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COMMISSIONING GUIDE**

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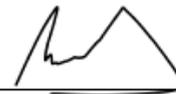
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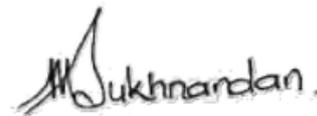
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## **1. Introduction**

This document outlines the steps required to adequately commission the SEL-2240 Axion Station IED and associated peripherals in accordance with the design.

## **2. Supporting clauses**

### **2.1 Scope**

This document covers the commissioning procedures for the SEL-2240 Axion Station IED and associated peripherals.

#### **2.1.1 Purpose**

The purpose of this document is to detail the guidelines to be followed after the physical installation of the Common Equipment Panel, containing the Station IED 1 and Station IED 2 SEL-2240 Axion Station IEDs and associated peripherals in a substation control room. The guideline covers the connections to other systems, so as to ensure the safe and proper working of the equipment prior to energising, and to ensure it operates correctly after energising.

#### **2.1.2 Applicability**

This document shall apply throughout the Transmission Division, Eskom Holdings Limited.

## **2.2 Normative/informative references**

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

### **2.2.1 Normative**

- [1] ISO 9001, Quality Management Systems.
- [2] 240-64100247 – Standard for Earthing of Secondary Plant in Substations
- [3] SEL-3555 Substation, Instruction Manual
- [4] SDR, Eskom Transmission Integrated Protection and Substation Automation Solution System Design Report
- [5] 20-FDS, Functional Design Specification of Substation Gateway and Station RTU/IED for EHV Substations
- [6] 20-DDS, Detailed Design Specification of Substation Gateway and Station RTU/IED for EHV Substations
- [7] 23-Commissioning, SEL-2488 GPS Time Synchronising Unit Commissioning Guide
- [8] 20-Configuration, Configuration Guide of SEL-3555 Substation Gateway and SEL-2240 Station RTU/IED for EHV Substations
- [9] 20-Maint-IED, Maintenance Standard for the SEL-2240 AXION Station IED

### **2.2.2 Informative**

None.

## 2.3 Definitions

### 2.3.1 General

Definition	Description
Ping	Means the computer network administration software utility that is used to determine whether a specific IP address is accessible.

### 2.3.2 Disclosure classification

**Controlled disclosure:** controlled disclosure to external parties (either enforced by law, or discretionary).

## 2.4 Abbreviations

Abbreviation	Description
AC	Alternating Current
AUX	Auxiliary
CD	Compact Disc
DC	Direct Current
DHCP	Dynamic Host Configuration Protocol
DIN	Deutsches Institut für Normung
DVD	Digital Versatile Disc
EtherCAT	Ethernet for Control Automation Technology (IEC 61158)
FTP	File Transfer Protocol
IDF	Intermediate Distribution Frame
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device
IP	Internet Protocol
ISO	International Organisation for Standardisation
LED	Light-Emitting Diode
MAC	Media Access Control
MCB	Miniature Circuit Breaker
NTP	Network Time Protocol
PC	Personal Computer
ROM	Read-Only Memory
RTAC	Real-Time Automation Controller
RTU	Remote Terminal Unit
RX	Receive
SCADA	Supervisory Control and Data Acquisition
SEL	Schweitzer Engineering Laboratories

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Abbreviation	Description
SNTP	Simple Network Time Protocol
TCP	Transmission Control Protocol
TX	Transmit
Vac	Volts Alternating Current
Vdc	Volts Direct Current
VLAN	Virtual Local Area Network

## 2.5 Roles and responsibilities

Work roles and responsibilities are allocated according to requirements and individual competencies. All managers of Eskom Holdings Limited Transmission Division will ensure that this document is complied with in respect of the commissioning of all SEL-2240 Axion Station IED applications.

## 2.6 Process for monitoring

Not applicable.

## 2.7 Related/supporting documents

Not applicable.

# 3. SEL-2240 Axion Station IED commissioning procedure

## 3.1 Prerequisites

Only employees who are deemed competent to work on the SEL-2240 Axion Station IED are permitted to perform visual inspections, carry out diagnostics, and commission the device.

This procedure applies to each SEL-2240 Axion Station IED that may be installed in a substation. Typically, there are two SEL-2240 Axion Station IEDs in a Common Equipment Panel per substation, which are designated as Station IED 1 and Station IED 2.

## 3.2 Requirements

- 1) The SEL-2240 Axion Station IED shall be commissioned according to a pre-determined commissioning plan prepared by the Commissioning Team.
- 2) A commissioning report outlining all completed works as well as any outstanding work shall be completed by the Commissioning Team.
- 3) The as-commissioned signal list and configuration files shall be stored in the Eskom standard configuration management system in operation at the time.
- 4) The Common Equipment Panel containing the SEL-2240 Axion Station IEDs installed at the substation shall adhere to the relevant installation and earthing standards [2].

## 3.3 Commissioning plan

- 1) A commissioning plan is essential to the successful commissioning of the SEL-2240 Axion Station IEDs.
- 2) The final commissioning plan shall be distributed to all stakeholders prior to commissioning. These parties include but are not limited to the following:
  - a) Managers of Control Centre(s);

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- b) The Protection, Metering/Measurement, DC and substation control commissioning teams involved in the project;
- c) The Project Manager; and
- d) The Substation Control Applications Engineer.

## 4. Required tools and equipment

### 4.1 Hardware

- A 5-metre Category 5e (or better) Ethernet cable;
- A 1,8 metre USB 2.0 cable – A-Male to B-Male;
- A punch-down tool for insulation displacement connectors (Krone LSA-PLUS punch blocks);
- A laptop with the software installed on it, as listed below.

### 4.2 Software

- SEL AcSELerator RTAC v139 software;
- Web Browser e.g. Google Chrome, Internet Explorer, or Mozilla Firefox;
- Command Prompt – Included with Windows programs.

### 4.3 Pre-commissioning checks

All pre-commissioning checks have to be performed **PRIOR** to powering up the Common Equipment Panel containing the SEL-2240 Axion Station IEDs.

#### 4.3.1 Drawings

- 1) Ensure that the latest revision of the application drawings has been issued to the commissioning team.
- 2) Any changes that may be necessary must first be verified with the application engineer. All modifications shall be marked up on the issued drawings. A copy of all marked-up drawings must be submitted to the responsible application engineer so that the as-built revision of the drawings can be generated.

#### 4.3.2 Check hardware build

Check that the installed SEL-2240 Axion units (Station IED 1 and Station IED 2) have the correct build and port interfaces. The part number for the SEL-2240 Axion chassis backplane is shown in Table 1.

**Table 1: SEL-2240 Chassis Backplane**

Description	Part Number	Configuration Summary
SEL-2242 Chassis/Backplane	2242R1X0	Horizontal Rack Mount, 5U 10 Slot, 19-inch Rack Width

The part numbers for the SEL-2240 Axion Station IEDs and the chassis backplane slot positions for the modules are shown in Table 2.

