CENTRAL ELECTRICITY REGULATORY COMMISSION

NEW DELHI

No.- L-1/210/2016/CERC

CORAM:

Shri Jishnu Barua, Chairperson
Shri I. S. Jha, Member
Shri Arun Goyal, Member
Shri P. K. Singh, Member

Date of Order: 19th January, 2024

In the matter of:

Approval of Guidelines on "Interface Requirements" under the Central Electricity Regulatory Commission (Communication System for inter-State transmission of electricity) Regulations, 2017.

Order

The Central Electricity Regulatory Commission (Communication System for inter-State transmission of electricity) Regulations, 2017 (hereinafter referred to as the 'Communication Regulations') were published on 29.05.2017 in the Gazette of India Extraordinary (Part-III, Section-4, No. 218).

2. Regulation 7.4, read with Regulation 14.2 of the Communication Regulations requires NLDC to prepare Guidelines on "Interfacing Requirements" in consultation with the stakeholders and submit the same for approval of the Commission.

3. Accordingly, NLDC has submitted the Guidelines on "Interfacing Requirements" after stakeholder consultation for approval of the Commission.

4. The Commission has examined the Guidelines submitted by NLDC, and after incorporating suitable changes, the Commission hereby approves the Guidelines on “Interfacing Requirements”, which are enclosed as an Annexure to this Order.

Sd/-	**Sd/-**	**Sd/-**	**Sd/-**
(P. K. Singh)	**(Arun Goyal)**	**(I. S. Jha)**	**(Jishnu Barua)**
Member	**Member**	**Member**	**Chairperson**

Annexure

GUIDELINES ON "INTERFACING REQUIREMENTS"

1. Introduction

1.1. These Guidelines have been prepared in accordance with the Regulation 7.4 (i) of the CERC (Communication System for inter-State transmission of electricity) Regulation, 2017. The relevant extract of the same is as follows:

> "*The National Load Despatch Centre (NLDC) shall be responsible for preparation and issuance guidelines with the approval of the Commission on the "Interfacing Requirements" in respect of terminal equipment, RTUs, SCADA, PMUs, Automatic Generation Control (AGC), Automatic Meter Reading (AMR) Advanced Metering Infrastructure (AMI), etc. and for data communication from the User's point to the respective control centre(s) based on technical standards issued by CEA within 60 days of issuance of technicalstandards.*"

1.2. The Central Electricity Authority (Technical standards for Communication System in Power Systems Operations) Regulations, 2020 was issued by CEA on 27th February, 2020.

1.3. The Guidelines on "Interfacing Requirements" focus on the general data acquisition systems for RTUs, SAS Gateway computers, communications and AMI metering systems required for reliable, secure and economic operations of the control centre(s).

1.4. All Users, SLDCs (State Load Despatch Centres), RLDCs (Regional Load Despatch Centres), NLDC (National Load Despatch Centre), CTU (Central Transmission Utility), STUs (State Transmission Utilities), NHPTL (National High Power Test Laboratory), REMC (Renewable Energy Management Centre), FSP (Forecasting Service Provider), Power Exchanges and ISTS (inter State Transmission System) licensees etc. shall abide by these guidelines as applicable to them.

1.5. Requirement mentioned herein under this document shall be applicable to Main and Backup Control Centre (wherever applicable) irrespective it is mentioned or not mentioned separately in subsequent sections.

2. Definitions

2.1. The words and expressions used in these guidelines shall have the same meaning assigned in the Electricity Act, CERC (Communication System for inter-State transmission of Electricity) Regulations, 2017, Indian Electricity Grid Code Regulations, 2023 and CEA (Technical Standards for Communication System in Power System Operations) Regulations, 2020, and amendments thereof.

2.2. "Remote Station" means transmission substations/ generating stations operated by the users from which data/real-time data is collected.

3. Real time data Telemetry

3.1. All entities as specified in Para 1.4 of these Guidelines, as applicable, shall provide Systems to telemeter power system parameter such as flow, voltage and status of switches/ transformer taps, Sequence of Events (SOE) etc. in line with interface requirements and other guideline made available by NLDC. While many of design details related to control systems are not included in these guidelines, the Users, who are getting connected to the ISTS, shall require to include functionalities and the interfaces compatible with the respective Control Centre data collection systems available and being maintained at NLDC / RLDCs and SLDC/Sub-LDC and other LDC level. Control Centre may request or transmit data periodically or "by exception" (periodically, as the need for information arises) on demand, or interactively.

3.2. A list showing the parameters to be telemetered from various sub-stations and generating stations with respect to various equipment is enclosed for reference as ***Annexure-I***. This list shows minimum required parameters, however, some other parameters shall be provided as per Control Centre requirement. The analog signal sign convention shall be as per IEEE power flow convention and digital status shall be as per IEC standard. Digital status for circuit breaker must be double point while Isolator status can be either single point or double point as per end device. All users shall comply with interface requirements as specified and shall share interface details with respective control centre.

3.3. The typical layout diagram showing point of interface for real time telemetry is attached as ***Annexure- II***.

3.4. The communication media being used for data transfer and data rate shall be in accordance with the Central Electricity Authority(Technical Standards for Communication System in Power System Operations) Regulations, 2020.

4. Communication Interface

The Users shall support at least the following facilities and plan for communication interfaces accordingly at the time of implementation:

1. Real time data exchange including AGC/Control signal with Control Centre (Main & Backup).
2. Phasor data exchange
3. Meter data exchange
4. Protection signal transmission (SPS, Direct Tripping and Permissive Tripping Carrier Signal etc.)
5. Voice communication
6. Video Communication

Other requirements, if any, users may include while designing the local communication interface requirement.

The required communication interfaces shall be provided for both sending and receiving ends based upon jurisdiction/ownership. All the interfaces shall be provided with audio-visual status indication to indicate its normal operation as per relevant standards.

Users shall have functionality to support any of the interfaces given below based on requirement of data flow as per CEA/CERC guidelines from their respective end to control centres.

