



5.17.3. ETHERNET SWITCH CONFIGURATION

Purpose

To verify that

- Proper configuration of Ethernet switches at the Station & Process level.
- To enable proper ring formation of the Ethernet switch in station & Process level
- To Document the Ethernet switch configuration considering the proper function of Ring network.

Typical Procedure:

- All IEDs & TCP/IP devices which are connected to non-RSTP ports, such ports should be configured as Edge port.
- Edge port should not be enabled with RSTP or Auto to reduce the ethernet switch processing.
- Only Point to Point port should be enabled with RSTP.
- Other than Edge port, all other unused ports should be disabled.
- Point to Point port & Discarding port need to be properly connected as per the System architecture.
- Ensure Bridging priority, Edge port, RSTP, VLAN configuration in Root & Non-Root Ethernet switches should be as per project requirement & Documented as below given example.

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Sr. No	Panel Location	Switch Identification	Switch Port No	Bridge Priority	Edge Port	Switch to Switch Port	Un-used Port	RSTP	VLAN
1.	+R404A	K404	1	8192	No	Yes	No	Yes	As per Network requirement
2.	+R404A	K404	2	8192	No	Yes	No	Yes	As per Network requirement
3.	+R404A	K404	3	8192	No	Yes	No	Yes	As per Network requirement
4.	+R404A	K404	4	8192	No	Yes	No	Yes	As per Network requirement
5.	+R404A	K404	5	8192	Yes	No	No	No	As per GCB Table
6.	+R404A	K404	6	8192	Yes	No	No	No	As per GCB Table
7.	+R404A	K404	7	8192	Yes	No	No	No	As per GCB Table
8.	+R404A	K404	8	8192	Yes	No	No	No	As per GCB Table
9.	+R404A	K404	9	8192	Yes	No	No	No	As per GCB Table
10.	+R404A	K404	10	8192	Yes	No	No	No	As per GCB Table
11.	+R404A	K404	11	8192	Auto	Auto	Disabled	Yes	Default/Not applicable
12.	+R404A	K404	12	8192	Auto	Auto	Disabled	Yes	Default/Not applicable
13.	+R404A	K404	13	8192	Auto	Auto	Disabled	Yes	Default/Not applicable
14.	+R404A	K404	14	8192	Auto	Auto	Disabled	Yes	Default/Not applicable

Note: Control Room Switches has to be Kept as Root Bridge Switch and rest of the switch has to be followed the RSTP Philosophy. SAS Architecture has to be updated with these number if possible for better clarity.

	Checked	Comments see log sheet no.
Document Switch port configuration -IP address of the switch, Bridge numbering, VLAN, IP address, Edge port of as per project requirement considering GCB & considering Ring system	<input type="checkbox"/>	

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5.17.4. NETWORK REDUNDANCY

The reliability and security of the redundant LAN configuration will be checked.

Purpose

To verify that

- Ethernet connections in the Substation Automation System are functional and running.
- LAN Switch Redundancy is functional.

To establish that in the event of a loss in communications, the SAS device is OFFLINE. When the communications link is restored, the SAS device is automatically back to ON-LINE.

ETHERNET LAN REDUNDANCY CHECK

1. Choose a Switch in the LAN. Let it be Switch B in below fig having switches A & B adjacent to it. There are two ports, 3 & 4 of switch B connected to two ports, 1 & 2 of switch A. Similarly there are 2 other ports in switch B, 5 & 6 connected to ports 7 & 8 of switch C (as shown in figure).



2. On switch B Disconnect port 3 LAN cable. Verify that no device in the entire system fails to communicate.
3. On switch B Disconnect port 4 LAN cable. Verify that no device in the entire system fails to communicate.
4. On switch B Disconnect port 5 LAN cable. Verify that no device in the entire system fails to communicate.
5. On switch B Disconnect port 6 LAN cable. Verify that only those devices, which are connected to switch B, fail to communicate.
6. Restore the LAN cables in reverse order and check that communication of the devices above gets restored.
7. Repeat the above for all other switches in the Redundant RING LAN.

LAN Communication Functional Check test Results Log

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S.NO.	Panel	Equipment	Communication check	Redundancy check
1	KV BCU (Bay01/02/03---)			
2	KV BCU (Bay01/02/03---)			
3	Networking Panel			

	Checked	Comments see log sheet no.
<p>Checking Station Ethernet ring Checking functionality in case of disconnecting and connecting the ring at several points. Initiate control of any switching device.</p> <ul style="list-style-type: none"> • Check redundancy. • Check fault indication from adjacent units. • Check appearance on HMI 1 & 2 • Check execution of command • Check dynamic animation of SCADA pictures (Communication ports status etc.) 	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	
<p>Checking Bay Ethernet ring Checking functionality in case of disconnecting and connecting the ring at several points. Initiate control of any switching device.</p> <ul style="list-style-type: none"> • Check redundancy. • Check fault indication from adjacent units • Check appearance on HMI 1 & 2 • Check execution of command • Check dynamic animation of SCADA pictures (communication ports status etc.) 	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	
<p>Checking the communication of switches Checking functionality in case of disconnecting and connecting the Ethernet switches and router at several points. Initiate control of any switching device. (1x optical, 1x electrical, 1x 1GB port)</p> <ul style="list-style-type: none"> • Check redundancy • Check fault indication from adjacent units • Check appearance on HMI 1 & 2 • Check execution of command • Check dynamic animation of SCADA pictures (communication ports status etc.) 	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	

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5.17.5. GATEWAY REDUNDANCY (IEC 101 & IEC104 PORTS)

The redundancy of the IEC 101/104 communication interface from the Gateways will be checked. As the real SCADA system is not available, two no of Laptops with the IEC TEST – Softwares are used to simulate the RCC& RSCC.

5.17.6. TIME SYNCHRONIZATION REDUNDANCY

Redundancy of GPS time synchronization is tested. One clock will be disconnected from the network. It is checked that the various devices are still time synchronized (i.e. by changing the time manually for a device and checking that it gets synchronized again).

Time synchronization redundancy	Checked	Comments see log sheet no.
Disconnect GPS time server 1 from the network Check availability of correct time synchronization Reconnect GPS time server 1 and disconnect time server 2 (any one of the IED/OWS internal clock) from the network Check availability of correct time synchronization	<input type="checkbox"/>	

5.17.7. SAFETY TAG FACILITY

It is checked that safety tag facility is realized in SCADA. A triangle with exclamation mark is set on the respective switching device.

	Checked	Comments see log sheet no.
Processing of safety tag facility	<input type="checkbox"/>	
Properties of safety tagging - 3 different types of safety tags - notebook facility (date, time, user, ...) - prevent of SCADA control	<input type="checkbox"/>	
Display on the - overview picture - individual bay display	<input type="checkbox"/>	
Check appearance on redundant server/operator	<input type="checkbox"/>	

5.17.8. MAINTENANCE MODE

It is checked that individual feeders can be set into maintenance mode. No control is possible, and no alarms/events can come up during the feeder is in maintenance mode, which is indicated by annunciation “MAINTENANCE MODE.”

	Checked	Comments see log sheet no.
Feeder is in “Maintenance Mode”	<input type="checkbox"/>	

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	Checked	Comments see log sheet no.
Check appearance on HMI Display	<input type="checkbox"/>	
Check control blocking	<input type="checkbox"/>	
Check suppression of data transmission	<input type="checkbox"/>	

5.17.9. IMPORT AND EXPORT OF ARCHIVED PROCESS DATA

The backup/ archiving function will be checked under this chapter. Data, which was outsourced as backup files will be imported into the runtime and displayed in the event list in conjunction with the filter function. During import mode no changes of any other archive type or date are possible. The “Archive” button starts blinking when an import succeeded. Afterwards the imported messages can be saved into a readable format (as *.csv or *.txt). The export button function will remove the backup database from the event list and the “Archive” button stops blinking.

