MODEL S471
PORTABLE OPTOMETER

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UDT INSTRUMENTS
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Product Summary

MODEL S471 PORTABLE OPTOMETER

Introducing the latest Optometer from UDT Instruments - the Model S471. This new handheld instrument is designed to be used in a laboratory setting or field environment. The Model S471 is microprocessor controlled and has three measurement data presentation options: direct display measurement with analog bar; RS232 computer interface and analog voltage input.

In addition to its exceptional technical and functional characteristics, this system is fully compatible with all of UDT Instruments sensor heads in any configuration as a Radiometer, Photometer or Fiber Optics tester. All calibrations are traceable to the National Institute of Standards and Technology (NIST).

Preliminary Specifications

Display
Monochrome Graphic 128x64 dot chip-on-glass LCD module

Displayed Precision
Up to 5 digits

Display Update Rate
2 readings per second

Display Modes
Linear / Log

Display Modes (Analog)
Bar graph with respect to power input or power measured

Bandwidth
7.5 Hz

Sensor Configuration
Compatible with all UDT Instruments Sensors

Features

- High accuracy measurements
- Wide dynamic range
- Computerized high speed update rate
- Programmable averaging readings in low pass or boxcar average
- Large calibration capacity
- Large monochrome LCD graphics/backlit
- Calibration data/accessories information display
- Long operational battery life or direct external power
- Simple touch key pad
- Portable and durable
- Optional USB to serial bridge converter

Performance Specifications

Accuracy/Precision

	Full Scale	A to D Converter Resolution	Measurement ± (% of full scale)
A	4.12 mA	8 nA	±.01%
B	412 uA	800 pA	±.02%
C	41.2 uA	80 pA	±.02%
D	4.13 uA	8 pA	±.01%
E	416 nA	800 fA	±.04%
F	45.4 nA	87 fA	±.01%
G	4.12 nA	8 fA	±.01%

Update Rates
RS232 (Display Enabled) > 2 times per second
RS232 (Display Disabled) > Up to 53 times per second

Measurement
Direct measurement, RS232 interface and analog output

Analog Output
± 4.0 Volts

Communication Rate
9600 Baud

Operational Battery Life (with new batteries)
Backlight Off . . 32 hours
Backlight On . . 24 hours

Operating Temperature Range
10°C to 60°C

Storage Temperature Range
-20°C to 35°C for < 1 year

Power Source (AC)
Universal input desktop power supply
100-240V .7A 50-60 Hz
TUV, CSA, UL, CE Approved

Calibration Capacity
9 continuous calibrations or 50 single point calibrations

Power Source (DC)
Rechargeable integral battery pack
Five Nimh AA 1800 ma hr batteries

Recharge Time
< 4 hours

Power Supply Output
+12v DC 2.5A
(Center Conductor Positive)

Power Supply Dimensions
Height . . . . . 41 mm (1.63”)
Width . . . . . 59 mm (2.3”)
Length. . . . . 112 mm (4.4”)
Weight . . . . . 267 g (0.59 lb)
Cable Length. . 1.04 m (41.0”)

Display Unit Dimensions
Height . . . . . 36 mm (1.4”)
Width . . . . . 114 mm (4.5”)
Length. . . . . 234 mm (9.25”)
Weight . . . . . 590 g (1.3 lb)

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Model S471 Operating Instructions
17 APRIL 2006

1 GENERAL OPERATING MODES

1.1 OVERVIEW

The model S471 can be controlled from the front panel, or the RS-232 communications port. The purpose of this document is to give the user directions in controlling the model S471 using the front panel keyboard.

1.2 TURN ON

When the S471 is turned on it comes up with a display describing itself. This display provides useful information about its model number, manufacturer, and code revision and date. While this display is on the front panel keypad is disabled. During this time you will hear beeps from the S471. This is an indication of its turn on condition.

