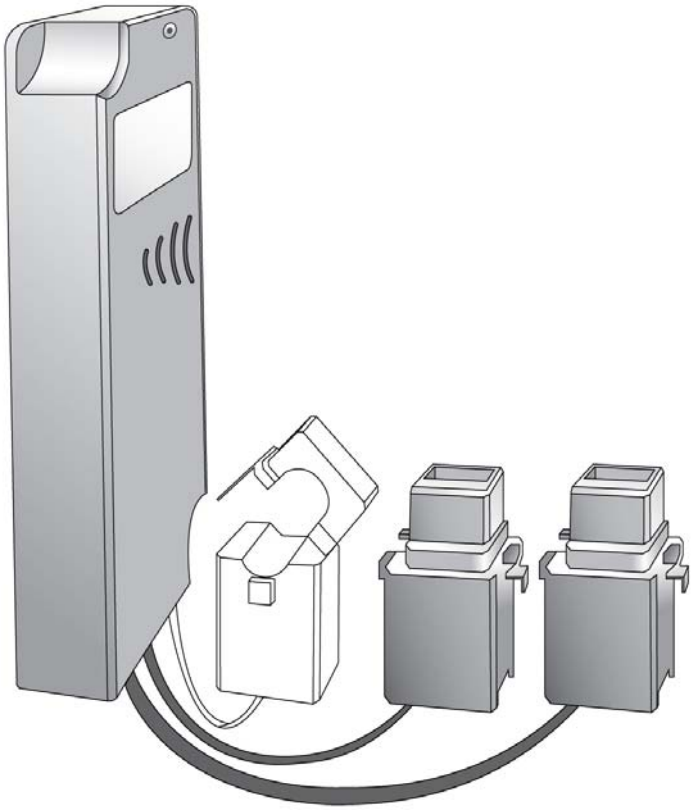
EMU

User Guide



Thank you for purchasing this product.

- First of all, be sure to read this manual for correct use of the product.
- If you find any missing contents or error, please inform us.
- KEPID AMSTech assumes no responsibility for any direct or indirect loss or damage which may occur through use of this product, regardless of any failure to perform on the part of this product.

Table of Contents

1. General Information

1.1 Certification related

This product has been designed to comply with the following standards and directives:

- IEC 62053-21 Class 1.0 (Measurement Standard)
- IEC 61010-1: 2001 (Safety Specification)
- FCC Part 15, Class B
- FCC Part 15, Class C

FCC compliance Information

This device complies with part 15 of 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.

Information to the user

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.

Caution: Exposure to Radio Frequency Radiation.

To comply with FCC RF exposure compliance requirements, a separation distance of at least 20 cm must be maintained between the antenna of this device and all persons.

For more details, see this manual.

1.2 Labeling

The label including the model name, identification number and etc. is placed on the back cover. The identification number of each device is placed on the bottom center of the back cover.

1.3 Glossary

- Wi-GEM (Wireless Green Energy Meter): Product name that consists of EMU, EMG, and EMR.
- EMU (Energy Meter Unit): Energy meter that collects the required electrical parameters.
- EMG (Energy Meter Gateway): The network gateway.
- EMR (Energy Meter Router): Router between EMU and EMG.
- RTC (Real Time Clock)
- Modbus: Communication protocol.
- R/S/T/N: In case of 3-phase 4-wire, it indicates the phases of power. In case of 3-phase 3-wire, only R, S, and T exist. Depending on the country, they are also displayed as L1, L2, L3, and N.

1.4 Safety instructions

DANGER

If you do not follow the instructions in this manual, it may cause serious accidents.

- Only qualified persons from the manufacturer or agent must handle the inside components of the product.
- Owners, maintenance and service personnel, managers, operators, setters, programmers, foremen, mechanics, and all personnel related to these products must read and strictly follow the safety instructions in this manual.

Please read the following warnings and cautions to prevent injury or damage to the product.

DANGER

This symbol alerts that ignoring an instruction or incorrect action may cause a death or serious injury.

WARNING

This symbol alerts that ignoring an instruction or incorrect action may cause minor injury or damage to the product.

CAUTION

This symbol alerts that ignoring an instruction or incorrect action may cause a product malfunction or data or property loss.

1.5 General description

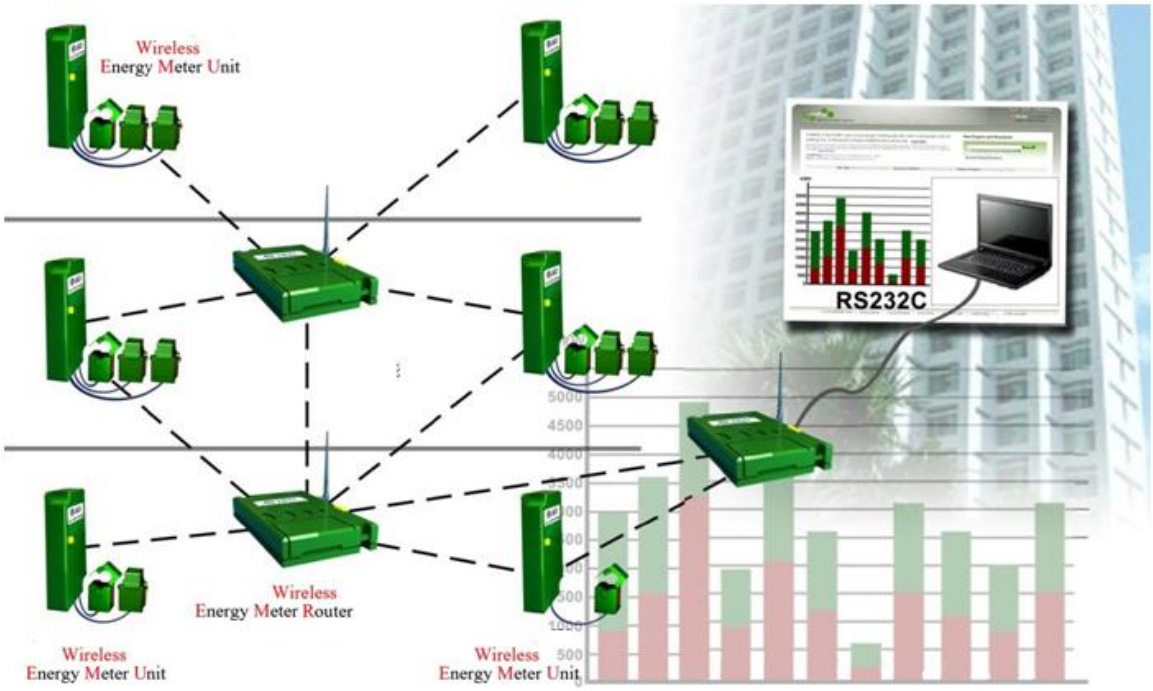


Figure 1.1 Communication Concept Diagram

To reduce power consumption or carbon emission, detailed power measurement for each process, line, and device is required.

By installing Wi-GEM, detailed power measurement is enabled. Wi-GEM also can perform the following:

- Measurement of voltage, current, active/reactive power, apparent power, power factor, and frequency
- Measurement of peak power
- Simultaneous event monitoring and storing for instantaneous low-voltage and over-current
- Measurement of 21 harmonic data (voltage and current) for each phase

Because we open the Modbus protocol and register map for measurement, you can easily build your own system.

1.5.1 EMU (Energy Meter Unit)

EMU is the energy meter that collects the required electrical parameters at the specific interval after its sensors are fixed on the power cable. A single EMU can also be connected to a computer for analysis.

An EMU can have 2 sensors that measure the electrical parameters for 3 phase 3 wire (R/S/T).

An EMU can have 3 sensors that measure the electrical parameters for 3 phase 4 wire (R/S/T/N).

It can support wirings for single phase, 3 phases 3 wires, and 3 phases 4 wires.

Communication is possible by a single EMU or multiple EMUs.

