เอกสารแนบท้ายเอกสารประกวดราคาอิเล็กทรอนิกส์

1.7 มาตรฐานและคุณสมบัติทางเทคนิค
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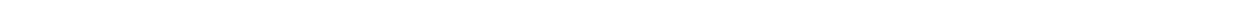
(1) FRTU Technical Specifications

(2) Specification No.: RMIS 102/2559: Cellular Equipment for Field Devices Interface

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1.7(1) FRTU Technical Specifications

FRTU Technical Specifications

Table of Contents

Scope

This Specification Describes the requirements with the manufacturer shall comply in order to supply Feeder Remote Terminal Unit for Remote Controlled Switches for 22 kV and 33 kV 50 Hz in Provincial Electricity Authority Distribution System.

1. Common Requirements

This clause describes the Authority's common requirements that apply to the FRTU equipment.

1.1 General

The following general requirements shall be met:

1) The FRTU equipment shall be designed, fabricated, assembled, finished, and documented with workmanship of the highest production quality and shall conform to all applicable quality control standards of the original manufacturer and/or Contractor.

2) All materials shall be new, unused, and of the best industrial grade.

3) The equipment shall incorporate all recent improvements in both design and materials and, in this respect, shall be assembled using current production components from reliable component manufacturers. Manufacturer standard designs shall be used as much as possible.

4) To facilitate expansion and maintenance, modularity shall be employed in the design of the equipment.

5) Major components shall carry permanent labels providing a cross-reference to the Contractor's corresponding documentation.

6) Materials promoting the growth of fungus or susceptibility to corrosion and heat degradation shall not be used. Steps shall be taken to provide rodent proof installations.

7) The equipment shall support internal clock time retention in the event of a power supply failure. In this respect, the use of an on-board battery is not acceptable (also refer to Clause 2.3.4). The mechanism for internal clock retention shall not require periodic maintenance.

8) All features of the proposed equipment, as described in the Contractor's proposal and associated reference materials, shall be fully supported by the equipment delivered.

1.2 Standards

With respect to installation procedures and associated accessories (such as power cables, ground cables, surge arrestors, etc.), the standards of the Engineering Institute of Thailand shall apply. Otherwise, the FRTU equipment shall be designed in accordance with applicable International Electro technical Commission (IEC) standards and comply, as may be necessary, to standards published by other organizations, such as the Institute of Electrical and Electronic Engineers (IEEE), American National Standards Institute (ANSI), National Equipment Manufacturers Association (NEMA), and Electronic Industries Alliance (EIA).

For conditions not covered by the referenced standards, other internationally recognized standards identified by the Contractor and approved by the Authority shall apply. In all cases, the provisions of the latest current edition or revision of the referenced standard or code shall apply. If the initially referenced standard or code has been superseded, any such reference shall imply a reference to the new standard or code.

1.3 Service Conditions

The FRTU equipment shall be suitable for continuous outdoor operation in Thailand's tropical monsoon climate, which includes exposure to severe frequently occurring thunderstorms. It shall also be suitable for conditions where it will be exposed to heavy industrial pollution, salt-spray, and high levels of airborne dust. These exposure requirements shall apply to all accessories that may be vulnerable to such weather and environmental conditions as well. Thus, the Contractor's proposal shall have clearly clarified how the FRTU equipment and its accessories comply with such requirements. Otherwise, as may be necessary, conformal coating (Class 2 in accordance with IEC 60870-2-2 or Class 3K7 in accordance with IEC 60721) shall apply to all components that are prone to misoperation and/or damage from such exposure.

In addition, the equipment shall have been type tested for continuous operation under specific conditions as follows:

1) *Temperature:* 0°C to 70°C (IEC 60068-2-1, 2, 3, and 14, or equivalent)

2) *Temperature Gradient:* Up to 30°C (IEC 60068-2-1, 2, 3, and 14, or equivalent)

3) *Relative Humidity:*   Up to 95% at 40°C (IEC 60068-2-30 and 38, or equivalent)

4) *Cyclic Damp Heat:* 40°C to 25°C at 95% Relative Humidity (IEC 60068-2-30 and 38, or equivalent)

5) *Absolute Humidity:*   Up to 29g/m^3 (IEC 60068-2-30 and 38, or equivalent)

6) *Vibration (sinusoidal):*   2g acceleration, 9 to 350Hz (IEC 60068-2-6, or equivalent)

7) *Shock:*   15g, 11ms test (IEC 60068-2-27, or equivalent)

8) *Tilted Pole:*   Up to 10 degrees from vertical in any direction

9) *Altitude:*   Up to 1,000 meters.

The required type tests shall have been carried out by suitably accredited test laboratories that are independent of the manufacturer and Contractor. Certified copies of all type test certificates and test results shall have been included as part of the Contractor's proposal.

1.4 Fail Safe Design

The FRTU shall be designed to prevent false control actions being executed and erroneous data being transmitted. In this respect, they shall incorporate the following fail-safe design criteria in their control output logic:

1) No false output shall result from a single point of failure in any FRTU.

2) No false output shall result during FRTU power up or power down.

3) No false output shall result from inadvertently inserting a circuit card into a wrong slot within the FRTU.

1.5 Maintainability

The Authority prefers FRTU equipment designs that do not require periodic preventive maintenance and inspection. If periodic maintenance is required, it shall be possible to perform all such work in the field without dismounting the equipment and without requiring that the associated power system circuit be de-energized.

Within this context, the FRTU hardware shall:

1) Be designed to minimize or eliminate the need for periodic maintenance.

2) Be assembled from modules to facilitate troubleshooting on a module basis.

3) Be configured to simplify the removal and replacement of modules or component parts with minimum effort.

4) Include module interfaces that minimize opportunities for damage due to removal and replacement of modules and plugging and unplugging cables within the control cabinet.

5) Include graphic placard warnings of hazardous and potentially damaging actions.

The FRTU software, including firmware and firmware parameters where applicable, shall:

1) Include a mechanism to locally display the operating software and firmware versions.

2) Be remotely downloadable and upgradeable in an encrypted form to assure a secure and complete download (refer to Clause 2.3.3).

3) Be downloaded into parallel memory for error check and decryption before being loaded into operating memory.

4) Be stored locally as a previous version before new software and firmware is executed and, on this basis, be available for restoration.

5) Employ watchdog timers to detect FRTU failure and generate a restart.

6) Be supported by operation and maintenance information in the FRTU user manual.

1.6 Immunity to Electrical Stress and Disturbance

The electrical and electronic components of the FRTU shall satisfy the requirements for insulation, isolation, and immunity from electromagnetic interference, radiated disturbance, and electrostatic discharge by complying with relevant international standards. In this respect, the standards with which the FRTU comply shall be identified by the Contractor for Authority approval and shall have been verified by type tests carried out by suitably accredited test laboratories that are independent of the Contractor and/or manufacturer of the FRTU components. Certified copies of all relevant test certificates and test results shall have been included as part of the Contractor's proposal.

1.6.1 Minimum Insulation of Equipment

The following classes of exposure to electrical interference shall be used in interpreting the insulation requirements of all components and wiring as installed:

1) *Exposed Equipment* - Exposed equipment terminals may be interconnected without special protection of the insulation. Equipment terminals shall be considered exposed if they are galvanically connected to current or potential transformer secondary circuits.

