Orion Capacitor Control System

Introduction

NovaTech Automation has developed the expertise for programming logic schemes for maintaining the balance of the power system using the distribution capacitors. An example is a customer in Tennessee, USA that required an automatic capacitor control logic scheme for their distribution network.

Use Case

The customer has a small distribution network with a large heavy industrial load and is contracted, under penalty of fine, to keep the power factor (PF) of their power system which is connected to a Transmission Network Operator as close to 1.000 as possible. The customer has two substations with interconnecting feeders through their distribution network with the feeder circuit breaker on either end acting as the open or closed point. The capacitors are positioned outside the substation fence at various locations on those interconnected feeders.

Figure 1: Pole-mounted capacitor bank

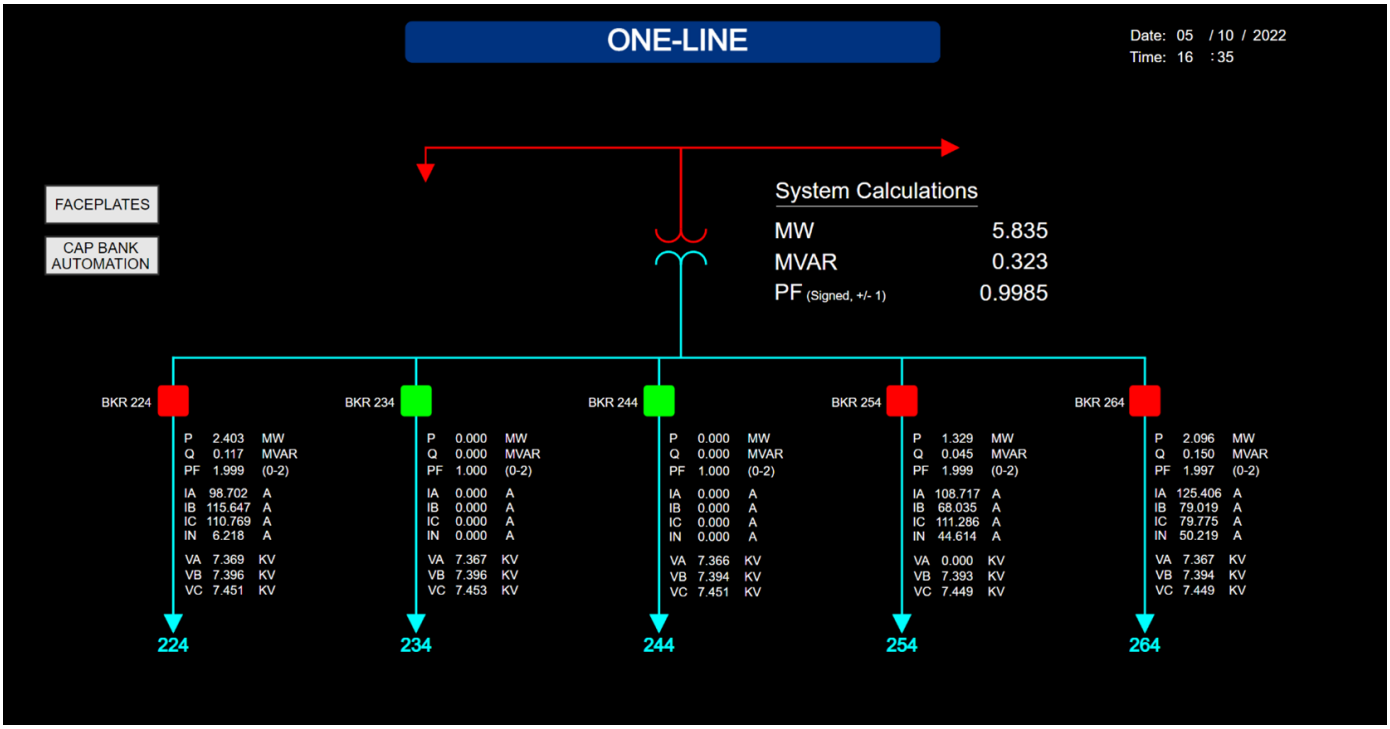

Figure 2: System one line diagram and power factor overview

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System Balance

NovaTech Automation has developed the System Balance scheme to ensure each substation maintains a 1.000 power factor. An additional scheme discussed later that is under consideration will ensure that individual feeders within the two substations are in balance or within tolerance.