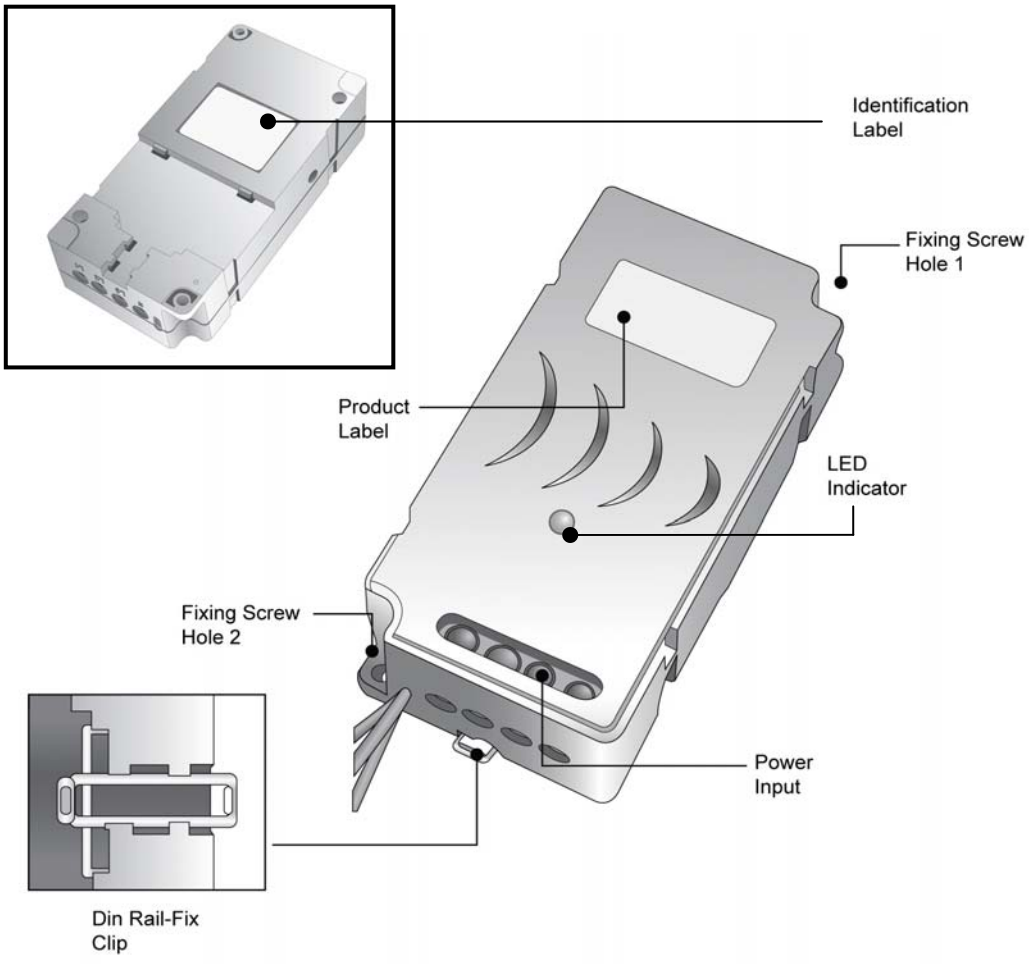


Figure 1.2 EMU Parts

Name	Description
DIN Rail Fix Clip	To fix EMU onto a DIN rail, use this clip on the back cover.
Fixing Screw Hole 1 & 2	To fix EMU on a wall of the distribution panel, insert screws in these holes and fasten them.
Product Label	The product label is placed here.
Identification Label	The label is attached on the back cover. The ID can be set using the DIP switches or using a program. In case of using DIP switches, the maximum number of IDs is 63. With the program, maximum 255 IDs can be set while all DIP switches are off.
LED Indicator	It displays the current status. It can display various statuses.
Power Inputs	For 3 phase 4wire, Connect power input sources (L1 (R), L2 (S), L3 (T), and N). For single phase, connect power input sources (L1 (R), N) For 3 phase 3wire, connect power input sources (L1 (R), L2 (S), L3 (T))
Zigbee RS485 Port (optional)	If EMU needs to be directly connected to a PC, use the RS485 connection port. Connect P+ and N- of EMU with the USB port on a PC via the connector. It supports Zigbee or RS485 communication.

Main features of EMU are as follows:

- Measuring instantaneous values for voltage, current, active power, reactive power, and apparent power of each phase
- Measuring accumulative values for active energy and reactive energy, apparent energy of each phase, and the total of each phase.
- Measurement of frequency: 50/60Hz
- Measurement of harmonic of each voltage and current up to 21st
- Wide operating voltage (phase voltage 57 to 277 V~, L1-N)
- Measurement of wide input voltages: Max. 300V Vrms, 3~, CAT III
- Measurement of input currents using the split core CT: 5A, 50A, 100A, 200A,

300A, 400A, 500A, 600A, 800A, 1200A, 1600A, 2400A

- Measurement of input currents using Rogowski coil: 1000A, 2000A, 3000A, 5000A
- Power consumption: 12 VA
- Isolation: Isolation class II, IEC61010-1 CAT III Vrms
- Measurement category: CAT III
- Environment: Indoor use
- Ambient operating temperature: -10 to +55℃
- Ambient storage temperature: -25 to + 85℃
- Mass: 160 g
- Maximum altitude: 2000 m
- Pollution degree: I
- Degree of protection: IP2x
- 2.4 GHz wireless ZigBee module
- Data logging into a PC
- Time stamps for each transmission data
- Logging interval: 1, 2, 3, 5, 6, 10, 15, 30, 60 minutes
- Easy installation and DIN rail mounting
- Modbus protocol
- Economic price
- A management program to be developed at user's taste

1.5.2 EMG (Energy Meter Gateway)

EMG (Energy Meter Gate) is the gateway that controls the wireless network and periodically gathers the collected data from EMUs. It can be accessed by an application program for data analysis. The program shows the power-related values such as voltage, current, frequency, etc. It is connected with PC via the USB cable.

EMG has the following parts:

Name	Function
Fixing Screw Hole 1 & 2	To fix EMG on a wall, insert screws in these holes and fasten them.
Antenna	Used for wireless communication.
USB Port	Used to connect EMG with a PC. EMR does not have this port.
Product Label	The product label is placed.

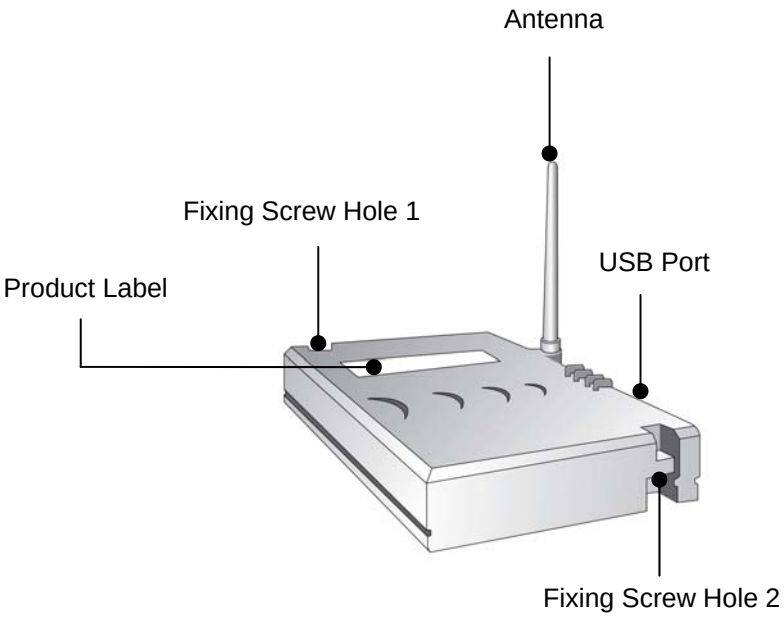
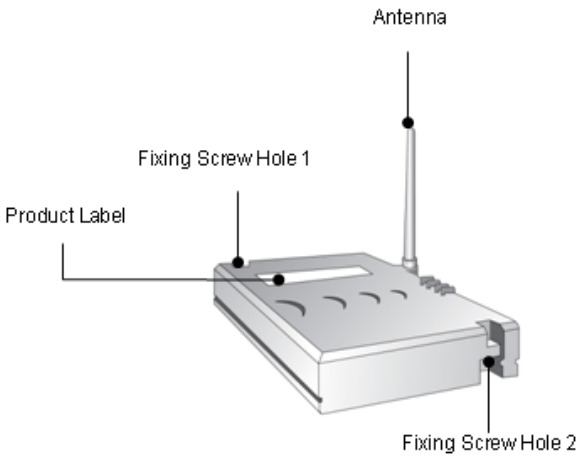


Figure 1.3 EMG Parts

1.5.3 EMR (Energy Meter Router)

EMR is the router that relays the data between EMU and EMG. It is automatically detected by an EMG. An EMG can connect EMRs up to 255 logically.



EMR has the same shape as EMG except for USB connection port to a PC. EMR has no connection port. The adapter that is used to supply power must have been evaluated by UL. The DC power to EMR can use the DC adapter for 5 to 9 V.

1.5.4 Handling multiple EMUs using Zigbee

If multiple EMUs need to be monitored and controlled, the collected data can be transferred to a wireless EMR via the wireless Energy Meter routers (EMR) as shown in Figure 1.1. Otherwise, an EMR is directly connected to an EMU.

Each individual EMU has its own unique ID that can be set using the DIP switches inside EMU. Otherwise, users can use the factory default settings.

The network communication has been implemented following the ZigBee specification. The communication features are:

- RF wireless frequency: 2.4 GHz
- IEEE 802.15.4 compliant radio
- Channel access via CSMA-CA
- Extensible to multiple nodes (maximum 64: EM357 code spec)
- Q-QPSK modulation
- Data transmission speed: up to 250 kbps
- Data transmission distance: up to 100 m
- Channel bandwidth: 5 MHz

Available network configurations are:

- Single path network topology: EMG is connected to an EMR (with an EMU) that is connected to another EMR (with an EMU).
- Star-network topology: EMG is connected to multiple EMUs.
- Star Mesh network topology

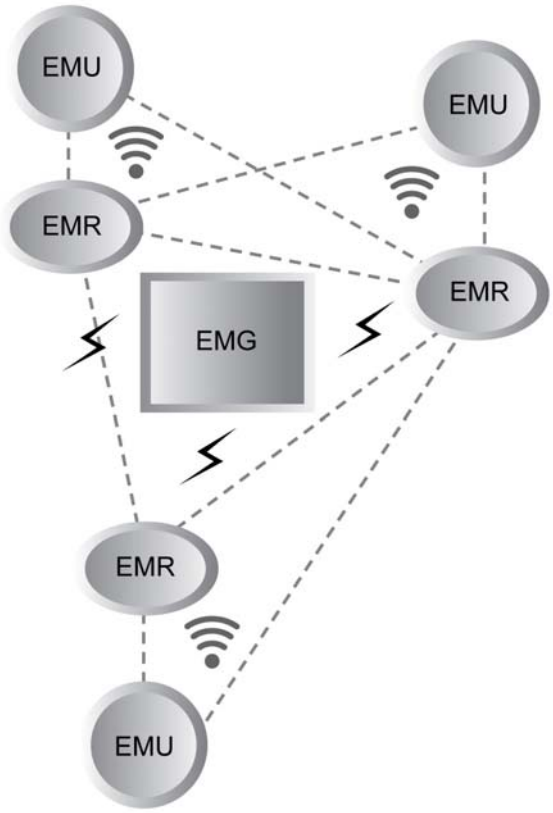


Figure 1.4 An Example of Star Mesh Network Topology

2. Installing and Configuring Hardware

2.1 Before installation

⚠ **DANGER**	Electrical shock or fire! This product can cause serious injury or death to persons if the instructions are not cautiously kept.
⚠ **CAUTION**	Follow the standard specifications and safety requirements.
⚠ **CAUTION**	Do not cut or forcibly pull the cables.
⚠ **WARNING**	Only qualified persons must install the product.

First of all, be sure to familiar with this manual.

Perform the following suggestions for correct installation.

- If multiple EMUs are required to be installed, plan the layout of EMUs. For this purpose, think over the network topology and fixing method.
- Check whether any other interference generating devices exist or not. If so, relocate the installation location.
- Check whether the rated voltage and current on the label are correct.
- Install the product to the place that is not affected by strong magnetic field for correct operation and precision.
- The temperature must be within the operation temperature range. Do not install the product outdoors.
- The upper or lower clamp must be kept clean for correct operation and precision.
- Install the product following the instructions in this manual. An arbitrary

installation may cause damage to the product or personal injury.

- Do not keep four side locks and power input terminal blocked for ventilation flow.

