1. Brief Introduction

KS833 Comprehensive Calibration Unit for Electrical Measuring Instruments is fully compatible with the relevant national codes: JJG124-93 Verification Regulation of Ammeter, Voltmeter & Ohmmeter, GB/T767-1999 Direct Acting Indicating Analogue Electrical Measuring Instruments and Their Accessories, SD110-83 Inspection Regulation of Electrical Indicating & Measuring Instruments, JJG440-86 Verification Regulation of Frequency Single Phase Meters, JJG603-89 Verification Regulation of Pointer Frequency Meters, JJG 307 -1998 Verification Regulation of Verification Equipment for AC Electrical Energy Meter, JJG596-1999 Verification Regulation of Electrical Energy Meters, GB/T 11150-2001 National Standard of Electrical Energy Meter Inspection Instruments, JJG (Power) 01-94 Verification Regulation of Electrical Measuring Transducers; it applies the latest embedded system, DSP Very Large Scale field programmable FPGA, advanced software system, high-power PAM (power amplifier module), large LCD displayer, and imported components and ICs. With its advanced technology, multi-function, small and portable size, with its superb performance and strong function, KS833 has been welcomed by our customers.

2. Functions

a） May be used for calibrating indicating instruments, AC acquisition units, multimeters, FTU, RTU, electrical measuring transducers, and electrical energy meters;

b） Built-in Grade 0.05 high precision voltage, current, phase, power, power factor, harmonic meters;

c） Standard output (Grade 0.05) of voltage, ampere, phase, active power, cross-phase reactive power and real reactive power.

d） Output current, voltage, power, phase and harmonic for closed-loop control, to ensure low wandering & annual stability rate.

e） Calibrating electrical energy meters (Grade 0.1)

f） Standard output at Grade 0.1 for 1^{st} -19^{th} harmonics, and standard output of Grade 0.2 for 20^{th} -31^{st} harmonics;

g） Work mode: instrument calibration output mode and standard source output mode;

h） Built-in USB and RS232 interfaces, software upgrading and data transfer can be done without opening the box;

i） The software can perform self-calibration, and can calibrate the electrical measuring parameters without opening the box;

j） The software can perform auto fault detector and indicate the defect location;

k） Large LCD display, all Chinese pop-up menus for these operations: 1. rotary encoder operation, 2. soft touch keyboard operation, and 3. operation under

Windows on PC;

l） Storage capacity up to 1,000 calibrated meters' data.

m） Through software you can round off the calibrated data, print verification report and calibration data.

3. Main Technical Parameters of KS833 Series

3.1 Main Technical Parameters of KS833 (Grade 0.05) Products

a) Output & measure AC voltage

Available steps: 10V, 30V, 100V, 300V, 750V; automatic switch is possible between the steps.

Adjustment range: Step x (0 – 120)%

Adjustment fineness: Step x 0.01%

Resolving power: Step x 0.01%

Accuracy: 0.05%RG

Stability: 0.01% / 1min

b) Output & measure AC current

Available steps: 100mA, 1A, 5A, 10A, 25A; automatic switch is possible between the steps.

Adjustment range: Step x (0 – 120)%

Adjustment fineness: Step x 0.01%

Resolving power: Step x 0.01%

Accuracy: 0.05%RG

Stability: 0.01% / 1min

c) Output & measure AC power

Adjustment fineness: Step x 0.01%

Resolving power: Step x 0.01%

Accuracy: 0.05%RG (F>0.5)

Stability: 0.01% / 1min

d) Output & measure AC voltage and current frequency

Frequency range: 45,000 - 65,000Hz

Adjustment fineness: 0.001Hz

Accuracy: 0.01%RD

e) Output & measure AC phase

Phase shift range: 0.00º ~ 359.99º

Resolving power: 0.01º

Adjustment fineness: 0.01

Accuracy: 0.05º

f) Output & measure AC power factor

Output range: －1～0～＋1

Measuring accuracy: 0.0005

Adjustment fineness: 0.0001

g) Output & measure harmonic

Harmonic setting: 2~31

Harmonic content: voltage, current ≤30% (as against fundamental)

Harmonic output precision: 0.1% (1^{st} ~19^{th}, as against fundamental)

0.2% (20^{th} ~31^{st} ， as against fundamental)

Harmonic phase: 0~360º, adjustable

h) Measure electrical energy

Measuring accuracy: 0.1%RD, PF≥0.5

Volt measuring range: 100V, 220V ,380V

Current range: 0.05 ~ 24A

i) Distortion in AC voltage & current output

< 0.2% (non-capacitance load)

j) Max output load capacity of AC voltage & current

Voltage output 25VA, current output 25VA

k) Output & measure DC voltage

Steps available: 100mV, 1V, 10V, 30V, 100V, 300V, 750V

Adjustment range: Step x (0 – 120)%, (0%~110% output range at Step 750V)

Resolving power: Step x 0.01%

Adjustment fineness: Step x 0.01%

Accuracy: 0.05%RG

Stability: 0.01% / 1min

l) Output & measure DC current

Steps available: 1mA, 10mA, 100mA, 1A, 5A, 10A, 25A

Adjustment range: Step x (0 – 120)%

Resolving power: Step x 0.01%

Adjustment fineness: Step x 0.01%

Accuracy: 0.05%RG

Stability: 0.01% / 1min

m) Max output load capacity of DC voltage & current

Voltage output 20VA, current output 25VA

n) Measure DC:

Voltage measuring: ±10V

Current measuring: ±20mA

Accuracy: 0.01%RG

o) Reference conditions for parameter test:

Ambient temperature: 22º± 1º

Working temperature: 0º~ 40º, humidity: ≤85%

Working voltage range: 220VAC±15%，50Hz

3.2 Main Technical Parameters of KS833 (Grade 0.1) Products

a) Output & measure AC voltage

Available steps: 10V, 30V, 100V, 300V, 750V; automatic switch is possible between the steps.

Adjustment range: Step x (0 – 120)%

Adjustment fineness: Step x 0.01%

Resolving power: Step x 0.01%

Accuracy: 0.1%RG

Stability: 0.02% / 1min

b) Output & measure AC current

Available steps: 100mA, 1A, 5A, 10A, 25A; automatic switch is possible between the steps.

Adjustment range: Step x (0 – 120)%

Adjustment fineness: Step x 0.01%

Resolving power: Step x 0.01%

Accuracy: 0.1%RG

Stability: 0.02% / 1min

c) Output & measure AC power

Adjustment fineness: Step x 0.01%

Resolving power: Step x 0.01%

Accuracy: 0.1%RG (PF≥0.5)

Stability: 0.02% / 1min

d) Output & measure AC voltage and current frequency

Frequency range: 45.000 – 65.000Hz

Adjustment fineness: 0.001Hz

Accuracy: 0.02%RD

e) Output & measure AC phase

Phase shift range: 0.00º ~ 359.99º

Resolving power: 0.01º

Adjustment fineness: 0.01

Accuracy: 0.1º

f) Output & measure AC power factor

Output range: －1～0～＋1

Measuring accuracy: 0.001

Adjustment fineness: 0.0001

g) Output & measure harmonic

Harmonic setting: 2^{nd} ~31^{st}

Harmonic content: voltage, current ≤30% (as against fundamental)

Harmonic output precision: 0.2% (as against fundamental)

Harmonic phase: 0~360º adjustable

h) Measure electrical energy

Measuring accuracy: 0.1%RD, PF≥0.5

Volt measuring range: 100V, 220V, 380V

Current range: 0.05 ~ 24A

i) Distortion in AC voltage & current output

< 0.5% (non-capacitance load)

j) Max output load capacity of AC voltage & current

Voltage output 25VA, current output25VA

k) Output & measure DC voltage

Steps available: 100mV, 1V, 10V, 30V, 100V, 300V, 750V

Adjustment range: Step x (0 – 120) %, (0%~110% output range at Step 750V)

Resolving power: Step x 0.01%

Adjustment fineness: Step x 0.01%

Accuracy: 0.1%RG

Stability: 0.02% / 1min

l) Output & measure DC current

Steps available: 1mA, 10mA, 100mA, 1A, 5A, 10A, 25A

Adjustment range: Step x (0 – 120)%

Resolving power: Step x 0.01%

Adjustment fineness: Step x 0.01%

Accuracy: 0.1%RG

Stability: 0.02% / 1min

m) Max output load capacity of DC voltage & current

Voltage output 20VA, current output 25VA

n) Measure DC:

Voltage measuring: ±10V

Current measuring: ±20mA

Accuracy: 0.02%RG

o) Reference conditions for parameter test:

Ambient temperature: 22º± 1º

Working temperature: 0º~ 40º, humidity: ≤85%

Working voltage range: 220VAC±15%，50Hz

p) Size:

450mm×380mm×180mm

q) Weight:

20kg

3.3 KS833 Operation Panel

a —— Phase A - AC current output terminal - positive
b —— Phase A - AC current output terminal - negative

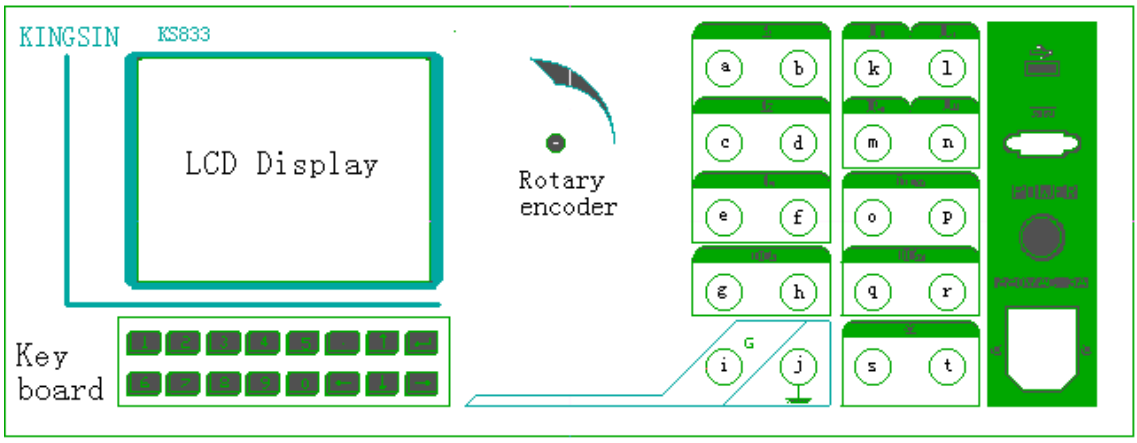


Figure 1 KS833 Operation Panel Interface

c —— Phase B - AC current output terminal - positive
d —— Phase B - AC current output terminal - negative
e —— Phase C - AC current output terminal - positive
f —— Phase C - AC current output terminal - negative
g —— DC current output terminal - positive
h —— DC current output terminal - negative
i —— Photo-electronic socket for calibrating electrical energy meters
j —— Grounding port
k —— Phase A - AC voltage output terminal - positive
l —— Phase B - AC current output terminal - positive
m —— Phase C - AC voltage output terminal - positive
n —— Common low terminal for three-phase AC voltage
o —— DC voltage input terminal - positive
p —— DC voltage input terminal - negative
q —— DC voltage output terminal - positive
r —— DC voltage output terminal - negative
s、t —— Transducer (DC input measuring)

3.4 System Configuration

KS833 Comprehensive Calibrating Unit for Electrical Measuring Instruments - host	1 unit
Operating software for KS833 Comprehensive Calibrating Unit for Electrical Measuring Instruments	1 set
Cable	1 cable

Test wire for power industry	1 parcel
Special serial port cable	1 cable
Operating Instruction	1 copy
Al-alloy package	1
Portable computer (optional)	1 set
Matrix printer and printer cable (optional)	1 set
Computer software for instrument calibration (optional)	1 set

3.5 Maintenance & Service

Three-year guarantee of free repair of the host unit, and life-long maintenance for the equipment. Free software update and free training. Please refer to the printer manual for printer operation instructions.

4. Operation Interface

4.1 Welcome Interface

The following welcome interface will be displayed on start, press ENTER to go to the main menu.

Figure 2 Welcome interface

4.2 Main Menu

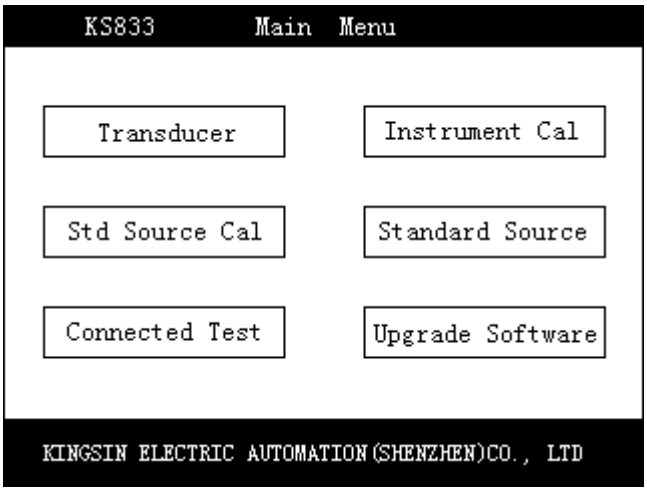


Figure 3 Main menu

4.2.1 Brief Introduction

Six items are displayed on the main menu, you can select them by the following steps: press direction keys or turn the Rotary Encoder to move the cursor on the button you want, then press ENTER or press down the Rotary Encoder to enter corresponding menu; henceforward the above operations will be referred to as “press down xx button” in short.

Press down “Transducer” button to enter transducer system setting; press down “Instrument Calibration” button to enter KS833’s function module of instrument calibration; press down “Standard Source Calibration” button to enter KS833 standard source calibration; press down “Standard Source” button to enter KS833 standard source; press down “Connected test” to connect to host (upper) computer, which then controls the unit; press down “Upgrade Software” button to upgrade the software.

5. Multifunction Standard Source

5.1 Brief Introduction

KS833 multifunction standard source is composed of six parts: DC Standard Source, Single Phase Standard Source, Phase Standard Source, Three-phase Standard Source, Power Standard Source and Harmonic Standard Source; the interface is shown as below in Figure 4:

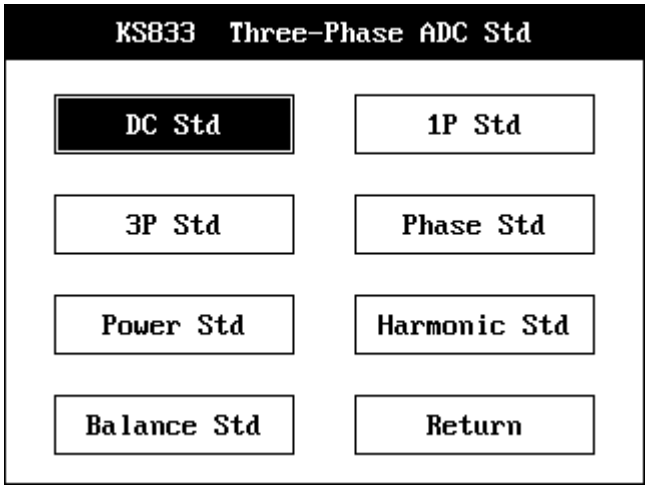


Figure 4 KS833 Standard Source main interface

5.2 Operation Flow

5.2.1 Select Standard Source in the Main Menu to enter selections, click the button to select standard sources, or click Return to go back to Main Menu

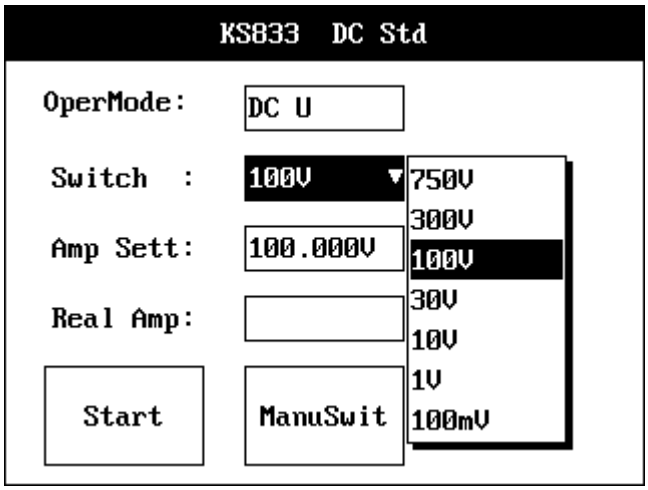


Figure 5 KS833 DC Standard Source interface

5.2.2 DC Standard Source: see Figure 5 for its interface

5.2.2.1 Select output mode

Click the “Operation Mode” dropdown box, select “DC Voltage” or “DC Current.” When you select “DC Voltage” or “DC Current”, the output amplitude tagtext will automatically switch into output voltage or output current. The working amplitude tagtext will automatically switch into actual output voltage or output current. Working Step can switch between volt steps and amp steps according to different operation modes.

5.2.2.2 Select Working Step

Click on volt steps or amp steps (depending on different operation modes) and select the step you want, take into mind to select the step value closest to output value so that you can get higher output precision. Or turn on the Auto Switch to let the system select the step with highest precision according to output amplitude.

5.2.2.3 Set Voltage & Amp amplitude

In the edit box of Output Voltage or Output Current, input the volt or amp value you

want the instrument to output. The applicable volt and amp range is 0%~120% (0%~110% output range at DC Voltage – Step 750V), anything exceeding the range will be automatically truncated by the system.

5.2.2.4 Auto Switch & Manual Switch

Click Auto Switch button to toggle between auto switch and manual switch. When you enter Manual Switch, you can select working step by the Working Step dropdown box. When you enter Auto Switch, the Working Step dropdown box will be inaccessible, the system will automatically select working step for the user according to the input amplitude value.

5.2.2.5 Instrument Output

Click on “Start Test” button, a dialogue box will pop up, click OK to confirm and start test. After test starts, the button’s tag text changes into Stop Test; the cursor’s input center moves to Stop Test button. The system will, according to the Step amplitude, increase 1% progressively until it reaches the output value. During the output increasing process, you can click Enter to stop test at any time; the detailed procedure is the same as that of Stop Test.

5.2.2.6 Real-time Closed Loop Calibration

During the test, the instrument can automatically calibrate the output according to the load connected into it.

5.2.2.7 Actual Output Display

During test, the system can automatically collect actual output data and display it as it is at the moment in the text box for actual voltage (or actual current).

5.2.2.8 Overload Warning

During test, the instrument can automatically check its own load and the load connected into it, if the connection load exceeds its output load, the system will close all output and then give an overload warning; at the same time it will prompt the user with overload phase and sound alarm. You can click OK in the dialogue box to stop the alarm. You can restart the test after eliminating the fault.

5.2.2.9 Stop Test

When output is not needed from the instrument, you can click Stop Test button to stop, and the tagtext on the button will change into Start Test, a prompt for starting next test; meanwhile, the cursor’s input focus changes to Start Test button. The system will, according to the Step amplitude, decrease 1% progressively until the output becomes zero. During the process to stop test, the user cannot click Enter to cancel Stop Test; if you want to output again, you have to wait till after test stops and then click Start Test button to restart test output.

5.2.2.10 On-line Adjustment

During test, the user can change output value at any time according to needs. Steps: move the cursor to Volt amplitude (Amp amplitude), click Enter to modify the amplitude, click Enter again, the instrument will step change the output to new amplitude. After that the same as Start Test, start closed loop calibration.

5.2.2.11 Return

Click Return to return to the upper page.

