



**GUJARAT ENERGY TRANSMISSION**  
**CORPORATION LTD.**

**SARADAR PATEL VIDYUT BHAVAN,**  
**RACE COURSE, BARODA – 390 007.**

**TECHNICAL SPECIFICATIONS**

**FOR**

**SUB STATION AUTOMATION SYSTEM (SAS)**

**AND SAS EQUIPMENTS**

GETCO/ E / TS – SAS & SAS Equipments 3702/ *R10 March 2026*

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## **SUBSTATION AUTOMATION SYSTEM (SAS)**

### **1.0 SCOPE**

The scope covers supply of Substation Automation System (SAS) including design, engineering, configuration, integration, testing & commissioning of Local as well as Remote operation and monitoring of control & protection system and all the substation auxiliaries of 765/400/220/132/66/33/11kV AIS/GIS/Hybrid Substation from Master Control Center(MCC) as well as from Local substation, as mentioned in respective tender.

The scope of the bidder shall be as follow.

- 1.1 Design, Engineering, Configuration, Testing & Commissioning of Local as well as Remote operation and monitoring of control & protection system of 765/400/220/132/66 kV sub-station (Name mentioned in Schedule – A of the Tender) from the 765/400/220/132/66 kV Main Sub Station or say Master Control Centre (Name mentioned in Schedule – A of the Tender).
- 1.2 Submission of drawings/documents of the offered Substation Automation System(SAS) as per clause no. 9.0.
- 1.3 Configuration of IEDs for protection as well as substation automation aspects.
- 1.4 Configuration of SAS equipments in SAS as per SCADA Architecture.
- 1.5 To establish state of the art Substation Automation System having all the features/functionalities as per clause No. 4.
- 1.6 Integration of all SCADA compatible equipments as per SCADA Architecture in SAS.
- 1.7 Integrated testing of SAS as per clause no. 5.3.1 at works before offering the inspection.
- 1.8 Inspection for integrated testing of SAS, as per approved FAT procedures, at manufacturer's works.
- 1.9 Dispatch of completely assembled, tested and configured SAS at site.
- 1.10 To ensure and coordinate for delivery of all required SAS Equipments from OEM.
- 1.11 Testing of complete SAS at site, in due coordination with purchaser / EPC bidder, as per clause No. 5.5.
- 1.12 The point to point testing of all signals from switchyard equipment terminal to substation controller as well as Remote Control station.
- 1.13 To establish network performance as per clause No. 5.6 & 5.7
- 1.14 To achieve availability as per clause No. 13.
- 1.15 To impart training from appropriate trainer of SAS OEM as per clause No.11.
- 1.16 Supply and service support as per clause no 20.
- 1.17 To supply system with consideration of future extension in proposed substation as shown in SLD/Layout.
- 1.18 Complete engineering, supply of necessary equipments at Local as well as Remote installation, testing & successful commissioning of entire system as stated above.
- 1.19 Supply of spares as listed in Schedule-A of bid documents.
- 1.20 Supply of SCADA system furniture as per Furniture TS. (For SCADA Furniture, separately attached specifications shall be referred)

### **2.0 STANDARDS:**

- 2.1 Unless otherwise specified elsewhere, in this specification, the rating, performance and testing of IEDs and SAS equipments shall confirm to the latest revisions, available of all relevant standards listed in Annexure – II.

**2.2** The equipment shall also comply the latest revision of Indian Electricity Act and Indian Electricity Rules and any other applicable statutory provisions, rules and regulations applicable in the locations where these are to be installed.

### **3.0 PRINCIPAL TECHNICAL PARAMETERS:**

The Substation Automation System covered in this specification shall have the technical requirements as listed in Clause 4 and its sub clauses.

The IEDs and other SAS Equipments covered in this specification shall have to fulfill all the technical requirements as listed in Annexure – III.

### **4.0 GENERAL TECHNICAL REQUIREMENTS:**

#### **4.1 Substation Automation System requirement:**

**4.1.1** The Substation Automation System (SAS) shall be installed to control and monitor all the sub-station equipments from Master Control Center (MCC) **(If specified in tender document)** as well as from locally.

The SAS shall contain the following equipments/components as per technical requirement listed in Annexure-III.

- a) IEC 61850 compatible Bay Control Units - BCU for 765/400/220/132KV/66/33kV system for control, interlocking, measurement and monitoring.
- b) IEC 61850 compatible Bay control and protective relays (IEDs) - BCPU for protection, control, interlocking and monitoring of respective bays for 66KV/33/11kV system (As per Schedule-A of bid documents)
- c) IEC 61850 compatible Bay control unit / RTU having sufficient I/Os for Sub Station auxiliaries control, measurement and monitoring.
- d) IEC 61850 compatible Bay control unit/Units for PLCC/FOTE Panels (If specified in Schedule-A of bid documents).
- e) Redundant Station Human Machine Interface (HMI) at Local as well as at MCC **(If specified in tender document)** in Hot-Hot Standby mode
- f) **Engineering / DR** work station at Local as well as at MCC **(If specified in tender document)**.
- g) Redundant managed switched Ethernet Local Area Network communication infrastructure with hot standby.
- h) **Dual Redundant Gateways (in Hot-Hot Standby mode)** for remote control & monitoring **as well as SLDC Data** via industrial grade PC on IEC60870-5-104 protocol.
- i) **Data transmission to SLDC on IEC60870-5-104 protocol which shall match existing SCADA system installed at SLDC-Gotri.**
- j) GPS based TSE having network based time synch protocol SNTP **(separately attached specifications shall be referred).**
- k) Industrial grade peripheral equipments like printers, display units, key boards, Mouse, terminal equipments for communication link etc. with necessary furniture.
- l) SCADA Furniture as per Furniture TS. (For SCADA Furniture, separately attached specifications shall be referred.)

**4.1.2** It shall enable local station control as well as remote control from MCC **(If specified in tender document)** via an industrial grade PC by means of human machine interface (HMI) and control software package, which shall contain an

extensive range of Supervisory Control and Data Acquisition (SCADA) functions. HMI must be capable of handling all the future equipments over and above present scope of equipments supply.

**4.1.3** Following are the key areas of philosophy of local as well as Remote Control **(If specified in tender document)** Operation & Monitoring of system.

- a) **765/400/220/132/66/33kV** System - Bay wise Bay Control Unit i.e. BCU for control, interlocking, measurement & monitoring and IEC 61850 compatible protective relays (IEDs) for protection as per protection philosophy.
- b) 66/33/11kV System – Bay wise Bay Control and Protective Relay i.e. BCPU (If specified in Schedule-A of bid documents) for protection, control, interlocking and monitoring as per protection philosophy.
- c) IEC 61850 compatible BCU / RTU having sufficient I/Os for station auxiliaries.
- d) Control, measurement and monitoring of Substation Auxiliaries (DC & AC system including battery chargers, DCDBs, ACDBs & LT Panel Boards etc.).
- e) Integration of Online capturing & monitoring of Transformer/**Reactor** readings as well as IEC 61850 compatible Transformer monitoring devices i.e. AVR, online DGA etc. (Integration of these devices with SCADA along with required accessories like LIU, FO cable, etc. are in bidder's scope).
- f) **In case of AIS substation with yard Kiosk concept**, Energy meters with Mod bus protocol shall be connected to F.O. network by using appropriate converter so as metering data shall be available to the dedicated computer (DAS metering PC).
- g) In case of GIS substation, looping of energy meters in conventional manner to DAS computer.
- h) Availability of Metering, event, Alarm, NMS and DR data to local station as well as in Master Control Centre (i.e. availability in Gateway).
- i) Connection of all Relays, BCUs and BCPU to Ethernet switches in star topology whereas Gateways, Station auxiliary BCU/RTU and other peripherals are connected to station level Ethernet switches.
- j) All Ethernet switches shall be looped to form a redundant ring via F.O. cable to have star-redundant ring substation topology
- k) Separate dedicated redundant F.O. network between Bus Bar Central unit and Peripheral unit.
- l) IEC 61850 compatible intelligent Ethernet switches.
- m) Ethernet base 100Mbps LAN.
- n) All inter-bay interlocks through GOOSE messages by forming logics in IEDs.
- o) Remote Data transmission to Master Control Centre through GATEWAY which shall support IEC 61850 and convert data to IEC60870-5-104 protocol for remote control and monitoring.
- p) Remote data transmission to SLDC through GATEWAY which shall support IEC 61850 and convert data to IEC60870-5-104 protocol to match existing SCADA system installed at SLDC Gotri.
- q) HMI configuration as per respective approvals.
- r) Network performance establishment and related configuration and testing thereof.
- s) The supplied SAS shall have Option/ provision to independently run slave S/S, i.e. the proposed substation locally.
- t) If specified;
  - Optional price shall be submitted for 3 years AMC for remote control and protection of equipments and no down time is permitted except for tripping on faults. This shall be operated only if GETCO requires. For

this detailed scope and liability shall be furnished at time of technical bid.

- List of optional spares for above stated scope shall be furnished separately along with prices. However, it will not be part of evaluation.
- Master Control Centre shall also be fully automated as per the **765kV**/400kV/220kV/132kV proposed substation by replacement / modifications of existing equipments/ relays for localized control.

- 4.1.4** It shall include communication gateway, intelligent electronic devices (IED) for bay control and inter IED communication infrastructure. Typical architecture drawing for SAS is enclosed. In case of Yard Kiosk concept, **765**/400/ 220 / 132kV bay panels equipped with IEDs along with its LIU & ethernet switches shall be housed in one Kiosk for two/three bays (unless specified otherwise) and for 66/33kV bays, panels equipped with IEDs along with its LIU & ethernet switches shall be housed in one Kiosks for five to ten bays (unless specified otherwise) as shown in architecture drawing.
- 4.1.5** For **765kV**, 400kV, 220kV and 132kV systems, Peripheral Units (PU) for Bus-bar protection scheme shall be placed in **respective bay panels** and Central Unit (CU) shall be placed in central Kiosk Panel or separate Panel (as specified in architecture drawing for SAS) Separate redundant fiber optic cables shall be provided to have connectivity between all PUs and CU for Bus-bar protection scheme of **765kV**/ 400kV, 220kV & 132kV systems.
- 4.1.6** The communication gateway shall facilitate the information flow with Master control center. The bay level intelligent electronic devices (IED) for protection and control shall have the direct connection to the switchgear without the need of interposing components and perform control, protection, and monitoring functions.
- 4.1.7** **In case of yard Kiosk concept**, PLCC/FOTE panels are to be installed in PLCC room near SCADA room, interface between Distance protection IEDs and PLCC/FOTE panels shall be established through GOOSE by means of interfacing device called PLCC/FOTE BCU.
- 4.1.8** Integrated internal Factory Acceptance test shall be performed before offering the inspection and same shall be got witnessed during inspection. Detailed test procedure covering each and every aspect for this shall be furnished for approval.
- 4.1.9** Site testing and commissioning of Substation Automation System as well as integration in Control & Protection panels.
- 4.1.10** To demonstrate guaranteed availability by conducting the availability test on the total sub-station automation system as a whole after commissioning of total Sub-Station Automation system.
- 4.1.11** The successful bidder shall be required to provide facility for one-week training at no extra cost to the GETCO engineers. The successful bidder has to furnish the training module at the time of detailed engineering. The training shall cover familiarization with procedure of configuration, operation, maintenance and troubleshooting on supplied the Substation Automation system and its equipments.

## **4.2 System design requirement:**

### **4.2.1 General system design**

- a) The Substation Automation System (SAS) shall be suitable for operation and monitoring of the complete substation including future extensions. Interoperability with third party IEC 61850 compatible IEDs to be incorporated in future with offered SAS shall be ensured and necessary data/information shall be provided in this regard.
- b) The systems shall be of the state-of-the art suitable for operation under electrical environment present in Extra High Voltage substations, follow the latest engineering practice, and ensure long-term compatibility requirements and continuity of equipment supply and the safety of the operating staff.
- c) The offered SAS shall support remote control and monitoring from Master Control Center via gateway.
- d) The system shall be designed such that personnel without any background knowledge in Microprocessor-based technology should be able to operate the system. The operator interface shall be intuitive such that operating personnel shall be able to operate the system easily after having received some basic training.
- e) The system shall incorporate the control, interlocking, measurement, monitoring, and protection functions specified, self-monitoring, signaling and testing facilities as well as memory functions, event recording and evaluation of disturbance records. It shall also have provisions for inhibiting control on any or all devices for purpose of maintenance.
- f) Maintenance, modification or extension of components may not cause a shutdown of the whole substation automation system. Self-monitoring of components, modules and communication shall be incorporated to increase the availability and the reliability of the equipment with minimize maintenance.
- g) The successful bidder shall offer the Bay level unit (a bay comprises of one circuit breaker and associated disconnectors, earth switch/es and instrument transformers), along with control and protection panels (described in other sections of technical specifications). It shall be housed in air-conditioned Cemented / Prefabricated Kiosks suitably located in switchyard or any other air-conditioned control room specified by the purchaser. PLCC/FOTE panels shall be installed in PLCC room near SCADA room/ LCC-Panel room (for GIS), and Redundant station HMI & DR Work station in SCADA Room of Control room building for overall optimization in respect of cabling and Control Room building. Remote control and monitoring of the substation shall be from Main Sub Station i.e. Master Control Centre through OPGW / Fiber communication link unless specified otherwise. Required equipments for controlling the substation remotely from MCC as well as transmitting all necessary SCADA data to SLDC shall also be considered.

### **4.2.2 System architecture:**

- a) The SAS shall be based on a decentralized architecture on a concept of bay-oriented, distributed intelligence.

- b) Functions shall be decentralized, object-oriented and located as close as possible to the process. All IEDs of respective bay inside the Kiosk / Control room (such as BCU, BCP, BBCU, Prot. Unit, etc.) shall be connected to EFS through fiber optic only.
- c) The main process information of the station shall be stored in distributed databases. The typical SAS architecture shall be structured in two levels, i.e. in a station and a bay level.
- d) At bay level, for **765** / 400 / 220 / 132kV (AIS / Hybrid / GIS) system & 66/33kV (Hybrid / GIS) system IEC 61850 compatible BCU shall be provided for all bay level functions regarding control, monitoring and I/O processing. Bay wise IEC 61850 compatible Protective Relays shall be provided as per specifications given separately. The BCU / IEDs shall be connected to the switchgear through TB without any need for additional transducers.
- e) For 66/33/11kV AIS system, bay wise IEC 61850 compatible Bay Control & Protective Relays (BCPU) shall be provided for control, monitoring, I/O processing and protection.
- f) Each bay controller & IED shall be independent from each other and its functioning shall not be affected by any fault occurring in any of the other bay control units of the station.
- g) IEC 61850 compatible Bay control unit / RTU having sufficient I/Os for Sub Station auxiliaries shall be provided.
- h) **In case of AIS substation with yard Kiosk concept** Energy meters with Modbus protocol to be connected to SCADA F.O. network through appropriate converter to have metering data to dedicated computer in control room. **In case of GIS substation, looping of energy meters in conventional manner to DAS computer.**
- i) The data exchange between IEDs on bay and station level system shall take place via the communication infrastructure. This shall be realized using fiber-optic cables, thereby guaranteeing disturbance free communication. The fiber optic cables for substation SCADA & Bus bar Protection shall run in separate HDPE ducts of suitable size. The HDPE ducts shall be laid on both the side of cable trench. **One side** ducts are to be tied on cable **tray** at a regular distance of 2 meters and **on** opposite side it shall be laid **through** clamp/hook at a regular distance of 2 meter.
- j) Substation LAN data exchange is to be realized using IEC 61850 protocol having minimum speed of 100 mbps with a redundant managed switched Ethernet communication infrastructure having priority tagging. Each component/module of SAS including entire communication link shall be provided with built-in supervision and self diagnostic features and any failures shall be alarmed to the operator.
- k) The communication network shall be formed with redundant fiber optic link on Rapid Spanning Tree Protocol (RSTP) configuration excluding the links between individual bay IEDs to switch (wherein the redundant connections are not envisaged), clearly defining dataflow direction and also alternative routes in case of link failure to avoid circulating packets such that failure of one set of fiber shall not affect the normal operation of the SAS. However, it shall be



alarmed in SAS. Each fiber optic cable shall have four (4) spare fibers in ring topology.

- l) At station level, the entire station shall be controlled and supervised from the station HMI. It shall also be possible to control and monitor the bay from the bay level equipment at all times.
- m) Clear control priorities shall prevent operation of a single switch at the same time from more than one of the various control levels, i.e. MCC, station HMI, bay level or apparatus level. The priority shall always be on the lowest enabled control level.
- n) The station level contains the station-oriented functions, which cannot be realized at bay level, e.g. Remote communication, Station level supervision, Station level control, Alarm and event management, Data evaluation and achieving alarm list or event list related to the entire substation, gateway for the communication with remote control centers.
- o) The GPS time synchronizing signal for the synchronization of the entire system shall be provided. GPS system shall be compatible with network based protocol NTP (SNTP) in case of IEC 61850. A time accuracy of 1ms shall be achieved for all the devices within SAS. The time display unit shall be provided with GPS, showing real time display date in DD:MM:YY and time in HH:MM:SS(IST) in 24hrs mode. In case of failure of the **GPS-1**, all the SNTP devices shall get time from EWS/Station Auxiliary BCU / **GPS-2** and it shall be working as SNTP server.
- p) Bay level shall contain bay level functions like, Bay level control, Bay level interlock, Bay level automation, object orientation, time synchronization, data acquisition, condition monitoring etc.
- q) In case of Yard Kiosk philosophy, Carrier & Direct Trip signals exchange between Line BCU/Relay and PLCC BCU shall be on IEC 61850 GOOSE message service.
- r) For GOOSE service based protection functions, network performance shall be ensured as per IEC 61850 standard requirement and overall event time of protection function shall be better or at par with conventional system i.e. @ 10 to 15 ms maximum with consistency. GOOSE event timing shall be measured for each and every function. It shall be specified in FDS and shall also be demonstrated and recorded during FAT & SAT.
- s) For **765kV**, 400kV, 220kV & 132kV bays, Peripheral Units (PU) for Bus-bar protection shall be provided in each bay panel and Central Unit (CU) shall be provided in one of the bay panel/**Separate Busbar Panel** as per SCADA Architecture drawing for Bus Bar protection. Separate Redundant Fiber optic cable shall be provided between two / three nos. of PUs (each using 2 fibers) and Bus-bar CU. Each fiber optic cable shall than have two (2) spare fibers. CUs shall have connectivity to IEC 61850 SCADA ring network for all Bus bar scheme related interfaces with HMI as well as Remote Control.

#### **4.2.3 Operational Requirements:**

Operation shall be possible by only one operator at a time.

**4.2.3.1 Select-before-execute:**

- (i) For security reasons the command is always to be given in two stages:
- (ii) Selection of the object and command for operation under all mode of operation except emergency operation.
- (iii) Final execution shall take place only when selection and command are actuated.

**4.2.3.2 Command supervision:**

- (i) Bay/station interlocking and blocking
- (ii) Software Interlocking shall be provided to ensure that inadvertent/incorrect operation of switchgear causing damage and accidents in case of false operation does not take place.
- (iii) Looking to safety aspect, in addition to software interlocking hardwired interlocking shall also be provided for:
  - a) Bus Earth switch Interlocking
  - b) Bay Earth switch Interlocking
  - c) Transfer Bus interlocking (if applicable) through GOOSE and if required then through hardwired
- (iv) It shall be a simple layout, easy to test and simple to handle when upgrading the station with future bays. For software interlocking the bidder shall describe the scenario while an IED of another bay is switched off or fails.
- (v) A software interlock override function shall be provided which can be enabled to bypass the interlocking function. Interlock Bye-pass authority shall be allowed to specific user authority level only.

**4.2.3.3 Run Time Command cancellation:**

- (i) Command execution timer (configurable) shall be available for each control level connection.
- (ii) If the control action is not completed within a specified time, the command should get cancelled and an alarm shall be generated to indicate the failure of command.

**4.2.3.4 Self-supervision:**

- (i) Continuous self-supervision function with self-diagnostic feature shall be included.
- (ii) The redundant components such as servers shall be configured for HOT-HOT Standby mode and it shall monitor each other for availability and the active device shall takeover all the functions of the failed device.
- (iii) The events occurring when a server is in failed state shall be synchronized from the active server.

#### 4.2.3.5 User configuration:

- (i) The monitoring, controlling & configuration of all input & output (as per Annexure-I) logical signals and binary inputs & relay outputs for all built-in functions & signals shall be possible both locally and remotely.
- (ii) It shall also be possible to interconnect and derive input and output signals, logic functions, using built-In functions, complex voltage and currents, additional logics (AND-gates, OR-gates and timers). (Multi activation of these additional functions should be possible).

#### 4.3 Functional requirement:

The Functional requirement shall be divided into following levels:

- a) Bay Level Functions (a bay comprises of one circuit breaker and associated disconnector, earth switches and instrument transformer).
- b) System Level Functions

##### 4.3.1 Bay level functions:

In a decentralized architecture the functionality shall be as close to the process as possible. In this respect, the following functions can be allocated at bay level:

- Bay control, measurement, monitoring, interlocking functions including data collection functionality.
- Bay protection functions

Separate IEDs shall be provided for bay control function, bay protection function. However, for medium voltage level (i.e. 66kV and below) combined Bay control and Protection unit shall be considered if specified.

##### 4.3.1.1 Bay Control functions:

###### A. Overview:

Functions:

- i. Control mode selection
- ii. Select-before-execute principle
- iii. Command supervision:
  - Interlocking and blocking
  - Double command
- iv. Synch check, No voltage selection
- v. Run Time Command cancellation
- vi. Transformer tap changer control (Raise and lower of Tap) (for power transformer bays)
- vii. Operation counters for circuit breakers
- viii. Operating pressure supervision
- ix. Breaker position indication per phase
- x. Disconnecter & Earth switch position indicator
- xi. Alarm annunciation
- xii. Measurement display
- xiii. Local HMI (local guided, emergency mode)
- xiv. Interface to the station HMI.
- xv. Data storage for at least 200 events

- xvi. Auto-reclose mode selection control (as applicable) (either Physical switch or Soft switch on HMI & Function key of IEDs)
- xvii. Protection transfer switch control (as applicable) (either Physical switch or Soft switch on HMI)
- xviii. Carrier In-Out (either Physical switch or Soft switch on HMI & Function key of IEDs)
- xix. Direct Trip In-Out (either Physical switch or Soft switch on HMI & Function key of IEDs)
- xx. Bus Bar In-Out (either Physical switch or Soft switch on HMI & Function key of IEDs)
- xxi. Resetting of Trip Relays
- xxii. Measurement of Analogue signals
- xxiii. Extension possibilities with additional I/O's inside the unit or via fiber-optic communication and process bus.

#### **B. Control mode selection:**

##### **i. Bay Level Operation:**

Local-Remote selection shall be available in Bay control unit through which the control of equipments locally from BCU or remotely from automation system is possible. As soon as the operator receives the operation access at bay level the operation is normally performed via bay control IED. During normal operation bay control unit allows the safe operation of all switching devices via the bay control IED. The IEDs shall be equipped with sufficient number of output contacts capable of making and breaking current for circuit breaker closing and breaking coil currents.

##### **ii. EMERGENCY Operation**

It shall be possible to close or open the selected Circuit Breaker with CONTROL SWITCH provided on control and protection panel during the outage of bay IED.

##### **iii. REMOTE mode**

Control authority in this mode is given to a higher level (Remote Control Centre) and the installation can be controlled only remotely. Control operation from lower levels shall not be possible in this operating mode.

#### **C. Synchronism and energizing check**

The synchronism and energizing check functions shall be bay-oriented and distributed to the bay control and/or protection devices. These features are:

- a. The settings pertaining to synch check and dead line charging shall be provided in Bay Control Unit (i.e. Settable voltage, phase angle, and frequency difference).
- b. The breaker operation with or without synchro check shall be selectable during command execution in HMI. When equipment is selected, it shall give option for breaker operation with or without synchro-check.
- c. Energizing for deadline -live bus, live line -dead bus or dead line –dead bus with no synchro-check function.
- d. Synchronizing between live line and live bus with synchro-check function.

#### **D. Voltage selection**

The voltages relevant for the Synchro check functions are dependent on the station topology, i.e. on the positions of the circuit breakers and/or the isolators. The correct voltage for synchronizing and energizing shall be derived from the auxiliary switches of the circuit breakers & isolator and shall be routed to bay IEDs through PT selection relay operations by BCU contacts operated through logic configured in respective BCU.

#### **E. Transformer tap changer control**

Raise and lower operation of OLTC taps of transformer shall be facilitated through Bay controller IED.

### **4.3.1.2 Bay protection functions**

#### **A. General**

- a. The protection functions are independent of bay control function. The protection shall be provided by separate protection IEDs (numerical relays) and other protection devices as per section Relay & Protection in case of BCU. However, BCPU shall have O/C & Breaker Failure protection function as per separately attached technical specification.
- b. IEDs, shall be connected to the communication infrastructure for data sharing and meet the real-time communication requirements for automatic functions. The data presentation and the configuration of the various IEDs shall be compatible with the overall system communication and data exchange requirements.

#### **B. Event and disturbance recording function**

Each IED (BCU/BCPU) should contain an event recorder capable of storing at least 2000 time-tagged events.

### **4.3.1.3 Bay Interlocking function:**

Bay switchgear interlocks shall be achieved by forming soft logics in respective bay IEDs. Also, inter bay interlocks like Bus coupler and Bus Transfer bay interlock shall also be achieved through GOOSE messages as well as soft logics. **Additionally, interlocking for Bus earth switches shall be through hard wiring also.**

### **4.3.1.4 Bay Monitoring functions:**

- a. At bay level all switchgear status and discrepancies, CB pressure, CB Spring charging, Trip circuits, trip relays, healthiness of Transformer monitoring devices, protection and control IEDs etc. shall be monitored continuously and shall be reported with audible alarm in case of any abnormality.
- b. **Monitoring of Gas Chambers in GIS Sub-stations:**

**In case of a GIS sub-stations, all the gas tight chambers are required to be monitored individually phase wise for their SF6 gas**

**density status by the bay control unit in a bay. Sufficient numbers of inputs are required to be provided in the BCU. In case there is any limitation of number of inputs in the BCU, additional BCUs are required to be provided without any cost implication to purchaser. These inputs shall be used for necessary monitoring, control and protection purpose.**

#### 4.3.2 System level functions

##### 4.3.2.1 Status supervision

- i. The position of each switchgear, e.g. circuit breaker, isolator, earthing switch, transformer tap changer etc., shall be supervised continuously. Every detected change of position shall be immediately displayed in the single-line diagram on the station HMI screen, recorded in the event list and it shall be possible to print a hard copy printout as and when required. Alarms shall be initiated in the case of equipment, system or bay switchgear troubles only.
- ii. The switchgear positions shall be double point status(DPS) indicated by two auxiliary switches, normally closed (NC) and normally open (NO), which shall give ambivalent signals. An alarm shall be initiated if these position indications are inconsistent or if the time required for operating mechanism to change position exceeds a predefined limit.
- iii. The SAS shall also monitor the status of sub-station auxiliaries. The status and control of auxiliaries shall be done through separate one or more IED (**BCU**) /RTU and all alarm and analogue values shall be monitored and recorded through this IED (**BCU**)/RTU.
- iv. The high-voltage apparatus, station auxiliaries like 220/110 V DC chargers, 1000A LT Panels, **ACDB, DCDB** etc. within the station shall be operated from different places like:
  - Remote control centers
  - Station HMI
  - Local Bay controller IED (in the bays)
  - Equipment level

##### 4.3.2.2 Measurements:

The measured values shall be displayed locally on the station HMI and in the control center. These measurements can be used for display, creation of trends and reports on HMI, storage in historian etc. The abnormal values must be discarded. The analogue values shall be updated every 2 seconds if time based or percentage change based (1.5 or 2%) as specified and the same shall be demonstrated during FAT of the system. Threshold limit values shall be selectable for alarm indications.

##### 4.3.2.3 Event and alarm handling:

Events and alarms are generated either by the switchgear, by the control IEDs, or by the station level unit. They shall be recorded in an event list in the station HMI. Alarms shall be recorded in a separate alarm list and appear on the screen. All, or a freely selectable group of events and alarms

shall also be printed out on an event printer. The alarms and events shall be time-tagged with a time resolution of 1 ms.

#### 4.3.2.4 Station HMI:

Operation of the system by the operator from the MCC or at the substation shall take place via industry standard HMI (Human Machine interface) consisting of graphic colour VDU, a standard keyboard and a cursor positioning device (mouse).

##### A. HMI Requirement:

- a. HMI screens shall give a visual representation of various real time process data coupled with control facilities. **HMI server computer shall have dual screens to monitor two different HMI views for various monitoring and control of system.** The operator shall have access to various HMI screens with discretion to monitor the system in its entirety via overview screen or take an in-depth approach to individual bay level for detailed monitoring and control functionality. Redundant HMI **servers** in Hot-Hot Standby configuration shall be provided. In case of trouble of any of the HMI the another HMI can take over and all the operation/monitoring shall be possible from standby HMI.

The coloured screen shall be divided into following sections:

- I. Status bar- The operator has quick and easy access to various monitoring and control specific screens on authorization given via his/her login criteria.
  - II. Process Visualization: Detailed bay view including bay SLD, metering, control & status of relay and switches, annunciator etc.
  - III. Navigation bar with alarm/condition indication: The designations of the individual displays shall be shown on the associated navigation button to quick and easy access to particular view. Also, latest alarm shall be displayed in this bar.
- b. On the HMI the object has to be selected first. In case of a blocking or interlocking conditions are not met, the selection shall not be possible and an appropriate alarm annunciation shall occur. If a selection is valid the position indication will show the possible direction, and the appropriate control execution button shall be pressed in order to close or open the corresponding object.
  - c. For display of alarm annunciation, lists of events etc. a separate HMI View node shall be provided.
  - d. All operations shall be performed with mouse and/or a minimum number of function keys and cursor keys. The function keys shall have different meanings depending on the operation. The operator shall see the relevant meanings as function tests displayed in the command field (i.e. operator prompting). For control actions, the switchgear (i.e. circuit breaker etc.) requested shall be selectable on the display by means of the cursor keys.

- e. The switching element selected shall then appear on the background that shall be flashing in a different color. The operator prompting shall distinguish between:

Prompting of indications e.g. fault indications in the switchgear, and prompting of operational sequences e.g. execution of switching operations.

- f. The summary information displayed in the message field shall give a rapid display of alarm/message of the system in which a fault has occurred and alarm annunciation lists in which the fault is described more fully.
- g. Each operational sequence shall be divided into single operation steps which are initiated by means of the function keys/WINDOW command by mouse. Operator prompting shall be designed in such a manner that only the permissible keys are available in the command field related to the specific operation step. Only those switching elements shall be accessed for which control actions are possible. If the operation step is rejected by the system, the operator prompting shall be supported by additional comments in the message field. The operation status shall be reset to the corresponding preceding step in the operation sequence by pressing one of the function keys. All operations shall be verified. Incorrect operations shall be indicated by comments in the message field and must not be executed.
- h. Control operation from other places (e.g. REMOTE) shall not be possible in Local mode.
- i. The offer shall include a comprehensive description of the system. The above operation shall also be possible via WINDOWS based system by mouse.

#### **B. HMI design principles:**

Consistent design principles shall be adopted with the HMI concerning labels, colours, dialogues and fonts. Non-valid selections shall be dimmed out.

The object status shall be indicated using different status colours for:

- a. Selected object under command
- b. Selected on the screen
- c. Not updated, obsolete values, not in use or not sampled
- d. Alarm or faulty state
- e. Warning or blocked
- f. Update blocked or manually updated
- g. Control blocked
- h. Normal state



- i. Energized or de-energized state (based on substation topology)

**C. Process status displays and command procedures:**

- a. The process status of the substation in terms of actual values of currents, voltages, frequency, active and reactive powers as well as the positions of circuit breakers, isolators and transformer tap-changers shall be displayed in the station single-line diagram.
- b. In order to ensure a high degree of security against undesired operation, a "select-before-execute" command procedure shall be provided. After the "selection" of a switch, the operator shall be able to recognize the selected device on the screen, and all other switchgear shall be blocked. As communication between control center and device to be controlled is established, the operator shall be prompted to confirm the control action and only then final execute command shall be accepted. After the "execution" of the command the operated switching symbol shall flash until the switch has reached its new position.
- c. The operator shall be in a position to execute a command only, if the switch is not blocked and if no interlocking condition is going to be violated. The interlock permissive status of respective switchgears shall be displayed as pop up menu and on clicking the menu it shall display complete logic along with all the conditions. In case of non-permissive of interlock, the condition, which is not being fulfilled, should be displayed in RED for easy identification and trouble shooting.
- d. After command execution the operator shall receive a confirmation that the new switching position has been reached or an indication that the switching procedure was unsuccessful with the indication of the reason for non-functioning.