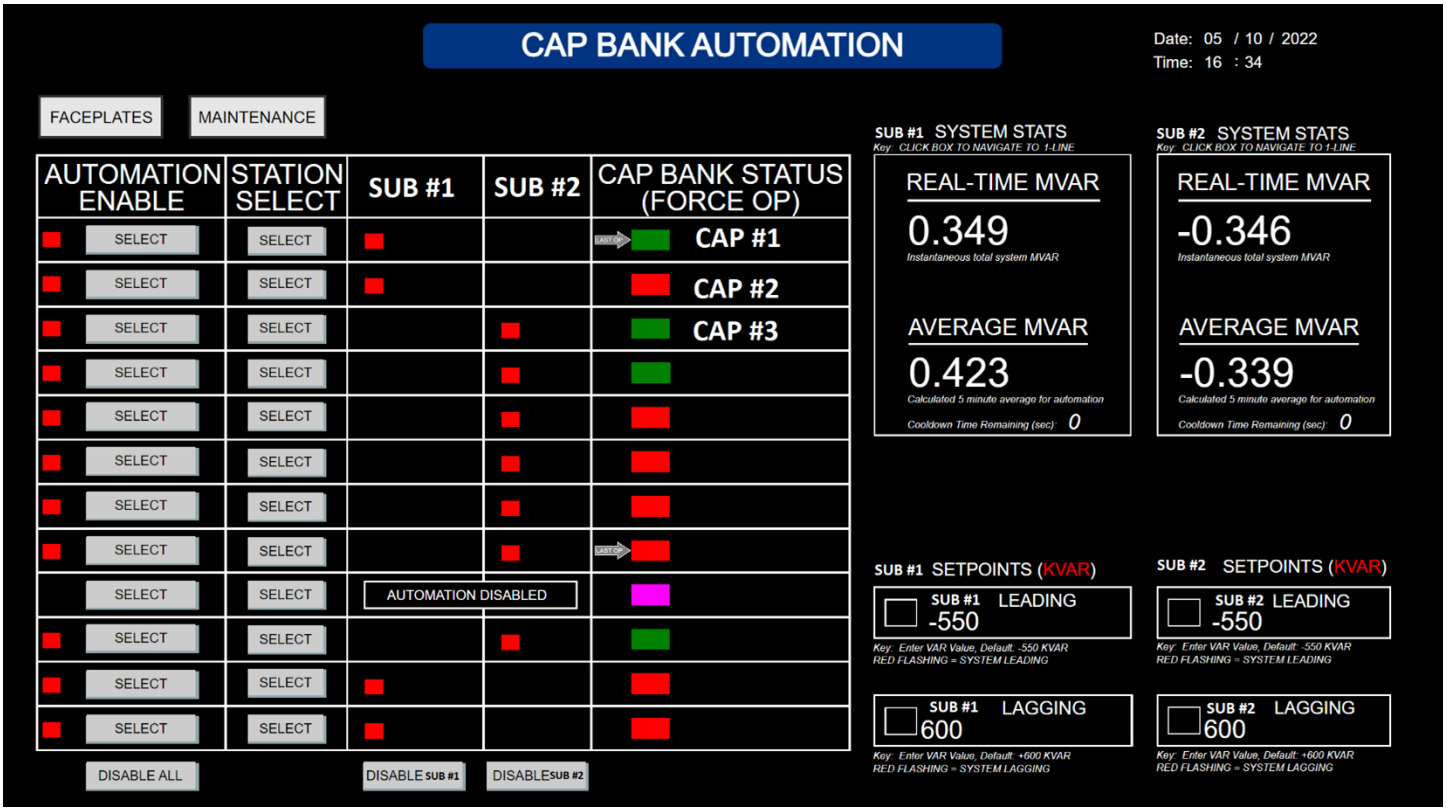
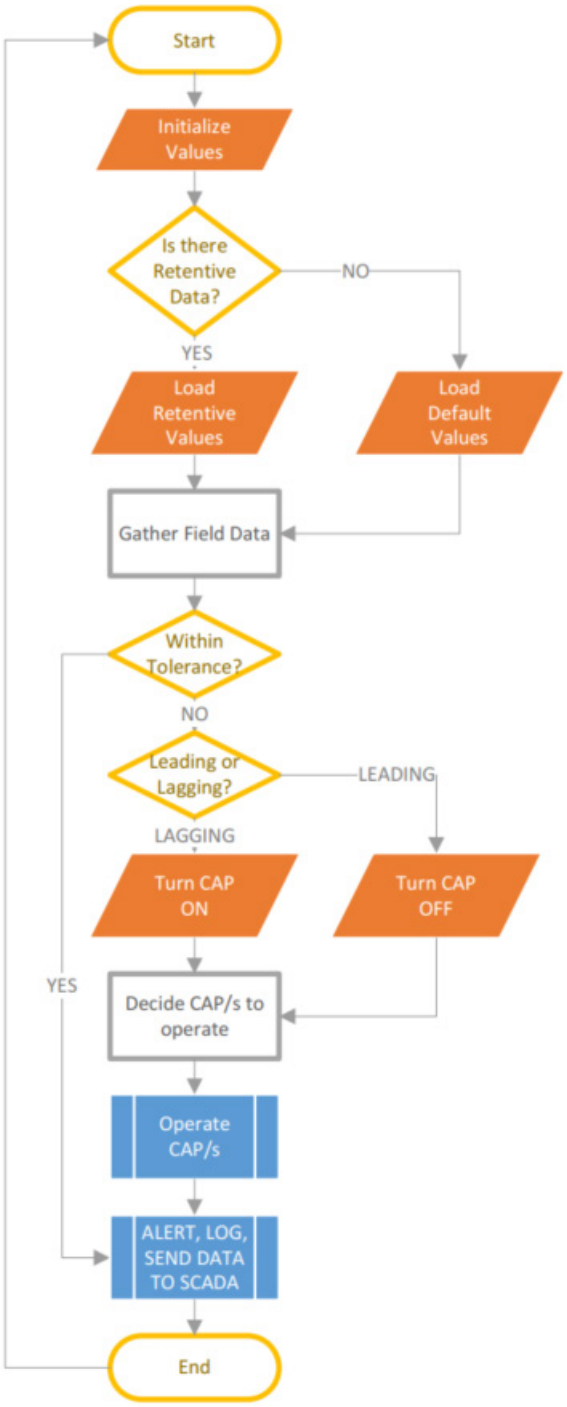


