



ERTU – BS02

User Manual

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1. Overview

Blue Star's Energy Remote Terminal Unit ERTU-BS02 is a remote terminal equipment for energy Tele-Metering Reading system (TMR). BS02 is developed according to "China Power Industry Standard DL/T 743—2001 for Energy Remote Terminal Unit". An energy billing system can be constructed by BS-02 together with energy billing main station, which can be used to collect and process remote energy information at all levels of dispatch and settlement centers. In addition to being able to collect multi-type energy meters' energy data, BS02 can handle the necessary data processing, can store, display and print the data locally, it also can transmit the energy data to the main station system actively or passively. Moreover BS02 supports communications with multiple main stations; each main station can operate independently according to its own login right.

BS02 takes advantage of mature and advanced hardware and software technologies. In hardware, components and connectors used by BS02 are all internationally famous brands' industrial level products. The principle is mature and stable technique, powerful and efficient performance. In software, BS02 is equipped with the most advanced real-time multitasking operating system, all functional modules are implemented based on this operating system. In this way, BS02 can achieve high performance, high efficiency, high dependability and high stability.

2. Features

- BS02 runs the most advanced embedded real-time multitasking operating system, VxWorks by WindRiver Co. All applications are implemented on top of this OS.
- BS02 supports multiple energy meter protocols, so it can collect data from different energy meters made by different manufacturers.
- BS02 communicates with main station system using compatible IEC60870-5-102 protocol. This compatible protocol is extended on the top of standard IEC60870-5-102 protocol. Therefore BS02 can provide a lot of extended functions for users when keeping compatibility.
- BS02 supports up to 11 communications ports, including 1 Ethernet port, 2 full duplex RS-232 ports, 1 parallel port, 3 internal modems, 4 RS-485 ports (4-wire), among which Ethernet port and internal modems are used to communicate with main stations, RS-485 (4-wire) is used to collect energy data from energy meters, RS-232 can be configured by user to either communicate with main stations or collect energy meters data, parallel port is connected to local printers

to print energy data.

- Friendly user interface. BS02 user interface panel consists of 23 keys, 320x240 matrix LCD screen and 8 LEDs. It can display graphical data.
- User can operate BS02 through user panel, local computer or remote control. BS02 user panel interface supports all inquiry operations and part of configuration operations. Through local PC or remote mode, all operations are available from the main stations software.
- Security: Firstly BS-02 protects system using login mechanism. All operations in all modes need to log in using correct user name and password. User is able to obtain access rights according to what have been assigned to the login account. BS-02 system supports 3 user authorities: General, System and Super user. Secondly when ERTU-BS02 communicates with main station using IEC60870-5-102 protocol, every protocol packet is transmitted after encrypted. Both encryption key data and account data are stored after encrypted.
- Easy to Maintain. User can achieve system maintenance, hardware diagnosis and online software upgrade remotely through remote diagnosis interface.
- ERTU-BS02 data storage media uses standard IDE interface Flash Disk from 4M up to 2Gbytes, or even more. User can select proper data storage capacity according actual requirement or easily upgrade capacity when ensuring secure and stable data storage.
- ERTU-BS02 supports DOS file system, both parameters and data are saved in configuration files and DBF database files. User can easily process the files after transferring them to PC.
- ERTU-BS02 functionalities are implemented in multitasking mode. It supports multi-main-station parallel operation; it also supports multi-thread parallel meter reading. In this way, BS-02 can shorten system respond time for user operation and meter-reading and increase system efficiency dramatically.
- Timing task is the core of ERTU-BS02 design concept, main operations and functions are implemented based on timing tasks. There are 3 types of timing tasks: Timing meter-reading, timing broadcasting clock synchronization, and timing mailing task. Each timing task can be configured independently and can be executed in parallel. User can flexibly set up timing tasks according to actual demand including energy meter object, electricity data item, start-stop time, task cycle etc.
- ERTU-BS02 has GPS clock and high precision calendar clock embedded internally.
- ERTU-BS02 has both software watchdog and hardware watchdog.
- ERTU-BS02 has audition function. System running events (system power-up, system reset and system power-loss etc) and user operation information (user login, user meter-reading etc) are all saved in files and can be viewed locally or remotely.
- ERTU-BS02 uses standard 19"/3U case. All components and connectors are industrial level well-known brands products. Central processing unit is mature and reliable MOTOROLA networking communication controller which has super

characteristics such as immunity to static electricity, immunity to electromagnetic interference, low power consumption and superb communication capability etc. Power supply is a switch power module by DENSEI-LAMBDA which takes both AC and DC with zero switching time. This makes BS-02's power supply very reliable.