**D. Presentation and dialogues:**

General

- a. The operator station HMI shall be a redundant with hot-hot standby and shall provide basic functions for supervision and control of the substation. The operator shall give commands to the switchgear on the screen via mouse clicks or keyboard commands.
- b. The HMI shall give the operator access to alarms and events displayed on the screen. Aside from these lists on the screen, there shall be a printout of alarms or events in an event log.
- c. An acoustic alarm shall indicate abnormalities, and all unacknowledged alarms shall be accessible from any screen selected by the operator.

The following standard views shall be available on the HMI:

- 1. Single-line diagram as per the voltage level showing the exact equipment arrangement, switchgear status and measured values.

2. In case of GIS substations, 3 Line Diagram to replicate primary system and compartment wise dynamic SF6 gas pressure monitoring
3. SCADA system Architecture showing whole Substation Automation Control system installed in the substation and interconnection between all equipment.
4. Detailed bay view including metering for all the bays under scope
5. Busbar protection view as well as CU-PU Architecture
6. Control dialogues with interlocking and blocking details. This control dialogue shall tell the operator whether the device operation is permitted or blocked and show the Interlocking logic with status.
7. Measurement dialogues
8. Alarm list view, station / bay-oriented – showing all configured alarm
9. Event list view, station / bay-oriented – showing all configured event
10. Station Auxiliaries View – Control, Measurement and Status of station auxiliaries
11. Pop-up menu for NIFPS, DGA, LEDs of IEDs, LCC Supervision alarms etc.
12. NMS view on Engineering work station
13. Help View – Display of various symbols defining their meaning.

**Note:** HMI Bay views shall be configured covering all the aspects of respective bay in single screen as far as possible. Typical HMI Bay views are provided as Annexure as a reference for better understanding.

**E. System supervision & display:**

The SAS shall be comprehensively self-monitored such that faults are immediately indicated to the operator, possibly before they develop into serious situations. Such faults are recorded as a faulty status in a system supervision display. This display shall cover the status of the entire substation including all switchgear, IEDs, communication infrastructure and remote communication links, and printers at the station level, etc.

**F. Event list:**

- a. The event list shall contain events that are important for the control and monitoring of the substation.
- b. The event and associated time (with 1 ms resolution) of its occurrence has to be displayed for each event. The operator shall be able to call up the chronological event list on the monitor at any time for the whole substation or sections of it. A printout of each display shall be possible on the hard copy printer.

- c. The events shall be registered in a chronological event list in which the type of event and its time of occurrence are specified. Each event shall be presented by displaying an event text line which consists of a time stamp, object identification, as signal text and text indication the status. The information shall be obtainable also from a printed event log.

The chronological event list shall contain:

1. Position changes of circuit breakers, isolators and earthing devices
2. Switchgear Local / Remote Status
3. Switchgear Interlock by pass position switch status (In case of Hybrid and GIS)
4. All switchgear monitoring and supervision conditions
5. All Transformer and Reactor troubles
6. All protection signals Indication of protective relay operations
7. SAS Network troubles
8. System level equipments status and monitoring signals
9. All the GOOSE based Switchgear status as well as Protection function signals of all the bays
10. Fault signals from the switchgear
11. Indication when analogue measured values exceed upper and lower limits. Suitable provision shall be made in the system to define two level of alarm on either side of the value or which shall be user defined for each measured.
12. Loss of communication.
13. User Log in and Log off
14. Remote Log in and Log off

Filters for selection of a certain type or group of events shall be available.

The filters shall be designed to enable viewing of events grouped per:

1. Date and time
2. Bay
3. Device
4. Function e.g. trips, protection operations etc.
5. Alarm class

**G. Alarm list:**

Faults and errors occurring in the substation shall be listed in an alarm list and shall be immediately transmitted to the control center. The alarm list shall substitute conventional alarm tableau, and shall constitute an evaluation of all station alarms. It shall contain unacknowledged alarms and persisting faults. The date and time of occurrence shall be indicated.

The alarm list shall consist of a summary display of the present alarm situation. Each alarm shall be reported on one line that contains:

1. The date and time of the alarm.
2. The name of the alarming object.
3. A descriptive text.
4. The acknowledgement state.

Whenever an alarm condition occurs, the alarm condition must be shown on the alarm list and must be displayed in a flashing state along with an audible alarm. After acknowledgement of the alarm, it should appear in a steady (i.e. not flashing) state and the audible alarm shall stop. The alarm should disappear only if the alarm condition has physically cleared and the operator has reset the alarm with a reset command. The state of the alarms shall be shown in the alarm list (Unacknowledged and persistent, unacknowledged and cleared, Acknowledged and persistent). All protection relay alarms shall also be configured as latch type alarms i.e. it shall disappear only with reset command (as IEC addresses of respective functions are spontaneous and will disappear with resetting of respective protection functions).

Filters for selection of a certain type or group of alarms shall be available as for events.

The chronological Alarm list shall contain:

1. All Transformer and Reactor troubles
2. All switchgear supervision and troubles
3. All protection signals Indication of protective relay operations
4. All supervision and troubles of Control & Protection Panels
5. SAS Network troubles
6. All communication troubles of IEDs
7. All the GOOSE based protection signals of all the bays

**In addition to the regular alarms, following alarms shall also be displayed and logged.**

- **Alarms shall be displayed on the HMI, for each device of SAS When they loose time synchronization**

- **'GOOSE Fail Alarm' shall be configured which shall be generated when any of the subscriber IEDs fails to receive any of the GOOSE messages. These alarms shall be mapped IED-wise in the bay wise HMI view.**

#### **H. Object picture:**

When selecting an object such as a circuit breaker or isolator in the single-line diagram, the associated bay picture shall be presented first. In the selected object picture, all attributes like:

- a. Type of blocking.
- b. Authority.
- c. Local / remote control mode
- d. RCC / SAS control.
- e. Errors etc. shall be displayed.

#### **I. Control dialogues:**

The operator shall give commands to the system by means of mouse click on respective control menu in bay views. It shall also be possible to use the keyboard for command activation. Data entry is performed with the keyboard. Dedicated control dialogues for controlling, following devices shall be available wherever applicable:

1. Breaker and disconnecter
2. Transformer tap-changer
3. Mode selection (L/R, Non-Auto/1-ph, Auto/Manual etc.)
4. Station auxiliaries
5. Carrier In-Out
6. Direct Trip In-Out
7. Auto Reclose In-Out
8. Bus bar Zone In –Out
9. "Normal-Inter-Transfer" mode selection
10. Annunciation Reset
11. LED reset
12. Bay level or System level control transfer to MCC etc.
13. Reverse blocking BB In-Out

#### **J. Station level monitoring:**

All the feeder rms values of MW/MVAr shall be summed up at the Station level. This sum shall normally be equal to zero and any difference greater than a specified value which shall be user programmable shall be alarmed. This alarm shall also be sent to the RCCs as an event.

Zone wise Bus bar differential Current shall also be configured on HMI SLD view and shall be monitored. Data shall be directly integrated from Bus bar protection Central unit

#### **4.3.2.5 User-authority levels**

It shall be possible to restrict activation of the process pictures of each object (bays, apparatus...) within a certain user authorization group. Each user shall then be given access rights to each group of objects, e.g.:

- a. Display only
- b. Normal operation (e.g. open/close of switchgear)
- c. Restricted operation (e.g. by-passed interlocking)
- d. System administrator

For maintenance and engineering purposes of the station HMI, the following authorization levels shall be available:

- a. No engineering allowed
- b. Engineering/configuration allowed
- c. Entire system management allowed

The access rights shall be defined by passwords assigned during the login procedure. Only the system administrator shall be able to add/remove users and change access rights.

**In case of non-activity for a pre-determined period (say 30 minutes), the system will automatically logged out the user and user has to log in again for doing any operation. Further each operation must be logged in in the event/alarm list along with the user name.**

#### **4.3.2.6 Reports:**

The reports shall provide time-related follow-ups of measured and calculated values. The data displayed shall comprise:

##### **A. Trend reports:**

- a. Day (mean, peak)
- b. Month (mean, peak)
- c. Semi-annual (mean, peak)
- d. Year (mean, peak)

##### **B. Historical reports of selected analogue Values:**

- a. Day (at 15 minutes' interval)
- b. Week
- c. Month
- d. Year

It shall be possible to select displayed values from the database in the process display on-line. Scrolling between e.g. days shall be possible. Unsure values shall be indicated. It shall be possible to select the time period for which the specific data are kept in the memory.

Following printouts shall be available from the printer and shall be printed on demand:

- i. Daily voltage and frequency curves depicting time on X-axis and the appropriate parameters on the Y-axis. The time duration of the curve is 24 hours.
- ii. Weekly trend curves for real and derived analogue values.
- iii. Printouts of the maximum and minimum values and frequency of occurrence and duration of maximum and minimum values for each analogue parameter for each circuit in 24 hr. period.
- iv. Provision shall be made for logging information about breaker status like number of operation with date and time indications.
- v. Equipment operation details shift wise and during 24 hours.
- vi. Printout on adjustable time period as well as on demand for MW, MVAR, Current, Voltage on each feeder and transformer as well as Tap Positions, temperature and status of pumps and fans for transformers.
- vii. Printout on adjustable time period as well as on demand system frequency and average frequency.
- viii. The successful bidder has to develop these reports. The reports are limited to the formats for which data is available in the SAS database.
- ix. **It shall be possible to generate user made reports based on measured/recorded values of various combination of parameters particularly for transformer and reactors for healthiness of equipment depending upon defined criteria. These generation of reports must be user friendly and shall be easy to define.**

All the tools used for building a report shall be provided with the system so that the owner is able to build new reports. The tools shall be user friendly with 'drag & drop' or 'menu based selection' features and shall not require any knowledge of programming. The tools shall always use the original data as a base for further calculations or analysis.

#### **4.3.2.7 Trend display (historical data):**

It shall be possible to illustrate all types of process data as trends –input and output data, binary and analogue data. It shall allow user to visualize real-time or historical evolution of any measurement configured to be logged. The trends shall be displayed in graphical form as column or curve diagrams with a maximum of 10 trends per screen. Adjustable time span and scaling ranges must be provided.

It shall be possible to change the type of value logging (direct, mean, sum, or difference) on-line in the window. It shall also be possible to change the update

intervals on-line in the picture as well as the selection of threshold values for alarming purposes.

#### **4.3.2.8 Automatic disturbance file transfer:**

All recorded oscillograph data from the IEDs with integrated disturbance recorder as well as dedicated disturbance recording systems shall be automatically uploaded when fault occurs (event triggered or cyclically) or manually uploaded on operator's request to Engineering Work station of Local as well as Remote control center and be stored on the hard disc.

#### **4.3.2.9 Disturbance analysis:**

Engineering Work station which shall have necessary software to evaluate all the required information for proper fault analysis. The operator shall access these DR files and analyze them using the DR evaluation software. The Disturbance waveforms shall be printed out on the color laser printer.

#### **4.3.2.10 IED parameter setting:**

It shall be possible to access all protection and control IEDs for reading the parameters (settings) from the Engineering Work station as well as from Remote Engineering work station i.e. MCC. The setting of parameters or the activation of parameter sets shall only be allowed after due authentication by means of a password.

#### **4.3.2.11 Automatic sequences:**

The available automatic sequences in the system shall be listed and described, (e.g. sequences related to the bus transfer). It must be possible to initiate pre-defined automatic sequences by the operator and also define new automatic sequences wherever required. The automatic sequencing is required to be developed at SCADA.

### **4.4 Firewall Cum Router**

Firewall cum Router shall be provided in offered SAS, and shall be connected at network periphery of sub-station. Separate Firewall cum Router shall be provided for Substation Remote Control and Substation Data to SLDC/WRLDC respectively, as per requirement specified in tender drawing / document.

Offered Firewall cum Router shall have to fulfill all the technical requirements as listed in Annexure – III.

### **4.5 Gateway**

In the offered SAS, two Gateways shall be provided which shall have modular structure design & high availability. The Gateway provided for the above system shall be industrial grade and rack mounted. Looking to Cyber security challenges and technological advancements in IT sector latest software and hardware shall be provided. Gateway shall have to fulfill all the technical requirements as listed in Annexure – III. The Gateway shall be compatible to IEC61850, IEC 60870-5-104.

#### **4.5.1 Communication Interface:**



**4.5.1.1 The Substation Automation System GATEWAY shall**

- a. Have capability to support simultaneous communication with multiple independent remote master stations,
- b. Have minimum Nos. of communication ports on each gateway as per technical requirements listed in Annexure-III.
- c. Allow scanning and control of defined points within the substation automation system independently for each control center.
- d. Simultaneously respond to independent scans and commands from purchaser's control centers.
- e. Support the use of a different communication data exchange rate (bits per second), scanning cycle, and/or communication protocol to each remote control center. Also, each control center's data scan and control commands may be different for different data points within the substation automation system's database.
- f. Identify the actions performed by the each of the remote masters individually and log it in its database. The logs for last 30 days shall be stored and accessible at the station HMI.
- g. Allow all necessary status as well as measurement data transfer to SLDC SCADA system. Communication media may be leased line /PLCC/ OPGW/ which is not in the scope of bidder unless otherwise specified.
- h. Not allow simultaneous commands from multiple control level. Commands shall be accepted from the level where user authority is provided from local SAS

**4.5.2 Master Control Centre Communication Interface:**

Communication channels between the local Substation Automation System and the Master control centre will be physical wired optical Ethernet medium consist either of OPGW or optical fiber, as the case may be, as specified.

**4.5.3 Communication Protocol:**

The communication protocol for gateway to control center shall be an open protocol and shall support IEC 60870-5-104 for Gateway to remote station and IEC 61850 for all levels of communication for sub-station automation such as Bay to station HMI, between bays etc. respectively. The protocol shall support the features such as Report by exception; Periodic reporting so that the data update times at the SLDC can be optimized.

**4.6 System hardware requirement:**

**4.6.1 SCADA Equipments:**

- a) The bidder shall provide redundant station HMI Servers in Hot & Hot standby mode. The servers used in these work station shall be industrial grade. **Each HMI server computer shall have dual screen. It shall be suitable to support dual screen functionality as per requirements.**
- b) It shall be capable to perform all functions for entire substation including future requirements as indicated in the SLD. It shall use industrial grade components.
- c) The minimum capacity of hard disk shall be selected such that the following requirement should occupy less than 50% of disk space:

- I. Storage of all analogue data (at 15 Minutes interval) and digital data including alarm, Event for minimum two years and trend data for minimum thirty (30) days.
- II. Storage of all necessary software,

Supplier shall demonstrate that the capacity of RAM / Hard disk is sufficient to meet the above requirement.

#### **4.6.1.1 HMI (Human Machine Interface)**

The HMI shall show overview diagrams (Single Line Diagrams) and complete details of the switchgear with a colour display. All event and alarm annunciation shall be selectable in the form of lists. Operation shall be by a user friendly function keyboard and a cursor positioning device. The user interface shall be based on WINDOWS concepts with graphics & facility for panning, scrolling, zooming, decluttering etc.

HMI Servers as well as Engineering work stations shall have to fulfill all the technical requirements as listed in Annexure – III.

Monitor with UPS

- a. The bidder shall provide **Five Nos.** display units, Two **Nos.** for **each** station HMI and one for Engineering / **DR** work station.
- b. These shall have full HD resolution and reflection protected (Anti-Glare) LED screen. High stability of the picture geometry shall be ensured.
- c. The screen shall be LED at least 24" diagonally in size and capable of colour graphic displays.
- d. The display shall accommodate resolution of 1920 X 1080 pixels.
- e. Monitor with UPS shall have to fulfill all the technical requirements as listed in Annexure – III.

#### **4.6.1.2 Printers:**

Printer shall have to fulfill all the technical requirements as listed in Annexure – III.

All reports and graphics prints shall be printed on laser jet colour printer. All printers shall be continuously online.

#### **4.6.1.3 Switched Ethernet Communication Infrastructure:**

The successful bidder shall provide the redundant switched optical Ethernet communication infrastructure for SAS as per the architecture of the respective project.

Ethernet switch shall have to fulfill all the technical requirements as listed in Annexure – III.

#### **4.6.1.4 KVM Extender (Keyboard, Video and Mouse Extender)**

- a. The successful bidder shall provide a KVM Extender (KVM is an acronym for Keyboard, Video and Mouse) to extend control and

display from panel to operator desk, and the connection shall be extended through Cat-5/Cat-6 or Fiber optic cable. The bidder shall provide KVM extender ensuring the minimum HMI resolution (1920 x 1080) @ 60 Hz for minimum of 30 m distance. However, the bidder shall make sure that the overall system performance (screen resolution, smooth display) shall not be compromised.

**b. KVM extender shall be suitable to support dual screen functionality as per architecture.**

**4.6.1.5 KVM Switch**

The successful bidder shall provide a KVM Switch to connect DR PC, Gateway-1 and Gateway -2 to one monitor, keyboard and mouse. The bidder shall provide KVM Switch ensuring the **minimum 5 port**. However, the bidder shall make sure that the overall system performance (screen resolution, smooth display) shall not be compromised.

**4.6.2 Bay level unit (BCU):**

General

- a) Bay Control Unit (BCU) shall be provided for each Bays (a bay comprises of one circuit breaker and associated disconnect, earth switches and instrument transformer, Number of bays shall be as per SLD) for control and monitoring of the bay equipments. Separate BCU/RTU as specified shall be provided for the monitoring of substation auxiliaries.
- b) BCU shall be capable of integration with the substation automation system based on IEC61850.
- c) The BCUs shall be of modular in construction with adequate capacity for the estimated hardwired Inputs & Outputs plus 20% spare capacity.
- d) Each BCU shall be equipped with Local HMI facilities, enabling control of each particular bay from BCU whenever required. The Local HMI facilities preferably shall be accomplished by means of Graphical LCD display embedded into the front panel of the BCU. Display shall show simplify SLD diagram (with device identification number) showing status of bay switching equipment (such as circuit breaker, isolators, earth switches) and enabling issuance of switching controls. Other display type will be multiple displays of analogue values readings / reports, displays for controls other than switching, Alarm panel displays, Diagnostic/ on-line configuration displays etc.
- e) In the event of switchgear apparatus controls, the software-interlocking scheme shall be applied based on hardwired analogue/digital as well as GOOSE inputs. In the event of closing control for circuit breakers requiring checking of synchronization conditions, software synchro-check scheme shall be applied as well.

**4.6.2.1 Design:**

A. The Bay Control Unit shall,

- a. Use industrial grade components. The bay level unit, based on microprocessor technology, shall use numerical techniques for the calculation and evaluation of externally input analogue signals.

- b. Incorporate select-before-operate control principles as safety measures for operation via the HMI.
- c. Perform all bay related functions, such as control commands, bay interlocking, data acquisition, data storage, event recording and shall provide inputs for status indication and outputs for commands.
- d. Acquire and process all data for the bay (Equipment status, fault indications, measured values, alarms etc.) and transmit these to the other devices in sub-station automation system. In addition, this shall receive the operation commands from station HMI and control centre. The bay unit shall have the capability to store all the data for at least 24 hours.
- e. Be equipped with analogue and binary inputs/outputs for handling the control, status monitoring and analogue measurement functions.

Note: Nos. of BCU per bay shall be provided considering control, monitoring and analogue measurement functions of complete bay.

- f. Have capability to build memory block particularly for control switch / trip transfer schemes to exhibit or retain last position even after in case of rebooting.
- g. Meet the requirements for withstanding electromagnetic interference according to relevant parts of IEC 61850. Failure of any single component within the equipment shall neither cause unwanted operation nor lead to a complete system breakdown.

**B. One No. Bay Control Unit shall be provided for supervision and control of each bay (a bay comprises of one circuit breaker and associated Disconnectors, earth switches, instrument transformers etc). In case of non-availability of sufficient I/Os, additional BCU/s shall be provided to fulfill the requirement. Same shall be considered as single set of BCU and same set shall be considered for spares also (as a highest configuration).**

- C. All bay level interlocks are to be incorporated in the Bay Control unit so as to permit control from the Bay Control unit/ local bay mimic panel, with all bay interlocks in place, during maintenance and commissioning or in case of contingencies when the Station HMI is out of service.
- D. Firmware version of BCU/BCPU shall be thoroughly tested and validated for all protection as well as control aspects prior to performing internal FAT.

#### **4.6.2.2 Input / Output (I/O) modules:**

- a. The I/O modules shall form a part of the bay Control unit and shall provide coupling to the substation equipment.
- b. The I/O modules shall acquire all switchgear information (i.e. data coming directly from the switchgear or from switchgear interlocking devices) and transmit commands for operation of the switchgear.

- c. It shall be suitable for analogue input from secondary of instrument transformers.
- d. Binary input threshold voltage shall be minimum 70% of rated DC auxiliary voltage of respective substation.
- e. Time tagging to a resolution of 1ms shall be provided.
- f. Digital filtering to suppress contact bounce shall be provided for each input.
- g. Connections from BCU to switchgear shall not be terminated directly on I/O boards but shall be routed through Terminal Boards (TB).
- h. The pulse counting inputs shall be provided as per scheme requirement. These input shall acquire and count impulses produced by “volt free” contacts, which can be either, normally open or normally closed. Pulse counting inputs shall be provided as either a separate input module or using digital inputs. These inputs shall meet the same requirements specified for digital inputs; additionally, they shall be able to cater for pulse rates up to 10 per second.
- i. Where analogue measurement inputs are provided as per the scheme requirement, they shall be capable of accepting unipolar and bipolar current of range 0-10/4-20mA and -10 to +10 mA selected on channel basis, with over/under range detection. The accuracy of the AC-DC conversion shall be +0.1% or better of full scale.
- j. The command outputs shall be designed to provide select and execute outputs. The period of the command pulse shall be configurable between 0.1 second and 15 seconds on point basis. The command pulses shall reset immediately after the command is executed. Controls transmitted between the operator workstation of SAS / SCADA and the BCU shall comprise a select, check back & execute sequence (or other means of providing high message security).
- k. Analogue & Binary Input as well as Output module requirements shall be as per respective schemes considering 20% spare. Typical I/O list is provided as Annexure-I for reference.

**4.6.3 Uninterrupted Power Supply (UPS) (If mentioned in schedule-A of bid document):**

- a) Uninterrupted 230V AC power supply to the substation automation system shall be provided from redundant UPS system with Auto changeover facility. Separate battery set for both UPS shall be provided.
- b) UPS of suitable capacity (3KVA at 0.8 pf with 12V SMF battery set, Ah rating and nos of battery cell shall be suitable for 2 hours back-up as per UPS DC voltage rating) or as specified shall be provided for station HMI PCs, DR work station, Gateways, Modems, all printers etc. in SCADA Control room.
- c) UPS auto changeover facility shall be such that both UPS shares half the load in normal condition and in case of failure of one UPS seamless changeover between UPS takes place without affecting SCADA equipments performance.
- d) Separate Redundant UPS with auto changeover shall be considered for Master Control centre.
- e) UPS shall have to fulfill all the technical requirements as listed in Annexure – III.

**4.6.4 Extendibility in future:**

- a) Offered substation automation system shall be suitable for extension in future for additional bays. During such requirement, all the drawings and configurations, alarm/event list etc. displayed shall be designed in such a manner that its extension shall be easily performed by the purchaser. During such event, normal operation of the existing substation shall be unaffected and system shall not require a shutdown.
- b) The successful bidder shall provide all necessary software tools along with source codes to perform addition of bays in future and complete integration with SAS by the user. These software tools shall be able to configure IED, add additional analogue variable, alarm list, event list, modify interlocking logics etc. for additional bays/equipment which shall be added in future. HMI h/w & s/w should also support extreme extendibility as per future layout.
- c) All the licenses for various components such as SCADA, servers, Gateways etc. shall be for complete system i.e. system as per single line diagram including both present and future scope. All the servers shall be capable of handling total system (present and future).
- d) **All the server shall be capable of handling total system in proposed substation as shown in SLD/Layout.**
- e) **In case of extension of packages, the interoperability between devices compliant to IEC 61850 Edition 2 (or latest) and existing compliant to IEC 61850 Edition 1 shall be ensured.**

#### **4.7 Software structure:**

The software package shall be structured according to the SAS architecture and strictly divided in various levels. Necessary firewall shall be provided at suitable points in software to protect the system. An extension of the station shall be possible with lowest possible efforts. Maintenance, modification or an extension of components of any feeder may not force a shut-down of the parts of the system which are not affected by the system adaptation.

##### **4.7.1 Station level software:**

###### **4.7.1.1 Human-machine interface (HMI):**

The base HMI software package for the operator station shall include the main SAS functions and it shall be independent of project specific hardware version and operating system. It shall further include tools for picture editing, engineering and system configuration. The system shall be easy to use, to maintain, and to adapt according to specific user requirements.

Systems shall contain a library with standard functions and applications.

###### **4.7.1.2 System software:**

The system software shall be structured in various levels. This software shall be placed in a non-volatile memory. The lowest level shall assure system performance and contain basic functions, which shall not be accessible by the application and maintenance engineer for modifications. The system shall support the generation of typical control macros and a process database for user specific data storage. In case of restoration of links after failure, the software along with hardware shall be capable of automatically synchronizing with the remaining system without any manual interface. This shall be demonstrated by bidder during integrated system test.

**All applications(software) / OS supplied shall be licensed to GETCO (if applicable) and any updates shall be provided.**

#### **4.7.1.3 Gateways Software:**

**Dual redundant** Gateway (RCC & SLDC) **(in Hot-Hot Standby mode)**

Software of Gateway shall be suitable for controlling substation remotely **as well as sending data to existing SLDC SCADA** on IEC60870-5-104 protocol.

#### **4.7.1.4 SCL Engineering software:**

Substation Configuration Language engineering software shall be capable for following IEC 61850 based SAS engineering and configuration aspects.

The software shall be capable to;

- a) Perform IEC 61850 based SCL engineering.
- b) Configure SCD file from SSD & ICD files.
- c) Configure various report control blocks for mapping SAS LAN ASCII data to MMS services for reporting at system level.
- d) Configure GOOSE messages based services for Control/Interlock/Protection functions between IEDs and also mapping of related signals to MMS services from respective functions for reporting at system

#### **4.7.1.5 Application software:**

In order to ensure robust quality and reliable software functions, the main part of the application software shall consist of standard software modules built as functional block elements. The functional blocks shall be documented and thoroughly tested. They form part of a library. The application software within the control/protection devices shall be programmed in a functional block language.

The successful bidder shall provide each software with license duly configured and loaded in engineering workstation.

The original and latest version of software shall be provided.

The software version and its compatibility with OS shall be provided and any upgradation or patch management in future shall invariably be upgraded in the provided system without any cost implications.

#### **4.7.1.6 Network Management System:**

The successful bidder shall provide network management system software for following management functions:

- a. Configuration Management
- b. Fault Management
- c. Performance Monitoring

This system shall be used for management of communication devices and other IEDs in the system. This NMS can be loaded in Engineering Work station and shall be easy to use, user friendly and menu based. The NMS shall monitor all the devices in the SAS including all communication links & ports and report if

there is any fault in the monitored devices locally as well as at MCC. The NMS shall;

- a. Maintain performance, resource usage, and error statistics for all managed links and devices and present this information via displays, periodic reports and on demand reports.
- b. Maintain a graphical display of SAS connectivity and device status.
- c. Issue alarms when error conditions occur.
- d. Provide facility to add and delete addresses and links.

## **5.0 TESTS**

### **5.1 Type Test of IEDs (BCU / BCPU):**

The following tests from NABL accredited laboratory shall be carried out in accordance with IEC 60255, IEC 60068, IEC 61000, IEC 60529, IEC 61010-1, IEC 60255-27 & IEC 61850 or the latest / amended / up to date IS/IEC. The bidder has to submit the all type test reports as stated hereunder for the offered item along with the technical bid. The type test reports from NABL approved laboratory shall not be older than seven years. Type test reports shall be valid as on the last date of submission of bid.

### **5.2 Testing of IEDs (BCU / BCPU) shall confirm to the latest revisions, available of all relevant standards listed in Annexure – II.**

The substation automation system offered by the bidder shall be subjected to following tests to establish compliance with IEC 61850 for EHV substation equipment installed in sheltered area in the outdoor switchyard and specified ambient conditions:

The list of type test reports to be submitted for Control IEDs shall be as follows.

- a. Performance tests
  - i. Accuracy requirements
  - ii. Limits of operating range of auxiliary energizing inputs and auxiliary Voltage dependence
  - iii. Limits of frequency range and frequency dependence
  - iv. Rated burden
  - v. Mechanical Endurance test
  - vi. Characteristic and Functional test
- b. Thermal requirements
  - i. Maximum allowable temperature
  - ii. Limits of short time thermal withstand value of input energizing quantities
  - iii. Limiting dynamic value
- c. Insulation Tests:
  - i. Dielectric Tests
  - ii. Impulse Voltage withstand Test
  - iii. Insulation resistance measurement
- d. Influencing Quantities
  - i. Permissible ripples



- ii. Interruption of input voltage
- e. Electromagnetic Compatibility Test:
  - i. 1 MHZ burst disturbance test
  - ii. Electrostatic Discharge Test
  - iii. Radiated Electromagnetic Field Disturbance Test
  - iv. Electrical Fast transient Disturbance Test
  - v. Conducted Disturbance Tests induced by Radio Frequency Field
  - vi. Magnetic Field Test
  - vii. Emission (Conducted and Radiated) Test
  - viii. Surge Immunity Test
- f. Contact performance Test
  - i. Contact Making/Breaking capacity test
  - ii. Continuous capacity
- g. Environmental tests:
  - i. Dry Cold Test
  - ii. Dry Heat Test
  - iii. Storage temperature test
  - iv. Damp Heat Cyclic Test
- h. Mechanical Tests:
  - i. Vibration response & Vibration endurance test
  - ii. Bump test
  - iii. Shock response test
  - iv. Seismic test
- i. Enclosure Test:
  - i. Degree of Protection test – IP51
- j. Safety Test:
  - i. Single fault condition assessment
  - ii. Earth bonding impedance test
  - iii. Mechanical resistance to shock and impact
  - iv. Protection against electrical shock
  - v. Protection against the spread of fire
- k. IEC 61850 Compatibility tests

Note:

In case of non-submission / partial submission or type test reports of which validity is over, bidder shall submit pending type test report/s from NABL accredited laboratory, in the event of an order, before commencement of supply without affecting delivery schedule, free of cost to GETCO. Confirmation for above shall be invariably submitted along with technical bid.

### **5.3 Routine and Factory Acceptance Tests:**

The manufacturing and configuration phase of the SAS shall be concluded by the factory acceptance test (FAT). The purpose is to ensure that the Bidder has interpreted the specified requirements correctly and that the FAT includes checking to the degree required by the user. 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.

Following Routine and Acceptance tests shall be carried out on offered items.

### **5.3.1 Routine Testing (Internal-FAT):**

- a) The integrated system tests shall be performed as detailed in subsequent clauses:

All other switches for complete sub-station as detailed in section project shall be simulated as needed.

#### **1. Hardware Integration Tests:**

The hardware integration test shall be performed on the specified systems to be used for Factory tests when the hardware has been installed in the factory. The operation of each item shall be verified as an integral part of system. Applicable hardware diagnostics shall be used to verify that each hardware component is completely operational and assembled into a configuration capable of supporting software integration and factory testing of the system. The equipment expansion capability shall also be verified during the hardware integration tests.

#### **2. Integrated System Tests:**

Integrated system tests shall verify the stability of the hardware and the software. During the tests all functions shall run concurrently and all equipment shall operate a continuous 100 Hours period. The integrated system test shall ensure the SAS is free of improper interactions between software and hardware while the system is operating as a whole.

