KAIFA

Data Concentrator Unit

Model No. AJ102
Version: 1.4
Release Date: 2018.09.11

Safety Instruction

⚠ WARNING

Read all safety information and operating instructions before using the DCU to avoid personal injury.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Caution: The user is cautioned that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning
the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

—Reorient or relocate the receiving antenna.

—Increase the separation between the equipment and receiver.

—Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

—Consult the dealer or an experienced radio/TV technician for help.

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20cm between the radiator and any part of your body.

Installation

- DCU must be installed with additional applicable protection SPDs(limit transient voltage to 2500Vac) and a four pole circuit-breaker(rating 10 A) provided external to the equipment prior to the input, limit over voltage category to OVII.

The circuit breaker shall be installed incorporated external to the equipment and shall be readily accessible.

- DCU should be installed inside an IP54 outdoor used cabinet(outdoor enclosure, material: SABIC INNOVATIVE PLASTICS B V, type 503R(f1), 3.0mm thickness, flammability 5VA), which is restricted access area. Access can only be gained by users with tools or other securities controlled by the authority responsible for the location, who acknowledge the restriction reasons and precautions.

- DCU should be used with power wiring Min. 0.1A, 17AWG, and wiring screw terminal nominal Min. 3.5 mm diameter.

Power must be cut off before installation or removal of the DCU. Refer to “DCU Installation” for more details.

Operation

1. Do not break the seal and remove terminal cover without authorization.
2. Never remove the DCU main cover while the DCU is in operation. The exposed circuits and components may lead to injuries or damage to the DCU.

3. DCU working voltage should be less than 120% nominal voltage (120%Un). Long time over voltage may lead to damage the DCU.
4. Do not operate the DCU with wet hands.

Notice

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Content

1 Overview

The AJ102 data concentrator unit (DCU) is capable of providing automatic data collection and remote control of smart electricity meters in AMI system. As a part of AMI solution, the DCU is used for managing meter, monitoring meter work status, collecting and storing meter data, transferring the data to central system, and transfer the message/command from the central system to meters or vice versa.

2 Abbreviation

AMI	Advance Metering Infrastructure
DCU	Data Concentrator Unit
HES	Head End System
MDMS	Meter Data Management System
RF	Radio Frequency
WAN	Wide Area Network
LAN	Local Area Network
RTC	Real Time Clock
HLS	High Level Security
SNTP	Simple Network Time Protocol

3 General Description

3.1 Front View and Rear View

Figure 1a, front view.

Figure 1b, terminal cover opened.

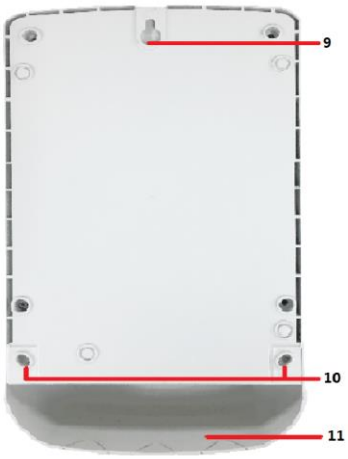


Figure 1c, rear view.

1. Optical port
2. Nameplate
3. Terminal cover sealing screws
4. RF antenna interface sealing screw
5. LED indicators
6. Main terminals
7. 3G communication module
8. Auxiliary terminals
9. Device fixing hook
10. Device fixing holes
11. Terminal cover

3.2 Technical Features

Feature	Value
Voltage	3×230V/400V (80% to 120%Un)
Frequency	60 Hz (± 5%)
Meter capacity	Not less than 200 smart meters (Daily profile data)
Power consumption	Static power consumption: active ≤ 5W, apparent ≤ 10VA With communication: active ≤ 10W, apparent ≤ 15VA
Communication protocol	DLMS/COSEM
Display feature	LED indicators
Tamper protection	Terminal cover removal detection Main cover removal detection DCU dismantling or removal detection
Communication interfaces	**WAN:** One plug and play 3G module support DLMS/COSEM with TCP/UDP profile. (UMTS-B1 , UMTS-B5, GSM-900, GSM-1800) One 10/100M Ethernet port with RJ-45 connector. **LAN:** One Lora RF port, which is embedded in the main board. The basic parameter as follows: Frequency：915.25 ~ 917.75 MHz TX power：≤14±1dbm RX sensitivity：≤-119dbm（@SF=8，BW=500KHz，Data rate=12500bps） 6 dB BW：≥500KHz **Local:** One optical port for local communication with 9600bps baud rate, DLMS/COSEM with direct HDLC profile.
Auxiliaries power supply	N/A
RTC	0.5s/day at reference temperature, comply with IEC 62054-21 Clock backup source: lithium battery
Insulation protection	Class II
Mechanical	Dimensions (mm): 310mm×175mm×86mm Enclosure material: PC
Environmental	Operating temperature range:+10℃~ +85℃ Storage and transport temperature range: -25℃~ +85℃ Relative humidity up to 95% non-condensing

