Remote Digital Controller SHM-KX

User Manual

HM 0.460.5901/2024

IMPORTANT:
Please read this manual carefully before using the tap-changer and save it for reference.

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Chapter 1 Overview

The SHM-KX digital controller is a new generation of intelligent products with independent intellectual property rights launched by our company. It adopts all localized chips inside and can support different types of Motor-Drive Units MDU, including SHM-D, CMA7, SHM-X, ZDK-A, and so on.

The SHM-KX remote controller features a 5" color high-resolution screen with a resolution of 1280*720. It is equipped with an A7 chip CPU with a main frequency of 1.2GHz, 4GB FLASH memory, and 1GB RAM, providing exceptional operating speed and substantial memory space.

1.1 Main Functions

Information Reception:
Receives gear position information from the motor-drive unit and various status information from the MDU.

Information Transmission:
Sends Raise, Lower, and Stop commands to the motor-drive unit to control the operation of the on-load tap-changer motor-drive unit.

Automatic Voltage Regulation (Optional Function):
The bus voltage (40V to 140V) or current (5A or 1A) is sampled as a reference for voltage regulation.

The set voltage value can be adjusted within a range of 50% to 150% of the primary voltage.

Adjustment accuracy can be freely set from 0.2% to 10.00%, with a default value of 2.50%.

Delay time can be freely set from 10 seconds to 180 seconds, with a default value of 30 seconds. The delay T2 operation option is also supported.

Based on the set voltage and adjustment accuracy, the SHM-KX will automatically perform a tap change operation (raise or lower) when the sampled value exceeds the adjustment accuracy range and the duration exceeds the set delay time.

Parallel Voltage Regulation (Optional Function):
Supports up to 8 SHM-KX controllers for parallel voltage regulation.

Other Features:
- Equipped with a historical database to record all local, remote, and numerical control operations.
- Network communication capability with other intelligent devices (optional).
- Can connect to various gear position transmitters through RS485 communication to output gear position information as analog signals.

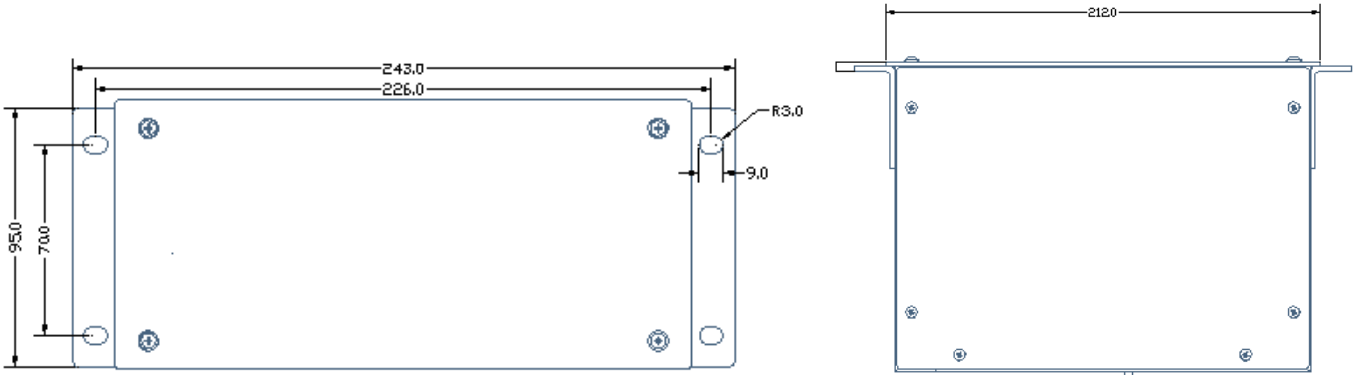
- Capable of outputting BCD gear position information (can also be defined as dry contact output for other purposes).
- External buttons can be connected to perform raise, lower, and stop operations.
- LCD screen with adjustable brightness.

1.2 Technical Specifications

Operating Power Supply	AC 85-264V AC: 50/60Hz, DC 100-250V
Power Consumption	Approximately 7W
CPU	A8, 64-bit, 1GHz
Bus Architecture	AMBA
Memory	8G FLASH, 1GB SDRAM
Operating System	Linux
Switching Output	16-channel passive, relay output, contact capacity: 5A 250VAC, 5A 30VDC.
Status Signal Input	16-channel Digital Input signal inputs. Must be passive, internally opto-isolated >2500V. Specific functions can be customized.
*1Analog Input	Voltage Acquisition: 40V - 140V Current Acquisition: 1A - 5A
Statistical Function	Records operation time, raise/lower operations, and fault records.
Communication Function	1 optical fiber port: multimode, 62.5/125μm, ST connector, wavelength 820nm, maximum transmission distance 1km. 2 RS485 communication ports (X2 terminal). These are 3 independent communication channels, each can be configured for different functions. 1 TCP/IP 1000M RJ45 network port. Supported Protocols: IEC60870-5-101,103,104;SC1801;MODBUS;CDT;IEC61850; etc.
Liquid Crystal Display	5-inch touchscreen, 16-bit true color, 1280*720pixel,100dpi Displays gear position Alarm Functio: communication failure, local device failure. Status information: local, remote/numerical control status, hand crank status, gear operation status, temperature, etc. Log records; Parameter settings.
Operating Environment	Indoor, operating temperature 0°C - 50°C, relative humidity ≤ 95% RH non-condensing.
Installation Method	Panel or cabinet mounting.

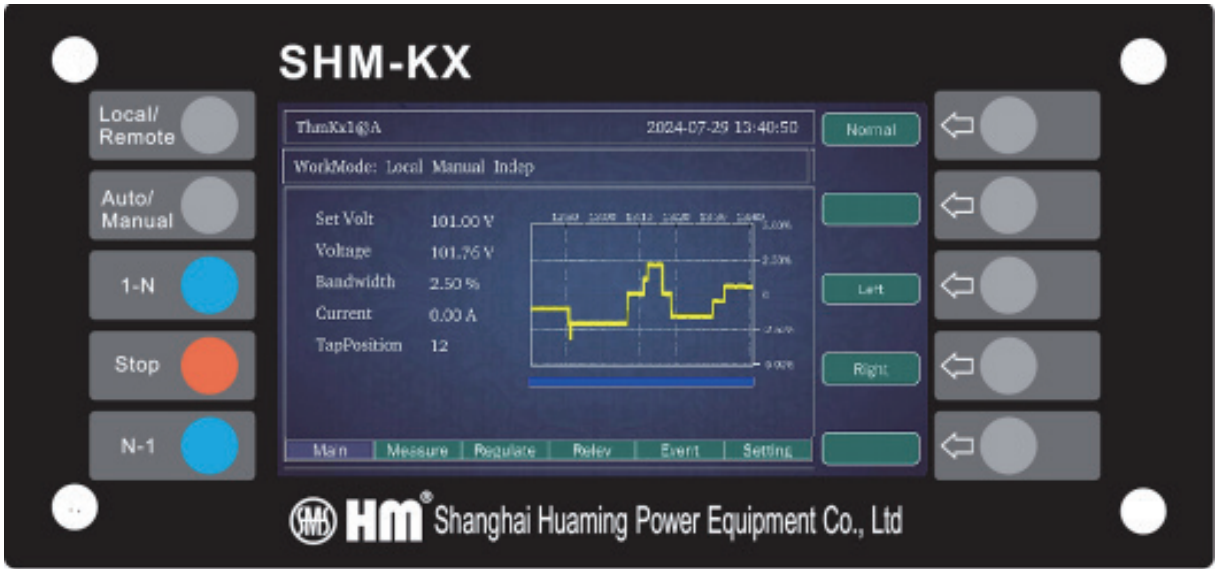
Chapter 2 Installation and Wiring

2.1 External Dimensions and Mounting Method



The installation method can be fixed by screws on the front, or it can be locked by pins on both sides as shown in the upper right figure.
Panel cutout dimensions: 210mm × 96mm (Length × Width).
The external dimensions are identical to the SHM-K.

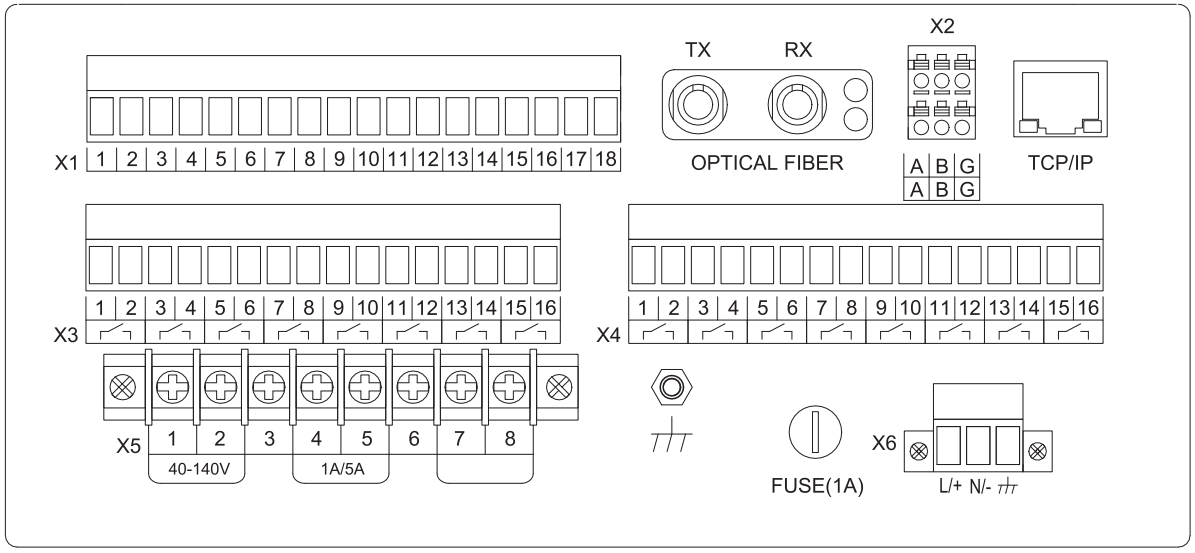
2.2 Panels



Description

- On the left are 5 fixed function keys
- On the right are 5 buttons for human-computer interaction

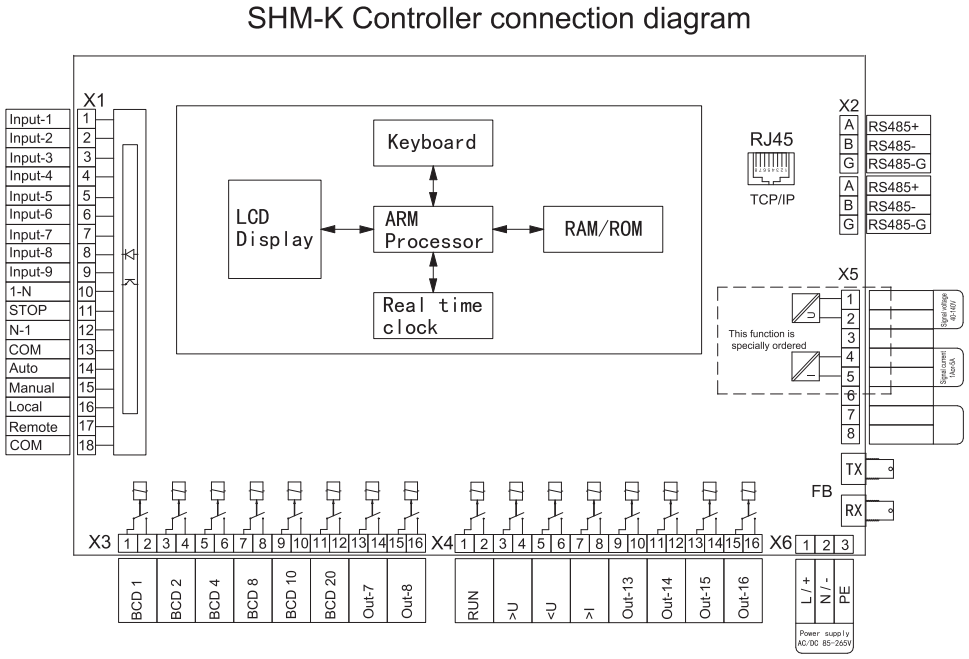
Rear Panel



Description

- X1 is the digital input terminal block. X1-13 and X1-18 are common terminals. All input signals must be passive.
- X2 is the RS485 communication port terminal block. There are two sets of RS485 ports. The first row of terminals (A, B, G) is for the first RS485 port, and the second row (A, B, G) is for the second RS485 port.
- X3 and X4 are relay output terminal blocks. There are 16 relay outputs, and their functions can be customized.
- X5 is the voltage and current sampling input terminal block.
- X6 is the power supply input terminal block. It accepts AC 85V to 264V, 50/60Hz, or DC 100V to 250V.
- One set of terminals is provided for chassis grounding.

2.3 Wiring Diagram



- The operating power supply is AC 85V to 265V (can also be customized for DC 110V or 220V input).

The ground terminal on the power supply terminal block must be reliably grounded.

- All communication ports are optically or electromagnetically isolated.
- The network port is a 100M TCP/IP port (optional), supporting IEC104, TcpModbus, IEC 61850 protocols. It can also be used to connect with other remote controllers for parallel operation.
- Communication with the motor-drive unit can be established through fiber optic or RS485 connection. Hardwiring is also possible.
- The controller can connect to various types of gear position transmitters through RS485 communication, enabling the output of gear position information in various formats such as BCD code, resistance, and 4-20mA, to meet user requirements.
- The BCD code gear position output and motor operation signal output (motor rotation signal) from the remote digital controller are dry contact relay outputs. These outputs can also be configured as dry contact outputs for other purposes, as per user requirements.
- The SHM-K digital controller supports external buttons for raise, lower, and stop operations. These functions need to be defined in the digital input settings.
- Bus voltage and current can be input to the remote controller through PT/CT for automatic voltage regulation functionality.

2.4 How to Insert and Remove Fiber Optic Connectors

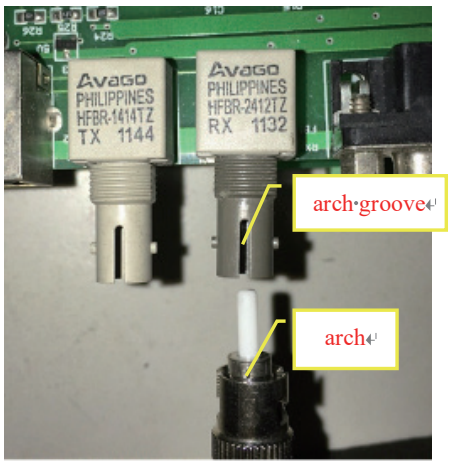
The fiber optic interface between the SHM-D(S) and SHM-KX is an ST type connector. Fiber optic connectors are precision devices, and care should be taken when connecting and disconnecting them to avoid damage.

When connecting the fiber optic cable, ensure that the TX (transmit) port of one device is connected to the RX (receive) port of the other device, and vice versa.

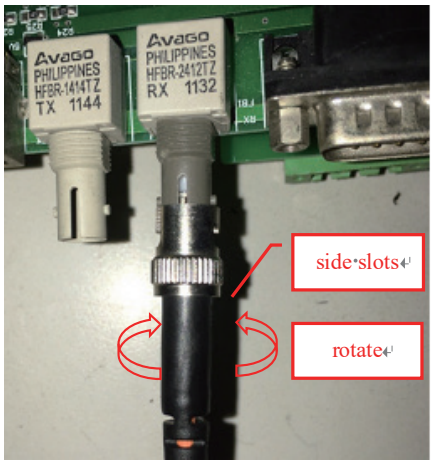
You can check the integrity of the fiber optic cable by shining a laser pointer into one end and observing the light at the other end (caution: do not look directly into the fiber optic cable).

2.4.1 Inserting the Fiber Optic Connector

Step 1:
Align the key on the fiber optic connector with the slot on the fiber optic receptacle and gently insert the connector.



Step 2:
Slightly rotate the connector to ensure it engages with the side latch.



Step 3:
Once the connector is fully inserted, rotate it clockwise to lock it in place. The connection is now complete.

2.4.2 Removing the Fiber Optic Connector

Step 1: Gently push the connector forward while rotating it counterclockwise, as shown in the figure above.
Step 2: Pull the connector out, reversing the process of insertion as described in section 2.4.1.

2.5 Precautions for Installation and Use

The using environment is indoor, (ambient) temperature please do not exceed 0℃ to 50℃, in the harsh environment, special orders are required.

The using environment (ambient) relative humidity should be less than 95%, and no condensation.
In environments with high levels of dust or metallic particles, install a protective enclosure or cabinet.

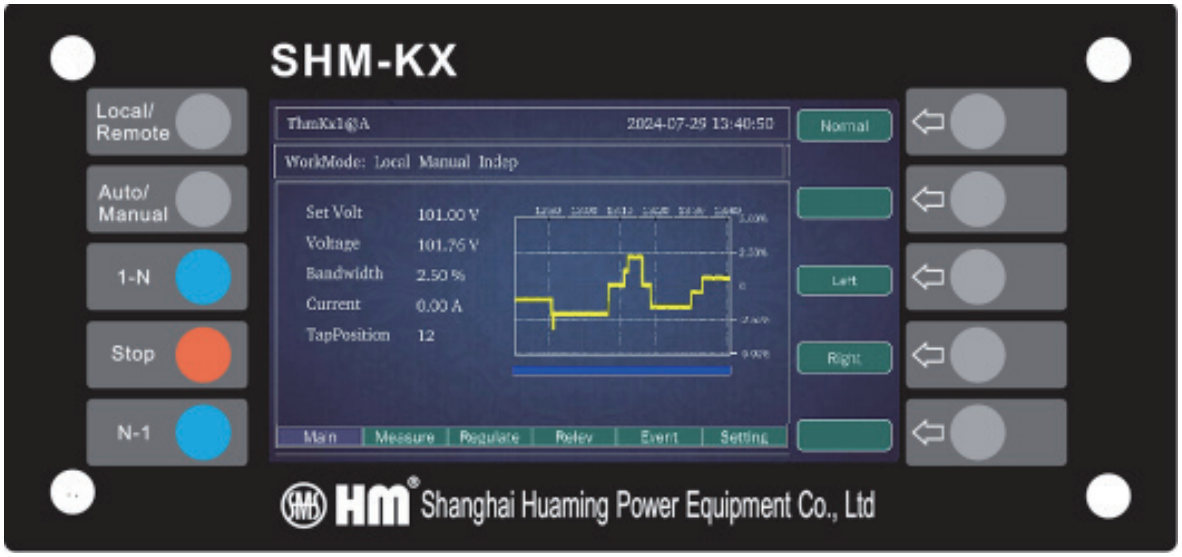
Chapter 3 Main Screen and Control Modes

3.1 Control Modes

The SHM-KX has three control modes: Local/Remote, Auto/Manual, and Parallel/Independent.

Users can select the desired mode using the "Local/Remote" and "Auto/Manual" buttons on the front panel.

The Parallel/Independent mode can only be configured through the parallel settings menu (see Chapter 4 for details).



The control mode can also be switched via digital inputs if the corresponding functionality is configured (see the Digital Input Settings section).

After switching the work permission, the corresponding system status will prompt the status of the current work mode.

3.1.1 Local/Remote Mode

When SHM-KX is in Manual mode, SHM-D(S) can be controlled to raise, lower, and stop by the following methods.

1. Front panel raise/lower/stop buttons.
2. External raise/lower/stop signals connected to the rear terminal block (requires configuration).
3. Control commands received from a supervisory control system through communication.

In Local mode, commands from the front panel buttons are considered valid.
If switched to Remote mode, only the communication or the digital input signal from the rear terminal will be recognized as a valid signal.

3.1.2 Auto/Manual Mode

When SHM-KX is in Auto mode, the automatic raising, lowering and stopping control is done according to the sampling data and related parameters. In this state, external gear shifting commands are ignored by the system. When SHM-KX is in Manual mode, it will accept gear shifting commands from the panel, terminal, and communication, and operate according to the current setting.

3.1.3 Parallel Mode

When the SHM-KX is in Parallel Slave mode, it will follow the Master to perform synchronized raise, lower, and stop operations. At this time, the Slave will ignore all raise/lower commands and only follow the actions of the Master.

In Parallel Master mode and Manual mode, when the SHM-KX receives a raise/lower command, it will not only execute the command itself but also send the command to the Slave controllers, ensuring synchronized operation.

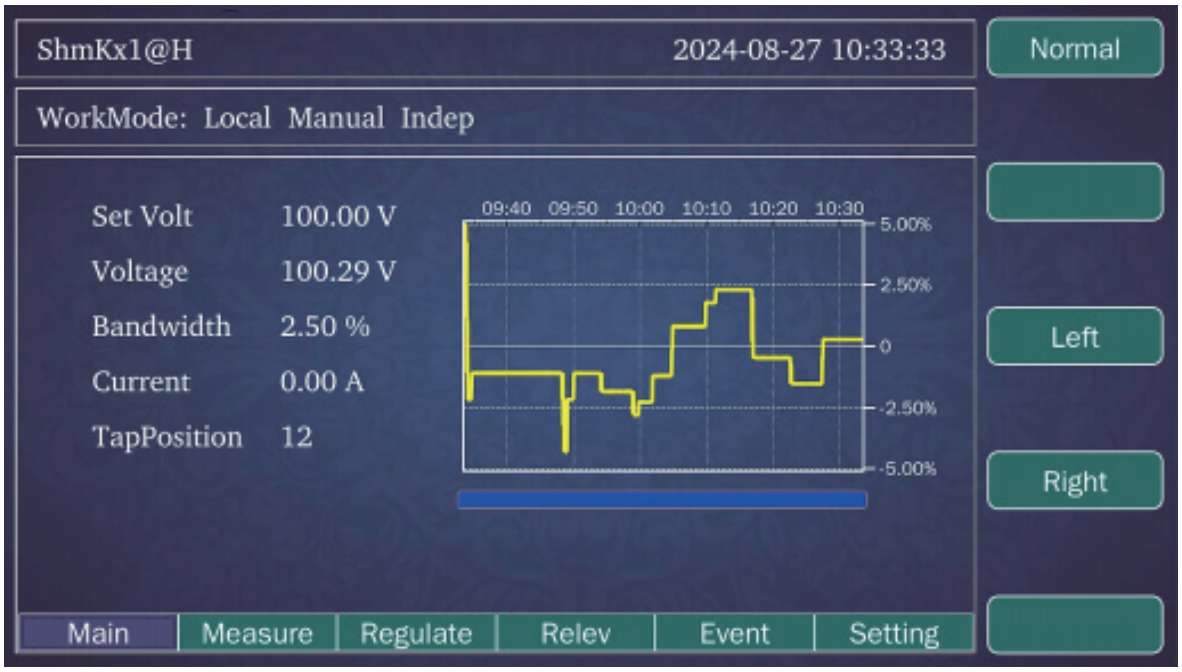
In Parallel Master mode and Automatic mode, the SHM-KX will perform automatic voltage regulation based on its own sampled data and distribute the commands to the Slave controllers.

3.2 Main Screen

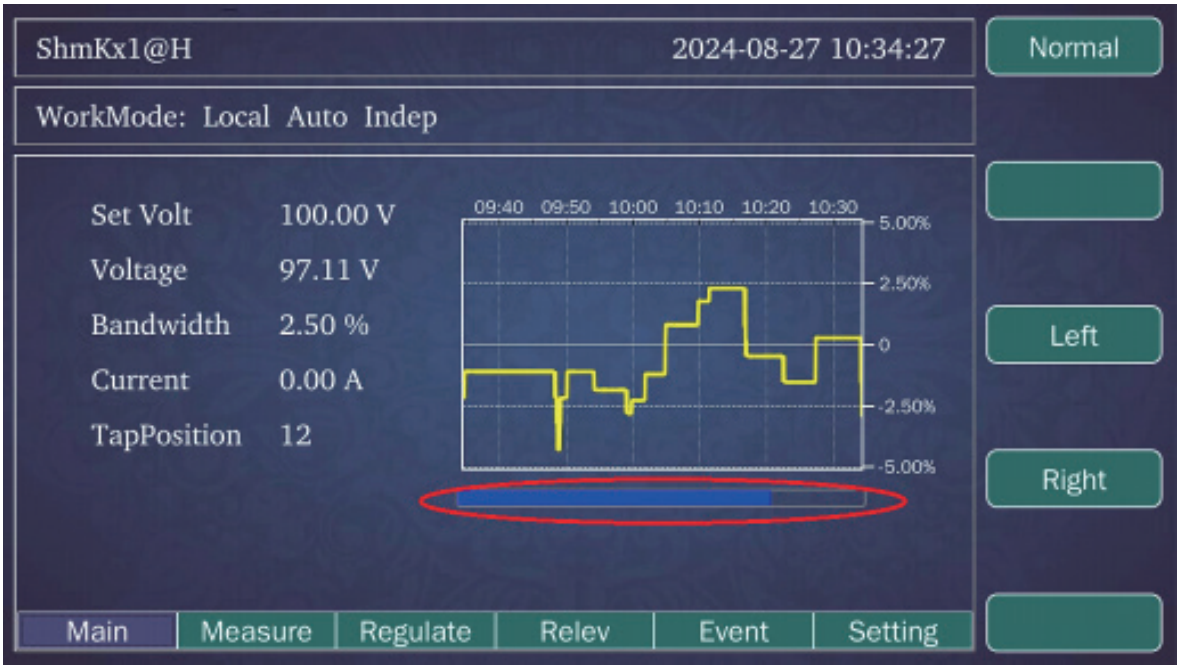
After powering on the remote controller, the initial screen will appear. The system will take approximately 10 seconds to load the program. Afterward, the main screen will be displayed.
There are three main screen views: Normal, Simplified, and Detailed.
Users can switch between these views by pressing the first button on the right side of the front panel.
The Normal view is the default screen. To change the default screen, please contact the manufacturer.

3.2.1 Normal View

The Normal view displays a voltage waveform graph, monitoring information, and key data, as shown below.



The progress bar below the voltage waveform represents the voltage regulation time window. When the sampled value exceeds the adjustment accuracy range, the progress bar will count down. Once it reaches zero, a tap change operation will be executed.



3.2.2 Simplified View

The Simplified view displays different information depending on the control mode.
In Manual mode, only the current tap position is displayed.
The figure below shows the Simplified view in Manual mode.

In Auto mode (including Auto-Independent and Auto-Parallel), a bar graph is displayed. A red bar indicates that the sampled voltage is outside the adjustment accuracy range, and the voltage regulation time window is active. A green bar indicates that the voltage is within the adjustment accuracy range, and no voltage regulation is required.

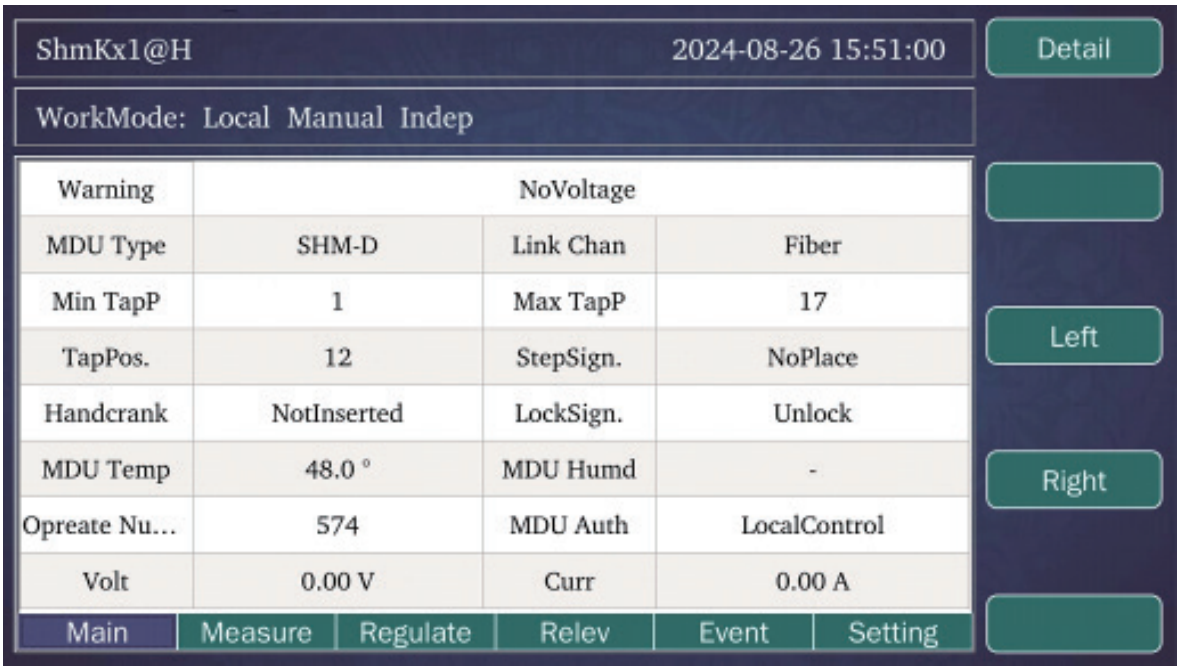
The figure below shows the Simplified view in Auto mode.

The progress bar below the tap position information functions similarly to the progress bar in the Normal view, indicating the remaining time in the voltage regulation time window.

When the column prompt bar displays red, it indicates that the current reference voltage exceeds the set range.

3.2.3 Detailed View

The Detailed view displays the real-time status of the MDU in a tabular format, as shown below.



This view provides a more comprehensive understanding of the current system status. The SHM-KX displays detailed information received from the SHM-D(DL). The information displayed may vary depending on the type of motor-drive unit connected.

The following is a description of each item:

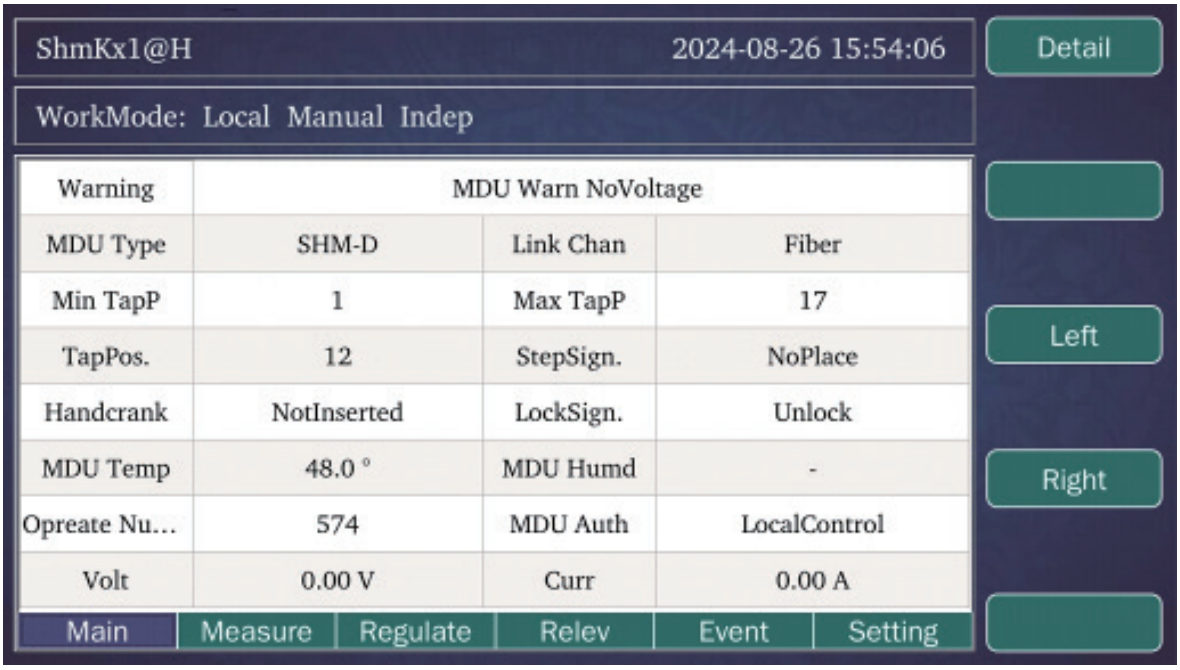
- **MDU Type**
  Displays the type of motor-drive unit configured in the SHM-KX.
- **Link Channel**
  Displays the communication method used by the SHM-KX to acquire information, which can be Fiber Optic, RS485, or Hardwired.
- **Minimum Tap Position/Maximum Tap Position**
  These parameters are obtained through communication for SHM-D and SHM-X and do not require configuration. For CMA7, these parameters need to be configured.
- **Current Tap Position**
  Displays the current tap position of the motor-drive unit, including information about consecutive taps. For example, if the current tap position is 9B, then 9B will be displayed, not just 9.
- **MDU Authority**
  Local Control: Indicates that the motor-drive unit can only be operated locally.
  Terminal Control:
  Indicates that the motor-drive unit can only be operated through hardwired signals connected to its terminal block.
  Digital Control:
  Indicates that the motor-drive unit is controlled by the AVR through fiber optic or RS485 communication.
  Stop Control:
  Indicates that the motor-drive unit is in a stopped state and will not accept any raise/lower commands.
- **Hand Crank**
  Indicates the status of the hand crank, either Inserted or Not Inserted.
- **Lock Position**
  Normally, there are two states: locked and unlocked. Locked means the motor-drive unit is locked by an external protection device, and in this case, the motor-drive unit cannot perform any raise, lower or stop operation.
- **Temperature and Humidity**
  SHM-D provides temperature information, while SHM-X provides both temperature and humidity information. CMA7 does not provide this information, and "-" will be displayed.
- **Step Signal**
  Indicates whether the tap changer has reached the target position. It can be either Running or In Position.
- **Operation Count**
  Displays the total number of raise/lower operations performed by the motor-drive unit.
- **Voltage**
  In Auto mode, displays the real-time sampled voltage (secondary value).
- **Current**
  In Auto mode, displays the real-time sampled current (secondary value).
- **Real-Time Flags**
  Displays the real-time status of the motor-drive unit, including alarms and operating status.

The following is a list of possible Real-Time Flags:

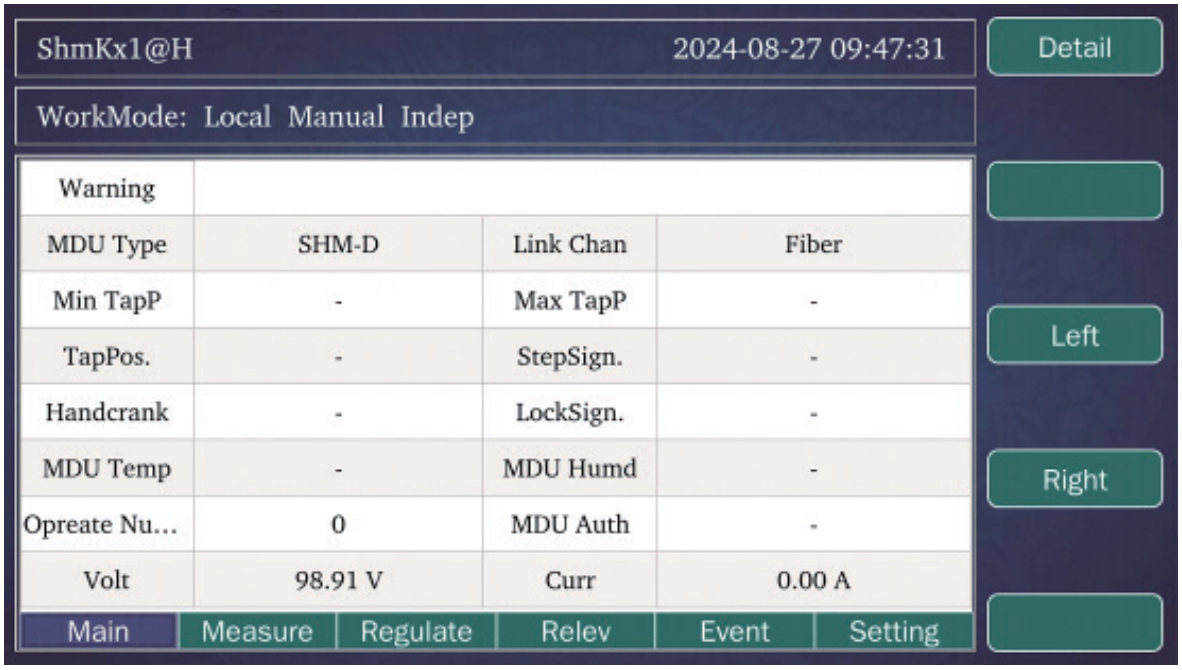
MDU Warn	Indicates a hardware error in the motor-drive unit.
Motor Release	Indicates that the motor release signal is active.
Oil Filter Working	This status indicates that the oil filter working status signal is being output.
Cam Signal	This status indicates the cam signal is being output.
Raising	The motor-drive unit is raising.
Lowering	The motor-drive unit is lowering.
Min Tap Position	Indicates that the motor-drive unit is at the minimum tap position.
Max Tap Position	Indicates that the motor-drive unit is at the maximum tap position.
Power Supply or Motor Failure	The power supply is malfunctioning, or the input power supply has a phase sequence error or a missing phase.
OverVolt	Indicates that the sampled voltage exceeds the set value.
UnderVolt	Indicates that the sampled voltage is below the set value.
OverCurrent	Indicates that the sampled current exceeds the set value.
ReleCommErr	Indicates a communication error with the Slave controllers in Parallel Master mode. Parallel operation is not possible in this state.
ReleDiffErr	Indicates a discrepancy in tap position or status between the Master and Slave controllers in Parallel Master mode. Parallel operation is not possible in this state.

3.2.4 Mechanism Failure Analysis

If the mechanism fails to operate or a fault occurs, check the Detailed view for more information to diagnose the problem.



For example, in the figure above, the "MDU Warn" flag indicates a hardware error in the motor-drive unit. Further investigation is required to determine the cause of the error.