3. Main Functions

Main functions are as following:

3.1. Energy Data Acquisition

ERTU-BS02 collects data by reading energy data directly from energy meters. BS-02 can also gather data from different energy meters using different protocols. System can activate gathering option in 2 ways:

- User Command: User sends collecting command which specifies the target energy meter and energy data item; ERTU-BS02 will activate data gathering option after receiving the command and read corresponding energy data.
- Timing meter-reading: When timing meter-reading task has been configured in BS-02, data collection will be executed automatically according to the start-stop time and meter-reading cycle. The target energy meter and the energy data item should have been assigned in the timing task. Collected data will be saved to corresponding DBF database file.

3.2. Energy Data Inquiry

ERTU-BS02 allows local or remote users to check energy data. Energy data could be historical data in DBF database or real-time data in energy meter.

- Historical Data Inquiry. This inquiry can only check energy data that have already been stored in database. Energy database is built according to timing meter-reading task. Before executing inquiry, user needs to select timing meter-reading task to specify the energy database. User can specify the time range for the inquiry or check the most recent data in the database. User can also specify the target energy meter and energy data item which are included in the timing metering-reading task.
- Real-time Data Inquiry: This inquiry can check the latest data in the current energy. User can specify the target energy meter and energy data item. The

result energy data of this inquiry will not be stored.

3.3. Archive Management

ERTU-BS02 can inquire and configure archives. There are 2 types of archives:

- ERTU-BS02 Terminal Archive. This archive matches with each ERTU-BS02 terminal one by one. This archive contains all the necessary information for ERTU-BS02 terminal. Main information include: ERTU-BS02 terminal ID, ERTU-BS02 terminal IP address and port number, main station IP address and port number, communication protocol type flag, communication mode word, communication telephone number, alarm telephone number, reply telephone number, mailbox address, mailbox user name and password etc. User can locally or remotely check this archive information, or modify this archive after environmental changes (such as telephone number change, IP address change etc) . This archive does not support delete operation.
- Energy Meter Archive. This archive corresponds to the energy meter under ERTU-BS02 terminal. Every energy meter has an energy meter archive to record its detailed information which includes meter ID (Serial Number?), meter number, meter address, communication routing number, communication type, communication baud rate, mode mark, meter type and etc. This information is primarily used for multi-type and multi-channel energy meter data gathering. User can locally or remotely check all the energy meter archive information or add and delete corresponding energy meter archive when ERTU-BS02 terminal needs to add, delete or modify energy meters.

Archive modification operations including adding, modifying and deleting operation require main station PC software to cooperate. Refer to "Energy Telemetry System TMR-BS02 Manual" for detailed descriptions of ERTU-BS02 archive operations.

3.4. Timing Task Management

Timing task is the core of the whole ERTU-BS02 system; most energy data collecting and transmission are implemented by timing tasks. By setting up timing tasks, ERTU-BS02 terminal can execute the specified tasks in specified time and cycle according to specified preference. Timing task cycle ranges from 0 minute to 65535 minutes. 0 means this task halts forever. In this flexible way, user can schedule multiple timing tasks with different start-stop time, different execution cycles and execution preference to avoid conflict and fully take advantage of available resources.

User can configure, delete and inquire timing tasks with main station software on a local or remote PC. Only timing task inquiry is available from local operation panel

interface. See the description of timing tasks in the “Energy Telemetry System TMR-BS02 Manual” for related main station software description.