The S471 automatically performs auto-zeroing at turn on and several self tests. The whole process takes about 15 seconds. After the auto-zeroing and self tests are complete, the S471 will go into its measurement screen. The measurement screen shows the number and measurement units of the light it is measuring, a bar graph to give a relative light indication, and a line of four icons for control of the S471's operation.

2 KEYPAD DESCRIPTION

The keypad has seven buttons. They are labeled power, light, enter, and arrows up, down, left and right. The power button is a push on push off button which will toggle the power to the S471. The light button controls the backlight in the same push on push off manner as the power button. The enter button is used to tell the S471 that a function signified using the arrow keys is to be launched. The chosen function's icon is marked by being negative in appearance in relation to the other icons. If no icons are negative in appearance, the enter key will have no effect. The arrow keys are used to choose the icon of the function that the user would like to launch.

3 ICON DESCRIPTION

The S471 has three icon sets. These are main, secondary and the calibration icons. The main and secondary icons are accessible from the measurement screen. The third, the calibration icons, are at the bottom of the calibration screen. The calibration screen is accessed through the calibration icon on the main screen.

3.1 MAIN ICONS

The main icon set has four icons. The left most icon is a two digit number. It shows the calibration selection and can be a number from 00 to 99. Selecting it will suspend the measurement screen and place the calibration screen on the display.

The second from the left on the main icon set is the Sample/Hold icon. Selecting it will toggle the sample or hold mode. In sample mode the S471 is regularly taking measurements. In the hold mode it will continue to display the reading it had when the hold started.

The third icon from the left is the Log/Lin icon. The S471 will display readings in native units for the calibration in Lin mode. In Log mode it will display readings in db.

The fourth icon, the one farthest to the right, is the Az or auto-zero icon. Selecting this icon starts the S471 auto-zero. **It does not do ambient zero - the icon that controls that function is among the secondary icons.**

3.2 SECONDARY ICONS

The secondary icon screen can be accessed by pressing either the arrow up or down button while the display is in the measurement screen. Another set of four icons will then become visible.

The first icon the left most is the icon that allows manual control of the gain. This icon starts with the letter G and is followed by a number from 0 to 6 or the letter A. Letter A is auto-range and is the default. The S471 in this range will change range automatically depending on signal strength of the input. Numbers 0, 1, 2, 3, 4, 5, and 6 signify ranges A, B, C, D, E, F, and G. Range A is the least sensitive, range G is the most sensitive. Selecting this icon will allow the user to choose a range for making readings. Once selected the S471 will not change from this setting until manually changed or the unit is turned off.

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The second icon from the left is once again the Sample/Hold icon. It is the only icon that appears on both the main and secondary icon sets. It allows toggling between the normal continuous sample modes to the hold mode, where it holds the reading it had when the hold mode was started.

The third icon from the left is the Timeout icon. The S471 has a provision to shut itself off after 40 minutes of no activity on the keypad or serial ports. This is done to preserve battery life. If the user does not want this, the TO icon can be chosen and toggled off to allow unlimited operation. Toggling back will start the timeout again.

The fourth icon, the one on the far right, is labeled ‘Am” and will start the ambient zero function. This is like the auto-zero, except that it also expects that the user wants whatever light is coming in the detector to be subtracted out. **Caution -** if this is chosen when a high level of light is coming in, the display could lock up. This can be mistaken for ‘hold’ mode.

3.3 CALIBRATION ICONS

The calibration icons are at the bottom of the calibration screen, which are accessible through the calibration icon of the Main icon set. There are four of icons; Prev, Lambda, Acc, and Next. As with the other sets pressing the left or right arrows will cycle through the icons, but only if that icon has functionality in the context of the available calibrations. If none have functionality, then pressing left or right arrows will only provide beeps, no icons will turn to the negative (selected indication). This will be the case if the S471 has only one calibration, with one wavelength, and no accessories. The up and down arrows will scroll the description of the calibration up or down. Pressing enter will choose the described calibration for use in measurements and return the screen to the measurement screen.

