♦ PRECISION INSTRUMENTS FOR TEST AND MEASUREMENT ♦

1888
Megohmmeter/
High Resistance Meter

IET LABS, INC.

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1888 IM / March 2025

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WARRANTY

We warrant that this product is free from defects in material and workmanship and, when properly used, will perform in accordance with applicable IET specifications. If within one year after original shipment, it is found not to meet this standard, it will be repaired or, at the option of IET, replaced at no charge when returned to IET. Changes in this product not approved by IET or application of voltages or currents greater than those allowed by the specifications shall void this warranty. IET shall not be liable for any indirect, special, or consequential damages, even if notice has been given to the possibility of such damages.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

Revision History	
Revision	**Description**
January 2025	Initial release
March 2025	Changes to section 3 and section 5.7 and 5.8

SAFETY PRECAUTIONS

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific WARNINGS elsewhere in this manual may impair the protection provided by the equipment. Such noncompliance would also violate safety standards of design, manufacture, and intended use of the instrument.

IET Labs assumes no liability for the customer's failure to comply with these precautions.

The 1888 complies with INSTALLATION CATEGORY I as well as POLLUTION DEGREE 2 in IEC61010-1.

If an instrument is marked CAT I (IEC Measurement Category I), or it is not marked with a measurement category, its measurement terminals must not be connected to line-voltage mains.

The 1888 is an indoor use product.

 DANGEROUS PROCEDURE WARNINGS 

Comply with all WARNINGS - Procedures throughout in this manual and instructions on the instrument prevent you from potential hazard. These instructions contained in the warnings must be followed.

BEFORE APPLYING POWER

Verify that all safety precautions are taken. Make all connections to the instrument before applying power. Note the instrument's external markings described under "Safety Symbols".

GROUND THE INSTRUMENT

This is a Safety Class I instrument. To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The power terminal and the power cable must meet International Electrotechnical Commission (IEC) safety standards.

 **WARNING** 

The 1888 Megohmmeter/High Resistance meter can supply an output voltage as high as 1000Vdc to the external device under test (DUT).

Although the 1888 is designed with full attention to operator safety, serious hazards could occur if the instrument is used improperly and these safety instructions are not followed.

Never touch the test leads, test fixture or DUT in any manner (this includes insulation on all wires and clips) when the high voltage is applied and the red DANGER! HIGH VOLTAGE is shown at the bottom of the TFT display.

After each test, press the [STOP] (red) button for safety. This terminates the high voltage being applied to the output terminals.

When the DANGER! HIGH VOLTAGE is shown, NEVER touch the device under test, the lead wires or the output terminals.

SAFETY PRECAUTIONS CONTINUED

CAUTION

Before touching the test lead wires or output terminals make sure:

a) The [STOP] button has been pressed.

b) The DANGER! HIGH VOLTAGE message is not shown

In the case of an emergency, turn OFF the [POWER] switch using a “hot stick” and disconnect the ac power cord from the wall. DO NOT TOUCH THE 1888 INSTRUMENT.

Position the equipment so it is easy to disconnect. Disconnect by means of the power plug or power connector.

If the DANGER! HIGH VOLTAGE message does not go off when the [STOP] button is pressed, immediately stop using the instrument. It is possible that the output voltage is still being delivered regardless of any other indication.

When the 1888 instrument is used in remote control mode, be extremely careful. The High Voltage Output is being turned on and off with an external signal.

- DO NOT Operate in an Explosive Atmosphere
- Do not operate the instrument in the presence of inflammable gasses or fumes
- Operation of any electrical instrument in such an environment clearly constitutes a safety hazard
- Use Caution around live circuits and whenever hazardous voltages > 45 V are present
- Operators must not remove instrument covers
- Component replacement and internal adjustments must be made by qualified maintenance personnel only
- DO NOT substitute parts or modify the instrument
- When working with high voltages: post warning signs, train personnel and keep unauthorized personnel away.

Do not apply any voltage or currents to the terminals of the instrument in excess of the maximum limits indicated in the specifications section of this manual.

To avoid the danger of introducing additional hazards, do not install substitute parts or perform unauthorized modifications to the instrument.

Return the instrument to an IET Labs for service and repair to ensure that safety features are maintained in operational condition.

Safety Symbols

General definitions of safety symbols used on the instrument or in manuals are listed below.

Caution symbol: the product is marked with this symbol when it is necessary for the user to refer to the instruction manual.

Hazardous voltage symbol: the product is marked with this symbol when high voltage maybe present on the product and an electrical shock hazard can exist.

Indicates the grounding protect terminal, which is used to prevent electric shock from the leakage on chassis. The ground terminal must connect to earth before using the product

Direct current.

Alternating current.

Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

On supply.

Off supply.

Hot surface. Avoid contact. Surfaces are hot and may cause personal injury if touched.

Disposal

Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC
This product complies with the WEEE Directive (2002/96/EC) marking requirements.
The affixed label indicates that you must not discard this electrical/ electronic product in domestic household waste.
Product Category: With reference to the equipment types in the WEEE directive Annex 1, this product is classified as a “Monitoring and Control instrumentation” product.

Do not dispose of electrical appliances as unsorted municipal waste, use separate collection facilities.

Contact your local government for information regarding the collection systems available. If electrical appliances are disposed of in landfills or dumps, hazardous substances can leak into the groundwater and get into the food chain, damaging your health and well-being.

When replacing old appliances with new one, the retailer is legally obligated to take back your old appliances for disposal.

Proposition 65 Warning for California Residents

WARNING: Cancer and Reproductive Harm - www.P65Warnings.ca.gov.

This product may contain chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm

CONTENTS

Chapter 1
INTRODUCTION

The 1888 Megohmmeter/High Resistance Meter is a general purpose high voltage instrument for resistance measurements on insulating materials and components.

It is designed for easy, accurate and direct readings of high resistance typically found in thick-film resistors, synthetic resins, porcelains, insulating oils, plastics, and other similar materials.

The 1888 is ideal for measurement of volume and surface resistivity using the 1888-11 Resistivity Test fixture. The 1888 can directly display volume resistivity and surface resistivity and allows entry of the cell constants and thickness.

It is also used for measurements on capacitors, transformers, switches, cables, and connectors.

The 1888 provides a direct readout of resistance from 1000 Ω to 100 TΩ with fully automatic ranging. The voltage applied to the unknown is programmable from 1 V to 1000 V.

The 1888 includes a TFT color capacitive touch screen, softkeys, and keypad for ease of use.

The test cycle is fully automatic with programmable charge, measure, and discharge times. These times, along with other test conditions, can be stored in instrument memory and recalled for later use.

The unit also contains automatic zeroing at the test leads and built-in self-test routines. Safety features include current limiting to less than 2 mA and a indication on the display when voltage is applied to the test terminals, thus permitting connections to be made safely. An interlock connector is located on the rear panel.

The 1888 comes standard with USB, GPIB and LAN interfaces for remote control operation.

The voltage and current are displayed and are available via the remote interfaces.

The 1888 has a BNC output for the source voltage and triaxial connector for the current detector on the front panel.

The triaxial detector connection has current input, guard/analog ground, and chassis ground terminals to permit measurements of 2 and 3 terminal devices.

Figure 1.1 - 1888 Megohmmeter/High Resistance Meter

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Chapter 2
SPECIFICATIONS

2.1 Specifications

For convenience to the user, the pertinent specifications are given in an Specifications Label. Figure 2.1 shows a typical label that is affixed to the case of the instrument.

Resistance range:

1 kΩ (10^3 Ω) to >100 TΩ (10^{14} Ω)

No of ranges:

7 manually selectable plus auto-ranging

Resistance range for set voltage

Voltage Setting	Rmin	Rmax [1]
1 Vdc	1 kΩ (10^3 Ω)	100 GΩ (10^{11} Ω)
10 Vdc	10 kΩ (10^4 Ω)	1 TΩ (10^{12} Ω)
100 Vdc	100 kΩ (10^5 Ω)	10 TΩ (10^{13} Ω)
1000 Vdc	1 MΩ (10^6 Ω)	100 TΩ (1x10^{14} Ω)

[1] Rmax is stated for > 25% accuracy and resistive load only. Capacitance and/or noise will reduce useful resistance range.

Voltage range:

1 to 1,000 volts, programmable in two ranges, resolution: 1 V

Voltage accuracy at front panel BNC:

1 - 100 V: ±[(1% of setting + 1 V)
100 - 1,000 V: ±[(1% of setting + 2 V)

Resistance accuracy* (k=2):

$\pm[0.25\% + \{(R_X/V_X)(0.0005* FS + 0.2pA) + 30\Omega/R_X\}100\%]$
where:
R_X = Measured resistance in ohms
V_X = Programmed voltage in volts
FS = Full scale current range in amperes

[1] Accuracy is stated for 18 - 28 °C < 70% RH

Measurement time > 5 seconds, Avg = 3

Measuring current :

0.1 pA (10^{-13} A) to 1 mA (10^{-3} A)

Current accuracy (k=2):

1 nA to 1 mA: ±[0.25% + (0.0005 FS + 0.2 pA)]
100 pA to 1 nA: ±[0.5% + (0.0005 FS + 0.2 pA)]
1 pA to 100 pA: ±[5% + (0.0005 FS + 0.2 pA)]

Temperature Coefficient:

±(0.1*Accuracy/°C from 23 °C) (10 - 17 °C and 29 to 40 °C)

Short-circuit current:

< 2 mA

Test cycle:

Automatic: Charge time: 0 - 300 seconds
Measure time: 0 - 999 seconds
Discharge time: 0 - 300 seconds

Measurement limits:

Pass/Fail (1 limit)

Display:

Resistance, current, volume resistivity, surface resistivity
Note: resistivity measurements require input of cell constant and material thickness.

Input/Output terminals:

Detector: Triaxial (Input, Guard, GND)
Source: BNC (Output, GND)

Remote control:

USB: USB Type B connector standard on rear panel and uses standard MCP2200 chip set

GPIB:

GPIB standard 24 pin connector, conforms to IEEE-488.2; SCPI 1994.0 command set
Addressing range of 1 to 30 Default: 7

Ethernet:

IEEE 802.3 compliant, Speeds 10 BaseT (10 Mb/s) and 100 BaseT (100 Mb/s), IP Address Static or DHCP, Factory setting 192.168.1.254 static

Power requirements:

100 - 240 Vac ±10%, 50 - 60 Hz., 30 Watts Max.
Fuse: T 0.8A, 250V, 5 x 20 mm

Environmental conditions:

Operating: 10°C to 40°C; <70% RH non-condensing
Storage: -40°C to 70°C; <90% RH non-condensing
Altitude: < 2000 m

Dimensions:

Bench model: 43 cm W x 8.9 cm H x 33 cm D (17” x 3.5” x 13”) in front of panel: 3.8 cm (1.5”).
Rack Mount: 47 cm W x 8.9 cm H x 33 cm D (19” x 3.5” x 13”) in front of panel: 3.8 cm (1.5”)

Weight: 5.5 kg (12 lb) nominal

2.2 General Specifications and Stability

Warm-up:
The 1888 should be allowed to stabilize for 15 minutes. The 1888 should be turned on for 1/2 hour for best accuracy. Warm-up the detector for best accuracy. Warm-up can be done by performing a single 60 second measurement at 1000 V with no device connected to the cables.

Recommended Calibration Interval:
Typical calibration interval 12 months. Adjustment can easily and automatically be accomplished using the built-in Calibration routine along with a DMM and seven resistors. The 1888 requires 7 x resistance values from 1 MΩ to 1 TΩ for calibration of the 1888.

Environmental:

This product complies with the WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/electronic product in domestic household waste.

Product Category: With reference to the equipment types in the WEEE Directive Annex I, this product is classed as a “Monitoring and Control instrumentation” product.

Effects of Humidity:
Exposure to humidity >70% for a periods of weeks can cause the resistors to drift. It is recommended that the 1888 be used and stored at humidities less than 70% to minimize this.

2.3 Typical Specifications Label

A label is affixed to each 1888 with relevant specifications. The typical specifications label is shown in Figure 2.1

1888 MEGOHMMETER/HIGH RESISTANCE METER

CONSULT INSTRUCTION MANUAL FOR PROPER INSTRUMENT OPERATION

Resistance range:
1 kΩ (10^3 Ω) to 100 TΩ (10^{14} Ω)

Voltage range:
1 to 1,000 volts, programmable in two ranges, resolution: 1 V

Voltage accuracy at front panel bnc:
1 - 100 V: ±[(1% of setting + 1 V)
100 - 1,000 V: ±[(1% of setting + 2 V)

Resistance accuracy* (k=2):
$\pm[0.25\% + \{(R_X/V_X)(0.0005* FS + 0.2pA) + 30\Omega/R_X\}100\%]$
R_X = Measured resistance in ohms
V_X = Programmed voltage in volts
FS = Full scale current range in amperes

Measuring current :
0.1 pA (10^{-13} A) to 1 mA (10^{-3} A)

Current accuracy* (k=2):
1 nA to 1 mA ±[0.25% + (0.0005 FS + 0.2 pA)]
100 pA to 1 nA ±[0.5% + (0.0005 FS + 0.2 pA)]
1 pA to 100 pA ±[5% + (0.0005 FS + 0.2 pA)]

Temperature Coefficient (< 18°C and > 28 °C):**
±(0.1*Accuracy/°C from 23 °C) (10 - 17 °C and 29 to 40 °C)

Humidity Coefficient (> 50% RH):**
±(0.1*Accuracy) * (RH% - 50% RH) from 50% RH to 80%RH

Short-circuit current:
<2 mA

Input/Output terminals:
Detector: Triaxial (Input, Guard, GND)
Source: BNC (Output, GND)

Power requirements:
90 - 264 Vac, 47 - 63 Hz. 30 W. Max.