Figure 3: Capacitor automation control screen

System Balance Scheme Features

- It is retentive and will remember its previous state of operation if anything causes the routine to stop, or the system to restart.
- It has configurable tolerance setpoints.
- It can log scheme actions, decisions, and states.
- It can send alerts and alarms via SCADA, email, and/or SMS.
- It can be controlled via SCADA points down to the granularity of individual capacitor participation.
- A dashboard control screen showing System Balance's operations for easy navigation.

System Balance Process



The System Balance scheme will initialize values and then load all previous retentive values, or default values if there are no retentive values. It will then proceed to do the following in order:

1. Read in all applicable data values.
2. Check values against configured or default tolerances.
3. Calculate whether system is leading or lagging (go to step 4) or within tolerance (go to step 7).
4. Calculate how many capacitors need to be operated.
5. Select which capacitor/s to operate based on certain configurable criteria.
6. Operate capacitor/s.
7. Inform and log to SCADA the scheme's actions, if any, then save its current state.

Note that an overall leading power system state will cause one or more capacitors to be turned off, an overall lagging power system state will cause one or more capacitors to be turned on.

Individual Feeder Balance

The second logic scheme will be called Individual Feeder Balance and will run every five minutes, on completion of the System Balance scheme. This is needed due to the configuration of their distribution network assets. It will come with all the alerting and control of the System Balance scheme.

Total substation power factor can be balanced, but it is possible to have two feeders out of balance in the condition of one lagging and one leading. The Individual Feeder Balance scheme looks at individual feeder power factor tolerance and will correct as needed. It calculates the two feeders with the widest variance per substation and then compares them against configured or default tolerances. If a feeder is out of tolerance, a capacitor on that feeder will be operated to correct the balance, independent of the System Balance scheme. If one feeder is leading and another is lagging in the same substation a swap operation will take place to correct both at the same time. There is a maximum of two capacitor operations per logic scheme run to ensure stability. If more operations are determined to be needed, these operations are logged but not operated on until the next scheme run unless corrected by the System Balance scheme.

