B+K PRECISION
ELECTRONIC TEST INSTRUMENTS

BA6010, BA6011

Battery Analyzer

User Manual

Safety Summary

The following safety precautions apply to both operating and maintenance personnel and must be followed during all phases of operation, service, and repair of this instrument.

⚠WARNING

Before applying power to this instrument:

- Read and understand the safety and operational information in this manual.
- Apply all the listed safety precautions.
- Verify that the voltage selector at the line power cord input is set to the correct line voltage. Operating the instrument at an incorrect line voltage will void the warranty.
- Make all connections to the instrument before applying power.
- Do not operate the instrument in ways not specified by this manual or by B&K Precision.

Failure to comply with these precautions or with warnings elsewhere in this manual violates the safety standards of design, manufacture, and intended use of the instrument. B&K Precision assumes no liability for a customer's failure to comply with these requirements.

Category rating

The IEC 61010 standard defines safety category ratings that specify the amount of electrical energy available and the voltage impulses that may occur on electrical conductors associated with these category ratings. The category rating is a Roman numeral of I, II, III, or IV. This rating is also accompanied by a maximum voltage of the circuit to be tested, which defines the voltage impulses expected and required insulation clearances. These categories are:

Category I (CAT I): Measurement instruments whose measurement inputs are not intended to be connected to the mains supply. The voltages in the environment are typically derived from a limited-energy transformer or a battery.

Category II (CAT II): Measurement instruments whose measurement inputs are meant to be connected to the mains supply at a standard wall outlet or similar sources. Example measurement environments are portable tools and household appliances.

Category III (CAT III): Measurement instruments whose measurement inputs are meant to be connected to the mains installation of a building. Examples are measurements inside a building's circuit breaker panel or the wiring of permanently-installed motors.

Category IV (CAT IV): Measurement instruments whose measurement inputs are meant to be connected to the primary power entering a building or other outdoor wiring.

⚠WARNING

Do not use this instrument in an electrical environment with a higher category rating than what is specified in this manual for this instrument.

⚠WARNING

You must ensure that each accessory you use with this instrument has a category rating equal to or higher than the instrument's category rating to maintain the instrument's category rating. Failure to do so will lower the category rating of the measuring system.

Electrical Power

This instrument is intended to be powered from a CATEGORY II mains power environment. The mains power should be 115 V RMS or 230 V RMS. Use only the power cord supplied with the instrument and ensure it is appropriate for your country of use.

Ground the Instrument

⚠WARNING

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical safety ground. This instrument is grounded through the ground conductor of the supplied, three-conductor AC line power cable. The power cable must be plugged into an approved three-conductor electrical outlet. The power jack and mating plug of the power cable meet IEC safety standards.

⚠WARNING

Do not alter or defeat the ground connection. Without the safety ground connection, all accessible conductive parts (including control knobs) may provide an electric shock. Failure to use a properly-grounded approved outlet and the recommended three-conductor AC line power cable may result in injury or death.

⚠WARNING

Unless otherwise stated, a ground connection on the instrument's front or rear panel is for a reference of potential only and is not to be used as a safety ground. Do not operate in an explosive or flammable atmosphere.

⚠WARNING

Do not operate the instrument in the presence of flammable gases or vapors, fumes, or finely-divided particulates.

⚠WARNING

The instrument is designed to be used in office-type indoor environments. Do not operate the instrument

- In the presence of noxious, corrosive, or flammable fumes, gases, vapors, chemicals, or finely-divided particulates.
- In relative humidity conditions outside the instrument's specifications.
- In environments where there is a danger of any liquid being spilled on the instrument or where any liquid can condense on the instrument.

- In air temperatures exceeding the specified operating temperatures.
- In atmospheric pressures outside the specified altitude limits or where the surrounding gas is not air.
- In environments with restricted cooling air flow, even if the air temperatures are within specifications.
- In direct sunlight.

This instrument is intended to be used in an indoor pollution degree 2 environment. The operating temperature range is 0°C to 40°C and 20% to 80% relative humidity, with no condensation allowed. Measurements made by this instrument may be outside specifications if the instrument is used in non-office-type environments. Such environments may include rapid temperature or humidity changes, sunlight, vibration and/or mechanical shocks, acoustic noise, electrical noise, strong electric fields, or strong magnetic fields.

Do not operate instrument if damaged

If the instrument is damaged, appears to be damaged, or if any liquid, chemical, or other material gets on or inside the instrument, remove the instrument's power cord, remove the instrument from service, label it as not to be operated, and return the instrument to B&K Precision for repair. Notify B&K Precision of the nature of any contamination of the instrument.

Clean the instrument only as instructed

Do not clean the instrument, its switches, or its terminals with contact cleaners, abrasives, lubricants, solvents, acids/bases, or other such chemicals. Clean the instrument only with a clean dry lint-free cloth or as instructed in this manual. Not for critical applications

This instrument is not authorized for use in contact with the human body or for use as a component in a life-support device or system.

Do not touch live circuits

Instrument covers must not be removed by operating personnel. Component replacement and internal adjustments must be made by qualified service-trained maintenance personnel who are aware of the hazards involved when the instrument's covers and shields are removed. Under certain conditions, even with the power cord removed, dangerous voltages may exist when the covers are removed. To avoid injuries, always disconnect the power cord from the instrument, disconnect all other connections (for example, test leads, computer interface cables, etc.), discharge all circuits, and verify there are no hazardous voltages present on any conductors by measurements with a properly-operating voltage-sensing device before touching any internal parts. Verify the voltage-sensing device is working properly before and after making the measurements by testing with

known-operating voltage sources and test for both DC and AC voltages. Do not attempt any service or adjustment unless another person capable of rendering first aid and resuscitation is present.

Do not insert any object into an instrument's ventilation openings or other openings.

⚠WARNING

Hazardous voltages may be present in unexpected locations in circuitry being tested when a fault condition in the circuit exists.

⚠WARNING

Fuse replacement must be done by qualified service-trained maintenance personnel who are aware of the instrument's fuse requirements and safe replacement procedures. Disconnect the instrument from the power line before replacing fuses. Replace fuses only with new fuses of the fuse types, voltage ratings, and current ratings specified in this manual or on the back of the instrument. Failure to do so may damage the instrument, lead to a safety hazard, or cause a fire. Failure to use the specified fuses will void the warranty.

Servicing

⚠WARNING

Do not substitute parts that are not approved by B&K Precision or modify this instrument. Return the instrument to B&K Precision for service and repair to ensure that safety and performance features are maintained.

For continued safe use of the instrument

- Do not place heavy objects on the instrument.
- Do not obstruct cooling air flow to the instrument.
- Do not place a hot soldering iron on the instrument.
- Do not pull the instrument with the power cord, connected probe, or connected test lead.
- Do not move the instrument when a probe is connected to a circuit being tested.

CE Declaration of Conformity

Safety testing has been performed on submitted samples and found in compliance with the council LVD directive 2014/35/EU.

- EN 61010-1:2010
- EN 61010-2-030:2010

Safety Symbols

DANGER	**DANGER** indicates a hazardous situation which, if not avoided, will result in death or serious injury.
WARNING	**WARNING** indicates a hazardous situation which, if not avoided, could result in death or serious injury
CAUTION	**CAUTION** indicates a hazardous situation which, if not avoided, will result in minor or moderate injury
	A **Caution**. Refer to the text near the symbol.
	Electric Shock hazard
	Alternating current (AC)
	Chassis ground
	Earth ground
	On (Power). This is the In position of the power switch when instrument is ON.
	Off (Power). This is the Out position of the power switch when instrument is OFF.
NOTICE	**NOTICE** is used to address practices not related to physical injury.

Contents

Chapter 1

Product Overview

The B&K Precision models 6010 and 6011 battery analyzers enable far better accuracy than previous offerings. With the BA6011 featuring an input range up to 300V, measurement of a greater range of battery configurations is possible.

Features:

- Best accuracy 0.05%
- Test frequency 1kHz
- Bin sorting comparator
- Adjustable measurement speed for fast readout or better accuracy
- USB, GPIB and Ethernet interfaces come standard
- Save and recall up to 100 measurement setups
  (10 internal, and 90 external (USB stick) records)
- 4.3" color TFT LCD with 480 x 272 pixels

1.1 Package Contents

Please inspect the instrument mechanically and electrically upon receiving it. Unpack all items from the shipping carton, and check for obvious signs of physical damage that may have occurred during transport. Report any damage to the shipping agent immediately. Save the original packing carton for future shipping and storage.

Every instrument ships with the following contents:

- 1 x Model BA6010/BA6011 Battery Tester
- 1 x User Manual
- 1 x AC power cord
- 1 x 4-wire kelvin clips
- 1 x Certificate of calibration
- 1 x Test report

Verify that all items above are included in the shipping container. If anything is missing, please contact B&K Precision.

1.2 Front Panel

Figure 1.1: Front Panel

1. Power On/Off Switch
2. Function Keys
   Corresponds to on-screen menu items
3. LCUR, LPOT, HPOT, HCUR Input Terminals
   Note: LCUR center pin is connected to ground.
4. Navigation Arrow Keys
   (Up), (Down), (Left), (Right), (Down x 2) Keys for navigating on-screen and selecting parameters, file menu, and tools menu.
5. Bin Comparator Pass/Fail Indicator
   PASS – PASS FAIL – FAIL
6. USB Host Port
   For storing/recalling setups, measurements and screen capturing.
7. Lock, Copy, Reset, Trig Keys
8. Numeric Keypad
   Positive/Negative sign and backspace button.
9. Display (DISP) and Setup Keys
   Selects display menu and setup menu.
10. 480 x 272 dot-matrix Color LCD Display

1.3 Rear Panel

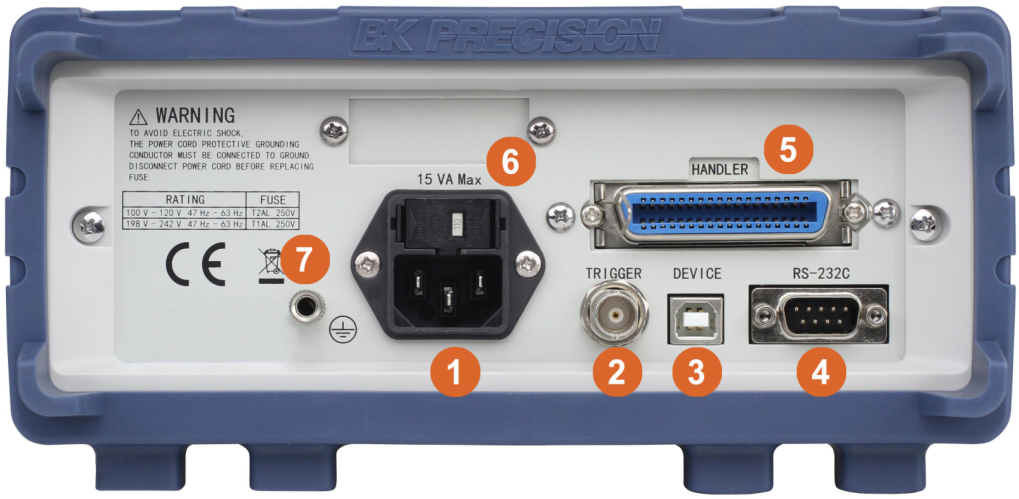


Figure 1.2: Rear Panel

1. AC Power Input
2. BNC Trigger Terminal
3. USB Interface supporting:
   USBTMC, USBCDC (virtual COM)
4. RS-232 Interface
   Accepts null modem or cross over serial DE-9 cable
5. Handler Interface
   36-pin handler interface (Centronix type)
6. Fuse/Line Voltage Selector Box
   110V or 220V AC Input Selectable
7. Chassis Ground Terminal

1.4 Display

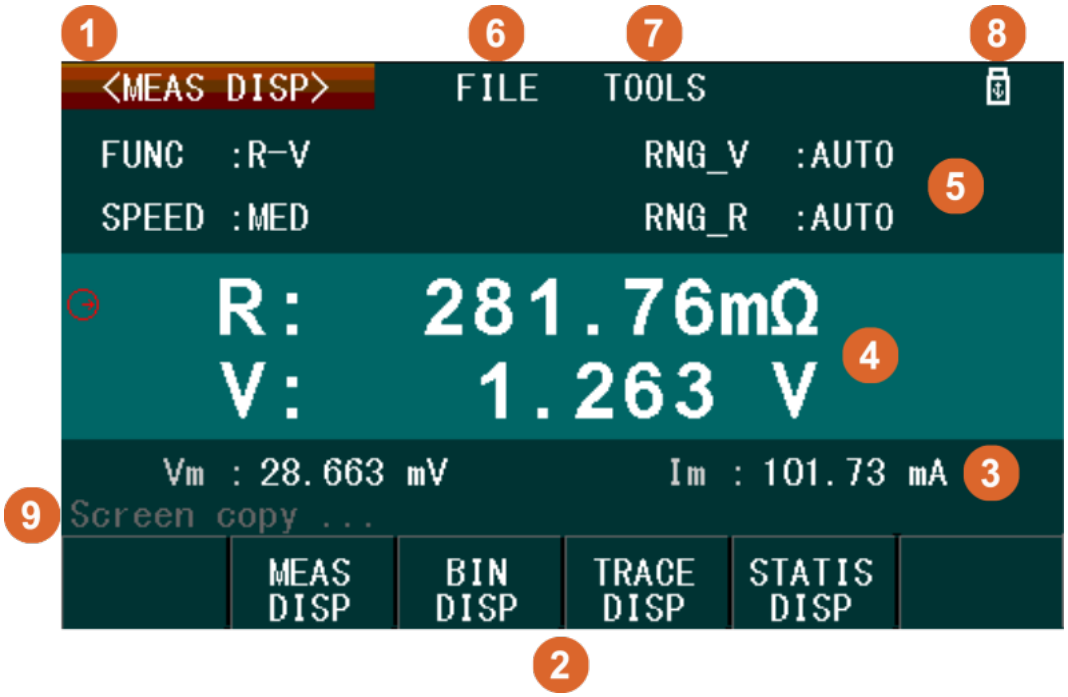


Figure 1.3: Front Panel

1. **Menu Title**
   Indicates the current menu display.
2. **Soft Menu**
   Displays soft menu options relevant to current display.
3. **Measurement Display**
   Displays additional measurement readings.
4. **Primary/Secondary Measurement Display**
   Displays the primary and secondary measurements of the selected functions.
5. **File Menu**
   Select to enter the file menu system.
6. **File Menu**
7. **Tools Menu**
   Select to enter the tool menu relevant to the current menu.
8. **External USB Disk Indicator**
9. **Message Prompt**
   Prompts status, actions, and errors for various operations.