- b) Routine testing of IEDs/accessories and communication equipments as well as complete SAS system (i.e. integrated testing) shall be performed at manufacturer's works on 100% material to be offered for inspection as per standards mentioned in specifications, and approved FAT procedures.
- c) On successful completion of Internal-FAT, Test reports along with RTCs of IEDs, components, accessories, Configured HMI Bay views, GOOSE event timings etc. shall be submitted to GETCO.
- d) Successful bidder has to ensure full-proof testing as well as appropriateness of the test documents prior to submission to GETCO.
- e) Purchaser reserves right for witnessing of routine test as and when required, in presence of Purchaser's representative.

### **5.3.2 Factory Acceptance Testing:**

After successful completion of Internal-FAT, the SAS system shall be offered for integrated factory acceptance testing as mentioned below.

Immediately after finalization of the program of acceptance testing the supplier/bidder shall give advance intimation to the purchaser to enable him to depute his representative for witnessing the acceptance tests.

- a) Acceptance testing shall be performed on Integrated SAS as per approved FAT procedures at manufacturer's works.
- b) Acceptance test shall be performed in presence of GETCO representative.
- c) Representative of EPC bidder shall also witness acceptance test with GETCO representative.
- d) During FAT the entire Substation Automation System including complete control and protection system to be supplied under present scope shall be

- offered for complete functionality and configuration in factory itself.
- e) Acceptance testing shall be performed on each type of Control & Protection panels (voltage class wise) from the offered Control & Protection panels for acceptance testing. Selection of typical bays shall be as per discretion of the inspector.
  - f) If the FAT comprises only a certain portion of the system for practical reason, it has to be assured that this test configuration contains at least one unit of each and every type of equipment incorporated in the delivered system.
  - g) The extensive testing shall be carried out during FAT. The purpose of Factory Acceptance Testing is to ensure trouble free installation at site. No major configuration setting of system is envisaged at site.
  - h) If the complete system consists of parts from various suppliers or some parts are already installed on site, the FAT shall be limited to sub-system tests. In such a case, the complete system test shall be performed on site together with the site acceptance test (SAT).
  - i) **In case of an extension project,**
    - **The new bays shall be configured in existing database and Integrated Factory Acceptance Test shall be performed at manufacturer's works with the help of demo system revealing complete system (i.e. existing and new bays) to be made available at site.**
    - **The complete system shall be tested in all respect with existing system installed at site as a part of SAT.**

#### **5.4 Site Acceptance Tests:**

- a) The site acceptance tests (SAT) shall completely verify all the features of SAS hardware and software.
- b) A detailed SAT shall be performed as per FAT procedures on all the bays under scope in conjunction with related approved drawings/documents and specification at site.
- c) In case of extensions, apart from bay level tests, system level tests shall also be performed to ensure overall network performance as per specification requirement.

#### **5.5 System Performance:**

It shall be the responsibility of the bidder to predict and indicate in the bid, the worst case loading condition and design the system accordingly to meet the same. The worst case loading condition shall include following

1. All analogue inputs scanning and processing in progress and all data is being transmitted over the system bus every one second.
2. A burst of 100 alarms is generated over a period of 10 seconds.
3. An operator control is generated every 10 seconds.
4. Data collection for logs/reports is in progress.
5. Data collection for historical storage and trend function in progress.
6. Data collection of fault record is in progress.
7. All health monitoring functions/diagnostics in progress.
8. All output devices are in operation with rated performance/speed.
9. All data are transferred to the control centre.

The updating time on the operator station under normal and calm/worst conditions in the station shall be:

Function	Response Time
From Selection of object to picture colour change form object	< 1 Sec.
Command Execute	< 1 Sec.
Display of binary change	< 0.5 Sec.
Display of Analog Value Change	<1 Sec.
System Display with 100 variables	Max. 3 Sec.
Times taken to report the last of 50 simultaneous alarms	Max. 5 Sec.
Updating Database	< 1 Sec.

### 5.5.1 Duty cycle time:

- a) Under worst loading condition processor shall have
  1. 40 % free time when measured over any two second period
  2. 60% free time when measured over any one-minute period
- b) Substation network spare time
 

50 % spare time when measured over any two second period during worst case loading conditions.

Bidder shall furnish necessary data to fully satisfy purchaser that processor spare duty cycle figures quoted by the bidder are realistic and based on configuration and computational capability of the offered system and these shall be actually implemented system as commissioned at project site.

### 5.6 Network performance:

- a) Network performance parameters shall be ensured as classified in IEC 61850-5 standard and also critical protection function GOOSE timings shall be within acceptable limits (i.e. LBB, carrier, TBC A/R goose etc).
- b) Clear GOOSE priorities shall be distinguished for Status, Monitoring, Command, Control and Trip as classified in IEC 61850-5 standard as under.

	Performance Class (referring to total transfer time t)						
	No class Applicable	P1	P2	P3	M1	M2	M3
<b>Type 1A</b>	N/A	10ms	3ms	3ms	N/A	N/A	N/A
<b>Type 1B</b>	N/A	100ms	20ms	20ms	N/A	N/A	N/A
<b>Type 2</b>	100ms	N/A	N/A	N/A	N/A	N/A	N/A
<b>Type 3</b>	500ms	N/A	N/A	N/A	N/A	N/A	N/A
<b>Type 4</b>	N/A	10ms	3ms	3ms	1500Hz	4000Hz	12000Hz
<b>Type 5</b>	>1000ms	N/A	N/A	N/A	N/A	N/A	N/A
<b>Type 7</b>	500ms	N/A	N/A	N/A	N/A	N/A	N/A

- c) As per system design, each IED may be interfaced with other IEDs extensively through GOOSE for Status, Control, Command, Monitoring, and Tripping based on system configuration. Hence, it is mandatory to verify GOOSE performance for all these functions with consistency to ensure proper configuration. All critical protection functions as specified in FAT shall be demonstrated during FAT and SAT and all the GOOSE event timings shall be mentioned in the FAT and SAT documents also (ensuring desired performance class 1A P2).
- d) Following shall be ensure while configuring GOOSE based schemes.

1. 'Native' Logical Nodes (e.g. PDIS, PTOC, PSCH etc.) of respective protection functions shall be utilized as far as possible instead of Generic Logical Nodes (e.g. GGIO).
2. Separate datasets shall be configured for GOOSE and MMS services.
3. For GOOSE message structure, data attribute shall be 'quality' & 'status' only. 'Time' shall not be selected being Layer-2 services
4. All GOOSE messages shall be segregated in different data sets based on applications to avoid unnecessary traffic, queuing etc. and thereby to optimise network performance.
5.  $T_{Max}$ ,  $T_{Min}$  and Holdover time shall be precisely configured to achieve optimum network performance and reporting abnormalities.

## **6.0 INSPECTION**

- 6.1 The SAS System shall be offered for integrated inspection.
- 6.2 No material shall be dispatched without inspection.
- 6.3 The purchaser shall have access at all the times to the works of manufacturer where SAS System are being manufactured & configured. The supplier shall provide purchaser's representative all facilities for unrestricted inspection of the works, raw material, bought out items, accessories and for conducting necessary tests.
- 6.4 The successful bidder shall have to give advance intimation of inspection programme.
- 6.5 On successful completion of acceptance testing, inspection report shall be submitted.
- 6.6 On acceptance of inspection report, dispatch instruction will be issued from Chief Engineer (Project), Vadodara.
- 6.7 SAS System shall be dispatched only after receipt of dispatch instruction
- 6.8 The acceptance of any quantity of the equipment shall in no way relieve the successful bidder from his responsibility for meeting all the requirements of this specification & shall not prevent subsequent rejection, if such equipments are found defective later.
- 6.9 Inspection during manufacturing
  - 6.9.1 The inspection may be carried out by the purchaser at any stage of manufacture. The successful bidder shall grant free access to the purchaser's representative at a reasonable time when the work is in progress. Inspection and acceptance of any equipment under this specification by the purchaser shall not relieve the supplier of his obligation of furnishing equipment in accordance with the specifications and shall not prevent subsequent rejection if the equipment is found to be defective.
  - 6.9.2 The supplier shall keep the purchaser informed well in advance, about the manufacturing program so that the arrangement can be made for inspection.

## **7.0 QUALITY ASSURANCE PLAN**

- 7.1 The bidder shall invariably furnish along with his offer the quality assurance plan adopted in him/his sub-supplies in the process of manufacturing all major equipments/components and SAS Aux / RTU panel.

- 7.2** Precaution taken in testing for ensuring usage of quality raw materials and sub-components shall be stated in the quality assurance plan.
- 7.3** The bidder should specifically express their consent to accept additions, revisions to their quality assurance plan to meet the purchaser's requirements if needed.
- 7.4** In the event of supply order, successful bidder shall have to submit Quality assurance plan comprising above details for approval.

## **8.0 GUARANTEE PERIOD**

All equipment supplied against this specification shall be guaranteed for a period 36 months from the date of commissioning. However, any engineering error, omission, wrong provision, equipment failure etc, if found during actual commissioning of the equipment shall be attended by the bidder free of cost.

## **9.0 DOCUMENTATION**

- 9.1** The bidder shall furnish, as a part of their offer, complete set of following drawings/documents, of the offered products as mentioned in respective clauses.

- a) System Architecture Drawing
- b) Hardware Specification
- c) Sizing Calculations of various components
- d) Response Time Calculation
- e) Functional Design Document
- f) Type test reports
- g) Bill of quantity
- h) Quality assurance plan

- 9.2** After issue of detailed purchase order, the successful bidder shall have to submit following drawings/documents to the CE (Projects), GETCO, Sardar Patel Vidyut Bhavan, Race Course, VADODARA – 390 007 **in soft form**.

- a) Substation automation system architecture.
- b) Guaranteed technical parameters
- c) Functional Design Specification
- d) Calculation for Guaranteed availability and reliability.
- e) Calculation for power supply dimensioning.
- f) I/O Signal lists.
- g) Schematic diagrams.
- h) List of Softwares
- i) List of Hardwares
- j) Logic Diagram (hardware & software).
- k) Soft protection alarm signal list
- l) GOOSE signal list
- m) HMI bay views (Bay wise typical)
- n) LED list
- o) Kiosk layout drawing.
- p) GA of Kiosk and GTP.
- q) Control Room Lay-out.
- r) Test Specification for Factory Acceptance Test (FAT).
- s) Test specification for Site Acceptance Test (SAT)
- t) Site Acceptance Verification Test

- u) Product Manuals (Installation, Configuration, maintenance, Troubleshooting, detailed diagnostics etc.)
- v) Assembly Drawing.
- w) Operator's Manual.
- x) Complete documentation of implemented protocols between various elements.
- y) List of software

Other documents as may be required during detailed engineering.

Soft copy of complete set of As built drawings/documents shall be provided in 1 TB hard drive and handover to field office as well as corporate office.

**9.3** The supplier/bidder shall dispatch sets of approved drawings and sets of technical literature/ commissioning manuals along with the SAS system at site.

**9.4** All the drawings submitted in soft form shall be in pdf format. However, requirement in AutoCAD form shall be at the discretion of GETCO.

## **10.0 PACKING AND TRANSPORT:**

**10.1** All equipment/material shall be suitably packed for transport, carriage at site and outdoor storage during transit. The bidder shall be responsible for any damage to the equipment during transit due to improper and inadequate packing. The cases containing easily damageable material shall be very carefully packed and marked with appropriate caution symbols i.e. 'FRAGILE' 'HANDLE WITH CARE', 'USE NO HOOK' etc. The contents of each package shall bear marking that can be readily identified from the package list and packing shall provide complete protection from moisture, termites and mechanical shocks etc.

**10.2** Wherever necessary proper arrangement for attaching slings for lifting shall be provided and all packages clearly marked with gross weight, signs showing 'UP' and 'DOWN' sides of boxes, contents of each package, order no. and date, name of the plant/SS/ of which the material in the package forms part of and any handling and unpacking instructions considered necessary. Any material found short inside the intact packing cases shall be supplied by the manufacturer/supplier without any extra cost.

**10.3** Bidder shall ascertain, prior to shipment, from concerned authorities, the transport limitations like weight and maximum allowable package size for transportation. Fragile material such as IED cases, SCADA equipments and other glass material shall be carefully covered with shock absorbing protective materials, such as thermocol, silica gel or equivalent moisture absorbent material in small cotton bags shall be placed inside the packing wherever necessary.

**10.4** Each consignment shall be accompanied by a detailed packing list containing the following information.

- a) Purchase order reference.
- b) Name of consignee
- c) Details of consignment
- d) Destination
- e) Total weight of consignment

- f) Handling and unpacking instructions.
- g) Bill of materials indicating contents of each package
- h) Sign showing upper/lower side of the crate.

## 11.0 TRAINING

The successful bidder shall be required to provide facility for one-week training at no extra cost to the GETCO engineers. The successful bidder has to furnish the training module at the time of detailed engineering. The training shall cover familiarization with procedure of configuration, operation, maintenance and troubleshooting on the Substation Automation system and its equipments.

SAS OEM personnel who are experienced instructors and who speak understandable English shall have to conduct training. The bidder shall arrange on its own cost all hardware training platform required for successful training and understanding in India. The Bidder shall provide all necessary training material. Each trainee shall receive individual copies of all technical manuals and all other documents used for training. Class materials, including the documents sent before the training courses as well as class handouts, shall become the property of Purchaser. Purchaser reserves the right to copy such materials, but for in-house training and use only. Hands-on training shall utilize equipment identical to that being supplied to purchaser.

For all training courses, the travel (e.g., airfare) and per-diem expenses will be borne by the participants.

The schedule, location, and detailed contents of each course will be finalized during Purchaser and Bidder discussions.

### 11.1 Computer System Hardware Course:

A computer system hardware course shall be offered, but at the system level only. The training course shall be designed to give Purchaser hardware personnel sufficient knowledge of the overall design and operation of the system so that they can correct obvious problems, configure the hardware, perform preventive maintenance, run diagnostic programs, and communicate with contract maintenance personnel. The following subjects shall be covered:

- a) **System Hardware Overview:** Configuration of the system hardware.
- b) **Equipment Maintenance:** Basic theory of operation, maintenance techniques and diagnostic procedures for each element of the computer system, e.g., processors, auxiliary memories, LANs, routers and printers. Configuration of all the hardware equipments.
- c) **System Expansion:** Techniques and procedures to expand and add equipment such as loggers, monitors, and communication channels.
- d) **System Maintenance:** Theory of operation and maintenance of the redundant hardware configuration, failover hardware, configuration control panels, and failover switches. Maintenance of protective devices and power supplies.



- e) **Subsystem Maintenance:** Theory of design and operation, maintenance techniques and practices, diagnostic procedures, and (where applicable) expansion techniques and procedures. Classes shall include hands-on training for the specific subsystems that are part of Purchaser's equipment or part of similarly designed and configured subsystems. All interfaces to the computing equipment shall be taught in detail.
- f) **Operational Training:** Practical training on preventive and corrective maintenance of all equipment, including use of special tools and instruments. This training shall be provided on Purchaser equipment, or on similarly configured systems.

### 11.2 Computer System Software Course

The successful bidder shall provide a computer system software course that covers the following subjects:

- a) **System Programming:** Including all applicable programming languages and all stand-alone service and utility packages provided with the system. An introduction to software architecture, Effect of tuning parameters (OS software, Network software, database software etc.) on the performance of the system.
- b) **Operating System:** Including the user aspects of the operating system, such as program loading and integrating procedures; scheduling, management, service, and utility functions; and system expansion techniques and procedures
- c) **System Initialization and Failover:** Including design, theory of operation, and practice
- d) **Diagnostics:** Including the execution of diagnostic procedures and the interpretation of diagnostic outputs,
- e) **Software Documentation:** Orientation in the organization and use of system software documentation.
- f) **Hands-on Training:** One week, with allocated computer time for trainee performance of unstructured exercises and with the course instructor available for assistance as necessary.

### 11.3 Application Software Course

The successful bidder shall provide a comprehensive application software courses covering all applications including the database and display building course. The training shall include:

- a) **Overview:** Block diagrams of the application software and data flows. Programming standards and program interface conventions.
- b) **Application Functions:** Functional capabilities, design, and major algorithms. Associated maintenance and expansion techniques.
- c) **Software Development:** Techniques and conventions to be used for the preparation and integration of new software functions.

- d) **Software Generation:** Generation of application software from source code and associated software configuration control procedures.
- e) **Software Documentation:** Orientation in the organization and use of functional and detailed design documentation and of programmer and user manuals.
- f) **Hands-on Training:** One week, with allocated computer time for trainee performance of unstructured exercises and with the course instructor available for assistance as necessary.

#### **11.4 Requirement of training:**

**11.4.1** The successful bidder has to provide comprehensive training on Control & Protection and Substation Automation to GETCO engineers, free of cost, at site.

**11.4.2** Training shall be imparted through qualified trainer of the SAS OEM.

**11.4.3** Training shall cover classroom training (in presentation form) as well as hands on training for practical aspects.

**11.4.4** Training programme shall cover following

- a) Explanation of System Architecture of respective project followed with visit to see Installations of equipments and SCADA system in Control Room as well as Yard Kiosk.
- b) Explanation of basic theory on hardware devices (Industrial PCs, Ethernet switches, Fiber optics etc).
- c) Explanation of basic of networking with IP structure.
- d) Explanation of basics of Substation Automation, modelling approach, SAS softwares and configuration tools.
- e) Formation of SCADA ring & establishment of communication.
- f) Configuration of Ethernet switch and RSTP configuration defining network path.
- g) Establishment of Time Synchronization of IEDs.
- h) Hands on with the SCADA Softwares right from installation
- i) Database Engineering covering following,
  - i. Explanation of various file formats and its significance i.e. ICD, CID, SSD, SCD
  - ii. Explanation of database creation procedures key attributes to be taken care.
  - iii. Configuration of IEDs for reporting to HMI for Alarms, Events, Inputs, Outputs, Analogue inputs.
  - iv. Configuration of Bay interlocks & Automation Logics.
  - v. Explanation of GOOSE attributes (File format, GOOSE Transmission, Priority etc) and configuration of GOOSE message services.
  - vi. Configuration of Bay view and HMI Graphics.
  - vii. Procedure of Addition/Modification of any bay / configuration and points to be taken care - Explanation in detail.
  - viii. Configuration of Status, Events and Alarm and procedure for modification.
  - ix. Preparation of various load data formats as per GETCO requirement including data back-up and historian configuration.
- j) Integration of Transformer/**Reactor** monitoring devices.
- k) Configuration of Gateway for Communication with the SLDC/RTU right from Installation
- l) Configuration of Gateway for Remote control & monitoring right from Installation.

- m) Configuration of Engineering PC for DR, Relay parameterization for various make & type of relays.
- n) Configuration of Network Monitoring software.
- o) Explanation of procedure for Project data back up and Project Restoration.
- p) Trouble shooting of various problems in case of failure of device, Relay, IED, Communication link, Boot-up, software corrupt etc.
- q) System hardware maintenance and troubleshooting of equipments & services of Gateway, GPS, UPS, etc.
- r) Explanation of Do's & Don'ts of SAS in detail to be given & explained in detail for whole SCADA system & Individual equipments / components (Configuration as well as Operational aspects).
- s) GETCO Protection Philosophy and explanation of configuration of all Relays, topology, logic.
- t) Explanation of Protection Principles and configurations of various relays like Distance, Diff, REF, Bus bar Protection, LBB etc.
- u) Explanation of operational procedures through Process flow chart for operating staff for following operational functions.
  - i. Basic bay operational procedures.
  - ii. Procedure for Project data back up and Project Restoration.
  - iii. Procedures for extraction of DR, Setting file and Events files.
  - iv. Procedures for various alarms, events acknowledgements and Analysis of Tripping data & Fault Data.
  - v. Reporting of MIS report to higher authority.
  - vi. Explanation of basic trouble shooting and providing trouble shooting chart thereof.
  - vii. Do's & Don'ts of SAS from Operational aspects
  - viii. Historian back-up and storage
  - ix. Procedure after rebooting of any IED/Computer etc.
  - x. Handing over soft copy of all training documents in CD/s.

## **12.0 Maintenance Responsibility during the Guaranteed Availability Period:**

During guaranteed Availability Period, the successful bidder shall take continual actions to ensure the guaranteed availability and shall make available all the necessary resources such as specialist personnel, spare parts, tools, test devices etc. for replacement or repair of all defective parts and shall have prime responsibility for keeping the system operational.

## **13.0 Reliability and availability:**

The SAS shall be designed so that the failure of any single component, processor, or device shall not render the system unavailable. Each component and equipment offered by the bidder shall be of established reliability. The minimum target reliability of each piece or equipment like each electronic module/card Power supply, Peripherals etc. shall be established by bidder considering its failure rates/mean time between failures (MTBF), meantime to repair (MTTR), such that the availability of complete system is assured. The guaranteed annual system availability shall not be less than 99.9%. This shall be supported by detailed calculation according to availability calculations specified in IEEE standard –1046 or equivalent. This shall be submitted by bidder along with offer. The SAS shall be designed to satisfy the very high demands for reliability and availability concerning:

- Mechanical and electrical design
- Security against electrical interference (EMI)

- High quality components and boards
- Modular, well-tested hardware
- Thoroughly developed and tested modular software
- Easy-to-understand programming language for application programming
- Detailed graphical documentation and application software
- Built-in supervision and diagnostic functions
- Security
- Experience of security requirements
- Process know-how
- Select before execute at operation
- Process status representation as double indications
- Distributed solution
- Independent units connected to the local area network
- Back-up functions
- Panel design appropriate to the harsh electrical environment and ambient conditions
- Panel grounding immune against transient ground potential rise

### **Outage terms:**

#### **1) Outage**

The state in which substation automation system or a unit of SAS is unavailable for Normal Operation as defined in the clause 4.3.2.4 due to an event directly related to the SAS or unit of SAS. In the event, the owner has taken any equipment/ systems other than Sub-Station Automation System for schedule/forced maintenance, the consequent outage to SAS shall not be considered as outage for the purpose of availability.

#### **2) Actual outage duration (AOD)**

The time elapsed in hours between the start and the end of an outage. The time shall be counted to the nearest 1/4th of an hour. Time less than 1/4th of an hour shall be counted as having duration of 1/4th of an hour.

#### **3) Period Hours (PH)**

The number of hours in the reporting period. In a full year the period hours are 8760h (8784h for a leap year).

#### **4) Actual Outage hours (AOH)**

The sum of actual outage duration within the reporting period  $AOH = \sum AOD$

#### **5) Availability:**

Each SAS shall have a total availability of 99.98 % i.e. the ratio of total time duration minus the actual outage duration to total time duration.

### **14.0 Guarantees Required:**

1. The availability for the complete SAS shall be guaranteed by the Bidder.
2. Bidder shall include in their offer the detailed calculation for the availability.

3. The bidder shall demonstrate their availability guaranteed by conducting the availability test on the total sub-station automation system as a whole after commissioning of total Sub-Station Automation system.
4. The test shall verify the reliability and integrity of all sub-systems.
5. Under these conditions the test shall establish an overall availability of 99.98%. After the lapse of 1000 Hours of cumulative test time, test records shall be examined to determine the conformance with availability criterion.
6. In case of any outage during the availability test, the bidder shall rectify the problem and after rectification, the 1000 Hours period start after such rectification. If test object has not been met the test shall continue until the specified availability is achieved.
7. The bidder has to establish the availability in a maximum period of three months from the date of commencement of the availability test.

After the satisfactory conclusion of test both bidder and purchaser shall mutually agree to the test results and if these results satisfy the availability criteria, the test is considered to be completed successfully. After that the system shall be taken over by the purchaser and then the guarantee period shall start.

#### **15.0 Consumables:**

All consumables such as paper, cartridges shall be supplied by the successful bidder till the SAS is taken over by the purchaser.

#### **16.0 ERECTION, TESTING & COMMISSIONING:**

- 16.1** The successful bidder shall have to carry out the testing and commissioning of Substation Automation System as well as integration in Control & Protection panels by deputing his Engineer/s at site without any extra cost to GETCO.
- 16.2** Testing and commissioning shall be carried out with their all required tools, tackles, test kits etc. for successful commissioning & integration of Substation Automation System.
- 16.3** The service charges for above purpose shall not be paid during first testing & commissioning and any services to be provided within guarantee period of 36 months after commissioning.

#### **17.0 SCHEDULES:**

- 17.1** The bidder shall fill in the following schedules which form part of the tender specification and offer. In case of non-submission of the same, the offer is liable to be rejected.

Schedule – B	Guaranteed Technical particulars
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- 17.2** Any deviation from the specification shall be mentioned in Annexure-12 (schedule of deviations) only. Any deviations mentioned other than above shall not be considered.

#### **18.0 INFORMATION TO BE FILLED IN INVARIABLY BY THE BIDDER:**

For ready reference of the purchaser, the items of information required to be invariably furnished by him in his offer, are listed below:

1. Schedule - 'B'
2. Documents specified in clause no. 9.0
3. Schedule of deviations (Annexure-12)

## 19.0 GUARANTEE FOR MAINTENANCE SPARES AND SERVICES:

1. The bidder shall guarantee for supplying maintenance spares and services as well as repairing of SAS & SAS equipments for a period of the life expectancy of **15** years. Authorization letter and service support guarantee from IED/SAS OEM shall be submitted for offered products along with the bid.
2. **If so desired by the purchaser, the IED/SAS OEM shall submit the specifications, price and the terms and conditions relating to the supply thereof for such spares identified by the purchaser with validity period of 6 months within 30 days of receipt of request from purchaser for its consideration and placement of order.**
3. **The IED/SAS OEM shall guarantee that in the event of termination of production of spare parts by the IED/SAS OEM or his Sub-Contractor:**
  - i. **The IED/SAS OEM shall submit advance notification to the purchaser of the pending termination, with 2(two) years time to permit the Purchaser to procure needed requirements, and**
  - ii. **Following such termination, the IED/SAS OEM shall furnish at no cost to Purchaser the blueprints, drawings and specification of the spare parts, if requested.**

## 20.0 GENERAL IMPORTANTS POINTS:

1. The successful bidder shall ensure looping to Ethernet switch of IEDs of all the bays for inter communication and time synchronization.
2. **In case of single GPS based TSE**, GPS Unit suitable for SNTP and IRIG-B and other output ports as per specification shall be supplied and commissioned. All the IEDs shall be time synchronized on SNTP protocol and GPS based TSE shall be configured as primary time source. IRIG-B output shall be provided to adjacent IED/RTU and that IED shall be configured as secondary time source for all other IEDs in case of any trouble of SNTP.
3. Any modifications in wiring required by the purchaser at site shall be carried out by the successful bidder at the time of commissioning, free of cost.
4. Configuration of Relays/IEDs for GOOSE based various logics, interlocking as well as protection aspects shall be ensured along with establishing network performance in all respect as per FAT/SAT procedure documents.
5. Configuration of Relays/IEDs for reporting of all the protection alarms to HMI with latched functionality shall be ensured as per the FAT/SAT procedure as well as HMI bay view configuration.
6. Configuration of Relays/IEDs function keys as Control keys for Carrier In-Out, DT In-Out, A/R In-Out, Bus bar Zone In-Out etc. shall be ensured as per the FAT/SAT procedure as well as HMI configuration.
7. The redundant managed bus shall be realized by 100 Mbps optical star redundant ring network using industrial grade components and shall be as per IEC 61850.
8. Inside the sub-station, all communication shall be realized as per IEC 61850 protocol.
9. The printer as required shall be connected to station bus directly and can be managed either from station HMI, HMI view node or disturbance recorder work station.
10. Typical Input-Output signal list is provided at Annexure-I.

11. Soft protection signals for Alarm (LED status) and GOOSE signal lists are provided in separately attached specification of Control & Protection Panel.
12. Basic Monitoring requirements shall be:
  - a. Switchgear status indication
  - b. All supervision / Monitoring signals for IEDs, CB, Isolator, Transformers / Reactors etc.
  - c. Measurements (U, I, P, Q, f)
  - d. Event
  - e. Alarm
  - f. Oil & Winding temperature of transformers & reactors
  - g. Ambient temperature, Battery room temperature, GIS-LCC Room temperature etc.
  - h. Status and display of Station auxiliaries i.e. 415V LT system, 220V / 110V DC System
  - i. Status of display of Fire protection system and Air conditioning system.
  - j. Acquisition of all counters in PLCC panels through potential free contacts from PLCC or independently by counting the receive/send commands.
  - k. Acquisition of alarm, LEDs and fault record from protection relays
  - l. Disturbance records
  - m. Monitoring the state of batteries by displaying DC voltage, charging current and load current etc.
  - n. Tap-position of Transformer.
  - o. Dissolved Hydrogen/ multi gas & Moisture Content monitor of Transformer
  - p. Status and display of LT transformer & its associated switchgear for station auxiliary supply
  - q. NIFPS Signals
  - r. Hotspot temperature detector / Any other on line monitoring devices

**Annexure-I****List of Inputs/Outputs**

Bay wise Typical I/O requirement of BCU / IED is tabulated here under. The exact number and description of digital inputs shall be as per detailed engineering. Apart from the below mentioned I/Os, 20 % spare I/Os BCU wise for all BCUs shall be considered for future use.