Interfaces are classified as following: -

1. Remote Station Interfaces
2. Control Centre Interfaces
3. Terminal Equipment Interfaces

4.1. Remote Station

"Interfacing Requirements" in respect of terminal equipment, Remote Terminal Unit (RTUs)/ Substation Automation System (SAS), Supervisory Control and Data Acquisition System (SCADA), Phasor Measurement Unit (PMU) /Phasor Data Concentrators (PDC), Automatic Generation Control

(AGC), Station Protection / System Protection Schemes (SPS), Automatic Meter Reading (AMR), Advanced Metering Infrastructure (AMI), etc. and for data communication is decided based on communication protocol used for transfer of data between user and respective control centres through dedicated and redundant communication channel with route diversity.

Remote end equipment like RTUs, PMUs, SAS, Metering Gateways, Meter Data Collection Unit, PLCs for AGC etc. shall report through communication protocol which is supported at the reporting Control Centre.

While designing the interface requirement of the remote locations, all the interfaces required for data (power system parameter, meter data, AGC/Control Signal), voice, video, protection signal shall be considered and shall be compatible with respective control centre as well as intervening Communication System equipment.

A typical General Arrangement drawing for a Remote Station is enclosed as ***Annexure-III***.

The interfaces shall be designed to operate under single contingency failure condition. Equipment should support interfaces with multiple ports, cards, gateways etc. and configured in redundant mode so that failure of single hardware element, i.e. communication port, card, gateway etc. of the users shall not lead to failure of data communication. Communication system shall be designed as per planning criterion to be notified by CEA.

Availability of communication links shall be maintained as per the CERC Communication Regulations, 2017. Further, the communication channel provided/configured for the real time data communication shall be made error free and shall not lead to intermittency in real time data at respective Control Centre.

4.1.1. Remote Terminal Unit (RTU)/Substation Automation System (SAS)/PLCs

"Remote Terminal Units" (RTU) / Substation Automation System (SAS) is the device suitable for measuring, recording and storing the consumption of electricity or any other quantity related with electrical system and status of the equipment in real time basis and exchanging such information with the data acquisition system for display and control.

The RTU/SAS System /device should communicate with Control Centre front end system in either

IEC-60870-5-101 or IEC-60870-5-104 protocol.

i) IEC - 101 works on serial communication between site and control centre and it requires serial interface. Different Physical interface that can be used for 101 communications which are:
   a) RS-232 / RS 422 / RS 485.

ii) IEC 104 works on TCP/IP based communication and it can use following Physical interface:
   a) Ethernet (IEEE 802.3 / IEEE 802.3u)
   b) Optical communication Port
   c) 10/100 BaseT(Electrical) or 100BaseFX(Optical) Ethernet Link

The communication interface equipment at the remote (RTU/SAS) location shall support the interfaces as mentioned above and the communication provider shall ensure the proposed data sharing protocol by the stations so that the compatible interface is provided.

4.1.2. Phasor Measurement Unit

PMU (Phasor Measurement Unit) provides phasor information (both magnitude and phase angle) for one or more phases of AC voltage or current waveforms including positive sequence phasors and analog quantities like MW, MVAR, frequency, Rate of Change of Frequency (ROCOF) in real time.

Control Centre shall exchange phasor information between their respective Synchrophasor systems via high-speed real-time data acquisition networks, using the protocol specified in latest IEEE C37.118 communication standard preferably.

PMU shall report on C37.118 2011 or higher protocol with configuration Frame 3 or better for data communications. Different Physical Interface for PMU includes:

1. Ethernet (IEEE 802.3 / IEEE 802.3u)
2. Optical Interface (100 BASE-FX Multimode 850 nm/1300nm nm)
3. 10/100/1000 BaseT(Electrical) or 100/1000 BaseFX(Optical) Ethernet Link

All data items, regardless of type, are generally collected and disseminated at a frequency of 25 samples per second (can be higher rate of samples per second in future) and should be sent to Control Centre with the associated data quality codes in compliance with latest IEEE C37.118 communication standards.

4.1.3. Metering gateway

Automatic Meter Reading system uses its front end for transferring meter data from interface meters' gateway / Meter Data Collection Unit to control centre. It uses DLMS protocol for data communication. Different types of interface required are:

1. Ethernet (IEEE 802.3 / IEEE 802.3u) or Ethernet VLAN IEEE 802.1 P/Q).
2. 10/100/1000 BaseT(Electrical) or 100/1000 BaseFX(Optical) Ethernet Link.
3. For Meters-Three ports accessible only through optically isolating modules
4. RS 485/LAN port for communication with Local PC

The internal communication with the main meter data gateway and other meters in a particular location may use available communication and interface may be decided based on local available communication protocol.

4.1.4. Tele-protection/Control

Equipment protection, Tele-protection /control interface shall be used for transmitting control signalfrom one end to other, it can be from one sub-station to other sub-station or control centre to sub- station/generating station. Interface requirement for tele-protection devices are given below:

1. E1 G.703 Interface Option for transmission over E1 Link
2. 10/1000BaseT (Electrical) or 100/1000BaseFX (Optical) Ethernet Link
3. Optical interface
4. IEEE C37.94, ITU-T G.703 interface.
5. 4W Analog / Digital PLCC
6. IEC 61850 GOOSE Interface

4.1.5. Voice communication

Voice communication interface shall have following network interface for voice communication between user location to Control Centre:

a. 2-wire FXO/2-wire FXS

b. 4- wire E&M.
c. VOIP system uses TCP/IP communication and it can use Ethernet (IEEE 802.3 / IEEE 802.3u) or Ethernet VLAN IEEE 802.1 P/Q).
d. 10/100BaseT (Electrical) or 100BaseFX (Optical) Ethernet Link
e. EPABX exchange to be interfaced with Wide-band network

There shall be provision for establishing voice communication to main and backup control Centre. The user end communication equipment shall be compatible with respective Control Centres.

4.1.6. Video Communication

Video communication interface shall be provided on TCP/IP communication and it can use Ethernet (IEEE 802.3 / IEEE 802.3u) or 10/100/1000BaseT (Electrical) or 100/1000BaseFX (Optical) Ethernet Link.

4.2. Control Centre

The communication interfaces to be provided at the control centre end shall support all the interfaces that is required at the remote end. Apart from interface requirements of the remote stations, high bandwidth links are required for inter control centre protocol (ICCP) communication and proprietary protocol like ISD / Multisite for Main & Backup operation. Configurable Ethernet ports supporting up to 1 Gbps may be provided at the control centre end.

The communication equipment shall also support internal VLAN configuration to optimise the communication with the remote end.

