Verticross India Pvt. Ltd.

Remote Terminal Unit

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INTRODUCTION

An **RTU** is a communication and control device that collects data from sensors and equipment at a remote site, processes it, and transmits it to a central monitoring system. It can also receive commands from the control centre to operate local devices.

The Remote Terminal unit (RTU) monitors all sub-station equipment and acquires data on a real time basis. It captures status signals of devices and conduct automatic data logging to provide substation level control. In-addition, it monitors entire sub-station equipment, Viz, Transformers, Feeders, Batteries, Transducers Breakers, energy, meter, etc.

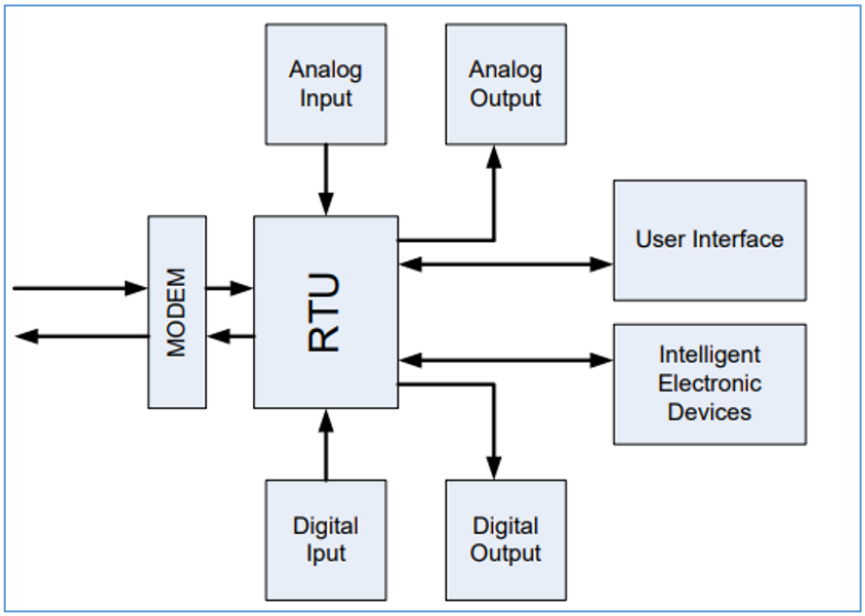
This facelifting, energy management, load forecasting and scheduling, and eventually leading to sub-station automation. They serve as a critical interface between field devices, such as sensors and circuit breakers, central control systems, like Supervisory Control and Data Acquisition (SCADA) systems. Using Real Time Data Acquisition System (RTDAS) software, RTU works as full-fledged SCADA system. It can communicate with the master control stations through LAN or GPRS/ 4G.

- **Data Acquisition** – Collects data such as voltage, current, power, breaker status, and alarms.
- **Remote Control** – Allows operators to open/close breakers or adjust equipment settings remotely.
- **Communication** – Transmits and receives data via standard protocols like IEC 60870-5-101/104, DNP3, Modbus, or IEC 61850.
- **Event Logging** – Records time-stamped events and disturbances for analysis.
- **Supervision and Diagnostics** – Monitors the health and performance of substation equipment and its own internal components.
- **Distribution Automation**: Enhancing the reliability and efficiency of power distribution.
- **Fault Detection and Isolation**: Identifying faults and enabling automatic reconfiguration of the network.
- **Load Management**: Monitoring load conditions and facilitating demand-side management.

Major modules in RTU are:

- Central Processing Unit
- Digital Input
- Digital output
- Analog Input
- Analog Output
- Redundant Power Supply
- Communication