2.2 Installing EMU

⚠ **DANGER**	During EMU installation, be sure to turn off the power.
⚠ **DANGER**	Do not apply physical damage to the product. If the clamp is separated or its insulation tube is stripped, it may cause injury or death.
⚠ **CAUTION**	Only qualified persons must install EMU.
⚠ **CAUTION**	Be sure to install EMU in the distribution panel with an additional lock. Only the qualified person must access the distribution panel.
⚠ **CAUTION**	Be sure to follow the instruction in this manual during installation. Keep the specified specifications and regulations.

2.2.1 Installing the EMU body

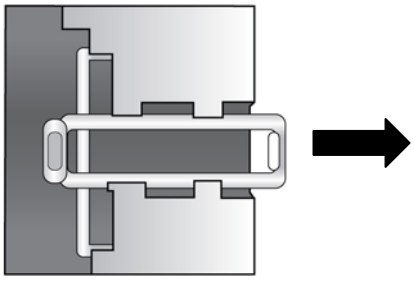
To keep effective wireless network communication, do not install EMU in front of interference generating materials or metal surfaces. If the embedded antenna is close to the material, it can decrease the efficiency of the embedded antenna.

To mount the EMU on the wall, perform the following steps:

1. Prepare two screws.
2. Insert screws in the holes shown in Figure 1.2 and fasten them with a screwdriver.

To mount the EMU onto a DIN rail, perform the following steps:

1. Insert the EMU onto the DIN rail and move it to a desired position.
2. Pull up the fix clip to fix the EMU.



The following figure shows an example of correct installation.

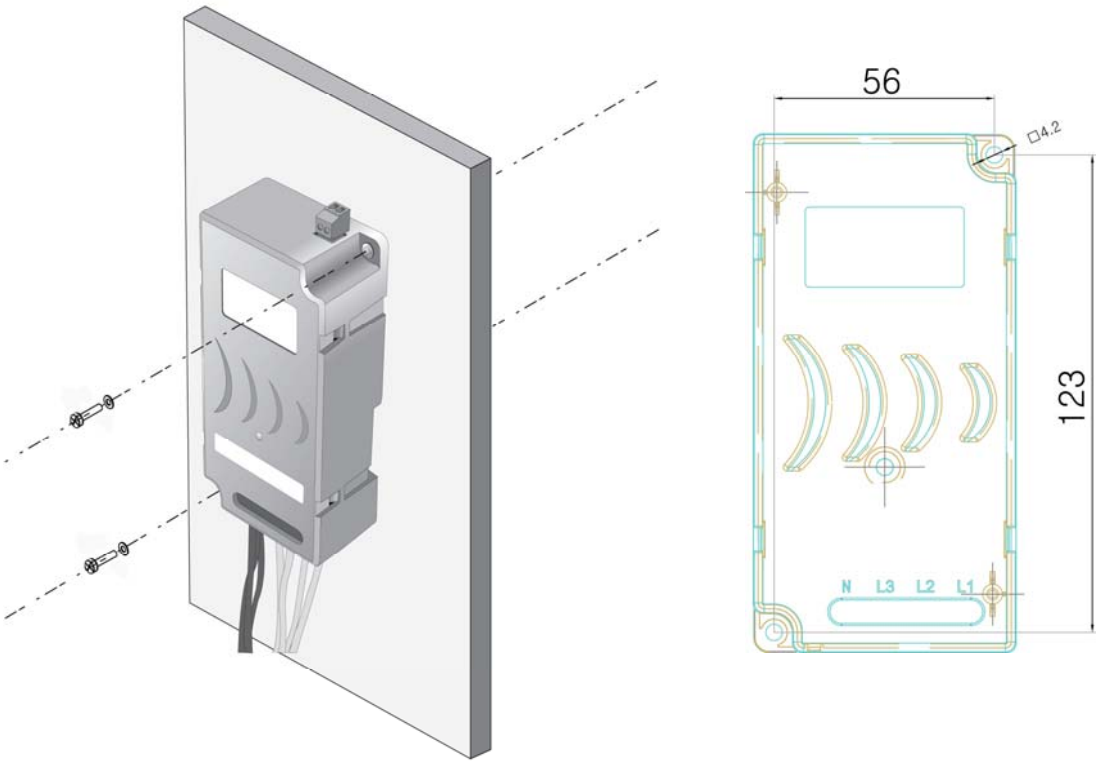


Figure 2.1 Correct EMU Installation

2.2.2 LED display of EMU

EMU has an LED lamp to display the current status as explained below:

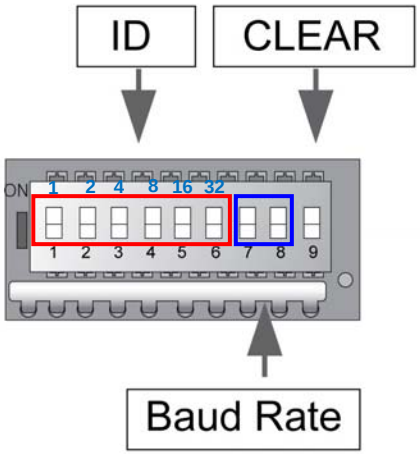
Status	Description
Green lamp blinks	EMU operates in normal mode. (On for one second and off for one second)
Orange lamp blinks	EMU is performing the TX communication.
Red lamp blinks	EMU is performing the RX communication.

⚠ **CAUTION**	If the green lamp does not blink after power supply, see 5. Troubleshooting and take a specified action.

2.2.3 Setting EMU ID and Baud Rate

⚠ **DANGER**	Only the qualified personnel from the manufacturer or agent must set the EMU ID and baud rate.

Before installation of EMU, set the EMU ID and its baud rate using the DIP switches inside the EMU.



The following shows the ID setting examples:

SW1	SW2	SW3	SW4	SW5	SW6	ID
On	Off	Off	Off	Off	Off	1
On	On	Off	Off	Off	Off	3
On	On	On	On	On	On	63
Off	Off	Off	Off	Off	Off	Program IDs are applied

EMU ID can be set with 6 switches so the total number of EMU IDs can become 63.

When all DIP switches are off (000000), it turns to the program ID mode. In this mode, maximum 255 IDs can be set.

Users can set the baud rate as shown below:

Value	Setting (Baud Rate)
10	4,800
01	9,600

Value	Setting (Baud Rate)
11	19,200

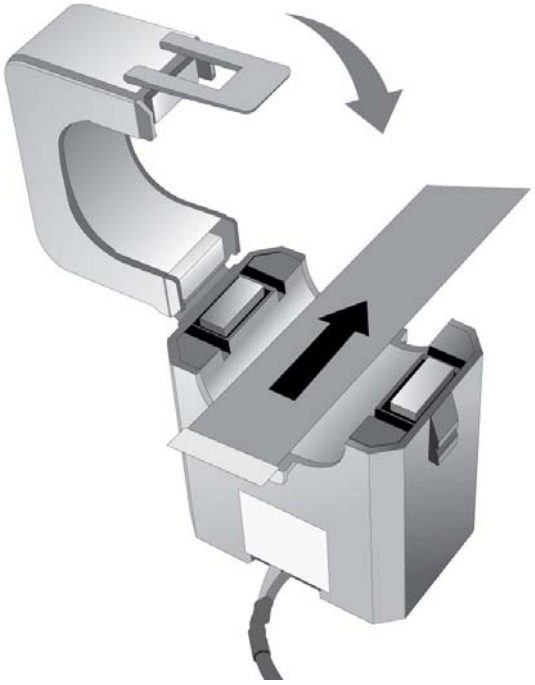
2.2.4 Mounting sensors

The sensors that measure electrical parameters are connected to an EMU. The sensors are fixed on power cables. So please keep the following cautions:

⚠ **DANGER**	The clamp must be attached to the wire with 300 V insulation capability.
⚠ **CAUTION**	Before installing a sensor, please check no current flows into the cable.
⚠ **CAUTION**	Clean the surface of the cable. Otherwise, foreign materials can cause a malfunction or incorrect measurement.
⚠ **CAUTION**	If phase allocation is wrong, incorrect energy data will be collected.
⚠ **CAUTION**	The allowable number of clamp openings is 50 times or below. Frequent clamp openings may shorten the life of clamp.

To mount a sensor on the target cable, perform the following steps:

1. Place the sensor on the target cable according to the specified phase.
2. Keep the direction of the arrow sign on the sensor same as the current flow direction.
3. Close the sensor clamp over the cable.
4. To fix the sensor on the cable, use the cable tie.



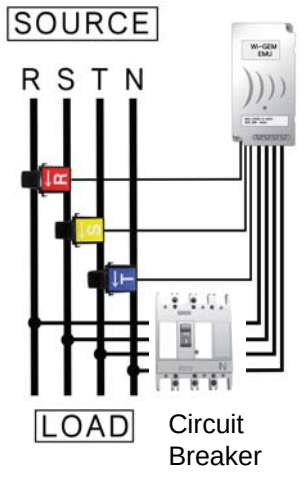
2.2.5 connecting voltage wires

Now, connect the wires to the power input points (L1, L2, L3, N) at the bottom panel of EMU.

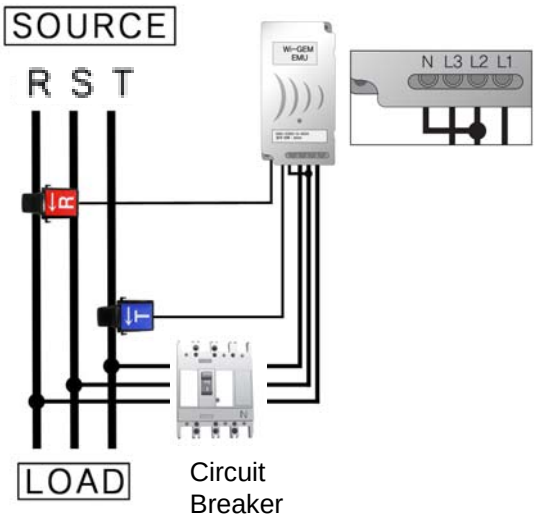
⚠ **CAUTION**	Before connection, be sure to check no current flows into the wires.
⚠ **CAUTION**	The wire must have been covered by the tube with 300 V insulation capability. The size of the conductor must be within the range of 1.0 to 6.0 mm^2.
⚠ **CAUTION**	For protection, the circuit breaker must be installed between the voltage wire and power.

