1. Objective
The objective of this system is to learn synchrophasor system capabilities and analyse the data using a PDC and SEL 351S PMU

2. Introduction
A minimal synchrophasor system consists of phasor measurement units (PMUs) and integrates the collected data into centralized operator displays. A more capable system includes a substation phasor data concentrator (PDC) with archiving capability or a distributed control processor such as a synchrophasor vector processor (SVP). These solutions greatly expand synchrophasor system capabilities.

3. Software Required
SEL Acselerator Quickset, SEL PDC Assistant

4. Installation
- The first steps in setting up the SEL-3573 and SEL 351S are installing the software and connecting the devices.
• Provide the appropriate power and ground connections

5. Ethernet Port Configuration
Use the Ethernet port on the SEL-3573 to connect to the laptop. In order to configure the PDC’s ethernet settings the following changes need to be done to the user’s laptop/desktop. Go to Control Panel > Network and Sharing > Change Adapter Settings > Ethernet Properties.
Then double click on Internet Protocol Version 4 (TCP/IPv4)
Make sure that the IP address, Subnet mask and Default gateway are set to the values shown above.

6. Configuring the PDC Assistant Software
   - Install and Open the SYNCHROWAVE PDC Assistant Software, and select New, as shown in Figure
• Select the appropriate PDC model (SEL 3573) and the version number
• Select the Settings > Inputs tab, and click Add PMU, as shown in Figure

• Set up the added PMU by entering a Station Name, PMU ID, and Data Rate. Ensure that the Enabled box is checked. The Station Name, PMU ID, and Data Rate must exactly match what was set in the relay.
• Under Primary Connection, select TCP for the transport protocol. Input the IP address (IPADDR) and command port number (PMOTCP1) of the SEL-351S, as shown in Figure 43. This protocol and the port number need to match the PMU synchrophasor output settings.
• Click the Query Tags button
• All of the possible measurement tags load. Click on the Edit Tags button to add or remove any of the measurement tags. Figure below shows the interface used to add new tags or to remove tags.
• Real and Reactive Three-Phase Power Calculation Setup
Click Settings > Calculations on the menu to configure SYNCHROWAVE PDC for the necessary power calculations. Then click the Add Calculation Group button, as shown.

• Select the Target PMU to use for the power calculations

• Click the Add Calculation button, and then click Power on the drop-down menu
• Set up the A-phase power calculation by selecting the corresponding voltages and currents, as shown in Figure 48. Complete the procedure in Steps 1 through 4 for each of the three phases.

• Click the Add Calculation button, and then click Algebra on the drop-down menu, as shown in Figure 49. Summing the individual phase power is required to meet the PRC-002-2 three-phase power requirements.
- Add the A- and B-phase real powers together

- Add the C-phase real power to the previous A- and B-phase real power summation

7. Archiving the setup
- Click Archives on the menu to configure SYNCHROWAVE PDC for archiving data using continuous recording. Then click the Add Continuous Archive button

- Set up the added archive by entering the Archive Name, Archive Retention, and Data Rate.
Check the Archive Enabled box

- Click the Edit button in order to select which tags are archived.
- Select the measurement tags to be archived, click Add, and then click OK. PRC-002-2 requires measurements for all phase voltages, phase currents, frequency, and three-phase real and reactive power.
8. Sending settings to PDC and Data Collection from 351S
   - Click the Send Settings button. This will establish a connection with the PDC. If the settings have already been sent to the PDC, the Connect button can be clicked instead.
   - Click on Connect and enter the following details:
     Username: ASU_SEL
     Password: Asu12345@
Select Status > Real-time. This window shows the connection status with the relay and archive status of the PDC.
### Real-time Status

#### Input Connections

<table>
<thead>
<tr>
<th>Name</th>
<th>PDC ID</th>
<th>Connection State</th>
<th>Time Quality</th>
<th>Received Data Frames</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEST STATION 1</td>
<td>1</td>
<td>Receiving Data</td>
<td>Normal</td>
<td>13590</td>
</tr>
</tbody>
</table>

#### Network Latency

- **Maximum Latency:** ~1 minute(s) (00:01:03.5252630)
- **Average Latency:** ~1 minute(s) (00:01:03.5432730)