Different types of interface required at Control Centre are:

a) E1/ G.703 Interface Option for transmission over E1 Link
b) 10/100/1000BaseT(Electrical) or 100/1000BaseFX(Optical) Ethernet Link
c) Optical interface
d) IEEE C37.94, ITU-T G.703 interface.
e) Gigabit Ethernet or Gigabit optical interface

4.3. Communication Equipments

The various types of Interfaces required in communication equipment at Remote Station and ControlCentre shall be governed in accordance with Schedule II of CEA (Technical Standards for Communication System in Power System Operations) Regulations, 2020, as applicable.

5. Cross-Border Power System Connections

The Regulation 18 (Data and Communication Facilities) of the CERC (Cross Border Trade of Electricity) Regulations2019 stipulates as follows:

> *"Reliable and efficient voice and data communication systems shall be provided to facilitate necessary communication and data exchange, and supervision or control of the grid by the NLDC or RLDC, under normal and extraordinary conditions. Such communication system must be established from generating station or concerned grid substation(s) to control room of System Operator of a neighbouring country and from there to control room of System Operator of India. Provided that the Cross Border Transmission Link shall necessarily have reliable and efficient voice and data communication systems with the System Operators on both the sides."*

Accordingly, at each point of interconnection on Indian side; respective transmission licensee should ensure facilitating interface requirement for cross border interconnections and shall take necessary measures to comply with the aforesaid regulation and the interface guidelines issued by NLDC in this regard.

From Network Security point of view, at Landing Locations (in India Side) a layer of isolation shall be made between interfacing point/node & ISTS (Inter State Transmission System) Communication Network node. Further complete separation shall also be maintained for configuring End-to-End connectivity of Identified Data & Voice Channels.

The provisions mentioned under this Clause 5 shall comply with the cyber security requirements outlined in Clause 6 of this document.

6. Cyber Security Requirements

The communication service provider while providing the interfaces for the data exchange between the control centres, between the user station and the Control Centre must comply with CERT-In, NCIIPC (National Critical Information Infrastructure Protection Centre) guidelines for the interface

being provided to the end user in accordance with CEA (Technical Standards for Communication System in Power System Operations) Regulations, 2020.

Necessary firewall/router as per requirement shall be provided by the respective users while connecting the remote equipment with the control centre network. Direct connectivity with the operational network be avoided while connecting the remote station and shall be through firewall with necessary VLAN configuration.

A typical diagram related to the cyber security requirements is attached at ***Annexure – IV***.

7. Maintenance, Validation and Testing

Users shall facilitate for periodic maintenance and testing of interface equipment owned by them in accordance with procedure for maintenance and testing to be prepared by CTU in accordance with CERC Communication Regulations, 2017.

8. Document Revision

The interface requirement is based on current protocols implemented at different control centres and remote end equipment and the available protocols and communication interfaces available based on the available communication technology. The documents shall be revised as and when there is change in technology, and as and when any deficiency is noticed with approval of CERC.

ANNEXURE-I

A list of parameters to be telemetered from various sub-stations and generating stations with respect to various equipment

A. SCADA System

Sl. No	Description	Analog Points	Digital Points	Protection Signal
1	Line	-MW -MVAR	- line Isolator Status SOE with Time Stamping	Main1/Main2 protection, Over Voltage protection, LBB
2	Bays		- Breaker -Isolator/ Disconnector (Line Selection in DMT scheme) SOE with Time Stamping	
3	Main Buses, Transfer Bus, Bus Coupler, Bus Sectionalizer	-Voltage -Frequency -MW & MVAR flow in case of bus sectionalizer -MW& MVAR flow across Bus Couplers	- Breaker, Isolator, - SOE with Time Stamping	Main1/Main2 protection
4	Transformer	-MW/MVAR for HV/LV Side -Tap Position	-Breaker -Isolator Status SOE with Time Stamping	Main1/Main2 protection
5	(Hot standby) Transformer	-MW/MVAR for HV/LV Side	-Breaker -Isolator Status	
6	Reactor	MVAR	-Breaker -Isolator Status --Bypass isolator status of NGR -SOE with Time Stamping	Main 1 and 2 Protection
	(Hot standby) Spare Reactor	MVAR	-Breaker -Isolator Status	
7	FSC/TCSC	-% compensation	-Bypass Breaker -Bypass Isolator -FSC ON/OFF Status	Oscillation Damping Controller

Sl. No	Description	Analog Points	Digital Points	Protection Signal
			SOE with Time Stamping	(Operated or not) status
8	SVC	-Slope -Gain -Q-Ref -V-Ref -V min -Vmax -Current for each branch -total MVAR compensation	-Isolator Status for each branch with SOE -SVC Mode (Automatic/Manual) -Q Control Mode (Enable/Disable) SOE with Time Stamping	Oscillation Damping Controller (Operated or not) status
9	HVDC (Both Type: Line Commutate Converter & Voltage Source Converter)	-DC Voltage -DC Power Flow -DC Current -Individual Filter MVAR -Firing Angle-Alpha -Extinction angle- Gamma, etc. -Power order, set point Compensation settings if applicable	-Individual Filter Status -HVDC Mode (Metallic return / Ground return) -Isolator/CB Status of DC Switchyard -RPC Status -Run back Status -POD Status -SSDC Status - SOE with Time Stamping -DMR -1 status -DMR-2 status -MRTB status -GRTB status -SoE for HVDC auto-restart	DC line Fault Protection, ESOF (emergency Switch Off) and HVDC Pole Block protection, POD Status (operated or not
10	Converter Transformer	-MW/MVAR for HV/LV Side -Tap Position	-Breaker -Isolator Status	
11	Spare Converter transformer	-MW/MVAR for HV/LV Side	-Breaker -Isolator Status	
12	Generator	-MW (HV/LV) -MVAR (HV/LV) -LV Voltage / Frequency Unit Set point -Unit DeltaP for AGC,	- RGMO/FGMO ON/OFF Status - LV Breaker Status - AGC Local / Remote status - PSS ON/OFF status	Class A, B, C protection status