There are 3 types of timing tasks:

- Timing meter-reading and reply task. This type of task is the most important one among timing tasks. There may be multiple different timing meter-reading and reply tasks according to different requirements in ERTU-BS02 terminal. When configuring a timing task, the execution start-stop time, execution cycle, target energy meter and energy data item can be specified. If the data collected by this timing task need to be sent to main station initiatively, the send-back start-stop time and cycle can also be specified. When configuring successfully, ERTU-BS02 terminal will schedule the execution of tasks according to the tasks preferences.
- Timing Broadcasting Clock Synchronization Task: This task is to synchronize all of the energy meters under ERTU-BS02 terminal. There is only one such a task at most for each ERTU-BS02 terminal.
- Timing Mailing Task. This task is responsible to package energy data in energy database of ERTU-BS02 terminal and sends to a certain mailbox. Similarly there is only one this type of task in each ERTU-BS02 terminal. Only existing timing meter-reading task can have its corresponding energy database and can be specified by user to send mails. When configuring this task, different meter-reading tasks can have different mail-sending start-stop times and cycles.

3.5. Local Display and Print

Friendly local user interface consists of LCD screen, keypad and LED's.

- 320x240 LCD. Supports upper-case and lower-case English letters and numeric inputs.
- 8 LED's to display running status.
- 18-key keypad and 5 additional function keys.
- Local login mechanism requires user name and password. Both user name and password are up to 16 characters which could be 26 English letters (case sensitive) or numbers.
- System will logout automatically and shut off display upon timeout.
- Display hibernation and automatic backlight on and off.
- Energy data inquiry
- Audition information inquiry
- ERTU-BS02 terminal and energy meter archive management.
- Timing task management

- Communication and system parameters configuration
- User management
- Local debugging.
- BS02 terminal help including system date and time, product and company info, etc.
- Standard parallel printer port supports local printing when connecting to a printer.

3.6. Parameters Configuration

ERTU-BS02 terminal parameters configuration is mainly for local functions. There are 2 types of parameters:

- Communications parameters: ERTU-BS02 terminal has multiple different ports (including serial port, embedded internal modem, LPT parallel port, etc). User can configure each communication port by specifying the baud rate, hardware flow control, parity, stop bit, main station communication and meter-reading mode, etc.
- Display Parameters. Display parameters include display hibernation parameter and display shutoff parameters. Display hibernation is like PC screen saver function, terminal will display black screen without logout if user didn't operate panel keypad for a long time; any key pushing will restore terminal to the previous working status. Display shut-off is to turn off display and log out of system after long idle. By configuring display parameters, user can enable or disable display hibernation and display shut-off functions and specify the time-out times for display hibernation and display shut-off.

3.7. User Management

ERTU-BS02 terminal allows multiple users; each user can have his user information which includes user name, password and access level. Users with different access levels can have different operation levels. General user can only perform inquiry operation, system user can perform inquiry and configuration, and super user can perform all operations supported by ERTU-BS02. User management primarily includes:

- Add new user
- Delete user information
- Modify user information
- Inquire user information

3.8. Self-checking function

- Both software and hardware watchdogs
- Hardware self-diagnosis function

3.9. Clock synchronization

ERTU-BS02 terminal supports clock synchronization for itself and broadcasting clock synchronization for energy meters. According to different requirements and hardware configurations, GPS clock synchronization and main station synchronization can be chosen from when synchronizing ERTU-BS02 terminal.

- GPS clock synchronization. ERTU-BS02 terminal supports an optional internal GPS signal receiving device which can synchronize time by reading GPS signals.
- Main station clock synchronization. Done by sending clock synchronization commands from main station.
- Energy meters broadcasting clock synchronization. Done by sending energy meter broadcasting clock synchronization commands from main station or by configuring timing task of energy meters broadcasting clock synchronization.

3.10. System Maintenance and Upgrade

- Online diagnosis. ERTU-BS02 terminal can provide diagnosis information including tasks running status, system resources information during system running time.
- Remote online upgrade. This function provides a fast and convenient way to upgrade ERTU-BS02 software.

