



AM471e

User Manual

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Safety Precautions

A. General Information

- ❖ Refer to the User Manual prepared by the manufacturer for proper usage of the instrument.
- ❖ If the product is used in a manner not specified, the protection provided by the instrument warranty may be impaired.
- ❖ Return the instrument to Aemulus for service and repair to ensure that safety features are maintained.

WARNING

The **WARNING** heading explains hazards that might occur if an operating procedure, practice, or the like that, if not correctly performed or adhered to might result in personal injury or death. Always read the associated information very carefully and make sure the indicated information is met before performing the indicated procedure.

CAUTION

The **CAUTION** heading in the user documentation explains hazards that could damage the instrument. Such damage may invalidate the warranty.

B. Identification and Discouragement of Hazardous Applications

CAUTION

Main Power

- Ensure that the mains power is turned off before plugging or removing the PXI module into or from the chassis.
 - Make sure the power cord is plugged properly to the chassis before applying power.
 - The chassis that carries the instrument has to be plugged into a grounded (earthed) power outlet. By not doing so, it will defeat the power cord safety ground feature.
 - Ensure that the power is removed from the product before connecting/disconnecting the cables to the product connectors.
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WARNING

Instrument Cables / Connectors

- Inspection of the connecting cable and test leads for possible wear, cracks, or breaks must be done before each use.
 - Make sure the cables used for the product are rated to the specified voltage and current level.
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WARNING

Instrument Output

- Extreme caution is to be practiced when a shock hazard is present. Lethal voltage may be present on cable connector jacks.
 - When power is applied to the circuit under test, do not touch the product and test cables or test leads.
 - Do not touch the connector jacks or cables when the output of the product is turned on.
-

WARNING

*Operating
Temperature*

- The fan speed of the chassis that carries the instrument has to be in HIGH speed to allow proper heat ventilation.
 - Make sure the product temperature is under 46°C before operating the product.
-

C. Identification of Authorized Personnel

<i>End user</i>	Individual or group who is responsible for the use and maintenance of the product, as well as being responsible for ensuring that the product is operated within its specifications. Knowledge on electrical safety procedures and proper use of the product are prerequisite before operating the product.
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<i>Maintenance personnel</i>	Individual or group who is responsible for performing routine procedures on the product to keep it operating properly. Any service should only be done by qualified service personnel.
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<i>Service personnel</i>	Installation and service procedures may only be carried out by properly trained service personnel. Knowledge on working with live circuits, performing safe installations, and repairing the products are prerequisite for this individual or group.
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Section 1: Quick Start

1.1 Product Start-up Configuration

Each product is carefully inspected before it leaves the factory. Upon receipt and before unpacking the product, please inspect the unit for any obvious damage that may occur during shipment. If any damage is found, notify the instrument manufacturer immediately.

Please verify that the following items are included in the original packing of this product. Contact the instrument manufacturer immediately if any of these items are found missing.

❖ Reference / Drivers CD-ROM

The product is designed to be used in an indoor environment, an area with low condensation and a temperature of between $23^{\circ}\text{C} \pm 10^{\circ}\text{C}$. Ensure that the area where the product is installed is free from the presence of any explosive or flammable fumes or gases.

CAUTION

The product is shipped in materials that prevent static damage to the module. The module should only be removed from the packaging in an anti-static area ensuring that correct anti-static precautions are taken. Store all modules in anti-static envelopes when not in use.

1.2 Product Software & Hardware Installation

Refer to AM400e installation guide.

