

S470 Parametric Test System

User's Manual

S470-900-01 Rev. A / August 2004

WARRANTY

S350, S400, S600, & S900 Warranty

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Keithley Instruments, Inc. warrants that for a period of one (1) year (from the date of shipment) the Keithley manufactured portion or the “Keithley Hardware” product will be free from defects in materials or workmanship; provided that such defect has not been caused by use of the Keithley Hardware which is not in accordance with the instructions therefore. This warranty shall be null and void upon: (1) any modification of Keithley Hardware which is made by other than Keithley and not approved in writing by Keithley or (2) operation of the Keithley Hardware outside of the environmental specifications therefore.

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S470
Parametric Test System
User's Manual

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Manual Print History

The print history shown below lists the printing dates of all Revisions and Addenda created for this manual. The Revision Level letter increases alphabetically as the manual undergoes subsequent updates. Addenda, which are released between Revisions, contain important change information that the user should incorporate immediately into the manual. Addenda are numbered sequentially. When a new Revision is created, all Addenda associated with the previous Revision of the manual are incorporated into the new Revision of the manual. Each new Revision includes a revised copy of this print history page.

Revision A (Document Number S470-900-01) August 2004

Safety Precautions

The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read the operating information carefully before using the product.

The types of product users are:

Responsible body is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.

Maintenance personnel perform routine procedures on the product to keep it operating, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the manual. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

Service personnel are trained to work on live circuits, and perform safe installations and repairs of products. Only properly trained service personnel may perform installation and service procedures.

Keithley products are designed for use with electrical signals that are rated Installation Category I and Installation Category II, as described in the International Electrotechnical Commission (IEC) Standard IEC 60664. Most measurement, control, and data I/O signals are Installation Category I and must not be directly connected to mains voltage or to voltage sources with high transient over-voltages. Installation Category II connections require protection for high transient over-voltages often associated with local AC mains connections. The user should assume all measurement, control, and data I/O connections are for connection to Category I sources unless otherwise marked or described in the Manual.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. **A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.**

Users of this product must be protected from electric shock at all times. The responsible body must ensure that users are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product users in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000 volts, **no conductive part of the circuit may be exposed.**

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

When installing equipment where access to the main power cord is restricted, such as rack mounting, a separate main input power disconnect device must be provided, in close proximity to the equipment and within easy reach of the operator.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.


The instrument and accessories must be used in accordance with its specifications and operating instructions or the safety of the equipment may be impaired.


Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture panels, or switching card.


When fuses are used in a product, replace with same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

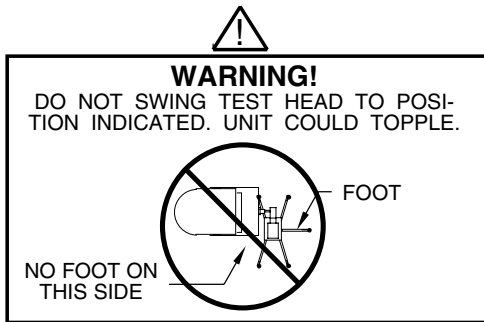
If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

If a  screw is present, connect it to safety earth ground using the wire recommended in the user documentation.

The  symbol indicates that the user should refer to the operating instructions located in the manual.

The  symbol indicates that voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. Use standard safety precautions to avoid personal contact with these voltages.

The **WARNING** heading in a manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.



The **CAUTION** heading in a manual explains hazards that could result in minor injury or damage the instrument. Such damage may invalidate the warranty.

The **ATTENTION** heading in a manual explains hazards that could damage the instrument. Such damage may invalidate the warranty.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits, including the power transformer, test leads, and input jacks, must be purchased from Keithley Instruments. Standard fuses, with applicable national safety approvals, may be used if the rating and type are the same. Other components that are not safety related may be purchased from other suppliers as long as they are equivalent to the original component. (Note that selected parts should be purchased only through Keithley Instruments to maintain accuracy and functionality of the product.) If you are unsure about the applicability of a replacement component, call a Keithley Instruments office for information.

To clean the instrument, use a damp cloth or mild, water based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument.