3.11. File Transfer

ERTU-BS02 terminal can transfer files with main stations. With this function, parameters files can be downloaded and energy database files uploaded.

- File transfer in control direction: file transferred from main station to ERTU-BS02 terminal
- File transfer in monitoring direction: files transferred from ERTU-BS02 terminal to main station.

3.12. Replacement of Substitution Channels

ERTU-BS02 terminal can recognize and replace substitution channels with switching Value quantities control.

- Supports 32 channels of Switching Value input measures
- Supports 32 channels of Switching Value output measures

3.13. Audition Function

ERTU-BS02 terminal monitors and logs system running status and save information to database. User can inquire audition information by specifying type and time ranges. There are 3 types of audition information:

- Discrete event information including: system power-up, system power-loss, system reset, hardware error, warning information, error message, timing tasks reply event, etc.
- System running information, including execution of timing tasks, GPS automatic clock synchronization
- User operation information including user login, timing tasks configurations, energy data inquiry, etc.

4. ERTU-BS02 Technical Data

ERTU-BS02 terminal's technical data meets or exceeds "China DL/T 743-2001 Energy Remote Terminal Unit".

4.1. Power Supply

Terminal can have AC and DC power supply simultaneously, so it can work properly as long as one power channel works properly. It can switch between power supplies without any delay.

- AC Power 85~265VAC (47~63Hz), harmonic < 10%.
- DC Power
 - 24VDC rated - voltage range: 18V~36V
 - 48VDC rated - voltage range: 36V~76V
- Power consumption: 50W Max, depends on number of function modules running
- Input and output over-voltage and over-current protection, DC reverse input polar protection.

4.2. Environment

- Storage temperature: -25°C ~ +70°C, running temperature: -20°C ~ +55°C.
- Humidity: 90% r.F max (without dew)
- Vibration: in accordance with IEC68-2-6
- Mechanical Strength: in accordance with IEC68-2-27
- Insulation, withstand voltage: in accordance with GB/T-13729-92
- EMC Interference Rejection: Level 3 or 4 according to IEC60870-2-1
- Rejection to static discharge interference: in accordance with GB/T 15153.1
- Rejection to fast transient pulse group interference: in accordance with GB/T 17626.4
- High frequency interference: in accordance with GB/T 15153.1
- Power frequency magnetic field interference rejection: in accordance with GB/T 15153.1
- Voltage surge rejection: in accordance with GB/T 15153.1
- Impulse voltage withstand: in accordance with DL/T 743-2001。

4.3. Usability

- Mean Time Between Failures (MTBF) \geq 100000 hours
- Lifetime \geq 15 years.

4.4. Internal Clock

- Daily timing error $<$ 1 second / day

4.5. Data Storage

Data storage capacity can be easily configured and expanded with Flash Disk.

- Storage capacity: Flash Disk's capacity range: 4M~2G bytes, user can select according to actual requirement.
- Energy data storage days: depends on number of meters, number of energy data items and tasks cycles assigned in timing meter-reading task
- Energy Data Types: Since data is saved in parameter files, almost all types of energy data can be saved, which include energy, demand, voltage, current etc, as long as it is included in the parameter file. In the meantime, it is very convenient to add a new energy data item.

4.6. Local User Interface

Local user interface consists of graphic display, keypad and LED's. User can input alphanumeric characters.

- Display Screen: 320x240 matrix LCD screen
- Keypad: 23 keys total. 18-key keypad for alphanumeric input, direction control (up, down, left, right), Enter, Cancel, Display On operations. 5 shortcut function keys for shortcut operations.

4.7. Main Station Communication Interface

- Transmission Protocol: DL/T 719-2000 (idt IEC60870-5-102: 1996), compatible with DL/T 719-2000 extended protocol. If communication interface uses Ethernet networking interface, communication protocol is running based on TCP/IP.
- Number and types of Interface: Supports up to 6 ports which include: 1

10BASE-T TCP/IP Network Interface (Ethernet) , 3 Internal Embedded Modem, 2 Full Duplex RS-232.