Table 2: SEL-2240 Axion module configuration

Description	Part number	Configuration summary	Chassis slot position
SEL-2241 RTAC Module	2241X21323X000XXXX	<p><b>Ethernet Connections:</b> Two 100BASE-FX (Multimode)                      Web Human Machine Interface (HMI): Basic HMI Run-Time Licence</p> <p><b>Client Protocols:</b> SEL, DNP3, Modbus, IEC 60870-5-101/104, C37.118 Synchrophasors, L&amp;G 8979, CP2179, SNMP, IEC 61850 MMS and MMS Client File Services</p> <p><b>Server Protocols:</b> SEL, DNP3, Modbus, L&amp;G 8979, SES-92, IEC 60870-5-101/104, C37.118 Synchrophasors, CDC Type II, IEC 61850 MMS and MMS Server File Services</p> <p><b>Peer-to-Peer Protocols:</b> Mirrored Bits, IEC 61850 GOOSE</p> <p>Library Extension Support: FileIO</p>	A
SEL-2243 Power Coupler Module	224312X0	<p><b>Power Supply Rating:</b> 125/250 Vdc; 120/240 Vac</p> <p>Communications Ports: Two 100BASE-FX</p>	B
SEL-2244-3 Digital Output Module (x1)	22443131X0	16 Standard Current Digital Outputs: Form A Control Outputs	C
SEL-2245-2 DC Analog Input Module (x1)	22452121XX0	<b>DC Analog Input:</b> 16 AI ( $\pm 20$ mA, $\pm 2$ mA, $\pm 10$ V)	D
SEL-2244-2 Digital Input Module (x3)	22442222X0	24 Digital Inputs: 48 Vdc/Vac	E, F and G

4.3.3 SEL-2240 Axion Station IED Front

The front panel of the SEL-2240 Axion Station IED provides access to the status indicators, the lamp test push-button and diagnostic LEDs, as shown in Figure 1.



Figure 1: SEL-2240 Station IED Front Panel

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**SEL-2240 Axion Station IED Front Panel LEDs**

The front panel of the SEL-2240 Axion Station IED is equipped with diagnostic LEDs to indicate the health and status of the device. Figure 3 describes each LED.

**Table 3: Front Panel LED Indicators**

LED	State	Description	
ENABLED LED per slot for slots A to J	Green	Indicates the following dependent on the module:	
		SEL-2241 RTAC Module	Module has passed self-tests and is operational.
		SEL-2243 Power Coupler Module	The ENABLED LED is related to the backplane EtherCAT network operation. The green ENABLED LED will illuminate when the module is operating normally on the network.
		SEL-2244-2 Digital Input Module	
		SEL-2244-3 Digital Output Module	
	SEL-2245-2 DC Analog Input Module		
	Off	Module is conducting power-on self-tests; or There is no power to the module.	
ALARM LED per slot for slots A to J	Red	Indicates the following dependent on the module:	
		SEL-2241 RTAC Module	Module is halted or booting, or an alarm condition has occurred
		SEL-2243 Power Coupler Module	The ALARM LED is related to the backplane EtherCAT network operation. The ALARM LED will illuminate RED during network initialisation or when there is a problem with the network.
		SEL-2244-2 Digital Input Module	
		SEL-2244-3 Digital Output Module	
	SEL-2245-2 DC Analog Input Module		
	Off	No abnormal or alarm condition exists on the relevant module.	

**4.3.4 SEL-2240 Axion Station IED Rear**

The rear of the SEL-2240 Axion Station IED provides access to the communication ports, field wiring connections, status indicators, user connections, and power coupler units. The module faceplate LEDs are described per module in 4, 5, 6, 7, and 8 below.

**Table 4: SEL-2243 Power Coupler Module LED Indicators**

Module	LED	State	Description
 <p>SEL-2243 Power Coupler Module</p>	ENABLED	Green	The ENABLED LED is related to the backplane EtherCAT network operation. The green ENABLED LED will illuminate when the module is operating normally on the network.
		Off	Module is conducting power-on self-tests; or There is no power to the module.
	ALARM	Red	The ALARM LED is related to the backplane EtherCAT network operation. The ALARM LED will illuminate RED during network initialisation or when there is a problem with the network.
		Off	No abnormal or alarm condition exists on the relevant module.
	POWER	Green	The POWER LED will illuminate if incoming power is present and the power supply is operating normally.
		Off	No power is present to the module.

**Table 5: SEL-2241 RTAC Module LED Indicators**

Module	LED	State	Description	
 <p>SEL-2241 RTAC Module</p>	ENABLED	Green	Unit has passed self-tests and is operational.	
		Off	Module is conducting power-on self-tests; or there is no power to the module; or there is an alarm condition on the device.	
	ALARM	Red	Indicates that the system is halted or booting, or that an alarm condition has occurred.	
		Off	No abnormal or alarm condition exists on the module.	
	COM 1 to 4 (not used in this application)	Green	Indicates activity on serial ports.	
		Off	The LED is off when there is no serial communications activity.	
	AUX LEDs	Bicolour	Three bicolour AUXILIARY LEDs which are customisable for the application. By default, these are applied as follows: The AUX 1 LED is used to indicate the communications status to the Substation Gateway 1. (Green = Substation Gateway 1 is online, Red = Substation Gateway 1 is offline) The AUX 2 LED is used to indicate the communications status to the Substation Gateway 2. (Green = Substation Gateway 2 is online, Red = Substation Gateway 2 is offline) The AUX 3 LED is used to indicate the time synchronization status (Green = Synchronised from the SEL-2488 GPS clocks, Red = Not synchronised from the SEL-2488 GPS clocks).	

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**Table 6: SEL-2244-2 Digital Input Module LED Indicators**

Module	LED	State	Description
 <p>SEL-2244-2 Digital Input Module</p>	ENABLED	Green	The ENABLED LED is related to the backplane EtherCAT network operation. The green ENABLED LED will illuminate when the module is operating normally on the network.
		Off	Module is conducting power-on self-tests; or There is no power to the module.
	ALARM	Red	The ALARM LED is related to the backplane EtherCAT network operation. The ALARM LED will illuminate RED during network initialisation or when there is a problem with the network.
		Off	No abnormal or alarm condition exists on the relevant module.

**Table 7: SEL-2244-3 Digital Output Module LED Indicators**

Module	LED	State	Description
 <p>SEL-2244-3 Digital Output Module</p>	ENABLED	Green	The ENABLED LED is related to the backplane EtherCAT network operation. The green ENABLED LED will illuminate when the module is operating normally on the network.
		Off	Module is conducting power-on self-tests; or There is no power to the module.
	ALARM	Red	The ALARM LED is related to the backplane EtherCAT network operation. The ALARM LED will illuminate RED during network initialisation or when there is a problem with the network.
		Off	No abnormal or alarm condition exists on the relevant module.

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**Table 8: SEL-2245-2 DC Analogue Input Module LED Indicators**

Module	LED	State	Description
 <p>SEL-2245-2 DC Analogue Input Module</p>	ENABLED	Green	The ENABLED LED is related to the backplane EtherCAT network operation. The green ENABLED LED will illuminate when the module is operating normally on the network.
		Off	Module is conducting power-on self-tests; or There is no power to the module.
	ALARM	Red	The ALARM LED is related to the backplane EtherCAT network operation. The ALARM LED will illuminate RED during network initialization or when there is a problem with the network.
		Off	No abnormal or alarm condition exists on the relevant module.