	Checked	Comments see log sheet no.
Import from archive	<input type="checkbox"/>	
Export data to readable format to Excel (*.csv or *.txt)	<input type="checkbox"/>	
Export to archive	<input type="checkbox"/>	

5.18. ADDITIONAL TESTS

In this chapter the remote access to bay control unit and protection relays will be checked. In addition, some protection tests will be simulated for checking information recording in SAS-system.

	Checked	Comments see log sheet no.
Remote access to IED devices via DR PC: <ul style="list-style-type: none"> - Password security - Access/Load function with ability to change relay settings. - Download of fault records - Automatic download of DR (Built-in & Stand-alone) fault record with necessary S/w - Evaluation of Fault records with evaluation S/w - Connection to 3rd party relays 	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	
Remote access to BCUs and via DR PC: <ul style="list-style-type: none"> - Password security - Access/Load function with ability to change relay settings 	<input type="checkbox"/> <input type="checkbox"/>	

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Information recording in SAS-system		
- Reset of trip lockout relay	<input type="checkbox"/>	
- Autoreclosing ON/OFF selection	<input type="checkbox"/>	
- Reporting of fault location		
- Hardcopy print (to paper and file)	<input type="checkbox"/>	

5.19. REMOTE DESKTOP

The remote desktop function is a feature of Windows. It is shown as an icon on the desktop of all PCs of this station. Pressing this button and a window will appear. Choose the desired PC by selecting its IP address; the remote desktop function opens the desktop of the desired PC. It is mainly used for configuring the station controllers and HMI servers from the Engineering PC.

Remote desktop	Checked	Comments see log sheet no.
Remote desktop functionality by using both IP & Their PC name	<input type="checkbox"/>	

5.20. TIME SYNCHRONIZATION

The time synchronization is checked under this chapter. The antenna of the GPS clock is disconnected. An alarm should be generated. Then the times of the devices is changed by hand for a few minutes only. Connect the antenna again. The devices have to synchronize again by themselves after some minutes and the alarm must disappear. The time synchronization test shall be performed by making GPS as the master clock for synchronizing all IED's present on ring network.

Procedure

1. Disconnect the GPS Receiver Antenna. Set the GPS Receiver to send Local Time.
2. Confirm that the External Time Display Unit displays this local time.
3. Confirm that IEDs Operator Workstations and Substation Gateway Times match this local time. This confirms that the Sntp packets are broadcast by the GPS receiver.
4. Confirm that GPS Receiver unsynchronized alarm is received in the workstations.
5. Power off the GPS receiver.
6. Verify that all IEDs are synchronized with any of the IED/OWS designated as redundant Timeserver.
7. Power on the GPS receiver.
8. Connect the GPS receiver Antenna. Verify that the GPS receiver is locked with satellite and GPS is updated to satellite time.

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9. Confirm that the External Time Display Unit, The IEDs, Operator workstations and the Substation Gateway are updated to the correct time of GPS.

Time synchronization	Checked	Comments see log sheet no.
OWS-1 & Server-1	<input type="checkbox"/>	
OWS-2 & Server-2	<input type="checkbox"/>	
DR PC	<input type="checkbox"/>	
Auxiliary System	<input type="checkbox"/>	
Reporting of Time synchronization alarm of connected all IEDs in the network	<input type="checkbox"/>	
Bay Control Unit	<input type="checkbox"/>	
Event list printer/ Hardcopy/ Logbook printer	<input type="checkbox"/>	

5.21. VALIDATION OF MEMORY AND DISK UTILIZATION

Purpose

To verify that the OWS/HMI have Memory and Disk Usage and allocation those are within the specification requirements. Processor and RAM shall be selected in such a manner that during normal operation not more than 30% capacity of processing and memory are used. Supplier shall demonstrate these features. The capacity of hard disk shall be selected such that the following requirement should occupy less than 50% of disk space:

1. Storage of all analogue data (at 15 Minutes interval) and digital data including alarm, event for two years and trend data for thirty(30) days,
2. Storage of all necessary software,
3. 500GB space for OWNER'S use.

Supplier shall demonstrate that the capacity of hard disk is sufficient to meet the above requirement.

Setup

Ensure that the Servers are running and functioning properly.

Validation of OWS Memory and Disk Utilization

Computer	Physical Memory	Hard Drive Free Space	PASS/FAIL
SERVER-1			PASS/FAIL
SERVER-2			PASS/FAIL
OWS-1			PASS/FAIL

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Computer	Physical Memory	Hard Drive Free Space	PASS/FAIL
OWS-2			PASS/FAIL
DR/EWS PC			PASS/FAIL
GATEWAY-1			PASS/FAIL
GATEWAY-2			PASS/FAIL

5.22. BCU INPUT/OUTPUT/ANALOG DATA RETRIEVAL

Configuration of data reporting at defined interval/cyclic and dead band shall be verified as per approved profile to evade hanging of both SCADA and IED.

The following are the procedures in the BCU I/O Data retrieval. The individual BCU Test result logs are to be filled up in the following sections.

Digital Input Retrieval

Purpose

To verify that the change of state of Digital Input points are updated in the BCU L HMI, the Operator Workstations and Master Station Simulator.

To verify that the Digital Inputs are mapped correctly as per the approved drawing.

Setup/Program

1. Connect the test jig to the BCU under test.
2. Go to the BCU LHMI Digital Inputs Display screen.
3. On the OWS-1 go to the relevant HMI screen.
4. On the OWS-2 go to Alarm/Event list.

Procedure

1. Select a Digital Input point on the BCU under test.
2. Change its state from 'OFF' to 'ON' (single points) or from 'OPEN' to 'CLOSED' (double points) by toggling the corresponding jig.
3. Verify that the state of this point in the BCU LHMI and HMI is changed correctly.
4. Verify that the state of this point in the OWS-2 event list screen is changed correctly.
5. For points configured with alarm, verify that alarms are displayed in the Alarm Screen of the OWS-2 with correct time stamp.
6. For points considered in the IEC 60870-101/104 List, verify that the state of this point in the Master Station Simulator is changed correctly with correct time stamp.
7. Change its state from 'ON' to 'OFF' (single points) or from 'CLOSED' to 'OPEN' (double points) by toggling the corresponding jig.
8. Repeats step 3 to 6

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9. Repeat 1 to 8 for all Digital Input points to be tested on this BCU.
10. Repeat steps 1 to 9 for all BCU's.
11. Data reporting shall be verified to evade hanging of both SCADA and IED.
Necessary simulation (including analog) shall be done by vendor.

Digital Output

Purpose

To verify that digital output operations are successfully executed.
To verify that the Digital Output points are mapped correctly according to the approved drawings & Data List.

Setup/Program

1. Connect the test jig to the BCU under test.
2. Go to the BCU MMI Digital Outputs Display screen.
3. On the OWS-1 go to the relevant HMI screen.
4. On the OWS-2 go to Alarm/Event list.

Procedure

1. Choose BCU to test. From the HMI workstation initiate digital output requests.
2. Verify that the corresponding output activated.

Software Interlock Logic

Purpose

To verify that software interlock logic for CBs and Isolators are operational based on simulated conditions.

Note: Since not all interlock conditions can be tested during FAT, other interlock inputs shall be simulated by shorting auxiliary contacts at the terminal blocks of the panels.

Setup

1. Set up the test jig to simulate software interlock positive and negative test conditions.
2. Set up shorting links to simulate other auxiliary contacts.
3. Refer approved drawings.

Procedure

1. Select a BCU to test.
2. Refer to the interlock conditions for testing. First set up a negative condition.
Attempt to operate controls related to the interlock logic being tested. Verify that the interlock is successful.

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- Set up for a positive test condition. Verify that interlock is successful when control operation is performed on related to the interlock logic being tested.

CB/ Isolators	CB/Isolators Interlock Negative Test Result	CB/Isolators Interlock Positive Test Result	CB/Isolator Condition	Checked

Note: Interlock involving GOOSE signal shall also be checked. It shall be ensured that absence of required GOOSE signal does not enable any interlocking condition. Interlock verification page for each control device as per TS based on the available input in the BCU to be prepared in HMI. Spare switching arrangement for Single phase reactor and transformer banks shall be verified by simulation and software interlocks to be verified.