The left most icon is ‘Prev’ which if chosen will take the screen to the next lower numbered calibration. If the calibration showing is already the lowest numbered, this icon will not select.

The icon second to the left is the lambda icon. It allows selection of the wavelength in multipoint calibrations. The arrow up and down buttons changes their functions while this icon is selected. Arrow up will increment to the next wavelength, arrow down will decrement to the next lower wavelength. Decreasing below the lowest wavelength offered will cause the selection to recycle

to the highest. Increasing above the highest available wavelength will cause recycling back to the lowest offered wavelength.

The icon third from the left is the 'Acc' or accessory icon. Selection of this icon will allow viewing of the accessories listed on a separate screen. Once in that screen, pressing enter will return the screen to the calibration screen.
The icon on the far right is the 'Next' icon. Selecting this icon will allow viewing of the next higher numbered calibration. If the calibration now in view is the highest numbered calibration, the 'Next' icon will not select.

3.4 MAINTENANCE SCREEN

You may access the S471 Maintenance screen by pressing both the arrow left and arrow right at the same time. This screen has the revision of the S471's code, the serial number, the last calibration date and the calibration due date.

3.5 CONNECTORS

The S471 has four connectors. The power connector is on the right and is a common barrel connector. The S471 requires 12 volts, center positive, with a draw of up to one ampere. It will only draw that much if the batteries are exhausted and the S471 is turned on.

The S471 has a RS-232 connector. In the case of the RS-232 connector running at 9600 baud, 8 bits, no parity and one or two stop bits is expected. The API for the RS-232 can be found in the serial interface document for the S471.

The BNC connector near the power connector is the input (marked I). The light sensor plugs into this input. The other connector, the one near the RS-232 connector, is the analog output (marked O).

3.6 ANALOG OUTPUT

The S471 provides an analog representation of the light measurement. Any change in range will cause the analog output to jump, so it is recommended that the analog value be used in fixed range measurements. To get the light value in terms of current from the detector use the following conversion values:

Range A:	824.6 micro-amperes/volt
Range B:	82.46 micro-amperes/volt
Range C:	8.246 micro-amperes/volt
Range D:	824.6 nano-amperes/volt
Range E:	83.26 nano-amperes/volt
Range F:	9.061 nano-amperes/volt
Range G:	824.6 pico-amperes/volt

Calculation to the detector's native units can be done form the calibration value for the detector.

3.7 BATTERIES

The S471 takes 5 Ni-Mh batteries and charges while the unit is plugged in. These batteries are AA sized and have a 1.2 volt 1600 mah rating. They are in battery holders for easy replacement.

Model S471 Serial Communication
17 APRIL 2006

1 GENERAL OPERATING MODES

1.1 OVERVIEW

The model S471 has an RS-232 serial port. This port is used for calibration, commissioning, user interfaces, and downloads. Downloads can be either of panel code or of calibration code. Each command consists of a series of letters or numbers terminated with the enter key. This is valid for version 0541b and higher.

1.2 TEST/SERVICE

Calibration of the instrument will require a precision current source. It will also require a serial hook up to a computer so commands during the process can be issued to the Model S471. Responses from the S471 either displayed for an operator or acted upon by a computer running custom software.

2 HARDWARE

2.1 SERIAL COMMUNICATION

Serial Communication is handled by a RS-232 running at 9600 baud, 8 bits, no parity, and one or two stop bits, with no handshaking.

3 HARDWARE

3.1 GENERAL MESSAGE FORMATS

The Model S471 does not initiate commands, but responds to commands sent to the unit. The first character sent by the communicating device defines the type of command. This device may be a computer, a terminal, or automated calibration device. Subsequent bytes are in many cases necessary to define the proper functionality. Since the communications will be done over a hard wire connection, no checksum or parity is used. Baud rate is 9600. Although the commands are shown as upper case, they are not case sensitive. For the command to complete it must end with an enter key.