**4.3.5 Panel inspection**

Before powering up the Common Equipment Panel which houses both the Station IED 1 and Station IED 2 SEL-2240 Axion Station IEDs, visually inspect the equipment for any physical damage and perform the following quality checks.

- 1) Inspect the SEL-2240 Axion Station IEDs for physical damage.
- 2) The interior of the panel must be clean and dry.
- 3) Ensure that there is free air-flow to the SEL-2240 Axion Station IEDs with no obstructions.
- 4) All metal parts, equipment, and blanking plates must be earthed to the panel earth bar; and the continuity of all earths must be confirmed.
- 5) The earthing cable used to bond the Common Equipment Panel which houses the SEL-2240 Axion Station IEDs to the substation earth bar, does not exceed 0,5 m [2]. The continuity of this earth must be confirmed and the impedance may not exceed 0,1 Ω [2].
- 6) Ensure that all the rack-mounted equipment, including the SEL-2240 Axion Station IEDs, is securely mounted and that no equipment has come loose during transportation and placement in the substation control room.
- 7) All identifying details, including the name, serial numbers or type codes of equipment must be checked and/or recorded.
- 8) All labels have to be in accordance with the scheme drawing.
- 9) All terminations shall be checked for tightness in compliance with the panel design.
- 10) All terminations using insulation displacement, i.e. the IDF in the Common Equipment Panel, shall be checked for continuity and punched down if necessary.
- 11) All circuits must be verified as per the electrical schematics (application drawings) for the scheme.
- 12) All communication circuits must be verified as per the application drawings for the scheme.

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#### 4.3.6 Check Physical Interfaces and Cable Connectors

- 1) Check that all connectors are securely connected to the cables.
- 2) Check that the power terminal blocks are tightly fitted to the unit, and that the securing screws for the power terminal blocks have been tightened.
- 3) Check that the terminal block protective covers are installed (as applicable).
- 4) Check that the Main 1 DC power supply is connected to Station IED 1 and that the Main 2 DC power supply is connected to Station IED 2.
- 5) Inspect the connectors and cables between items of equipment and ensure that their connections to the SEL-2240 Axion Station IED are firm. The use of strain-relief mechanisms must be verified (e.g. thumbscrews).
- 6) Check that all cables are firmly fitted to their correct interface on the networking hardware as per the connection diagram.
- 7) The integrity of any protective shielding connection (for communications cables) must be checked and must be correctly earthed.
- 8) Check that the physical interfaces on all units are not damaged/obstructed in any way.
- 9) Ensure that unused fibre-optic interfaces have their dust covers in place.

#### 4.3.7 Check External DC Power Connections and MCBs

- 1) Verify that the DC power cables to the Common Equipment Panel are connected to the correct circuits on the Main 1 and Main 2 DC distribution boards, and that the supply voltage is as indicated on the drawings. Ensure that the MCBs feeding the Common Equipment Panel at the DC distribution boards are off.
- 2) Confirm that the DC power cable numbers and wire ferrule numbers are correct in accordance with the application drawings.
- 3) Check that the DC power supply cables have enough slack and are correctly installed, glanded, and terminated.
- 4) Verify that the rating of the DC MCBs is correct as per the application drawing.
- 5) Check that the DC power cables are connected to the correct input terminals.

#### 4.3.8 Check External AC Power Connections and MCBs

Two AC supply cables are connected to the Common Equipment Panel. One cable is used to illuminate the Panel Not Healthy (PNH) lamp and the other is used to supply the plug socket. The difference between the two supplies is that the AC supply powering the plug socket is earth-leakage protected.

##### 4.3.8.1 Unprotected AC supply

- 1) Verify that the AC power cable is connected to the correct circuit at the AC distribution board. Ensure that the MCB at the AC distribution board is off.
- 2) Confirm that the AC power cable number and wire ferrule numbers are correct in accordance with the application drawings.
- 3) Check that the AC power supply cable has enough slack and is correctly installed, glanded, and terminated.
- 4) Verify that the rating of the AC MCB is correct as per the application drawing.
- 5) Check that the AC power cable is connected to the correct input terminals.

**4.3.8.2 Protected AC supply**

- 1) Verify that the AC power cable is connected to the correct circuit at the AC distribution board. Ensure that the MCB at the AC distribution board is off.
- 2) Confirm that the AC power cable number and wire ferrule numbers are correct in accordance with the application drawings.
- 3) Check that the AC power supply cable has enough slack and is correctly installed, glanded, and terminated.
- 4) Verify that the rating of the AC MCB is correct as per the application drawing.
- 5) Check that the AC power cable is connected to the correct input terminals.

**4.3.9 Check Failsafe Alarm Connections**

Check that the SEL-2240 Axion Station IED from the SEL-2241 RTAC OUT101 (alarm) contact is correctly connected to the NC (normally closed) and Common terminals on the failsafe relay terminal block.

**4.3.10 Power supply**

The Common Equipment Panel houses both the Station IED 1 and Station IED 2 SEL-2240 Axion Station IEDs to maximise availability in critical facility situations. Each SEL-2240 Axion Station IED is equipped with a single SEL-2243 Power Coupler. Ensure that the Power Coupler modules are rated for the correct DC input voltage as per the order code.

- 1) Verify that the input voltage matches the rating on the SEL-2243 Power Coupler modules. The input voltage rating for the standard SEL-2243 Power Coupler for Eskom Transmission applications is detailed in Table 9 below.
- 2) Ensure that the SEL-2243 Power Coupler is correctly clipped into the SEL-2242 chassis and that the thumbscrew holding the Power Coupler to the chassis is secured.
- 3) Confirm that the power supply wiring for the SEL-2240 Axion Station IED 1 is connected to the input DC MCB (designated DCI(M1)) with the correct polarity.
- 4) Confirm that the power supply wiring for the SEL-2240 Axion Station IED 2 is connected to the input DC MCB (designated DCI(M2)) with the correct polarity.

**Table 9: Power Supply Input Range**

Power Coupler Module	Input Voltage Range
SEL-2243 (P/N: 224312X0)	125/250 Vdc or 120/220/240 Vac; 50/60 Hz

**4.3.11 Wetting power supplies for digital input field wiring**

The SEL-2240 Axion Station IED does not supply a wetting voltage for the digital input circuits from the SEL-2244-2 Digital Input Modules. An external wetting voltage is supplied for the Digital Input Modules by means of a DC/DC converter for Station IED 1 and a second, identical DC/DC converter for Station IED 2.

- 1) Verify that the input voltage matches the rating on the DC/DC converters. The input voltage rating for the standard Meanwell MDR-100-48 DC/DC converter used for the Eskom Transmission applications is detailed in Table 10 below.
- 2) Ensure that the Meanwell MDR-100-48 DC/DC converter is correctly clipped and secured on the DIN rail.
- 3) Confirm that the power supply wiring for the Station IED 1 DC/DC converter for the digital input wetting supply is connected to the DC MCB (designated DC/DC(CONV)(IN)(IED1)) with the correct polarity.

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- 4) Confirm that the power supply wiring for the Station IED 2 DC/DC converter for the digital input wetting supply is connected to the DC MCB (designated DC/DC (CONV)(IN)(IED2)) with the correct polarity.