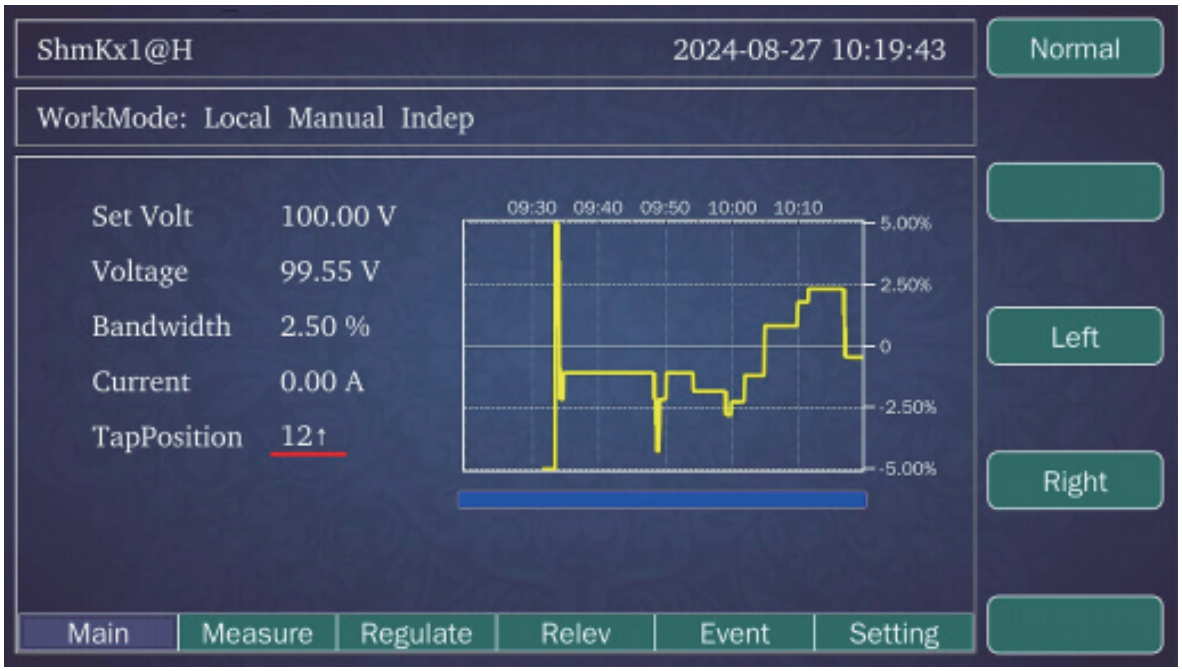


For example, in the figure above, all values are displayed as "-", indicating that the AVR is unable to communicate with the motor-drive unit. This could be due to a communication problem or the motor-drive unit being powered off.

3.3 Tap Position Information and Switching

When a tap change operation is in progress, the SHM-KX will display the direction of the operation. An up or down arrow will appear next to the tap position number, indicating a 1-N or N-1 tap change operation. The display varies slightly between the three main screen views.

In the Normal view, the direction of the tap change operation is indicated by an arrow in the Tap Position field, as shown below.



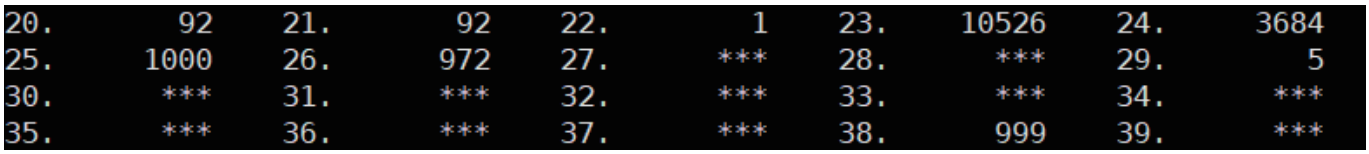
In the Simplified view, the direction of the tap change operation is indicated by an arrow, as shown below.

Chapter 4 Measurement Screen

The SHM-KX provides one voltage acquisition channel and one current acquisition channel. The voltage acquisition channel has a range of 50V to 240V, and the current acquisition channel can be configured for either 1A or 5A as the nominal value for calculations.
The Measurement screen displays the secondary voltage and current values, active power, reactive power, and power factor.
Users can configure the relationship between voltage and current in the "Sampling Correction" settings to adapt to the specific application environment.
The figure below shows a typical example of measured values.

The Measurement screen primarily provides data support for the automatic voltage regulation function.

Users can access the current sampled values through communication. The figure below shows the telemetry list. Please refer to the appendix for details.



There are five digital input signals related to the measured values (see the appendix):

40	Dii_OverVoltage_Sts	AVR Overvoltage Alarm
41	Dii_UnderVoltage_Sts	AVR Undervoltage Alarm
42	Dii_ZeroVoltage_Sts	AVR Zero Voltage Alarm
43	Dii_OverCurrent_Sts	AVR Overcurrent Alarm
44	Dii_Cs5460Error_Sts	AVR Sampling Error

The thresholds for the overvoltage, undervoltage, and overcurrent alarms can be configured in the relevant settings sections.

The zero voltage threshold is fixed at 10%. When the input voltage falls below 10% of the nominal value, the zero voltage alarm is triggered.

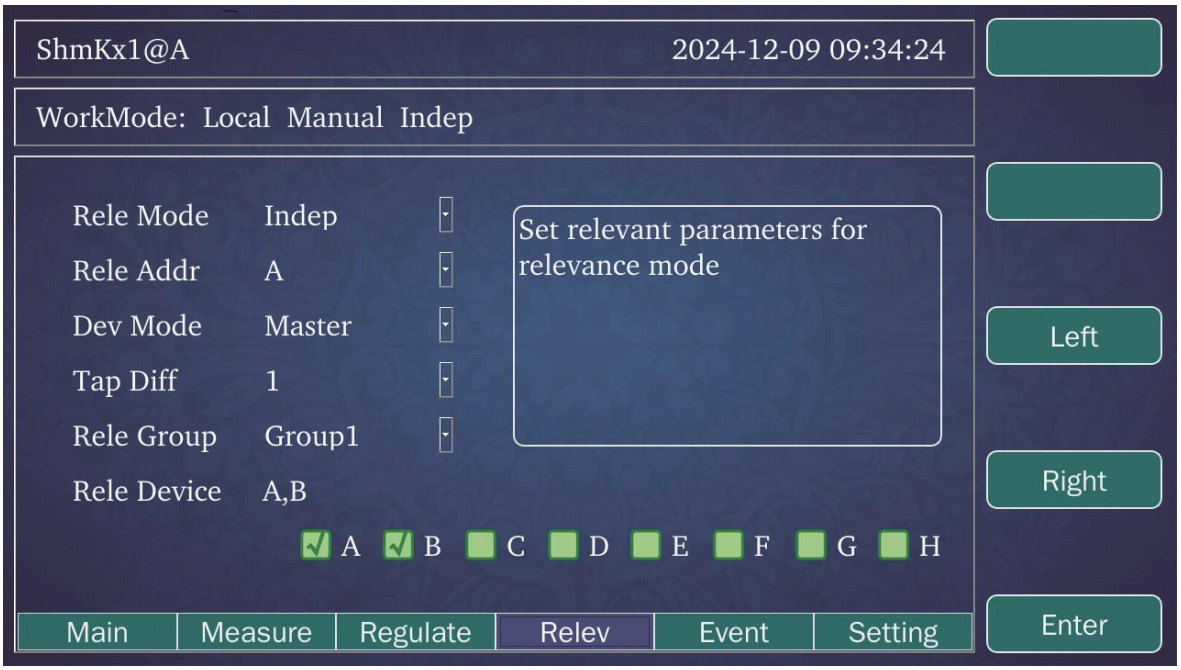
Chapter 5 Voltage Regulation Parameters

Users can switch between Auto and Manual voltage regulation modes by pressing the "Auto/Manual" button on the front panel.

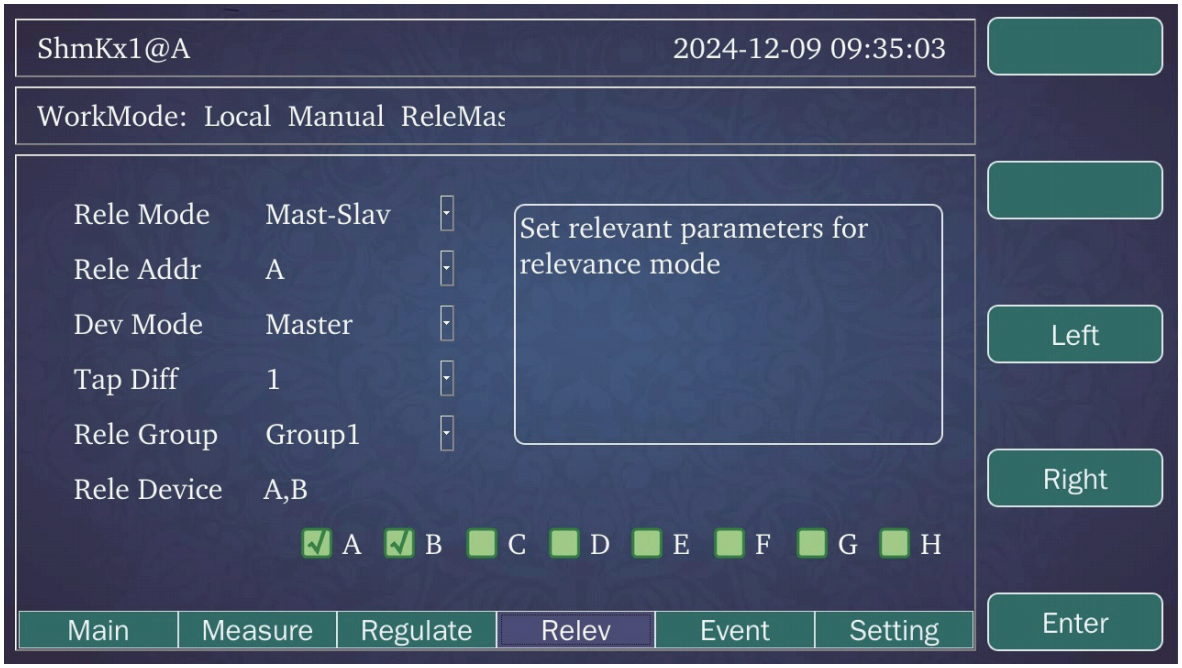
In Auto mode, the system will automatically regulate the voltage based on the configured voltage regulation parameters and limit parameters. The most important parameters are the voltage regulation parameters.

5.1 Auto Mode

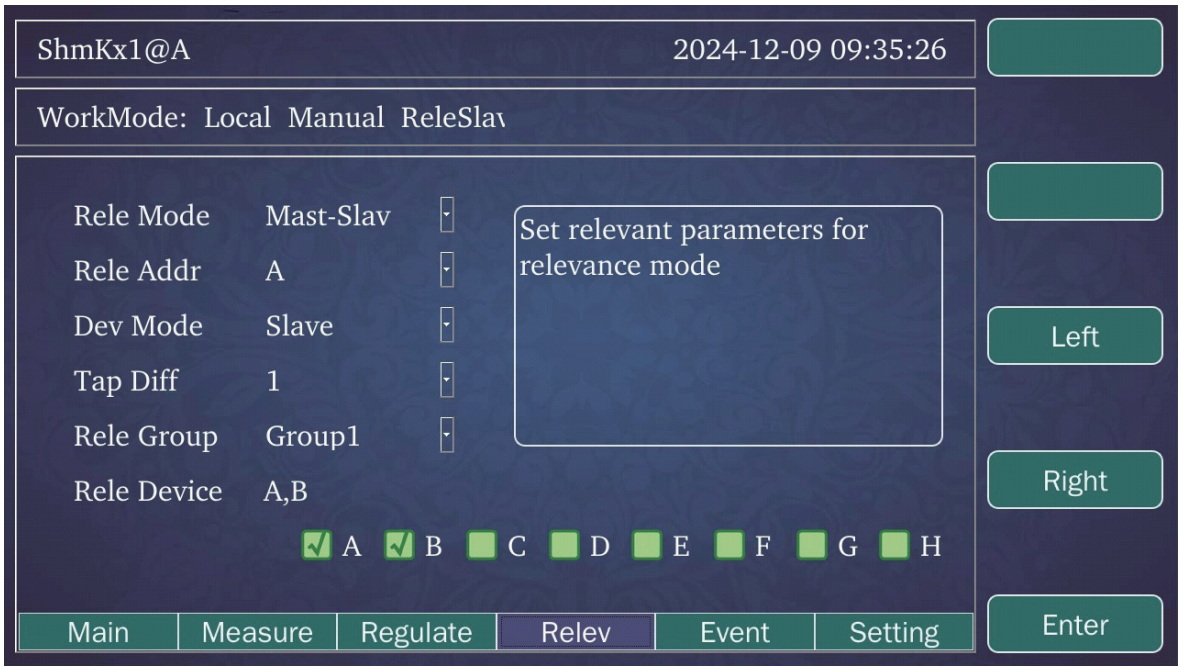
There are two Auto modes: Auto-Independent and Auto-Parallel. When the Parallel Mode is set to Independent and the controller is in Auto mode, the system will regulate the voltage based on the sampled values from the local device.



If the controller is in Parallel Master mode, the system will regulate the voltage based on its own sampled values and distribute the commands to the Slave controllers for synchronized operation.

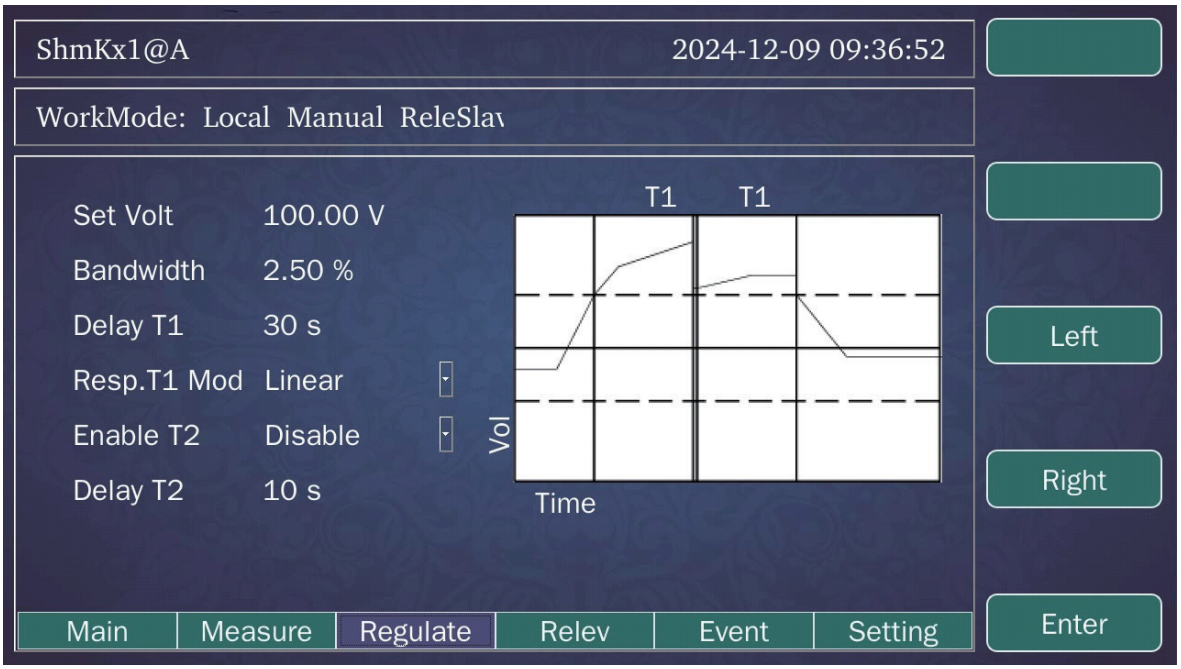


If the controller is in Parallel Slave mode, it will only follow the commands from the Parallel Master and will not perform voltage regulation based on its own sampled values.

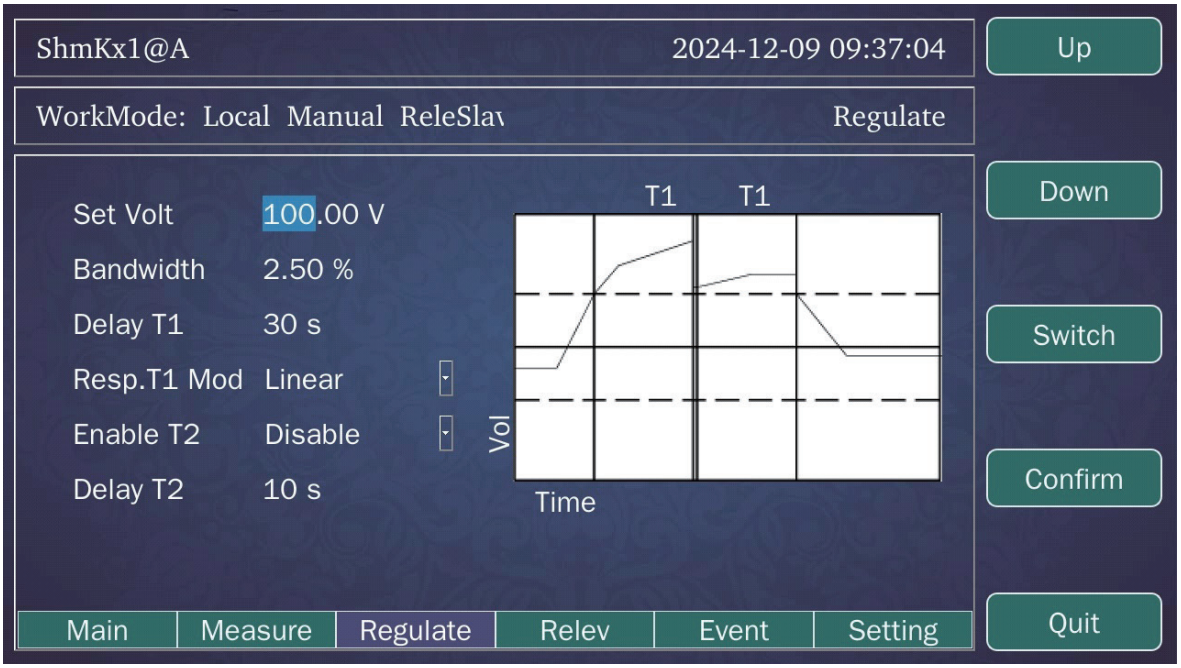


5.2 Accessing Voltage Regulation Parameter Settings

Press the "Left" or "Right" button to navigate to the Voltage Regulation Parameters screen.



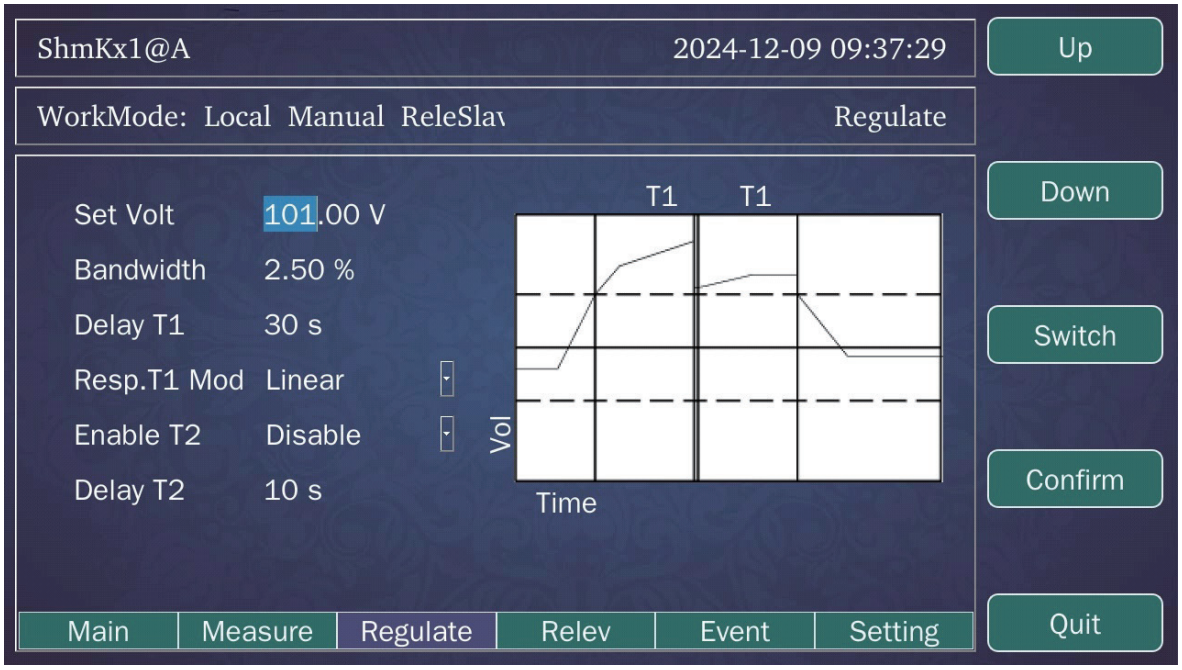
Press the "Enter" button to access the Voltage Regulation Parameter settings menu.



Use the "Up" and "Down" buttons to adjust the parameter values and the "Switch" button to change the focus between parameters.

5.3 Set Voltage

The Set Voltage is based on the secondary voltage value. For example, if the PT ratio is 35kV/100V, then 100V is the nominal voltage. Typically, the Set Voltage is set slightly higher than the nominal voltage if line drop compensation is not used. For example, it might be set to 101.00V (user-configurable), as shown below.



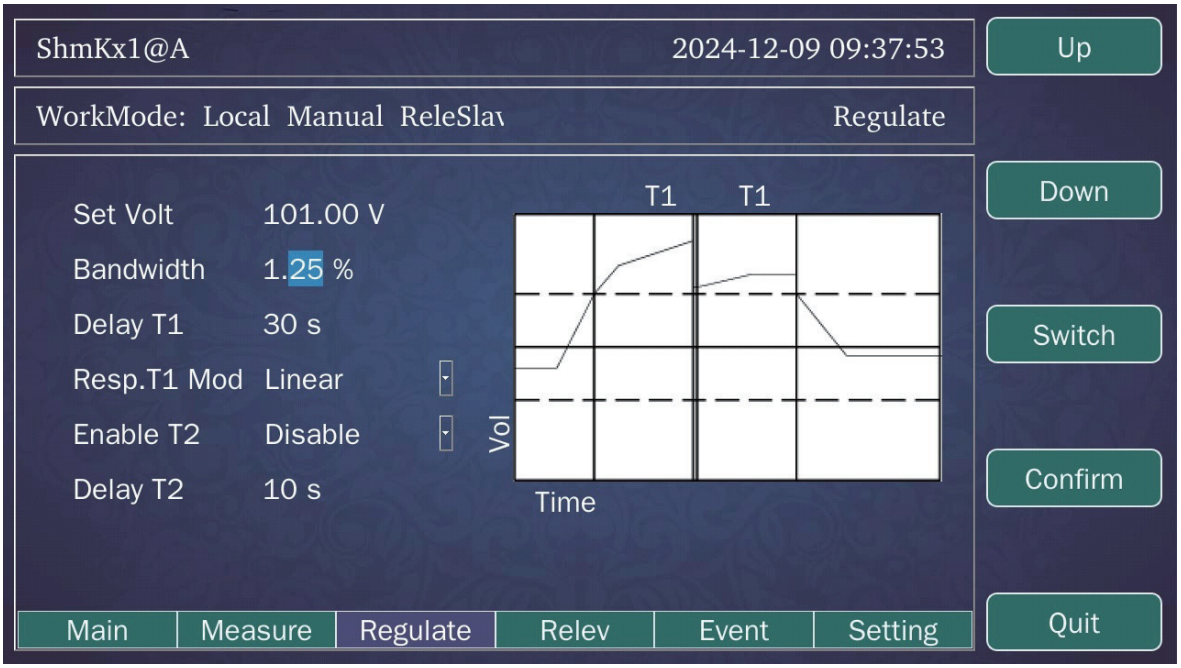
Users can adjust the Set Voltage according to the specific application requirements.

5.4 Bandwidth

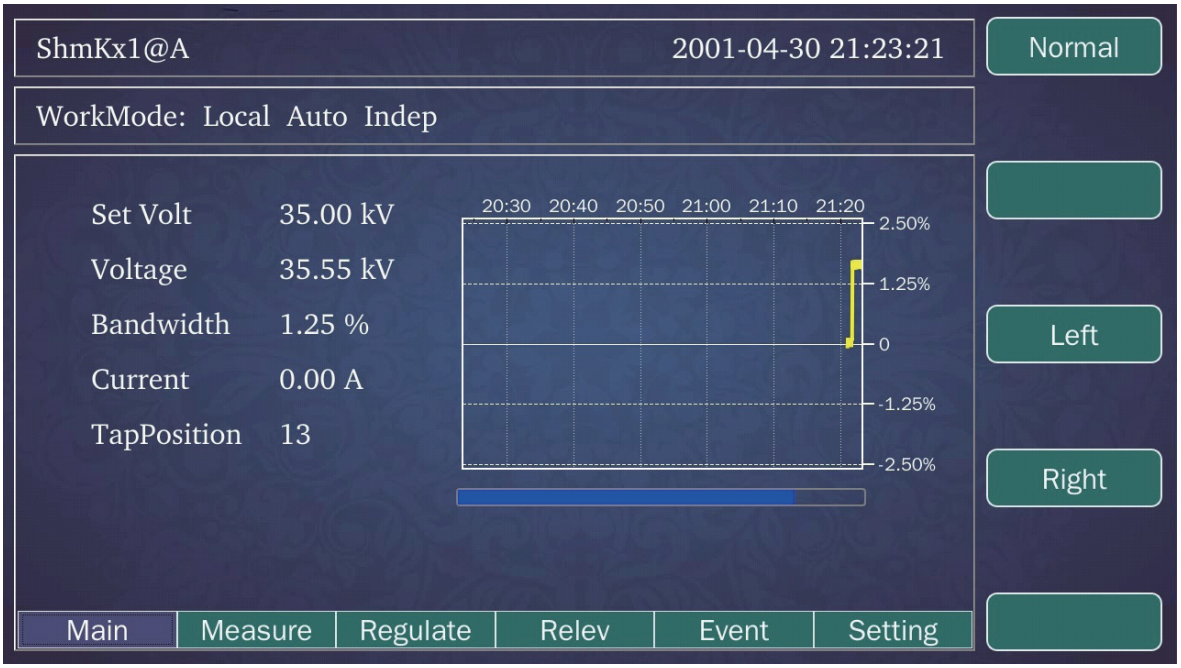
The Bandwidth, also known as the adjustment accuracy, defines the voltage range around the Set Voltage within which no voltage regulation action will be taken.

Adjustment Accuracy: This parameter can be set from 1% to 10%, with two decimal places. The system uses the configured Set Voltage and Adjustment Accuracy to determine when to initiate a tap change operation.

In the figure below, the Adjustment Accuracy is set to 1.25%. When the sampled voltage deviates from 101V by more than 1.25%, the system will initiate the voltage regulation logic.



In Auto mode, the corresponding displays on the main screen will change according to the Bandwidth setting. For example, in the Normal view, the Bandwidth will be displayed on the voltage waveform graph.



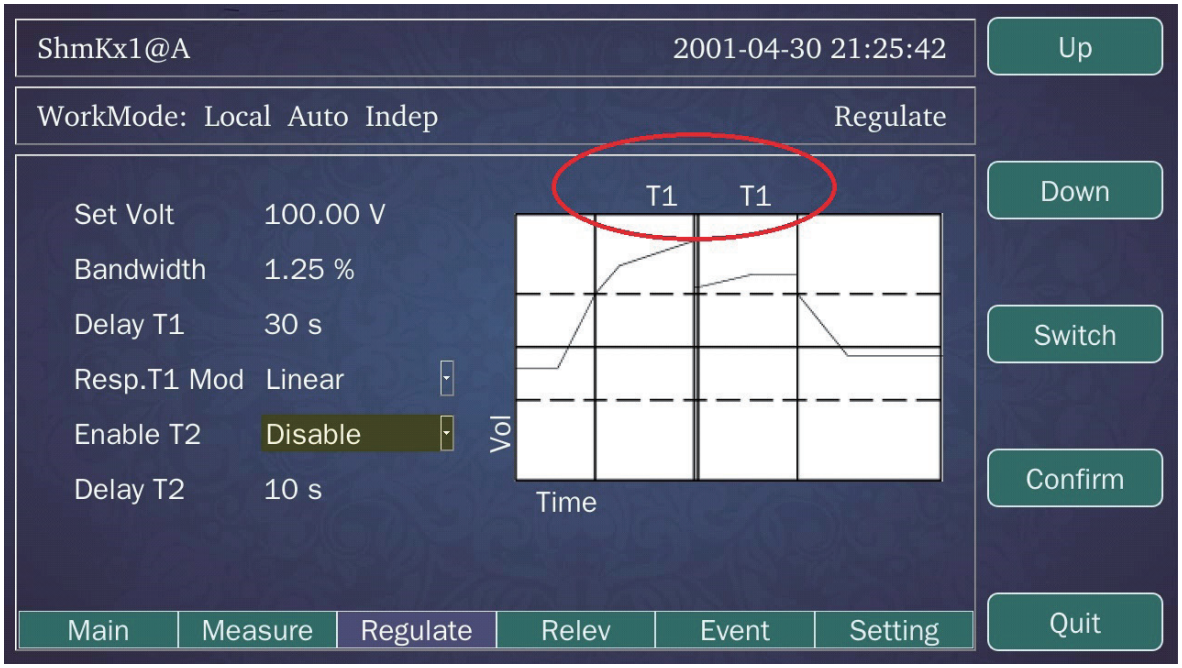
In the Simplified view, the bar graph will be green if the voltage is within the Bandwidth and red if it is outside the Bandwidth.

The system's decision logic is as follows:
Decision Value = Set Voltage + (Set Voltage * Adjustment Accuracy).
When the sampled voltage exceeds the Decision Value and the configured Delay Time T1 has elapsed, the AVR will issue a tap change command.

5.5 Operation Delay Time

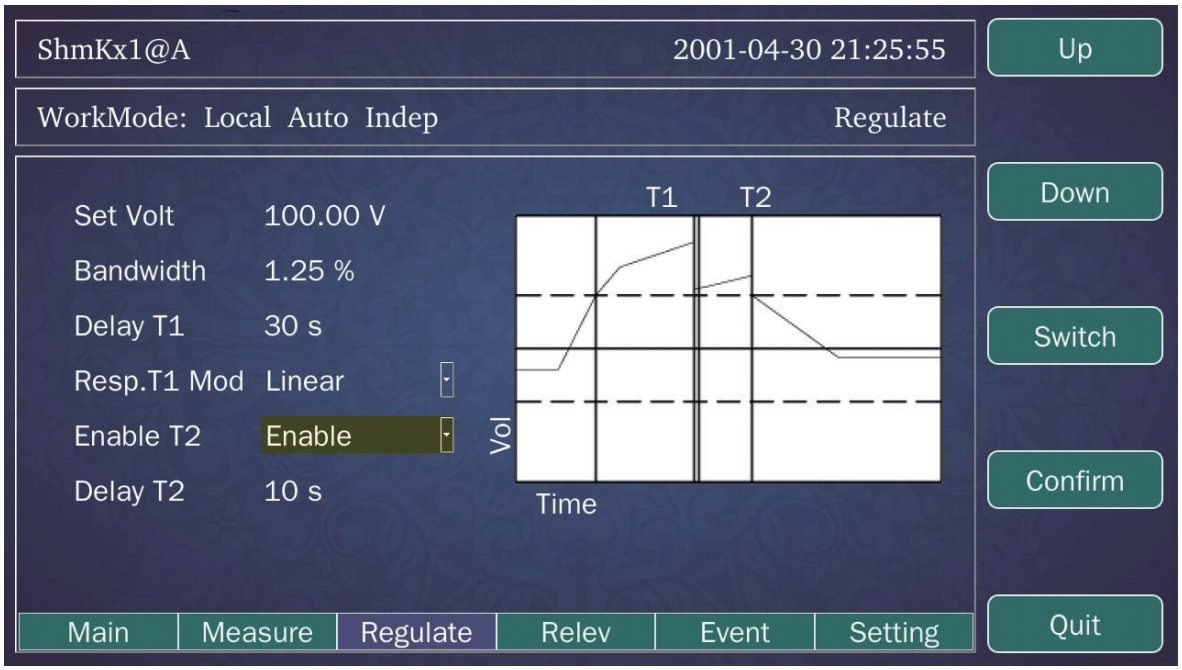
Operation Delay Time T1 defines the time window for voltage regulation decision-making. When the sampled voltage meets the criteria for a tap change operation, the system will wait for the duration of T1 before executing the command. The setting range for T1 is 2 to 300 seconds, with a default value of 30 seconds.

Under normal circumstances, the tap change operation is executed after the T1 time window has elapsed, as shown below.



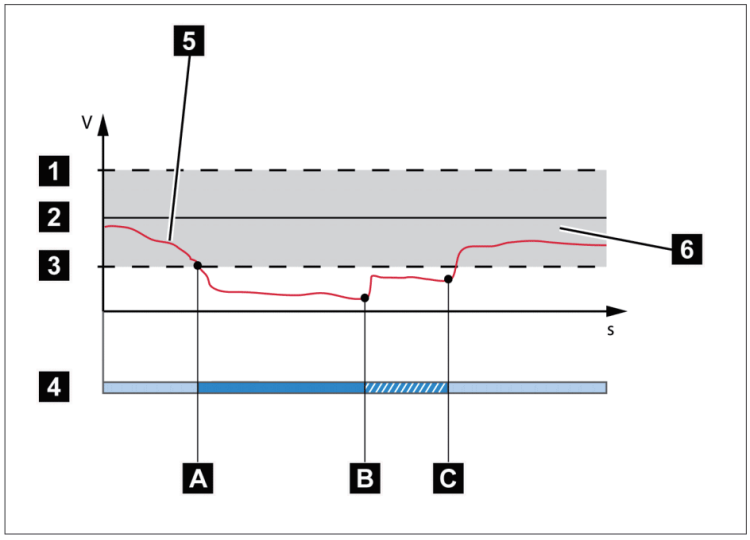
The time judgment for the automatic voltage regulation logic does not include the time required for raising and lowering gears itself.

Operation Delay Time T2 is an enhancement to T1. Its default value is 10 seconds, and the setting range is 1 to 100 seconds. However, T2 is disabled by default. To use this function, it must be enabled.



This time is used for adjustment. After the T1 time has elapsed, if the voltage is still outside the accuracy range of the set voltage, the system will directly perform a tap change operation after T2. See the figure.

Note that T2 cannot be longer than T1, as this would lead to logical conflicts.

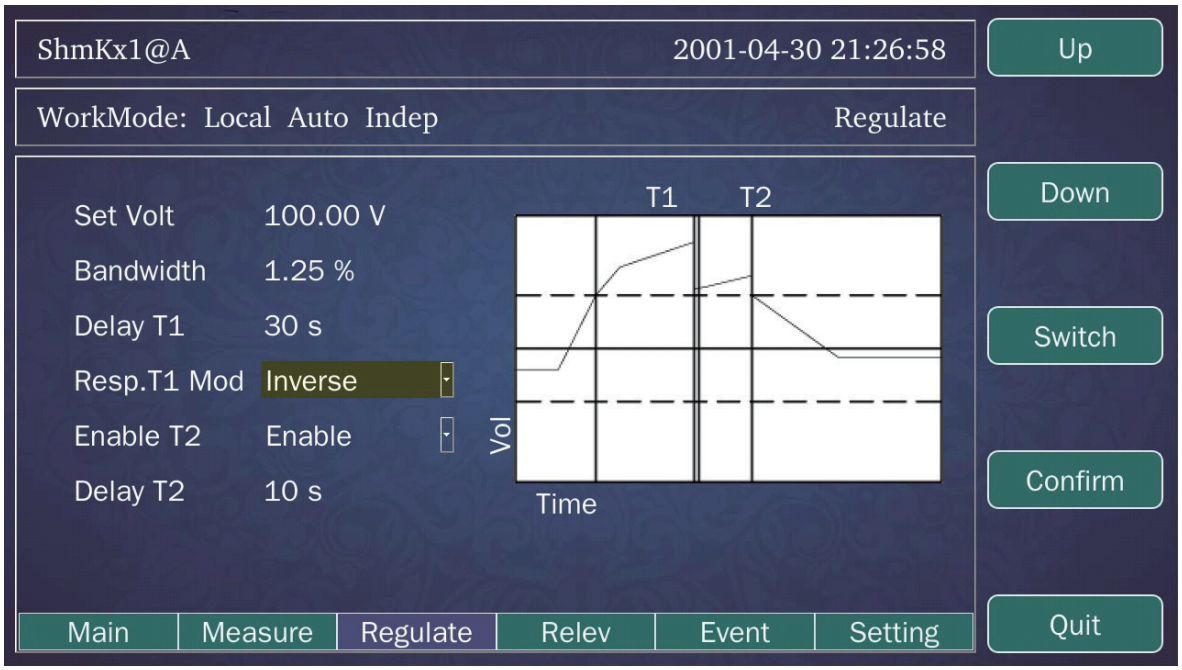


1, +B %: upper limit
2, V as required: expected voltage level
3, -B %: lower limit
4, Set Latency T1 and T2
5, V actual: measured voltage
6, B%: tolerance bandwidth
A, V actual beyond bandwidth, Latency T1 started.
B, Latency T1 finished, diverter switch operation triggered.
C, Latency T2 finished, diverter switch operation triggered.

5.6 Response Mode

In the Linear response mode, the AVR will issue a lower tap command when the voltage exceeds the Bandwidth and a raise tap command when the voltage falls below the Bandwidth.

However, in some applications, the opposite logic is required. In the Inverse response mode, the AVR will issue a raise tap command when the voltage exceeds the Bandwidth and a lower tap command when the voltage falls below the Bandwidth.



Chapter 6 Parallel Mode

The SHM-KX supports parallel operation, with a maximum of 8 units working together.

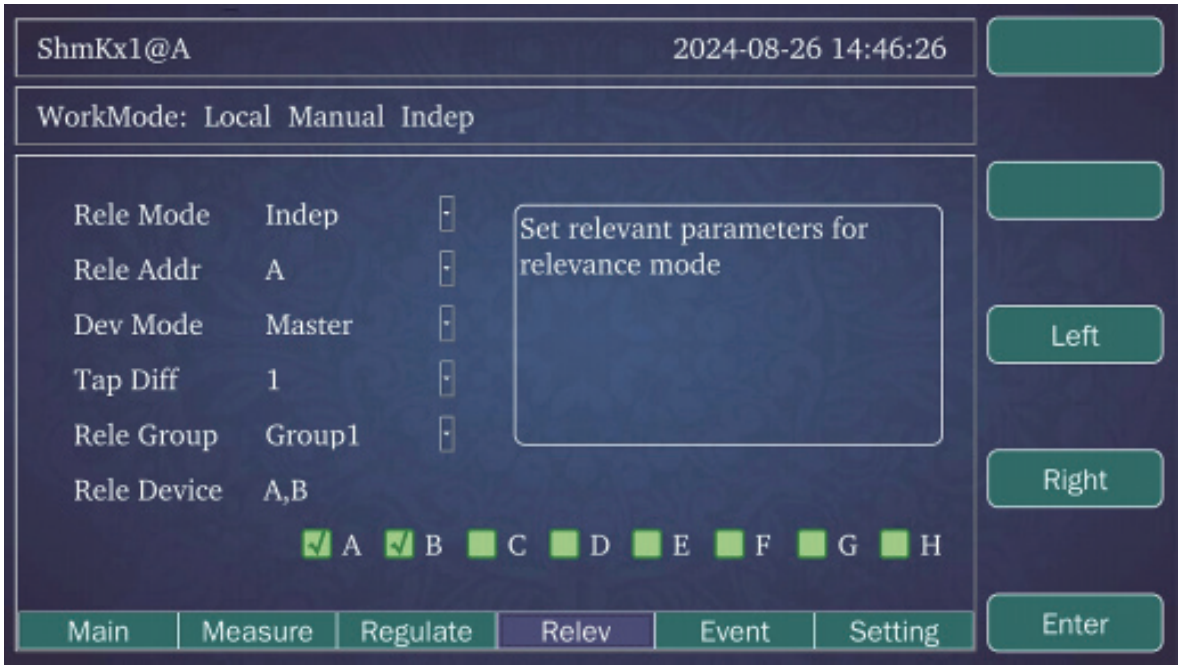
Users can select Parallel mode or Independent mode on the interface, or they can switch the operating mode by configuring the digital input (setup required).