Chapter 2

Getting Started

Before connecting and powering up the instrument, thoroughly review the instructions and information in this chapter.

2.1 Input Power Requirements

The instrument has a selectable AC input that accepts line voltage and frequency input within:

AC Input: 110 V ±10% or 220 V ±10%

Frequency: 47 — 63 Hz

Before connecting to an AC outlet or external power source, be sure that the line voltage selector is installed in the correct position of 110 V or 220 V and the power switch is in the OFF position. Also, verify that the AC power cord, including the extension line, is compatible with the rated voltage/current and that there is sufficient circuit capacity for the power supply. Once verified, connect the cable firmly.

The included AC power cord is safety certified for this instrument operating in rated range. To change a cable or add an extension cable, be sure that it can meet the required power ratings for this instrument. Any misuse with wrong or unsafe cables will void the warranty.

2.2 Fuse Requirements

An AC input fuse is necessary when powering the instrument. The fuse is located at the back of the instrument. If the fuse needs to be replaced, ensure the AC input power cord is disconnected from the instrument prior to replacement. Refer to Table 2.1 for fuse requirements.

Before replacing fuse, disconnect the AC power cord first to prevent electric shock.
Only use same rating of the fuse. Using a different fuse may damage the instrument.

110 V Fuse	220 V Fuse
T 2 AL, 250 V	T 1 AL, 250 V

Table 2.1: Fuses

2.2.1 Fuse Replacement

1. Check and/or Change Fuse
   - Locate the fuse box above the AC input in the rear panel.
   - With 2 fingers, press both left and right sides of the fuse box and pull it out.
   - Check and replace fuse (if necessary) for the required line voltage operation.
2. Check and/or Change Line Voltage
   Line voltage is selected and configured via fuse holder orientation.
   - The beige colored piece is the fuse holder and line voltage selector. To change the line voltage configuration between **110 V** and **220 V**, pull this piece out of the fuse box and rotate it 180 degrees.
   - Re–insert the fuse box. The configured line voltage is visible through an opening visible at the end of the holder. It will display either 110 or 220. If neither of these labels is shown, pull out the fuse holder and turn it until it shows the line voltage configuration desired.

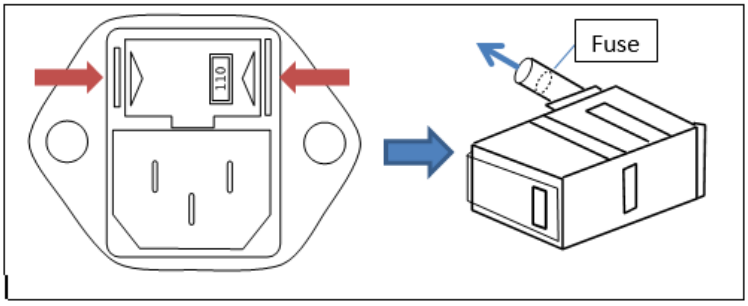


Figure 2.1: Change Line Voltage Configuration

WARNING

Do not connect power to the instrument until the line voltage is configured correctly.
Applying an incorrect line voltage or configuring the line voltage improperly will damage the instrument and void all warranty.
Disassembly of the case by any unauthorized persons will void the warranty.

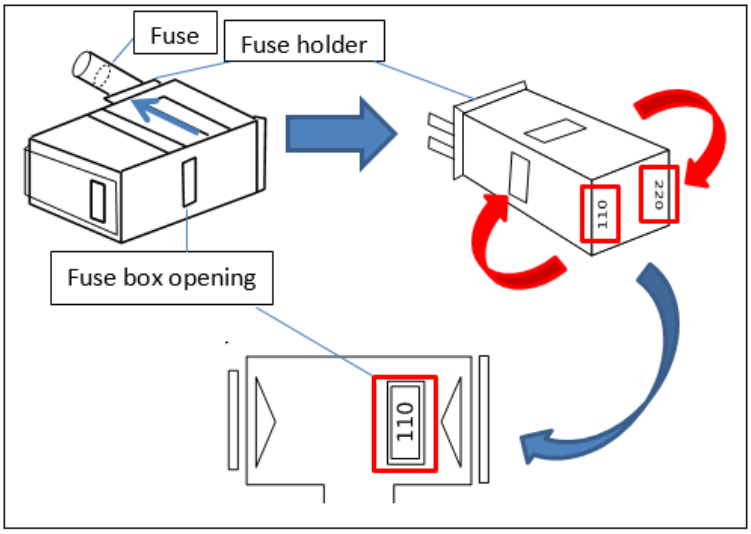


Figure 2.2: Change Line Voltage Configuration

2.3 Preliminary Check

1. **Verify AC Input Voltage**
   Verify and check to make sure proper AC voltages are available to power the instrument. The AC voltage range must meet the acceptable specification as explained in section 2.1.

2. **Connect Power**
   Connect AC power cord to the AC receptacle in the rear panel. The power button on the front panel should illuminate red. Press the power button to turn ON the instrument. The button should illuminate green, and show the boot screen while loading. After loading, the main screen will be displayed (Figure 2.3), and if password protection is enabled it will prompt the user for the password.
   Enter the password and press the function key below **[Enter]**.
   Default Password: ***2523***

Figure 2.3: Password Entry

2.4 Password Protection

The instrument has a password protection feature that allows the instrument to be locked at boot time to prevent unauthorized users from using it. The default password is: **2523**

To change the password, select the **Password** parameter from the **System Setup** menu, and select the **Modify** soft menu option. The user is prompted with "Input password:". Enter the current password (or default password if this is setup for the first time), then press **Enter**. Then, "New password:" prompt will appear. Enter your new password. The password **MUST** be numeric and must be 1 — 8 numbers in length.

NOTICE	**This instrument does not have a recovery mechanism to retrieve forgotten passwords.** Once password protection is enabled, the instrument will be locked during boot-up until the password is entered.

2.5 Connecting Kelvin Clips (TLKB1)

The instrument comes included with the TLKB1 Kelvin clips accessory (Figure 2.4) which connects to the four BNC connectors. To connect, align all four BNC connectors of the TLKB1 to the input terminals of the instrument. Ensure that the connectors slide all the way into each terminal (you may need to adjust the BNC lock rings). Then, turn the lock rings of each terminal all the way to the right for a secure connection.

Figure 2.4: TLKB1 Kelvin Clips

Chapter 3

Operation

There are two main menu groups: “Display” and “Setup”. Each menu may include File and/or too

Display Menu - Accessible by pressing the DISP button.

MEAS DISP Section 3.7

BIN DISP Section 3.9

TRACE DISP Section 3.10

STATIS DISP Section 3.11

Setup Menu - Accessible by pressing the SETUP button.

MEAS SETUP Section 3.8

BIN SETUP Section 3.9.5

TRACE SETUP Section 3.10.1

STATIS SETUP Section 3.11

File Menu Accessible by using the arrow keys to select [FILE] on-screen. The file system is accessible in all menus.

Tools Menu Accessible by using the arrow keys to select [TOOLS] on-screen.

The Tools menu is only available for display menus and will not appear in setup menus. Each display menu (i.e. MEAS DISP, BIN DISP, TRACE DISP, STATIS DISP) has different options available.

3.1 Front Panel Keys

3.1.1 Key Lock

The front panel buttons are locked by pressing the LOCK button or via remote command. When enabled, all buttons except and LOCK are disabled, and the lock button will illuminate red, LOCK. The lock icon appears in the upper right corner of the screen.

To disable key lock, press the LOCK button.

3.1.2 Screen Capture

The display screen may be captured and saved as a .GIF file to an external USB flash drive.

1. Insert a USB flash drive into the front USB host port and wait for the USB icon to appear in the upper right corner of the screen.
2. Press the COPY button.
   A message prompt will say “Screen Copy … ”.
3. Wait until the message says “Copy completed.” and disappears.
   The screenshot will be saved into the USB subfolder /PIC.

3.1.3 Reset Key

The reset key initiates a reboot of the system.

3.2 Menu Operation

1. Press the DISP button or the SETUP button to access the display or setup menus.
2. At the bottom of the screen, related soft menu items are displayed. Use the function keys to select the corresponding soft menu times that are directly above them. Each item has its own unique display showing setup parameters, measurements, and more.
3. Use the △, ▽, ◁, or ▷ arrow keys to select the on-screen parameters of the [FILE] or [TOOLS] menus. Selected items are highlighted in **BLUE**.

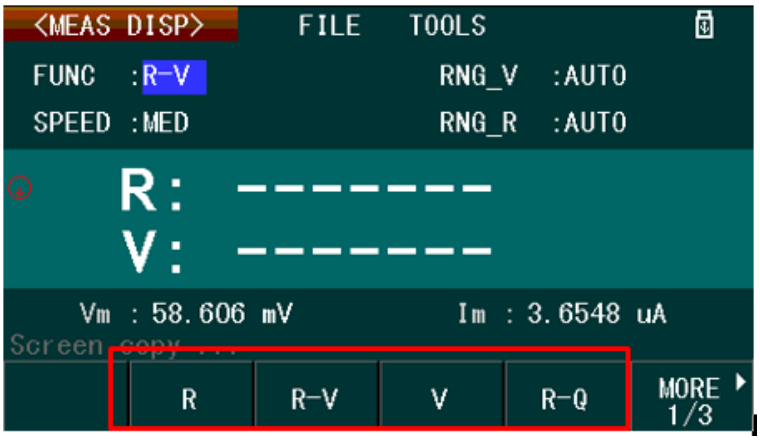


Figure 3.1: Soft Menu

4. Most on-screen parameters, when selected, will have options to select or change using the soft menu at the bottom of the screen.
5. If an on-screen parameter is numeric, the keypad may be used to enter and change the values. Numeric values are highlighted in **RED**, and additional items in the soft menu will be available to set the units (u, m, k, x1). To enter a negative value, press the +/− button first, and then enter the number. The +/− button is also the backspace button, and works in the usual way.

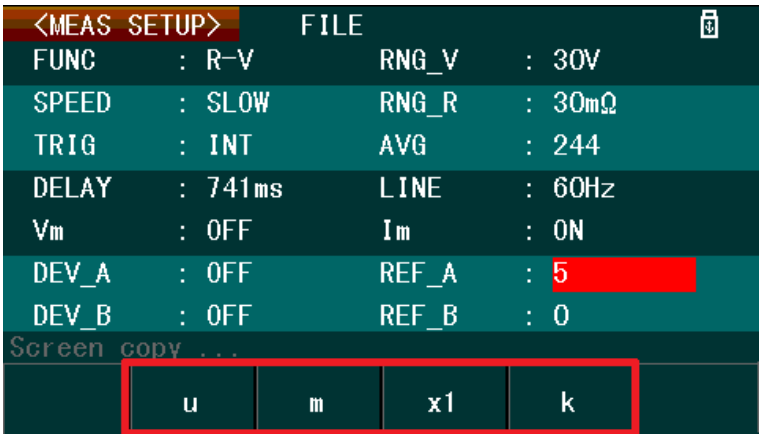


Figure 3.2: Entering A Numeric Value

3.2.1 Numeric Notations

When entering a parameter using the numeric keypad entry is completed by selecting the units from the on-screen soft-keys as shown in Figure 3.3. Some parameters have fewer unit options than others. The list of all options and their descriptions is as follows:

x1 Denotes $x1$ unit prefix of the entered value.

u Denotes micro ($x10^{-6}$) unit prefix of the entered value.

m Denotes milli ($x10^{-3}$) unit prefix of the entered value.

k Denotes kilo ($x10^{+3}$) unit prefix of the entered value.

Other parameters (like "Delay" in Measurement Setup) may be changed by the keypad and another set of on-screen soft-keys. Table 3.1 describes these keys and their function.

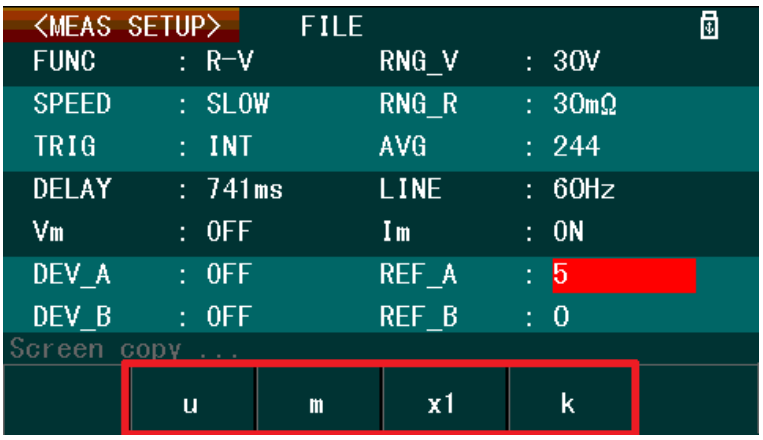


Figure 3.3: Numeric Notations

Note: Baudrate settings in SYSTEM SETUP menu is an exception, where INCR+ and DECR− options are available to select between the following discrete rates: 9600, 19200, 28800, 38400, 96000, 115200.