**Table 10: Digital Input Wetting Supply DC/DC Converter Ratings**

DC/DC Converter	Ratings
Meanwell MDR-100-48	<b>Input Voltage Range:</b> 120-370 Vdc <b>Output Voltage Range:</b> 48 Vdc Active Power Rating: 96 W

#### 4.3.12 Wetting power supplies for digital output field wiring

The SEL-2240 Axion Station IED does not supply a wetting voltage for the digital output circuits from the SEL-2242-3 Digital Output Modules. An external wetting voltage is supplied for the Digital Output Modules by means of a DC/DC converter for the Station IED 1 and a second, identical DC/DC converter for the Station IED 2.

- 1) Verify that the input voltage matches the rating on the DC/DC converters. The input voltage rating for the standard Meanwell MDR-100-48 DC/DC converter used for the Eskom Transmission applications is detailed in Table 11 below.
- 2) Ensure that the Meanwell MDR-100-48 DC/DC converter is correctly clipped and secured on the DIN rail.
- 3) Confirm that the power supply wiring for the Station IED 1 DC/DC converter for the digital output wetting supply is connected to the DC MCB (designated DC/DC(CONV)(OUT)(IED1)) with the correct polarity.
- 4) Confirm that the power supply wiring for the Station IED 2 DC/DC converter for the digital output wetting supply is connected to the DC MCB (designated DC/DC(CONV)(OUT)(IED2)) with the correct polarity.

**Table 11: Digital Output Wetting Supply DC/DC Converter Ratings**

DC/DC Converter	Ratings
Meanwell MDR-100-48	<b>Input Voltage Range:</b> 120-370 Vdc <b>Output Voltage Range:</b> 48 Vdc Active Power Rating: 96 W

## 4.4 Commissioning checks

### 4.4.1 Energisation tests

- 1) At the AC board, close the MCB feeding the earth-leakage protected AC circuit to the Common Equipment Panel.
- 2) At the Common Equipment Panel, measure the AC supply voltage at the input terminals (as per the application drawings) and confirm the presence of 230 Vac. Test the plug socket by using a laptop power supply plug inserted into the socket.
- 3) At the AC board, close the MCB feeding the unprotected (no earth-leakage protection) AC circuit to the Common Equipment Panel.
- 4) At the Common Equipment Panel, measure the AC supply voltage at the input terminals (as per the application drawings) and confirm the presence of 230 Vac. If the voltage is correct, close the AC MCB.

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- 5) Verify that the Panel Not Healthy (PNH) light illuminates as the failsafe alarm contacts for all the equipment should be in the normally closed position.
- 6) At the Main 1 DC board, close the MCB feeding the Main 1 DC supply to the Common Equipment Panel.
- 7) At the Common Equipment Panel, measure the DC supply voltage at the input terminals (as per the application drawings). Confirm the correct DC voltage and the correct polarity before switching on the DC MCB for the SEL-2240 Axion Station IED 1 in the Common Equipment Panel. The MCB should be labelled DCI (M1).
- 8) Close the DCI (M1) MCB and confirm that the SEL-2240 Axion Station IED 1 energises by monitoring the LEDs at the front panel. After completing the booting process, the ENABLED LED will illuminate.
- 9) Confirm the correct DC voltage and the correct polarity before switching on the DC MCB for the SEL-2240 Axion Station IED 1 Digital Input wetting supply in the Common Equipment Panel. The MCB should be labelled DC/DC (CONV) (IN)(IED1). Close this MCB.
- 10) Confirm the correct DC voltage and the correct polarity before switching on the DC MCB for the SEL-2240 Axion Station IED 1 Digital Output wetting supply in the Common Equipment Panel. The MCB should be labelled DC/DC (CONV) (OUT)(IED1). Close this MCB.
- 11) At the Main 2 DC board, close the MCB feeding the Main 2 DC supply to the Common Equipment Panel.
- 12) At the Common Equipment Panel, measure the DC supply voltage at the input terminals (as per the application drawings). Confirm the correct DC voltage and the correct polarity before switching on the DC MCB for the SEL-2240 Axion Station IED 2 in the Common Equipment Panel. The MCB should be labelled DC I(M2).
- 13) Close the DCI (M2) MCB and confirm that the SEL-2240 Axion Station IED 2 energises by monitoring the LEDs at the front panel. After completing the booting process, the ENABLED LED will illuminate.
- 14) Confirm the correct DC voltage and the correct polarity before switching on the DC MCB for the SEL-2240 Axion Station IED 2 Digital Input wetting supply in the Common Equipment Panel. The MCB should be labelled DC/DC (CONV)(IN)(IED2). Close this MCB.
- 15) Confirm the correct DC voltage and the correct polarity before switching on the DC MCB for the SEL-2240 Axion Station IED 2 Digital Output wetting supply in the Common Equipment Panel. The MCB should be labelled DC/DC (CONV)(OUT)(IED2). Close this MCB.

#### **4.4.2 Setting up the SEL-2240 Axion Station IED**

##### **4.4.2.1 Ethernet ports**

The SEL-2240 Axion Station IED is equipped with two on-board Fast Ethernet 100BASE-FX fibre ports labelled ETH1 and ETH2. The factory default communication settings for these ports are as follows:

- Auto-negotiation is disabled (not settable for fibre interfaces);
- Both ports are enabled;
- Each port is independent of the other (i.e. no bridging or teaming is enabled);
- The default IP address for ETH1 is 192.168.1.2/24;
- The default IP address for ETH2 is 192.168.2.2/24.

Confirm if the unit had a configuration installed prior to installation and, if so, what the configured IP addresses are as per the IP address allocation for the substation.

#### **4.4.2.2 Secure Web Access**

The SEL-2241 RTAC module of the SEL-2240 Axion Station IED has a built-in web browser for secure access to the SEL-2240 Axion Station IED. The web interface allows the application-specific network parameters to be configured, in addition to a number of other configuration and diagnostic options.

If the SEL-2241 RTAC module has factory default settings, proceed as follows:

- 1) Connect to the SEL-2241 RTAC module from the engineering PC using a USB cable. The RTAC module emulates an Ethernet port over the USB interface and will provide an IP address to the engineering PC using DHCP.
- 2) Open a browser and connect to the URL <https://172.29.131.1>.
- 3) If no user has been previously configured, a user with appropriate credentials must first be defined. The username and password must be as specified by the applications engineer.
- 4) Reconnect to the web interface of the SEL-2240 Axion Station IED and login with the correct credentials.
- 5) Configure the network parameters as well as any other parameters that must be configured as specified by the application design documentation and drawings. Ensure that ping is enabled on the network interfaces to facilitate troubleshooting.
- 6) After completing the initial configuration settings, connect the SEL-2240 Axion Station IED to the network as shown in the application drawings.
- 7) Repeat the above steps for the second SEL-2240 Axion Station IED.
- 8) Set the IP address of the Ethernet port on the configuration PC to be obtained automatically and reconnect the PC to an engineering port located just above the Station Switch on front of the Common Equipment Panel. Verify connectivity to the SEL-2240 Axion Station IED over the network after disconnecting the USB cable from the SEL-2241 RTAC module.

If the SEL-2240 Axion Station IEDs' network interfaces have already been configured, the SEL-2240 Axion Station IEDs should be available for connection by using a web browser over the substation network from any engineering port configured in the Engineering VLAN.

