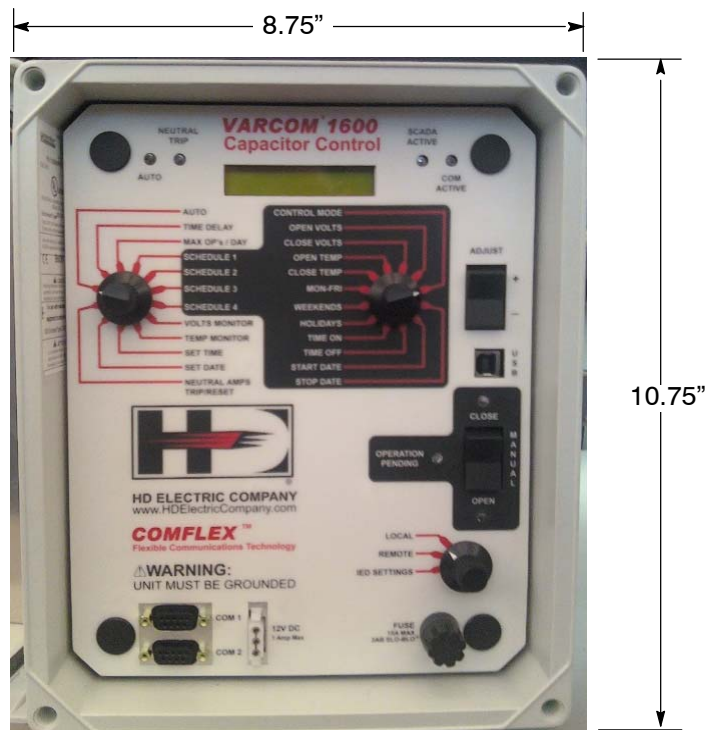
**Non-SCADA Controls**

**S&C IntelliCAP:** Code M013530 provides an electronic programmable time, temperature, and voltage capacitor control with voltage override for time and temperature. New units are purchased as the S&C IntelliCAP model. Older units were purchased as the Energyline 1000 series, both with and without an LCD display.



**Figure 1**  
**S&C IntelliCAP**  
**(M031530)**

**HD Electric VarCom 1600:** Code M262087 provides an electronic programmable time, temperature, and voltage capacitor control with voltage override for time and temperature. The VarCom 1600 is purchased without a radio, but could be retrofitted in the future with a radio for SCADA applications. Purchasing this unit could prevent the potential more expensive cost of replacing a non-SCADA capacitor control when SCADA applications are required.



**Figure 2**  
**HD Electric VarCom 1600**  
**(M262786)**

SCADA and VAR Controls

**S&C IntelliCAP PLUS:** The SCADA capacitor control approved for purchase is the S&C IntelliCAP PLUS (formerly Energyline). This is an electronic programmable time, temperature, and voltage capacitor control with voltage override for time and temperature. VAR control is also available with the addition of a CT input. See [Document 054421](#) and [Document 054422](#) for details of SCADA applications. See Table 2 for available purchase options.