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1 Introduction

Introduction and system description

This manual provides a description of S470 system operation and use. The S470 system provides complete parametric test capabilities optimized for the 130nm node. This parametric test solution is designed for use in both technology development and production process monitoring. The S470 system offers all tools needed for DC and RF parametric testing such as:

- 130nm CMOS processes on 200mm wafers (optional)
- analog bipolar
- automotive
- GaAs
- telecom
- LCD devices

With the S470 system's current measurement resolution and magnitude (up to 2A), it is able to test most common ICs. The S470 system combines powerful software tools for test code development and modification, wide measurement ranges, high throughput, exceptional measurement integrity, and advanced data analysis tools to provide a complete parametric test solution. (The S470 system is based on the flexible UNIX platform.) System upgradeability handles new measurement needs, including RF S-parameter measurements at up to 40GHz.

Standard configuration

Refer to [Table 1-1](#) for standard S470 system configuration.

Table 1-1

Standard S470 system configuration

Description	Qty
DC Source-Measure Units (SMU)	4
100kHz capacitance/conductance meter	1
10fA picoammeter	1
24-pin system	1
Switch matrix	1
Probe card adapter	1
Unix controller with: -19-inch monitor -Solaris operating system -C language compiler -KTE v5.1.1 -Measurement libraries (CMOS and BiCMOS)	1

Available options

Refer to [Table 1-2](#) for available S470 system options.

Table 1-2

S470 options

Description	Qty
DC Source-Measure Units	Additional 4
1MHz capacitance or multi-frequency meter (for advanced dielectrics)	1
Micro-voltmeter (for Cu measurements)	1
Pulse generators	1
Frequency counter	1
Spectrum analyzer	1

Additional software options

Software options are available dependent on configuration required include:

- Adaptive test option—Automates first-level process diagnostics
- SECS/GEM option for 200mm—Integrated factory automation
- Testing at up to 40GHz with RF Option—RF as easy as DC (see [“RF hardware/software option”](#) on page 1-4 for additional information)

Instrument descriptions

[Table 1-3](#) contains descriptions of the available instruments with the S470 system.

NOTE *Not all instruments listed in [Table 1-3](#) are contained in standard S470 system configurations.*

Table 1-3
Instrument descriptions

Description	Specification
DC capability (up to eight SMUs)	<ul style="list-style-type: none"> • 10fA and 15μV measurement resolution • 2A and 200 V maximum output • All channels Kelvin and fully guarded to probe tip
Capacitance/conductance meter	<ul style="list-style-type: none"> • 10fF–1nF measurement range • 100kHz frequency, 45mV AC bias
RF option	<ul style="list-style-type: none"> • 40GHz (non-extrapolated) • Uses standard production prober
Micro-voltmeter option	<ul style="list-style-type: none"> • 100nV resolution using Keithley 2001 DMM
Medium current voltage source option	<ul style="list-style-type: none"> • Voltage pulses down to 20μS • Measure current up to 2A maximum
Multi-frequency capacitance meter option	<ul style="list-style-type: none"> • 1pF–100nF measurement range • 1kHz, 10kHz, 100kHz, and 1MHz frequencies
Spectrum analyzer option	<ul style="list-style-type: none"> • 9kHz–1GHz frequency range • <100mV noise level (typical)
Frequency counter option	<ul style="list-style-type: none"> • 1MHz–30MHz measurement range (AC coupled)
Pulse generator option	<ul style="list-style-type: none"> • 50ns–999ms pulse width • 20ns–200ms fall/rise time • 20V output amplitude (20V peak-to-peak)
Standard reference unit	<ul style="list-style-type: none"> • NIST-traceable calibration
Switching matrix (24 pins standard)	<ul style="list-style-type: none"> • Based on Keithley Models 707A/7174A air matrix • Fast settling • Up to 36 or 48 pins, optional
Probe card	<ul style="list-style-type: none"> • Standard Kelvin probe card adapter • Familiar ceramic blade technology

RF hardware/software option

This option combines DC and RF testing in a single-insertion system practical for both technology develop and process monitoring environments. The VNA (for on-wafer RF S-parameter testing) is added, and the software supports full automation of calibration, de-embedding, RF parameter extraction, probe contact resistance compensation, consumables tracking, data analysis, and revision control. For additional information on this option, refer to the S400RF/DC User's Manual, document number S400RF-901-01.

Other documentation

NOTE *This manual provides specific information about the S470 system.*

In addition to the other manuals contained with your system, refer to the following for specific information.

Receiving and unpacking the system:

- S400 Series Installation Guide, document number 4500-906-01, current revision.

