Lab 2B: Commissioning SEL Real Time Automation Controller (RTAC) with SEL Protective Relays

1. Due Date for Lab Report

Due Session 29 (April 28), Outreach (Extension on permission)

2. Background information:

The objective of lab 2B is to develop a basic understanding of several types of IEDs and learn how to communicate with them over a network. You will learn how to connect devices and how to use them. This lab will require manual wiring work (already physically connected to all IEDs), learning to use AcSELerator RTAC and AcSELerator QuickSet to complete the interconnection of devices, as well as changing device settings to measure voltage, current, and phase angle.

3. Learning outcomes

- Primary

1. Establish connection to downstream devices from an automation controller. Downstream device options are a SEL 849 relay, SEL 421, SEL 451, SEL 311 or SEL 487). You may also establish DNP communication among two automation controllers to exchange data.
2. Learn how to establish communication between different devices

- Secondary

1. Identify voltage and current tags
2. Use KoCoS ARTES 460 to produce the voltage and current outputs in a proper range for the relay to measure.

3. Equipment

- Hardware:

--SEL 849, SEL 421, SEL 451, SEL 311, SEL 487

--SEL RTAC

--KoCoS ARTES 460

--Desktop PC

--Wiring appropriate for connections (Four insulated voltage cables and four insulated current cables.)

- Software:

--AcSELerator RTAC

--AcSELerator QuickSet

Lab Procedure

Initial Lab Set Up

1. Log into the computer:

   User name: [redacted]

   Password: [redacted]

2. Complete manual wiring job

A. Use a stripped male serial cable to connect the SEL 849 to the SEL RTAC.

Here is the table for SEL-849: (RTAC input):

Pin2- TXD	Red is 2
Pin3- RXD	Orange is 3
Pin5- GND	Blue is 4
Pin8- CTS	Brown is 5
	Black is 6
	White is 7
	Green is 8

When connecting, you may need to use a suitable wire stripper to fix the wire as shown in the figure below.

The rest of the relay devices are physically connected to the RTAC over Ethernet and also are connected to the computer through USB to Serial c662 interface.

B. Use voltage transducer cables to connect to the KoCoS voltage outputs to the SEL 849 voltage inputs in a wye configuration as shown below (Figure 1).

C. Use current transducer cables to connect the KoCoS current outputs through the SEL 849's CT in a wye configuration as shown below (Figure 2).