Section 2: Operation

2.1 Front Panel Connectors

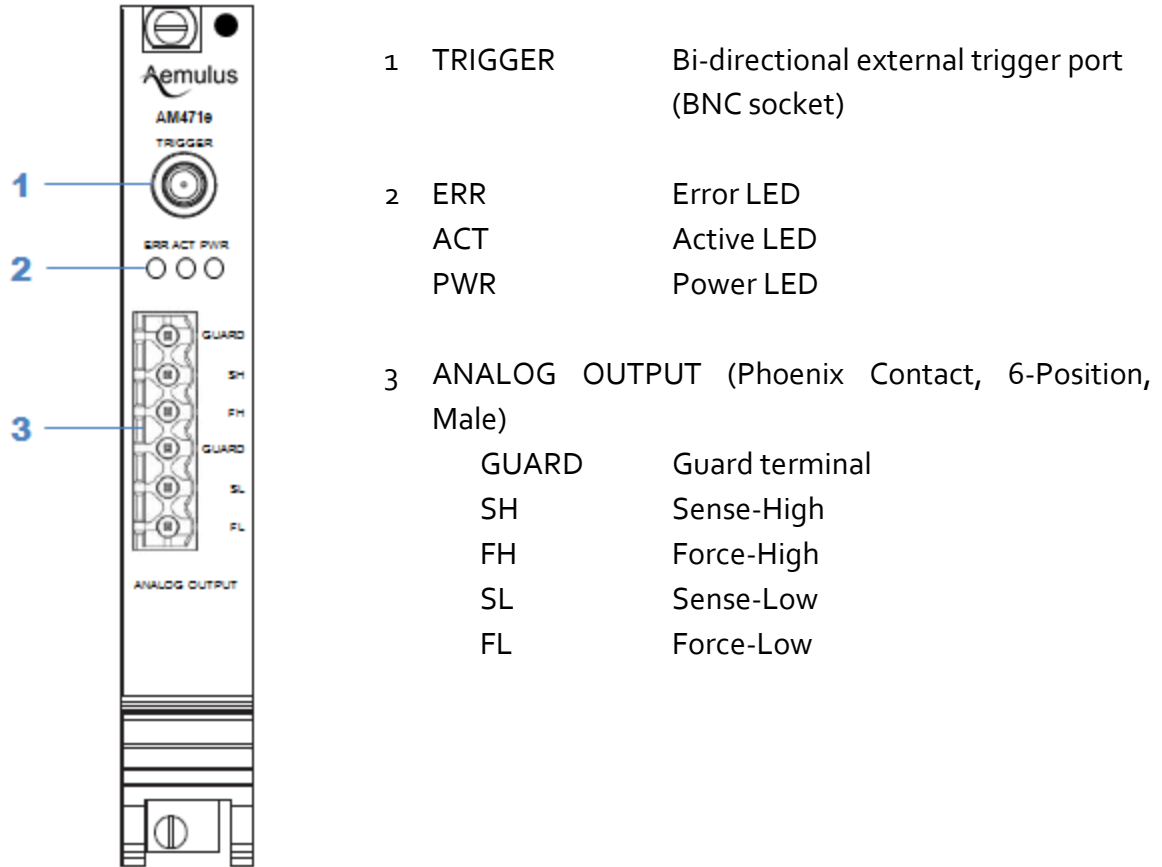


Figure 1: AM471e Front Panel

LED	Description
ERR	Light up when module encounters any one of the following hardware issues: <ol style="list-style-type: none"> 1. Temperature sensed by the temperature sensor on the module is more than 75°C 2. Phase-locked loop (PLL) on the module fails to lock
ACT	Blink when module in action
PWR	Light up when module is power on

Table 1: Status LED

2.2 Soft Front Panel

The soft front panel provides a graphical interface for operating the module. It is intended for testing and diagnosing, for demonstration and training, and for basic operation of the module. It represents most of the functions available in the instrument driver. It is not however a comprehensive application suitable for measurements; for this, remote programming the module.