Operating the system:

- S400UX Series Parametric Test System Operator's Manual, document number 4622-900-01, current revision.

Workstation manual:

- UNIX — S400UX Workstation User's Manual, document number 4615-901-00, current revision.

KTE software:

- S400UX/S600 Parametric Test Systems KTE Software Manual, document number KTE-900-01, current revision.

Probers:

- S400UX/S600 Parametric Test Systems Probers and Prober Drivers, document number 60000-911-01, current revision.

Maintenance and Service:

- S400 Series Maintenance and Service Manual, document number 4022-902-01, current revision.

RF:

- S400RF/DC User's Manual, document number S400RF-901-01, current revision.

2 Operation

Operation

The S470 system uses the same operating information as an S400 system. This section contains information on power controller operation and is arranged as follows:

- **Control locations** — Details information on the front panel controls and on the power distribution unit.
- **Grounding (protective earthing)** — Describes proper grounding at a site's power receptacle.
- **System operation** — Provides procedures for placing system in operation, restarting after a loss of line voltage, and turning system off.
- **VME controls** — Details VME controls and indicators.

Control locations

Controls are located on the front panel of the system (Figure 2-1).

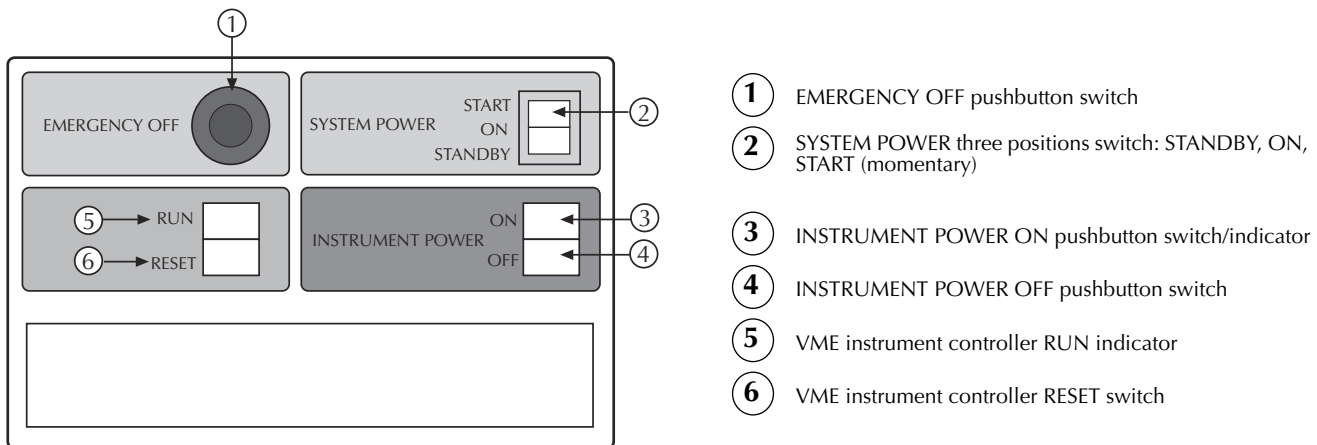
Grounding (protective earthing)

The power cord connects the power controller to a protective earth ground. The safety ground wire location (close to the phase and neutral wires) ensures a low impedance connection between the power controller and a properly grounded outlet. The safety ground connects directly to the chassis inside the power controller.

Ground the power controller to a properly grounded receptacle before operation. For effective protection, a low impedance connection must be provided to the outlet (installed within your facility). Wiring installed in accordance with local electrical codes ensures that this requirement is met.

WARNING The power controller must be grounded to a properly grounded receptacle before operation. Failure to properly ground the power controller may result in severe injury or death.

Figure 2-1
Model 9203-CPA front panel controls and indicators



System operation

This section contains procedures for system operation. Perform these procedures only after becoming familiar with the operation of the power distribution unit.

Operation procedure

Use the following procedure to place the system in operation:

1. Make sure power cord is plugged into a properly grounded outlet and all DUT connections have been removed.
2. Press SYSTEM POWER to START (Figure 2-1).
 - The momentary switch will revert to the ON position when pressure is released.
 - When SYSTEM POWER is in the ON position after being in the START position, the switch is illuminated, which indicates power is applied to the system including the cabinet fans.
3. Press INSTRUMENT POWER ON.
 - When INSTRUMENT POWER ON is pressed, the pushbutton will illuminate indicating power is applied to the relay matrix and system instruments.
 - DUT connections can be made, and instrument power can only be turned on after system power is on.
4. To start the software after booting system, refer to the S400UX Workstation User's manual (UNIX), document number 4615-901-00.