2) *Controlled Exposure Equipment* - Controlled exposure equipment terminals may be interconnected when relevant conditions are satisfied. Equipment terminals shall be considered controlled exposure terminals when the following criteria are met:

a) The rated voltage of the associated circuit does not exceed 32 Vac or 48 Vdc.

b) Direct galvanic connections to exposed equipment terminals are made using a suitable barrier device that has the isolation ratings required for exposed equipment.

Exposed equipment terminals shall be intrinsically designed to meet the insulation requirements. The provision of externally mounted "add-on" circuitry, including

devices such as auxiliary relays, isolating transformers, and electronic or gas suppressors, solely for compliance with the insulation requirements shall not be permitted.

Within the context above, the FRTU shall meet or exceed the minimum insulation requirements listed in Exhibit 1-1.

Exhibit 1-1: Minimum Insulation Requirements

Requirements	Test Standard (or equivalent)	Specified Details	
		Exposed Equipment	Controlled Exposure Equipment
Rated Insulation Voltage	IEC 60255-5 Table I	500 V	60 V
Dielectric Test Voltage	IEC 60255-5 Table I Series B (Clause 6)	2.0 kV rms	1.0 kV rms
Insulation Resistance Test	IEC 60255-5 (Clause 7)	Required	Required
Impulse Voltage Test	IEC 60255-5 (Clause 8)	5 kV 1.2/50 μs 0.5 J	5 kV 1.2/50μs 0.5 J

1.6.2 Immunity from EMI, Radiated Disturbance, and Electrostatic Discharge

The FRTU shall be designed for safe operation in harsh environments subject to high voltages. Their data communication ports shall be designed to withstand disturbance testing without permanent corruption of data and subsequent delay of data transfer. Within this context, they shall conform to the immunity, susceptibility, and interference requirements shown in Exhibit 1-2.

Exhibit 1-2: Immunity, Susceptibility, and Interference Requirements

Requirements	Test Standard (or equivalent)	Class or Level	Specified Details
High Voltage Impulse	IEC 60060-1	-	5 kV, 0.5 J
Electrical Disturbances (1 MHz Burst)	IEC 60255-22-1 IEC 60255-22-1	Class 3 Class 3	2.5 kV CM 1.0 kV DM
Electrostatic Discharge Immunity	IEC 61000-4-2 IEC 61000-4-2	Level 3 Level 4	8 kV air 8 kV direct

Requirements	Test Standard (or equivalent)	Class or Level	Specified Details
Radiated Immunity	IEC 61000-4-3	Level 3	80 MHz-1 GHz
Fast Transient/Burst Immunity	IEC 61000-4-4	Level 4	4 kV
	IEC 60255-22-4	Class 4	4 kV
	ANSI/IEEE C37.90.1	-	4-5 kV
Surge Immunity	IEC 61000-4-5	Level 4	2 kV/4 kV
Conducted Immunity	IEC 61000-4-6	Level 3	10 V
Harmonics Emissions	IEC 61000-4-7	-	Required for ac powered systems
Power Frequency Magnetic Field Immunity	IEC 61000-4-8	Level 4	30 A/m
Pulse Magnetic Field Immunity	IEC 61000-4-9	Level 5	1000 A/m
Damped Oscillatory Magnetic Field Immunity	IEC 61000-4-10	Level 4	30 A/m
Oscillatory Transient Immunity	IEC 61000-4-12 IEC 61000-4-12	Level 3	Ring Wave Damped Oscillatory 2 kV

2. FRTU Functional Requirements

This clause describes FRTU functional requirements from the perspective of remote monitoring and control of the Authority's remote controlled switches. Required FRTU configuration, maintenance, and diagnostic features are also described.

2.1 TDMS Interface

Each FRTU shall support two-way communications at least four Front-End Processors (FEPs) which have specific IP Address for each of FEPs. These FEPs and other servers will comprise the central computer platforms for DDIP's new Transmission and Distribution Management System (TDMS). The TDMS computer platforms will host the SCADA and EMS/DMS applications that will support remote power system operations from multiple Authority control centers and, in this respect, the computer platforms and control centers will provide backup for each other. The FRTUs shall communicate with the FEPs at data centers using the secure authentication of the DNP 3.0 protocol over IP.

Within this context, each FRTU shall use the co-located Communication Equipment supplied and installed by contractor, such that the data can be received by data centers simultaneously. It shall be possible for the data to be sent under the following DNP 3.0 defined modes of operation:

1) During a Class 0, 1, 2, and/or 3 poll by the TDMS. This shall include:

   a) Integrity and report by exception polling.

   b) Sending selected status or analog points on demand.

2) During an unsolicited (spontaneous) Class 1, 2, and/or 3 FRTU response to a power system event. This shall include sending an analog or status point value in the event:

   a) An analog value exceeds an individually configurable dead band around its previously reported value.

   b) An analog value exceeds an individually configurable Threshold.

   c) A status point changes state.

The FRTU shall include the capability to receive and implement DNP 3.0 control commands as sent from any SCADA server that is a part of the two TDMS data center platforms. The capability to configure the FRTU remotely using a secured and/or encrypted TCP/IP protocol like "https" shall also be supported.

2.2 Input/Output Points

The FRTU shall include facilities for handling all required analog input, status input, and control output points. The requirements for each type of Input/Output point are described in the Input/Output point for FRTU-RCS Interface table.

2.2.1 Analog Inputs

The FRTU shall:

1) Acquire analog inputs directly without transducers from each of three power system voltage and current terminals in the existing or Contactor-provided RCS control cabinets.

2) Apply suitable filtering to eliminate the risk of signal aliasing.

3) Use voltage and current inputs for calculations that support TDMS acquisition of the following data as a minimum:

   a) Line-to-line voltages.

   b) Phase current magnitudes and phase angles.

c) Real and reactive powers (three-phase kW and kVar totals with sign).

d) Power factor.

4) Accept ac voltage input signals with a normal input level of 110 V.

5) Employ analog to digital converters with minimum of 16-bit resolution for a bipolar input signal.

6) Accurately resolve ac voltage input signal levels from 0 to 150 V.

7) Accurately resolve ac current input signals with normal ranges of 0 to 5 A or 0 to 1 A.

8) Include the capability to report all analog values that have changed by more than their programmable dead bands from their last values successfully reported to the TDMS.

9) Record maximum rms fault current signals, over a period of at least one (1) second, up to 20 times normal (100 A) within a maximum error of 2.5% of Full Scale Deflection (FSD).

10) Not impose a total analog input burden of more than 0.5 VA for all current and voltage inputs.

11) Demonstrate an overall analog input error of no more than ±0.2% of 1.2 times normal FSD over the temperature range 0 to 70 °C.

12) Demonstrate an analog input linearity better than ±0.05%.

13) Reject common mode ac (50 Hz) voltages up to 150 V.

2.2.2 Status Inputs

As a minimum, the FRTU shall accept isolated wet and dry single contact two-state status inputs and two-state status inputs with memory, i.e., Momentary Change Detection (MCD) inputs. Input change of state shall be timestamped to a precision of 1 millisecond.

Within this context:

1) All necessary wetting voltage, current limiting, input isolation, and bounce filtering shall be provided.

