OptiCAL
User's Guide

Version 4.02 4th February 1995

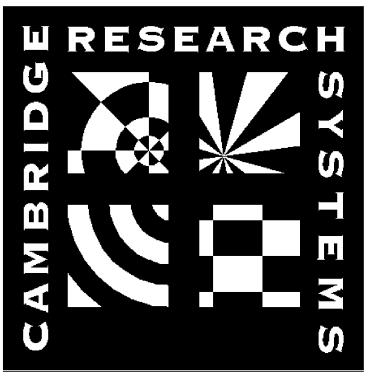


Table of Contents

Welcome to OptiCAL

❑ Introduction

This package consists of two applications; *OptiCAL* for DOS and *OptiCAL* for Windows. The two applications are identical in the majority of aspects of their use. Each application enables you to perform luminance measurements with the *OptiCAL* hardware. The applications are standalone and require no programming to use.

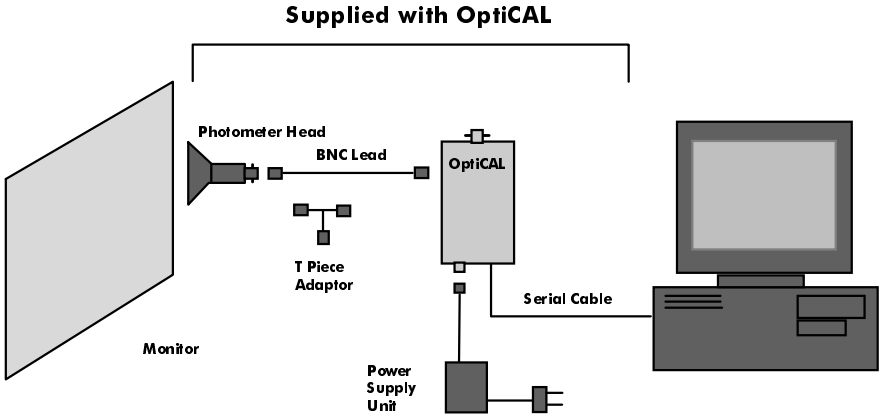


Figure 1

❑ What's supplied

- *OptiCAL* with integrated 9 way serial cable to PC.
- Mains adapter (country dependent).
- BNC to BNC lead from *OptiCAL* to photometer head.
- T piece for making voltage measurements.
- Photometer head including calibration sheet (optional).
- Disc containing software for DOS and Windows.
- Manual (you're currently reading it).

❑ Main Features

- Four modes of operation; absolute and relative luminance, contrast and voltmeter.
- Automatic calibration of software via settings in ***OptiCAL*** hardware.
- Common user interface between DOS & Windows.
- Ability to record readings to a text file, either automatically at regular intervals or manually.
- Data files compatible with MS-Excel, Lotus 123 and other spreadsheets supporting ASCII import.
- Mouse support under DOS.
- Auto search of COM1 - COM4 to find ***OptiCAL*** hardware.

❑ Computer Required

By supplying separate DOS & Windows versions the software should run on the majority of IBM PC compatibles. The minimum system requirements are:

- 640 kbytes of memory.
- a serial port.
- Microsoft compatible mouse (recommended) .
- Hard disc (software will run from floppy but this is not recommended).
- MS-DOS V3.1 or higher.
- MS-Windows V3.1 or higher.
- VGA screen minimum 640 x 480 x 16 colours.

Installation

This section handles the installation for both the DOS & Windows ***OptiCAL***. The recommended install method is to use the supplied Windows based install routine, though a method to allow DOS-only users to install the software is also supplied.

❑ Installing the DOS/Windows Software

Installing the software is simply a case of running Windows and then from the ***File/Run*** menu, typing ***A:SETUP*** (assuming the master disc is in drive A) to start the installation process.

When Setup starts follow the instructions on your screen. You will be prompted to supply the path to the directory where you want to install the ***OptiCAL*** software. To ensure successful installation it is recommended that no applications other than Program Manager are running.

Previous versions

If a previous version of the ***OptiCAL*** software is found and the software being installed is a later version, the original version will be overwritten.

After setup has finished the program group will have been created which holds icons for Windows ***OptiCAL*** (winoptic.exe), DOS ***OptiCAL*** (optical.exe) and a README.TXT file. (This file holds details of any changes made after this manual was written).