**A. 765/400/220/132/66/33kV GIS Substation:****Note:**

**For 765kV system, typical I/O requirements shall be similar to 400kV system in general. Bidder shall also consider I/O requirements for TIE bays, 1-Ph switching arrangement for ICT & Reactors and I/O requirements for Switchable Reactors, Tertiary loading etc. for 765 & 400kV systems as per SLD and scheme requirement.**

**a. 400kV Line Bay BCU I/O:**

SR. NO.	INPUT	OUTPUT
1	CB R-PH OPEN POSITION	TO MAIN-1 RELAY (SOTF INI.)
2	CB R-PH CLOSE POSITION	TO MAIN-2 RELAY (SOTF INI.)
3	CB Y-PH OPEN POSITION	TO CB CLOSING (Synch Check Interlock)
4	CB Y-PH CLOSE POSITION	TO RESET 86A RELAY
5	CB B-PH OPEN POSITION	TO RESET 86B RELAY
6	CB B-PH CLOSE POSITION	TO RESET 96 RELAY
7	ISOL. DS-1 OPEN POSITION	ISOL. DS-1 OPEN COMMAND
8	ISOL. DS-1 CLOSE POSITION	ISOL. DS-1 CLOSE COMMAND
9	ISOL. DS-2 OPEN POSITION	ISOL. DS-2 OPEN COMMAND
10	ISOL. DS-2 CLOSE POSITION	ISOL. DS-2 CLOSE COMMAND
11	E/SW ES-1/2 OPEN POSITION	ISOL. DS-3 OPEN COMMAND
12	E/SW ES-1/2 CLOSE POSITION	ISOL. DS-3 CLOSE COMMAND
13	ISOL. DS-3 OPEN POSITION	BUS-1 PT SELECT
14	ISOL. DS-3 CLOSE POSITION	BUS-1 PT RESET
15	E/SW ES-3 OPEN POSITION	BUS-2 PT SELECT
16	E/SW ES-3 CLOSE POSITION	BUS-2 PT RESET
17	FES R PHASE OPEN POSITION	TO 87BB (CB MANUAL CLOSE)
18	FES R PHASE CLOSE POSITION	DIRECT TRIP SEND CH-1 (CB manual trip)
19	FES Y PHASE OPEN POSITION	DIRECT TRIP SEND CH-2 (CB manual trip)
20	FES Y PHASE CLOSE POSITION	CB CLOSE
21	FES B PHASE OPEN POSITION	CB TC-1 R PHASE OPEN
22	FES B PHASE CLOSE POSITION	CB TC-1 Y PHASE OPEN
23	CRP DC SUPPLY-1 FAIL	CB TC-1 B PHASE OPEN
24	CRP DC SUPPLY-2 FAIL	CB TC-2 R PHASE OPEN
25	86A TRIP RELAY RESET	CB TC-2 Y PHASE OPEN
26	86B TRIP RELAY RESET	CB TC-2 B PHASE OPEN
27	96 TRIP RELAY RESET	TEST KIT FEEDBACK
28	86A TRIP RELAY FAULTY	
29	86B TRIP RELAY FAULTY	
30	BB PU FAULTY	
31	CB TC-1 FAULTY	
32	CB TC-2 FAULTY	
33	CB MANUAL CLOSE	



34	CB MANUAL TRIP
35	96 TRIP RELAY FAULTY
36	DIRECT TRIP RECEIVED CH-1
37	DIRECT TRIP SEND CH-1
38	DIRECT TRIP RECEIVED CH-2
39	DIRECT TRIP SEND CH-2
40	CB AUTO TRIP
41	DS-1 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH
42	DS-1 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH
43	DS-1 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH
44	DS-1 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH
45	DS-1 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH
46	DS-1 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH
47	DS-2 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH
48	DS-2 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH
49	DS-2 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH
50	DS-2 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH
51	DS-2 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH
52	DS-2 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH
53	ES-1/2 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH
54	ES-1/2 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH
55	ES-1/2 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH
56	ES-1/2 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH
57	ES-1/2 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH
58	ES-1/2 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH
59	DS-3/ES3/FES COMPARTMENT GAS PRESS STG-1 ALARM R PH
60	DS-3/ES3/FES COMPARTMENT GAS PRESS STG-1 ALARM Y PH
61	DS-3/ES3/FES COMPARTMENT GAS PRESS STG-1 ALARM B PH
62	DS-3/ES3/FES COMPARTMENT GAS PRESS STG-2 ALARM R PH
63	DS-3/ES3/FES COMPARTMENT GAS PRESS STG-2 ALARM Y PH
64	DS-3/ES3/FES COMPARTMENT GAS PRESS STG-2 ALARM B PH
65	CT COMPARTMENT GAS PRESSURE STG-1 ALARM R PH
66	CT COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH
67	CT COMPARTMENT GAS PRESSURE STG-1 ALARM B PH
68	CT COMPARTMENT GAS PRESSURE STG-2 ALARM R PH
69	CT COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH
70	CT COMPARTMENT GAS PRESSURE STG-2 ALARM B PH
71	LINE BB DUCT COMPARTMENT GAS PRESS STG-1 ALARM R PH
72	LINE BB DUCT COMPARTMENT GAS PRESS STG-1 ALARM Y PH
73	LINE BB DUCT COMPARTMENT GAS PRESS STG-1 ALARM B PH
74	LINE BB DUCT COMPARTMENT GAS PRESS STG-2 ALARM R PH
75	LINE BB DUCT COMPARTMENT GAS PRESS STG-2 ALARM Y PH
76	LINE BB DUCT COMPARTMENT GAS PRESS STG-2 ALARM B PH
77	CB GAS PRESSURE NORMAL R PH
78	CB GAS PRESSURE NORMAL Y PH
79	CB) GAS PRESSURE NORMAL B PH
80	CB GAS PRESSURE LOW R PH
81	CB GAS PRESSURE LOW Y PH
82	CB GAS PRESSURE LOW B PH
83	CB SPRING CHARGE R PH
84	CB SPRING CHARGE Y PH
85	CB SPRING CHARGE B PH

86	CB SF6 GAS PRESSURE LOCKOUT R PH
87	CB SF6 GAS PRESSURE LOCKOUT Y PH
88	CB SF6 GAS PRESSURE LOCKOUT B PH
89	CB POLE DISCREPANCY -1 OPTED
90	CB POLE DISCREPANCY -2 OPTED
91	LCC DC SUPPLY-1 FAIL
92	LCC DC SUPPLY-2 FAIL
93	LCC DC SUPPLY MCB TRIP
94	CB MOTOR TRIP R PH
95	CB MOTOR TRIP Y PH
96	CB MOTOR TRIP B PH
97	LCC AC SUPPLY FAIL
98	LCC AC SUPPLY MCB TRIP
99	LCC L/R IN LOCAL MODE
100	LCC L/R IN REMOTE MODE
101	LCC N/M SWITCH IN NORMAL MODE
102	LCC N/M SWITCH IN MAINTAINANCE MODE
103	CB MOTOR SUPPLY FAIL
104	CB MOTOR RUN TIME EXCEED
105	CB READY TO CLOSE
106	NO VOLTAGE AT LINE
107	BUS PT-1 SELECTED
108	BUS PT-2 SELECTED
109	BB RELAY OPTD.
110	M1 RELAY OPTD.
111	M2 RELAY OPTD.
112	CARRIER-1 IN
113	CARRIER-1 OUT
114	CARRIER-2 IN
115	CARRIER-2 OUT
116	59 (O/V STAGE-1) OPTD.
117	CB CLOSE & TC-1 MCB TRIP
118	CB TC-2 MCB TRIP
119	CB CONTROL CKT MCB TRIP
120	DISCONNECTOR CONTROL CKT MCB TRIP
121	AUX RELAY & I/L CKT MCB TRIP
122	INDICATION MFM & ANN. MCB TRIP
123	DS1 ISO MOTOR MCB TRIP
124	DS-2 ISO MOTOR MCB TRIP
125	DS3 ISO MOTOR MCB TRIP
126	ES1/2 E/SW MOTOR MCB TRIP
127	ES-3 E/SW MOTOR MCB TIRP
128	FES E/SW MOTOR MCB TRIP
129	DS-1 MOTOR SUPPLY FAIL
130	DS-2 MOTOR SUPPLY FAIL
131	DS-3 MOTOR SUPPLY FAIL
132	ES-1/2 MOTOR SUPPLY FAIL
133	ES-3 MOTOR SUPPLY FAIL
134	FES MOTOR SUPPLY FAIL
135	EFS FAULTY
136	BB DC SUPPLY-1 FAIL
137	BB DC SUPPLY-2 FAIL

138	BB CU RELAY FAULTY
139	SENSE CONTACT FOR KIT RESET

**b. 400/220kV ICT/Reactor Bay BCU I/O list:**

SR. NO.	INPUT	OUTPUT
1	CB R-PH OPEN POSITION	CB CLOSE
2	CB R-PH CLOSE POSITION	CB TC-1 R PHASE OPEN
3	CB Y-PH OPEN POSITION	CB TC-1 Y PHASE OPEN
4	CB Y-PH CLOSE POSITION	CB TC-1 B PHASE OPEN
5	CB B-PH OPEN POSITION	CB TC-2 R PHASE OPEN
6	CB B-PH CLOSE POSITION	CB TC-2 Y PHASE OPEN
7	ISOL. DS-1 OPEN POSITION	CB TC-2 B PHASE OPEN
8	ISOL. DS-1 CLOSE POSITION	TO CB CLOSING (Synch Check)
9	ISOL. DS-2 OPEN POSITION	TO RESET 86A RELAY
10	ISOL. DS-2 CLOSE POSITION	TO RESET 86B RELAY
11	E/SW ES-1/2 OPEN POSITION	TO RESET 96 RELAY
12	E/SW ES-1/2 CLOSE POSITION	ISOL. DS-1 OPEN COMMAND
13	ISOL. DS-3 OPEN POSITION	ISOL. DS-1 CLOSE COMMAND
14	ISOL. DS-3 CLOSE POSITION	ISOL. DS-2 OPEN COMMAND
15	E/SW ES-3 OPEN POSITION	ISOL. DS-2 CLOSE COMMAND
16	E/SW ES-3 CLOSE POSITION	ISOL. DS-3 OPEN COMMAND
17	E/SW ES-4 OPEN POSITION	ISOL. DS-3 CLOSE COMMAND
18	E/SW ES-4 CLOSE POSITION	BUS-1 PT SELECT
19	CRP DC SUPPLY-1 FAIL	BUS-1 PT RESET
20	CRP DC SUPPLY-2 FAIL	BUS-2 PT SELECT
21	86A TRIP RELAY RESET	BUS-2 PT RESET
22	86B TRIP RELAY RESET	TO BB PU (CB MANUAL CLOSE)
23	96 TRIP RELAY RESET	E/S ES-4 I/L PERMISSIVE
24	86A TRIP RELAY FAULTY	OLTC TAP RAISE COMMAND
25	86B TRIP RELAY FAULTY	OLTC TAP LOWER COMMAND
26	BB PU FAULTY	TEST KIT FEEDBACK
27	CB TC-1 FAULTY	<b>ANALOGUE</b>
28	CB TC-2 FAULTY	TAP POSITION
29	CB MANUAL CLOSE	WTI
30	CB MANUAL TRIP	WTI
31	96 TRIP RELAY FAULTY	WTI
32	CB AUTO TRIP	OTI
33	DS-1 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH	LUMASCENCE - WTI HV TEMP.
34	DS-1 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH	LUMASCENCE - WTI HV TEMP.
35	DS-1 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH	LUMASCENCE - WTI HV TEMP.
36	DS-1 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH	LUMASCENCE - OTI HV TEMP.
37	DS-1 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH	LUMASCENCE - WTI LV TEMP.
38	DS-1 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH	LUMASCENCE - WTI LV TEMP.
39	DS-2 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH	LUMASCENCE - WTI LV TEMP.
40	DS-2 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH	LUMASCENCE - OTI LV TEMP.
41	DS-2 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH	LCC & CRP ROOM TEMPERATURE
42	DS-2 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH	
43	DS-2 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH	
44	DS-2 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH	

45	ES-1/2 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH
46	ES-1/2 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH
47	ES-1/2 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH
48	ES-1/2 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH
49	ES-1/2 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH
50	ES-1/2 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH
51	DS-3/ES3/ES4 COMP GAS PRESSURE STG-1 ALARM R PH
52	DS-3/ES3/ES4 COMP GAS PRESSURE STG-1 ALARM Y PH
53	DS-3/ES3/ES4 COMP GAS PRESSURE STG-1 ALARM B PH
54	DS-3/ES3/ES4 COMP GAS PRESSURE STG-2 ALARM R PH
55	DS-3/ES3/ES4 COMP GAS PRESSURE STG-2 ALARM Y PH
56	DS-3/ES3/ES4 COMP GAS PRESSURE STG-2 ALARM B PH
57	CT COMPARTMENT GAS PRESSURE STG-1 ALARM R PH
58	CT COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH
59	CT COMPARTMENT GAS PRESSURE STG-1 ALARM B PH
60	CT COMPARTMENT GAS PRESSURE STG-2 ALARM R PH
61	CT COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH
62	CT COMPARTMENT GAS PRESSURE STG-2 ALARM B PH
63	LINE BB DUCT COMP GAS PRESSURE STG-1 ALARM R PH
64	LINE BB DUCT COMP GAS PRESSURE STG-1 ALARM Y PH
65	LINE BB DUCT COMP GAS PRESSURE STG-1 ALARM B PH
66	LINE BB DUCT COMP GAS PRESSURE STG-2 ALARM R PH
67	LINE BB DUCT COMP GAS PRESSURE STG-2 ALARM Y PH
68	LINE BB DUCT COMP GAS PRESSURE STG-2 ALARM B PH
69	CB GAS PRESSURE NORMAL R Ph
70	CB GAS PRESSURE NORMAL Y Ph
71	CB) GAS PRESSURE NORMAL B Ph
72	CB GAS PRESSURE LOW R Ph
73	CB GAS PRESSURE LOW Y Ph
74	CB GAS PRESSURE LOW B Ph
75	CB SPRING CHARGE R Ph
76	CB SPRING CHARGE Y Ph
77	CB SPRING CHARGE B Ph
78	CB SF6 GAS PRESSURE LOCKOUT R Ph
79	CB SF6 GAS PRESSURE LOCKOUT Y Ph
80	CB SF6 GAS PRESSURE LOCKOUT B Ph
81	CB POLE DISCREPANCY -1 Opted
82	CB POLE DISCREPANCY -2 Opted
83	LCC DC SUPPLY-1 FAIL
84	LCC DC SUPPLY-2 FAIL
85	LCC DC SUPPLY MCB TRIP
86	CB MOTOR TRIP R PH
87	CB MOTOR TRIP Y PH
88	CB MOTOR TRIP B PH
89	LCC AC SUPPLY FAIL
90	LCC AC SUPPLY MCB TRIP
91	LCC L/R IN LOCAL MODE
92	LCC L/R IN REMOTE MODE
93	LCC N/M SWITCH IN NORMAL MODE
94	LCC N/M SWITCH IN MAINTAINANCE MODE
95	CB MOTOR SUPPLY FAIL
96	CB MOTOR RUN TIME EXCEED

97	CB READY TO CLOSE
98	BUS PT-1 SELECTED
99	BUS PT-2 SELECTED
100	BB RELAY OPTD.
101	220KV SIDE DS-3 ISO. OPEN
102	220KV SIDE ES-4 E/S OPEN
103	CB CLOSE & TC-1 MCB TRIP
104	CB TC-2 MCB TRIP
105	CB CONTROL CKT MCB TRIP
106	DISCONNECTOR CONTROL CKT MCB TRIP
107	AUX RELAY & I/L CKT MCB TRIP
108	INDICATION MFM & ANN. MCB TRIP
109	DS1 ISO MOTOR MCB TRIP
110	DS-2 ISO MOTOR MCB TRIP
111	DS3 ISO MOTOR MCB TRIP
112	ES1/2 E/SW MOTOR MCB TRIP
113	ES-3 E/SW MOTOR MCB TIRP
114	ES-4 E/SW MOTOR MCB TRIP
115	DS-1 MOTOR SUPPLY FAIL
116	DS-2 MOTOR SUPPLY FAIL
117	DS-3 MOTOR SUPPLY FAIL
118	ES-1/2 MOTOR SUPPLY FAIL
119	ES-3 MOTOR SUPPLY FAIL
120	ES-4 MOTOR SUPPLY FAIL
121	EFS FAULTY
122	CSD IN/OUT SW IN SERVICE MODE
123	CSD IN/OUT SW IN OUT MODE
124	NIFPS - FIRE DETECTOR TRIP
125	NIFPS - SYSTEM OPERATED TRIP
126	NIFPS - SYSTEM IN OFF MODE
127	NIFPS - DC SUPPLY FAIL
128	NIFPS - VISUAL AUDIO ALARM
129	NIFPS - TCIV CLOSED
130	NIFPS - LINE FAULT DIFFERENTIAL RELAY
131	NIFPS - LINE FAULT BUCHOLZ RELAY
132	NIFPS - LINE FAULT PRV
133	NIFPS - LINE FAULT TRANSFORMER
134	NIFPS - LINE FAULT TCIV
135	DIFF RELAY FAULTY
136	REF RELAY FAULTY
137	<b><u>Back-up Impedance</u></b> / O/C & E/F RELAY FAULTY
138	BUSBAR PROTN FAULTY
139	TRAFO TROUBLE TRIP
140	TRAFO TROUBLE ALARM
141	COOLER PUMP ON
142	COOLER FAN AC SUPPLY ON
143	OLTC SUPPLY ON
144	TAP CHANGER ON REMOTE
145	TAP CHANGER ON PROGRESS
146	TAP CHANGE OUT OF STEP
147	COOLER FAN ON
148	COOLER PUMP SUPPLY ON

149	CSD VOLTAGE ERROR
150	CSD SYNC DATA ERROR
151	CSD SYNC OPERATION FAILED
152	CSD DEVICE OK
153	CSD BYPASSED
154	SENSE CONTACT FOR KIT RESET

**c. 400KV BUSCOUPLER BCU I/O**

SR. NO.	INPUT	OUTPUT
1	CB R-PH OPEN POSITION	CB CLOSE
2	CB R-PH CLOSE POSITION	CB TC-1 R PHASE OPEN
3	CB Y-PH OPEN POSITION	CB TC-1 Y PHASE OPEN
4	CB Y-PH CLOSE POSITION	CB TC-1 B PHASE OPEN
5	CB B-PH OPEN POSITION	CB TC-2 R PHASE OPEN
6	CB B-PH CLOSE POSITION	CB TC-2 Y PHASE OPEN
7	ISOL. DS-1 OPEN POSITION	CB TC-2 B PHASE OPEN
8	ISOL. DS-1 CLOSE POSITION	TO CB CLOSING (Synch Check Interlock)
9	ISOL. DS-2 OPEN POSITION	TO RESET 86 RELAY
10	ISOL. DS-2 CLOSE POSITION	TO RESET 96A RELAY
11	E/SW ES-1 OPEN POSITION	TO RESET 96B RELAY
12	E/SW ES-1 CLOSE POSITION	ISOL. DS-1 OPEN COMMAND
13	E/SW. ES-2 OPEN POSITION	ISOL. DS-1 CLOSE COMMAND
14	E/SW ES-2 CLOSE POSITION	ISOL. DS-2 OPEN COMMAND
15	BUS PT-1 DS-1 OPEN POSITION	ISOL. DS-2 CLOSE COMMAND
16	BUS PT-1 DS-1 CLOSE POSITION	BUS PT-1 ISOL. DS-1 OPEN COMMAND
17	BUS PT-1 ES-1 OPEN POSITION	BUS PT-1 ISOL. DS-1 CLOSE COMMAND
18	BUS PT-1 ES-1 CLOSE POSITION	BUS PT-2 ISOL. DS-2 OPEN COMMAND
19	BUS PT-2 DS-2 OPEN POSITION	BUS PT-2 ISOL. DS-2 CLOSE COMMAND
20	BUS PT-2 DS-2 CLOSE POSITION	TO BB PU (CB MANUAL CLOSE)
21	BUS PT-2 ES-2 OPEN POSITION	BUS-1 FES I/L PERMISSIVE
22	BUS PT-2 ES-2 CLOSE POSITION	BUS-2 FES I/L PERMISSIVE
23	BUSPT-1 E/SW FES-1 R PH OPEN	TEST KIT FEEDBACK
24	BUSPT-1 E/SW FES-1 Y PH OPEN	
25	BUSPT-1 E/SW FES-1 B PH OPEN	
26	BUSPT-2 E/SW FES-2 R PH OPEN	
27	BUSPT-2 E/SW FES-2 Y PH OPEN	
28	BUSPT-2 E/SW FES-2 B PH OPEN	
29	CRP DC SUPPLY-1 FAIL	
30	CRP DC SUPPLY-2 FAIL	
31	96A TRIP RELAY RESET	
32	96B TRIP RELAY RESET	
33	86 TRIP RELAY RESET	
34	86 TRIP RELAY FAULTY	
35	96A TRIP RELAY FAULTY	
36	BB PU FAULTY	
37	CB TC-1 FAULTY	
38	CB TC-2 FAULTY	
39	CB MANUAL CLOSE	
40	CB MANUAL TRIP	
41	96B TRIP RELAY FAULTY	
42	CB AUTO TRIP	

43	DS-1 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH
44	DS-1 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH
45	DS-1 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH
46	DS-1 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH
47	DS-1 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH
48	DS-1 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH
49	DS-2 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH
50	DS-2 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH
51	DS-2 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH
52	DS-2 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH
53	DS-2 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH
54	DS-2 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH
55	ES-1 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH
56	ES-1 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH
57	ES-1 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH
58	ES-1 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH
59	ES-1 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH
60	ES-1 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH
61	ES-2 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH
62	ES-2 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH
63	ES-2 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH
64	ES-2 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH
65	ES-2 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH
66	ES-2 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH
67	BUSPT-1 DS/ES/FES COMP. GAS PRESSURE STG-1 ALARM R PH
68	BUSPT-1 DS/ES/FES COMP. GAS PRESSURE STG-1 ALARM Y PH
69	BUSPT-1 DS/ES/FES COMP. GAS PRESSURE STG-1 ALARM B PH
70	BUSPT-1 DS/ES/FES COMP. GAS PRESSURE STG-2 ALARM R PH
71	BUSPT-1 DS/ES/FES COMP. GAS PRESSURE STG-2 ALARM Y PH
72	BUSPT-1 DS/ES/FES COMP. GAS PRESSURE STG-2 ALARM B PH
73	BUSPT-2 DS/ES/FES COMP. GAS PRESSURE STG-1 ALARM R PH
74	BUSPT-2 DS/ES/FES COMP. GAS PRESSURE STG-1 ALARM Y PH
75	BUSPT-2 DS/ES/FES COMP. GAS PRESSURE STG-1 ALARM B PH
76	BUSPT-2 DS/ES/FES COMP. GAS PRESSURE STG-2 ALARM R PH
77	BUSPT-2 DS/ES/FES COMP. GAS PRESSURE STG-2 ALARM Y PH
78	BUSPT-2 DS/ES/FES COMP. GAS PRESSURE STG-2 ALARM B PH
79	BUSPT-1 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH
80	BUSPT-1 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH
81	BUSPT-1 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH
82	BUSPT-1 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH
83	BUSPT-1 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH
84	BUSPT-1 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH
85	BUSPT-2 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH
86	BUSPT-2 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH
87	BUSPT-2 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH
88	BUSPT-2 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH
89	BUSPT-2 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH
90	BUSPT-2 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH
91	CT COMPARTMENT GAS PRESSURE STG-1 ALARM R PH
92	CT COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH
93	CT COMPARTMENT GAS PRESSURE STG-1 ALARM B PH
94	CT COMPARTMENT GAS PRESSURE STG-2 ALARM R PH

95	CT COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH
96	CT COMPARTMENT GAS PRESSURE STG-2 ALARM B PH
97	CB GAS PRESSURE NORMAL R PH
98	CB GAS PRESSURE NORMAL Y PH
99	CB) GAS PRESSURE NORMAL B PH
100	CB GAS PRESSURE LOW R PH
101	CB GAS PRESSURE LOW Y PH
102	CB GAS PRESSURE LOW B PH
103	CB SPRING CHARGE R PH
104	CB SPRING CHARGE Y PH
105	CB SPRING CHARGE B PH
106	CB SF6 GAS PRESSURE LOCKOUT R PH
107	CB SF6 GAS PRESSURE LOCKOUT Y PH
108	CB SF6 GAS PRESSURE LOCKOUT B PH
109	CB POLE DISCREPANCY -1 OPTED
110	CB POLE DISCREPANCY -2 OPTED
111	LCC DC SUPPLY-1 FAIL
112	LCC DC SUPPLY-2 FAIL
113	LCC DC SUPPLY MCB TRIP
114	CB MOTOR TRIP R PH
115	CB MOTOR TRIP Y PH
116	CB MOTOR TRIP B PH
117	LCC AC SUPPLY FAIL
118	LCC AC SUPPLY MCB TRIP
119	LCC L/R IN LOCAL MODE
120	LCC L/R IN REMOTE MODE
121	LCC N/M SWITCH IN NORMAL MODE
122	LCC N/M SWITCH IN MAINTAINANCE MODE
123	CB MOTOR SUPPLY FAIL
124	CB MOTOR RUN TIME EXCEED
125	CB READY TO CLOSE
126	BB RELAY OPTD.
127	CB CLOSE & TC-1 MCB TRIP
128	CB TC-2 MCB TRIP
129	CB CONTROL CKT MCB TRIP
130	DISCONNECTOR CONTROL CKT MCB TRIP
131	AUX RELAY & I/L CKT MCB TRIP
132	INDICATION MFM & ANN. MCB TRIP
133	DS1 ISO MOTOR MCB TRIP
134	DS-2 ISO MOTOR MCB TRIP
135	BUS PT-1 DS-1 ISO MOTOR MCB TRIP
136	BUS PT-2 DS-2 ISO MOTOR MCB TRIP
137	BUS PT-1 ES-1 E/SW MOTOR MCB TIRP
138	BUS PT-2 ES-2 E/SW MOTOR MCB TIRP
139	DS-1 MOTOR SUPPLY FAIL
140	DS-2 MOTOR SUPPLY FAIL
141	ES-1 MOTOR SUPPLY FAIL
142	ES-2 MOTOR SUPPLY FAIL
143	BUS PT-1 FES MOTOR SUPPLY FAIL
144	BUS PT-2 FES MOTOR SUPPLY FAIL
145	EFS FAULTY
146	BUS-1 FES E/SW MOTOR MCB TRIP



147	BUS-2 FES E/SW MOTOR MCB TRIP
148	BUS PT-1 DS-1 MOTOR FAIL
149	BUS PT-1 ES-1 MOTOR FAIL
150	BUS PT-2 DS-2 MOTOR FAIL
151	BUS PT-2 ES-2 MOTOR FAIL
152	O/C & E/F PROTN OPTD
153	O/C & E/F RELAY FAULTY
154	BUSBAR PROTN FAULTY
155	SENSE CONTACT FOR KIT RESET
156	BUS PT-1 R PH MCB FAIL
157	BUS PT-1 Y PH MCB FAIL
158	BUS PT-1 B PH MCB FAIL
159	BUS PT-2 R PH MCB FAIL
160	BUS PT-2 Y PH MCB FAIL
161	BUS PT-2 B PH MCB FAIL
162	SENSE CONTACT FOR KIT RESET

**d. 220kV Line BCU I/O:**

SR. NO.	INPUT	OUTPUT
1	CB R-PH OPEN POSITION	TO MAIN-1 RELAY (SOTF INI.)
2	CB R-PH CLOSE POSITION	TO MAIN-2 RELAY (SOTF INI.)
3	CB Y-PH OPEN POSITION	TO CB CLOSING (Synch Check Interlock)
4	CB Y-PH CLOSE POSITION	TO RESET 86A RELAY
5	CB B-PH OPEN POSITION	TO RESET 86B RELAY
6	CB B-PH CLOSE POSITION	TO RESET 96 RELAY
7	ISOL. DS-1 OPEN POSITION	ISOL. DS-1 OPEN COMMAND
8	ISOL. DS-1 CLOSE POSITION	ISOL. DS-1 CLOSE COMMAND
9	ISOL. DS-2 OPEN POSITION	ISOL. DS-2 OPEN COMMAND
10	ISOL. DS-2 CLOSE POSITION	ISOL. DS-2 CLOSE COMMAND
11	E/SW ES-1/2 OPEN POSITION	ISOL. DS-3 OPEN COMMAND
12	E/SW ES-1/2 CLOSE POSITION	ISOL. DS-3 CLOSE COMMAND
13	ISOL. DS-3 OPEN POSITION	BUS-1 PT SELECT
14	ISOL. DS-3 CLOSE POSITION	BUS-1 PT RESET
15	E/SW ES-3 OPEN POSITION	BUS-2 PT SELECT
16	E/SW ES-3 CLOSE POSITION	BUS-2 PT RESET
17	FES R PHASE OPEN POSITION	TO 87BB (CB MANUAL CLOSE)
18	FES R PHASE CLOSE POSITION	DIRECT TRIP SEND CH-1 (CB MANUAL TRIP)
19	FES Y PHASE OPEN POSITION	DIRECT TRIP SEND CH-2 (CB MANUAL TRIP)
20	FES Y PHASE CLOSE POSITION	CB CLOSE
21	FES B PHASE OPEN POSITION	CB TC-1 R PHASE OPEN
22	FES B PHASE CLOSE POSITION	CB TC-1 Y PHASE OPEN
23	CRP DC SUPPLY-1 FAIL	CB TC-1 B PHASE OPEN
24	CRP DC SUPPLY-2 FAIL	CB TC-2 R PHASE OPEN
25	86A TRIP RELAY RESET	CB TC-2 Y PHASE OPEN

26	86B TRIP RELAY RESET	CB TC-2 B PHASE OPEN
27	96 TRIP RELAY RESET	TEST KIT FEEDBACK
28	86A TRIP RELAY FAULTY	
29	86B TRIP RELAY FAULTY	
30	BB PU FAULTY	
31	CB TC-1 FAULTY	
32	CB TC-2 FAULTY	
33	CB MANUAL CLOSE	
34	CB MANUAL TRIP	
35	96 TRIP RELAY FAULTY	
36	DIRECT TRIP RECEIVED CH-1	
37	DIRECT TRIP SEND CH-1	
38	DIRECT TRIP RECEIVED CH-2	
39	DIRECT TRIP SEND CH-2	
40	CB AUTO TRIP	
41	DS-1 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH	
42	DS-1 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH	
43	DS-1 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH	
44	DS-1 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH	
45	DS-1 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH	
46	DS-1 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH	
47	DS-2 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH	
48	DS-2 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH	
49	DS-2 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH	
50	DS-2 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH	
51	DS-2 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH	
52	DS-2 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH	
53	ES-1/2 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH	
54	ES-1/2 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH	
55	ES-1/2 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH	
56	ES-1/2 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH	
57	ES-1/2 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH	
58	ES-1/2 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH	
59	DS-3/ES3/FES COMP. GAS PRESSURE STG-1 ALARM R PH	
60	DS-3/ES3/FES COMP. GAS PRESSURE STG-1 ALARM Y PH	
61	DS-3/ES3/FES COMP. GAS PRESSURE STG-1 ALARM B PH	
62	DS-3/ES3/FES COMP. GAS PRESSURE STG-2 ALARM R PH	
63	DS-3/ES3/FES COMP. GAS PRESSURE STG-2 ALARM Y PH	
64	DS-3/ES3/FES COMP. GAS PRESSURE STG-2 ALARM B PH	
65	CT COMPARTMENT GAS PRESSURE STG-1 ALARM R PH	
66	CT COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH	
67	CT COMPARTMENT GAS PRESSURE STG-1 ALARM B PH	
68	CT COMPARTMENT GAS PRESSURE STG-2 ALARM R PH	
69	CT COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH	
70	CT COMPARTMENT GAS PRESSURE STG-2 ALARM B PH	

71	LINE BB DUCT COMP. GAS PRESSURE STG-1 ALARM R PH
72	LINE BB DUCT COMP. GAS PRESSURE STG-1 ALARM Y PH
73	LINE BB DUCT COMP. GAS PRESSURE STG-1 ALARM B PH
74	LINE BB DUCT COMP. GAS PRESSURE STG-2 ALARM R PH
75	LINE BB DUCT COMP. GAS PRESSURE STG-2 ALARM Y PH
76	LINE BB DUCT COMP. GAS PRESSURE STG-2 ALARM B PH
77	CB GAS PRESSURE NORMAL R PH
78	CB GAS PRESSURE NORMAL Y PH
79	CB) GAS PRESSURE NORMAL B PH
80	CB GAS PRESSURE LOW R PH
81	CB GAS PRESSURE LOW Y PH
82	CB GAS PRESSURE LOW B PH
83	CB SPRING CHARGE R PH
84	CB SPRING CHARGE Y PH
85	CB SPRING CHARGE B PH
86	CB SF6 GAS PRESSURE LOCKOUT R PH
87	CB SF6 GAS PRESSURE LOCKOUT Y PH
88	CB SF6 GAS PRESSURE LOCKOUT B PH
89	CB POLE DISCREPANCY -1 OPTED
90	CB POLE DISCREPANCY -2 OPTED
91	LCC DC SUPPLY-1 FAIL
92	LCC DC SUPPLY-2 FAIL
93	LCC DC SUPPLY MCB TRIP
94	CB MOTOR TRIP R PH
95	CB MOTOR TRIP Y PH
96	CB MOTOR TRIP B PH
97	LCC AC SUPPLY FAIL
98	LCC AC SUPPLY MCB TRIP
99	LCC L/R IN LOCAL MODE
100	LCC L/R IN REMOTE MODE
101	LCC N/M SWITCH IN NORMAL MODE
102	LCC N/M SWITCH IN MAINTAINANCE MODE
103	CB MOTOR SUPPLY FAIL
104	CB MOTOR RUN TIME EXCEED
105	CB READY TO CLOSE
106	NO VOLTAGE AT LINE
107	BUS PT-1 SELECTED
108	BUS PT-2 SELECTED
109	BB RELAY OPTD.
110	M1 RELAY OPTD.
111	M2 RELAY OPTD.
112	CARRIER-1 IN
113	CARRIER-1 OUT
114	CARRIER-2 IN
115	CARRIER-2 OUT

116	59 (O/V STAGE-1) OPTD.
117	CB CLOSE & TC-1 MCB TRIP
118	CB TC-2 MCB TRIP
119	CB CONTROL CKT MCB TRIP
120	DISCONNECTOR CONTROL CKT MCB TRIP
121	AUX RELAY & I/L CKT MCB TRIP
122	INDICATION MFM & ANN. MCB TRIP
123	DS1 ISO MOTOR MCB TRIP
124	DS-2 ISO MOTOR MCB TRIP
125	DS3 ISO MOTOR MCB TRIP
126	ES1/2 E/SW MOTOR MCB TRIP
127	ES-3 E/SW MOTOR MCB TRIP
128	FES E/SW MOTOR MCB TRIP
129	DS-1 MOTOR SUPPLY FAIL
130	DS-2 MOTOR SUPPLY FAIL
131	DS-3 MOTOR SUPPLY FAIL
132	ES-1/2 MOTOR SUPPLY FAIL
133	ES-3 MOTOR SUPPLY FAIL
134	FES MOTOR SUPPLY FAIL
135	EFS FAULTY
136	BB DC SUPPLY-1 FAIL
137	BB DC SUPPLY-2 FAIL
138	BB CU RELAY FAULTY
139	SENSE CONTACT FOR KIT RESET