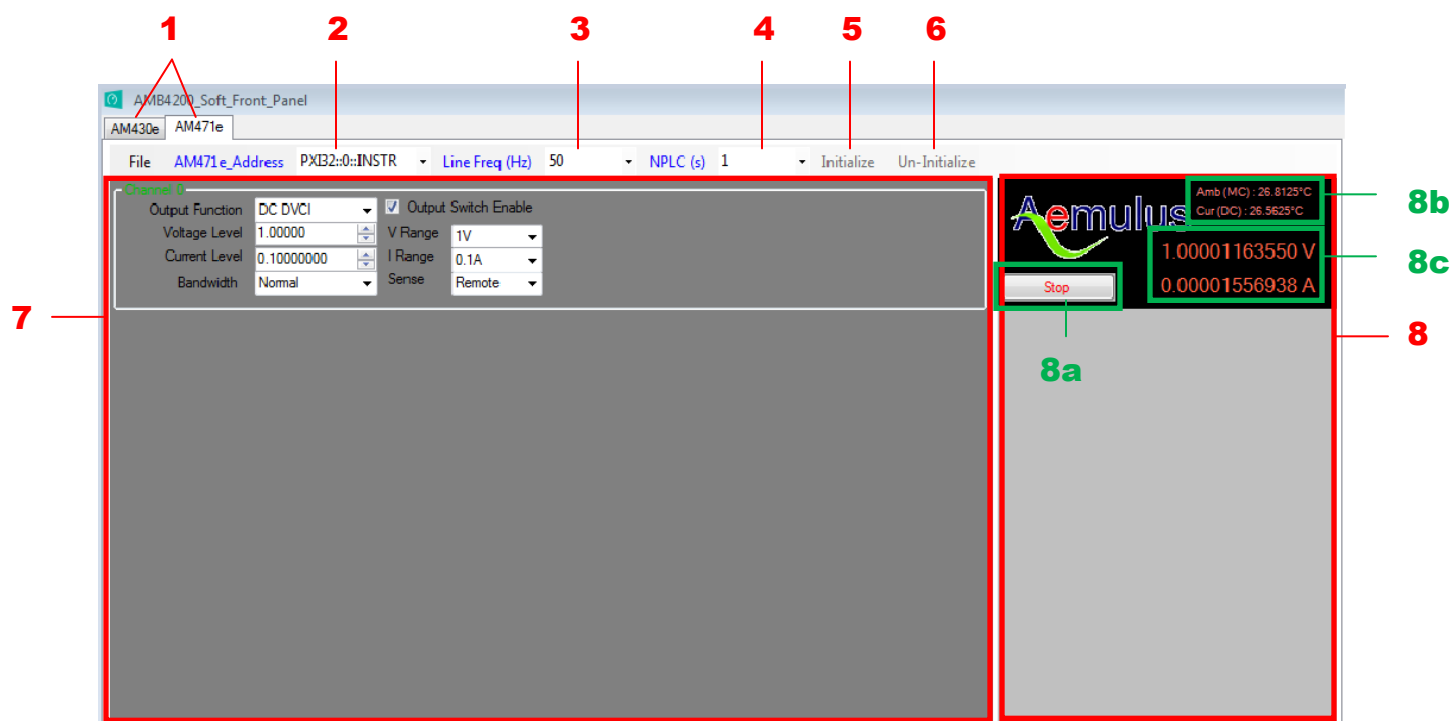


Figure 2: AM400e Soft Front Panel

Item	Description
1	Select the module of interest.
2	Select the PXI address of the module. A list of addresses is shown for all detected modules in the chassis.
3	Select the power line frequency – 50Hz or 60Hz.
4	Set the number of power line cycle (PLC). 1 PLC equals to 20ms (50Hz) of measurement time.
5	Initialize the selected module. This includes opening a session to communicate with the module, and then reset the module in its default state
6	Un-initialize the selected module. This includes closing the current communication session to the module.

7	Configuration panel:		
	a	Output Function	DC DVCI: Drive-Voltage Clamp-Current operation. Continuous mode. DC DICV: Drive-Current Clamp-Voltage operation. Continuous mode.
	b	Output Switch Enable	Turn on the selected channel if the box is checked
	c	Voltage Level	Voltage level
	d	V Range	Range of the voltage level
	e	Current Level	Current level
	f	I Range	Range of the current level
	g	Bandwidth	Select either <i>Slow</i> , <i>Normal</i> or <i>Fast</i> setting
	h	Sense	Select either <i>Remote</i> or <i>Local</i> sense connection
8	Result panel:		
	a	Start/Stop Button	Press "Start" to execute the configured settings. The button will become "Stop". Press "Stop" to turn off the channel. The button will appear as "Start" again automatically.
	b	Temperature	Temperature readouts from the module. MC: Master board DC: Daughter board
	c	Voltage/Current	Measured voltage and current.