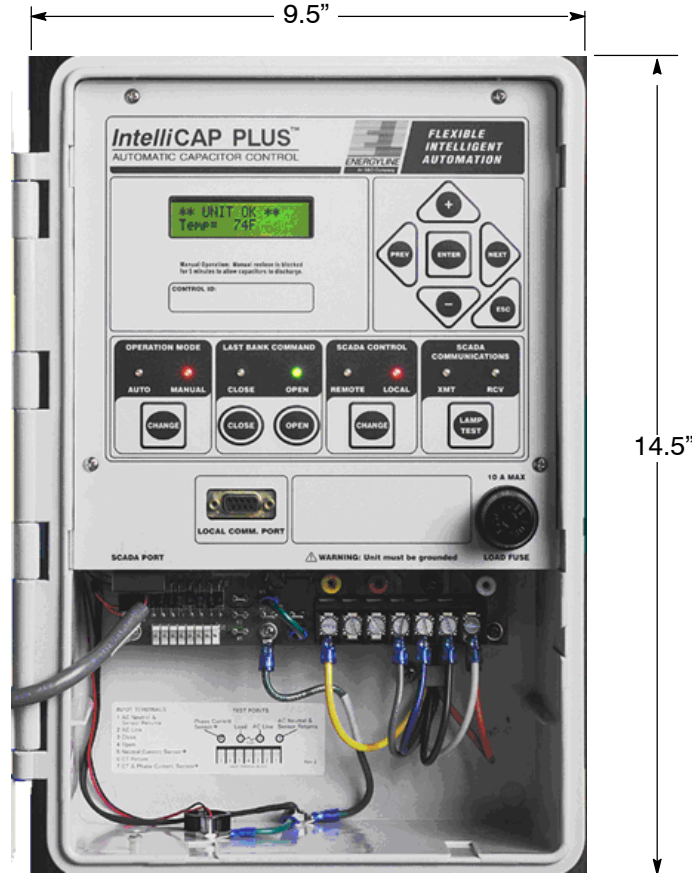


Figure 3  
S&C IntelliCAP PLUS

Table 2 SCADA Capacitor Controls

Material Code	Communication Type	Communication Interface
M031531	Leased Phone Line	Modem
M262886	MDS 9710B	RS-232
M262887	UtiliNet Series 4	RS-232

**Control Strategy for Units in Close Proximity**

When determining settings for capacitor banks located in close proximity to each other, the set points and control strategy should be the same on all banks, except for the time delay settings (see examples below).

**Table 3 Example 1**

	Temperature	Voltage	Time Delay
Bank #1	95-85	121-126	On 45 seconds/Off 45 seconds
Bank #2	95-85	121-126	On 60 seconds/Off 60 seconds
Bank #3	95-85	121-126	On 90 seconds/Off 90 seconds

**Table 4 Example 2**

	Time	Voltage	Time Delay
Bank #1	0800-2100	121-126	On 45 seconds/Off 45 seconds
Bank #2	0800-2100	121-126	On 60 seconds/Off 60 seconds
Bank #3	0800-2100	121-126	On 90 seconds/Off 90 seconds

This will allow Bank #1 to come on first because of the 45 second time delay. Banks #2 and #3 will monitor the rise in voltage. Bank #2 will come on in 15 seconds, if needed, and Bank #3 will come on 15 seconds later, if needed. The capacitor banks will also turn off in sequence, using the off time delay, when the time, temperature, or voltage settings dictate.

***Setting Electronic Controls***

The simplest method of setting the electronic controls is to use a personal computer. Connect the computer to the control using a standard RS-232 DB9 connector for the S&C IntelliCAP and IntelliCAP PLUS. To connect to the HD Electric VarCom 1600 use a standard USB A to B cable. The RS-232 ports on the VarCom 1600 are for used for SCADA only, not computer interface. The control can be set either in the field or in the office.

Each control must be energized in order to receive new settings. After settings have been changed, the program and time clock functions will be stored for up to 10 years without the control being energized. Refer to the manufacturer's manual for details on making settings.

The front panel of all three devices can be used to change their control settings. This is done through two switches on the IntelliCAP, push buttons on the IntelliCAP PLUS, and dials on the VarCom 1600.

***Reclose Block Delay***

To allow the capacitors to discharge, the control prevents the capacitor bank from being switched online for 5 minutes after the bank has been taken offline. If a delay was in effect at the time of a loss of power, the remainder of the delay is enforced on power-up. It must count down completely before the bank can switch online. This feature ensures that the reclose block delay is accounted for in all circumstances. This means that during bench testing, it will no longer be possible to override the reclose block delay by cycling power to the unit. The controls provide an indication that the reclose delay is in effect.

### ***Manual Operation***

The capacitor bank can be switched on or off by placing the Auto/Manual switch in the Manual position and then operating the Open/Close switch. The control contacts are under software control and will close for a selectable period of time. When shipped from the factory, the closure time is 7 seconds, which should be sufficient to operate all switches used at PG&E for capacitor applications.