2) Contact de-bounce time periods shall be individually configurable.

3) The input circuits shall be optically isolated from the external signal.

4) Unless the FRTU can provide its own self-supplied wetting voltages, input contact wetting voltages shall be 24 Vdc as obtained from the dc power supply in the existing or Contactor-provided RCS control cabinets.

5) Each wetting voltage circuit shall be protected with its own circuit breaker.

2.2.3 Control Outputs

The FRTU shall support the following control output features:

1) A Select-CheckBack-Before-Operate (SCBO) procedure for all control operations. In this respect, the following concepts shall apply:

   a) On receipt of a control point select command, the FRTU shall check that no other point is selected, select the requested point, acknowledge the select command, and start a Command Receipt Timer.

   b) Control point selection shall be canceled if the subsequent operate command is not received within the Control Receipt Timer's programmable time-out period, which shall be adjustable from five (5) to thirty (30) seconds.

   c) On receipt of the operate command, if the control point has remained selected and no other point has become selected, the FRTU shall then initiate the requested control action.

   d) The SCBO procedure shall be canceled automatically on completion of the control action or if not completed within an adjustable time-out period of up to 60 seconds.

   e) Any further attempt at control shall require a new SCBO procedure.

2) RCS opening and closing by sending commands to a complimentary pair of contact outputs such that:

   a) One command activates the contact used to open the switch.

   b) The other command activates the contact used to close the switch.

   c) Only one contact output in a complimentary pair can be activated at a time.

3) Momentary control where each output provides a contact closure pulse having an individually programmable duration from 1 to 60 seconds in increments of 1 second.

The following requirements shall also apply:

1) The voltage rating of the control output contacts shall be 24 Vdc.

2) All control power shall be obtained from the existing or Contractor supplied 24 Vdc power supply.

3) FRTU control outputs shall be able to drive loads of at least six (6) amps.

4) Output relays shall be designed for 10^6 (one million) mechanical operations.

5) The FRTU shall monitor all operations and local status information and give warnings or advisory messages when any wrong operational sequence is requested.

6) Abnormal conditions shall inhibit control operations, e.g., low gas-pressure lockout of an RCS.

2.2.4 Feeder Fault Current Detection

The FRTU shall be able to detect and report the passage of momentary as well as sustained feeder fault currents. Within this context, sensitive earth fault as well as all other fault type detection shall be supported. It shall also be able to detect and report loss of power system voltage and a return-to-normal feeder energized state. In this respect, the following functional requirements shall be met:

1) Fault passage detection shall be based on checking if a current set point value has been exceeded. If such a condition is detected and continues for a specified time duration, the detection logic shall result in a Fault Event being registered and reported to the TDMS.

2) Fault passage detection shall include reporting features for the different types of fault that can occur. In this respect, for example, the fault detection features associated with such relays as follows shall be incorporated, where equivalent IEC 60617 codes as well as the referenced ANSI codes may apply:

    a) Overcurrent (ANSI 50/51, 50G/51G)

    b) Sensitive earth fault (ANSI 50SEF)

    c) Directional relay (ANSI 67)

    d) Broken conductor (ANSI 46BC or ANSI 47BC)

    e) Negative sequence voltage (ANSI 47)

3) Detection of a return-to-normal state shall be based on recognizing that the voltage level has been above a configurable set point for a specified time, in which case a Fault Cleared Event shall be registered, reported to the TDMS, and used to reset the FRTU so it is ready to detect any subsequent fault.

4) The FRTU shall support TDMS downloading and uploading of the set points and time periods that correspond to Fault Events and Fault Clearance Events using the DNP 3.0 protocol.

5) The FRTU's feeder fault detection function shall:

a) Work properly for all possible configurations of the power system circuit where the FRTU is installed.

b) Prevent miss-operation due to magnetizing inrush currents and other transient no-fault conditions.

c) Report the fault current level with time stamp to the TDMS and reset the fault current register to zero.

d) Report Fault Event, Fault Direction, and Fault Clearance Event details as time-stamped Sequence of Events (SOEs).

e) Save the last 128 Fault Events along with their corresponding Fault Direction and associated Fault Clearance Event details and, on demand, report them to the TDMS.

f) Support a configurable format for local fault record reporting including the Comma Separated Variable (CSV) format for use in a spreadsheet and the COMTRADE (IEEE C37.111-1999) format for use with a commercial COMTRADE viewer.

2.2.5 Point Counts

The FRTU shall be equipped to handle the I/O list described in the relevant tables shown in the Input/Output point for FRTU-RCS Interface table. They shall also include spare I/O points fully configured and available for immediate use by the Authority. In this respect, at least 5% of the number of status points, and 5% of the control output point in each as-built distributed I/O module shall be spare.

The spare status and control output points shall be wired from the FRTU I/O card to the associated terminal strips in the associated control cabinet. Additional I/O point on the I/O card beyond those needed to satisfy the requirement for spare points need not be wired.

2.3 FRTU Architecture

The FRTU shall incorporate a programming capability within an architecture that supports convenient installation, maintenance, and expansion features. The architecture shall include a central processing module, I/O module, control module, communications Interface, and time and date Facility. Associated equipment such as dc power supply and local control panel are described elsewhere in the Technical Specifications.

2.3.1 Central Processing Module

The Central Processing Module (CPM) shall:

1) Support a high-level language processing capability per the open IEC-61131-3 standard for programmable logic controllers.

2) Support management of the FRTU database from a local test set including the DAC Simulator.

3) Support download and upload of FRTU parameters and configuration data.

4) Implement the DNP 3.0 Secure Authentication protocol interface with the TDMS.

5) Control data acquisition from the RCS and the sending of control commands to the RCS using an I/O module.

6) In accepting commands from the TDMS:
    a) Perform address recognition.
    b) Assemble response messages in accordance with the received command messages.
    c) Transmit these messages to the TDMS.

7) Provide interfaces for a time standard and test set.

8) Manage communications between all other functional modules of the FRTU.

9) Determine the integrity of the FRTU.

10) Provide diagnostic information in the message structure that the TDMS shall monitor.

11) Set a flag if the FRTU performs a restart for any reason including power failure.

12) Include a watch-dog timer that is reset regularly by FRTU software. If the software fails to reset the watch-dog timer (e.g., because of a software error causing the software to "loop" or "hang"), then the timer shall expire causing the CPM to reset and restart.

2.3.2 I/O Module

I/O module requirements include the following capabilities and features:

1) Capability to accept analog and status inputs and send control outputs. This shall include fault current measurements.

2) Capability of being replaced without reprogramming, redefinition of configuration parameters, or rewiring.

3) A Control Switch (CS) that, if not in its normal control position, inhibits RCS control from the TDMS or test set.

4) A status input contact so that the TDMS or test set can monitor if the position of the CS is in its normal control position.

5) Capability to report the position of the Local/Remote (L/R) switch supplied with the RCS. For the CS to be effective, the L/R switch must be in "Remote." Otherwise, with the L/R switch in "Local", remote control from the TDMS or test set shall be disabled irrespective of the CS position.

2.3.3 Communications Interface

The FRTU shall be provided with a communications including necessary and sufficient numbers and types of port that can be used to support:

1) Remote data communications with external systems and devices over an Ethernet/IP network using the secure authentication of DNP 3.0 protocol over IP. This shall include data communications with multiple masters, as in the TDMS systems at the Authority's two data centers, and the DAC Simulator.