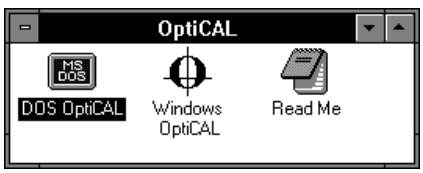


Figure 2, Program Manager group

❑ Installing the DOS Only Software

To make installation of the DOS software as simple as possible, the DOS executable is supplied uncompressed on the setup disk. The files required to run the DOS version are:

OPTICAL.EXE
OPTICAL.INI

These files should be placed together in the desired directory on your desired drive. Once copied across, the software is ready to run by typing ***OPTICAL*** at the command line. The file ***OPTICAL.INI*** is a simple text file used to hold configuration information for optical.exe and the same file is used for both DOS & Windows. See 'Configuring OptiCAL Software' on page 11 for more information on the INI file.

Mouse Detection

By default, the DOS version auto detects the presence of most mouse hardware. If no mouse is found, the program can still be controlled by the keyboard using various key combinations which are listed in a separate menu that appears on the screen as well as the main display.

Using OptiCAL

This section details the various controls in both versions of the *OptiCAL* software.

❑ Windows User Interface

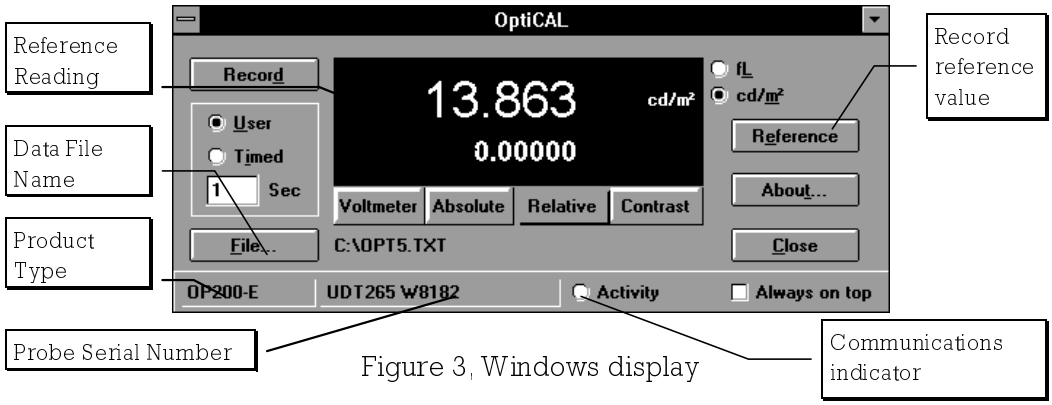


Figure 3, Windows display

❑ DOS User Interface

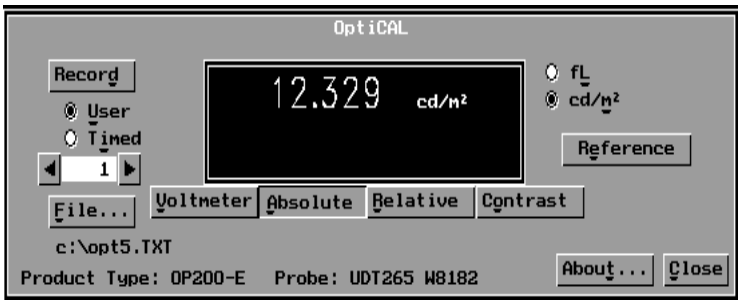


Figure 4, DOS display

Display Update

The display reading is updated every second regardless of user action and is not configurable.

Overload Detection

OptiCAL will detect overload conditions (conditions that cause the input to saturate) by drawing the displayed current value in the overload colour, normally red, producing a regular audible warning and also changing the window title caption. This state continues until the overload condition has been removed. The overload default colour can be altered by editing the *OPTICAL.INI* file.

Controls

The *OptiCAL* software can be used in four modes depending on requirements. Each of these modes is exclusive, i.e. software will only display one mode at a time. A mode is indicated as selected when the button is in a depressed state.

Contrast Mode <ALT>O

This mode is similar to relative mode except luminance values are calculated as contrasts compared to the reference value. 0% contrast is a luminance equivalent to the reference, 100% is twice the reference etc. Luminance values measured less than the reference are displayed as negative contrasts. The diagram below illustrates this.