The following explains how to connect the wires for each case.

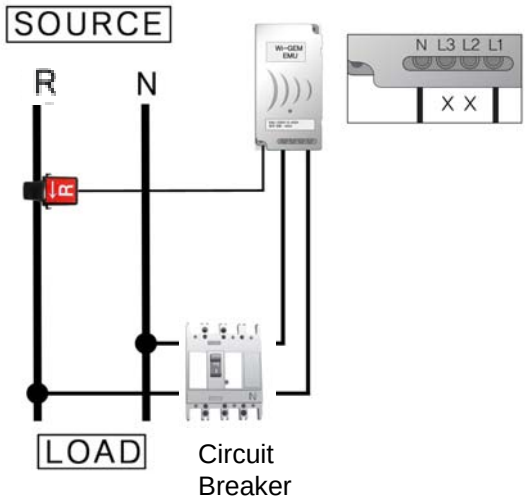
- Wiring for 4 phases 3 wires



- Wiring for 3 phases 3 wires



- Wiring for single phase 2 wires



2.3 Installing EMRs and EMG

According to the prepared topology plan, install EMRs near the installed EMUs. Then install EMG near the monitoring computer.

- Power connection to EMR
- USB connection to EMG

Figure 2.2 Installation of EMR and EMG

2.4 Connecting EMG to PC

EMG is configured for the MODBUS protocol. When the EMG is turned on, the network starts building the structure. It may take a while.

For connection between EMG and PC, use the USB cable. EMG has a USB port on it.

2.5 Installing the monitoring program

After connecting EMG to PC, install the monitoring program.

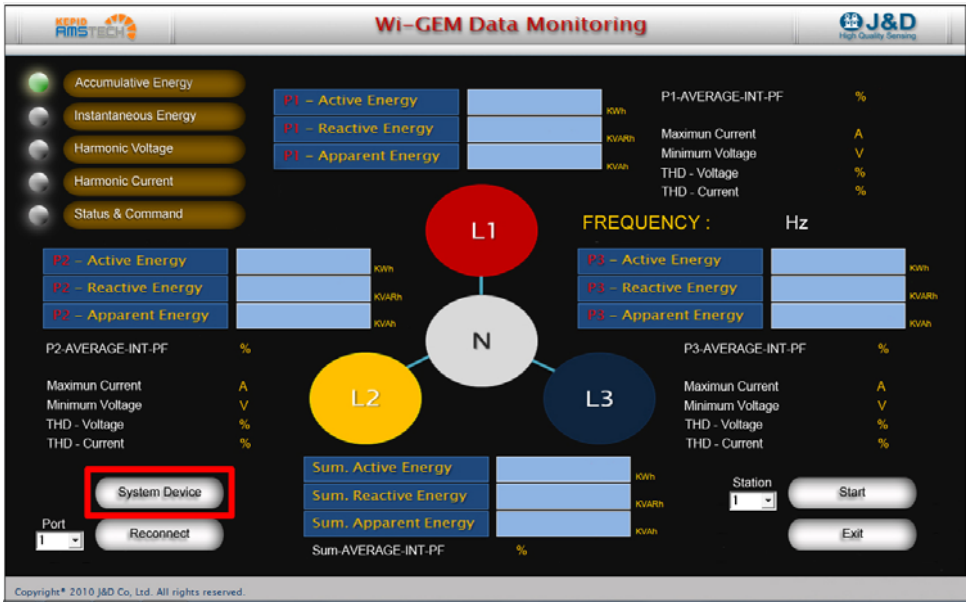
For this purpose, perform the following steps:

1. The setup file is provided with a CD. Double-click the setup file (setup.exe).
2. Answer the prompts on the installation screen by clicking **Next**. Then the installation is easily completed.
3. Check the WIGEM program icon appears on Desktop.

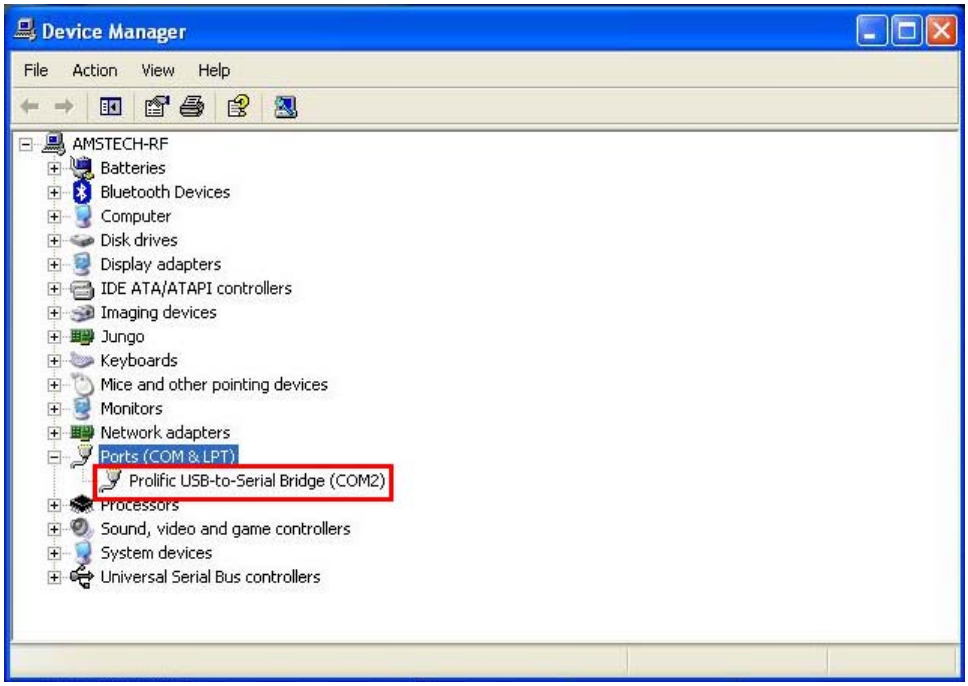
After the monitoring program is installed, the serial port of the PC must be set.

For the setting, perform the following steps:

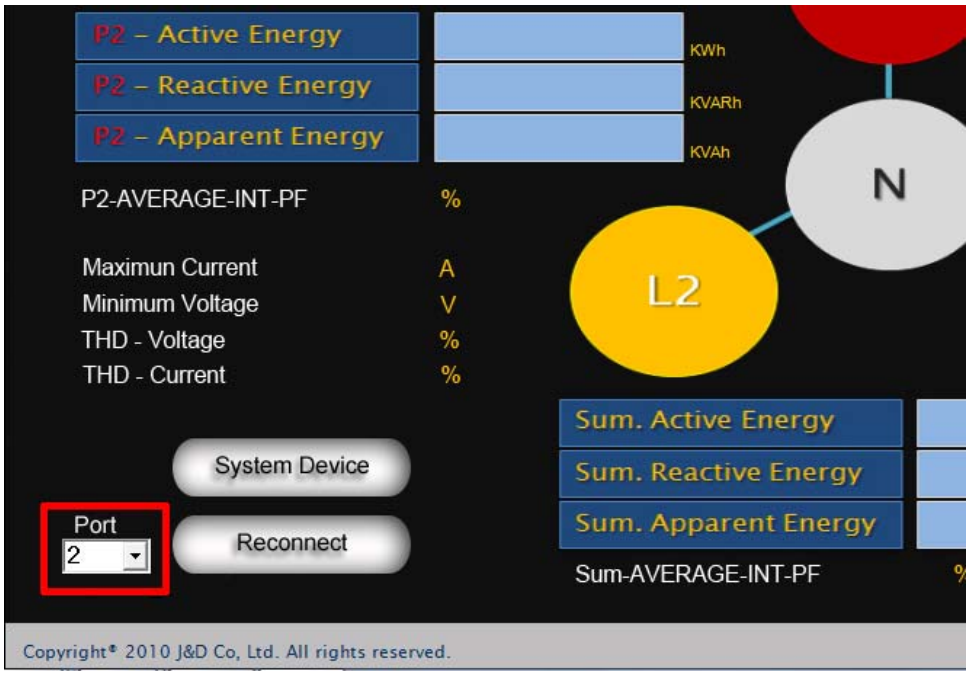
1. Run the monitoring program by clicking the program icon (distinguished in red in the above figure).
2. Click **System Device**.



3. Check the USB serial port number. The default setting is COM2 as shown in the following figure.



4. Select **2** in Port.



5. Click **Reconnect** for connection trial.
6. Check the displayed values for frequency, voltage, etc.

⚠ **CAUTION**	If the measurement data is not correctly displayed or installation is not successful, see 5. Troubleshooting.

3. Monitoring Program

After all things are made, you can monitor the energy data from EMUs. To start the monitoring program, double-click the **WIGEM** program icon on Desktop. Then the **Wi-GEM Data Monitoring** screen appears.

3.1 Main screen (Accumulative Energy)

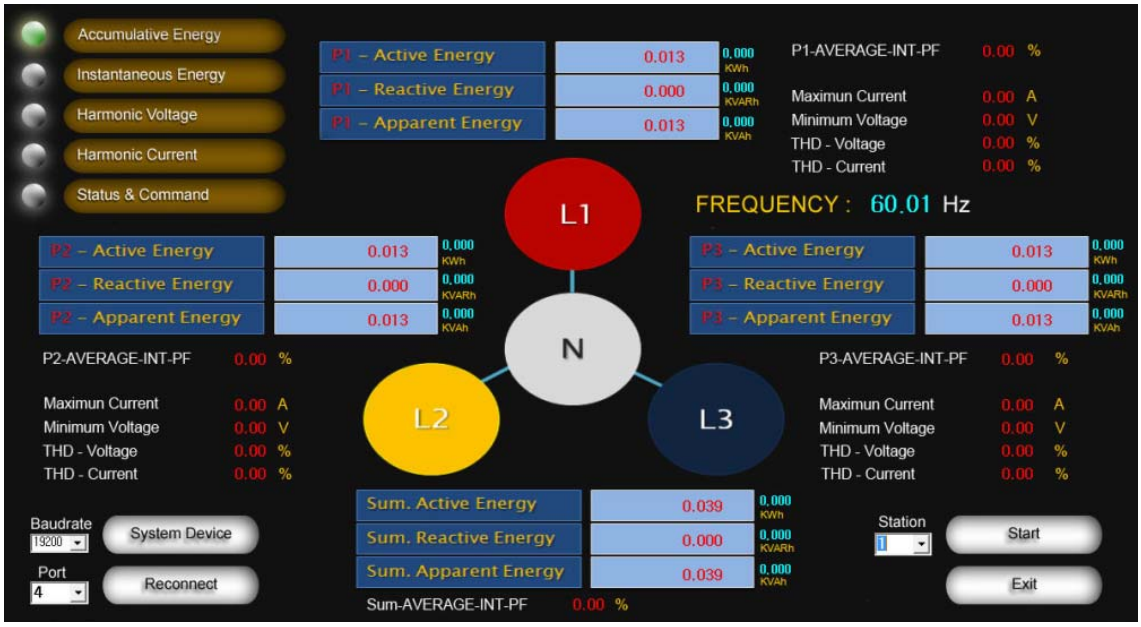


Figure 3.1 Accumulative Energy Screen

The screen shows the following accumulative information:

- Wire connection status
- Active energy for each phase
- Reactive energy for each phase
- Apparent energy for each phase
- Average INT PF for each phase

- Maximum current for each phase
- Minimum voltage for each phase
- THD of voltage for each phase
- THD of current for each phase
- Frequency
- Sum of active energy
- Sum of reactive energy
- Sum of apparent energy
- Sum of average INT PF
- Station
- Baud Rate
- Connected port

If you click **Reconnect**, the system information is refreshed.