ARCHITECTURE



RTU INTERNAL ARCHITECTURE

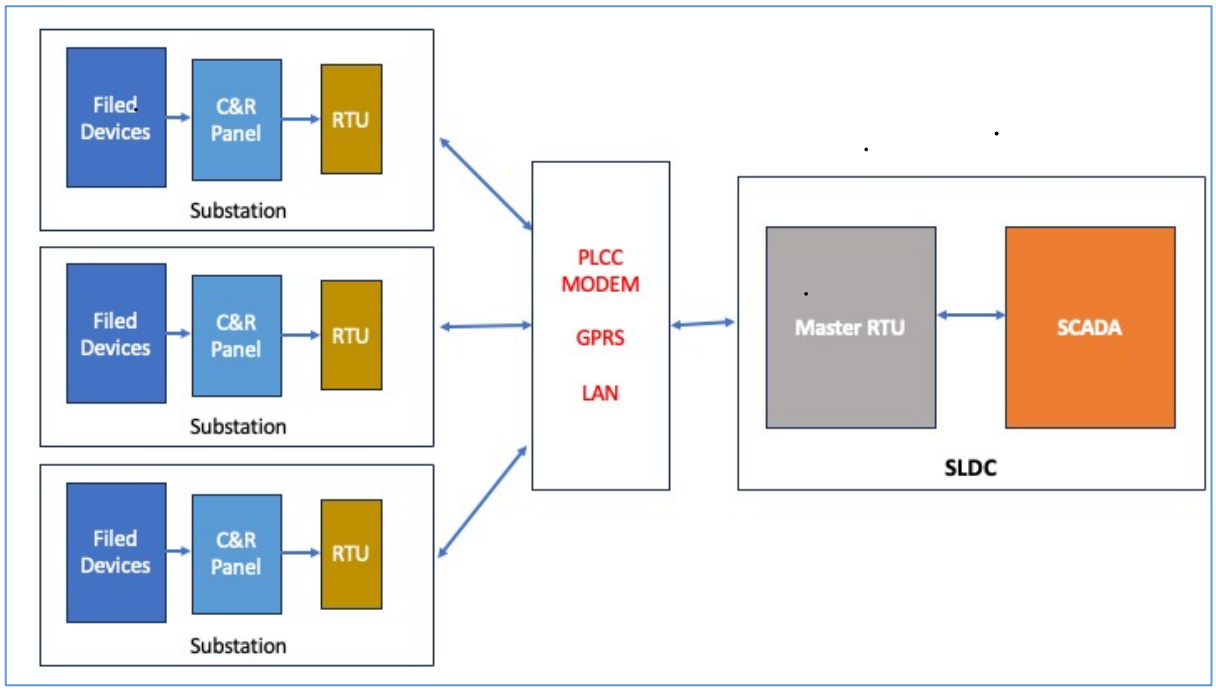
RTU Configuration

Processor / CPU Module	32-bit or 64-bit industrial-grade microprocessor, real-time operating system (RTOS / Linux-based), supporting redundant CPUs.
Communication Interfaces	Minimum 4 serial ports (RS-232/RS-485), 2–4 Ethernet ports (10/100/1000 Mbps), fiber-optic interfaces for LAN/WAN.
Digital Input (DI) Modules	Inputs for breaker, isolator, relay, and alarm statuses (potential-free contacts). 1 ms event resolution or better.
Digital Output (DO) Modules	Relay-type outputs for control commands (breaker open/close, OLTC raise/lower). Interlocked for safety.
Analog Input (AI) Modules	For monitoring voltage, current, power, frequency, temperature, etc. Input range: 0–20 mA or 4–20 mA.
Analog Output (AO) Modules	Optional, for analog control or setpoint commands (rarely used in substations).
Power Supply Unit	Dual redundant, operating from 24 V DC, 48 V DC, or 110 V DC (depending on utility standard).
Local HMI / Display	Optional LCD or touchscreen for local monitoring, control, and diagnostics.
Time Synchronization	Through GPS clock (IRIG-B or NTP). Required for event time-stamping (< 1 ms accuracy).

Communication Protocols	IEC 60870-5-101 / 104, DNP3, Modbus RTU/TCP, IEC 61850 (for IED integration).
Event Recorder / Data Logger	Internal memory for storing SOE (Sequence of Events) and analog data during link failure.
Cabinet / Panel	Rack-mounted or floor-standing cubicle, IP54 minimum, dust-proof, with front access.

Communication Media:

- Fiber Optic (preferred) / LAN
- RS-485 twisted pair for short distances
- GPRS/4G/5G or VSAT for remote substations



COMMUNICATION SYSTEM LEVEL ARCHITECTURE

RTUs serve as intermediary devices that collect data from various sensors and devices in the field and transmit it to a central control system. They play a crucial role in enhancing the reliability, efficiency, and automation of power distribution / transmission systems.