The system currently supports master-slave mode for parallel operation (other types will be available in future versions). Users can select Master or Slave on the interface, or they can switch between Master and Slave by configuring the digital input functionality (setup required).

The system also supports parallel grouping mode, with a maximum of two groups. Grouping can be configured in the settings menu.

6.1 Parallel Settings

Press the "Left" and "Right" buttons to navigate to the Parallel Operation screen.



Press "Enter" to access the Parallel Settings screen.

6.1.1 Parallel Mode Selection

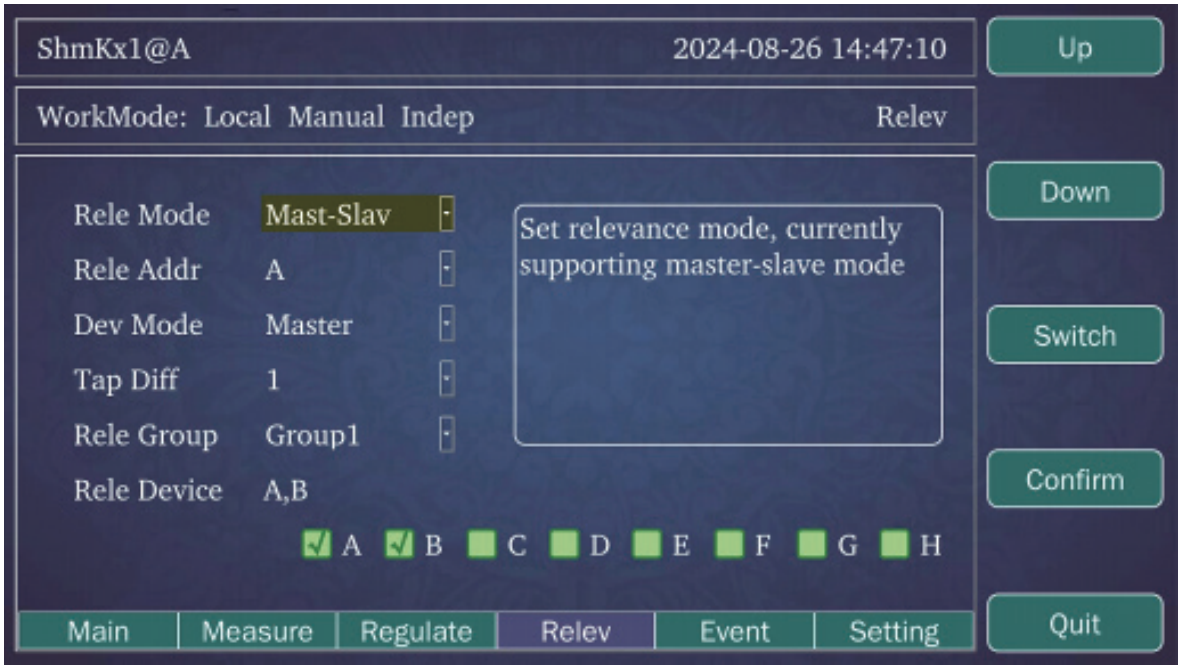
You can select Independent mode or Master-Slave mode.

In Independent mode, the system does not need to consider other devices and realizes raising and lowering operations independently.

In Master-Slave mode, if the device is configured as the Master, it will distribute control commands to the Slaves

in the same group for synchronized operation. If the device is configured as a Slave, it will only accept control commands from the Master and ignore commands from other sources.

Other parallel modes will be available in future versions.



This option can be switched using a digital input.

6.1.2 Device Mode

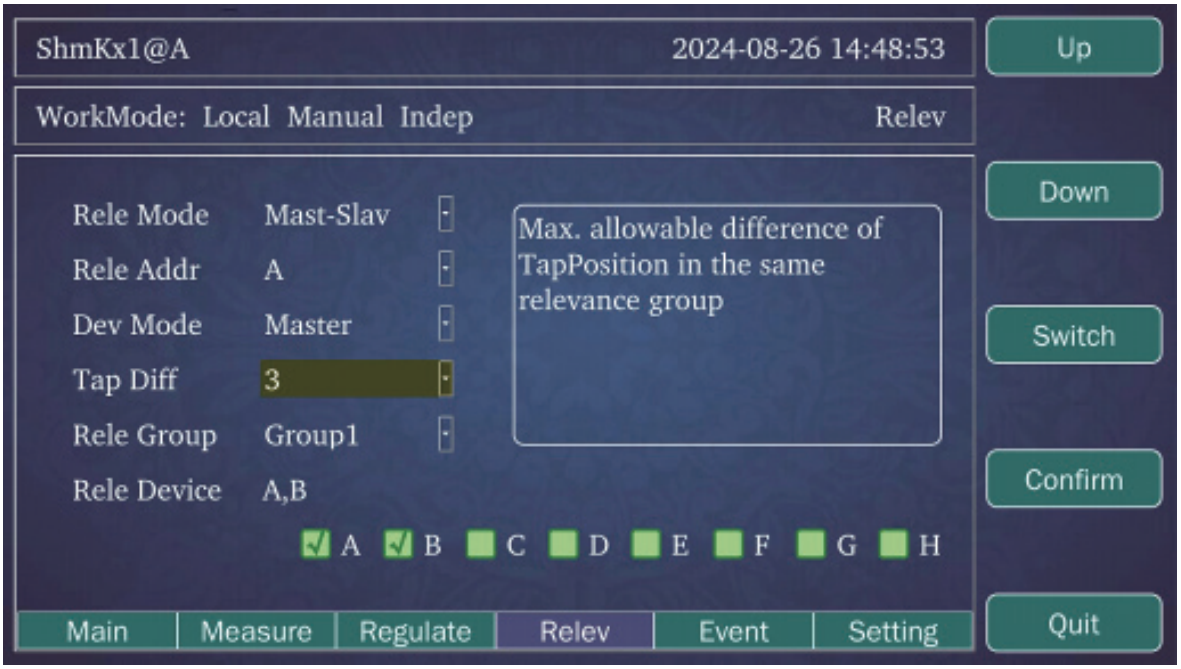
This option supports Master and Slave modes and only takes effect in Master-Slave mode.

This option can be switched using a digital input.

6.1.3 Tap Difference

This option configures the maximum allowable tap position difference between devices in parallel operation, with a maximum setting of 4.

When the tap position difference between devices exceeds this value, the Master will generate an out-of-step alarm.

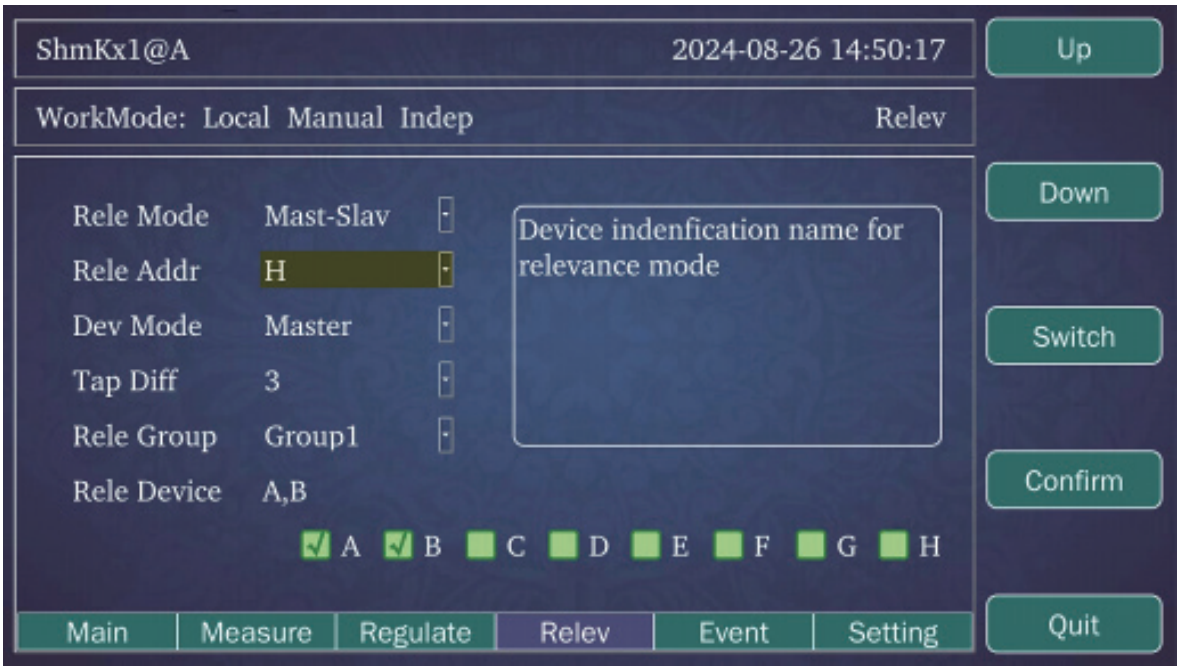


6.1.4 Parallel Address

The Device Address in the Parallel Operation menu is the Parallel Address. Each device in a parallel group must have a unique address.

The system supports up to 8 devices in parallel, so the address can be set to any letter from A to H.

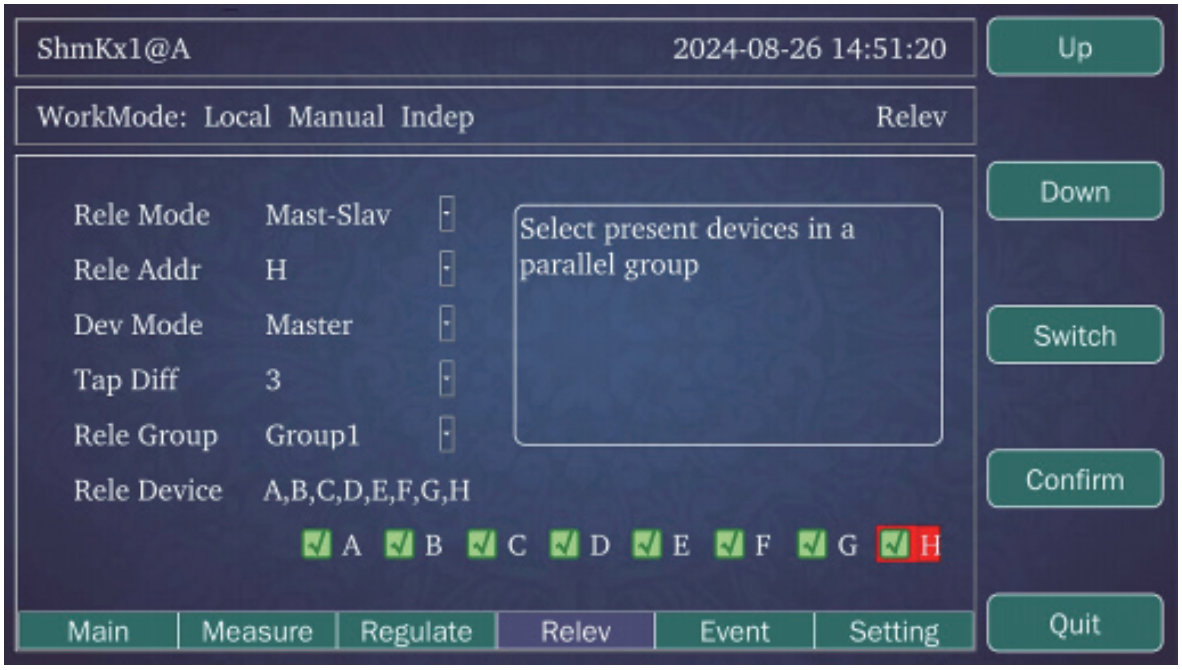
This address is used for grouping devices and establishing communication within the same group.



6.1.5 Parallel Grouping

The system supports a maximum of two groups, with up to 8 devices in each group. The total number of devices in both groups cannot exceed 8. Devices within the same group operate in parallel.

The figure below shows an example of 8 devices in parallel. The current device has the address H and is configured as the Master.



The figure below shows an example of 4 devices in parallel operation using Group 2. The device with address H is the Master.

6.1.6 Parallel Interaction with SHM-K

The SHM-KX supports parallel configuration with the SHM-K. Please contact the manufacturer for specific settings.

6.2 Parallel Operation Modes

6.2.1 Parallel Slave Mode

In this mode, the device follows the commands of the Master in the same group on the same local area network (including Auto-Parallel-Master and Manual-Parallel-Master).

The SHM-KX uses a local area network for parallel communication. The Master monitors the status of the Slaves and receives command inputs (in Manual-Parallel mode) or sends control commands based on its own voltage measurements (in Auto-Parallel mode). The Master also sends control commands to the Slaves.

If only two devices need to be connected in parallel, they can be directly connected using a network cable. If multiple devices are involved, a network switch is required.

Generally, the Slave only accepts control commands from the Master and ignores commands from other sources, including the front panel raise/lower/stop buttons, external raise/lower/stop inputs connected to the rear terminal block, and commands received through communication protocols.

6.2.2 Parallel Master Mode

Parallel Master mode includes Auto-Parallel-Master and Manual-Parallel-Master. Users can switch between these modes using the Up and Down buttons on the operation panel.

6.2.2.1 Manual-Parallel Mode

In Manual-Parallel mode, the control logic is the same as Manual-Independent mode.
However, in Manual-Parallel mode, the system also monitors the status and tap position of the Slaves to ensure they are synchronized with the Master. If any Slave is out of step, the Master will not execute control commands.

6.2.2.2 Auto-Parallel Mode

In Auto-Parallel mode, the control logic is the same as Auto-Independent mode.
However, in Auto-Parallel mode, the system also monitors the status and tap position of the Slaves to ensure they are synchronized with the Master. If any Slave is out of step, the Master will not execute control commands.

6.2.3 Parallel Communication

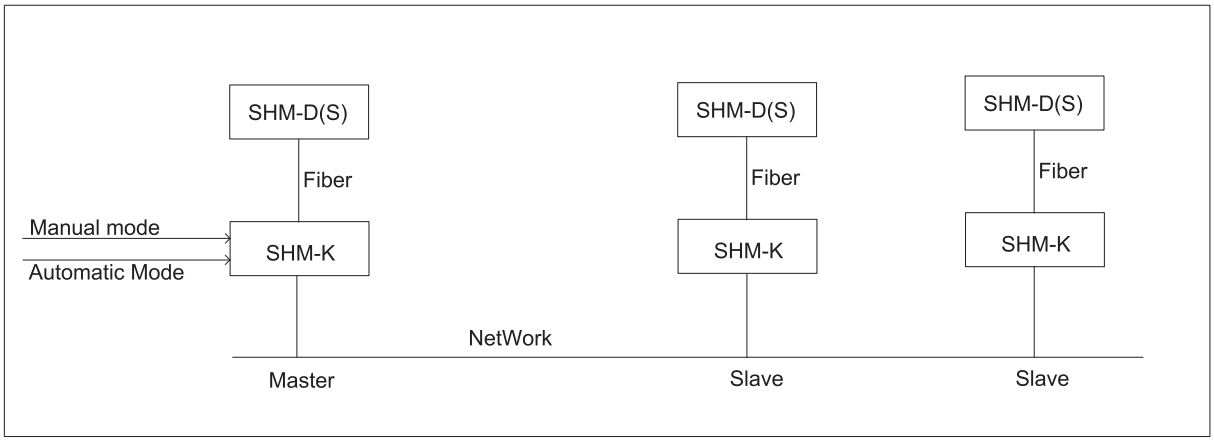
After configuring the Parallel Group and Parallel Addresses, the Master will automatically discover the other devices in the group. No additional configuration is required.

The SHM-KX uses a network connection for parallel operation. When operating in Auto-Parallel-Master, Manual-Parallel-Master, or Parallel-Slave mode, network parameters must be configured. However, this does not conflict with IEC 104 or IEC 61850 communication, which also utilize network connections.

All remote controllers participating in parallel operation must be on the same local area network, and each device must have a unique IP address. According to TCP/IP conventions, the MAC addresses must also be unique.

6.3 Parallel Configuration Procedure

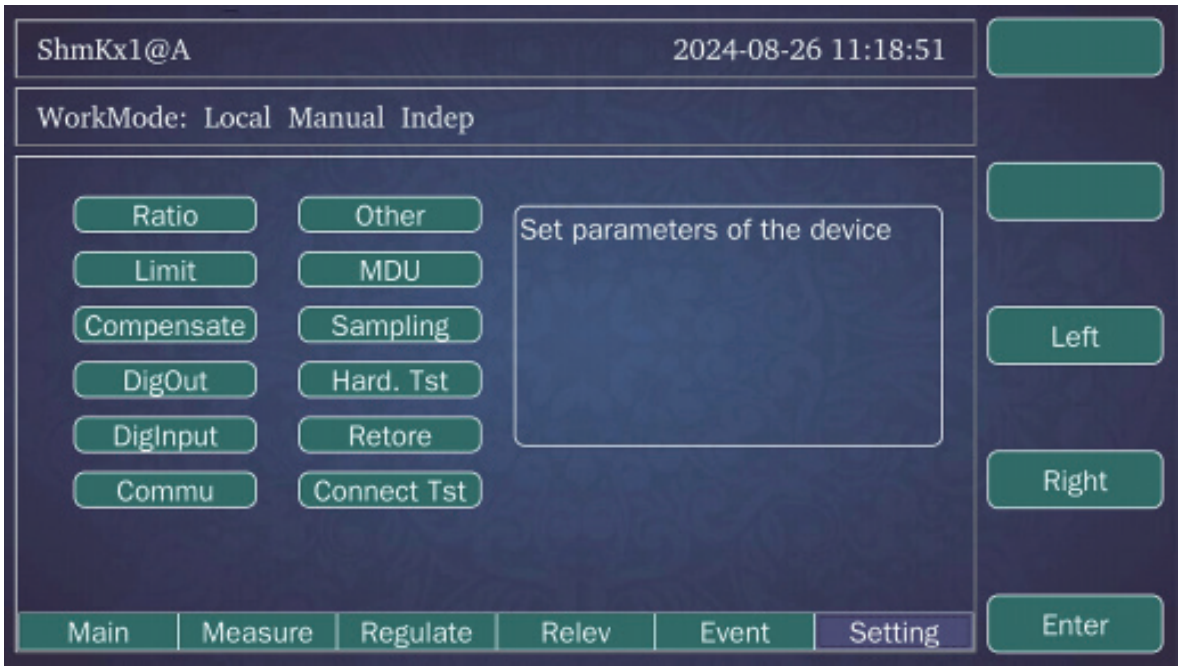
Step 1: Assign a unique Parallel Address to each SHM-KX controller that will participate in parallel operation.
Step 2: Configure the Group information for the parallel network.
Step 3: Select the Parallel Master (this can be switched).
Step 4: Switch the operating mode to Master-Slave mode.



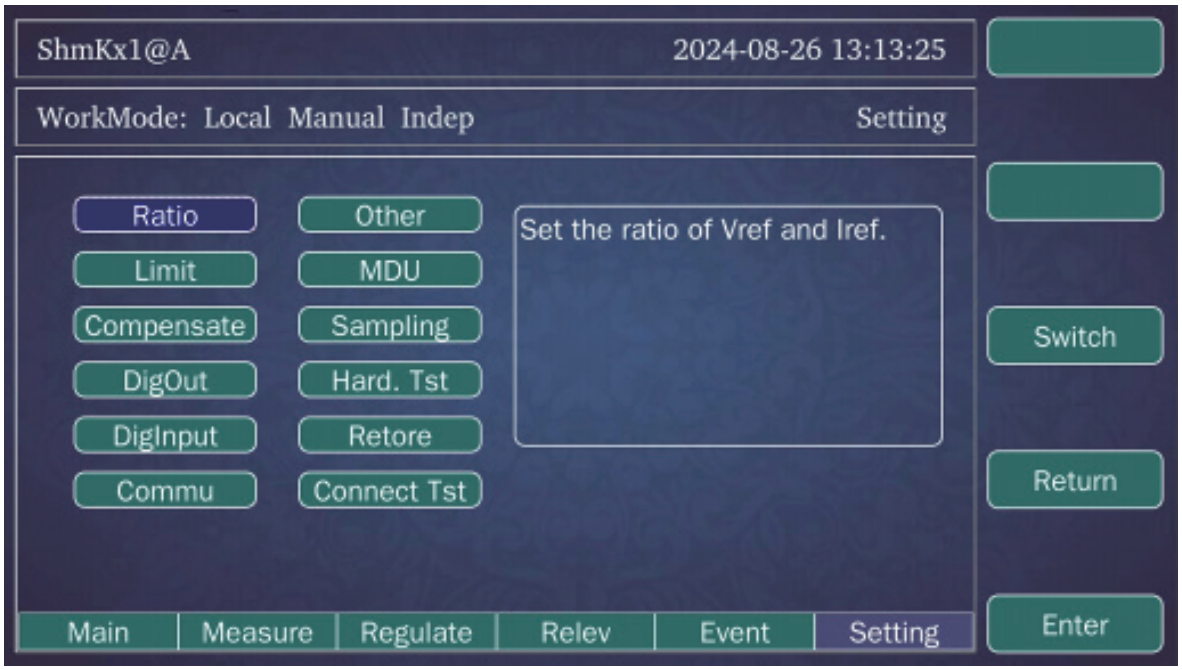
Chapter 7 MDU Type

The SHM-KX supports various types of motor-drive units, including SHM-D, SHM-X, ZDKA, and CMA7.
Users can select the corresponding MDU type in the settings menu. Depending on the specific MDU and its wiring configuration, different digital inputs and outputs can be assigned for control.

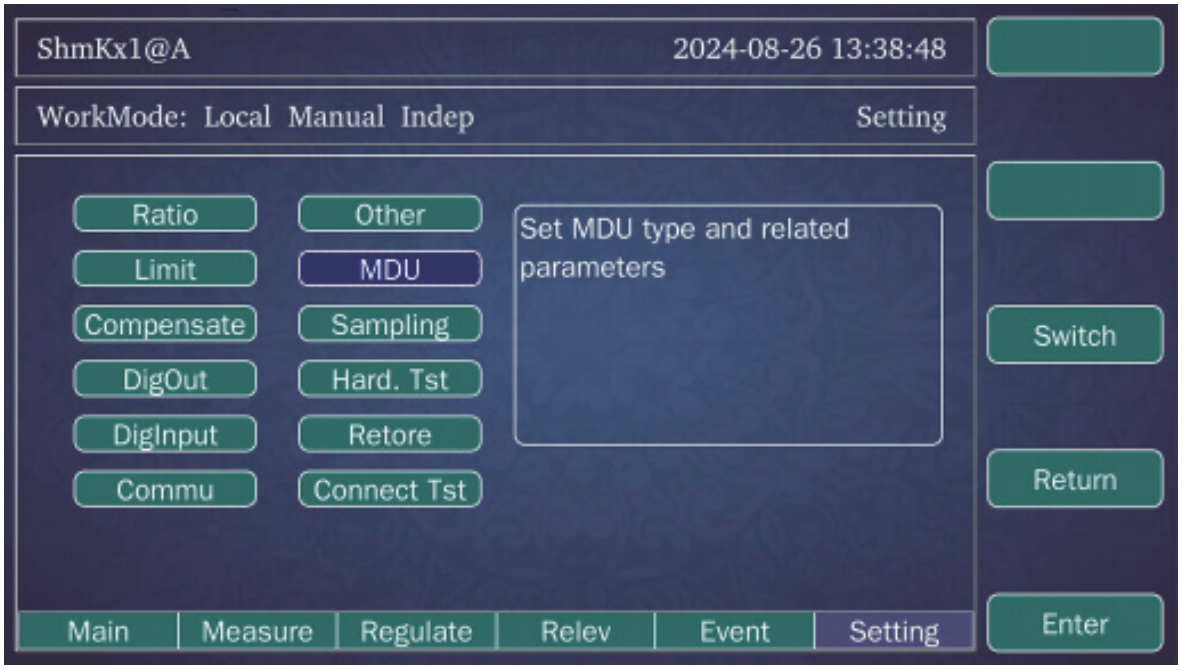
7.1 Accessing the MDU Type Settings



Press the "Left" or "Right" button to navigate to the Settings screen, then press "Enter" to access the Settings menu.



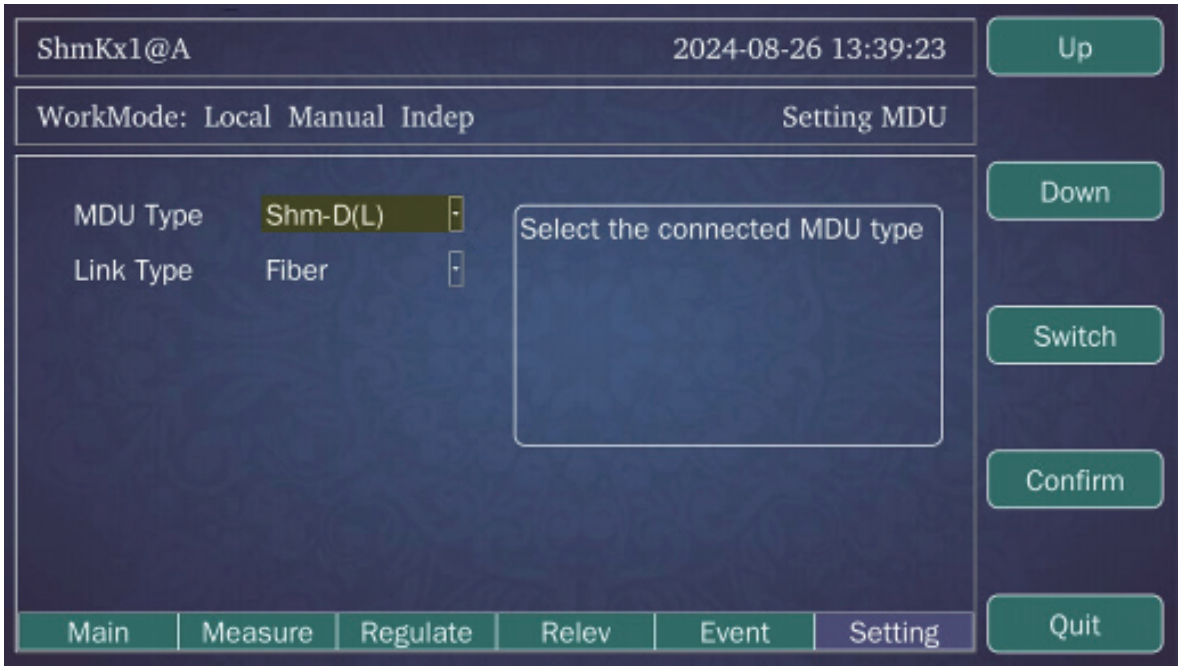
The "Setting" label will appear in the upper right corner of the screen, indicating that you are in the Settings menu.
Press the "Switch" button to select the "MDU Type" option.



Press "Enter" to access the MDU Type settings menu.

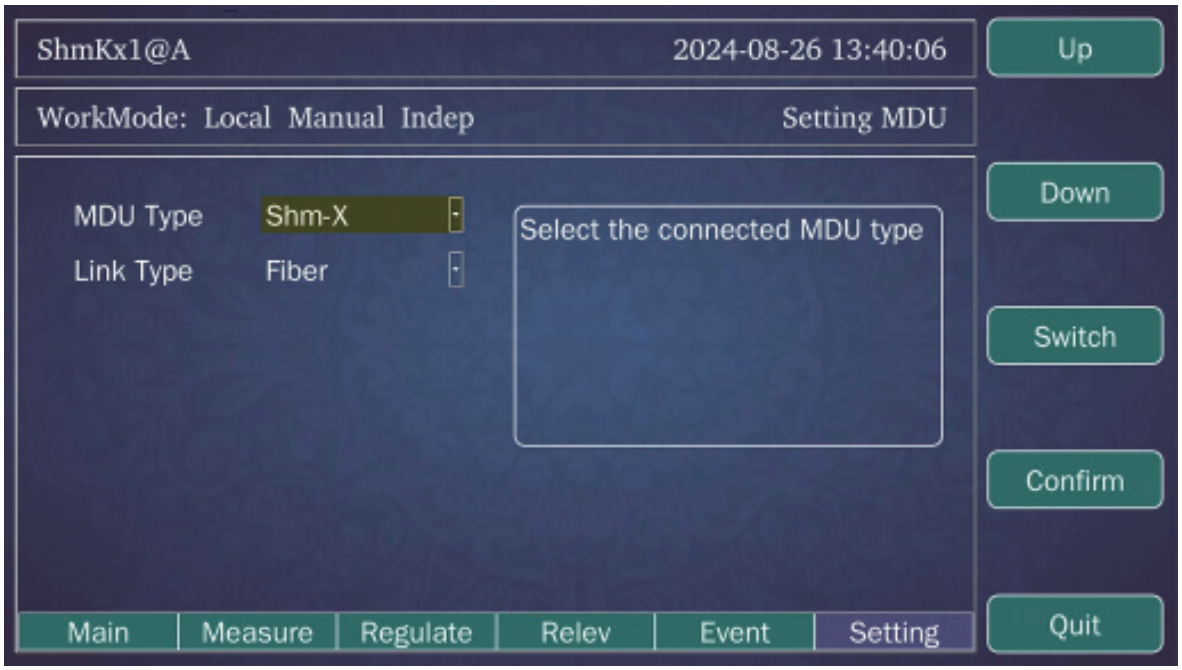
7.2 SHM-D (DL) Type

If the connected motor-drive unit is an SHM-D(DL), you only need to select "Fiber Optic" as the Link Type.



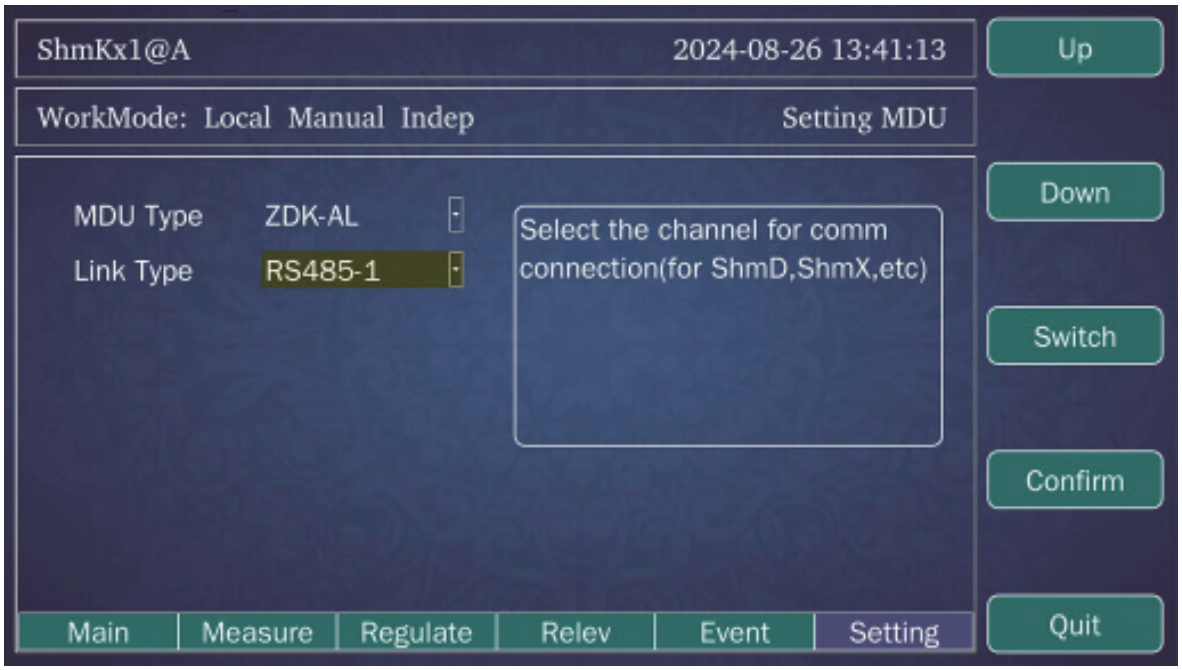
7.3 SHM-X Type

Similarly, if the connected motor-drive unit is an SHM-X, you only need to select "Fiber Optic" as the Link Type.



7.4 ZDK-A or ZDK-AL Type

If the connected motor-drive unit is a ZDK-A or ZDK-AL, select the corresponding MDU type and the desired communication method.
ZDK-A and ZDK-AL support both "Fiber Optic" and "RS485" as the Link Type.
Note that if you select "RS485" as the Link Type, it cannot conflict with the locally extended RS485 channel in the communication settings.

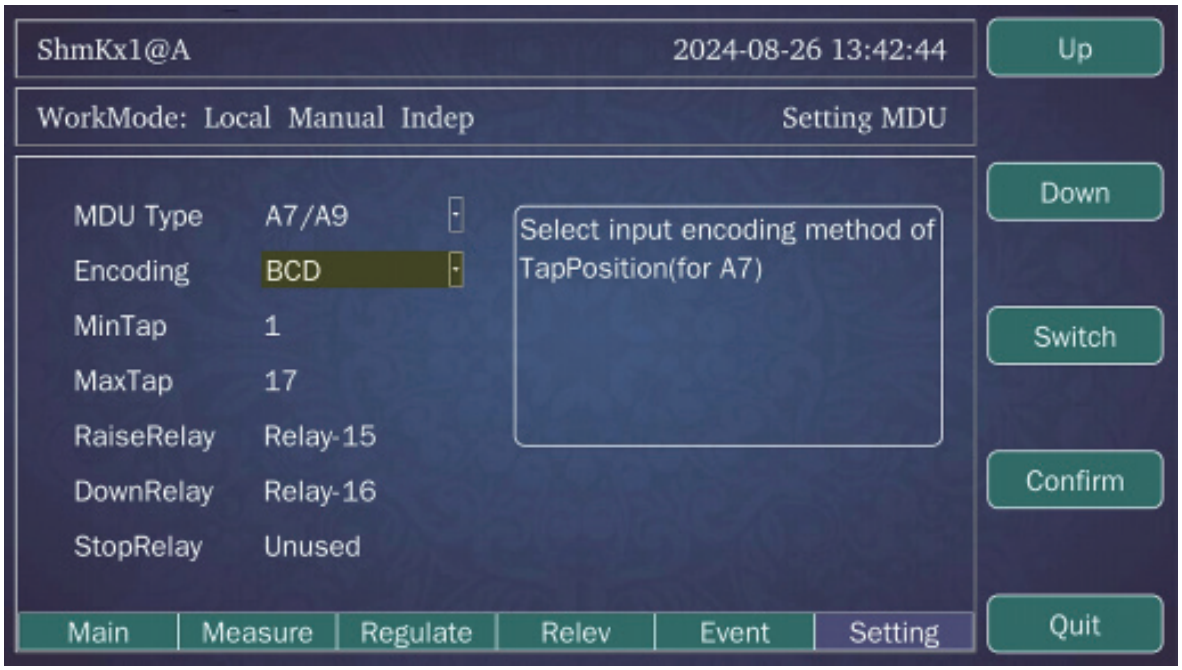


7.5 CMA7 Motor-Drive Unit

The CMA7 type can be selected for any motor-drive unit that uses hardwired connections. When this type is selected, additional parameters need to be configured, such as Minimum Tap Position, Maximum Tap Position, and Encoding Mode.

7.5.1 Encoding Mode

When using hardwired connections to acquire tap position information, you need to specify the encoding method in addition to assigning the corresponding digital input.



The following encoding modes are currently supported:

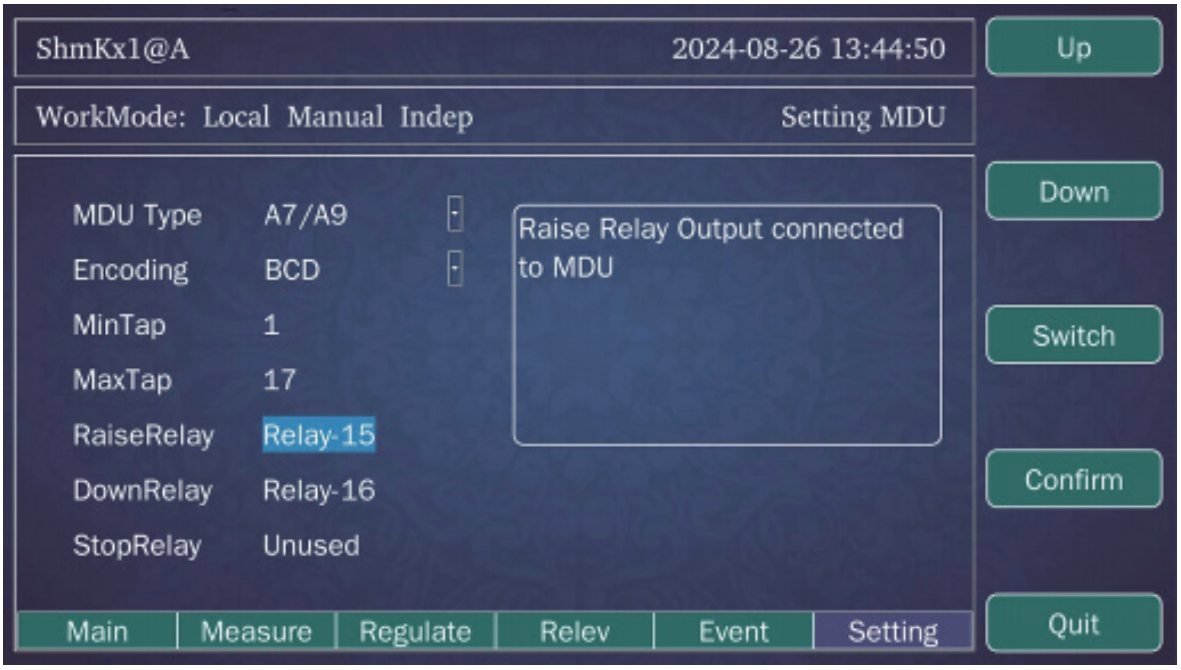
Encoding Mode	Description
BCD	BCD encoding, where the digital inputs are combined from least significant bit to most significant bit to represent the tap position.
Grey	Gray encoding, where the digital inputs are combined from least significant bit to most significant bit to represent the tap position.
Bin	Binary encoding, where the digital inputs are combined from least significant bit to most significant bit to represent the tap position.
1X1	One-to-one correspondence, where each digital input represents a specific tap position. For example, if the input for tap position 1 is active, then the tap changer is at position 1.

7.5.2 Maximum and Minimum Tap Position

For CMA7 motor-drive units, the Minimum Tap Position and Maximum Tap Position must be specified in the AVR. The AVR will operate within this range and generate corresponding flags.