4 Function Characteristics

4.1 Clock Management

DCU has a RTC which complies with IEC 62052-21/62054-21. At reference voltage and reference temperature (23°C), clock accuracy is better than ±0.5 s/day.

The RTC supports leap year, day light saving time. In case of power off, clock of DCU is active for at least two years after manufactured with battery support.

DCU automatically synchronizes its clock with SNTP server every day.
The central system can synchronize the DCU's clock.
When the DCU's clock is invalid, DCU will not automatically collect the data from meters.

4.2 Synchronize Meter Clock

DCU automatically synchronizes the clock of the meters once a day.
DCU interrogates the clock of meters. Depending on the clock difference, DCU take following action:

Clock difference	DCU action
≥10 minutes	Record a clock over limit event for the meter.
≥ 5 minutes And < 10 minutes	Set the clock of meter
< 5 minutes	No action, the meter's clock will be synchronized in next day's clock synchronization procedure of DCU.

4.3 Node Discovery and Auto-routing

DCU automatically discover the new-installed RF repeater. Automatically routing will be provided by DCU for RF repeater. DCU supports maximum two levels of RF repeater.
Once DCU discovers new meter, if the meter is not registered in the DCU, DCU will report this meter to central system, then central system will download the meter archive information into DCU.

4.4 Automatically Meter Data Collection

DCU automatically collects the data from single phase meter, three phase meter with direct connection and three phase meter with CT connection. The data type for automatically connection includes monthly billing data, daily profile data, load profile data, and meter event logs. It is configurable to enable or disable the data collection for each type of data.

4.4.1 Re-collect the Data

In case of missing some data for the meters, DCU will automatically re-collect it from the meters:

Data Type	Re-collection Period
Monthly billing data	Last month

Daily profile data	Last two days
Energy load profile	Last two days
Power quality load profile	Last two days

4.4.2 Storage Capacity

Below table defines the storage capacity for meter monthly billing data, daily profile data, load profile data and meter event logs:

Data Type	Capacity
Monthly billing data	13 months
Daily profile data	32 days
Energy load profile	4 days
Power quality load profile	4 days
Event logs	200 events for each meter

The data will be first in first out (FIFO).

4.4.3 Data Upload to Central System

Central system can read the meters' data stored in DCU through DLMS protocol via the DCU's WAN communication port.

The new read data will be compressed in files and sent to the central system by FTP. It is configurable for the FTP data uploading schedule.

4.5 On Demand Request and Response Transferring

DCU works transparently to get the on request from the central system, and transfer the request to specified meter, and transfer the response from the meter to the central system. DCU does not interpret the request and response.

The request to meter includes but not limit to:

1) Read meter energy registers, instant parameters, other registers
2) Read tariff schedule
3) Read clock
4) Set meter parameters, tariff schedule
5) Set tariff schedule
6) Set clock
7) Connect or disconnect the meter
8) Read monthly billing data, daily profile data, load profile data.

4.6 DCU Firmware Upgrade

DCU's firmware is upgradable from the central system through FTP protocol.
DCU's firmware is also upgradable from the central system or optical port through DLMS protocol.

4.7 Meter Firmware Upgrade

Central system can request DCU to upgrade the meter's firmware. DCU will firstly download the meter firmware from central system via FTP protocol, then start to download the firmware to the meters. The meter firmware upgrade procedure compliant to the DLMS firmware upgrade procedure.