5.23. SUBSTATION CONTROLLER DEVICE REPORTING

Purpose

To verify that the Substation Controller (Server/Client) is successfully communicating with the bay level devices using IEC 61850 protocol.

Setup

- Ensure that the Server/Clients are running.
- Go to the System Architecture Screen on Client.

Procedure

- On the System Architecture screen, verify that the bay device status is Normal.
- Go to a remote device and disconnect the LAN cable, verify that the System Architecture screen shows the bay device is Failed.
- Connect the LAN cable. Monitor the communication between Server and remote device and verify that the IEC 61850 packets between the two TCP/IP addresses are passing through.
- Verify that the System Architecture Screen shows that the device is Normal. Repeat the above procedures for other devices.

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6.EWS/DR PC

6.1. SETTING AND CONFIGURING OF IEDS

Purpose

To verify that the IEDs configuration with proper tool for each type has been installed and all the IEDs (Protection, BCU, RTCC, CSD, FOTS & other TCP/IP devices) are accessible via the station ethernet ring. The DR PC should be able to change any configuration, settings, IP address & other parameters via TCP/IP should be possible.

Setup

1. Ensure that DR PC is running.

Procedure

(For example, for BCU)

1. Change some parameters in S/W for the BCU to test. Compile the Database for which parameters have been changed. (Wherever applicable)
2. Run S/W on the DR PC and select the compiled Database. Connect the BCU for which the parameters have been changed. (Wherever applicable)
3. Upload the database. (Wherever applicable)
4. Verify that the download is successful and check the DB version on the BCU. (Wherever applicable)

(For example, for Protection IED)

1. Change some parameters in S/W for the Protection IED to test. Compile configuration for which parameters have been changed. (Wherever applicable)
2. Connect the IED for which the parameters have been changed. (Wherever applicable)
3. Download the configuration or setting changed to the respective device. (Wherever applicable)
4. Verify that the download is successful and check the version on the IED. (Wherever applicable)

6.2. NETWORK MONITORING SYSTEM

Purpose

To verify that the Network Monitoring System (NMS) application software can perform the following functions on the LAN devices for both station bus & process bus:

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- Configuration Management
- Fault Management
- Performance Monitoring
- Device Monitoring
- Log analysis
- Historical Data storage

Note:

1. **The Network Management System is based on Simple Network Monitoring Protocol (SNMP).** Some background on this protocol is needed to understand how the application software works. If a separate network is available, then the each network has to have NMS separately example like **Sample Values network in Process bus substation.**
2. **SNMP V3 may be implemented for the new projects. For extension projects, the existing SNMP version may be used.**

Procedure

1. Verify that NMS software monitors LAN devices statistics and present these using displays.
2. Verify that it maintains connectivity and device status, issues alarms on errors conditions. This can be verified in the Operator interface(OI) client screens.
3. Verify that it has tools for maintenance of addressed and links.

6.3. AUTO RECLOSE TEST

6.3.1.TEST FOR AUTO-RECLOSE SUCCESSFUL CASE

1. Select the Circuit Breakers of Main & Tie on which Auto reclose must be tested.
2. Ensure that the Circuit Breakers are in closed condition and Auto-recloser is in ON state and all interlock conditions for closing the breaker are satisfied.
3. Simulate 1-Phase trip, ensure that the corresponding phase of the Main & tie breakers open.
4. Ensure that the Main Circuit Breaker Auto recloses first with predefined dead time (1sec) and Tie-breaker auto recloses once the main breaker reclose cycle is completed as per the priority logic.
5. Ensure that once Auto-recloser is successful for main, the respective reclaim timer starts and Auto-reclose State goes back to Normal once the reclaim time is over and the same is applicable for TIE bay.
6. Put Auto-recloser of main CB in off position. Repeat steps 1 to 3. In this case ensure that Main CB does not go for Auto-reclose and tie CB Auto-reclosers without priority (1 sec)
7. Check that Auto-reclose does not take place for CB which are already in open condition. Check this for both main & tie CB.
8. Check that A/R does not take place for CB having A/R lockout condition (SF6 gas pressure/Oil pressure/spring discharge). The healthy CB associated with the feeder shall A/R successfully.
9. **Repeat steps 4-6 for 3 phase auto reclose and single phase/3 ph. Auto reclose**

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10. In case of single-phase fault for 3ph. Autoreclose selection, the single phase trip shall be connected to 3 ph. trip before autoreclose.

6.3.2.TEST FOR AUTO-RECLOSE FAILURE CASE

1. Repeat steps 1to 5 of successful case, Once the reclaim time starts, simulate another 1-Phase trip.
2. Ensure that the Auto-reclose enters Locking State and a 3-Ph tripping is issued to the both Main and Tie Breaker and all the 3-phases of the breaker open.
3. Repeat steps 1to 3 of successful case, Once the Auto-recloser cycle starts, before the dead time is over and close command is issued to the Main and Tie Breaker, Simulate another 1-ph trip. In thiscase also Auto-recloser enters Locking State and a 3-Ph tripping is issued to the both Main and TieBreaker and all the 3-phases of the breaker open.
4. Repeat steps 1to 3 of successful case, Once the Auto-recloser cycle starts, before the dead time is over and close command is issued to the breaker, simulate the AR blocking signal, ensure that theAuto-reclose does not take place and Auto-recloser goes back to its Initial state.

7. DR CONFIGURATION

Check DR is configured as per TS & Latest standardized DR signal list configuration.

- i. Analog triggering level
- ii. Signal name and order
- iii. Pre-& Post fault time (Pre-fault time: min 500ms)
- iv. Triggering Channel
- v. Re-trigger option etc.

7.1. AUTO DR FUNCTIONALITY

Purpose

To verify that the automatic disturbance file is uploaded to DR PC when the disturbance is created.

Setup

1. Ensure that DR PC is running.
2. System Software should be running on the DR PC.

Procedure

1. Create the Disturbance on Main-1 &2, Verify that the disturbance has been created in the relay.
2. Ensure the Folders must be created for all Main-1&2, BCU folders based on the substation structure.
3. Observe that the Disturbance File (.cfg/.dat etc.) is automatically created in the DR PC.

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4. Open the Disturbance file with DR software.
5. As per the NTAMC AFAS requirement all the details of the IEDs has to be provided along with the location of the Folder created for each Protection IED
6. Verification of auto DR downloading functionality on triggering of waveform in each IED.
- 7.

8. IEC 60870-5-101/104 DATA RETRIEVAL

Purpose

To perform preliminary verification that the IEC 60870-5-101/104 Communication Ports are functional.

Setup/Program

- Ensure that the test equipment is in the FAT room.
- Use a Protocol Analyzer Test set to simulate an IEC 60870-5-101/104 Master Station polling with General Interrogation and data changes with 2 no of laptop. Use the Protocol Analyzer Test set to Monitor IEC 60870- 5-101/104 Telegram on the redundant serial communications links.

Procedure

1. Verify that communication is established with the simulator Protocol Analyzer Test set.
2. Verify that the simulator is sending requests on the primary channel and that the SAS Gateways is responding on both the primary (Main) and the secondary (Standby) channels.
3. Disconnect the simulator from the primary channel and connect it to the secondary channel; verify that the SAS Gateway will respond on both channels to requests received on the secondary channel.
4. Verify that data present at HMI should be same at Protocol Analyzer Test also.
5. Verify that all the configured required data points are sent by the gateway to the simulator.
6. Configuration of data reporting at defined interval/cyclic (generally analog without time tag), dead band shall be verified as per approved profile.

8.1. MASTER DIGITAL INPUTS RETRIEVAL

Purpose

To verify that the Substation Gateway is polled for Digital Input data correctly by the Master Simulator.