**e. 220kV ICT LV BAY BCU I/O:**

<b>SR. NO.</b>	<b>INPUT</b>	<b>OUTPUT</b>
1	CB R-PH OPEN POSITION	TO CB CLOSING (Synch Check Interlock)
2	CB R-PH CLOSE POSITION	TO RESET 86A RELAY
3	CB Y-PH OPEN POSITION	TO RESET 86B RELAY
4	CB Y-PH CLOSE POSITION	TO RESET 96 RELAY
5	CB B-PH OPEN POSITION	ISOL. DS-1 OPEN COMMAND
6	CB B-PH CLOSE POSITION	ISOL. DS-1 CLOSE COMMAND
7	ISOL. DS-1 OPEN POSITION	ISOL. DS-2 OPEN COMMAND
8	ISOL. DS-1 CLOSE POSITION	ISOL. DS-2 CLOSE COMMAND
9	ISOL. DS-2 OPEN POSITION	ISOL. DS-3 OPEN COMMAND
10	ISOL. DS-2 CLOSE POSITION	ISOL. DS-3 CLOSE COMMAND
11	E/SW ES-1/2 OPEN POSITION	BUS-1 PT SELECT
12	E/SW ES-1/2 CLOSE POSITION	BUS-1 PT RESET
13	ISOL. DS-3 OPEN POSITION	BUS-2 PT SELECT
14	ISOL. DS-3 CLOSE POSITION	BUS-2 PT RESET
15	E/SW ES-3 OPEN POSITION	TO 87BB (CB MANUAL CLOSE)
16	E/SW ES-3 CLOSE POSITION	ES-4 INTERLOCK PERMISSIVE

17	E/SW ES-4 OPEN POSITION	CB CLOSE
18	E/SW ES-4 CLOSE POSITION	CB TC-1 R PHASE OPEN
19	CRP DC SUPPLY-1 FAIL	CB TC-1 Y PHASE OPEN
20	CRP DC SUPPLY-2 FAIL	CB TC-1 B PHASE OPEN
21	86A TRIP RELAY RESET	CB TC-2 R PHASE OPEN
22	86B TRIP RELAY RESET	CB TC-2 Y PHASE OPEN
23	96 TRIP RELAY RESET	CB TC-2 B PHASE OPEN
24	86A TRIP RELAY FAULTY	TEST KIT FEEDBACK
25	86B TRIP RELAY FAULTY	
26	BB PU FAULTY	
27	CB TC-1 FAULTY	
28	CB TC-2 FAULTY	
29	CB MANUAL CLOSE	
30	CB MANUAL TRIP	
31	96 TRIP RELAY FAULTY	
32	CB AUTO TRIP	
33	DS-1 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH	
34	DS-1 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH	
35	DS-1 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH	
36	DS-1 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH	
37	DS-1 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH	
38	DS-1 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH	
39	DS-2 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH	
40	DS-2 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH	
41	DS-2 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH	
42	DS-2 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH	
43	DS-2 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH	
44	DS-2 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH	
45	ES-1/2 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH	
46	ES-1/2 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH	
47	ES-1/2 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH	
48	ES-1/2 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH	
49	ES-1/2 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH	
50	ES-1/2 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH	
51	DS-3/ES3/ES-4 COMP. GAS PRESSURE STG-1 ALARM R PH	
52	DS-3/ES3/ES-4 COMP. GAS PRESSURE STG-1 ALARM Y PH	
53	DS-3/ES3/ES-4 COMP. GAS PRESSURE STG-1 ALARM B PH	
54	DS-3/ES3/ES-4 COMP. GAS PRESSURE STG-2 ALARM R PH	
55	DS-3/ES3/ES-4 COMP. GAS PRESSURE STG-2 ALARM Y PH	
56	DS-3/ES3/ES-4 COMP. GAS PRESSURE STG-2 ALARM B PH	
57	CT COMPARTMENT GAS PRESSURE STG-1 ALARM R PH	
58	CT COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH	
59	CT COMPARTMENT GAS PRESSURE STG-1 ALARM B PH	
60	CT COMPARTMENT GAS PRESSURE STG-2 ALARM R PH	
61	CT COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH	

62	CT COMPARTMENT GAS PRESSURE STG-2 ALARM B PH
63	LINE BB DUCT COMP. GAS PRESSURE STG-1 ALARM R PH
64	LINE BB DUCT COMP. GAS PRESSURE STG-1 ALARM Y PH
65	LINE BB DUCT COMP. GAS PRESSURE STG-1 ALARM B PH
66	LINE BB DUCT COMP. GAS PRESSURE STG-2 ALARM R PH
67	LINE BB DUCT COMP. GAS PRESSURE STG-2 ALARM Y PH
68	LINE BB DUCT COMP. GAS PRESSURE STG-2 ALARM B PH
69	CB GAS PRESSURE NORMAL R PH
70	CB GAS PRESSURE NORMAL Y PH
71	CB) GAS PRESSURE NORMAL B PH
72	CB GAS PRESSURE LOW R PH
73	CB GAS PRESSURE LOW Y PH
74	CB GAS PRESSURE LOW B PH
75	CB SPRING CHARGE R PH
76	CB SPRING CHARGE Y PH
77	CB SPRING CHARGE B PH
78	CB SF6 GAS PRESSURE LOCKOUT R PH
79	CB SF6 GAS PRESSURE LOCKOUT Y PH
80	CB SF6 GAS PRESSURE LOCKOUT B PH
81	CB POLE DISCREPANCY -1 OPTED
82	CB POLE DISCREPANCY -2 OPTED
83	LCC DC SUPPLY-1 FAIL
84	LCC DC SUPPLY-2 FAIL
85	LCC DC SUPPLY MCB TRIP
86	CB MOTOR TRIP R PH
87	CB MOTOR TRIP Y PH
88	CB MOTOR TRIP B PH
89	LCC AC SUPPLY FAIL
90	LCC AC SUPPLY MCB TRIP
91	LCC L/R IN LOCAL MODE
92	LCC L/R IN REMOTE MODE
93	LCC N/M SWITCH IN NORMAL MODE
94	LCC N/M SWITCH IN MAINTAINANCE MODE
95	CB MOTOR SUPPLY FAIL
96	CB MOTOR RUN TIME EXCEED
97	CB READY TO CLOSE
98	BUS PT-1 SELECTED
99	BUS PT-2 SELECTED
100	BB RELAY OPTD.
101	67/67N RELAY OPTD.
102	O/F RELAY OPTED
103	O/F RELAY FAULTY
104	67/67N RELAY FAULTY
105	CB CLOSE & TC-1 MCB TRIP
106	CB TC-2 MCB TRIP

107	CB CONTROL CKT MCB TRIP
108	DISCONNECTOR CONTROL CKT MCB TRIP
109	AUX RELAY & I/L CKT MCB TRIP
110	INDICATION MFM & ANN. MCB TRIP
111	DS1 ISO MOTOR MCB TRIP
112	DS-2 ISO MOTOR MCB TRIP
113	DS3 ISO MOTOR MCB TRIP
114	ES1/2 E/SW MOTOR MCB TRIP
115	ES-3 E/SW MOTOR MCB TRIP
116	ES-4 E/SW MOTOR MCB TRIP
117	DS-1 MOTOR SUPPLY FAIL
118	DS-2 MOTOR SUPPLY FAIL
119	DS-3 MOTOR SUPPLY FAIL
120	ES-1/2 MOTOR SUPPLY FAIL
121	ES-3 MOTOR SUPPLY FAIL
122	ES-4 MOTOR SUPPLY FAIL
123	EFS FAULTY
124	400KV SIDE DS-3 OPEN
125	400KV SIDE ES-4 OPEN
126	SENSE CONTACT FOR KIT RESET

**f. 220/66kV TRAFO HV BCU I/O:**

SR. NO.	INPUT	OUTPUT
1	CB R-PH OPEN POSITION	CB CLOSE
2	CB R-PH CLOSE POSITION	CB TC-1 R PHASE OPEN
3	CB Y-PH OPEN POSITION	CB TC-1 Y PHASE OPEN
4	CB Y-PH CLOSE POSITION	CB TC-1 B PHASE OPEN
5	CB B-PH OPEN POSITION	CB TC-2 R PHASE OPEN
6	CB B-PH CLOSE POSITION	CB TC-2 Y PHASE OPEN
7	ISOL. DS-1 OPEN POSITION	CB TC-2 B PHASE OPEN
8	ISOL. DS-1 CLOSE POSITION	TO CB CLOSING (Synch Check)
9	ISOL. DS-2 OPEN POSITION	TO RESET 86A RELAY
10	ISOL. DS-2 CLOSE POSITION	TO RESET 86B RELAY
11	E/SW ES-1/2 OPEN POSITION	TO RESET 96 RELAY
12	E/SW ES-1/2 CLOSE POSITION	ISOL. DS-1 OPEN COMMAND
13	ISOL. DS-3 OPEN POSITION	ISOL. DS-1 CLOSE COMMAND
14	ISOL. DS-3 CLOSE POSITION	ISOL. DS-2 OPEN COMMAND
15	E/SW ES-3 OPEN POSITION	ISOL. DS-2 CLOSE COMMAND
16	E/SW ES-3 CLOSE POSITION	ISOL. DS-3 OPEN COMMAND
17	E/SW ES-4 OPEN POSITION	ISOL. DS-3 CLOSE COMMAND
18	E/SW ES-4 CLOSE POSITION	BUS-1 PT SELECT
19	CRP DC SUPPLY-1 FAIL	BUS-1 PT RESET
20	CRP DC SUPPLY-2 FAIL	BUS-2 PT SELECT
21	86A TRIP RELAY RESET	BUS-2 PT RESET

22	86B TRIP RELAY RESET	TO BB PU (CB MANUAL CLOSE)
23	96 TRIP RELAY RESET	E/S ES-4 I/L PERMISSIVE
24	86A TRIP RELAY FAULTY	OLTC TAP RAISE COMMAND
25	86B TRIP RELAY FAULTY	OLTC TAP LOWER COMMAND
26	BB PU FAULTY	TEST KIT FEEDBACK
27	CB TC-1 FAULTY	
28	CB TC-2 FAULTY	
29	CB MANUAL CLOSE	
30	CB MANUAL TRIP	
31	96 TRIP RELAY FAULTY	
32	CB AUTO TRIP	
33	DS-1 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH	
34	DS-1 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH	
35	DS-1 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH	
36	DS-1 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH	
37	DS-1 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH	
38	DS-1 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH	
39	DS-2 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH	
40	DS-2 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH	
41	DS-2 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH	
42	DS-2 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH	
43	DS-2 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH	
44	DS-2 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH	
45	ES-1/2 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH	
46	ES-1/2 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH	
47	ES-1/2 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH	
48	ES-1/2 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH	
49	ES-1/2 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH	
50	ES-1/2 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH	
51	DS-3/ES3/ES4 COMP GAS PRESSURE STG-1 ALARM R PH	
52	DS-3/ES3/ES4 COMP GAS PRESSURE STG-1 ALARM Y PH	
53	DS-3/ES3/ES4 COMP GAS PRESSURE STG-1 ALARM B PH	
54	DS-3/ES3/ES4 COMP GAS PRESSURE STG-2 ALARM R PH	
55	DS-3/ES3/ES4 COMP GAS PRESSURE STG-2 ALARM Y PH	
56	DS-3/ES3/ES4 COMP GAS PRESSURE STG-2 ALARM B PH	
57	CT COMPARTMENT GAS PRESSURE STG-1 ALARM R PH	
58	CT COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH	
59	CT COMPARTMENT GAS PRESSURE STG-1 ALARM B PH	
60	CT COMPARTMENT GAS PRESSURE STG-2 ALARM R PH	
61	CT COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH	
62	CT COMPARTMENT GAS PRESSURE STG-2 ALARM B PH	
63	LINE BB DUCT COMP GAS PRESSURE STG-1 ALARM R PH	
64	LINE BB DUCT COMP GAS PRESSURE STG-1 ALARM Y PH	
65	LINE BB DUCT COMP GAS PRESSURE STG-1 ALARM B PH	
66	LINE BB DUCT COMP GAS PRESSURE STG-2 ALARM R PH	



67	LINE BB DUCT COMP GAS PRESSURE STG-2 ALARM Y PH
68	LINE BB DUCT COMP GAS PRESSURE STG-2 ALARM B PH
69	CB GAS PRESSURE NORMAL R PH
70	CB GAS PRESSURE NORMAL Y PH
71	CB) GAS PRESSURE NORMAL B PH
72	CB GAS PRESSURE LOW R PH
73	CB GAS PRESSURE LOW Y PH
74	CB GAS PRESSURE LOW B PH
75	CB SPRING CHARGE R PH
76	CB SPRING CHARGE Y PH
77	CB SPRING CHARGE B PH
78	CB SF6 GAS PRESSURE LOCKOUT R PH
79	CB SF6 GAS PRESSURE LOCKOUT Y PH
80	CB SF6 GAS PRESSURE LOCKOUT B PH
81	CB POLE DISCREPANCY -1 OPTED
82	CB POLE DISCREPANCY -2 OPTED
83	LCC DC SUPPLY-1 FAIL
84	LCC DC SUPPLY-2 FAIL
85	LCC DC SUPPLY MCB TRIP
86	CB MOTOR TRIP R PH
87	CB MOTOR TRIP Y PH
88	CB MOTOR TRIP B PH
89	LCC AC SUPPLY FAIL
90	LCC AC SUPPLY MCB TRIP
91	LCC L/R IN LOCAL MODE
92	LCC L/R IN REMOTE MODE
93	LCC N/M SWITCH IN NORMAL MODE
94	LCC N/M SWITCH IN MAINTAINANCE MODE
95	CB MOTOR SUPPLY FAIL
96	CB MOTOR RUN TIME EXCEED
97	CB READY TO CLOSE
98	BUS PT-1 SELECTED
99	BUS PT-2 SELECTED
100	BB RELAY OPTD.
101	220KV SIDE DS-3 ISO. OPEN
102	220KV SIDE ES-4 E/S OPEN
103	CB CLOSE & TC-1 MCB TRIP
104	CB TC-2 MCB TRIP
105	CB CONTROL CKT MCB TRIP
106	DISCONNECTOR CONTROL CKT MCB TRIP
107	AUX RELAY & I/L CKT MCB TRIP
108	INDICATION MFM & ANN. MCB TRIP
109	DS1 ISO MOTOR MCB TRIP
110	DS-2 ISO MOTOR MCB TRIP
111	DS3 ISO MOTOR MCB TRIP

112	ES1/2 E/SW MOTOR MCB TRIP
113	ES-3 E/SW MOTOR MCB TIRP
114	ES-4 E/SW MOTOR MCB TRIP
115	DS-1 MOTOR SUPPLY FAIL
116	DS-2 MOTOR SUPPLY FAIL
117	DS-3 MOTOR SUPPLY FAIL
118	ES-1/2 MOTOR SUPPLY FAIL
119	ES-3 MOTOR SUPPLY FAIL
120	ES-4 MOTOR SUPPLY FAIL
121	EFS FAULTY
122	NIFPS - FIRE DETECTOR TRIP
123	NIFPS - SYSTEM OPERATED TRIP
124	NIFPS - SYSTEM IN OFF MODE
125	NIFPS - DC SUPPLY FAIL
126	NIFPS - VISUAL AUDIO ALARM
127	NIFPS - TCIV CLOSED
128	NIFPS - LINE FAULT DIFFERENTIAL RELAY
129	NIFPS - LINE FAULT BUCHOLZ RELAY
130	NIFPS - LINE FAULT PRV
131	NIFPS - LINE FAULT TRANSFORMER
132	NIFPS - LINE FAULT TCIV
133	DIFF RELAY FAULTY
134	REF RELAY FAULTY
135	O/C & E/F RELAY FAULTY
136	BUSBAR PROTN FAULTY
137	TRAFO TROUBLE TRIP
138	TRAFO TROUBLE ALARM
139	COOLER PUMP ON
140	COOLER FAN AC SUPPLY ON
141	OLTC SUPPLY ON
142	TAP CHANGER ON REMOTE
143	TAP CHANGER ON PROGRESS
144	TAP CHANGE OUT OF STEP
145	COOLER FAN ON
146	COOLER PUMP SUPPLY ON
147	SENSE CONTACT FOR KIT RESET
	<b>ANALOGUE</b>
1	TAP POSITION
2	WTI
3	WTI
4	WTI
5	OTI
6	LUMASCENCE - WTI HV
7	LUMASCENCE - WTI HV

8	LUMASCENCE - WTI HV
9	LUMASCENCE - OTI HV
10	LUMASCENCE - WTI LV
11	LUMASCENCE - WTI LV
12	LUMASCENCE - WTI LV
13	LUMASCENCE - OTI LV
14	LCC & CRP ROOM TEMPERATURE

**g. 220kV Buscoupler Bay BCU I/O:**

SR. NO.	INPUT	OUTPUT
1	CB R-PH OPEN POSITION	CB CLOSE
2	CB R-PH CLOSE POSITION	CB TC-1 R PHASE OPEN
3	CB Y-PH OPEN POSITION	CB TC-1 Y PHASE OPEN
4	CB Y-PH CLOSE POSITION	CB TC-1 B PHASE OPEN
5	CB B-PH OPEN POSITION	CB TC-2 R PHASE OPEN
6	CB B-PH CLOSE POSITION	CB TC-2 Y PHASE OPEN
7	ISOL. DS-1 OPEN POSITION	CB TC-2 B PHASE OPEN
8	ISOL. DS-1 CLOSE POSITION	TO CB CLOSING (SYNCH CHECK INTERLOCK)
9	ISOL. DS-2 OPEN POSITION	TO RESET 86 RELAY
10	ISOL. DS-2 CLOSE POSITION	TO RESET 96A RELAY
11	E/SW ES-1 OPEN POSITION	TO RESET 96B RELAY
12	E/SW ES-1 CLOSE POSITION	ISOL. DS-1 OPEN COMMAND
13	E/SW. ES-2 OPEN POSITION	ISOL. DS-1 CLOSE COMMAND
14	E/SW ES-2 CLOSE POSITION	ISOL. DS-2 OPEN COMMAND
15	BUS PT-1 DS-1 OPEN POSITION	ISOL. DS-2 CLOSE COMMAND
16	BUS PT-1 DS-1 CLOSE POSITION	BUS PT-1 ISOL. DS-1 OPEN COMMAND
17	BUS PT-1 ES-1 OPEN POSITION	BUS PT-1 ISOL. DS-1 CLOSE COMMAND
18	BUS PT-1 ES-1 CLOSE POSITION	BUS PT-2 ISOL. DS-2 OPEN COMMAND
19	BUS PT-2 DS-2 OPEN POSITION	BUS PT-2 ISOL. DS-2 CLOSE COMMAND
20	BUS PT-2 DS-2 CLOSE POSITION	TO BB PU (CB MANUAL CLOSE)
21	BUS PT-2 ES-2 OPEN POSITION	BUS-1 FES I/L PERMISSIVE
22	BUS PT-2 ES-2 CLOSE POSITION	BUS-2 FES I/L PERMISSIVE
23	BUSPT-1 E/SW FES-1 R PH OPEN	TEST KIT FEEDBACK
24	BUSPT-1 E/SW FES-1 Y PH OPEN	
25	BUSPT-1 E/SW FES-1 B PH OPEN	
26	BUSPT-2 E/SW FES-2 R PH OPEN	
27	BUSPT-2 E/SW FES-2 Y PH OPEN	
28	BUSPT-2 E/SW FES-2 B PH OPEN	
29	CRP DC SUPPLY-1 FAIL	
30	CRP DC SUPPLY-2 FAIL	
31	96A TRIP RELAY RESET	
32	96B TRIP RELAY RESET	
33	86 TRIP RELAY RESET	
34	86 TRIP RELAY FAULTY	

35	96A TRIP RELAY FAULTY
36	BB PU FAULTY
37	CB TC-1 FAULTY
38	CB TC-2 FAULTY
39	CB MANUAL CLOSE
40	CB MANUAL TRIP
41	96B TRIP RELAY FAULTY
42	CB AUTO TRIP
43	DS-1 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH
44	DS-1 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH
45	DS-1 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH
46	DS-1 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH
47	DS-1 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH
48	DS-1 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH
49	DS-2 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH
50	DS-2 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH
51	DS-2 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH
52	DS-2 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH
53	DS-2 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH
54	DS-2 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH
55	ES-1 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH
56	ES-1 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH
57	ES-1 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH
58	ES-1 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH
59	ES-1 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH
60	ES-1 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH
61	ES-2 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH
62	ES-2 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH
63	ES-2 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH
64	ES-2 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH
65	ES-2 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH
66	ES-2 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH
67	BUSPT-1 DS/ES/FES COMP. GAS PRESSURE STG-1 ALARM R PH
68	BUSPT-1 DS/ES/FES COMP. GAS PRESSURE STG-1 ALARM Y PH
69	BUSPT-1 DS/ES/FES COMP. GAS PRESSURE STG-1 ALARM B PH
70	BUSPT-1 DS/ES/FES COMP. GAS PRESSURE STG-2 ALARM R PH
71	BUSPT-1 DS/ES/FES COMP. GAS PRESSURE STG-2 ALARM Y PH
72	BUSPT-1 DS/ES/FES COMP. GAS PRESSURE STG-2 ALARM B PH
73	BUSPT-2 DS/ES/FES COMP. GAS PRESSURE STG-1 ALARM R PH
74	BUSPT-2 DS/ES/FES COMP. GAS PRESSURE STG-1 ALARM Y PH
75	BUSPT-2 DS/ES/FES COMP. GAS PRESSURE STG-1 ALARM B PH
76	BUSPT-2 DS/ES/FES COMP. GAS PRESSURE STG-2 ALARM R PH
77	BUSPT-2 DS/ES/FES COMP. GAS PRESSURE STG-2 ALARM Y PH
78	BUSPT-2 DS/ES/FES COMP. GAS PRESSURE STG-2 ALARM B PH

79	BUSPT-1 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH
80	BUSPT-1 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH
81	BUSPT-1 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH
82	BUSPT-1 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH
83	BUSPT-1 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH
84	BUSPT-1 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH
85	BUSPT-2 COMPARTMENT GAS PRESSURE STG-1 ALARM R PH
86	BUSPT-2 COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH
87	BUSPT-2 COMPARTMENT GAS PRESSURE STG-1 ALARM B PH
88	BUSPT-2 COMPARTMENT GAS PRESSURE STG-2 ALARM R PH
89	BUSPT-2 COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH
90	BUSPT-2 COMPARTMENT GAS PRESSURE STG-2 ALARM B PH
91	CT COMPARTMENT GAS PRESSURE STG-1 ALARM R PH
92	CT COMPARTMENT GAS PRESSURE STG-1 ALARM Y PH
93	CT COMPARTMENT GAS PRESSURE STG-1 ALARM B PH
94	CT COMPARTMENT GAS PRESSURE STG-2 ALARM R PH
95	CT COMPARTMENT GAS PRESSURE STG-2 ALARM Y PH
96	CT COMPARTMENT GAS PRESSURE STG-2 ALARM B PH
97	CB GAS PRESSURE NORMAL R PH
98	CB GAS PRESSURE NORMAL Y PH
99	CB) GAS PRESSURE NORMAL B PH
100	CB GAS PRESSURE LOW R PH
101	CB GAS PRESSURE LOW Y PH
102	CB GAS PRESSURE LOW B PH
103	CB SPRING CHARGE R PH
104	CB SPRING CHARGE Y PH
105	CB SPRING CHARGE B PH
106	CB SF6 GAS PRESSURE LOCKOUT R PH
107	CB SF6 GAS PRESSURE LOCKOUT Y PH
108	CB SF6 GAS PRESSURE LOCKOUT B PH
109	CB POLE DISCREPANCY -1 OPTED
110	CB POLE DISCREPANCY -2 OPTED
111	LCC DC SUPPLY-1 FAIL
112	LCC DC SUPPLY-2 FAIL
113	LCC DC SUPPLY MCB TRIP
114	CB MOTOR TRIP R PH
115	CB MOTOR TRIP Y PH
116	CB MOTOR TRIP B PH
117	LCC AC SUPPLY FAIL
118	LCC AC SUPPLY MCB TRIP
119	LCC L/R IN LOCAL MODE
120	LCC L/R IN REMOTE MODE
121	LCC N/M SWITCH IN NORMAL MODE
122	LCC N/M SWITCH IN MAINTAINANCE MODE
123	CB MOTOR SUPPLY FAIL

124	CB MOTOR RUN TIME EXCEED
125	CB READY TO CLOSE
126	BB RELAY OPTD.
127	CB CLOSE & TC-1 MCB TRIP
128	CB TC-2 MCB TRIP
129	CB CONTROL CKT MCB TRIP
130	DISCONNECTOR CONTROL CKT MCB TRIP
131	AUX RELAY & I/L CKT MCB TRIP
132	INDICATION MFM & ANN. MCB TRIP
133	DS1 ISO MOTOR MCB TRIP
134	DS-2 ISO MOTOR MCB TRIP
135	BUS PT-1 DS-1 ISO MOTOR MCB TRIP
136	BUS PT-2 DS-2 ISO MOTOR MCB TRIP
137	BUS PT-1 ES-1 E/SW MOTOR MCB TIRP
138	BUS PT-2 ES-2 E/SW MOTOR MCB TIRP
139	DS-1 MOTOR SUPPLY FAIL
140	DS-2 MOTOR SUPPLY FAIL
141	ES-1 MOTOR SUPPLY FAIL
142	ES-2 MOTOR SUPPLY FAIL
143	BUS PT-1 FES MOTOR SUPPLY FAIL
144	BUS PT-2 FES MOTOR SUPPLY FAIL
145	EFS FAULTY
146	BUS-1 FES E/SW MOTOR MCB TRIP
147	BUS-2 FES E/SW MOTOR MCB TRIP
148	BUS PT-1 DS-1 MOTOR FAIL
149	BUS PT-1 ES-1 MOTOR FAIL
150	BUS PT-2 DS-2 MOTOR FAIL
151	BUS PT-2 ES-2 MOTOR FAIL
152	O/C & E/F PROTN OPTD
153	O/C & E/F RELAY FAULTY
154	BUSBAR PROTN FAULTY
155	SENSE CONTACT FOR KIT RESET
156	BUS PT-1 R PH MCB FAIL
157	BUS PT-1 Y PH MCB FAIL
158	BUS PT-1 B PH MCB FAIL
159	BUS PT-2 R PH MCB FAIL
160	BUS PT-2 Y PH MCB FAIL
161	BUS PT-2 B PH MCB FAIL
162	SENSE CONTACT FOR KIT RESET

**h. 66kV Line Bay BCU I/O:**

<b>SR. NO.</b>	<b>INPUT</b>	<b>OUTPUT</b>
1	CB OPEN POSITION	CB CLOSE
2	CB CLOSE POSITION	CB TC-1 OPEN

3	ISOL. DS-1 OPEN POSITION	CB TC-2 OPEN
4	ISOL. DS-1 CLOSE POSITION	TO CB CLOSING (SYNCH CHECK I/L)
5	ISOL. DS-2 OPEN POSITION	TO RESET 86 RELAY
6	ISOL. DS-2 CLOSE POSITION	TO RESET 96 RELAY
7	ISOL. DS-3 OPEN POSITION	ISOL. DS-1 OPEN COMMAND
8	ISOL. DS-3 CLOSE POSITION	ISOL. DS-1 CLOSE COMMAND
9	E/SW ES-1 OPEN POSITION	ISOL. DS-2 OPEN COMMAND
10	E/SW ES-1 CLOSEPOSITION	ISOL. DS-2 CLOSE COMMAND
11	E/SW ES-3 OPEN POSITION	ISOL. DS-3 OPEN COMMAND
12	E/SW ES-3 CLOSEPOSITION	ISOL. DS-3 CLOSE COMMAND
13	FES OPEN POSITION	BUS PT-1 SELECTED
14	FES CLOSEPOSITION	BUS PT-1 RESET
15	CB AUTO TRIP	BUS PT-2 SELECTED
16	CB READY	BUS PT-2 RESET
17	CB SF6 GAS PRESSURE LOCKOUT	TEST KIT FEEDBACK
18	CB SPRING CHARGED	
19	CB SF6 GAS PRESSURE LOW	
20	CB) SF6 GAS PRESSURE NORMAL	
21	LCC L/R IN LOCAL MODE	
22	LCC L/R IN REMOTE MODE	
23	LCC N/M SWITCH IN NORMAL MODE	
24	LCC N/M SWITCH IN MAINTAINANCE MODE	
25	CB MOTOR MCB TRIP	
26	LCC AC SUPPLY FAIL	
27	DES-1 MOTOR MCB TRIP	
28	ISO DS-2 MOTOR MCB TRIP	
29	DES-3 MOTOR MCB TRIP	
30	FES MOTOR MCB TRIP	
31	HEATER & ILLUMINATION MCB TRIP	
32	CB CLOSE/TC-1 DC SUPPLY MCB TRIP	
33	CONTROL DC SUPPLY DES-1 MCB TRIP	
34	CONTROL DC SUPPLY DS-2 MCB TRIP	
35	CONTROL DC SUPPLY DES-3 MCB TRIP	
36	CB TC-2 CONTROL DC SUPPLY MCB TRIP	
37	SIGNAL SUPPLY MCB	
38	CB MOTOR RUN TIME EXCEEDED	
39	DES-1 MOTOR SUPPLY FAIL	
40	DE-2 MOTOR SUPPLY FAIL	
41	DES-3 MOTOR SUPPLY FAIL	
42	FES MOTOR SUPPLY FAIL	
43	CB MANUAL TRIP	
44	CB MANUAL CLOSE	
45	67/67N RELAY FAULTY	
46	86 TRIP RELAY RESET	
47	96 TRIP RELAY RESET	

48	CB TC-1 FAULTY
49	CB TC-2 FAULTY
50	86 TRIP RELAY FAULTY
51	96 TRIP RELAY FAULTY
52	BUS PT-1 SELECTED
53	BUS PT-2 SELECTED
54	67/67N OPTED
55	LINE PT MCB FAIL
56	DES-1 COMP. SF6 GAS PRESSURE LOW STAGE-1 ALARM
57	DS-2 COMP. SF6 GAS PRESSURE LOW STAGE-1 ALARM
58	DES-3 COMP. SF6 GAS PRESSURE LOW STAGE-1 ALARM
59	LINE PT COMP. SF6 GAS PRESSURE LOW STAGE-1 ALARM
60	LA COMP. SF6 GAS PRESSURE LOW STAGE-1 ALARM
61	BUSDUCT COMP. SF6 GAS PRESSURE LOW STAGE-1 ALARM
62	DES-1 COMP. SF6 GAS PRESSURE LOW STAGE-2 ALARM
63	DS-2 COMP. SF6 GAS PRESSURE LOW STAGE-2 ALARM
64	DES-3 COMP. SF6 GAS PRESSURE LOW STAGE-2 ALARM
65	LINE PT COMP. SF6 GAS PRESSURE LOW STAGE-2 ALARM
66	LA COMP. SF6 GAS PRESSURE LOW STAGE-2 ALARM
67	BUSDUCT COMP. SF6 GAS PRESSURE LOW STAGE-2 ALARM
68	NO VOLTAGE AT LINE
69	CRP DC-1 SUPPLY FAIL
70	CRP DC-2 SUPPLY FAIL
71	LCC DC -1 SUPPLY FAIL
72	LCC DC-2 SUPPLY FAIL
73	SENSE CONTACT FOR KIT RESET
74	EFS FAULTY

**i. 66kV TRAFO LV Bay BCU I/O:**

SR. NO.	INPUT	OUTPUT
1	CB OPEN POSITION	CB CLOSE
2	CB CLOSE POSITION	CB TC-1 OPEN
3	ISOL. DS-1 OPEN POSITION	CB TC-2 OPEN
4	ISOL. DS-1 CLOSE POSITION	TO CB CLOSING (SYNCH CHECK)
5	ISOL. DS-2 OPEN POSITION	TO RESET 86 RELAY
6	ISOL. DS-2 CLOSE POSITION	TO RESET 96 RELAY
7	ISOL. DS-3 OPEN POSITION	ISOL. DS-1 OPEN COMMAND
8	ISOL. DS-3 CLOSE POSITION	ISOL. DS-1 CLOSE COMMAND
9	E/SW ES-1 OPEN POSITION	ISOL. DS-2 OPEN COMMAND
10	E/SW ES-1 CLOSE POSITION	ISOL. DS-2 CLOSE COMMAND
11	E/SW ES-3 OPEN POSITION	ISOL. DS-3 OPEN COMMAND
12	E/SW ES-3 CLOSE POSITION	ISOL. DS-3 CLOSE COMMAND
13	ES-4 OPEN POSITION	BUS PT-1 SELECTED
14	ES-4 CLOSE POSITION	BUS PT-1 RESET