2) Local and remote configuration with a static IP address.

3) The fully implemented message security features of the DNP 3.0 protocol running over TCP/IP. This capability shall be demonstrated successfully as part of factory acceptance testing.

4) Communications that is not degraded by simultaneous activity in other parts of the FRTU.

5) Temporary connection of laptops (such as the DAC Simulator or FRTU test set) for local installation, maintenance, diagnostic, and test purposes for all configurations and data access functions associated with the FRTU.

6) SCP/SSH with respect to downloading, for example, FRTU configuration parameters and firmware updates.

7) Features such as HTTPS for web server functionality (refer to Clause 2.3.5).

8) Blocking or disabling of ports to prevent unauthorized access.

9) MAC and IP filtering so that Ethernet traffic is limited to a configurable "whitelist" of network device MAC and IP addresses.

10) Access control using a secure log-in procedure. As a minimum, this shall include user authentication based on a unique username and password.

11) System logging (syslog) at a device or system level. Syslog alerts shall include remote user access activity including successful and unsuccessful login attempts.

2.3.4 Time and Date Function

The FRTU's time and date shall:

1) Include an internal time-of-day clock for data collection coordination. The time resolution of the internal clock shall be one (1) ms or better and, without synchronization, the time shall drift by no more than 5 ms per hour.

2) Use the existing or Contractor-provided RCS control cabinet's 24 Vdc power supply as the only source of power for the internal clock, i.e., no other source such as an internal (on-board) battery shall be used.

3) Synchronize the internal clock whenever the FRTU is powered up. This shall not prevent the FRTU from immediately registering inputs even before the time and date reference signal has been received. Any such inputs shall be reported to the TDMS with the appropriate time and date, i.e., use of an arbitrary default time and date is not acceptable.

4) Be able to receive a DNP 3.0 compliant time and date message that contains a Greenwich Mean Time (GMT) reference signal, generated by the TDMS in long format and in such a way as to properly account for communication path delays.

5) Be able to synchronize the internal clock to the GMT time and date received from the TDMS.

6) Be able to synchronize to an optional Global Positioning System (GPS) receiver. The GPS antenna shall be of low profile type for secure and moisture-resistant mounting on top of the FRTU enclosure. The receiver shall be used to synchronize the internal clock to the correct GMT time and date within a time resolution of at least 1 millisecond.

2.3.5 Web Server Function

The FRTU shall include a web server. The module's facilities shall be accessible through a secure HTTPS connection both locally and remotely by means of not only the FRTU test set, but also a standard laptop PC, tablet, or smartphone. Access shall be password protected and allow for different permissions based on defined user roles. Passwords and roles shall be defined during project implementation and after project has completed. As a minimum, the facilities of the web server shall include:

1) Maintenance features that include the capability to upgrade and configure FRTU firmware.

2) The capability to set FRTU communication parameters such as DNP3 Source Address, Destination Address, Timeouts, Retries, Frame Size, etc.

3) The capability to set FRTU clock time, time synchronization, and fault detection features.

4) Display and clearance of historical logs and the capability to export logs in CSV format.

5) MMI features such as mimic and graphic displays supporting for example RCS monitoring and control, visualization of site location details, and presentation of voltage and current measurements.

6) An FRTU field testing feature that allows a locally entered data point (simulating for example a power system voltage measurement) to be sent to the TDMS via DNP 3.0 along with an appropriate data quality code.

2.4 Software/Firmware

The term "software" is used in these Technical Specifications to mean software or software implemented through firmware. Complete and comprehensive documentation shall be provided for all software.

2.4.1 Operating System

The FRTU operating system shall:

1) Be a real-time non-proprietary operating system.

2) Manage and support all FRTU applications.

3) Support editing and customization by the Authority as needed to maintain FRTU operation.

4) Provide automatic restarts of the FRTU on power restoration, memory parity errors, hardware failures, and manual request.

5) Initialize the FRTU on power-up and begin execution of the FRTU functions without intervention by the TDMS.

6) Report all restarts to the TDMS.

2.4.2 Operating Software

The FRTU operating software shall be:

1) Prepared in a high-level language such as the IEC61131 programming suite.

2) Documented in detail.

3) Free of additional licensing charges or license agreements.

4) Supported by protocol, configuration, and application data contained in easily programmable non-volatile memory such as Flash EPROM.

5) Independent of any data communications protocol that would impose restrictions on the flexibility or functionality of the FRTU. In this respect, protocol changes shall be capable of being accomplished by locally and remotely implemented software/firmware changes only.

2.4.3 Diagnostic Software

FRTU diagnostic software shall:

1) Continuously monitor operation of the FRTU.

2) Report FRTU hardware errors to the TDMS.

3) Check for memory, processor, and input/output errors and failures.

4) Be sufficiently detailed to detect malfunctions to the level of the smallest replaceable component.

5) Facilitate isolation and correction of all failures.

6) Include features promoting rapid fault isolation and component replacement.

7) Include integrated on-line diagnostic functions in all functional module nodes.

8) Report diagnostic results to the CPM for store and forward to the TDMS.

2.5 Interlocking

The FRTU shall include configurable interlock logic to prevent misoperation of the RCS. In addition to preventing RCS operation locally and/or remotely in accordance with the positions of the Local/Remote and Mechanical Lock/Free switches, the RCS control command shall be prohibited in the case of a low SF_6 gas alarm. The interlock information shall be sent to the TDMS via the DNP 3.0 protocol.

2.6 FRTU Testing

2.6.1 Factory Acceptance Test

The Factory Acceptance Test (FAT) shall take place on each and every FRTU Interfaces when fully assembled in readiness for transportation to site. The FAT shall demonstrate that all of the component parts and functions of the FRTU interfaces are in good working order and properly configured for the FRTU Interface's designated site including integration with the DMS. Where applicable, the FAT procedures shall make full use of the test set.

The FAT shall verify that the FRTU can meet such basic requirements as follows:

1) Visual Inspection of Equipment (refer to Approval Drawing).

2) Fail safe design.

3) Rigorous testing of each input and output function of the FRTU (refer to Annex A: Input/Output point for FRTU-RCS Interface).

4) Detection of fault current amplitude and direction as follow:

- Phase Fault Current A, B, C

- Overcurrent (ANSI50/51, 50G/51G)

- Sensitive earth fault (ANSI 50SEF)

- Directional Relay (ANSI 67)

- Broken conductor (ANSI 46BC or ANSI 47BC)

- Negative sequence voltage (ANSI47)

5) Ability to communicate with external systems using the DNP 3.0 (Secure Authentication) over serial and IP protocols at the specified data rates.

6) Ability to support download and upload FRTU parameters and configuration data.

At the end of FAT, the Contractor shall submit a corresponding test report for Authority review and approval.

2.6.2 Site Acceptance Testing

Each FRTU Interfaces shall be tested at site. This shall include unit testing by the Contractor, at the time of installation of each FRTU Interfaces to ensure all components can be powered up and are in good working order, and subsequent site acceptance testing (SAT) to demonstrate that the FRTU Interfaces is fully operational with respect to the functional capabilities intended for use at its specifically assigned site. Prior to SAT, the Authority shall inspect the interface installation and corresponding Contractor maintenance records to identify all equipment that may have been modified, repaired, or replaced between the completion of FAT and the start of SAT.