3.1.1 HOST ➔ S471 COMMANDS WITH S471 RESPONSES

All functions start with a host to Model471 command. These are listed below. The character, <n> or <nnn> are used to indicate a number or string of decimal numbers to be substituted, and <h> or <hhh> is used to indicate a hex or string of hex numbers (0-9, A-F) to be substituted.

3.1.1.1 AZ – AUTO-ZERO

This command has two bytes and initiates the auto-zeroing. This is the same as starting auto-zeroing from the front panel, except that when it finishes ‘Complete’ will be reported back to the host. Ambient zeroing is NOT done. To get ambient zeroing use ‘AB’ described below.

3.1.1.2 AB – AMBIENT ZERO

This command has two bytes and initiates auto zeroing with ambient zeroing. This is the same as starting ambient-zeroing from the front panel, except that when it finishes ‘Complete’ will be reported back to the host.

3.1.1.3 AOS – SHOW ANALOG OUTPUT PARAMETERS

This command has three bytes. It shows the parameters that the analog output is operating with, without changing any of the parameters. A sample return would be “AO Range = +/- 4, AO OFFSET = 0.0, AO SLOPE = 1.000”. The example is for the default.

When slope is zero the range and offset values are stored in non-volatile memory.

3.1.1.4 AOO – CHANGE ANALOG OUTPUT OFFSET

This command has six or seven bytes. The next to last character must always be a decimal point. This command controls the zero point of the analog output. A command of 'AOO0.0' will place the zero point near zero. A command of 'AOO4.0' will place the zero point at the most positive analog output if the +/- 4 volt range is chosen, thus only negative values could be read. This will give a greater range to the negative readings, though. A command of 'AOO-4.0' would make the analog output only respond to positive readings. The number may be –4.0 to 4.0 if in the +/- 4-volt range, –2.0 to 2.0 if in the +/- 2-volt range, and –1.0 to 1.0 if in the +/- 1-volt range. The default is 0.0. When understood, all current settings of the analog output will be reported back to the host. See command AOS for details.

3.1.1.5 AOM – CHANGE ANALOG OUTPUT SLOPE

This command has six to eight bytes and controls the scaling of the analog output. The next to last character must always be a decimal point. Normally, with the default slope of 1 and the extremes set to +/-4 volts, the read voltage will track the reading on the display. If, however, a greater span is desired, such as readings close to zero, a slope of greater than 1 can be put in. Slopes up to 100.0 are acceptable, negative slopes are not supported. The default value is 1.0. Examples would be 'AOM1.0' to return to default and 'AOM100.0' to achieve maximum slope. Slope can be made zero. When slope is zero (0.0) the 'U' and 'D' commands become active and the analog output can be calibrated for removal of the any offset in the analog output. See the 'U' and 'D' commands for their function. When understood, all current settings of the analog output will be reported back to the host. See command AOS for details.

3.1.1.6 AOR – CHANGE THE ANALOG OUTPUT EXTREMES

This analog output can operate at +/-1, +/-2, or +/-4 extremes. This three-byte command controls how far the extremes of the analog output will be from zero. The default, 'AOR4', is +/-4 volts. Range changes are stored in non-volatile memory. The three allowable forms of this command are 'AOR1', 'AOR2', and 'AOR4'. When understood, all current settings of the analog output will be reported back to the host. See command AOS for details.

3.1.1.7 C<N> – CALIBRATION NUMBER

This command has two bytes. It allows remote switching to calibrations by number. Only calibrations 1 through 9 are available. If the asked for calibration is higher than the maximum available, this returns 'Error' and no action is taken. C+ selects amp_pos.dat; C- selects amp_neg.dat.

3.1.1.8 D – ANALOG OUTPUT DOWN

This command has a single byte. It is useful in calibrating the analog output. It is only active when the analog output slope is zero. Each press causes the analog output voltage to go down or negative by one bit of DAC resolution.