Table 2: Soft Front Panel Control

Quick steps to configure the module:

1. Select PXIe address of the targeted module from the drop-down list.
2. Press "Initialize".
3. Set desired operation. In the example above, the module is set to drive 1V and its current compliance is set to 0.1A.
4. Press "Start" to execute the commands.
5. Both voltage and current are measured.
6. Press "Stop" to turn off the channel.
7. Press "Un-Initialize" to turn off the whole module.

2.3 Remote Operation

Refer to programming manual.

Section 3: Brief Technical Description

AM471e is a source-measure unit (SMU).

3.1 Basic Operation

AM471e is more than the just a power supply. It is fast-response, read-back voltage and current sources with high accuracy measurement capabilities. It is designed for circuit and device evaluation where a DC signal must be applied to a device under test (DUT) and the response to that signal measured. AM471e is capable of multi-quadrant operation, such as acting as a positive DC source or as a sink (Load).

AM471e can be set up to function as a voltage source/current monitor, current source/voltage monitor:

1. Source Current, Measure Voltage / Current
 - a. This configuration turns AM471e into high-impedance current source
 - b. The voltage developed is limited by compliance setting
 - c. If current is 0A, AM471e becomes a voltmeter
2. Source Voltage, Measure Current / Voltage
 - a. This configuration turns AM471e into low-impedance voltage source
 - b. Current flow is limited by compliance setting

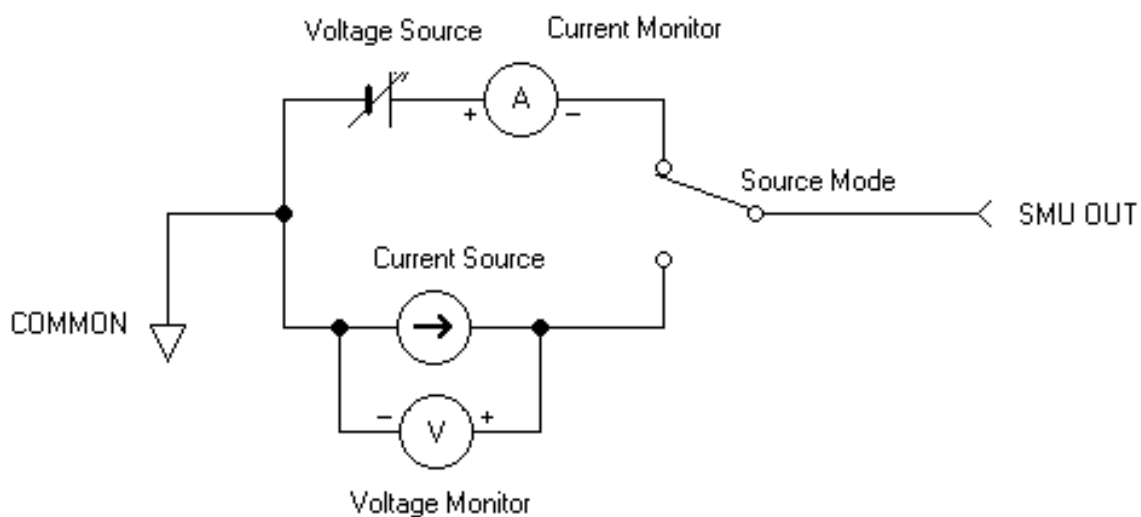


Figure 3: Typical Operation

To prevent over-voltage or over-current damage to the device-under-test (DUT), several levels of output protection, termed COMPLIANCE, is incorporated. Maximum specifiable compliance depends on the voltage or current range at which the source channel is operating. The specified compliance is valid for positive and negative values, regardless of the polarity specified in the COMPLIANCE field. For example, specifying a current compliance of 40mA, is valid for +40mA and -40mA, output current more than $\pm 40\text{mA}$ are not possible.