Restarting after a loss of line voltage

The emergency shutdown circuit automatically turns off all power to the system if line power is interrupted. This trips the EMO circuit. After the EMO circuit is tripped, it must be reset before power can be applied to the system and the instruments. Call maintenance personnel to reset the EMO circuit. Then start the system using the operation procedure.

Turning system off

Certain components can be turned off while leaving others on (computers, cabinet fans, etc.). In addition, the EMERGENCY OFF pushbutton (one switch) turns off all components connected to the power controller.

The two ways to turn off the system are as follows:

- Emergency turn off.
- Turning system power to STANDBY.

Emergency turn off

Press the EMERGENCY OFF button on the front panel of the system. Emergency off can also be accomplished by pressing an optional remote emergency off button.

NOTE *To start after an emergency turn off, use the procedure in the paragraph "Restarting after a loss of line voltage".*

Turning off the complete system

- Press the INSTRUMENT POWER OFF button.
- Press the SYSTEM POWER button to the STANDBY position.

Optional remote EMO Emergency Off switches

Optional remote EMO Emergency Off switches are available for the S400 system. The remote EMO switches function the same as the EMO switch located on the front panel of the system. The switches are a normally closed, momentary action type switch, connected in series with the front panel EMO switch. Pressing any switch disconnects the system from line power which contains all voltages within the power controller chassis.

Two safety features are built into each remote EMO switch. The emergency OFF switches are connected to the low voltage (24VAC) control voltage. This prevents line voltage from being connected to the remote switches. Voltage to the remote emergency OFF switches is disconnected after an emergency off switch is pressed.

VME controls

The front panel contains the VME RUN indicator and the VME RESET switch. The VME RUN indicator is illuminated when the instrument controller in the instrument card file (Model 9000- ICF) is operating. Reset the instrument controller by pressing the RESET switch.

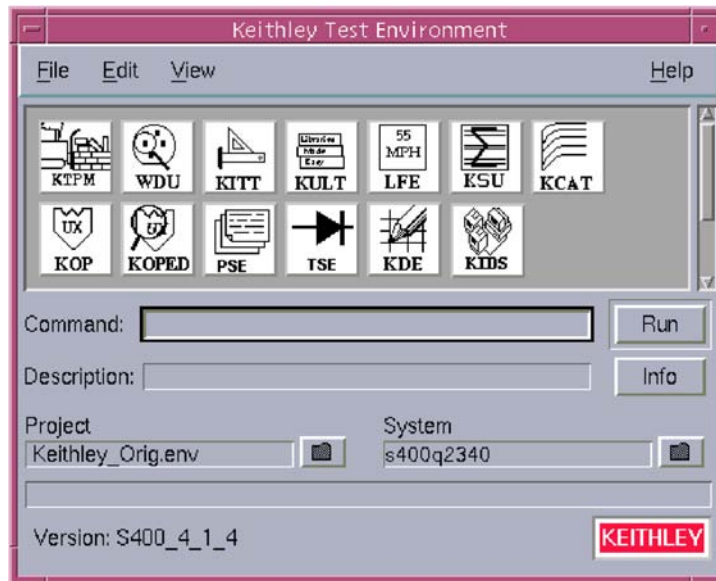
NOTE *The operating software for the instrument controller must be downloaded to the applications processor if the instrument controller is reset. The instrument controller may also be reset using the local reset button on the instrument controller itself.*

Executing a cassette plan

Cassette plans may be executed one of four ways:

- Using KIDS (see [Figure 2-2](#))
- Using KOPED and KOP (see [Figure 2-2](#))
- Directly accessing KTXE
- From the shop floor control system (i.e., through SECS/GEM)

Figure 2-2
S400 Series Keithley Tool Pallet



Refer to the applicable manual for specific details:

S400UX Series Parametric Test System Operator's Manual, document number 4622-900-01, current revision.

Workstation manual, UNIX — S400UX Workstation User's Manual, document number 4615-901-00, current revision.

KTE software, S400UX/S600 Parametric Test Systems KTE Software Manual, document number KTE-900-01, current revision.

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