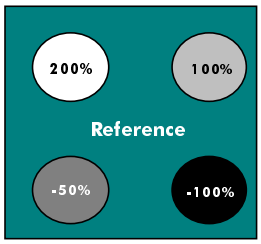


Figure 5, Contrast definition

Voltage Mode <ALT>V

This mode is designed primarily for calibrating the DAC outputs of the VSG although it can be used as a regular voltmeter. You must remove the photometer head and instead connect the voltage to be measured to the photometer input using the T piece supplied, as shown on the next page. Units are selectable for the display in either volts or millivolts.

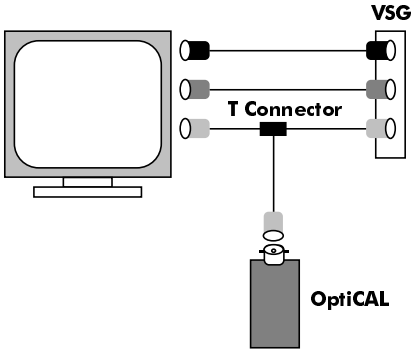


Figure 6, Voltage mode connection

The voltage input range is approximately ±1.25V.

Relative Mode <ALT> R
Identical to absolute mode except that the value displayed is relative to the current reference value. This reference value is selected by pressing the reference button and the current value is shown below the main display.

Absolute Mode <ALT> A
The value displayed is the absolute luminance measured in either fL or cd/m^2. In absolute mode the reference button is disabled.

fL <ALT>L
Displays the current luminance in foot Lamberts. This is only applicable to absolute and relative measurement modes.

cd/m^2 <ALT>M
Displays the current luminance in candelas per square metre. This is only applicable to absolute and relative measurement modes.

V <ALT>L
Displays the current voltage in volts. This is only applicable to voltage mode.

mV <ALT>M
Displays the current voltage in millivolts. This is only applicable to voltage mode.

Reference <ALT>E
Captures the next read luminance and stores it as the reference. The current value is displayed under the main readout and is used by the relative and contrast measurement modes.

About <ALT>T
Displays a dialog providing information about the software version number and release date. This information is needed when reporting any problems about the software.

Close <ALT>C
Closes the application. Under Windows this may also be achieved by double clicking the system menu button, or pressing **<ALT>F4**. Under DOS an additional keyboard shortcut is the **<ESC>** key.

Always On Top (Windows Only)
When this box is checked, the Window along with any child windows will remain in the foreground of any other applications that may be running. The state of this checkbox is recorded in the ***OPTICAL.INI*** file, so that when the program is next run, the state of the check box can be restored.

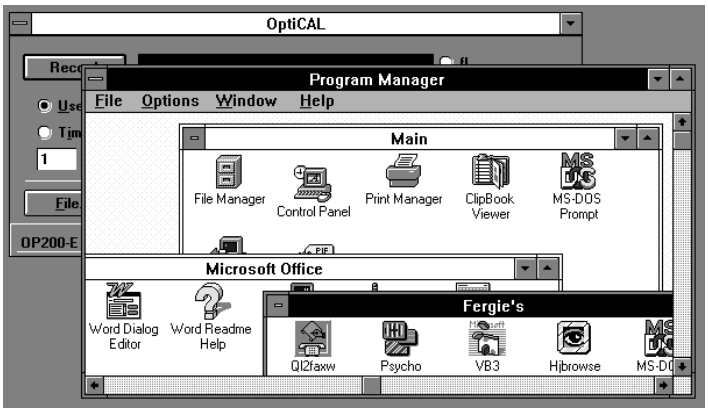


Figure 7, On Top Off

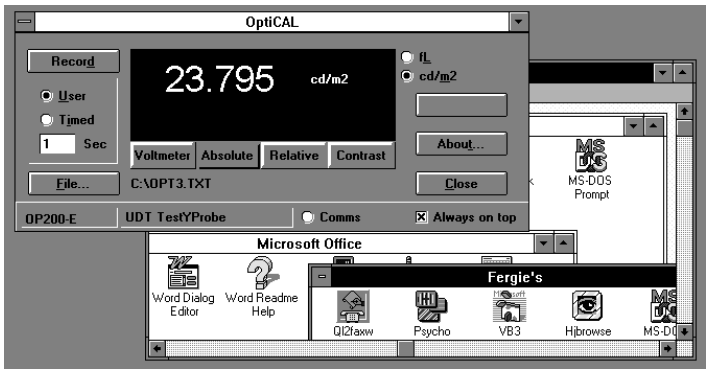


Figure 8, On Top On

Activity (Windows Only)
No user interaction is possible with the radio button as it is only used to indicate when communications is taking place with the ***OptiCAL*** hardware, by turning black when awaiting a reply from the hardware. If this radio button should stay set for a long period i.e. > 5 seconds, it indicates a communication problem.