If a source channel reaches compliance during measurement, this indicates an error in the operation. Example:

1. AM471e is set to voltage source/current monitor mode; compliance of 1mA; output load is a 1kohm resistor
2. If source voltage is 5V, the current that should flow through the resistor is $5\text{V}/1\text{k} = 5\text{mA}$
3. Due to compliance of 1mA, the source channel turns into a constant current source of 1mA. This yields a voltage of 1V across the resistor

The measurement result is the average value of all samples taken for n^{th} number of power line cycle (PLC). For example, if the line frequency is set to 50Hz (period is 20ms), then 1 PLC equals to 20ms. The measured data is a resultant of averaged of raw samples captured by ADC on AM471e for 20ms.

NOTE

The NPLC setting of an instrument allows adjustment of the tradeoff between speed and accuracy. The greater the number of power line cycles, the greater noise rejection and better resolution the signal value will be.

3.2 SMU Connection

There are 5 leads per channel:

1. Guard
2. Force-High
3. Force-Low
4. Sense-High
5. Sense-Low

Force-High and Force-Low outputs are where voltage and current are generated during source or sink operation.

Sense-High and Sense-Low outputs are high impedance paths. Connect these lines as close to the DUT terminal as possible for more accurate voltage source or measure operations. Presence of Sense lines at the DUT terminals is known as 4-wire, remote-sense, or Kelvin operation.

For high power device testing, there can be significant voltage drops in test leads due to the high current flow. Using remote sense becomes very critical to ensure accurate source and measure operation. Advantages of using 4-wires measurement:

1. It eliminates the resistance of your interface cabling
2. Lengthy wires would not be an issue anymore
3. It allows measurements on lower resistance values than 2-wire testing

Guard terminal is a low impedance output that is very close to the signal voltage on the Force-High output. Typically, the Guard output is kept within 2mV on the Force-High output.

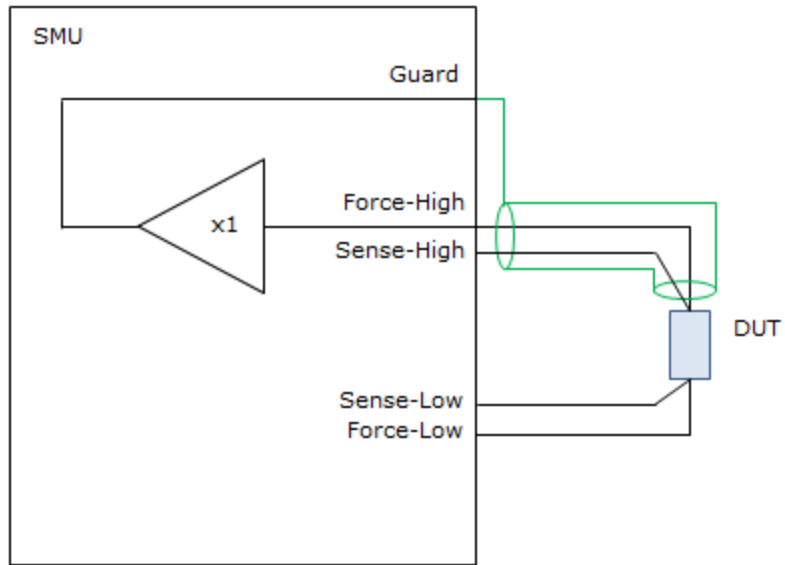


Figure 4: Typical 5-Wire Connection

3.2.1 Guard Terminal

The purpose of Guard is to reduce current leakage into sensitive node, from SMU output connector all the way to the DUT terminal, via cables, PCB, and/or test fixture. This current leakage can affect the measurement results if not being taken carefully. Measurement test time can become very long in order to fully charge up the leakage current caused by the parasitic paths, before actual test results of the DUT can be taken.