Parameter	**Specification**
Operating Voltage	110 V DC ±20% (or as per site standard)
Operating Temperature	−10 °C to +55 °C (industrial grade)
Humidity	Up to 95% non-condensing
EMC / EMI Compliance	IEC 61000-4-2/3/4/5/6, IEC 60255-26
Environmental Standard	IEC 60068-2 (Temperature, humidity, vibration)
Input Isolation	2 kV or higher optical/electrical isolation
Digital Input Resolution	1 ms or better for SOE recording
MTBF (Mean Time Between Failures)	≥ 100,000 hours
Storage Capacity	30 days of data (minimum), expandable

Redundancy	Dual power supply, dual CPU, dual LAN (hot standby)
Protocol Support	IEC 60870-5-101/104, DNP3, Modbus RTU/TCP, IEC 61850
Cybersecurity	User authentication, secure passwords, HTTPS, SSH, firewall, role-based access
Configuration Tool	Windows/Linux-based engineering tool for setup, diagnostics, and firmware updates
Compliance	IEC 60870-5 series, IEC 61850, IS SCADA standards (CEA 2015 Technical Regulations)

FEATURES & FUNCTIONALITIES

Data Acquisition

- Collects **real-time data** from field devices such as:
  - Circuit breakers
  - Isolators
  - Current transformers (CTs)
  - Potential transformers (PTs)
  - Energy meters
  - Relays and protection devices
- Measures parameters like:
  - Voltage, Current, Power (kW, kVAR)
  - Frequency
  - Power Factor
  - Energy (kWh, kVAh)
  - Transformer tap position, oil level, temperature, etc.

Remote Monitoring

- Continuously monitors equipment status and conditions.
- Sends alarms or status updates to the control center for:
  - Breaker ON/OFF
  - Trip/fault conditions
  - Transformer overloads
  - Communication failures

Remote Control

- Enables **remote operation** of substation equipment:
  - Open/close circuit breakers and isolators
  - Start/stop auxiliary systems (e.g., fans, pumps)
  - Change transformer tap positions (OLTC)
- Control actions are executed with **interlocks and safety checks**.

Data Communication

- Communicates with:
  - **SCADA master station** (Control Center)
  - **IEDs (Intelligent Electronic Devices)** within the substation
- Supports multiple protocols:
  - **IEC 60870-5-101 / 104**
  - **DNP3**
  - **Modbus RTU/TCP**
  - **IEC 61850 (in modern RTUs)**
- Can function as a **gateway** between different communication systems.

Event Logging & Time Synchronization

- Logs events with accurate timestamps (typically 1 ms or better).
- Synchronizes time via **GPS**, **NTP**, or **IRIG-B**.
- Helps in sequence-of-event (SOE) analysis during fault or disturbance.

Alarm & Status Management

- Generates and classifies alarms (critical, major, minor).
- Maintains alarm history.
- Supports alarm acknowledgment and clearance from SCADA.

Local HMI (Optional)

- Local display panel for:
    - Real-time monitoring
    - Alarm acknowledgment
    - Control operations
    - Configuration and diagnostics

Central Processing Unit (CPU)

- IEC 60870-5-101 and IEC 60870-5-104 protocols used to transmit data from substations to master control centers
- Diagnostic software for continuous monitoring of the RTU and reporting of hardware errors to the connected master stations
- 1GHz ARM Cortex -A8 32-Bit RISC Processor Manages input, output, energy meter data and sends all this data to the server.
- Database configuration and maintenance software tool for database modification, configuration, and data downloads
- GPRS/GSM/4G , PLCC, LAN, used to transmit data
- Generates custom reports for aggregation, analysis and creation of MIS reports
- Auto detects devices and performs device checks using the required baud rate and protocol stack
- Reads data from different device makes/models with varying standards of communication protocols
- 0.5 to 1.0 m sec digital data scanning resolution and time stamping
- User friendly configuration tool for ease of configuration and management
- Devices that can interface with RTU include sub-station batteries, transducers, breakers, switches, transformers, isolators, feeder meters and sensors
- Data can be integrated with the sub-station monitoring system (SCADA)

Digital Input (DI)

- Digital input refers to signals that are represented in discrete values, typically binary (0s and 1s). These inputs are used to read the state of a device or sensor.