4.8 Self-diagnose and Working Status

DCU self-diagnose the communication ports (i.e. 3G module, RF, RS485, optical port etc), clock.
The DCU status word shows the self-diagnostic result and the current working status:

Bit#	Description	Condition to Set	Condition to reset
0	Device power up	DCU is power up	-
1	3G module failure	3G module failure	Recovered from failure
2	3G signal level is too low	3G CSQ less than 11, signal quality level is too low	3G CSQ is not less than 11
4	RF module failure	RF communication module failure	Recovered from failure
5	NAND flash space full alarm	Flash memory is occupied over 80%	Flash memory is not full.
6	Main cover removal	Main cover is removed	Main cover is closed
7	DCU unlock	DCU is unlock	DCU is locked.
8	Optical port failure	Optical port loop back test failure	Recovered from failure
9	RS-485 failure	RS-485 loop back test failure	Recovered from failure
10	Terminal cover removal	Terminal cover is removed	Terminal cover is closed
11	Clock invalid	Clock is invalid	Clock is set
12	Reserved		
13	Reserved		
14	Reserved		
15	Image download flag	Meter firmware upgrade is in progress	Meter firmware upgrade is not running

4.9 Event Logs

The DCU records the following events. It is configurable whether push the event to central system.

Group	Capacity	Code	Description	Push	Capture Objects
Standard Event	200	0x0001	Power off	Yes	Event code, timestamp
		0x0002	Power on	Yes	
		0x0009	System reboot	No	
		0x0010	Clock is invalid	Yes	
		0x0017	3G module failure	Yes	
		0x0019	RF module failure	Yes	
		0x0032	Parameters is changed	No	
		0x0057	Input event (SPD detected) SPD OK: Giving a disconnect signal SPD Fail: Giving a connect signal	Yes	
		0x0603	Clock is adjusted since the clock is over limit (10 minutes)	No	
		0x0023	Flash memory full (80% used)	Yes	
Fraud Event	200	0x011F	Main cover is removed	Yes	Event code, timestamp
		0x0120	Main cover is closed	Yes	
		0x0121	Terminal cover is removed	Yes	

		0x0122	Terminal cover is closed	Yes	
Firmware Upgrade	20	0x0301	DCU firmware upgrade successfully	No	Event code, timestamp
Communication Event	200	0x0503	Local communication connection happened	No	Event code, timestamp
		0x0505	Remote communication connection happened	No	
		0x0502	Error communication key	Yes	
Meter Event	200 for each meter	0x3201	Meter is unreachable for 72 hours	Yes	Event code, timestamp
		0x3202	Meter is reachable	Yes	
		0x3203	Meter's clock is over limit (10 minutes)	Yes	
		0x3204	Meter's status word error	Yes	
		-	All types of meter event pushed by meter	Yes	

4.10 LED Indicators

DCU has seven LED to indicate the working status.

No.	LED	Status	Description
1	RF	ON	RF module failure
		BLINK	Communication with RF repeater is ongoing
		OFF	No RF communication
2	RS-485	ON	Indicate RS-485 communication port fail
		BLINK	Communication with RS485 meter is ongoing
		OFF	No RS-485 communication
3	Res.	-	Reserved
4	WLNK	ON	DCU has connected to HES
		BLINK	Communication with HES is ongoing
		OFF	No connection to HES
5	WCSQ	ON	3G signal quality is good
		BLINK	3G signal quality is weak
		OFF	3G signal quality is poor or the channel is not 3G
6	ALARM	ON	Alarm (3G module failure, RF module failure, optical port failure, RS-485 port failure, main cover clock invalid) is detected in DCU
		OFF	No alarm
7	PWR.	ON	Always on when power supply is ok

5 Communication Interfaces

The DCU provides following communication interfaces:

Function	Interface	Baud Rate	Protocol
Local	Optical port	9,600 bps	DLMS/COSEM HDLC profile
	RS-232	115,200 bps	
WAN	3G	Downlink transfer: max. 85.6 kbps Uplink transfer: 42.9 kbps	DLMS/COSEM TCP/IP Profile.
	RJ-45 Ethernet	10/100M	DLMS/COSEM TCP/IP Profile.
LAN	RF	1,700 bps	DLMS/COSEM HDLC profile
	RS-485	4,800 bps	DLMS/COSEM HDLC profile

5.1 Optical Port Communication

The optical port is used to read DCU and configure the DCU parameter or control the DCU locally. In general, PC software is used to communicate with DCU via this optical port.