INCR++	Coarse adjustment - Increments the selected numeric value by the hundreds digit (i.e. 100 will increase to 200)
INCR+	Fine adjustment - Increments the selected numeric value by the tens digit (i.e. 10 will increase to 20) or by the ones digit (i.e. 10 will increase to 11) depending on the selected parameter.
DECR- -	Coarse adjustment - Decrements the selected numeric value by the hundreds digit (i.e. 200 will decrease to 100)
DECR-	Fine adjustment - Decrements the selected numeric value by the tens digit (i.e. 20 will decrease to 10) or by the ones digit (i.e. 11 will decrease to 10) depending on the selected parameter.
CLEAR	The selected value will be set to 0.
CLEAR LINE	The value of all parameters at the selected row/line will be set to 0.

Table 3.1: Coarse and Fine numeric adjustments

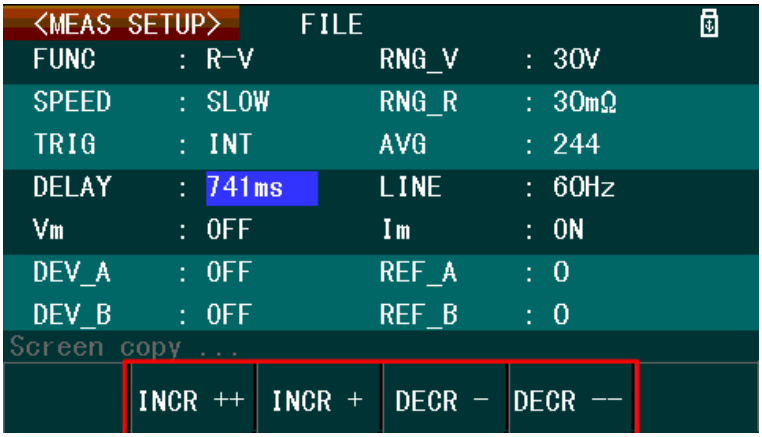


Figure 3.4: Increment/Decrement Values

3.3 System Setup Menu

The system menu is accessible by pressing the SETUP button and selecting SYSTEM SETUP from the on-screen menu.

In this menu, all parameters can be configured by using the arrow keys for selection, and the function keys or numeric keypad to make changes.

Table 3.2 lists the configurable parameters in the system menu: **Key sound, Remote Interface, Language, Baud Rate, Password Protection, Bus Address, Date, Time**.

3.3.1 System Tools

The system tools menu is accessed from the **System Setup Display** by pressing SETUP once, and then pressing the ▷ key twice to select **TOOLS**. If the current selection is on a parameter, then use any of the arrow keys to navigate to **TOOLS**. Selection of on-screen fields is always available, however, the selector may be hidden behind the main screen label.

When **TOOLS** is selected, the soft menu displays 3 options described in Table 3.3. Use the corresponding function

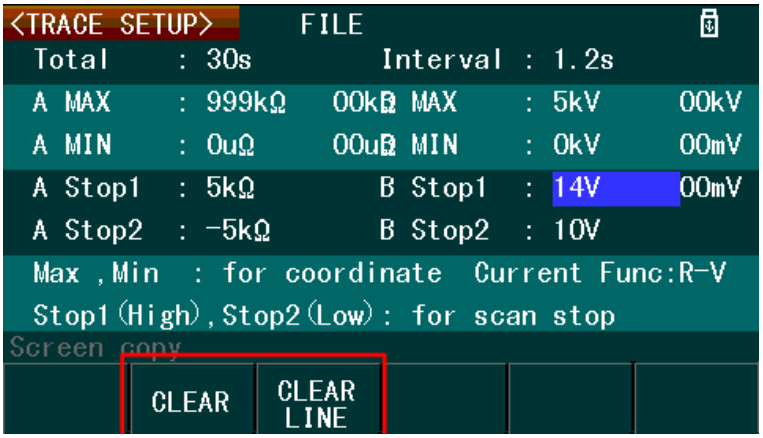


Figure 3.5: Clear Values

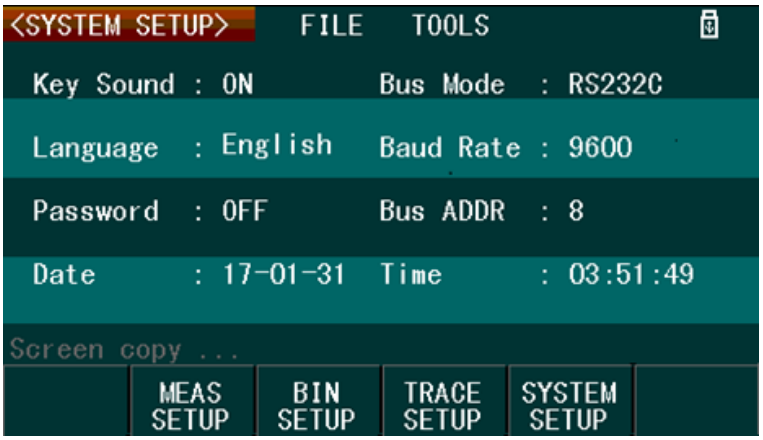


Figure 3.6: System Menu

keys to select each.

Parameter	On-screen Label	Description Options
Key Sound	Key Sound	Enables/disables the beep sound after any button press. Options: OFF, ON
Remote Interface	Bus Mode	Selects the remote interface to use for remote communication. See Section 5.1 for detailed operation instructions. Options: RS232, GPIB, USBTMC, USBCDC
Language	Language	Changes the language display. Options: English, Chinese
Baud Rate	Baud Rate	Selects the baud rate setting to use for remote communication for RS232 and USBCDC interface options. Options: 9600, 19200, 28800, 38400,96000, 115200
Password Protection	Password	Enables/disables and configures password protection. See Section 2.4 for more information. Options: OFF, ON, Modify
GPIB Address	Bus ADDR	The address of the GPIB interface. Valid Range: 1 - 31
System Date	Date	Sets the system date. The format is as follows: Year-Month-Day (YY-MM-DD)
System Time	Time	Sets the system time. The format is as follows: Hour-Minutes-Seconds (HH-MM-SS)

Table 3.2: System Setup Parameters

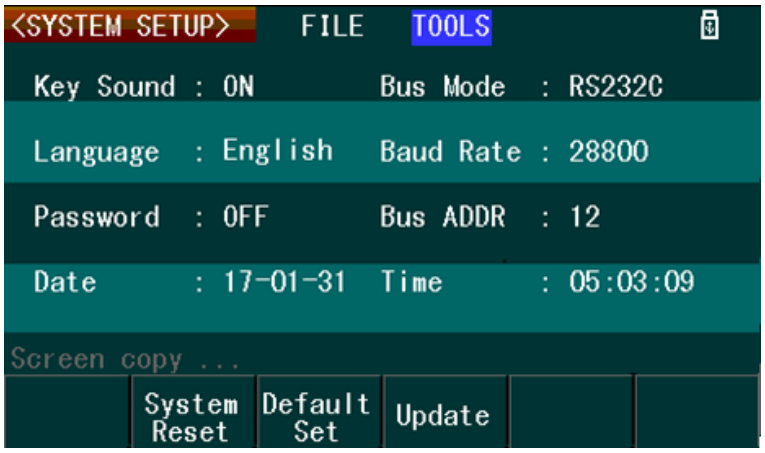


Figure 3.7: System Tools

Parameter	On-screen Label	Description and Options
System Reset	System Reset	Reboot the instrument.
Default Settings	Default Set	Change all settings to defaults and reboot. See Section 3.3.2 for the default values.
Firmware Update	Update	Using firmware loaded to a USB memory stick, update the firmware of the instrument.

Table 3.3: System Tools Menu

3.3.2 Default Settings

Tables 3.4,3.5,3.6,3.7 list the default instrument settings.

Parameter	Default Value
FUNC	R-V
SPEED	MED
TRIG	INT
DELAY	0 ms
Vm	ON
DEV_A	OFF
DEV_B	OFF
RNG_V	AUTO
RNG_R	AUTO
AVG	1
LINE	60 Hz
Im	ON
REF_A	0
REF_B	0

Table 3.4: Measurement Defaults

Parameter	Default Value
Mode	ABS
COMPA	ON
COMPB	ON
NOMA	0
NOMB	0
HIGHA (all bins)	0
LOWA (all bins)	0
HIGHB (all bins)	0
LOWB (all bins)	0

Table 3.5: BIN Setup default settings

Parameter	Default Value
Total	20 s
A MAX	5 kΩ
A MIN	0 $\mu\Omega$
A Stop1	5 kΩ
A Stop2	-5 kΩ
Interval	1.0 s
B MAX	5 kV
B MIN	0 μV
B Stop1	5 kV
B Stop2	-5 kV

Table 3.6: Trace setup default settings

Parameter	Default Value
Key Sound	ON
Language	English
Password	OFF
Bus Mode	RS232C
Baud Rate	9600
Bus ADDR	8

Table 3.7: System setup default settings

3.4 Short Correction

Short correction helps measurement accuracy by eliminating the measured short compensation value to the primary and secondary measurements.

1. Connect the TLKB1 Kelvin clips to the input terminals of the instrument securely.
2. Clip both clips together to create a short. Figure 3.8
3. Select SHORT from the soft menu, and the display will show “Shorting … ”.

4. Wait for a few seconds.
5. When finished, the display shows “Short completed” message briefly.
6. To apply the short compensation to the measurements, select SHORT ON from the soft menu.

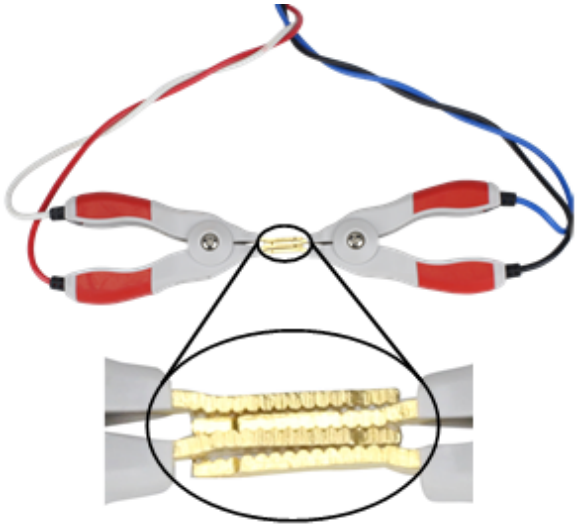


Figure 3.8: Zeroing the kelvin clip leads

NOTICE Incorrectly performing the short correction will introduce meaurement offsets and reduce accuracy.

3.5 Measurement Accuracy

Resistance and Voltage are primary measurements of this analyzer, and their accuracy is specified in the main specifications section. Measurement of resistance, more accurately impedance, is accomplished by driving a sinusoid signal and measuring the voltage developed across the output terminals of the unit. For a purely resistive device, the resistance and impedance are simple, $Z = r$. See Chapter 6, specifically the resistance section for the impedance accuracy, A_e.

The measurement accuracy of the reactive (X, L and C) parameters depends on the **R**eal impedance component. The smaller the resistive (Real) component the more accurate the measurement. The resistive element of an Inductor or Capacitor is related to the Dissipation (D) and Quality (Q) Factors. As dissipation increases, the relative contribution of the reactive component to the impedance is reduced.

Essentially, when the resistive component of a device’s complex impedance at 1kHz (the frequency output by this unit) is small compared to the real impedance, the accuracy is $\approx R_{acc}$.

3.5.1 L,C,X,R accuracy

$$L, C, X \qquad D_x \leq 0.1 \qquad A_e = A_e \tag{3.1}$$
$$R \qquad Q_x \leq 0.1 \qquad A_e = A_e \tag{3.2}$$
$$L, C, X \qquad D_x \geq 0.1 \qquad A_e = A_e\sqrt{1 + D_x^2} \tag{3.3}$$
$$R \qquad Q_x \geq 0.1 \qquad A_e = A_e\sqrt{1 + D_x^2} \tag{3.4}$$
$$\tag{3.5}$$

Example Resistance Accuracy

$$Z = 60m\Omega \tag{3.6}$$
$$Z_{range} = 60 \pm [60m\Omega * 0.006 + (0.003 * 300m\Omega)] \tag{3.7}$$
$$= 60 \pm (.36 + .9) \tag{3.8}$$
$$= 60 \pm 1.26m\Omega \tag{3.9}$$
$$\text{Accuracy} = \frac{1.26}{60} * 100\% \approx \pm 2.1\% \tag{3.10}$$

3.5.2 Quality and Dissipation Factor Accuracies

Q_x is the measured value of Q

D_e is the accuracy of D as calculated

The dissipation factor accuracy depends on its tested value.

$$D_x \leq 0.1 \qquad D_e = \pm\frac{A_e}{100} \tag{3.11}$$
$$D_x > 0.1 \qquad D_e = \pm\frac{A_e}{100} * (1 + D_x) \tag{3.12}$$

The accuracy of Q is derived from D.

$$Q_e = \pm\frac{Q_x * D_e}{1 \mp Q_x * D_e} \tag{3.13}$$

3.5.3 θ Accuracy

Measuring the phase angle (current to voltage) accuracy depends directly on the accuracy of the impedance measurement.

$$\theta_e = \frac{180}{\pi} * \frac{|Z_{acc}|}{100}\text{degrees} \tag{3.14}$$

3.5.4 Example battery measurements

A PowerSonic PS-1270 battery of unknown origin connected to a BA6011.