Procedure

1. Inject digital input changes to single point and double point inputs.
2. Verify change of the state in the Gateway Machine and Protocol Analyzer.

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8.2. MASTER ANALOG INPUTS RETRIEVAL

Purpose

To verify that substation gateway is polled for Analog Input data correctly by the Master Simulator.

Procedure

Inject Analog Inputs and verify that the Analog data are correctly received by the Master Simulator.

9. STATEMENT OF SYSTEM ACCEPTANCE

Upon satisfactory completion of all applicable tests specified in this document and the proper disposition of all properly documented and witnessed discrepancies resulting from tests specified in the procedure, the system, tested and witnessed by the POWERGRID is functionally accepted by POWERGRID.

The following documents has to be submitted for the clearance of the SAS wherever applicable.

Final FAT submission Verification log:

SI No.	Description	Drg No.	Checked
1	Standard Approved MQP		<input type="checkbox"/>
2	Approved FAT Procedure		<input type="checkbox"/>
3	GTP-General Technical Parameters		<input type="checkbox"/>
4	Complete SAS Architecture		<input type="checkbox"/>
5	Standard General Technical Particulars for SAS		<input type="checkbox"/>
6	Hardware specification		<input type="checkbox"/>
7	Functional Design Specification		<input type="checkbox"/>
8	VLAN Architecture drawing wherever applicable		<input type="checkbox"/>
9	Matrix for GOOSE messages for each feeder (with publisher& subscriber details, Mac id, APP Id, VLAN as required)		<input type="checkbox"/>
10	Matrix for SV (with publisher & subscriber details, SV ID, Destination mac and VLAN details) in case of Process Bus substation		<input type="checkbox"/>
11	Ethernet Network Configuration Document (RSTP details, VLAN details, Port details etc.)		<input type="checkbox"/>
12	IP Addressing Details		<input type="checkbox"/>
13	Single SCD File of the Entire substation		<input type="checkbox"/>

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SI No.	Description	Drg No.	Checked
14	Exported HMI signal list file in spreadsheet/CSV format.		<input type="checkbox"/>
15	Exported NTAMC signal list file in spreadsheet/CSV format.		<input type="checkbox"/>
16	Common BCU/Alarm Panel-01		<input type="checkbox"/>
17	Common BCU/Alarm Panel-02		<input type="checkbox"/>
18	GA & Scheme of Networking Panel		<input type="checkbox"/>
19	CRP (Line/Trafo/BR/LR/Tie/BC/TBC/BS/Etc)		<input type="checkbox"/>
20	Product Manuals(Installation, Configuration, maintenance, Troubleshooting, detailed diagnostics etc.)		<input type="checkbox"/>
21	Control Room Lay-out		<input type="checkbox"/>
22	Switchyard Panel Room layout drawing		<input type="checkbox"/>
23	Bill of Quantity-Spares		<input type="checkbox"/>
24	Other applicable drgs (not listed above)	Attach the list as annexure	<input type="checkbox"/>

Note: A single SCD file shall be there for the entire substation. For extension projects too, the SCD file shall be a single file after integrating the newer IEDs.

Softcopy of Manuals Log:

Document Title	Doc. No.	Checked
Operation and Technical Guide for BCU, Gateway, Server, OWS Software		<input type="checkbox"/>
Operation and Technical Guide IED configuration softwares		<input type="checkbox"/>
Operation and Technical Guide NMS Software		<input type="checkbox"/>
Operation and Technical Guide Ethernet Switch		<input type="checkbox"/>
Operation and Technical Guide Time synchronizing Equipment		<input type="checkbox"/>
Operation and Technical Guide Router Cum Firewall		<input type="checkbox"/>
Operation and Technical Guide UPS/Inverter		<input type="checkbox"/>
Other applicable equipment Operational & Technical Guide		<input type="checkbox"/>

Softwares/Project Backups/License details Backup:

Software/License	Doc. No.	Checked
Protection Project Configuration- As Manufactured		<input type="checkbox"/>
HMI Project Database – As Manufactured		<input type="checkbox"/>

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



Software/License	Doc. No.	Checked
Gateway Project Database – As Manufactured		<input type="checkbox"/>
Ethernet Configuration – As Manufactured		<input type="checkbox"/>
Any other Configuration(NMS, Syslog, etc)- As Manufactured		<input type="checkbox"/>
HMI associated Software & their license		<input type="checkbox"/>
Gateway associated software & their License		<input type="checkbox"/>
MS office & license		<input type="checkbox"/>
NMS & their license		<input type="checkbox"/>
Protection & Control each type Software & license		<input type="checkbox"/>
CSD, FOTS, RTCC & Other Devices Software & license		<input type="checkbox"/>
Antivirus software & license		<input type="checkbox"/>
Printers software & license		<input type="checkbox"/>
GPS clock software & license		<input type="checkbox"/>
Other applicable equipment Operational & Technical Guide		<input type="checkbox"/>

10. DURATION OF FACTORY ACCEPTANCE TEST

The duration of the Factory Acceptance Testing will be mutually agreed depending upon the size of the substation.

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



11. INDICATION AND CORRECTION REPORT

Any comments should be added in “log sheets”; Along with the Clearance the Indication and Correction report with compliance has to be submitted to the respective Site/RHQ/CC AM.

INDICATION AND CORRECTION REPORT

LOG SHEET:

No.	Reference	Author	Date

Description

--

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



पारदर्शिता
POWERGRID

12. APPENDIX

GLOSSARY

BCU: Bay Control Unit
DR: Disturbance Recorder
EWS: Engineering Workstation
FAT: Factory Acceptance Test
FPT: Functional Performance Test
FST: Factory Simulation Test
GTW: Gateway
GPS: Global Positioning System
IED: Intelligent Electronic Device
NMS: Network Management (Monitoring) System
OWS: Operator Workstation
RCC: Remote Control Centre
RSCC: Regional System Co-ordination Centre
SAS: Sub-station Automation System
SAT: Site Acceptance Test
SCADA: Supervisory Control And Data Acquisition

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



Factory Acceptance Test (FAT) Procedures & Formats -Control Protection System



Power Grid Corporation of India Ltd.
Saudamini, Plot no.2, Sector-29, Gurgaon, Haryana 122 001



DOC: PG/CC/CRP/FAT, Rev01				
Revision	Department	Date	Signature	Signature
01	CC/Engg CC/QAI CC/AM	09.11.2023	Sd/	Sd/

REVISION HISTORY

SI.No.	Pages	Revision	Remarks
01	All Pages	01	First Release



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POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



About This Document

Purpose of this document

This document shall be used as a standard for conducting all tests during the Factory Acceptance Test (FAT) for the Control & Protection system of every substation as per POWERGRID requirements and specifications.

The aim of the Factory Acceptance Test (FAT) is to demonstrate equipment functionalities as well as the approval process of the system-parameterization by POWERGRID to reduce the change requests during commissioning at site. The general philosophy shall be to deliver a system to site only after it has been thoroughly tested and its specified performance has been verified, as far as site conditions can be simulated in a test lab.

During FAT the entire Sub-station Control and Protection system to be supplied shall be tested for complete functionality and configuration in the factory itself. The extensive testing shall be carried out during FAT. The purpose of Factory Acceptance Testing is to ensure defect free installation at site. No major change in configuration/setting of system is envisaged at site.

This document details the equipment and functions under test and the corresponding test methods as well as the test documentation.

Who should use this document

This document to be used by the Vendor representatives (Q&I, Engg, Factory) for Factory acceptance test as per the project requirement. This approved document will be followed by the Vendor Representatives (Q&I, Engg, Testing) and POWERGRID representatives to test and evaluate the complete system.

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



1. GENERAL

1.1. Introduction

The purpose of this document is to define the Factory Acceptance Test procedures of Substation Control & Protection system supplied by the Vendor to POWERGRID.

The tests are performed by Vendor and each test, or set of tests as appropriate, is covered by an approval stage, which will be signed off upon completion by Vendor and POWERGRID representatives.