5.2.3 Single Phase AC Standard Source, see Figure 6 for its interface (Phase A output)

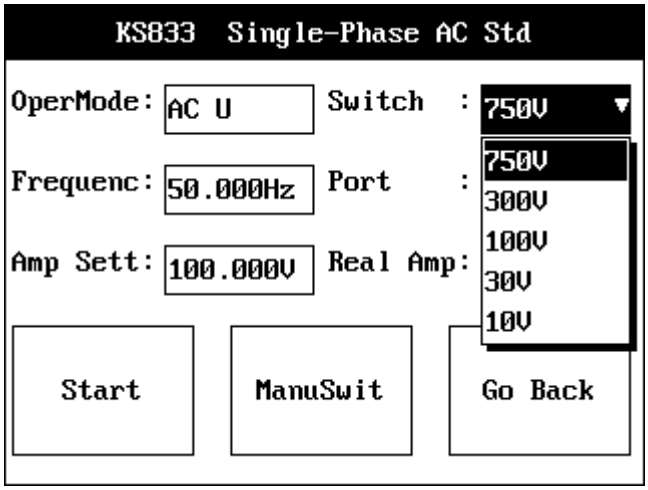


Figure 6 KS833 Single Phase AC Standard Source interface

5.2.3.1 Same test procedure as that of DC Standard Source.

5.2.3.2 The text box of Output Port will display the amplitude of output voltage or current.

5.2.3.3 Set Working Frequency

You can set working frequency before test starts or during test. The frequency may change between 45Hz and 65Hz. The actual output amplitude will not be affected when you set the frequency.

5.2.4 Phase Standard Source: see Figure 7 for its interface

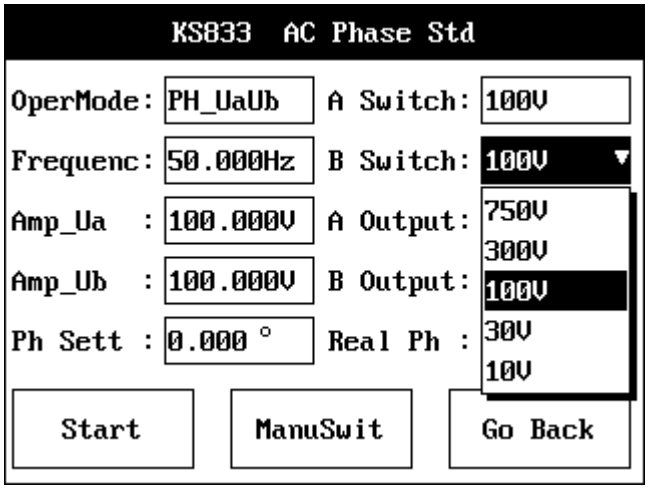


Figure 7 KS833 AC Phase Standard Source interface

5.2.4.1 Select Operation Mode

Click the “Operation Mode” dropdown box, select UaUb Phase, Uala Phase or Ialb Phase positions. The instrument will output the voltage or ampere at the corresponding output terminal, the difference between two phases will be the phase value you need.

5.2.4.2 Select Working Step

Click Phase A Step and Phase B Step or volt step or amp step (depending on different operation modes) and select the step you want, take into mind to select the step value closest to output value so that you can get higher output precision. Or switch on the Auto

Switch to let the system select the step with highest precision according to output amplitude.

5.2.4.3 Set Phase Value

In the edit box for output phase you can input the phase value you want the instrument to output. Phase range: 0°~360°, the system automatically switch it into 0°~360° according to the user's input.

5.2.4.4 Auto Switch & Manual Switch

Click Auto Switch button to toggle between auto switch and manual switch. When you enter Manual Switch, you can select step switch by the Working Step dropdown box, at the same time the edit box for inputting amplitude will be shielded. When you enter Auto Switch, the Working Step dropdown box will be inaccessible, the system will automatically select working step for the user according to the input amplitude value.

5.2.4.5 Instrument Output

Click Start Test button. Then Start Test button becomes unavailable, the tagtext changes into Testing; at the same time Stop & Void button becomes available, the tagtext changes into Stop Test. The system will step increase by 10° progressively until it reaches the output value.

5.2.4.6 Real-time Closed Loop Calibration

During the test, the instrument can automatically calibrate the output according to the load connected into it.

5.2.4.7 Actual Output Display

During test, the system can automatically collect actual output data and display it as it is at the moment in the text box for actual phase.

5.2.4.8 Overload warning: identical as 5.2.2.8

5.2.4.9 Stop Test: identical as 5.2.2.9

5.2.4.10 On-line Adjustment

During test, the user can change output value at any time according to needs. Steps: move the cursor to output phase, click Enter to modify the amplitude, click Enter again, the instrument will step change the output to new amplitude. After that the same as Start Test, start closed loop calibration.

5.2.4.11 Return

Click Return to return to the upper page.

5.2.5 Three-phase Standard Source: see Figure 8 for its interface

5.2.5.1 Select Output Port

Click Enter of your selection button, when the selected button displays "Yes", which indicates the corresponding output port is effective, the instrument will be able to output voltage or current at that output port. When a "No" displayed, it indicates ineffectiveness of that output port and hence no output at that port. Of which the Ua output port cannot be changed, and it is always effective.

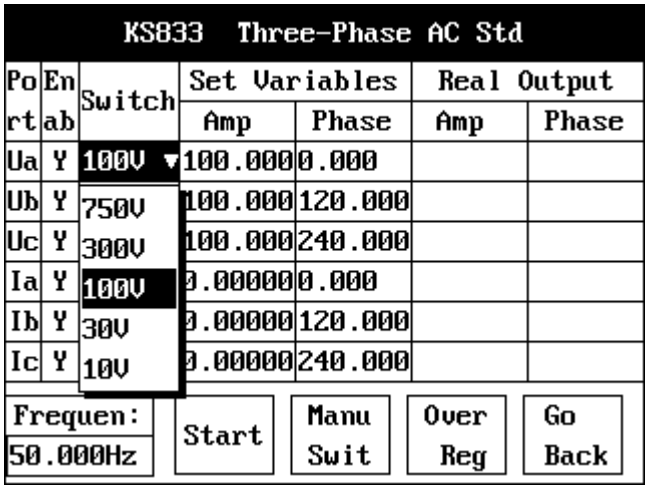


Figure 8 KS833 Three-phase AC Standard Source interface

5.2.5.2 Change Working Step

Click Enter on the dropdown box of Working Step to select the working step you want, the selected Step is effective only for the corresponding output port, and different output ports and output simultaneously under different working steps.

5.2.5.3 Set Output Amplitude and Phase Of Voltage & Current

Input the amplitude and phase you want in the columns under variable output (in the same way as that of Single Phase Standard Source and Phase Standard Source). You may also use dropdown menu to input the amplitude and phase preset by the program (Remark: Ua's amplitude cannot be zero). Take the amplitude of Ub as an example:

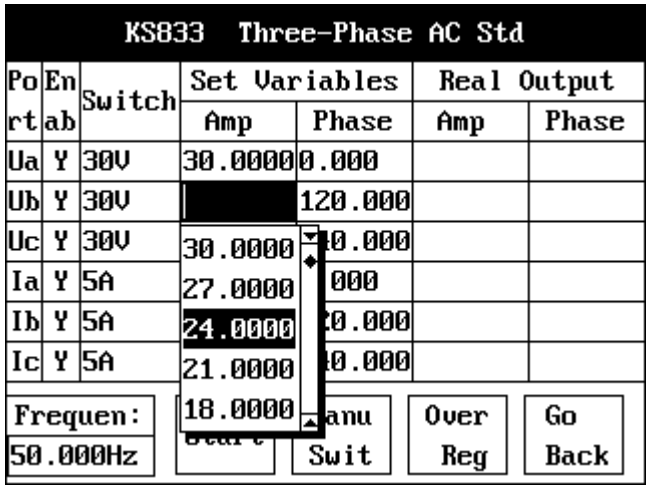


Figure 9 Input variable under Three-Phase Standard Source

Move cursor to the set place and click Enter, then click "DOWN" of the direction keys, you'll see a dropdown menu as Figure 9; select the value you want by using the direction keys and click Enter to confirm.

5.2.5.4 Set Working Frequency

Set the working frequency you want in the edit box of Working Frequency (45Hz~65Hz).

5.2.5.5 Auto Switch & Manual Switch

Click Manual Switch button to toggle between manual switch and auto switch. When you enter Manual Switch, you can switch working steps in the dropdown box of Working

Step column; when you enter Auto Switch, the dropdown box of Working Step will not be usable, the system will automatically switch working steps according to the amplitudes set by the user. Manual Switch & Auto Switch are effective to all output ports simultaneously.

5.2.5.6 Overall Regulating & Phase Regulating

When the system displays Overall Regulating, the voltage & amp amplitudes of the three phases are equal. For instance, if you change Ua amplitude in Figure 9 into 20V, then Ub and Uc amplitudes will automatically changed into 20V. Click “Overall Regulating”, the key will turn into “Phase Regulating.” In Phase Regulating, there can be different amplitude for different phases. (Remark: in Overall Regulating, the phases will automatically have a difference of 120 degrees between them.)

5.2.5.7 Start Test

Click Start Test button, the instrument will output the voltage and current of each port in sequence according to step length. And the output value at the moment will be displayed in the text boxes of the amplitude and phase columns under Actual Output.

5.2.5.8 Real-time Closed Loop Calibration

During the test, the instrument can automatically calibrate the output according to the load connected into it.

5.2.5.9 On-line Adjustment: identical as 5.2.4.10

5.2.5.10 Fine Adjustment

Move cursor to the edit boxes of amplitude or phases, then turn the selection encoder, the figures will increase or decrease by step length of its minimum position.

5.2.5.11 Overload Warning

During test, the instrument can automatically check its own load and the load connected into it, if the connection load exceeds its output load, the system will close all output and then give an overload warning; at the same time it will prompt the user with overload phase and sound alarm. You can click OK in the dialogue box to stop the alarm. You can restart the test after eliminating the fault.

5.2.6 Power Standard Source: see Figure 10 for its interface

5.2.6.1 Select Operation Mode

Click the dropdown box of Operation Mode to select different power output modes, which are available in seven modes: “3P4W Active Power” (3P4W short for “3 Phase 4 Wire”), “3P3W Active Power”, “1P Active Power”, “3P4W Real Reactive Power”, “3P3W Real Reactive Power”, “3 Element 90° Reactive Power”, “2 Element 90° Reactive Power.”

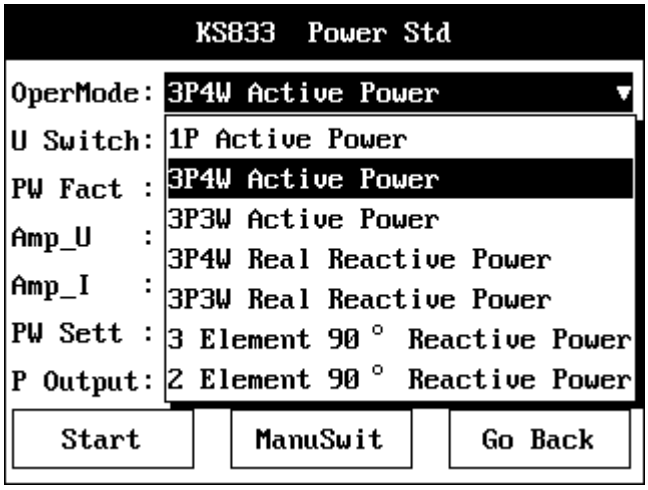


Figure 10 KS833 Power Standard Source interface

5.2.6.2 Change Working Step

Click enter on the dropdown box of Volt step and Amp step, select the working step you want (the standard source provides 3 volt steps: 750V, 300V, 100V; and 5 amp steps: 25A, 10A, 5A, 1A, 100mA.)

5.2.6.3 Select Power Factor

Click enter on the dropdown box of Power Factor, press “DOWN” of the direction keys to select the power factors you want (5 power factors are available in the standard source: 1.0, 0.5, 0.8L, 0.5C, 0.8C.) You can also use the built-in small keyboard to input other power factors, refer to the appendix for instructions on how to use the small keyboard.

5.2.6.4 Toggle Between Power Factor and Phase Angle

Move cursor to the Power Factor dialogue box, click rotary encoder to toggle to Power Phase Angle, you can input value by using the numerical keyboard. (Remark: Power Factor and Phase Angle may have different corresponding relation under different operation modes.)

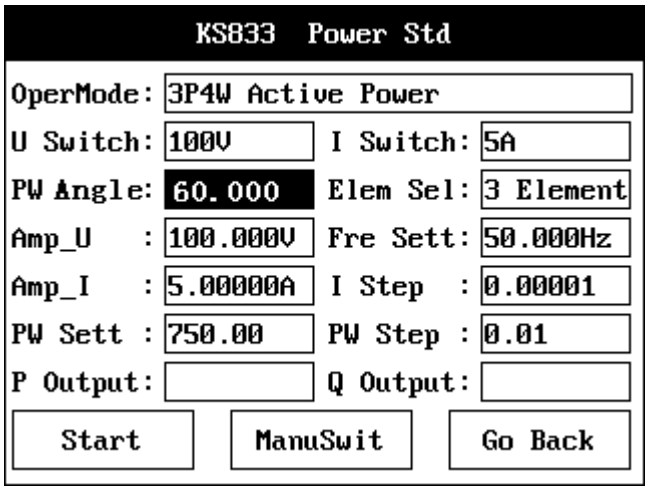


Figure 11 Power Phase Angle toggle interface

5.2.6.5 Element Selection

When the user select operation modes other than 1P Active Power, then Element Selection is available; when 1P Active Power is selected, Element Selection will not be applicable. When Element Selection is activated, the user may select different output

elements (default is Combined Element Output)

5.2.6.6 Select Volt Amplitude

When the user selects a volt step, the standard source provides three output voltages under the step, which are: 380V, 600V and 750V output under Step 750V; 150V, 220V and 300V output under Step 300V; 57.735V, 75V and 100V under Step 100V. The user may also manually input the value by using the numerical keyboard in the instrument panel.

5.2.6.7 Set Frequency

The user may change the working frequency in the frequency input edit box. The frequency may change between 45Hz and 65Hz.

5.2.6.8 Set Current

When the user select a amp step, the standard source provides 10 output currents under the step, which are: 25A，22.5A，20A，17.5A，15A，12.5A，10A，7.5A，5A and 2.5A output under Step 25A; 0A，9A，8A，7A，6A，5A，4A，3A，2A and 1A under Step 10A; 5A，4.5A，4A，3.5A，3A，2.5A，2A，1.5A，1A and 0.5A output under Step 5A; 1A，0.9A，0.8A，0.7A，0.6A，0.5A，0.4A，0.3A，0.2A and 0.1 under Step 1A; 100mA，90mA，80mA，70mA，60mA，50mA，40mA，30mA，20mA and 10mA output under Step 100mA. The user may also manually input the value by using the numerical keyboard in the instrument panel.

5.2.6.9 Power Setting

Set the output power in the power input edit box. The maximum value for power setting is, under the corresponding output voltage, the actual output power when the current output is 120% of the Amp step; the exceeded part will be truncated by the system automatically. When you have selected element test, due to the effect of power factor, the element's power will be zero under all voltage and current. Therefore when the user inputs the element's power, the display is zero, which only implies that it is zero under the effect of power factor, voltage and current outputs are still there during test, so you can only modify the amplitudes of current or voltage but you cannot modify power.

5.2.6.10 Set Stepping

Set Stepping is divided into Amp step Length and Power Step Length, each has 4 steps, whose value is determined by the Volt step and Amp step. The figure shows the Amp step Length under 100V & 25A.

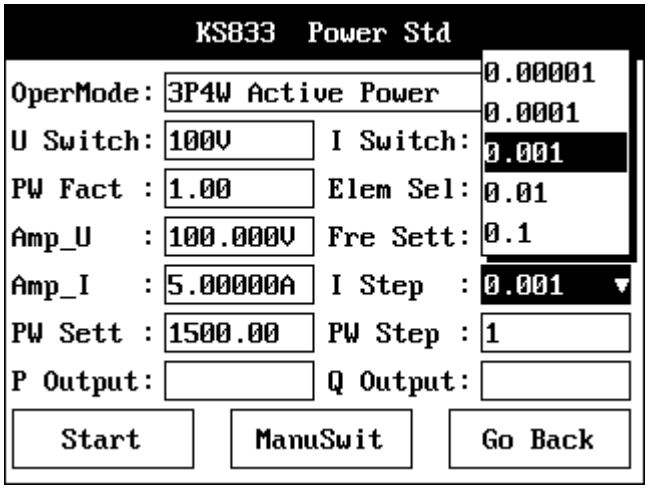


Figure 12 Set Stepping in Power Standard Source

Click Start Test and turn the rotary encoder during test, as it turns cell by cell, the changed amplitude will set the step length.

5.2.6.11 Instrument Output Display

Click enter on the Output Display button, the system will display the actual output amplitudes and phases of all ports at the moment, as well as the active power & reactive power of all elements.

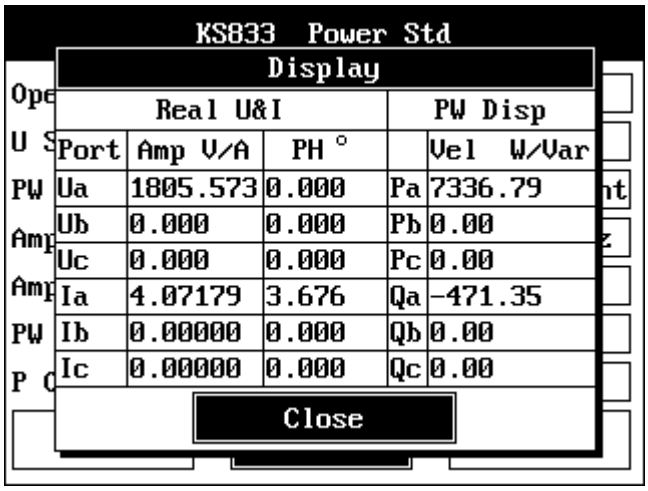


Figure 13 KS833 Output Power Display Interface

5.2.6.12 Auto Switch & Manual Switch

Click Auto Switch button to toggle between manual switch and auto switch. When you enter Manual Switch, you need to switch amp steps to enhance the precision of power output. When you enter Auto Switch, the Amp Step dropdown box will be unavailable, the system will automatically switch amp steps according to the power set by you, while at the same time you have to switch the volt step and volt amplitude.

5.2.6.13 Start Test

Click the Start Test button; the instrument will directly output volt amplitude & phase as well as current phase. The amp amplitude will increase by 1% of the amp step progressive until it reaches the power value needed.

5.2.6.14 Real-time Closed Loop Calibration

During the test, the instrument can automatically calibrate the output according to the load connected into it.

5.2.6.15 On-line adjustment

During test, the user can change output value, power factor or volt amplitude at any time according to needs. Procedure: move the cursor center to Power Input edit box, Power Factor dropdown box or Volt Amplitude dropdown box, click Enter to modify power input, power factor or volt amplitude, click Enter again, the instrument will change the output to the new power. After that the same as Start Test, start closed loop calibration.

5.2.6.16 Power Output Display

During test, the system can automatically collect actual output data and display the output power as it is at the moment in the text boxes of active power and reactive power.

5.2.6.17 Fine Tuning (take amp amplitude as an example)

After test starts, move cursor to Amp Amplitude and turn the rotary encoder, the amp amplitude will increase or decrease on the step length, and power will also change

accordingly. Take similar steps to fine tune the power. (Note: You can only fine tune current and power)

5.2.7 Harmonic Overlapping Standard Source: see Figure 14 for its interface

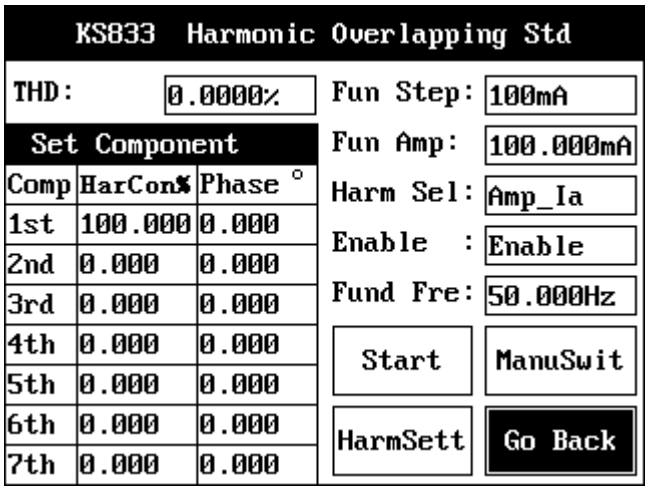


Figure 14 KS833 Harmonic Overlapping Standard Source interface

5.2.7.1 Select Fundamental Step

Click Fundamental dropdown box to select from the steps, the standard source provides five volt steps: 750V, 300V, 100V, 30V and 10V; and five amp steps 25A, 10A, 5A, 1A and 100mA.