Measured at Slow speed

$$V = 12.958V \tag{3.15}$$
$$R = 18.194m\Omega \tag{3.16}$$
$$C = 176mF \tag{3.17}$$
$$D_x = 20.14 \tag{3.18}$$

To determine the accuracy of each measurement, use the specifications Chapter 6.

The range setting is 30mΩ.

Resistance

$$Q = \frac{1}{D_x} = \quad \frac{1}{20.14} = 0.0496 \leq 0.1 \tag{3.19}$$

$$\therefore \quad R_{acc} = A_e \tag{3.20}$$

$$R_{acc} = \quad \pm 0.6\% + 0.3\% \text{Full Scale} \tag{3.21}$$

$$R = \quad 18.194 \pm (18.194 * 0.006 + 30 * 0.003) m\Omega \tag{3.22}$$

$$= \quad 18.194 \pm .199 m\Omega \tag{3.23}$$

Voltage

$$V = \quad 12.958V \tag{3.24}$$

$$V_{acc} = \quad \pm(0.05\% + 0.1\% FS) \tag{3.25}$$

$$V = \quad 12.958 \pm ((0.0005 * 12.958) + 0.001 * 30) \tag{3.26}$$

$$V = \quad 12.958 \pm 0.036V \tag{3.27}$$

$$V_{acc} = \quad \pm \frac{0.036}{12.958} * 100\% = \pm 0.28\% \tag{3.28}$$

Capacitance Impedance |Z| and resistance accuracy are equivalent due to how the unit measures. Voltage generated across the measurement terminals at a given current and frequency is determined and used to compute resistance/impedance. D is greater than 0.1, so the accuracy correction is dominated by it.

$$C_{acc} = \quad Z_{acc} * \sqrt{1 + D^2} \tag{3.29}$$

$$Z_{acc} = R_{acc} = \quad \pm(0.6\% * Z + 0.3\% FS) \tag{3.30}$$

$$= \quad \pm(0.006 * 18.194 m\Omega + 0.003 * 30 m\Omega) \tag{3.31}$$

$$= \quad \pm 0.199 m\Omega \tag{3.32}$$

$$C_{acc} = \quad 0.199 * \sqrt{1 + D^2} * 100\% \tag{3.33}$$

$$= \quad 0.199 * \sqrt{1 + 20^2} \tag{3.34}$$

$$= \quad 3.98\% \tag{3.35}$$

$$C = \quad 176mF \pm (0.0398 * 176mF) = 176mF \pm 7mF \tag{3.36}$$

3.6 Saving Measurement Data

The primary and secondary measurement readings are saved to an external USB drive.

1. Connect a USB flash drive to the USB host port on the front panel.
   Note: The USB flash drive must be formatted to FAT16 or FAT32 file system.
2. Go to the **TOOLS** menu from Measurement Display screen, and select SAVE from the soft menu.
3. When set to **ON**, primary and secondary measurements start saving to a **.CSV** file on the USB flash drive. The file will be located inside a folder labeled **CSV**.
4. To stop saving, select **SAVE** from soft menu to toggle **OFF**.

3.7 Main Measurement Display

The measurement display is accessed by pressing the DISP button. Shown are the selected measurements as well as the voltage measured and current sourced to make the measurements.

The **FUNC**, **SPEED**, **RNG_V**, and **RNG_R** parameters are also configurable from this screen. Use the arrow keys to select them, and the keypad and soft menu function keys to change them. Refer to Table 3.8 for a detailed description.

Figure 3.9: Measurement Display

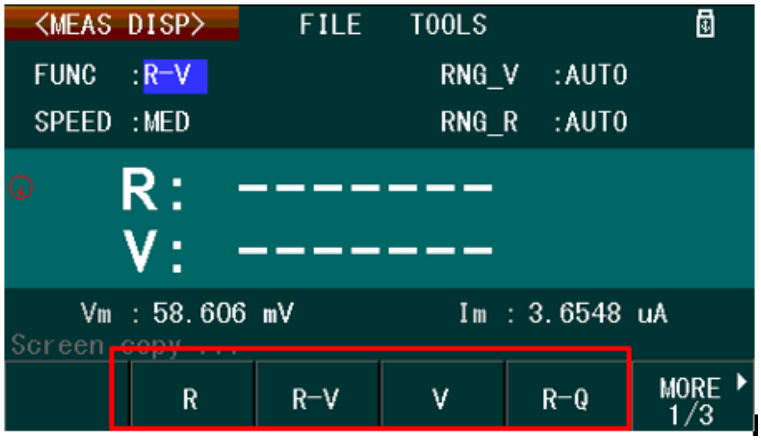


Figure 3.10: Measurement Setup Function Keys

Note: When the Trigger parameter in Measurement Setup is *not* set to **INT** (internal trigger), the measurement display will not show primary and secondary measurement until a triggered.

When Vm (Measured voltage display) and/or Im (Measured current display) parameters are set to OFF in Measurement Setup, **"OFF"** is shown beside **Vm** and/or **Im**.

3.8 Measurement Setup

Access the Measurement setup display (Figure 3.11) by pressing the SETUP button, and then press the function key corresponding to **MEAS SETUP** from the soft menu. All measurement parameters in this menu are

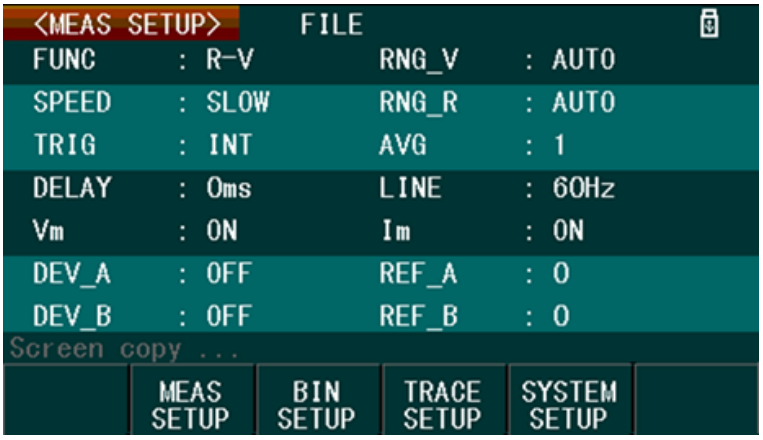


Figure 3.11: Measurement Setup Display

configured using the arrow keys to select, and the function keys or numeric keypad to make, changes.

3.8.1 Measurement Parameters, Ranges and Options

Parameter	On-screen Label	Description/Options
Measurement Function	FUNC	Selects the measurement function(s). *Options:* R, R-V, V, R-Q, L-Q, L-R, R-X, C-D, $Z-\theta d$, $Z-\theta r$, R-C **R** Resistance **V** Voltage **Z** Impedance **L** Inductance **Q** Quality factor **X** Reactance **r** Radian θ Phase angle
Measurement Speed	SPEED	Selects the measurement speed. *Options:* FAST, MED, SLOW **FAST** Approx. 50 measurements/sec *4 digit resolution max* **MED** Approx. 10 measurements/sec **SLOW** Approx. 6 measurements/sec

Parameter	On-screen Label	Description/Options
Trigger Source	TRIG	Selects the trigger source. *Options:* INT, MAN, EXT, BUS **INT** (Internal) – Automatic continuous measurement **MAN** (Manual) – Each measurement is made by pressing the TRIG button. **EXT** (External) – Measurement is made upon receiving a trigger signal from either the rear panel BNC or handler interface terminals. **BUS** (Bus) – Measurement is made upon receiving a trigger command from a remote interface.
Measurement Delay	DELAY	Sets a measurement delay time. **Valid Range:** 0 ms - 60 seconds *Note:* Values entered are in milliseconds (ms).
Measurement Voltage Display	Vm	Enables/disables the measured voltage display in the measurement display screen. Options: OFF, ON
Deviation Primary Measurement Display	DEV_A	Enables/disables the deviation measurement display of the primary measurement function. Options: OFF, ABS, % **ABS** - Primary measurement display will show the difference between measured value and REF_A value. **%** - Same as ABS, but measurement will show percentage difference instead.
Voltage Range	RNG_V	Configures the measurement DC voltage range. Options: AUTO, HOLD, 300V (*60V), 30V (*6V) **Model BA6010* **AUTO** - Autoranging. **HOLD** - Locks the current voltage range. **300V(60V)** - Selects the 300 V/60 V range. **30V(6V)** - Selects the 30 V/6 V range.
Current Range	RNG_R	Configures the measurement AC impedance range. Options: AUTO, HOLD, ▽,△ AUTO - Autoranging. HOLD - Locks the current impedance range. ▽,△ - Selects between 30mΩ, 300mΩ, 3Ω, 30Ω, 300Ω, 3kΩ range.
Measurement Averaging	AVG	Sets the number of samples for measurement averaging. Valid Range: 1 to 255
Measurement Frequency	LINE	Selects the frequency of the measurement source. Options: 50Hz, 60Hz Select the same frequency as that of the AC power source to minimize measurement error.

Parameter	On-screen Label	Description/Options
Primary Measurement Reference Value	REF_A	Sets the reference value for the primary measurement when displayed in ABS or % (See DEV_A parameter) Valid Range: Dependent on the measurement range of the selected primary function. A **MEAS** option will appear in the soft menu. Select this to set the reference value to the last measured value. To update the measured value, press DISP to go to the Measurement Display. Then, press SETUP to go back to Measurement Setup and select REF_A and press **MEAS** again.
Secondary Measurement Reference Value	REF_B	Sets the reference value for the secondary measurement when displayed in ABS or % (See DEV_A parameter) Valid Range: Dependent on the measurement range of the selected primary function. A **MEAS** option will appear in the soft menu. Select this to set the reference value to the last measured value. To update the measured value, press DISP to go to the Measurement Display. Then, press SETUP to go back to Measurement Setup and select REF_B and press **MEAS** again.

Table 3.8: Measurement Setup Parameters

3.8.2 Measurement Tools

Access the measurement tools menu from the Measurement Display by pressing DISP once, and then press ▷ twice to select TOOLS. If the current selection is on a parameter, use the arrow keys to navigate to TOOLS.

Figure 3.12: Measurement Tools Menu

When **TOOLS** is selected, the soft menu has five configurable and selectable options. Use the corresponding function keys to make a selection. See Table 3.9 for details.

Parameter	On-screen Label	Description
Relative Mode	REL ON/OFF	Measures the relative difference between a reference and the current value.
Short Correction	SHORT	Performs a short correction measurement when pressed. See Section 3.4 for details.
Short Compensation	SHORT ON/OFF	Applies a compensation value to primary and secondary measurements using the results of a “short correction”.
Measurement Display Mode	DISP ON/OFF	Sets the state of the display measurements’ visibility. Measurement operation is not affected only whether to show on screen or not is changed.
Save Measurements	SAVE ON/OFF	Save measurement data. See Section 3.6 section for detailed operation instructions.

Table 3.9: Measurement Tools Menu

3.9 BIN Function

The bin comparator function allows for sorting, comparison against preset limits, and pass/fail testing of components. A total of 9 bins are available, each with high and low limits for both primary and secondary measurements.

To use the bin function:

1. Select the primary and secondary measurement parameters for the test. See Section 3.8, Measurement Setup for details.
2. Setup the bin parameters from the BIN Setup display.
3. Navigate to the BIN Display to start using this function.

3.9.1 BIN Display

The BIN comparator measurements and test results are accessed in the **BIN DISP** screen. To access, press the DISP button, and then press the function key corresponding to BIN DISP from the soft menu.

The **Mode, Sound, COMP**, and **Load BIN** parameters are configurable settings. To select, use the arrow keys, and the keypad and soft menu function keys to change them. See Table 3.10 for details.

Note: When the Trigger parameter in Measurement Setup is NOT set to INT (internal trigger), the display will not show compare test results until a trigger is received from the selected source. When Vm (Measured voltage display) and/or Im (Measured current display) parameters are set to OFF in Measurement Setup, the measurement display will show OFF next to Vm: and/or Im: below the secondary measurement.

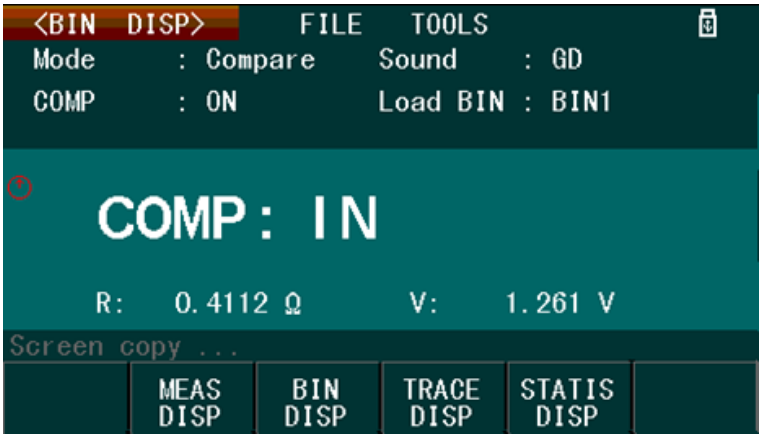


Figure 3.13: BIN Comparator Display

3.9.2 BIN Sorting

The BIN comparator function also can sort measured values into BINs.