- Communication speed: Ethernet Interface - 10Mbps; Internal Embedded Modem - 56Kbps, RS-232 - 300~38400bps optional.

4.8. Energy Meter Communication Interface

- Communication Protocol: DLT/645
- Number and Types of Interfaces: Supports up to 6 ports which include 4 4-wire RS-485 ports, 2 Full Duplex RS-232 ports. RS-485 supports up to 255 energy meters.
- Communication Baud Rate: 300~38400bps selectable.

4.9. Integration Cycle

Energy data integration cycle depends on the execution cycle of timing tasks. The execution cycle of timing task can be set from 1 to 65535 minutes (about 45 days) arbitrarily.

4.10. Internal Modem

- Transmission Type: CCITT, V.90, V.34+, V.34, V.32bis (TCM) , V.32 (QAM & TCM) , V.22bis, v.23 Main (host) , V.23 Back (user) , V.22, V.21; Bell: 212A, 103.
- Hardware Error Correction and Compression: ITU-T V.42 & V.42bis, MNP class 2-5.
- Bell Voltage and Frequency: 15.3~68Hz, TTL Compatible.
- Bell 's Ringing Times: 2 times

4.11. Standards

- "China Power Industry Standard DL/T 743 - 2001 for Energy Remote Terminal Unit"
- "China Power Industry Standard DL/T 719 - 2000 idt IEC60870-5-102: 1996 Telecontrol Equipment and System Part 5, Transmission Protocol Chapter 102: Electrical System Energy Accumulative Transmission Auxiliary Standard"

5. Data Flow Brief Description

ERTU-BS02 terminal executes timing tasks based on system clock, which include (Timing meter-reading/reply task, timing mailing task, timing broadcasting clock synchronization task). According to the specified integration cycle, timing meter-reading/reply task collects energy data and saves to database, and regularly sends the data in database back to main station system. Timing mailing task packages the energy data in the database and sends to mailbox according to specified execution cycle. Timing broadcasting clock synchronization task is to synchronize the energy meters' clocks periodically. ERTU-BS02 monitors running status; records audition information including discrete events, system running information and user operation information. Energy data and audition information can be collected and inquired through local and remote communications ports with main station software, or inquired on panel LCD display with keypad. User can also maintain system archives and running parameters using panel keypad and LCD display or local and remote main station system.

See Appendix 1: ERTU-BS02 Terminal Data Flow Diagram

6. Hardware Architecture and Installation Instruction

Overall Description

BS-02 uses plug-board structure (back-plugging), basic plugging components include: CPU (MCU), Communications Expanded (TXEX), Parallel LPT, RS-485 isolation (485), 16 Channels of Switching Values Input (SI), 16 Channels of Switching Values Output, AC Power (AC), DC Power (DC). BS-02 can connect 2 SI board and 2 SO boards, i.e. BS-02 can have to 32 channels of switching inputs and 32 channels of switching outputs.