5.2 WAN Communication

The DCU has one replaceable 3G module as the main WAN communication interface, and has an Ethernet communication interface as a backup WAN communication interface.

5.2.1 3G Communication

Remote communication uses 3G, and bases on DLMS/COSEM TCP/IP profile. The key features of 3G are listed in below table:

General Function	**Performance & Availability**	Class 12 3G communication slot. Support reconnection behavior after detecting an unexpected interrupted communication session.
	SIM	Support 2FF SIM card. Support IMEI lock of the USIM card.
	Indications of 3G signal strength	Indicate 3G signal strength in a minimum of 3 separate levels. Refer to LED indicators. RSSI value is readable.
	Antenna	Support both internal antenna and external antenna. Exchange the antenna without de-energizing the device.
Access and connection	**Wake-up**	Support fully qualified domain names. Receive and store the IP addresses of the primary and secondary address when establishing a PDP context based on the DHCP protocol Support data pushing.
	Authentication and security	Changeable APN/password Support RADIUS authentication using PAP or CHAP. Network access information is not saved on the SIM cards Communication settings to be remotely configurable
	Assign IP address	3G module support dynamic IP address assignment

The 3G communication parameters are generally programmed in the factory. It is also possible to change the communication parameter remotely or locally.
Refer to LED indicators chapter for the communication status indication.

5.2.2 Ethernet Communication

DCU supports one Ethernet port which can also be used for remote communication.

5.3 LAN Communication

DCU supports three LAN communication interfaces:

1) A RF communication interface which is embedded on the main board.
2) A RS-485 communication interface.

5.3.1 RF Communication

RF communication is based on DLMS/COSEM HDLC profile. The key features of RF are listed below:

- Communication frequency: 915.25M , 915.85M, 916.60M, 917.10M, 917.75M
- Auto-repeater, network self-healing
- Meter auto-registration
- Up to two repeater levels

Refer to LED indicators chapter for the RF communication status indication.

5.3.2 RS-485 Communication

DCU has one RS-485 communication port, which can be used to connect to RS-485 meters. The interface supports DLMS/COSEM HDLC profile.

6 Security

6.1 Physical Security

The DCU has two seals for the terminal cover, one seal for the RF antenna box. It is impossible to access the DCU internal part unless physically and transparently destroy the seals and the DCU face or terminal cover. The DCU records the main cover removal event and terminal cover removal event in both power on condition and power off condition.
The DCU detects the meter dismantle/removal event.

6.2 Communication Security

The DCU supports state-of-art security for data access and data transportation basing on a role-based security. Each role has its own access privileges. Here below table lists all the roles, their privileges, security mechanism:

Role	Client ID	Privileges	Security Mechanism
Public	16	Read limited DCU information, like the DCU serial number.	No
Read-Only	2	Read DCU	LLS Mechanism id 1
Read-Write	1	Read DCU, configure DCU parameters	HLS Mechanism id 2

6.3 Keys of DCU

The DCU has the following keys for each DLMS HLS client.

No	Type Name	Description
1	Authentication key	Ensure data integrity and authenticity
2	Encryption key	Ensure data confidentiality
3	Master key	Use to change other keys

Each DCU has its own individual keys once out of factory.

All the keys are updatable from central system.

6.4 Communication Security to Meters

DCU follows smart meter’s security policy. All communication to meters are authenticated and encrypted.

7 Transportation and Storage

The DCU should be placed on pallet and the height should not exceed 5 layers. The storage condition should be clean, with an environmental temperature of between -25°C and +85°C, relative humidity of less than 95% and with an absence of rusty matter in the air.