#### **4.4.2.3 Installation of AcSELERator RTAC software**

If the configuration/commissioning PC does not have the AcSELERator RTAC software (SEL-5033) installed, it must be installed before commencing the SEL-2240 Axion Station IED commissioning process.

Using the appropriate installation media, install the R139 (or higher) version of the AcSELERator RTAC software on the configuration PC.

If the installation medium is a CD, take the following steps:

- Step 1. Ensure that all software applications are closed.
- Step 2. Place the CD in the computer's CD/DVD-ROM drive.
- Step 3. If Windows autorun is enabled, the file will load automatically. If Windows autorun is not enabled, run setup.bat from the CD.
- Step 4. Click on the link for AcSELERator RTAC software in the window that appears.
- Step 5. Follow the on-screen instructions to complete the installation.
- Step 6. Close the window when the installation is complete.

### 4.4.3 SEL-2240 Axion Station IED commissioning

#### 4.4.3.1 Verify Network Reachability of both the SEL-2240 Axion Station IEDs

- 1) Connect the commissioning PC to the network using an Engineering Access port. Since the Engineering ports are configured to operate in the Engineering VLAN, the commissioning PC should be able to obtain an IP address automatically from the router.
- 2) Confirm that both of the SEL-2240 Axion Station IEDs are physically connected to the network as shown in the network diagram. It is assumed, at this point, that both of the SEL-2240 Axion Station IEDs are powered on and configured with their correct IP address, mask, and gateway settings.
- 3) Open a Command Prompt on the configuration PC and, using the ping utility, confirm the reachability of both of the SEL-2240 Axion Station IEDs on the network.

#### 4.4.3.2 Confirm the Firmware Version on the SEL-2240 Axion Station IEDs

- 1) Connect to both of the web interfaces of the SEL-2240 Axion Station IEDs and login with the correct credentials.
- 2) Navigate to the Dashboard display pages and confirm that the Firmware Version on both units is correct.

#### 4.4.3.3 Load the SEL-2240 Axion Station IED project files onto the SEL-2240 Axion Station IEDs

If either, or both of the SEL-2240 Axion Station IEDs do not have an existing project, or you want to load an updated project:

- 1) Using the AcSELeRator RTAC software, open the correct RTAC project file for the device as supplied by the applications engineer.
- 2) Using the AcSELeRator RTAC software, connect to the correct SEL-2240 Axion Station IED using the device's IP address and the previously configured user credentials.
- 3) The project is loaded onto the SEL-2240 Axion Station IED by clicking on the *Go Online* icon which will compare the currently open project with the project loaded on the SEL-2240 Axion Station IED unit (if any). Follow the prompts to load the project.

If the SEL-2240 Axion Station IED has an existing project loaded, the project can be read from the device by using the Read Menu option.

#### 4.4.3.4 Time synchronisation

- 1) The SEL-2240 Axion Station IEDs are time synchronised, using (S)NTP directly from the SEL-2488 GPS clocks in the gateway panels.
- 2) Ensure that both of the SEL-2488 GPS clocks (one in each gateway panel) are commissioned as per the commissioning guide for the device [7].
- 3) Ensure that the SEL-2488 GPS clocks in the gateway panels are synchronised and correctly distributing time by using (S)NTP on the substation network.
- 4) AUX 3 LED on the SEL-2241 RTAC modules in the SEL-2240 Axion Station IEDs indicates the status of the GPS time synchronisation. Time synchronisation can also be verified via the web interface on the SEL-2240 Axion Station IED.

#### 4.4.3.5 Confirm devices are online

The SEL-3555 Substation Gateways are designed to concentrate all information received from the SEL-2240 Axion Station IEDs and to transmit this information to remote SCADA master stations and external HMI clients.

- 1) Using the AcSELeRator RTAC software, connect to the SEL-3555 Substation Gateway using the device's IP address and the previously configured user credentials.

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- 2) If the correct project has been loaded, the software will go online and show the online data on the SEL-3555 Substation Gateway.
- 3) Verify that each SEL-2240 Axion Station IED is online and communicating to the SEL-3555 Substation Gateways by selecting the IED device in the tree structure. Click on the “Controller” menu item to confirm if the IED is online. Click on the “Tags” menu item to confirm the received data.
- 4) AUX 1 LED on the SEL-2241 RTAC modules in the SEL-2240 Axion Station IEDs indicates the communication status to the Substation Gateway 1.
- 5) AUX 2 LED on the SEL-2241 RTAC modules in the SEL-2240 Axion Station IEDs indicates the communication status to the Substation Gateway 2.
- 6) If an IED is not online, follow the appropriate troubleshooting procedure to resolve the issue.

#### **4.4.3.6 Plant I/O Testing**

- 1) The status of the actual plant must be verified against the indication on the SEL-2240 Axion Station IED, the relevant I/O module in the Station IED, and the SEL-3555 Substation Gateways.
- 2) All bays at the substation have to be switched off from the plant supervisory function for the duration of the . This is to ensure that no inadvertent plant operation occurs while testing.
- 3) Once all bays are off the plant supervisory function, local testing may begin.
- 4) The status of the digital inputs can be verified on the corresponding SEL-2244-2 Digital Input Module as the state of each input is indicated by an associated red LED on the right-hand edge of the module. The LED will illuminate when the input is asserted.
- 5) The status of each digital input must be asserted from the furthest point to allow the entire circuit to be verified. Appropriately trained staff members must be available to simulate the alarms from the respective equipment.
- 6) The status of the digital outputs can be verified on the SEL-2244-3 Digital Output Module as the state of each output is indicated by an associated red LED on the right-hand edge of the module. The LED will illuminate when the output is asserted.
- 7) The status of each digital output must be verified at the furthest point to allow the entire circuit to be verified.
- 8) All analogue inputs have to be tested by injecting to the relevant input on the SEL-2245-2 module. The monitored input value can be verified by using the SEL-5033 RTAC software. The analogue value can then be verified on the SEL-3555 Substation Gateway. The analogue value deadbands must also be tested.
- 9) The successful testing of all analogue values, digital points, and controls will be ticked off on the signal list checklists.
- 10) When testing I/O from an SEL-2240 Axion Station IED to the Control Centres, the Control Centre staff members must tick off each point successfully tested on the signal commissioning checklists and field staff members must indicate the same in the space provided on the signal list.
- 11) Once all the bays have been tested, they will be deemed ready to be put into service.

## **4.5 Troubleshooting**

Table 12 below lists the common issues and indicators with the SEL-2240 Station IED, which can be used to help identify and resolve common issues.