Sl. No	Description	Analog Points	Digital Points	Protection Signal
		-Droop settings Value, -AVR Reference Voltage	- AVR ON/OFF Status - SOE with Time Stamping	
13	Generator Transformer	-MW/MVAR for HV/LV Side -Tap Position	-Breaker -Isolator Status	Main1/Main2 protection
14	Synchronous Condenser	-MW (HV/LV) -MVAR (HV/LV) -LV Voltage / Frequency	-Breaker -Isolator Status	
15	STATCOM	Qstat, QMSC, QMSR, VHV, VMV, Q_{tra} , P_{aux}, Q_{aux}, Tap Position of Coupling transformer Power Oscillation damping setting Inductive slope Capacitive slope Up set reference/ Down set reference Feedback signal voltage MSC/MSR switching in and out setting (voltage, time)	- CB - Isolator STATCOM modes status (Voltage/Reactive/NSC etc) POD status - SOE with Time Stamping	
16	Phase Shifter	MW / MVAR Angle of shift	- CB - Isolator - SoE with time stamping	
17	Wind	- Wind speed at hub height - Wind direction - Blade Angle - Ambient air temperature - Relative Humidity (%) - Air Density -Atmospheric Pressure - Total MW/MVAR - Individual Turbine MW, -MVAR, wind speed - Total number of turbines online - Total Power Capacity.	WTG CB Status CB and Isolator status of pooling station Turbine Availability PPC modes status (Voltage/PF/Reactive Power) Frequency control (FGMO/RGMO) status	

Sl. No	Description	Analog Points	Digital Points	Protection Signal
		- Available Power Capacity -Available Power (Active and Reactive) at Plant level. -Active Power set point -Reactive Power set point -PPC modes signals: Reference and actual values of Voltage Control mode, Power Factor Control mode and Reactive Power Control mode) -Droop setting of Voltage Control mode -Active power ramp rate UP and down setting	LVRT/HVRT status	
18	Solar	-Global horizontal irradiance -Global plane of array irradiance - Diffusion Irradiance- Watt per meter square - Direct Irradiance- Watt per meter square - Sunrise and Sunset timings -Tilt angle - Dust fall -Ambient temperature (deg C) -Back of PV module temperature -Battery charge -MW/MVAR -Relative Humidity - Performance Ratio - Cloud Cover (Okta)	- Inverter Status (ON/OFF) -Module Availability -CB/Isolator Status -Rectifier Availability -PPC modes status Voltage/PF/Reactive Power) Frequency control (FGMO/RGMO) status AGC status LVRT/HVRT status	

Sl. No	Description	Analog Points	Digital Points	Protection Signal
		-Temperature, Wind Speed, Rainfall, Wind Speed, Wind Direction - Inverter MW/MVAR (AC Side & DC Side) -Available Power (Active and Reactive) at Plant level. -Active Power set point -Reactive Power set point -PPC modes signals Reference and actual values of Voltage Control mode, Power Factor Control mode and Reactive Power Control mode) -Droop setting of Voltage Control mode -Active power ramp rate UP and down setting		
19	Energy Storage Resource	State of Charge MW/MVAR (AC Side & DC Side) Modes (Energy storage, Frequency regulation, etc.)	CB/Isolator Status Controller status, RGMO/FGMO	
20	SPS Signal		DIGITAL STATUS: Enable/Disable, Operated/No Operated. (Condition/Logic Wise)	
21	Weather Parameter	-Temperature - Wind Speed -Humidity -Rainfall		
22	AGC	-Unit Load Set Point (ULSP) -Actual Generation MW -Unit Capability	-Circuit Breaker Status on/off -Governor status on/off	

Sl. No	Description	Analog Points	Digital Points	Protection Signal
		-RGMO/FGMO/Governor input to governor -DeltaP -Reactive Power -AVR Voltage Set Point -Low Voltage (LV) side Actual Voltage -Generator Transformer (GT) Tap Position -Distribution Factor Additional Analog inputs from Hydro power plants -Minimum load at which unit can stably run after synchronization – Unit wise (P1) (in MW) - Forbidden zones or high cavitation zones - Unit-wise (From MW to MW) - P2 to P3 - Maximum loading possible on unit (continuous) (P4) - Declared Energy for the day - Schedule Energy (Cumulative) - Water gross head (m) Additional Analog inputs from Gas power plants - Reference exhaust gas temperature - Actual exhaust gas temperature	- AGC Local/Remote Additional Digital inputs from Hydro power plants - Pumping Status on/off	
23	Loads (Lift Irrigation etc.)	- MW/MVAR	-Breaker -Isolator Status	