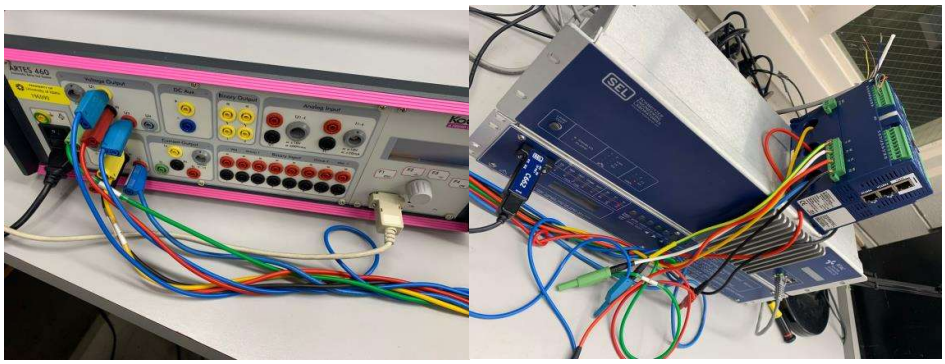


Figure 1: Connection between KoCoS ARTES and SEL 849 voltage inputs

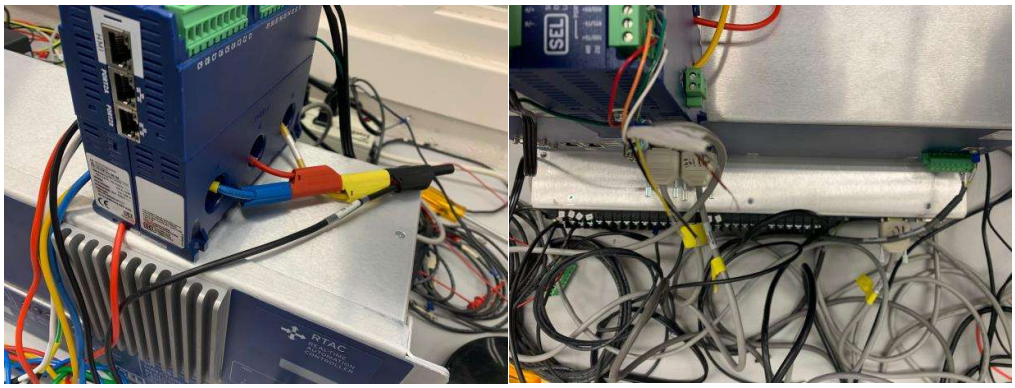


Figure 2: Connection between KoCoS ARTES and SEL 849 current inputs

3. Open the AcSELerator RTAC software
4. Login to the AcSELerator RTAC Database

   User Name:[redacted]

   Password:[redacted]
5. Create a new project

   -- Click New SEL RTAC Project

   -- Set the project name (Your First name or anything else you may want)
6. Connect the SEL-849 to the RTAC

   -- Right click “devices”

   -- choose “Add SEL Device”-800 Series and find SEL-849

   -- For the Protocol, we use SEL Protocol

   -- Choose Client-Serial as our Connection type

Connect the SEL-849 to RTAC

1. Configure the baud rate to 9600
2. Save the setting

3. Click the button “go online” to check the connection

   * watch out which port you use and it can be changed in setting

   * on connector (the offline need be changed to FALSE)

   Password:[redacted]

Setting up SEL-849

1. Right click “Devices”

   --click “Add Other Device”

   --choose “SEL Protocol”

   --choose “Server - Ethernet Tunneled Serial”

2. Now you can find the “port number” we need use on the AcSELerator QuickSet

3. On Other_1_SEL (just the other device you have created)

   -- find setting and “Allow Anonymous SEL IP...” from “FALSE” to “TRUE”

   -- Go online to save the changes.

4. Open AcSELerator QuickSet

5. Click Communication button

   --click network (Active Connection Type)

   -- change the port number to the determined in step 2.

   -- The IP address varies with the port you use on RTAC

Here is the table:

RTAC1 IP Table:

[redacted]	Port 1
[redacted]	Port 2
[redacted]	Port F

RTAC2 IP Table:

[redacted]	Port 1
[redacted]	Port 2
[redacted]	Port F

6. Open the terminal window
7. Login to the SEL 849

   --type acc

   --password[redacted]

   --type 2ac

   --password[redacted]

   --type who

   --type port 2

   --password[redacted]

   display the current setting

   --type sho

   Change the setting of the range (sheet from SEL website)

   --type 2ac

   --password[redacted]

Connect KoCoS to the whole system

1. Connect the KoKoS ARTES 460 to the SEL-849 relay (as picture shown above)
2. Set the voltage, current (60 V_{LN}, 2A, and 60 Hz is what we use on our lab), students should make sure that they will not damage the device).

Lab procedure

1. Open the software AcSELerator RTAC
2. Choose “Devices” - “SEL_849_1_SEL” find Meter
3. Find the “IA” “IB” “IC” “VAB” “VBC” “VCA” inputs and change the setting from False to True
4. Check the voltage current phase angle whether it is true as we set

   -- Go online

-- Find “Tags” and check that

$$|V_{\text{Line-Line}}| = \sqrt{3}|V_{\text{Line-neutral}}|$$

Report:

1. Please describe briefly what you’ve learned in this lab
2. Please add a picture of successful communication with RTAC to any of the devices showing the data exchange worked and the commissioning was successful.