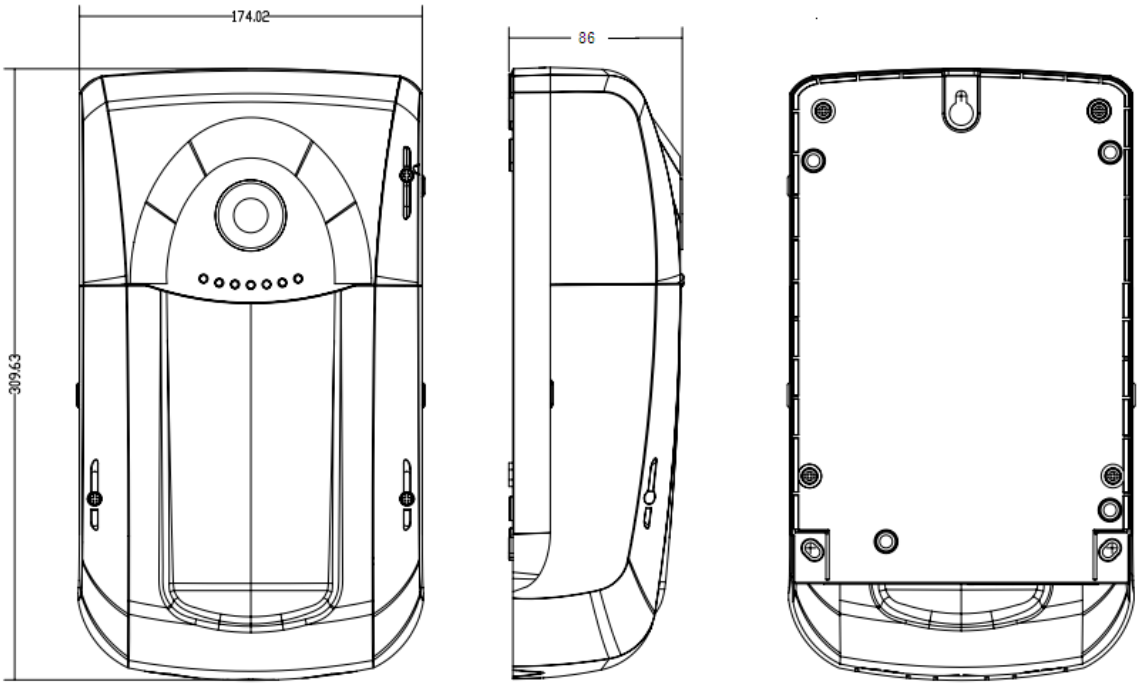
8 DCU Installation

8.1 Installation Environment

DCU should be installed at a dry and well-ventilated place. The installation board should be fixed on a solid, fire-resistant and sturdy wall. The suggested installation height is about 1.8 meters.

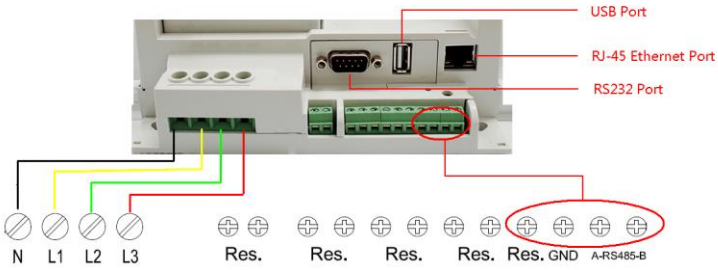
8.2 Dimension and Weight

The dimension of DCU is 310mm×175mm×86mm (L×W×H), and weight is 1.2kg.



8.3 Wiring Diagram and Auxiliary Terminals

The wiring diagram and auxiliary terminals of DCU：



8.4 Installation Guide

8.4.1 What You Need

To install DCU, you should prepare:

- Screw driver: FD3 screw driver for main terminal screw.
- Fixing screw and Hook screw: M5 slotted countersunk (flat) head tapping screw.
- Electric drill with M3 broach for metal meter box installation.
- Electric drill with M5 broach and plastic plug for concrete wall installation.

8.4.2 DCU Installation

Cut off the power supply to where the DCU will be installed, this is the most important thing!!!