Remote control:

USB: Standard USB Type B connector on rear panel, uses MCP2200 driver.

GPIB: GPIB standard 24 pin connector, conforms to IEEE-488.2; SCPI 1994.0 command set. Address range of 1 to 30. Default address: 3.

Ethernet: IEEE 802.3 compilant, Speeds 10 BaseT (10 Mb/s) and 100 BaseT (100 Mb/s), IP Address Static or DHCP, Factory setting 192.168.1.254 static.

[1] Accuracy is stated for 18 - 28 °C < 50% RH, measurement time > 5 seconds, Avg = 3
[1]* Add to resistance and current accuracy

MODEL: 1888 **SN: B2-23xxxx**

WARNING

Observe all safety rules when working with high voltages or line voltages. Connect the (GND) terminal to earth ground in order to maintain the case at a safe voltage. Whenever hazardous voltages (>45 V) are used, take all measures to avoid accidental contact with any live components: a) Use maximum insulation and minimize the use of bare conductors. b) Remove power when adjusting switches. c) Post warning signs and keep personnel safely away.

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1888 Jan 2025

FIGURE 2.1 - Typical Specifications Label Affixed to Unit
(Please see label affixed to your unit)

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Chapter 3
OPERATION

3.1 Initial Inspection and Features

This section details initial inspection, purpose, features and storage of the 1888.

3.1.1 Initial Inspection and Accessories

This instrument was tested and carefully inspected before shipment. The unit should be in proper electrical and mechanical order upon receipt.

The 1888 Megohmmeter includes the following:

- Instruction manual
- Calibration certificate traceable to SI
- AC power cable
- 1888-01 Triaxial to alligator clip leads
- 1888-02 BNC-m to banana plug with alligator clip
- 1888-03 Interlock

An **Specification Label** is attached to the case of the instrument to provide ready reference to specifications.

3.1.2 Purpose

The purpose of the 1888 is to measure resistance in the range of 1000 Ω to 100 TΩ for calibration of insulation, volume and surface resistivity, and and calibration of high resistances.

In addition to displaying resistance, the 1888 can display the applied voltage and measured current. All values are available via the USB, Ethernet and GPIB interfaces.

The 1888 can also directly display volume and surface resistivity when used with the 1888-11 Resistivity Cell or similar cell. Cell constants can be entered into the menu system to accommodate various cells.

The 1888 is designed for easy, accurate, and direct readings of high resistance typically found in thick-film resistors, synthetic resins, porcelains, insulating oils, plastics, and other similar materials. The 1888 is also used for measurements on capacitors, transformers, switches, cables and connectors.

The voltage applied to the unknown is programmable from 1 V to 1000 V

3.1.3 Storage

If this instrument is to be stored for any lengthy period of time, it should be sealed in plastic and stored in a dry location. The instrument should not be subjected to temperature extremes beyond the specifications. Extended exposure to such temperatures can result in an irreversible change in range resistors, and require recalibration.

3.1.4 Bench and Rack Setup

The 1888 should be placed on a stable flat work surface. A front bail is provide to make viewing easier.

Mount the unit in a standard 19” rack if the rack mount option is specified.

3.1.5 Front and Rear Panel

The front panel, as shown in Figure 3.1, has a capacitive touchscreen, front binding posts, softkeys, numeric keypad and power switch.

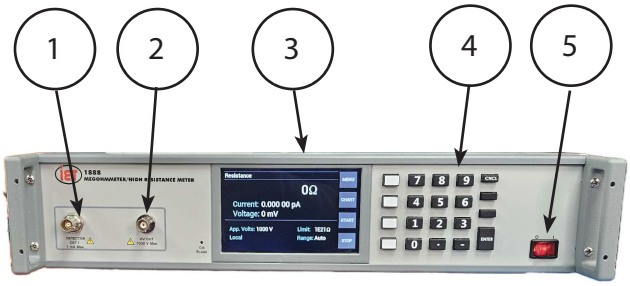


Figure 3.1 - Front Panel

Model Ref.	Description
1	Detector Input, Triaxial
2	Voltage Output, BNC
3	Capacitive Touchscreen with Softkeys
4	Numeric Keypad
5	Power Switch

The rear panel, as shown in Figure 3.2, has an IEC inlet module for connection to mains power, GPIB, USB and LAN interfaces, interlock connector and ground post.

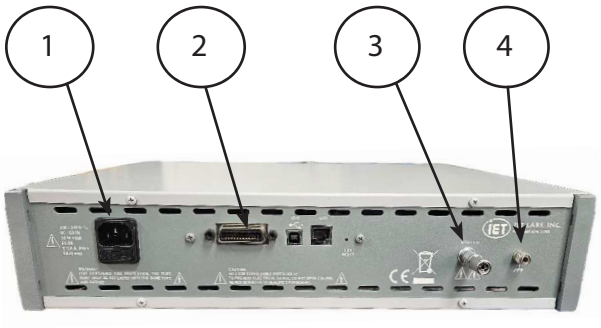


Figure 3.2 - Rear Panel

Model Ref.	Description
1	IET Inlet Module
2	GPIB, USB and Ethernet Interfaces
3	Interlock Lemo Connector
4	Ground Chassis Terminal

3.1.6 Power Connections

Power connection to the rear panel is through an ac inlet module comprised of an ac connector and fuse drawer.

Always use a power cord and outlet that has a properly connected protection ground to avoid shock. The 1888 is provided with a 3-prong power cord with ground.

Plug the supplied IEC power cord into the instrument into a power receptacle that has a ground. The power cord may of course be selected to match the available receptacle.

Confirm that the power supplied to the 1888 meets the following requirements

Power requirements:

90 - 264 Vac , 47 - 63 Hz., 30 W. Max.

The 1888 can be operated from a power source between 90 and 250 Vac at a power line frequency of 47 to 63 Hz. Power connection to the rear panel is through an ac inlet module comprised of an ac connector and fuse drawer. Before connecting the 3-wire power cord between the unit and ac power, verify that the fuse is 2.5 A, 250 V, slow-blow, 5x20 mm. Always use an outlet which has a properly connected ground.

Fuse 

Only replace fuse with the same type and rating. The fuse can be found in the fuse draw at the bottom of the IEC Inlet Module on the back panel of the 1888.

UL/CSA type, T 0.8 A,250 V, 5 x 20 mm

3.1.7 Environmental

Do not operate the instrument in the presence of flammable gasses or fumes.

The 1888 is for indoor use only.

To ensure that the safety requirements, the specifications, and the measurement accuracy of the 1888 are met, you must maintain the environmental temperature to within the specified range by providing an appropriate cooling clearance around the 1888 or, for the rack-mounted type, by forcefully air-cooling inside the rack housing, if necessary.

Temperature and Humidity

Operating: 10°C to 40°C; <70% RH non-condensing

Storage: -40°C to 70°C ; <90% RH non-condensing

Altitude

Operating: 0 - 2000 m; storage: 0 - 4600 m

3.1.8 Safety Considerations 

Refer to the Safety Summary page at the beginning of this guide for general safety information. Before installation or operation, review this guide for safety warnings and instructions. Safety warnings for specific procedures are located at appropriate places throughout this guide.

There are no user serviceable parts inside the 1888. Servicing should be referred to qualified personnel.

Before operating the instrument inspect the ac power inlet module on the rear of the 1888 instrument to ensure that the properly rated fuse is in place. Otherwise damage to unit is possible.

The 1888 instrument is shipped with a standard U.S. power cord or approved international cord set. Make sure the instrument is only used with these cables (or other approved international cord set) which ensures the instrument is provided with connection to earth ground.

When the 1888 instrument is used in a rack installation (using the 1888-50 Rack Mount Kit) make sure the unit is secured using the cabinet mounting rails and not secured solely by the front panel angle brackets.

In bench or rack mount applications the instrument should be positioned with consideration for ample air flow to the rear panel ventilation holes. An open space of at least 3 inches (75 mm) is recommend behind the rear panel. The surrounding environment should be free from excessive dust to prevent contamination of electronic circuits.

3.1.9 Cleaning

To prevent shock, unplug the 1888 from mains prior to cleaning.

Use a dry cloth or a cloth slightly dampened with water or soap and water to clean the external case parts.

Do not use detergents or chemical solvents.

Do not attempt to clean internally.

Denatured alcohol can be used to clean external case if necessary.

Do not use abrasive cleaners that might scratch the display. The display can be cleaned with a glass cleaner and soft cloth.

3.2 Connection

The following sections describe the various connections to the 1888.

3.2.1 General Connections and Considerations

The 1888 Megohmmeter/High Resistance Meter utilizes a triaxial and BNC connector for the measurement of resistance, as shown in Figure 3.3. The triaxial connector is a standard 3 lug triaxial connector that is standard on a wide variety of other megohmmeters. The BNC is a standard 2 lug BNC-to-BNC cable with Pomona 1894 BNC to Banana adapter.

The 1888 is delivered standard with a 1888-01 triaxial to alligator clip cable and 1888-02 BNC to alligator clip cable for connection to a wide variety of resistors and other devices.

An earth ground binding post is available on the rear panel or the outer shields of either the triaxial or BNC connect can be used as earth/chassis ground.

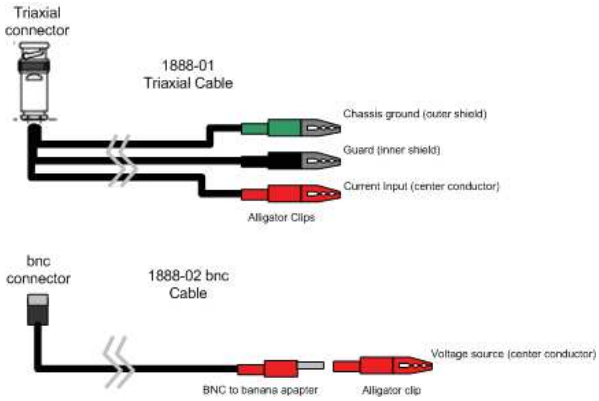


Figure 3.3 - 1888-01 and 1888-02 Standard Cables

3.2.2 Interlock Connector IMPORTANT

The interlock connector, 1888-03 included with the unit, needs to be installed in the rear panel lemo connector for the 1888 to perform a measurement. The interlock connector 1888-03 is made from a Lemo FGG.1B.302.CLAD42 connector.

The 2 pins on the lemo connector must be connected together using a PTFE wire or similar for the interlock to open. The pins are reference analog ground so if the 1888 is used with positive on ground connection the pins will be hot negative at the programmed voltage. Any relay or switch used to control the interlock must be isolated from earth ground and be able to withstand 1000 Vdc.

3.2.3 Warm-up IMPORTANT

The 1888 should be turned on for 1/2 hour for best accuracy. It is also important to warm-up the detector. This can be done by performing a single 60 second measurement at 1000 V with no device connected to the cables.

3.3 Condensed Operating Instructions

1. Turn on the 1888 using the POWER SWITCH
2. From the **HOME SCREEN**, go to **MENU>MEASUREMENT SETTINGS**

   a) Highlight each field one at a time and press **ENTER.** Use the touchscreen or keypad to enter the A**PPLIED VOLTAGE**, **CHARGE TIME**, and **MEASUREMENT TIME**.
   b) When complete, press the **BACK** button to return the **HOME SCREEN**

3. Connect the device to be tested between the red alligator on the triaxial cable and the red alligator on the BNC cable to perform a basic 2-terminal resistance measurement.

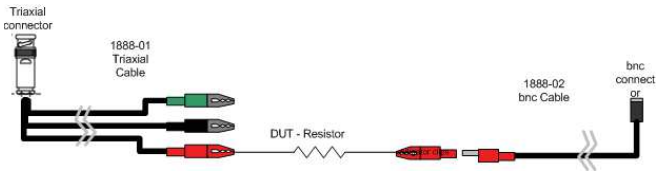


Figure 3.4 - 1888-01 and 1888-02 Standard Cables connected to DUT

4. Keep hands away from cable. Press the START softkey. At anytime, you can press the STOP softkey to end the measurement.

The measured resistance, voltage, and current will be shown on the display.

3.4 Operation

The interlock connector (included with the unit) needs to be installed on the rear panel in the socket marked **Interlock.**

Zeroing

Before making measurements, the 1888 instrument should be zeroed to correct for leakage in the test lead or fixture. The unit should be zeroed at least once per day and each time test leads or fixtures are changed.

When measuring on devices like the HRRS or devices with capacitance, it is beneficial to keep the Detector, Guard and Ground connected to the DUT during zeroing. Make sure the HV Output cable is not connected during the zeroing process.

During the zeroing process, corrections are calculated and stored in instrument memory and applied to ongoing measurements.