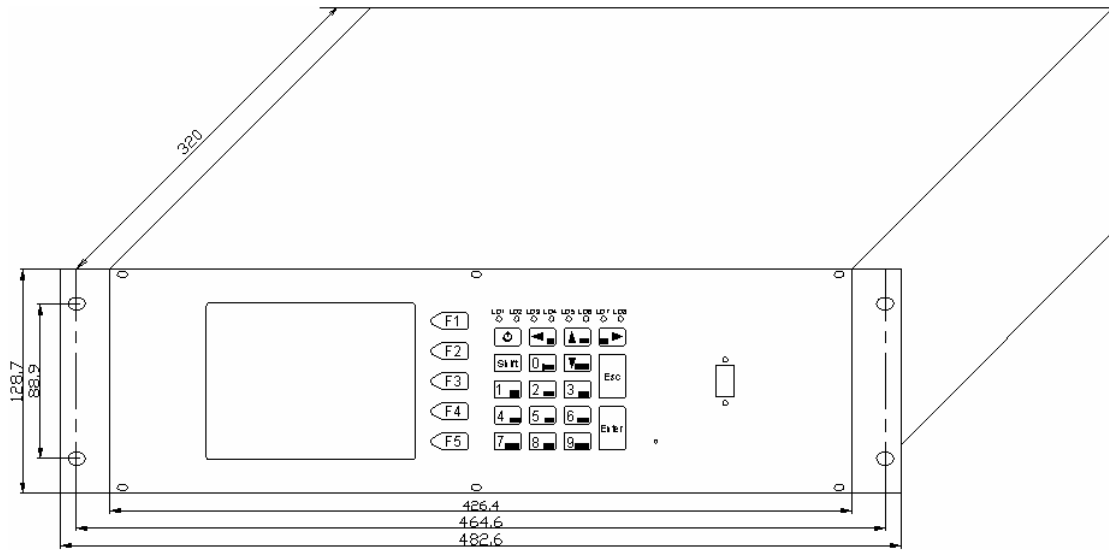
Functional Features

- Power Supply:
 - a. AC (220V), DC (24V) simultaneous inputs. Will not consume DC power when system is supplied by AC power; if AC power is lost, power supply will switch to DC automatically without manual operation. System uses local on-site DC power supply as backup so it can always have a working power source.

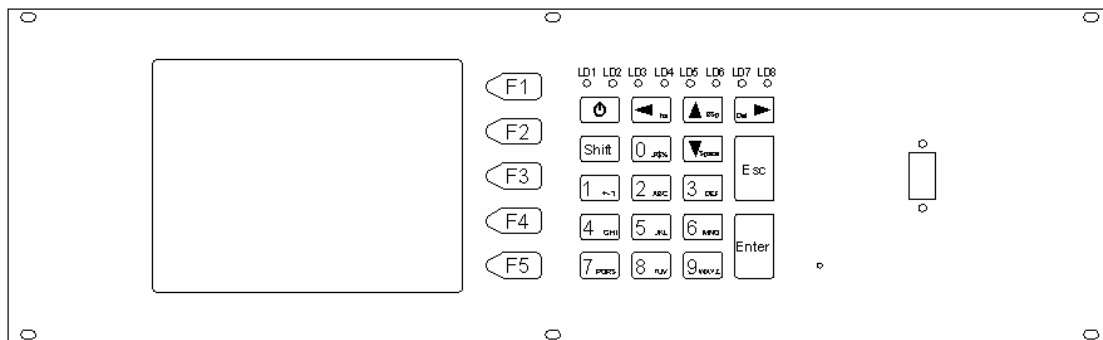
- b. All power modules made by Japanese LAMBDA Corp. which has multiple international safety certificates. System reliability can be ensured and the interferences to surrounding environment can be controlled within standard range.
 - c. In addition to the internal work power, BS-02 also provides up to 64 channels of isolated power source (current 20mA max) for switching values.
 - d. All communication ports (including Ethernet, MODEM Phone jacks, RS-232 port, RS-485 port and LPT port) and switching values are isolated from system main power supply
 - e. External power supply is isolated from system main power.
- Devices
- a. MCU: MOTOROLA 32 bit embedded industrial level MCU
 - b. Operating System: VxWorks real-time OS
 - c. Watchdog: internal and external combined.
 - d. Main Frequency : >20MHz
 - e. RAM: 2M bytes
 - f. Data space: Industrial level Flash Disk, default size 256M bytes
 - g. Clock: External clock chip with independent backup power can guarantee continuous clock running during system power-loss for up to 10 years. BS-02 can synchronize clock through system time synchronization or by GPS if GPS module is selected.
 - h. Alarm: Communications alarm, local beeper alarm, LCD display alarm
 - i. Self-Checking: MCU can automatically check if each function module works properly.
- Communications
- a. Communications with main station: Remote communications through 10M Ethernet port and 3 56K MODEM; Local through 2 RS-232 ports
 - b. Communications with energy meters: 4 channels of isolated 1/8-load RS-485, each RS-485 channel can have up to 256 connections.
- Print: supports local printing
- User-Machine Interface
- a. Display: 320×240 Matrix LCD screen for wide temperature range
 - b. Keypad: 23 buttons total; among which F1 to F5 are used with LCD display; functions of other keys see the instruction manual.