5.2.7.2 Set Fundamental Amplitude

Click fundamental amplitude edit box to set the output fundamental amplitude for corresponding ports, different output ports may have different fundamental amplitudes.

5.2.7.3 Select output port

Select the harmonic port you want to modify under the dropdown box of Select Harmonic. When it switches to new output port, all the setting in the interface will be the setting of that output port. You have to switch output port to view other output port.

5.2.7.4 Select output function

Click the dropdown box of Enable Output to enable or disable output, it's only effective on the corresponding harmonic output port, and different harmonic output ports have separate Enable Output status. To output harmonic in different output ports, you need to select corresponding harmonics, at the same time enable each port's output (by default the system disables all output except Ua.)

5.2.7.5 Set Harmonic Component

The standard source provides harmonics from fundamental to the 31st, move curse to enter Harmonic Component line and set the corresponding values in the edit boxes under Harmonic Content and Phase (the same as that of Three Phase Standard Source); of which the Content ratio refers to the percentage of harmonic amplitude over fundamental amplitude and the added ratio of all the non-fundamental harmonics shall not exceed 30% of the fundamental component, the exceeded part will be truncated automatically by the system; the Harmonic Phase refers to the phase difference with the fundamental phase position of the phase (Fundamental Phase is the phase position of the fundamental in relation to the fundamental of Phase A voltage), the range is 0°~360°. Due to space limit,

only seven harmonics can be displayed for component, you can move up and down by using the direction keys to select the harmonic you want. Of which the content of fundamental component cannot be changed. The system sets its default value at 100%.

5.2.7.6 Auto Switch & Manual Switch

Click Manual Switch button to toggle between manual switch and auto switch. When you enter Manual Switch, you can select fundamental steps through the dropdown box; when you enter Auto Switch, the system will automatically switch fundamental step according to the fundamental amplitude input by the user.

5.2.7.7 Start Test

Click Start Test to start, the instrument will output harmonic at all the output-enabled ports; and there will be no harmonic output at the disabled ports (Note: except Phase A voltage, the default values of all the Enable Output value are set at Disable.) At the same time, Set Harmonic will be switched to output display; the harmonic component table will become harmonic overlapping output component table and display the actual output value of each harmonic component at the selected harmonic output port.

5.2.7.8 Stop Test

Click Stop Test during test, the instrument will close output. At the same time, output display will be switched to Set Harmonic, the harmonic component table will become harmonic overlapping input component table and display the set value of each harmonic component of the selected harmonic output port.

6 Instrument Calibration

Select Instrument Calibration in the Main Menu to enter the main interface as shown below. In the main interface if you select Delete Report, all the stored reports will be deleted. If you select Transfer Report, all the reports will be transferred to PC, you need to connect to the host computer for this.

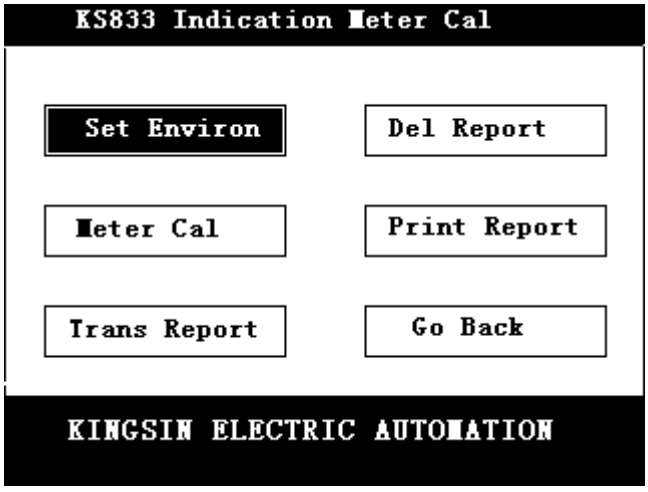


Figure 15 Main Interface of Instrument Calibration

6.1 Set Working Environment

On this interface, the user can set temperature and humidity, and input the name of the work unit or company for whom this calibration is performed; when you input the company

name, the system will automatically call Chinese input method –Section-Position Code, you may refer to the Code list for the desired Chinese character and input it as the code specified, both temperature and humidity are ranged between 0 and 100.

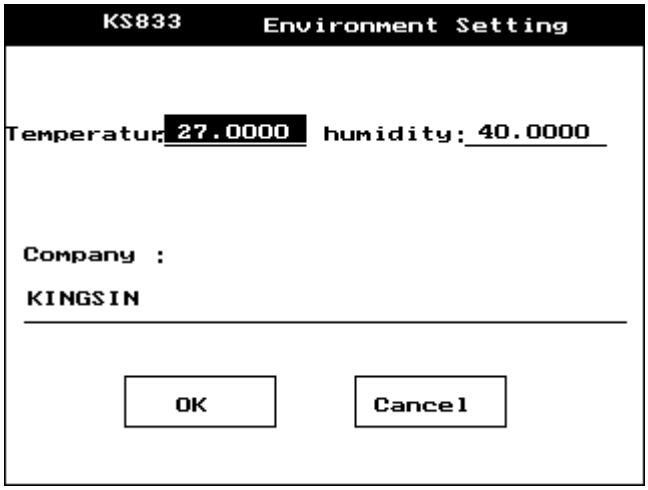


Figure 16 KS833 Set Working Environment Interface

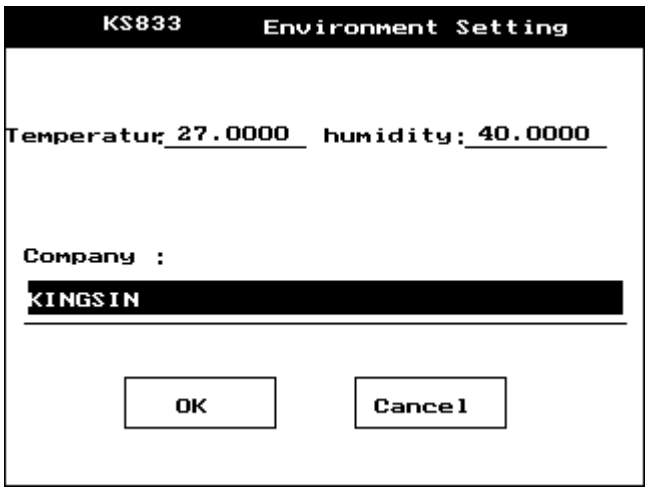


Figure 17 KS833 Set Working Environment

6.2 Print Report

Enter Print Report interface, first select instrument type, then input Model and Number, if previously stored data of this instrument is available the system will automatically call it out, finally, click Print button; if there's no printable data, the system will give a prompt, it will also give a prompt when printing is completed.

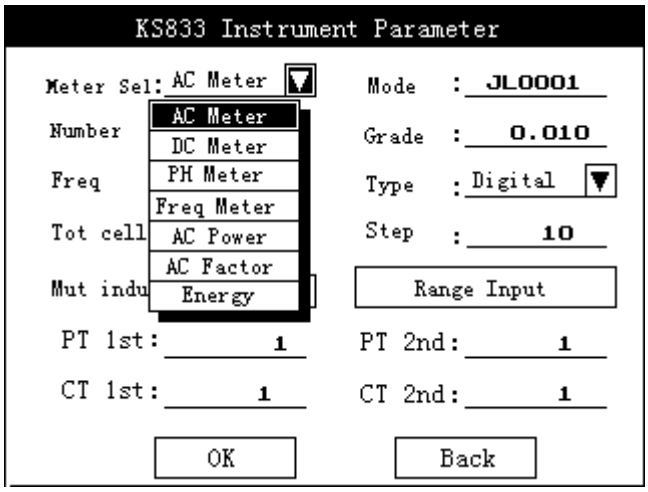


Figure 18 KS833 Instrument Attributes

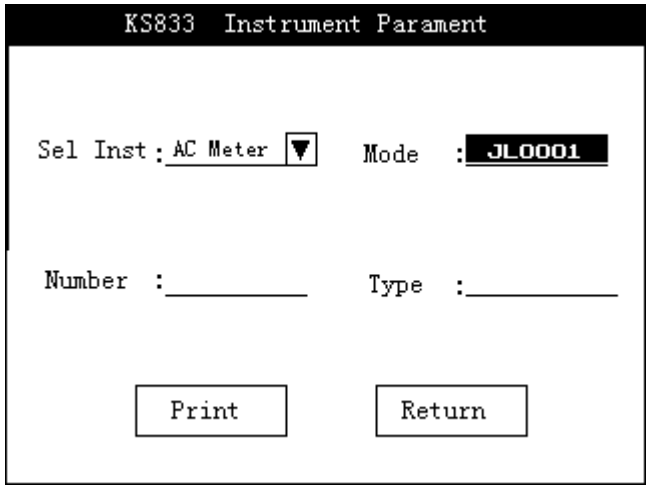


Figure 19 KS833 Instrument Attributes

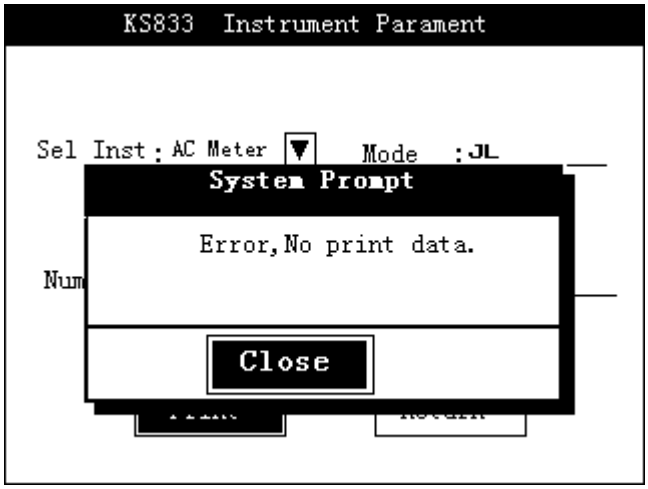


Figure 20 KS833 Instrument Attributes – Attention interface

6.3 Input Instrument Attributes

Figure 21 shows the input interface of KS833 Instrument Attributes, the user may select instrument name and type and input other information displayed, then press down “Range Input” button to enter corresponding instrument input interface; after entering all data then press down “OK” button to store the data in the reference database and then enter

instrument calibration interface; if you press down “Return” button, the data will not be saved and instrument calibration interface will not be displayed.

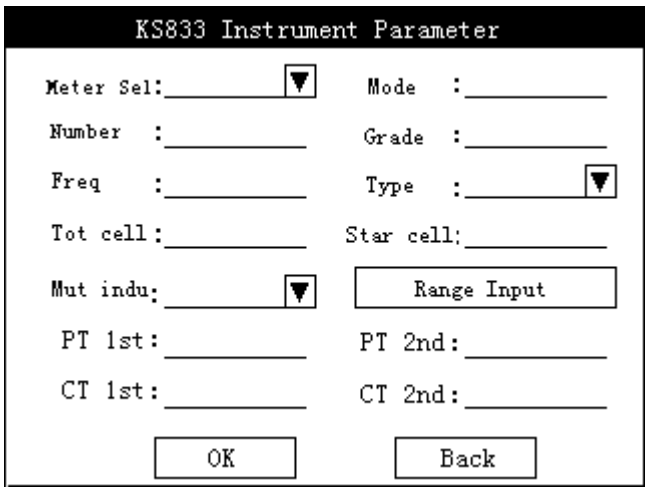


Figure 21 KS833 Instrument Attributes interface

Figure 22 is the setting of Mutual Inductance Parameters PT 1st indicates primary voltage, PT 2nd indicates secondary voltage; CT 1st indicates primary current and CT 2nd indicates secondary current. “PT 1st is 66000” indicates the range of the meter being calibrated is 66,000V, “PT 2nd is 100” indicates that the instrument’s actual output is 100V. It’s similar for CT setting.

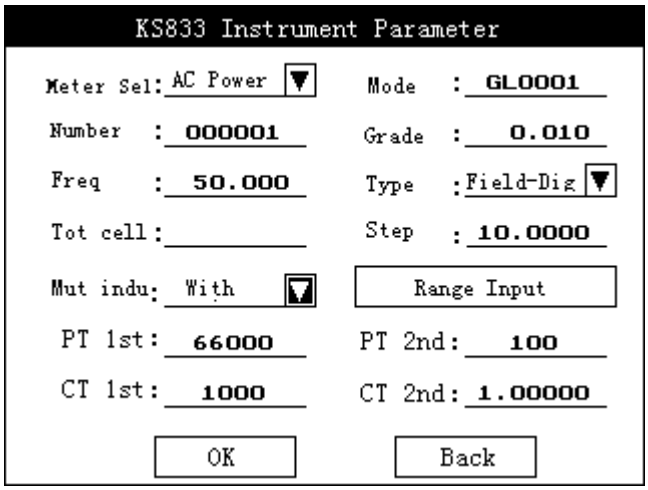


Figure 22 Mutual Inductance Parameters setting

6.4 Input Range

6.4.1 AC/DC Range Input

Figure 23 shows the interface of AC/DC Range Input, the user may, according to circumstances, select voltage and current to input relevant information; press down “OK” button to record the input information; press down “Return” button to cancel recording the input information.

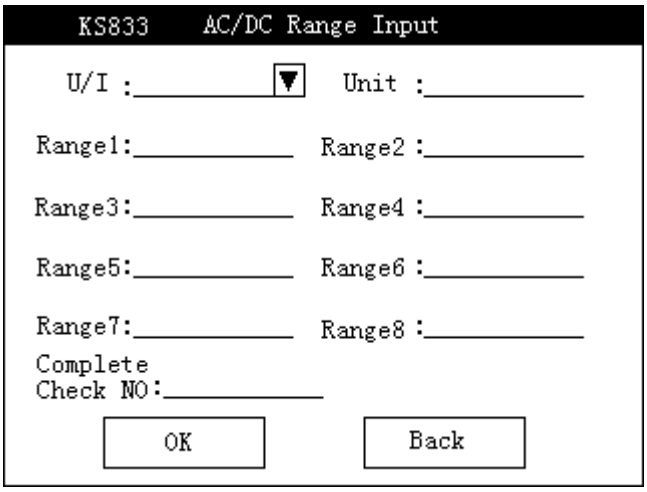


Figure 23 AC/DC Range Input interface

6.4.2 Power Range Input

Figure 24 shows Power Range Input interface, the inputting method is similar with that of AC/DC Range Input.

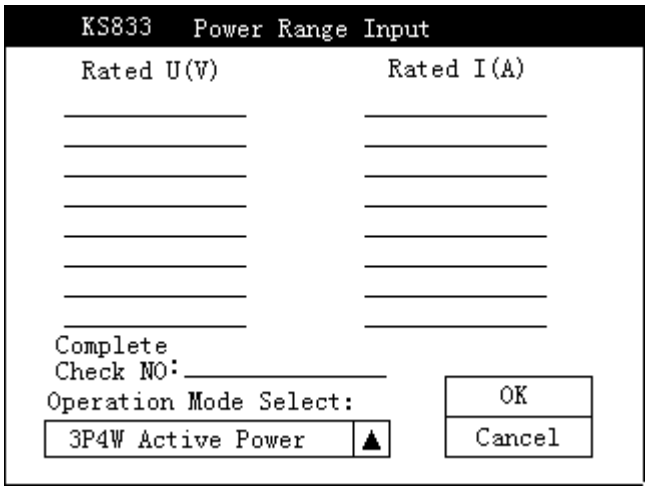


Figure 24 Power Range Input interface

6.4.3 Phase Range Input

Figure 25 shows Phase Range Input interface, the inputting method is similar with that of AC/DC Range Input.

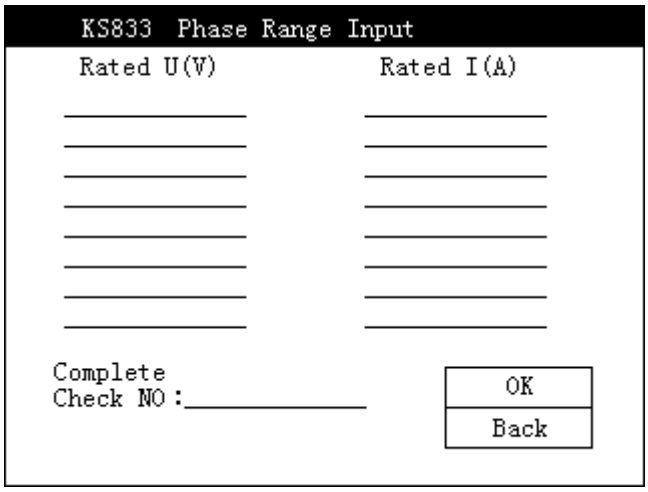


Figure 25 Phase Range Input interface

6.5 Types of Calibration

6.5.1 Portable Meters

6.5.1.1 Portable AC Voltmeter and Ammeter (Phase A Output)

When you want to calibrate portable AC voltmeter and ammeter, you need to enter the interfaces show in Figure 26 & 27. Figure 26 is for Complete Check - Range Calibration, Figure 27 is for Incomplete Check – Range Calibration.

a) **Complete Check – Range Calibration** After entering Complete Check interface, the program will process initialization based on the input parameters and display complete check ranges. Select "Start Test" button, press down Enter to start test, the instrument will deliver the corresponding voltage or current in a stable way, faster at the beginning, then in slower and slower pace (to avoid pointer meter's overshooting), and finally stop at the specified location; during this process, the user can press down rotary encoder to interrupt the test at any moment. Then you can use the rotary encoder to adjust, at this time, you can select the corresponding adjustment fineness by pressing down the direction key “→”, when it's adjusted to overlap with the calibrated value, press Enter to get the actual voltage or current, which is displayed in the Up cell of the standard meter; then it automatically calibrate the next point. Due to space limit, not all tables can be listed, when the cursor moves to the last line, press Enter, the table will automatically goes to the first line of the following page to continue test after previous page, until the highest tested value is calibrated, the cursor will automatically move one cell to the right to start Down tests. After that, the cursor will move up one line after each point calibration is completed.

During the test, calibrating one point will: 1). First display the value of the calibrated meter; 2). Show the Up value or Down value of the standard meter; 3) calculate the error this time and update max. Error; 4) if it’s Down, calculate and display correction value, calculate the variation this time and update the max.

Variation; 5) according to the max. Error and max. Variation, determine the calibrated data is passed or not and display it in “Conclusion”.

Press “Next” to enter Incomplete Check Range Calibration shown in Figure 27; after the calibration is completed, press “Save” button print all calibration data and result; press “Return” button to return to Main Menu; press “OK” to save all calibration data, return to Main Menu; press “Show Status” to display output status; press “Pg Up” to move up one page; press “Pg Dn” to move down one page.

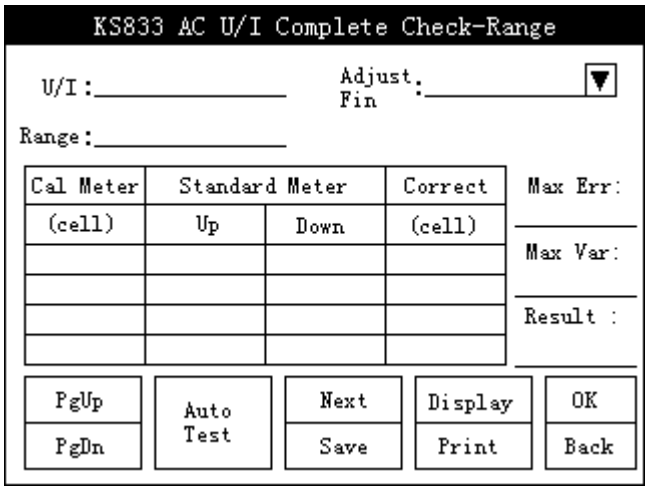


Figure 26 AC Voltage / Current Complete Check Range Calibration

b) **Incomplete Check – Range Calibration** Enter the interface of Incomplete Check, the program will automatically initialize, click “Start Test’, the test will start on the ranges, one by one from the highest to the lowest. When switch the ranges, a dialogue box will pop up, till the user adjust the calibrated meter and press OK, then start test on the next range. For each range, only the full scale value, the calibrated value of the max. error in complete check range, and the middle value will be calibrated. The operation is similar with complete check range calibration.