B. PMU Signal List

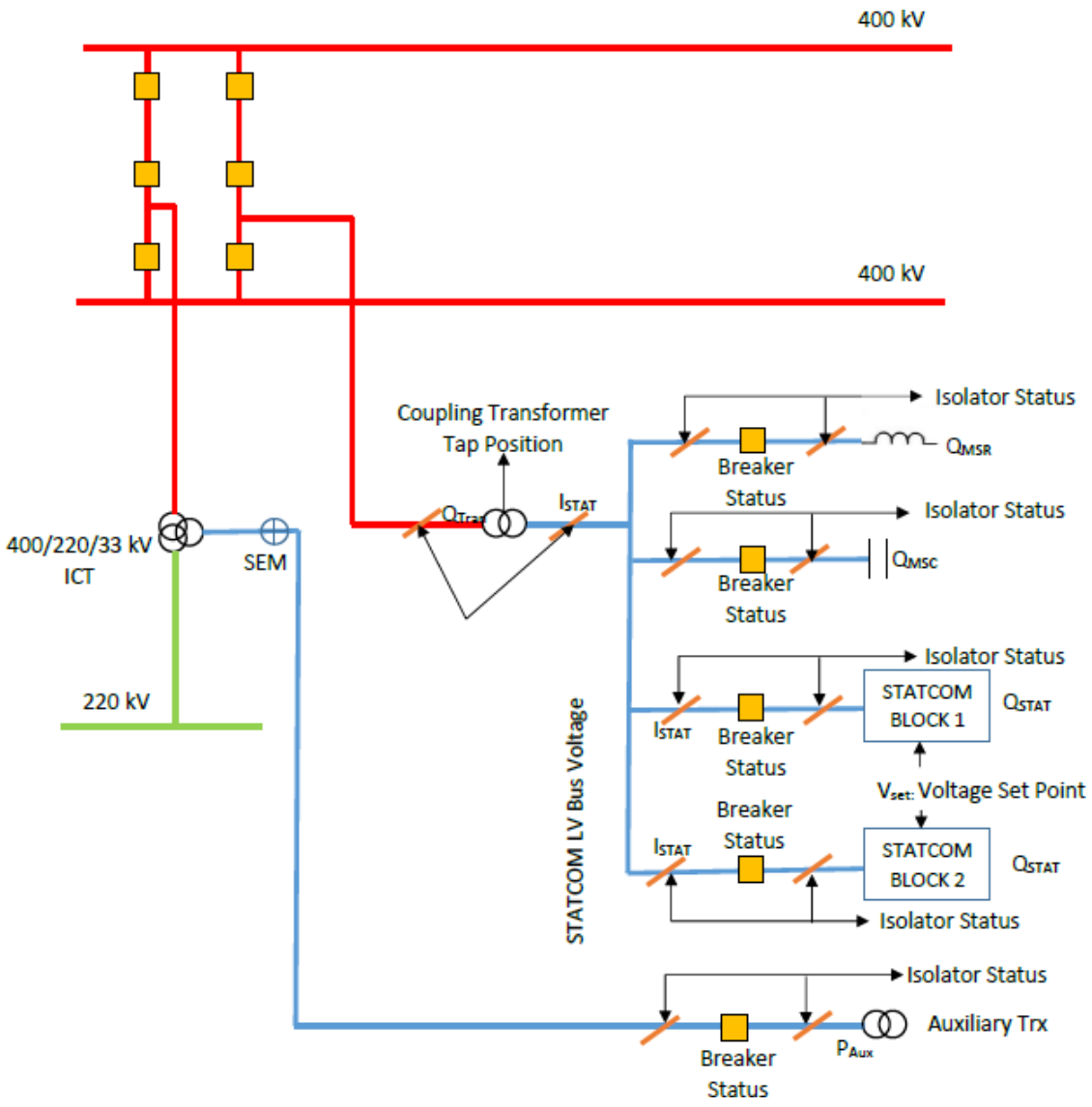
Sl. No	Description	Analog Points	Digital Points	Protection Signal
1	Line	**VOLTAGE** {VRM, VYM, VBM, VPM, VRA, VYA, VBA, VPA} **CURRENT** {IRM, IYM, IBM, IPM, IRA, IYA, IBA, IPA} MW, MVAR, F , DF/DT	-Main Breaker status -Tie Breaker status -Isolators	Main1/Main2 protection,
2	Bays		- Breaker -Isolators	
3	Main Buses, Transfer Buses	- **VOLTAGE** {VRM, VYM, VBM, VPM, VRA, VYA, VBA, VPA} F, DF/DT	Bus Sectionalizer, Bus Coupler Breaker	
4	Transformer/Coupling Transformer/Converter Transformer	- **VOLTAGE** {VRM, VYM, VBM, VPM, VRA, VYA, VBA, VPA} **CURRENT** {IRM, IYM, IBM, IPM, IRA, IYA, IBA, IPA} MW/MVAR for HV& LV Side	-Breaker -Isolators	Main1/Main2 protection
5	Reactor	**VOLTAGE** {VRM, VYM, VBM, VPM, VRA, VYA, VBA, VPA} **CURRENT** {IRM, IYM, IBM, IPM, IRA, IYA, IBA, IPA} MVAR	-Breaker -Isolators	
6	FSC/TCSC	**VOLTAGE** {VRM, VYM, VBM, VPM, VRA, VYA, VBA, VPA} **CURRENT** {IRM, IYM, IBM, IPM, IRA, IYA, IBA, IPA} MVAR	-Bypass Breaker - -FSC ON/OFF Status	

7	SVC	**VOLTAGE** {VRM, VYM, VBM, VPM, VRA, VYA, VBA, VPA} **CURRENT** {IRM, IYM, IBM, IPM, IRA, IYA, IBA, IPA} MVAR	Breaker	
8	Generator	**VOLTAGE** {VRM, VYM, VBM, VPM, VRA, VYA, VBA, VPA} **CURRENT** {IRM, IYM, IBM, IPM, IRA, IYA, IBA, IPA} MW, MVAR, F, DF/DT for HV& LV Side	-RGMO/FGMO ON/OFF Status Breaker Status -Isolators	V
9	STATCOM	**VOLTAGE** {VRM, VYM, VBM, VPM, VRA, VYA, VBA, VPA} **CURRENT** {IRM, IYM, IBM, IPM, IRA, IYA, IBA, IPA} MW, MVAR, F, DF/DT	- CB OF EACH MODULE MSR, MSC	
10	Phase Shifter	**VOLTAGE** {VRM, VYM, VBM, VPM, VRA, VYA, VBA, VPA} **CURRENT** {IRM, IYM, IBM, IPM, IRA, IYA, IBA, IPA} HV & LV MW / MVAR F, DF/DT	- CB	