To the fullest extent, site acceptance testing shall be carried out by using the functional capabilities of each FRTU to monitor and control the site's associated power system equipment. This may require power system outages in full coordination with the Authority's dispatchers. Otherwise, the functional capabilities shall be exercised using non-outage techniques such as simulating analog and status inputs and checking for control output signals at points of connection that may need to be temporarily isolated from power system equipment.

SAT shall also include a full demonstration of the FRTU Interfaces from the perspective of interoperating with its assigned DMS. In this respect, the Contractor shall make full use of the Test Sets to be provided for this purpose. Testing via a Test Set shall verify that the FRTU Interfaces are fully operational and capable of meeting or supporting all functional performance requirements. This shall include point-by-point checks to make sure that the database in the FRTU Interfaces is properly mapped to the corresponding DMS database.

The Test Set shall be connected to the FRTU's communication ports.

It is the Authority's intent to formally witness all FRTU tests. These tests shall be conducted by the Contractor using Contractor-prepared test plans and procedures approved by the Authority. In addition, the Authority reserves the right to subject selected FRTU Interfaces to the same tests performed in the factory. If several FRTU Interfaces of the same type fail SAT, such that a consistent pattern of failure becomes evident, the Authority also reserves the right to suspend SAT, and the transportation to site of additional FRTU interfaces of the same type, until a satisfactory resolution is reached concerning the steps to be taken to correct such failures.

The Contractor shall also prepare and submit reports following completion of the tests whether successful or not successful. These reports shall be duly signed by Authority and Contractor representatives participating in the tests. In the event any SAT test or associated site inspection is not completed successfully, the Contractor shall take all necessary corrective actions and inform the Authority of a schedule for retesting and/or re-inspection.

No FRTU Interfaces shall be accepted as complete until the Authority is satisfied that all variances associated with an individual site have been corrected and that the FRTU Interfaces is SCADA ready, i.e., can be considered fully available for integration with its DMS master station.

2.6.3 End-to-End Tests

The Authority will be responsible for commissioning each DMS master station under typical field conditions, including the need to verify that it can interoperate successfully with the Contractor's installed FRTU Interfaces. Verification shall be based on end-to-end tests concerned with:

1. Checking for correct database mapping between the DMS and the FRTU Interfaces

2. Making sure that the DMS and FRTU Interfaces, working together as an integrated system, can meet the Authority's overall functional performance requirements.

In effect, the end-to-end tests shall serve as a means of commissioning the FRTU interfaces as well as the DMS. The Contractor, therefore, shall support commissioning by having adequate Contractor personnel on hand to witness the end-to-end tests and to help resolve any variances that may be raised in connection with the FRTU interfaces. Variances specifically identified as FRTU interface problems shall be taken care of as quickly as possible. Otherwise, commissioning of the FRTU interfaces and the beginning of the corresponding warranty period may be unduly delayed.

Prior to starting the warranty period, the Contractor shall submit a report clearly identifying the results of all end-to-end testing from the perspective of the FRTU interfaces. This shall include a summary of the variances detected and whether or not these variances were successfully corrected. Where necessary, for Authority consideration, the report shall also include the Contractor's plan for resolving any and all variances not yet correct.

2.7 FRTU Accessories

2.7.1 Miniature Circuit Breaker (MCB)

MCB shall be qualified as following;

– Standard: IEC60898 or IEC60947 or equivalent

– Current rating: suitable for FRTU and Communication Equipment

– Voltage rating: at least 48 Vdc

– Interrupting rating: 10 kA

– No. of poles: 2 poles

– Mounting: DIN Rail

– Contact position indicator: shows the correct position of the contact

2.7.2 Control inhibit switch

Control Inhibit Switch shall be qualified as following;

– Standard: IEC60947-3or equivalent

– Type: 2 positions, 90°, CAM switch

– Nameplate: Control inhibit switch

– Current rating: at least 10 A

– Voltage rating: at least 400V

– Contacts: 4NO/4NC

– Handle: Short handle

2.7.3 Terminal Blocks

Terminal blocks shall be qualified as following;

1) They shall be used for connecting dc power cables to the FRTU and Communication Equipment and for terminating all I/O signals between the RCS and FRTU.

2) They shall be of heavy-duty at least 400 Vdc molded-block (bare-wire compression) type with molded insulating barriers between terminals.

3) No more than two cable wires shall be connected to any terminal.

4) Each terminal block and individual terminal shall have white, removable, self-extinguishing fireproof marking strips for circuit identification.

5) Termination blocks with by-pass bridges shall be provided for all ac inputs from CTs.

6) Adequate space as well as terminal blocks shall be provided for routing all associated cabling within the control cabinet.

7) All individual status input, AC voltage input and control output point shall be isolatable without the need to remove wiring by means of individual terminal blocks of the removable link type.

8) Terminal Blocks shall be tested with accordance with IEC60947-7-1 or equivalent.

9) Ground terminal block shall be green/yellow.

2.7.4 Metallic Cables and Wiring

All metallic cables and wiring shall be qualified as following;

1) Use copper conductors with flame retardant insulation. They shall also meet the flame test requirements of IEC60332-3 Category C.

2) Rated Voltage: 600 V

2) Be neatly laced and clamped.

3) Employ permanent labels for identification.

4) Use size and color-coded conductor's following in Exhibit 2-1

Exhibit 2-1: Cable Size & Insulation Color

Cable	Nominal cross-sectional area (sq.mm.)	Insulation Color
DC Supply (Positive)	2.5	White
DC Supply (Negative)	2.5	Black
Digital Input	1	Gray
Digital Output	1.5	Gray
Analog Input (Voltage)	1.5	A – Red
	1.5	B – Yellow
	1.5	C – Blue
	1.5	N – Green
Analog Input (Current)	2.5	A – Red
	2.5	B – Yellow
	2.5	C – Blue
	2.5	N – Green
Ground	4	Green/Yellow

2.7.5 FRTU Steel Plate Dimension

FRTU Steel Plate shall be qualified as following;

- Material: steel
- Primer coat: the number of coats is one (1) or two (2) coats of Epoxy (Misc) Anti-Corrosive Primer.
- Subsequent coat: RAL 7032 gray color.
- Dimensions: height between 450 - 530 mm. width between 580 - 600 mm. and thickness 2 mm.