During the calibration, the work after reading each number is the same with complete check calibration except that the variation will not be calculated.

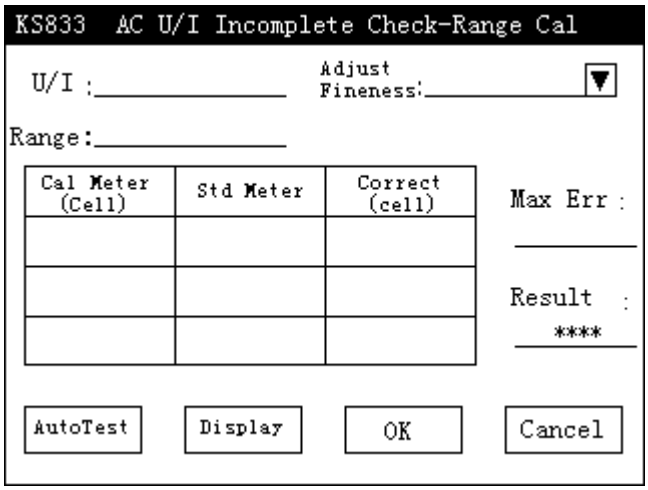


Figure 27 AC Voltage / Current Incomplete Check Range Calibration

6.5.1.2 Portable DC Voltmeter and Ammeter

When you want to calibrate portable DC voltmeter and ammeter, you need to enter the interfaces show in Figure 28 & 29. Figure 28 is for Complete Check - Range Calibration, Figure 29 is for Incomplete Check – Range Calibration. All the operations are the same with those of Portable AC voltmeter and ammeter.

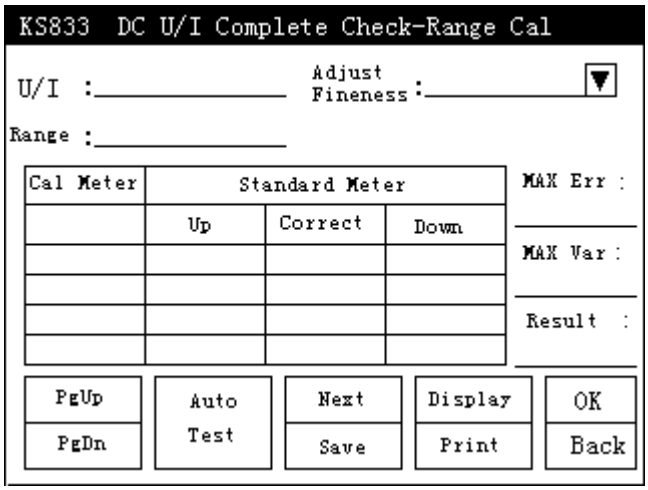


Figure 28 DC Voltage / Current Complete Check Range Calibration

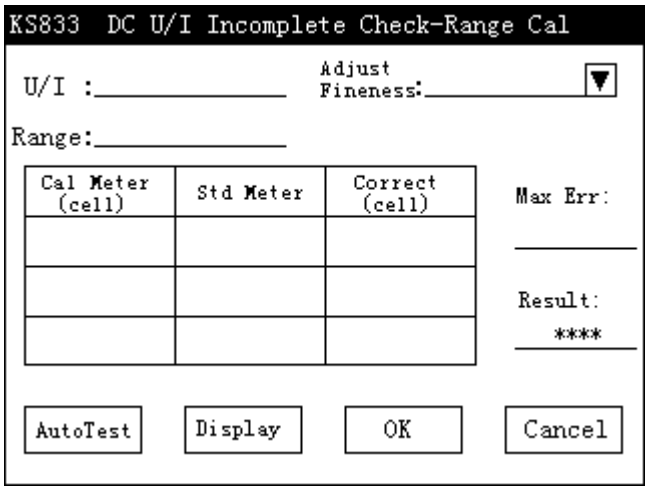


Figure 29 DC Voltage / Current Incomplete Check Range Calibration

6.5.1.3 Portable Phase Meter (Phase A Output)

When you want to calibrate portable phase meter, you need to enter the interfaces shown in Figure 30 & 31. Figure 30 is for Complete Check - Range Calibration, Figure 31 is for Incomplete Check – Range Calibration. Only that the calibration values of phase meter are angular degrees.

a) Complete Check – Range Calibration Figure 30: the two items on the upper left are the nominated voltage and nominated current of complete check ranges. Move the direction key to “Start Test” button, press down Enter to start calibration. For complete check range calibration, the initial value of phase angle is fixed at 0º, the

final value is 90º, both are not changeable; quadrant is fixed at first quadrant. The calibration process is the same as that of portable AC voltmeter / ammeter.

Press “Save” to save all the data calibrated; press “Return” button to return to Main Menu; press “OK” to save all calibration data, return to Main Menu; press “Next” to enter the incomplete check range calibration interface shown in Figure 31; press “Print” to print all calibration data and result; press “Show Status” to display output status; press “Pg Up” to move up one page; press “Pg Dn” to move down one page.

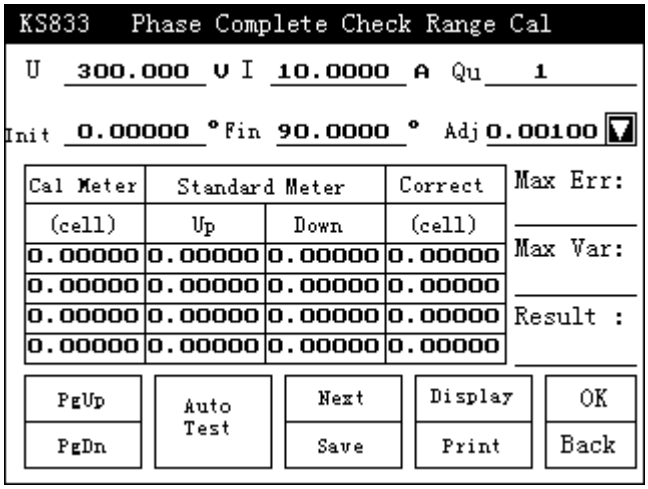


Figure 30 Phase Complete Check – Range Calibration

b) Incomplete Check – Range Calibration Figure 31: the two items on the upper left are the nominated voltage and nominated current of incomplete check ranges. Move the direction key to “Start Test” button, press down Enter to start calibration. The verification points of incomplete check range calibration is the same as those of portable AC voltmeter and current meter, during the test, quadrant, initial value and final value need not to be selected, and the operation process for each quadrant is the same with that of portable AC voltmeter and current meter, it then automatically switch to the next quadrant until the completion of all the voltage and current in the group, then it repeats the above process to complete all calibrations.

Press “Show Status” button to display output status; press “Return” button to return to the interface of complete check range; press “OK” to save calibration data and return to complete check range.

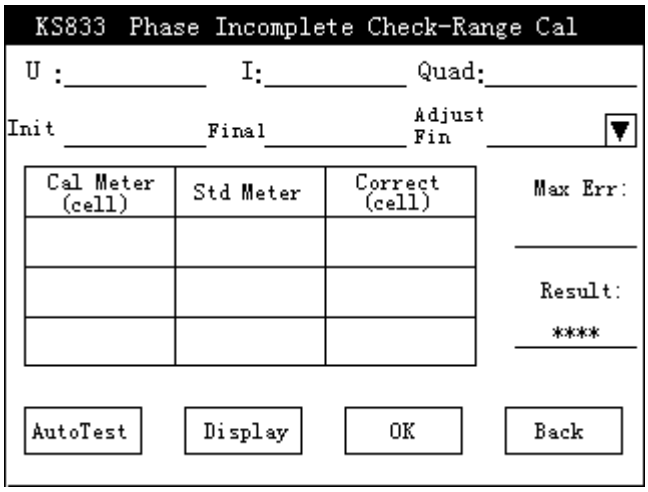


Figure 31 Phase Incomplete Check – Range Calibration

6.5.1.4 Portable Frequency Meter (Phase A Output)

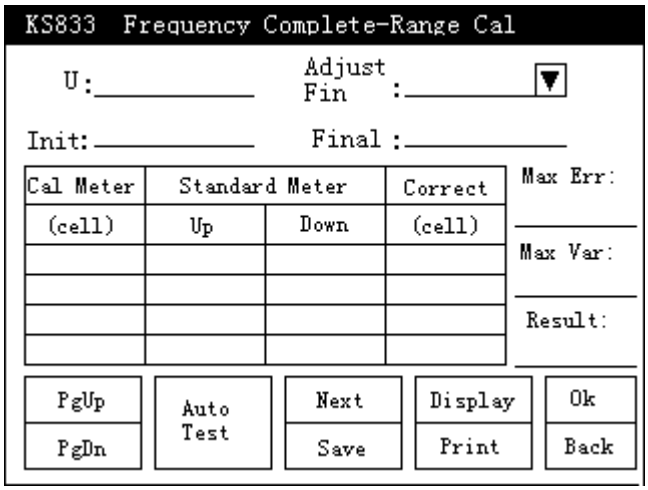


Figure 32 Frequency Complete Check – Range Calibration

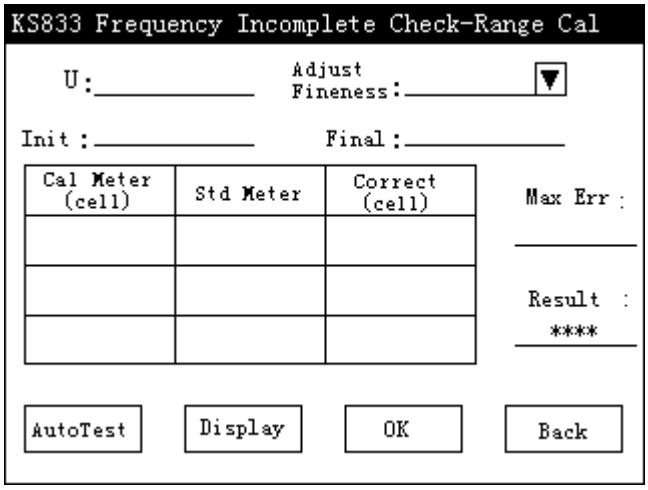


Figure 33 Frequency Incomplete Check – Range Calibration

The interfaces of calibrating frequency meter are the same as those of calibrating phase meters, as shown in Figure 32 & 33. Figure 29 is for Complete Check - Range Calibration, Figure 33 is for Incomplete Check – Range Calibration.

The calibration process for portable frequency meter is similar with that of portable AC

voltmeter and ammeter.

6.5.1.5 Calibrate Power Meter

1. On the KS833 Instrument Attributes page, click OK to enter the page of KS833 power meter complete check range calibration.

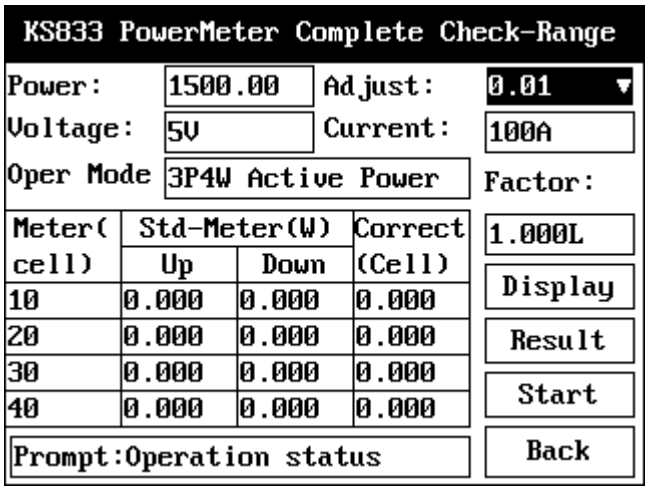


Figure 34 KS833 Power Meter Complete Check Range interface

2. Complete Check – Range Calibration

A) According to the instrument range parameters input in Instrument Attributes page, the system will first enter complete check range (also called basic range). Based on the rated voltage and rated current of complete check ranges, and the activation mode of power meter, the system will calculate the rated max. power and display it in the text box of power range. At the same time, the reference voltage and current of the complete check ranges will be displayed in the text boxes of Rated Voltage and Rated Current. In the dropdown box of Adjustment Fineness, the minimum adjustment step length will be displayed, whose unit is identical with that of the power unit shown in the text box of Power Range; the default adjustment fineness is the minimum adjustment step length of the power range. During the test, you can operate the direction keys and move the focus to the dropdown box of Adjustment Fineness at any time, click Enter to select different adjustment fineness values.

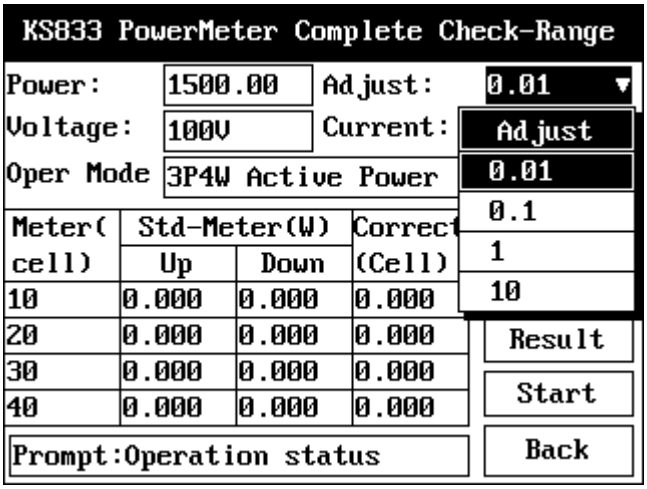


Figure 35 KS833 Power Meter Complete Check Range

B) Select the power factor you want to calibrate, click Start Test button.

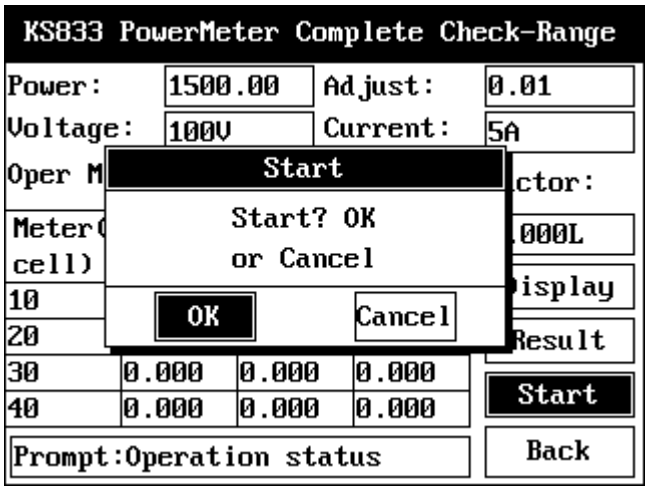


Figure 36 KS833 Power Meter Complete Check Range

i. When the power factor is 1.0, both up value and down value need to be calibrated for pointer meter. When the power factor is 0.5L or 0.5C, only up value needs to be calibrated, either it be a digital meter or a pointer meter.

ii. The system will display different calibration cell according to different meter types, for portable meters and installation meters, both up and down values need to be tested; for experimental digital meters and field digital meters, only up values need to be tested.

iii. When test starts, the instrument will start with 0 and increase it stably to the power value of the initial cell, at the same time the page bottom will prompt the user to adjust instrument output, when it's adjusted to overlap with the calibrated value, click turning rotary encoder, the system prompts that it's collecting data and the collected actual power value will be displayed in the cells under standard meter (if it's a pointer meter then the value will be displayed in Up or Down cells). The system will calculate corresponding error and correction values, which are displayed in corresponding cells. Then it will automatically move to the next calibration point. Due to space limit, not all tables can be listed, when the test point is in the last line of the table, the system will automatically roll up one line, until the completion of testing the full range calibration point. If it's a pointer meter, the cursor will automatically move one cell to the right to start calibrating Down cells; if it's a digital meter, then the power factor calibration is completed here.

iv. For each verification point of the test, the system will calculate the error, if only up value calibration is needed, the error of the verification point will be displayed in the error cell, at the same time the system will update max. error value and its corresponding verification point. If down value calibration is needed, when it's performed, the system will calculate and display the correction value of the verification point, at the same time, calculate the variation of the verification point and update max. variation value and max. variation point.

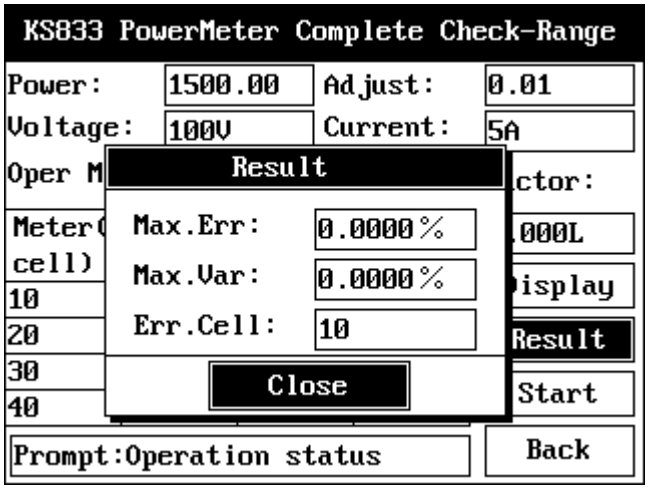


Figure 37 KS833 Power Meter Complete Check Range conclusion interface

v. After the instrument completes testing one verification point, the user may click Conclusion button to view the max. error, max. variation and max. variation point (cell) at the moment.

vi. Based on the max. error and max. variation, the system will determine whether the calibrated meter is passed or not. The user may also click "Output Display" button to view the status of the machine at the moment.

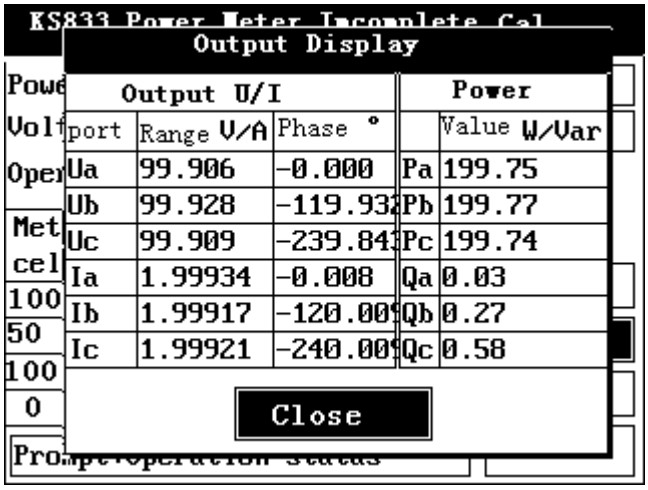


Figure 38 KS833 Output Power Display Interface

C) When calibration for one power factor is completed, according to system prompt, click Stop Test button to close test output, at the same time select non-calibrated power factors to continue calibration. When all the power factors are calibrated, Start Test button will change into Next, at the same time the system will prompt the user to click Next to enter incomplete check range calibration.

D) When it returns after incomplete check range calibration, and if the data of such calibration is complete and valid, “Print” & “Save” buttons will appear to prompt the user to save the calibration data of the meter. And the user can click Print to print the calibration report.

E) Test Return. When the user clicks Go Back, the system will go back to the previous page. When the user completes the calibration of the meter, and the calibration data is complete and valid, if the user doesn’t save data before return,

the system will prompt the user to save data.

F) During test, the user can click Output Display to show the instrument output at the moment.

3. Incomplete Check – Range Calibration

A) According to the power incomplete check ranges input by the user, the system will calibrate each range one by one.