7.5.3 Operation Relays

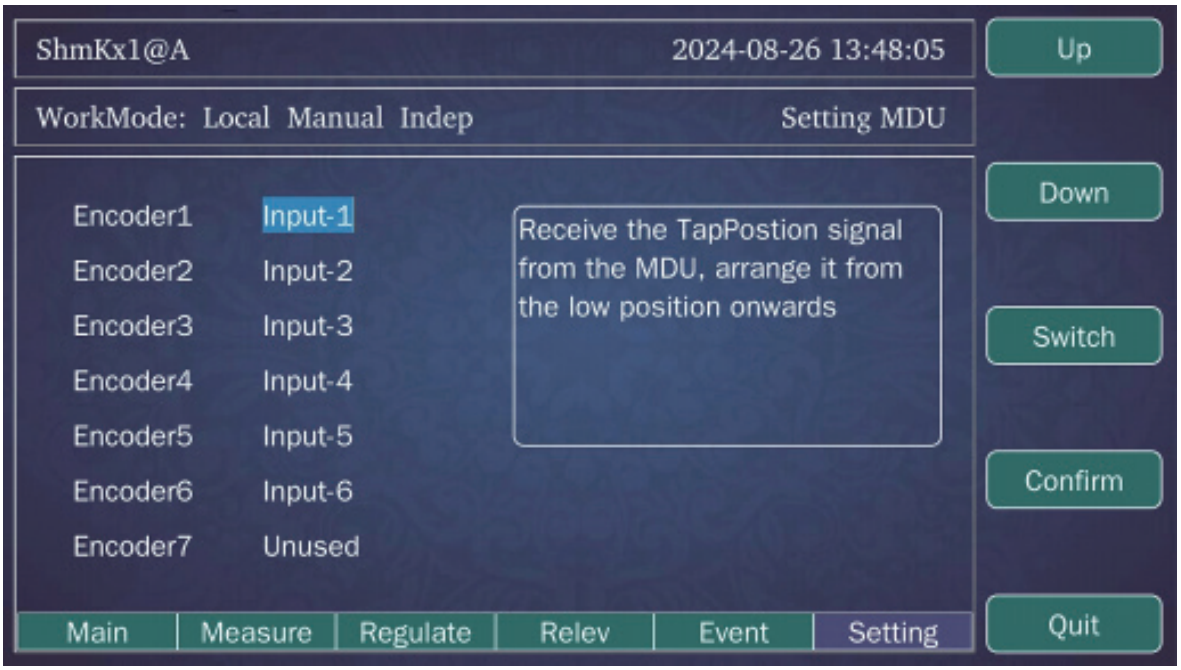
The AVR has 16 relay outputs. You need to assign two relay outputs for the raise and lower commands to the motor-drive unit.



7.5.4 Tap Position Digital Inputs

The CMA7 can only acquire tap position information through hardwired connections. The system supports up to 7 digital inputs for tap position information, which are combined to calculate the current tap position. An additional input can be configured as a sign input for special applications.

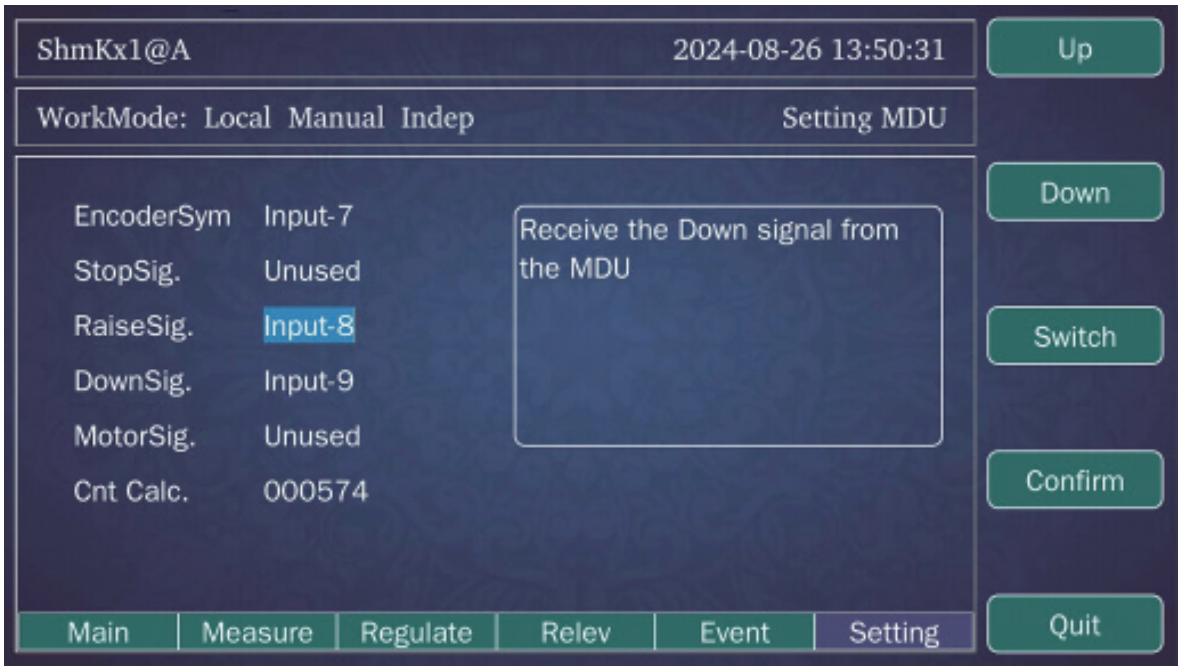
For example, if the Maximum Tap Position is 35 and the Minimum Tap Position is 1, using BCD encoding, you only need to configure 6 digital inputs.



For some special motor-drive units, a sign input is required to indicate negative tap positions. For example, if the current tap position is -6, the sign input must be active.

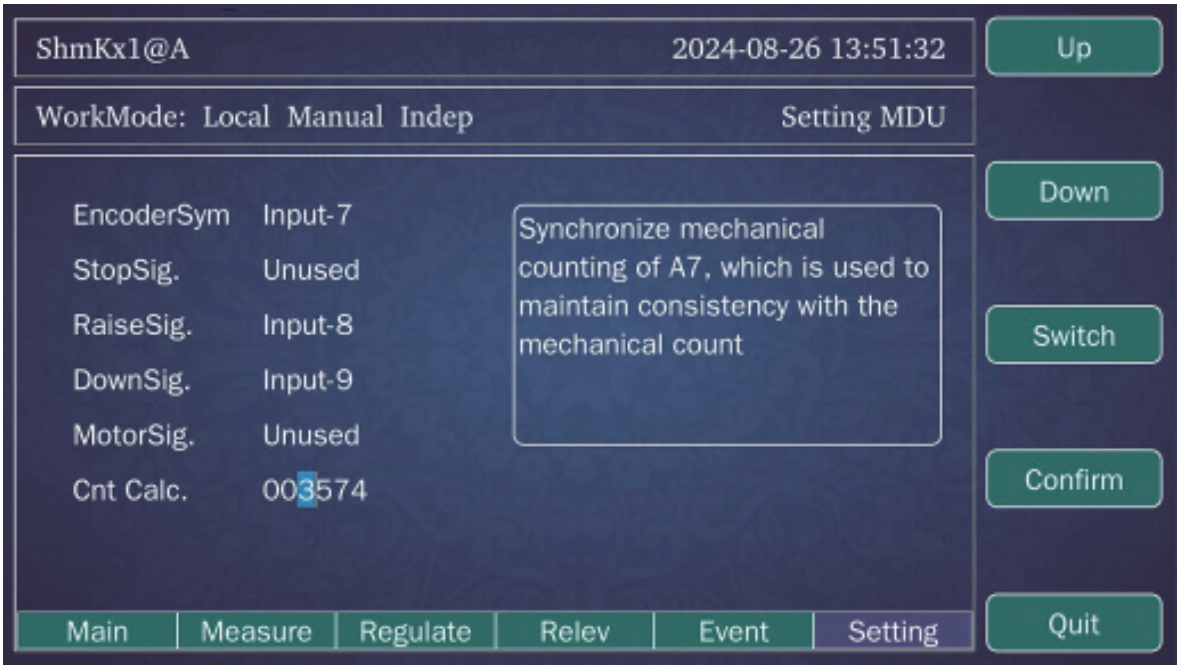
7.5.5 Operation Status Digital Inputs

Assign digital inputs for the raise and lower operation status signals based on the specific motor-drive unit.



7.5.6 Counter Calibration

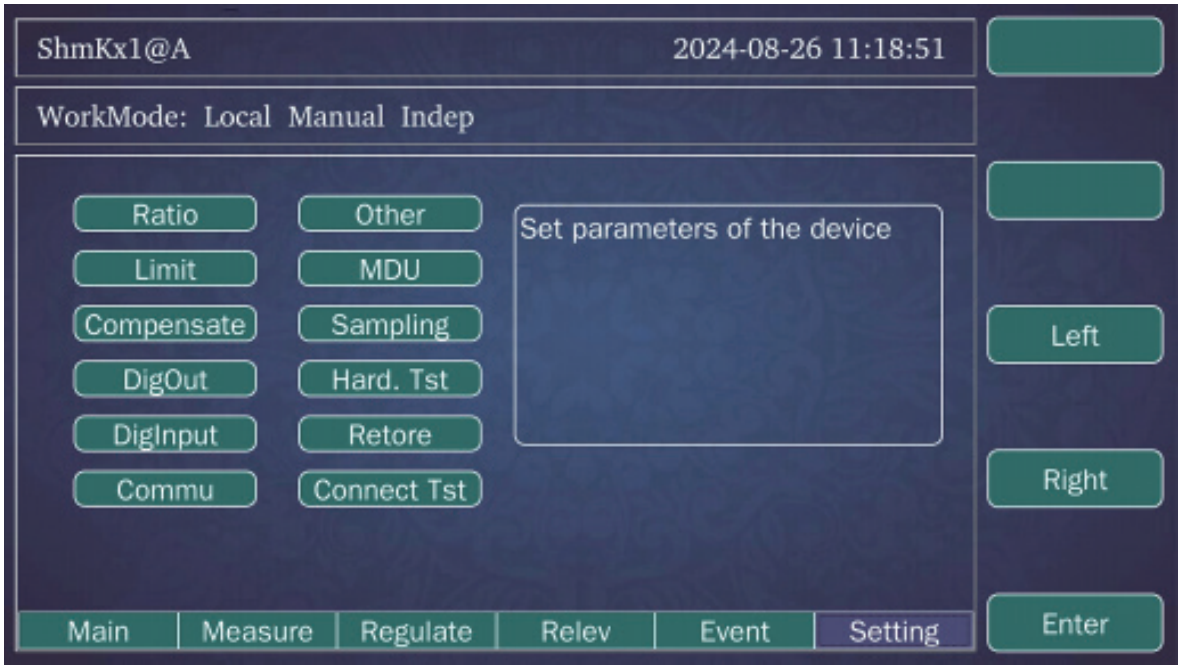
The CMA7 motor-drive unit uses a mechanical counter. You can use this option to synchronize the AVR's counter with the mechanical counter on the motor-drive unit.



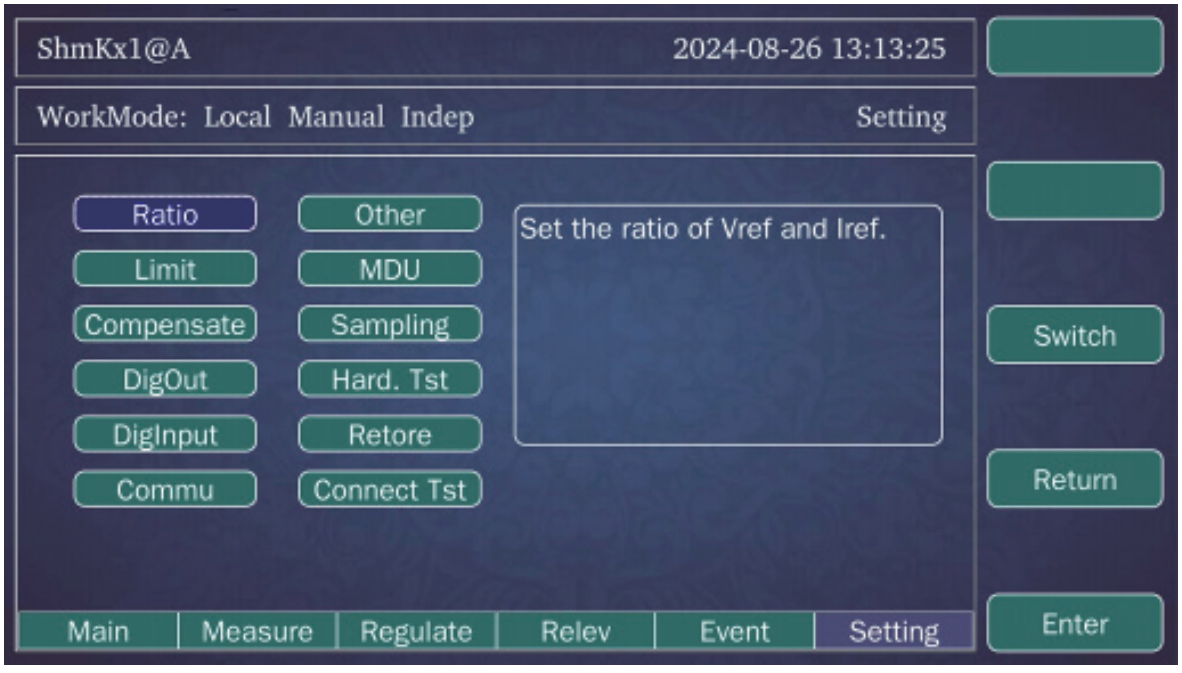
Chapter 8 Ratio and Compensation Settings

The SHM-KX provides one voltage acquisition channel and one current acquisition channel. The voltage acquisition channel has a range of 50V to 240V. The current acquisition channel can be set to 1A or 5A as the nominal value for calculations.
To display field conditions more intuitively, you can configure the parameters in this section to display the primary voltage values and establish the relationship between primary and secondary values.

8.1 Accessing the Ratio Settings Menu



Press the "Left" or "Right" button to navigate to the Settings screen, then press "Enter" to access the Settings menu.



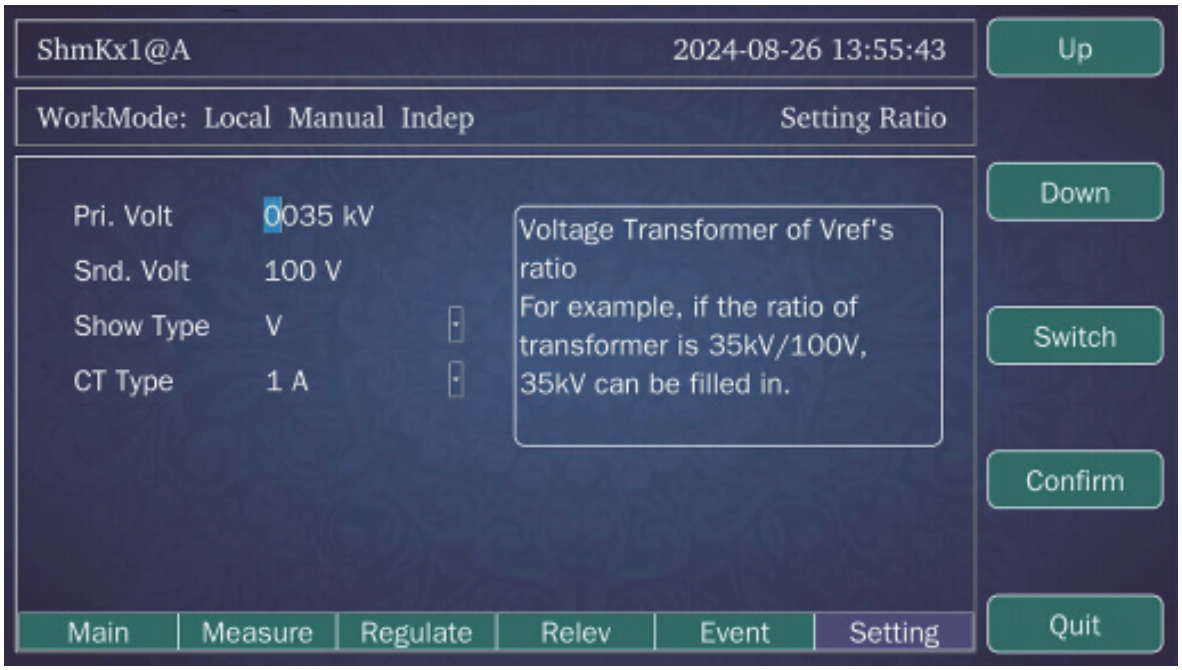
At this point, press "Enter", and the system will enter the sampling correction parameter setting interface.

8.2 Voltage Ratio Setting

Configure the primary and secondary voltage values according to the actual field conditions. If you need to use the overcurrent blocking function, configure the primary and secondary current values as well.

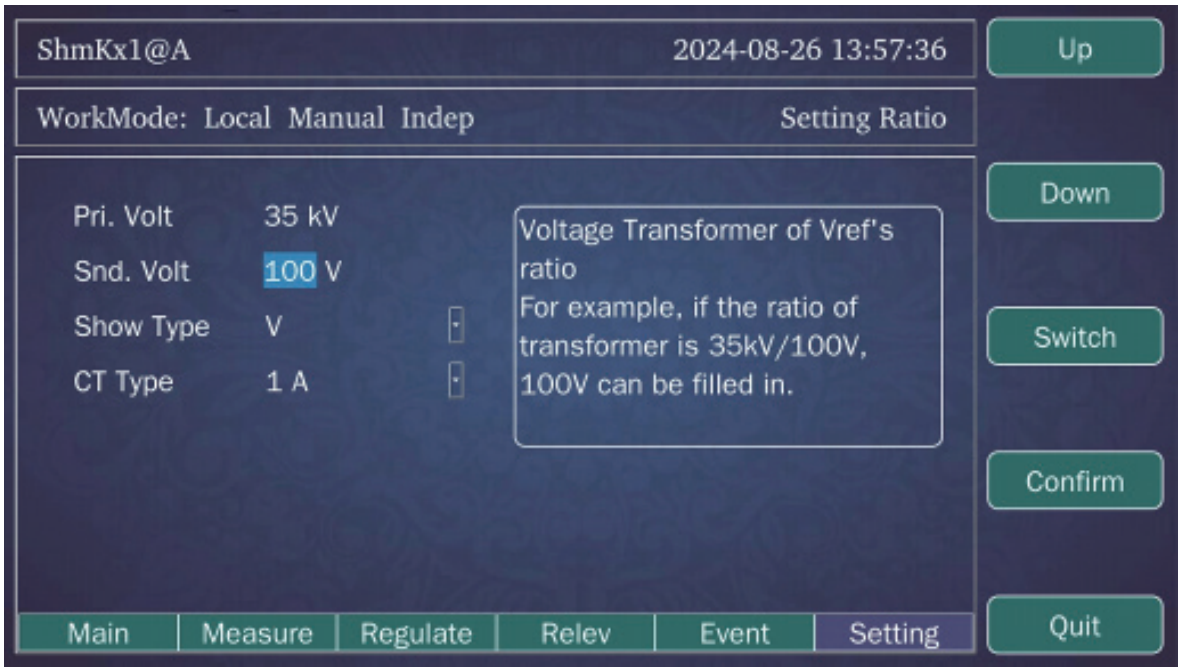
Pay attention to the units for the primary voltage value (V or kV).

Use the "Switch" button to select the parameter and the "Up" and "Down" buttons to adjust the value.

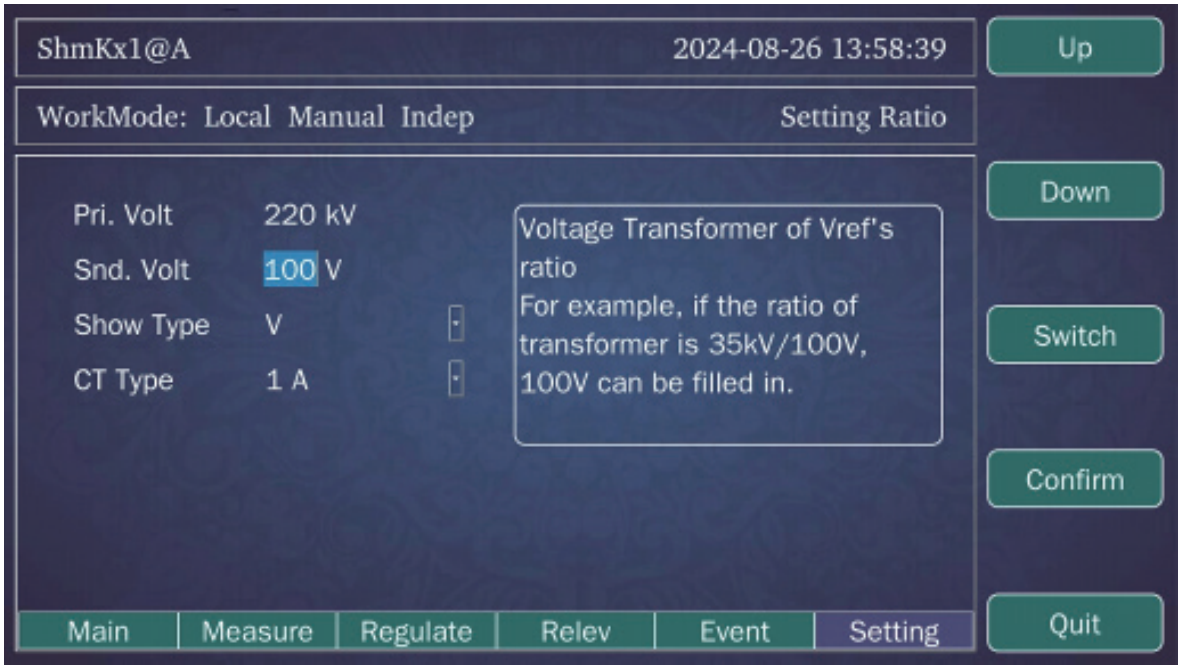


The default voltage ratio is 35kV/100V. Here are some examples of setting the voltage ratio based on different field conditions:

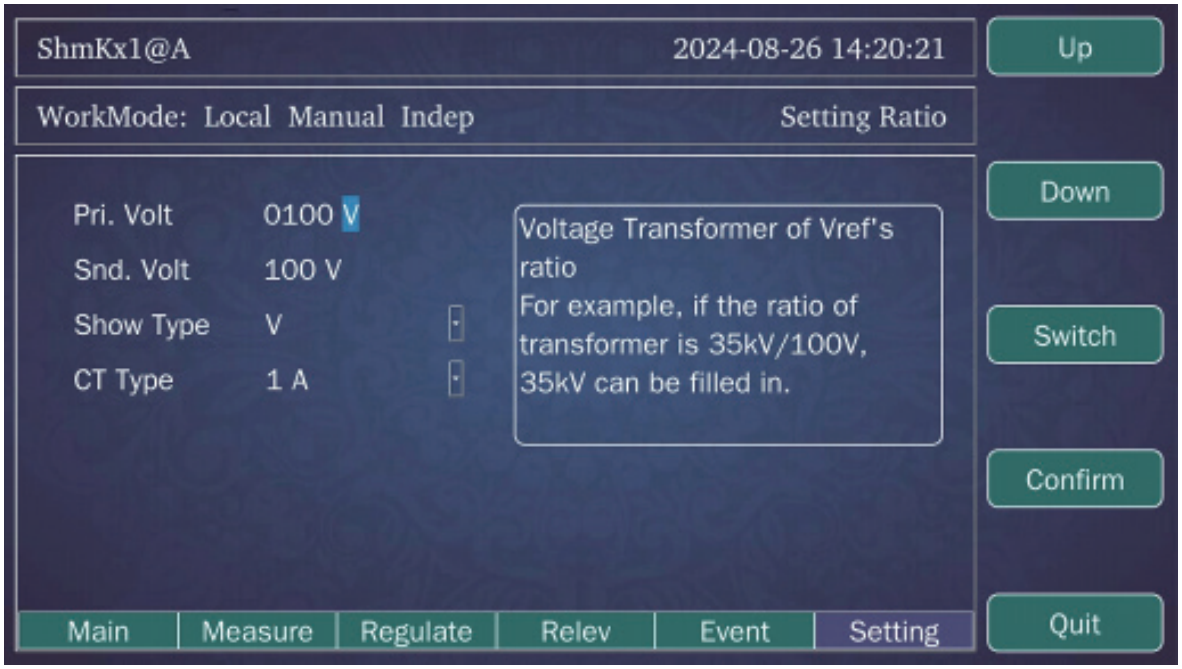
Example 1: If the PT ratio is 35kV/100V, set the Primary Voltage to 35kV and the Secondary Voltage to 100V. When the input voltage is 100V and the "Show Type parameter" is set to "kV", the main screen will display 35kV. See the figure below:



Example 2: If the PT ratio is 220kV/100V, set the Primary Voltage to 220kV and the Secondary Voltage to 100V. See the figure below:

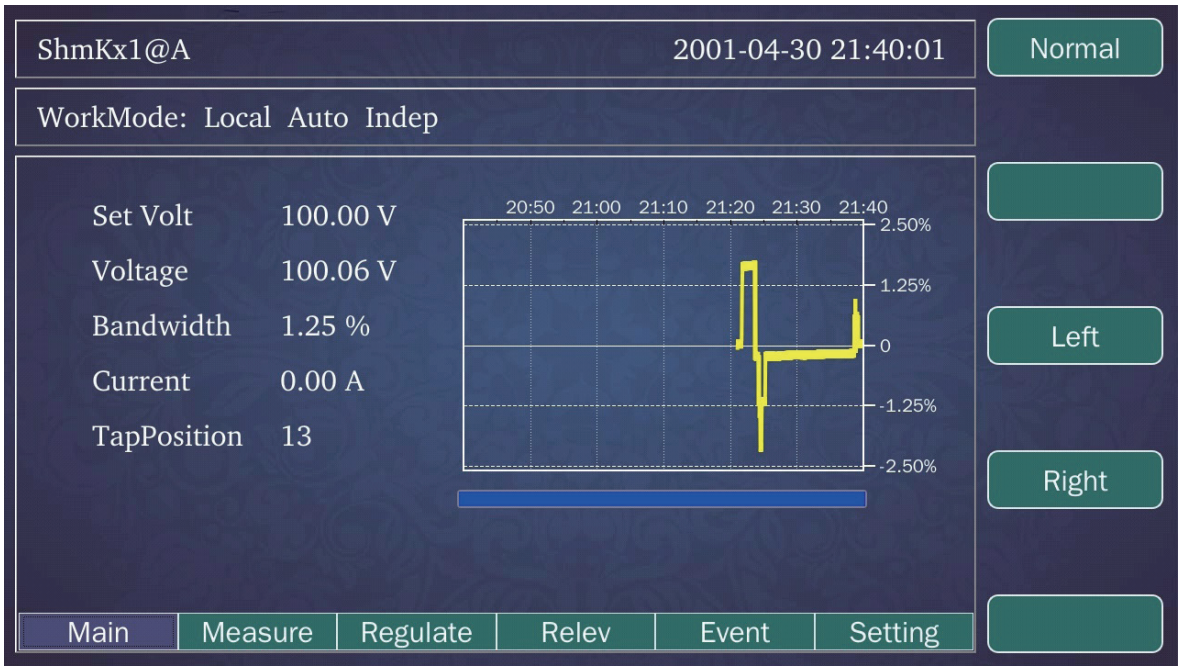


Example 3: If you are unsure of the actual voltage and current ratios, you can configure the settings based on the actual voltage and current measured at the X5 terminal block. For example, if the voltage measured at X1-3 and X1-4 is 100V, configure the settings as shown below.

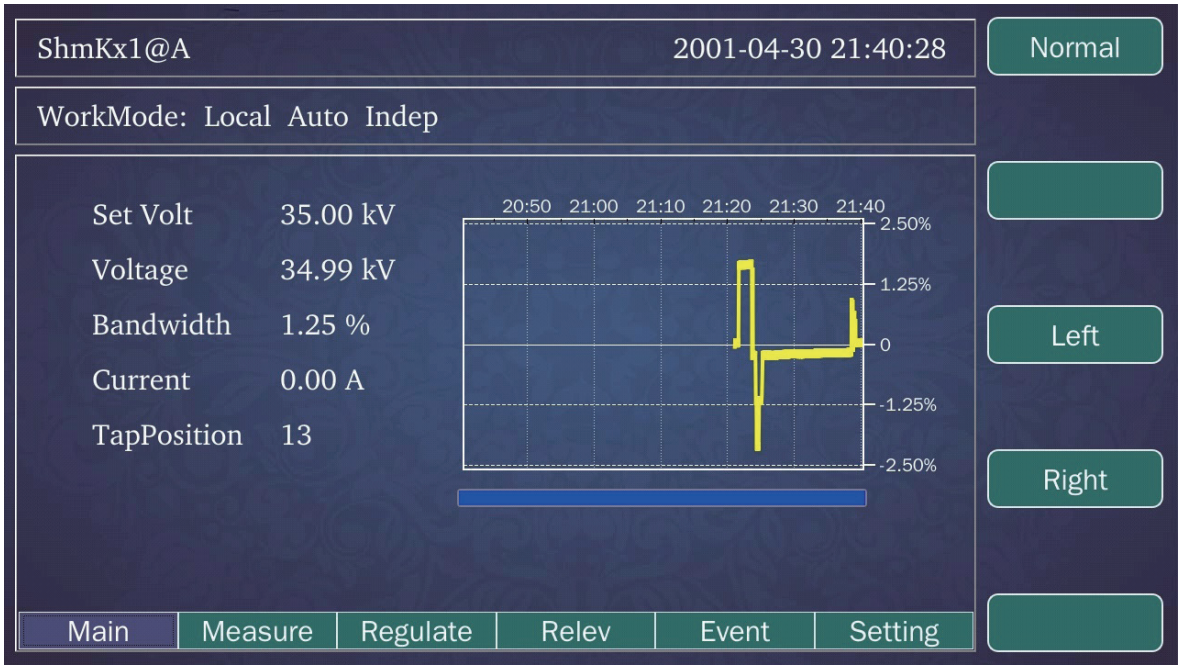


8.3 Show Type

By default, the main screen displays secondary values. For example, if the nominal secondary voltage is 100V, the main screen will display a voltage reading of around 100.06V.

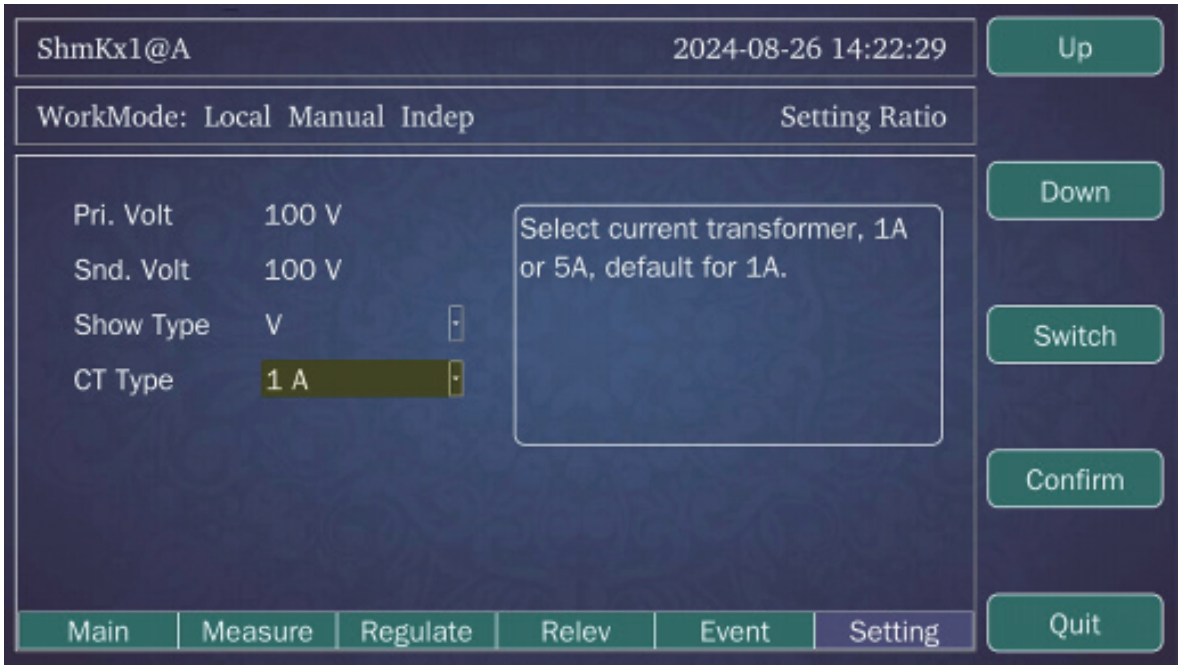


If you change the "Show Type" parameter to "kV", the main screen will display primary values, as shown below.



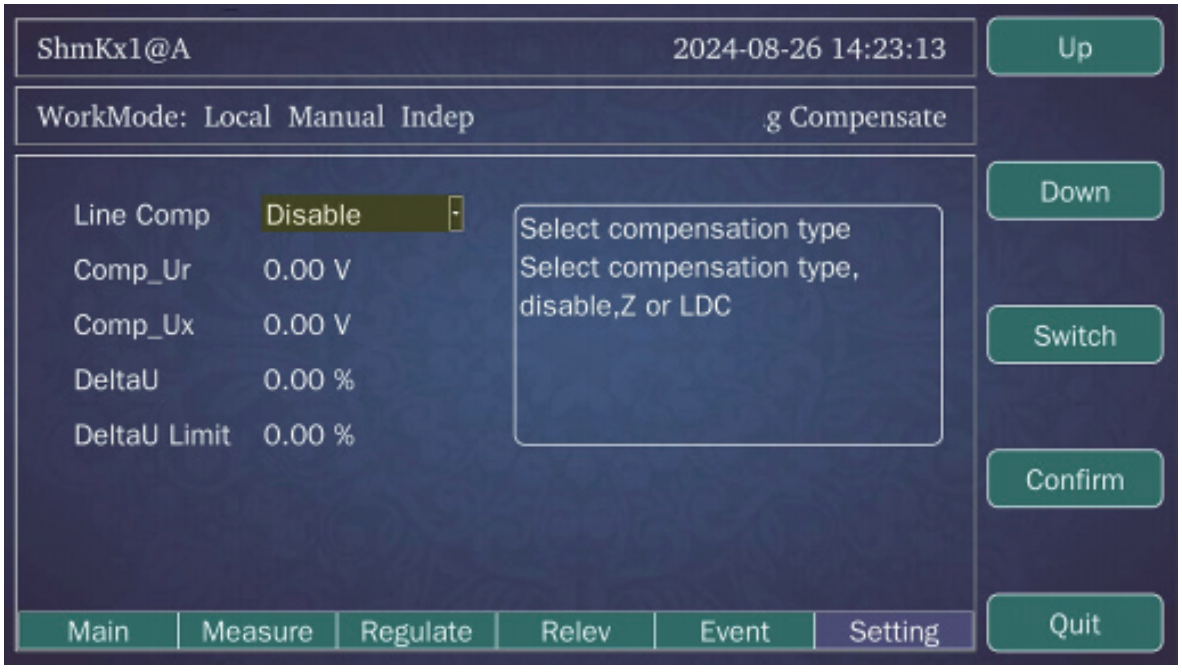
8.4 Current CT Type

The SHM-KX supports two current CT types. You can select either 1A or 5A as the nominal current.
This setting affects power calculations and the minimum circulating current function in Parallel mode. The default setting is 1A.



8.5 Compensation Parameters

The SHM-KX supports the line compensation function, which is off by default.
You can enable compensation and configure the parameters according to the actual field conditions. The system supports both Z compensation and LDC compensation.
After setting the compensation parameters, it will be directly reflected in the Sampled Values screen.

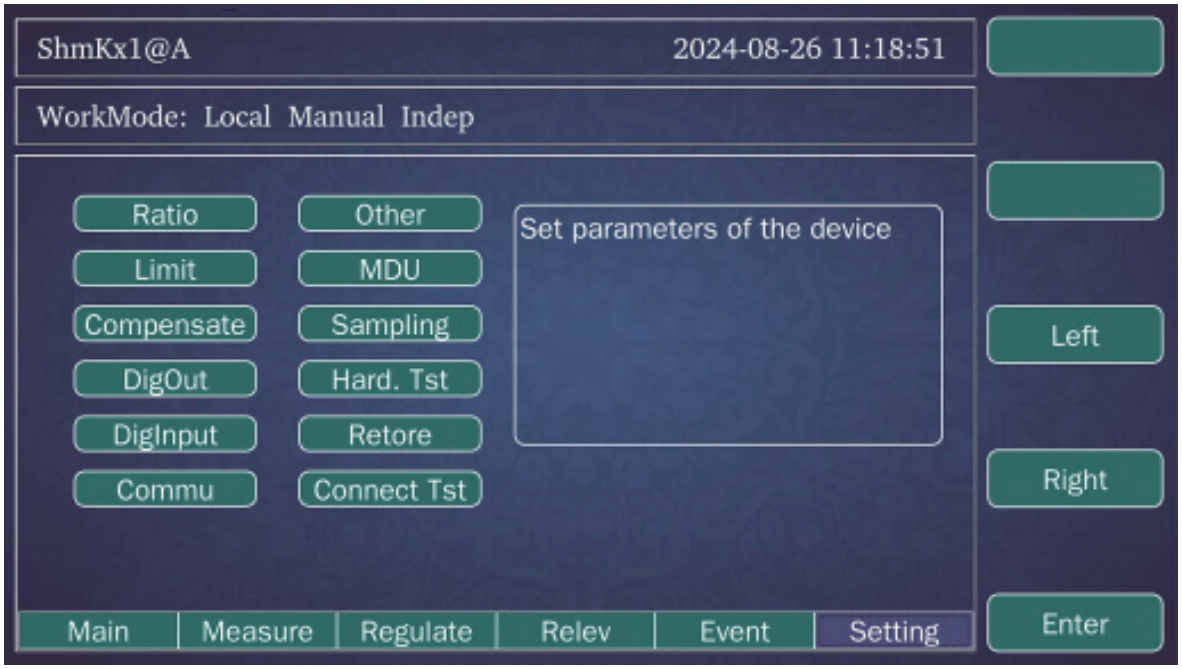


The current version does not support compensation functionality.