The zeroing routine is accessed through the Utilities Menu by selecting [ZERO]. Instructions are given on the display. Quick Zero corrects for ranges 6-7. If using an 1865-11, Full Zero should be utilized in order to zero ranges 4-5 as well.

Connection to Device Under Test

Figure 3.4 shows the front panel input terminals. Figure 3.5 shows the front panel input terminals and a basic block diagram of their function.

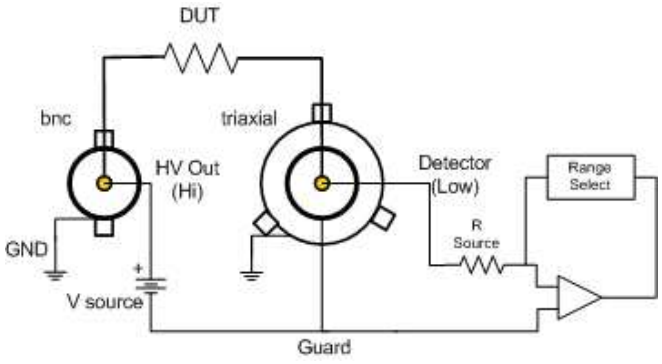


Figure 3.5 - Block Diagram

DO NOT GROUND the Detector Current Input (Low) terminal
This will result in invalid measurements.

The configuration of connecting to the DUT depends on if the unknown is a grounded, ungrounded or guarded device.

Two Wire Ungrounded Connection

The two-wire grounded measurement is a common type of connection to be used on the 1888. This is the recommended connection on most components that have both connections floating, not connected to earth ground.

Connection of GND and Guard terminals are based upon the application. When measuring resistors with both ground and guard connections, the guard and ground should be connected respectively. If the device only has 2 terminals, connection of GND to GUARD can minimize noise.

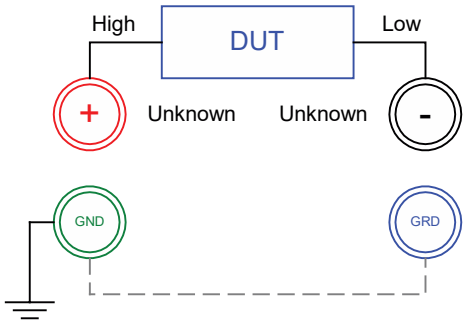


Figure 3.6 - Two Wire Ungrounded Connection

Two Wire Grounded Connection

The two-wire grounded measurement is a type of connection that can be used on the 1888.

The Applied voltage should be limited to 500 V to prevent damage to the 1888.

This type of connection must be used when the device under test or component has one lead physically connected to earth ground. In this connection care must be taken as the Detector Input Terminal and Guard Terminal will be at the applied voltage and negative.

DO NOT GROUND the Detector Current Input terminal

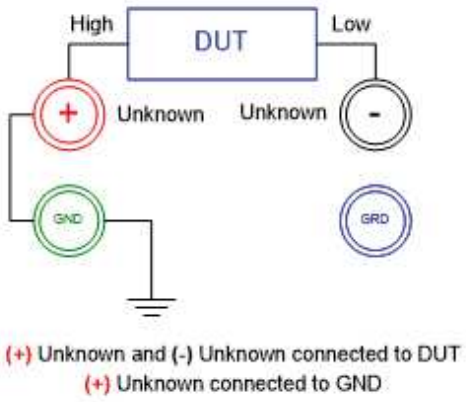


Figure 3.7 - Two Wire Grounded Connection

Measurement Procedure

The test cycle is sequenced automatically through three phases: Charge, Measure, and Discharge, in accordance with user-programmed times.

The 1888 instrument employs an auto-ranging technique at the start of the Measure Time. The auto-range process can take up to 7 seconds to go from Range 1 to Range 7.

The Auto-range would generally be used for general measurements on a wide variety of devices.

In a production environment where measurements are repetitive and setup conditions have been previously established, the Range can be fixed, to reduce auto-ranging time.

Measurement Settings
I/O Settings
Utilities
Instrument Calibration (only shown when Cal Enable pressed)
About

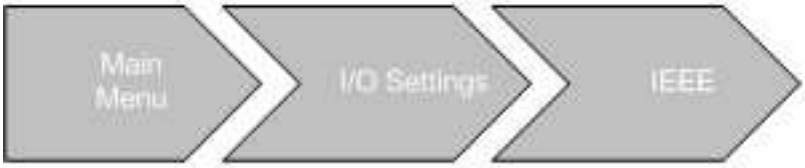
Applied Voltage:
Charge Time:
Measure Time:
Discharge Time:
Range:
Limit:
Stop on Pass:
Average:

Display Type:
Cell Constants
IEEE
Ethernet

Save Setup
Recall Setup
Change Time/Date
Debug (only shown if Cal Enable Button is pressed)

Main Menu>Settings and Utilities

IEEE
Ethernet

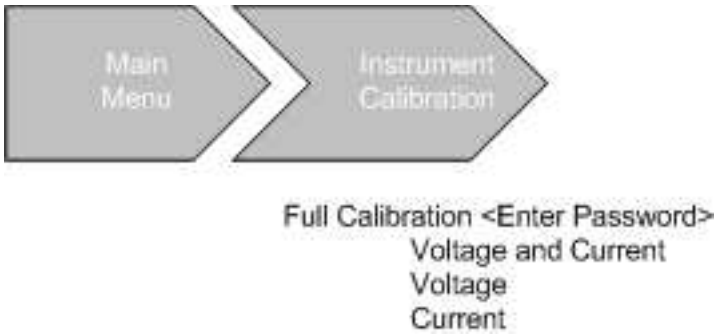


IEEE Address: 1 - 30

IP Address: 192.168.100.101
Network Gateway: 192.168.100.1
Network Mask: 255.255.255.0
Mac Address: 00:00:00:00:00:00

IET Labs, Inc.
1888
SN: XX-XXXXXXXX
FW: 1.15
HW: 1.00

Main Menu>Continued



Main Menu>Calibration

Measurements in the automatic mode can be initiated after connecting the DUT by simply pressing [START]. Test conditions are determined by either the power-up default conditions, or by recalling a previously stored setup from instrument memory. In either case, a test cycle is sequenced automatically once [START] is pressed and results displayed.

Default Measurement Conditions

A set of default measurement conditions are initially established at the factory and stored in instrument memory. Default conditions are those that determine the instruments status on power up, thus the instrument is always set to a known state before any testing begins. These conditions can be changed by the user for tailoring to a specific application. Refer to paragraph 3.4.1 under Save Setup on the Utilities menu.

Factory default measurement conditions are:

Under Measurement Settings Menu
Voltage – 1 V
Charge - 0 sec
Measure and Discharge times – 1 sec
Range - Auto (Selected on lower level menu)
Limit - 1e21
Stop on Pass - 0 (not active)
to Average - 1

Under I/O Settings Menu
Display Type - Normal (Resistance)
Surface Resistivity Cell Constant- 18.80
Volume Resistivity Cell Constant- 19.60
Volume Resistivity Thickness- 0.01
IEEE Address - 7
Ethernet IP Address: 192.168.1.254

3.5 Menu Structure

The tables on the next few pages shows the menu structure of the 1888.

Menu items with a "**:**" allow selection of a value or feature when **ENTER** pressed. Menu items without ":" have a submenu with more than 1 item.
Press **MENU** to display **Main Menu** and press the **Back** key to return to **Home** screen.

Below is the basic menu structure of the 1888.

3.5.1 Home Screen

The home screen shows the measured Resistance, Current, Voltage and settings for Applied Voltage, Limit, Range and if Local or Remote control.

The home screen can be changed based upon **MENU>>I/O Settings>>Display Type**.

The **Display Type** can be Resistance, Surface Resistivity and Volume Resistivity.

The Resistance display type is shown in Figure 3.8 and shows the calculated resistance in ohms based upon the voltage and current measured.

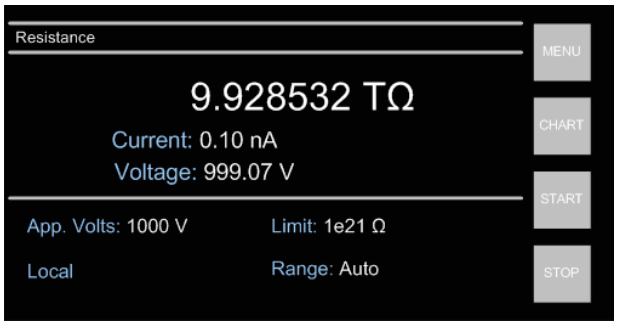


Figure 3.8 - Home screen Resistance

The Surface Resistivity display is shown in Figure 3.9 and shows the surface resistivity based upon the calculated resistance and the **Surface Resistivity Cell Constant**.

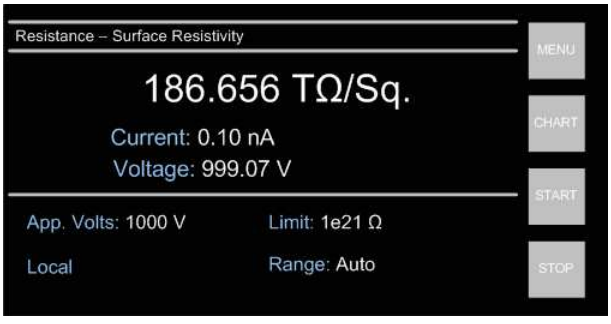


Figure 3.9 - Home screen Surface Resistivity

The Volume Resistivity display is shown in Figure 3.10 and shows the volume resistivity based upon the calculated resistance and the **Volume Resistivity Cell Constant** and **Volume Resistivity Thickness**.

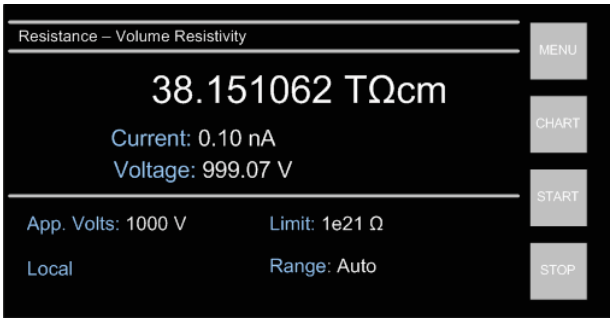


Figure 3.10 - Home screen Volume Resistivity

Volume and Surface Resistivity settings are specifically designed for use with the 1888-11 Resistivity Cell.

The Resistance can also be shown in a Chart and Graph by pressing the **CHART** button this will show the chart/table display.

This is ideal for being able to visualize what the resistance is doing over time.

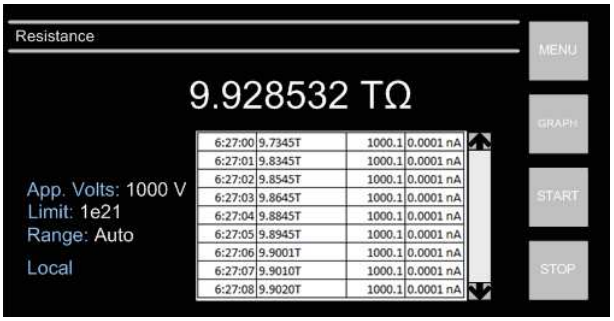


Figure 3.11 - Home screen Chart Display

The softkey that showed **CHART** will change to **GRAPH** when on the chart display.

Pressing the **GRAPH** button will show the data in a graphical format.

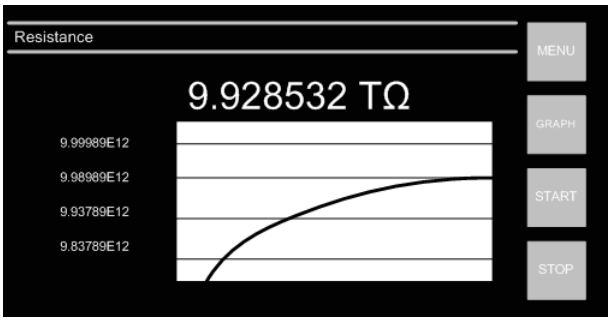


Figure 3.12 - Home screen Graph Display

When in the graph display, pressing the **NUM** button will cycle back to the Resistance display.

The 1888 can be cycled between all 3 displays during the measurement or once the measurement is complete.

Pressing **MENU** will display the main menu where various settings can be changed.

Pressing **START** or **STOP** will start a measurement or stop a measurement.

The bottom part of the home screen shows relevant setup information. These settings can be changed in the **Measurement Settings** menu.

3.5.2 Menu Key

Pressing the **MENU** key will show the MAIN menu screen See Figure 3.13.

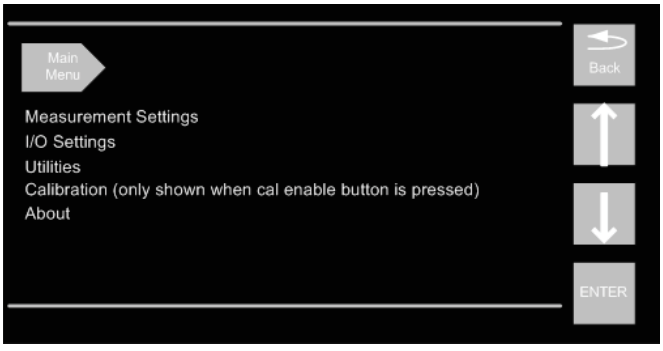


Figure 3.13 - Menu Screen

Use the ↑ key to move UP and the ↓ to move DOWN within the items shown on screen.