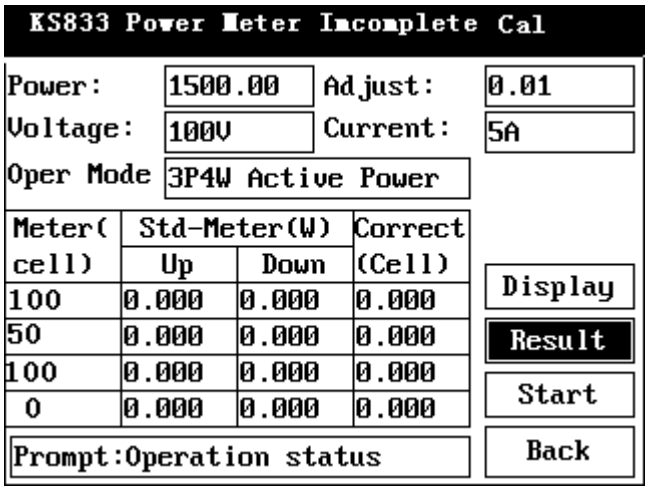


Figure 39 KS833 Power Meter Incomplete Check Range

B) Click Start Test button, the system will initialize verification points, and pop up the dialogue box of Range Switch to tell the user to switch the working voltage and current ranges of the instrument.

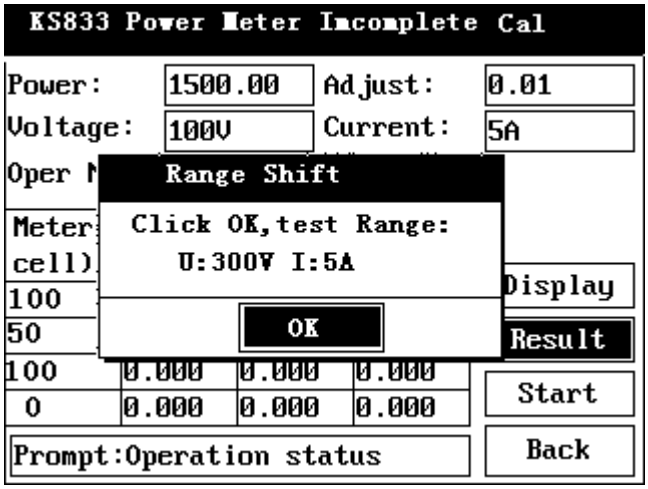


Figure 40 KS833 Power Meter Incomplete Check Range Switch interface

C) After switching the working ranges of the instrument, the user can click OK to start test. In incomplete check, for each power factor of every range, only calibrate the calibrated point, medium point and full scale value point of the max. error in complete check. For digital meters, only calibrate the 10% point of the full scale value (initial step point), medium point and full scale point.

D) After calibrating one power factor, the system will automatically switch to other power factors to calibrate. After calibrating all power factors, the system will automatically switch to the next range to continue calibration.

E) Except that no calibration on down value, the rest of the calibration process for

pointer meters are the same with that of complete check range.

6.5.1.5 Calibrate Low Power Factor Meter

On the KS833 Instrument Attributes page, click OK to enter the page of KS833 power factor meter complete check range calibration.

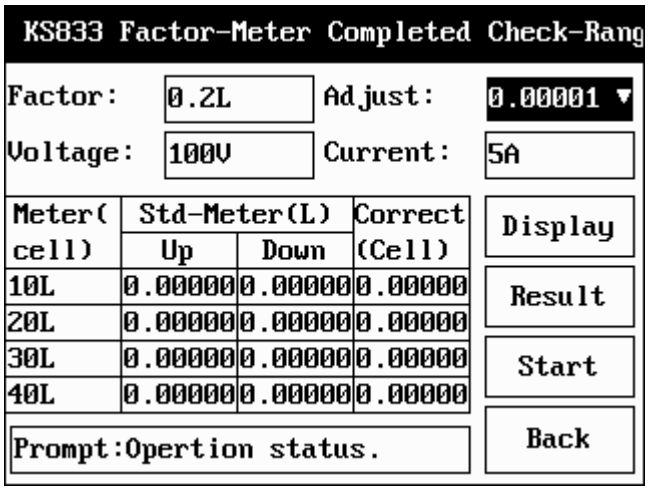


Figure 41 KS833 Power Factor Meter Complete Check Range

1. Complete Check – Range Calibration
   A) According to the instrument range parameters input in Instrument Attributes page, the system will first enter complete check range (also called basic range). The instrument's rated power factor is displayed in the text box of Power Factor. At the same time, the reference voltage and current of the complete check ranges will be displayed in the text boxes of Rated Voltage and Rated Current. In the dropdown box of Adjustment Fineness, the minimum adjustment step length will be displayed, the default adjustment fineness is the minimum adjustment step length of the power factor. During the test, you can operate the direction keys and move the focus to the dropdown box of Adjustment Fineness at any time, click Enter to select different adjustment fineness values.
   B) Click Start Test button.
      i. The system will display different calibration cell according to different meter types, for portable meters and installation meters, both up and down values need to be tested; for experimental digital meters and field digital meters, only standard values need to be tested.
      ii. When test starts, the instrument will start with 0 and increase it stably to the power factor value of the initial cell, at the same time the page bottom will prompt the user to adjust instrument output, when it's adjusted to overlap with the calibrated value, click turning rotary encoder, the system prompts that it's collecting data and the collected actual power factor value will be displayed in the cells under standard meter (if it's a pointer meter then the value will be displayed in Up or Down cells). The system will calculate corresponding error and correction values, which are displayed in corresponding cells. Then it will automatically move to the next calibration point. Due to space limit, not all tables can be listed, when the test point is in the last line of the table, the system will automatically roll up one line, until

the completion of testing the full range calibration point. If it's a pointer meter, the cursor will automatically move one cell to the right to start calibrating Down cells; if it's a digital meter, then the range calibration is completed here.

iii. The rest process is the same with that of power meter calibration.

2. Incomplete Check – Range Calibration

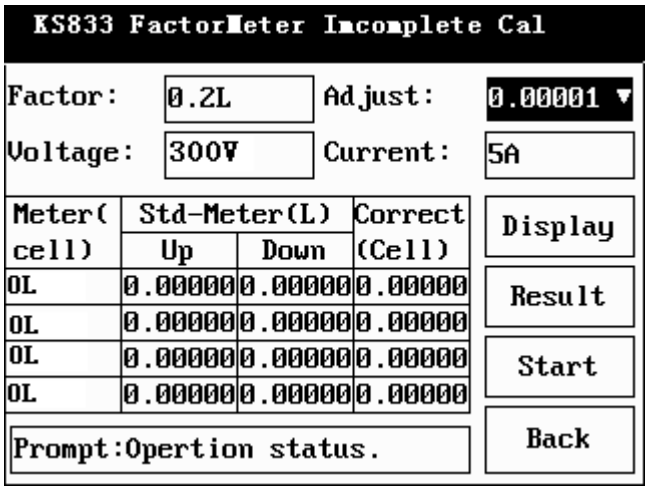


Figure 42 KS833 Power Factor Meter Incomplete Check Range

A) According to the power factor incomplete check ranges input by the user, the system will calibrate each range one by one. In calibrating power factor meters, the instrument's ranges are the rated voltage and current values of the instrument.

B) Click Start Test button, the system will initialize verification points, and pop up the dialogue box of Range Switch to tell the user to switch the working voltage and current ranges of the instrument. After switching the working ranges of the instrument, the user can click OK to start test. In incomplete check, for each range, only the calibrated point, medium point and full scale value point of the max. error in complete check will be calibrated. For digital meters, only calibrate the 10% point of the full scale value (initial step point), medium point and full scale point.

C) After calibrating one range, the system will automatically switch to the next range to continue calibration.

D) Except that no calibration on down value, the rest of the calibration process for pointer meters are the same with that of complete check range.

6.5.2 Installation Meter

Installation meters are divided into two types: with or without mutual inductance. If it's a meter with mutual inductance, the indicating value is the actual value times the coefficient of mutual induction; the others are the same as portable meters.

6.5.3 Experimental Digital Meters

6.5.3.1 For experimental digital AC voltmeter and ammeter, Figure 43 shows the interface of complete check range calibration, Figure 44 shows incomplete check range calibration.

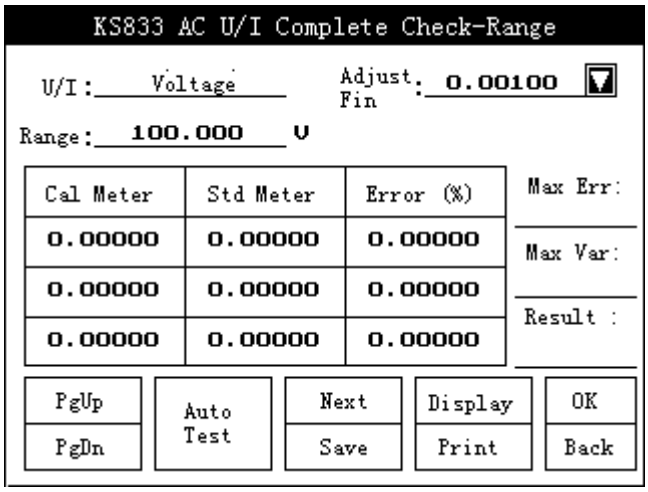


Figure 43 Experimental Digital AC Complete Check Range Calibration interface

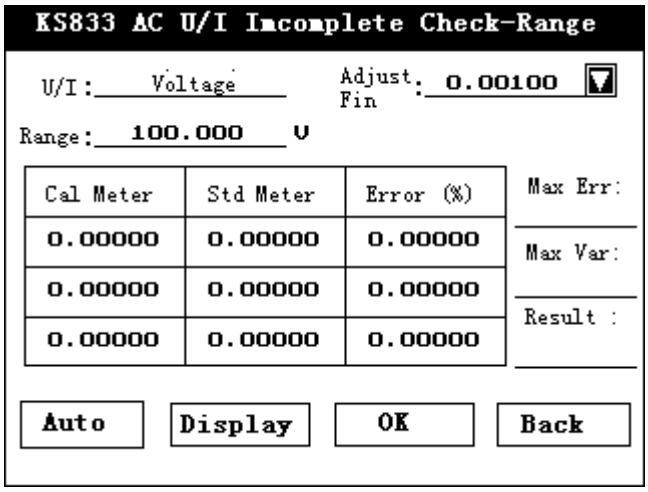


Figure 44 Experimental Digital AC Incomplete Check Range Calibration interface

The calibration process of experimental digital AC voltmeter and ammeter are basically the same with that of portable voltmeter and ammeter, only that for digital meters there's no need to calibrate variation.

6.5.3.2 For experimental digital DC voltmeter and ammeter, Figure 45 shows the interface of complete check range calibration, Figure 46 shows incomplete check range calibration.

The calibration process of experimental digital DC voltmeter and ammeter are basically the same with that of portable DC voltmeter and ammeter, only that for digital meters there's no need to calibrate variation.

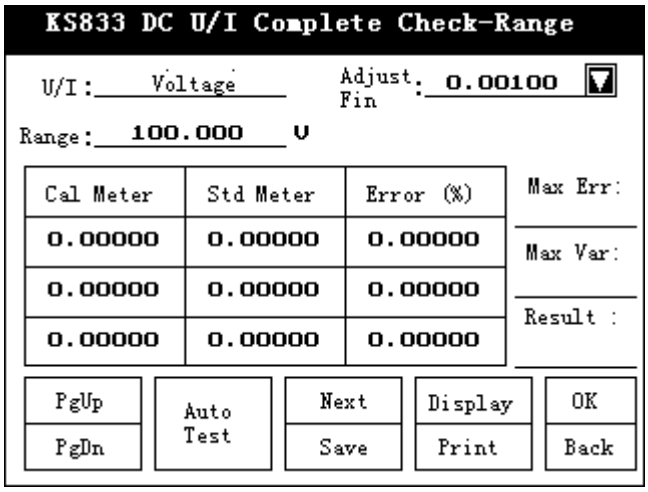


Figure 45 Experimental Digital DC Voltmeter and Ammeter Complete Check Range Calibration interface

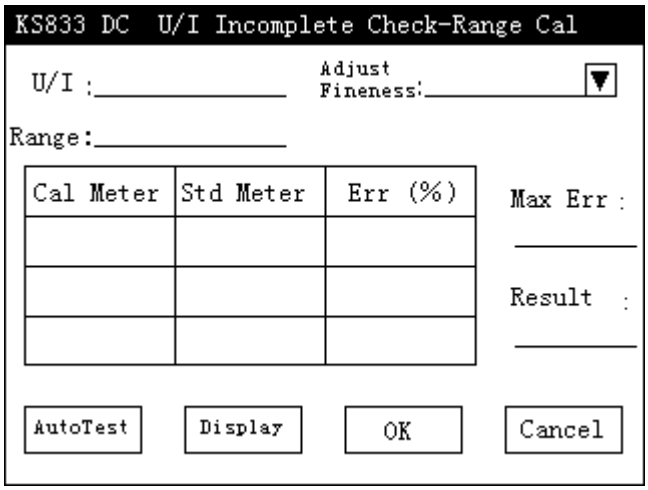


Figure 46 Experimental Digital DC Voltmeter and Ammeter Incomplete Check Range Calibration interface

6.5.3.3 Experimental Digital Phase Meter

When you want to calibrate experimental phase meter, you need to enter the interfaces shown in Figure 47 & 48. Figure 47 is the interface of complete check range calibration; Figure 48 is the interface of incomplete check range calibration.

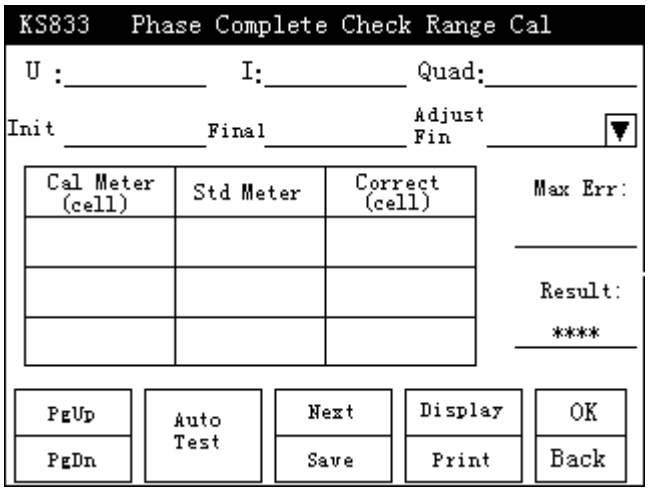


Figure 47 Experimental Digital Phase Complete Check Range Calibration interface

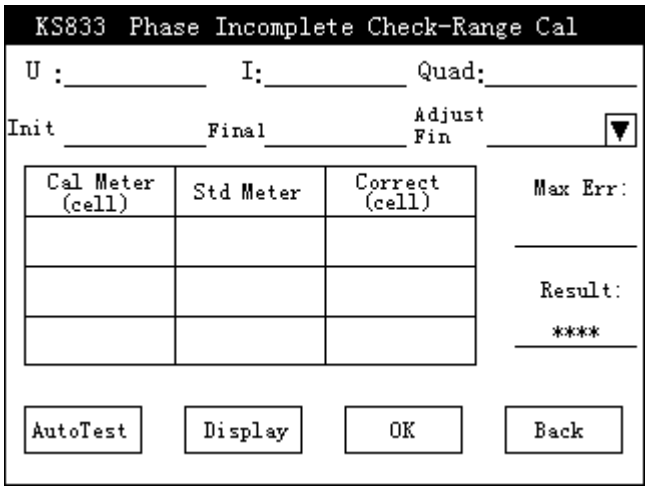


Figure 48 Experimental Digital Phase Incomplete Check Range Calibration interface

The calibration process of digital phase meter is basically the same with that of portable phase meter, the difference is that for digital phase meters, you don't have to check variation, nor is it necessary to calibrate in four quadrants.

Experimental Digital Frequency Meter

Figure 49 & 50 show the interfaces of calibrating digital frequency meters. Figure 49 is for Complete Check - Range Calibration, Figure 50 is for Incomplete Check – Range Calibration. The calibration process of digital frequency meter is basically the same with that of portable frequency meter. The only difference is that for digital frequency meters there's no need the check variation.

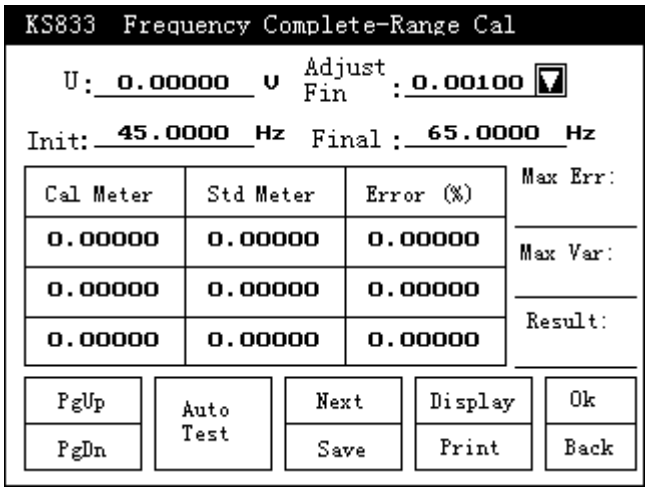


Figure 49 Experimental Digital Frequency Complete Check Range Calibration interface

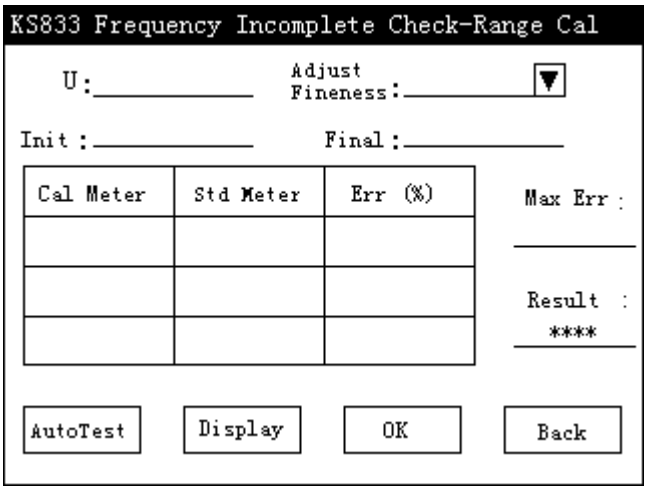


Figure 50 Experimental Digital Frequency Incomplete Check Range Calibration interface

6.5.4 Field Digital Meter

Field digital meters are also divided into two types: with or without mutual inductance, the calibration process is corresponding with that of experimental digital meters.

7 Calibrate Electrical Energy Meters

7.1 Enter Energy Meter Interface

Select Instrument Calibration in the Main Menu to enter the interface as shown in Figure 51.