Installation Instruction

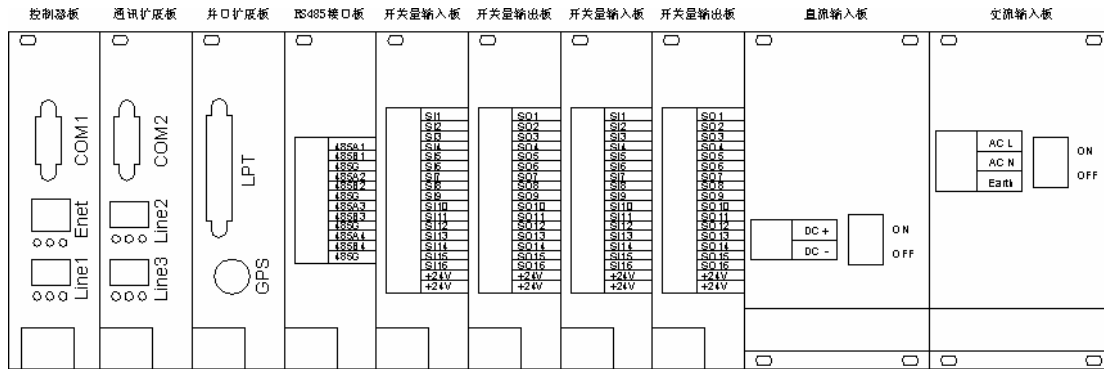
- 1) External Size: Standard 19" 3U case. Detailed size see the following figure: (Unit: mm)



- 2) Front Panel: There is a standard null modem DB9 connector which can be used for communications with local main station.



- 3) Back Panel Diagram:



- 4) Microcontroller Board: (MCU)
 - COM1:** Standard null modem RS-232 port for main station communication
 - ENet:** 10M Ethernet networking interface.
 - Line1:** Phone jack, internally connected to 56K industrial level modem
- 5) Communication Expanded Board (TXEX)
 - Line2:** Phone jack, internally connected to 56K industrial level modem
 - Line3:** Phone jack, internally connected to 56K industrial level modem
- 6) Parallel Expanded Board (LPT)
 - LPT:** Standard parallel printer interface
 - GPS:** for GPS antenna (If GPS option selected)
- 7) RS-485 Board (485)

4 channels of 1/8-load chips, each of them can connect up to 256 same type chips. RS-485 network topology must use terminal-match bus structure instead of ring or star structure. PHOENIX butterfly spring connector makes the connection reliable and convenient. Wire section: 0.2 - 1.5mm²
- 8) Switching Value Input (SI)
 - Each board has 16 input channels of switching value, 24V DC, 20mA current max
 - Connectors same as RS-485
- 9) Switching Value Output (SO)
 - Each board has 16 output channels of switching value, 24V DC, 20mA current max
 - Connectors same as RS-485
- 10) AC Input Board (AC)
 - External AC Power, voltage 220V, frequency 50Hz
 - PHOENIX plug and socket make the connection reliable and convenient.
 - Wire section: 1 - 4mm²

- 11) DC Input Board (DC)
External DC power supply, voltage 18V - 36V
Connectors same as AC

7. ERTU-BS02 Installation & Operation

ERTU-BS02 System runs automatically after it powers up and user can operate BS-02 through local user interface (keypad and LCD display) or main station software. See “ERTU-BS02 Energy Remote Terminal Unit Operation Manual” and “Energy Telemeter Reading System TMR-BS02 Operation Manual” for detailed related operation process and methods.

8. Other Comments:

The actual hardware and software configurations may be slightly different from this manual due to different versions and different user configurations.

9. References

- “ERTU-BS02 Energy Remote Terminal Unit Operation Manual”
- “Energy Telemeter Reading System TMR-BS02 Operation Manual”

10. Appendix

Appendix 1.ERTU-BS02 Terminal data flow diagram