**Note:** An operation delay is optional on these controls. When enabled, operation will be delayed for a time following the Open/Close switch operation. An indication of this delay is provided, such as the open or close light blinking during the delay period. The recommended default setting is 30 seconds.

### ***Local/Remote Switch***

The Local/Remote switch blocks remote SCADA operation of the capacitor switches when placed in the Local position.

### ***Switching Procedure for SCADA Capacitor Controls***

#### **Secondary Power Present and Control Operational**

1. Place the Local/Remote switch in Local. Tag Caution.
2. Place the Auto/Manual switch in Manual. Tag Caution.
3. Check and confirm the present capacitor switch position.
4. Operate the control Open/Close switch.
5. Verify that the capacitor switches have operated.
6. Place the Local/Remote switch in Remote.

#### **Secondary Power Not Present, Switch or Control Non-Operative**

1. Place the Local/Remote switch in Local. Tag Caution.
2. Place the Auto/Manual switch in Manual. Tag Caution.
3. Check and confirm the present capacitor switch position.
4. Operate all three capacitor switches by hot stick.
5. Place the Local/Remote switch in Remote.

### Control Installation

See Figure 4 for control installation. Consult the manufacturer's instruction manual for detailed installation instructions.

#### Instructions for S&C IntelliCAP and IntelliCAP PLUS

1. Connect the ground lug on the bottom of the control and plug the control into the meter base socket. Notice that the IntelliCAP's relative size is smaller than what is pictured in Figure 4. See Figure 1 on Page 3 for IntelliCAP dimensions.
2. Lock the control to the meter base.

#### Instructions for HD Electric VarCom 1600

1. Rotate the main switch out of the AUTO position or remove the front panel fuse. Align the terminals on the back of the control and press firmly into the meter socket.
2. Use the supplied ring to complete the installation. Attach a ground wire to the external ground lug. Seal or lock the ring only after the entire system has been verified.

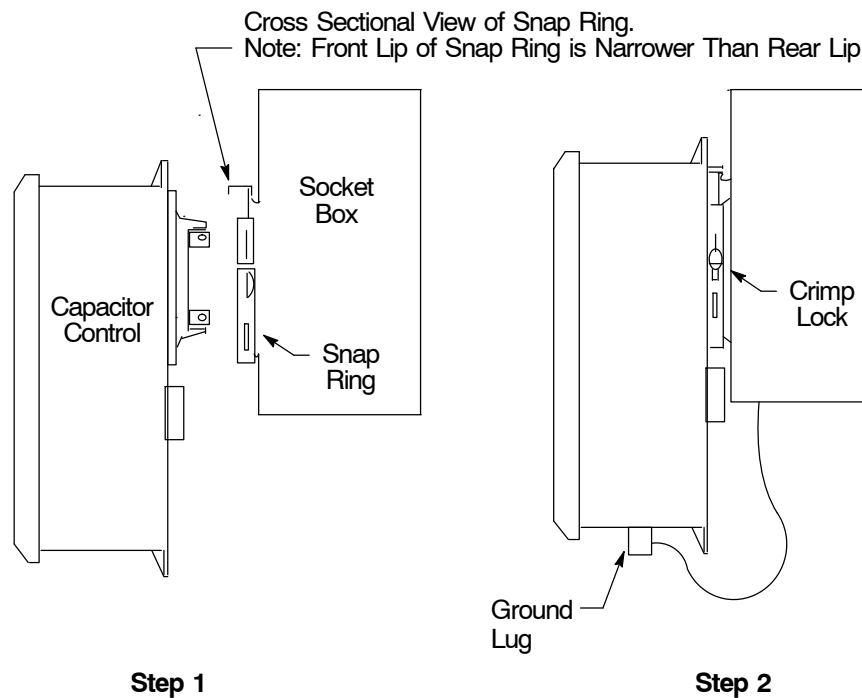


Figure 4  
Control Installation Using Stainless Steel Snap Ring

**Revision Notes**

Revision 08 has the following changes:

1. Updated Table 1 and Table 2.