Step 1: Inspect DCU before installation

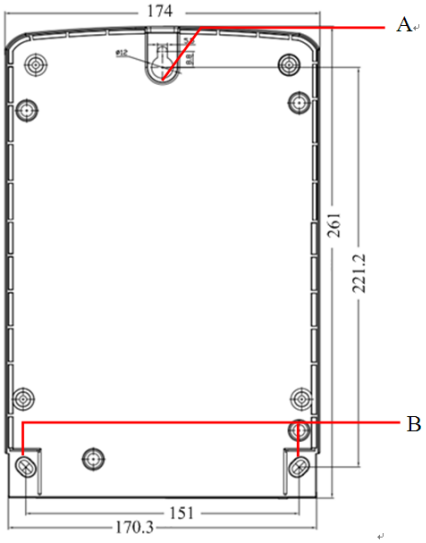
Before installation, please make sure there is no damage, broken or other defect on DCU.

If defect is found, please don't install the DCU.

Step 2: Fixing

DCU is 3-point mounting system, fixed by 1 hook and 2 fixing screws.

To fix DCU, hang the DCU by hook then fasten two fixing screws.



A: Hook, B: Fixing hole

Step 3: Install RF antenna

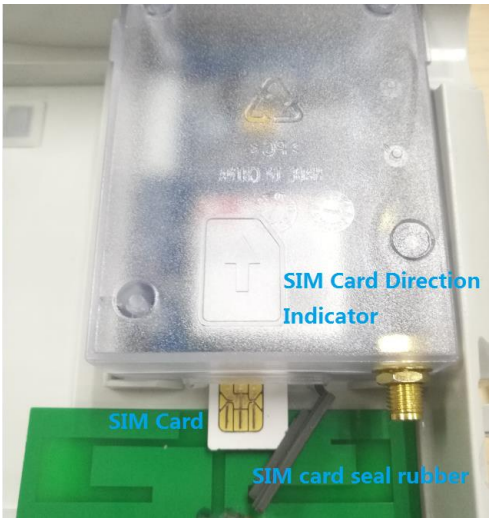
1) Remove the RF antenna cover
2) Connect tightly the RF antenna to the RF antenna connector
3) Remove the cut-out of the RF antenna cover
4) Install the RF antenna cover, the RF antenna cable should pass through the cut-out
5) Fix the screw
6) Seal the RF antenna cover.

***Note**: Before install the RF antenna, you may need to fix the RF antenna on the cabinet of the DCU. Make sure the RF antenna is fixed in the top right direction, and Antenna location according to actual can be installed at the scene of the adjustment.*

Step 4: Install 3G SIM card (2FF SIM card)

1) Open the SIM card seal rubber.
2) Insert the SIM card into the slot with right direction, and make sure the SIM card is installed rightly.
3) Close the SIM card seal rubber, and make sure the slot is totally sealed.

***Note**: It's better to install the SIM card without removing the 3G module from the DCU. It is important to seal the slot with the rubber completely.*



Step 5: Install 3G external antenna

Tightly connect the external 3G antenna to SMA connector on the 3G module.

***Note**:*

1) It's better to install 3G antenna without removing the 3G module from the DCU.

2) Before install the 3G antenna, you may need to fix the 3G antenna on the cabinet of the DCU. Make sure the 3G antenna is fixed at the bottom of the 3G module, and as show in figure shows are as follows.(The antenna has been fixed on the bottom of the 3G module with 3m glue)

3) After installed the SIM card and 3G antenna, please check if the 3G module is tightly connected to the main box of DCU.

Step 6: Connect the power wires

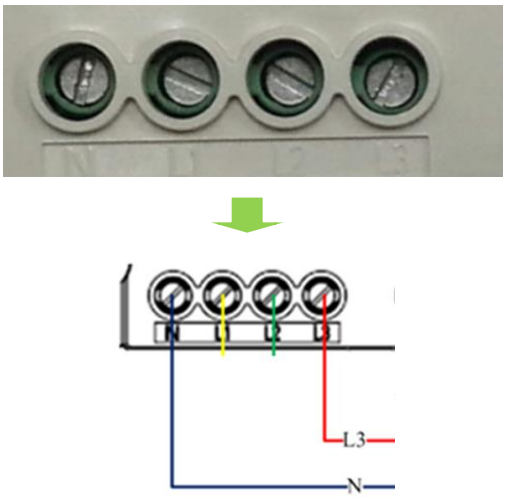
Connect the power wires according to the marking on the terminals.

Note:

1) To insure the reliable connection, install torque must higher than 3.5Nm.