3.1.1.9 G – RESUME READINGS

This command is a single byte. It effectively undoes the 'H' command. It resumes all interrupts of the micro-controller, and allows the resumption of reading of the A/D converter. The S471 responds with 'Understood' reported to the host.

3.1.1.10 GA – GAIN A SET

This command has two bytes and sets the range to gain A, the least sensitive range. This range allows reading of currents between 4.123 milliamperes to -4.123 milliamperes. The S471 will stay in this range until either auto range or another explicit range is chosen from either the serial port or from the front panel.

3.1.1.11 GAUTO – GAIN AUTOMATIC COMMAND

This command places the S471 in auto-ranging mode. It returns the present range setting. The Model S471 responds to the first three letters, so 'gau' could be typed to save time.

3.1.1.12 GB – GAIN B SET

This command has two bytes and sets the range to gain B. This range allows reading of currents between 412.3 microamperes to -412.3 microamperes. The S471 will stay in this range until either auto range or another explicit range is chosen from either the serial port or from the front panel.

3.1.1.13 GC – GAIN C SET

This command has two bytes and sets the range to gain C. This range allows reading of currents between 41.23 microamperes to -41.23 microamperes. The S471 will stay in this range until either auto range or another explicit range is chosen from either the serial port or from the front panel.

3.1.1.14 GD – GAIN D SET

This command has two bytes and sets the range to gain D. This range allows reading of currents between 4.127 microamperes to -4.127 microamperes. The S471 will stay in this range until either auto range or another explicit range is chosen from either the serial port or from the front panel.

3.1.1.15 GE – GAIN E SET

This command has two bytes and sets the range to gain E. This range allows reading of currents between 4126.5 nanoamperes to -416.5 nanoamperes. The S471 will stay in this range until either auto range or another explicit range is chosen from either the serial port or from the front panel.

3.1.1.16 GF – GAIN F SET

This command has two bytes and sets the range to gain F. This range allows reading of currents between 45.36 nanoamperes to -45.36 nanoamperes. The S471 will stay in this range until either auto range or another explicit range is chosen from either the serial port or from the front panel.

3.1.1.17 GG – GAIN G SET

This command has two bytes and sets the range to gain G, the most sensitive range. This range allows reading of currents between 4.123 nanoamperes to -4.123 nanoamperes. The S471 will stay in this range until either auto range or another explicit range is chosen from either the serial port or from the front panel.

3.1.1.18 GS – GAIN SHOW COMMAND

This command has two bytes. It will prompt the S471 to notify the host if the present gain setting. If auto gain is active, it will respond with what the gain happened to be when the inquiry was issued from the host.

3.1.1.19 H – HALT READINGS

This command is a single byte. It stops all interrupts of the micro-controller. This shuts off all reading of the A/D converter. It is used mainly when a download of new panels or calibrations is about to start. The S471 responds with 'Understood' reported to the host. This command is

useful before a code download because it halts all interrupts. This command also aborts mX+b electrical calibration.

3.1.1.20 J – TOGGLE THE BATTERY SAVING TIMEOUT

If the battery saving timeout is running, this command will turn it off. If it is not running, it will turn it on. The battery saving timeout is designed to preserve battery power by automatically turning off the S471 when not in use. When enabled the battery saving timeout will shut off the S471, if there is no activity on the keyboard or serial ports for 40 minutes.

3.1.1.21 LIN – CHANGE THE DISPLAY AND REPORTING TO LINEAR FORMAT

This command is has three bytes. It changes the display and RS-232 reporting to linear unit format. If the Model S471 is already in linear unit format, this command has no effect. It will respond with 'understood.'

3.1.1.22 LOG – CHANGE THE DISPLAY AND REPORTING TO LOGARITHMIC FORMAT

This command is has three bytes. It changes the display and RS-232 reporting to logarithmic unit format. If the Model S471 is already in logarithmic unit format, this command has no effect. It will respond with 'understood.'