Comments are noted in separate Incident and correction reports (snag list) attached as annexure.

2. CONTROL & PROTECTION SYSTEM

2.1. FAT test methodology

FAT testing will be performed for Control & relay panels for ensuring the manufacturing as per the approved CAT-I drawings. Pre-FAT test sheets will be used as a reference for the tests to be performed during the FAT.

These test sheets will indicate the specific units that were tested during pre-FAT tests.

2.2. List of Control & Protection Panels

Feeder / Panel	Feeder Specification	Description	Drawing CSD No.	Rev. No.
401	400kV Meerut-Moradabad Line-1	LINE	CPD KZ5J SC43	CAT-I
402	TIE	TIE	CPD KZ5J SC44	CAT-I
403	ICT-500MVA-1	ICT	CPD KZ5J SC45	CAT-I
BB	Busbar Protection panel	BB	CPD KZ5J SC55	CAT-I
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POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



2.3. Test report overview

FAT Test	Description	Line	Auto/Power Transf.	Bus/Line Reactor	Busbar	Tie	BC/TBC
FAT001	Visual Inspection	X	X	X	X	X	X
FAT002	Hardware Verification	X	X	X	X	X	X
FAT003	AC Scheme Check	X	X	X	X	X	X
FAT004	DC Scheme Check	X	X	X	X	X	X
FAT005	Auxiliary Report	X	X	X	X	X	X

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



2.4. Document verification
2.4.1. Document verification test

Purpose:

This test verifies that the correct manufacturing drawings and documentation for the equipment/system under the test will be used during the Factory Acceptance Test.

Procedure:

1. Verify that approved drawings (printed and soft copies) of all assembled equipment are present.
2. Verify all required hardware and software manuals are present.
3. Guaranteed Technical Parameters (GTPs) as approved by POWERGRID.
4. A copy of Customer Technical Specification for reference is made available in the FAT room.
5. Availability of the approved Drawing list in the FAT room.

Document Verification Log:

SI No.	Description	Drg No.	Checked
1	Approved Standard MQP		<input type="checkbox"/>
2	Standard FAT Procedure		<input type="checkbox"/>
3	Approved GTP-Guaranteed Technical Particulars		<input type="checkbox"/>
4	Approved Hardware specification & BOM		
5	Latest Approved Protection Logic diagram (Line/Transformer/Reactor/BB/etc) (Refer POWERGRID Intranet) *		<input type="checkbox"/>
6	Latest Approved settings/configuration template (pdf) (Refer POWERGRID Intranet)		<input type="checkbox"/>
7	Approved GA & Schematic CRP Drawings (Line/Transformer/Reactor/BB/etc)		<input type="checkbox"/>
8	Product Manuals (Installation, Configuration, maintenance, Troubleshooting, detailed diagnostics etc.)		<input type="checkbox"/>
9	Approved Bill of Quantity spares		<input type="checkbox"/>
10	Operation and Technical Guide of IED configuration softwares.		<input type="checkbox"/>
11	Operation and Technical Guide of Ethernet Switch		
12	Other applicable drawings (not listed above)	Attach the list as annexure	<input type="checkbox"/>

Note:- *if there is a variation between the approved protection scheme and the latest approved protection logic diagram uploaded on POWERGRID intranet, later shall prevail.

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



2.5. Pre-acceptance test

2.5.1. Visual inspection

Purpose: This test will be carried out on the panels before commencing any testing on the panels. This test verifies the cleanliness, physical damages, dimensions, color of the panel and its thickness, mounting arrangements and proper ferruling and labeling etc.

Procedure:

1. Record the name and reference number of the panel to be tested in the test sheet.
2. Verify the check list detailed in the test sheet and ensure that the panel under test is in line with the base document.
3. Record if any comments in the Indication and Correction Report (snag list) attached as to this document.
4. Repeat step 1 to 3 for the other control & protection panels.

Test Document:

Refer Protection FAT Test Sheet in unit 7 (Annexure)

- FAT001: Visual Inspection

Note: Copy of this Visual Inspection test sheets will be used for other panels under test

2.5.2. Hardware verification test

Purpose: This test verifies the list, identification data and the quantities of the equipment mounted in each protection panels.

Procedure:

1. Select one of the typical bays.
2. Verify the test sheet selected for the Hardware Verification Test, belongs to the selected typical panel under test.
3. Record the reference number of the selected typical panel to be tested in the test sheet.
4. Verify the list of equipment and its quantities, as specified in the test sheet and it is in line with the base documents.
5. Record if any comments in the Indication and Correction Report (snag list) attached as to this document.
6. Repeat step 3 to 5 for the other panels of the same type.
7. Repeat step 1 to 6 for the other control & protection panels.

Test Documents:

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



Refer Protection FAT Test Sheet in unit 7 (Annexure)

- FAT002: Hardware Verification Test

Note: Copy of the respective Hardware Verification test sheets will be used for more than one panel of the same type under test.

2.6. Power scheme verification

2.6.1. AC scheme check

Purpose: This test verifies the AC power circuit of the panel under test. In brief, the test verifies the AC power to the MCBs, heating and lighting circuits and to the power sockets and ensures their operation is correct.

Procedure:

1. Select any of the typical bays.
2. Record the name and reference number of the panel to be tested in the test sheet.
3. Verify the check list detailed in the test sheet and ensure AC circuit is as per the scheme and AC devices are working properly.
4. Record if any comments in the Indication and Correction Report (snag list) attached as to this document.

Test Document:

Refer Protection FAT Test Sheet in unit 7 (Annexure)

- FAT003: AC Power Verification

Note: Copy of the same test sheets will be used for the other Control & protection panels

2.6.2. DC scheme check

Purpose: This test verifies the DC power circuit of the panel under test. In brief, the test verifies the DC1 and DC2 to the MCBs, DC changeovers and DCs to the various equipment in the panel.

Procedure:

1. Record the name and reference number of the panel to be tested in the test sheet.
2. Verify the check list detailed in the test sheet and ensure the DC circuit of the panel works properly.
3. Perform a DC change over and ensure for no power failures in any equipment
4. Record if any comments in the Indication and Correction Report (snag list) attached as to this document.
5. Check complete cubicle wiring as per schematic diagram.

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



- 6. Repeat step 1 to 6 for the other Control & protection panels.

Test Documents:

Refer Protection FAT Test Sheet in unit 7 (Annexure)

- FAT004: DC Scheme Check

Note: Copy of the same test sheets will be used other protection panels

2.6.3. Auxiliary relay test

Purpose: This test verifies the functionality and properties of Auxiliary Relay under test.

Procedure:

1. Select a Trip Relay/Lockout Relay from any one of the protection panels
2. Record the panel reference in the test sheet
3. Perform the following routine tests which is applicable for this relay
 - Name plate rating details
 - General inspection
 - Resistance check
 - Secondary injection test
 - Pick-Up / Drop-Off test (operating and resetting coil)
4. Record if any comments in the indication and correction report (snag list) attached as to this document.
5. Repeat step 1 to 5 for the same type of relays for the other panels.

Test Documents:

Refer Protection FAT Test Sheet in unit 7 (Annexure)

- FAT005: Routine Test – Auxiliary Relay

Note: Copy of FAT005 test sheet will be used for more than one relay of the same type under test

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



2.7. Relay configuration & setting

The configuration of each IED in the system shall be adopted as per the approved scheme by POWERGRID. This configuration must be verified for each feeder (Line, Transformer, Reactor, Busbar & etc) as per the POWERGRID standard setting/configuration template (in pdf format).

The POWERGRID standard setting/configuration template must be referred to finalise the configuration. For any clarifications or corrections on the configurations changes if required the same has to be recorded in the observation & compliance report.

Note:

1. However, if the approved setting is not available during FAT, standard setting may be used to complete the FAT.
2. The Final setting/configuration project file must be submitted as part of the FAT documentation.

Following important points must be considered during configuration to ensure the proper Configuration & settings.