Go to BIN Setup, Section 3.9.5, and configure the upper and lower limits for the set of bins desired, up to 9 of them. Set all other parameters as necessary, see Table 3.20.

Parameter	On-screen Label	Description/Options
Comparator Mode	Mode	**Compare** The comparator function will test the measurements against the upper and lower limits of the Loaded BIN, which are configured in BIN Setup. **BIN** The comparator function will test the measurements against the upper and lower limits of all nine bins 1 through 9. The bin number that passes will be indicated. If it passes multiple bin limits, only the first bin will be indicated (based on bin numeric order). This option is useful for component sorting.
Pass/Fail Beep Sound	Sound	**NG** Enables the beep sound when test fails. **GD** Enables the beep sound when test passes. **OFF** Disables the beep sound regardless of test results.
Comparator Function State	COMP	**ON** Enable the BIN comparator **OFF** Disabled
Loaded Bin	Loaded BIN	Comparison range (BIN) Uses limits defined for the specified BIN. *Only available when in Comparison mode.*

Table 3.10: BIN Comparator Display Parameters

1. Go to the BIN Display, and select BIN for the Mode parameter.
2. Configure all other parameters as necessary, see Table 3.10.
3. Connect the TLKB1 kelvin clips to the DUT.

> **Note:** If both COMPA and COMPB are enabled, the test will apply to both primary and secondary measurements. If either of the results fail, the instrument will indicate fail.

When measurements **pass**, the display will indicate the passing BIN number. If the measurements pass in multiple bins, the first BIN (in numerical order) is displayed. For example, if the measurements pass in BIN3 and BIN6, the display will indicate BIN 3. Figure 3.14 shows the display when the measurements pass in BIN 1.

When measurements **fail**, the display indicates **OUT** as shown in Figure 3.15.

3.9.3 Compare Pass/Fail Testing

The BIN comparator function can be used to compare the DUT (device under test) measurements against a specified upper and lower limit for pass/fail (Go/No Go) style testing.

Go to BIN Setup, Section 3.9.5, and configure all the upper and lower limits for the bins to use in the test. Setup all other parameters as necessary, as described in Table 3.10.

Note: If both COMPA and COMPB are enabled, the test will apply to both primary and secondary measurements. If either of the results failed, the final result will indicate fail.

Figure 3.14: BIN Sorting - BIN1 Pass

Figure 3.15: BIN Sorting - Fail

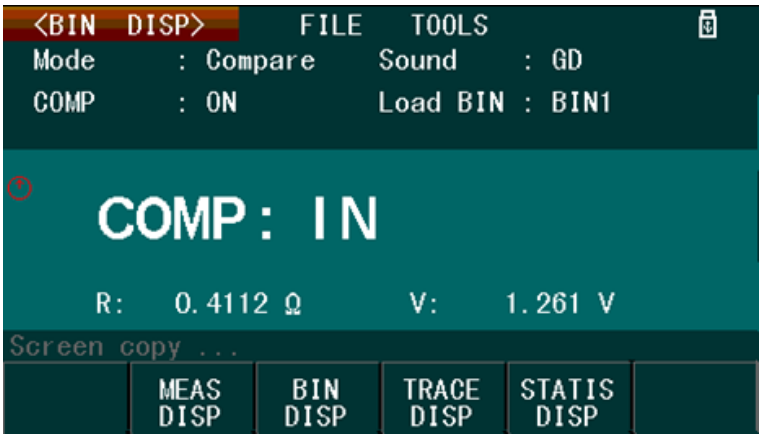


Figure 3.16: Compare Test Pass

1. Go to the BIN Display, and set **Mode** to **Compare**.
2. Configure all other parameters as necessary, see Table 3.10.
3. Connect the TLKB1 kelvin clips to the DUT.

When measurements pass, the display will show IN, as shown in Figure 3.16. The front panel pass/fail indicator PASS FAIL will illuminate green PASS FAIL.

When the measured value fails, the display will show LO or HI. The front panel pass/fail indicator PASS FAIL will illuminate red PASS FAIL.

LO measured value is **below** the "Load BIN" range settings.

HI measured value is **above** the "Load BIN" range settings.

Figure 3.17: Compare Test - Below Limits

Figure 3.18: Compare Test - Above Limits

3.9.4 BIN Tools

The BIN tools menu is accessed from the **BIN Display** by pressing the DISP and selecting BIN DISP. Then press ▷ right arrow key twice to select TOOLS. If the current selection is on a parameter, then use any of the arrow keys to navigate to TOOLS.

Figure 3.19: BIN Tools Menu

3.9.5 BIN function setup

Press the SETUP button, and then press the function key corresponding to **BIN SETUP** to open the **BIN SETUP** menu; Figure 3.20 will be displayed. Use the arrow keys to select each parameter, and the function keys to make changes. Enter numeric parameters (i.e. nominal and high and low limits) using the keypad, and the function keys to select the units. See Table 3.11 for parameter and option details in this menu.

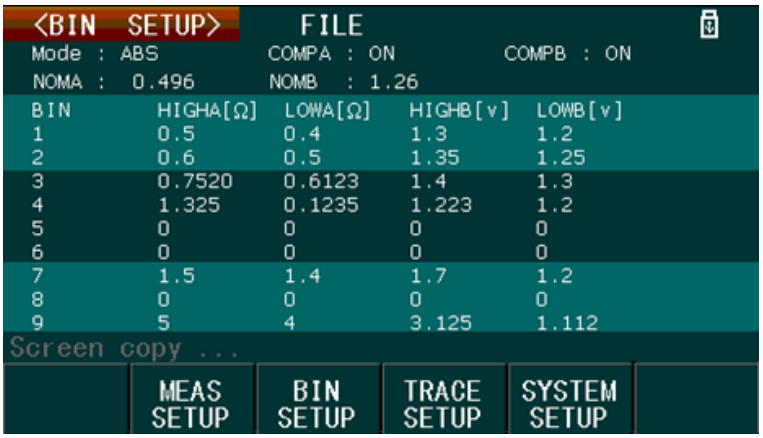


Figure 3.20: BIN Setup Display

Parameter	On-screen Label	Description/Options
Measurement Mode	Mode	Selects the measurement mode for the BIN function. Options: %, ABS **%** — The high and low limits used for testing is a tolerance percentage. **ABS** — The high and low limits used for testing is an absolute value of the selected parameter. **HIGHA[], LOWA[], HIGHB[], LOWB[]** — labels display either [X] units, where 'X' denotes the primary and secondary measurement units when applicable (i.e. Ω, V, H, F, r(radians)), or [%] with the limits defining a percentage.
Comparator State Primary Measurement	COMPA	Enables or disables the primary measurement comparator function. When disabled, primary measurements will not be tested. Options: OFF, ON
Comparator State Secondary Measurement	COMPB	Enables or disables the secondary measurement comparator function. When disabled, secondary measurements will not be evaluated. Options: OFF, ON
Nominal Value Primary Measurement	NOMA	Sets the nominal value of the bin comparator function for the primary measurement. This parameter only applies when Mode is set to %. *Valid Range*: Dependent on the range of the primary measurement selected.
Nominal Value Secondary Measurement	NOMB	Sets the nominal value of the bin comparator function for the secondary measurement. This parameter only applies when Mode is set to %. *Valid Range*: Dependent on the range of the secondary measurement selected.
High Limit Primary Measurement	HIGHA	Sets the upper limit value for the comparator function that applies to the primary measurement. *Valid Range*: -100 - 100 (%), -10000 - 10000 (ABS)

Parameter	On-screen Label	Description/Options
Low Limit Primary Measurement	LOWA	Sets the lower limit value for the comparator function that applies to the primary measurement. *Valid Range*: -100 - 100 (%), -10000 - 10000 (ABS)
High limit Secondary Measurement	HIGHB	Sets the upper limit value for the comparator function that applies to the secondary measurement. *Valid Range*: -100 - 100 (%), -10000 - 10000 (ABS)
Low Limit Secondary Measurement	LOWB	Sets the lower limit value for the comparator function that applies to the secondary measurement. *Valid Range*: -100 - 100 (%), -10000 - 10000 (ABS)

Table 3.11: Bin Setup Parameters

3.9.6 Saving BIN Comparator Results

When **TOOLS** is selected, the soft menu will have the **SAVE** option; this saves the primary and secondary measurements and the test result of the BIN comparator function to an external USB flash drive.

1. Insert an external USB flash drive to the front panel USB host port until the USB icon on the top right of the display will appear.
   During USB activity, the unit will pause and not respond until the activity is complete.
2. Press the function key below the **SAVE START** option to save. Data is saved as a .CSV (comma delimited) file in the folder named **CSV** in the USB flash drive.
3. To stop saving, press the function key below the **SAVE STOP** option.

Note: The saved data has the following format: Primary measurement, Secondary measurement, Test Result. Test Result is either **LO, HI, or IN** for **Compare Mode**. For **BIN MODE**, it is either OUT or the BIN number (1 – 9). If measurements are made continuously, the instrument saves data at approximately twice a second.

3.10 Trace Function

The trace function measures the primary and secondary measurements and plots them versus time. To use the trace function, there are three steps to follow:

1. Select the primary and secondary measurement parameters for the test. To do this, follow instructions in Measurement Setup, Section 3.8.
2. Setup the trace parameters from the **Trace Setup** display.
3. Navigate to the Trace Display Tools menu to start the test.

3.10.1 Trace Setup

The trace setup menu can be accessed by pressing the (SETUP) button, and then press the function key corresponding to **TRACE SETUP** from the soft menu. Use the arrow keys to select each parameter, and the

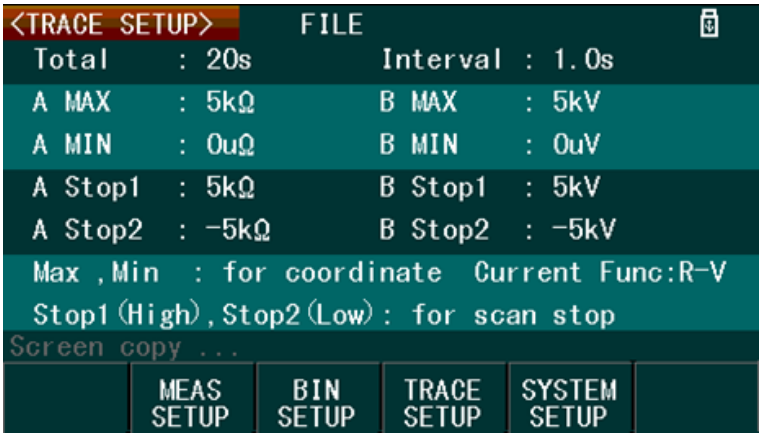


Figure 3.21: Trace Setup Display

function keys to make changes. Parameters that require entering a numeric value must use the keypad, and the function keys to select the units.

The below table explains the parameters and their options/range.

Parameter	On-screen Label	Description/Options
Total Time	Total	Sets the total time to run the trace function. The test will complete when this time has elapsed. Valid Range: 1 - 99999 seconds
Sampling Interval	Interval	Sets the time between each primary and secondary measurement captured and traced. *Valid Range*: 1.0 - 86400.0 seconds
Primary Measurement Trace Scale Maximum	A MAX	Sets the maximum range of the scale of the trace for the primary measurement. *Valid Range*: 0 - 99999k
Primary Measurement Trace Scale Minimum	A MIN	Sets the minimum range of the scale of the trace for the primary measurement. *Valid Range*: 0 - 99999k
Secondary Measurement Trace Scale Maximum	B MAX	Sets the maximum range of the scale of the trace for the secondary measurement. *Valid Range*: 0 - 99999k
Secondary Measurement Trace Scale Minimum	B MIN	Sets the minimum range of the scale of the trace for the secondary measurement. *Valid Range*: 0 - 99999k
Primary Measurement Upper Limit	A Stop 1	Sets the upper limit value as a stop condition of the test. If the primary measured value exceeds this for 2 consecutive samples, the test will stop. *Valid Range*: Dependent on the measurement range of the selected primary function.
Primary Measurement Lower Limit	A Stop 2	Sets the lower limit value as a stop condition of the test. If the primary measured value exceeds this for 2 consecutive samples, the test will stop. *Valid Range*: Dependent on the measurement range of the selected primary function.

Parameter	On-screen Label	Description/Options
Secondary Measurement Upper Limit	B Stop 1	Sets the upper limit value as a stop condition of the test. If the secondary measured value exceeds this for 2 consecutive samples, the test will stop. *Valid Range*: Dependent on the measurement range of the selected secondary function.
Secondary Measurement Lower Limit	B Stop 2	Sets the lower limit value as a stop condition of the test. If the secondary measured value exceeds this for 2 consecutive samples, the test will stop. *Valid Range*: Dependent on the measurement range of the selected secondary function.