File <ALT>F
Pressing this button launches a dialog, allowing you to specify what file will be used to record data in. In Windows the standard ***File/Save As*** dialog is used.

Under DOS a simplified dialog allowing you to specify the file name from the keyboard is used, this dialog comprises of three controls, an edit field where the filename is typed, a CANCEL and an OK button.

Record <ALT> D
The effect of pressing the record button depends upon the state of the two buttons ***User*** & ***Timed***. In User mode, every time the record button is pressed the currently displayed value is written to the data file. In Timed mode, the value in the Sec edit field, specifies how often the current display value will be automatically written to the file, also in Timed mode once Record has been pressed, the buttons caption changes to Stop Rec. to indicate the system is recording, plus various other controls are disabled.

User <ALT>U
Select manual recording of readings to the specified file.

Timed <ALT>T
Select automatic recording of readings at regular intervals to the specified file.

Sec (Windows Only)
The value in this edit field is the number of seconds apart that values are written to the data file during a timed record to a data file. The minimum time is 2 seconds and the maximum time gap is 600 seconds. Under DOS, the number of seconds is selected using a spin control rather than typing in a new value. This value can be increased and decreased using **<ALT>Y** and **<ALT>Z** respectively.

Configuring OptiCAL Software

The *OptiCAL* software has a user editable configuration file to allow configuration of various parts of the software. Most options are applicable to both DOS & Windows versions although this file must be manually edited and cannot be altered by the program directly.

❑ Editing OPTICAL.INI File

This file will normally be located in the same directory as the executable. Any plain text editor can be used to alter this file, e.g. ***edit.com*** from DOS, or ***notepad.exe*** in Windows.

The files format matches that for Windows INI files, i.e. options are grouped under bracketed titles, then each option has a name, with the value to the right of an equals sign. Comments can be attached to the INI file, by placing a semi-colon at the start of the line.

The software has default values built into it, so if an INI is lost or corrupted the software should still function.

❑ Configurable Options

Startup Group

Consists of a single option that is only applicable to the Windows software.

```
[STARTUP]
AlwaysOnTop = <VALUE>
```

A value of 0 (default) indicates that window can be overlapped by other applications. A value of 1 indicates that window will remain on top of screen at all times

Comms Group

Consists of a single option applicable to both DOS and Windows versions.

```
[COMMS]
Port = <VALUE>
```

This value indicates the serial port that the ***OptiCAL*** hardware is connected to. Valid values are 1 (default), 2, 3, 4 which correspond respectively to COM1, COM2, COM3 and COM4. If ***OptiCAL*** hardware is not found on the specified port the system will check the other ports before reporting an error.

Colours Group

Consists of two options allowing you to configure the colours of the display area of the software, i.e. readings obtained from ***OptiCAL*** hardware. This allows configuration of the display for use with LCD displays etc.

```
[COLOURS]
Background = <COLOUR>
Foreground = <COLOUR>
OverloadForeground = <COLOUR>
```

Colours should be chosen from the following names: ***Black, Gray, LtBlue, LtCyan, LtGray, LtGreen, LtMagenta, LtRed, LtYellow, White***. If an unrecognised colour name is specified ***Black*** will be selected by default or if a value for Background and Foreground cannot be found in the INI file, the default colours ***Black, LtGreen*** and ***LtRed*** will be selected respectively.

Debug Group

Consists of a single option applicable to both DOS & Windows.

```
[DEBUG]
Window = <VALUE>
```

A value of 1 will display a debug window, showing the current ***OptiCAL*** settings and readings. A value of 0 (default) will stop the window from being displayed.

Communicating with OptiCAL

The process of obtaining data from an ***OptiCAL*** is relatively simple and the details of the protocol used are supplied here, so that custom applications may be written, e.g. to use it on any computer that supports serial communication ports.

Onboard parameters

OptiCAL contains 128 bytes of EEPROM onboard which stores all of the parameters required by your program to produce correct readings. These parameters include internal resistances, calibration information about the photometer head, serial numbers and offset values. and the first action of your program must be to read these parameters.