Press the **ENTER** key to change the item's value or go to the next menu.

Press the **BACK** key to return to previous MENU or home screen at anytime.

3.5.3 Measurement Settings Menu

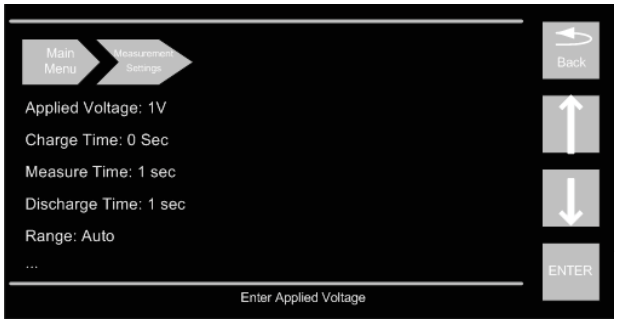


Figure 3.14 - Measurement Settings Menu

There are 8 selections available in the **Measurement Settings** menu.

Highlight the selection and press **ENTER** to change the selection.

Applied Voltage: Accepts entry of a test voltage (up to 4 digits) between 1 and 1000 V. This is the voltage applied to the unit under test during the test cycle and present at the DUT connection anytime that the START button is pressed.

Charge Time: Accepts entry of a charge time between 0 and 300 seconds in 1 second intervals (up to 3 digits). This marks the time when the test voltage is first applied and the unit under test is allowed to charge up to this voltage. Even if the charge time is entered as zero there is still a small delay during the charge phase. In this case or even with much longer charge times the possibility exists that full charge voltage may not

be reached at the start of the measurement phase if the DUT has a long time constant.

Measure Time: Accepts entry of a measure time between 0 and 1200 seconds in 1 second intervals. This is the time during which repeated measurements are made and results displayed as resistance, surface of volume resistivity depending on the results format selected. The display is updated once per second during the measurement time.

Discharge Time: Accepts entry of a discharge time between 0 and 300 seconds in 1 second intervals. This is the time when the test voltage is removed and the device under test discharged.

The **DANGER! HIGH VOLTAGE** message is shown until the end of the programmed interval and the last measurement result is retained on the display (unless no display is selected).

Range: A lower-level menu (accessed by pressing [ENTER]) allows the selection of Auto or one of seven different measurement ranges (1 mA through 1 nA), which is the maximum current for the selected range. In auto mode, the 1888 instrument will automatically select the optimum range depending on the programmed test voltage and current drawn by the test device.

Any choice other than Auto (1 mA through 1 nA range) is at the user's discretion. Determination of the range is governed by the maximum current available to the DUT for that measurement range and is listed in Table 3-1.

To eliminate operator errors in range setting and ensure specified instrument accuracy the 1888 unit should generally be left in AUTO. There may be an exception to this when repetitive measurements are to be made on a known range and there is a desire to reduce test time by eliminating range switching.

When auto ranging is selected ,the 1888 instrument will always begin the measurement phase on the highest current range 1 mA, and progress down depending on the current to the device under test. If the current reaches 10% or less of the maximum for a given range the next lowest range will be switched in.

NOTE: There are 7 ranges. The auto-ranging process can take up to 7 seconds to complete.

If a range has been selected and the current exceeds 115% of the maximum for that range the unit will indicate **Stopped: Overrange CADC** on the display. This can also occur if the current is greater than 1.15 mA.
One needs to keep in mind that a **Stopped: Overrange CADC** indication does not necessarily mean that the incorrect range has been selected; the device under test could also be arcing or have another condition causing too much current to flow. **Stopped: Overrange CADC** should not be confused with an **Stopped: Overload** display.

Stopped: Overload occurs anytime current to a device exceeds 2mA, this would generally mean a shorted or very-low-resistance device.

Range	Maximum Current
1	1 mA
2	100 µA
3	10 µA
4	1 µA
5	100 nA
6	10 nA
7	1 nA

Table 3.1 - Range Current

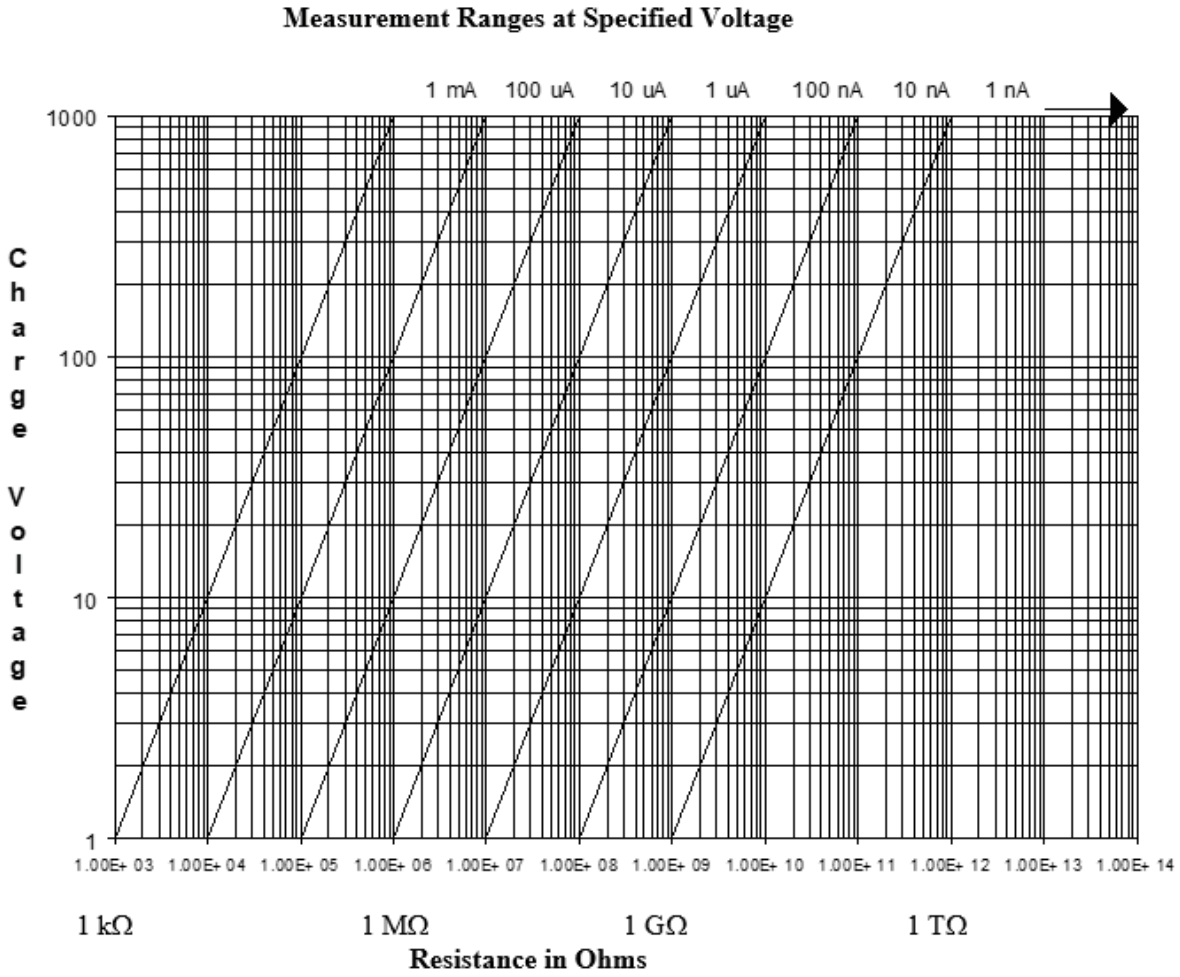
Example:

When measuring an unknown of 200 MΩ at 100 V, Ohm's Law tells us that the device under test would draw 0.5 µA (I = 100 V/200 MΩ). Based on the above, one would expect the 1888

instrument to auto-range from the 1 mA to 1 µA range (50% of maximum current), or that the user should select the 1µA range based on prior knowledge of the expected results.

NOTE
When measuring in the current mode, in order to calculate the unknown resistance, the input resistance of the instrument (5 kΩ) must be taken into consideration. This is done during calibration of source resistance.

The measurement range capability is represented graphically in Figure 2-14. By locating the charge voltage on the vertical axis and the measured resistance – or expected measured resistance – on the horizontal axis, one can determine the optimum range. When Auto-Range is selected, the range switching is done automatically and the specified instrument accuracy always applies. If a range other than Auto is selected, and the resistance value for the given voltage falls outside the range band shown, the measurement accuracy specified does not necessarily apply.



Limit: Allows entry of a single measurement limit in scientific units (up to 4 digits with decimal and exponent) for resistance. The exponent must be 3 through 14 for resistance. This limit determines the measurement continues.

Stop on Pass: Accepts entry of a value between 0 and 300 which the number of consecutive measurements above the limit that must accrue to. This is only active when there is a measure time and limit specified. An entry of 0 disables the stop on pass function.

Average: Accepts entry of a value between 1 and 99 which is the number of measurements to be averaged and displayed. If the value is 1, averaging is disabled, and the display is updated with each measurement. If the value is n (between 2 and 99), the average is displayed after n measurements. If the measure time has not elapsed after the first averaged display, a running average of measurements is made until the measure time is up. For example, if n is 5, the first five measurements are made, averaged and then displayed. The sixth measurement is averaged with the last four. This continues until the user specified measurement time is complete.

3.5.4 I/O Settings Menu

From the Main Menu use the UP and DOWN arrow keys, **I/O Settings** can be highlighted in yellow, press the **ENTER** key to go to the **I/O Settings** menu.

Breadcrumb navigation shown at the top of the screen shows exactly where you are in the menu system.

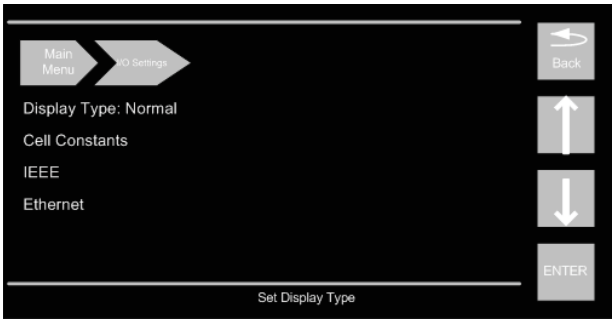


Figure 3.15 - I/O Settings Menu

There are 4 selections available in the **I/O Settings** menu.

Highlight the selection and press **ENTER** to change the selection.

Display Type: Allows selection of **Normal**, **Surface Resistivity** and **Volume Resistivity**.

The **Normal** display type shows the measured resistance in Ωs.

The **Surface Resistivity** display type shows surface resistivity in Ω/square. The **Surface Resistivity** is calculated based upon the measured resistance in Ωs * the surface resistivity cell constant in 1/square. The **Surface Resistivity Cell Constant** can be set by the user based upon the setting in **Cell Constants.**

The **Volume Resistivity** display type shows volume resistivity in Ω cm. The **Volume Resistivity** is calculated based upon the measured resistance in Ωs * the volume resistivity cell constant in cm^2 / Volume Resistivity Thickness in cm. The **Volume Resistivity Cell Constant** and **Volume Resistivity Thickness** can be set by the user based upon the setting in **Cell Constants.**

Cell Constants: Allows entry of **Surface Resistivity Cell Constant, Volume Resistivity Cell Constant** and **Volume Resistivity Thickness**.

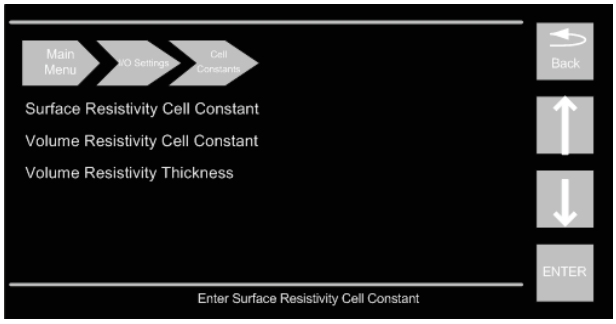


Figure 3.16 - Cell Constants Menu

The **Surface Resistivity Cell Constant** has a default value of 18.80 1/sq for use with the 1888-11 Resistivity Cell. Accepts entry of a value between 0.01 and 400 1/sq.

The **Volume Resistivity Cell Constant** has a default value of 19.60 cm^2 for use with the 1888-11 Resistivity Cell. Accepts entry of a value between 0.01 and 400 cm^2.

IEEE: Accepts an entry of the IEEE address from 1 to 30. The default value is 4. The IEEE address is immediately changed based upon this field.

See Chapter 6 for more information on the IEEE Interface.

Ethernet: Allows entry of the IP address, Network Gateway and Network Mask. The MAC address of the LAN card is also shown.

Figure 3.17 - Ethernet Menu

There are 3 selections: **IP Address**, **Network Gateway**, **Network Mask**, which can be highlighted and then press ENTER to change the value of each. Mac Address is set at the factory and only be changed via remote commands.