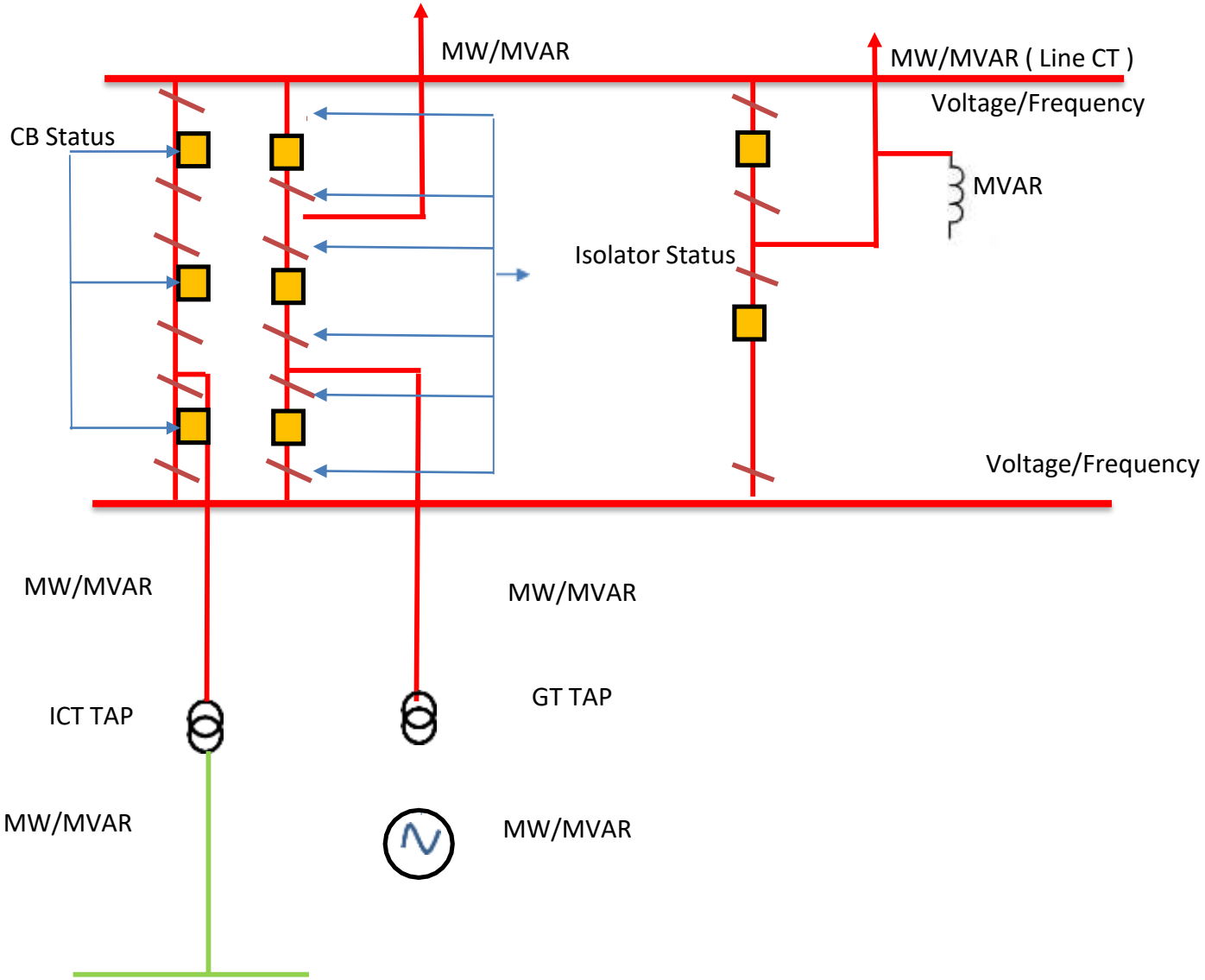
ANNEXURE-II

The layout diagrams showing point of interface for real time telemetry

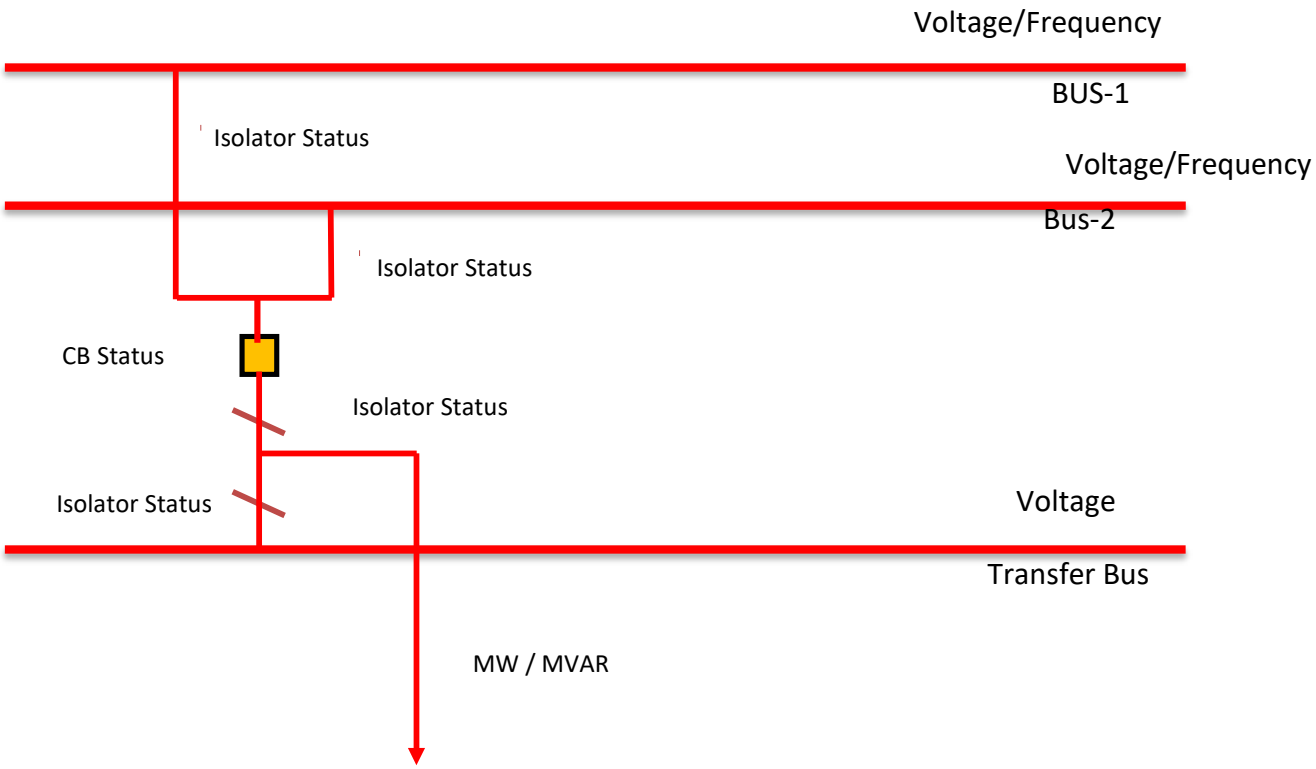
A. TYPICAL BAYS DIAGRAM: *STATCOM*