1. Defined functionality should be available in the configuration as per POWERGRID TS/Standard drawing.
2. Defining the proper input & output variables as per the approved drawings.
3. Tripping & signal assignment as per the approved Trip matrix.
4. Proper Flow of configuration as per the OEM (Ex. Proper instance of function block to avoid any delay or creating loop)
5. Only inbuilt logical functions should be used until otherwise specified.
6. Proper naming of Each section like Binary input, Protection functions, Binary output, LED, DR, SCADA & etc.
7. Naming of the IED should be proper (Ex SS_Name, Feeder Name).
8. Proper SNTP time setting (DST disabled, NTP ip address, SNTP selected).
9. DR channel configuration shall be done as per POWERGRID standard list.
10. Aesthetic alignment of the configuration in a proper readable format.

2.8. Protection relay - FAT

In addition to the standard routine tests as per the manufacturer OEM recommendations, it's important to verify the functioning and operation of Intelligent Electronic Devices (IEDs) according to specified logic required as per POWERGRID during the Factory Acceptance Testing (FAT) period.

For the demonstration of the following tests, the required simulation tools should be available during FAT.

For each feeder, the FAT reports has to be submitted along with the routine test report of the manufacturer.

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



Line Feeder (Distance/Auto-reclose/LBB):

SI No.	Description	Checked
1	Configuration Check as per the approved drawing & Setting/ Configuration.	<input type="checkbox"/>
2	Correct operation of Tripping relays and associated auxiliary relays.	<input type="checkbox"/>
3	Carrier aided Permissive Scheme in Main-1 & Main-2.	<input type="checkbox"/>
4	Current Reversal & Weak infeed in Main-1 & Main-2.	<input type="checkbox"/>
5	Fault location for each type of faults.	<input type="checkbox"/>
6	AR logic for the One and half breaker system (Both Main & Tie with priority logic) with Main-1 & Main-2 (For Auto reclose logic refer “Pre-Commissioning Procedures and Formats for Substation Equipment & Protection System, section- Circuit Breaker Panel”, DOC ref: D-2-01-03-01-XX)	<input type="checkbox"/>
7	AR 3 Ph trip logic as per standard setting template	<input type="checkbox"/>
8	DT circuit checking with all possible condition for 1 ½, DM, DMT busbar scheme.	<input type="checkbox"/>
9	DT & Carrier send/receive logic with Carrier switch out & Carrier fail.	<input type="checkbox"/>
10	Single phase initiation to LBB relay.	<input type="checkbox"/>
11	Simulation of Cross-country fault in Distance function.	<input type="checkbox"/>
12	3Ph trip initiation to LBB relay.	<input type="checkbox"/>
13	LBB Retrip assignment & Backup assignment for one and half CB, DM & DMT scheme	<input type="checkbox"/>
14	Ensure the timing for both the LBB Retrip and Backtrip Should start only after the current pickup alongwith LBB Initiation. Resetting the current should also reset the LBB function.	<input type="checkbox"/>
15	Metering function (V, I, P, Q, Hz, PF).	<input type="checkbox"/>
16	DR Standardization as per the POWERGRID Standard. Apart from the DR standardization if the channel available required signals may be configured for better analysis.	<input type="checkbox"/>
17	Red Ferruling in the Tripping circuit	<input type="checkbox"/>

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



Line Feeder (Differential/Distance/Autoreclose/LBB):

SI No.	Description	Checked
1	Configuration Check as per the approved drawing & Setting/ Configuration.	<input type="checkbox"/>
2	Correct operation of Tripping relays and associated auxiliary relays.	<input type="checkbox"/>
3	Communication failure of Differential enabling the Distance Z-1 function.	<input type="checkbox"/>
4	Carrier aided Permissive Scheme in Main-1 & Main-2.	<input type="checkbox"/>
5	Current Reversal & Weak infeed in Main-1 & Main-2.	<input type="checkbox"/>
6	Fault locator & Mutual compensation Fault location (If applicable).	<input type="checkbox"/>
7	AR logic for the One and half breaker system (Both Main & Tie with priority logic) with Main-1 & Main-2 (For Auto reclose logic refer “Pre-Commissioning Procedures and Formats for Substation Equipment & Protection System, section- Circuit Breaker Panel”, DOC ref: D-2-01-03-01-XX)	<input type="checkbox"/>
8	AR 3 Ph trip logic as per POWERGRID standard protection logic diagram.	<input type="checkbox"/>
9	DT circuit checking with all possible condition for 1 ½, DM, DMT busbar scheme.	<input type="checkbox"/>
10	DT & Carrier send/receive logic with Carrier switch out & Carrier fail.	<input type="checkbox"/>
11	Simulation of Cross-country fault in Distance function.	<input type="checkbox"/>
12	Single phase initiation to LBB relay.	<input type="checkbox"/>
13	3Ph trip initiation to LBB relay.	<input type="checkbox"/>
14	Ensure the timing for both the LBB Retrip and Backtrip Should start only after the current pickup alongwith LBB Initiation. Resetting the current should also reset the LBB function.	<input type="checkbox"/>
15	LBB Retrip assignment & Backup assignment for one and half CB, DM & DMT scheme	<input type="checkbox"/>
16	Metering function (V, I, P, Q, Hz, PF).	<input type="checkbox"/>
17	DR Standardization as per the POWERGRID Standard. Apart from the DR standardization if the channel available required signals may be configured for better analysis	<input type="checkbox"/>
18	Red Ferruling in the Tripping circuit	<input type="checkbox"/>

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



Transformer Feeder (Differential/REF/Backup OC&EF/Backup Impedance):

SI No.	Description	Checked
1	Configuration Check as per the approved drawing & Setting/ Configuration .	<input type="checkbox"/>
2	Correct operation of Tripping relays and associated auxiliary relays.	<input type="checkbox"/>
3	Differential & HV Overflux operation	<input type="checkbox"/>
4	REF & LV Overflux operation	<input type="checkbox"/>
5	HV OC&EF operation.	<input type="checkbox"/>
6	IV/LV OC&EF operation	<input type="checkbox"/>
7	Backup impedance operation	<input type="checkbox"/>
8	Blocking logic for Backup impedance as per the POWERGRID requirement.	<input type="checkbox"/>
9	Configuration check of 33kV Protection to the Utility feeder & Tertiary feeder availability.	<input type="checkbox"/>
10	Mechanical protection logic has to be implemented as per POWERGRID standard protection logic diagram.	<input type="checkbox"/>
11	Mechanical protection operation extended to Master trip operation.	<input type="checkbox"/>
12	Simulation of the VT Selection logic as per the POWERGRID requirement. VT selection output stability should be checked during / after BCU restart and intermediate state of associated BCU binary inputs.	<input type="checkbox"/>
13	3Ph trip initiation to LBB relay.	<input type="checkbox"/>
14	Ensure the timing for both the LBB Retrip and Backtrip Should start only after the current pickup alongwith LBB Initiation. Resetting the current should also reset the LBB function.	<input type="checkbox"/>
15	LBB Retrip assignment & Backup assignment for one and half CB, DM & DMT scheme	<input type="checkbox"/>
16	Metering function (V, I, P, Q, Hz, PF).	<input type="checkbox"/>
17	DR Standardization as per the POWERGRID Standard. Apart from the DR standardization if the channel available required signals may be configured for better analysis.	<input type="checkbox"/>
18	Simulation of Spare selection logic the CT switching & Tripping scheme. Spare selection output stability should be checked during / after BCU restart and intermediate state of associated BCU binary inputs.	<input type="checkbox"/>
19	Red Ferruling in the Tripping circuit	<input type="checkbox"/>

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



Bus/Line Reactor Feeder (Differential/REF/Backup Impedance):