- Push buttons, switches, and digital sensors (like a temperature sensor that outputs a digital signal).
- **Characteristics:**
  Discrete Levels: Only two states (high/low, on/off).
  Noise Immunity: More resistant to noise compared to analog signals.
- 16 channel opto-isolated inputs
- Monitors feeder status, switch positions, etc.

Digital Output (DO)

- Digital output refers to signals that are sent out in discrete values, typically to control devices or indicate a state.
- LEDs, relays, and digital displays.
- **Characteristics**:
  Binary Control: Can only be in one of two states (on/off).
  Simplicity: Easier to design and implement in digital circuits.
  Power Consumption: Generally lower power consumption when in a low state.
- 8 channel Digital output with 2Amps current carrying capacity potential free contacts.
- Controls (On/Off) feeders, relays, alarms, etc.

Analog Input (AI)

- Analog input refers to signals that can take on a continuous range of values. These inputs are used to read varying signals from sensors.
- Potentiometers, thermocouples, and microphones.
- **Characteristics**:
  Continuous Levels: Can represent an infinite number of values within a range.
  Sensitivity: Can detect small changes in the input signal.
- 8 /16 channel analog inputs with 24-bit ADC resolution
- Reads voltages, currents, power factors, and other data from transducers.

Analog Outputs (A0)

- Analog input refers to signals that can take on a continuous range of values. These inputs are used to read varying signals from sensors.
- Potentiometers, thermocouples, and microphones.
- **Characteristics:**
  Continuous Levels: Can represent an infinite number of values within a range.
  Sensitivity: Can detect small changes in the input signal.
- 8 channel analog outputs with 16-bit DAC resolution
- Analog output values are updated for every transmission.

Power Supply

The green colored POWERLED glows when the unit is switched ON. An adequate protection against reverse polarity, overcurrent and under voltage conditions is present to prevent the module from being damaged in an
event of external effects.

- 48V DC input power supply.
- 220V AC power optional.

Supplies required voltages to all equipment.

DATESHEET

Main Processing Unit (MPU)

- CPU: - 32-bit ARM Coryex-A8,1.0 GHz
- DDRAM: -256MB
- SPI Flash: -8MB

Communication Interface

- Description: RS-232
- Connector: DB-9 Female
- Type: -Serial Port
- Bit rate: 100 bit/s – 9600 bit/s
- Signal lines: TXD PIN 2
  RXD PIN 3
  GND PIN 5
- Level: typical: ± 10V DC

Ethernet Interface

- Type: IEEE 802.3,10/100BaseT
- Connector: RJ 45

Environmental Conditions

- Nominal operating: -10 °C to +55 °C
- temperature range: -10 °C to +55°C
- Max. operating temperature: -10 °C to +55 °C
- Relative humidity: upto to 95 % (non-condensing)

Power Supply

- Input Voltage: 36V to 52V DC
- Output Voltage: 5.0V DC
- Output Current: 2.5 Amps max
- Protections: Short circuit and overload
- Surge handling capacity: 4KV / 6KV as per IEC 61000-4-5
- Connection type: Single phase 2 wire

Immunity Test

- Surge: 4 KV/6KV
- IEC 61000-4-5, 2005: Performance criteria A

- Conducted Emission: 150 KHz to 30 MHz
- CISPR 22: Performance criteria A
- Radiated Emission: 30 MHz to 1000 MHz
- CISPER 22: Performance criteria A
- Electrostatic Discharge 6 KV in Contact Discharge
- IEC 61000-4-2, 2008: 8 KV in Air Discharge
- Radiated Susceptibility: 80 MHz to 1000 MHz (3 V/m)
- IEC 61000-4-3, 2010: Performance criteria A
- Electrical Fast Transient: 4KV
- IEC 61000-4-4, 2011: Performance criteria A
- RS-485 ports of RTU at port 1
- First pin is RX/D-/B and
- second pin is TX/D+/A.

Integration with Substation Automation System (SAS)

- RTU interfaces with:
    - Intelligent Electronic Devices (IEDs) like numerical relays, meters, fault recorders.
    - Communication equipment such as routers, modems, and network switches.
    - SCADA master at SLDC/ALDC for real-time data and control.
- Acts as a gateway between multiple communication protocols.

Supports redundant communication paths (Main & Standby channels).