15	CB AUTO TRIP	BUS PT-2 SELECTED
16	CB READY	BUS PT-2 RESET
17	CB SF6 GAS PRESSURE LOCKOUT	TEST KIT FEEDBACK
18	CB SPRING CHARGED	
19	CB SPRING CHARGE MOTOR SUPPLY FAIL	
20	CB SF6 GAS PRESSURE LOW	
21	CB) SF6 GAS PRESSURE NORMAL	
22	LCC L/R IN LOCAL MODE	
23	LCC L/R IN REMOTE MODE	
24	LCC N/M SWITCH IN NORMAL MODE	
25	LCC N/M SWITCH IN MAINTAINANCE MODE	
26	CB MOTOR MCB TRIP	
27	LCC AC SUPPLY FAIL	
28	DES-1 MOTOR MCB TRIP	
29	ISO DS-2 MOTOR MCB TRIP	
30	DES-3 MOTOR MCB TRIP	
31	ES-4 MOTOR MCB TRIP	
32	HEATER & ILLUMINATION MCB TRIP	
33	CB CLOSE/TC-1 DC SUPPLY MCB TRIP	
34	CONTROL DC SUPPLY DES-1 MCB TRIP	
35	CONTROL DC SUPPLY DS-2 MCB TRIP	
36	CONTROL DC SUPPLY DES-3 MCB TRIP	
37	CB TC-2 CONTROL DC SUPPLY MCB TRIP	
38	CONTROL DC SUPPLY OF ES-4 MCB TRIP	
39	SIGNAL SUPPLY MCB	
40	CB MOTOR RUN TIME EXCEED	
41	DES-1 MOTOR SUPPLY FAIL	
42	DE-2 MOTOR SUPPLY FAIL	
43	DES-3 MOTOR SUPPLY FAIL	
44	ES-4 MOTOR SUPPLY FAIL	
45	CB MANUAL TRIP	
46	CB MANUAL CLOSE	
47	67/67N RELAY FAULTY	
48	86 TRIP RELAY RESET	
49	96 TRIP RELAY RESET	
50	CB TC-1 FAULTY	
51	CB TC-2 FAULTY	
52	86 TRIP RELAY FAULTY	
53	96 TRIP RELAY FAULTY	
54	BUS PT-1 SELECTED	
55	BUS PT-2 SELECTED	
56	67/67N OPTED	
57	DES-1 COMP. SF6 GAS PRESSURE LOW STAGE-1 ALARM	
58	DS-2 COMP. SF6 GAS PRESSURE LOW STAGE-1 ALARM	
59	DES-3 COMP. SF6 GAS PRESSURE LOW STAGE-1 ALARM	

60	LA COMP. SF6 GAS PRESSURE LOW STAGE-1 ALARM
61	BUSDUCT COMP. SF6 GAS PRESSURE LOW STAGE-1 ALARM
62	DES-1 COMP. SF6 GAS PRESSURE LOW STAGE-2 ALARM
63	DS-2 COMP. SF6 GAS PRESSURE LOW STAGE-2 ALARM
64	DES-3 COMP. SF6 GAS PRESSURE LOW STAGE-2 ALARM
65	LA COMP. SF6 GAS PRESSURE LOW STAGE-2 ALARM
66	BUSDUCT COMP. SF6 GAS PRESSURE LOW STAGE-2 ALARM
67	CRP DC-1 SUPPLY FAIL
68	CRP DC-2 SUPPLY FAIL
69	LCC DC -1 SUPPLY FAIL
70	LCC DC-2 SUPPLY FAIL
71	SENSE CONTACT FOR KIT RESET
72	EFS FAULTY
73	220KV SIDE DS3 OPEN
74	220KV SIDE ES4 OPEN

**j. 66kV BUSCOUPLER BAY BCU I/O:**

SR. NO.	INPUT	OUTPUT
1	CB OPEN POSITION	CB CLOSE
2	CB CLOSE POSITION	CB TC-1 OPEN
3	ISOL. DS-1 OPEN POSITION	CB TC-2 OPEN
4	ISOL. DS-1 CLOSE POSITION	TO CB CLOSING (SYNCH CHECK)
5	ISOL. DS-2 OPEN POSITION	TO RESET 86 RELAY
6	ISOL. DS-2 CLOSE POSITION	TO RESET 96 RELAY
7	BUS PT-1 ISO DS-1 OPEN POSITION	ISOL. DS-1 OPEN COMMAND
8	BUS PT-1 ISO DS-1 CLOSE POSITION	ISOL. DS-1 CLOSE COMMAND
9	BUS PT-2 ISO DS-1 OPEN POSITION	BUS PT-1 DS-1 OPEN COMMAND
10	BUS PT-2 ISO DS-1 CLOSE POSITION	BUS PT-2 DS-2 CLOSE COMMAND
11	E/SW ES-1 OPEN POSITION	FES-1 E/S INTERLOCK PERMISSIVE
12	E/SW ES-1 CLOSE POSITION	FES-2 E/S INTERLOCK PERMISSIVE
13	E/SW ES-2 OPEN POSITION	TEST KIT FEEDBACK
14	E/SW ES-2 CLOSE POSITION	
15	BUS PT-1 E/SW ES-1 OPEN POSITION	
16	BUS PT-1 E/SW ES-1 CLOSE POSITION	
17	BUS PT-2 E/SW ES-2 OPEN POSITION	
18	BUS PT-2 E/SW ES-2 CLOSE POSITION	
19	CB AUTO TRIP	
20	CB READY	
21	CB SF6 GAS PRESSURE LOCKOUT	
22	CB SPRING CHARGED	
23	CB SPRING CHARGE MOTOR SUPPLY FAIL	
24	CB SF6 GAS PRESSURE LOW	
25	CB SF6 GAS PRESSURE NORMAL	
26	BC LCC L/R IN LOCAL MODE	

27	BC LCC L/R IN REMOTE MODE
28	BC LCC N/M SWITCH IN NORMAL MODE
29	BC LCC N/M SWITCH IN MAINTAINANCE MODE
30	BUS PT LCC L/R IN LOCAL MODE
31	BUS PT LCC L/R IN REMOTE MODE
32	BUS PT LCC N/M SWITCH IN NORMAL MODE
33	BUS PT LCC N/M SWITCH IN MAINTAINANCE MODE
34	CB MOTOR MCB TRIP
35	BC LCC AC SUPPLY FAIL
36	BUS PT LCC AC SUPPLY FAIL
37	BC DES-1 MOTOR MCB TRIP
38	BC DES-2 MOTOR MCB TRIP
39	BUS PT DES-1 MOTOR MCB TRIP
40	BUS PT DES-2 MOTOR MCB TRIP
41	BC LCC HEATER & ILLUMINATION MCB TRIP
42	BUS PT LCC HEATER & ILLUMINATION MCB TRIP
43	CB CLOSE/TC-1 DC SUPPLY MCB TRIP
44	CONTROL DC SUPPLY DES-1 MCB TRIP
45	CONTROL DC SUPPLY DES-2 MCB TRIP
46	CONTROL DC SUPPLY BUS PT-1 DES-1 MCB TRIP
47	CONTROL DC SUPPLY BUS PT-2 DES-2 MCB TRIP
48	CB TC-2 CONTROL DC SUPPLY MCB TRIP
49	CONTROL DC SUPPLY OF FES-1 MCB TRIP
50	CONTROL DC SUPPLY OF FES-2 MCB TRIP
51	BC LCC SIGNAL SUPPLY MCB
52	BUS PT LCC SIGNAL SUPPLY MCB
53	CB MOTOR RUN TIME EXCEED
54	BC DES-1 MOTOR SUPPLY FAIL
55	BC DES-2 MOTOR SUPPLY FAIL
56	BUS PT DES-1 MOTOR SUPPLY FAIL
57	BUS PT DES-2 MOTOR SUPPLY FAIL
58	BUS FES-1 MOTOR SUPPLY FAIL
59	BUS FES-2 MOTOR SUPPLY FAIL
60	CB MANUAL TRIP
61	CB MANUAL CLOSE
62	50/51N RELAY FAULTY
63	86 TRIP RELAY RESET
64	96A TRIP RELAY RESET
65	96B TRIP RELAY RESET
66	CB TC-1 FAULTY
67	CB TC-2 FAULTY
68	86 TRIP RELAY FAULTY
69	96ATRIP RELAY FAULTY
70	96BTRIP RELAY FAULTY
71	50/51N RELAY OPTED

72	BC DES-1 COMP. SF6 GAS PRESSURE LOW STAGE-1 ALARM
73	BC DES-2 COMP. SF6 GAS PRESSURE LOW STAGE-1 ALARM
74	BUS PT-1 DES-1 COMP. SF6 GAS PRESS LOW STAGE-1 ALARM
75	BUS PT-2 DES-2 COMP. SF6 GAS PRESS LOW STAGE-1 ALARM
76	BUS PT-1 COMP. SF6 GAS PRESSURE LOW STAGE-1 ALARM
77	BUS PT-2 COMP. SF6 GAS PRESSURE LOW STAGE-1 ALARM
78	BC DES-1 COMP. SF6 GAS PRESSURE LOW STAGE-2 ALARM
79	BC DES-2 COMP. SF6 GAS PRESSURE LOW STAGE-2 ALARM
80	BUS PT-1 DES-1 COMP. SF6 GAS Press LOW STAGE-2 ALARM
81	BUS PT-2 DES-2 COMP. SF6 GAS PRESS LOW STAGE-2 ALARM
82	BUS PT-1 COMP. SF6 GAS PRESSURE LOW STAGE-2 ALARM
83	BUS PT-2 COMP. SF6 GAS PRESSURE LOW STAGE-2 ALARM
84	CRP DC-1 SUPPLY FAIL
85	CRP DC-2 SUPPLY FAIL
86	BC LCC DC -1 SUPPLY FAIL
87	BC LCC DC-2 SUPPLY FAIL
88	BUS PT LCC DC -1 SUPPLY FAIL
89	BUS PT LCC DC-2 SUPPLY FAIL
90	SENSE CONTACT FOR KIT RESET
91	EFS FAULTY

**k. 66/11kV STATION TRAF0 HV BAY BCU I/O:**

SR. NO.	INPUT	OUTPUT
1	CB OPEN POSITION	CB CLOSE
2	CB CLOSE POSITION	CB TC-1 OPEN
3	ISOL. DS-1 OPEN POSITION	CB TC-2 OPEN
4	ISOL. DS-1 CLOSE POSITION	TO RESET 86 RELAY
5	ISOL. DS-2 OPEN POSITION	TO RESET 96 RELAY
6	ISOL. DS-2 CLOSE POSITION	ISOL. DS-1 OPEN COMMAND
7	ISOL. DS-3 OPEN POSITION	ISOL. DS-1 CLOSE COMMAND
8	ISOL. DS-3 CLOSE POSITION	ISOL. DS-2 OPEN COMMAND
9	E/SW ES-1 OPEN POSITION	ISOL. DS-2 CLOSE COMMAND
10	E/SW ES-1 CLOSE POSITION	ISOL. DS-3 OPEN COMMAND
11	E/SW ES-3 Open Position	ISOL. DS-3 Close Command
12	E/SW ES-3 Close Position	E/SW ES-4 INTERLOCK PERMISSIVE
13	E/SW ES-4 Open Position	BUS PT-1 SELECTED
14	E/SW ES-4 Close Position	BUS PT-1 RESET
15	CB AUTO TRIP	BUS PT-2 SELECTED
16	CB READY	BUS PT-2 RESET
17	CB SF6 GAS PRESSURE LOCKOUT	Test kit feedback
18	CB SPRING CHARGED	TAP RAISE TO RTCC
19	CB SF6 GAS PRESSURE LOW	TAP LOWER TO RTCC
20	CB) SF6 GAS PRESSURE NORMAL	
21	LCC L/R IN LOCAL MODE	

22	LCC L/R IN REMOTE MODE
23	LCC N/M SWITCH IN NORMAL MODE
24	LCC N/M SWITCH IN MAINTAINANCE MODE
25	CB MOTOR MCB TRIP
26	LCC AC SUPPLY FAIL
27	DES-1 MOTOR MCB TRIP
28	ISO DS-2 MOTOR MCB TRIP
29	DES-3 MOTOR MCB TRIP
30	ES-4 MOTOR MCB TRIP
31	HEATER & ILLUMINATION MCB TRIP
32	CB CLOSE/TC-1 DC SUPPLY MCB TRIP
33	CONTROL DC SUPPLY DES-1 MCB TRIP
34	CONTROL DC SUPPLY DS-2 MCB TRIP
35	CONTROL DC SUPPLY DES-3 MCB TRIP
36	CB TC-2 CONTROL DC SUPPLY MCB TRIP
37	SIGNAL SUPPLY MCB
38	CB MOTOR RUN TIME EXCEEDED
39	DES-1 MOTOR SUPPLY FAIL
40	DE-2 MOTOR SUPPLY FAIL
41	DES-3 MOTOR SUPPLY FAIL
42	ES-4 MOTOR SUPPLY FAIL
43	CB MANUAL TRIP
44	CB MANUAL CLOSE
45	50/50N RELAY FAULTY
46	86 TRIP RELAY RESET
47	96 TRIP RELAY RESET
48	CB TC-1 FAULTY
49	CB TC-2 FAULTY
50	86 TRIP RELAY FAULTY
51	96 TRIP RELAY FAULTY
52	BUS PT-1 SELECTED
53	BUS PT-2 SELECTED
54	50/50N RELAY OPTED
55	DES-1 COMP SF6 GAS PRESSURE LOW STAGE-1 ALARM
56	DS-2 COMP SF6 GAS PRESSURE LOW STAGE-1 ALARM
57	DES-3 COMP SF6 GAS PRESSURE LOW STAGE-1 ALARM
58	LA COMP SF6 GAS PRESSURE LOW STAGE-1 ALARM
59	BUSDUCT COMP SF6 GAS PRESSURE LOW STAGE-1 ALARM
60	DES-1 COMP SF6 GAS PRESSURE LOW STAGE-2 ALARM
61	DS-2 COMP SF6 GAS PRESSURE LOW STAGE-2 ALARM
62	DES-3 COMP SF6 GAS PRESSURE LOW STAGE-2 ALARM
63	LA COMP SF6 GAS PRESSURE LOW STAGE-2 ALARM
64	BUSDUCT COMP SF6 GAS PRESSURE LOW STAGE-2 ALARM
65	CRP DC-1 SUPPLY FAIL

66	CRP DC-2 SUPPLY FAIL
67	LCC DC -1 SUPPLY FAIL
68	LCC DC-2 SUPPLY FAIL
69	SENSE CONTACT FOR KIT RESET
70	EFS FAULTY
71	87T RELAY FAULTY
72	87T RELAY OPTD
73	TRAFO TROUBLE TRIP
74	TRAFO TROUBLE ALARM
75	TAP CHANGER OUT OF STEP
76	TAP CHANGER PROGRESS
77	OLTC ON LOCAL MODE
78	OLTC ON REMOTE MODE
79	OLTC AC SUPPLY ON
80	OLTC AC SUPPLY OFF
81	NIFPS OPTD
82	NIFPS FAIL
83	NIFPS - LINE FAULT TRANSFORMER TRIP
84	NIFPS - FIRE DETECTOR TRIP
85	NIFPS - SYSTEM OPERATED TRIP
86	NIFPS - SYSTEM IN OFF MODE
87	NIFPS - DC SUPPLY FAIL
88	NIFPS - VISUAL AUDIO ALARM
89	NIFPS - TCIV CLOSED
90	NIFPS - LINE FAULT DIFFERENTIAL RELAY
91	NIFPS - FAULT BUCHOLZ RELAY
92	NIFPS - LINE FAULT TCIV
93	NIFPS - LINE FAULT PRV/RPRR
94	11KV SIDE ISO 89T OPEN
	<b>ANALOGUE</b>
1	TAP POSITION
2	WTI HV WINDING
3	WTI LV WINDING
4	OIL TEMP
5	TAP POSITION

Note:

Typical binary Inputs and Outputs Signal list provided above for 66kV GIS bay shall be applicable to 132kV and 33kV GIS bay also. However, actual requirement may vary as per interfaces of different projects/tender.

**I. STATION AUX. BCU I/O LIST:**

<b>SR. NO.</b>	<b>INPUT</b>	<b>OUTPUT</b>
1	LTPB-1 INCOMER-1 ON	BATTERY CHARGER-1 FLOAT CHARGER ON
2	LTPB-1 INCOMER-1 OFF	BATTERY CHARGER-1 FLOAT CHARGER OFF
3	LTPB-1 INCOMER-2 ON	BATTERY CHARGER-1 BOOST CHARGER ON
4	LTPB -1 INCOMER-2 OFF	BATTERY CHARGER-1 BOOST CHARGER OFF
5	LTPB-1 BUS COUPLER ON	BATTERY CHARGER-1 ON CV MODE
6	LTPB-1 BUS COUPLER OFF	BATTERY CHARGER-1 ON CC MODE
7	LTPB-1 DG INCOMER ON	BATTERY CHARGER-2 FLOAT CHARGER ON
8	LTPB-1 DG INCOMER OFF	BATTERY CHARGER-2 FLOAT CHARGER OFF
9	LTPB-1 BUS-1 U/V OPTD	BATTERY CHARGER-2 BOOST CHARGER ON
10	LTPB-1 BUS-2 U/V OPTD	BATTERY CHARGER-2 BOOST CHARGER OFF
11	LTPB-1 ON LOCAL MODE	BATTERY CHARGER-2 ON CV MODE
12	LTPB-1 ON AUTO MODE	BATTERY CHARGER-2 ON CC MODE
13	LTPB-1 ON REMOTE MODE	UPS-1 INVERTER ON
14	LTPB-1 ON MANUAL MODE	UPS-1 INVERTER OFF
15	LT TRAFO-1 BUCHHOLZ ALARM	UPS-2 INVERTER ON
16	LT TRAFO-1 BUCHHOLZ TRIP	UPS-2 INVERTER OFF
17	LT TRAFO-1 OTI ALARM	LTPB-1 INCOMER-1 CB OFF
18	LT TRAFO-1 OTI TRIP	LTPB-1 INCOMER-1 CB ON
19	LT TRAFO-1 WTI ALARM	LTPB-1 INCOMER-2 CB OFF
20	LT TRAFO-1 WTI TRIP	LTPB-1 INCOMER-2 CB ON
21	LT TRAFO-2 BUCHHOLZ ALARM	LTPB-1 BUS COUPLER CB OFF
22	LT TRAFO-2 BUCHHOLZ TRIP	LTPB-1 BUS COUPLER CB ON
23	LT TRAFO-2 OTI ALARM	LTPB-1 DG SET CB ON
24	LT TRAFO-2 OTI TRIP	LTPB-1 DC SET CB OFF
25	LT TRAFO-2 WTI ALARM	
26	LT TRAFO-2 WTI TRIP	<b>ANALOGUE</b>
27	GATEWAY PANEL DC-1 FAIL	BATTERY CHARGER-1 BOOST VOLTAGE
28	GATEWAY PANEL DC-2 FAIL	BATTERY CHARGER-1 BOOST CURRENT
29	GATEWAY PANEL ETHERNET SW-1 FAIL	BATTERY CHARGER-1 FLOAT VOLTAGE
30	GATEWAY PANEL ETHERNET SW-2 FAIL	BATTERY CHARGER-1 FLOAT CURRENT
31	GATEWAY PANEL ETHERNET SW-3 FAIL	BATTERY CHARGER-1 LOAD VOLTAGE
32	GATEWAY PANEL GPS FAIL	BATTERY CHARGER-1 LOAD CURRENT
33	RTU PANEL DC-1 FAIL	BATTERY CHARGER-1 BATTERY VOLTAGE
34	RTU PANEL DC-2 FAIL	BATTERY CHARGER-1 BATTERY CURRENT
35	BATTERY CHARGER-1 MAIN AC FAIL	BATTERY CHARGER-2 BOOST VOLTAGE
36	BATTERY CHARGER-1 LOAD BUS U/V	BATTERY CHARGER-2 BOOST CURRENT
37	BATTERY CHARGER-1 LOAD BUS O/V	BATTERY CHARGER-2 FLOAT VOLTAGE
38	BATTERY CHARGER-1 FLOAT CHARGER FAIL	BATTERY CHARGER-2 FLOAT CURRENT
39	BATTERY CHARGER-1 DC EARTH LEAKAGE	BATTERY CHARGER-2 LOAD VOLTAGE
40	BATTERY CHARGER-1 FLOAT CHARGER ON	BATTERY CHARGER-2 LOAD CURRENT
41	BATTERY CHARGER-1 FLOAT CHARGER OFF	BATTERY CHARGER-2 BATTERY VOLTAGE
42	BATTERY CHARGER-1 FLOAT CHARGER ON MANUAL MODE	BATTERY CHARGER-2 BATTERY CURRENT

43	BATTERY CHARGER-1 FLOAT CHARGER ON AUTO MODE	LTPB-BUS-1 VOLTAGE R PH
44	BATTERY CHARGER-1 BOOST CHARGER ON	LTPB-BUS-1 VOLTAGE Y PH
45	BATTERY CHARGER-1 BOOST CHARGER OFF	LTPB-BUS-1 VOLTAGE B PH
46	BATTERY CHARGER-1 BOOST CHARGER ON CV MODE	LTPB-BUS-2 VOLTAGE R PH
47	BATTERY CHARGER-1 BOOST CHARGER ON CC MODE	LTPB-BUS-2 VOLTAGE Y PH
48	BATTERY CHARGER-1 ON LOCAL MODE	LTPB-BUS-2 VOLTAGE B PH
49	BATTERY CHARGER-1 ON REMOTE MODE	LTPB-1 INCOMER-1 CURRENT R PH
50	BATTERY CHARGER-2 MAIN AC FAIL	LTPB-1 INCOMER-1 CURRENT Y PH
51	BATTERY CHARGER-2 LOAD BUS U/V	LTPB-1 INCOMER-1 CURRENT B PH
52	BATTERY CHARGER-2 LOAD BUS O/V	LTPB-1 INCOMER-1 VOLTAGE R PH
53	BATTERY CHARGER-2 FLOAT CHARGER FAIL	LTPB-1 INCOMER-1 VOLTAGE Y PH
54	BATTERY CHARGER-2 DC EARTH LEAKAGE	LTPB-1 INCOMER-1 VOLTAGE B PH
55	BATTERY CHARGER-2 FLOAT CHARGER ON	LTPB - DG SET CURRENT R PH
56	BATTERY CHARGER-2 FLOAT CHARGER OFF	LTPB - DG SET CURRENT Y PH
57	BATTERY CHARGER-2 FLOAT CHARGER ON MANUAL MODE	LTPB - DG SET CURRENT B PH
58	BATTERY CHARGER-2 FLOAT CHARGER ON AUTO MODE	LTPB- DG SET VOLTAGE R PH
59	BATTERY CHARGER-2 BOOST CHARGER ON	LTPB - DG SET VOLTAGE Y PH
60	BATTERY CHARGER-2 BOOST CHARGER OFF	LTPB - DG SET VOLTAGE B PH
61	BATTERY CHARGER-2 BOOST CHARGER ON CV MODE	LTPB-1 INCOMER-2 CURRENT R PH
62	BATTERY CHARGER-2 BOOST CHARGER ON CC MODE	LTPB-1 INCOMER-2 CURRENT Y PH
63	BATTERY CHARGER-2 ON LOCAL MODE	LTPB-1 INCOMER-2 CURRENT B PH
64	BATTERY CHARGER-2 ON REMOTE MODE	LTPB-1 INCOMER-2 VOLTAGE R PH
65	FIRE ZONE OPERATED	LTPB-1 INCOMER-2 VOLTAGE Y PH
66	FIRE DETECTION DEVICE FAULT	LTPB-1 INCOMER-2 VOLTAGE B PH
67	GPS FAIL	LTPB-DG SET BATTERY VOLTAGE
68	UPS-1 SYSTEM UNDER VOLTAGE	LT TRAFO-1 OTI TEMP.
69	UPS-1 SYSTEM INVERTER FAIL	LT TRAFO-1 WTI TEMP.
70	UPS-1 SYSTEM LOCAL MODE	LT TRAFO-2 OTI TEMP.
71	UPS-1 SYSTEM REMOTE MODE	LT TRAFO-2 WTI TEMP.
72	UPS-1 SYSTEM INVERTER ON	AMBIENT TEMP-SWITCHYARD
73	UPS-1 SYSTEM INVERTER OFF	BATTERY ROOM TEMP.
74	UPS-1 SYSTEM AC MAINS FAIL	
75	UPS-1 SYSTEM OVERVOLTAGE	
76	UPS-2 SYSTEM UNDER VOLTAGE	
77	UPS-2 SYSTEM INVERTER FAIL	
78	UPS-2 SYSTEM LOCAL MODE	
79	UPS-2 SYSTEM REMOTE MODE	
80	UPS-2 SYSTEM INVERTER ON	
81	UPS-2 SYSTEM INVERTER OFF	
82	UPS-2 SYSTEM AC MAINS FAIL	
83	UPS-2 SYSTEM OVERVOLTAGE	



**B. 220/66kV AIS SUBSTATION:****a) 220kV LINE BAY BCU I/O LIST:**

SR. NO.	INPUT	OUTPUT
1	CB R PHASE OPEN	CB TRIP TC-1 R PHASE
2	CB R PHASE CLOSED	CB Trip TC-1 Y PHASE
3	CB Y PHASE OPEN	CB TRIP TC-1 B PHASE
4	CB Y PHASE CLOSED	CB TRIP TC-2 R PHASE
5	CB B PHASE OPEN	CB TRIP TC-2 Y PHASE
6	CB B PHASE CLOSED	CB TRIP TC-2 B PHASE
7	CB ON LOCAL MODE	BUS-1 PT SELECT
8	CB ON REMOTE MODE	BUS-1 PT DE-SELECT
9	CB SPRING CHARGED	BUS-2 PT SELECT
10	CB READY	BUS-2 PT DE-SELECT
11	SF6 GAS PRESSURE LOW	TO BC CUM TBC TRIP RELAY 86A (Direct Trip-1 Receive Goose in IT Mode-Hard wired)
12	CB LOCKOUT	TO BC CUM TBC TRIP RELAY 86B (Direct Trip-2 Receive Goose in IT Mode-Hard wired)
13	CB POLE DISCREPANCY ALARM	TO TRIP RELAY 86A ( Direct Trip-1 Receive GOOSE in NI Mode-Hard wired)
14	CB DC-1 SUPPLY FAIL	TO TRIP RELAY 86B ( Direct Trip-2 Receive GOOSE in NI Mode-Hard wired)
15	CB DC-2 SUPPLY FAIL	TO 21M1 SOTF INI.
16	CB AC SUPPLY FAIL	TO 21M2 SOTF INI
17	CB SPRING CHARGED MOTOR MCB TRIP	CB CLOSE
18	MANUAL CB CLOSE	86A RELAY RESET
19	MANUAL CB TRIP	86B RELAY RESET
20	CB AUTO TRIP	96 RELAY RESET
21	89A ISOLATOR OPEN	CB CLOSE TO PU
22	89A ISOLATOR CLOSED	89A ISOLATOR OPEN
23	89A ISOLATOR ON REMOTE MODE	89A ISOLATOR CLOSE
24	89B ISOLATOR OPEN	89A ISOLATOR I/L PERMISSIVE
25	89B ISOLATOR CLOSED	89B ISOLATOR OPEN
26	89B ISOLATOR ON REMOTE MODE	89B ISOLATOR CLOSE
27	89C ISOLATOR OPEN	89B ISOLATOR I/L PERMISSIVE
28	89C ISOLATOR CLOSED	89C ISOLATOR OPEN
29	89C ISOLATOR ON REMOTE MODE	89C ISOLATOR CLOSE
30	89L ISOLATOR OPEN	89C ISOLATOR I/L PERMISSIVE
31	89L ISOLATOR CLOSED	89L ISOLATOR OPEN
32	89L ISOLATOR ON REMOTE MODE	89L ISOLATOR CLOSE
33	EARTH SWITCH OPEN	89L ISOLATOR I/L PERMISSIVE
34	EARTH SWITCH CLOSED	EARTH SWITCH I/L PERMISSIVE
35	DC-1 SUPPLY FAIL	TO 21M1 (CB READY)
36	DC-2 SUPPLY FAIL	TO 21M2 (CB READY)
37	BUSBAR DC-1 FAIL	CB CLOSE SYNCH CHECK OK
38	BUSBAR DC-2 FAIL	BAY IN NI MODE

39	NO VOLTAGE AT LINE	BAY IN T MODE
40	BUS PT-1 SELECTED	BAY IN IT MODE
41	BUS PT-2 SELECTED	BAY IN N MODE
42	87 CU RELAY FAULTY	
43	CB TC-1 FAULTY	
44	CB TC-2 FAULTY	
45	86A TRIP RELAY RESET	
46	86B TRIP RELAY RESET	
47	LBB TRIP RELAY RESET	
48	86A TRIP RELAY FAULTY	
49	86B TRIP RELAY FAULTY	
50	96 TRIP RELAY FAULTY	
51	PU FAULTY	
52	DEAD ZONE/LBB OPTED	
53	Z1 CT SWITCHING OK	
54	Z2/ZT CT SWITCHING OK	
55	CT CIRCUIT FAULTY	
56	ISOLATOR DISCREPANCY	
57	50/51N RELAY OPTD.	
58	EFS FAULTY	
59	KIOSK SMOKE DETECTOR OPTD.	
60	KIOSK SUPPLY FAIL	

**b) 220/66kV TRANSFORMER BAY BCU I/O LIST:**

SR. NO.	INPUT	OUTPUT
1	CB R PHASE OPEN	CB TRIP TC-1 R PHASE
2	CB R PHASE CLOSED	CB TRIP TC-1 Y PHASE
3	CB Y PHASE OPEN	CB TRIP TC-1 B PHASE
4	CB Y PHASE CLOSED	CB TRIP TC-2 R PHASE
5	CB B PHASE OPEN	CB TRIP TC-2 Y PHASE
6	CB B PHASE CLOSED	CB TRIP TC-2 B PHASE
7	CB ON LOCAL MODE	BUS-1 PT SELECT
8	CB ON REMOTE MODE	BUS-1 PT DE-SELECT
9	CB SPRING CHARGED	BUS-2 PT SELECT
10	CB READY	BUS-2 PT DE-SELECT
11	SF6 GAS PRESSURE LOW	TO BC CUM TBC TRIP RELAY 86A (Trafo Trouble Trip in IT Mode-Hard wired)
12	CB LOCKOUT	TO BC CUM TBC TRIP RELAY 86B (Trafo Trouble Trip in IT Mode-Hard wired)
13	CB POLE DISCREPANCY ALARM	TAP RAISE
14	CB DC-1 SUPPLY FAIL	TAP LOWER
15	CB DC-2 SUPPLY FAIL	CB CLOSE
16	CB AC SUPPLY FAIL	86A RELAY RESET
17	CB SPRING CHARGED MOTOR MCB TRIP	86B RELAY RESET
18	MANUAL CB CLOSE	96 RELAY RESET
19	MANUAL CB TRIP	CB CLOSE TO PU