2) The wire sequence from left to right be neutral, L1, L2, L3. It is important to have a right phase sequence. Single-phase power supply is recommended to connect neutral and L3.

3) *It is proposed to install a fuse-controlled disconnect switch before the DCU, so that it is easy to power off the DCU for any maintain purpose.*



Step 7: Power on inspection

After right connection of power wires, turn on the power. Inspect LED status according to chapter 4.10.

1) "PWR" LED should be on.
2) "WCSQ" LED should be on, or at least blink.
3) "Res." LED should not be always on.
4) "RF" LED should not be always on.
5) "ALARM" LED should not be on.

If "WCSQ" LED is off, it means 3G signal quality is very low, please try to adjust the position the 3G external antenna. If "WCSQ" is still off, there will be no connection the 3G.

If "ALARM" LED is on, it means there is some failures on DCU. Please contact the expert or replace to install a new DCU.

If the 3G parameter (APN, user, and password etc.) and HES parameter (server IP, port no etc.) is configured before the installation, the DCU will try to dial 3G and connect to the HES. After successfully connect to HES, the "WLNK" LED will be on or blink.

***Note**: before power on DCU, please make sure 3G module is tightly connected to the DCU box.*

Step 8: Configure the communication parameters (This step is needed only if DCU is not rightly configured before installation)

Use configuration software to configure the right 3G communication parameters (APN, user name, password etc.), and HES communication parameters (server IP, port no etc.). Use configuration software to send a reboot command to reboot DCU. After reboot is finished, DCU tries to connect to HES. After successfully connect to HES, the "WLNK" LED will be on or blink.

***Note**: It is strongly proposed to configure the DCU communication parameters before installation of DCU.*

Step 9: Install the terminal cover

1) Install the terminal cover tightly
2) Fix the terminal screws
3) Seal the terminal cover screws.

The installation of DCU is finished.

Note：The detail installation guide in the box refers to "Meter and Meter Box Installation Specification.pdf".

Annex 1 Reference Standards

No.	Standard No.	Title
1	IEC 62056-21 Ed. 1.0:2002	Electricity metering – Data exchange for meter reading, tariff and load control – Part 21: Direct local data exchange
2	IEC 62056-46 Ed. 1.1:2007	Electricity metering – Data exchange for meter reading, tariff and load control – Part 46: Data link layer using HDLC protocol
3	IEC 62056-53 Ed. 2.0:2006	Electricity metering – Data exchange for meter reading, tariff and load control – Part 53: COSEM Application layer
4	IEC 62056-61 Ed. 2.0:2006	Electricity metering – Data exchange for meter reading, tariff and load control – Part 61: Object identification system (OBIS)
5	IEC 62056-62 Ed. 2.0:2006	Electricity metering – Data exchange for meter reading, tariff and load control – Part 62: Interface classes
6	ETSI EN301 511 V9.0.2(2003-03)	
7	ETSI EN301 489-1 V1.9.2(2011-09)	Electromagnetic compatibility and Radio spectrum Matters(ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements
8	ETSI EN301 489-7 V1.3.1(2005-11)	Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 7: Specific conditions for mobile and portable radio and ancillary equipment of digital cellular radio telecommunications systems (GSM and DCS)
9	EN 60950-1:2006 +A11:2009 +A1: 2010 +A12:2011	
10	EN 62311:2008	

Annex 2 RF communication channel

Channel	Frequency(MHz)	Channel	Frequency(MHz)	Channel	Frequency(MHz)
1	915.25	18	916.10	35	916.95
2	915.30	19	916.15	36	917.00
3	915.35	20	916.20	37	917.05
4	915.40	21	916.25	38	917.10
5	915.45	22	916.30	39	917.15
6	915.50	23	916.35	40	917.20
7	915.55	24	916.40	41	917.25
8	915.60	25	916.45	42	917.30
9	915.65	26	916.50	43	917.35
10	915.70	27	916.55	44	917.40
11	915.75	28	916.60	45	917.45
12	915.80	29	916.65	46	917.50
13	915.85	30	916.70	47	917.55
14	915.90	31	916.75	48	917.60
15	915.95	32	916.80	49	917.65
16	916.00	33	916.85	50	917.70
17	916.05	34	916.90	51	917.75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