2.7.6 Surge Protector for protect FRTU and Radio

Surge Protector shall be qualified as following;

- Number of pole: 2 Poles
- Rated Operational DC Voltage: 24 Vdc
- Maximum Discharge Current (8/20 µs) not less than 5 kA

Annex A

Input/Output point for FRTU-RCS Interface

INPUT/OUTPUT POINT FOR FRTU-RCS Interface

STATUS INPUT POINT

ITEM	POINT DESCRIPTIONS (UP TO 50 CHARS)	DESCRIPTION	STATE				PANEL	TERMINAL CONECTION	DIM NO.	POINT TYPE	DMS(DNP Mapping)					REMARK
			0	1	2	3					Obj.	Var	Qii	Class	ADDRESS	
1	RCS 1st FAULT DETECTED POSITIVE	NORMAL/FAULT	NORMAL	FAULT	-	-	FRTU-RCS	-	FRTU	SOE	2	2	17,28 and 00,01	Class 1	0	CREATE BY INTERNAL LOGIC
2	RCS 2nd FAULT DETECTED POSITIVE	NORMAL/FAULT	NORMAL	FAULT	-	-	FRTU-RCS	-	FRTU	SOE	2	2	17,28 and 00,01	Class 1	1	CREATE BY INTERNAL LOGIC
3	RCS 3rd FAULT DETECTED POSITIVE	NORMAL/FAULT	NORMAL	FAULT	-	-	FRTU-RCS	-	FRTU	SOE	2	2	17,28 and 00,01	Class 1	2	CREATE BY INTERNAL LOGIC
4	RCS 1st FAULT DETECTED NEGATIVE	NORMAL/FAULT	NORMAL	FAULT	-	-	FRTU-RCS	-	FRTU	SOE	2	2	17,28 and 00,01	Class 1	3	CREATE BY INTERNAL LOGIC
5	RCS 2nd FAULT DETECTED NEGATIVE	NORMAL/FAULT	NORMAL	FAULT	-	-	FRTU-RCS	-	FRTU	SOE	2	2	17,28 and 00,01	Class 1	4	CREATE BY INTERNAL LOGIC
6	RCS 3rd FAULT DETECTED NEGATIVE	NORMAL/FAULT	NORMAL	FAULT	-	-	FRTU-RCS	-	FRTU	SOE	2	2	17,28 and 00,01	Class 1	5	CREATE BY INTERNAL LOGIC
7	RCS CONTROL MODE STATUS	REMOTE	UNDEFINE	LOCAL	REMOTE	FAULT	FRTU-RCS	XD/1	FRTU	DI	2	1	17,28 and 00,01	Class 1	6	
8		LOCAL					FRTU-RCS	XD/2	FRTU	DI	2	1	17,28 and 00,01	Class 1	7	
9	RCS SWITCH STATUS	CLOSED	UNDEFINED	CLOSED	OPEN	FAULT	FRTU-RCS	XD/3	FRTU	SOE	2	2	17,28 and 00,01	Class 1	8	
10		OPEN					FRTU-RCS	XD/4	FRTU	SOE	2	2	17,28 and 00,01	Class 1	9	
11	RCS BATTERY LOW VOLTAGE	NORMAL/ALARM	NORMAL	ALARM	-	-	FRTU-RCS	XD/5	FRTU	DI	2	1	17,28 and 00,01	Class 3	10	
12	RCS BATTERY HIGH VOLTAGE	NORMAL/ALARM	NORMAL	ALARM	-	-	FRTU-RCS	XD/6	FRTU	DI	2	1	17,28 and 00,01	Class 3	11	
13	RCS BATTERY CHARGER OVER VOLTAGE	NORMAL/ALARM	NORMAL	ALARM	-	-	FRTU-RCS	XD/7	FRTU	DI	2	1	17,28 and 00,01	Class 3	12	
14	RCS GROUND BATTERY/CHARGER	NORMAL/ALARM	NORMAL	ALARM	-	-	FRTU-RCS	XD/8	FRTU	DI	2	1	17,28 and 00,01	Class 3	13	
15	RCS SF6 GAS LOW PRESSURE	NORMAL/ALARM	NORMAL	ALARM	-	-	FRTU-RCS	XD/9	FRTU	DI	2	1	17,28 and 00,01	Class 1	14	
16	RCS ENCLOSER DOOR OPEN	NORMAL/ALARM	NORMAL	ALARM	-	-	FRTU-RCS	XD/10	FRTU	DI	2	1	17,28 and 00,01	Class 1	15	
17	RCS CONTROL INHIBIT STATUS	NORMAL/ALARM	NORMAL	INHABIT	-	-	FRTU-RCS	XD/11	FRTU	DI	2	1	17,28 and 00,01	Class 3	16	
18	RCS MECHANICAL STATUS	FREE	UNDEFINE	FREE	LOCK	FAULT	FRTU-RCS	XD/12	FRTU	DI	2	1	17,28 and 00,01	Class 1	17	
19		LOCK					FRTU-RCS	XD/13	FRTU	DI	2	1	17,28 and 00,01	Class 1	18	
20	RCS SF6 GAS LOW LOCKOUT	NORMAL/LOCKOUT	NORMAL	LOCKOUT	-	-	FRTU-RCS	XD/14	FRTU	DI	2	1	17,28 and 00,01	Class 1	19	
21	RCS FRTU DATA QUALITY STATUS	NORMAL/ALARM	NORMAL	ALARM	-	-	FRTU-RCS	-	FRTU	DI	2	1	17,28 and 00,01	Class 3	20	CREATE BY INTERNAL LOGIC
22	RCS FRTU TESTING STATUS	NORMAL/TEST	NORMAL	TEST	-	-	FRTU-RCS	XD/15	FRTU	DI	2	1	17,28 and 00,01	Class 1	21	
23	RCS BATTERY FAIL STATUS	NORMAL/ALARM	NORMAL	ALARM	-	-	FRTU-RCS	XD/16	FRTU	DI	2	1	17,28 and 00,01	Class 3	22	
24	RCS FAULT CURRENT A	NORMAL/FAULT	NORMAL	FAULT	-	-	FRTU-RCS	-	FRTU	SOE	2	2	17,28 and 00,01	Class 1	23	CREATE BY INTERNAL LOGIC
25	RCS FAULT CURRENT B	NORMAL/FAULT	NORMAL	FAULT	-	-	FRTU-RCS	-	FRTU	SOE	2	2	17,28 and 00,01	Class 1	24	CREATE BY INTERNAL LOGIC
26	RCS FAULT CURRENT C	NORMAL/FAULT	NORMAL	FAULT	-	-	FRTU-RCS	-	FRTU	SOE	2	2	17,28 and 00,01	Class 1	25	CREATE BY INTERNAL LOGIC
27	RCS EARTH FAULT CONDITION	NORMAL/FAULT	NORMAL	FAULT	-	-	FRTU-RCS	-	FRTU	SOE	2	2	17,28 and 00,01	Class 1	26	CREATE BY INTERNAL LOGIC
28	RCS DIRECTIONAL PHASE FAULT(Pos)	NORMAL/FAULT	NORMAL	FAULT	-	-	FRTU-RCS	-	FRTU	SOE	2	2	17,28 and 00,01	Class 1	27	CREATE BY INTERNAL LOGIC
29	RCS DIRECTIONAL PHASE FAULT(Neg)	NORMAL/FAULT	NORMAL	FAULT	-	-	FRTU-RCS	-	FRTU	SOE	2	2	17,28 and 00,01	Class 1	28	CREATE BY INTERNAL LOGIC
30	RCS BROKEN CONDUCTOR	NORMAL/FAULT	NORMAL	FAULT	-	-	FRTU-RCS	-	FRTU	SOE	2	2	17,28 and 00,02	Class 1	29	CREATE BY INTERNAL LOGIC