To check the system device information, click **System Device**. Then the connected devices appear.

User can check the connected device information.

To start this program, click **Start**. To exit from this program, click **Exit**.

3.2 Instantaneous Energy

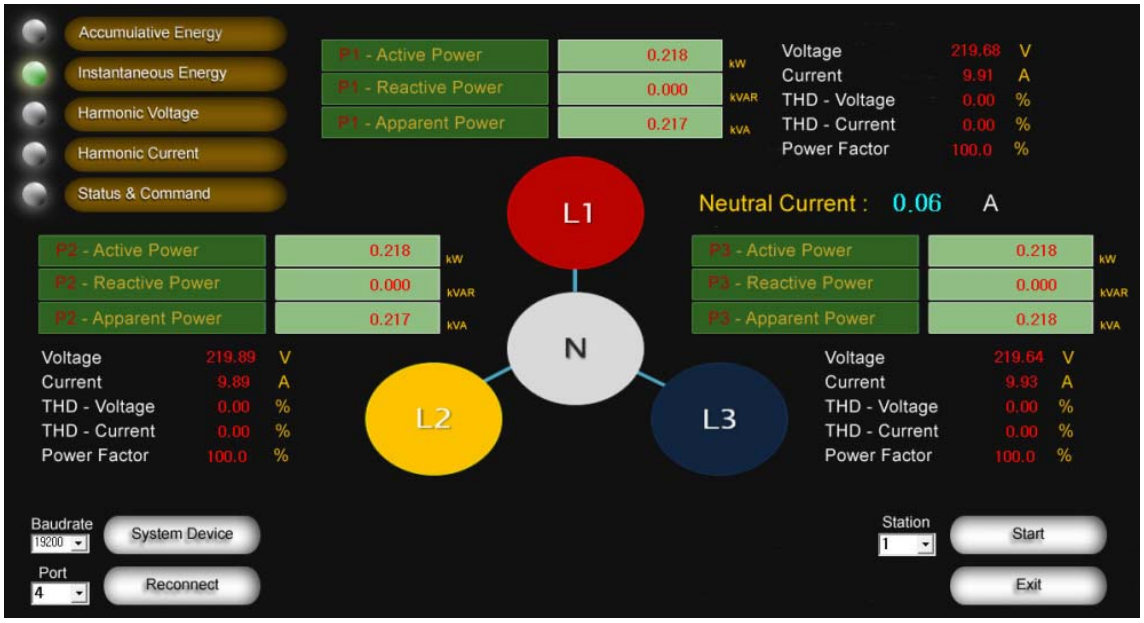


Figure 3.2 Instantaneous Energy Screen

If **Instantaneous Energy** is clicked, the screen shows the following instant information:

- Wire connection status
- Active power for each phase
- Reactive power for each phase
- Apparent power for each phase
- Voltage for each phase
- Current for each phase
- THD of voltage for each phase
- THD of current for each phase
- Neutral current
- Power factor : ratio of the real power flowing to the load over the apparent power in the circuit
- Station
- Baud Rate
- Connected port

3.3 Harmonic Voltage

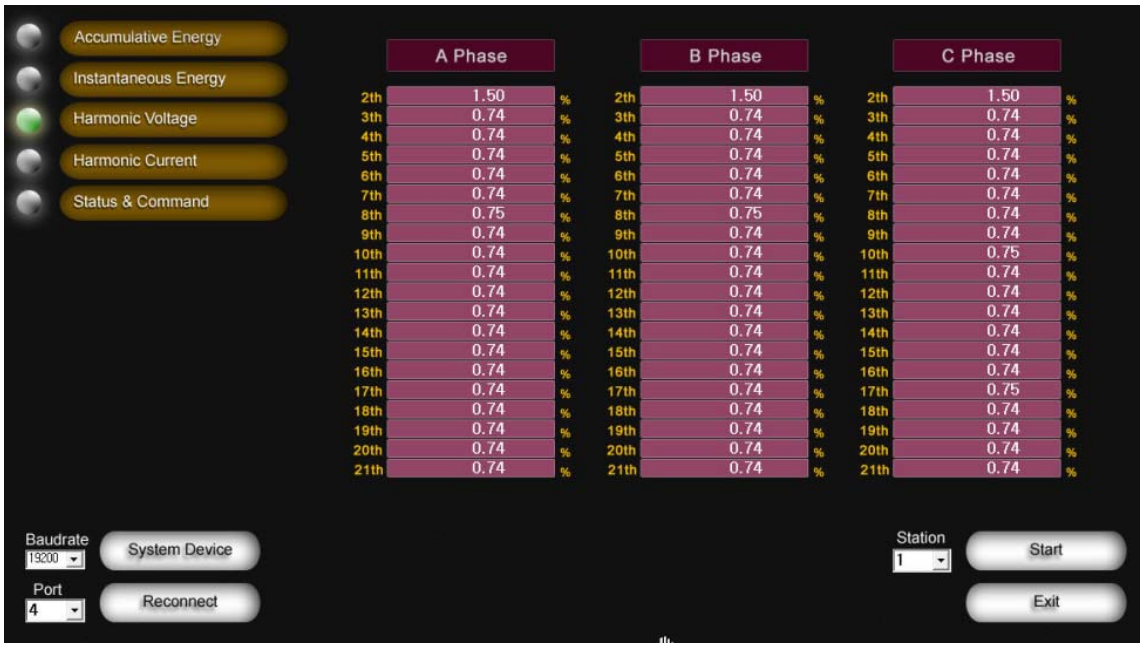


Figure 3.3 Harmonic Voltage Screen

If **Harmonic Voltage** is clicked, the screen shows the following harmonic voltage related data:

- 21 harmonic voltage elements for each phase
- Baud Rate
- Connected port
- Station

3.4 Harmonic Current

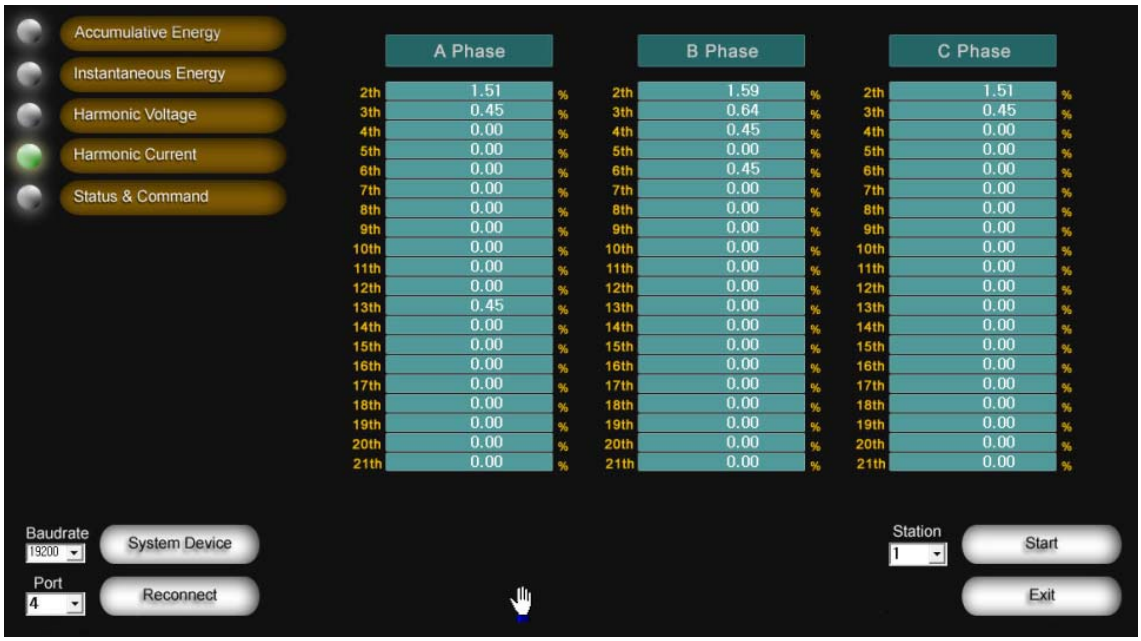


Figure 3.4 Harmonic Current Screen

If **Harmonic Current** is clicked, the screen shows the following harmonic current related data:

- 21 harmonic current elements for each phase
- Baud Rate
- Connected port
- Station