Table 3.12: Trace Setup Parameters

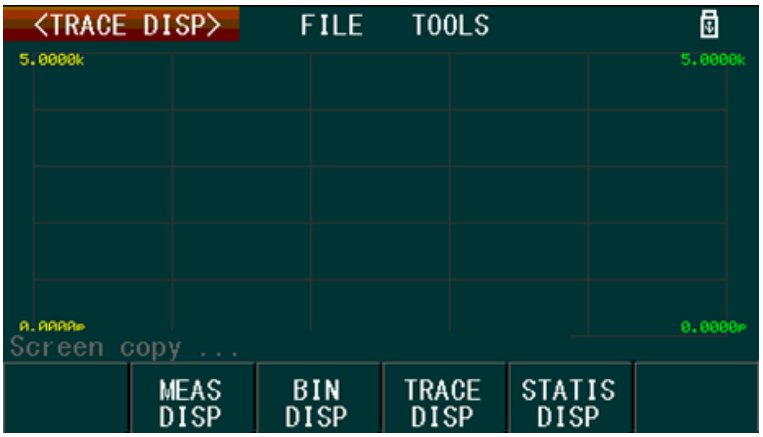


Figure 3.22: Trace Display

The **Trace Display**, Figure 3.22 shows the measurements and trace results on the screen. To show this display, press the DISP button, then pressing the function key corresponding to **TRACE DISP** from the soft menu.

3.10.2 Trace Display Tools

The trace display tools menu, Figure 3.23, is accessed from the Trace Display by pressing DISP and select **TRACE DISP**, and then pressing the ▷ key twice to select **TOOLS**.

The trace display tools menu has options to start the trace test and to control what to display on the screen. See Table 3.13.

3.10.3 Start a Trace

- Configure all the settings under Trace Setup, and then go to the Trace Display Tools menu.
- Select the **TRACE** to display then select **SCAN START**.
- While testing, the display plots the measured values.
- To stop testing at any time, select **SCAN STOP**.

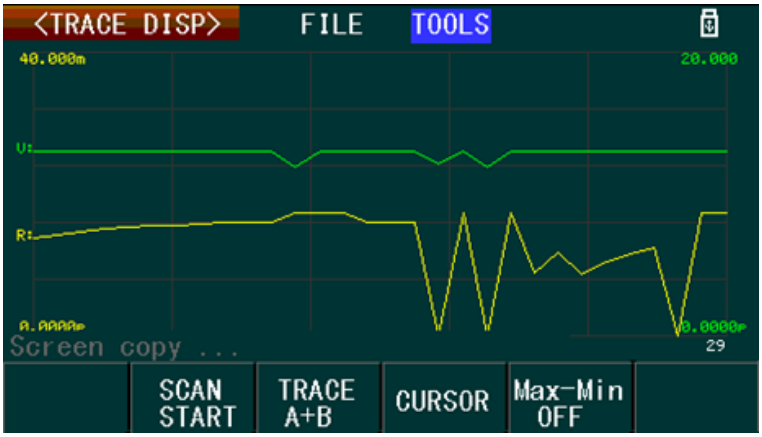


Figure 3.23: Trace Tools Display

Parameter	On-screen Label	Description/Options
Initiate or stop trace test	SCAN START (SCAN STOP)	Starts or stops the trace test. Options: START, STOP
Trace Display	TRACE	Selects the trace to display. Valid Range: A, B, A+B **A** The primary measurement trace. **B** The secondary measurement trace.
Cursor Display	CURSOR	Enables/disables the cursor. When enabled, the cursor can be controlled using the ◁ ▷ arrow keys. The cursor is used to view the primary and secondary measurements, and the timestamp of any measured points on the trace.
Maximum/Minimum Value Display	Max-Min	Enables/disables the display of the maximum and minimum values of both the primary and secondary measurement traces. Options: ON, OFF

Table 3.13: Trace Display Tools Parameters

- Press **CURSOR** to see the values of a measured point on the trace. Using the ◁ ▷ keys to move the cursor along the trace.
- The maximum and minimum values of the primary and secondary measurements of the trace may also be displayed by pressing **Max-Min** to **ON**.

3.11 Statistical Measurement

The instrument can calculate statistical measurements, which are accessed by pressing DISP and selecting **STATIS DISP** from the soft menu.

Before performing a statistical calculation, some parameters must be configured first. They are grouped together on display the box highlighted in cyan like this, parameter. See Figure 3.26. Use the arrow keys to select each parameter, and the function keys to make changes. Parameters requiring entering a numeric values are entered

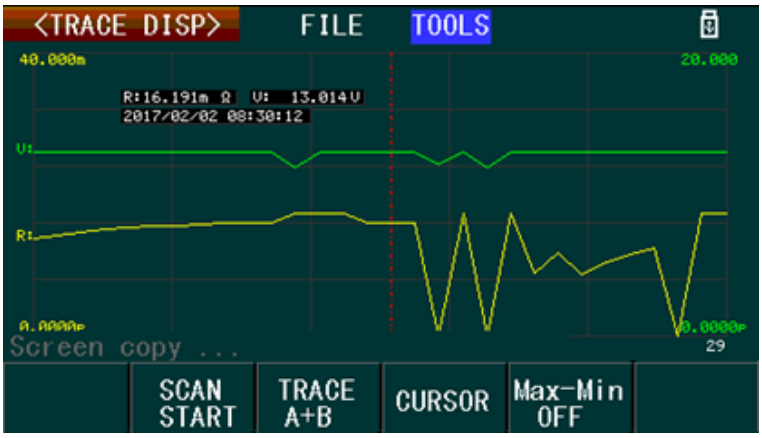


Figure 3.24: Trace Cursor

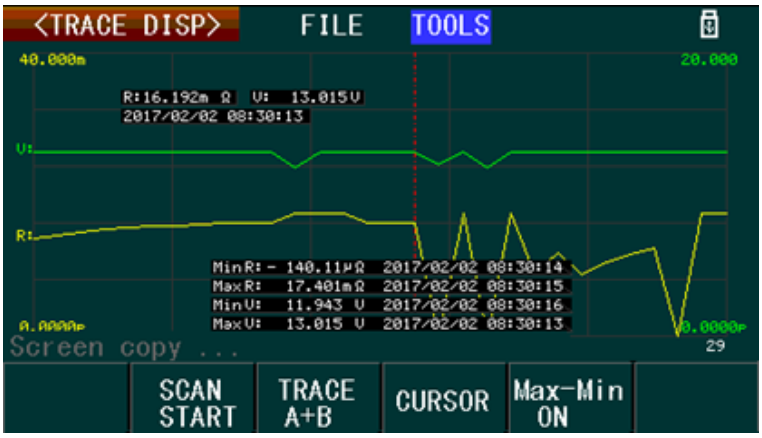


Figure 3.25: Trace Min/Max

with the keypad, and then the function keys to select the units. See Table 3.14 for the parameters and their options/range.

Parameter	On-screen Label	Description/Options
Measurement Mode	Mode	Selects the measurement mode for the statistical measurement function. Options:%, ABS **%** The high and low limits used for measurement is a tolerance percentage. **Upper limit** $(Hi) = Nominal * (1 + Upperlimit\%)$ **Lower limit** $(Lo) = Nominal * (1 + LowerLimit\%)$ **ABS** The high and low limits used for testing is an absolute value of the selected parameter. When selected, the Hi and Lo parameters will display [X] units, where 'X' denotes the primary and secondary measurement units when applicable (i.e. Ω, V, H, F, r(radians)).

Parameter	On-screen Label	Description/Options
Primary Measurement Nominal Value	NOMA	Sets the nominal value of the primary measurement. This only applies when in % mode. *Valid Range*: Dependent on the measurement range of the selected primary function.
Secondary Measurement Nominal Value	NOMB	Sets the nominal value of the secondary measurement. This only applies when in % mode. *Valid Range*: Dependent on the measurement range of the selected primary function.
Statistical Measurement State	STAT	Enables/disables the statistical measurement function. If disabled, statistical measurements are not taken even when initiated or triggered. Options: OFF, ON
Select Measurement	Statis	Selects which measurement parameter to calculate for statistical measurements. Options: A, B **A** The primary measurement. **B** The secondary measurement.
Measurement Samples	Number	The total number of measurement samples to capture and to be stored in before performing the statistical calculations. *Valid Range*: 0 - 30000
Upper Limit	Hi	The upper limit value for the statistical measurement calculation. *Valid Range*: Dependent on the measurement range of the selected function (primary or secondary depending on the Statis parameter setting).
Primary Measurement Low Limit	Lo	The lower limit value for the statistical measurement calculation. *Valid Range*: Dependent on the measurement range of the selected function (primary or secondary depending on the Statis parameter setting).

Table 3.14: Statistical Measurement Parameters

The statistical measurement parameters that the instrument can calculate, as indicated in the red box in Figure 3.27, are described below.

$(\overline{X})Average/Mean$

$$\overline{X} = \frac{\sum x}{n}$$

$$\sigma = \sqrt{\frac{\sum x^2 - nx^{-2}}{n}}$$

(s)Sample Standard Deviation

$$s = \sqrt{\frac{\sum x^2 - nx^{-2}}{n-1}}$$

(C_p)Process Capability Index (Dispersion)

Figure 3.26: Statistics Display Screen

Figure 3.27: Statistics Measurements

$$C_p = \left| \frac{Hi - Lo}{6s} \right|$$

C_pKProcess Capability Index (Deviation)

$$C_pK = \frac{|Hi - Lo| - |Hi + Lo - 2\overline{x}|}{6s}$$

Where,

n	Denotes the total number of measurement samples used for the statistical measurement calculation (equivalent to **Number** parameter on display).
x	Denotes the measurements. Data are saved into the instrument buffer for the calculation.
Hi	Denotes the upper limit value, which corresponds to the Hi[] parameter.
Lo	Denotes the lower limit value, which corresponds to the Lo[] parameter.
$C_p, C_pK > 1.33$	Working capacity is Ideal.
$1.33 \geq C_p$	Working capacity is qualified.
$C_pK > 1.00, 1.00 \geq C_p, C_pK$	Working capacity is insufficient.

Hi(num) Total number times the measurement results exceed the upper limit value **Hi[]**.

Lo(num) Total number times the measurement results are below the lower limit value **Lo[]**.

In(num) Total number of times the measurement result is within the upper and lower limits.

Max Displays the maximum measurement value from all the captured measurement samples.

MaxIndex Displays the index from the internal buffer containing all the captured measurement samples, in which contains the maximum measurement value.

Min Displays the minimum measurement value from all the captured measurement samples.

MinIndex Displays the index from the internal buffer containing all the captured measurement samples, in which contains the minimum measurement value.

3.11.1 Statistical Measurement Operation

To operate the statistical measurement function, press the DISP button and select **STATIS DISP** from the soft menu. Press ▷ right arrow key twice to select **TOOLS**. If the current selection is on a parameter, then use any of the arrow keys to navigate to **TOOLS**.

Figure 3.28: Statistics Tools Menu

In the TOOLS menu, there are two options: Statis START, TRIG.

Operation steps

1. Select the primary and secondary measurement parameters to perform the calculation. To do this, follow instructions in Section 3.8, Measurement Setup.
2. Configure all statistical parameters (described in Table 3.14) as necessary.
3. From the TOOLS menu, press the function key corresponding to **Statis START** soft key to begin the calculation.
   - If the trigger source is not set to internal trigger **(INT)**, select **TRIG** from the soft menu to manually trigger a single capture of a measurement sample.
   - To complete calculation, continue to press **TRIG** until the message prompt displays *"Measurement Completed"*.

4. The instrument will begin capturing measurement samples and store them into an internal buffer. In the message prompt, display will indicate the sample index and the value stored into that index in this format: $num = X, val = \#$

   Where,

   $X =$ measurement sample index

   $val =$ measurement sample value

5. When the calculation completes, the message prompt will display **"Measurement Completed"**. All statistical measurement results from the calculation will be displayed on the same screen.

6. Press **Statis STOP** to stop at any time.

Chapter 4

File System

The instrument file system menu is used to browse, save, and load files from the internal storage memory or an external USB flash drive connected to the front panel USB port.

The file system is accessible from any display screen by using the arrow keys and selecting **FILE**. See Table 4.1 for available options shown in the soft menu.

Parameter	On-screen Label	Description/Options
Internal Memory	INTER File	Select to browse the internal memory directory.
External USB Memory	EXTER File	Select to browse the external USB flash drive directory.

Table 4.1: File Menu

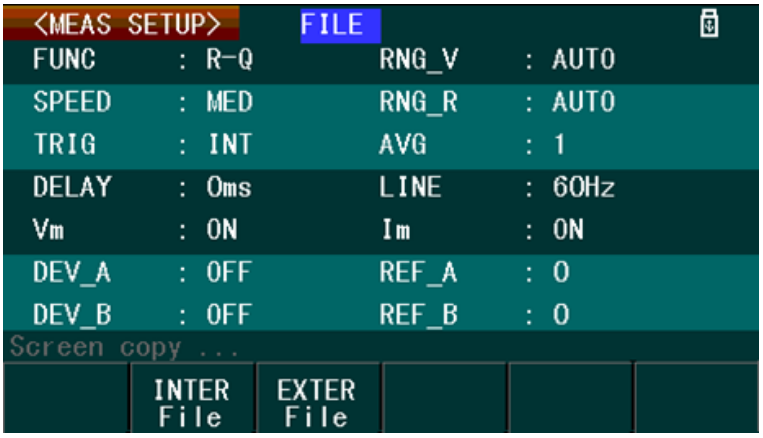


Figure 4.1: File Menu

Internal Memory Internal memory can save and recall instrument settings. The storage file has a .STA file extension. To access internal memory, select **INTER File** from the **FILE** menu. Shown on the display is the internal memory directory listing, and any instrument setting files stored there. Three options are available. See Table 4.2 for details.

To exit out of the directory, press the △ arrow key until the **Exit** option in the soft menu becomes available. Then, select it to exit.