Challenges you may encounter

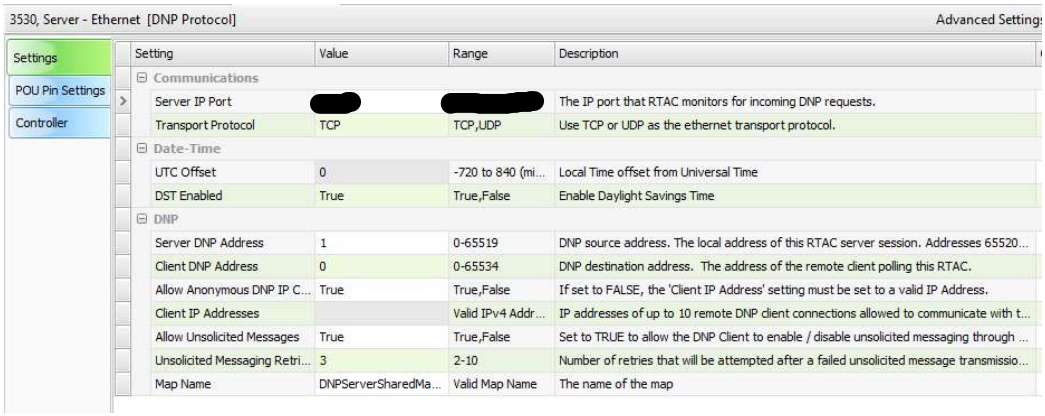
1. Lack of cables (Use wire strippers to cut the wiring)
2. Connection-- After adding the device on the AcSELerator, the device doesn’t connect (Check whether the Project is on-line. if it still doesn’t work, check the IP address and the wiring)
3. The device’s setting cannot be changed (The AcSELerator should be off-line when they need change some settings)
4. Can’t log into the device using AcSELQuickSet (You may verify or change the port number which can be found on the AcSELerator-Meter. Also when they need change the setting the device need go on-line)
5. The voltage tested by the SEL-849 is not true.

$$|V_{\text{Line-Line}}| = \sqrt{3}|V_{\text{Line-neutral}}|$$

RTAC to RTAC Communication:

1. Check RTAC1 IP address from the IP table above for Port 1 and note it down.
2. In AcSELerator Software find the Insert tab from the Ribbons, Click on SEL drop down tab and find 3500 Series side scroll tab. Choose 3530 and click on DNP Protocol. From the same ribbons find Tag List drop down tab and click on DNP Server Shared Map.
3. On the screen popup to choose the type of connection RTAC will make, find Server – Ethernet and click Insert.
4. Find Settings tab in the RTAC Server sub window. Here leave the settings defaults at Server IP Port at 20000. Server DNP Address at 1, Client DNP Address at 0. In Allow Anonymous DNP IP Clients choose True (You can also just enter the IP address of RTAC 2 Port 1 from the RTAC2 IP table).

5. Click on Go Online and upload your settings.

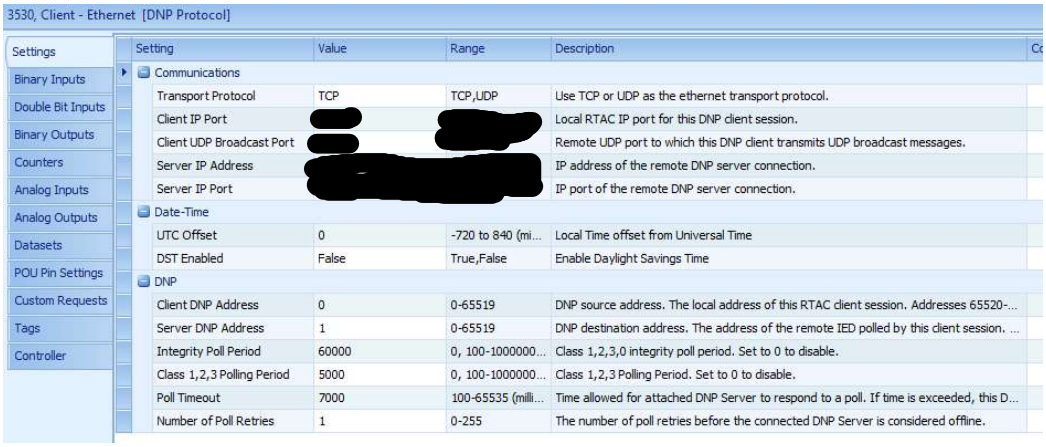


6. Navigate to the second RTAC and repeat the same procedure from Steps 1 and 2, in Step 3 choose Client – Ethernet and click insert.