There are known current leakage issues from Force-High to Force-Low conductors in a coaxial cable. Imperfect insulators between center and outer (shield) conductors result in current leakage. In this case, guarding can be used to eliminate parasitic capacitances.

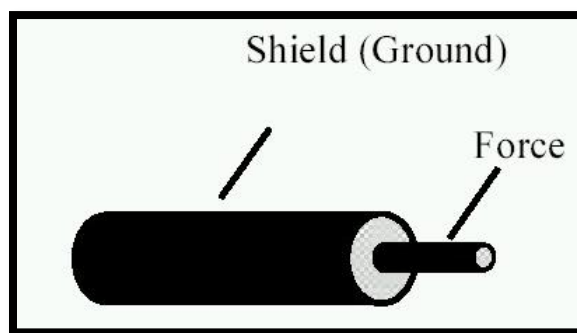


Figure 5: Coaxial Cable Connection

Guard terminal can effectively solve the current leakage issues in a triaxial cable. For triaxial cable, there is an additional layer (driven guard) that exactly tracks the voltage sweep (force line) which eliminates cable charging since the inner and outer parts of the cable are always kept at the same potential. It eliminates any noise since the driven guard is connected to a separate low noise amplifier inside the SMU.

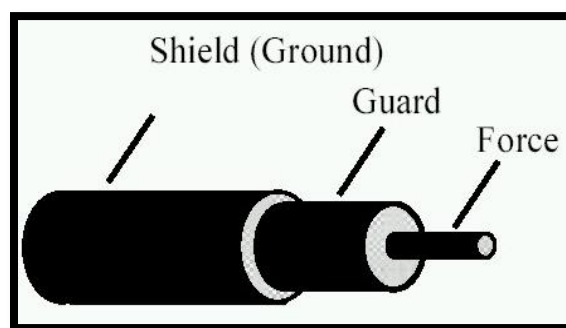


Figure 6: Triaxial Cable Connection

WARNING

Never short the guard and force line together because it will defeat the effect of the driven guard.

3.2.2 Floated Output

AM471e is a floated SMU. This means it can be cascaded in series to produce higher voltage source, or connected in parallel to produce higher current source.

Section 4: Maintenance

4.1 Cleaning

Before doing any cleaning to the product, switch off the chassis and disconnect it from main power supply.

You can wipe the front panel of the module using a soft cloth moistened in water, taking care not to wet the connectors. Do not use aerosol or liquid solvent cleaners.

You can use a handheld vacuum cleaner to remove any accumulated dust on the product, if necessary.

CAUTION

Be careful NOT to be in direct contact with any circuits on the product to prevent any damages. Contaminants such as oils and salts from the human skin can affect the performance of the product.

Comply with good ESD practice when handling the product during cleaning.

4.2 Calibration

Electronic components tend to drift over time. Environmental changes, operation stresses and aging increase the measurement uncertainty. Periodic calibration is required to ensure the accuracy of the instrument.

The recommended calibration interval for the product is 6 months.

4.3 Servicing

There are no user-serviceable parts in the product; if any attention is needed, return it to instrument manufacturer.

NOTE

Any repair that is not covered in this manual should only be performed by qualified Aemulus personnel.

Section 5: Warranty

Aemulus warrants that the product delivered will be free from defects in material and workmanship for 1 year from the date of delivery order. This warranty does not cover the product if it is damaged in the process of being installed.

This warranty does not cover replacement of products damaged by abuse, accident, misuse, neglect, alteration, repair, improper installation or improper testing. If the product is found to be defective otherwise, Aemulus, at its option, will replace or repair the product at no charge. If you ship the product, you must assume the risk of damage or loss in transit. Aemulus may replace or repair the product with either a new or reconditioned unit, and the product returned becomes Aemulus property.

Section 6: Revision History

1.0	DEC 2012	INITIAL RELEASE
1.1	OCT 2013	ADDED OPERATING TEMPERATURE WARNING MESSAGE

Section 7: Contact Us

To obtain service, warranty or technical assistance, please contact Aemulus.



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