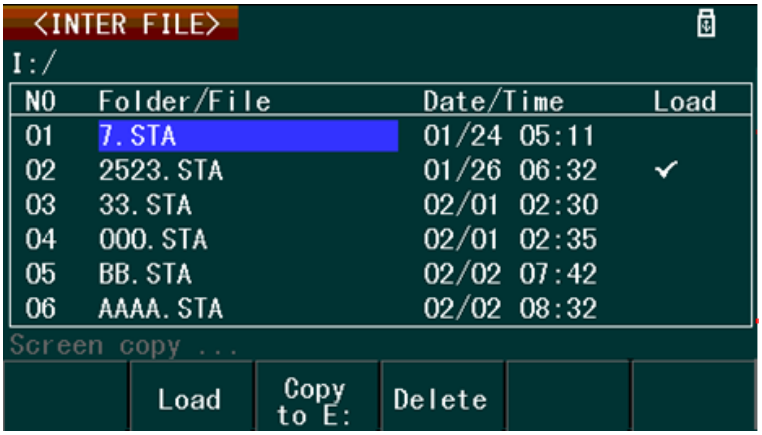


Figure 4.2: Internal Memory Directory

Parameter	On-screen Label	Description/Options
Recall Instrument Settings	Load	Loads the selected .STA instrument settings file.
Copy File to External USB Drive	Copy to E:	Copies the selected .STA instrument settings file to the external USB flash drive /**STA** subfolder.
Delete File	Delete	Select to delete the selected .STA instrument settings file.

Table 4.2: Internal Memory Options

4.1 Save current settings

1. Enter all desired system settings to the instrument.
2. Navigate to the **FILE** menu on the <SYSTEM SETUP>screen.
3. Select where to save the settings, **INTER** or **EXTER** for internal or external memory respectively.
4. Use the arrow keys to navigate to a blank Folder/File location.
5. Select the **SAVE** soft key.
6. Press yes to confirm you really want to save a file at that location.
7. Enter a name for the file using the arrow keys and by pressing **ADD CHAR** to enter the highlighted character.
8. Press the **ENTER** soft key when finished. The file is then saved.

4.2 Load saved settings to active settings

1. If the configuration is not in the internal storage, move it there.
2. Navigate to the “FILE” menu on the <SYSTEM SETUP>screen.
3. Select the storage location containing the “sta” file holding your system setup state.
4. Select the file and press “LOAD”.
5. Confirm “YES” to commit the selected file as the startup configuration.

4.3 External Memory (USB)

When an external USB flash drive is connected to the instrument's front panel USB host port, the directory can be viewed from the FILE menu.

The instrument supports USB drives that meet the following requirements:

- Support USB 2.0
- FAT16 or FAT32 (recommended) file system

When connected, the instrument will automatically create three subfolders in the root directory of the drive: **/CSV, /STA, /PIC.**

/CSV	The CSV subfolder is where all measurement data files (in .CSV format) are stored.
/STA	The STA subfolder is where all instrument settings files (in .STA format) are stored.
/PIC	The PIC subfolder is where all screen capture images (in .GIF format) are stored.

To access the directory, select **EXTER File** from the **FILE** menu. The display will show the external USB flash drive directory listing (Figure 4.3). Use the **Sub Dir** and **Parent Dir** soft keys to navigate through the directories. See Table 4.3 for available option details.

Note: ONLY setup files from the /STA subfolder may be saved or recalled in the FILE menu system. Measurement data or screen captures cannot be saved from within this menu system.

Note: The instrument's file system can only save/select/view 100 files within the root directory and any subfolders contained in the external USB flash drive.

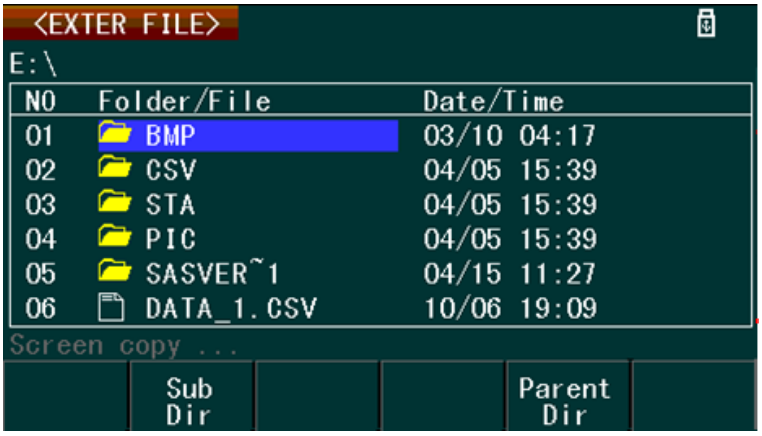


Figure 4.3: External USB Drive Directory

To exit out of the directory, press the △ arrow key until the **Exit** option in the soft menu becomes available, and then select it to exit.

Parameter	On-screen Label	Description/Options
Recall Instrument Settings	Load	This option will load the selected .STA instrument settings file. Note: The selected file must have a .STA file extension and is located inside the /STA subfolder of the drive.
Copy File to Internal Memory	Copy to I:	Select this to copy the selected .STA instrument settings file to the internal memory of the instrument.
Delete File	Delete	Delete the selected file.
Enter Sub Directory	Sub Dir	Enter the selected sub folder.
Browse Root Directory	Parent Dir	Go back to the root directory of the drive.

Table 4.3: Save/Recall Instrument Settings

4.4 Save/Recall Instrument Settings

Instrument settings including all measurement setup settings, BIN setup settings, Trace setup settings, and system setup settings, can be stored and recalled to and from internal memory.

4.4.1 Save settings to internal memory

1. Select **FILE** menu from any display, and then select **INTER File** from the soft menu.
2. Use the △▽ keys to browse and select an empty location in the internal memory directory. A **Save** option will appear in the soft menu when an empty location is selected.
3. Press **Save** using the corresponding function key, and confirm by pressing **Yes** in the soft menu.
4. The message prompt then shows “Input FileName:”, and an on-screen soft keyboard will be displayed, prompting for a file name to save the instrument settings to.
5. Use the △▽◁▷ keys to navigate the soft keyboard. The character highlighted in **BLUE** is the selected character. Press **Add Char** to add the selected character to the file name. Repeat selection and enter the complete file name.
6. Select **Enter** from the soft menu when finished. The file is then saved to internal memory. The saved file includes the date and time.

Recall settings from internal memory

1. Select the **FILE** menu from any display, and then select **INTER File** option from the soft menu.
2. Use the △▽ arrow keys to browse and select setting files from the internal memory directory. Once the desired file is selected, press the **Load** option from the soft menu.
3. The message prompt will ask for confirmation of this action. Select **Yes** to recall the settings.
4. The recalled file will have a check mark ✔ in the Load column. The check mark identifies the file containing the current instrument settings.
5. The soft menu **Load** option will change to **UnLoad** when the file with the ✔ is shown.
6. To clear the ✔ and unset the setting file as default, select the **Unload** option from the soft menu.

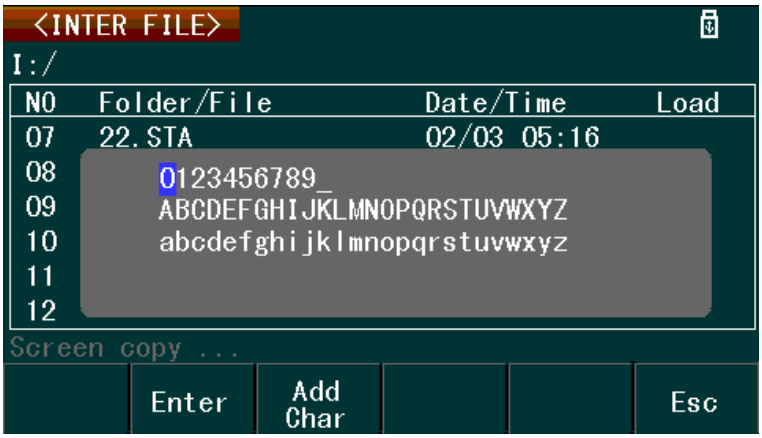


Figure 4.4: Setting the Internal File Name

Save settings to the external USB flash drive

1. Select **FILE** from any display, and then select **EXTER** File from the soft menu using the corresponding function key.
2. Use the △▽ keys to browse and select an empty location within the /**STA** subfolder. A **Save** option will appear in the soft menu when an empty location is selected.
3. Press the **Save** function key, and confirm by pressing the **Yes** option in the soft menu.
4. The message prompt will then say “Input FileName:”. An on-screen soft keyboard is displayed prompting the operator to enter a file name where the instrument settings will be saved. See Figure 4.5
5. Use the △▽◁▷ keys to navigate the soft keyboard. The character highlighted in BLUE is the selected character. Add the selected character to the file name using the Add Char option from the soft menu, and repeat this to enter the complete file name.
6. Select the **Enter** option from the soft menu when finished. The file is then saved to the external memory. The saved file includes the date and time.

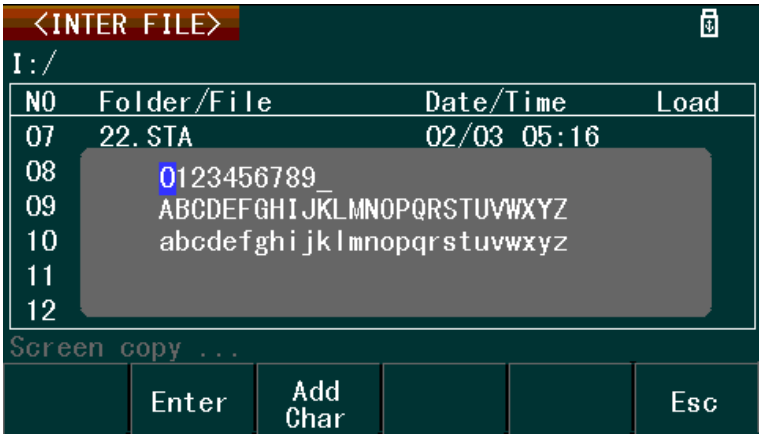


Figure 4.5: Setting the External File Name

Recall settings from the external USB flash drive

1. Select the **FILE** menu from any display, and then select **EXTER** File option from the soft menu.
2. Use the △▽ keys to browse and select the setting files from within the /**STA** subfolder of the drive. Once the desired file is selected, press the **Load** option from the soft menu.
3. The message prompt will ask for confirmation. Select **Yes** to recall the settings.

Chapter 5

Remote Operation

The instrument supports numerous SCPI commands and some instrument specific commands. These commands enable a computer to remotely communicate and control the instrument over any of the supported remote interfaces: USBTMC, USBCDC(Virtual COM), RS-232, and GPIB.

Refer to the programming manual for details, which can be downloaded from www.bkprecision.com.

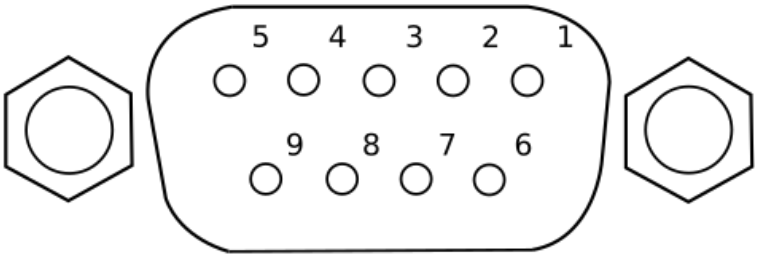
5.1 Remote Interfaces

5.1.1 RS232

For RS232 interface, use the DB-9 serial port in the back panel. The baud rate settings must be configured to match the same baud rate as configured on the computer that is connected to the instrument for remote control. Select the Baud Rate parameter to change/set the baud rate. The instrument is set to the following serial settings:

- Parity:*None*
- Data bits: *8*
- Stop bits: *1*
- Flow Control: *None*

Note: The DB-9 serial connector (RS-232C) on the back of the instrument requires using a null modem or crossover DB-9 serial cable.



PIN	1	2	3	4	5	6	7	8	9
Description	-	TXD	RXD	-	GND	-	-	-	-

Table 5.1: RS232 Pinout

5.1.2 USBTMC

The instrument supports USBTMC (Test & Measurement Class) interface. Use a USB Type A to Type B cable to connect the USB device port in the rear panel to the computer. A driver is required before it can be used for remote communication. A computer with VISA-such as NI-VISA-installed will automatically have the driver available, and upon connecting the USB to the device, drivers will automatically install on Windows®7 or later.

5.1.3 USBVCP

USBVCP is a USB Virtual COM interface option. A driver is required (downloaded from www.bkprecision.com) to be installed before it can be used. The setup is similar to an RS232 interface, except that a USB Type A to Type B cable is required for remote connection instead of a DE-9 serial cable.

5.2 Handler Interface

The instrument has a 36-pin handler interface, which is primarily used for outputting BIN sorting results. This section describes the pin definition of this interface.

Mating connector: 36 pin Centronics type, male.