Protocol

Information is read from the hardware by sending a single byte command and receiving one or more bytes in return. All return messages from the hardware end with an ACK byte (value of 6) to show that the command was correctly carried out. If the command failed or was not understood the ***OptiCAL*** returns a NAK byte instead (value of 21) to show an error occurred.

The following points should be noted when writing software to communicate with an ***OptiCAL***:

1. There must be a 100µS or greater delay between writing each byte to the hardware.
2. Internal calibration which should be performed once as the first action whenever power is applied and takes approximately 3s, so time-outs must allow for this long period, (other commands usually reply within 50 ms).
3. Calibration parameters must be read from ***OptiCAL*** not hard coded.
4. No new command should be sent to the ***OptiCAL*** until the last command has been completed i.e. the ACK return byte has been read.

Port setup

Connection is via a standard RS-232 serial port, using the protocol: 9600 baud rate, no parity and 1 stop bit.

Connections

The *OptiCAL* comes with its own interface cable normally terminated with a 9-way 'D' type female connector which plugs straight into your computer's serial port. If you wish to connect to another type of connector then listed below are the connections you will have to make:

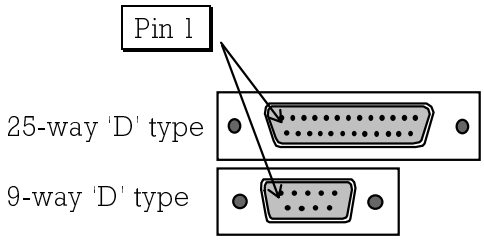


Figure 9

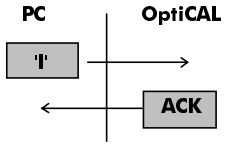
Colour	Signal Name	25-way	9-way
Green	Rx	3	2
Yellow	Tx	2	3
Red	Ground	7	5
Blue	DSR	6	6
Link	CTS	5 - linked to 6	8 - linked to 6

❑ OptiCAL Commands

All commands consist of one byte messages (normally an ASCII character) to which the *OptiCAL* returns at least one answer byte. The *OptiCAL* never sends a return byte without a command being sent first. All return bytes are sent in binary not ASCII form.

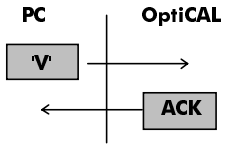
Current mode

This command ('I' or 49_{16}) sets the *OptiCAL* into current mode. All ADC readings from this point should be converted into measured luminances using the calculation provided. See 'Reading ADC values' on page 16.



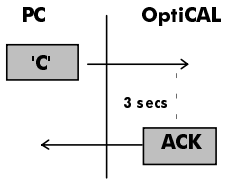
Voltage mode

This command ('V' or 56_{16}) sets the OptiCAL into voltage mode. All ADC readings from this point onwards should be converted into voltages using the calculation provided. See 'Reading ADC values' on page 16.



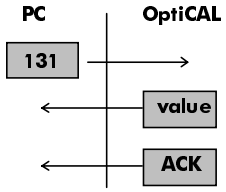
Calibration

This command ('C' or 67_{16}) calibrates the *OptiCAL* internally and should be performed once every time the hardware is powered up. This command usually takes around 3 seconds to perform, and is finished when the hardware returns the ACK byte.

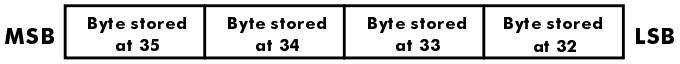


Reading EEPROM

This command (address + 128) returns a byte stored at one of the EEPROM addresses. The command takes the form of the address number plus 128. For example, the following reads the value stored at address 3 (128+3).



Each parameter is stored low byte first. For example, the zero count is stored like this:



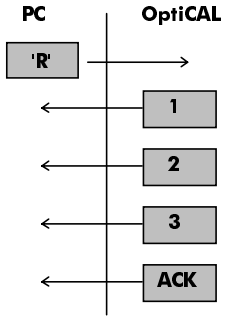
The following table shows the addresses and contents of all the parameters currently stored.