Table 12: SEL-2240 Axion troubleshooting procedures

Issue/Indicator	Possible causes	Solution
Front-panel ENABLED LED is off.	Input power is not present, power supply is not properly seated.	Remove power source. Verify power cabling and connections. Check MCB.
	Invalid logic project installed.	Reload a known good project with AcSElerator RTAC software.
Front-panel ENABLED LED remains unlit after start-up.	Device has had a diagnostics failure that prevents it from operating.	Please refer to the maintenance guide [9].
The SEL-2240 Axion Station IED does not respond to connection attempts on the substation network.	Incorrect IP address.	Verify IP address.
	Invalid subnet.	Verify subnet and subnet mask.
	Incorrect or disconnected cable.	Verify cable is crossover if needed.
	Ethernet cable connected to SEL-2243 Power Coupler module.	Verify that the network connection is made to the SEL-2241 RTAC module and not to the SEL-2243 Power Coupler module.
	Ethernet port disabled.	Verify settings via web interface.
	More than one port configured for the same subnet.	Use a different subnet for each Ethernet port on the SEL-2241 RTAC module on the SEL-2240 Axion.
The SEL-2240 Axion Station IED does not synchronise via NTP.	Configuration incorrect.	Verify the configuration in the AcSElerator RTAC project and reload into the SEL-2241 module.
	SEL-2488 GPS clocks not reachable on the network.	Verify that the SEL-2488 GPS clocks have been commissioned and are reachable on the network from the SEL-2241 RTAC module.
	Cable disconnected.	Verify that the network cable is secure.
Unable to download a project with AcSElerator RTAC.	Version mismatch between SEL-2241 RTAC module firmware and AcSElerator RTAC PC software.	The version of the AcSElerator RTAC software on the PC must be the same (or higher) than the version of the RTAC firmware. Verify versions match by using the web interface on the SEL-2241 and the <b>About</b> menu on the AcSElerator RTAC software.
Unable to go online with project, or because other network-related issues occur.	Certain needed network ports (TCP or UDP ports) are closed.	Enable use of these ports by either turning off or adding exceptions to the firewall and antivirus software.
Password not accepted in web interface and during project download.	Incorrect password.	Use the correct password. If the password has been lost or forgotten, please contact the relevant organisational support department.
A user cannot log in.	The user's account is missing or disabled.	Login to the SEL-2241 RTAC module as an administrator or user manager and verify the details for the subject's account on the Local Users page.
Front-panel ENABLED LED is off, ALARM LED illuminated.	SEL-2241 RTAC module has an invalid project.	Usually the SEL-2241 RTAC will reset an invalid project to the factory-default project. If the SEL-2241 RTAC module remains in this disabled state, the unit will generate an error log which will describe the issue that caused the alarm. Please contact the relevant organisational support department.

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## 5. Authorisation

This document has been seen and accepted by:

Name and surname	Designation
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## 6. Revisions

Date	Rev	Compiler	Remarks
Sept 2020	1	T Visser	First Issue

## 7. Development Team

The following people were involved in the development of this document:

- Ian Naicker
- James Ranyane
- Dumisani Gojela

## 8. Acknowledgements

- CONCO Energy Solutions (PTY) Ltd.

**Annex A – Commissioning Checklist**

<b>Substation</b>	<b>Grid</b>
<b>Device Name</b>	<b>Device IP</b>
Station IED 1	
<b>Device Name</b>	<b>Device IP</b>
Station IED 2	

Section	Description	Pass (✓)/ Fail (X)	Notes
3.2	Commissioning of the SEL-2240 Axion Station IED shall be performed per a pre-determined commissioning plan as prepared by the relevant engineer.		
4.3.1	Ensure that the latest revision of the application drawings have been issued to the commissioning team.		
	Any changes that may be necessary must first be verified with the application engineer. All modifications have to be marked up on the issued drawings. A copy of all marked-up drawings must be submitted to the responsible application engineer so that the as-built revision of the drawings can be generated.		
4.3.2	Check Hardware Build and Slot (Station IED 1)		
	SEL-2242 Backplane		
	SEL-2241 RTAC Module (Slot A)		
	SEL-2243 Power Coupler (Slot B)		
	SEL-2244-2 Digital Input Modules (Slots E, F, G)		
	SEL-2244-3 Digital Output Module (Slot C)		
	SEL-2245-2 DC Analogue Input Module (Slot D)		
4.3.2	Check Hardware Build and Slot (Station IED 2)		
	SEL-2242 Backplane		
	SEL-2241 RTAC Module (Slot A)		
	SEL-2243 Power Coupler (Slot B)		
	SEL-2244-2 Digital Input Modules (Slots E, F, G)		
	SEL-2244-3 Digital Output Module (Slot C)		
	SEL-2245-2 DC Analogue Input Module (Slot D)		

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Section	Description	Pass (✓)/ Fail (X)	Notes
4.3.5	Common Equipment Panel inspection.		
1)	Inspect the SEL-2240 Axion Station IEDs for physical damage.		
2)	The interior of the panel must be clean and dry.		
3)	Ensure that there is free air-flow to the SEL-2240 Axion Station IEDs with no obstructions.		
4)	All metal parts, equipment, and blanking plates must be earthed to the panel earth bar and the continuity of all earths must be confirmed.		
5)	The earthing cable used to bond the common equipment panel which houses the SEL-2240 Axion Station IEDs to the substation earth bar does not exceed 0,5 m [2]. The continuity of this earth must be confirmed and the impedance may not exceed 0,1 Ω [2].		
6)	Ensure that all the rack-mounted equipment, including the SEL-2240 Axion Station IEDs, is securely mounted and that no equipment has come loose during transportation and placement in the substation control room.		
7)	All identifying details, including the name, serial numbers or type codes of equipment must be checked and/or recorded.		
8)	All labels have to be in accordance with the scheme drawing.		
9)	All terminations shall be checked for tightness in compliance with the panel design.		
10)	All terminations using insulation displacement, i.e. the IDF in the Common Equipment Panel, shall be checked for continuity and punched down if necessary.		
11)	All circuits must be verified as per the electrical schematics (application drawings) for the scheme.		
12)	All communication circuits must be verified as per the application drawings for the scheme.		
4.3.6	Check Physical Interfaces and Cable Connectors		
1)	Check that all connectors are securely connected to the cables.		
2)	Check that the power terminal blocks are tightly fitted to the unit, and that the securing screws for the power terminal blocks are tightened.		
3)	Check that the terminal block protective covers are installed (as applicable).		

Section	Description	Pass (✓)/ Fail (X)	Notes
4)	Check that the Main 1 DC power supply is connected to Station IED 1 and that the Main 2 DC power supply is connected to Station IED 2.		
5)	Inspect the connectors and cables between items of equipment and ensure their connections to the SEL-2240 Axion Station IED are firm. The use of strain-relief mechanisms must be verified (e.g. thumbscrews).		
6)	Check that all cables are firmly fitted to their correct interface on the networking hardware as per the connection diagram.		
7)	The integrity of any protective shielding connection (for communications cables) must be checked and be correctly earthed.		
8)	Check that the physical interfaces on all units are not damaged/obstructed in any way.		
9)	Ensure that unused fibre-optic interfaces have their dust covers in place.		
4.3.7	Check External DC Power Connections and MCBs		
1)	Verify that the DC power cables to the Common Equipment Panel are connected to the correct circuits on the Main 1 and Main 2 DC distribution boards, and that the supply voltage is as indicated on the drawings. Ensure that the MCBs feeding the Common Equipment Panel at the DC distribution boards are off.		
2)	Confirm that the DC power cable numbers and wire ferrule numbers are correct in accordance with the application drawings.		
3)	Check that the DC power supply cables have enough slack and are correctly installed, glanded, and terminated.		
4)	Verify that the rating of the DC MCBs is correct as per the application drawing.		
5)	Check that the DC power cables are connected to the correct input terminals.		
4.3.8	Check External AC Power Connections and MCBs		
4.3.8.1	Unprotected AC supply		
1)	Verify that the AC power cable is connected to the correct circuit at the AC distribution board. Ensure that the MCB at the AC distribution board is off.		