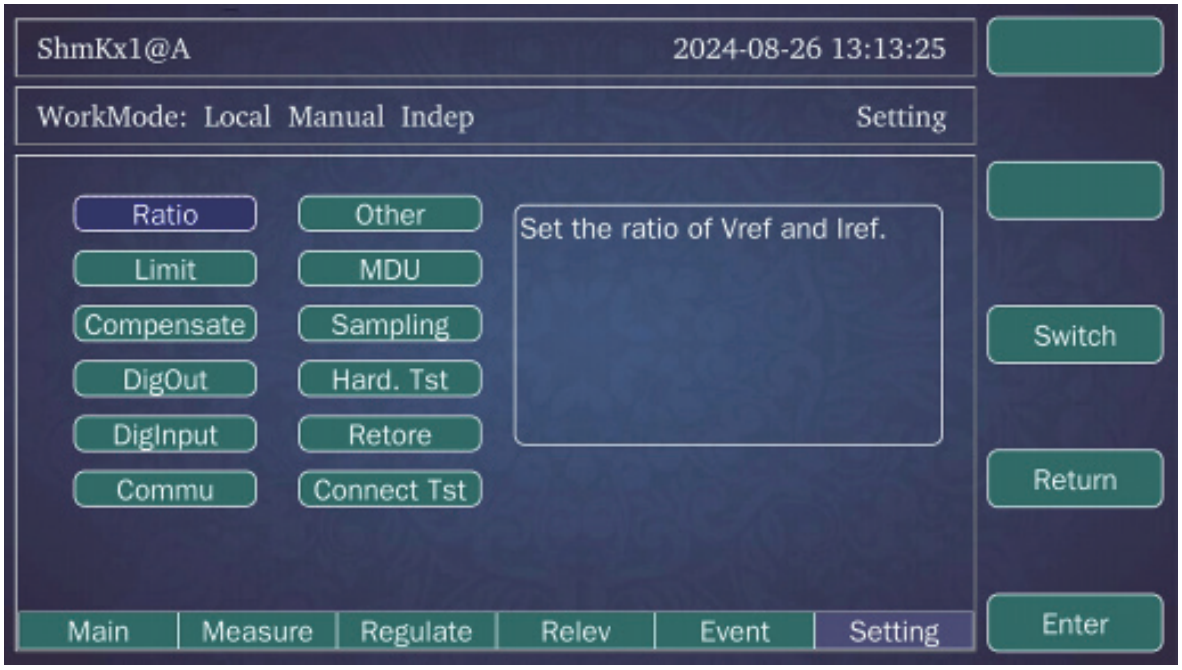
Chapter 9 Sampling Correction

This section provides tools for adjusting the sampled values.

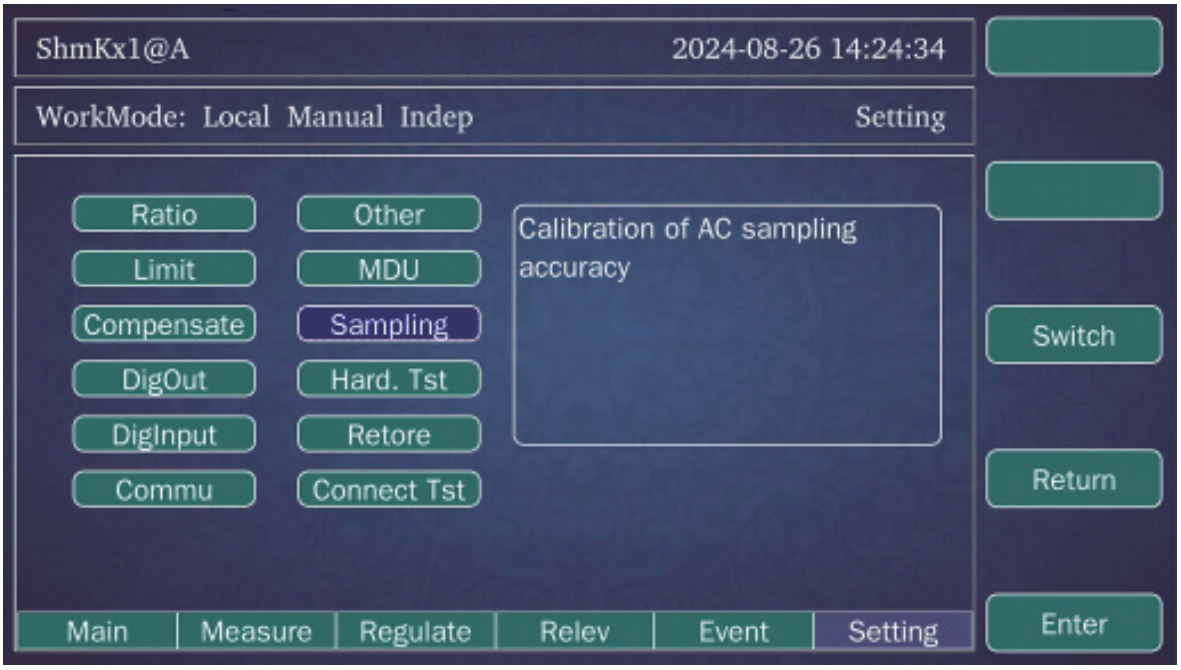
9.1 Accessing the Sampling Correction Menu



Press the "Left" or "Right" button to navigate to the Settings screen, then press "Enter" to access the Settings menu.



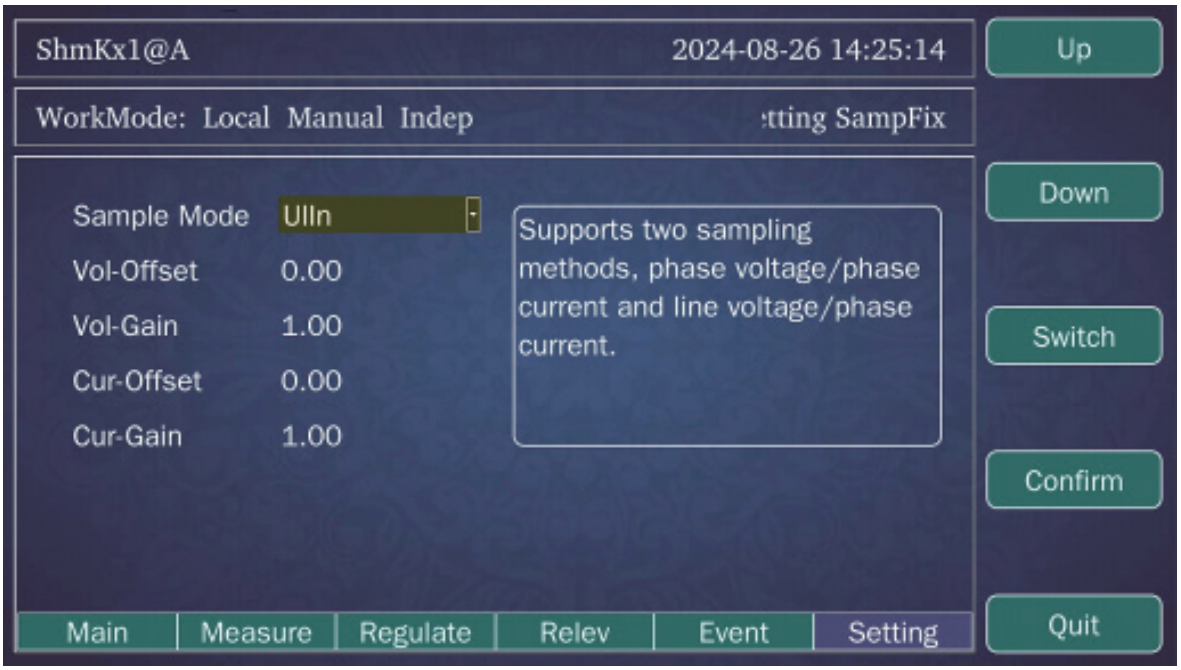
The "Setting" label will appear in the upper right corner of the screen, indicating that you are in the Settings menu. Press the "Switch" button to select the "Sampling Correction" option.



Press "Enter" to access the Sampling Correction menu.

9.2 Sample Mode

The SHM-KX can acquire one voltage signal and one current signal. You can configure the sampling mode based on the field wiring configuration. The two available options are "Phase Voltage/Phase Current" (e.g., UaIa, UbIb, UcIc) and "Line Voltage/Phase Current" (e.g., UabIa, UbcIb, UcaIc). This setting affects the calculation of active power, reactive power, and power factor.

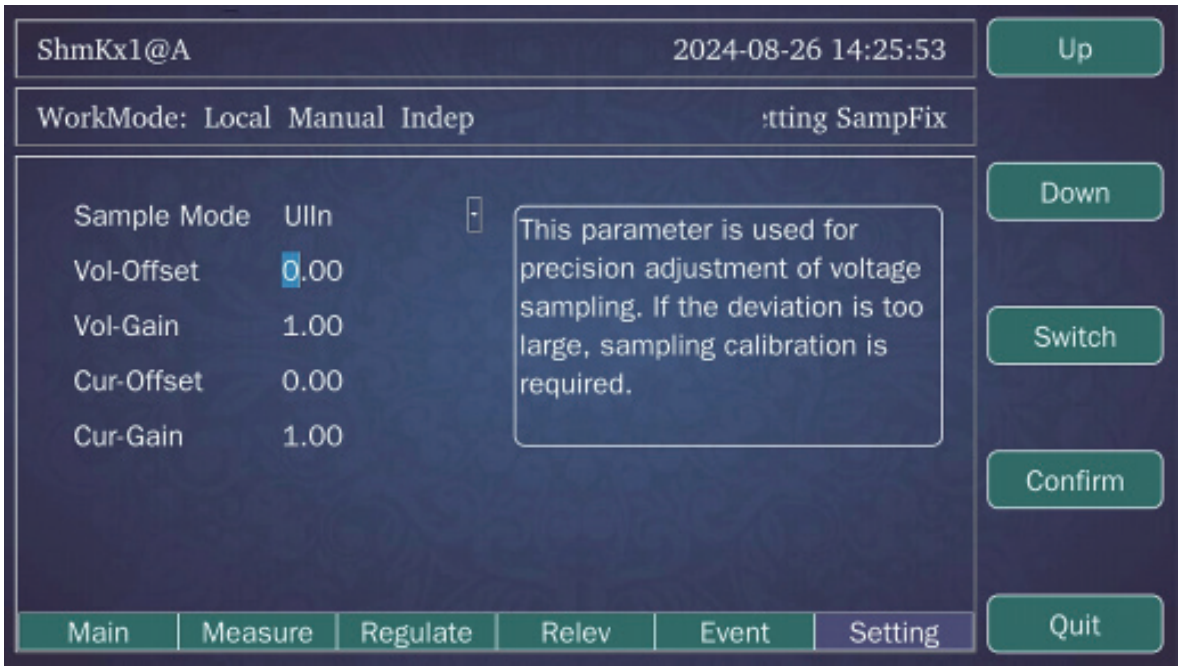


Select "UnIn" for phase voltage/phase current sampling or "UlIn" for line voltage/phase current sampling.

9.3 Sampling Fine-Tuning

The SHM-KX is factory calibrated for voltage and current sampling accuracy. In most cases, no adjustments are necessary. However, if there is a discrepancy between the sampled values and the actual voltage and current in the field, you can make fine-tuning adjustments in this menu.

The SHM-KX allows you to adjust both the offset and gain for voltage and current sampling. The calculation formula is as follows:
Adjusted Value = (Sampled Value + Offset) * Gain

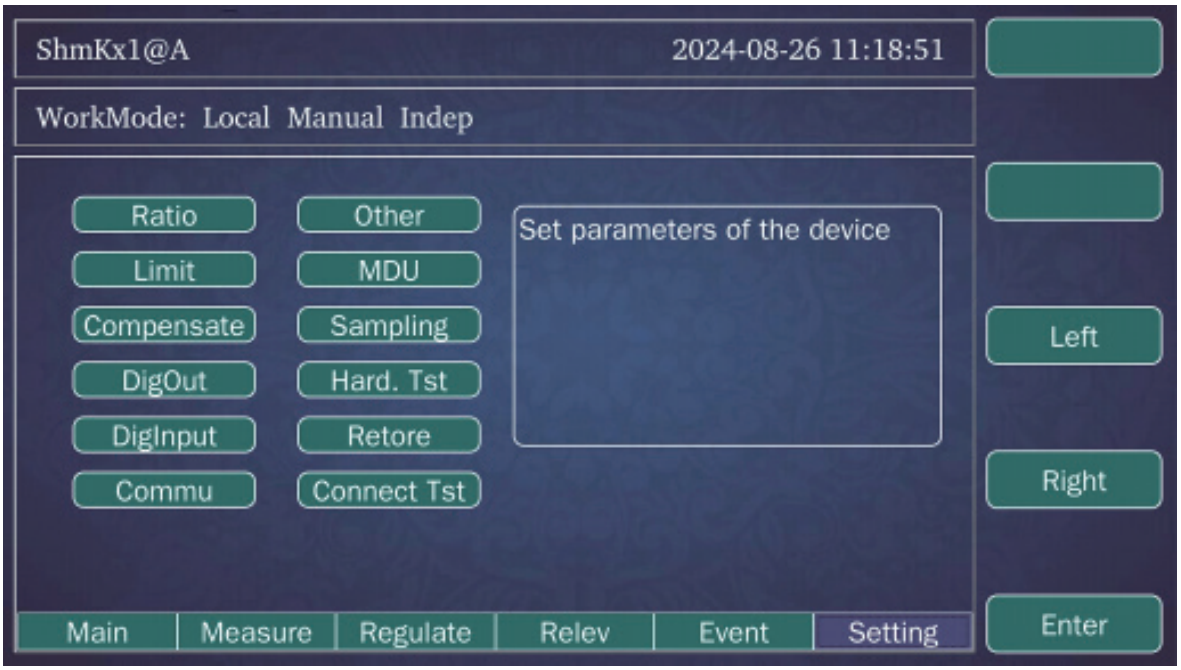


The adjusted values will be reflected on the Measurement screen.

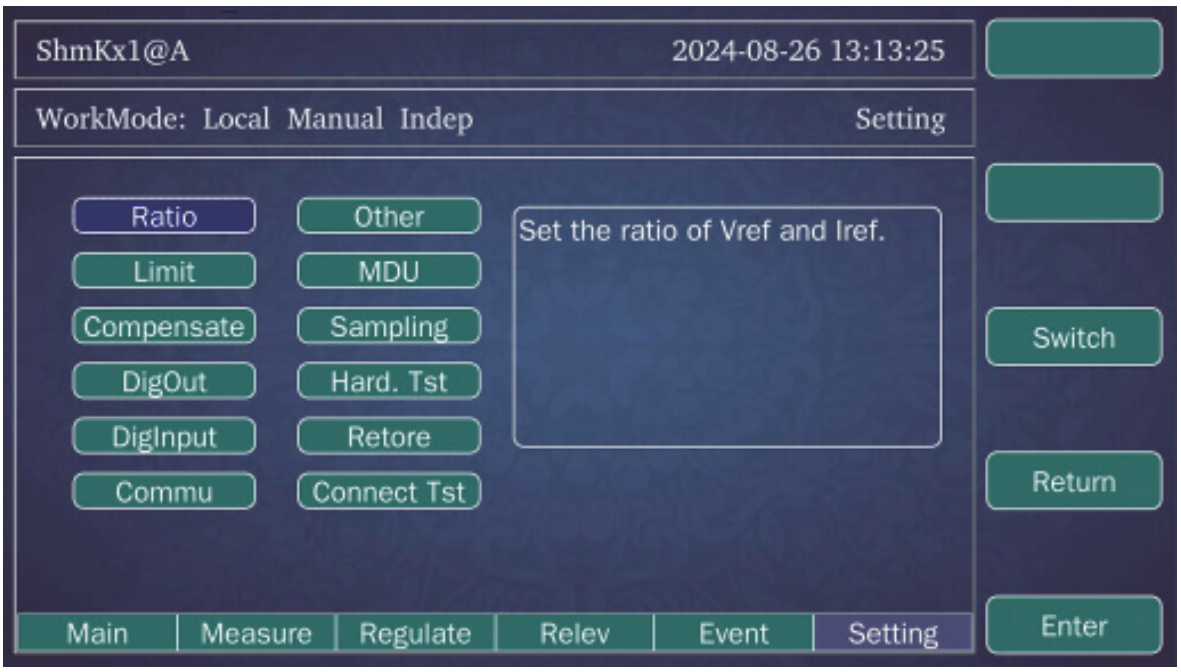
Chapter 10 Limit Settings

The SHM-KX supports overvoltage protection, undervoltage protection, and overcurrent protection. These functions work in conjunction with the automatic voltage regulation function to implement the necessary blocking logic.

10.1 Accessing the Limit Settings Menu

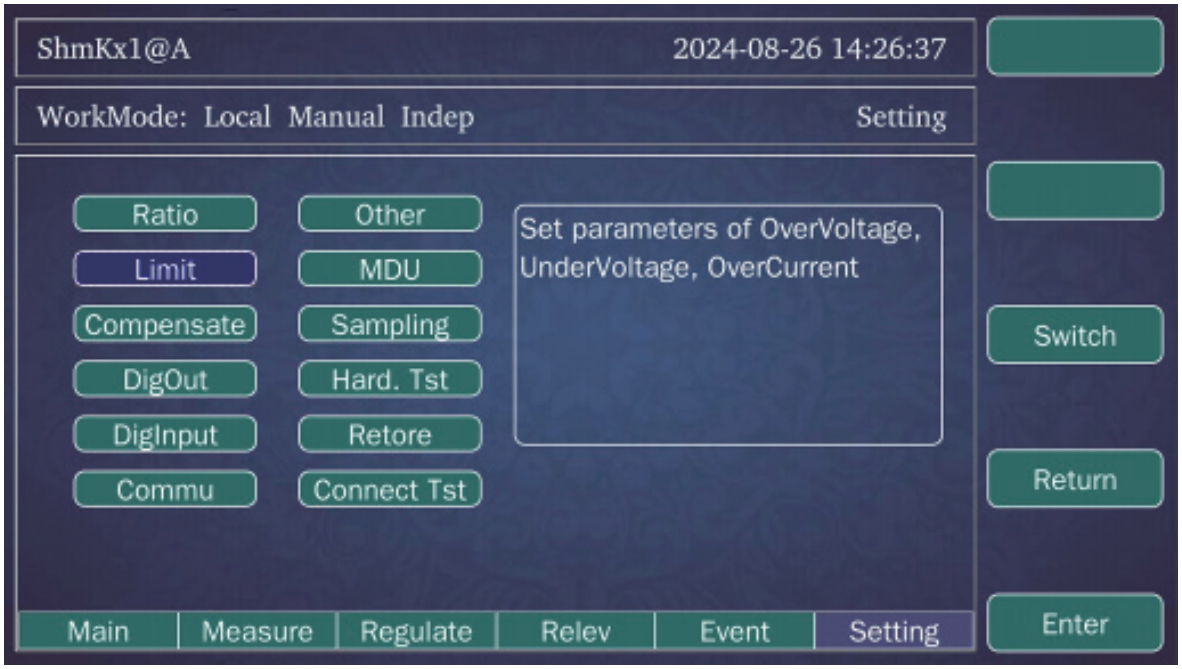


Press the "Left" or "Right" button to navigate to the Settings screen, then press "Enter" to access the Settings menu.



The "Setting" label will appear in the upper right corner of the screen, indicating that you are in the Settings menu.

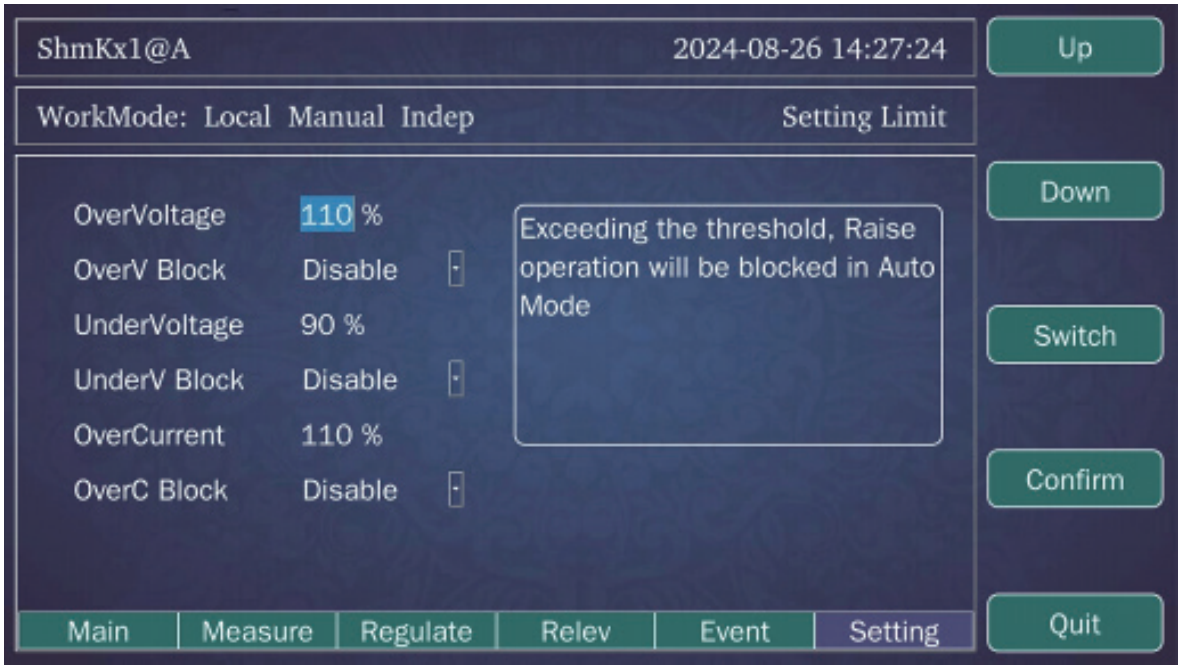
Press the "Switch" button to select the "Setting Limit" option.



Press "Enter" to access the Limit Settings menu.

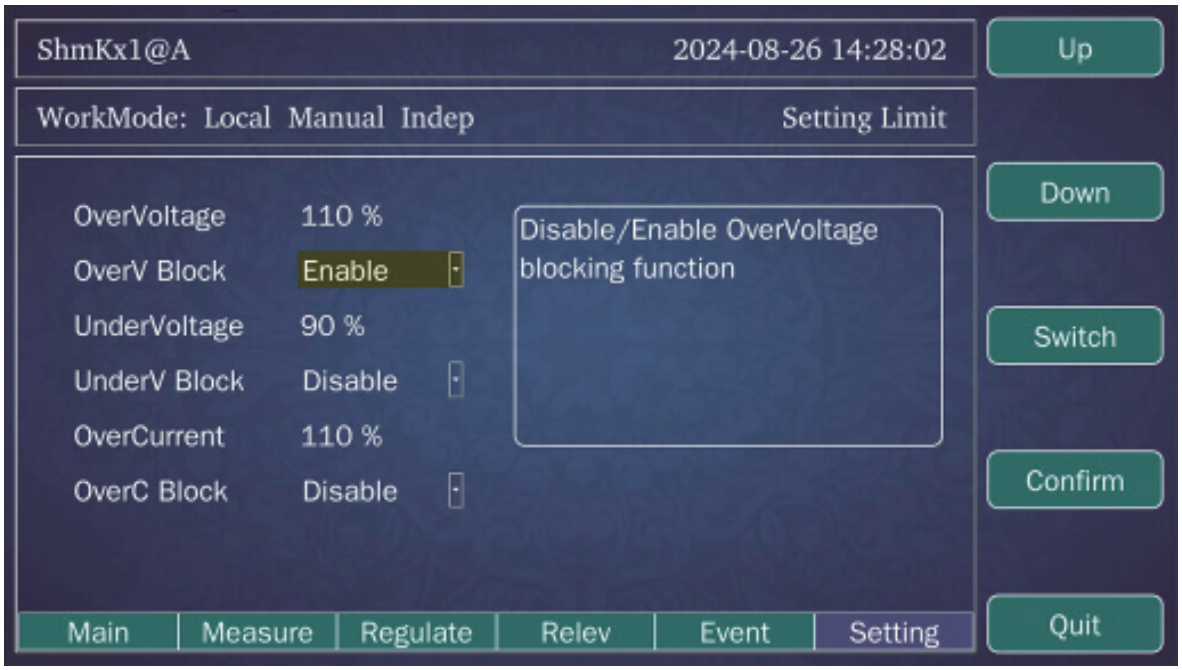
10.2 Overvoltage Block

By default, the overvoltage block function is triggered when the voltage exceeds 110% of the Set Voltage. You can adjust this value according to the specific application requirements.
The overvoltage block function is disabled by default.



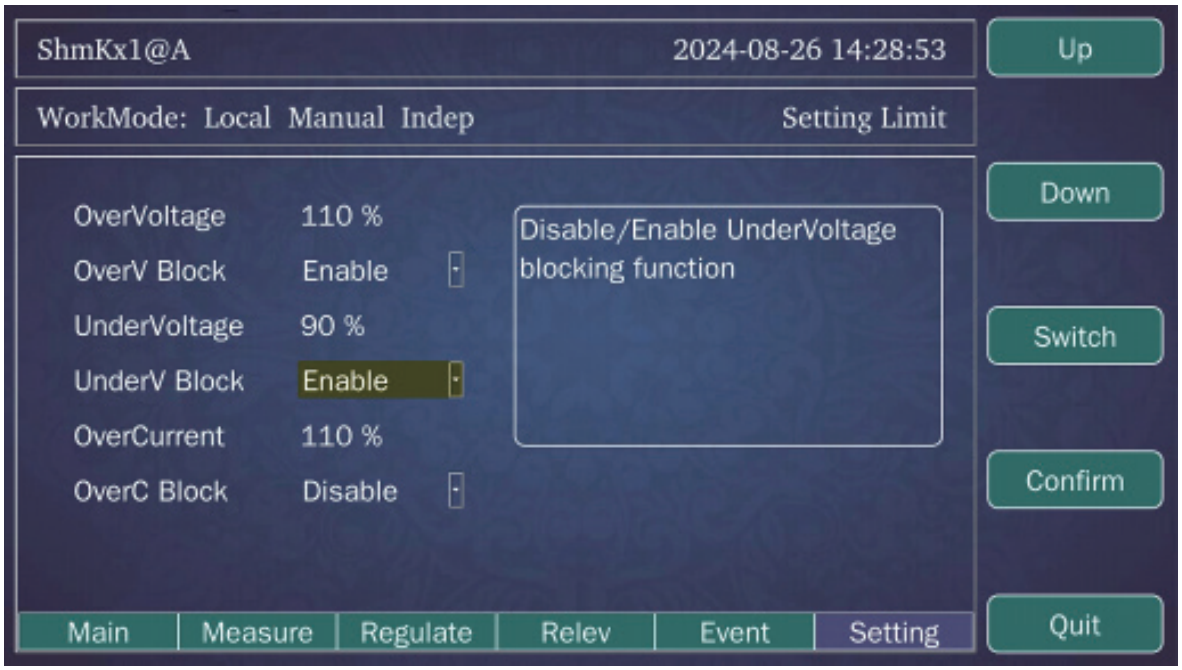
To use the overvoltage block function, you must first enable it.

Press the "Up" and "Down" buttons to adjust the parameter value, and press "Switch" to select different parameters. The overvoltage threshold can be set from 100% to 140% of the Set Voltage.



10.3 Undervoltage Block

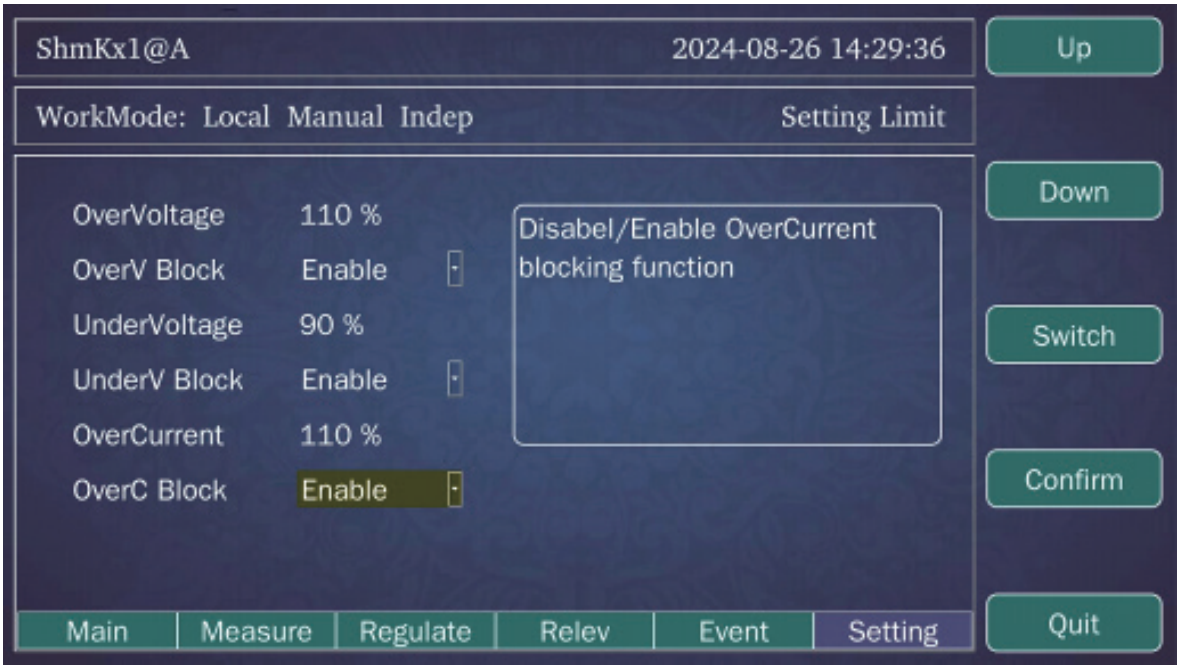
By default, the undervoltage block function is triggered when the voltage falls below 90% of the Set Voltage. You can adjust this value according to the specific application requirements.
The undervoltage block function is disabled by default.



To use the undervoltage block function, you must first enable it.
Press the "Up" and "Down" buttons to adjust the parameter value, and press "Switch" to select different parameters. The undervoltage threshold can be set from 60% to 100% of the Set Voltage.

10.4 Overcurrent Block

By default, the overcurrent block function is triggered when the current exceeds 110% of the nominal current. You can adjust this value according to the specific application requirements.
The overcurrent block function is disabled by default.



To use the overcurrent block function, you must first enable it.
Press the "Up" and "Down" buttons to adjust the parameter value, and press "Switch" to select different parameters.
The overcurrent threshold can be set from 40% to 200% of the nominal current.

10.5 Memory Data Feedback

When a limit function is enabled, the corresponding digital input signal in the system database will reflect the status of the function. This information can be accessed through communication.

No.	Display	Description
40	Dii_OverVoltage_Sts	AVR Overvoltage Alarm
41	Dii_UnderVoltage_Sts	AVR Undervoltage Alarm
42	Dii_ZeroVoltage_Sts	AVR Zero Voltage Alarm
43	Dii_OverCurrent_Sts	AVR Overcurrent Alarm

```
 0. OFF          1. OFF          2. OFF          3. ON           4. OFF
 5. OFF          6. ON           7. ***          8. OFF          9. OFF
10. OFF         11. OFF         12. OFF         13. ***         14. ***
15. OFF         16. OFF         17. OFF         18. OFF         19. OFF
20. OFF         21. ***         22. ***         23. ***         24. ***
25. ***         26. ***         27. ***         28. ***         29. OFF
30. OFF         31. OFF         32. OFF         33. ***         34. ***
35. ***         36. ***         37. OFF         38. OFF         39. OFF
40. OFF         41. OFF         42. ON          43. OFF         44. OFF
```

Note: A zero voltage alarm is generated when the voltage falls below 10% of the nominal voltage.

Chapter 11 Communication Extensions

The rear panel of the SHM-KX provides two RS485 communication ports, one fiber optic communication port, and one standard RJ45 1000M TCP/IP network interface.

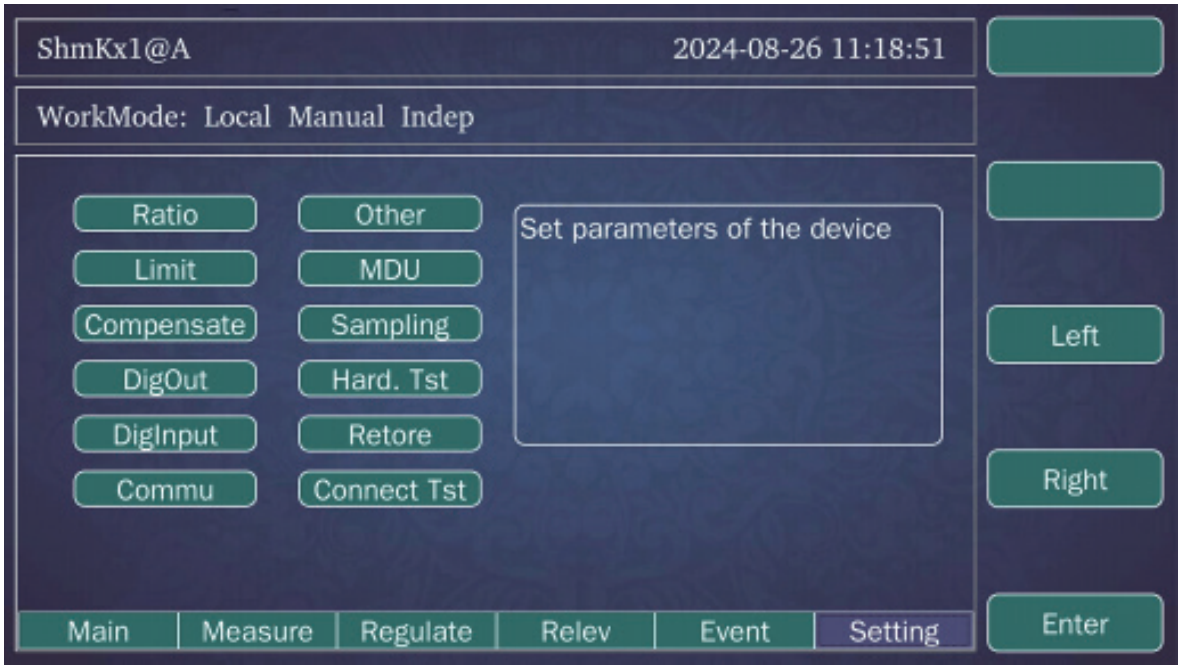
The local expansion can use either the RS485 or fiber optic communication interface. It supports protocols such as Modbus, CDT, IEC 101, IEC 103, DNP3.0, and Hm-Pt. The default communication settings are 9600bps, 8databit, 1stopbit,none, communication address 1, and Modbus protocol.

Users can select any one of the communication interfaces for local expansion. If the MDU type is SHM-D or another type that uses communication to acquire MDU data, the corresponding communication interface can be selected in the MDU Type settings. However, the communication interfaces for local expansion and MDU communication cannot be the same.

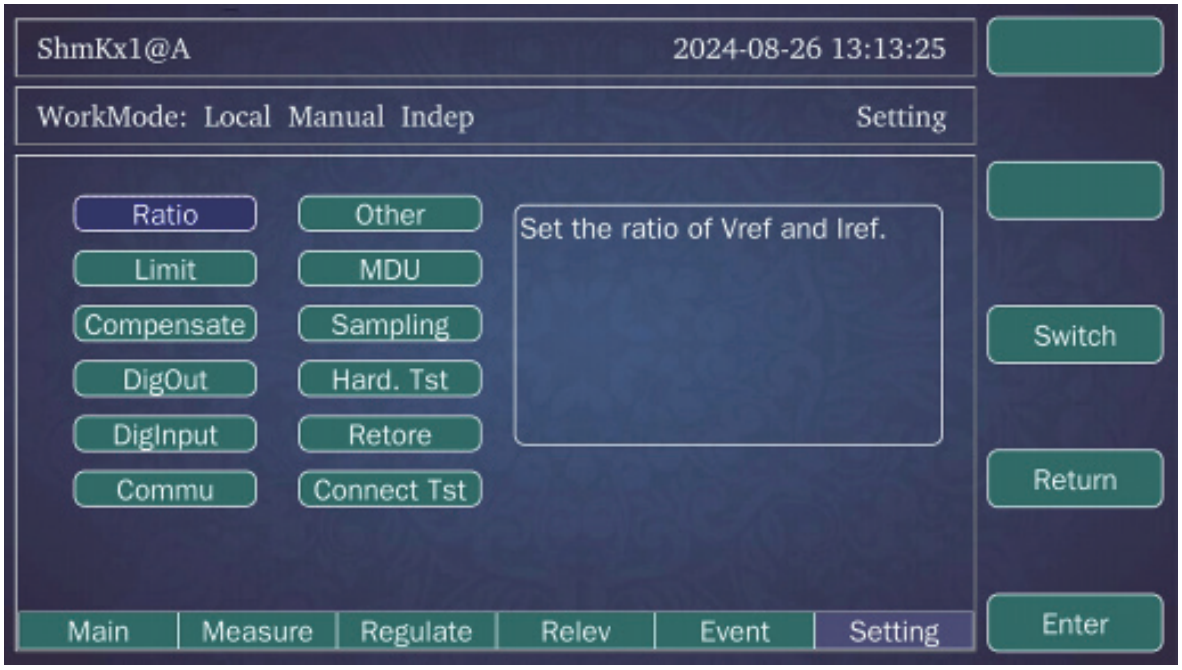
The TCP/IP network interface supports IEC104, IEC61850, and TCP Modbus protocols. Communication over TCP/IP is disabled by default.

The SHM-KX also uses the TCP/IP network interface for parallel operation.

11.1 Accessing the Communication Settings Menu

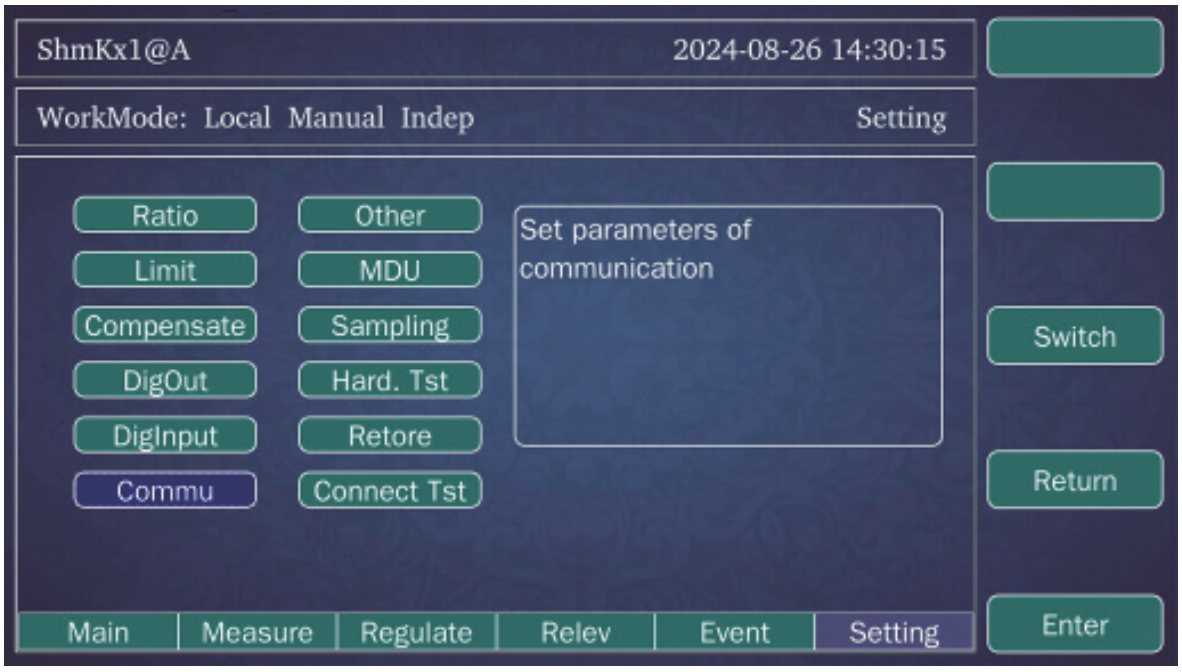


Press the "Left" or "Right" button to navigate to the Setting screen, then press "Enter" to access the Setting menu.