3.5 Status & Command

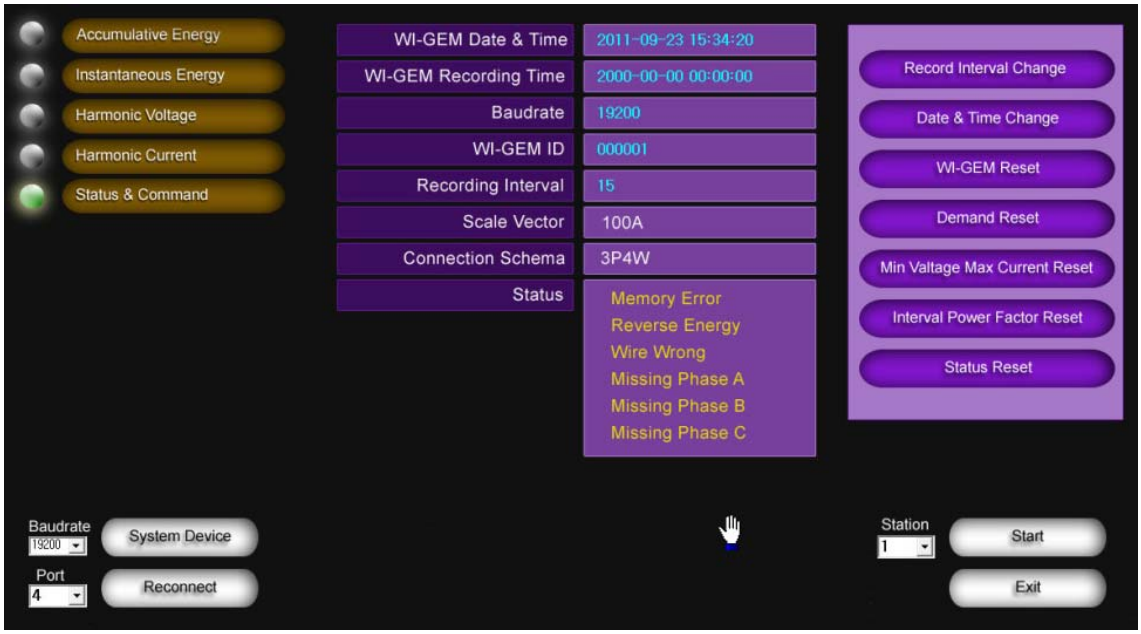


Figure 3.5 Status & Command Screen

If **Status & Command** is clicked, the screen shows the following information:

- Date & time
- Recording time
- Baud Rate
- Wi-GEM ID
- Recording interval
- Scale vector
- Connection schema
- Status: memory error, reverse energy, wrong wire, and phase missing status
- Connected port
- Station

By clicking buttons, user can perform the following functions:

- Changing the recording interval
- Changing the date & time
- Resetting Wi-GEM
- Resetting the demand
- Resetting the minimum voltage and maximum current
- Resetting the interval power factor
- Resetting the status

4. Software Interfaces

To program a customer specific application, the following software development data is required.

4.1 EMU related

4.1.1 Parameters and functions

The related parameters and functions are:

Function/Setting	Description
RTC & Time	Using the built-in real time clock, the current time can be set.
Programmable Demand Interval	1/2/3/5/10/15/30/60 minute
Energy registers	Used to reset them.
Direct connections & voltage ratings	▪ 3 phase (Wye): 57/110 to 277/480 V ▪ 3 phase (Delta): 110 to 480 V ▪ Single phase: 57 to 277 V
Current rating of Split core CT	▪ 5/50/100 A ▪ 200 A ▪ 300/400/500 A ▪ 600/800/1200 A ▪ 1600/2400 A
Current rating of Rogowski coil	▪ 1000/2000/3000/5000 A
Communications	▪ ZigBee (selectable up to 250 kbps) ▪ RS485 (selectable up to 19200 bps)

Function/Setting	Description
Diagnostic	▪ Memory error ▪ Reverse energy ▪ Wrong writing ▪ Missing phase
Accuracy @ 25°C	▪ Current RMS Irms < 1.0% ▪ Voltage RMS Vrms < 1.0% ▪ Watt and Watt-hour < 1.0% ▪ Var and Var-hour < 2.0%

4.1.2 Modbus commands

The commands used in the Modbus register map are:

- Read holding register (0x03)
- Write multiple register (0x06)

4.1.3 Modbus register map #1

*NV: Non-volatile, V: Volatile, S: Signed, U: Unsigned, R: Read, W: Write

Modbus Register	Description	Type/ Length	Storage	Unit after Scaling	Access
0	Active Energy Consumption, Phase 1 MSW (valid)	U32	NV	Wh	R
1	Active Energy Consumption, Phase 1 LSW	U32	NV	Wh	R
2	Active Energy Consumption, Phase 2 MSW	U32	NV	Wh	R
3	Active Energy Consumption, Phase 2 LSW	U32	NV	Wh	R
4	Active Energy Consumption, Phase 3 MSW	U32	NV	Wh	R
5	Active Energy Consumption, Phase 3 LSW	U32	NV	Wh	R
6	Active Energy Consumption, Phase Sum MSW	U32	NV	Wh	R
7	Active Energy Consumption, Phase Sum LSW	U32	NV	Wh	R
8	Reactive Energy Consumption, Phase 1 MSW(무효)	U32	NV	VARh	R
9	Reactive Energy Consumption, Phase 1 LSW	U32	NV	VARh	R

Modbus Register	Description	Type/ Length	Storage	Unit after Scaling	Access
10	Reactive Energy Consumption, Phase 2 MSW	U32	NV	VARh	R
11	Reactive Energy Consumption, Phase 2 LSW	U32	NV	VARh	R
12	Reactive Energy Consumption, Phase 3 MSW	U32	NV	VARh	R
13	Reactive Energy Consumption, Phase 3 LSW	U32	NV	VARh	R
14	Reactive Energy Consumption, Phase Sum MSW	U32	NV	VARh	R
15	Reactive Energy Consumption, Phase Sum LSW	U32	NV	VARh	R
16	Apparent Energy Consumption, Phase 1 MSW (apparent)	U32	NV	VAh	R
17	Apparent Energy Consumption, Phase 1 LSW	U32	NV	VAh	R
18	Apparent Energy Consumption, Phase 2 MSW	U32	NV	VAh	R
19	Apparent Energy Consumption, Phase 2 LSW	U32	NV	VAh	R
20	Apparent Energy Consumption, Phase 3 MSW	U32	NV	VAh	R
21	Apparent Energy Consumption, Phase 3 LSW	U32	NV	VAh	R
22	Apparent Energy Consumption, Phase Sum MSW	U32	NV	VAh	R
23	Apparent Energy Consumption, Phase Sum LSW	U32	NV	VAh	R
24	Energy Counter Time-stamp, Min/Sec	U16	V		R
25	Energy Counter Time-stamp, Day/Hour	U16	V		R
26	Energy Counter Time-stamp, Year/Month	U16	V		R
27	Line Frequency (frequency)	U16	V	Hz	R
28	Recording Interval Time-stamp, Min/Sec	U16	V		R
29	Recording Interval Time-stamp, Day/Hour	U16	V		R
30	Recording Interval Time-stamp, Year/Month	U16	V		R

Modbus Register	Description	Type/ Length	Storage	Unit after Scaling	Access
31	Interval Cycle	U16	V		
32	Recording Interval Active Energy, Phase 1 (valid)	U16	V	W	R
33	Recording Interval Active Energy, Phase 2	U16	V	W	R
34	Recording Interval Active Energy, Phase 3	U16	V	W	R
35	Recording Interval Active Energy, Phase Sum	U16	V	W	R
36	Recording Interval Reactive Energy, Phase 1 (invalid)	U16	V	VAR	R
37	Recording Interval Reactive Energy, Phase 2	U16	V	VAR	R
38	Recording Interval Reactive Energy, Phase 3	U16	V	VAR	R
39	Recording Interval Reactive Energy, Phase Sum	U16	V	VAR	R
40	Recording Interval Apparent Energy, Phase 1 (apparent)	U16	V	VA	R
41	Recording Interval Apparent Energy, Phase 2	U16	V	VA	R
42	Recording Interval Apparent Energy, Phase 3	U16	V	VA	R
43	Recording Interval Apparent Energy, Phase Sum	U16	V	VA	R
44	Maximum Current in Interval, Phase 1 (current)	U16	V	A	R
45	Maximum Current in Interval, Phase 2	U16	V	A	R
46	Maximum Current in Interval, Phase 3	U16	V	A	R
47	Minimum Voltage in Interval, Phase 1	U16	V	V	R
48	Minimum Voltage in Interval, Phase 2	U16	V	V	R
49	Minimum Voltage in Interval, Phase 3	U16	V	V	R
50	Average Power Factor in interval, Phase 1	U16	V	%	R
51	Average Power Factor in interval, Phase 2	U16	V	%	R
52	Average Power Factor in interval, Phase 3	U16	V	%	R
53	Average Power Factor in interval, Sum	U16	V	%	R
54	THD Voltage Phase 1	U16	V	%	R

Modbus Register	Description	Type/ Length	Storage	Unit after Scaling	Access
55	THD Voltage Phase 2	U16	V	%	R
56	THD Voltage Phase 3	U16	V	%	R
57	THD Current Phase 1	U16	V	%	R
58	THD Current Phase 2	U16	V	%	R
59	THD Current Phase 3	U16	V	%	R
60	BAUD RATE [BIT14-15] WI_GEM PRODUCT ID [BIT 7-13] Frequency [BIT6, 0:60 Hz, 1:50 Hz] CURRENT CALIBER [BIT3-5] CONNECTION SCHEMA [BIT0-2]	U16	NV		R
61	Software Version (bits 8-15) Software Revision (bits 0-7)	U16	NV		R
62	Status Word	U16	V		R
63	Command Word	U16	V		R/W
64	Recording Interval Time Setting	U16	NV	min	R/W

4.1.4 Modbus register map #2

*NV: Non-volatile, V: Volatile, S: Signed, U: Unsigned, R: Read, W: Write

Modbus Register	Description	Type/ Length	Storage	Unit after Scaling	Access
65	Voltage Phase 1	U16	V	V	R
66	Voltage Phase 2	U16	V	V	R
67	Voltage Phase 3	U16	V	V	R
68	Current Phase 1	U16	V	I	R
69	Current Phase 2	U16	V	I	R
70	Current Phase 3	U16	V	I	R
71	Active Power Phase 1	U16	V	W	R
72	Active Power Phase 2	U16	V	W	R
73	Active Power Phase 3	U16	V	W	R
74	Reactive Power Phase 1	U16	V	VAR	R
75	Reactive Power Phase 2	U16	V	VAR	R
76	Reactive Power Phase 3	U16	V	VAR	R
77	Apparent Power Phase 1	U16	V	VA	R
78	Apparent Power Phase 2	U16	V	VA	R
79	Apparent Power Phase 3	U16	V	VA	R
80	Power Factor Phase 1	U16	V	%	R
81	Power Factor Phase 2	U16	V	%	R
82	Power Factor Phase 3	U16	V	%	R
83	THD Voltage Phase 1	U16	V	%	R
84	THD Voltage Phase 2	U16	V	%	R
85	THD Voltage Phase 3	U16	V	%	R
86	THD Current Phase 1	U16	V	%	R
87	THD Current Phase 2	U16	V	%	R
88	THD Current Phase 3	U16	V	%	R
89	Neutral Current	U16	V	I	R