Section	Description	Pass (✓)/ Fail (X)	Notes
2)	Confirm that the AC power cable number and wire ferrule numbers are correct in accordance with the application drawings.		
3)	Check that the AC power supply cable has enough slack and is correctly installed, glanded, and terminated.		
4)	Verify that the rating of the AC MCB is correct as per the application drawing.		
5)	Check that the AC power cable is connected to the correct input terminals.		
4.3.8.2	Protected AC supply		
1)	Verify that the AC power cable is connected to the correct circuit at the AC distribution board. Ensure that the MCB at the AC distribution board is off.		
2)	Confirm that the AC power cable number and wire ferrule numbers are correct in accordance with the application drawings.		
3)	Check that the AC power supply cable has enough slack and is correctly installed, glanded, and terminated.		
4)	Verify that the rating of the AC MCB is correct as per the application drawing.		
5)	Check that the AC power cable is connected to the correct input terminals.		
4.3.9	Check Failsafe Alarm Connections		
	Check that the SEL-2240 Axion Station IED from the SEL-2241 RTAC OUT101 (alarm) contact is correctly connected to the NC (normally closed) and Common terminals on the failsafe relay terminal block.		
4.3.10	Power supply		
1)	Verify that the input voltage matches the rating on the SEL-2243 Power Coupler modules. The input voltage rating for the standard SEL-2243 Power Coupler for Eskom Transmission applications is detailed in Table 9.		
2)	Ensure that the SEL-2243 Power Coupler is correctly clipped into the SEL-2242 chassis and that the thumbscrew holding the Power Coupler to the chassis is secured.		
3)	Confirm that the power supply wiring for the SEL-2240 Axion Station IED 1 is connected to the input DC MCB (designated DCI(M1)) with the correct polarity.		

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Section	Description	Pass (✓)/ Fail (X)	Notes
4)	Confirm that the power supply wiring for the SEL-2240 Axion Station IED 2 is connected to the input DC MCB (designated DCI(M2)) with the correct polarity.		
4.3.11	Wetting power supplies for digital input field wiring		
1)	Verify that the input voltage matches the rating on the DC/DC converters. The input voltage rating for the standard Meanwell MDR-100-48 DC/DC converter used for the Eskom Transmission applications is detailed in Table 10.		
2)	Ensure that the Meanwell MDR-100-48 DC/DC converter is correctly clipped and secured on the DIN rail.		
3)	Confirm that the power supply wiring for the Station IED 1 DC/DC converter for the digital input wetting supply is connected to the DC MCB (designated DC/DC(CONV)(IN)(IED1)) with the correct polarity.		
4)	Confirm that the power supply wiring for the Station IED 2 DC/DC converter for the digital input wetting supply is connected to the DC MCB (designated DC/DC(CONV)(IN)(IED2)) with the correct polarity.		
4.3.12	Wetting power supplies for digital output field wiring		
1)	Verify that the input voltage matches the rating on the DC/DC converters. The input voltage rating for the standard Meanwell MDR-100-48 DC/DC converter used for the Eskom Transmission applications is detailed in Table 11.		
2)	Ensure that the Meanwell MDR-100-48 DC/DC converter is correctly clipped and secured on the DIN rail.		
3)	Confirm that the power supply wiring for the Station IED 1 DC/DC converter for the digital output wetting supply is connected to the DC MCB (designated DC/DC(CONV)(OUT)(IED1)) with the correct polarity.		
4)	Confirm that the power supply wiring for the Station IED 2 DC/DC converter for the digital output wetting supply is connected to the DC MCB (designated DC/DC(CONV)(OUT)(IED2)) with the correct polarity.		
4.4	Commissioning Checks		
4.4.1	Energisation Tests		

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Section	Description	Pass (✓)/ Fail (X)	Notes
1)	At the AC board, close the MCB feeding the earth-leakage protected AC circuit to the Common Equipment Panel.		
2)	At the Common Equipment Panel, measure the AC supply voltage at the input terminals (as per the application drawings) and confirm the presence of 230 Vac. Test the plug socket using a laptop power supply plug inserted into the socket.		
3)	At the AC board, close the MCB feeding the unprotected (no earth-leakage protection) AC circuit to the Common Equipment Panel.		
4)	At the Common Equipment Panel, measure the AC supply voltage at the input terminals (as per the application drawings) and confirm the presence of 230 Vac. If the voltage is correct, close the AC MCB.		
5)	Verify that the Panel Not Healthy (PNH) light illuminates because the failsafe alarm contacts for all the equipment should be in the normally closed position.		
6)	At the Main 1 DC board, close the MCB feeding the Main 1 DC supply to the Common Equipment Panel.		
7)	At the Common Equipment Panel, measure the DC supply voltage at the input terminals (as per the application drawings). Confirm the correct DC voltage and the correct polarity before switching on the DC MCB for the SEL-2240 Axion Station IED 1 in the Common Equipment Panel. The MCB should be labelled DCI(M1).		
8)	Close the DCI(M1) MCB and confirm that the SEL-2240 Axion Station IED 1 energises by monitoring the LEDs at the front panel. After completing the booting process, the ENABLED LED will illuminate.		
9)	Confirm the correct DC voltage and the correct polarity before switching on the DC MCB for the SEL-2240 Axion Station IED 1 Digital Input wetting supply in the Common Equipment Panel. The MCB should be labelled DC/DC(CONV)(IN)(IED1). Close this MCB.		
10)	Confirm the correct DC voltage and the correct polarity before switching on the DC MCB for the SEL-2240 Axion Station IED 1 Digital Output wetting supply in the Common Equipment Panel. The MCB should be labelled DC/DC(CONV)(OUT)(IED1). Close this MCB.		

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Section	Description	Pass (✓)/ Fail (X)	Notes
11)	At the Main 2 DC board, close the MCB feeding the Main 2 DC supply to the Common Equipment Panel.		
12)	At the Common Equipment Panel, measure the DC supply voltage at the input terminals (as per the application drawings). Confirm the correct DC voltage and the correct polarity before switching on the DC MCB for the SEL-2240 Axion Station IED 2 in the Common Equipment Panel. The MCB should be labelled DCI(M2).		
13)	Close the DCI(M2) MCB and confirm that the SEL-2240 Axion Station IED 2 energises by monitoring the LEDs at the front panel. After completing the booting process, the ENABLED LED will illuminate.		
14)	Confirm the correct DC voltage and the correct polarity before switching on the DC MCB for the SEL-2240 Axion Station IED 2 Digital Input wetting supply in the Common Equipment Panel. The MCB should be labelled DC/DC(CONV)(IN)(IED2). Close this MCB.		
15)	Confirm the correct DC voltage and the correct polarity before switching on the DC MCB for the SEL-2240 Axion Station IED 2 Digital Output wetting supply in the Common Equipment Panel. The MCB should be labelled DC/DC(CONV)(OUT)(IED2). Close this MCB.		
4.4.2	Setting up the SEL-2240 Axion Station IED (Perform this step only if necessary)		
4.4.2.2	Secure Web Access		
1)	Connect to the SEL-2241 RTAC module from the engineering PC using a USB cable. The RTAC module emulates an Ethernet port over the USB interface and will provide an IP address to the engineering PC using DHCP.		
2)	Open a browser and connect to the URL <a href="https://172.29.131.1">https://172.29.131.1</a> .		
3)	If no user has been previously configured, a user with appropriate credentials must first be defined. The username and password must be as specified by the applications engineer.		
4)	Reconnect to the web interface of the SEL-2240 Axion Station IED and login with the correct credentials.		