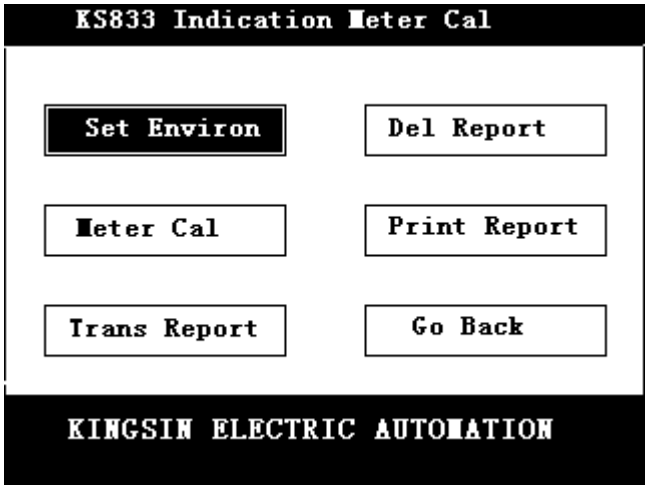


Figure 51 Interface of Instrument Calibration

Select Instrument Calibration again to enter Instrument Attributes dialogue box. As in Figure 52, select Energy Meter in Select Instrument, then input other parameters, click OK to enter the input interface of energy meter. (Note: Model and Number are required to fill out)

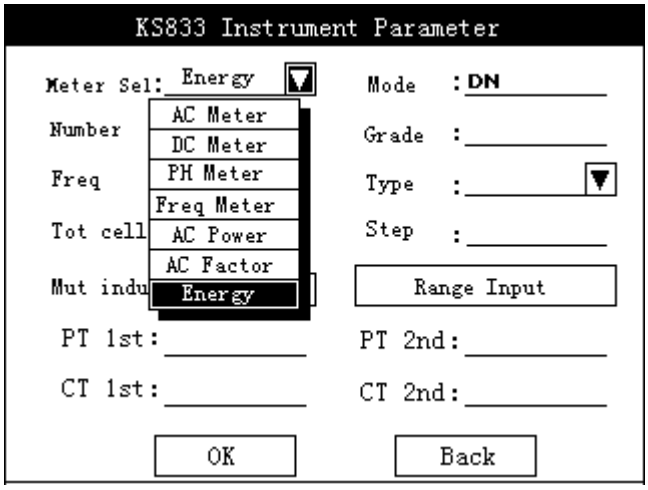


Figure 52 KS833 Instrument Attributes

7.1.1 Input Parameters For Energy Meter

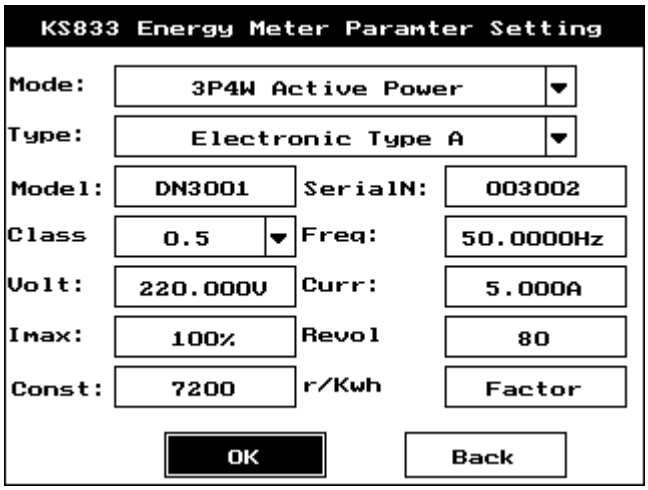


Figure 53 Input Interface for parameters for energy meter

Set the voltage and current values, and select proper constant of the energy meter, we recommend the rotation speed be greater than 2 (requiring a calculation error time greater than 3s.) The system will automatically save the parameter setting in accordance with the numbering. For instance, the Number in the above figure is 003002, after the test completion, next time if you input 003002 in Number, the same parameter setting will be called out.

7.1.2 Click the combo box of Operation Mode to see the dropdown menu as shown in Figure 54, which are “3P4W Active Power Energy Meter”, “3P3W Active Power Energy Meter”, “1P Active Power Energy Meter”, “3P4W Real Reactive Power Energy Meter”, “3P3W Real Reactive Power Energy Meter”, “3 Element 90 Degrees Reactive”, “2 Element 90 Degrees Reactive.” Click the combo box of Type to see the dropdown menu as shown in Figure 55, which is divided into Inductive Portable Meter, Inductive Installation Meter, Electronic Meter - Type A, Electronic Meter – Type B, Electronic Installation Meter. You can select the operation mode and type you want in these dropdown menus.

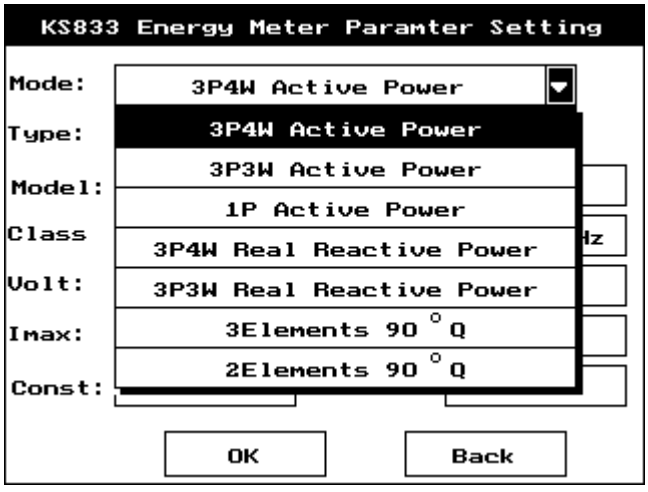


Figure 54 Combo Box of Operation Mode

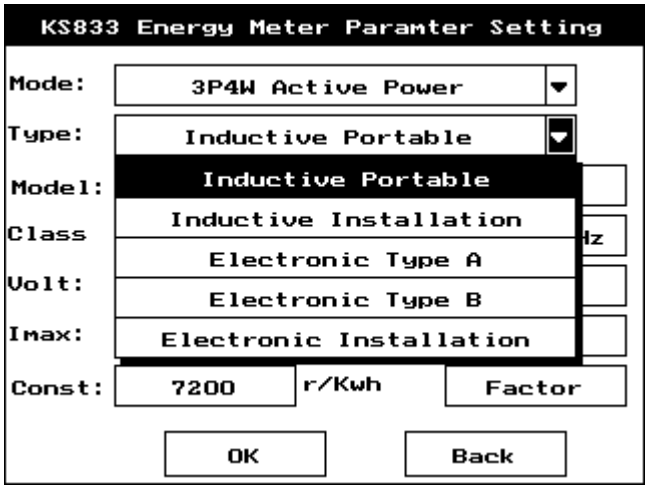


Figure 55 Combo Box of Type

Take 3P4W Active Power Energy Meter – Electronic Meter – Type A as an example, click Power Factor to be Calibrated, an interface as shown in Figure 56 will pop up:

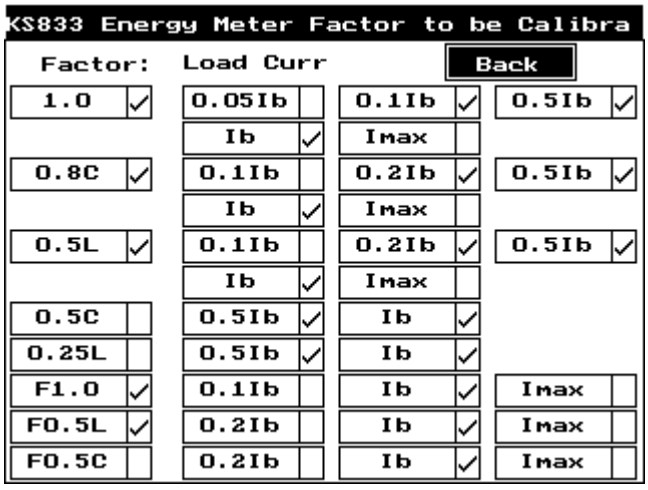


Figure 56 Select power factors to be calibrated for energy meter

The usual power factors are already selected (here, checked), if needed, you may check other power factors as well. In this dialogue box, you can move the selection box by using Left and Right of the direction keys. After finishing selection of power factors, press Return to go back.

7.1.3 Set the parameters required in Figure 53, click OK to enter the dialogue box of energy meter calibration, as is shown in Figure 57, you can select and enter any of the items.

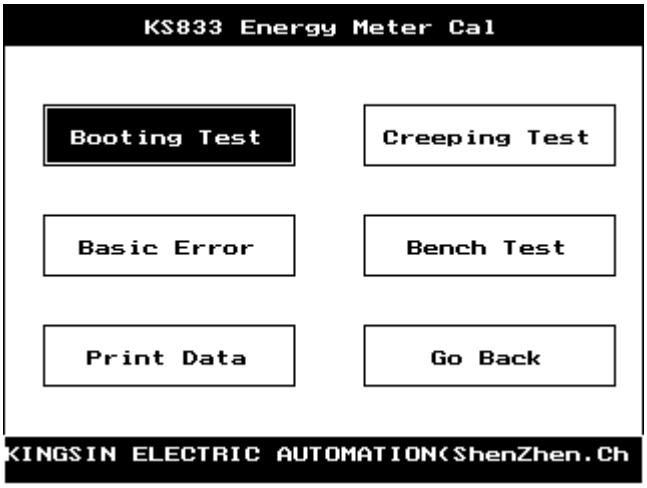


Figure 57 Calibrate electrical energy meters

7.2 Booting Test of Electrical Energy Meters

In Figure 57, select Booting Test and press Enter to enter Booting Test dialogue box as shown in Figure 58.

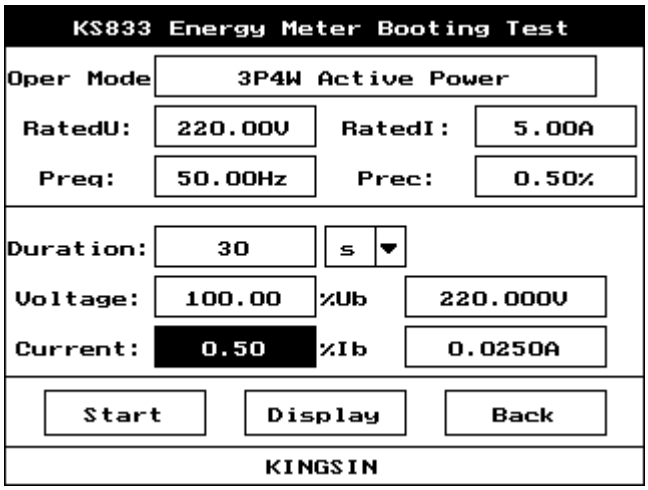


Figure 58 Booting tests of electrical energy meters

In the dialogue box of Booting Test, moving direction keys can only select Working Current, Start Test and Return. While Operation Mode, Rated Voltage, Rated Current, Working Frequency and Precision Class should be set in the interface of Figure 53 (input energy meter parameters.) You can change the current to change test duration, for instance, in Figure 55, if you change the working current from 0.50% IB to 1% Ib, the test duration will change to 545 sec.

Click Start Test and confirm that, after the test it will prompt whether the booting test of energy meter is passed or not.

7.3 Creeping Test of Electrical Energy Meters

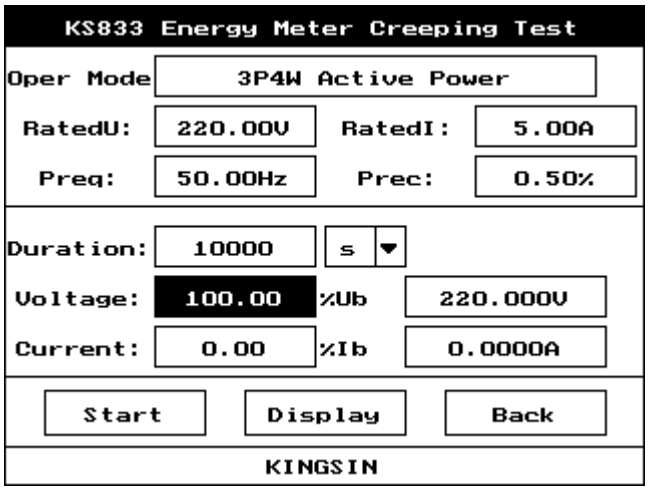


Figure 59 Creeping tests of electrical energy meters

See Figure 59 for the interface of creeping test. You can only change Test Duration and Working Voltage, the range of working voltage is 80%~120%, and like Booting Test, you have to set other parameters in the parameter input interface of energy meters.

7.4 Basic Error Test of Electrical Energy Meters

Divided into balanced load test and imbalanced load test.

7.4.1 Balanced Load Test of Energy Meters

Select Basic Error in Figure 57 and press Enter to enter the interface of Balanced Load Test of Energy Meter, see Figure 60. The power factor should be set in Figure 53 (energy meter - power factor to be calibrated).

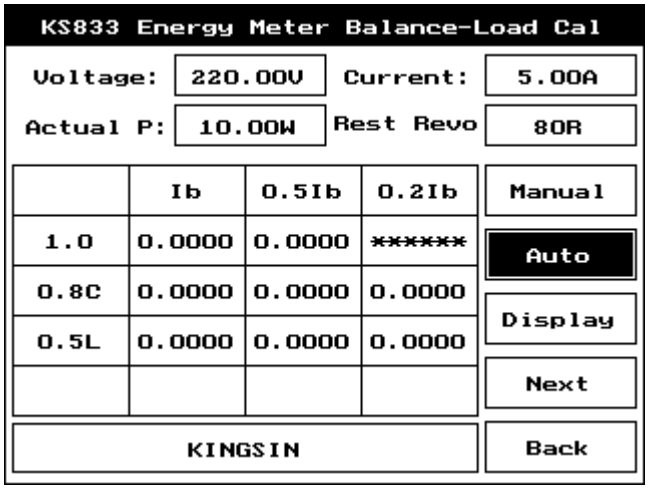


Figure 60 Balanced load test of energy meters

7.4.1.1 Auto Test

Select Auto Test, press Enter to confirm. The Instrument will test automatically, when one loop is closed, the system will deduct the Remaining Revolutions by one, till it becomes zero, then one calibration cession is over. The asterisk area indicates non-test points, the system will automatically jump over it, for instance, the (1.0, 0.2Ib) point in the figure. You can select Show Status to view status in the test process. After test completion, if a lot verification

points are selected, there will not be enough space to show all in the interface of Figure 60, you can turn the rotary encoder to move the cursor in the table and display other verification points.

7.4.1.2 Manual Test

Select Manual Test, you will see Figure 61. Press Enter, the selection box will go to the test columns, you can operate the direction keys to move the selection box to the test points you want. Press down the rotary encoder, the system will start test on the point, when it completes, the corresponding result will be displayed. Press Enter you will exit Manual Test and return to the interface of Figure 60.

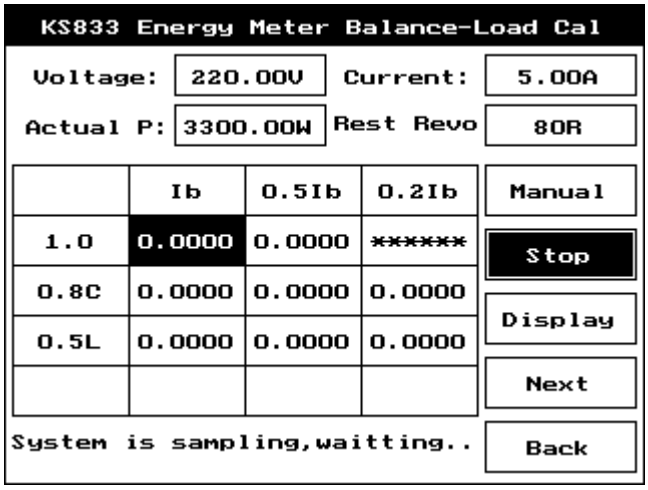


Figure 61 Balanced load test of energy meters (Manual Test)

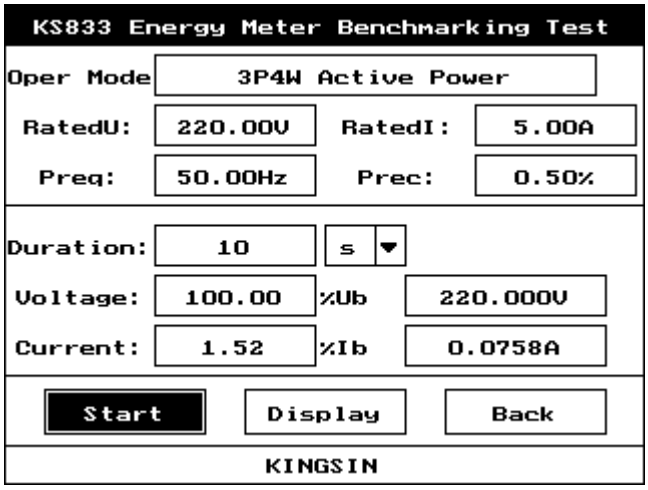
7.4.2 Imbalanced load test of energy meters

After the completions of balanced load test, select Next to enter the interface of imbalanced load test, the test procedure and operation are similar with those of balanced load test.

Note: There is no imbalanced load test for single-phase active energy meters.

7.5 Benchmarking Test of Electrical Energy Meters

The interface is shown in Figure 60. One thing to note, you cannot change any setting in the dialogue box, all the parameters should be input in energy meter input interface. Select Start Test, press Enter to confirm, the system will prompt that it's closing the loop, at the same time the test duration is shortening, till it reaches the set duration the test will be over, and test result will be displayed.



62 Benchmarking test of electrical energy meters

7.6 Data Processing

Data processing is only applicable on the basic error test of energy meters. In Basic Error Test, select Balanced Load Test – Auto Test, when it completes, press Next to select Imbalanced Load Test – Auto Test, and when it completes you press Return. At this time the interface of Balanced Load Test will display “Save”, you click “Save” and it will automatically changed into “Print”, plug the printer, test result will be printed. (Note: For auto tests, the result cannot be saved or printed.)

8 KS833 Electrical Measuring Transducer Calibration

8.1 Operation Flow

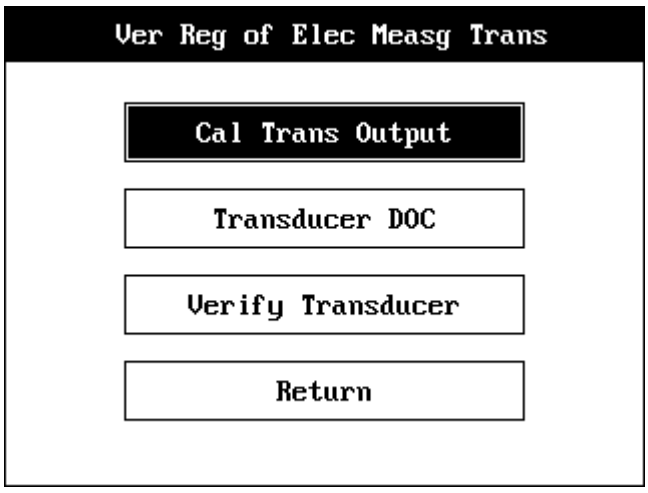


Figure 63 Transducer Calibration interface

8.1.1 In the main interface of KS833 Electrical Measuring Transducer Calibration, click “Calibrate Transducer Output” button to enter the calibration interface of calibrating transducer output nominal value. Click “Calibrate Transducer Measuring” button to enter instrument calibration page. Click “Search Transducer File” to enter search page.

8.1.2 Search Transducer File

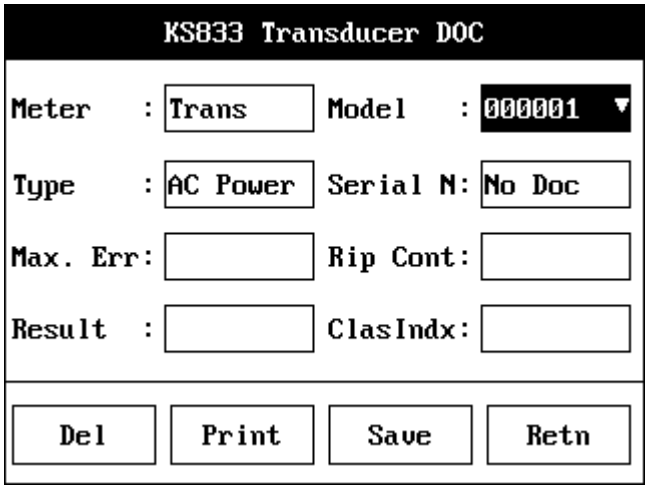


Figure 64 Search Transducer File

Select Instrument Type, Model and Number, the corresponding file will be called out. Then you can proceed to “Delete” or “Print”. Click Delete, the following page will appear, you can choose to delete file or delete model. Delete File will only delete the current file, i.e. delete the instrument number; Delete Model will delete all the meters under the model, i.e. delete the instrument model (Note: the database will also be deleted).