The "Setting" label will appear in the upper right corner of the screen, indicating that you are in the Setting menu.

Press the "Switch" button to select the "commucation" option.

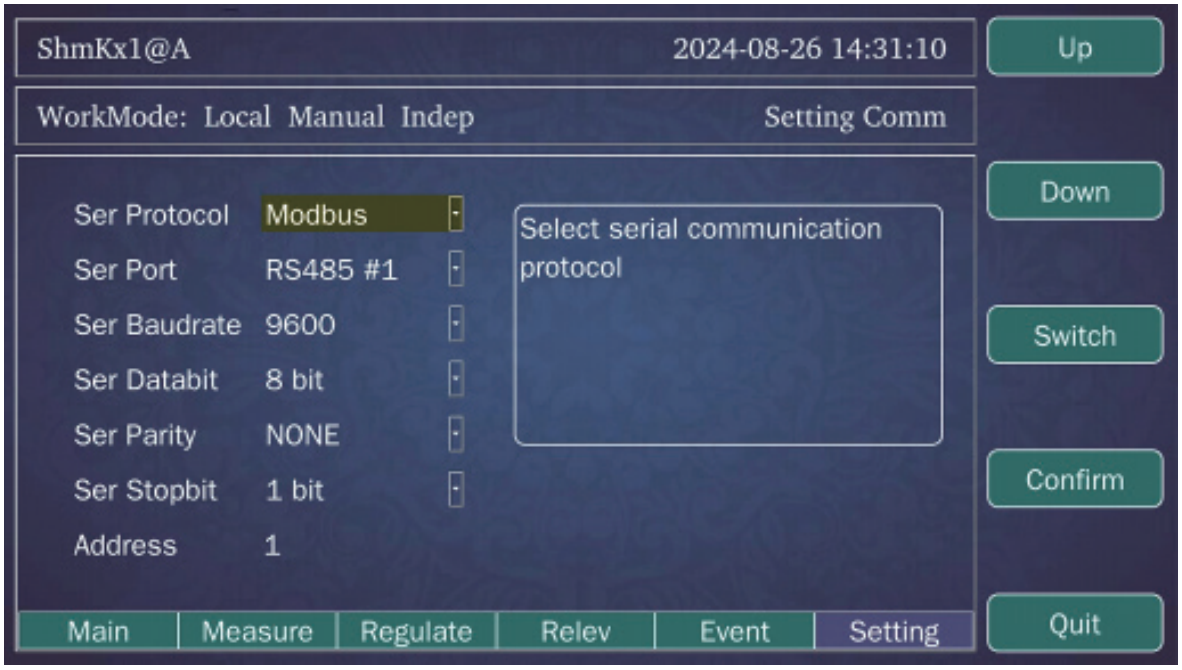


Press "Enter" to access the digital output Settings menu.

11.2 Serial Port Configuration

11.2.1 Protocol Selection

The Serial Protocol setting configures the communication protocol for the serial communication interface. Users can select the protocol required for their application, as shown below.



The following table lists the currently supported serial communication protocols. Use the "Up" and "Down" buttons to select the desired protocol.

Disable	Disables serial communication.
Cdt	CDT, which can be used to connect to a gear position transmitter for hardwired expansion.
Modbus	Modbus-RTU
Iec101	IEC60870-5-101
Iec103	IEC60870-5-103
Dnp3.0	DNP3.0
Hm-pt	Compatible with the HMBK-35 protocol from Huaming Electric.

The register mapping for all protocols is the same as the internal data information table. Point-to-point communication is not currently supported. For details about specific protocols, please refer to the relevant protocol documentation.

11.2.2 Port Selection

Users can select the desired serial communication port:

Disable	Disables serial communication.
RS485#1	Uses the first RS485 port (X2-1, 2, 3).
RS485#2	Uses the second RS485 port (X2-4, 5, 6).
Fiber	Uses the fiber optic communication port.
Iec103	IEC60870-5-103
Dnp3.0	DNP3.0
Hm-pt	Compatible with the HMBK-35 protocol from Huaming Electric.

11.2.3 Serial Parameters

The serial port rate, databit, stopbit, and parity bits are provided for users to modify to meet their actual engineering requirements.

The default communication parameters are 9600bps, 8 databit, 1 stopbit, and none.

11.2.4 Communication Address

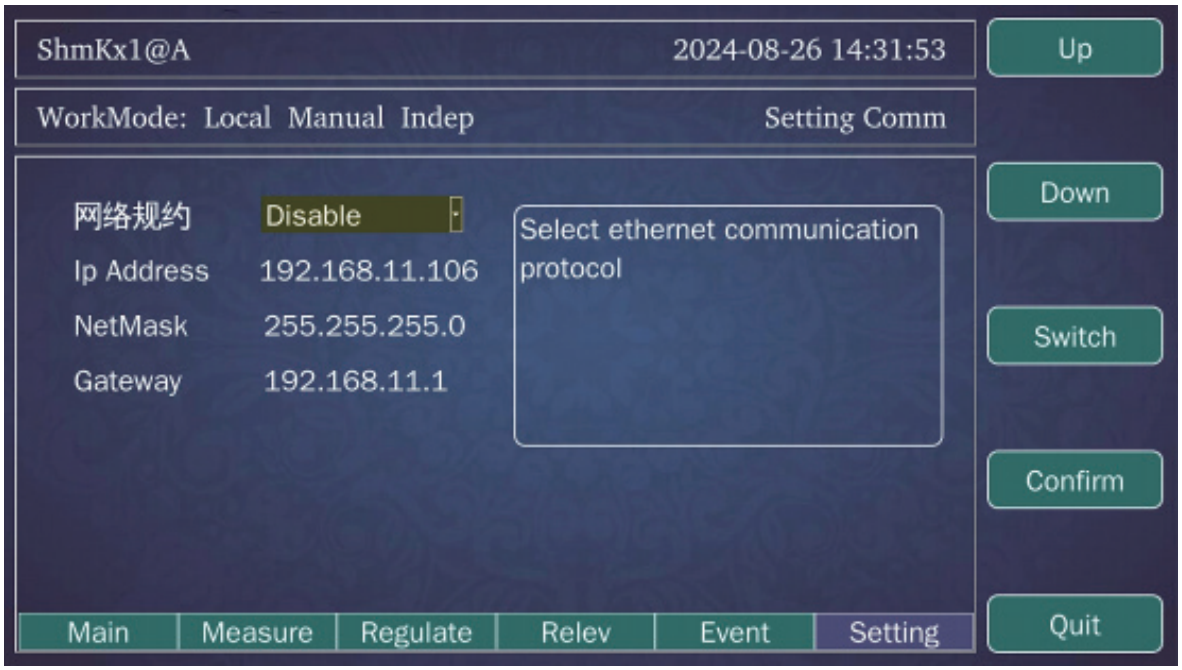
This option provides a unified communication address parameter for all communication protocols, allowing users to select the address. The default address is 1.

For Modbus, Hm-PT, and CDT protocols, this address is the device address. For example, in Modbus, this address is the first byte of the message. For IEC101, IEC103, and IEC104 protocols, this address is both the device address and the link address.

11.3 Network Expansion

11.3.1 Network Protocol Selection

The Network Expansion setting configures the communication protocol for the RJ45 100M/10M TCP/IP network interface. Users can select the protocol required for their application.



The following table lists the currently supported network communication protocols. Use the "Up" and "Down" buttons to select the desired protocol.

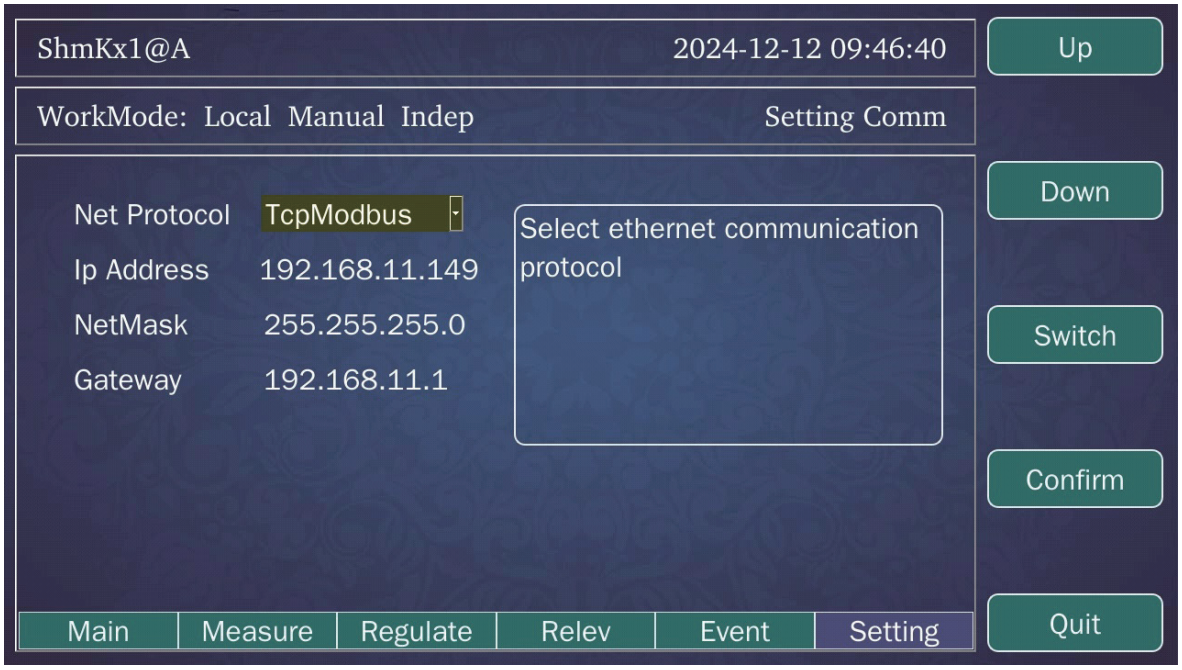
Disable	Disables network communication.
TcpModbus	The register mapping is consistent with Modbus.
IEC104	IEC60870-5-104
IEC61850	IEC61850
IEC61850-V2	IEC61850 V2.00

IEC61850 adopts the version of IEC61850-V1.00, using a fixed cid configuration file, the user needs to configure according to the cid file provided by the manufacturer, there is no need to set parameters such as the IEDName, IP address using the system IP address can be adopted, the IEDName can be changed according to the extension of the address, if the address is 1, this IEDName is Dev1.

IEC61850-V2 adopts the version of IEC61850-V2.00, the user can cut and modify the IP address according to the icd file provided by the manufacturer, and can also modify the related definitions of Rtp and DataSet to generate a valid cid file. After modification, the user must upload to the system to make the system effective.

11.3.2 Network Communication Parameters

You must configure the network parameters for network communication, as shown below.

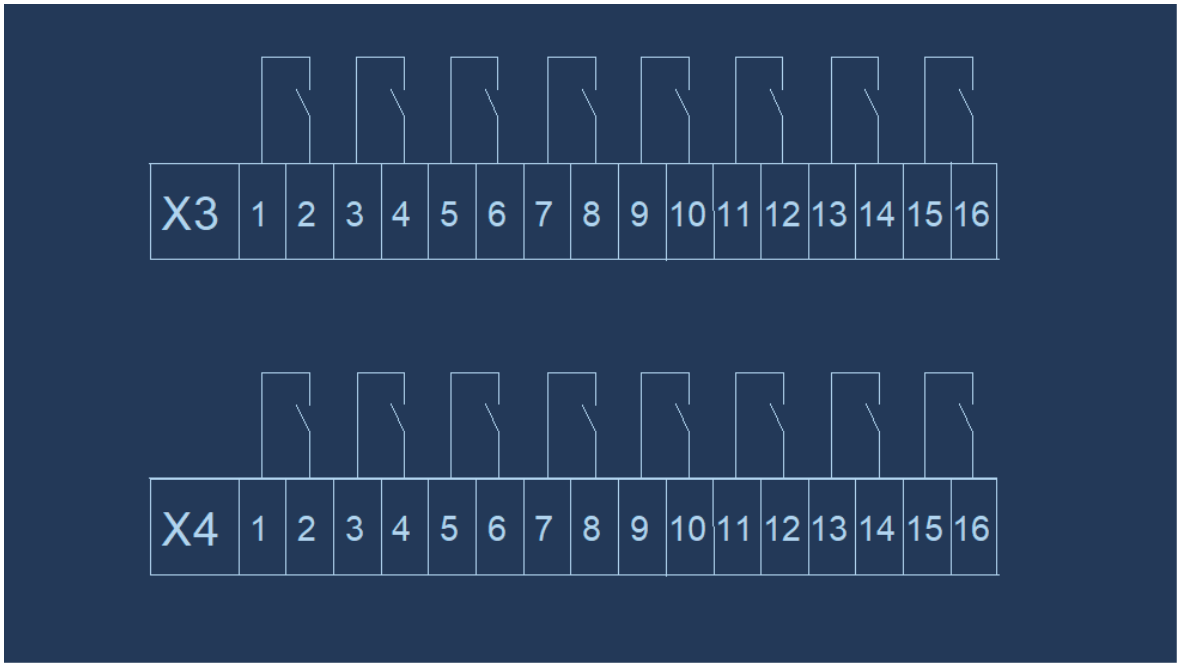


The device will be randomly assigned an IP address and a MAC address to the SHM-KX when shipped from the factory. Users can modify them according to project needs.

Note: These network parameters are not only for the protocols mentioned above, but also for the parallel service, as well as the communication parameters for FTP and SSH2 services.
The sntp protocol uses the gateway address as the default time server. For further information about sntp, please contact the manufacturer.

Chapter 12 Digital Output Definitions

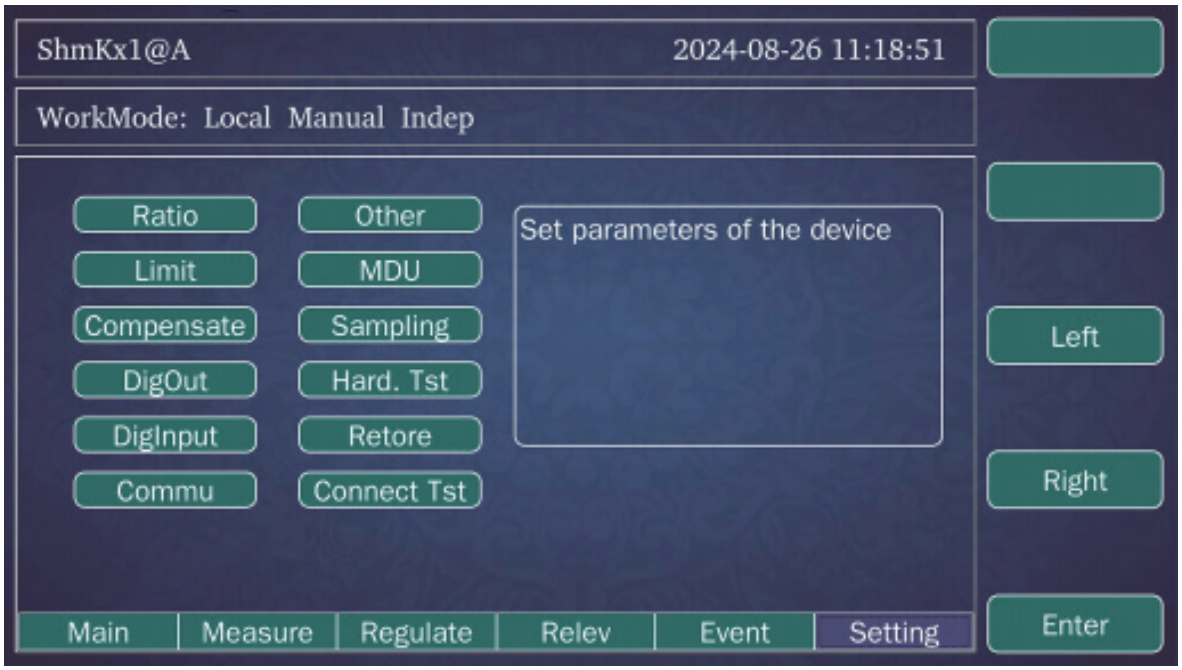
The SHM-KX has 16 relay outputs on the X3 and X4 terminal blocks. The functions of these outputs can be customized. In addition to being mapped to internal digital input signals (see the Appendix), they can be used to output tap position information or indicate operating modes.



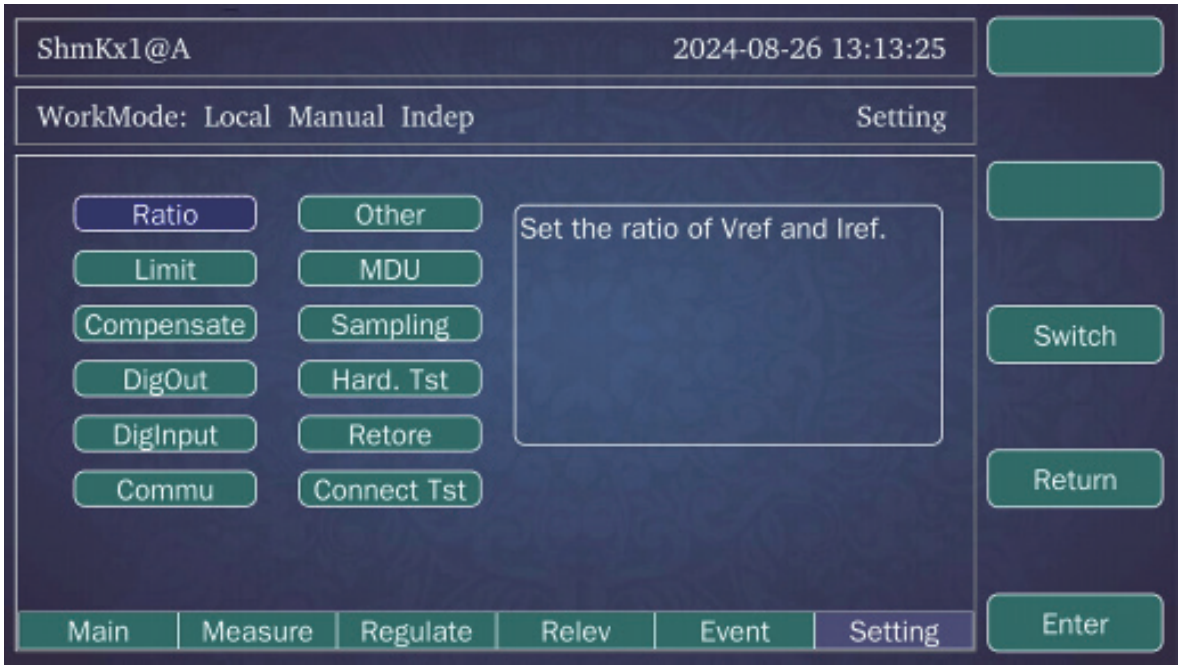
By default (factory default), these 16 relays are defined as follows:
The first 6 relay outputs are the BCD code of the current TapPos.;
The 7th and 8th relay outputs are reserved;
The 9th relay output is the motor running status;
The 10th relay output is the Manual/Auto mode indication (closed represents Auto, open represents Manual);
The 11th relay output is the Local/Remote mode indication (closed represents Remote, open represents Local);
The 12th relay output is the OverVoltage alarm indication;
The 13th relay output is the UnderVolt alarm indication;
The 14th relay output is the OverCurr alarm indication;
The 15th and 16th relay outputs are reserved.

When the MDU type is CMA7, these 16 relay outputs are also used to send raise, lower, and stop commands to the motor-drive unit. See Chapter VII for details about configuring these settings.

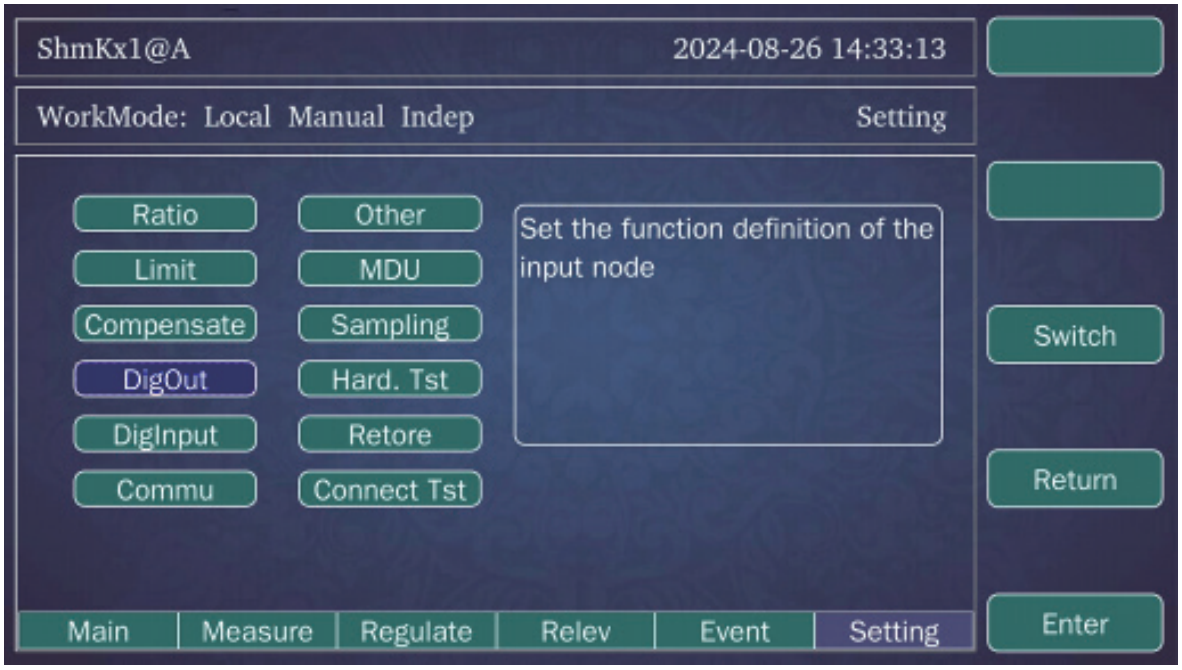
12.1 Accessing the Digital Output Settings



Press the "Left" or "Right" button to navigate to the Setting screen, then press "Enter" to access the Setting menu.



The "Setting" label will appear in the upper right corner of the screen, indicating that you are in the Setting menu. Press the "Switch" button to select the "Setting DigOut" option.

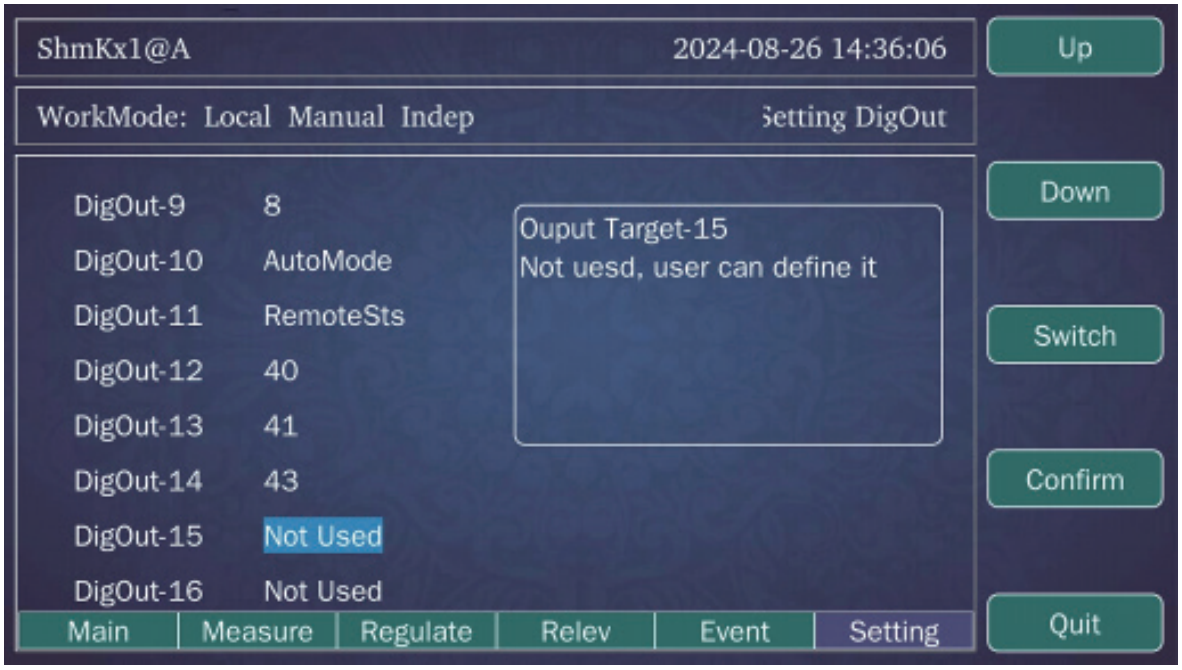


Press "Enter" to access the Digital Output settings menu.

The "Setting DigOut" label will appear in the upper right corner of the screen, indicating that you are in the Digital Output settings menu.

Press the "Switch" button to select the output you want to configure.

The figure below shows the first 8 outputs configured as BCD encoding for the current tap position.



Press "Up" or "Down" to change the output definition. The first 100 entries correspond to the digital input signals listed in the appendix.

In the figure above, output 9 is defined as 8, indicating that this relay output is linked to digital input signal number 8. According to the digital input list in the appendix, input signal number 8 represents the motor running status of the MDU. Therefore, relay output 9 is configured as the motor running status indicator.

No.	Name	Description
8	Dii_Working_Sts	MDU motor running status

Output 10 is defined as "AutoMode". It will be on when the controller is in Automatic mode and off when the controller is in Manual mode.

Output 11 is defined as "RemoteSts". It will be on when the controller is in Remote mode and off when the controller is in Local mode.

Outputs 12, 13, and 14 are defined as 40, 41, and 43, respectively. These outputs are mapped to the overvoltage alarm, undervoltage alarm, and overcurrent alarm signals in the digital input list, as shown below:

No.	Name	Description
40	Dii_OverVoltage_St	AVR Overvoltage Alarm
41	Dii_UnderVoltage_Sts	AVR Undervoltage Alarm
42	Dii_ZeroVoltage_Sts	AVR Zero Voltage Alarm
43	Dii_OverCurrent_Sts	AVR Overcurrent Alarm

As mentioned above, the output definition is associated with the status of the system's digital input signal list.

Refer to the Output Definition Table in Section 12.2 to configure each relay output according to your application requirements.

12.2 Output Definition Table

When you need to modify the output definition, you can refer to the following table.

No.	Display	Description
100	TapBcd0	Bit 0 status indication of the MDU's current TapPos. BCD code.
101	TapBcd1	Bit 1 status indication of the MDU's current TapPos. BCD code.
102	TapBcd2	Bit 2 status indication of the MDU's current TapPos. BCD code.
103	TapBcd3	Bit 3 status indication of the MDU's current TapPos. BCD code.
104	TapBcd4	Bit 4 status indication of the MDU's current TapPos. BCD code.
105	TapBcd5	Bit 5 status indication of the MDU's current TapPos. BCD code.
106	TapBcd6	Bit 6 status indication of the MDU's current TapPos. BCD code.
107	TapBcd7	Bit 7 status indication of the MDU's current TapPos. BCD code.
108	TapBin0	Bit 0 status indication of the MDU's current TapPos. binary code.
109	TapBin1	Bit 1 status indication of the MDU's current TapPos. binary code.
110	TapBin2	Bit 2 status indication of the MDU's current TapPos. binary code.
111	TapBin3	Bit 3 status indication of the MDU's current TapPos. binary code.
112	TapBin4	Bit 4 status indication of the MDU's current TapPos. binary code.
113	TapBin5	Bit 5 status indication of the MDU's current TapPos. binary code.
114	TapBin6	Bit 6 status indication of the MDU's current TapPos. binary code.
115	TapBin7	Bit 7 status indication of the MDU's current TapPos. binary code.
116	TapGry0	Bit 0 status indication of the MDU's current TapPos. Gray code.
117	TapGry1	Bit 1 status indication of the MDU's current TapPos. Gray code.
118	TapGry2	Bit 2 status indication of the MDU's current TapPos. Gray code.
119	TapGry3	Bit 3 status indication of the MDU's current TapPos. Gray code.
120	TapGry4	Bit 4 status indication of the MDU's current TapPos. Gray code.
121	TapGry5	Bit 5 status indication of the MDU's current TapPos. Gray code.
122	TapGry6	Bit 6 status indication of the MDU's current TapPos. Gray code.
123	TapGry7	Bit 7 status indication of the MDU's current TapPos. Gray code.
124	TapOne1	Tap 1 indication for the MDU's current TapPos. one-to-one encoding.
125	TapOne2	Tap 2 indication for the MDU's current TapPos. one-to-one encoding.
126	TapOne3	Tap 3 indication for the MDU's current TapPos. one-to-one encoding.
127	TapOne4	Tap 4 indication for the MDU's current TapPos. one-to-one encoding.
128	TapOne5	Tap 5 indication for the MDU's current TapPos. one-to-one encoding.
129	TapOne6	Tap 6 indication for the MDU's current TapPos. one-to-one encoding.

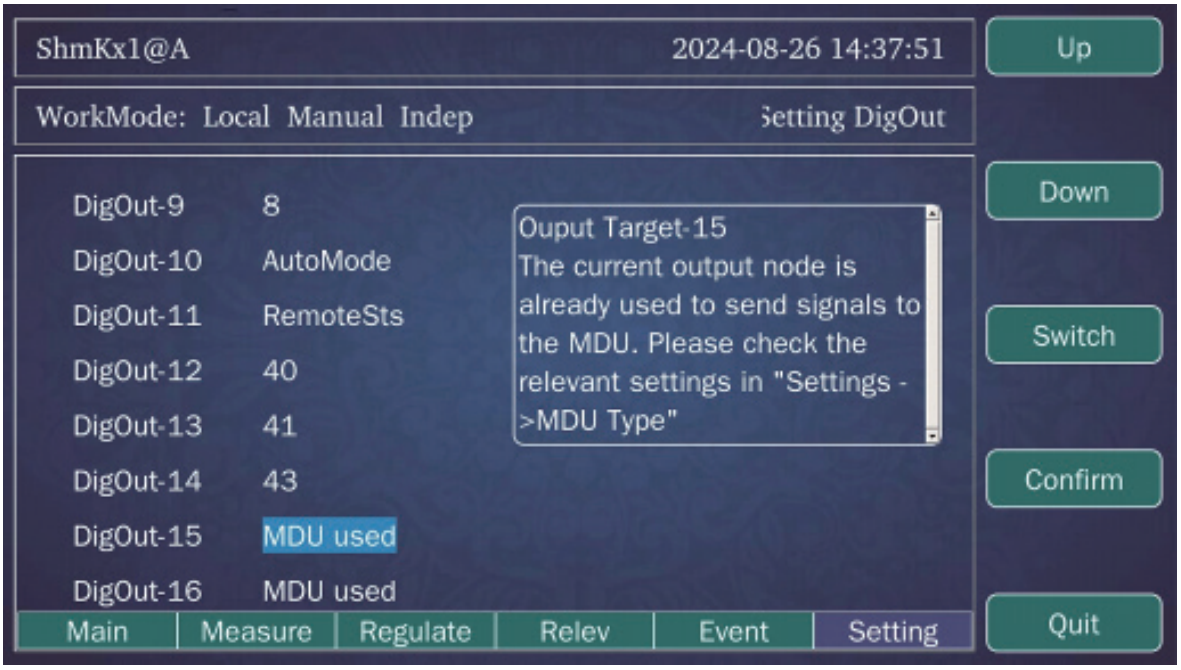
No.	Display	Description
130	TapOne7	Tap 7 indication for the MDU's current TapPos. one-to-one encoding.
131	TapOne8	Tap 8 indication for the MDU's current TapPos. one-to-one encoding.
132	TapOne9	Tap 9 indication for the MDU's current TapPos. one-to-one encoding.
133	TapOne10	Tap 10 indication for the MDU's current TapPos. one-to-one encoding.
134	TapOne11	Tap 11 indication for the MDU's current TapPos. one-to-one encoding.
135	TapOne12	Tap 12 indication for the MDU's current TapPos. one-to-one encoding.
136	TapOne13	Tap 13 indication for the MDU's current TapPos. one-to-one encoding.
137	TapOne14	Tap 14 indication for the MDU's current TapPos. one-to-one encoding.
138	TapOne15	Tap 15 indication for the MDU's current TapPos. one-to-one encoding.
139	TapOne16	Tap 16 indication for the MDU's current TapPos. one-to-one encoding.
140	StpBcd0	Bit 0 status indication of the MDU's current step position BCD code.
141	StpBcd1	Bit 1 status indication of the MDU's current step position BCD code.
142	StpBcd2	Bit 2 status indication of the MDU's current step position BCD code.
143	StpBcd3	Bit 3 status indication of the MDU's current step position BCD code.
144	StpBcd4	Bit 4 status indication of the MDU's current step position BCD code.
145	StpBcd5	Bit 5 status indication of the MDU's current step position BCD code.
146	StpBcd6	Bit 6 status indication of the MDU's current step position BCD code.
147	StpBcd7	Bit 7 status indication of the MDU's current step position BCD code.
148	StpBin0	Bit 0 status indication of the MDU's current step position binary code.
149	StpBin1	Bit 1 status indication of the MDU's current step position binary code.
150	StpBin2	Bit 2 status indication of the MDU's current step position binary code.
151	StpBin3	Bit 3 status indication of the MDU's current step position binary code.
152	StpBin4	Bit 4 status indication of the MDU's current step position binary code.
153	StpBin5	Bit 5 status indication of the MDU's current step position binary code.
154	StpBin6	Bit 6 status indication of the MDU's current step position binary code.
155	StpBin7	Bit 7 status indication of the MDU's current step position binary code.
156	StpGry0	Bit 0 status indication of the MDU's current step position Gray code.
157	StpGry1	Bit 1 status indication of the MDU's current step position Gray code.
158	StpGry2	Bit 2 status indication of the MDU's current step position Gray code.
159	StpGry3	Bit 3 status indication of the MDU's current step position Gray code.
160	StpGry4	Bit 4 status indication of the MDU's current step position Gray code.
161	StpGry5	Bit 5 status indication of the MDU's current step position Gray code.
162	StpGry6	Bit 6 status indication of the MDU's current step position Gray code.

No.	Display	Description
163	StpGry7	Bit 7 status indication of the MDU's current step position Gray code.
164	StpOne1	Step 1 indication for the MDU's current step position one-to-one encoding.
165	StpOne2	Step 2 indication for the MDU's current step position one-to-one encoding.
166	StpOne3	Step 3 indication for the MDU's current step position one-to-one encoding.
167	StpOne4	Step 4 indication for the MDU's current step position one-to-one encoding.
168	StpOne5	Step 5 indication for the MDU's current step position one-to-one encoding.
169	StpOne6	Step 6 indication for the MDU's current step position one-to-one encoding.
170	StpOne7	Step 7 indication for the MDU's current step position one-to-one encoding.
171	StpOne8	Step 8 indication for the MDU's current step position one-to-one encoding.
172	StpOne9	Step 9 indication for the MDU's current step position one-to-one encoding.
173	StpOne10	Step 10 indication for the MDU's current step position one-to-one encoding.
174	StpOne11	Step 11 indication for the MDU's current step position one-to-one encoding.
175	StpOne12	Step 12 indication for the MDU's current step position one-to-one encoding.
176	StpOne13	Step 13 indication for the MDU's current step position one-to-one encoding.
177	StpOne14	Step 14 indication for the MDU's current step position one-to-one encoding.
178	StpOne15	Step 15 indication for the MDU's current step position one-to-one encoding.
179	StpOne16	Step 16 indication for the MDU's current step position one-to-one encoding.
180	ManMode	AVR Manual mode status indication.
181	AutoMode	AVR Auto mode status indication.
182	LocSts	AVR Local control authority indication.
183	RemoteSts	AVR Remote control authority indication.
184	Linear	AVR automatic voltage regulation Linear operating mode status indication.
185	Inverse	AVR automatic voltage regulation Inverse operating mode status indication.
186	Indep	AVR Indep operating mode indication.
187	Rele-MasSlv	AVR Rele-MasSlv operating mode indication.
188	Rele-Circ	AVR circulating current operating mode indication.
189	Rele-MasDev	AVR Rele-Master indication in Rele Mode.
190	Rele-SlvDev	AVR Rele-Slave indication in Rele Mode.
191	Rele-Grp1	AVR Rele-Group1 status indication in Rele Mode.
192	Rele-Grp2	AVR Rele-Group2 status indication in Rele Mode.
193	NotUsed	Reserved
194	NotUsed	Reserved
195	NotUsed	Reserved

No.	Display	Description
196	NotUsed	Reserved
197	NotUsed	Reserved
198	NotUsed	Reserved
199	NotUsed	Reserved

Note:
When the MDU Type is SHM-D, the tap position and step position values are acquired from the SHM-D(S). Refer to the Appendix for the meaning of these values.

When the MDU Type is CMA7 or Mixed Mode, the raise/lower relay outputs will be used for controlling the motor-drive unit, and the interface will indicate that these outputs are in use.

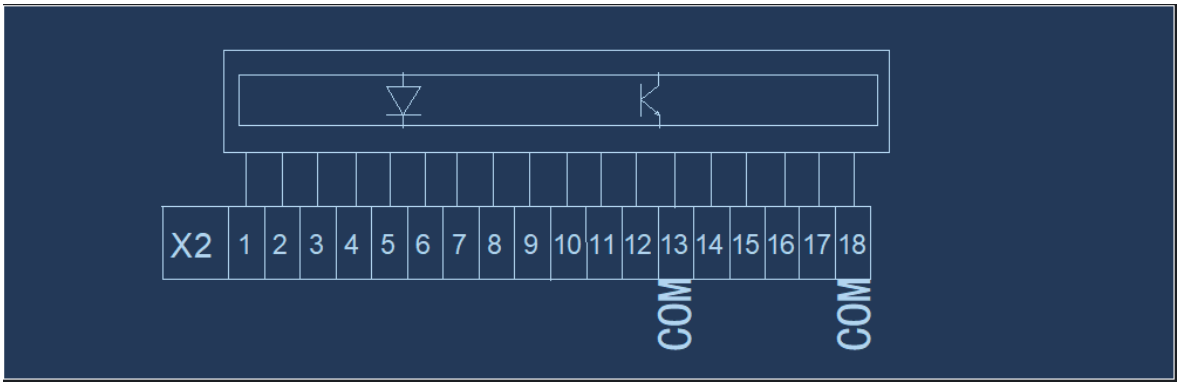


Chapter 13 Digital Input Definitions

The SHM-KX provides 16 digital inputs on terminals X1-1 to X1-18. The functions of these inputs can be customized. They can be used to switch operating modes, accept hardwired remote control commands, or other functions.