4.1.5 Modbus register map #3: Voltage Harmonic

*NV: Non-volatile, V: Volatile, S: Signed, U: Unsigned, R: Read, W: Write

Modbus Register	Description	Type/ Length	Storage	Unit after Scaling	Access
90	2nd Harmonic Voltage Phase 1	U16	V	%	R
91	3rd Harmonic Voltage Phase 1	U16	V	%	R
92	4th Harmonic Voltage Phase 1	U16	V	%	R
93	5th Harmonic Voltage Phase 1	U16	V	%	R
94	6th Harmonic Voltage Phase 1	U16	V	%	R
95	7th Harmonic Voltage Phase 1	U16	V	%	R
96	8th Harmonic Voltage Phase 1	U16	V	%	R
97	9th Harmonic Voltage Phase 1	U16	V	%	R
98	10th Harmonic Voltage Phase 1	U16	V	%	R
99	11th Harmonic Voltage Phase 1	U16	V	%	R
100	12th Harmonic Voltage Phase 1	U16	V	%	R
101	13th Harmonic Voltage Phase 1	U16	V	%	R
102	14th Harmonic Voltage Phase 1	U16	V	%	R
103	15th Harmonic Voltage Phase 1	U16	V	%	R
104	16th Harmonic Voltage Phase 1	U16	V	%	R
105	17th Harmonic Voltage Phase 1	U16	V	%	R
106	18th Harmonic Voltage Phase 1	U16	V	%	R
107	19th Harmonic Voltage Phase 1	U16	V	%	R
108	20th Harmonic Voltage Phase 1	U16	V	%	R
109	21st Harmonic Voltage Phase 1	U16	V	%	R
110	2nd Harmonic Voltage Phase 2	U16	V	%	R
111	3rd Harmonic Voltage Phase 2	U16	V	%	R
112	4th Harmonic Voltage Phase 2	U16	V	%	R
113	5th Harmonic Voltage Phase 2	U16	V	%	R
114	6th Harmonic Voltage Phase 2	U16	V	%	R
115	7th Harmonic Voltage Phase 2	U16	V	%	R
116	8th Harmonic Voltage Phase 2	U16	V	%	R
117	9th Harmonic Voltage Phase 2	U16	V	%	R
118	10th Harmonic Voltage Phase 2	U16	V	%	R
119	11th Harmonic Voltage Phase 2	U16	V	%	R
120	12th Harmonic Voltage Phase 2	U16	V	%	R
121	13th Harmonic Voltage Phase 2	U16	V	%	R

Modbus Register	Description	Type/ Length	Storage	Unit after Scaling	Access
122	14th Harmonic Voltage Phase 2	U16	V	%	R
123	15th Harmonic Voltage Phase 2	U16	V	%	R
124	16th Harmonic Voltage Phase 2	U16	V	%	R
125	17th Harmonic Voltage Phase 2	U16	V	%	R
126	18th Harmonic Voltage Phase 2	U16	V	%	R
127	19th Harmonic Voltage Phase 2	U16	V	%	R
128	20th Harmonic Voltage Phase 2	U16	V	%	R
129	21st Harmonic Voltage Phase 2	U16	V	%	R
130	2nd Harmonic Voltage Phase 3	U16	V	%	R
131	3rd Harmonic Voltage Phase 3	U16	V	%	R
132	4th Harmonic Voltage Phase 3	U16	V	%	R
133	5th Harmonic Voltage Phase 3	U16	V	%	R
134	6th Harmonic Voltage Phase 3	U16	V	%	R
135	7th Harmonic Voltage Phase 3	U16	V	%	R
136	8th Harmonic Voltage Phase 3	U16	V	%	R
137	9th Harmonic Voltage Phase 3	U16	V	%	R
138	10th Harmonic Voltage Phase 3	U16	V	%	R
139	11th Harmonic Voltage Phase 3	U16	V	%	R
140	12th Harmonic Voltage Phase 3	U16	V	%	R
141	13th Harmonic Voltage Phase 3	U16	V	%	R
142	14th Harmonic Voltage Phase 3	U16	V	%	R
143	15th Harmonic Voltage Phase 3	U16	V	%	R
144	16th Harmonic Voltage Phase 3	U16	V	%	R
145	17th Harmonic Voltage Phase 3	U16	V	%	R
146	18th Harmonic Voltage Phase 3	U16	V	%	R
147	19th Harmonic Voltage Phase 3	U16	V	%	R
148	20th Harmonic Voltage Phase 3	U16	V	%	R
149	21st Harmonic Voltage Phase 3	U16	V	%	R

4.1.6 Modbus register map #4: Current Harmonic

*NV: Non-volatile, V: Volatile, S: Signed, U: Unsigned, R: Read, W: Write

Modbus Register	Description	Type/ Length	Storage	Unit after Scaling	Access
150	2nd Harmonic Current Phase 1	U16	V	%	R
151	3rd Harmonic Current Phase 1	U16	V	%	R
152	4th Harmonic Current Phase 1	U16	V	%	R
153	5th Harmonic Current Phase 1	U16	V	%	R
154	6th Harmonic Current Phase 1	U16	V	%	R
155	7th Harmonic Current Phase 1	U16	V	%	R
156	8th Harmonic Current Phase 1	U16	V	%	R
157	9th Harmonic Current Phase 1	U16	V	%	R
158	10th Harmonic Current Phase 1	U16	V	%	R
159	11th Harmonic Current Phase 1	U16	V	%	R
160	12th Harmonic Current Phase 1	U16	V	%	R
161	13th Harmonic Current Phase 1	U16	V	%	R
162	14th Harmonic Current Phase 1	U16	V	%	R
163	15th Harmonic Current Phase 1	U16	V	%	R
164	16th Harmonic Current Phase 1	U16	V	%	R
165	17th Harmonic Current Phase 1	U16	V	%	R
166	18th Harmonic Current Phase 1	U16	V	%	R
167	19th Harmonic Current Phase 1	U16	V	%	R
168	20th Harmonic Current Phase 1	U16	V	%	R
169	21st Harmonic Current Phase 1	U16	V	%	R
170	2nd Harmonic Current Phase 2	U16	V	%	R
171	3rd Harmonic Current Phase 2	U16	V	%	R
172	4th Harmonic Current Phase 2	U16	V	%	R
173	5th Harmonic Current Phase 2	U16	V	%	R
174	6th Harmonic Current Phase 2	U16	V	%	R
175	7th Harmonic Current Phase 2	U16	V	%	R
176	8th Harmonic Current Phase 2	U16	V	%	R
177	9th Harmonic Current Phase 2	U16	V	%	R
178	10th Harmonic Current Phase 2	U16	V	%	R
179	11th Harmonic Current Phase 2	U16	V	%	R
180	12th Harmonic Current Phase 2	U16	V	%	R
181	13th Harmonic Current Phase 2	U16	V	%	R

Modbus Register	Description	Type/ Length	Storage	Unit after Scaling	Access
182	14th Harmonic Current Phase 2	U16	V	%	R
183	15th Harmonic Current Phase 2	U16	V	%	R
184	16th Harmonic Current Phase 2	U16	V	%	R
185	17th Harmonic Current Phase 2	U16	V	%	R
186	18th Harmonic Current Phase 2	U16	V	%	R
187	19th Harmonic Current Phase 2	U16	V	%	R
188	20th Harmonic Current Phase 2	U16	V	%	R
189	21st Harmonic Current Phase 2	U16	V	%	R
190	2nd Harmonic Current Phase 3	U16	V	%	R
191	3rd Harmonic Current Phase 3	U16	V	%	R
192	4th Harmonic Current Phase 3	U16	V	%	R
193	5th Harmonic Current Phase 3	U16	V	%	R
194	6th Harmonic Current Phase 3	U16	V	%	R
195	7th Harmonic Current Phase 3	U16	V	%	R
196	8th Harmonic Current Phase 3	U16	V	%	R
197	9th Harmonic Current Phase 3	U16	V	%	R
198	10th Harmonic Current Phase 3	U16	V	%	R
199	11th Harmonic Current Phase 3	U16	V	%	R
200	12th Harmonic Current Phase 3	U16	V	%	R
201	13th Harmonic Current Phase 3	U16	V	%	R
202	14th Harmonic Current Phase 3	U16	V	%	R
203	15th Harmonic Current Phase 3	U16	V	%	R
204	16th Harmonic Current Phase 3	U16	V	%	R
205	17th Harmonic Current Phase 3	U16	V	%	R
206	18th Harmonic Current Phase 3	U16	V	%	R
207	19th Harmonic Current Phase 3	U16	V	%	R
208	20th Harmonic Current Phase 3	U16	V	%	R
209	21st Harmonic Current Phase 3	U16	V	%	R

4.1.7 Modbus register map #5: User Map

*NV: Non-volatile, V: Volatile, S: Signed, U: Unsigned, R: Read, W: Write

Modbus Register	Description	Type/ Length	Storage	Unit after Scaling	Access
300	Active Energy Consumption, Phase 1 MSW (valid)	U32	NV	Wh	R
301	Active Energy Consumption, Phase 1 LSW	U32	NV	Wh	R
302	Active Energy Consumption, Phase 2 MSW	U32	NV	Wh	R
303	Active Energy Consumption, Phase 2 LSW	U32	NV	Wh	R
304	Active Energy Consumption, Phase 3 MSW	U32	NV	Wh	R
305	Active Energy Consumption, Phase 3 LSW	U32	NV	Wh	R
306	Active Energy Consumption, Phase Sum MSW	U32	NV	Wh	R
307	Active Energy Consumption, Phase Sum LSW	U32	NV	Wh	R
308	Active Power Phase 1	U16	V	W	R
309	Active Power Phase 2	U16	V	W	R
310	Active Power Phase 3	U16	V	W	R
311	Line Frequency (frequency)	U16	V	Hz	R
312	Voltage Phase 1	U16	V	V	R
313	Current Phase 1	U16	V	I	R
314	Power Factor Phase 1	U16	V	%	R
315	THD Voltage Phase 1	U16	V	%	R
316	THD Current Phase 1	U16	V	%	R
317	Maximum Current in Interval, Phase 1 (current)	U16	V	A	R
318	Minimum Voltage in Interval, Phase 1 (voltage)	U16	V	V	R
319	Voltage Phase 2	U16	V	V	R
320	Voltage Phase 3	U16	V	V	R
321	Current Phase 2	U16	V	I	R