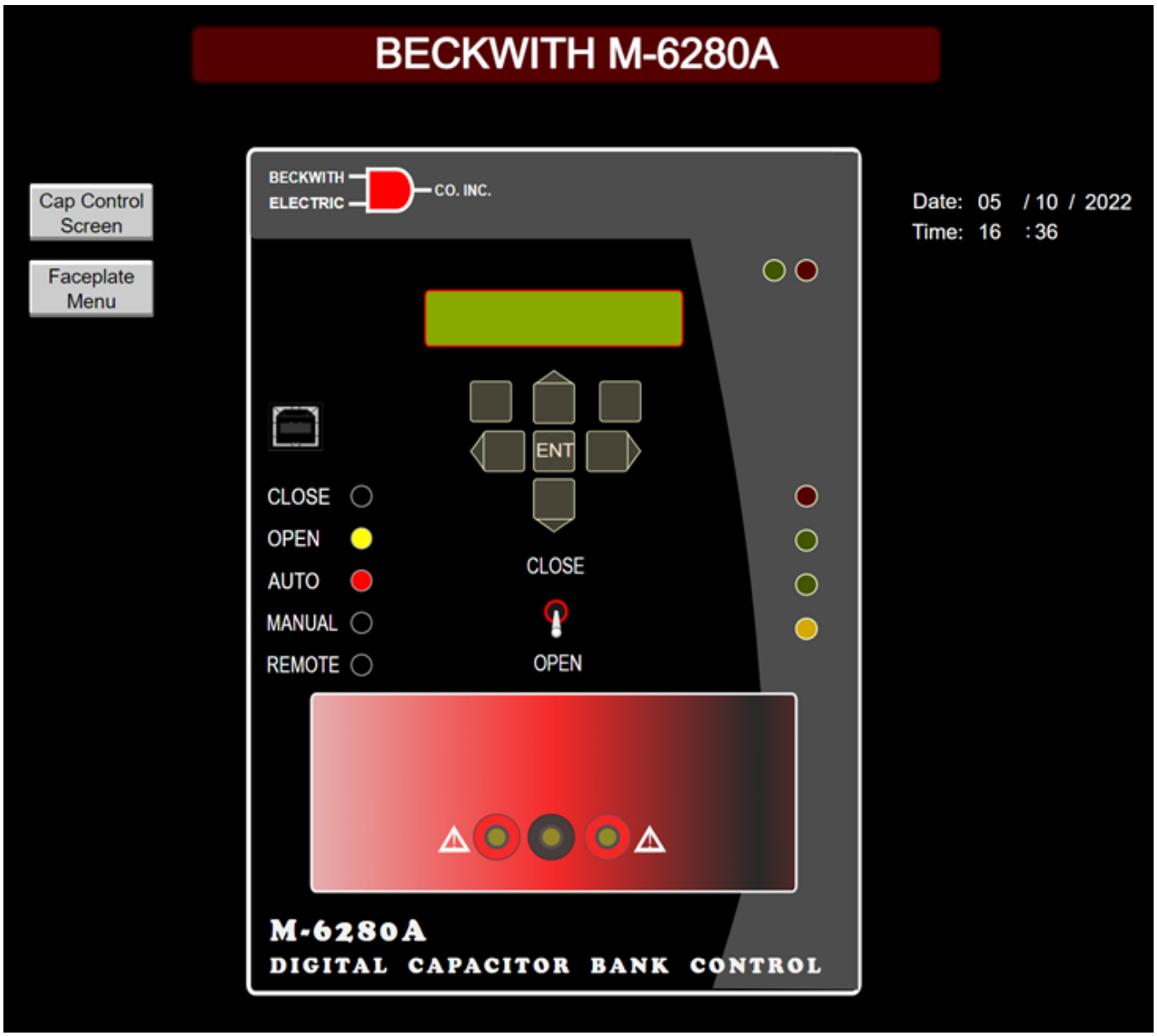


Figure 4: Capacitor Bank Control Module Faceplate Screen

Feedback and Review

The System Balance scheme has been extremely beneficial for the customer in Tennessee. It has reduced the manpower required to look after their distribution grid and has maintained almost full power factor compliance with the Transmission Network Operator.

NovaTech Automation has a proud history of developing logic schemes to help with any utility use case.

Glossary of Terms

Balance	The power system being as close to power factor 1.000 as conceivably possible. Customer required accuracy to 3 decimal places.
Correction	The control system calculates whether the power system is out of tolerance, and if so, initiates a correction to operate a capacitor to move the power factor back towards 1.000.
Leading	The power system has a capacitive nature, and the sine wave of the alternating current is in front of what a sine wave of balance would be. Potential causes: system load drops substantially while capacitors are turned on.
Lagging	The power system has an inductive nature, and the sine wave of the alternating current is behind what a sine wave of balance would be. Potential Causes: Sudden system load that uses motors turn on.
Tolerance	The configurable or default setpoints indicating how tolerant the power system should be to leading or lagging.
Variance	When the system or individual feeders are out of tolerance.

For more information, please book at technical session with one of our sales engineers (**https://booking.novatechautomation.com/**) or visit our website at **https://novatechautomation.com**.

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