X1-13 and X1-18 are common terminals for the digital inputs. The field power supply should be 24V DC.
The digital inputs must be passive.

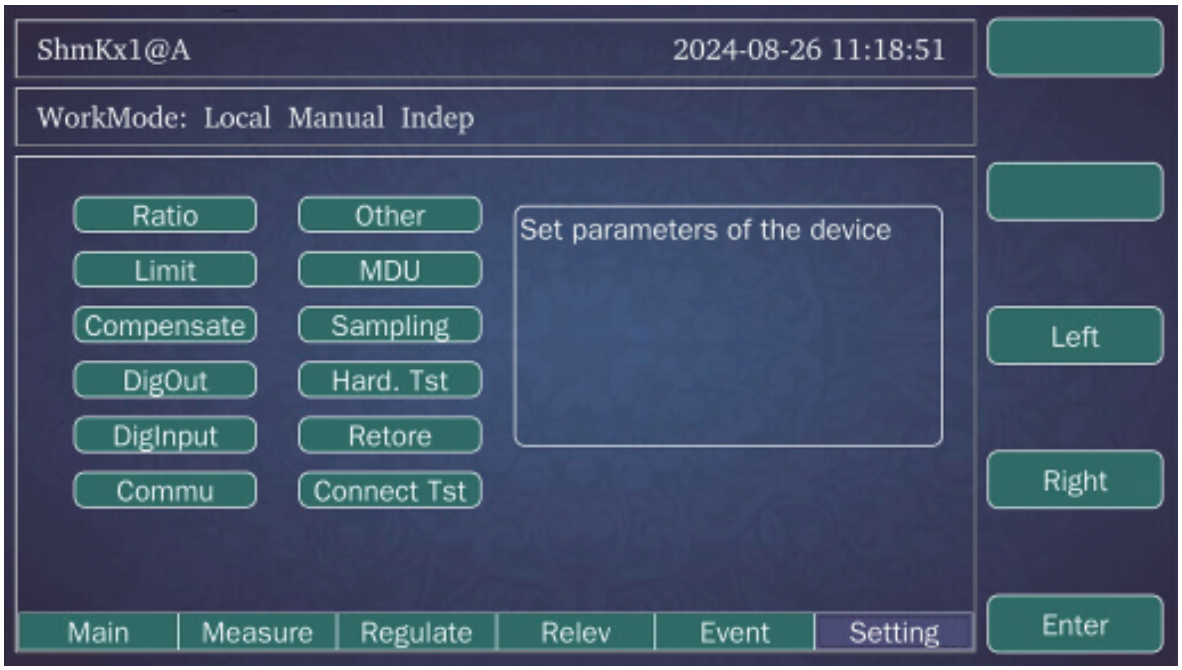
Note: The input signal must be maintained for at least 200ms to be considered valid.



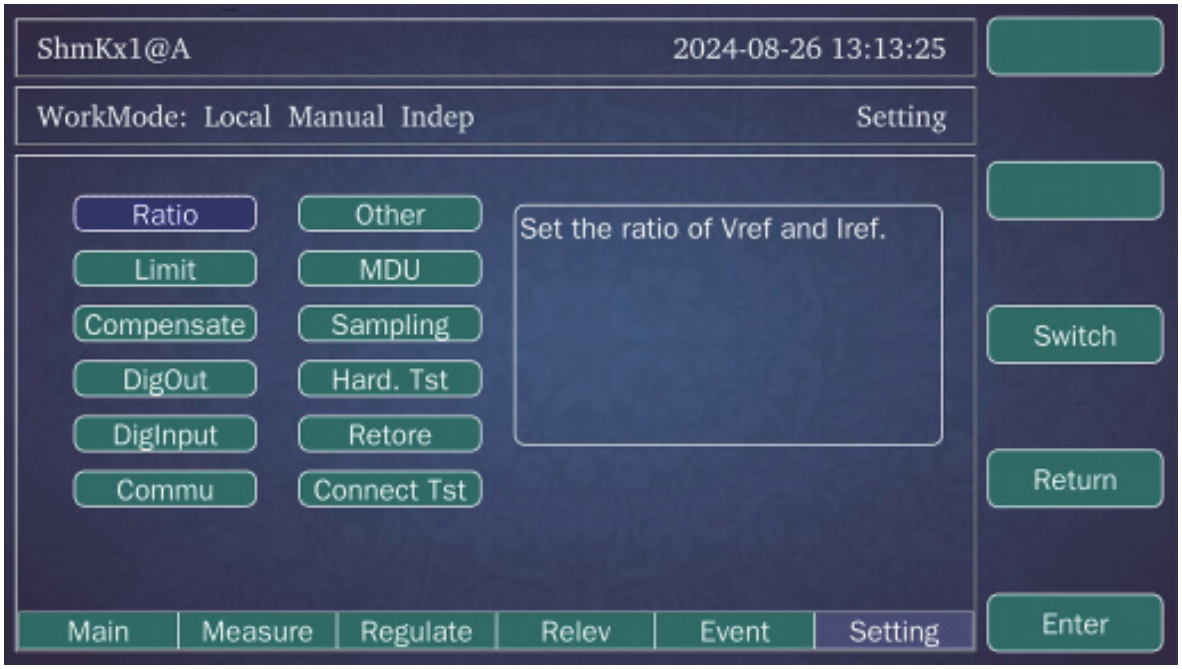
By default (factory default), these 16 digital input signals are defined as follows:
The first 9 digital inputs are not used.
The 10th digital input is RaiseCmd, which is used to receive a Raise command signal.
The 11th digital input is LowerCmd, which is used to receive a Lower command signal.
The 12th digital input is StopCmd, which is used to receive a Stop command signal.
The 13th digital input is Sw2Auto, which is used to switch the AVR's WorkMode to Auto.
The 14th digital input is Sw2Man, which is used to switch the AVR's WorkMode to Manual.
The 15th digital input is Sw2Loc, which is used to switch the AVR's operation authority to Local.
The 16th digital input is Sw2Remote, which is used to switch the AVR's operation authority to Remote.

When the MDU type is CMA7, these 16 digital inputs will be used to acquire tap position information and status signals from the motor-drive unit.

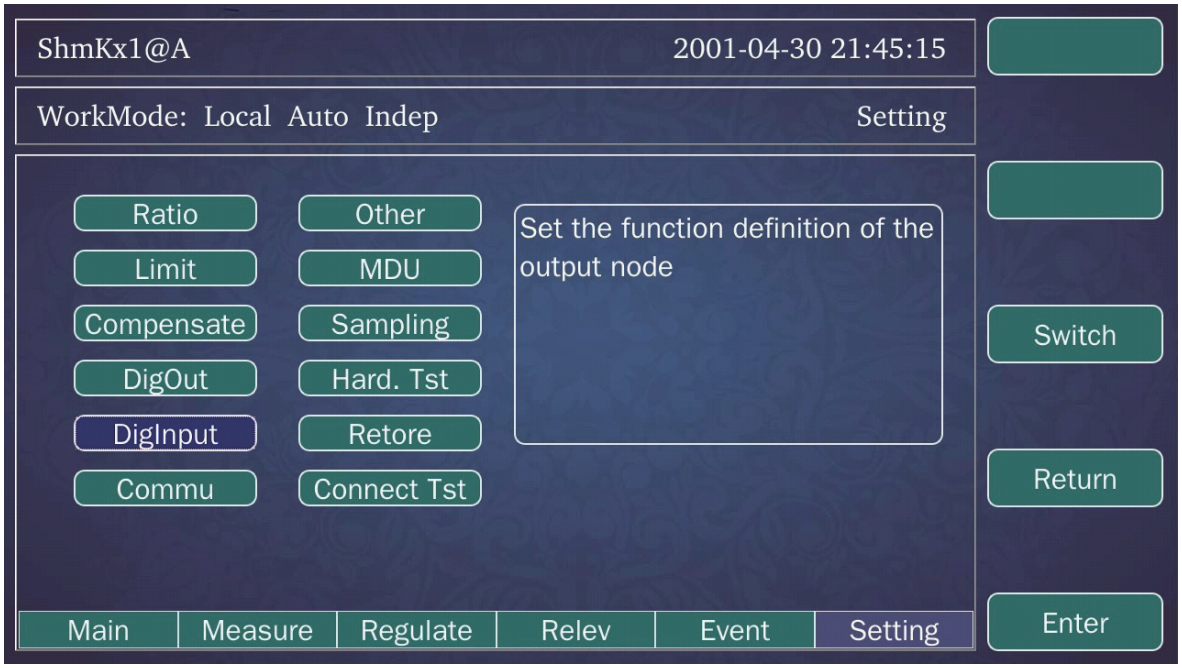
13.1 Accessing the Digital Input Settings Menu



Press the "Left" or "Right" button to navigate to the Setting screen, then press "Enter" to access the Setting menu.

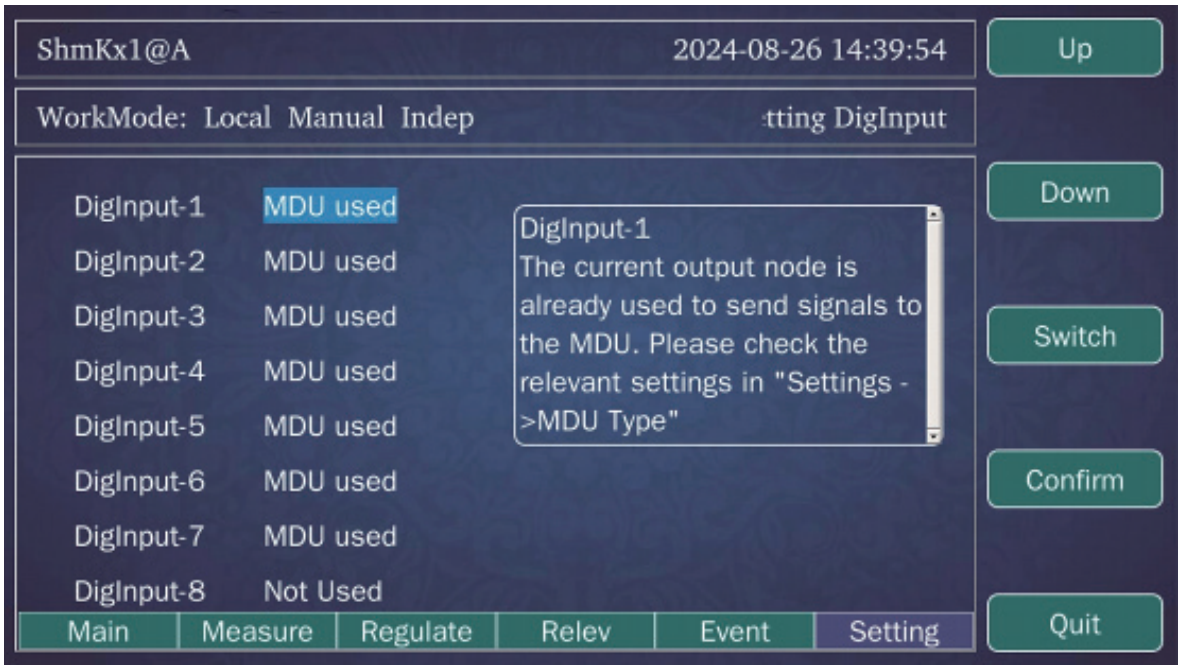


The "Setting" label will appear in the upper right corner of the screen, indicating that you are in the Setting menu. Press the "Switch" button to select the "Setting DigInput" option.



Press "Enter" to access the Digital Input settings menu.

13.2 Function Selection



When the MDU type is CMA7, some of the 16 digital inputs will be used by the MDU.

If the MDU type is SHM-D or another type that uses communication to acquire MDU data, the first 9 inputs are not used by default. The functions of the last 7 inputs are raise/lower/stop commands, Auto/Manual mode switching, and Local/Remote mode switching. Users can customize these functions as needed.

Press "Switch" to select the digital input you want to configure.

Press "Up" or "Down" to change the input definition.
The figure above shows the default functions for inputs 10 to 16. Refer to the Input Definition Table for details about each function.

13.3 Input Definition Table

The following table lists the currently supported digital input functions:

Display	Description
StopCmd	Sends a Stop command to the motor-drive unit (in Remote mode).
RaiseCmd	Sends a Raise command to the motor-drive unit (in Remote mode).
DownCmd	Sends a Lower command to the motor-drive unit (in Remote mode).
Sw2Auto	Switches the WorkMode to Auto mode.
Sw2Man	Switches the WorkMode to Manual mode.
AutoManSw	If the WorkMode is in Auto mode, it switches to Manual mode; if it is in Manual mode, it switches to Auto mode.
Sw2Loc	Switches the operating authority to Local.
Sw2Rem	Switches the operating authority to Remote.
LocRemSw	If the operating authority is Local, it switches to Remote; if it is Remote, it switches to Local.
Sw2Ind	Switches to Independent mode.
Sw2Rel	Switches to Parallel Master-Slave mode.
IndRelSw	If in Independent mode, it switches to Parallel mode; if in Parallel mode, it switches to Independent mode.
Sw2RelM	Switches to Parallel Master.
Sw2Rele	Switches to Parallel Slave.
RelM/SSw	If it is a Parallel Master, it switches to Parallel Slave; if it is a Parallel Slave, it switches to Parallel Master.

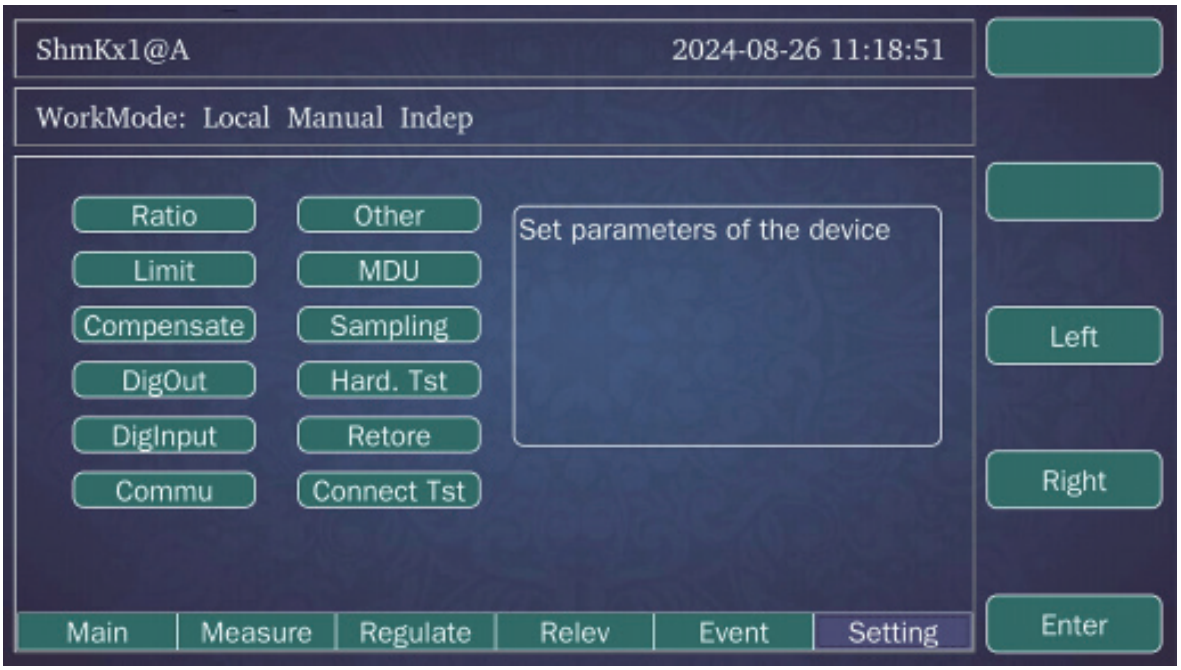
Note 1:
When the AVR is in Local mode, digital input signals for raise/lower/stop commands, Auto/Manual mode switching, and Parallel mode switching will be ignored.

Digital input signals for Local/Remote mode switching are always considered valid, regardless of whether the controller is in Local or Remote mode. This input has the same priority as the "Local/Remote" button on the panel.

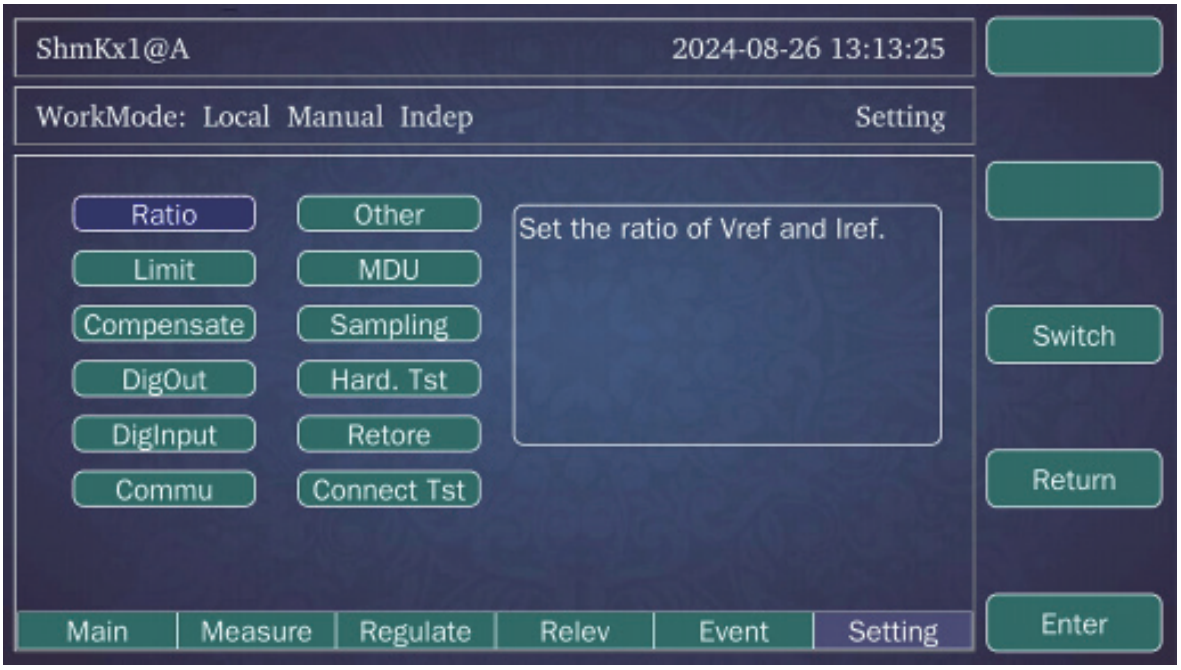
Chapter 14 Other Settings

SHM-KX offers corrections for language, display brightness, backlight time, and time in the Other Settings screen.

14.1 Accessing the Other Settings Menu

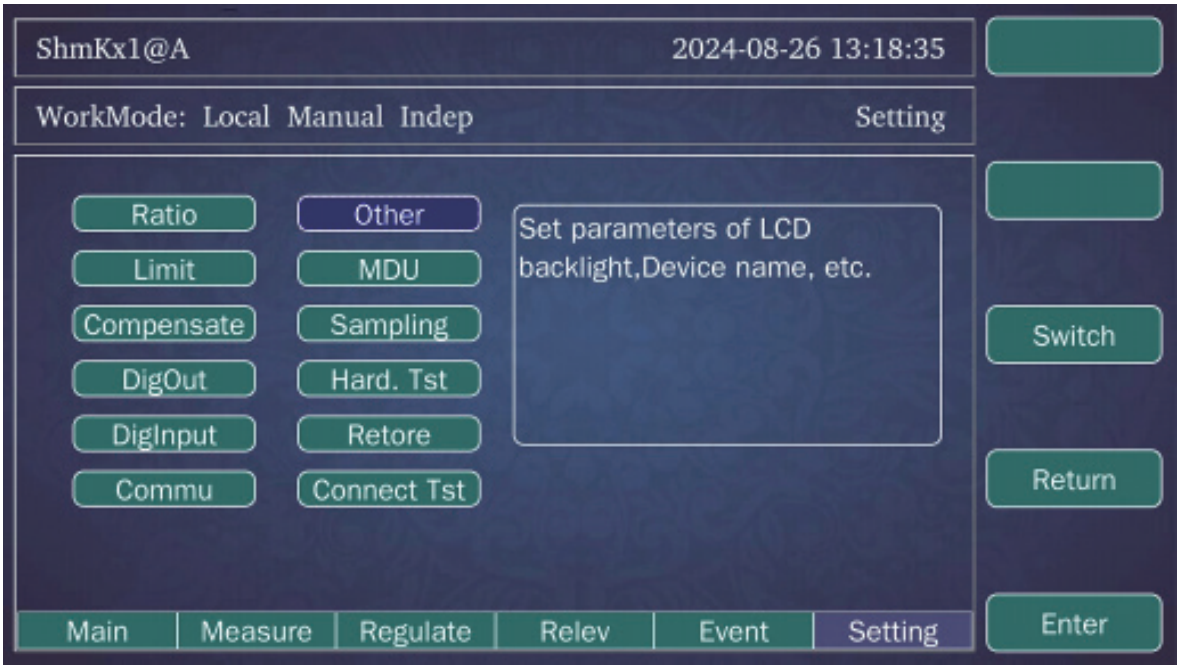


Press the "Left" or "Right" button to navigate to the Setting screen, then press "Enter" to access the Setting menu.



"Setting" label will appear in the upper right corner of the screen, indicating that you are in the Setting menu.

Press the "Switch" button to select the "Setting Other" option.



Press "Enter" to access the Other Settings menu.

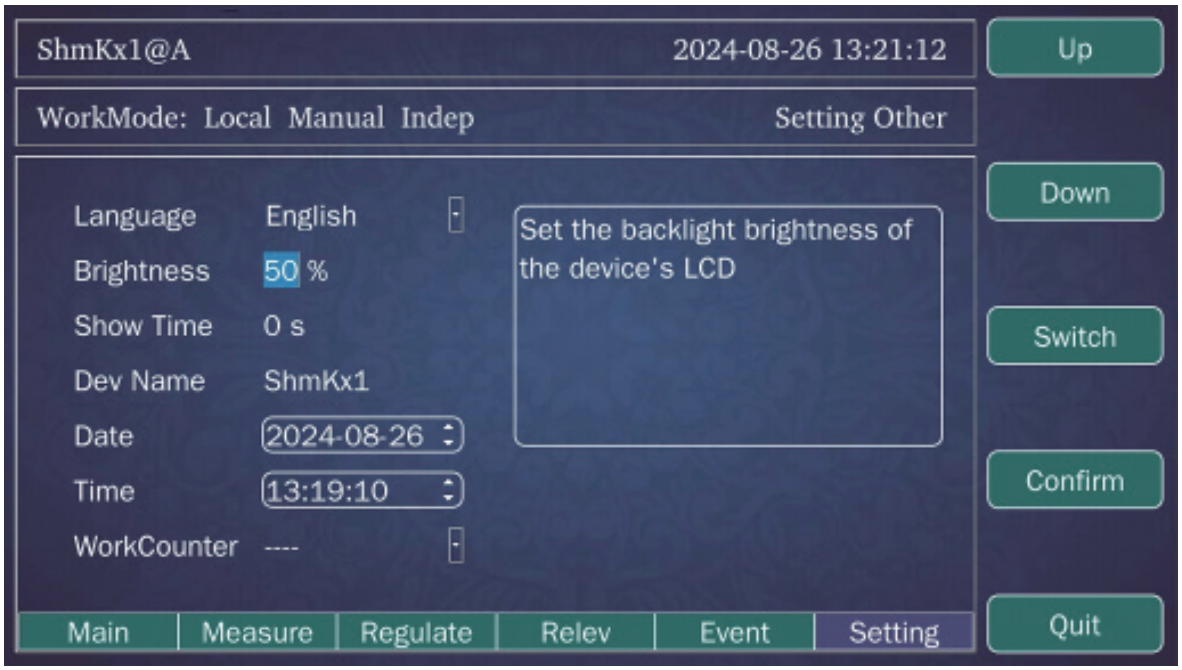
14.2 Language Setting

The SHM-KX allows you to select the language for the human-machine interface. The currently supported languages are Chinese, English, Russian, Spanish, Portuguese, Italian, and French. The default language is Chinese.

14.3 Display Brightness

Adjust this parameter to change the brightness of the LCD backlight. If the backlight time is set to 0 (meaning the backlight is always on), it is recommended to set the display brightness to the minimum value to extend the life of the LCD. The adjustable range is 1% to 100%.

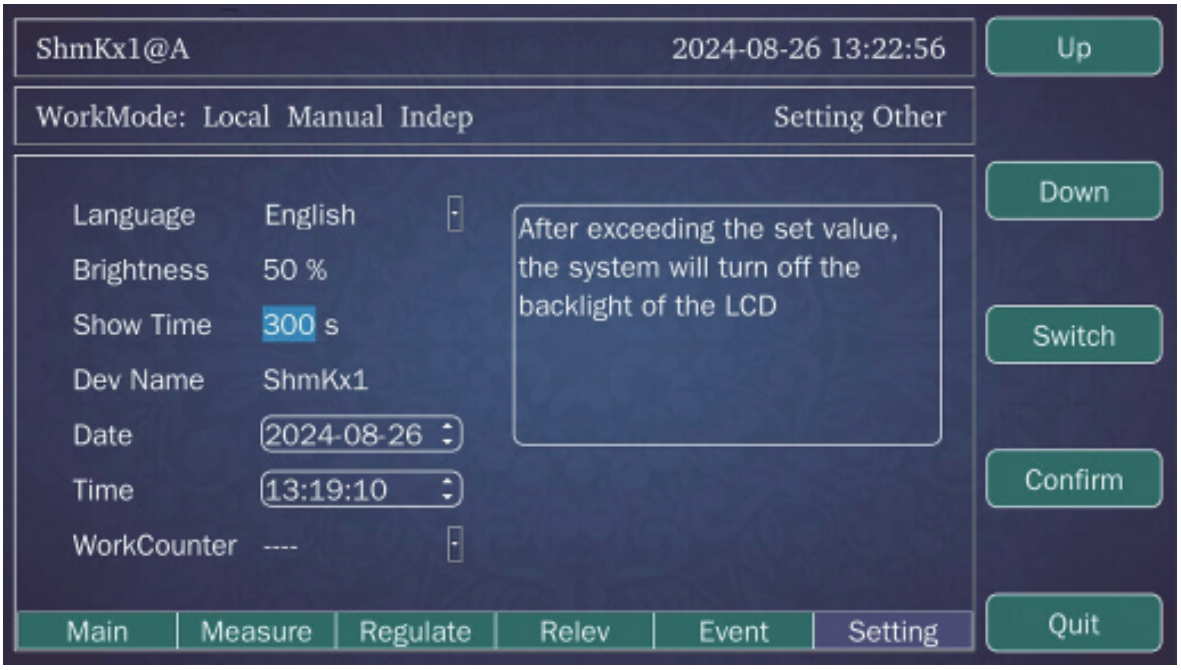
The default display brightness is 50%.



14.4 Backlight Time

You can configure the backlight time, which can be set from 10 to 600 seconds. After the specified time has elapsed, the system will turn off the LCD backlight to extend its lifespan.

If the backlight time is set to 0 seconds, the LCD backlight will remain on. In this case, it is recommended to set the display brightness to 1% to extend the life of the LCD.



When the backlight is off, pressing any button on the panel will turn it back on.

14.5 Device Name

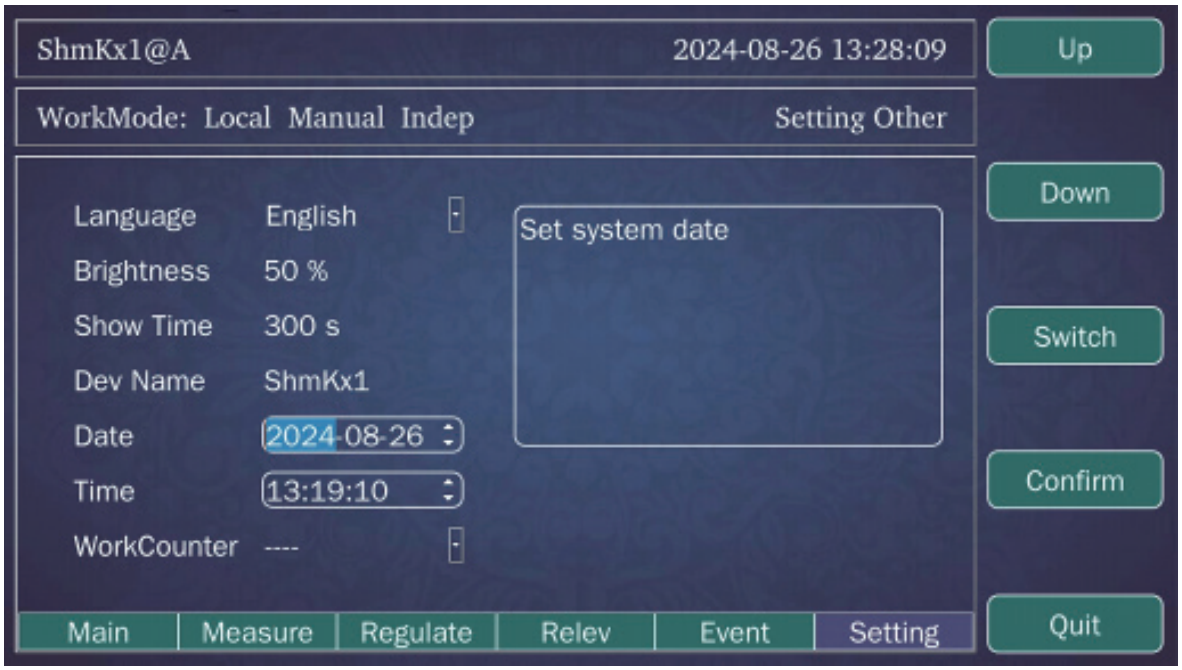
It is typically used for the device name IEDName in the IEC 61850 protocol. Modifying this name changes the IEDName in the protocol. Similarly, the device name in the upper left corner of the screen will also change.

The device name can only contain numbers and English letters and can be up to 8 characters long.

14.6 System Time

The SHM-KX allows you to set the system time through the Setting menu. The system time is used for event logging (see Section 3.3) to facilitate event analysis and troubleshooting.

Users can also synchronize the time through communication, which can ensure the accuracy of the system time better. The communication protocols supported by the system for time synchronization include IEC101, IEC103, DNP3.0, IEC104, and IEC61850. For the specific synchronization commands, please refer to the corresponding communication protocol manuals. If you need to use the SNTP protocol for time synchronization, please consult the manufacturer.



The user can use the Up and Down keys on the operation panel to increase or decrease the value, and use the Left and Right keys to switch between year, month, day, hour, minute and second.

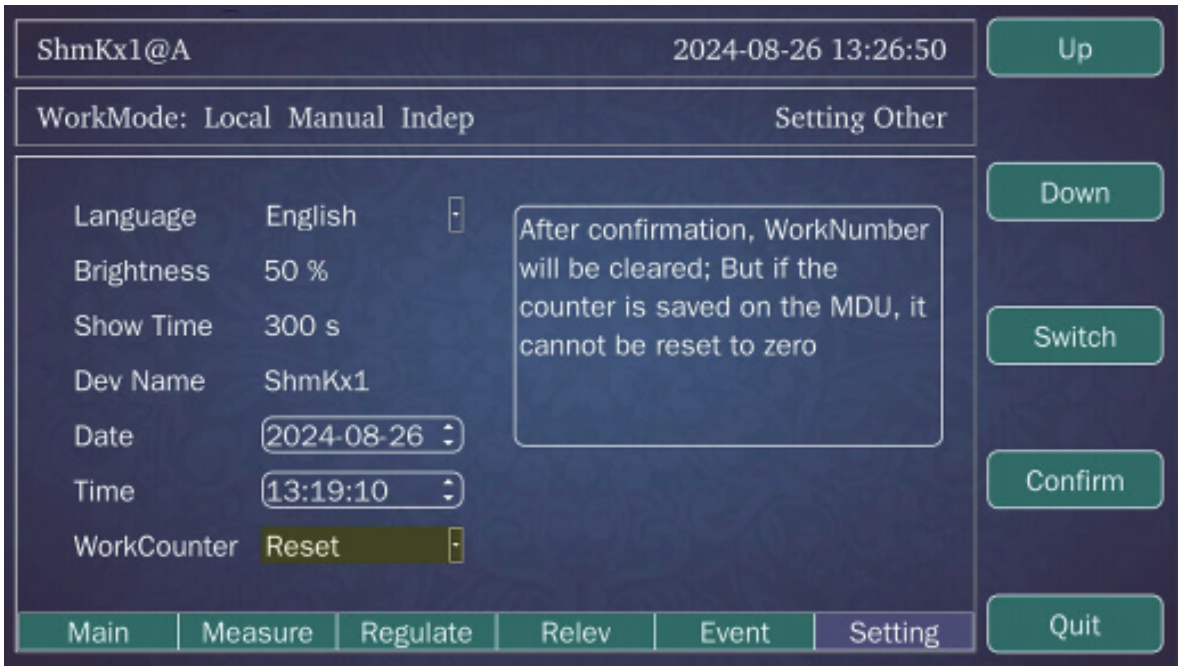
After setting, press Confirm to save the system time and exit.

Note: If the communication protocol selected by the user has a time synchronization function, this function setting will be refreshed by the time sent from the communication.

14.7 Counter Reset

When the MDU type is CMA7, all device information is acquired through hardwired connections. In this case, the operation counter value from the motor-drive unit is not available. You can set the counter value manually in the MDU Type settings to synchronize it with the motor-drive unit.

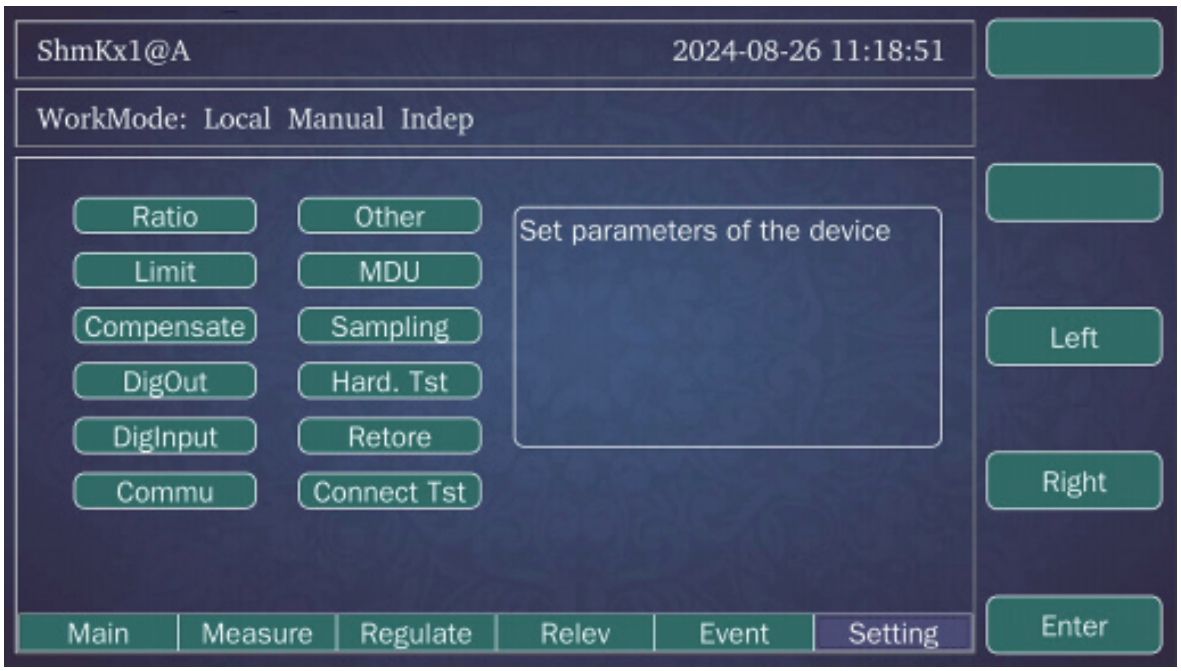
This menu also provides an option to clear the operation counter value stored in the system database.



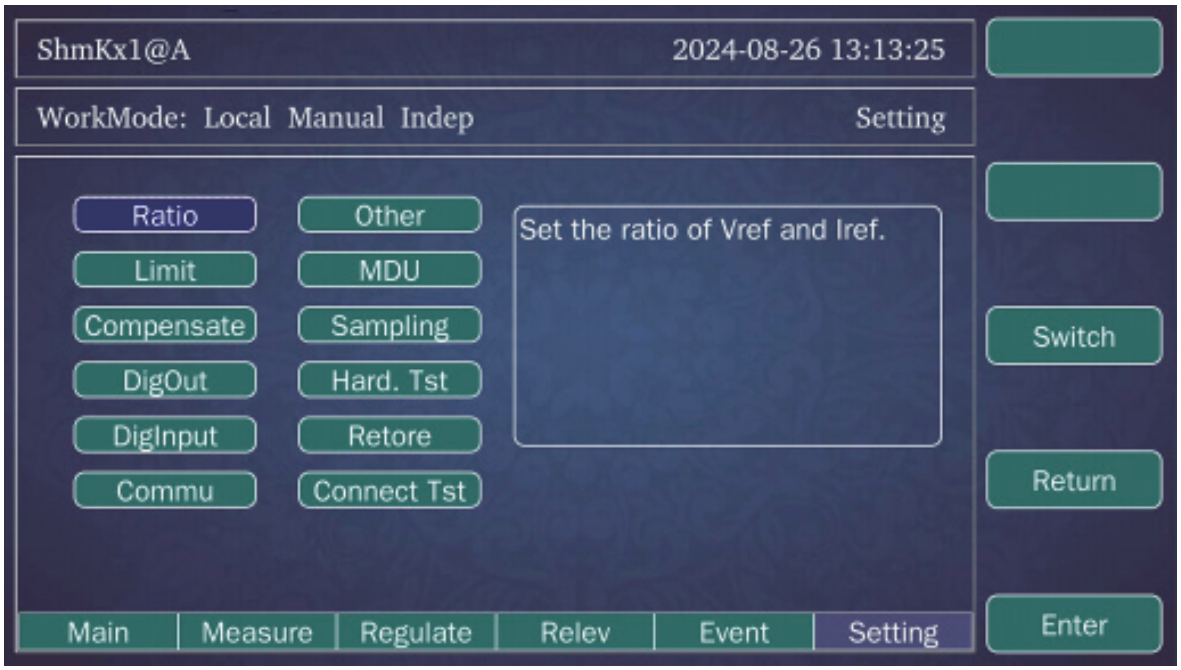
After pressing "Confirm", the system will clear the operation counter value in the database. If the MDU type is SHM-D or another type that acquires data through communication, this operation will have no effect.