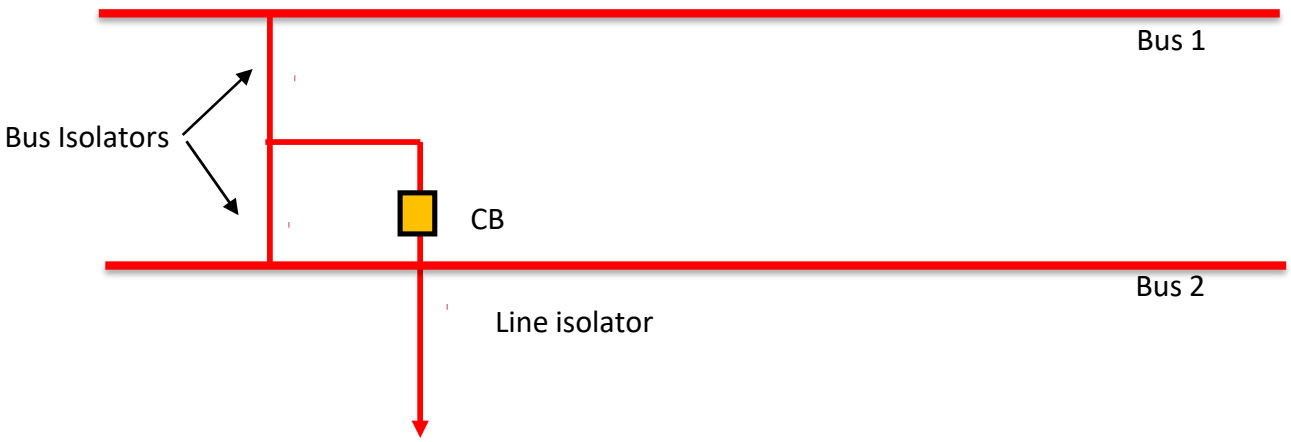
B. TYPICAL BAYS: *One and a half breaker Scheme*



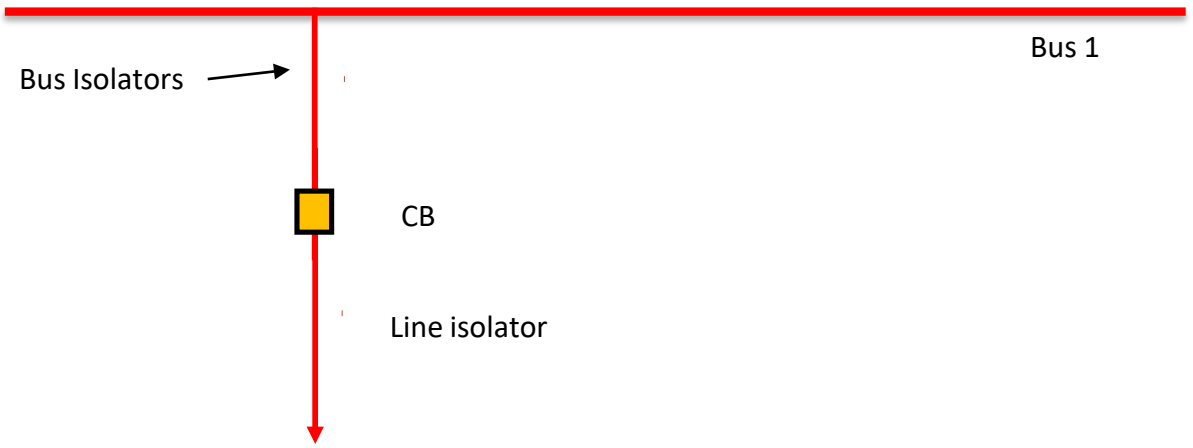
C. TYPICAL BAYS: *Double Bus and Transfer Scheme*