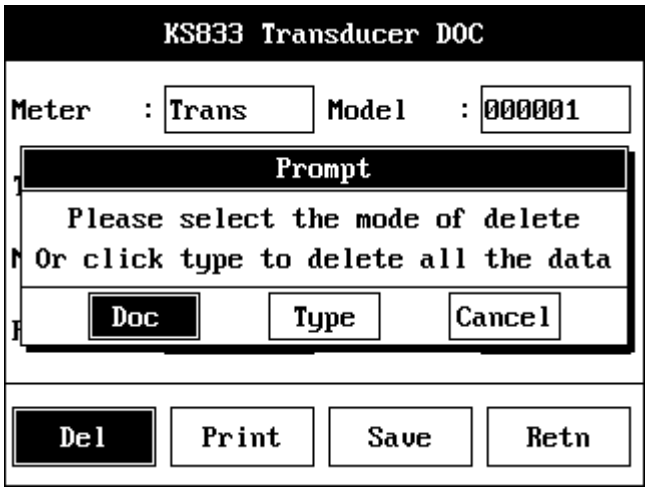


Figure 65 Delete Transducer Calibration File

8.2 Calibrate the Nominal Value of Transducer Output

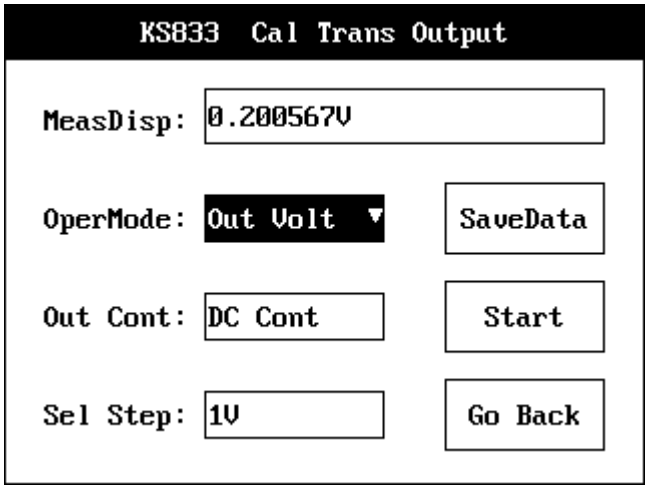


Figure 66 Transducer Output Calibration interface

Note: 1. If the data hasn't been calibrated, the measuring display will not be accurate; 2. after switching Operation Mode or Step, a time delay is needed before the accurate measuring display.

8.2.1 Select Operation Mode

8.2.1.1 Click the "Operation Mode" combo box, select "DC Voltage" or "DC Current" according to the output nominal value to be calibrated.

8.2.2 Select Output Content

8.2.2.1 Click "Output Content" combo box, select "DC Content" or "Ripple Content" to determine the calibration variable.

8.2.3 Select Working Step

8.2.3.1 Click "Working Step" combo box; select the working step to be calibrated. Three steps for DC Voltage: 1V, 5V, 10V; and three steps for DC Current: 1mA, 10mA, 20mA. (Note: For each step, the DC content and ripple content have to be calibrated)

8.2.4 Instrument Calibration

8.2.4.1 Click "Start Test" button; connect the semaphore to the DC measuring port for calibration.

8.2.4.2 Since two calibration points are required for DC measuring of the instrument, after measuring one calibration point, you need to modify the semaphore to generate the second calibration point. (Note: The instrument only requires that the difference between the two calibration points be greater than the its resolving power. However, to get a higher calibration precision, the system recommends to calibrate at the default calibration points, which are 20% and 100% of the working step.）

8.2.4.3 Wait till the connected semaphore is stable, then input the standard value in the edit box of the popup dialogue box. click Enter, wait till the system completes sampling and make sure that there is no error in the input, click OK (if you find the input standard value is wrong, you can press Up of the direction keys to move the cursor to the standard value and input the correct one, then press Enter to confirm correction). Then the instrument will proceed to calibrate the second calibration point. After modifying the semaphore, wait till the input signal is stable, then follow the same process as that of the first calibration point. After completing calibration of two calibration points, click Stop Test to close instrument output.

8.3 Continue Calibration

8.3.1 Select other calibration items to continue. After the completion of any calibration item, you can click Save Data button to save the calibration data. Before exit this page, the system will automatically save all the unsaved calibration data of the cession. (Note: there will not be prompt to save, the saving process is mandatory.)

8.4 Verify Transducer Measuring

8.4.1 Instrument Parameter Setting

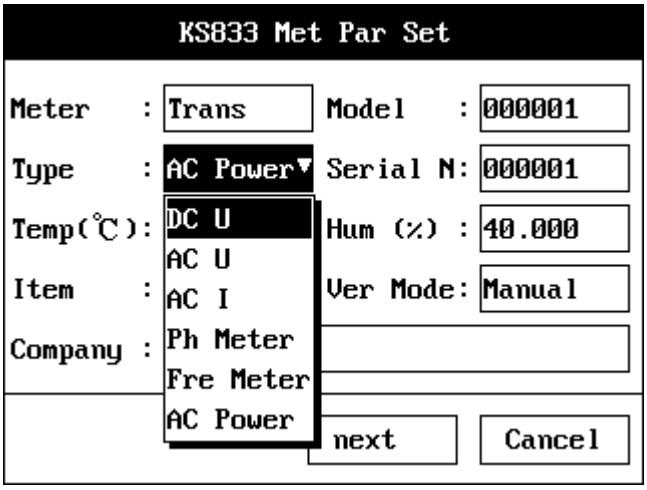


Figure 67 Instrument Parameter Setting interface

8.4.1.1 Click “Calibrate Transducer Measuring” button to enter instrument parameter setting page. Set the class, type, model and number of the instrument to be calibrated. Input the parameters of the instrument in the edit boxes of the page.

8.4.1.2 In the combo box of Verification Mode, select “Auto” or “Manual.” For auto verification, the system will enter closed loop all-through fully automatic verification mode, and the user is not permitted to alter calibration parameter during the verification process. In manual test, the user can select any test point to test.

8.4.2 Parameter Setting for the Instrument to be Calibrated

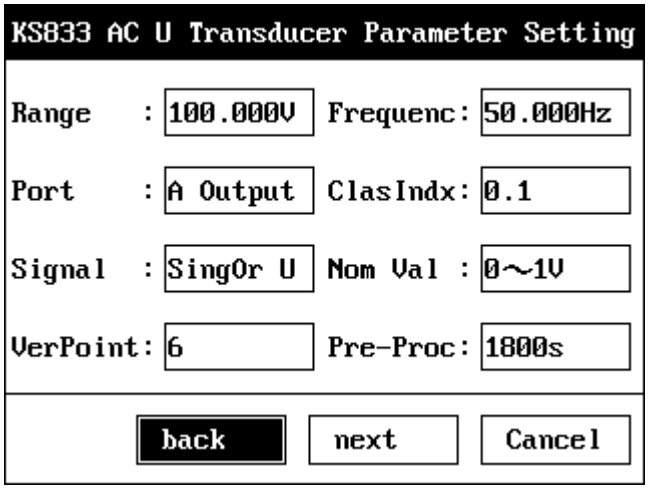


Figure 68 AC Voltage Transducer Parameter Setting interface

8.4.2.1 In Instrument Parameter Setting page, click next to enter parameter setting for the

instrument to be calibrated.

8.4.2.2 When you select Transducer in instrument type, you need to set the transducer's inherent parameters (output signal, output nominal value, verification points and pre-process duration). When the Verification Mode is set as Manual, you cannot set Verification points and Pre-processing duration.

8.4.2.3 Select different instruments (there are different types of transducers: DC voltage, AC voltage, AC current, frequency phase, frequency, and AC power), different parameter settings will appear on the instrument attributes setting page for you to set.

8.4.2.4 If you want to select other instrument to be calibrated, click "Back" to return to the Instrument Parameter Setting page. Click "Next" to enter Instrument Inspection page, to do inspection test. Click "Cancel" to cancel this cession of transducer inspection and return to Main Menu.

8.4.3 Transducer Inspection Test

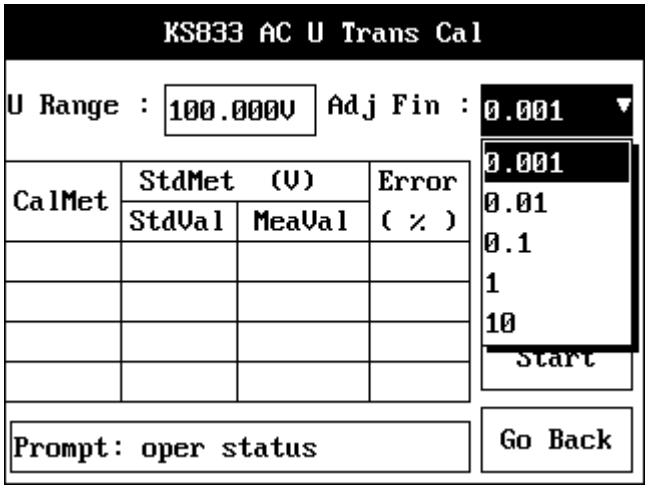


Figure 69 AC Voltage Transducer Inspection interface

8.4.3.1 For different types of meters, the system will display different inspection pages after it enters transducer inspection page（It is mainly which display different type parameters of the inspection）.

Example 1: AC Voltage Transducer Inspection, set the output signal as single-phase voltage, 9 verification points, for this meter to be verified they are: 0, 12.5, 25, 37.5, 50, 62.5, 75, 87.5, 100.

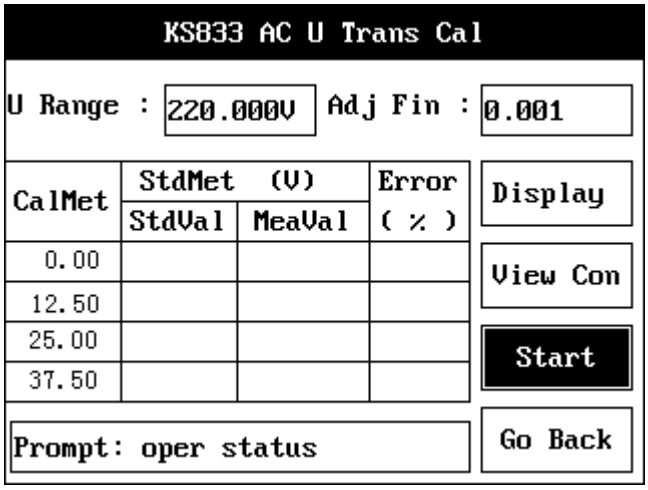


Figure 70 Example 1

Example 2: Frequency frequency Transducer Verification, set the output signal as bi-directional voltage, 7 verification points, for this meter to be verified they are: -100, -66.67, -33.33, 0.00, 33.33, 66.67, 100.

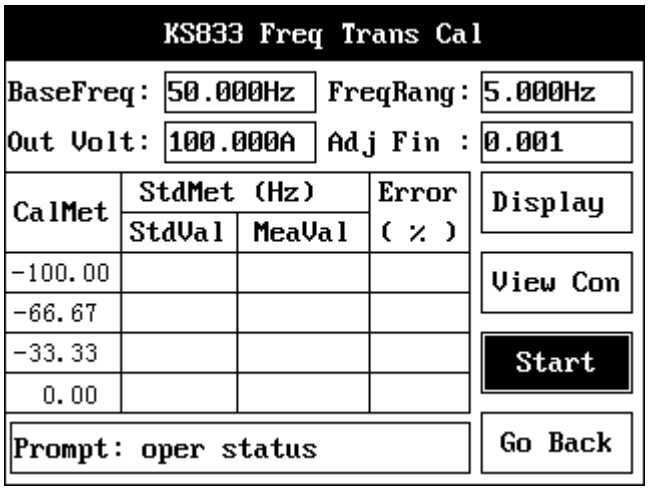


Figure 71 Example 2

8.4.3.2 Click Start Test button to start. Since the measured values of the transducer are directly connected to the instrument's DC measuring port (DC 20Ma/10V), so during auto inspection the system will enter all-through closed loop fully automatic inspection, during the process, no intervention or setting will be required from the user.

8.4.3.3 For manual inspection, the user will set the present verification points for inspection. Take the point of 50% as an example: click "Start Test" and then turn the rotary encoder to alter the Standard Value, when it becomes 15V (50% point), press down the rotary encoder to start inspection.

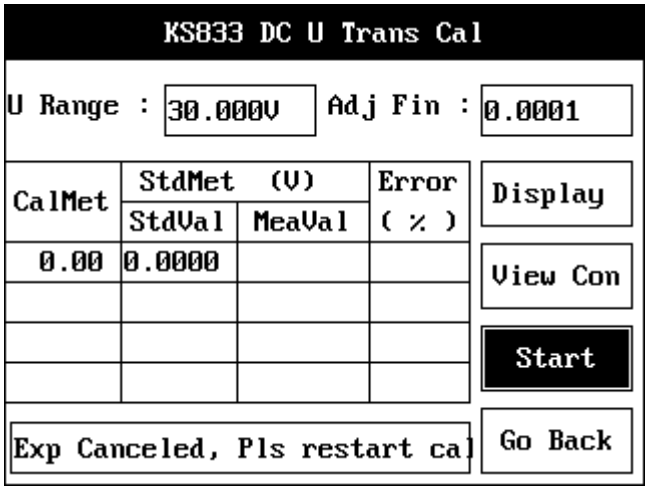


Figure 72 DC Voltage Transducer Inspection

Select different "Adjustment Fineness" to adjust the step length of the rotary encoder. After inspecting one point, the next inspection point will take the previous one as the initial value. (Note: 1. Adjusting Fineness is only applicable in manual test; 2. Only when calibrating max. Value wills the ripple content be calibrated.)

8.4.3.4 Power Transducer Inspection

Select "AC Power" from the Instrument Parameter Setting interface of Figure 67, you

will see Figure 73 the Power Transducer Parameter Setting interface, input the voltage and current ranges, number of verification points and pre-processing duration, and select other parameters; 12 verification points means 12 points for each power factor. (Note: Pre-processing Duration is only applicable when the verification mode is Auto.)

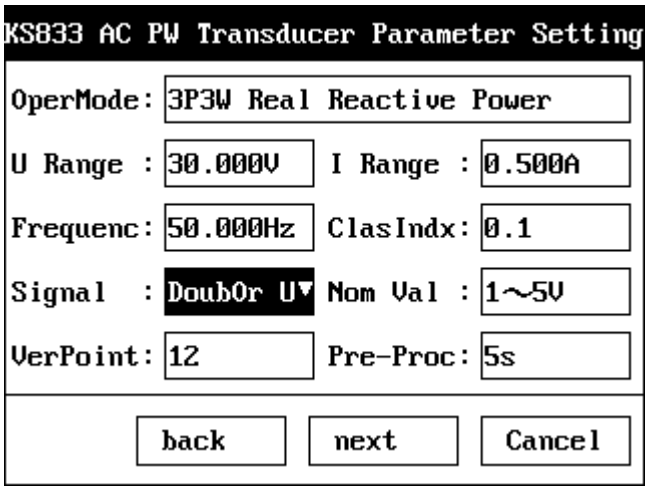


Figure 73 Power Transducer Parameter Setting

Click “Next” to see Figure 74, the interface for testing-process of power transducer inspection

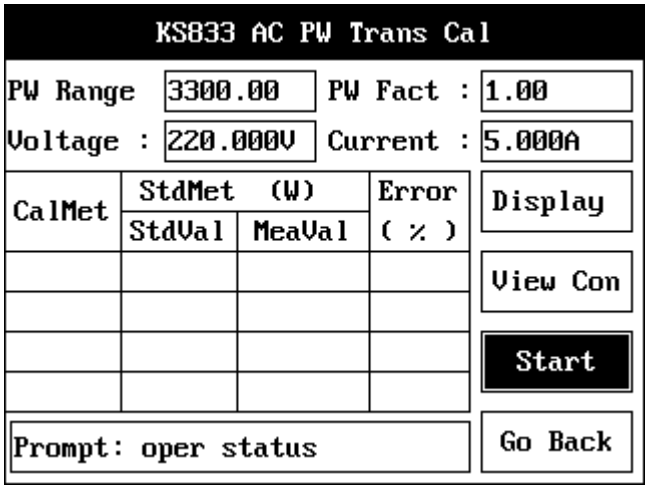


Figure 74 Power Frequency Transducer Inspection

Available power factors: 1.0,0.5L, 0.5C. When the verification mode is Auto, you cannot select power factor, the system will set it as 1.0 at the beginning of the test, then 0.5L and 0.5C subsequently. When it’s Manual, you can select any of the three power factors to test. When the output signal is bi-directional, under the column of Calibrated Meter there appears +0 or -0, which indicates that the current is zero at the moment, and the powers factors are ±1, ±0.5L, ±0.5C respectively.

8.5 Test Conclusion:

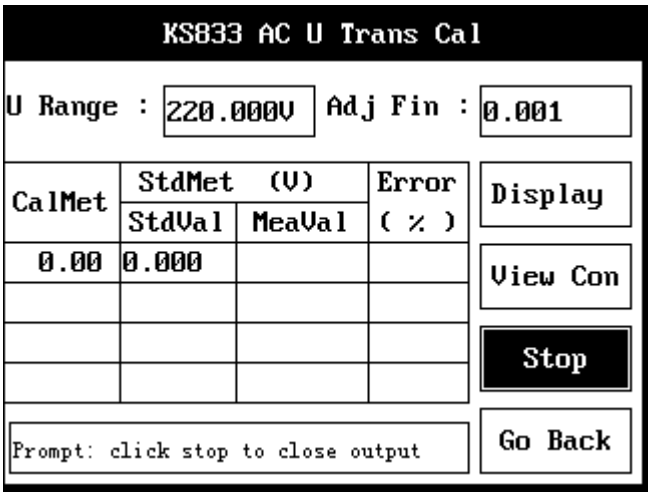


Figure 75 AC Voltage Transducer Inspection interface

Click Stop Test, the user can then click Conclusion button to view the max. error and max. error point of this cession; when the verification point is the full scale range, the system will automatically test ripple, but only once. (Note: When you click “Stop Test” button, the final conclusion (passed or not) will be displayed.)

8.6 Stop Test

In Auto test, after closing the test on all inspection points, you can click “Stop Test” button to close instrument output, at the same time the “Stop Test” button will change to “Save”, “Output Display” become “Print”.

8.7 Data Processing

After Stop Test, you can click “Conclusion” to view whether the tested instrument passed or not, click “Print” to print the file, click “Save” to save the data of this test cession.

9. Calibrate Multifunction Standard Source

9.1 Brief Introduction

KS833 multifunction standard source calibration is divided into five parts: AC standard source calibration, phase standard source calibration, DC standard source calibration, power standard source calibration and change password; the interface is shown in Figure 76.

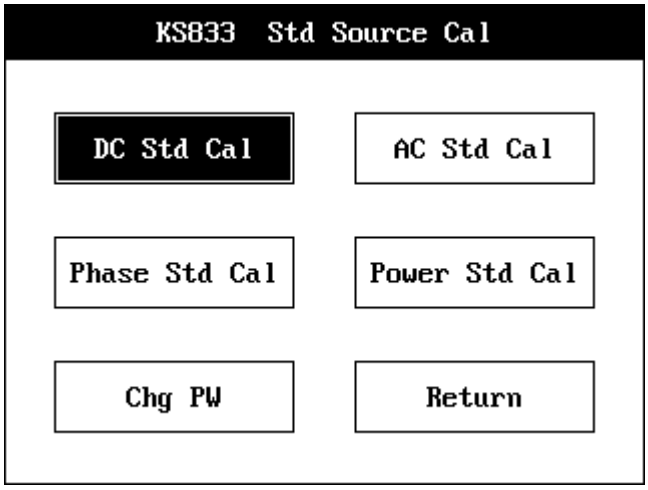


Figure 76 KS833 Standard Source Calibration main menu interface

9.2 Operation Flow

9.2.1 In the Main Menu, select Standard Source Calibration to enter the standard source calibration page, click button the enter corresponding calibration page, you will be requested to input password on the page (as shown below), access would be denied if the password is incorrect. Click Return to return to the Main Menu. (Note: You can set the authorization password in "Change Password."