7. Find Settings tab in the RTAC Client sub window. Here leave the settings defaults at Server IP Port at[redacted]. Server DNP Address at 1, Client DNP Address at 0. In Server IP Address please enter the Port 1 Address of RTAC 1.

8. Click on Go Online and upload your settings.

9. Verify communications by checking the Controller tab and see if ENO is TRUE and Offline is FALSE. You will start seeing the message counters increase on both side of the RTAC which will complete the Commissioning process successfully.

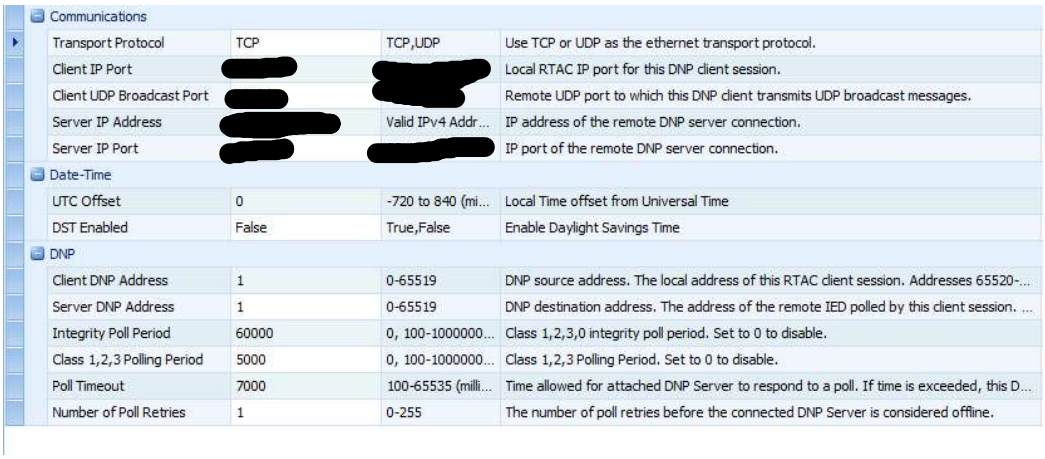


RTAC to Protective Relay Communication:

Relay IP Table:

SEL 451	[redacted]
SEL 411L	[redacted]
SEL 311L	[redacted]
SEL 487E	[redacted]
SEL 421	[redacted]

1. You're a substation engineer tasked with commissioning a Relay and an RTAC, and verify the communication between devices.
2. Choose a Relay for your protection needs, from the Relay IP Table please note down the IP Address of your Relay.
3. Navigate to RTAC AcSELerator software window. In AcSELerator Software find the Insert tab from the Ribbons, Click on SEL drop down tab and find the 400/300 Series side scroll tab and find the appropriate relay you've chosen and click on DNP Protocol.
4. On the screen popup to choose the type of connection RTAC will make, find Client - Ethernet and click Insert.
5. Find Settings tab in the Relay Client - Ethernet sub window. Here leave the settings defaults at Server IP Port at [redacted] or change it to a number between [redacted]. Server DNP Address at 1, Client DNP Address at 1. Enter the IP address of the Relay from your notes from the Relay IP table.
6. Click on Go Online and upload your settings.