3.1.1.23 R – REPORT READING

This command is a single byte. It will report the most current reading in the same form as seen on the display on the first line. If any of the start up errors; eeprom blank, eeprom fail, A/D fail or A/D clock fail is active; this command will report those errors instead of the light level reading. It reports them in readable format. Issuance of this command will terminate the reading streaming if active.

3.1.1.24 RH – REPORT READING, DIAGNOSTIC

This command reports the most recent reading of the A/D converter. It is meant for troubleshooting and not for normal operation. If any of the start up errors; eeprom blank, eeprom fail, A/D fail or A/D clock fail is active; this command will report those errors instead of the light level reading. It reports them by error number codes, 1, 2, 3, and 4. At least one and possibly all can be present. Issuance of this command will terminate the reading streaming if active.

3.1.1.25 STREAM – TELLS THE S471 TO START STREAMING ITS OUTPUT TO THE SERIAL PORT.

It requires all 6 letters to start. It replies with readings almost immediately. The reception of any byte in the serial port will stop the stream. The readings are in terms of A/D counts, with all offsets taken off. Conversion of the values to a detected current requires the following scaling factors based on range:

Range A:	7.864 nano-amperes per count
Range B:	786.4 pico-amperes per count
Range C:	78.64 pico-amperes per count
Range D:	7.864 pico-amperes per count
Range E:	794.3 fempto-amperes per count
Range F:	86.42 fempto-amperes per count
Range G:	7.864 fempto-amperes per count

Because the scaling factors are different for each range operating in a fixed range rather than auto range is usually advisable.

3.1.1.26 SN<????> – READ OR SET THE UNIT SERIAL NUMBER.

If the panels have not been programmed into the S471, the 5 characters after the 'sn' are expected. Characters '*', ' ', and '?' cannot be used. These will be used to set the serial number. In this case, the response from the Model S471 will be 'complete.' If the panels have been set, this command is complete without the four characters following the 'sn' and is interpreted as a command to read the serial number. It responds with the serial number.

3.1.1.27 TB – CHANGE TO BOXCAR AVERAGING

This two-byte command will change the averaging technique from Painting to Boxcar. It will also change the time constant to 0.5 seconds. However, if the Model S471 is already set to boxcar averaging, it will not change any setting and act like a TS command.

3.1.1.28 TP – CHANGE TO PAINTING AVERAGING

This two-byte command will change the averaging technique from Boxcar to Painting. It will also change the time constant to 2 seconds. However, if the Model S471 is already set to Painting averaging, it will not change any setting and act like a TS command.

3.1.1.29 TS – SHOW THE AVERAGING TIME CONSTANT SETTING

This two-byte command will create a response showing the time constant and type of averaging, boxcar or Painting. It does not change any setting.

3.1.1.30 T<NNNN> – CHANGE THE AVERAGING TIME CONSTANT SETTING

1 to four decimal numbers must follow the 'T'. The acceptable range is from '.001' to '300.'. Format allows for leading zeros and a decimal point is acceptable, even expected. If more than four digits (including the decimal point) are entered, the remaining digits will be ignored. Shorter entries may be done. Examples: to get a 2 second time constant, one could enter "T2<ENTER>", "T2.0<ENTER>" or "T2.00" .

3.1.1.31 U – ANALOG OUTPUT UP

This command has a single byte. It is useful in calibrating the analog output. It is only active when the analog output slope is zero. Each press causes the analog output voltage to go up or positive by one bit of DAC resolution.

3.1.1.32 V – REPORT REVISION

This command is a single byte. The S471 will respond with its firmware revision number.

3.1.1.33 W – REPORT TEMPERATURE

This command is a single byte. The S471 will respond with its current internal temperature reading. The reported number is decimal and is 16 times the temperature in degrees Celsius.