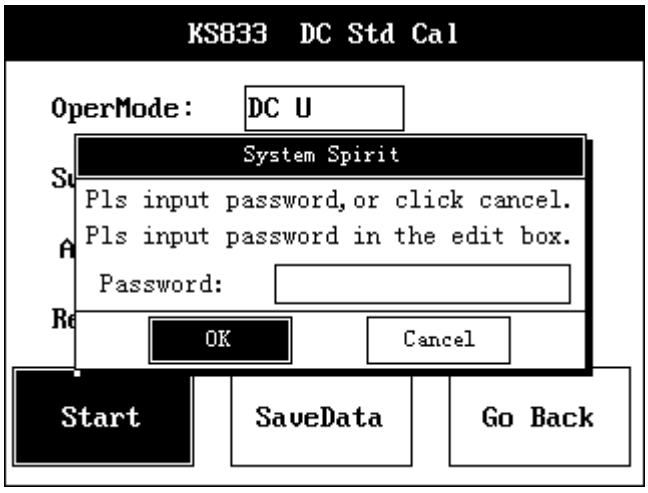


Figure 77 Password Input interface

9.2.2 AC Standard Source Calibration: see Figure 78 for its interface

9.2.2.1 Click the "Operation Mode" dropdown box, select "AC Voltage" or "AC Current."

In the Working Step dropdown box, select the working step you want to calibrate, if voltage is selected for the operation mode, voltage steps will be display, and current steps will be displayed if current is selected. In the Output Port dropdown box, select Phase A, B or C output. Output port and operation mode will determine the output item for calibration. For instance: calibrating Ua would require selection of both AC Voltage and Phase A output, calibrating Ia would require selection of both AC Current and Phase A output. Select the voltage and current steps in Working Step dropdown box.

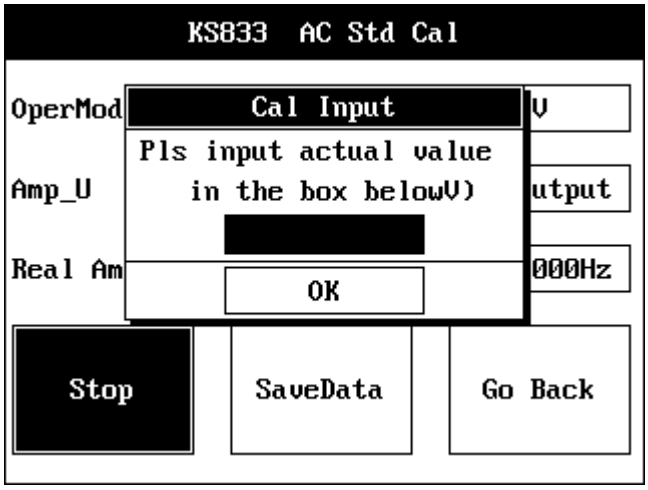


Figure 78 KS833 AC Standard Source Calibration interface

9.2.2.2 Connect the standard source meter to the selected the output port.

9.2.2.3 Click Start Test button, wait till system output is stable, then input the indicating value of the standard source in the edit box of the popup dialogue box. Click enter, wait till the completion of system sampling, make sure the input is correct, then click OK. At this time the calibration of the step of the output terminal is over, click Stop Test to close instrument output.

9.2.2.4 Repeat the first step; select other calibration items to continue. After the completion of any calibration item, you can click Save to save data. After calibration, before exit this page, the system will automatically save all the unsaved calibration data of the cession. (Note: there will be no prompt to save.)

9.2.3 Phase Standard Source Calibration: see Figure 79 for its interface

9.2.3.1 When calibrating phase standard source, you need to calibrate the corresponding AC standard source. That is, you have to calibrate amplitude first, then calibrate phase, but you can re-calibrate amplitude without re-calibrate phase.

9.2.3.2 When calibrating phase standard source, select the phase output terminal in the dropdown box of Operation Mode,

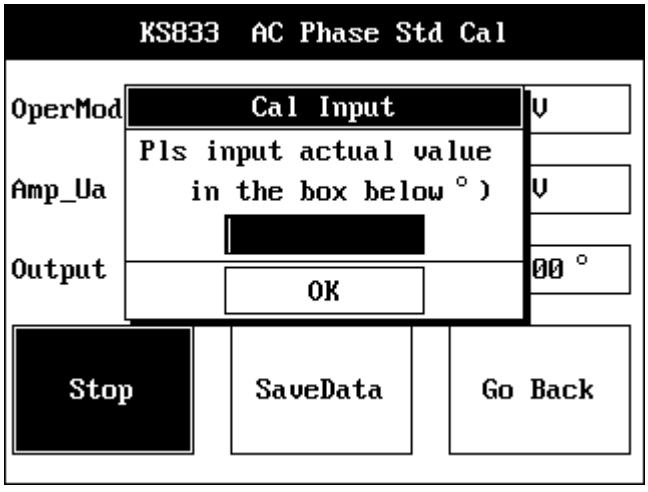


Figure 79 KS833 AC Phase Standard Source Calibration interface

Select all voltage steps in Working Step dropdown box.

9.2.3.3 Connect the phase meter to the corresponding output port, if the test phases are

those or Ua and Ub or Uc, then the two phases' rated voltage is the voltage of the selected working step; if the test phases are those of Ua and Ia, Ib or Ic, then Ua's rated voltage is the selected working voltage, while the rated current of the current phase is 5A.

9.2.2.4 Click Start Test button, wait till system output is stable, then input the indicating value of the standard source in the edit box of the popup dialogue box. Click enter, wait till the completion of system sampling, make sure the input is correct, then click OK. At this time the calibration of the step of the output terminal is over, click Stop Test to close instrument output.

9.2.3.5 Repeat 9.2.2.4.

9.2.4 DC Standard Source Calibration: see Figure 80 for its interface

9.2.4.1 When calibrating a DC standard source, if you want to calibrate DC voltage, that must wait till after calibrating the steps of 300V and 100V AC under voltage Ua and Ub. After re-calibrating Phases A & B voltage, generally there's no need to re-calibrate DC voltage. You don't have to calibrate Phase A and Phase B voltage before calibrating DC current.

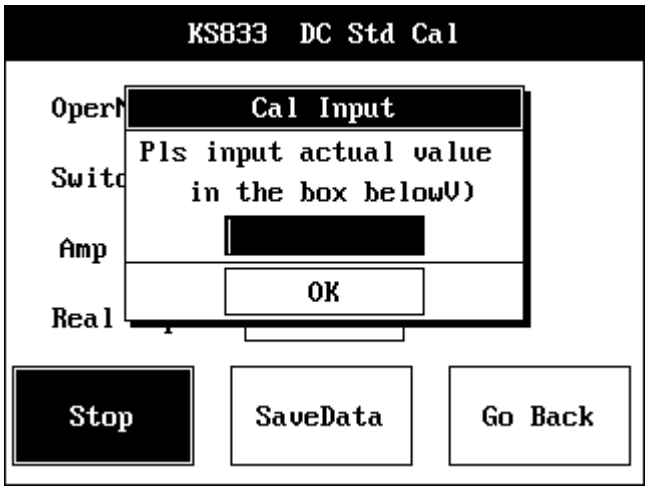


Figure 80 KS833 DC Standard Source Calibration interface

9.2.4.2 Click the "Operation Mode" dropdown box, select "DC Voltage" or "DC Current." In the Working Step dropdown box, select the working step you want to calibrate, if voltage is selected for the operation mode, voltage steps will be display, and current steps will be displayed if current is selected. Select the voltage and current steps in Working Step dropdown box.

9.2.4.3 Connect the standard source meter to the selected the output port.

9.2.2.4 Click Start Test button, the instrument will output the first calibration point, wait till system output is stable, then input the indicating value of the standard source meter in the edit box of the popup dialogue box. Click enter, wait till the completion of system sampling, make sure the input is correct, then click OK. At this time the instrument will output the second calibration point, as the first calibration point, you input the indicating value of the standard meter. Confirm that, then the calibration of the step of the output terminal is over; click Stop Test to close instrument output.

9.2.4.5 Repeat 9.2.2.4.

9.2.5 Power Standard Source Calibration: see Figure 81 for its interface

9.2.5.1 Calibration of power standard source must come after the completion of calibrating

AC standard source and phase standard source, meanwhile, after re-calibration of AC standard source and phase standard source, you need to re-calibrate power standard source.

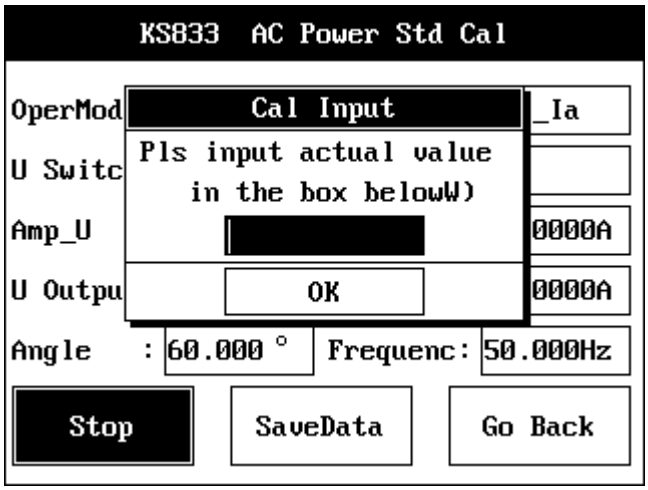


Figure 81 KS833 AC Phase Power Standard Source Calibration interface

9.2.5.2 Select the calibration options in the dropdown box of Operation Mode: 3P4W, 3P3W or Cross Phase Input; select the calibration voltage step in the Voltage Step dropdown box and select the current step in the dropdown box of Current Step; select Phase A, B or C current output in the dropdown box of Output Port. Output port and operation mode will determine the output terminal for calibration.

9.2.5.3 Cable connection in power calibration: When calibrating a power meter, connect the corresponding standard power meter (arbitrary phase angle) terminal to the output port of the instrument, when you calibrate 2 Element arbitrary phase angle power meter, Ub shorts with U0.

9.2.5.4 In the dropdown box of Voltage Step, select 750V, 300V and 100V in sequence, select the current steps one by one in the dropdown box of Current Step.

9.2.2.5 Click Start Test button, the instrument will output the first calibration point, wait till system output is stable, then input the indicating value of the standard source meter in the edit box of the popup dialogue box. Click enter, wait till the completion of system sampling, make sure the input is correct, then click OK. At this time the instrument will output the second calibration point, as the first calibration point, you input the indicating value of the standard meter. Confirm that, then the instrument will output the third calibration point; the operation process is the same of the above. The calibration of step of the output terminal is over; click Stop Test to close instrument output.

9.2.5.6 Repeat 9.2.2.4.

9.2.6 Change Password

Select Change Password, the following interface will pop up:

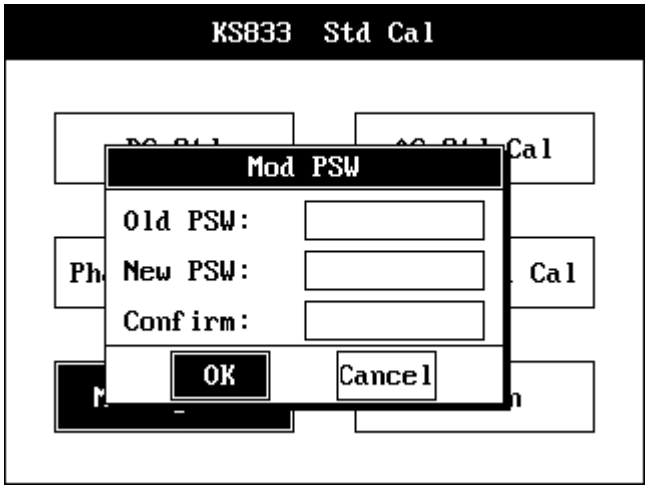


Figure 82 Change Password interface

If the Old Password was set as 12345, move the cursor to the Old Password box and input 12345, press Enter to confirm; move cursor to New Password box, input 123, press Enter; move cursor to Confirm Password box, input 123 again, press Enter to confirm; finally move cursor to OK button, press Enter to exit.

123 is the password for accessing standard source calibration, and it's the only valid one, that is, after you input a new password, the old one becomes invalid, as is 12345 in this example. (Note: The manufacturer will give the Old Password or make it a blank in default.)

When you modify a password, the system only display the number of characters in "*", without displaying the input character. If the Change Password process is accepted, the system will prompt that the password has been changed, and only when you see this prompt will the new password become valid. While any other prompt or operation will not change the password. Two reasons might lead to the failure in Change Password: first, incorrect Old Password; second, you input different New Passwords. So you should be careful when you change password

9.3 Attention：

Calibration data is the data necessary for the instrument to work normally, so in calibrating standard source, you should make sure the correctness of each calibration point.

10 Connected tests

10.1 Functions:

10.1.1 Connected test is used to communicate with the test software in host computer and exercise control of KS833 standard source.

10.1.2 Under the control of host computer software, directly calibrate the instrument's output, calibration and connected closed loop calibration, as well as the sampling of actual output.

10.2 Operation method:

10.2.1 In the Main Menu, click Connected test to enter the interface.

Figure 83 KS833 Connected test interface

10.2.2 Make sure the serial port and host computer are corrected connected, click Start Connection button, the system will pop up the Start Connection dialogue box, at the same time, the Connection spirit will automatically check serial port and host computer.

10.2.3 After receiving host computer's signal, the Connection spirit will close the dialogue box, at the same the tagtext of Start Connection will change into Disconnect. During connecting process, if there's a fault like incorrect serial port setting, or no serial port connection, or the software is not running in the host computer, the Connection spirit will wait till the above failures are corrected. During connecting process, the user may click Cancel in the Connection spirit dialogue box to cancel the connection at any time.

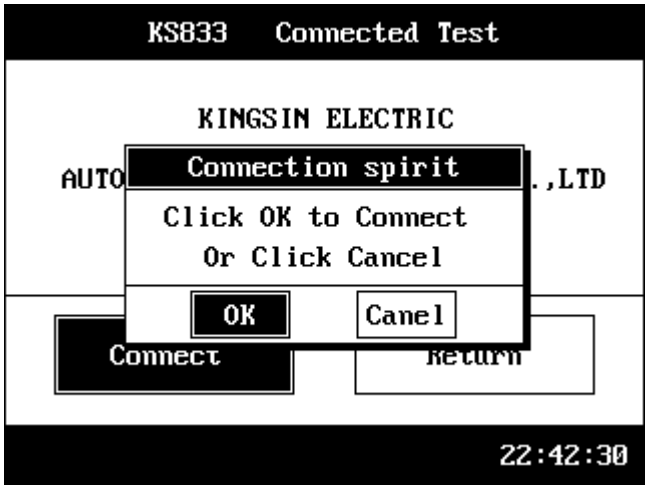


Figure 84 KS833 Connection spirit interface

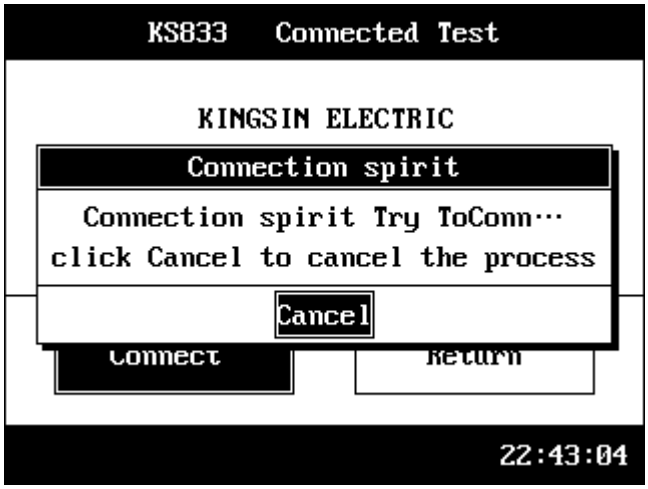


Figure 85 KS833 Connection spirit interface

10.2.4 When the connection is established, the system will be directly controlled by the host computer software, without any intervention from the user.

10.2.5 The user may click Disconnect at any time to disconnect with the host computer. If you want to disconnect during a test process, the system will automatically close test output and then disconnect with the host computer. If when you want to disconnect, the connection with host computer is already lost, then the Connection spirit will automatically disconnect after duration of waiting time, without any response from the host computer.

10.2.6 Click Return to Main Menu to exit connected test interface.

Appendix I

Error Calculation

Fiducial error is used in indicating instrument and transducer verification:

A: Calculation of the fiducial error of indicating instrument:

$$FiducialError = \frac{S\tan dardValue - MeasuredValue}{FullScale} \times 100\%$$

Of which: Standard Value is the indicated value of the indicating instrument

Measured Value is the actual output of the source

B: Calculation of the fiducial error of transducer

$$FiducialError = \frac{MeasuredValue - S\tan dardValue}{FullScale} \times 100\%$$

Of which: Measuring Range = Full Scale – Zero Scale

Standard Value = Measuring Range x Calibration Point Percentage

Relative error is used in verifying electrical energy meter:

$$\mathrm{Re}lativeError = \frac{MeasuredValue - S\tan dardValue}{S\tan dardValue} \times 100\%$$

Harmonic Terminology in Numeric Expression

1. Voltage content of the h[th] harmonic HRU_h:

$$HRU_h = \frac{U_h}{U_1} \times 100\%$$

In which: U_h —— voltage of the h[th] harmonic (root-mean-square)

U_1 ——Voltage of the fundamental (root-mean-square)

2. Current content of the h[th] harmonic HRI_h:

$$HRI_h = \frac{I_h}{I_1} \times 100\%$$

In which: I_h—— Current of the h[th] harmonic (root-mean-square)

I_1 ——Current of the fundamental (root-mean-square)

3. Voltage content of the harmonic U_H:

$$U_H = \sqrt{\sum_{h=2}^{\infty} (U_h)^2}$$

4. Current content of the harmonic I_H:

$$I_H = \sqrt{\sum_{h=2}^{\infty} (I_h)^2}$$

5. Voltage total harmonic distortion THD_u:

$$THD_u = \frac{U_H}{U_1} \times 100\%$$

6. Current total harmonic distortion THD_i:

$$THD_i = \frac{I_H}{I_1} \times 100\%$$

Attachment I

KS833 Software Upgrading

I. Software Introduction

1. This system is the assisting software of KS833 Comprehensive Calibrating Unit for Electrical Measuring Instruments developed by Kingsin Electric Automation (Shenzhen) Co., Ltd., it mainly functions to process software upgrading of KS833's Lower Computer system.

II. Instruction on Use

1. Software installation: Place the CD marked with KS833 Software Upgrading System into the computer's CDROM, click SETUP.EXE under the directory of KS833 Software Upgrading in the CDROM drive, then proceed the installation according to software prompts.

2. Connected test: Before data transfer, you must test the connection to ensure PC and the instrument are properly connected, when you make sure the computer and KS833 are properly connected through serial port cable, you should open the KS833 Software Upgrading software in the computer and KS833 Comprehensive Calibrating Unit for Electrical Measuring Instruments. Wait till KS833 Comprehensive Calibrating Unit enters its Main Menu, select software upgrading menu and confirm, then KS833 Comprehensive Calibrating Unit will enter a waiting status for connection, click Connected test button in KS833 Software Upgrading system, if it displays information for successful connection, then it's connected.

3. Software upgrading: After connection established successfully, click Send File button or menu, wait till a dialogue box pops up, select the latest program for KS833 Comprehensive Calibrating Unit for Electrical Measuring Instruments provided by Kingsin Electric Automation (Shenzhen) Co., Ltd. and press Enter, the system will prompt you that it's upgrading, you can view the upgrading process in the progress bar, when the transfer is over, the Transfer Status box in the bottom will display Sent, KS833 Comprehensive Calibrating Unit for Electrical Measuring Instruments will automatically return to Main Menu, then the upgrading is completed.

4. Interrupt transfer: If you want to interrupt the file transfer process, click Interrupt to cancel sending the data.

5. Exit: Click Exit to exit the system

Attachment Ⅱ

Logogram

Adj	adjustment fineness
Adjust Fin	adjustment fineness
Amp	amplitude
Bench	benchmarking
Cal	calibration
Chg	change
Clas	class
Curr	current
Comp	component
Dig	digital
DOC	document
Elem	element
Exp	experimental
Err	error
Fac	factor
Fin	final
Fr	frequency
Fun	fundamental
HarCon	harmonic content
Harm	harmonic
Hum	humidity
Inst	instrument
Inv	invalidation
MeasDisp	measuring display
MeaVal	measuring value
Mut	mutual
Oper	operation
OverReg	overall regulating
Ph	phase
PhReg	phase dividing regulating
PSW	password
Prec	precision
Pre-Proc	pre-processing
Qu	quadrant
Retn	return
Sel	select
Set	setting
Std	standard
StdVal	standard value
THD	total harmonic distortion

Trans	transducer
Var	variation
Ver	verify
Volt	voltage