Communications			
Transport Protocol	TCP	TCP,UDP	Use TCP or UDP as the ethernet transport protocol.
Client IP Port	[redacted]	[redacted]	Local RTAC IP port for this DNP client session.
Client UDP Broadcast Port	[redacted]	[redacted]	Remote UDP port to which this DNP client transmits UDP broadcast messages.
Server IP Address	[redacted]	Valid IPv4 Addr...	IP address of the remote DNP server connection.
Server IP Port	[redacted]	[redacted]	IP port of the remote DNP server connection.
Date-Time			
UTC Offset	0	-720 to 840 (mi...	Local Time offset from Universal Time
DST Enabled	False	True,False	Enable Daylight Savings Time
DNP			
Client DNP Address	1	0-65519	DNP source address. The local address of this RTAC client session. Addresses 65520-...
Server DNP Address	1	0-65519	DNP destination address. The address of the remote IED polled by this client session. ...
Integrity Poll Period	60000	0, 100-1000000...	Class 1,2,3,0 integrity poll period. Set to 0 to disable.
Class 1,2,3 Polling Period	5000	0, 100-1000000...	Class 1,2,3 Polling Period. Set to 0 to disable.
Poll Timeout	7000	100-65535 (milli...	Time allowed for attached DNP Server to respond to a poll. If time is exceeded, this D...
Number of Poll Retries	1	0-255	The number of poll retries before the connected DNP Server is considered offline.

7. On the Relay side of settings, Open SEL AcSELerator QuickSet software, and choose the relay from the Network Address book in Communications tab and Find the name and IP address of the relay you're connecting to.

8. Click on Parameters in the same Communications tab dropdown. In Connection Name, choose the Relay name from the Address book dropdown. The IP Address should automatically populate. Now click on OK. The software will automatically connect to the relay. Read the settings from the relay by clicking on File tab and Read button. After a few minutes your settings window will popup.

9. Navigate to Port 5 Settings Tree > DNP Protocol Settings.

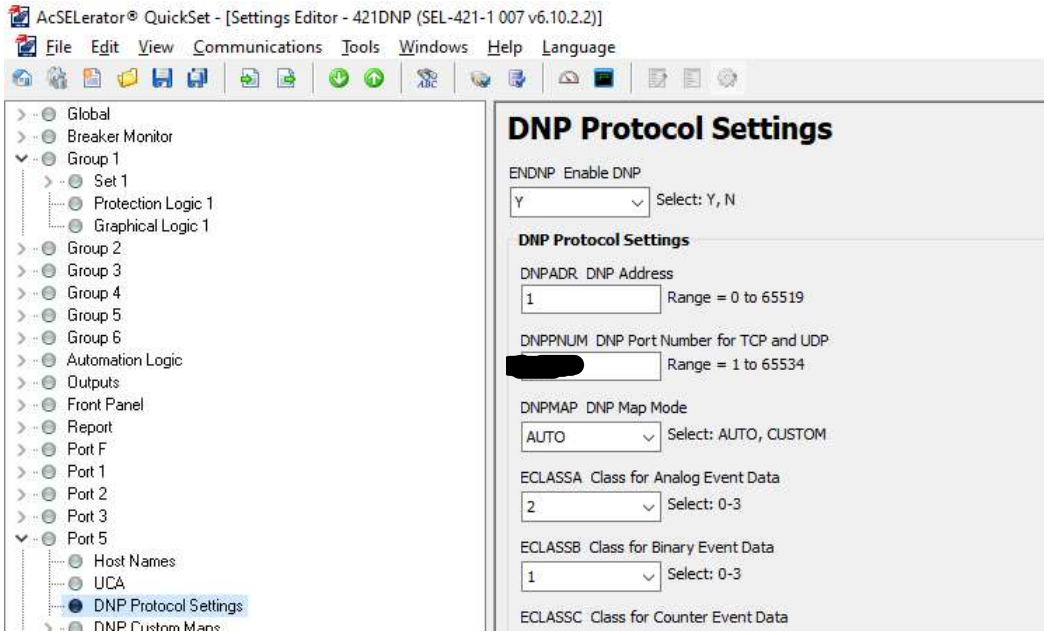
10. In this window, Enable DNP > Y, choose Yes in the tab to enable DNP3. Match the DNP Port Number from the RTAC port you've chosen. Enter the DNP Address as "1".