#### Frames

- **Data Frames:** 13590
- **Missed Frames:** 252276
- **Duplicate Data:** 0
- **Past Data:** 0
- **Configuration:** 1
- **Command:** 3

#### Additional Information

- **Archive No:** 11112009.0
- **Start Time:** 06.304240
- **Data Available:** 112114.6
9. Set Up File Archive for DDR

- To configure a collection of the archived data into the same folder as the fault recording and SOE report files, select Local Services > Archive Collection Service > Configure Collection Service

- Set up the name, location, and format of the archive
10. Relay and Clock Settings
   1. Install and Open SEL AcSElerator QuickSet.
2. Create new Project and Select Device family, model, and version from device Part No (P/N).
3. Enter Device Part No. as per given Part no. (P/N) make sure serial no. as well.
4. Use Terminal function to read or change the setting as per requirement.

   Example: use of sho command
   
   To open the Terminal window, Click terminal function or press Ctrl-T.

   • Now press enter and if you get same reply that means now relay is connected and communicating.

   • To read and change the settings, we need user name and password

      First level (to read): Username: acc (acc is just a command)
      Password: OTTER (Capital)

      Second level (to change or write): Username: 2ac (2ac is just a command)
      Password: TAIL (Capital)
• Now type sho to read and change the settings. And for additional command, please read the SEL-351s instruction manual from page 565.

```sh
==> sho

Group 1
Invalid Command
==> sho

Group 1
Group Settings:
RID =FEEDER 1
CTR - 2  CTRN - 1  TID =STATION A
VNOM = 67.00
Z1MAG - 2.14  Z1ANG = 68.66  ZOMAG - 6.38  Z0ANG - 72.47
IL = 4.84
ESOP = 1  ES0N = N  ES0G = N  ES0Q = N
ES1P = N  ES1N = N  ES1G = N  ES1Q = N
ES2 = N  ELOAD = N  ESOTF = N  EVOLT = Y
E25 = N  EFLOC = Y  ELOP = N  EC0MN = N
E61 = N  E79 = 3  ESV = 1  EDEN = TM
EFWR = N  ESSI = N
50P1P = 2.70
67P1D = 100.00
50P1P = OFF
27P1P = OFF  27P2P = OFF  59P1P = OFF  59P2P = OFF
59N1P = 0.20  59N2P = 0.20  59QP = 0.50  59V1P = OFF
27SP = OFF  59S1P = OFF  59S2P = OFF  27PP = OFF
59FP = OFF

Press RETURN to continue
```

5. Define Synchronized Phasor Measurement Unit as per following.

Example:
• Global > Synchronized Phasor Measurement Setting.
Global > Time and Date Management Setting.
### Time And Date Management Settings

**IRIGC IRIG-B Control Bits Definition**
- C37.118
  - Select: NONE, C37.118

**UTC_OFF Offset from UTC**
- -7.00
  - Range = -24.00 to 24.00

**DST_BEGM Month to Begin DST**
- NA
  - Range = 1 to 12, NA

**DST_BEGW Week Of The Month to Begin DST**
- 2
  - Range = 1 to 3, L

**DST_BEGD Day Of The Week To Begin DST**
- SUN
  - Select: SUN, MON, TUE, WED, THU, FRI, SAT

**DST_BEGH Local Hour To Begin DST**
- 2
  - Range = 0 to 23

**DST_ENDM Month To End DST**
- 11
  - Range = 1 to 12

**DST_ENDW Week Of The Month to End DST**
- 1
  - Range = 1 to 3, L

**DST_ENDD Day Of The Week To End DST**
- SUN
  - Select: SUN, MON, TUE, WED, THU, FRI, SAT

**DST_ENDH Local Hour To End DST**
- 2
  - Range = 0 to 23

- Global > Port 5 > Ethernet Synchrophasor Settings.
6. Connect SEL-2401 Satellite-Synchronized clock with the SEI 531s.

7. Open terminal window and type `time` command to check to ensure correct time and date.
FEEDER 1
STATION A
Level 1
=>
=>2ac
Password: ? ****

FEEDER 1
STATION A
Level 2
=>>clock
Close Breaker  (Y/N)?
Command Aborted
=>>
=>>
=>>time
15:46:03
=>>

Date: 10/12/19   Time: 15:45:27.712
Date: 10/12/19   Time: 15:45:39.459