23

CONTROL OUTPUT POINT

| ITEM | POINT DESCRIPTIONS (UP TO 50 CHARS) | DESCRIPTION | STATE | | PANEL | TERMINAL CONECTION | DIM NO. | POINT TYPE | DMS(DNP Mapping) | | | | | REMARK |
			1	2					Obj.	Var	Qii	Class	ADDRESS	
1	REMOTE CLOSE/ OPEN COMMAND	CLOSE	CLOSE	-	FRTU-RCS	XC/1-2	FRTU	SBO	12	1	ECHO OF REQUEST	-	0	
2		OPEN	-	OPEN	FRTU-RCS	XC/3-4	FRTU							
3	RCS TESTING COMMAND	TEST	TEST	-	FRTU-RCS	XC/5-6	FRTU	DOP	12	1	ECHO OF REQUEST	-	1	

ANALOGE INPUT POINT

| ITEM | POINT DESCRIPTIONS (UP TO 50 CHARS) | UNIT | SCALE | | PANEL | TERMINAL CONECTION | DIM NO. | POINT TYPE | DMS(DNP Mapping) | | | | | REMARK |
			ACTUAL DATA	RAW DATA					Obj.	Var	Qii	Class	ADDRESS	
1	CURRENT PHASE A	A	0-600(For 22 kV) , 0-400(For 33 kV)	0-600(For 22 kV) , 0-400(For 33 kV)	FRTU-RCS	ID/1-2	FRTU	AI	32	2	17,28 and 00,01	Class 2	0	600/1 A, 400/1 A
2	CURRENT PHASE B	A	0-600(For 22 kV) , 0-400(For 33 kV)	0-600(For 22 kV) , 0-400(For 33 kV)	FRTU-RCS	ID/3-4	FRTU	AI	32	2	17,28 and 00,01	Class 2	1	600/1 A, 400/1 A
3	CURRENT PHASE C	A	0-600(For 22 kV) , 0-400(For 33 kV)	0-600(For 22 kV) , 0-400(For 33 kV)	FRTU-RCS	ID/5-6	FRTU	AI	32	2	17,28 and 00,01	Class 2	2	600/1 A, 400/1 A
4	VOLTAGE PHASE A-B	kV	0-30.00(For 22 kV) , 0-40.00(For 33 kV)	0-3000(For 22 kV) , 0-4000(For 33 kV)	FRTU-RCS	UD/1	FRTU	AI	32	2	17,28 and 00,01	Class 2	3	22000/110 V, 33000/110 V
5	VOLTAGE PHASE B-C	kV	0-30.00(For 22 kV) , 0-40.00(For 33 kV)	0-3000(For 22 kV) , 0-4000(For 33 kV)	FRTU-RCS	UD/2	FRTU	AI	32	2	17,28 and 00,01	Class 2	4	22000/110 V, 33000/110 V
6	VOLTAGE PHASE C-A	kV	0-30.00(For 22 kV) , 0-40.00(For 33 kV)	0-3000(For 22 kV) , 0-4000(For 33 kV)	FRTU-RCS	UD/3	FRTU	AI	32	2	17,28 and 00,01	Class 2	5	22000/110 V, 33000/110 V
7	ACTIVE POWER	MW	-31.18 - +31.18	-3118 - +3118	FRTU-RCS	-	FRTU	AI	32	2	17,28 and 00,01	Class 2	6	CALCULATE BY SOFTWARE
8	REACTIVE POWER	MVAR	-31.18 - +31.18	-3118 - +3118	FRTU-RCS	-	FRTU	AI	32	2	17,28 and 00,01	Class 2	7	CALCULATE BY SOFTWARE
9	POWER FACTOR	%	+/- 100.00	-10000 - +10000	FRTU-RCS	-	FRTU	AI	32	2	17,28 and 00,01	Class 2	8	CALCULATE BY SOFTWARE
10	FAULT CURRENT A	A	0-20000	0-20000	FRTU-RCS	-	FRTU	AI	32	4	17,28 and 00,01	Class 1	9	
11	FAULT CURRENT B	A	0-20000	0-20000	FRTU-RCS	-	FRTU	AI	32	4	17,28 and 00,01	Class 1	10	
12	FAULT CURRENT C	A	0-20000	0-20000	FRTU-RCS	-	FRTU	AI	32	4	17,28 and 00,01	Class 1	11	

SBO	= OUTPUT COMMAND (SELECT BEFORE OPERATE), DOP = OUTPUT COMMAND (DIRECT OPERATE)	Noted : Qi (17,28) for poll class and Qii (00,01) for integrity scan
AI	= ANALOG INPUT (MEASUREMENT)	
DI	= REGULAR POINT (DIGITAL INPUT WITHOUT TIME TAG), SOE = MCD POINT (DIGITAL INPUT WITH TIME TAG)	
NOTE	: THE MEANING OF DESCRIPOR IS BEFORE "/" IS STATE "1" AFTER "/" IS STATE "0" FOR BINARY POINT; FIRST LINE IS STATE "0,1" SECOND LINE IS STAGE "1,0" FOR TERNARY POINT., CLASS 1 = UNSOLICITED, CLASS2,3 = POLLING	

เอกสารแนบท้ายเอกสารประกวดราคาอิเล็กทรอนิกส์

1.7(2)   Specification No.: RMIS 102/2559:

Cellular Equipment for Field Devices Interface

C3 Schedule of detailed requirement

Invitation to Bid No.:

Item	PEA Material No.	Quantity	Description
1	-	1 lot	**1.1 ………..set(s) 3G Modem**, suitable for connecting with field devices such as Remote Controlled Switches (RCS), reclosers, etc. for SCADA communication via cellular network, with:
			Cellular technology : GSM, GPRS, EDGE, UMTS and HSPA, or more
			Frequency bands : 850, 900, 1,800 and 2,100 MHz, or more
			Maximum output power : according to Thailand's telecommunication standards and regulations and approval certificate from NBTC shall be submitted
			Protocol support : UDP, TCP, IP, and PPP, or more
			Functions and securities : - automatic connection - transparent (for TCP client/server and UDP protocol for serial interface) - keep alive - built-in watchdog or equivalent function - or more
			SIM card interface : 1 x SIM card holders, or more
			Communication interface:
			- RS-232, with:
			- number of ports : not less than 1 port
			- baud rate : 1,200 bps – 115,200 bps, or better
			- data format : 8 bits, 1 stop bit, None/Odd/Even parity
			External antenna interface : SMA female, or other interface connectors provided with adaptor
			Mounting : wall mounted or standard DIN rail mounted
			Signal strength and status indicators : LED indicators
			Operating temperature : up to 70°C
			Operating relative humidity : up to 90% non-condensing
			Nominal power supply voltage : 12 V DC and 24 V DC, or better
			Complete with:
			1. One (1) set of communication cable, not less than 1 meter length, with connector for connecting the Modem to the field device via RS-232 port.
	I		2. One (1) set of communication cable, not less than 1 meter length, with connector (SMA male to SMA female) for connecting the Modem via external antenna interface to surge arrester.