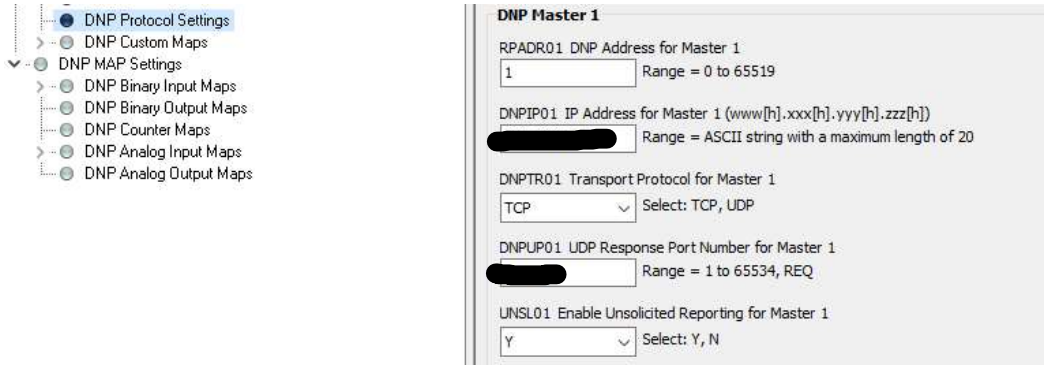
11. Now Navigate to DNP Master 1 section and enter the IP Address of the RTAC2 Port 1. Please make sure you match the port number in UDP Response Port Number for Master 1. Set the DNP Address for Master 1 to "1".

12. Click on File and click Send button to send your settings. Press OK and wait until the relay is online. This may disconnect the relay but you can connect to it again.

13. Navigate to the Controller section of your RTAC Relay Client – Ethernet Window and verify the communication by checking Offline logic bit if it is FALSE and the data counters are incrementing.

14. You've successfully commissioned a relay and established communication. Please take a snip of the controller to submit your report.


AcSELerator® QuickSet - [Settings Editor - 421DNP (SEL-421-1 007 v6.10.2.2)]
File Edit View Communications Tools Windows Help Language
Global
Breaker Monitor
Group 1
Set 1
Protection Logic 1
Graphical Logic 1
Group 2
Group 3
Group 4
Group 5
Group 6
Automation Logic
Outputs
Front Panel
Report
Port F
Port 1
Port 2
Port 3
Port 5
Host Names
UCA
DNP Protocol Settings
DNP Protocol Settings
ENDNP Enable DNP
Y
Select: Y, N
DNP Protocol Settings
DNPADR DNP Address
1
Range = 0 to 65519
DNPPNUM DNP Port Number for TCP and UDP
[redacted]
Range = 1 to 65534
DNPMAP DNP Map Mode
AUTO
Select: AUTO, CUSTOM
ECLASSA Class for Analog Event Data
2
Select: 0-3
ECLASSB Class for Binary Event Data
1
Select: 0-3
ECLASSC Class for Counter Event Data


DNP Protocol Settings
DNP Custom Maps
DNP MAP Settings
DNP Binary Input Maps
DNP Binary Output Maps
DNP Counter Maps
DNP Analog Input Maps
DNP Analog Output Maps
DNP Master 1
RPADR01 DNP Address for Master 1
1
Range = 0 to 65519
DNPIP01 IP Address for Master 1 (www[h].xxx[h].yyy[h].zzz[h])
[redacted]
Range = ASCII string with a maximum length of 20
DNPTR01 Transport Protocol for Master 1
TCP
Select: TCP, UDP
DNPUP01 UDP Response Port Number for Master 1
[redacted]
Range = 1 to 65534, REQ
UNSL01 Enable Unsolicited Reporting for Master 1
Y
Select: Y, N