Section	Description	Pass (✓)/ Fail (X)	Notes
5)	Configure the network parameters as well as any other parameters that must be configured as specified by the application design documentation and drawings. Ensure that ping is enabled on the network interfaces to facilitate troubleshooting.		
6)	After completing the initial configuration settings, connect the SEL-2240 Axion Station IED to the network as shown in the application drawings.		
7)	Repeat the above steps for the second SEL-2240 Axion Station IED.		
8)	Set the IP address of the Ethernet port on the configuration PC to be obtained automatically and reconnect the PC to an engineering port located just above the Station Switch on front of the Common Equipment Panel. Verify connectivity to the SEL-2240 Axion Station IED over the network after disconnecting the USB cable from the SEL-2241 RTAC module.		
4.4.3	SEL-2240 Axion Station IED commissioning		
4.4.3.1	Verify Network Reachability of both of the SEL-2240 Axion Station IEDs		
1)	Connect the commissioning PC to the network using an Engineering Access port. The Engineering ports are configured to operate in the Engineering VLAN and the commissioning PC should be able to obtain an IP address automatically from the router.		
2)	Confirm that both of the SEL-2240 Axion Station IEDs are physically connected to the network as indicated in the network diagram. It is assumed, at this point, that both of the SEL-2240 Axion Station IEDs are powered on and configured with their correct IP address, mask, and gateway settings.		
3)	Open a Command Prompt on the configuration PC and, using the ping utility, confirm the reachability of both SEL-2240 Axion Station IEDs on the network.		
4.4.3.2	Confirm the Firmware Version on the SEL-2240 Axion Station IEDs		
1)	Connect to both of the SEL-2240 Axion Station IEDs' web interfaces and login with the correct credentials.		
2)	Navigate to the Dashboard display pages and confirm that the Firmware Version on both units is correct.		
4.4.3.3	Load the SEL-2240 Axion Station IED project files onto the SEL-2240 Axion Station IEDs		

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Section	Description	Pass (✓)/ Fail (X)	Notes
	(Perform this step only if necessary)		
1)	Using the AcSELeRator RTAC software, open the correct RTAC project file for the device as supplied by the applications engineer.		
2)	Using the AcSELeRator RTAC software, connect to the correct SEL-2240 Axion Station IED using the IP address of the device and the previously configured user credentials.		
3)	The project is loaded onto the SEL-2240 Axion Station IED by clicking on the Go Online icon which will compare the currently open project with the project loaded on the SEL-2240 Axion Station IED unit (if any). Follow the prompts to load the project.		
4.4.3.4	Time synchronisation		
1)	The SEL-2240 Axion Station IEDs are time synchronised using (S)NTP directly from the SEL-2488 GPS clocks in the gateway panels. Ensure that both SEL-2488 GPS clocks (one in each gateway panel) are commissioned as per the commissioning guide for the device [7].		
2)	Ensure that the SEL-2488 GPS clocks in the gateway panels are synchronised and correctly distributing time by using (S)NTP on the substation network.		
3)	Check that the AUX 3 LED illuminates on the SEL-2241 RTAC modules in the SEL-2240 Axion Station IED 1 indicating the GPS time synchronisation status.		
4)	Check that the AUX 3 LED illuminates on the SEL-2241 RTAC modules in the SEL-2240 Axion Station IED 2 indicating the GPS time synchronisation status.		
4.4.3.5	Confirm that the devices are online		
1)	Using the AcSELeRator RTAC software, connect to the SEL-3555 Substation Gateway using the IP address of the device and the previously configured user credentials.		
2)	If the correct project has been loaded, the software will go online and show the online data on the SEL-3555 Substation Gateway.		
3)	Verify that each SEL-2240 Axion Station IED is online and communicating to the SEL-3555 Substation Gateways by selecting the IED device in the tree structure. Click on the "Controller" menu item to confirm if the IED is online. Click on the "Tags" menu item to confirm the received data.		

Section	Description	Pass (✓)/ Fail (X)	Notes
4)	The AUX 1 LED on the SEL-2241 RTAC modules in the SEL-2240 Axion Station IED 1 indicates the communication status to the Gateway 1.		
5)	AUX 2 LED on the SEL-2241 RTAC modules in the SEL-2240 Axion Station IED 1 indicates the communication status to Gateway 2.		
6)	AUX 1 LED on the SEL-2241 RTAC modules in the SEL-2240 Axion Station IED 2 indicates the communication status to Gateway 1.		
7)	AUX 2 LED on the SEL-2241 RTAC modules in the SEL-2240 Axion Station IED 2 indicates the communication status to the Gateway 2.		
4.4.3.6	Plant I/O Testing		
1)	The status of the actual plant must be verified against the indication on the SEL-2240 Axion Station IED, the relevant I/O module in the Station IED, and the SEL-3555 Substation Gateways.		
2)	All bays at the substation have to be switched off from the plant supervisory function for the duration of the commissioning. This is to ensure that no inadvertent plant operation occurs while testing.		
3)	Once all bays are off supervisory, local testing may begin.		
4)	The status of the digital inputs can be verified on the corresponding SEL-2244-2 Digital Input Module as the state of each input is indicated by an associated red LED on the right-hand edge of the module. The LED will illuminate when the input is asserted.		
5)	The status of each digital input must be asserted from the furthest point to allow the entire circuit to be verified. Appropriately trained staff members must be available to simulate the alarms from the respective equipment.		
6)	The status of the digital outputs can be verified on the SEL-2244-3 Digital Output Module because the state of each output is indicated by an associated red LED on the right-hand edge of the module. The LED will illuminate when the output is asserted.		
7)	The status of each digital output must be verified at the furthest point to allow the entire circuit to be verified.		

Section	Description	Pass (✓)/ Fail (X)	Notes
8)	All analogue inputs have to be tested by injecting to the relevant input on the SEL-2245-2 module. The monitored input value can be verified by using the SEL-5033 RTAC software. The analogue value can then be verified on the SEL-3555 Substation Gateway. The analogue value deadbands must also be tested.		
9)	The successful testing of all analogue values, digital points, and controls will be ticked off on the signal commissioning checklists.		
10)	When testing I/O from a SEL-2240 Axion Station IED to the Control Centres, the control centre staff members must tick off each point successfully tested on the signal commissioning checklists and field staff members should indicate the same in the space provided on the signal checklist.		
11)	Once all bays have been tested, they will be deemed ready to put into service.		
<b>Field Engineer/Technician</b>		<b>Senior Supervisor</b>	
Name:		Name:	
Date:		Date:	
Signature:		Signature:	

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