The **IP Address** can be changed using this field. The **IP Address** has a valid format of ###.###.###.### and a default value of 192.168.1.254

The **Network Gateway** can be changed using this field. The **Network Gateway** has a valid format of ###.###.###.### and a default value of 192.168.1.1.

The **Network Mask** can be changed using this field. The **Network Mask** has a valid format of ###.###.###.### and a default value of 255.255.255.0.

NOTE: After changing any Ethernet settings, wait 3 seconds for the settings to save. Power-cycle the 1888 and wait until the main menu is shown, for the remote control interface to load, then on the web browser enter the IP address to load the IET Labs Welcome Page.

NOTE: If you have accessed the welcome page via a web browser, you will have to power cycle the 1888 if you intend to change the IP address.

See Chapter 5 for more information on the Ethernet Interface.

3.5.5 Utilities Menu

Using the UP and DOWN arrow keys **Utilities** can be highlighted in yellow, press the **ENTER** key to go to the **Utilities** menu.

Figure 3.18 - Utilities Menu

There are 4 selections available in the **Utilities** menu.

Highlight the selection and press **ENTER** to change the selection.

Save Setup: Allows the **Measurement Settings** to be saved into memory. Press **Enter** on **Save Setup** then use the arrow keys to select ****New**.** Press **ENTER** and then use the **alpha keys** to enter in a filename to save the setup and then press **ENTER** or **SAVE**.

Recall Setup: Allows the **Measurement Settings** to be recalled from memory. Press **ENTER** on **Recall Setup** then use the arrow keys to select the file to be recalled and then press the **ENTER** to recall that setup.

Change Time/Date: Allows the Time and Date to be changed. This is used for the **Chart** feature.

Highlight the selection and press **ENTER** to change the Time or Date.

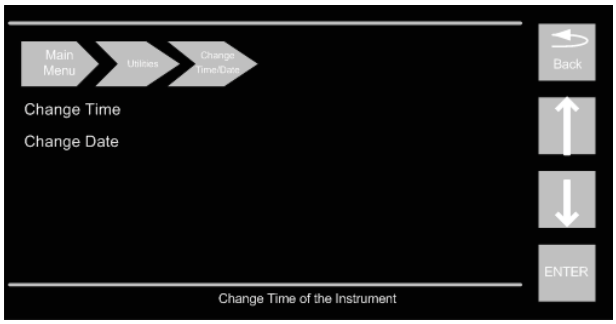


Figure 3.19 - Change Time/Date Menu

3.5.6 Instrument Calibration Menu

The Calibration Menu allows for the adjustment of both measured voltage and measured current . Note that Calibration is only shown in the Menu when the Cal. Enable button is pressed and held.

See Chapter 8 for more information on this process.

3.5.7 About Menu

The About menu shows manufacturer, Model, Serial number, Firmware (FW), Hardware (HW), and Reset to Default.

Figure 3.20 - About Menu

3.6 Environmental Conditions

The 1888 is built, calibrated and intended for use in a laboratory environment with a nominal ambient temperature near 23°C.

The accuracy of the unit may be affected when operated in non-laboratory environments. Always allow the instrument to stabilize at room temperature after unpacking or relocating the instrument.

Humidity should be maintained at laboratory conditions and typically < 70% RH non-condensing to minimize shifts in resistance.

3.7 Remote Operation

When the 1888 is in **REMOTE** with front panel locked out, a REMOTE indication will be shown in bottom half of the HOME screen. Pressing the LOCAL key will switch the 1888 back to local mode.

Chapter 4
USB INTERFACE

4.1 Introduction

The USB connection is via a standard USB B female connector located on the rear panel. This can be connected to a PC via a standard USB 2.0 A Male to B Male Cable, which is included.

Figure 4.1 - USB 2.0 A Male to B Male Cable

The SCPI standard provides a tree like series of standard commands for programmable instruments so that similar instruments by different manufacturers can be controlled by the same program.

4.2 Capabilities

The USB interface provides remote control over all functions except **POWER**.

4.3 USB Operation

The USB uses the command set outlined in Appendix B. Data should be terminated with LF line feed.

4.3.1 USB Interface Drivers

Normally when the 1888 is connected to a computer using the USB port, Windows 7 and higher will search for the correct driver and as long as the computer is connected to the internet the driver should automatically be installed.

The USB driver provides USB control through a virtual COM Port using the Microsoft's standard driver for Virtual COM Ports.

Data rates and formats are below;
Baud rate: 9600 baud
Data bits: 8
Parity: none
Stop bits: 1

If the driver cannot be found the USB interface uses a standard MCP2200 Driver. Drivers can be found at the link below if the drivers are not automatically installed.
http://www.ietlabs.com/Drivers/MCP2200.zip or http://www.ietlabs.com/prs-300-ieee-ethernet.html

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Chapter 5
ETHERNET INTERFACE

5.1 Ethernet Programming

The 1888 comes with Ethernet remote programming capability accessed through the RJ45 LAN connector. The connector is a RJ45 industry-standard connector found on the rear panel. The 1888's Ethernet connection is based upon the ICS Ethernet/GPIB/USB to Serial Interface Card. More information can be found at www.icselect.com on the 9006 Ethernet/GPIB/USB to Serial Interface Card.

Ethernet Protocols
The 1888 supports Raw Socket and the VXI-11 protocol which makes it easy to control from a PC or over the company network.
Raw socket lets you telnet to it and is best used with direct PC to instrument applications. VXI-11 operates over Sun RPC and is a more secure protocol that mimics GPIB control of an instrument and provides secure communication over a company network or over the Internet.

Raw Socket Operation
The 1888 can be used with a telnet connection and with NI MAX using TCPIP socket.

When using Raw Socket operation first open a browser and go to the web page for the 1888.

The default webpage can be found at 192.168.1.254.

When the web page opens to the Welcome Screen, go to the Configuration Page, turn Raw Socket Enable to ON, note the Raw Socket port number, Update Flash and the follow instructions shown.

If using NI MAX, you can then select Network Devices, Add network device, VISA TCP/IP Resource and select manual entry of raw socket.

Enter IP address and the Raw Socket port number typically 23, and click Finished in NI Max.

Open Visa Test Panel, under Configuration>I/O Settings make sure Enable Termination character is checked and termination character is xA and apply changes.

You can then go to Input/Output and send commands such as CONF:VOLT?\n which queries the 1888 for what the applied voltage is set to.

All raw socket messages are terminated with a line feed. Carriage returns are ignored. A backspace character causes the prior character to be deleted. Communication time out is two minutes and it is recommended that the client issue a Space-BS sequence on an occasional basis, less than the time out, to reset the time out counter.

VXI-11 Background
VXI-11 is a communication standard developed in conjunction with the VISA Specification. The

specification defines a VXI-11.3 interface like the 1888 as an instrument which can be controlled in Windows systems by programs that make VISA or SICL library calls and in UNIX/LINUX or similar operating system with RPC calls. The VXI-11 specification provides an RPCL (Remote Procedure Call Library) that can be used by virtually any operating system to control the 1888. Microsoft's RPC is not ONC compliant and cannot be used with a VXI-11.3 device like the 1888. An VXI-11.3 interface like the 1888 will operate in an LXl system and it supports LXI's 'VXI Discovery Method'.

5.2 Network Setup

The 1888 includes an internal WebServer with HTML web pages that can be accessed by a web browser from any computer. The web pages let the user quickly change the 1888 network settings. The default IP address is 192.168.1.254 static.

5.3 Ethernet Test Keyboard

To assist the user in setup and communication the VXI-11kybd program can be used which includes defined RPC calls to change the 1888 network settings.

VXI-11 Keyboard Control Program provides interactive control of VXI-11 instruments from the computer keyboard without having to write a program. The VXI-11 Keyboard program is the ideal utility program for configuring and testing the 1888 or any VXI-11 compatible instrument. Use the VXI-11kybd program to exercise the interface or to try out commands before using them in a program. The VXI-11kybd program can be found on the 1888 product page at www.ietlabs.com

Versatile Programming

The 1888 can be easily controlled by several programming techniques and languages because it is a VXI-11.3 instrument. If you program with LabVIEW, National Instruments' VISA supports VXI-11.3 instruments like the 1888. NI's Measurement and Automation Explorer treats the 1888 as a TCP/IP compliant device. Agilent's VISA library supports VXI-11.3 instruments and the Agilent Connection Manager sees the 1888 as a TCP/IP instrument.

If you are a Visual Basic, VB.Net or C/C++ programmer, you can write your program to call Agilent's or National Instruments' VISA or Agilent's SICL library in the Windows environment.

If you use LINUX or any other flavor of UNIX like SunOS, IBM-AIX, HP-UX, or Apple's OS X, you can communicate with the 1888 through RPC over TCP/IP. RPC (or Remote Procedure Calls)

provides an invisible communication medium for the developer. The VXI-11 specification provides an RPCL (Remote Procedure Call Library) that can be used by virtually any operating system to control the 1888.

If you program with Java then you can write a 1888 control program that can be easily moved to many different operating systems.

The Java jGpibEnet project on SourceForge was developed using an ICS 8065 Controller similar to the 1888 Controller.

5.4 Network Configuration

This paragraph configures the 9006 card in the 1888 for operation on your network. The board's digital interface is configured later by sending

commands as outlined in Appendix A.

When shipped, the boards are configured with default settings outlined in Table 4-1 Default Settings.

Command	Function	Factory Setting
IP Mode	Static or DHCP Mode	Static
IP Address	0.0.0.0 to 255.255.255.255.0	192.168.1.254
Net Mask	0.0.0.0 to 255.255.255.255.0	255.255.255.0
COMM Timeout	Sets socket timeout	120 sec.
Auto Disconnect	Aborts socket if link count goes to 0	Off

Table 5.1 - Default Settings

Review the Table with your network administrator and decide on which settings, if any, that need to be changed. Table 4-1 provides detailed information about each network setting to help you with your decisions. The minimum change is to set a static IP address so your PC can communicate with the board.

NOTE: After changing any Ethernet configurations, wait 3 seconds for the settings to save. Power-start the 1888 and wait 10 seconds for the remote control interface to load, then on the browser attempt to load the welcome page at the IP address.

The network configuration can be changed and the board's MAC Address can be read with a web browser, by running ICS's VXI-11 Configuration Utility on a WIN32 or WIN98 PC. ,

5.5 Web Browser Configuration Method

This method uses a standard browser such as Firefox, Internet Explorer or Safari to view and change the current network settings.

1. Temporarily disconnect the computer from the company network. Connect the 1888 and computer running the browser using a standard Ethernet Cables to a hub or switch. Temporarily disconnect the local network connection to avoid network conflicts until the board is configured.

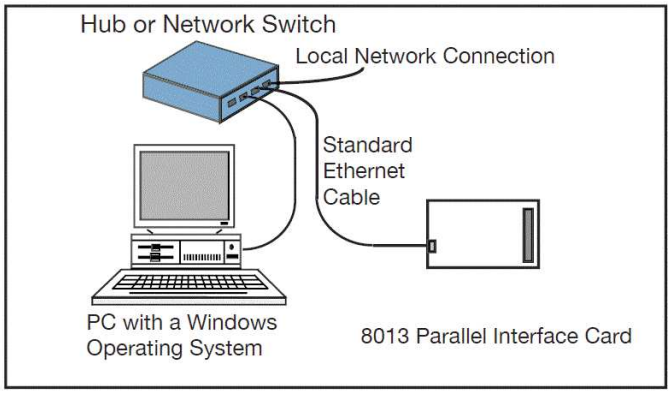


Figure 5.1 - 9006 Connected to the local hub

An alternate connection is to use an Ethernet Crossover Cable to connect the computer directly to the 1888 for initial configuration. This will eliminate any potential network conflicts while configuring the 1888.

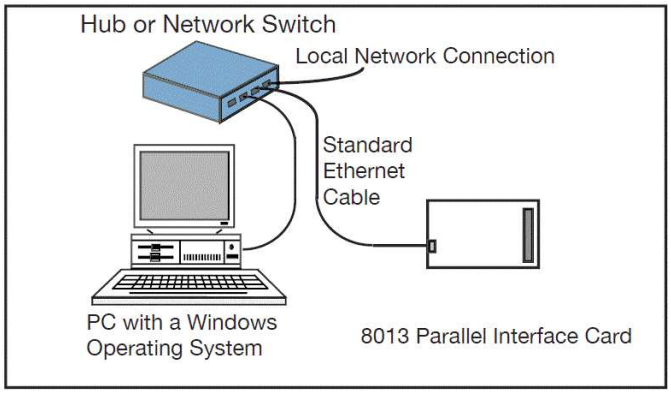


Figure 5.2 - 9006 Connected to the local hub

2. Apply power to the 1888. Set the Remote local switch to Remote.

3. Check your computer's network settings to be sure its IP address is in the 192.168.1.xxx range so it can communicate with the 1888 Ethernet board's default IP address. If it is not, it must be set before proceeding. Use the values shown below. For Windows PCs, right-click on My Network Places and click on Properties. Right-click on Local Area Connection and click Properties. Highlight Internet Protocol (TCP/IP) and click Properties. If your PC's IP address is in a different range, record the current settings and temporarily set the following network values:

Check 'Use the following IP Address'
IP Address 192.168.1.254
Subnet mask 255.255.255.0

4. Open the browser and enter the default IP address of 192.168.1.254 for new units (or your last set address for older units) in the browser address window.