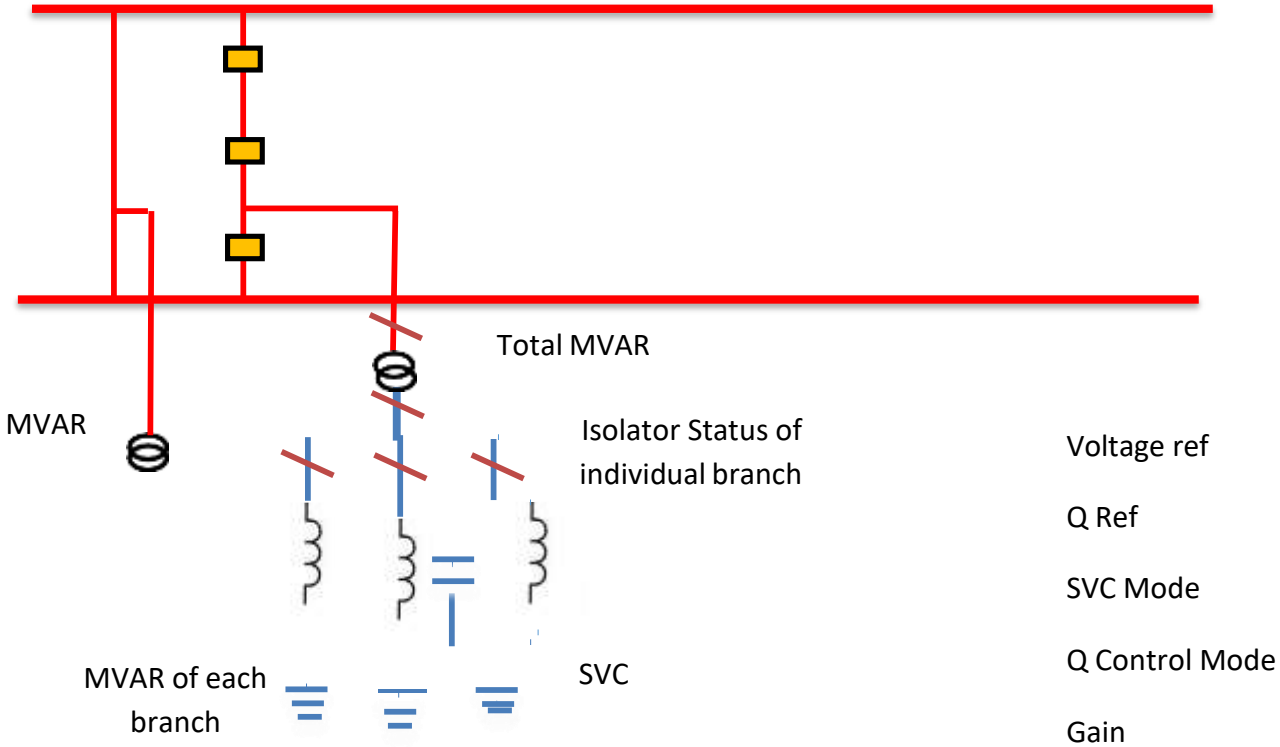
D. TYPICAL BAYS: DOUBLE BUS SCHEME



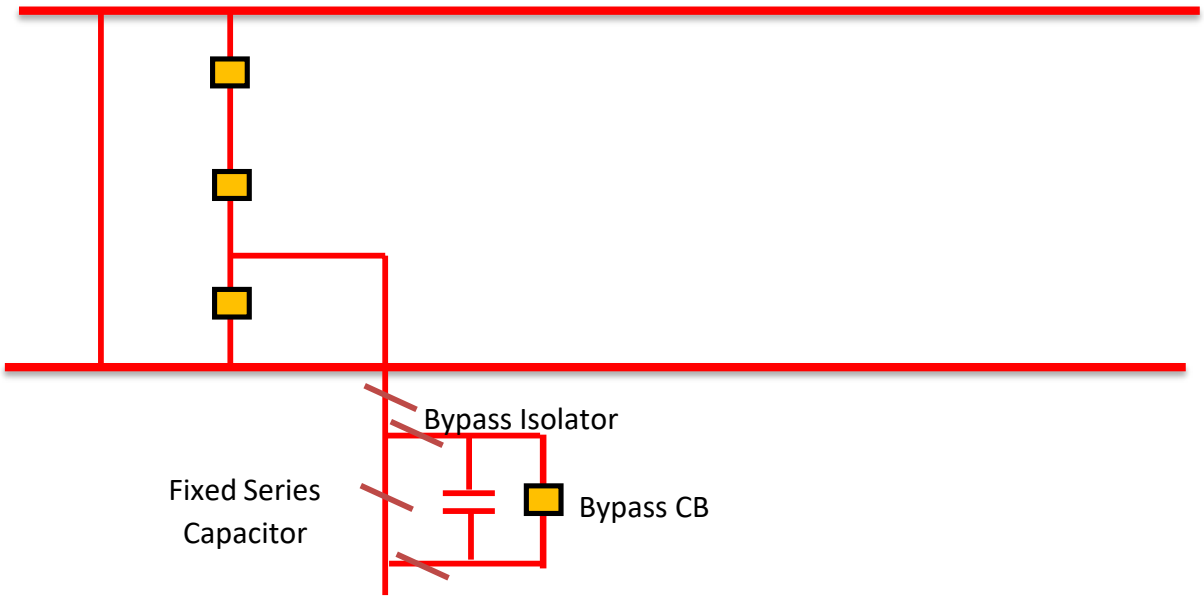
E. TYPICAL BAYS: SINGLE BUS SCHEME



F. STATIC VAR COMPENSATOR/BUS REACTORS

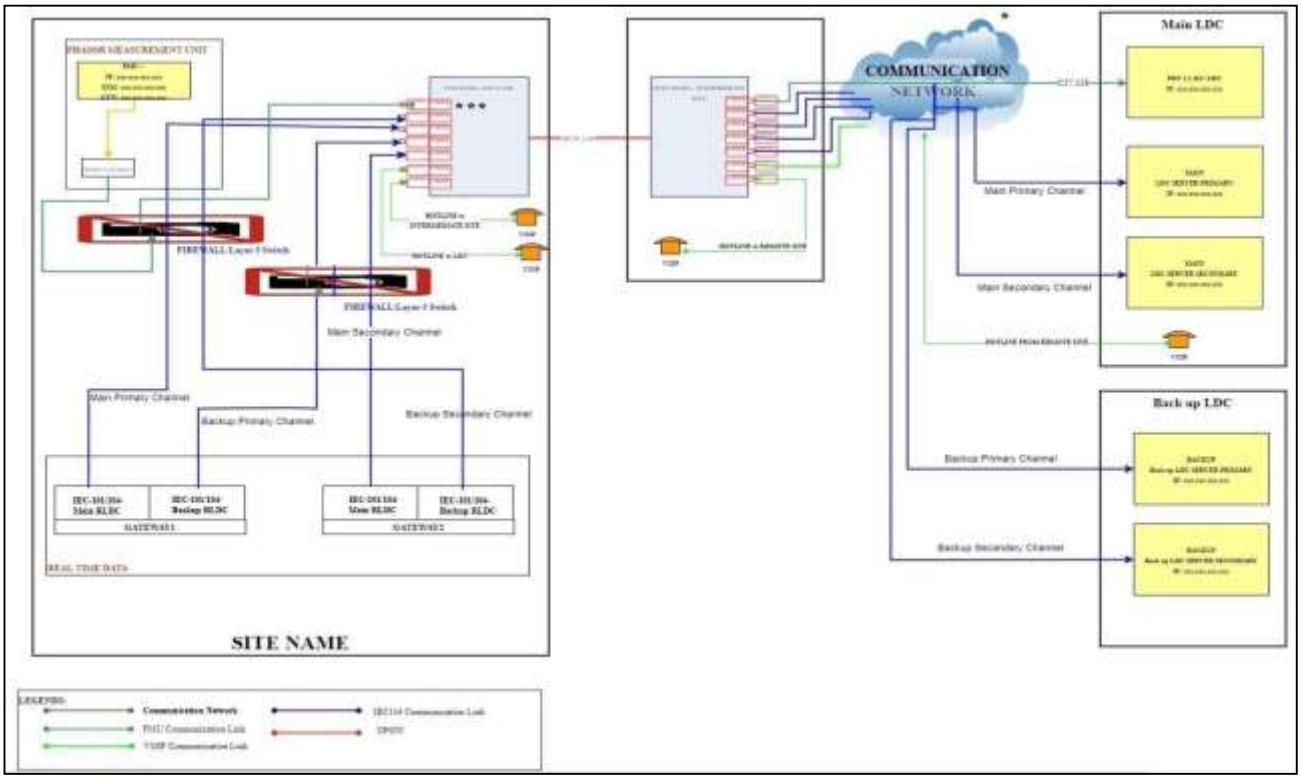


G. Fixed Series Capacitor



ANNEXURE-III

Typical Remote Station General Arrangement Diagram having IEC-101/104 RTU



ANNEXURE-IV

Typical Diagram showing Cyber Security Measures in Data Transfer