SI No.	Description	Checked
1	Configuration Check as per the approved drawing & Setting/ Configuration.	<input type="checkbox"/>
2	Correct operation of Tripping relays and associated auxiliary relays.	<input type="checkbox"/>
3	Differential operation	<input type="checkbox"/>
4	REF operation	<input type="checkbox"/>
5	Backup impedance operation.	<input type="checkbox"/>
6	Blocking logic for Backup impedance as per the POWERGRID requirement.	<input type="checkbox"/>
7	Mechanical protection logic has to be implemented as per POWERGRID standard protection logic diagram.	<input type="checkbox"/>
8	NGR Bypass operation, NGR equipment alarms such as CB alarms, Closing coil alarms & output configuration as per POWERGRID requirement.	<input type="checkbox"/>
9	Simulation of the VT Selection logic as per the POWERGRID requirement. VT selection output stability should be checked during / after BCU restart and intermediate state of associated BCU binary inputs.	<input type="checkbox"/>
10	3Ph trip initiation to LBB relay.	<input type="checkbox"/>
11	Ensure the timing for both the LBB Retrip and Backtrip Should start only after the current pickup alongwith LBB Initiation. Resetting the current should also reset the LBB function.	<input type="checkbox"/>
12	LBB Retrip assignment & Backup assignment for one and half CB, DM & DMT scheme	<input type="checkbox"/>
13	Metering function (V, I, P, Q, Hz, PF).	<input type="checkbox"/>
14	DR Standardization as per the POWERGRID Standard. Apart from the DR standardization if the channel available required signals may be configured for better analysis.	<input type="checkbox"/>
15	Simulation of Spare selection logic the CT switching & Tripping scheme. Spare selection output stability should be checked during / after BCU restart and intermediate state of associated BCU binary inputs.	<input type="checkbox"/>
16	Red Ferruling in the Tripping circuit	<input type="checkbox"/>

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



Centralized busbar differential relay

SI No.	Description	Checked
1	Configuration Check as per the approved drawing & Setting/ Configuration	<input type="checkbox"/>
2	Correct operation of Tripping relays and associated auxiliary relays.	<input type="checkbox"/>
3	For the status of the switchgear Double point type to be considered	<input type="checkbox"/>
4	For Centralized Busbar testing refer “Pre-Commissioning Procedures and Formats for Substation Equipment & Protection System,” DOC ref: D-2-01-03-01-XX) and simulate all logic as per the 1 ½, DM, DMT busbar scheme.	<input type="checkbox"/>
5	The report for the centralized busbar scheme has to be submitted as per the Point no 4.	<input type="checkbox"/>
6	DR Standardization as per the POWERGRID Standard. Apart from the DR standardization if the channel available required signals may be configured for better analysis.	<input type="checkbox"/>
7	Red Ferruling in the Tripping circuit	

De-Centralized busbar differential relay

SI No.	Description	Checked
1	Configuration Check as per the approved drawing & Setting/ Configuration.	<input type="checkbox"/>
2	Correct operation of Tripping relays and associated auxiliary relays.	<input type="checkbox"/>
3	For the status of the switchgear Double point type considered	<input type="checkbox"/>
4	For De-centralized Busbar testing refer “Pre-Commissioning Procedures and Formats for Substation Equipment & Protection System , DOC ref: D-2-01-03-01-XX) and simulate all logic as per the 1 ½, DM, DMT busbar scheme.	<input type="checkbox"/>
5	The report for the de-centralized busbar scheme has to be submitted as per the Point no 4.	<input type="checkbox"/>
6	DR Standardization as per the POWERGRID Standard. Apart from the DR standardization if the channel available required signals may be configured for better analysis.	<input type="checkbox"/>
7	Red Ferruling in the Tripping circuit	<input type="checkbox"/>

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



Bay control Unit(BCU) – Feeders

SI No.	Description	Checked
1	Interlock for the respective bays.	<input type="checkbox"/>
2	Metering function (V, I, P, Q, Hz, PF).	<input type="checkbox"/>
3	Graphical display of HMI page in BCU as per the SLD & their control	<input type="checkbox"/>
4	Measurement of bay in HMI page as per the SLD (if Menu not available)	<input type="checkbox"/>

Ethernet Switch & DR PC

Note:- If Ethernet Switch & DR PC only supplied as a part of Project without SAS, then SAS FAT procedure (DOC ref: D-2-03-20-05-XX) to be referred for checking the Performance, Document & configuration.

3. STATEMENT OF SYSTEM ACCEPTANCE

Upon successful completion of all applicable tests and the proper disposition of all documented and witnessed discrepancies resulting from tests specified in the procedure, the system, tested and witnessed by the POWERGRID, is accepted.

Note:- The approved corrected copies of the scheme drawings based on the FAT shall be submitted before SAT.

Documents Verification during FAT:

SI No.	Description	Doc No.	Submitted
1	Visual Inspection report for each feeder		<input type="checkbox"/>
2	Hardware Verification report for each feeder		<input type="checkbox"/>
3	AC Scheme Check Report for each feeder		<input type="checkbox"/>
4	DC Scheme Check Report for each feeder		<input type="checkbox"/>
5	Auxiliary Relay Report for each feeder		<input type="checkbox"/>
6	Typical configuration for each feeder verified (Line, Transformer, Bus reactor, Line reactor, Busbar)		<input type="checkbox"/>
7	Specified Logic Verification-Line Feeder (Distance/Auto-reclose/LBB) Report		<input type="checkbox"/>
8	Specified Logic Verification-Line Feeder (Differential/Distance/Auto reclose/LBB) Report		<input type="checkbox"/>

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



SI No.	Description	Doc No.	Submitted
9	Specified Logic Verification-Transformer Feeder (Differential/REF/Backup OC&EF/Backup Impedance) Report		<input type="checkbox"/>
10	Specified Logic verification-Bus/Line Reactor Feeder (Differential/REF/Backup Impedance) Report		<input type="checkbox"/>
11	Centralised Busbar protection Report		<input type="checkbox"/>
12	De-Centralised Busbar Protection Report		<input type="checkbox"/>
13	Project Backup after complete FAT for all feeder configuration for all Relays involved in the FAT		<input type="checkbox"/>
14	Operation and Technical Guide for Protection IEDs		<input type="checkbox"/>
15	Operation and Technical Guide for BCU & other IEDs supplied		<input type="checkbox"/>
16	Operation and Technical Guide IED configuration softwares		<input type="checkbox"/>
17	Operation and Technical Guide Ethernet Switch		<input type="checkbox"/>
18	Other applicable equipment Operational & Technical Guide		<input type="checkbox"/>

Softwares/License details Backup:

Software/License	Doc. No.	Checked
Protection & Control each type Software & license		<input type="checkbox"/>
CSD, FOTS, RTCC & Other Devices Software & license		<input type="checkbox"/>
Antivirus software & license		<input type="checkbox"/>
Other applicable equipment Operational & Technical Guide		<input type="checkbox"/>

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



4. OBSERVATION AND COMPLIANCE REPORT

Observations during FAT & its compliance shall be recorded in "log sheets".

OBSERVATION AND COMPLIANCE REPORT

LOG SHEET:

Sr. No.	Observations	Compliance	Remarks

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



5. GLOSSARY

BCU: Bay Control Unit
DR: Disturbance Recorder
EWS: Engineering Workstation
FAT: Factory Acceptance Test
FPT: Functional Performance Test
FST: Factory Simulation Test
GTW: Gateway
GPS: Global Positioning System
IED: Intelligent Electronic Device
NMS: Network Management (Monitoring) System
OWS: Operator Workstation
RCC: Remote Control Centre
RSCC: Regional System Co-ordination Centre
SAS: Sub-station Automation System
SAT: Site Acceptance Test
SCADA: System Control & Monitoring System

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



6. ANNEXURE

Annexure -PreFAT Formats

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



**Factory Acceptance Test (FAT)
Procedures & Formats
Control Protection System**

**Doc: PG/CC/CRP/FAT,
Rev01**



Factory Acceptance Test - Protection System

Visual Inspection

Manufacturer:	Equipment:
Contractor:	Feeder/Circuit:

VISUAL INSPECTION

Ref: FAT001

Name of the Panel:

Actions: Verify the check list and ensure that the panel under test is in line with the base document.