5. A Welcome Page similar to the one shown Figure 5.3 should appear in your browser.

6. If you want to change any of the settings, press the 'Go to Configuration Page' key. A Configuration Page similar to the one shown in Figure 5.4 should appear in your browser.

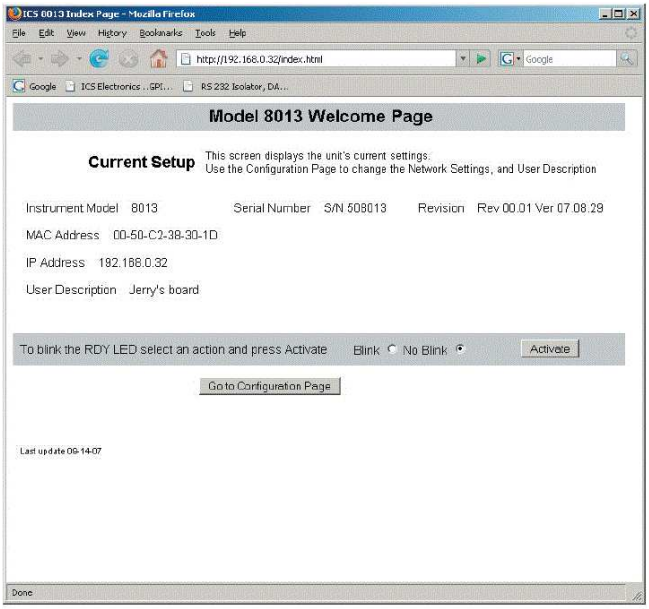


Figure 5.3 - 9006 Welcome Page

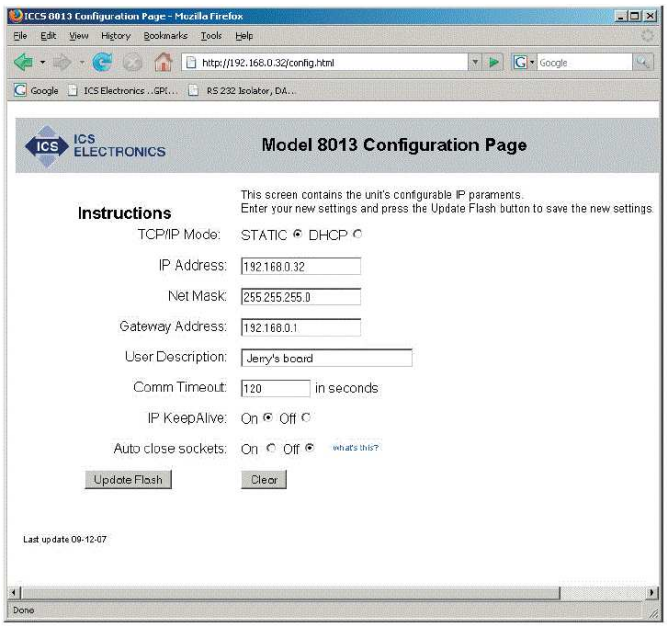


Figure 5.4 - 9006 Configuration Page

7. Enter the new settings as desired. If you select DHCP for the TCP/IP Mode, the page blanks out the IP, Net and Gateway addresses as they will be supplied by your DHCP server. Check the entered values carefully as the unit's webserver does minimal error checking. Press the 'Update Flash' key when done. A Confirmation Page

similar to the one shown in Figure 5.5 will appear in your browser.

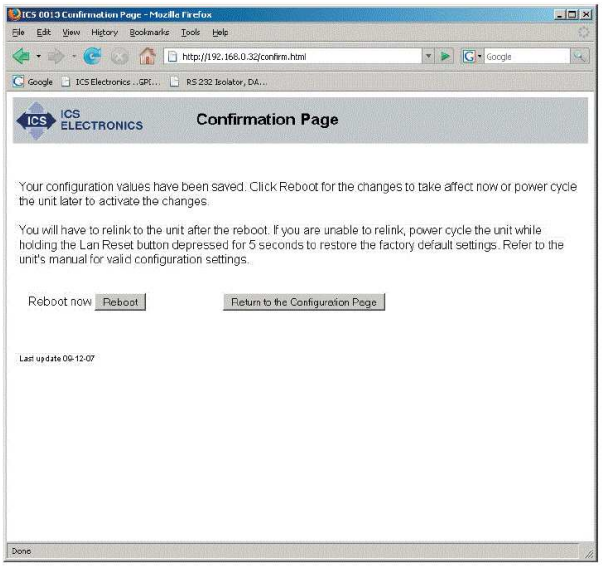


Figure 5.5 - 9006 Confirmation Page

8. Your new settings have been saved in the board's fl ash memory. You have to reboot the unit or power cycle it for the changes to take affect. Press the 'Reboot' key to reboot the unit now or the 'Return to the Configuration Page' key to revisit the new settings.

5.6 VXI-11 Configuration Utility Method

The VXI-11 Configuration Utility program is called 'VXI11_config.exe' and runs in any WIN32 PC with Windows 98, Me, 2K, XP, Vista, 7 and Server 2003 operating systems. The VXI11_config.exe program can be found on the 1888 product page at www.ietlabs.com.

The VXI11_config program can be run from the CD or can be installed onto your hard disk and run from the installation directory.

VXI11_config.exe is a Visual Basic program and requires that either Microsoft's Visual Studio 6 or VBruntime6 be installed on your PC to run.
1. Connect the board directly to the WIN32 PC that will be running the Configuration Utility. Disconnect the PC from the company network and use the supplied Ethernet Crossover Cable to connect the PC to the board as shown in Figure 5.6. This will eliminate any potential network conflicts while configuring the board.

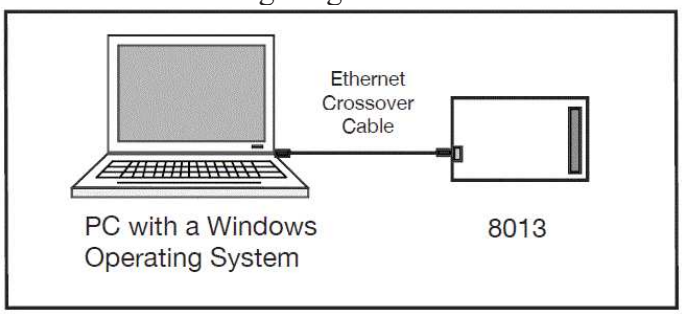


Figure 5.6 - 9006 Connected to PC with a Crossover Cable

Alternately, use a standard Ethernet patch cable to connect the 9006 to the same hub or switch that the PC running the Configuration Utility is connected to as shown in Figure 5.7. Temporarily disconnect the local network connection to avoid network conflicts until the board is configured.

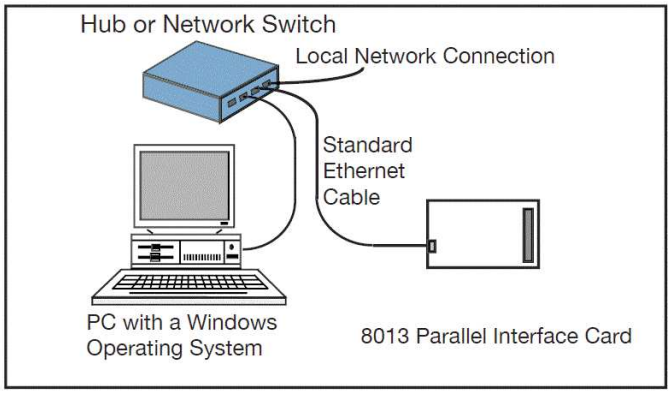


Figure 5.7 - 9006 Connected to the local hub

2. Apply power to the board

3. Check your PC's network settings to be sure its IP address is in the 192.168.1.xxx range so it can communicate with the board's default IP address. To check, right-click on My Network Places and click on Properties. Right-click on

Local Area Connection and click Properties. Highlight Internet Protocol (TCP/IP) and click Properties. If your PC's IP address is in a different range, record the current settings and temporarily set the following network values:

Check 'Use the following IP Address'
IP Address 192.168.1.254
Subnet mask 255.255.255.0

4. Run the VXI11_config program. The Configuration Utility opens a window as shown in Figure 5.8. Initially only the Find Server, Help and Exit keys are enabled on the program window. The other keys will be enabled as you advance through the program.

5. Click on the Find Server key. The program scans for all VXI-11 Services connected to the local LAN or to your PC. (The 9006 is an RPC server which provide a VXI-11 Service) The results are displayed in the Results box.

6. When the servers(s) have been found, use the pulldown arrow in the Found Servers box to view the Found Server addresses. The board's default address is 192.168.1.254. Highlight the board's IP address and click the Create Link key. If the server is not found, you can enter the default IP address (192.168.1.254) in the Found Servers box. Click the Create Link key.

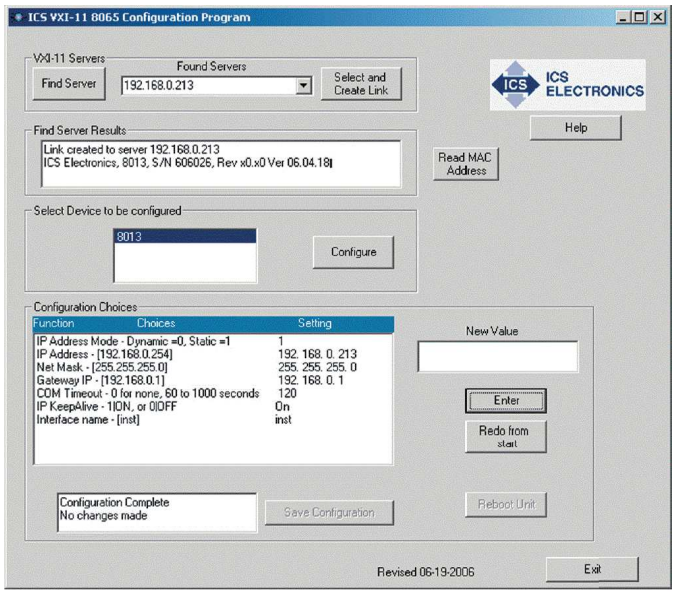


Figure 5.8 - VXI-11 Configuration Utility

(Showing all configuration choices with no changes)

7. When the link has been created, device model number(s) will appear in the 'Select Device to be Configured' box. Highlight the desired model number and click the Configure key to start the configuration process.

8. The Configuration Choices box displays only one line with the first parameter to be changed and its current setting. If you like the current setting, click Enter to advance to the next parameter. If you want to change the setting, type a new value in the New Value box and click Enter. The program will send your setting to the board and read back the new setting. Repeat as needed to make another change or click Enter again to advance to the next parameter.

9. Repeat step 8 for each configuration parameter. Figure 5.8 shows the VXI-11 Configuration Utility after all parameters have been entered for a Model 9006. Click the Redo From Start key if

you need to start over or if you want to change any of the prior settings

10. When done, the Save Configuration key is enabled if you changed any settings. Click the Save Configuration key to save the values in the board's flash memory. If you did not make any changes you can just exit the program.

11. The board has to be power cycled or rebooted before the configuration changes take affect. Click the Reboot key to reboot the board and use the new settings.

12. Press the Exit key to quit the VXI11_confi g program.

13. If the IP address was changed to an address outside the 192.168.1.xxx range in step 3, your PC's network settings will have to be changed to communicate with the board. Exit the VXI11_ config program and restore the PC's network settings.

5.7 Resetting Default Network Settings

The board can be reset to the default network settings listed in Table 5.2 at any time by holding the LAN Reset Key in for 5 seconds while applying power to the board. Access to this key is on the rear panel of the 1888.

The Digital I/O configuration values are not affected by the LAN Reset operation.

Command	Function	Factory Setting
IP Mode	Static or DHCP Mode	Static
IP Address	0.0.0.0 to 255.255.255.255.0	192.168.1.254
Net Mask	0.0.0.0 to 255.255.255.255.0	255.255.255.0
COMM Timeout	Sets socket timeout	120 sec.
Auto Disconnect	Aborts socket if link count goes to 0	Off

Table 5-2 Default Settings

5.8 1888 Programming

A 1888 SCPI command reference is included in Appendix A. This gives a complete set of commands.

An example of commands to be sent to place the 1888 in remote, this must be done first otherwise the will be no remote control of output impedance, and then configure the unit for a specific impedance value.

Where the command string is constructed as described in Appendix A and Appendix B.

A command string might be, for example:

```
CONF:VOLT 500<crlf>
CONF:VOLT?<crlf>
```

Chapter 6
GPIB INTERFACE

6.1 Introduction

The 1888 is a IEEE-488.2-1987 and SCPI 1994.0 compatible instrument. The 1888 IEEE-488 interface is based upon the ICS Ethernet/GPIB/ USB to Serial Interface Card.

More information can be found at www.icselect.com on the 9006 Ethernet/GPIB/USB to Serial Interface Card.

Commands sent to the 1888 must be terminated with line feed <LF>or carriage return and line feed <CRLF>.

The IEEE interface can be programmed via any of the commands listed in Appendix A and B.

It is also important to use 488 commands when using MetCal rather than 488.2 commands.