20	CB AUTO TRIP	89A ISOLATOR OPEN
21	89A ISOLATOR OPEN	89A ISOLATOR CLOSE
22	89A ISOLATOR CLOSED	89A ISOLATOR I/L PERMISSIVE
23	89A ISOLATOR ON REMOTE MODE	89B ISOLATOR OPEN
24	89B ISOLATOR OPEN	89B ISOLATOR CLOSE
25	89B ISOLATOR CLOSED	89B ISOLATOR I/L PERMISSIVE
26	89B ISOLATOR ON REMOTE MODE	89C ISOLATOR OPEN
27	89C ISOLATOR OPEN	89C ISOLATOR CLOSE
28	89C ISOLATOR CLOSED	89C ISOLATOR I/L PERMISSIVE
29	89C ISOLATOR ON REMOTE MODE	89L ISOLATOR OPEN
30	89T ISOLATOR OPEN	89L ISOLATOR CLOSE
31	89T ISOLATOR CLOSED	89L ISOLATOR I/L PERMISSIVE
32	89T ISOLATOR ON REMOTE MODE	EARTH SWITCH I/L PERMISSIVE
33	EARTH SWITCH OPEN	TO 21M1 (CB READY)
34	EARTH SWITCH CLOSED	TO 21M2 (CB READY)
35	DC-1 SUPPLY FAIL	CB CLOSE SYNCH CHECK OK
36	DC-2 SUPPLY FAIL	BAY IN NI MODE
37	BUS BAR DC-1 FAIL	BAY IN T MODE
38	BUS BAR DC-2 FAIL	BAY IN IT MODE
39	NO VOLTAGE AT LINE	BAY IN N MODE
40	BUS PT-1 SELECTED	
41	BUS PT-2 SELECTED	<b>ANALOGUE</b>
42	87 CU RELAY FAULTY	TAP POSITION
43	CB TC-1 FAULTY	WTI
44	CB TC-2 FAULTY	WTI
45	86A TRIP RELAY RESET	WTI
46	86B TRIP RELAY RESET	OTI
47	LBB TRIP RELAY RESET	LUMASCENCE - WTI HV TEMP.
48	86A TRIP RELAY FAULTY	LUMASCENCE - WTI HV TEMP.
49	86B TRIP RELAY FAULTY	LUMASCENCE - WTI HV TEMP.
50	96 TRIP RELAY FAULTY	LUMASCENCE - OTI HV TEMP.
51	PU FAULTY	LUMASCENCE - WTI LV TEMP.
52	DEAD ZONE/LBB OPTED	LUMASCENCE - WTI LV TEMP.
53	Z1 CT SWITCHING OK	LUMASCENCE - WTI LV TEMP.
54	Z2/ZT CT SWITCHING OK	LUMASCENCE - OTI LV TEMP.
55	CT CIRCUIT FAULTY	KIOSK TEMP.
56	ISOLATOR DISCREPANCY	
57	EFS FAULTY	
58	COOLER FAN ON	
59	COOLER PUMP ON	
60	COOLER FAN AC SUPPLY ON	
61	PUMP SUPPLY ON	
62	OLTC MAIN SUPPLY ON	
63	TAP CHANGER ON REMOTE	
64	TAP CHANGER IN PROGRESS	

65	TAP CHANGER OUT OF STEP
66	DIFF. RELAY FAULTY
67	LINE FAULT FIRE DETECTOR TRIP - NIFPS
68	LINE FAULT DIFF. RELAY OPTD. - NIFPS
69	LINE FAULT BUCH. RELAY OPTD - NIFPS
70	LINE FAULT PRV
71	LINE FAULT TRANSFORMER TRIP
72	LINE FAULT TCIV
73	NIFPS OPTD
74	NIFPS FAIL
75	TRAFO TROUBLE TRIP
76	TRAFO TROUBLE ALARM
77	KIOSK SMOKE DETECTOR OPTD
78	KIOSK SUPPLY FAIL
79	LUMANASENCE FAULTY
80	LUMANASENCE SUPPLY FAIL

**c) 220kV BUSCOUPLER CUM TBC BAY BCU I/O LIST:**

SR. NO.	INPUT	OUTPUT
1	CB R PHASE OPEN	CB TRIP TC-1 R PHASE
2	CB R PHASE CLOSED	CB TRIP TC-1 Y PHASE
3	CB Y PHASE OPEN	CB TRIP TC-1 B PHASE
4	CB Y PHASE CLOSED	CB TRIP TC-2 R PHASE
5	CB B PHASE OPEN	CB TRIP TC-2 Y PHASE
6	CB B PHASE CLOSED	CB TRIP TC-2 B PHASE
7	CB ON LOCAL MODE	CB CLOSE
8	CB ON REMOTE MODE	86A RELAY RESET
9	CB SPRING CHARGED	86B RELAY RESET
10	CB READY	96 RELAY RESET
11	SF6 GAS PRESSURE LOW	CB CLOSE TO PU
12	CB LOCKOUT	89A ISOLATOR OPEN
13	CB POLE DISCREPANCY ALARM	89A ISOLATOR CLOSE
14	CB DC-1 SUPPLY FAIL	89A ISOLATOR I/L PERMISSIVE
15	CB DC-2 SUPPLY FAIL	89B ISOLATOR OPEN
16	CB AC SUPPLY FAIL	89B ISOLATOR CLOSE
17	CB SPRING CHARGED MOTOR MCB TRIP	89 ISOLATOR I/L PERMISSIVE
18	MANUAL CB CLOSE	BUS-1 PT ISOLATOR OPEN
19	MANUAL CB TRIP	BUS-1 PT ISOLATOR CLOSE
20	CB AUTO TRIP	BUS-1 PT ISOLATOR I/L PERMISSIVE
21	89A ISOLATOR OPEN	BUS-2 PT ISOLATOR OPEN
22	89A ISOLATOR CLOSED	BUS-2 PT ISOLATOR CLOSE
23	89A ISOLATOR ON REMOTE MODE	BUS-2 PT ISOLATOR I/L PERMISSIVE
24	89B ISOLATOR OPEN	BUS-1 EARTH SWITCH I/L PERMISSIVE
25	89B ISOLATOR CLOSED	BUS-2 EARTH SWITCH I/L PERMISSIVE
26	89B ISOLATOR ON REMOTE MODE	CB CLOSE SYNCH CHECK OK

27	BUS-1 EARTH SWITCH OPEN	BUSCOUPLER IN TBC MODE
28	BUS-1 EARTH SWITCH CLOSED	BUSCOUPLER IN BC MODE
29	BUS-2 EARTH SWITCH OPEN	CB A/R CKT FROM TRANSFERRED LINE BAY
30	BUS-2 EARTH SWITCH CLOSED	LBB TRIP TO 96 (FROM TRANSFERRED BAY)
31	BUS-1 PT ISOLATOR OPEN	
32	BUS-1 PT ISOLATOR CLOSED	
33	BUS-1 PT ISOLATOR ON REMOTE MODE	
34	BUS-2 PT ISOLATOR OPEN	
35	BUS-2 PT ISOLATOR CLOSED	
36	BUS-2 PT ISOLATOR ON REMOTE MODE	
37	DC-1 SUPPLY FAIL	
38	DC-2 SUPPLY FAIL	
39	CB TC-1 FAULTY	
40	CB TC-2 FAULTY	
41	50/51N RELAY FAULTY	
42	86A TRIP RELAY RESET	
43	86B TRIP RELAY RESET	
44	LBB TRIP RELAY RESET	
45	86A TRIP RELAY FAULTY	
46	86B TRIP RELAY FAULTY	
47	96 TRIP RELAY FAULTY	
48	PU FAULTY	
49	DEAD ZONE/LBB OPTED	
50	Z1 CT SWITCHING OK	
51	Z2/ZT CT SWITCHING OK	
52	CT CIRCUIT FAULTY	
53	ISOLATOR DISCREPANCY	
54	50/51N RELAY OPTD	
55	EFS FAULTY	

**Note:**

Typical binary Inputs and Outputs Signal list provided above for 220kV AIS bay shall be applicable to 400kV AIS bay also. However, actual requirement may vary as per interfaces of different projects/tender.

**d) PLCC BCU I/O List (1 No. 220kV Line)**

SR. NO.	INPUT	OUTPUT
1	DC-1 FAIL	MAIN-1 CARRIER SEND (LINE-1)
2	DC-2 FAIL	MAIN-2 CARRIER SEND (LINE-1)
3	EFS FAULTY	DT-1 SEND (LINE-1)
4	MAIN-1 CARRIER RECEIVE (LINE-1)	DT-2 SEND (LINE-1)
5	MAIN-2 CARRIER RECEIVE (LINE-1)	
6	DT-1 RECEIVE (LINE-1)	
7	DT-2 RECEIVE (LINE-1)	
8	CH-1 HEALTHY (LINE-1)	
9	CH-2 HEALTHY (LINE-1)	

Note:

1. All the binary inputs and outputs Signals as per above shall be considered for all present and future scope of lines as per single line diagram/layout.
2. For 400kV Lines, dual channels for carrier interface shall be considered.

**e) 66kV LINE BAY BCPU I/O LIST:**

<b>SR. NO.</b>	<b>INPUT</b>	<b>OUTPUT</b>
1	CB OPEN POSITION	CB CLOSE
2	CB CLOSE POSITION	CB TC-1 OPEN
3	CB LOCAL MODE	CB TC-2 OPEN
4	CB REMOTE MODE	TO CB CLOSING (SYNCH CHECK INTERLOCK)
5	ISOL.89A OPEN POSITION	TO RESET 86 RELAY
6	ISOL. 89A CLOSE POSITION	TO RESET 96 RELAY
7	ISOL 89A REMOTE MODE	ISOL.89A I/L PERMISSIVE
8	ISOL.89B OPEN POSITION	ISOL.89A OPEN
9	ISOL. 89B CLOSE POSITION	ISOL. 89A CLOSE
10	ISOL 89B REMOTE MODE	ISOL.89B I/L PERMISSIVE
11	ISOL.89L OPEN POSITION	ISOL.89B OPEN
12	ISOL. 89L CLOSE POSITION	ISOL. 89B CLOSE
13	ISOL 89L REMOTE MODE	ISOL.89L I/L PERMISSIVE
14	E/SW 89LE OPEN POSITION	ISOL.89L OPEN
15	E/SW 89LE CLOSE POSITION	ISOL. 89L CLOSE
16	CB AUTO TRIP	E/SW 89LE I/L PERMISSIVE
17	CB SF6 GAS PRESSURE LOCKOUT	BUS PT-1 SELECTED
18	CB SPRING CHARGED	BUS PT-1 RESET
19	CB SF6 GAS PRESSURE LOW	BUS PT-2 SELECTED
20	CB MOTOR MCB TRIP	BUS PT-2 RESET
21	CB DC-1 SUPPLY FAIL	TO 86 TRIP RELAY (DIR. O/C & E/F OPTD.)
22	CB DC-2 SUPPLY FAIL	TO 96 TRIP RELAY
23	CB AC SUPPLY FAIL	TEST KIT FEEDBACK
24	CB MANUAL TRIP	
25	CB MANUAL CLOSE	
26	86 TRIP RELAY RESET	
27	96 TRIP RELAY RESET	
28	CB TC-1 FAULTY	
29	CB TC-2 FAULTY	
30	86 TRIP RELAY FAULTY	
31	96 TRIP RELAY FAULTY	
32	BUS PT-1 SELECTED	
33	BUS PT-2 SELECTED	
34	86 TRIP RELAY OPTD/LBB INI.	
35	86 TRIP RELAY OPTD/ LBB START	
36	96 TRIP RELAY OPTD	
37	DC-1 SUPPLY FAIL	
38	DC-2 SUPPLY FAIL	

39	ADJ. BCPU FAIL
40	NO VOLTAGE AT LINE
41	SENSE CONTACT FOR KIT RESET
42	EFS FAULTY
43	KIOSK AC SUPPLY FAIL
44	KIOSK FIRE DETECTOR ALARM

**f) 66kV TRAF0 LV BAY BCPU I/O LIST:**

SR. NO.	INPUT	OUTPUT
1	CB OPEN POSITION	CB CLOSE
2	CB CLOSE POSITION	CB TC-1 OPEN
3	CB LOCAL MODE	CB TC-2 OPEN
4	CB REMOTE MODE	TO CB CLOSING (SYNCH CHECK INTERLOCK)
5	ISOL.89A OPEN POSITION	TO RESET 86 RELAY
6	ISOL. 89A CLOSE POSITION	TO RESET 96 RELAY
7	ISOL 89A REMOTE MODE	ISOL.89A I/L PERMISSIVE
8	ISOL.89B OPEN POSITION	ISOL.89A OPEN
9	ISOL. 89B CLOSE POSITION	ISOL. 89A CLOSE
10	ISOL 89B REMOTE MODE	ISOL.89B I/L PERMISSIVE
11	CB AUTO TRIP	ISOL.89B OPEN
12	CB SF6 GAS PRESSURE LOCKOUT	ISOL. 89B CLOSE
13	CB SPRING CHARGED	LBB OPTD TO HV SIDE 86A TRIP
14	CB SF6 GAS PRESSURE LOW	LBB OPTD TO HV SIDE 86B TRIP
15	CB MOTOR MCB TRIP	LBB OPTD TO TBC SIDE 86A TRIP
16	CB DC-1 SUPPLY FAIL	LBB OPTD TO TBC SIDE 86B TRIP
17	CB DC-2 SUPPLY FAIL	BUS PT-1 SELECTED
18	CB AC SUPPLY FAIL	BUS PT-1 RESET
19	CB MANUAL TRIP	BUS PT-2 SELECTED
20	CB MANUAL CLOSE	BUS PT-2 RESET
21	86 TRIP RELAY RESET	TO 86 TRIP RELAY (DIR. O/C & E/F OPTD.)
22	96 TRIP RELAY RESET	TO 96 TRIP RELAY
23	CB TC-1 FAULTY	TEST KIT FEEDBACK
24	CB TC-2 FAULTY	
25	86 TRIP RELAY FAULTY	
26	96 TRIP RELAY FAULTY	
27	BUS PT-1 SELECTED	
28	BUS PT-2 SELECTED	
29	86 TRIP RELAY OPTD/LBB INI.	
30	86 TRIP RELAY OPTD/ LBB START	
31	96 TRIP RELAY OPTD	
32	DC-1 SUPPLY FAIL	
33	DC-2 SUPPLY FAIL	
34	ADJ. BCPU FAIL	
35	SENSE CONTACT FOR KIT RESET	

36	EFS FAULTY
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**g) 66kV BUSCOUPLER BAY BCPU I/O LIST:**

SR. NO.	INPUT	OUTPUT
1	CB OPEN POSITION	CB CLOSE
2	CB CLOSE POSITION	CB TC-1 OPEN
3	CB LOCAL MODE	CB TC-2 OPEN
4	CB REMOTE MODE	TO CB CLOSING (SYNCH CHECK INTERLOCK)
5	ISOL.89A OPEN POSITION	TO RESET 86 RELAY
6	ISOL. 89A CLOSE POSITION	TO RESET 96A RELAY
7	ISOL 89A REMOTE MODE	TO RESET 96B RELAY
8	ISOL.89B OPEN POSITION	ISOL.89A I/L PERMISSIVE
9	ISOL. 89B CLOSE POSITION	ISOL.89A OPEN
10	ISOL 89B REMOTE MODE	ISOL. 89A CLOSE
11	BUS PT-1 ISO 89A OPEN	ISOL.89B I/L PERMISSIVE
12	BUS PT-1 ISO 89A CLOSE	ISOL.89B OPEN
13	BUS PT-1 ISO 89A REMOTE	ISOL. 89B CLOSE
14	BUS PT-2 ISO 89B OPEN	BUS PT-1 ISOL. 89A I/L PERMISSIVE
15	BUS PT-2 ISO 89B CLOSE	BUS PT-1 ISOL. 89A OPEN
16	BUS PT-2 ISO 89B REMOTE	BUS PT-1 ISOL. 89A CLOSE
17	CB AUTO TRIP	BUS PT-2 ISOL. 89B I/L PERMISSIVE
18	CB SF6 GAS PRESSURE LOCKOUT	BUS PT-2 ISOL. 89B OPEN
19	CB SPRING CHARGED	BUS PT-2 ISOL. 89B CLOSE
20	CB SF6 GAS PRESSURE LOW	TO 86 TRIP RELAY (DIR. O/C & E/F OPTD.)
21	CB MOTOR MCB TRIP	TO 96A TRIP RELAY
22	CB DC-1 SUPPLY FAIL	TO 96B TRIP RELAY
23	CB DC-2 SUPPLY FAIL	TEST KIT FEEDBACK
24	CB AC SUPPLY FAIL	
25	CB MANUAL TRIP	
26	CB MANUAL CLOSE	
27	86 TRIP RELAY RESET	
28	96A TRIP RELAY RESET	
29	96B TRIP RELAY RESET	
30	CB TC-1 FAULTY	
31	CB TC-2 FAULTY	
32	86 TRIP RELAY FAULTY	
33	96A TRIP RELAY FAULTY	
34	96B TRIP RELAY FAULTY	
35	BUS PT-1 SELECTED	
36	BUS PT-2 SELECTED	
37	86 TRIP RELAY OPTD/LBB INI.	
38	86 TRIP RELAY OPTD/ LBB START	
39	96A TRIP RELAY OPTD	
40	96B TRIP RELAY OPTD	



41	DC-1 SUPPLY FAIL
42	DC-2 SUPPLY FAIL
43	ADJ. BCPU FAIL
44	SENSE CONTACT FOR KIT RESET
45	EFS FAULTY

**Note:**

Typical binary Inputs and Outputs Signal list provided above for 66kV AIS bay shall be applicable to 132kV AIS bay also. However, actual requirement may vary as per interfaces of different projects/tender.

**h) 66/11kV STATION TRAF0 HV BAY BCPU I/O:**

SR. NO.	INPUT	OUTPUT
1	CB OPEN POSITION	CB CLOSE
2	CB CLOSE POSITION	CB TC-1 OPEN
3	CB LOCAL MODE	CB TC-2 OPEN
4	CB REMOTE MODE	TO RESET 86 RELAY
5	ISOL.89A OPEN POSITION	TO RESET 96 RELAY
6	ISOL. 89A CLOSE POSITION	ISOL.89A I/L PERMISSIVE
7	ISOL 89A REMOTE MODE	ISOL.89A OPEN
8	ISOL.89B OPEN POSITION	ISOL. 89A CLOSE
9	ISOL. 89B CLOSE POSITION	ISOL.89B I/L PERMISSIVE
10	ISOL 89B REMOTE MODE	ISOL.89B OPEN
11	ISOL.89T OPEN POSITION	ISOL. 89B CLOSE
12	ISOL. 89T CLOSE POSITION	ISOL.89T I/L PERMISSIVE
13	ISOL 89T REMOTE MODE	ISOL.89T OPEN
14	CB AUTO TRIP	ISOL. 89T CLOSE
15	CB SF6 GAS PRESSURE LOCKOUT	BUS PT-1 SELECTED
16	CB SPRING CHARGED	BUS PT-1 RESET
17	CB SF6 GAS PRESSURE LOW	BUS PT-2 SELECTED
18	CB MOTOR MCB TRIP	BUS PT-2 RESET
19	CB DC-1 SUPPLY FAIL	TO 86 TRIP RELAY (DIR. O/C & E/F OPTD.)
20	CB DC-2 SUPPLY FAIL	TO 96 TRIP RELAY
21	CB AC SUPPLY FAIL	TEST KIT FEEDBACK
22	CB MANUAL TRIP	TO 11KV SIDE TRIP RELAY
23	CB MANUAL CLOSE	TAP RAISE TO RTCC
24	86 TRIP RELAY RESET	TAP LOWER TO RTCC
25	96 TRIP RELAY RESET	
26	CB TC-1 FAULTY	<b>ANALOGUE</b>
27	CB TC-2 FAULTY	TAP POSITION
28	86 TRIP RELAY FAULTY	WTI HV WINDING
29	96 TRIP RELAY FAULTY	WTI LV WINDING
30	BUS PT-1 SELECTED	OIL TEMP
31	BUS PT-2 SELECTED	TAP POSITION
32	86 TRIP RELAY OPTD/LBB INI.	KIOSK TEMP.

33	86 TRIP RELAY OPTD/ LBB START
34	96 TRIP RELAY OPTD
35	DC-1 SUPPLY FAIL
36	DC-2 SUPPLY FAIL
37	ADJ. BCPU FAIL
38	SENSE CONTACT FOR KIT RESET
39	EFS FAULTY
40	87T RELAY FAULTY
41	TRAFO TROUBLE ALARM
42	TRAFO TROUBLE TRIP
43	TAP CHANGER OUT OF STEP
44	TAP CHANGER PROGRESS
45	OLTC ON LOCAL MODE
46	OLTC ON REMOTE MODE
47	OLTC ON SUPPLY ON
48	OLTC SUPPLY OFF
49	NIFPS OPTD
50	NIFPS FAIL
51	NIFPS - LINE FAULT TRANSFORMER TRIP
52	NIFPS - FIRE DETECTOR TRIP
53	NIFPS - SYSTEM OPERATED TRIP
54	NIFPS - SYSTEM IN OFF MODE
55	NIFPS - DC SUPPLY FAIL
56	NIFPS - VISUAL AUDIO ALARM
57	NIFPS - TCIV CLOSED
58	NIFPS - LINE FAULT DIFFERENTIAL RELAY
59	NIFPS - FAULT BUCHOLZ RELAY
60	NIFPS - LINE FAULT TCIV
61	NIFPS - LINE FAULT PRV/RPRR
62	11KV SIDE ISO 89T OPEN

**i) STATION AUXILIARY BCU I/O:**

SR. NO.	INPUT	OUTPUT
1	LTPB-1 INCOMER ON	BATTERY CHARGER-1 FLOAT CHARGER ON
2	LTPB-1 INCOMER OFF	BATTERY CHARGER-1 FLOAT CHARGER OFF
3	LTPB-2 INCOMER ON	BATTERY CHARGER-1 BOOST CHARGER ON
4	LTPB-2 INCOMER OFF	BATTERY CHARGER-1 BOOST CHARGER OFF
5	LTPB-1 BUS U/V	BATTERY CHARGER-1 ON CV MODE
6	LTPB-1 BUS O/V	BATTERY CHARGER-1 ON CC MODE
7	LTPB-2 BUS U/V	BATTERY CHARGER-2 FLOAT CHARGER ON
8	LTPB-2 BUS O/V	BATTERY CHARGER-2 FLOAT CHARGER OFF
9	PLCC BCU FAIL	BATTERY CHARGER-2 BOOST CHARGER ON
10	LT TRAFO-1 BUCHHOLZ ALARM	BATTERY CHARGER-2 BOOST CHARGER OFF
11	LT TRAFO-1 BUCHHOLZ TRIP	BATTERY CHARGER-2 ON CV MODE

12	LT TRAFO-1 OTI ALARM	BATTERY CHARGER-2 ON CC MODE
13	LT TRAFO-1 OTI TRIP	UPS-1 INVERTER ON
14	LT TRAFO-1 WTI ALARM	UPS-1 INVERTER OFF
15	LT TRAFO-1 WTI TRIP	UPS-2 INVERTER ON
16	LT TRAFO-2 BUCHHOLZ ALARM	UPS-2 INVERTER OFF
17	LT TRAFO-2 BUCHHOLZ TRIP	
18	LT TRAFO-2 OTI ALARM	<b>ANALOGUE</b>
19	LT TRAFO-2 OTI TRIP	BATTERY CHARGER-1 BOOST VOLTAGE
20	LT TRAFO-2 WTI ALARM	BATTERY CHARGER-1 BOOST CURRENT
21	LT TRAFO-2 WTI TRIP	BATTERY CHARGER-1 FLOAT VOLTAGE
22	GATEWAY PANEL DC-1 FAIL	BATTERY CHARGER-1 FLOAT CURRENT
23	GATEWAY PANEL DC-2 FAIL	BATTERY CHARGER-1 LOAD VOLTAGE
24	GATEWAY PANEL ETHERNET SW-1 FAIL	BATTERY CHARGER-1 LOAD CURRENT
25	GATEWAY PANEL ETHERNET SW-2 FAIL	BATTERY CHARGER-1 BATTERY VOLTAGE
26	GATEWAY PANEL ETHERNET SW-3 FAIL	BATTERY CHARGER-1 BATTERY CURRENT
27	GPS FAIL	BATTERY CHARGER-2 BOOST VOLTAGE
28	GPS SYNCH. FAIL	BATTERY CHARGER-2 BOOST CURRENT
29	RTU/AUX. PANEL DC-1 FAIL	BATTERY CHARGER-2 FLOAT VOLTAGE
30	RTU/AUX PANEL DC-2 FAIL	BATTERY CHARGER-2 FLOAT CURRENT
31	BATTERY CHARGER-1 MAIN AC FAIL	BATTERY CHARGER-2 LOAD VOLTAGE
32	BATTERY CHARGER-1 LOAD BUS U/V	BATTERY CHARGER-2 LOAD CURRENT
33	BATTERY CHARGER-1 LOAD BUS O/V	BATTERY CHARGER-2 BATTERY VOLTAGE
34	BATTERY CHARGER-1 FLOAT CHARGER FAIL	BATTERY CHARGER-2 BATTERY CURRENT
35	BATTERY CHARGER-1 DC EARTH LEAKAGE	LTPB-1 VOLTAGE R PH
36	BATTERY CHARGER-1 FLOAT CHARGER ON	LTPB-1 VOLTAGE Y PH
37	BATTERY CHARGER-1 FLOAT CHARGER OFF	LTPB-1 VOLTAGE B PH
38	BATTERY CHARGER-1 FLOAT CHARGER ON MANUAL MODE	LTPB-2 VOLTAGE R PH
39	BATTERY CHARGER-1 FLOAT CHARGER ON AUTO MODE	LTPB-2 VOLTAGE Y PH
40	BATTERY CHARGER-1 BOOST CHARGER ON	LTPB-2 VOLTAGE B PH
41	BATTERY CHARGER-1 BOOST CHARGER OFF	LTPB-1 INCOMER CURRENT R PH
42	BATTERY CHARGER-1 BOOST CHARGER ON CV MODE	LTPB-1 INCOMER CURRENT Y PH
43	BATTERY CHARGER-1 BOOST CHARGER ON CC MODE	LTPB-1 INCOMER CURRENT B PH
44	BATTERY CHARGER-1 ON LOCAL MODE	LTPB-2 INCOMER CURRENT R PH
45	BATTERY CHARGER-1 ON REMOTE MODE	LTPB-2 INCOMER CURRENT Y PH
46	BATTERY CHARGER-2 MAIN AC FAIL	LTPB-2 INCOMER CURRENT B PH
47	BATTERY CHARGER-2 LOAD BUS U/V	LT TRAFO-1 OTI TEMP.
48	BATTERY CHARGER-2 LOAD BUS O/V	LT TRAFO-1 WTI TEMP.
49	BATTERY CHARGER-2 FLOAT CHARGER FAIL	LT TRAFO-2 OTI TEMP.
50	BATTERY CHARGER-2 DC EARTH LEAKAGE	LT TRAFO-2 WTI TEMP.
51	BATTERY CHARGER-2 FLOAT CHARGER ON	AMBIENT TEMP-SWITCHYARD
52	BATTERY CHARGER-2 FLOAT CHARGER OFF	BATTERY ROOM TEMP.
53	BATTERY CHARGER-2 FLOAT CHARGER ON MANUAL MODE	

54	BATTERY CHARGER-2 FLOAT CHARGER ON AUTO MODE
55	BATTERY CHARGER-2 BOOST CHARGER ON
56	BATTERY CHARGER-2 BOOST CHARGER OFF
57	BATTERY CHARGER-2 BOOST CHARGER ON CV MODE
58	BATTERY CHARGER-2 BOOST CHARGER ON CC MODE
59	BATTERY CHARGER-2 ON LOCAL MODE
60	BATTERY CHARGER-2 ON REMOTE MODE
61	SPARE PANEL DC-1 FAIL
62	SPARE PANEL DC-2 FAIL
63	UPS-1 SYSTEM UNDER VOLTAGE
64	UPS-1 SYSTEM INVERTER FAIL
65	UPS-1 SYSTEM LOCAL MODE
66	UPS-1 SYSTEM REMOTE MODE
67	UPS-1 SYSTEM INVERTER ON
68	UPS-1 SYSTEM INVERTER OFF
69	UPS-1 SYSTEM AC MAINS FAIL
70	UPS-1 SYSTEM OVERVOLTAGE
71	UPS-2 SYSTEM UNDER VOLTAGE
72	UPS-2 SYSTEM INVERTER FAIL
73	UPS-2 SYSTEM LOCAL MODE
74	UPS-2 SYSTEM REMOTE MODE
75	UPS-2 SYSTEM INVERTER ON
76	UPS-2 SYSTEM INVERTER OFF
77	UPS-2 SYSTEM AC MAINS FAIL
78	UPS-2 SYSTEM OVERVOLTAGE

**Annexure-II**

## List of IEC Standards – IEDs

Sr.No.	Standard no.	Title
Characteristic, Performance, Accuracy, Burden, Mechanical endurance test		
1.	IEC-60255-6/IEC 60255-1	Thermal requirements Mechanical requirements Limiting dynamic value Accuracy requirements Rated Burden
2.	IEC-60255-11/ IEC 60255-1	Interruption to and alternating component in DC aux. Energizing quantity
3.	IEC-60255-3, IEC-60255-12, IEC-60255-13/ IEC 60255-1	Relay characteristic & Performance test
4.	IEC-60255-23/ IEC 60255-1	Contact Performance test
Electromagnetic Compatibility type test:		
1.	IEC-60255-22-1, Class-III,	1MHz burst immunity test
2.	IEC-60255-22-2, Class-III IEC-61000-4-2, Class-III	Electrostatic discharge test Direct application Indirect application
3.	IEC-60255-22-4, Class-A	Fast transient / burst immunity test
4.	IEC-, 60255-22-5	Surge immunity test
5.	IEC-60255-22-7, Class-A	Power frequency immunity test
6.	IEC-61000-4-8, Class-V	Power frequency magnetic field test
7.	IEC- 60255-22-3	Radiated electromagnetic field immunity
9.	IEEE/ANSI/C37.90.2	Radiated electromagnetic field disturbance
10.	IEC- 60255-22-3	Immunity to conducted disturbances induced by radio frequency fields test
11.	IEC- 60255-25	Electromagnetic emission tests - Conducted emission test - Radiated emission test
Insulation tests:		
1.	IEC- 60255-5	Dielectric test Impulse voltage test Insulation resistance
Environmental tests:		
1.	IEC-60068-2-1	Cold test Storage test
2.	IEC-60068-2-2	Dry heat test
3.	IEC-60068-2-3	Damp heat test, steady state
4.	IEC-60068-2-30	Damp heat test, cyclic
5.	IEC-60068-2-48	Storage temperature test
CE compliance		
1.	IEC- 60255-26	Electromagnetic compatibility requirements
Mechanical tests		
1.	IEC- 60255-21-1	Vibration
2.	IEC- 60255-21-2	Shock and bump
3.	IEC- 60255-21-3	Seismic

Degree of protection test		
1.	IEC 60529	Degree of Protection Provided by enclosure test
Safety test		
1.	IEC 61010-1/IEC 60255-27	Single fault condition assessment Earth bonding impedance test Mechanical resistance to shock and impact - Rigidity test - Impact hammer test Protection against electrical shock Protection against the spread of fire

**TECHNICAL SPECIFICATIONS OF SCADA EQUIPMENTS: -****ANNEXURE: III****PRINCIPAL TECHNICAL PARAMETERS OF IEDs and SCADA EQUIPMENTS**

<b>SR. No.</b>	<b>Item</b>	<b>Specification</b>
<b>1</b>	<b>Bay Control Unit (BCU)</b>	<ol style="list-style-type: none"> <li><b>Power supply</b> :110/220 VDC, <math>\pm 15\%</math>, Power consumption : &lt; 15W Ripple (peak to peak) : <math>\leq 12\%</math> Binary Input threshold voltage: &gt;70% of rated DC Volt.</li> <li><b>Protocol Capabilities:</b> Ethernet based communication: Dual on -Board with dual I.P. addresses on IEC-61850 upgradeable in future.</li> <li><b>Binary Input processing:</b> Hardwired Digital Input should be acquired via digital boards or IED connected by a serial link. Software Digital Input coming from configurable relays &amp; other devices with 1 ms time tagging. Support GOOSE mode digital boards or IED connected by a serial link.</li> <li><b>Analogue Input processing:</b> 110V for Voltage inputs, 1A &amp; 5A for Current inputs and transducer (4-20 mA/0-10V/-10 to +10mA) inputs for station auxiliaries shall process measurements received through the communication network with 16-bit resolution.</li> <li><b>Measured value acquisition:</b> Monitoring of calculated four CT &amp; four PT/CVT direct primary measures.</li> <li><b>Derived values:</b> From the direct primary measures: RMS currents &amp; voltages, network frequency, active power, reactive power, apparent power, Power factor, Phase angles etc.</li> <li><b>Digital Outputs:</b> DO used for switching device in field or inside C/R via digital boards, should also be configurable &amp; contain security, interlocks etc.</li> <li><b>Sub-station/bay:</b> Should use logical equation and pre-defined Inter-locking rules &amp; sub-station topology for operation.</li> <li><b>Trip Circuit Supervision:</b> Supervise trip circuits for both the conditions of Breaker.</li> <li><b>Event Logging:</b> Storage of events up to 2000 in ROM.</li> </ol>