Chapter 15 Restoring Factory Settings

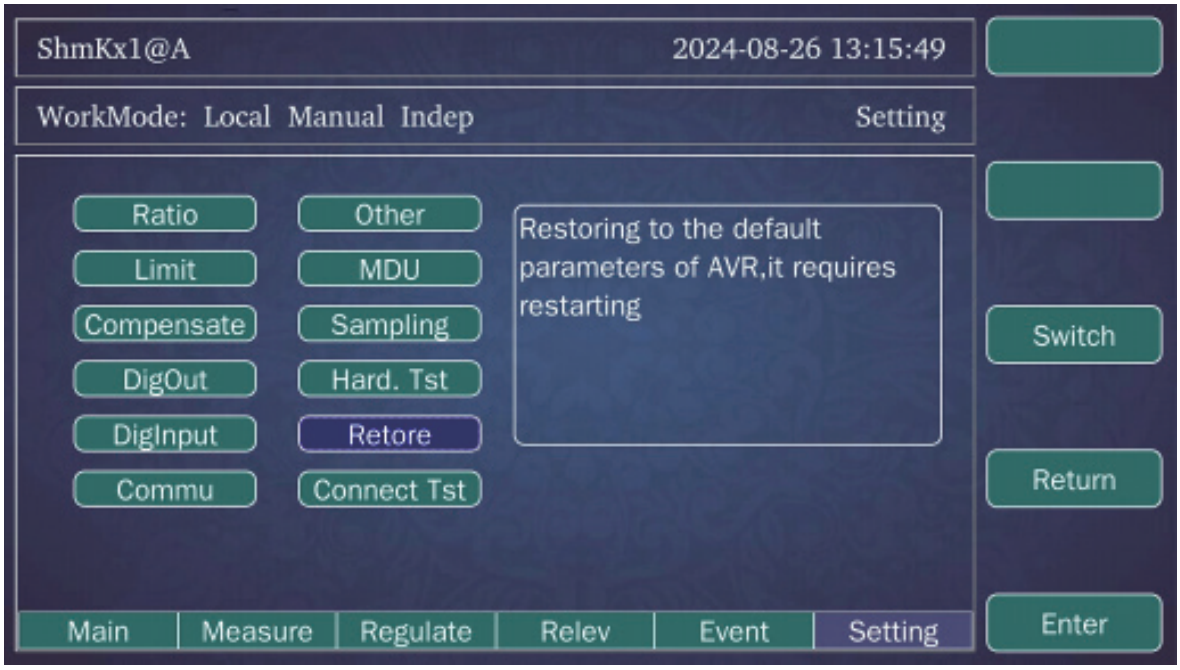
The Setting menu provides an option to restore the SHM-KX to its factory default settings.



Press the "Left" or "Right" button to navigate to the Setting screen, then press "Enter" to access the Setting menu.



The "Setting" label will appear in the upper right corner of the screen, indicating that you are in the Setting menu. Press the "Switch" button to select the "Restore" option.

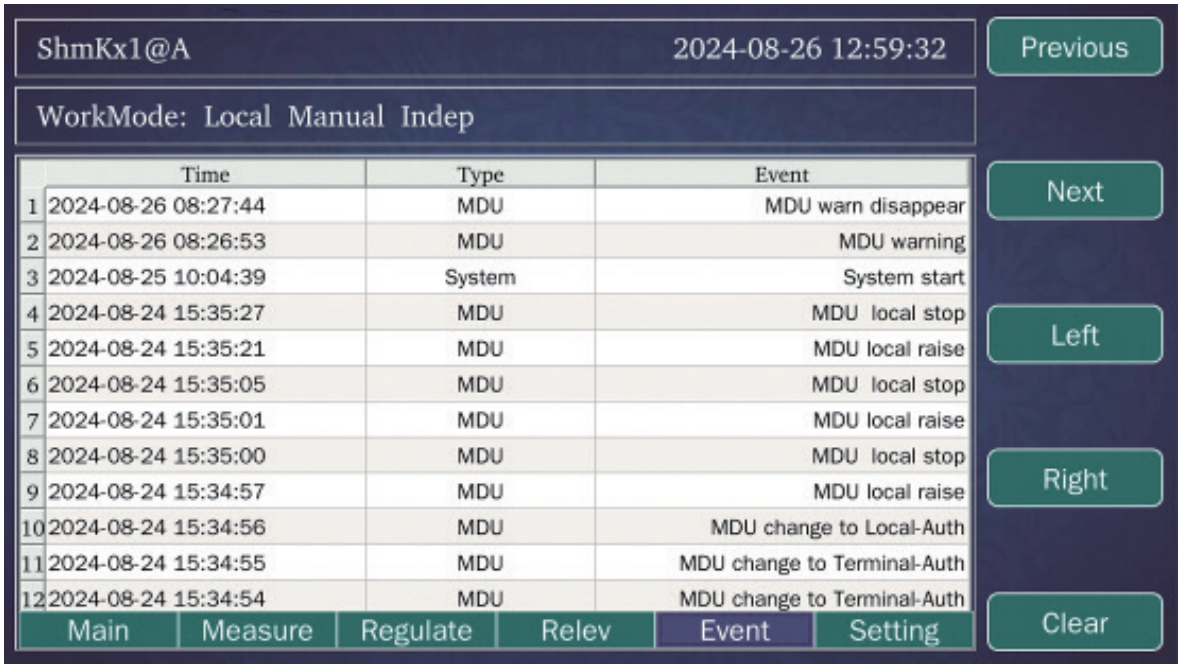


Press "Enter" to restore the factory default settings. The SHM-KX will reboot after the settings have been restored.

Chapter 16 Event Log

16.1 Accessing the Event Log

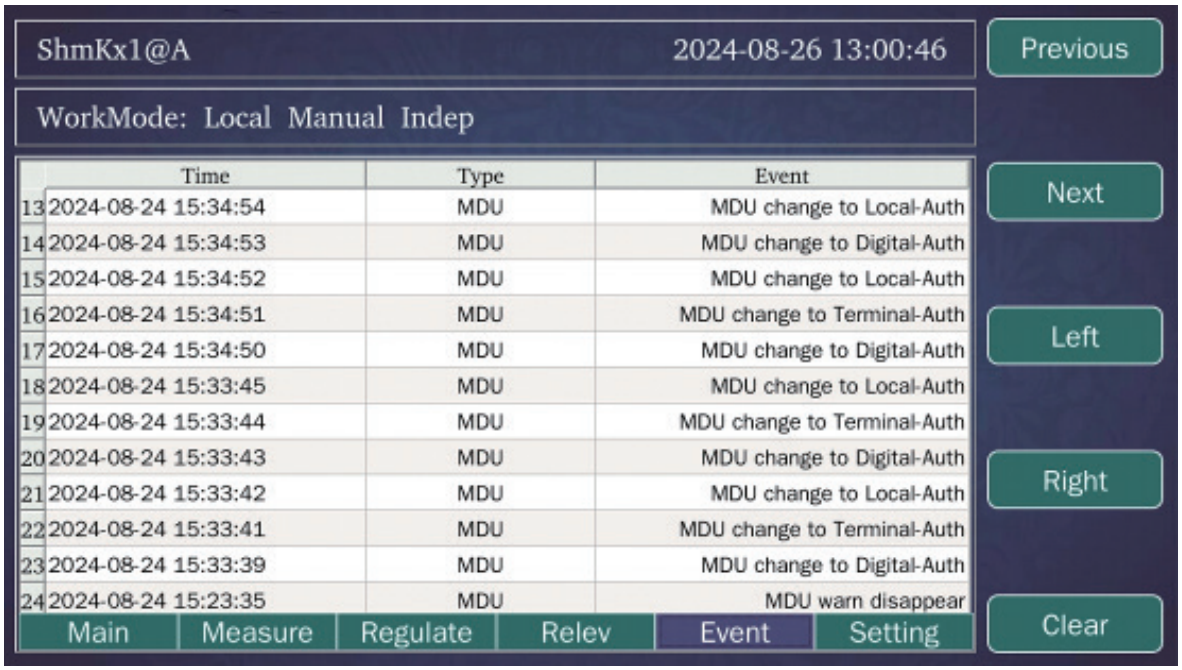
Press the "Left" or "Right" button to navigate to the Event Log screen, then press "Enter".



	Time	Type	Event
1	2024-08-26 08:27:44	MDU	MDU warn disappear
2	2024-08-26 08:26:53	MDU	MDU warning
3	2024-08-25 10:04:39	System	System start
4	2024-08-24 15:35:27	MDU	MDU local stop
5	2024-08-24 15:35:21	MDU	MDU local raise
6	2024-08-24 15:35:05	MDU	MDU local stop
7	2024-08-24 15:35:01	MDU	MDU local raise
8	2024-08-24 15:35:00	MDU	MDU local stop
9	2024-08-24 15:34:57	MDU	MDU local raise
10	2024-08-24 15:34:56	MDU	MDU change to Local-Auth
11	2024-08-24 15:34:55	MDU	MDU change to Terminal-Auth
12	2024-08-24 15:34:54	MDU	MDU change to Terminal-Auth

This screen displays a log of user operations and changes in device status. The event log can be used to understand the system operation history and for troubleshooting. It records historical local/remote operations and fault information. The event log can store up to 1800 entries, with newer entries overwriting older entries.

Press the "Previous" or "Next" button to browse the event log.



	Time	Type	Event
13	2024-08-24 15:34:54	MDU	MDU change to Local-Auth
14	2024-08-24 15:34:53	MDU	MDU change to Digital-Auth
15	2024-08-24 15:34:52	MDU	MDU change to Local-Auth
16	2024-08-24 15:34:51	MDU	MDU change to Terminal-Auth
17	2024-08-24 15:34:50	MDU	MDU change to Digital-Auth
18	2024-08-24 15:33:45	MDU	MDU change to Local-Auth
19	2024-08-24 15:33:44	MDU	MDU change to Terminal-Auth
20	2024-08-24 15:33:43	MDU	MDU change to Digital-Auth
21	2024-08-24 15:33:42	MDU	MDU change to Local-Auth
22	2024-08-24 15:33:41	MDU	MDU change to Terminal-Auth
23	2024-08-24 15:33:39	MDU	MDU change to Digital-Auth
24	2024-08-24 15:23:35	MDU	MDU warn disappear

16.2 Event Types

The following table lists the supported event types:

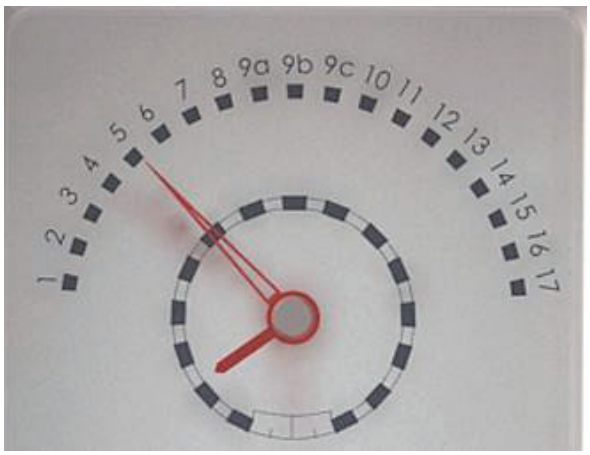
Name	Description
System start	SHM-KX startup event.
MDU local raise operation	MDU local button operation.
MDU local lower operation	MDU local button operation.
MDU local stop operation	MDU local button operation.
MDU digital raise operation	MDU receives a Raise command from the AVR.
MDU digital lower operation	MDU receives a Lower command from the AVR.
MDU digital stop operation	MDU receives a Stop command from the AVR.
MDU terminal raise operation	MDU Raise command triggered by the external terminal.
MDU terminal raise operation	MDU Lower command triggered by the external terminal.
MDU terminal stop operation	MDU Stop command triggered by the external terminal.
Tap position change	MDU TapPos. changed to
Communication offline	Communication between the AVR and the MDU failed, or the acquired TapPos. information becomes invalid.
Communication online	Communication between the AVR and the MDU is successful, or the acquired TapPos. information becomes valid.
Handcrank not inserted.	MDU Handcrank is not inserted; tap changer is operational.
Handcrank inserted.	MDU Handcrank is inserted; tap changer is in maintenance mode and cannot be operated.
LockSign. disappears.	MDU LockSign. is active; tap changer is locked and cannot be operated.
LockSign. appears.	MDU LockSign. is inactive; tap changer is unlocked and operational.
Limit-Lock present.	MDU Limit-Lock is active; tap changer cannot be operated.
Limit-Lock disappears.	MDU Limit-Lock disappears.
MotorDrv warn.	MDU MotorDrv warn (SHM-D only).
MotorDrv warn disappears.	MDU MotorDrv warn disappears (SHM-D only).
MDU changed to LocalControl mode.	MDU changed to LocalControl mode.
MDU changed to DigControl mode.	MDU changed to DigControl mode (SHM-D and SHM-X only).
MDU changed to TermControl mode.	MDU changed to TermControl mode.
MDU changed to StopControl mode.	MDU changed to StopControl mode (ZDK only).
MDU warning appeared.	MDU incident total alarm.

Name	Description
MDU warn disappeared.	MDU incident total alarm reset.
AVR gets a raise cmd (panel).	AVR gets a raise cmd (panel) in Manual mode.
AVR gets a stop cmd (panel).	AVR gets a stop cmd (panel) in Manual mode.
AVR gets a down cmd (panel).	AVR gets a down cmd (panel) in Manual mode.
AVR gets a raise cmd (Terminal).	AVR gets a raise cmd (Terminal) in Manual mode.
AVR gets a stop cmd (Terminal).	AVR gets a stop cmd (Terminal) in Manual mode.
AVR gets a down cmd (Terminal).	AVR gets a down cmd (Terminal) in Manual mode.
AVR gets a raise cmd (communication).	AVR gets a raise cmd (communication) in Manual mode.
AVR gets a stop cmd (communication).	AVR gets a stop cmd (communication) in Manual mode.
AVR gets a down cmd (communication).	AVR gets a down cmd (communication) in Manual mode.
AVR gets a raise cmd (AutoReg).	AVR gets a raise cmd (AutoReg) in Auto mode.
AVR gets a stop cmd (AutoReg).	AVR gets a stop cmd (AutoReg) in Auto mode.
AVR gets a down cmd (AutoReg).	AVR gets a down cmd (AutoReg) in Auto mode.
AVR gets a raise cmd (Relevance).	AVR gets a raise cmd (ReleSlave) in ReleSlave mode.
AVR gets a stop cmd (Relevance).	AVR gets a stop cmd (ReleSlave) in ReleSlave mode.
AVR gets a down cmd (Relevance).	AVR gets a down cmd (ReleSlave) in ReleSlave mode.
System refresh failure.	System background program failure; no longer refreshing.

Appendix. Explanation of Tap Position Information

The SHM-KX receives tap position information from the SHM-D(S) and can display the tap position information on the SHM-D(S) dial. The tap positions on the dial sometimes are not only numeric values, but also contain English symbols, plus or minus signs, consecutive taps, and reversed tap positions.

The following is a typical tap changer dial.



As can be seen from the figure, this dial is a dial for the 10193A (internal number of the tap type) switch. 9a, 9b, and 9c are all tap 9. 9a and 9c taps do not stop when switching (polarity switching), but this tap still needs to be displayed. So one number cannot accurately represent the actual tap position information.

Three parameters are used in the SHM-D(S) and SHM-KX to represent TapPos. information, namely, Current Step, Current Tap Position, and Consecutive Tap Information.

1. Current Step

Each tap position on the tap changer dial is assigned an absolute value, starting from 0. The leftmost position is 0, and the values increase sequentially. This value is independent of the actual tap position and consecutive tap information. Every position on the dial has a corresponding step value.

The following figure shows the step information for typical switching gears for easy understanding by the user.

	17																										
Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17										
Current step	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16										
	10193A																										
Position	1	2	3	4	5	6	7	8	9A	9B	9C	10	11	12	13	14	15	16	17								
Current step	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18								
	14271																										
Position	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Current step	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
	10171A																										
Position	8L	7L	6L	5L	4L	3L	2L	1L	N	1R	2R	3R	4R	5R	6R	7R	8R										
Current step	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16										
	10133																										
Position	1	2	3a	3b	4a	4b	5a	5b	6a	6b	6c	7	8a	8b	9a	9b	10a	10b	11								
Current step	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18								

- Switch tap changer type 17
  No consecutive taps, tap positions are numbered from 1 to 17. The step values range from 0 to 16.
- Switch tap changer type 10193A
  Two consecutive taps (9A and 9C). The step values range from 0 to 18.
- Switch tap changer type 14271
  The tap positions are arranged in reverse order, with 27 being the first tap position. The step values still range from 0 to 26.
- Switch tap changer type 10171A
  "L" represents the left side, "R" represents the right side, and "N" represents the neutral position. The step value for 8L is defined as 0.
- Switch tap changer type 10133
  This tap changer has multiple consecutive taps. However, the current step information is independent of the consecutive taps and is still organized from 0.

2. Current Tap Position

This parameter represents the numeric part of the tap position and ignores any letters, plus/minus signs, "L", or "N". If the tap position only contains letters, the Current Tap Position will be 0.

	17																										
Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17										
Current step	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16										
Current Postion	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17										
	10193A																										
Position	1	2	3	4	5	6	7	8	9A	9B	9C	10	11	12	13	14	15	16	17								
Current step	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18								
Current Postion	1	2	3	4	5	6	7	8	9	9	9	10	11	12	13	14	15	16	17								
	14271																										
Position	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Current step	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Current Postion	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
	10171A																										
Position	8L	7L	6L	5L	4L	3L	2L	1L	N	1R	2R	3R	4R	5R	6R	7R	8R										
Current step	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16										
Current Postion	8	7	6	5	4	3	2	1	9	1	2	3	4	5	6	7	8										
	10133																										
Position	1	2	3a	3b	4a	4b	5a	5b	6a	6b	6c	7	8a	8b	9a	9b	10a	10b	11								
Current step	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18								
Current Postion	1	2	3	3	4	4	5	5	6	6	6	7	8	8	9	9	10	10	11								

- Switch type 17
  Tap positions are numbered from 1 to 17, matching the tap position information.
- Switch type 10193A
  The Current Tap Position for steps 9A, 9B, and 9C is 9.
- Switch type 14271
  Tap positions are numbered from 27 to 1, matching the tap position information.
- Switch type 10171A
  This parameter only represents the numeric part of the tap position. The Current Tap Position for step N is 0.
- Switch type 10133
  This parameter only represents the numeric part of the tap position.

3. Consecutive Tap Information

This parameter represents the letters, plus/minus signs, or special characters associated with the tap position, according to the following convention:

- 170 : Invalid.
- 1-26: Corresponding characters A-Z.
- 27: NL
- 28: NR
- 43: +
- 45: -

Due to the wide variety of tap changer types, it is not possible to list all the special tap position representations. The following figures show the Consecutive Tap Information for typical tap changers:

	17																									
Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17									
Current step	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16									
Current Postion	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17									
Link Postion	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170									
	10193A																									
Position	1	2	3	4	5	6	7	8	9A	9B	9C	10	11	12	13	14	15	16	17							
Current step	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18							
Current Postion	1	2	3	4	5	6	7	8	9	9	9	10	11	12	13	14	15	16	17							
Link Postion	170	170	170	170	170	170	170	170	1	2	3	170	170	170	170	170	170	170	170							
	14271																									
Position	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Current step	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Current Postion	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Link Postion	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170
	10171A																									
Position	8L	7L	6L	5L	4L	3L	2L	1L	N	1R	2R	3R	4R	5R	6R	7R	8R									
Current step	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16									
Current Postion	8	7	6	5	4	3	2	1	9	1	2	3	4	5	6	7	8									
Link Postion	12	12	12	12	12	12	12	12	14	18	18	18	18	18	18	18	18									
	10133																									
Position	1	2	3a	3b	4a	4b	5a	5b	6a	6b	6c	7	8a	8b	9a	9b	10a	10b	11							
Current step	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18							
Current Postion	1	2	3	3	4	4	5	5	6	6	6	7	8	8	9	9	10	10	11							
Link Postion	170	170	1	2	1	2	1	2	1	2	3	170	1	2	1	2	1	2	170							

4. Communication Output

The SHM-KX uses three numerical values to express the tap position information. When the user wants to obtain it through protocol communication, it is usually obtained by telemetry.

Modbus	Rearrange the registers, with three registers representing Current Step, Current Tap Position, and Consecutive Tap Information respectively. See Modbus protocol description.
IEC101	Three telemetry values represent the Current Step, Current Tap Position, and Consecutive Tap Information, respectively. See the corresponding protocol description.
IEC103	Same as IEC 101.
DNP3.0	Same as IEC 101.
IEC104	Same as IEC 101.

IEC61850	One numerical value represents the Current Tap Position. One BOOLEAN value represents the sign of the Consecutive Tap Information (defaults to True if not present). One string type represents the character portion of the Consecutive Tap Information. See below. <DAType id="ValWithTrans"> <BDA name="posVal" bType="INT8" /> <BDA name="transInd" bType="BOOLEAN" /> <BDA name="transSts" bType="VisString32" /> </DAType> Refer to the IEC61850 ICD file and IEC61850 protocol description for details.

Appendix. System Digital Input Signal List

This table is used for communication or for defining the function of relay outputs.

No.	Name	Description
0	Dii_LinkStatus_Sts	MDU link status
1	Dii_HandcrankSts_Sts	Handcrank status
2	Dii_StepSingalSts_Sts	Step signal status
3	Dii_LockSts_Sts	Lock signal status
4	Dii_Local_Sts	MDU Local Control execution status indication
5	Dii_Ext_Sts	MDU Terminal Control execution status indication
6	Dii_Remote_Sts	MDU remote execution status indication
7	Dii_Stop_Sts	MDU Stop Control execution status indication
8	Dii_Working_Sts	MDU motor running status
9	Dii_MaxGear_Sts	MDU at maximum tap position
10	Dii_MinGear_Sts	MDU at minimum tap position
11	Dii_Raise_Sts	MDU raising tap position
12	Dii_Down_Sts	MDU lowering tap position
13	Dii_StopSignal_Sts	MDU stopped
14	Dii_NoQ1_Sts	Q1 open indication
15	Dii_Cycle_Sts	Cam signal status
16	Dii_Filter_Sts	Oil filter relay output indication
17	Dii_Free_Sts	Motor release status
18	Dii_Nip_Sts	Incomplete status
19	Dii_DriverError_Sts	Motor driver fault
20	Dii_Lock2_Sts	Motor lock fault
21	Dii_Heating_Sts	Heater relay indication
22	Dii_CheckErrorOutput_Sts	Stop self-test output fault
23	Dii_Q1OpenError_Sts	Q1 open operation failed alarm
24	Dii_PwrError_Sts	Power supply fault alarm
25	Dii_PhaseError_Sts	Phase sequence error or missing phase alarm
26	Dii_RamError_Sts	RAM error fault
27	Dii_Sht21Error_Sts	Temperature and humidity sensor fault

No.	Name	Description
28	Dii_Fm24C64Error_Sts	Memory chip fault
29	Dii_DirError_Sts	Motor running direction alarm
30	Dii_ConfigError_Sts	Configuration error alarm
31	Dii_HallError_Sts	Hall sensor alarm
32	Dii_AngleError_Sts	Tap position sensor alarm
33	Dii_SelfTestError_Sts	Self-test error alarm
34	Dii_SwitchError_Sts	Switching fault alarm
35	Dii_Reseved	Reserved
36	Dii_Reseved	Reserved
37	Dii_Cycle_NotWorking	Combined signal - cam signal incomplete
38	Dii_StepSignal_NotWorking	Combined signal - step signal incomplete
39	Dii_GetInfoWarn_Sts	General MDU fault; different devices are ultimately unified to this status
40	Dii_OverVoltage_Sts	AVR overvoltage alarm
41	Dii_UnderVoltage_Sts	AVR undervoltage alarm
42	Dii_ZeroVoltage_Sts	AVR zero voltage alarm
43	Dii_OverCurrent_Sts	AVR overcurrent alarm
44	Dii_Cs5460Error_Sts	AVR sampling fault
45	Dii_Reseved	Reserved
46	Dii_Reseved	Reserved
47	Dii_Reseved	Reserved
48	Dii_Reseved	Reserved
49	Dii_Reseved	Reserved
50	Dii_Rele_CommError_Sts	Parallel communication alarm in Parallel Master mode
51	Dii_Rele_StsError_Sts	Out-of-step alarm in Parallel Master mode
52	Dii_Rele_WarnError_Sts	Parallel communication or out-of-step alarm in Parallel Master mode
53	Dii_Rele_Working_Sts	General working status alarm in Parallel Master mode
54	Dii_Reseved	Reserved
55	Dii_OLTC_Warn_Sts	General fault, including AVR fault status
56	Dii_Reseved	Reserved
57	Dii_Reseved	Reserved
58	Dii_Reseved	Reserved
59	Dii_Reseved	Reserved

No.	Name	Description
60	Dii_DigInput1_Sts	Current status of the 1st digital input; OFF or ON
61	Dii_DigInput2_Sts	Current status of the 2nd digital input; OFF or ON
62	Dii_DigInput3_Sts	Current status of the 3rd digital input; OFF or ON
63	Dii_DigInput4_Sts	Current status of the 4th digital input; OFF or ON
64	Dii_DigInput5_Sts	Current status of the 5th digital input; OFF or ON
65	Dii_DigInput6_Sts	Current status of the 6th digital input; OFF or ON
66	Dii_DigInput7_Sts	Current status of the 7th digital input; OFF or ON
67	Dii_DigInput8_Sts	Current status of the 8th digital input; OFF or ON
68	Dii_DigInput9_Sts	Current status of the 9th digital input; OFF or ON
69	Dii_DigInput10_Sts	Current status of the 10th digital input; OFF or ON
70	Dii_DigInput11_Sts	Current status of the 11th digital input; OFF or ON
71	Dii_DigInput12_Sts	Current status of the 12th digital input; OFF or ON
72	Dii_DigInput13_Sts	Current status of the 13th digital input; OFF or ON
73	Dii_DigInput14_Sts	Current status of the 14th digital input; OFF or ON
74	Dii_DigInput15_Sts	Current status of the 15th digital input; OFF or ON
75	Dii_DigInput16_Sts	Current status of the 16th digital input; OFF or ON
76	Dii_Reseved	Reserved
77	Dii_Reseved	Reserved
78	Dii_Reseved	Reserved
79	Dii_Reseved	Reserved
80	Dii_DigOutput1_Sts	Current status of the 1st relay; CLOSED or OPEN
81	Dii_DigOutput2_Sts	Current status of the 2nd relay; CLOSED or OPEN
82	Dii_DigOutput3_Sts	Current status of the 3rd relay; CLOSED or OPEN
83	Dii_DigOutput4_Sts	Current status of the 4th relay; CLOSED or OPEN
84	Dii_DigOutput5_Sts	Current status of the 5th relay; CLOSED or OPEN
85	Dii_DigOutput6_Sts	Current status of the 6th relay; CLOSED or OPEN
86	Dii_DigOutput7_Sts	Current status of the 7th relay; CLOSED or OPEN
87	Dii_DigOutput8_Sts	Current status of the 8th relay; CLOSED or OPEN
88	Dii_DigOutput9_Sts	Current status of the 9th relay; CLOSED or OPEN
89	Dii_DigOutput10_Sts	Current status of the 10th relay; CLOSED or OPEN
90	Dii_DigOutput11_Sts	Current status of the 11th relay; CLOSED or OPEN
91	Dii_DigOutput12_Sts	Current status of the 12th relay; CLOSED or OPEN
92	Dii_DigOutput13_Sts	Current status of the 13th relay; CLOSED or OPEN

No.	Name	Description
93	Dii_DigOutput14_Sts	Current status of the 14th relay; CLOSED or OPEN
94	Dii_DigOutput15_Sts	Current status of the 15th relay; CLOSED or OPEN
95	Dii_DigOutput16_Sts	Current status of the 16th relay; CLOSED or OPEN
96	Dii_LcdShow_Sts	Current LCD backlight status; ON or OFF
97	Dii_Reseved	Reserved
98	Dii_Reseved	Reserved
99	Dii_Reseved	Reserved

Note: The first 40 DI signals are acquired from the motor-drive unit. Due to different acquisition methods, some of them may be invalid. The corresponding protocols will have corresponding flag bits to indicate the validity of these signals. For example, in the IEC 101 protocol, the DII_IQ flag is used for this purpose.

Appendix. System Analog Signal List

This table is used for communication.

No.	Name	Description
0	Aii_DevMinGear	Tap position of the minimum tap
1	Aii_DevMinUnion	Consecutive tap information for the minimum tap
2	Aii_DevMaxGear	Tap position of the maximum tap
3	Aii_DevMaxUnion	Consecutive tap information for the maximum tap
4	Aii_CurGearSt	Tap position of the current tap
5	Aii_CurUnionSts	Consecutive tap information for the current tap
6	Aii_DevStepLen	Maximum step number of the switch
7	Aii_CurStepSts	Current step of the switch
8	Aii_DipSwitchSts	MDU Dip Switch status
9	Aii_Temp	Current temperature of the MDU, retaining one decimal place
10	Aii_Humidity	Current humidity of the MDU, retaining one decimal place
11	Aii_WorkNumber	Operation counter of the MDU
12	Aii_WorkNumber	Operation counter of the MDU
13	Aii_RunSts	Internal status indication of the MDU
14	Aii_RunSts	Internal status indication of the MDU
15	Aii_CalcAng	MDU tap position calculation information
16	Aii_CalcAng	MDU tap position calculation information
17	Aii_DeviceStsLow	AVR internal status information
18	Aii_DeviceStsHigh	AVR internal status information
19	Aii_AutoModeDelayPrecent	AVR automatic tap change time counter (0-100)
20	Aii_Cur_Secondary	Secondary current sampled by the AVR
21	Aii_Cur_Primary	Primary current sampled by the AVR
22	Aii_Cur_PrimaryUnit	Unit of the primary current sampled by the AVR
23	Aii_Vol_Secondary	Secondary voltage sampled by the AVR
24	Aii_Vol_Primary	Primary voltage sampled by the AVR
25	Aii_Vol_PrimaryUnit	Unit of the primary voltage sampled by the AVR
26	Aii_P_Secondary	Secondary active power sampled by the AVR
27	Aii_P_Primary	Primary active power sampled by the AVR

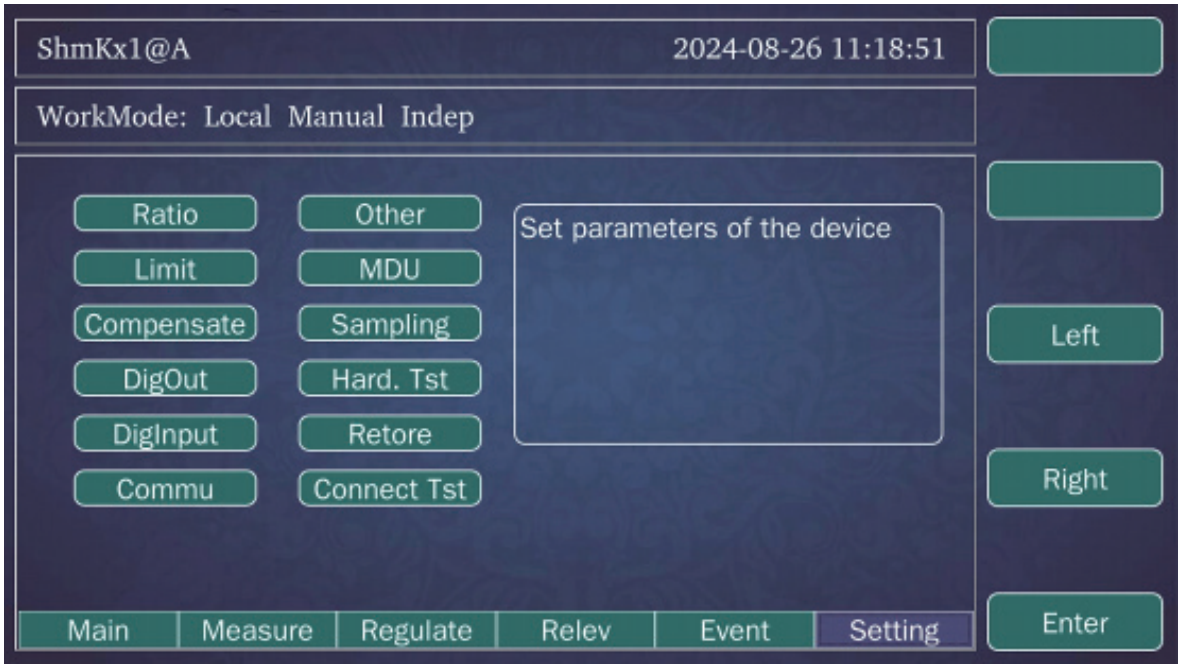
No.	Name	Description
28	Aii_P_PrimaryUnit	Unit of the primary active power sampled by the AVR
29	Aii_Q_Secondary	Secondary reactive power sampled by the AVR
30	Aii_Q_Primary	Primary reactive power sampled by the AVR
31	Aii_Q_PrimaryUnit	Unit of the primary reactive power sampled by the AVR
32	Aii_Pf_Secondary	Secondary j fundamental active power sampled by the AVR
33	Aii_Pf_Primary	Primary j fundamental active power sampled by the AVR
34	Aii_Pf_PrimaryUnit	Unit of the primary j fundamental active power sampled by the AVR
35	Aii_Qf_Secondary	Secondary j fundamental reactive power sampled by the AVR
36	Aii_Qf_Primary	Primary j fundamental reactive power sampled by the AVR
37	Aii_Qf_PrimaryUnit	Unit of the primary j fundamental reactive power sampled by the AVR
38	Aii_Cos	j power factor sampled by the AVR

Note: The first 19 AI signals are obtained from the motor-drive unit. Due to different acquisition methods, some of them may belong to invalid information. Corresponding flags are set in the corresponding protocols to indicate the validity of these signals. For example, in the IEC101 protocol, the AII_IQ flag is set for this purpose.

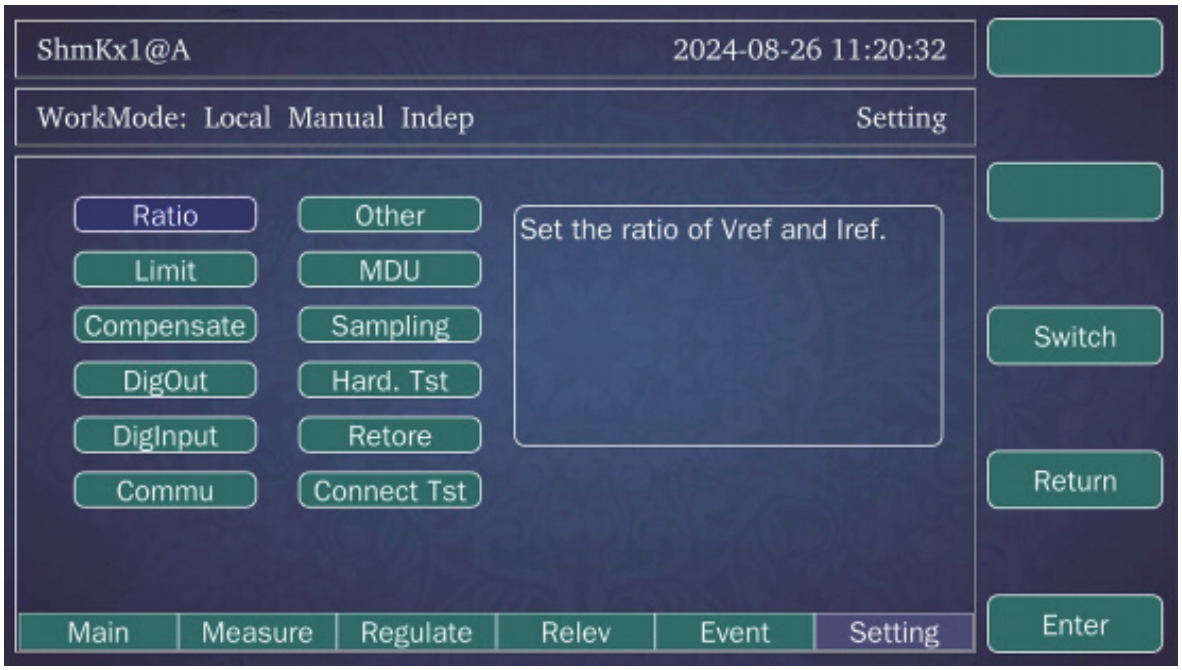
Appendix. Connect Test

The SHM-KX supports the Connect Test function for commissioning and testing.

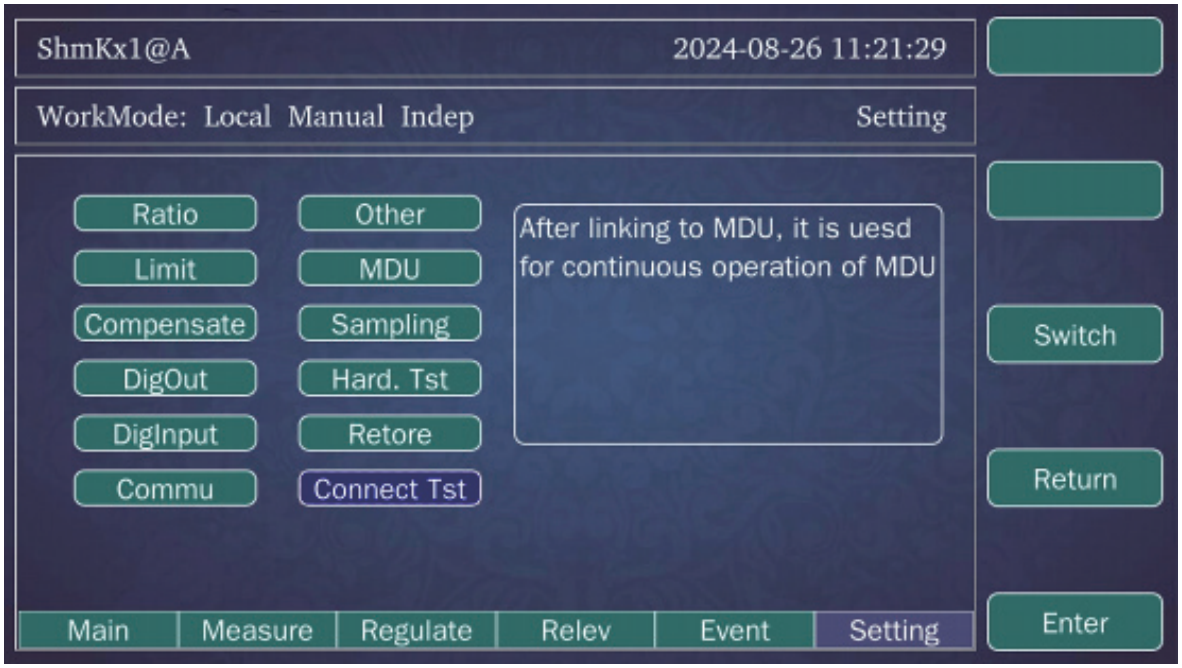
Press the "Left" or "Right" button to navigate to the Setting screen, then press "Enter" to access the Setting menu.



The "Setting" label will appear in the upper right corner of the screen, indicating that you are in the Setting menu.



Press the "Switch" button to select the "Connect Tst" option.



Press "Enter" to exit the Setting menu and enter the Connect Test subroutine.

In this screen, users can select the operation Interval and the number of Times, which is convenient for users to carry out the Connect Test.

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