Pin	Signal Name	Description
1	/BIN1	Bin Sorted Result
2	/BIN2	Outputs are all open collector.
3	/BIN3	
4	/BIN4	
5	/BIN5	
6	/BIN6	
7	/BIN7	
8	/BIN8	
9	/BIN9	
10	/OUT	
11	-	Not used
12	/EXT. TRIG	**External trigger (When TRIG set to EXT in System Setup)**: Triggered by the positive-edge pulse signal in this pin.
13		
14	EXT.DCV2	External DC voltage 2:
15		The DC provider pin for the optoelectronic coupling signal (/EXT_TRIG, /Key Lock, /ALARM, /INDEX, /EOM)

Pin	Signal Name	Description
16, 17, 18	+5 V	**Internal +5V**: It is not recommended to use the internal +5 V. If this voltage output is used, the current should be lower than 0.3 A, and that the signal line is far from a disturbance source.
19	/PHI	Indicates the primary measurement result is greater than the high limit set on BIN1 to BIN9.
20	/PLO	Indicates the primary measurement result is less than the low limit set on BIN1 to BIN9.
21	/PIN	Indicates the primary measurement result is PASS.
22	/SHI	Indicates the secondary measurement result is greater than the high limit set on BIN1 to BIN9.
23	/SIN	Indicates the secondary measurement result is PASS.
24	/SLO	Indicates the secondary measurement result is less than the low limit set on BIN1 to BIN9.
25	/KEYLOCK	When this line is asserted, the keys in the front panel are locked.
26	-	Not used
27, 28	EXT_DCV1	**The external DC voltage 1**: this is a pull-up DC Voltage pin for optoelectronic coupling signal.
29	-	Not used
30	/INDEX	Indicates when the internal ADC is processing.
31	/EOM	**End Of Measurement**: when the test data and the compared results are asserted, this signal is also asserted.
32, 33	COM2	The reference ground for external power EXTV2.
34, 35, 36	COM1	The reference ground for external power EXTV1.

Table 5.2: Handler Pinout

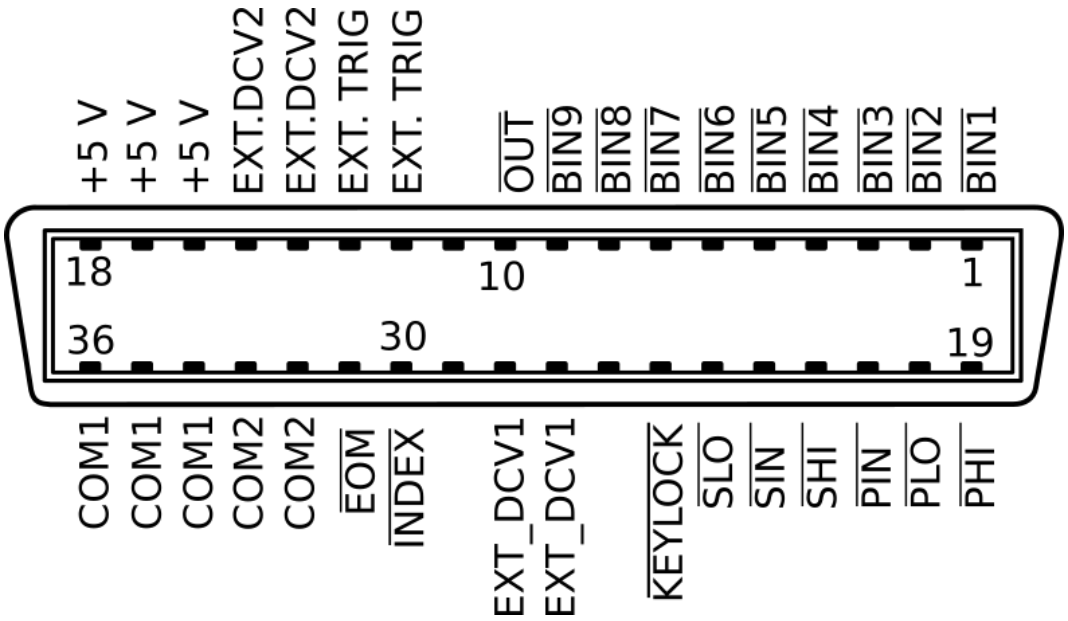


Figure 5.1: 36 pin Handler Connector

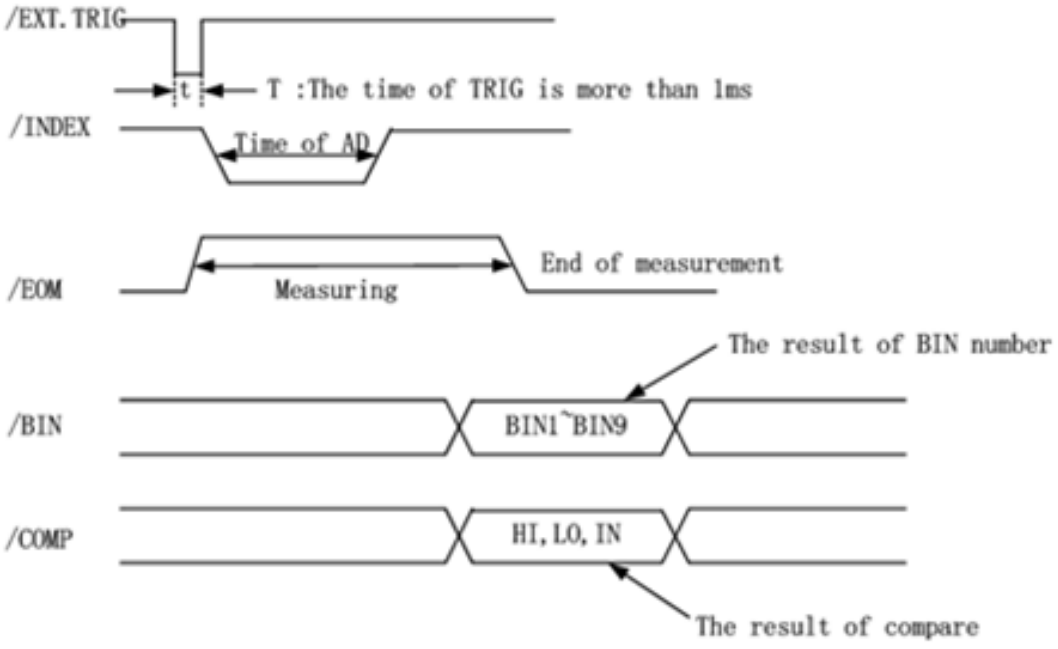


Figure 5.2: Handler Interface Timing

Chapter 6

Specifications

Note: All specifications apply to the unit after:

1. A temperature stabilization time of 15 minutes over an ambient temperature range of 23 °C ± 5 °C.
2. Short correction operation performed before making measurement.

Specifications are subject to change without notice.

Specifications

All specifications apply to the unit after a temperature stabilization time of 15 minutes over an ambient temperature range of 20 °C ± 5 °C. Specifications are subject to change without notice.

Model		BA6010, BA6011
Measurement Parameters	Main	V, R
	Auxiliary	L, C, D, Z, X, Q, θd, and θr
Test Frequency		1 kHz ± 0.2 Hz
Display Resolution		5 digits (SLOW & MED), 4 digits (FAST)
Measurement Speed		SLOW, approx. 6.25 measurements/sec MED, approx. 10 measurements/sec FAST, approx. 50 measurements/sec
Temperature Coefficient	Voltage Meas.	0.005 % / °C
	Resistance Meas.	0.05 % / °C
Triggering		Internal, External, Manual, Bus
Delay Time		On / Off, 0 ms to 60 s
Averaging		1 to 255 samples
Statistical Calculations		Valid data count, Invalid data count, Mean, Maximum, Minimum, Standard Deviation, Sample Standard Deviation, Process Capability Index (Dispersion), Process Capability Index (Deviation)

Voltage Measurement (BA6010)

SLOW, MED

Range	Maximum Display Value	Resolution	Accuracy
6 V	6.5000 V	100 µV	±(0.05 % FS)
60 V	65.000 V	1 mV	

FAST

Range	Maximum Display Value	Resolution	Accuracy
6 V	6.500 V	1 mV	±(0.1 % FS)
60 V	65.00 V	10 mV	

Voltage Measurement (BA6011)

SLOW, MED

Range	Maximum Display Value	Resolution	Accuracy
30 V	35.000 V	1 mV	±(0.05 % FS)
300V	310.00 V	10 mV	

FAST

Range	Maximum Display Value	Resolution	Accuracy
30 V	35.00 V	10 mV	±(0.1 % FS)
300 V	310.0 V	100 mV	

Specifications

Resistance Measurement				
SLOW, MED				
Range	**Maximum Display Value**	**Resolution**	**Measurement Current**	**Accuracy**
30 mΩ	33.000 mΩ	1 µΩ	100 mA (± 10 %)	±(0.3 % + 0.1 % FS)
300 mΩ	330.00 mΩ	10 µΩ	100 mA (±10 %)	
3 Ω	3.3000 Ω	100 µΩ	10 mA (± 10 %)	
30 Ω	33.000 Ω	1 mΩ	1 mA (± 10 %)	
300 Ω	330.00 Ω	10 mΩ	100 µA (± 10 %)	
3 kΩ	3.5000 kΩ	100 mΩ	10 µA (± 10 %)	
FAST				
Range	**Maximum Display value**	**Resolution**	**Measurement Current**	**Accuracy**
30 mΩ	33.00 mΩ	10 µΩ	100 mA (± 10 %)	±(0.5 % + 0.3 % FS)
300 mΩ	330.0 mΩ	100 µΩ	100 mA (± 10 %)	
3 Ω	3.300 Ω	1 mΩ	10 mA (± 10 %)	
30 Ω	33.00 Ω	10 mΩ	1 µA (± 10 %)	
300 Ω	330.0 Ω	100 mΩ	100 µA (± 10 %)	
3 kΩ	3.500 kΩ	1 Ω	10 µA (± 10 %)	

Accuracy of Auxiliary Measurement Parameters	
L, C, D, Z, X, Q, θd, and θr	5 % typical**

** see user manual for more details

Bin Comparator Function		
Limit Setting Mode		Tolerance (TOL) or Absolute (ABS) value
Number of Bins		9 sorting bins BIN1-BIN9
Beep Warning		OFF, PASS, FAIL
Trace Function		
Total Time		1 s - 99999 s
Sampling Interval		1 s - 86400 s
General		
Save/ Recall	**Instrument Settings**	
	Save / Recall	Internal or External Memory: Up to 100
	Measurements, Bin Comparator Results, Screenshots	
	Save	External Memory: Up to 100
Remote Interface		USBTMC / USB (Virtual COM), RS232, GPIB
Display		4.3", 480 × 272 LCD display
AC Input		110 V ±10 % or 220 V ± 10 %, 47 to 63 Hz
Power Consumption		15 VA Max.
Operating Temperature		0 °C to 40 °C
Storage Temperature		-10 °C to 70 °C
Relative Humidity		up to 80 %
Dimension (W×H×D)		9.25" x 4.1" x 14.17" (235 x 104 x 360 mm)
Weight		7.9 lbs (3.6 kg)
		Three-Year Warranty
Included Accessories		User manual (downloadable), power cord, 4-wire kelvin clip test fixture (TLKB1), certificate of calibration & test report

Chapter 7

Troubleshooting Information

The message prompt on the display may display different error messages during operation. The below table list the error messages and their description.

Error Message	Description
Error: LO Sense Open	LCUR terminal is opened or disconnected from DUT.
Error: LO Drive Open	LPOT terminal is opened or disconnected from DUT.
Error: HIGH Sense Open	HCUR terminal is opened or disconnected from DUT.
Error: HIGH Drive Open	HPOT terminal is opened or disconnected from DUT.
Error: Measure line open	All four input terminals are opened.
Short Failed	The short operation failed or aborted. This may be because the terminals are not shorted properly.
Load Failed	This error indicates that either a wrong instrument settings file type was selected (file must have .STA extension) or the selected file is corrupted, preventing the instrument from recalling instrument settings from the file.
???	Invalid remote command error.

Table 7.1: Error Description

Chapter 8

LIMITED THREE-YEAR WARRANTY

B&K Precision Corp. warrants to the original purchaser that its products and the component parts thereof, will be free from defects in workmanship and materials for a period of **three years** from date of purchase.

B&K Precision Corp. will, without charge, repair or replace, at its option, defective product or component parts. Returned product must be accompanied by proof of the purchase date in the form of a sales receipt.

To help us better serve you, please complete the warranty registration for your new instrument via our website www.bkprecision.com

Exclusions: This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized alterations or repairs. The warranty is void if the serial number is altered, defaced or removed.

B&K Precision Corp. shall not be liable for any consequential damages, including without limitation damages resulting from loss of use. Some states do not allow limitations of incidental or consequential damages. So the above limitation or exclusion may not apply to you.

This warranty gives you specific rights and you may have other rights, which vary from state-to-state.

B&K Precision Corp.
22820 Savi Ranch Parkway
Yorba Linda, CA 92887
www.bkprecision.com
714-921-9095

Chapter 9

Service Information

Warranty Service: Please go to the support and service section on our website at bkprecision.com to obtain a RMA #. Return the product in the original packaging with proof of purchase to the address below. Clearly state on the RMA the performance problem and return any leads, probes, connectors and accessories that you are using with the device. Non-Warranty Service: Please go to the support and service section on our website at bkprecision.com to obtain a RMA #. Return the product in the original packaging to the address below. Clearly state on the RMA the performance problem and return any leads, probes, connectors and accessories that you are using with the device. Customers not on an open account must include payment in the form of a money order or credit card. For the most current repair charges please refer to the service and support section on our website. Return all merchandise to B&K Precision Corp. with prepaid shipping. The flat-rate repair charge for Non-Warranty Service does not include return shipping. Return shipping to locations in North America is included for Warranty Service. For overnight shipments and non-North American shipping fees please contact B&K Precision Corp.

B&K Precision Corp.
22820 Savi Ranch Parkway
Yorba Linda, CA 92887
bkprecision.com
714-921-9095

Include with the returned instrument your complete return shipping address, contact name, phone number and description of problem.

Version – September 1, 2017