		<p>11. <b>Disturbance files &amp; record wave forms:</b> Five records of waveforms and disturbance files stored and accessible by HMI/DR work Station.</p> <p>12. <b>Gateway support:</b> Should interface with Gateway for Remote Control facility.</p> <p>13. <b>Local control, Operation and Display:</b> Local control &amp; Operation should be possible using backlit LCD Display and keypad of BCU.</p> <p>14. <b>Self- monitoring:</b> Power ON and continuous cyclic self-monitoring tests. Abnormality result should be displayed.</p> <p>15. <b>I/O processing Capacities:</b> As per our required I/O list with 20% extra for each bay.</p> <p>16. <b>Internal Ethernet Switches:</b> 2X10/100 Base Fx (optical) ports for redundant Ethernet network.</p> <p>17. <b>Additional ports:</b> 1 X RS232 and 3 X RS485 can support IEC 103 Modbus, should be s/w configurable.</p> <p>18. <b>Environmental conditions:</b> Operating temperature: 0°C to + 70 °C, Storage temperature: -40°C to + 70°C Humidity: 5 to 95 % (Non-condensing).</p> <p>19. <b>Mounting &amp; design:</b> 19" Rack fitting with modular design.</p> <p>20. <b>Warranty:</b> 3 year of on-site comprehensive after commissioning.</p>
2	<b>Ethernet Switch (EFS)</b>	<p>Features:</p> <p>a) Fast Ethernet Ports for copper and fiber as per architecture requirement</p> <p>b) Designed for Industrial Networking Capability:</p> <ul style="list-style-type: none"> <li>• Turbo Ring (Recovery time &lt; 20 ms) RSTP/STP (IEEE802.1 W/D) for Ethernet redundancy.</li> <li>• IGMP Snooping and GMRP for filtering multicast traffic from industrial Ethernet Protocols</li> <li>• Port based IEEE802.1Q VLAN and GVRP protocol to ease Network Planning</li> <li>• QoS-IEEE802.1p/1Q and TOS/Diff Serv to increase determinism 802.3ad, LACP for optimum bandwidth utilization</li> <li>• IEEE802.1X and https/SSL to enhance network security.</li> <li>• SNMP V1/V2c/V3 for different levels of network management</li> <li>• RMON for efficient network monitoring and proactive capability</li> <li>• Bandwidth management to prevent unpredictable network status</li> </ul>



		<ul style="list-style-type: none"> <li>• ABC-01 (Automatic Backup Configurator) for system configuration backup</li> <li>• Port Lock for access from unauthorized MAC address.</li> <li>• Port mirroring for online debugging</li> <li>• Automatic recovery of connected device's IP addresses.</li> <li>• Line-swap fast recovery</li> <li>• Ping commands to identify network segment integrity</li> </ul> <p>c) Standards: IEEE802.3, 802.3u, 802.3x, 802.1D, 802.1W, 802.1Q, 802.1p, 802.1X, 802.3ad</p> <p>d) Protocols: IGMP V1/V2/V3 device, GMRP, GVRP, SNMP V1/V2c/V3, DHCP Server/Client, DHCP Option 82, BootP, TFTP, SNTP, SMTP, RARP, RMON.</p> <p>e) Flow Control: IEEE802.3x flow control, back pressure flow control Interface</p> <p>f) RJ45 Ports: 10/100BaseT(X) auto negotiation speed Fiber Ports: 100BaseFX (SC/ST connector) Console: RS-232 (RJ45)</p> <p>g) Alarm Contact: Two relay outputs with current carrying capacity of 1A @ 24 VDC.</p> <p>h) Optical Fiber Distance: Multi mode: 0 to 5 km, 1300 nm (50/125 µm, 800 MHz*km) 0 to 4 km, 1300 nm (62.5/125 µm, 500 MHz*km) Min. TX Output: Multi mode: -20 dBm Max. TX Output : Multi mode : -14 dBm RX Sensitivity: -34 to -30 dBm (Multi)</p> <p>i) Input Voltage: Universal Power supply 230V AC 110/220V DC dual inputs for redundant power supply</p> <p>j) Operating Temperature: -40°C to +85°C</p> <p>k) IEC 61850 protocol Compatibility</p> <p>l) 19" rack mounting</p> <p>m) Minimum 05 Years Warranty</p>
<b>3</b>	<b>Firewall Cum Router</b>	<p><b>1. Compatibility:</b></p> <ul style="list-style-type: none"> <li>i. IEC 61850-3, suitable for Substation Environment</li> <li>ii. NERC Compliant</li> </ul> <p><b>2. Ethernet Switch support:</b></p> <ul style="list-style-type: none"> <li>i. Support upto 4 Ethernet Switches</li> </ul> <p><b>3. Ports:</b></p> <ul style="list-style-type: none"> <li>i. 4 Ethernet Ports of 100Mbps each</li> </ul> <p><b>4. Type:</b></p> <ul style="list-style-type: none"> <li>i. Next Generation Firewall or NGTP – For OT system</li> </ul> <p><b>5. Features:</b></p> <ul style="list-style-type: none"> <li>i. Firewall learning mode for rule configuration.</li> <li>ii. IP firewall features such as deep packet inspection, Address / Port inspection and filtering.</li> <li>iii. Stateful firewall.</li> <li>iv. IP sec/VPN with 3DES/AES encryption</li> <li>v. Support IPv4 and IPv6</li> <li>vi. NAT Capability</li> <li>vii. Syslog Capability</li> <li>viii. NGFW Throughput of 45Mbps</li> <li>ix. Static and Dynamic routing support</li> </ul>

		<p>x. Hot – <b><u>Hot</u></b> Standby operation with similar Firewall Cum Router</p> <p><b>6. Operating Temperature:</b> -40°C to +70°C</p> <p><b>7. Input Voltage:</b> 110/220V DC or to be achieved through suitable DC-DC converter.</p>
<b>4</b>	<b>Server Grade Industrial Computer</b>	<p><b>Power Supply:</b> Dual Redundant 220V or 110V DC, 400W</p> <p><b>Processor Type:</b> Intel® Core™ i7-12700K Processor. 12<sup>th</sup> GEN, 8 cores @ 3.60 GHz, 4 cores @2.70GHz Total core 12; 12 MB Intel® Smart Cache</p> <p><b>Chipset:</b> Compatible with processor</p> <p><b>Memory Type:</b> Dual Channel, ECC 2 X 16 GB DDR5 4800 MHz RAM</p> <p><b>Memory Upgrade:</b> Expandable up to 128 GB</p> <p><b>Internal Disk Drive:</b>  1 X 240GB MLC SSD, Enterprise grade, suitable for Network attached systems (NAS), 24X7 operation  2 X 1TB HDD type hot-swappable, Enterprise grade, suitable for Network attached systems (NAS), 7200rpm, 24X7 operation</p> <p><b>Optical drives:</b> 16X DVD-ROM (Combo)</p> <p><b>Chassis type:</b>  Industrial grade Micro tower / Rack mounted as per requirement with front accessible Hot-swappable 3 Nos. 2.5-inch drive trays, one internal drive tray, and front-accessible Cooling fan with filter.</p> <p><b>Expansion Slots :</b>  Minimum 4 expansion slots from following types  PCIe 1 Slot  PCIe 16 Slot  PCIe x 4</p> <p><b>Audio:</b> Integrated Audio with External speakers &amp; Microphone</p> <p><b>Graphics controller:</b> Intel ® integrated Graphics controller or 2GB GPU (1 VGA, 1 DVI-D, 1 HDMI) as per system requirement.</p> <p><b>Network Interface:</b> Integrated 10/100/1000 Gigabit Fast Ethernet-WOL.</p> <p><b>External I/O ports:</b>  1 x Serial port, 6 x USB 3.0/2.0 ports (4 rear, 2 internal), 1 x VGA / HDMI, Audio ports</p> <p><b>LAN Port:</b>  4 x RJ45, further expandable with expansion slot as per requirement</p> <p><b>Monitor:</b> 24" or higher LED having specification mentioned at Point No. 7.</p>

		<p><b>Keyboard:</b> Standard PS/2 Soft touch Keyboard.</p> <p><b>Pointing Device:</b> 2-Button Optical Scroll Mouse (USB)</p> <p><b>Operating System Installed:</b> Windows 10 or latest compatible to SCADA software</p> <p><b>Other:</b> Preloaded Latest MS office suite.</p> <p>Standard Anti-Virus software – Minimum 3 Year subscription</p> <p><b>Warranty:</b> 3 year of on-site comprehensive.</p> <p><b>Note:</b></p> <ol style="list-style-type: none"> <li>1. All hardware and components of Industrial computer shall be industrial grade.</li> <li>2. <b><u>These specifications are bare minimum requirement. Higher hardware shall be provided based on the system requirement and considering the future scope.</u></b></li> </ol>
5	<b>Non-Server Grade (i.e. DR / Engineering Workstation, HMI &amp; Gateway) Computer</b>	<p><b>Power Supply:</b> Dual Redundant 220V/110V DC, 400W</p> <p><b>Processor Type:</b> Intel® Core™ i7-12700K Processor. 12<sup>th</sup> GEN, 8 cores @ 3.60 GHz, 4 cores @2.70GHz Total core 12; 12 MB Intel® Smart Cache.</p> <p><b>Chipset:</b> Compatible with processor</p> <p><b>Memory Type:</b> Dual Channel, 2x16GB DDR5 4800 MHz ECC RAM for DR PC/EWS; 2x8GB DDR5 4800 MHz ECC RAM for GATEWAY PC</p> <p><b>Memory upgrade:</b> Expandable up to 128 GB</p> <p><b>Internal disk drive:</b> 1 X 240GB MLC SSD, Enterprise grade suitable for Network attached systems (NAS), 24X7 operation 2 X 1TB HDD type hot-swappable, Enterprise grade suitable for Network attached systems (NAS), 7200rpm, 24X7 operation.</p> <p><b>Optical drives:</b> 16X DVD-ROM (Combo)</p> <p><b>Chassis type:</b> Industrial grade Micro tower / Rack mounted as per requirement with front accessible Hot-swappable 3 Nos. 2.5-inch drive trays, one internal drive tray, and front-accessible cooling fan with filter</p> <p><b>Expansion slots :</b> Minimum 4 expansion slots from following types PCIe 1 Slot PCIe 16 Slot PCIe x 4</p> <p><b>Audio:</b> Integrated Audio with External speakers &amp; Microphone</p> <p><b>Graphics controller:</b> Intel® integrated Graphics controller or 2GB GPU (1 VGA, 1 DVI-D, 1 HDMI) as per system requirement.</p> <p><b>Network interface:</b> Integrated 10/100/1000 Gigabit Fast Ethernet-WOL</p>

		<p><b>External I/O ports:</b> 1 x Serial port, 6 x USB 3.0/2.0 ports (4 rear, 2 internal), 1 x VGA / HDMI, Audio ports LAN Port: 4 x RJ45, further expandable with expansion slot as per requirement</p> <p><b>Monitor:</b> 24" or higher LED having specification mentioned at Point No. 7.</p> <p><b>Keyboard:</b> Standard PS/2 Soft touch Keyboard.</p> <p><b>Pointing Device:</b> 2-Button Optical Scroll Mouse (USB)</p> <p><b>Operating system installed:</b> Windows 10 or latest compatible to SCADA software</p> <p><b>Other:</b> Preloaded Latest MS office suite.</p> <p>Standard Anti-Virus software – Minimum 3 Year subscription</p> <p><b>Warranty:</b> 3 year of on-site comprehensive.</p> <p><b>Note:</b></p> <ol style="list-style-type: none"> <li>1. All hardware and components of Industrial computer shall be industrial grade.</li> <li>2. <b><u>These specifications are bare minimum requirement. Higher hardware shall be provided based on the system requirement and considering the future scope.</u></b></li> </ol>
6	<b>Uninterrupted Power Supply with Battery bank</b>	<p>a) <b>Rating:</b></p> <ul style="list-style-type: none"> <li>• Capacity: 3 KVA, 120 Min Backup</li> <li>• Input Voltage: Single phase, 160-300V AC</li> <li>• Input Frequency: 50 Hz <math>\pm</math> 10%</li> <li>• Output Voltage: Single phase, 230V, 50Hz AC</li> <li>• Output Frequency: 50 Hz <math>\pm</math> 1%</li> </ul> <p>b) <b>UPS shall be microprocessor based.</b></p> <p>c) <b>Output Voltage Regulation:</b> &lt; 1%</p> <p>d) <b>Output Voltage waveform:</b> Sinusoidal</p> <p>e) <b>Total Harmonic Distortion:</b> &lt; 2.5 % for linear load</p> <p>f) <b>Load Power Factor:</b> 0.8 P. F</p> <p>g) <b>Output Isolation Transformer shall be provided.</b></p> <p>h) <b>Charger type:</b> Constant Voltage, Constant Current</p> <p>i) <b>Manufacturing standards/Testing:</b> ISO-9001 / As per IEC 146 Part - 4</p> <p>j) <b>Battery set:</b></p> <ul style="list-style-type: none"> <li>• Make: Any of the standard makes</li> <li>• Type: Sealed Maintenance Free (SMF)</li> <li>• Cell Voltage: 12V</li> <li>• Cell Ah rating &amp; Nos. of Cells: Ah rating and Nos. of battery cell shall be suitable for 2 hours back-up as per UPS DC voltage rating)</li> </ul> <p>k) <b>Inverter Efficiency:</b> &gt; 88% (At 100% Load)</p> <p>l) <b>Overload capacity:</b> 125% for 10 Minutes, 150% for 60 sec</p> <p>m) <b>Backup Time:</b> 120 Minutes</p>

		<p>n) <b>Indication:</b> Rectifier ON, Inverter ON, Bypass ON, Selection switch position, Inverter OFF.</p> <p>o) <b>Alarms:</b> Text readout LCD Display</p> <p>p) <b>Metering (Digital LCD Display):</b></p> <ul style="list-style-type: none"> <li>• Input Voltage &amp; Frequency,</li> <li>• Output Voltage, Current &amp; Frequency</li> <li>• Battery Voltage</li> <li>• Charging/Discharge Level</li> </ul> <p>q) <b>Following signals shall be available for remote monitoring of UPS system.</b></p> <ul style="list-style-type: none"> <li>• UPS Fail</li> <li>• Over Voltage &amp; Under Voltage</li> <li>• Battery Low</li> <li>• UPS On &amp; UPS OFF</li> <li>• Bypass ON</li> <li>• Load On Battery</li> </ul> <p>r) <b>Following Analogue Output signals shall be available for Monitoring.</b></p> <ul style="list-style-type: none"> <li>• Input Voltage</li> <li>• Output Voltage &amp; Current</li> <li>• Output Load in %</li> <li>• Battery Voltage</li> <li>• Input Frequency</li> </ul> <p>s) <b>Environment:</b> 0-45°C, Dust free</p> <p>t) <b>Warranty:</b> 3 Year of On-site comprehensive.</p>
7	Monitor with UPS	<p><b>Monitor:</b></p> <p>Power supply: 100 V to 240 V AC / 50Hz</p> <p>Size: 24 Inch Diagonal</p> <p>Aspect Ratio: 16:9</p> <p>Resolution: 1920 X 1080</p> <p>Display Technology: IPS LED, Flicker free</p> <p>Ports: 4 X USB, HDMI</p> <p>Screen: Anti-Glare, 3H Hardness</p> <p>Viewing Angle: 178° (Vertical/Horizontal)</p> <p>Brightness: ≥250cd/m<sup>2</sup> (Typical)</p> <p>Stand: Height, Tilt, Swivel and Pivot adjustable stand</p> <p>Warranty: 3 years (onsite)</p> <p><b>UPS</b> (If specified in Schedule-A of bid document)</p> <p>Rating: 600VA/360W</p> <p>Topology: Line Interactive</p> <p>Input Power Supply: 160-280V AC, 50Hz +/-3Hz (Auto sensing)</p>

		<p>Output Power Supply: 230V +/-6%, 50Hz +/-5%</p> <p>Efficiency at full load: ≥85%</p> <p>Battery:</p> <p>Sealed maintenance free (leak-proof);</p> <p>Minimum 120 minutes backup for 30W load at full derated battery</p> <p>Transfer time(Typical): 4 – 8 ms</p> <p>Operating Temperature: 0° to 40° C</p> <p>Humidity: 20-90% Relative humidity (non-condensing)</p> <p>Noise Level: ≤50dB at 1 meter distance</p> <p>Protection: Surge, Discharge, Overcharge and Overload protection</p> <p>Warranty: 3 years (onsite)</p>
8	<b>Line Interface Unit</b>	<p><b>Area Network Type:</b> LAN Capable</p> <p><b>Module:</b> 19" Chassis</p> <p><b>No. of Ports:</b> As per system requirement</p> <p><b>Ports/Interfaces:</b> Tx &amp; Rx fiber</p> <p><b>Features:</b> LED indicator: Full duplex</p> <p><b>Make:</b> International standard</p> <p><b>Manufacturer Warranty:</b> 1-year warranty</p> <p>Note: Suitable for entry of 6 fiber armored FO cable and outlet of same 6 fiber armored FO cable</p>
9	<b>Colour Laser Jet Printer</b>	<p><b>Model:</b> Latest Colour</p> <p><b>Power Supply:</b> 170-270 V AC, 50 Hz.</p> <p><b>Blank Print Speed:</b> Up to 19 PPM</p> <p><b>Blank Print Resolution:</b> Up to 1200 X 1200 dpi</p> <p><b>Print memory:</b> 16 MB</p> <p><b>Processor:</b> 266 MHz</p> <p><b>Supported paper sizes:</b> Letter, Legal, A4,</p> <p><b>Print technology:</b> Laser</p> <p><b>Pages quantity:</b> 8000 pages per month</p> <p><b>Paper handling:</b> 250 sheet input tray, 10 sheet priority feed slot</p> <p><b>Connectivity:</b> 1 USB</p>

		<p><b>Manufacturer warranty:</b> 1-year warranty</p> <p><b>Networking:</b> Print Server-Ethernet, Fast Ethernet-plug-in module.</p> <p><b>Supporting OS:</b> <b><u>Windows 10 or latest</u></b></p> <p><b>Make:</b> HP, Epson, Canon or any standard. Suitable for printing all types of draft and graphics.</p>
10	<b>Laser Jet Black &amp; White printer</b>	<p><b>Model:</b> Latest</p> <p><b>Power Supply:</b> 170-270 V AC, 50 Hz.</p> <p><b>Black Print Speed:</b> Up to 19 PPM</p> <p><b>Black Print Resolution:</b> Up to 1200 X 1200 dpi</p> <p><b>Print Memory:</b> 16 MB</p> <p><b>Processor:</b> 266 MHz</p> <p><b>Supported paper sizes:</b> Letter, Legal, A4,</p> <p><b>Print technology:</b> Laser</p> <p><b>Pages quantity:</b> 8000 pages per month</p> <p><b>Paper handling:</b> 250 sheet input tray, 10 sheet priority feed slot</p> <p><b>Connectivity:</b> 1 USB</p> <p><b>Manufacturer warranty:</b> 1-year warranty</p> <p><b>Networking:</b> Print Server-Ethernet, Fast Ethernet-plug-in module.</p> <p><b>Supporting OS:</b> <b><u>Windows 10 or latest</u></b></p> <p><b>Make:</b> HP, Epson, Canon or any standard. Suitable for printing all types of draft and graphics.</p>
11	<b>KVM Extender</b>	<p><b>Model:</b> Latest</p> <p><b>Power Supply:</b></p> <p><b>Monitor end:</b> 230V AC.</p> <p>For CPU end -&gt; DC supply as per substation DC aux. supply. If device does not support substation aux. supply, then DC-DC converter shall be provided.</p> <p><b>Console Ports:</b></p> <p><b>Keyboard:</b> 1 X USB Type A;</p> <p><b>Mouse:</b> 1 X USB Type A;</p> <p><b>Video:</b> 1 X HDB-15 port or as per system requirement;</p>

		<p>Speakers: 1 X Mini Stereo Jack; Mic: 1 X Mini Stereo Jack; KVM Ports (Local/CPU end): Keyboard/Video/Mouse: 1 x SPHD-17 or equivalent; Speakers: 1 X Mini Stereo Jack; Mic: 1 X Mini Stereo Jack; 1 * RJ45 RS-232 DB-9 port; LED: for Local/Remote indication KVM Ports (Remote/Monitor end): RS-232 DB-9 port; 1 * RJ45 LED: for Local/Remote indication Picture Compensation: It shall have a feature of automatic and manual picture compensation with indication. KVM Extender connection: Cat 6 / Cat 5 / Fiber Optic. Video: Resolution as well as refresh rate shall be as per monitor but, minimum shall be 1920*1200 @ 60 Hz at 30 m. <b><u>KVM extender shall be suitable to support dual screen functionality as per architecture.</u></b> Note: The bidder shall provide KVM extender with higher configuration if the SAS system requires higher resolution, higher refresh rate, etc. Warranty: 3 years</p>
12	<b>KVM Switch</b>	<p>Model: Latest DC supply as per substation DC Aux. supply. If device does not support substation aux. supply, then DC-DC converter shall be provided. No of Port: Min. 5 Ports or more if system requires. KVM Port: 1 Console Port, Min. 5 KVM Ports LAN Port: RJ45 USB Port: 1 nos Direct Computer Connection: Min. 5 Connection Port Selection: 5 x Push button (Minimum Requirements) LED: Online 5, Selected – 5, Power Supply-1 Mounting: Rack Mount/Din rail Type Warranty: 3 years</p>



**SCHEDULE – B****GUARANTEED TECHNICAL PARTICULARS**

(TO BE FILLED IN BY THE BIDDER AND FURNISH WITH TECHNICAL BID)

The bidder must fill up all the point of GTP for offered item/s. Instead of indicating “refer drawing, or as per IS/IEC”, the exact value/s must be filled in.

	<b>Description</b>	<b><u>To be filled by bidder</u></b>
<b>A</b>	<b>BCU</b>	
	<b>General</b>	
1	Make	
2	Type	
3	Detailed Model No.	
4	Drawings	
5	Type Test Reports	
6	Dimensions	
a	Height (mm)	
b	width (mm)	
c	Depth (mm)	
7	Mounting Type	
8	Degree of Protection	
9	Temperature & Humidity	
a	Ambient Temperature	
b	Operating Temperature	
c	Storage Temperature	
d	Relative humidity	
10	<b>PORTS</b>	
	Serial ports - Rear	
	Serial ports- Front	
	Ethernet ports	
11	<b>Auxiliary Supply Unit</b>	
	Model	
	<b>Auxiliary Voltage</b>	
	Supply Voltage	
	Power Consumption (Burden)	
	Ripple (Peak to Peak)	
	Binary Input Voltage	
	Watchdog	
12	<b>Central Processing Unit</b>	
	Model	
	Microprocessor	
	Watchdog	
	Clock	
	SDRAM	
	Flash Memory	

	SRAM	
	IRIG	
13	<b>Analog Inputs</b>	
	Model	
	Transducer Inputs	
	No of Channels	
	ADC resolution	
	Sampling period	
	<b>Transducer less CT/VT Module</b>	
	Model	
	CT Inputs	
	Current Rating (Amp)	
	Rating Selection (Jumper / Terminal)	
	Nos. of CT Inputs	
	VA Burden	
	Over load capability	
	Continuous	
	1 Sec	
	3 Sec	
	Dynamic	
	VT Inputs	
	Voltage Rating (Volts)	
	Nos. of VT Inputs	
	VA Burden	
	Over load capability - continuous	
	Terminals	
	Conversion period (ADC)	
	Width	
	Scanning period	
	Frequency Range	
	Quantity	
14	<b>Inputs &amp; Outputs</b>	
	<b>Binary Input</b>	
	Total Nos.	
	Time tagging accuracy	
	Interrogation voltage for Opto inputs	
	Continuous rating for nominal voltage	
	Fixed Inputs	
	Programmable Inputs	
	<b>Outputs</b>	
	Total Nos.	
	Power input for operation	
	Fixed Outputs	
	Programmable Outputs	
	Trip Outputs Contacts	
	--Nos.	

	--Rating	
	---Continuous carry	
	---Make & Carry for 0.5 Sec	
	---Make & Carry for 3 Sec	
	<b>Binary Outputs Contacts</b>	
	- Nos.	
	- Programmable Outputs	
	- Response time	
	<b>Control Outputs</b>	
	- Total Nos.	
	- Programmable Outputs	
15	<b>Display (HMI) &amp; Front LEDs</b>	
	Display / HMI	
	- Display type	
	- Lines in Display	
	- Characters in one Line	
16	<b>Features</b>	
	Measurement	
	Measurands in display	
	Front Programming Keys	
	Interlocking	
	Trip Circuit Supervision	
	Self-Monitoring Feature	
	- Software	
	- Hardware	
	Event Logging	
	<b>Fault Records in Display (HMI)</b>	
	- Nos.	
	- Data	
	-- Type of Fault	
	-- Faulty Phase	
	-- Fault Current	
	-- Time of Fault	
	-- All parameters of healthy phases at the time of fault	
	-- All operated protection functions	
	<b>Disturbance Records</b>	
	- Nos.	
	- Time duration of each DR (Sec)	
	- Total time duration (Sec)	
	- All the data of fault	
	Protocol Capabilities	
	Protocol for time Synchronizations	
	Warranty	

<b>B</b>	<b>ETHERNET SWITCHES</b>	
1	Make	
2	Model (detailed)	
	- EFS - A	
	- EFS - B	
	- EFS - C	
	- EFS - D	
	- EFS - E	
3	Operating Temperature	
4	Relative Humidity	
3	Type	
4	Power Supply	
	Redundant Power supply	
	Mounting	
5	Ports	
	- EFS - A	
	- EFS - B	
	- EFS - C	
	- EFS -D	
	- EFS -E	
	Port connectors	
	- Fibre Ports	
	- RJ45 Ports	
	Alarm contacts	
6	Switching Latency	
7	Standards	
	Protocol	
	Flow Control	
	Forwarding mode	
8	Network	
9	Manufacturer Warranty	
10	Latency Time	
11	Packet Buffer size	
12	Priority Processing	
13	VLAN	
14	Switching Bandwidth	
<b>C</b>	<b>Firewall Cum Router</b>	
1	Compatibility	
	EC 61850-3, suitable for Substation Environment	
	NERC Compliant	
2	Ethernet Switch Support (Nos.)	
3	Ports	
	Number of Ports	
	Each port supported speed (Mbps)	
4	Type of Firewall	

	Next Generation Firewall (NGFW) or NGTP	
	Suitable for OT System	
5	Features	
	Firewall learning mode for rule configuration.	
	IP firewall features such as	
	Deep packet inspection,	
	Address / Port inspection.	
	Address / Port filtering.	
	Stateful firewall	
	IP sec/VPN with 3DES/AES encryption	
	Support IPv4 and IPv6	
	NAT Capability	
	Syslog Capability	
	NGFW Throughput Capacity (In Mbps)	
	Static and Dynamic routing support	
	Hot – Standby operation with similar Firewall Cum Router	
6	Operating Temperature	
7	Input Voltage	
<b>D</b>	<b>Server Grade Industrial Computer</b>	
1	Make	
2	Model	
3	Power supply	
4	Processor Type	
5	Chipset	
6	Memory Type	
7	Memory upgrade	
8	Internal disk drive	
9	Optical drives	
10	Chassis type	
11	Expansion slots	
12	Audio	
13	Graphics controller	
14	Network Interface	
15	External I/O ports	
16	LAN Port	
17	Monitor	
18	Keyboard	
19	Pointing Device	
20	Operating system installed.	
21	Other	
22	Anti-Virus Software	
23	Warranty	

<b>E</b>	<b>Non-Server Grade (i.e. DR / Engineering Workstation, HMI &amp; Gateway) Computer</b>	
1	Make	
2	Model	
3	Power supply	
4	Processor Type	
5	Chipset	
6	Memory Type	
7	Memory upgrade	
8	Internal disk drive	
9	Optical drives	
10	Chassis type	
11	Expansion slots	
12	Audio	
13	Graphics controller	
14	Network Interface	
15	External I/O ports	
16	LAN Port	
17	Monitor	
18	Keyboard	
19	Pointing Device	
20	Operating system installed.	
21	Other	
22	Anti-Virus software	
23	Warranty	
<b>F</b>	<b>Uninterrupted Power Supply with Battery bank</b>	
1	Make	
2	Type	
3	Model	
	Operating temperature	
4	Rating	
	- Capacity	
	- Input Voltage	
	- Input Frequency	
	- Output Voltage	
	- Output Frequency	
	Load power factor (tolerance)	
	Load crest factor	
5	Output Voltage Regulation	
6	Output Voltage waveform	
7	Total Harmonic Distortion	
8	Output Isolation Transformer	
9	Charger type	
10	Batteries	
	- Make	

	- Type	
	- Cell Voltage	
	- Cell Ah rating	
	- Nos. of Cells	
11	Inverter Efficiency	
	Control Technique	
12	Overload capacity	
13	Backup Time	
14	Alarms	
15	Metering	
16	Outputs	
	- Over Voltage	
	- Under Voltage	
	- Inverter fail	
	- DC Low alarm	
	- Main Fail	
	- Local Mode	
	- Remote Mode	
	- Inverter On	
	- Inverter Off	
17	Inputs	
	- Inverter On	
	- Inverter Off	
	- Local/Remote Switch - Local	
	- Local/Remote Switch - remote	
18	Analogue Outputs (4 -20mA)	
	- Battery Voltage	
	- Output AC Voltage	
19	Warranty	
<b>G</b>	<b>Monitors with UPS</b>	
<b>a</b>	<b>Monitors</b>	
1	Make	
2	Model	
3	Power supply	
4	Size	
5	Aspect Ratio	
6	Resolution	
7	Display Technology	
8	Ports	
9	Screen	
10	Viewing Angle	
11	Brightness	
12	Stand	
13	Warranty	
<b>b</b>	<b>UPS for Monitor</b>	
1	Make	

2	Model	
3	Rating	
4	Topology	
5	Input Power Supply	
6	Output Power Supply	
7	Efficiency at full load	
8	Battery	
9	Minimum 120 minutes backup for 30W load at full derated battery	
10	Transfer time (Typical)	
11	Operating Temperature	
12	Humidity	
13	Noise Level	
14	Protection	
15	Warranty	
<b>H</b>	<b>Line Interface Unit</b>	
1	Make	
2	Type	
3	Nos. of FO Cable	
4	Nos. of connector Ports	
5	Mounting	
	Metal Box material	
	Fiber cable spooling material	
6	Weight	
7	Dimensions	
<b>I</b>	<b>COLOUR LASERJET PRINTER</b>	
1	Make	
2	Type	
3	Model	
4	Power Supply	
5	Power Consumption	
6	Dimensions	
7	Enclosure	
8	Print technology	
9	Print Speed (Black)	
10	Print Speed (Colour)	
11	Resolution	
12	Print Memory	
13	Processor Speed	
14	Supported paper sizes	
15	Monthly Print Volume	
16	Paper handling	
17	Connectivity / Interface	
18	Supporting Operating System	



19	Manufacturer Warranty	
20	Print Capability	
<b>J</b>	<b>BLACK &amp; WHITE LASERJET PRINTER</b>	
1	Make	
2	Type	
3	Model	
4	Power Supply	
5	Power Consumption	
6	Dimensions	
7	Enclosure	
8	Print technology	
9	Print Speed (Black)	
10	Resolution	
11	Print Memory	
12	Processor Speed	
13	Supported paper sizes	
14	Monthly Print Volume	
15	Paper handling	
16	Connectivity / Interface	
17	Supporting Operating System	
18	Manufacturer Warranty	
19	Print Capability	
<b>K</b>	<b>KVM Extender</b>	
1	Make	
2	Type	
3	Model	
4	Power Supply	
5	Power Consumption	
6	Console ports	
7	KVM ports	
8	Video	
9	Warranty	
<b>L</b>	<b>KVM Switch</b>	
1	Make	
2	Model No	
3	KVM Port	
4	LAN Port	
5	USB Port	

6	Power Supply	
7	Power Consumption	
8	Direct Computer Connection	
9	Port Selection	
10	LEDs	
11	Mounting Arrangement	
12	Warranty	