Addresses	Ref	Contents
0-1		Product Type, normally 1 for OPT200-E
2-5		OptiCAL Serial Number
6-7		Firmware Version Number *100
16-19	V_{ref}	Reference Voltage in µV, e.g. 2.5V = 2,500,000 µV
32-35	Z_{count}	Zero Error in ADC counts
48-51	R_{fbed}	Feedback resistor in Ω
64-67	R_{gain}	Voltage gain resistor in Ω
80-95		Probe Serial Number - ASCII 16 characters or digits
96-99	K_{cal}	Probe calibration in fA/cd/m^2

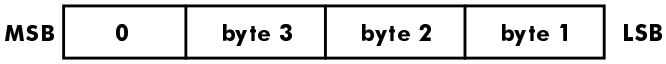
All parameters with a Ref. definition should be read by your program before any measurements are made.

Reading ADC values

This command ('R' or 52_{16}) returns the current ADC reading from ***OptiCAL***. How this value is treated depends on whether the current or voltage mode is set and the formula for converting this value into either a voltage or luminance is on the next page.



OptiCAL returns 4 bytes in response to this command, of which the first three bytes contain the ADC value. These bytes are sent least significant byte first and form the bottom three bytes of a four byte result. The top byte should always be 0.



Before the ADC reading can be converted, you must have read the calibration parameters from the *OptiCAL*. The following formula show how to apply the calibration parameters to the ADC value read back to convert it to meaningful units.

$$ADC_{adjust} = ADC - Z_{count} - 524288$$

Equation 1

Each calculation has two stages; the first corrects the ADC value (equation 1) and the second (equation 2 or 3) converts the corrected value to appropriate units.

Luminance calculation

Equation 2 converts the adjusted ADC value into a luminance with units cd/m^2.

$$\text{Luminance} = \frac{\left(\frac{ADC_{adjust}}{524288}\right).V_{ref}.10^{-6}.R_{gain}.K_{cal}}{R_{feed}}$$

Equation 2

To convert to foot Lamberts (fL) divide the reading by 3.426259101.

Voltage calculation

Equation 3 converts the adjusted ADC value into a voltage with units V.

$$\text{Voltage} = \frac{\left(\frac{ADC_{adjust}}{524288}\right).V_{ref}.10^{-6}.R_{gain}}{R_{feed}}$$

Equation 3

Data File Format

This section provides information on the format used in the data files that may be created with the *OptiCAL* software. The formats are identical for DOS & Windows. An example of how to import a file into MS-Excel 5.0 is also shown.

The data files consist of two parts, a header followed by the readings acquired. The header supplies information about the *OptiCAL* hardware that was used to record the settings. All new readings are appended to the end of the file.

❑ Data Format

The reading is written to the file on a new line, with each terminating in a comma to ensure that when imported into other applications the data is imported correctly. An example file is shown below:

```
"OPTICAL DATA FILE - GENERIC"
"Product Type", "OP200-E"
"OptiCAL Serial Number", "3"
"Firmware Version", "102"
"Reference Voltage", 2500000
"Zero Error", 0
"Feedback Resistance", 2000000
"Voltage Gain", -1000000
"Probe Serial Number", "UDT Test Probe"
"Probe Calibration", 1237000
"OptiCAL Mode", "Absolute Luminance"
"Units", "Candela (cd/m2)"
76.213 ,
76.576 ,
56.431 ,
56.487 ,
```

❑ Example Import To MS-Excel 5.0

The keystrokes here indicate the steps required to import a data file into Excel 5.0. The sequence being:

Start Excel
Select **File/Open** menu item
Change ***<List Files of Type>*** to display Text Files
Select **file** using directory and file list controls.
Click ***<OK>*** button
Set **Delimited Data** Type in Text Import Wizard Step 1
Click ***<NEXT>***
Check **Comma Delimiter** in Text Import Wizard Step 2
Click ***<NEXT>***
Click ***<FINISH>***

The file will now have appeared in Excel if everything has worked, note that header variable names may be truncated, this can be resolved widening column 1. The data readings should follow the header in column 1. Once data is in Excel you are free to manipulate the data but it is advisable if you save data from Excel not to use the same file name as the original data file, since you will overwrite the original data.

Hardware Specification

Description	Specification
Maximum ADC resolution	20 bits (2^{20} steps)
Calibration	Calibrated by CRS *
Frame rate rejection	>120db @ 50Hz
Maximum update rate	200ms
Power supply	
Input voltage	>7V D.C.
Power consumption	<50mA
Current (luminance) mode	
Maximum current	1.25µA
Maximum luminance	(depends on probe)
Voltage mode	
Input impedance	1MΩ
Input voltage range	±1.25V

* Calibration is performed by CRS before delivery. If you require calibration to a traceable standard, contact CRS.