The terminator CRLF should also be used with Met Cal as shown below.

1.001 IEEE CONF:TMEAS 60 [13][10]

The SCPI standard provides a tree like series of standard commands for programmable instruments so that similar instruments by different manufacturers can be controlled by the same program. SCPI information and a command reference are located in Appendix A.

Other tutorials are available on-line; consult IET for additional information. A software GPIB "keyboard" can be found at www.ietlabs.com

6.2 Capabilities

The IEEE option provides remote control over all functions except **POWER**. The IEEE option responds to all Basic Commands in Appendix B and all IEEE.2 Mandated common commands in Appendix A.

6.3 Address Switch and Communications Settings

The default GPIB address is 4. This address can be changed in the I/O Settings Menu by selecting IEEE and changing the address.

6.4 GPIB Test Keyboard

To aid the user in operating the 1888, a GPIB "Keyboard" Controller program - the easiest way to control GPIB devices without writing a program - is available from IET. This GPIB Keyboard program automatically finds your device at start-up and it lets you enter just the data that you want to send to the device. This program

works with ICS, Measurement Computing and National Instruments controllers.

To implement, request a download of **ICS_GPIBkybd_Install.zip** from IET Labs Tech Support.

Unzip the file and follow instructions to install.

Open the application. You may use the **Find Listeners** key to confirm that the 1888 unit is recognized. Other instruments may also be recognized at this time.

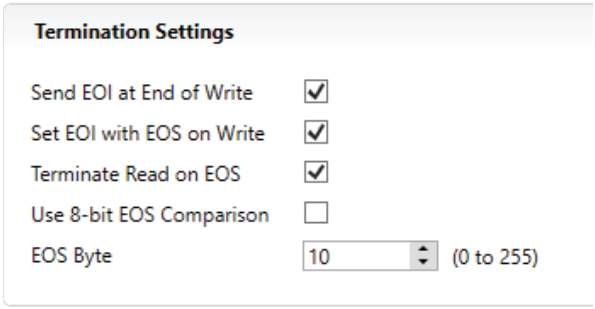
Enter and set the **Address** to the 1888 address. Use the window to send a **command string** to the 1888, where the command string is constructed as described in Chapter 7. A command string might be, for example:

```
START<crlf>
```

6.5 GPIB Control with National Instruments NI-MAX and Programmatically

Open NI-MAX, expand devices and interfaces, select NI GPIB-USB-HS"GPIB0" or GPIB interface being used.

Set the terminations settings as shown



From NI-Max Measurement and Automation Explorer you can now click on scan for instruments.

The 1888 will be found at address 4.

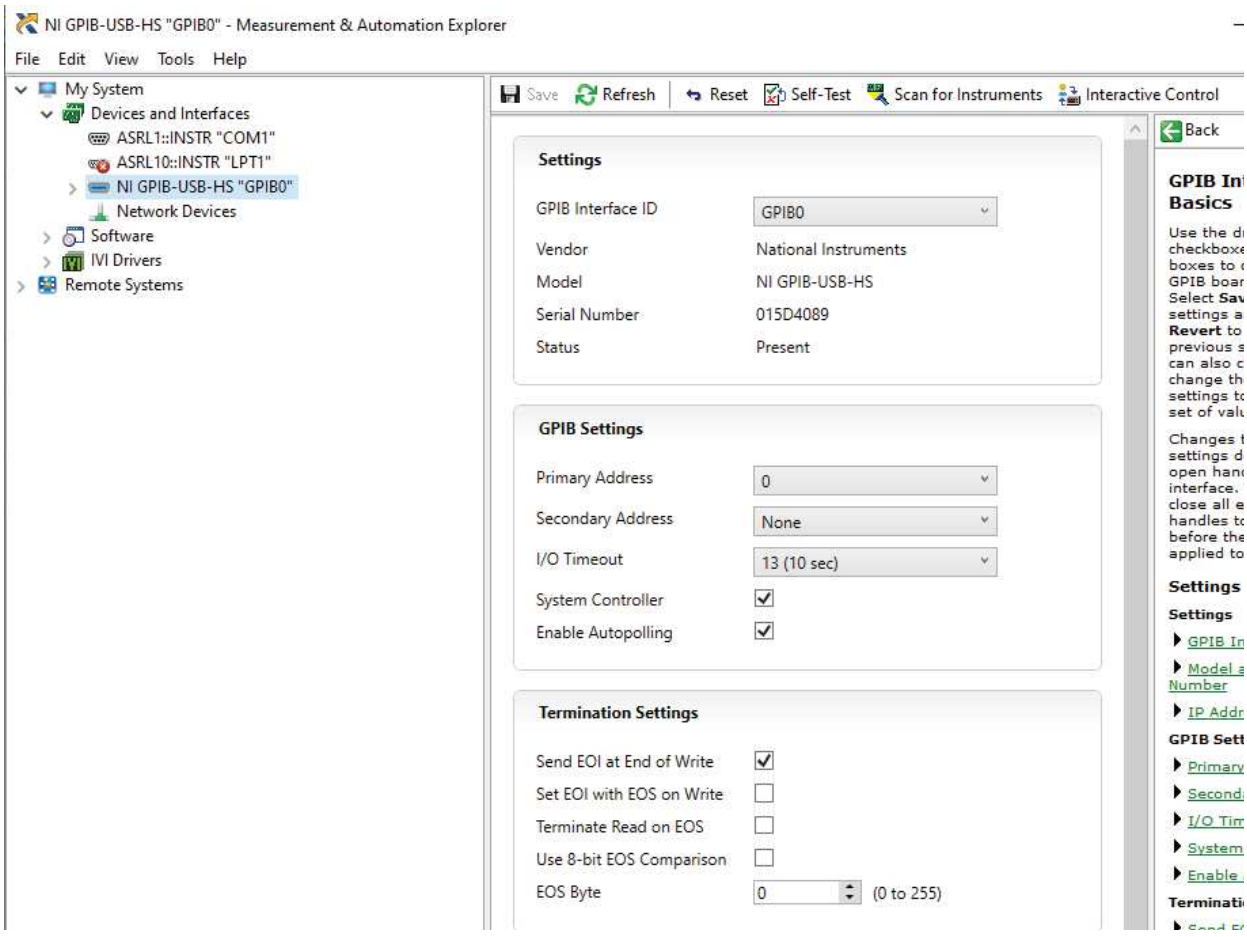
When you send a command in NI-Max make sure you send *IDN?\n or CONF:TME?\n.

Sending \n indicates the terminator will also be sent.

It is also important to use 488 commands when using MetCal rather than 488.2 commands.

The terminator CRLF should also be used with Met Cal as shown below.

1.001 IEEE CONF:VOLT 250 [13][10]



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Chapter 7
PROGRAMMING

7.1 Program Commands

Take advantage of the applications such as **ICS_VXI-11** and **ICS_GPIBkybd** that can be downloaded from on ietlabs.com to test communication via Ethernet, IEEE and USB to become familiar with programming and verify communications.

The USB, Ethernet and IEEE interface can be programmed via any of the commands listed in Appendix A and B.

For USB, IEEE and LAN <lf>, <cr> or <crlf>, should be used as terminator. The device returns in this case <crlf>.

The device performs all commands previously sent after it receives a terminator.

Commands not recognized have no effect on the unit's operation and will set the corresponding bits in the Standard Event Status Register.

SCPI commands that end with a question mark '?' are queries.

All queries should be followed by reading their response to avoid data loss.

Semicolon ';' is used to separate more commands written on one line.

Note: Only one query command should be send at one time so use of ";" as a separator is not value for multiple commands ending in "?".

Note: Commands from Appendix A should not be combined with commands from Appendix B using a semicolon. These should be sent as separate lines.

Examples
Examples of commands that are valid and can be strung together using a semicolon.

The command below sets the 1888 to a voltage of 250 V and a Measurement Time of 22 seconds.

CONF:VOLT 250;CONF:TME 22

Any of the commands can be queried by placing a ? at the end of the string.

For example if the Applied Voltage is set to 250 V then sending the command

CONF:VOLT? will return 250.000

Care must be taken when sending the *RST command. This command resets the 1888 and it cannot be combined with any other commands.

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Chapter 8
MAINTENANCE

8.1 Verification of Performance

8.1.1 Calibration Interval

The 1888 instruments should be verified for performance at a calibration interval of twelve (12) months. This procedure may be carried out by the user, if a calibration capability is available, by IET Labs, or by a certified calibration laboratory. If the user should choose to perform this procedure, then the considerations below should be observed.

8.1.2 General Considerations

It is important, whenever calibrating the 1888 to be very aware of the capabilities and limitations of the test instruments and standards used. Instruments should be significantly more accurate than the specified accuracy for all applicable ranges in order to perform this task, allowing for a band of uncertainty of the instrument itself, the test setup, and the environment. Consult IET Labs for information.

Allow both the testing instrument and the 1888 to stabilize for a number of hours at the nominal operating temperature of 23°C, and at nominal laboratory conditions of humidity. There should be no temperature gradients across the unit under test.

Warm-up IMPORTANT
The 1888 should be turned on for 1 hour for best accuracy. Warm-up the detector by performing a single 60 second measurement at 1000 V with no device connected to the cables.

Proper metrology practices should be followed in performing this verification.

8.1.3 Calibration Procedure

Equipment Required:
Keysight 3458A, Fluke 8508A, 8588A or equivalent to measure dc voltage from 1 V to 1000 V.

7 x SRL-1MΩ to 1 TΩ Resistance Standards or equivalent resistance standards. Appropriate high voltage shielded cables or equivalent for connection. Resistors should be calibrated to better than 620 ppm.

The **Voltage Calibration** of the 1888 can be performed by measuring the voltages of 1000 V, 500 V, 100 V, and 10 V and comparing these to published specifications.

The voltage should be measured between the center conductor of the HV output BNC and the Guard connection of the Detector Input.

The Resistance Calibration can be performed by measuring each of the 7 resistance values at using applied voltages of 1000 V, 500 V and 100 V and comparing the measured resistance values with published specifications using the resistance

accuracy formulas given the the Specifications Section of this manual.

8.1.4 Adjustment Procedure

This Calibration/Adjustment procedure is designed to be performed if the 1888 is found to be out of tolerance or to bring the equipment closer to published specifications.

Equipment Required:
Keysight 3458A, Fluke 8508A, 8588A or equivalent to measure dc voltage from 1 V to 1100 V.

7 x SRL-1MΩ to 1 TΩ Resistance Standards or equivalent resistance standards. Appropriate high voltage shielded cables or equivalent for connection. Resistors should be calibrated to better than 620 ppm. to minimize effect on accuracy.

Procedure:
Press in the Cal. Enable button on the front panel and keep it pressed until the Calibration Menu has been selected. From the front panel of the 1888 select MENU, using the UP and DOWN arrow keys to can be highlighted in yellow **Instrument Calibration** and press the **ENTER** key to go to the **Instrument Calibration** menu.

Enter the password: 1888001 to enter the calibration routine.

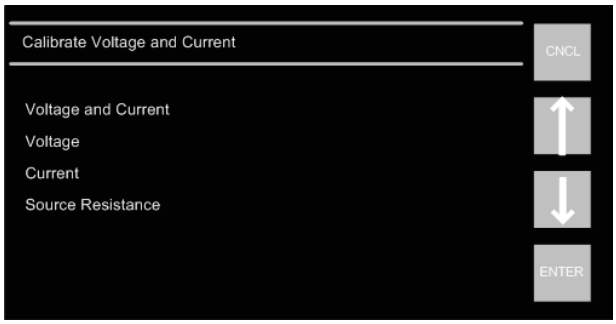

Figure 8.1 - Calibration Menu

Using the UP and DOWN arrow keys to select which calibration to perform. **Voltage and Current, Voltage, Current and Source Resistance** can be highlighted in yellow, press the **ENTER** key to go to begin the calibration process.

Note that selecting **Voltage and Current** is the same as selecting **Voltage** and then selecting **Current**. This gives the option to adjust just voltage or just current if only one is found to be out of specification.

Source Resistance is the input resistance to the detector. This resistance is in the range of 4 kΩ. This should only require adjustment at the factory and requires the shield be removed on the detector board. This is only recommend to be done at the factory.

Voltage Calibration will prompt the user to connect the DMM, measure the voltage, and then enter the DMM voltage reading.

Connect the DMM between the HV output, center conductor, and the Guard terminal prior to selecting Voltage calibration.

Prompts will be given to enter voltages from 1100 Vdc to 1 Vdc.

Current Calibration will prompt the user to enter the calibrated value of each range resistor

RS1 to RS7 corresponding to 1 MΩ to 1 TΩ.

The resistor must be connected between HV output and Detector Input (-) terminal.

Guard and ground can also be used depending upon the standard being used.

Important Note
The standard must be connected prior to entering the calibrated value of the standard, as once the value has been input and the Enter key is pressed, the calibration automatically starts.

8.2 Error Codes

There are various error codes which will be shown on at the bottom of the display if there is a hardware issue.

Most of these error codes are fatal hardware faults. This can give an idea of where the hardware fault occurred however service at the factory is required except for error 55.