Modbus Register	Description	Type/ Length	Storage	Unit after Scaling	Access
322	Current Phase 3	U16	V	I	R
323	Power Factor Phase 2	U16	V	%	R
324	Power Factor Phase 3	U16	V	%	R
325	THD Voltage Phase 2	U16	V	%	R
326	THD Voltage Phase 3	U16	V	%	R
327	THD Current Phase 2	U16	V	%	R
328	THD Current Phase 3	U16	V	%	R
329	Maximum Current in Interval, Phase 2 (current)	U16	V	A	R
330	Maximum Current in Interval, Phase 3 (current)	U16	V	A	R
331	Minimum Voltage in Interval, Phase 2 (voltage)	U16	V	V	R
332	Minimum Voltage in Interval, Phase 3 (voltage)	U16	V	V	R
300	Active Energy Consumption, Phase 1 MSW (valid)	U32	NV	Wh	R
301	Active Energy Consumption, Phase 1 LSW	U32	NV	Wh	R
302	Active Energy Consumption, Phase 2 MSW	U32	NV	Wh	R

4.1.8 Scaling factors

Current Range	5 A	20 A	50 A	100 A
Active Energy Wh [Interval]	64	16	6.4	3.2
Active Energy Wh [Counter]	8	2	0.8	0.4
Reactive Energy VARh [Interval]	64	16	6.4	3.2
Reactive Energy VARh [Counter]	8	2	0.8	0.4
Apparent Energy VAh [Interval]	64	16	6.4	3.2
Apparent Energy VAh [Counter]	8	2	0.8	0.4
Vrms	25	25	25	25
Irms	1200	300	120	60
Frequency	16	16	16	16
Active Energy Wh [Interval]	64	16	6.4	3.2

4.1.9 Energy counters

Energy counters have the total consumed energy calculated by EMU. The reset command resets the energy counters, the recording interval counters, and the on-going interval accumulated values.

The time-stamp of the energy counters is written into the register when the data is sent to EMG.

Energy counters will count positive for energy consumed, negative for energy generated and pushed into the grid. Active, reactive, and apparent energy consumption values are stored as 32-bit values, thus using 2 Modbus registers.

The lower register address contains the high word value (MSW: Most Significant Word) and the high register contains the low word value (LSW: Least Significant Word).

- Registers: 0 to 23.

0	1
16-bits	16-bits
MSW	LSW

4.1.10 Recording interval time (register 64)

Energy is integrated based on the recording time interval that is configurable.

The normal energy is calculated based on the period of five minutes with nominal current and nominal input voltage.

The last completed interval values are stored in the register map.

The time-stamp is set in the time-stamp register at the end of the integration interval.

- Registers: 32 to 43

4.1.11 Recording interval-based energy

The recording interval time is a configurable parameter that defines the recording interval (minutes). It can have values for 5, 6, 10, 12, 15, 20, and 30.

The start of an interval is at the hour + n* interval.

When writing a value different from the ones listed to this parameter, it is discarded and the EMU continues to use the previous set value.

Note that the EMG responds with an "ACK" to a write of an invalid value as it does not check the contents of the message sent to the EMU.

4.1.12 Time stamp

The time stamp of the recording interval have the same format that uses three Modbus registers.

Each of the registers is split into two parts as shown in the following table.

Register		High Byte	Low Byte
24	28	Minute	Second
25	29	Day	Hour
26	30	Year	Month

4.1.13 Frequency (register 27)

The Line Frequency is measured based on the phase of the power supply only (phase 1). The last value of the recording interval is stored in this register.

4.1.14 Maximum current

The RMS current is averaged for 10 line periods (200 ms in the 50 Hz system). The maximum current average of the recording interval is stored in this register.

4.1.15 Minimum voltage

The RMS voltage is averaged for 10 line periods (200 ms in the 50 Hz system). The minimum voltage value of the recording interval is stored in this register.

Parameter	Description
Scaling	UNorminal (230 V rms) = 5750 (d)
Access/Type	User, Read, Volatile

4.1.16 Product identification

The product identification identifies the Wi_GEM product, meter configuration, and the current caliber.

The corresponding codes are in the product ID register, bits [0-2]

Item	Model	Code	Number of Current Sensors
3-Phase 4-wires Wye	AM34	0	3
1-Phase 2-wires	AM12	10	1
3-Phase 3-wires Delta	AM33	11	2
3single Phase on same voltage	AM13	101	3

The current caliber of the connected current transducers and the nominal current can be read from the product ID register, bits [3-6].

Current Caliber	Code
5 A	0
20 A	10
50 A	11
100 A	100

The WI-GEM product ID (0001) is a 4-bit product identification code, bits [7-10].
All EMUs share the same product ID.

4.1.17 Software version

The software version means the major release number of the EMU software. The MSB of this register contains the version number. The LSB of this register contains the revision number.

4.1.18 Status word

The status of the EMU can be read from a read-only register.

Bit	Status Description
0	Set when synchronized to 50/60 Hz
1	Set if a checksum error has been detected at power-up
2, 3, 4, 5, 6, 7	Not used
8	Internal use only
9	Internal use only
10	Not used
11	Internal use only
12	Internal use only
13, 14, 15	Not used

4.1.19 Command word

The EMU can execute commands after a write to a command word, which is mapped to a R/W register. Setting a bit in the command word executes the command.

Bit	Command
0	This resets the device counters and the interval counters.
7	Places EMU in direct serial communication mode. It is used during manufacturing. Do not place EMU in this mode. Otherwise the EMU cannot communicate via the radio module. In this mode, turn off and on the device to reset to normal radio communication.
1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15	Not used/ignored

The reset meter command resets the energy counters to zero in both RAM and non-volatile RAM. This command does not affect the reporting intervals.

The direct serial word enables radio-communication to restore the radio-communication mode and power cycle EMU (Switch it off and on).

4.2 EMR related

The related parameters and functions are:

Function/Setting	Description
Number of connectable EMUs	255 EMUs
Selectable Baud Rate	Up to 250 kbps

4.3 EMG related

The related parameters and functions are:

Function/Setting	Description
Number of connectable EMUs or EMRs	255 EMUs or EMRs
Selectable Baud Rate	Up to 250 kbps

4.4 Communication protocol

For the communication protocol, the Modus RTU method has been adopted. The following lists the basic functions:

Code	Description
03	Multiple registers (read)
05	Force coil register (write); not used
06	Single register (write); not used

4.4.1 Frame structure of multiple registers for read

When requested to Wi-GEM, the frame structure is as follows:

Station Address	Function (03)	Starting Address		Word Count		Error Check	
		High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte
1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte

When replied by Wi-GEM, the frame structure is as follows:

Station Address	Function (03)	Byte Count	Data Word 1		…	Data Word 52		Error Check	
			High Byte	Low Byte		High Byte	Low Byte	High Byte	Low Byte
1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	…	1 Byte	1 Byte	1 Byte	1 Byte

4.4.2 Frame structure of force coil and single register for write

When requested to Wi-GEM, the frame structure of the force coil register is as follows:

Station Address	Function (05)	DO Address		Force Data Value		Error Check	
		High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte
1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte

When replied by Wi-GEM, it returns the frame that is requested to Wi-GEM in case of write success.

When requested to Wi-GEM, the frame structure of the single register is as follows:

Station Address	Function (06)	DO Address		FORCE Data Value		Error Check	
		High Byte	Low Byte	High Byte	Low Byte	High Byte	Low Byte
1Byte	1Byte	1Byte	1Byte	1Byte	1Byte	1Byte	1Byte

5. Troubleshooting

Symptom		Corrective Action
There is no measured data displayed in the monitoring program.		1. Check the cable connection status. 2. Check the communication port status. 3. Check the communication speed.
Wrong Measurement	Voltage Error	1. Check the cable wiring status. 2. Check the input voltage.
	Current Error Or Watt/var Error	1. Check the sensor wiring status. 2. Check the current flow of the sensor. 3. Check whether the sensor is open.
Power Operation Error		Check the input voltage.

⚠ **DANGER**	When the above-mentioned actions cannot solve the problem, contact with the manufacturer or purchasing agent. In case of product disassembly or modification, it may cause personal damage due to product failure. In this case, you cannot receive warranty services.

6. Specifications

6.1 EMU specifications

Item	Specification
Frequency	50/60 Hz
Operating temperature	-10 to 55°C
Storage temperature	-25 to 85°C
Weight	160 g except clamp(s)
Size	67 (W) x 133 (D) x 38 (H) mm

6.2 EMR & EMG specifications

Item	Specification
Operating temperature	-10 to 55°C
Storage temperature	-25 to 85°C
Weight	125 g
Size	68 (W) x 119 (D) x 25 (H) mm

6.3 Measurement information

Item	Instantaneous Values				Interval-based Values				Accumulated Values			
	L1	L2	L3	Sum	L1/L2/L3			Sum	L1	L2	L3	Sum
					Av	Min	Max					
Current (A) Irms	○	○	○	○			○					
Voltage (V) Vrms	○	○	○	○		○						
Active Energy (KWh)									○	○	○	○
Reactive Energy (KVARh)									○	○	○	○
Apparent Energy (KVAh)									○	○	○	○
Power Factor (%)	○	○	○	○	○							
Frequency (Hz)	○											
Active Power (KW)	○	○	○	○	○							
Reactive Power (KVAR)	○	○	○	○	○							
Apparent Power (KVA)	○	○	○	○	○							
Voltage Harmonic 2nd~21th(Option)	○	○	○									
Current Harmonic 2nd~21th(Option)	○	○	○									

7. Manufacturer Information

7.1 Manufacturer

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7.2 Documents and others

- User Guide revision 1.00
- Monitoring Program version 1.00
- Modbus Register Map revision 2.30
- Last modification date: 2011.10.10