C3 Schedule of detailed requirement

Invitation to Bid No.:

Item	PEA Material No.	Quantity	Description
			3. Power supply cord
			4. Mounting kit
			5. Software for modem configuration with Graphic User Interface (GUI) and instruction manual
			6. Other accessories according to manufacturer's design and auxiliary equipments necessary to complete.
			1.2 ………..set(s) Surge arrester, gas discharge type, suitable for protection the 3G Modem form an external surge by series connection, with:
			Working frequency range : DC to 3 GHz, or better
			DC breakdown voltage : not less than 90 V DC
			Voltage protection level : not more than 700 V
			Maximum discharge current : not less than 10 kA
			Voltage Standing Wave Ratio (VSWR) : not more than 1.5:1
			Insertion loss : not more than 0.9 dB
			Interface : SMA male (Modem/Router side) to SMA female (Antenna side) or other interface connectors provided with adaptor
			Operating temperature : up to 70°C
			Operating relative humidity : up to 90% non-condensing
			Complete with:
			1. Instruction manual
			2. Other accessories according to manufacturer's design and auxiliary equipments necessary to complete.
			1.3 ………..set(s) Antenna, omni directional and outdoor application, suitable for using with 3G Modem, with:
			Polarization type : vertical
			Gain : not less than 3 dBi
			Frequency : 850, 900, 1,800 and 2,100 MHz, or more
			Voltage Standing Wave Ratio (VSWR) : not more than 2.0:1
			Material : waterproof fiberglass
	I		

C3 Schedule of detailed requirement

Invitation to Bid No.:

Item	PEA Material No.	Quantity	Description
2	-	1 lot	Complete with: 1. Antenna mounting, suitable for installation the antenna on the top of the existing field device's control cabinet or beside of the concrete pole. 2. One (1) set of communication cable, not less than 1 meter length, with connector for connecting the antenna to surge arrester. The antenna interface of the arrester is SMA female. 3. Instruction manual 4. Other accessories according to manufacturer's design and auxiliary equipments necessary to complete. **2.1 ………...set(s) 3G Router**, industrial grade, suitable for connecting with field devices such as Remote Controlled Switches (RCS), reclosers, etc. for SCADA communication via cellular network, with: Electromagnetic compatibility (EMC) standards compliance : - IEC/EN 61000-4-3 level 3, or better - IEC/EN 61000-4-4 level 3, or better - IEC/EN 61000-4-5 level 3, or better - IEC/EN 61000-4-6 level 3, or better - IEC/EN 61000-4-12 level 3, or better Cellular technology : GSM, GPRS, EDGE, UMTS and HSPA, or more Frequency bands : 850, 900, 1,800 and 2,100 MHz, or more Maximum output power : according to Thailand's telecommunication standards and regulations and approval certificate from NBTC shall be submitted Protocol support : UDP, TCP, IP, PPP and Telnet, or more Functions, features and securities : - automatic connection - transparent (for TCP client/server and UDP protocol for serial interface) - keep alive - Network Address Translation (NAT), port forwarding, intrusion protection, filtering and Access Control List (ACL) or equivalent function - or more
	I		SIM card interface : 1 x SIM card holders, or more

C3 Schedule of detailed requirement

Invitation to Bid No.:

Item	PEA Material No.	Quantity	Description
			Communication interface:
			- Ethernet port (RJ-45), with:
			- number of ports : not less than 1 port
			- baud rate : 10/100 Mbps, or better
			- protection : not less than 1.5 kV Electro Static Discharge (ESD) protection
			- RS-232, with:
			- number of ports : not less than 1 port
			- baud rate : 1,200 bps – 115,200 bps, or better
			- data format : 8 bits, 1 stop bit, None/Odd/Even parity
			- protection : not less than 6 kV Electro Static Discharge (ESD) protection
			External antenna interface : SMA female, or other interface connectors provided with adaptor
			Mounting : wall mounted or standard DIN rail mounted
			Signal strength and status indicators : LED indicators
			Degree of protection : IP 20, or better
			Operating temperature : up to 70°C
			Operating relative humidity : up to 90% non-condensing
			Nominal power supply voltage : 12 V DC and 24 V DC, or better
			Complete with:
			1. One (1) set of communication cable, not less than 1 meter length, with connectors for connecting the Router to the field device via Ethernet port.
			2. One (1) set of communication cable, not less than 1 meter length, with connectors for connecting the Router to the field device via RS-232 port.
			3. One (1) set of communication cable, not less than 1 meter length, with connector (SMA male to SMA female) for connecting the Router via external antenna interface to surge arrester.
			4. Power supply cord
			5. Mounting kit
			6. Software for router and Telnet configuration with Graphic User Interface (GUI) and instruction manual
	I		7. Other accessories according to manufacturer's design and auxiliary equipments necessary to complete.

C3 Schedule of detailed requirement

Invitation to Bid No.:

Item	PEA Material No.	Quantity	Description
			2.2 ………..set(s) Surge arrester, gas discharge type, suitable for protection the 3G Router form a external surge by series connection, with:
			Working frequency range : DC to 3 GHz, or better
			DC breakdown voltage : not less than 90 V DC
			Voltage protection level : not more than 700 V
			Maximum discharge current : not less than 10 kA
			Voltage Standing Wave Ratio : not more than 1.5:1 (VSWR)
			Insertion loss : not more than 0.9 dB
			Interface : SMA male (Modem/Router side) to SMA female (Antenna side) or other interface connectors provided with adaptor
			Operating temperature : up to 70°C
			Operating relative humidity : up to 90% non-condensing
			Complete with:
			1. Instruction manual
			2. Other accessories according to manufacturer's design and auxiliary equipments necessary to complete.
			2.3 ………..set(s) Antenna, omni directional and outdoor application, suitable for using with 3G Router, with:
			Polarization type : vertical
			Gain : not less than 3 dBi
			Frequency : 850, 900, 1,800 and 2,100 MHz, or more
			Voltage Standing Wave Ratio : not more than 2.0:1 (VSWR)
			Material : waterproof fiberglass
			Complete with:
			1. Antenna mounting, suitable for installation the antenna on the top of the existing field device's control cabinet or beside of the concrete pole.
			2. One (1) set of communication cable, not less than 1 meter length, with connector for connecting the antenna to surge arrester. The antenna interface of the arrester is SMA female.
			3. Instruction manual
	I		4. Other accessories according to manufacturer's design and auxiliary equipments necessary to complete.

C3 Schedule of detailed requirement

Invitation to Bid No.:

Item	PEA Material No.	Quantity	Description
			Notes:
			1. Each Item shall be packed in suitable package.
			2. The Bidders have to quote the unit costs.
			3. The Bidders shall be sole distributor or authorized representative and have a permanent office in Thailand; otherwise shall not be accepted.
			4. The Bidders have to submit the sufficient references describing the previous experience of the suppliers (e.g. list of supply of equipment and/or materials having the same or similar design as proposed, field experience, the registration of TISI, the copies of license, and/or the inspection to supplier's factory by PEA's inspectors, etc.) to the satisfaction of PEA.
			5. In case the samples are requested by PEA, the Bidders have to supply at least one (1) sample of the proposed Item(s) within fifteen (15) calendar days. The bidders who cannot supply the samples shall be rejected. PEA reserves the right to test the sample(s) according to PEA's testing procedure. In case of the failing test results, the Bidders will be rejected. The sample(s) will be returned after the test and consideration.
			6. The Contractor has to guarantee the quality of the 3G Modem/ 3G Router, surge arrester and antenna for **Three (3) years** from date of issuance of the notice of acceptance. During the guarantee period, the Contractor shall replace the defective Modem/Router, arrester and antenna for free of charge or shall pay an amount equal to the exact purchasing value for the defective quantity of them.
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