50 ERROR_CODE_INPUT
51 ERROR_CODE_ADC
52 ERROR_CODE_EEPROM
53 ERROR_CODE_SOURCE_OVLD
54 ERROR_CODE_SOURCE_0V
55 ERROR_CODE_SOURCE_5V
56 ERROR_CODE_RTC

Error - 55 can be caused by cables see information below.

During self-test routine during power up the 1888 outputs 5 V and reads the voltage back. Remove all cables from Detector and HV Output and power cycle the 1888. If this fixes the issue the cables are shorted or have a fault.

If this does not fix the issue, it can be due to hardware failure or incorrect calibration.

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8.3 Replaceable Parts List

Model Ref	IET Pt No	Description
1	1888 BNC panel mount	Panel mount BNC connector
2	part of 1888 Detector board	triaxial connector
Not Shown	1888 Lemo bulk head	Rear bulkhead for interlock
Not Shown	1888-Bail-Feet kit	4 x feet and bale kit
Not Shown	1888 Source Board	Source Board Complete
Not Shown	1888 CPU Board	CPU Board Complete
Not Shown	1888 Detector Board	Detector Board Complete
Not Shown	1888 Remote Interface	USB,IEEE,Ethernet Interface Card
3	1888 Touch Screen	Touch Screen
4	1888 FP	Front Panel with Overlay and Bezel
5	1888 Keypad	Keypad and Keypad board
6	1888 Power Switch	Power Switch Illuminated

Appendix A
SCPI COMMAND REFERENCE

SCPI is an acronym for "Standard Commands for Programmable Instruments". For additional information or an on-line copy of this standard, see:

http://www.scpiconsortium.org.

The IEEE 488.2 Standard was established in 1987 to standardize message protocols and status reporting and to define a set of common commands for use on the IEEE 488 bus. IEEE 488.2 devices are supposed to receive messages in a more flexible manner than they send. A message sent from GPIB controller to GPIB device is called: PROGRAM MESSAGE. A message sent from device to controller is called: RESPONSE MESSAGE. As part of the protocol standardization the following rules were generated:

(;) Semicolons separate messages.
(:) Colons separate command words.
(,) Commas separate data fields.
<nl> Line feed and/or EOI as last character terminates a 'program message'. Line feed (ASCII 10) and EOI terminates a RESPONSE MESSAGE.
(*) Asterisk defines a IEEE 488.2 common command.
(?) Ends a query where a reply is expected.

SCPI builds on the programming syntax of IEEE-488.2 to give the programmer the capability of handling a wide variety of instrument functions in a common manner. This gives all instruments a common "look and feel". SCPI commands are not case-sensitive.

The portion of commands shown in capitals denotes the abbreviated form of the keyword. Either the abbreviated or whole keyword may be used when entering a complete command. There must be a space between the command and a parameter or channel list. Multiple SCPI commands may be concatenated together as a compound command by using semicolons as command separators.

Keywords shown inside braces [ ] are defaults, and are optional when constructing a PROGRAM MESSAGE.

Commands not recognized have no effect on the unit's operation and will set the corresponding bits in the Standard Event Status Register. SCPI commands that end with a question mark '?' are queries. All queries should be followed by reading their response to avoid data loss.

Semicolon ';' is used to separate more commands written on one line.

Note: Commands from Appendix A should not be combined with commands from Appendix B using a semicolon. These should be sent as separate lines.

Note: Multiple query commands should not be strung together with a semicolon. “SYSTEM:SVER?;SYST:HVER?” should not be combined. Multiple query commands should be sent as separate commands.

Terminators: For GPIB interface each command line must end with line feed <lf>. Response from the device also returns line feed <lf>.

IEEE-488.2 Common Commands

Note: Commands from Appendix A should not be combined with commands from Appendix B using a semicolon. These should be sent as separate lines.

*IDN?
Returns instrument identification “IET Labs Inc.,1888,<Serial Number>,<software version>”
Serial number in the form “Ax-xxxxxxxx” x = 0 to 9. A = Alpha can be A to Z.

*ESR?
Returns the read of the event status register.
*STB?
Returns the read of the status byte register.
*ESE?
Returns the read of the event status enable register.
*SRE?
Returns the read of the service request enable register.
*ESE
Set the event status enable register value
*SRE
Set the service request enable register value
*RST
Reset the buffer
*TST?
Self test query
*CLS
Clear standard event status register
*OPC
Operation complete
*OPC?
Operation complete query
*WAIT
Wait until operation is complete before executing next command(No Function in 1888)

*PCS
Power-on Status Clear

Note: Remote command can start with or without * symbol for compatibility.

Appendix B
IEEE.2 COMMON COMMANDS

Note: Commands from Appendix A should not be combined with commands from Appendix B using a semicolon. These should be sent as separate lines.

For USB, IEEE and LAN <lf>, <cr> or <crlf>, should be used as terminator. The device returns in this case <crlf>. A terminator is required for the 1888 to accept and process a command.

CONFIGURE Commands General

CONFigure:VOLTage <n>	Sets the voltage in volts <1 - 1000>.
CONFigure:TCHarge <n>	Sets the charge time in seconds <0 - 300>.
CONFigure:TMEasure <n>	Sets the measure time in seconds <0 - 1200>.
CONFigure:TDIScharge <n>	Sets the discharge time in seconds <0-300>.
CONFigure:RANGe <Auto, 1mA 100uA,10uA 1uA 100nA 10nA 1nA >	Sets the current range.
CONFigure:AVERage <n>	Sets the number to average <1 - 99>.
CONFigure:LIMit <n>	Sets the limit <1e4 to 1e21>.
CONFigure:SONPass <n>	Sets the stop on pass number <0 - 300>.
CONFigure:DISPlay <N, S, V>	Sets the display type. N (Normal) S (Surface Resistivity) V (Volume Resistivity)
CONFigure:VOLUme <n>	Sets the Volume Resistivity Constant (cm2) < 0.01 - 400>.
CONFigure:SURFace <n>	Sets the Surface Resistivity Constant (1/sq) < 0.01 - 400>.
CONFigure:THICkness <n>	Sets the Volume Resistivity Thickness in (cm) < 0.01 - 400>.
CONFigure:SAVe:NEW <string>	Saves the setup as new filename in memory. <10 characters>.
CONFigure:SAVe:RECall <string>	Recalls the setup filename <10 characters>.
CONFigure:SAVe:RECall?	Returns the current filename. For example CONF:SAVE:REC? returns Default or the last recalled filename.

Measure Commands

START	Initiates a measurement A REM CMD ERR 1 will result if START is sent when the 1888 is already performing a measurement.
STOP	Stops a measurement in process A REM CMD ERR 1 will result if STOP is sent when the 1888 is already stopped..
ESR?	Reads the status of the ESR Register. This is a destructive read and will also clear any “CMD Error” on the screen of the 1888..
DRDY?	Queries if data is available <0 = no data, 1 = data available>.
OPC?	Queries if the measurement is complete. This is a destructive read. <0 = no data, 1 = data available>.
FETCh?	Fetches the most recent measurement values Fetch can be used during and after the measurement Returns string in the format <Status integer>, <sp><Resistance, Volume Resistivity or Surface Resistivity floating point number>, <sp> <Voltage floating point number>, <sp><Current floating point number> Status integer: 0 = measurement in progress, 1 = measurement complete, 2 = user stopped For example FETC? returns 1, 9.999086383E+07, 9.997E+02, 9.997851520E-06.
MEASure:RESistance?	Return the measured resistance value. Unit in [ohm, ohm/sq, ohm cm]. For example MEAS:RES? returns 13.872198 Tohm
MEASure:CURRent?	Return the measured current value. Unit in A. For example MEAS:CURR? returns 0.08912 pA
MEASure:VOLTage?	Return the measured voltage value. Unit in V. For example MEAS:VOLT? returns 1.236 V

MEASure:ALL?	Return the measured resistance/resistivity, current, and voltage value. Units in [ohm, ohm/sq, ohm cm], A, and V. For example for a surface resistivity measurement MEAS:ALL? returns 260.7 Tohm/sq, -0.08 pA, 1.236 V

DISPLAYCommands

DISPlay:TIME <hh:mm>	Set the time to hours, minutes.
DISPlay:TIME?	Queries the time.
DISPlay:DATE <mm/dd/yy>	Set the date to month, day, year.
DISPlay:DATE?	Queries the date.
DISPlay:LOCKout <0,1>	0 = unlocked, 1 = locked.

SYSTEM Commands

SYSTem:INTerlock?	Query status of interlock (0 open, 1 closed). Must be 1 to perform measurements.
SYSTem:SERIal <Ax-xxxxxxxx>	Sets the serial number in non-volatile memory Serial number in the form “Ax-xxxxxxxx” x = 0 to 9. A = Alpha can be A to Z. Note that this is different from *idn? serial number. This is only within the GUI.
SYSTem:SERIal?	Queries the serial number of the instrument.
SYSTem:LOCal	Sets instrument into the LOCAL mode and unlocks all keys on front panel of the device. Note: If SYSTem:REMote was not issued as a previous command, then response is go to local and issue a REM CMD ERR1.
SYSTem:REMote	Sets instrument into the REMOTE mode and locks all keys on front panel of the device.
SYSTem:MODEL?	Queries the model of the instrument.
SYSTem:SVERsion?	Queries the instrument’s software version as a string <n.nn> where n = 1 to 9.
SYSTem:HVERsion?	Queries the instrument’s hardware version as a string <n.nn> where n = 1 to 9.
SYSTem:IP <string>	Sets the IP address with format of ###.###.###.### where # is 0 to 9 Wait 60 seconds for the setting to save in the internal memory.

SYSTem:IP?	Queries the IP address as a string ###.###.###.###.
SYSTem:GATE <string>	Sets the network gate address with format of ###.###.###.### where # is 0 to 9. Wait 60 seconds for the setting to save in the internal memory.
SYSTem:GATE?	Queries the network gate address as a string ###.###.###.###.
SYSTem:MASK <string>	Sets the network mask with format of ###.###.###.### where # is 0 to 9. Wait 60 seconds for the setting to save in the internal memory.
SYSTem:MASK?	Queries the network mask address as a string ###.###.###.###.
SYSTem:MAC?	Queries the MAC address as a string.
SYSTem:IEEEAddr <n>	Sets the IEEE address. <1 to 30> Default is 4
SYSTem:IEEEAddr?	Queries the IEEE address.
RST	Resets the 1888 as if unit was power cycled.
SYSTem:STATus:STRing?	Return the current status of the system as a string. When the measurement is in progress, the status replies:“Measurement in process – [Measuring, Starting, Charging, Discharging, Zeroing]” When the measurement is complete, the status replies: “Measurement complete” When the measurement is stopped, the status replies: “Measurement stopped – [Overload, Interlock, Over Range Voltage, Over Range Current, Over Limit, User, Ready to Measure]” When there is an error, the status replies: “Error – [Input Board, ADC Board, External Memory, Source Board Overload, Source Board 0V, Source Board 5V, RTC]”

SYSTem:STATus:NUMber?	Returns the status as a number When the measurement is in progress: 10 – Run Mode start 11 – Run Mode Charge 12 – Run Mode Measure 13 – Run Mode Discharge 14 – Run Mode Zero When the measurement is complete: 2 – Status Measure Complete When the measurement is stopped: 30 – Stopped Reason Overload 31 – Stopped Reason Interlock 32 – Stopped Reason Overrangevol 33 – Stopped Reason OverrangeCurr 34 – Stopped Reason OverLimit 35 – Stopped Reason User When the instrument is ready to measure: 4 – Status Ready To Measure When there is an error: 50 – Error Code Input 51 – Error Code ADC 52 – Error Code EEPROM 53 – Error Code Source OVLD 54 – Error Code Source 0V 55 – Error Code Source 5V 56 – Error Code RTC For example if measurement completed normally SYST:STAT:NUM? returns 2

SYSTem:KEY <n>	This can be used to mimic key presses on the front panel. 1-9 = <1-9> 10 = decimal 11 = negative 12 = Side Button 1 13 = Side Button 2 14 = Side Button 3 15 = Side Button 4 16 = Keypad back or keyboard menu 19 = Keypad enter or keyboard enter

CALIBRATION Commands

Calibration of the 1888 can only be performed manually via the user interface.

The calibration coefficients can be queried using the following commands when in the calibration menu.

SYSTem:CALIbrate:DATA?	Queries the calibration coefficients of the source board. For example SYST:CALI:DATA? returns 11.946428, -0.496421;119.464286, -6.964233;
SYSTem:CALIbrate:VOLTage <n>?	Queries the calibration coefficients of the voltage channel of the input board, where n is the range and returns m and b for the range <1 - 3>. For example SYST:CALI:VOLT 3? returns 5.029571E+02, 4.251708E-01;
SYSTem:CALIbrate:CURRent <n>?	Queries the calibration coefficients of the current channel of the input board, where n is the range and returns m and b for the range <1 - 7>. For example SYST:CALI:CURR 1? returns 5.038719391E-04, -4.526814052E-07;
SYSTem:CALIbrate:SRESistance?	Queries the detector series resistance in kΩ. For example SYST:CALI:SRES? returns 4.000 indicating series resistance is 4 kΩ.
SYSTem:CALIbrate:DATE?	Queries the calibration date of the instrument. For example SYST:CALI:DATE? returns 01/09/2025.