Sr.No.	Description	Passed	Failed
1	Ensure all the equipment are free of all foreign materials (dust, solder, droppings, etc)	<input type="checkbox"/>	<input type="checkbox"/>
2	Visually inspect the units and individual modules for cleanliness, healthiness and ensure that they are free from damage	<input type="checkbox"/>	<input type="checkbox"/>
3	Verify that the dimension of the panel as per GA	<input type="checkbox"/>	<input type="checkbox"/>
4	Visually inspect that the equipment are arranged as per the GA drawing of the panel (drawing pocket inside panel is available)	<input type="checkbox"/>	<input type="checkbox"/>
5	Verify the panel outside color and inside color is as per approved drawing	<input type="checkbox"/>	<input type="checkbox"/>
6	Verify the cabinet type is SWING FRAME	<input type="checkbox"/>	<input type="checkbox"/>
7	Verify the locker system of the panel is provided	<input type="checkbox"/>	<input type="checkbox"/>
8	Verify the size of the earthing bar is as per approved drawing	<input type="checkbox"/>	<input type="checkbox"/>
9	Verify the panel name plate and the equipment labels are correct and visible	<input type="checkbox"/>	<input type="checkbox"/>
10	Verify proper labeling is done for all the cables	<input type="checkbox"/>	<input type="checkbox"/>
11	Check for the arrangement of terminal blocks as per the drawing	<input type="checkbox"/>	<input type="checkbox"/>
12	Check the shorting and isolating accessories of CT terminals	<input type="checkbox"/>	<input type="checkbox"/>
13	Verify whether proper ferruling is done or not	<input type="checkbox"/>	<input type="checkbox"/>
14	Check if earth shield connections are provided	<input type="checkbox"/>	<input type="checkbox"/>
15	Check ventilation is provided as per the drawings	<input type="checkbox"/>	<input type="checkbox"/>
16	Check for proper panel door earthing	<input type="checkbox"/>	<input type="checkbox"/>
17	Verify paint thickness as specified in GA drawing	<input type="checkbox"/>	<input type="checkbox"/>
18	Check comprehensiveness of painting against external scratches, rusting, dents/damages etc.	<input type="checkbox"/>	<input type="checkbox"/>
19	Minimum spare TBs should be available as per TS & Truff size should be as accommodate with sufficient space for Field Cable.	<input type="checkbox"/>	<input type="checkbox"/>

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



**Factory Acceptance Test (FAT)
Procedures & Formats
Control Protection System**

**Doc: PG/CC/CRP/FAT,
Rev01**

		Factory Acceptance Test - Protection System	
Hardware verification			
Manufacturer:		Equipment:	
Contractor:		Feeder/Circuit:	
		Page:	23 of 26

HARDWARE VERIFICATION TEST

Ref: FAT002

Name of the Panel:

Actions: Verify the list of equipment and ensure the identification data, manufacturer and quantities are correct.

Sr.No.	Description	Passed	Failed
1	Verify the list of equipment of the scheme drawing as per GA with the existing cubicle layout & record any non-availability of equipment	<input type="checkbox"/>	<input type="checkbox"/>

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



Factory Acceptance Test - Protection System	
Hardware verification	
Manufacturer:	Equipment:
Contractor:	Feeder/Circuit:
	Page:
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AC POWER VERIFICATION

Ref: FAT003

Name of the Panel:

Actions: Verify the check list and ensure that the AC circuit of the panel is correct and the devices are working properly.

Sr.No.	Description	Passed	Failed
1	Ensure that rated AC supply is given to panel at the incoming terminals	<input type="checkbox"/>	<input type="checkbox"/>
2	Verify the equipment under test are rated for proper AC supply	<input type="checkbox"/>	<input type="checkbox"/>
3	Verify the supply at the 1phase AC supply in OFF condition	<input type="checkbox"/>	<input type="checkbox"/>
4	Switch ON the supply and verify the ON/OFF operation of LAMP of the cubicle by operating the miniature position switch	<input type="checkbox"/>	<input type="checkbox"/>
5	Verify the power supply at the socket DS is correct	<input type="checkbox"/>	<input type="checkbox"/>
6	Verify the power supply at the power socket is correct	<input type="checkbox"/>	<input type="checkbox"/>
7	Switch ON the supply and verify the operation of thermostat, heater and indicator lamp. Adjusting the thermostat settings to 25°C for heater ON and ensure the Heater circuit placement doesn't affect any cable entry.	<input type="checkbox"/>	<input type="checkbox"/>
8	AC circuit wiring checked according to corresponding drawing	<input type="checkbox"/>	<input type="checkbox"/>

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



Factory Acceptance Test - Protection System	
Hardware verification	
Manufacturer:	Equipment:
Contractor:	Feeder/Circuit:
	Page: 25 of 26

DC SCHEME CHECK

Ref: FAT004

Name of the Panel:

Actions: Verify the check list and ensure that the DC circuit of this panel is correct, and the devices are working properly.

S.No	Description	Passed	Failed
1	Ensure that rated DC supplies DC1 and DC2 are given to panel at the incoming terminals	<input type="checkbox"/>	<input type="checkbox"/>
2	Verify the equipment under test are rated for proper DC supply	<input type="checkbox"/>	<input type="checkbox"/>
3	Check continuity for DC circuit as per the drawing to ensure proper polarity before power ON	<input type="checkbox"/>	<input type="checkbox"/>
4	Check the Proper Co-ordination of the DC Fuse rating from the source -1 & 2 to till downstream circuit Fuse rating	<input type="checkbox"/>	<input type="checkbox"/>
5	Verify DC1 and DC2 at the main supply is in OFF condition. Now switch on DC Source-1. Check DC voltage at Fuse of DC Source-2. No DC voltage should be present. Switch off DC Source-1.	<input type="checkbox"/>	<input type="checkbox"/>
6	Verify DC1 and DC2 at the main supply is in OFF condition. Now switch on DC Source-2. Check DC voltage at Fuse of DC Source-1. No DC voltage should be present. Switch off DC Source-1.	<input type="checkbox"/>	<input type="checkbox"/>
7	Switch ON the DC1 and DC2 main MCBs and verify the supply at all other supply in the OFF condition	<input type="checkbox"/>	<input type="checkbox"/>
8	Switch ON all the supply in the panels and verify that all equipment rated for DC voltage is working properly	<input type="checkbox"/>	<input type="checkbox"/>
9	Perform a DC change over and ensure that no power failure happened in any of the equipment in the panel	<input type="checkbox"/>	<input type="checkbox"/>
10	Ensure that there is no mixing of DC1 and DC2 supply in the panel	<input type="checkbox"/>	<input type="checkbox"/>
11	Cubicle scheme checked according to corresponding drawing	<input type="checkbox"/>	<input type="checkbox"/>

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date:



		Factory Acceptance Test - Protection System	
Hardware verification		Manufacturer:	Equipment:
Contractor:		Feeder/Circuit:	
		Page:	26 of 26

Auxiliary Relay – xxxx

Ref: FAT005

Feeder Reference:

1. Name Plate Rating Details of the Equipment

Record the following details of the relay.

Relay Make	
Relay Model	
Order Number	
Serial Number	
Rated Voltage	
Contacts Details	

2. General Inspection of Relay

Sr.No.	Description	Passed	Failed
1	Installation and correct wiring as per drawing	<input type="checkbox"/>	<input type="checkbox"/>
2	Terminal tightness	<input type="checkbox"/>	<input type="checkbox"/>
3	Relay earth connected to local earth bar	<input type="checkbox"/>	<input type="checkbox"/>

3. Secondary Injection Test

Pick-up / Drop-off Test

Inject the relay via the front panel test sockets (if possible) and record the pick-up and drop-off values in the table below.

Operating Coil

Pick-Up		Drop-Off		Result
V	mA	V	mA	

POWERGRID Representative	Manufacturer Representative
Signature:	Signature:
Name:	Name:
Date:	Date: