OPTICAL DIMENSIONS™
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LASER CHECK®

Surface Roughness Measurement Gages

6212A Manual Version 14.56

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Operations and Specification Manual for the

Lasercheck 6212A System

Revision 14.56

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a) 0-10V 58

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PERFORMANCE SPECIFICATIONS

Measurement / Detection Method	Angle resolved laser scattering
Measurement speed	Single measurement in < 0.5 seconds
Measurement range	0.5 µinch to 40 µinch / 0.0125 µm to 1.0 µm
Repeatability	± 3.0% of measured value
Spot size (area-measured)	5 mm X 1 mm
Environmental considerations (temperature / humidity):	
Operating	-10º C to +55º C / 10% to 90% RH
Storage	-40º C to +80º C / 1% to 99% RH
Power requirements	110 / 220 VAC, 50 / 60 Hz

Other Features

Factory Calibrated to Ra Ground Surface Standards

Works on any material/color (rubber, glass, steel, etc.)

RS232 Interface Option

Stored items:

All Roughness Values

Date and Time

Average Ra Roughness and Standard Deviation

Minimum / Maximum Ra Roughness

CSV text Formatted File

SAFETY

Electrical

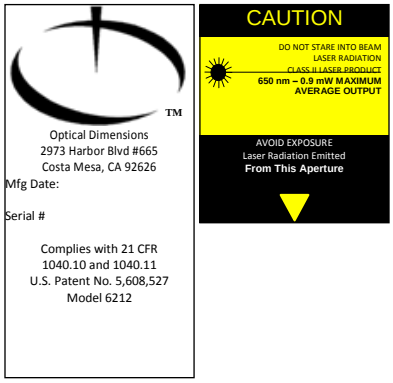
Lasercheck has been designed as a sealed and enclosed system. Voltages to operate the measurement sensor are low (0 to +5 Volts) to minimize shock hazard.

Laser

The laser used in Lasercheck is a class II laser device. Class II lasers are not considered hazardous to the skin but are considered a “chronic viewing hazard”. Users should not stare directly into the beam or directly into the beam reflected off a smooth specular surface. The ends of the Lasercheck measurement sensor have “Caution” and “Avoid Exposure” labels to remind the operator to avoid exposure to the radiation. The sensor also has “Identification” and “Certification” labels. The Lasercheck control unit also has "Identification” and “Certification” labels. Reproductions of these labels are shown below.

Caution – use of controls or adjustments or performance or procedures other than those specified herein may result in hazardous radiation exposure.

The measurement sensor emits a red visible (650-nm) laser beam pulsing at a 10 to 50 Hz. Each “pulse” contains as much as 90 microjoules of energy. Pulses can be as short as a 5 millisecond interval, with 20 microsecond rise and fall times. Maximum “peak” power can be as high as 2.0 milliwatts. Average maximum power being emitted from the laser can be as high as 900 microwatts. Once the beam strikes the measurement surface, the laser energy is reflected back into the Lasercheck detection system. However, multiple reflections and stray light may exit from between the sensor and measurement surface and care should be taken to avoid direct eye exposure to the radiation.



Typical Laser Identification and Warning Labels

WARRANTY OVERVIEW

Optical Dimensions certifies that the Lasercheck surface roughness measurement system meets specifications. The Lasercheck system has a warranty period of one (1) year from date of first usage. This warranty is against defects in material and workmanship. During the warranty period, Optical Dimensions will, at its option, either repair or replace products, which prove to be defective. For detailed warranty information, refer to second page of this manual.

LIMITATION OF WARRANTY

This warranty will not apply to defects resulting from improper or inadequate maintenance by Buyer (please refer to Maintenance section), unauthorized modification or misuse, operation outside the environmental specifications, improper site preparation or site maintenance, fire, flood earth movement or collapse. Optical Dimensions shall not be liable for any direct, indirect, special, incidental or consequential damages, whether based on contract, tort, or any other legal theory.

For warranty service or repair, the Lasercheck system must be returned to Optical Dimensions, after prior Return Material Authorization Number (RMA #) has been obtained. Buyer shall prepay shipping charges to Optical Dimensions. The return shipment should be labeled with the RMA #.

Contact Optical Dimensions customer service for shipping instructions:

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Phone: 831-287-0495

Email: info@optical-dimensions.com

MAINTENANCE

Lasercheck has been designed and assembled by skilled and experienced engineers and technicians. All components used in the system operate well within their rated specifications to ensure long life and reliability of the Lasercheck system. Electronics, lasers, and detectors are all solid-state devices and should not need to be serviced or maintained by the user.

The controller housing is made from impact-resistant ABS and is colored black. The housing is not waterproof, but it can be subjected to moderate rain or splash without harm.

The laser head is made of machined aluminum and plastic and all electronics and optics are secured and sealed within the head. The head is rugged enough to withstand handling that might be normally encountered in manufacturing shop floor gage operation. The head is also water resistant and can be subjected to moderate rain or splash without harm.

Boards and electronics used in the system are static sensitive and easily damaged by mishandling. The Lasercheck housing and electronics are well grounded. The head is sealed at all seams and holes to protect components from external contaminants. The user should not open the measurement head. *If opened by non-authorized personnel, the warranty provided by Optical Dimensions will be void.*

Cleaning the Windows

The internal optics and electronics are cleaned during assembly and kept within the sealed sensor. The internal windows at the bottom of the Lasercheck sensor cover and protect the internal sensors and laser source. They will be exposed to outside contaminants and in very dirty environments should be cleaned at least weekly.

The windows are rugged, but care needs to be taken to not scratch them during operation or cleaning. They should only be cleaned with ethanol, methanol, or a glass cleaner and a soft, clean paper towel, tissue, or Q-tip.

Assistance

Contact your nearest Optical Dimensions office.

INTRODUCTION TO LASERCHECK

Overview

Lasercheck is designed to perform high speed, repeatable, non-contact measurements of surface roughness. A built in visible laser diode emits a laser beam from the bottom of the gage illuminating the surface beneath it. After striking the surface, the laser light is reflected and scattered back into the Lasercheck detection system. The overall intensity and distribution of the reflected and scattered light is measured, digitized by Lasercheck electronics, and then Ra roughness is calculated for the illuminated area. This Ra value is then displayed on the LCD screen of the Lasercheck control unit. The Lasercheck Windows display and control software can be used to display the real time Ra values in graphical and numeric format along with statistical parameters.

Lasercheck has been designed for a nominal height standoff of 0.1 inch $\pm$ 0.01 inches from the measurement surface. Motions and vibrations within that tolerance range are monitored continuously and reflectance and scatter distribution are normalized and corrected during every measurement cycle to ensure accurate results. Surfaces are positioned 0.1 inches below the gage allowing non-contact measurements of the surface to be made.

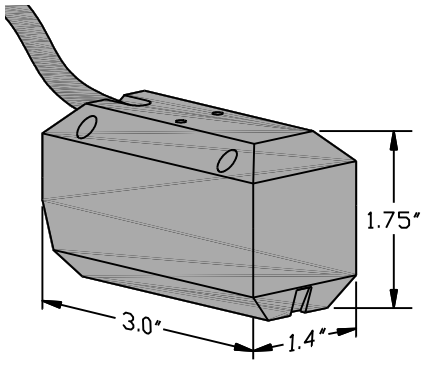
Measurements can be performed by manual pushbutton operation, or continuous high-speed measurements controlled by Windows software, or fully automated high speed on-line measurements triggered by external signals and the Windows software. At the end of a measurement sequence, the user is provided options for performing additional measurements, saving the current measurements or exiting the measurement sequence. When measurements are saved an ASCII file format can be created for reading into a variety of spreadsheet and analysis software packages.

Setting up the Instrument

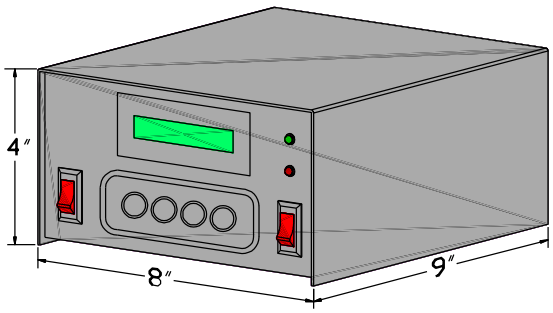
Unpacking Lasercheck

All components of Lasercheck have been inspected and tested individually and as a system before shipping. You should find the following items with your system:

1) Lasercheck measurement head.
2) Standoff (0.100”) plate (typically attached to measurement head)
3) Lasercheck control unit
4) 110 Volt Power Device Cable
5) RS232 serial null modem computer cable.
6) CD or 3.5 inch floppy disk with Lasercheck Calibration & Setup Files, Plus Manual
7) Alignment feet for cylindrical surface measurement (optional).

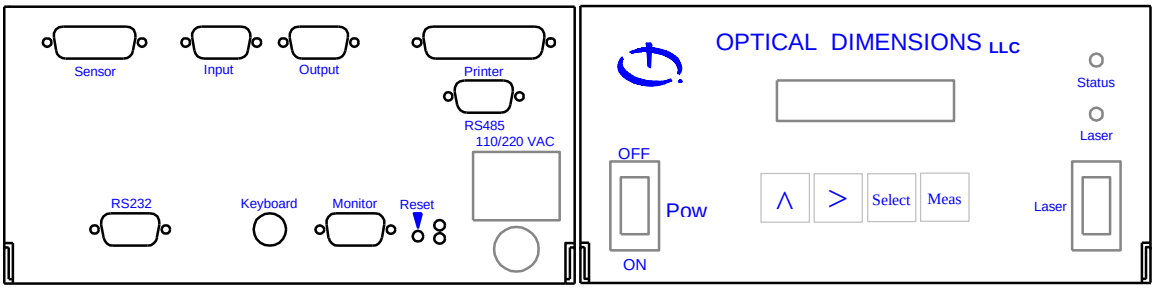


Measurement Head



Control Unit

Basic Connections Control Box



Rear Panel of Box *Front Panel of Box*

Attach the power cable to the "110/220VAC" plug and then connect to ***110/220 Volt Power Source***.

The control unit has a DB15 connector labeled "Sensor" which mates to the connector end of the measurement head cable. The cable should be secured with the thumbscrews on the cable.

The computer cable provided is a serial *null modem* variety. Standard serial connector adapters (25 to 9 pins, male to female etc.) can be used with these cables as necessary without affecting the null modem capability. The Lasercheck control unit has a 9-pin serial connector port for attaching one end of the cable (labeled RS232.) The connector should be screwed on to ensure strength and integrity during operation. The other end should be attached to an available serial port on your host computer. Be sure that port has been set up as COM1 to COM4 in your computer.

Note: During manual pushbutton measurement operation this computer connection is not required or used. This connection is used for transferring saved measurement files to a host computer for storage or input into SPC, spreadsheet, or other data analysis software or for automated measurements taken with Optical Dimensions Windows software.

The start and stop inputs must have a female DB9 connector. They should be connected to the connector on the control box labeled "Input". These would only be used during "automatic operation".

Analog (0-10 Volt or 4-20 mA Current Loop) or indicators for "out of spec" surfaces must have a DB9 connector. They should be connected to the connector on the control box labeled "Output". These would typically be used during "automatic operation".

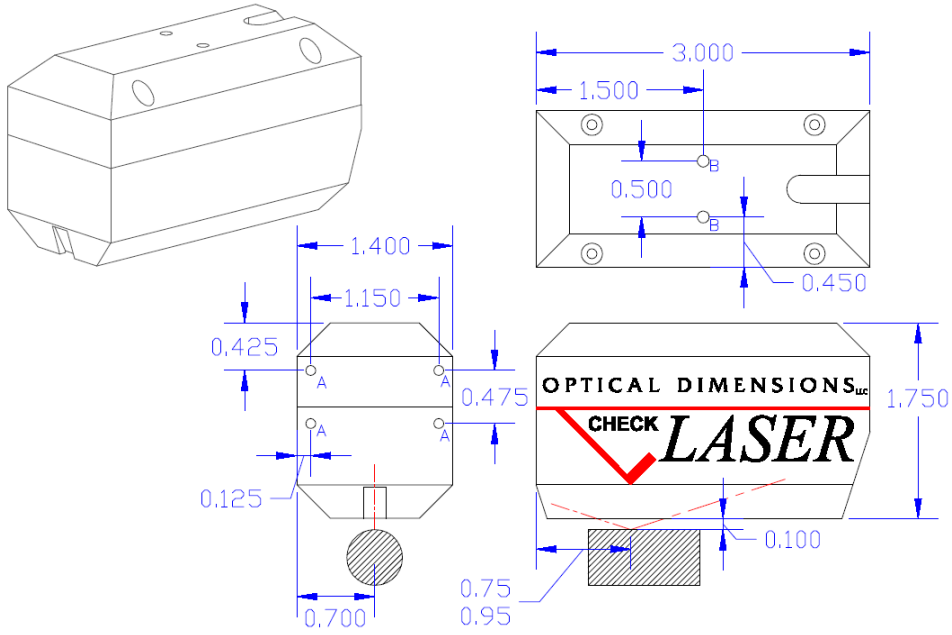
Physical Mounting

The Lasercheck head is supplied with a 1/10-inch thick footplate on the bottom. This will align the head within specification on flat surfaces. If surfaces are cylindrical, then optional alignment feet should be used. For surfaces with different geometry, alignment fixturing should be used. An understanding of alignment principals of Lasercheck is required for development of fixturing. Please read the section "LASERCHECK ALIGNMENT PRINCIPALS AND PRECEDURES" later in this manual to understand principals of alignment.

When performing measurements, set the long axis of the head perpendicular to the dominant "lay" of the surface that you wish to measure. The long axis of the head determines the direction of measurement in the same way that the direction of motion of a stylus on a stylus gage determines the direction of measurement.

Mounting/Fixturing Lasercheck

There are drilled and tapped holes on the Lasercheck sensor head that can be used for mounting and installing Lasercheck in an automated inspection application. The head should be positioned at a location where surface will be at the correct vertical and horizontal position relative to the gage head (see appendix section on Lasercheck Alignment Principles and Procedures). The surface can move under the gage or the gage can move over the surface. In either case, alignment must be maintained during relative motion. An air knife can be used prior to the gage to clean coolant etc. from surfaces to be inspected if necessary. A "Start" sensor or input should be positioned to be activated when the gage or surface is positioned to measure at the beginning of the surface or process. A "Stop" sensor or input should be positioned to be activated when the gage or surface is positioned to measure at the end of the surface or process. Both of these sensors should be wired to the "Input" connector on the back of the control box as described in the Appendix – Input and Output Pinouts section.



Software Setup

Lasercheck uses two different software packages. The control unit has software that initializes electronics, controls the LCD screen, monitors the laser, reads detector signals, and calculates the alignment and surface roughness. It also saves measurements in ASCII format files. This software comes *pre-installed* inside the control unit. It is designed to auto load and auto execute whenever the "on / off" switch is turned on.

A CD or floppy disk with calibration & setup files plus the manual is provided. This software is installed on a separate computer.

An optional Windows file transfer software program is provided on a separate CD. This software is installed on a separate computer and uses the optional 110V or 220V Adaptor & RJ12 / Serial Interface Connecting Cable to communicate with the control unit.

To Install Lasercheck Software

1) Insert Lasercheck CD or disk into the appropriate drive.
2) Click on the **Start** button. From the **Start** menu, choose **Run**.
3) Click on **Browse** button.
4) Select "a**ppropriate drive letter:**"
5) Double click on **Lasercheck Model 6212A setup.exe.**
6) Finally, click on **Finish** button.

Basic Operation Using Control Box Pushbuttons

Once the cables are attached and measurement head is mounted and aligned, you are ready to perform a measurement. Lasercheck is run from the control unit keypad and LCD screen or optionally the Windows software on the host computer. *Detailed* instructions on specific setups and operations can be found in the software users' manual. Following is an abbreviated description for setup and performance of a measurement sequence.

Turning the System On

The control unit has a main on/off power switch. The control box provides regulated DC power to the Lasercheck head. The control unit also powers the internal electronics, and automatically loads and executes software internal to the controller.

Main Screen

When the main power switch is turned to the "on" position the internal electronics will turn on and software will begin executing. During this startup period you will see will see the words displayed on the LCD screen:

Lasercheck Please Wait

Once the electronics and software are fully executed, you will see the LCD screen display:

Lasercheck Version 14.56

Or the current version of the software will be displayed. After 2 seconds, the LCD screen display will change to the Main Screen:

SELECT:>GRIND_ST ^System:

The system is now ready to perform measurements. The control unit also has a second non-backlit on/off switch. This must be turned to the on position to provide power to the internal laser. A red LED above the switch is illuminated when the laser is operational.

Control Unit and Displays

LCD Screen

The Lasercheck Sensor Control Box has a 2 row, 16-column LCD screen. There are also 4 push button inputs to control measurements, data storage, and data transfer.

LCD Push Buttons

The four push buttons are labeled as following (in the following order left to right) and are for:

^ Switch highlight between options

> Scroll through options

Select Select highlighted option

Meas Take measurement at any time from main or measure windows

Highlighting

The "^", ">", and "Select" buttons on the front panel of the Lasercheck are used to highlight and select desired options. Pushing the "^" push button on the front panel switches which main menu is ACTIVE and highlighted in CAPITAL letters. Options in that highlighted menu can be scrolled through are with a ">" on the LCD screen. To choose an option, the "Select" button is pushed. The option that appears in to the right of the menu in CAPITAL letters on the LCD screen is then selected. For example the main screen looks like:

```
SELECT>DEFAULT
^System:
```

Pushing the "^" button will highlight the System menu instead of the Select menu that is currently highlighted to change the screen to:

```
^Select
SYSTEM:   >files
```

Pressing the "Select" button will select the files option from the System menu.

```
Manage files:
FILES:  >Send
```

Changing options in the highlighted Files menu is done by pressing the ">" button. Pushing the ">" button once shows:

```
Manage files:
FILES:  >Receive
```

If Controller Does Not Respond to Pushbuttons

The automated Lasercheck controller is designed to work under external computer control or under control of the front panel pushbuttons. This is determined by configuration of an internal (user selectable) setup file inside the control box. When a setup file configured to respond to an external computer through the serial RS232 connector on the back of the control box is active, the system will not respond to the front panel pushbuttons.

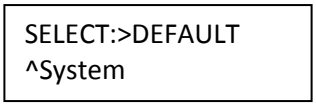
It takes about one second for the serial port to take control away from the pushbuttons when a “serial” based setup file is active. In fact, sometimes the controller may just come up with a “serial” based setup file displayed when you start the system making it difficult to ever get control of the pushbuttons. The solution is to fairly rapidly push either of the scroll (> or ^) pushbuttons as the “serial” based setup file appears. You can get the unit to briefly respond and scroll past a “serial” based setup file if you do it quickly and this will allow you control of the unit through the pushbuttons so that you can do routine measures, file maintenance, transfers and so on.

Performing Manual Measurements

The following section covers the minimum basics required to perform measurements. Additional features built into the Lasercheck Windows software are discussed in detail further in the Lasercheck Windows software manual.

Choose a Setup File

From the Main Screen use the ">" button to select the proper setup file. The controller is delivered with 4 factory provided setup files loaded – grind_st.set, uncal_r.set, uncal_s.set, and serial.set. For a detailed discussion of creation and installation of setup files please see the section labeled "SETUP FILES" and the

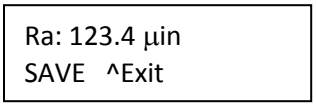


"Appendix - Calibration Procedures" later in this manual.

This shows the GRIND_ST.SET file as the active setup file.

Measure Window with Results

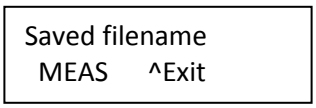
Pushing the Meas button will perform a measurement and the following screen is displayed:



The Ra roughness of the surface that the measurement head is placed on is displayed in microinches (µin) or microns (um) of roughness.

Saving a Measurement

Pushing the Select button saves last measurement in the control box. The following screen will be presented after the file is saved:



Pressing the Meas button without first pushing the Select button will perform another measurement without saving the last measurement in the control box.

File Management

File System Window

- From the Main Window, push the switch (^) push button to highlight the word SYSTEM.
- Scroll to the word “files” with the scroll (>) push button
- Push the Select push button. The following screen will be displayed:

Manage files: FILES: >Send

The file management options available by scrolling are:

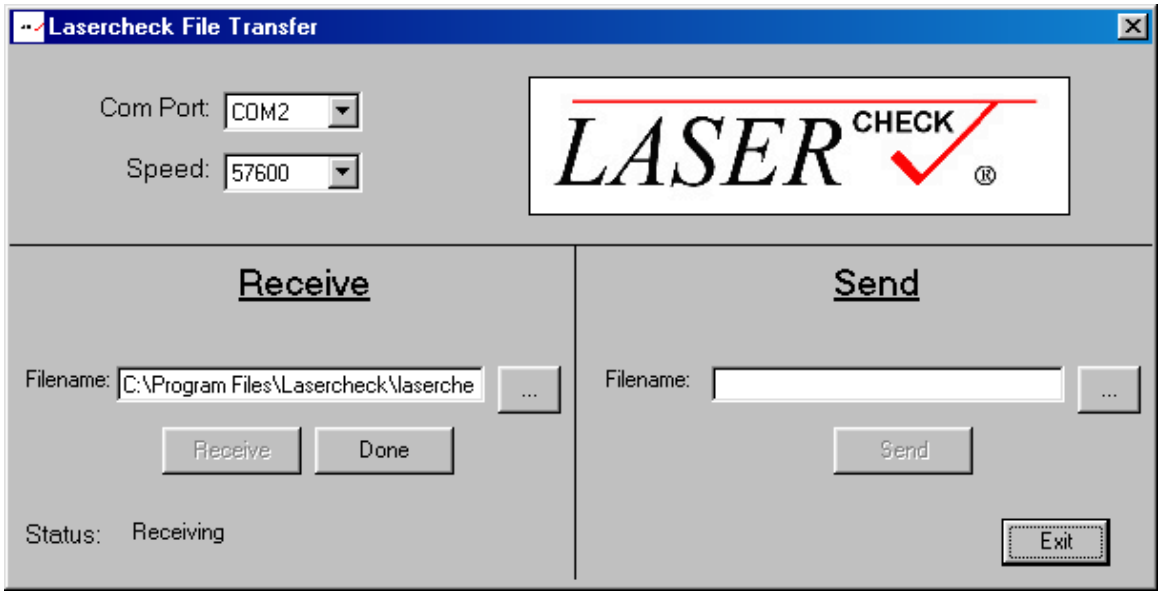
Send, Receive, New Cal, Delete, Reset, Exit

Send Command

This selection transfers data files to a PC via the serial null modem cable. Before selecting this in the control box, you must first prepare the PC to receive the data.

Preparing Windows Software to receive files

- Start the Lasercheck File Transfer Software by clicking on icon in the Start Menu under “Programs / Lasercheck / Lasercheck File Transfer”.
- Select the following options if they are not already selected:
  - Com Port: Select the serial port the Lasercheck cable is attached to on your computer
  - Speed: 9600
  - Filename: C:\Program Files\Lasercheck\Lasercheck.txt
- Leave the filename as “Lasercheck.txt”.
- Click the “Receive” button. Click "OK" if prompted regarding overwriting the file. Follow the directions below for sending the data from the Lasercheck Controller.



Lasercheck File Transfer Software Configured to Receive Saved Measurements

Sending Measurement Data from the Lasercheck Controller

Scroll to “FILES: >Send” on the control box with the scroll (>) push button and push the Select push button. The LCD displays the following screen:

Sending all data files now.

All data files are being transferred to the computer while this is displayed.

The receive operation in the windows software should finish automatically when all of the data is received from the controller. The status message in the windows software will show this by displaying “Finished Receiving”. If it does not, click the “Done” button in the windows software to finish and close the data text file.

When all files have been transferred, the control box will return to the File System Window. The files received in the PC are by default in the C:\Program Files\Lasercheck directory created on your computer, and these data files end in “.txt”.

Receive Command

This selection transfers setup files from a PC via the serial null modem cable.

File Naming

The Lasercheck installation software creates a directory with factory setup and calibration files. The default directory location is C:\Program Files\Lasercheck\ Control Box\Setup Files.

Each setup file must include a line similar the following:

RECEIVE_NAME= filename.set

This line determines what the name of the file will be displayed on the controller LCD screen. Examples are in the C:\Program Files\Lasercheck\ Control Box\Setup Files directory. For a detailed discussion of creation of setup files please see the “Appendix - Calibration Procedures” later in this manual.

Preparing Control Box to receive files

Scroll to “FILES: >Receive” on the control box with the scroll (>) push button and push the Select push button. The LCD displays the following screen:

Receiving setup files now

The control box is waiting to receive data files being transferred from the computer while this is displayed.

Sending Setup Data with the Windows Software

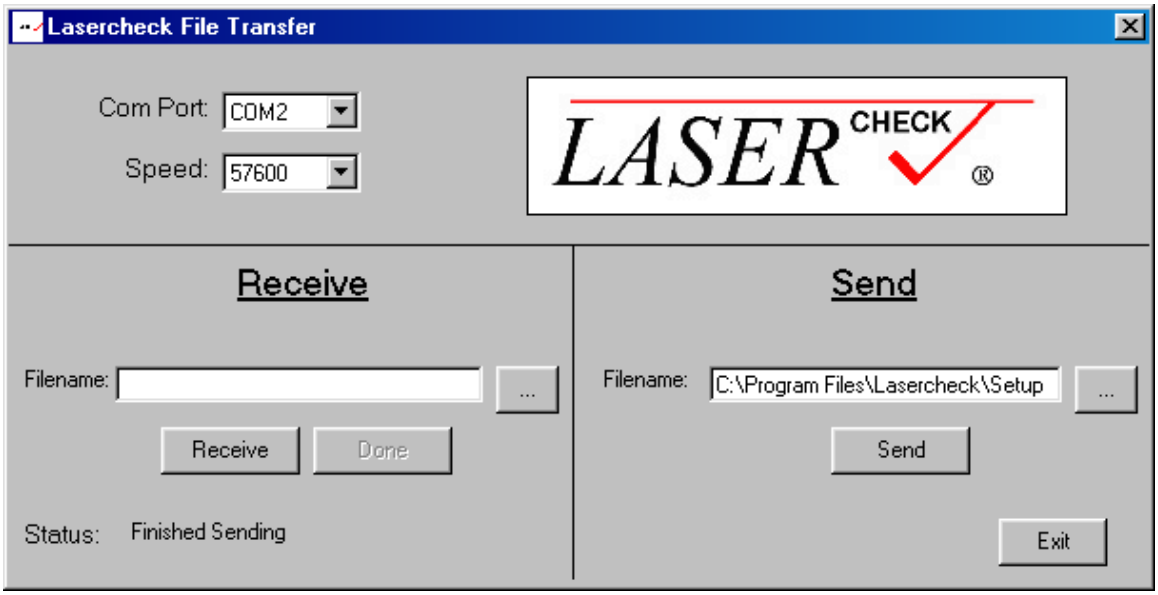
- Start the Lasercheck File Transfer Software by clicking on icon in the Start Menu under “Programs / Lasercheck / Lasercheck File Transfer”.
- Select the following options if they are not already selected:

  Com Port: Select the serial port the Lasercheck cable is attached to on your computer

  Speed: 9600

  Filename:

- In the Send “Filename:” input box enter the filename of the setup file you want to download into the control box. The small button next to the input box can be used to browse for files on the computer. The file extension will be “.set”.
- Click the “Send” button. The “Status” indication in the windows software will indicate “Finished Sending”. The control box will display:



Lasercheck File Transfer Software Configured to Send Calibration / Setup File

When all files have been transferred, the control box will return to the File System Window.

New Cal Command

This selection is for factory use in collecting measurements for custom calibration procedures.

Delete Command

This selection will delete all data measurement files from the control box. This would typically be done after the “Send Data Files” has been executed. Scroll to FILES: >Delete on the control box with the scroll (>) push button and push the Select push button. The LCD displays the following screen:

Delete all data files? >n/Y

Scrolling to highlight “Y” and pushing the Select push button, will delete all data files, then the system will return to the File System Window. Scrolling to highlight “N” and pushing the Select push button will return to the File System Window without deleting files.

Reset Command

This selection should only be used if the user experiences difficulties with files and software in the controller. Scroll to FILES: >Delete on the control box with the scroll (>) push button and push the Select push button. The LCD displays the following screen.

Reset to factory files? >y/N

Scrolling to highlight “Y” and pushing the Select push button will present the following display:

ALL data will be deleted! >y/N

Scrolling to highlight “Y” and pushing the Select push button will delete data, configuration, and setup files that have been added to the control box and return it to factory setups and configurations.

Exit Command

This selection exits the file management section of the system and returns to the Main Screen.

Data Files:

The data files stored in the control box have up to 8 letter file names as prescribed in the setup file. The filename extension is “TXT”. The data files contain measurements and headers. The data fields are separated from the header fields by tab characters so that SPC programs and spreadsheet programs like Excel can read the text files easily.

Sample Data File

Filename	grind001.txt
Date	02/15/2005
Time	22:45:12
Setupfile	GRIND_ST.SET
Average	16.131527
Standard Dev.	17.050699
Maximum	49.570293
Minimum	2.193076
# Measurements	5

1	7.252161
2	9.095555
3	2.193076
4	49.570293
5	12.546545

EOF

Advanced Operations

Operation Using Windows Software

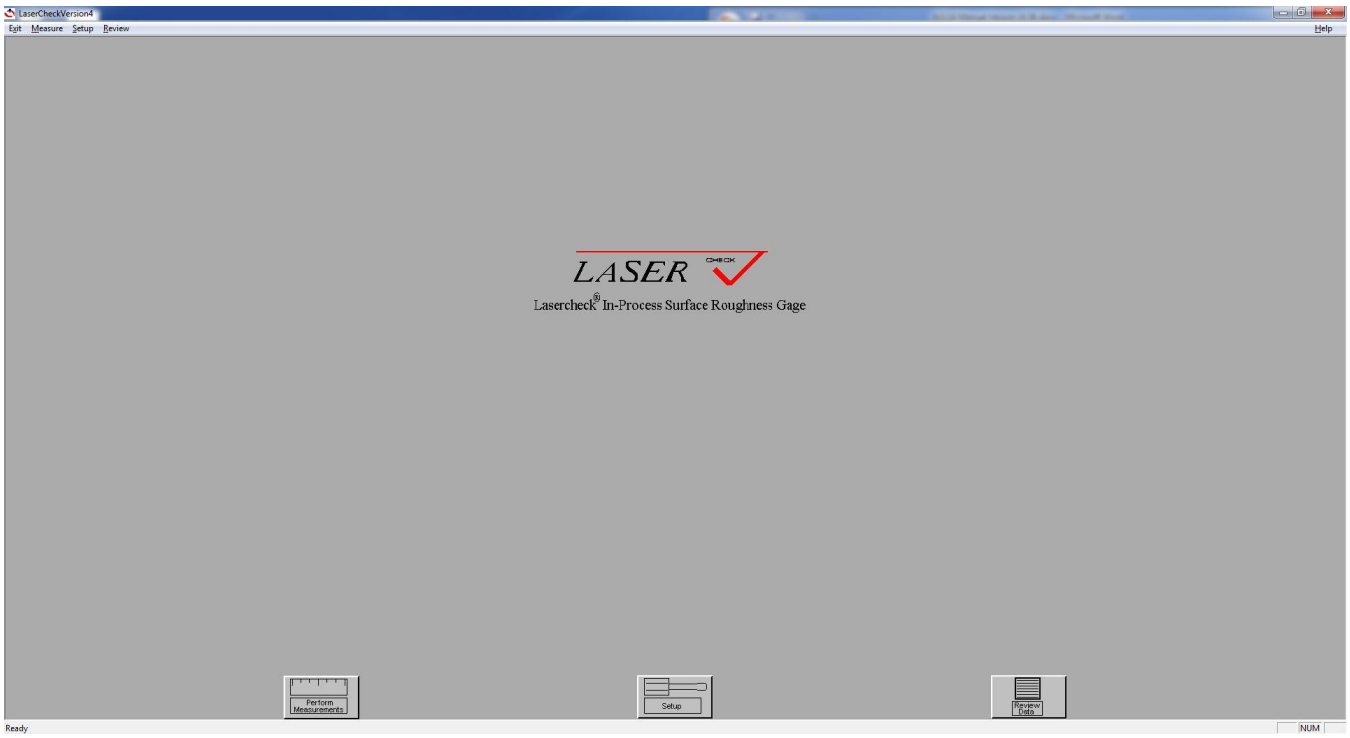
The Lasercheck can also be used and controlled through the Lasercheck windows software. The following is an example of using the basic features of the windows software.

Control Box Setup

Make sure the Lasercheck control box is connected to the computer with the serial null modem cable. For more detail on doing this refer to the “Setting Up the Instrument” section in the beginning of the manual.

Starting Windows Software

Start the Lasercheck Windows Software Program. From the **Start** select **Programs/Lasercheck/Lasercheck**



.

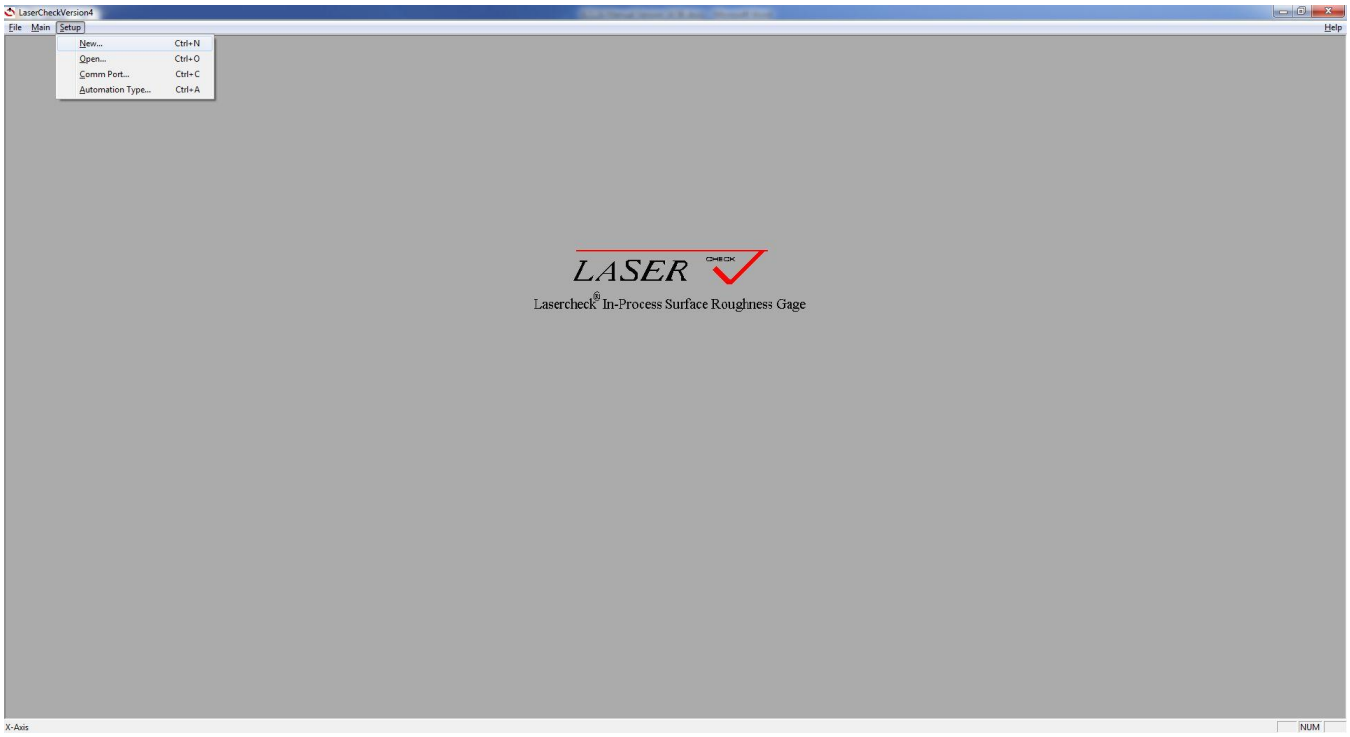
Entering the Setup Module

From the main window of the Lasercheck software select the “Setup” push-button. This invokes the “Password Entry” dialog box. Enter the password “4956”, and click OK.

Setup Options

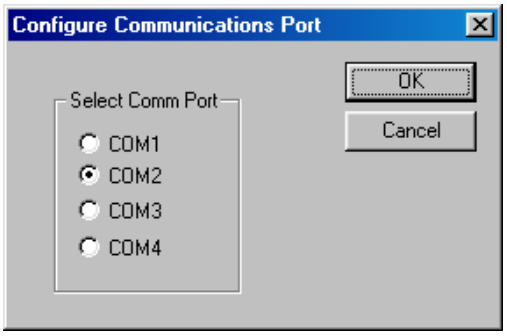
Two parameters should be set prior to creating setup files or performing measurements with the Lasercheck Windows program.

1) Comm Port
2) Automation Type



Select the Communications Port

Select Setup/Comm Port. Select the communications port that the RS232 null modem cable is connected to on your computer. Then select “OK”



Select Automation Types

Select Setup/Automation Type.

Setup for Lab System

Check Lab System. Then select “OK”.

Lab System Automation will cause Lasercheck to provide single measurements in response to input from the Windows software program or pushbutton on the control box.

Setup for Continuous Measurements / Roll Grinding

Check “Roll Grinding”. Then select “OK”.

“Roll Grinding” Automation will cause Lasercheck to provide streaming continuous measurements at a rate of approximately 10 Ra values per second in response to input from the Windows software or trigger inputs to the input port of the control box. Continuous measurements are stopped in response to input from the Windows software or trigger inputs to the input port of the control box.

This Automation is used to perform automated measurements on large continuous surfaces so the entire surface can be assessed as to its overall roughness and uniformity of roughness.

Set up for Individual Parts / Parts Inspection

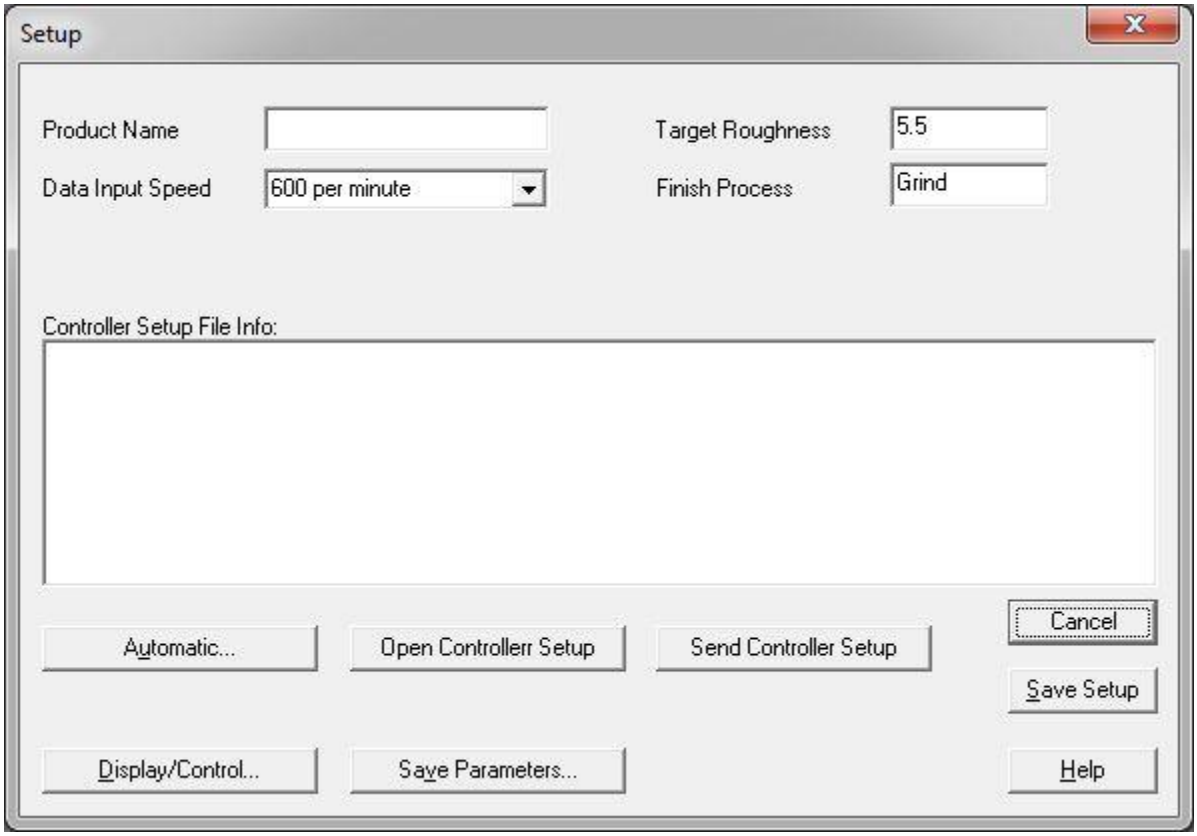
Check “Parts Inspection”. Then select “OK”.

Parts Inspection Automation will cause Lasercheck to provide single measurements in response to input from the Windows software program or trigger inputs to the input port of the control box.

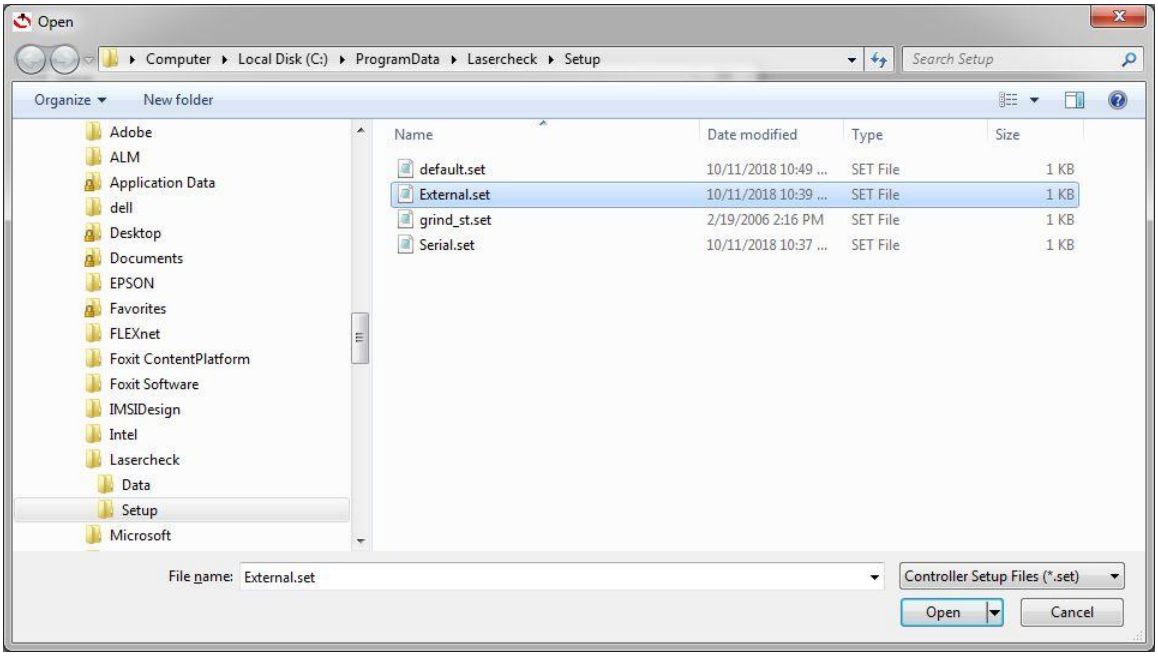
This Automation is used to perform automated measurements on individual parts in high volume production. Parts passing under Lasercheck will receive a single Ra measurement in response to any trigger mechanism. Parts can be presented to Lasercheck on a conveyor or robot arm, or the Lasercheck sensor can be brought to the part via robot.

Create New Lasercheck Windows Setup Files

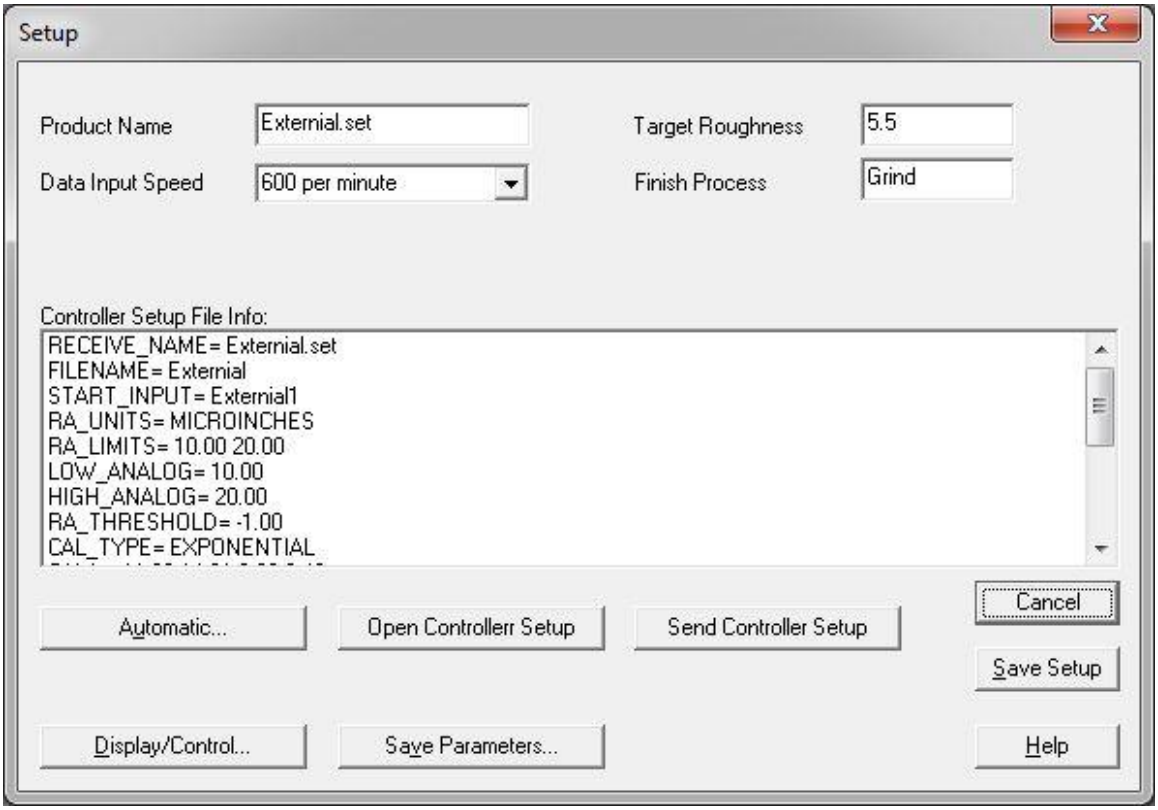
Select Setup/New. A blank setup file will be presented.



Select the “Open Controller Setup” button. A series of pre-installed controller setup files will be presented.



Select and open the desired controller setup file. This presents information that will transfer to the Lasercheck controller and define the measurement



Controller Setup Files

See the Appendix - Setup Files for more information on these files that are integrated into overall Lasercheck setup files.

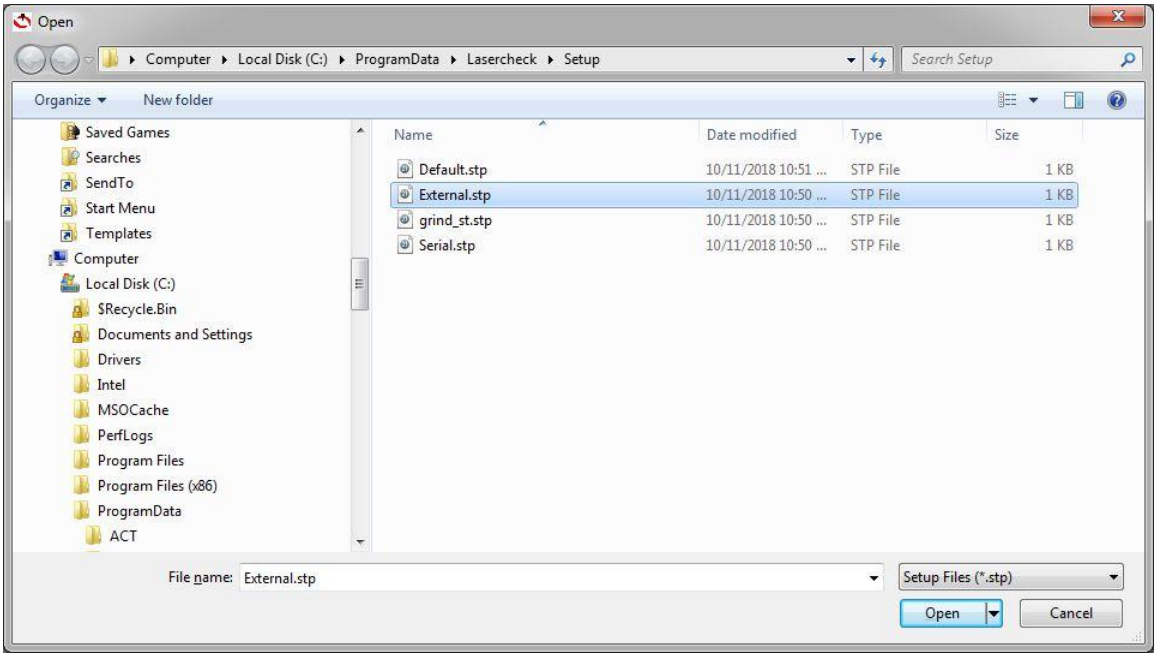
Creating Controller Setup Files

Included with the software is an Excel spreadsheet program titled “Setup File and Calibration Template.xls”. This program is found in the C:\Program Files\Lasercheck\Calibration directory created by the installation program. It is designed to calibrate the Lasercheck for specific processes and integrate the calibration in Lasercheck setup files.

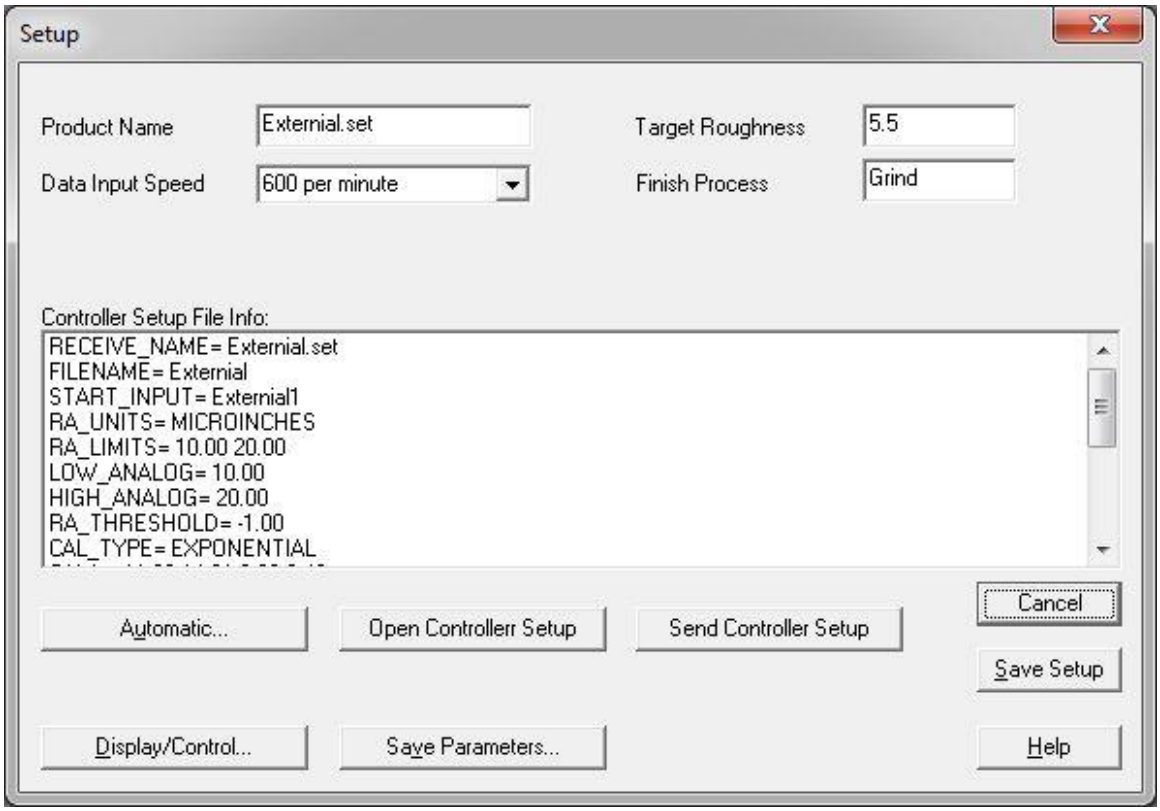
Detailed instructions on how to perform calibrations and use this Excel program are in the appendix of this manual under the section titled “Appendix - Calibration Procedures”. The three setup files that the spreadsheet creates can be renamed as long as the name is not longer than eight characters and its three-character extension, “.SET”, remains. These setup files need to be transferred to the control box; see the Receive Command in the section on File Management.

Open Lasercheck Windows Setup Files

Select Setup/Open. A series of pre-installed Lasercheck Windows setup files will be presented.

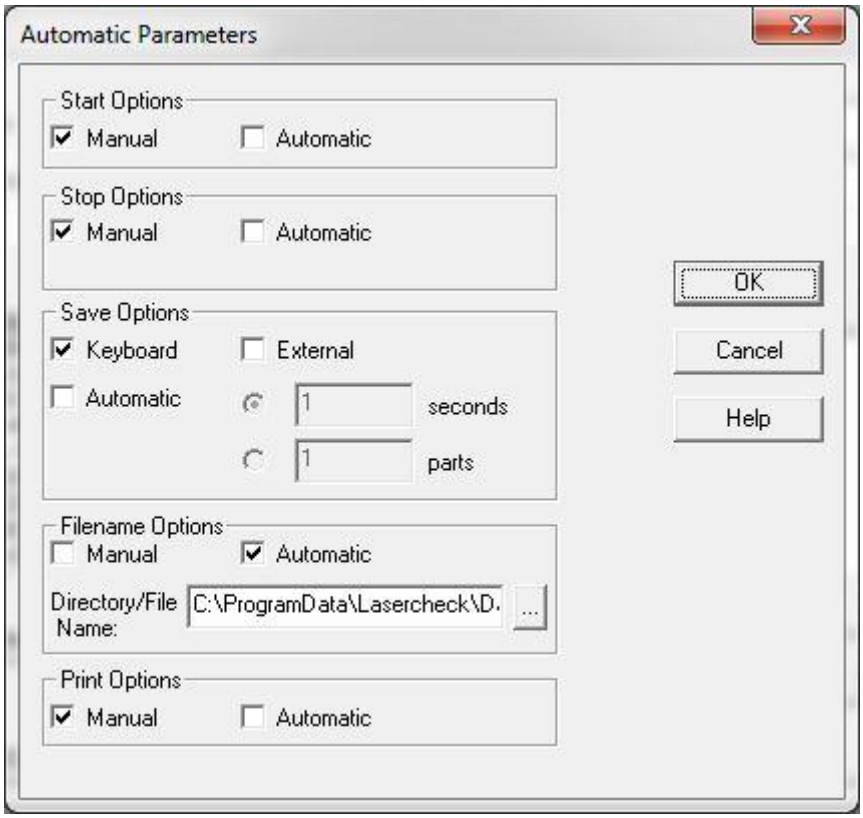


Select and open the desired setup file. This presents similar dialog box to creating a setup file with information that will transfer to the Lasercheck controller and define the measurement



Automatic

Pushing the “Automatic button opens a separate dialog box.

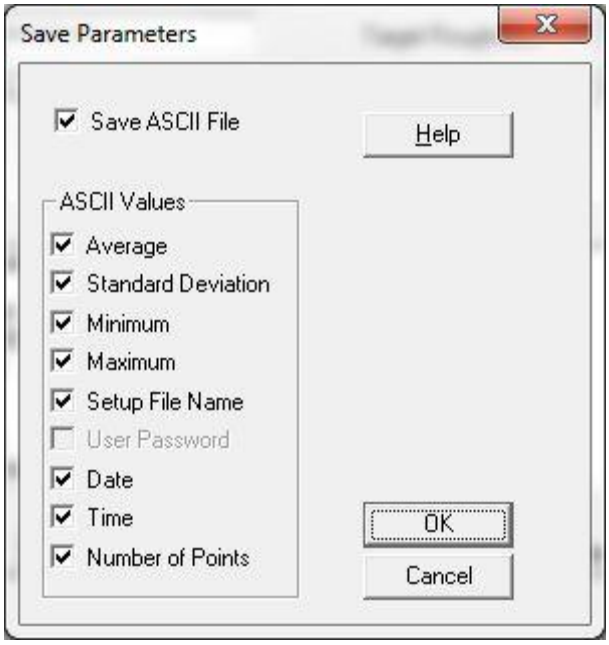


Only edit the “Filename Options” button.

- Manual checkbox setting requires the operator to create a filename whenever a measurement set is complete and ready for saving.
- Automatic checkbox setting will cause Lasercheck software to automatically create a filename whenever a measurement set is complete and ready for saving. The file location and filename is specified. Lasercheck will increment every new saved measurement (filename1, filename2, filename3 etc.)

Save Parameters

Pushing the “Save Parameters button opens a separate dialog box.



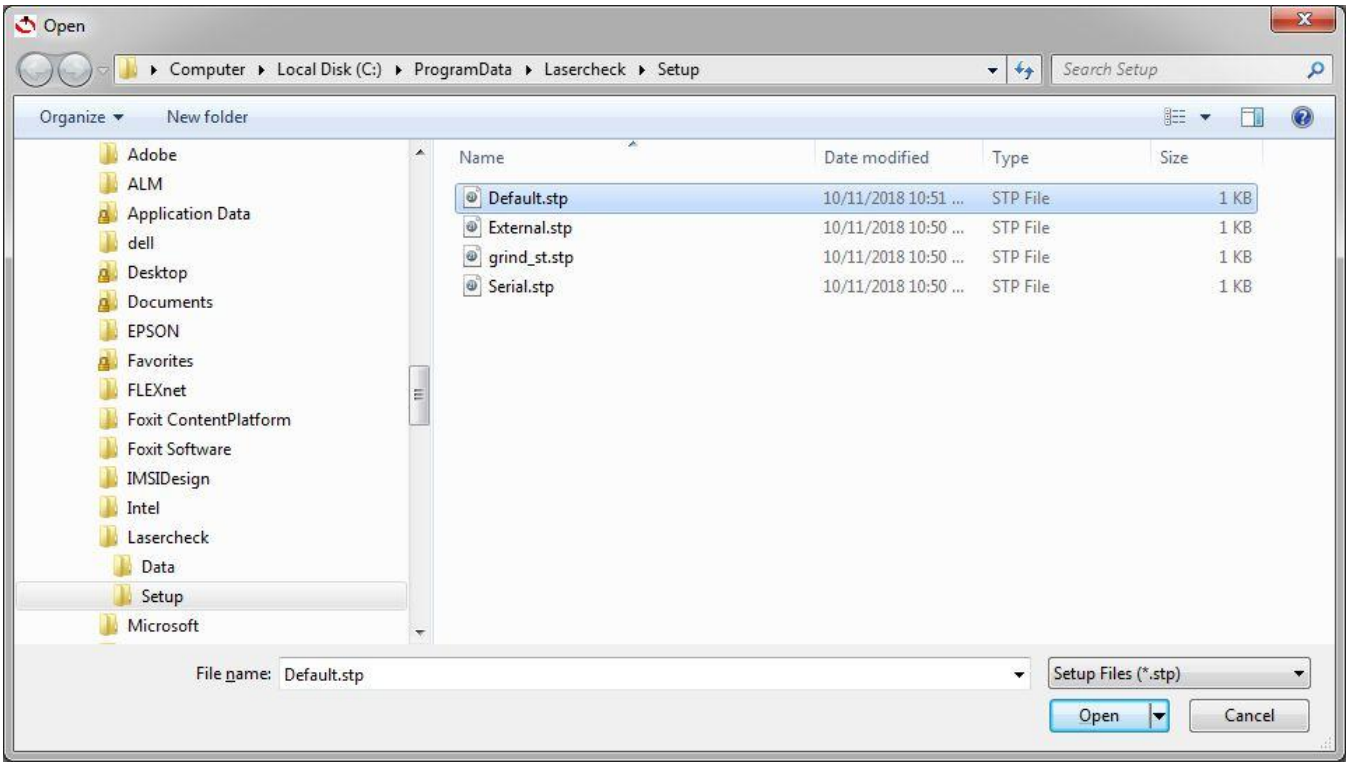
Lasercheck saves files in proprietary format (filename.lsc) that can be later opened, reviewed and printed using Lasercheck software. Checking the “Save ASCII File” checkbox allows a separate ASCII file to be automatically created and specify what elements are contained in that ASCII file. The ASCII file can then be imported into separate compatible programs including Excel spreadsheets for further review.

After reviewing, editing and saving Lasercheck setup files, selecting “Main: from the top menu selection of the Setup Module will return you to Lasercheck software main menu.

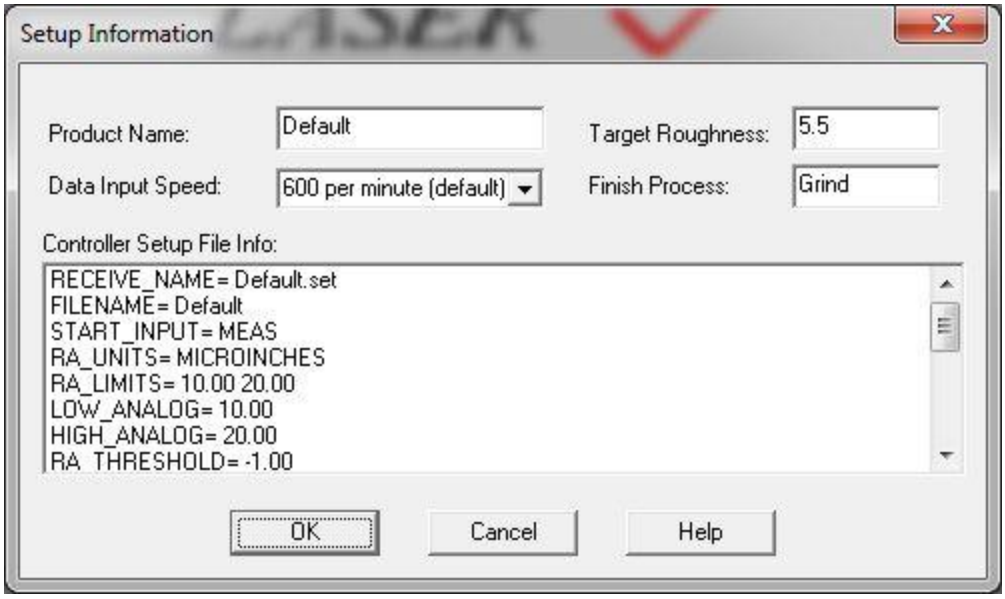
Software Manual Operation

Perform Measurements Module

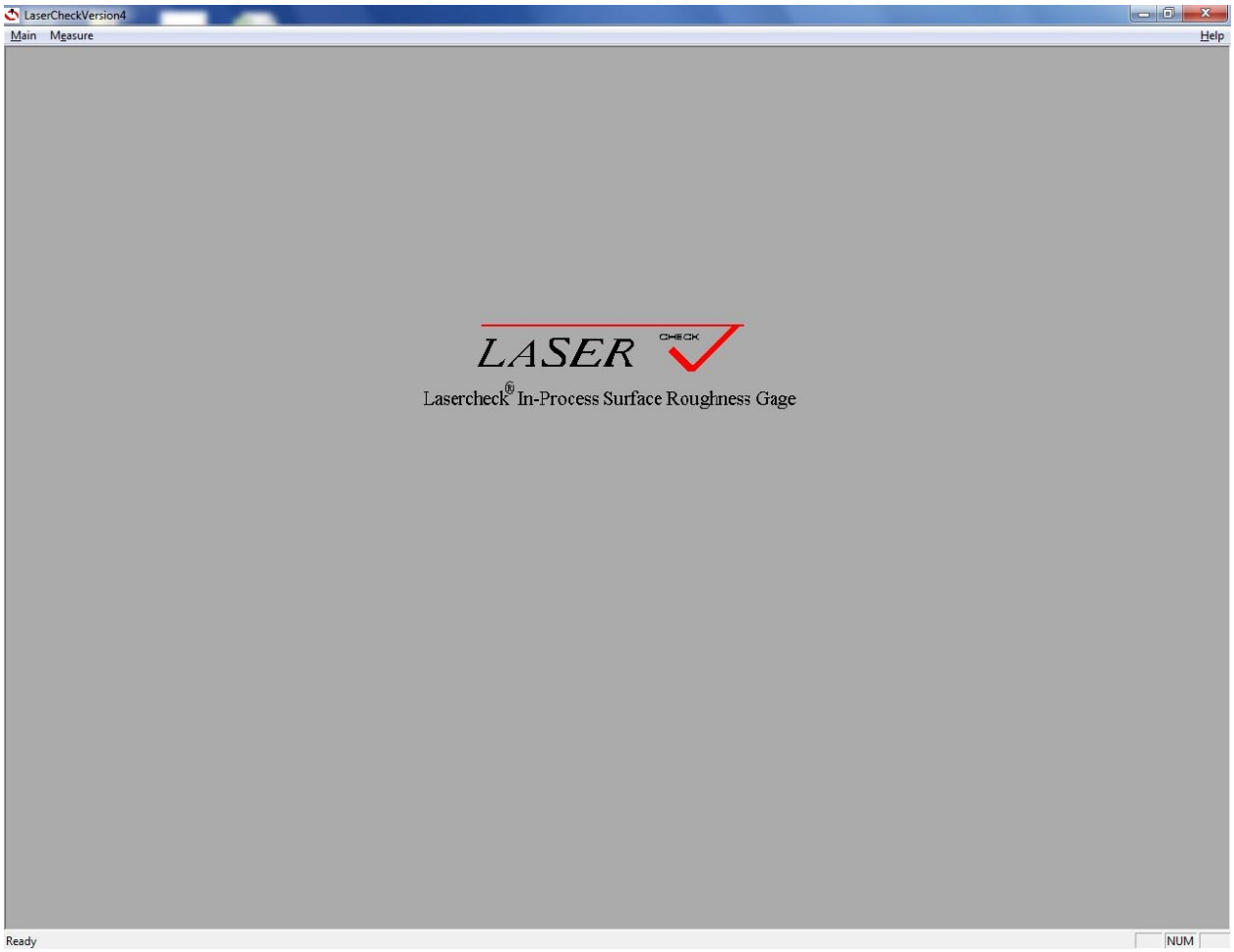
From the main window of the Lasercheck software select the “Perform Measurements” push-button. This invokes the “setup/open” dialog box.



Select a setup file that contained the line “START_INPUT= MEAS”. An information dialog box similar to what is shown during setup file creation will be presented.



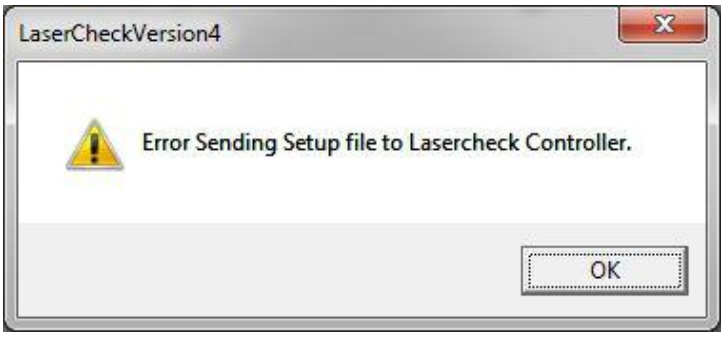
Select “OK”. The main measurement screen will be presented.

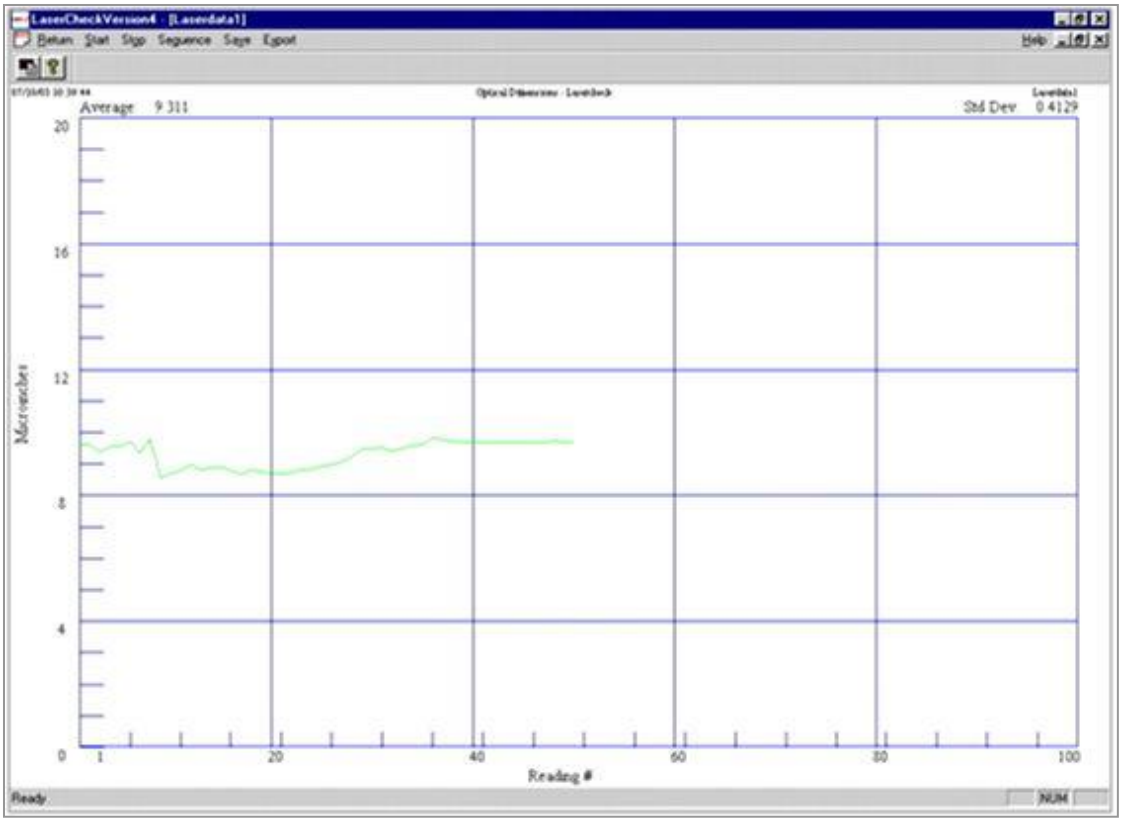


Measure Menu

Select the option “Measure”. An empty graph screen with a run menu appears.

Note: the following screen may appear. If so, try again and it should work. It may be necessary to reboot software and Lasercheck controller if this persists.





Start

Selecting “Start” from the Run Menu starts the Lasercheck and the graph begins displaying roughness information. A graph of roughness vs. reading number will begin appearing in real time on the screen. In addition, statistics of all measurements will be displayed digitally in real time at the top left and right corners of the graph, and the current measurement in the top center of the graph.

Stop

While the roughness display is running, the Stop menu selection can be used to stop the data acquisition. Selecting Start will restart the display. The “Stop / Start” cycle can be repeated as many times as is necessary for the measurement set.

Sequence

While the roughness display is running, the Sequence menu selection can be used to restart the data acquisition. All previous values on the screen will be discarded and an empty graph will be presented as the measurements resume.

Save

The Save menu selection will provide a Windows “Save As” dialog box prompting the user to enter a filename to save the data. Lasercheck software automatically attaches a Lasercheck “.LSC” data file extension to the file

name that is typed in. This data file can be opened for review in the Review Data module from the main screen of the software.

Export

The Export menu selection will save an ASCII text file of all measurements in the current measurement cycle. This text file will be automatically named “Lasrdata.txt” and it will be saved in the “C:\Program Files\Lasercheck” directory on your computer. The file will contain all saved values, statistics on the values, filename, date, time, and information on the specific windows software setup file.

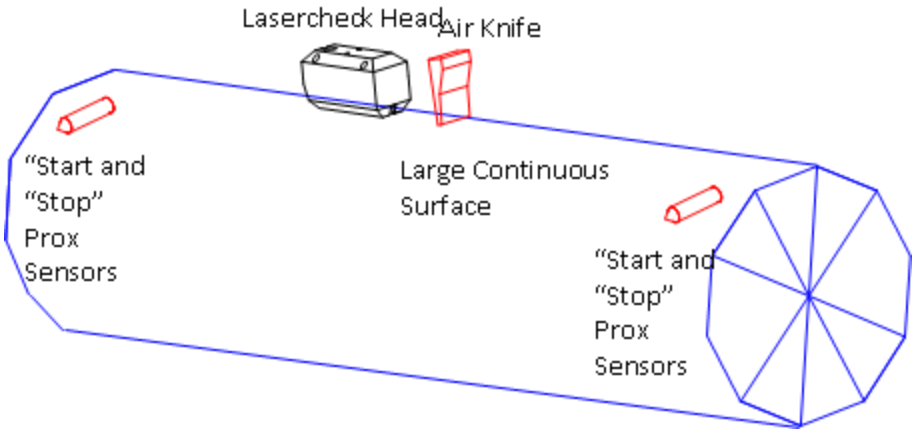
Return

The Return menu selection will return you to an empty Measure Menu window.

Automated Operation

The Lasercheck can be used with external inputs to start and stop the measurements in an automated installation. The inputs on the back of the Lasercheck control box are read by the Lasercheck Windows software, so the Lasercheck must be connected to a host computer for this option to work.

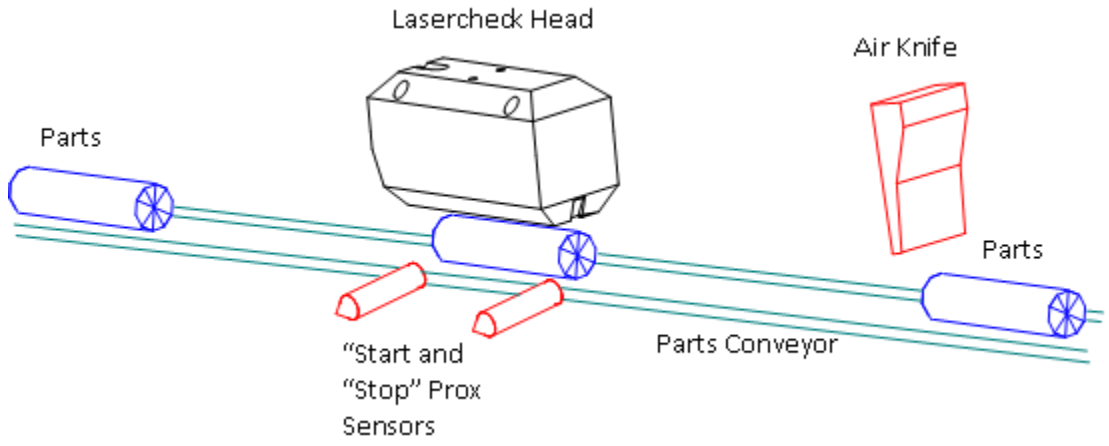
The windows software is designed to work with external inputs in two modes for automated applications. One is for continuous surface applications in which numerous measurements are taken between one start input and one stop input. This mode of operation is typically used to rapidly provide numerous roughness measurements on large surfaces such as mill rolls or sheet surfaces. All data points are displayed on the graph as they are being taken at a rate of approximately 10 readings per second. The second mode of operation is for measuring individual parts being presented to the gage, such as parts on a conveyor. In this mode the few measurements made between a start input and a stop are averaged and only the single average of that part is plotted on the graph; one average point for each start and stop input received.



Lasercheck Head Mounted over Large Surface for Continuous Automated Inspection

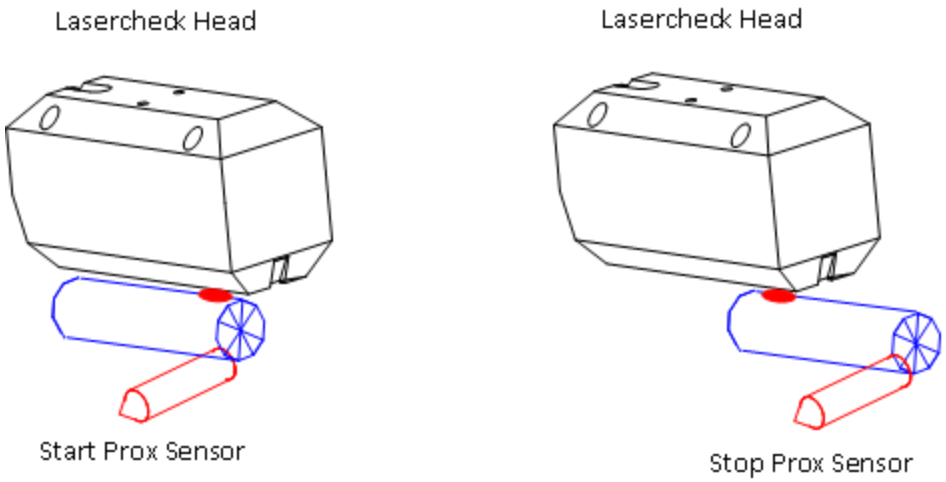
There are ten drilled and tapped holes on the Lasercheck sensor head that can be used for mounting and installing the Lasercheck in a continuous automated inspection application. The head should be positioned at a location where surface will be at the correct vertical and horizontal position relative to the gage head (see

appendix section on Lasercheck Alignment Principles and Procedures). Either the surface will move under the gage or the gage will be moved over the surface. In either case, alignment must be maintained during relative motion. An air knife can be used prior to the gage to clean coolant etc. from surfaces to be inspected if necessary. “Start” and “Stop” sensors or inputs should be positioned to be activated when the gage is positioned to measure at the start of the process and at the stop of the process. Both of these sensors should be wired to the “Input” connector on the back of the control box as described in the Appendix – Input and Output Pinouts section. Measurements will proceed at a rate of approximately 10 per second between the “Start” and “Stop” activation. Lasercheck Head Mounted on Conveyor for Automated Inspection



Lasercheck Head Mounted over Multiple Individual Parts for Automated Inspection

There are ten drilled and tapped holes on the Lasercheck sensor head that can be used for mounting and installing the Lasercheck in an automated inspection application. The head should be positioned at a location where parts will pass beneath the gage at the correct vertical and horizontal position relative to the gage head (see appendix section on Lasercheck Alignment Principles and Procedures). If parts are not clean, an air knife should be installed and mounted prior to the laser head to blow-dry excess coolant off of the surface to be measured. Ideally the parts would pass a few millimeters under the air knife, which would operate with a pressure of approximately 20 psi blowing on the surface.



Positioning Prox Sensors on Conveyor for Automated Inspection

A “start” sensor should be mounted in a location that activates as soon as the surface to be measured is entering a position for the Lasercheck head to measure (indicated by laser beam being fully positioned at the front edge of the measurement area of the part). A “Stop” sensor should be mounted in a location that activates as soon as the surface to be measured is leaving a position for the Lasercheck head to measure (indicated by laser beam being fully positioned at the front edge of the measurement area of the part). Both of these sensors should be wired to the “Input” connector on the back of the control box as described in the Appendix – Input and Output Pinouts section.

“Start” and “Stop” Sensor Wiring Inputs

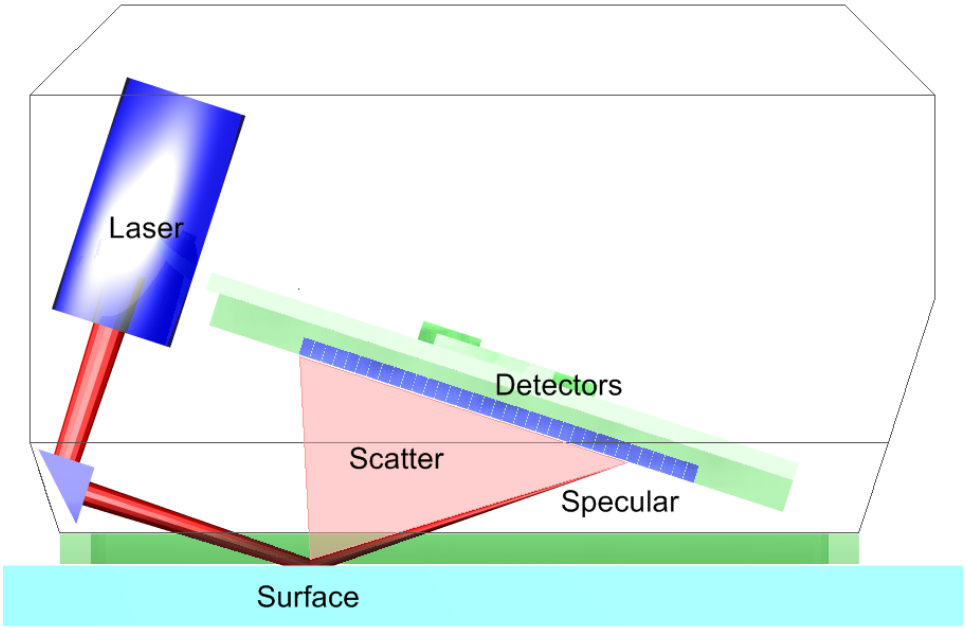
External inputs to trigger the starting and stopping of measurements can be push buttons, foot pedals, proximity sensors, or any type of input that momentarily closes contacts. Wire the inputs as indicated in the Appendix – Input and Output Pinouts.

Appendix A – Lasercheck Alignment Principles and Procedures

This section contains information on principals and procedures to install and align Lasercheck heads. The keys to getting accurate and repeatable data are controlling alignment and cleaning the surface.

How Does Lasercheck Work?

The visible (650-nm.) laser illuminates the surface with a shallow incident angle to measure surface roughness features. The distribution of reflected and scattered light from the surface is detected by a photodiode array with 35 small closely packed detectors. This relative distribution of reflected and scattered light is used to calculate the surface roughness of the area illuminated by the laser beam. The array is also scanned by software to find the specular beam (when there is one) and its position is used to determine height of the measurement head from the surface.



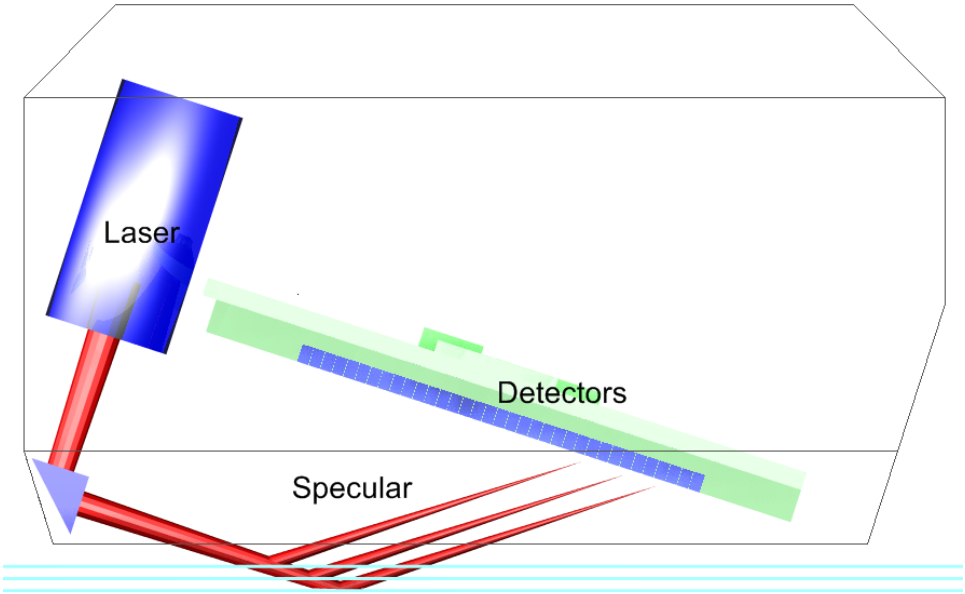
Schematic Diagram of Lasercheck Instrument

The image shows a schematic of the layout of the laser, the beam path and the detectors in Lasercheck. The “Photodiode Array” has 35 discrete detector elements.

Alignment

Vertical

The specular laser beam must fall on one of detectors 3 to 9 n the 35-element photodiode array. If Lasercheck is too close to the surface, the specular reflection falls on detector number 10 or greater. If Lasercheck is too far from a surface, the specular laser beam falls on detector 2 or smaller, or misses the photodiode array entirely.



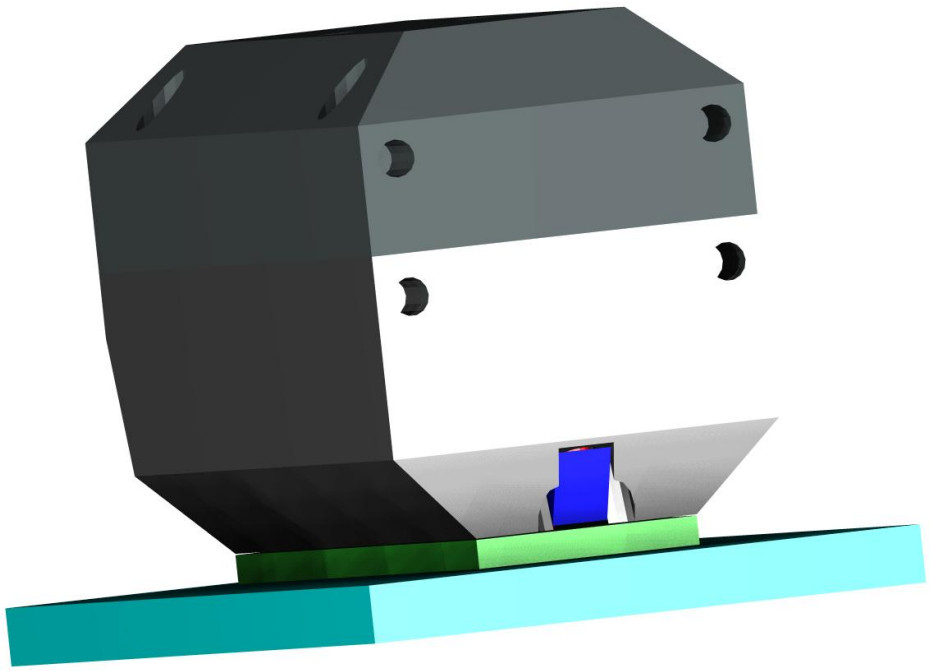
Three Surface Locations – Too Close, Correct, Too Far

The image depicts the laser path and specular reflection from surfaces at three different distances from the head. The bottom surface, the farthest from the head, shows the specular reflection about to strike detector 2. This is misaligned – the head is too far from the surface. The top surface is also misaligned because the specular beam is hitting higher than detector 9 on the detector array – the head is too close to the surface.

A good guideline is to try to maintain alignment so that specular falls on detector 6 with a tolerance of no more than +/- 1 detector elements. As a reference, the head movement is approximately 0.010 inches for every shift of the specular beam of one detector element.

Vertical Alignment Base plate

Lasercheck is shipped with base plate that is pre-aligned to set correct vertical positioning on flat parts. This base will set vertical position of the head so that the specular reflected laser beam will strike close to or on detector 6 in the middle of the detectors 4 to 8.

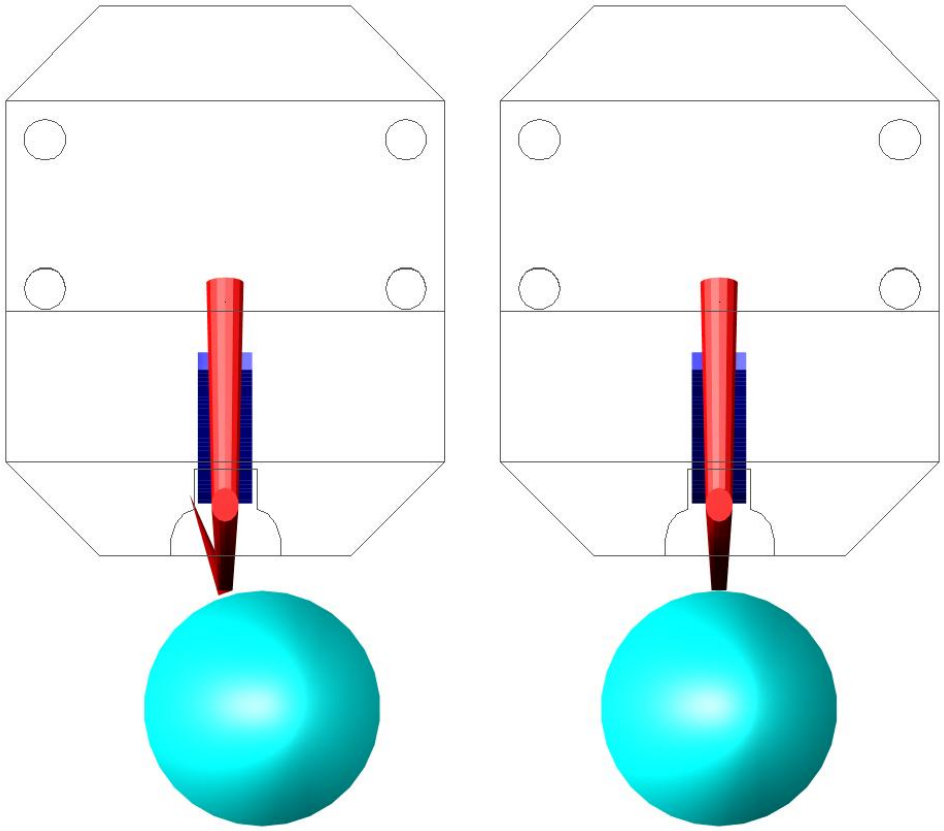


6212 on Flat Surface with 0.10 inch Base Plate to Set Vertical Alignment

Horizontal

The Lasercheck is also sensitive to horizontal misalignment on curved surfaces.

If the Lasercheck Head is correctly aligned, the reflected and scattered laser light reflects back into the center of the detector window. If it is misaligned, the reflected and scattered laser light reflects to one side or the other of the center of the detector window.

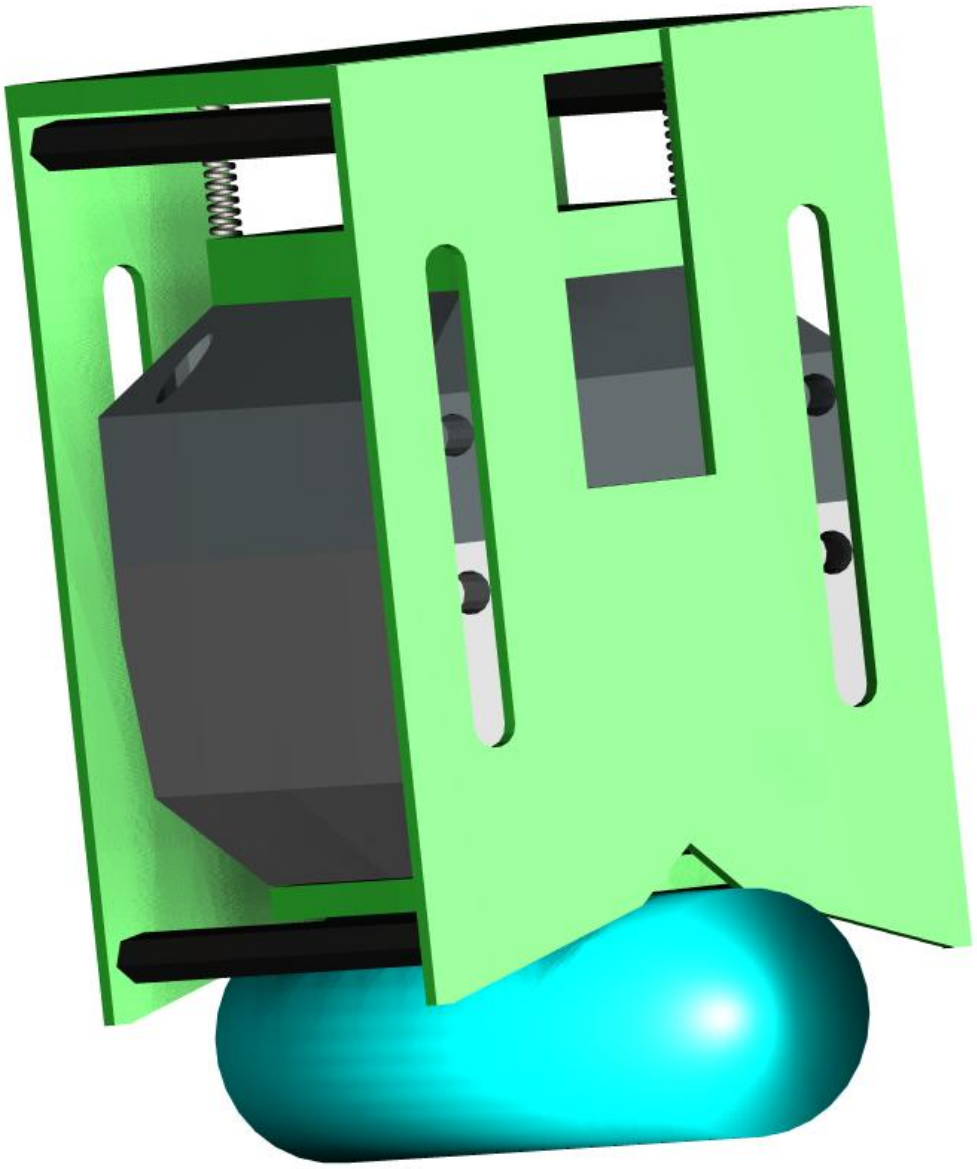


6212 End View showing misaligned and aligned cylindrical surfaces

This figure demonstrates horizontal misalignment because the laser beam and scatter does not reflect back into the center of the head where the sensors are positioned. When a cylindrical surface is perfectly horizontally aligned, all laser reflection is back into the centerline of the Lasercheck head.

Cylindrical Surface Measurement Alignment Fixture

Lasercheck can be equipped with our optional model 6216 spring loaded alignment fixture. This simple to use fixture, when attached to the Lasercheck head will set horizontal position of the head perfectly on cylindrical shaped surfaces ensuring accurate measurements.

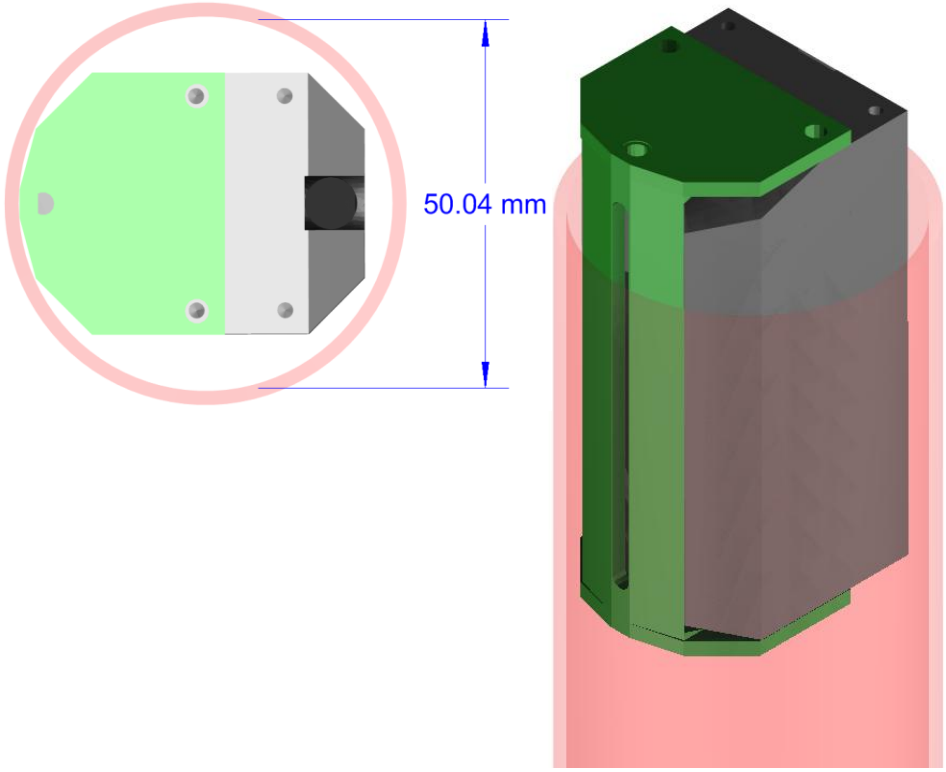


6212 on Cylinder Surface with Alignment Fixture Setting Correct Horizontal Position

Bore ID Surface Measurement Alignment Fixture

Lasercheck can be equipped with our optional model YMC070016 bore ID measurement alignment fixture. This mates and centers with a range of bore curvatures setting correct vertical and horizontal position of the head ensuring accurate measurements.

The YMC070016 fixture on the 6212 measurement head can be used on any ID bore diameter 2 inches (50 mm) or greater. This measurement capability is suited for large high quality bores like engine cylinder bores and hydraulic shafts that have been honed to high surface quality.



6212 in Cylinder Bore with Alignment Fixture End and Perspective View

Directional / Rotational

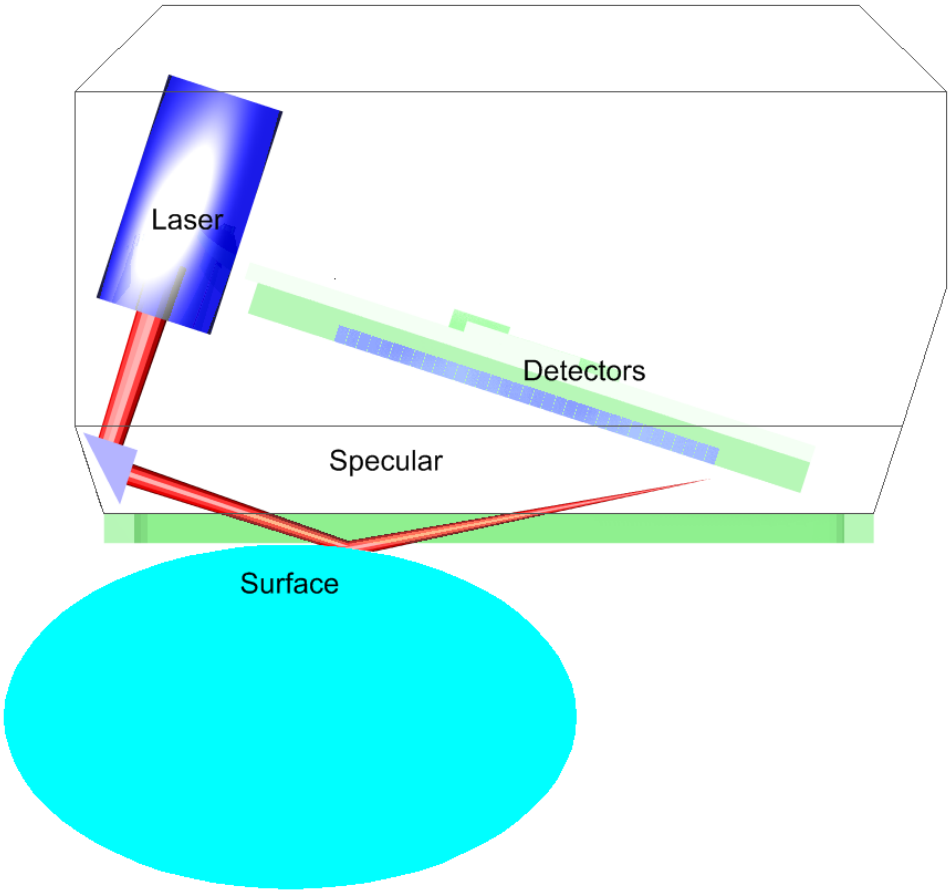
Many machined surfaces have a dominant direction of roughness. The length of the Lasercheck head must be oriented perpendicular to the direction of roughness so that the scatter strikes the detectors, which are oriented in a line down the middle of the head. Well-designed mounting hardware will ensure proper orientation.

If Lasercheck is not aligned at right angles to grinding groves on a directional ground surface for example (or straight along the length of a cylindrical barrel) then the “line” of scattered light will not perfectly fall on the detectors in Lasercheck. Well-designed fixtures will ensure accurate measurements.

Custom Shapes and Fixturing

3-Dimensional Shapes

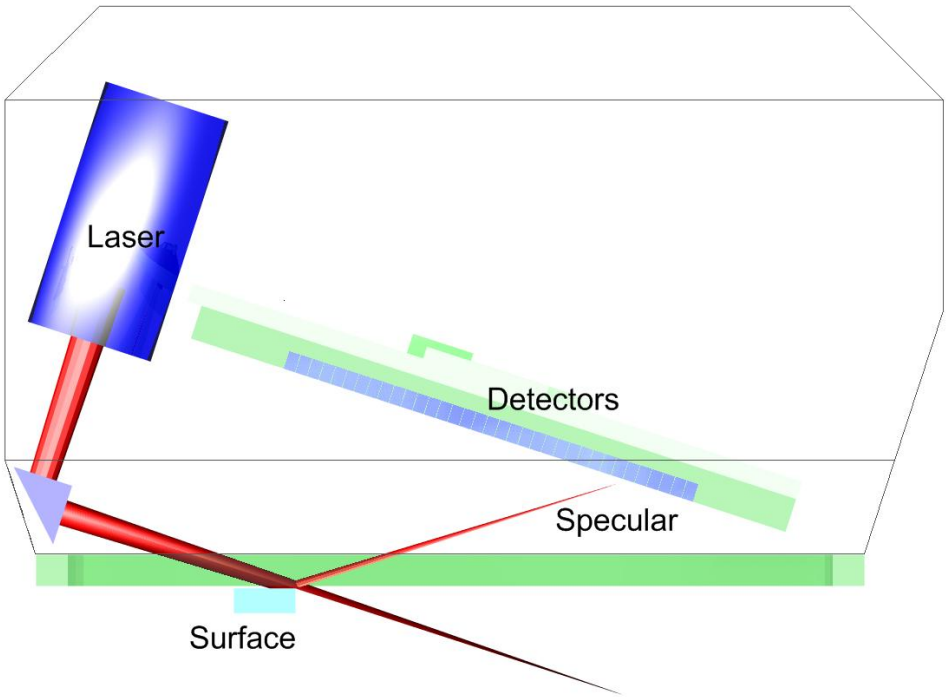
3-Dimensional curvatures and shapes cause Lasercheck to become easily misaligned either in the vertical or horizontal axis. Fixturing must be designed to carefully and repeatably control positioning in both axes so that the specular reflected beam strikes in the middle of the first 11 detectors and the overall reflection falls into the center of the detection window as viewed from the end of the measurement head.



6212 on “3-D” Curved Surfaces showing misalignment

Small Surfaces

Surfaces that are smaller than the actual footprint of the laser spot (approximately 5 to 6 mm long X 1 mm wide) can be measured. The part of the laser beam that “overfills” the surface can be allowed to pass by. It is important to ensure that part of the beam is not allowed to strike a “secondary” surface and reflect back into the sensors. This would affect the reading and the results of the “primary” small surface measurement. Fixturing must be designed to accommodate this requirement.

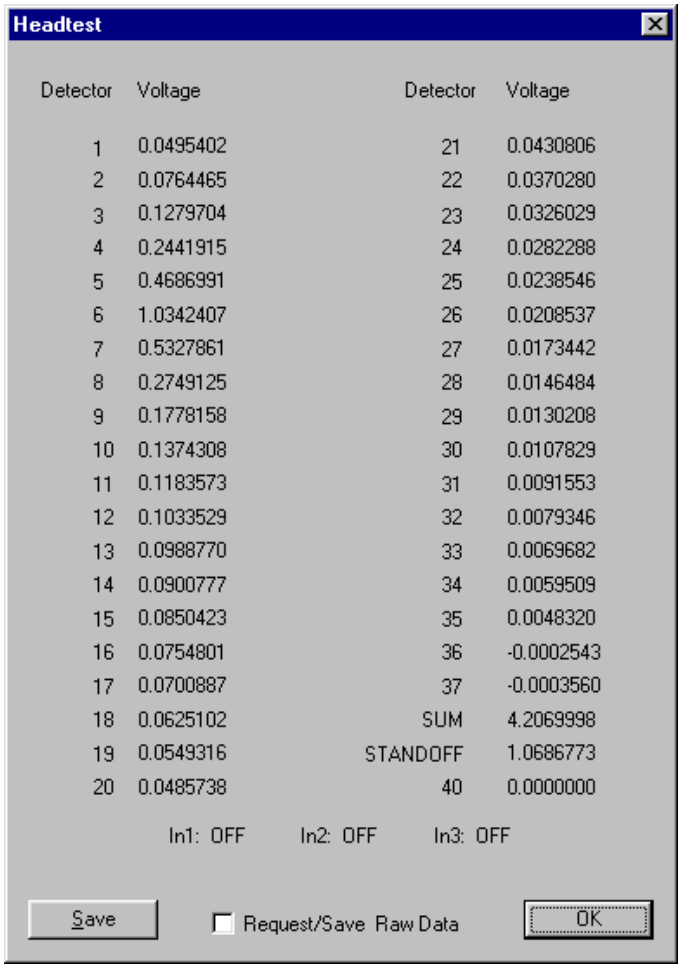


6212 can “over-illuminate” a small surface and measure roughness

Measure/Headtest Dialog Box

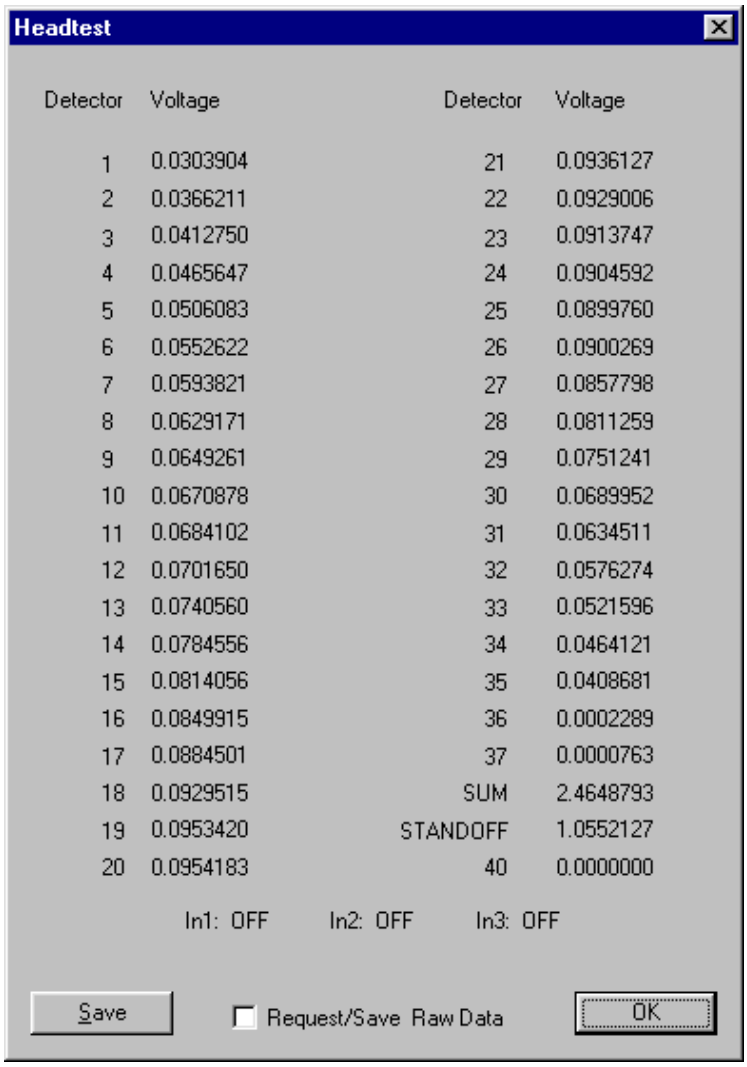
Measure/Headtest Screen A and B are printed out from our Measure/Headtest selection in our windows software. In this screen, you will see Lasercheck values displayed beside numbers 1 to 37. Numbers 1 to 35 are voltage readings from the 35 array detectors. Also displayed is a sum of voltages from all detectors and a "relative" height standoff calculation. Nothing is displayed beside number 40. Measure/Headtest can be used to assist in alignment of the Lasercheck head.

Measure/Headtest Screen A



Measure/Headtest Screen A shows a well-aligned smoother surface. A well-defined specular beam is maintained as it bounces off the surface into Lasercheck. It displays itself as the largest voltage readings in the array at # 6. A relative indication of the Lasercheck standoff height from the surface is also indicated. *Note: this Standoff Distance calculation is a relative reading only; the absolute values are not correct.* If Lasercheck were moved away from the surface, the specular laser beam would move up to detectors # 5, 4, 3, 2, 1 etc. and the standoff reading indication would increase. If Lasercheck were moved closer to the surface, the specular laser beam would move down to detectors # 7, 8, 9 etc. and the standoff reading indication would decrease.

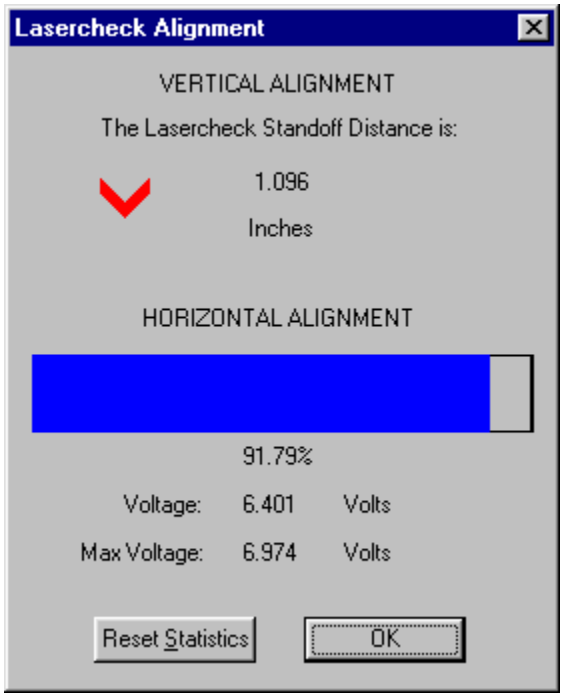
Measure/Headtest Screen B



Measure/Headtest Screen B is a display from a rougher surface. The specular beam is now lost as it bounces off the surface into Lasercheck. There is no obvious large voltage anywhere in the array. The standoff reading indication is no longer reliable. On these rougher surfaces, we cannot do height alignment with Lasercheck's help. What must be done is to either align on a smooth surface in the exact position the rough surface is at or make the rough surface look smooth to Lasercheck for just the alignment. A reliable way to make a rough surface look smooth to Lasercheck is to wipe a thin film of oil on the surface. This makes the surface look "slick" to the human eye and to Lasercheck. Position the oiled portion of the surface under Lasercheck and proceed with the vertical alignment using the Measure/Headtest to position the specular center on detector # 6.

It is important to perform this alignment at least once because the signals from a well-aligned rough surface can be identical to signals from a misaligned smooth or rough surface. You must be certain Lasercheck is aligned to rely on "rough" surface measurements.

Measure/Align Dialog Box



Horizontal Alignment with Measure/Align

Measure/Align in the windows software will help you with horizontal alignment on cylindrical surfaces. Remember SUM is a sum of all of the voltages from the detectors. When horizontally aligned, you will obtain the largest possible value on Bar Graph and indicated percentage because more light is reflecting into the center of the detector window and detectors. Move the head back and forth ***COMPLETELY*** over a cylindrical surface. This allows software to "learn" the optimal position. You will see this value go up and down. Position Lasercheck for maximum signal after at least one complete pass over the cylindrical surface. The continually updating bar graph helps with horizontal alignment.

Once it is found, then the head must be positioned to achieve a value as close to that maximum as possible.

NOTE: *Do not assume that a 100% reading in the Measure/Align dialog box is correct.* You must be sure to pass the head back and forth over the surface one or two times so that the maximum possible value can be learned.

Verifying Alignment Procedures

Set Head Close Correct Position

Horizontal and vertical alignment should be close before performing any alignment with Measure/Headtest or Lasercheck Windows software. If Lasercheck is badly misaligned, than the software cannot locate the specular laser beam for vertical alignment and has little or no signal for horizontal alignment.

Align Horizontally

Horizontal alignment works best on a clean, rough surface (greater than 10 microinches) with a dominant roughness direction, for example a ground surface. With alignment aid Measure/Align, set the horizontal alignment as close to optimal as possible. This is done by maximizing the value of SUM displayed on Measure/Headtest software or by maximizing the horizontal alignment percent within Measure/Align.

Align Vertically

Vertical alignment works best on a smooth surface. Move the head up or down over a smooth area (or a rough area coated with a film of oil). Use Measure/Headtest to position the specular beam on # 6.

Verify Alignment

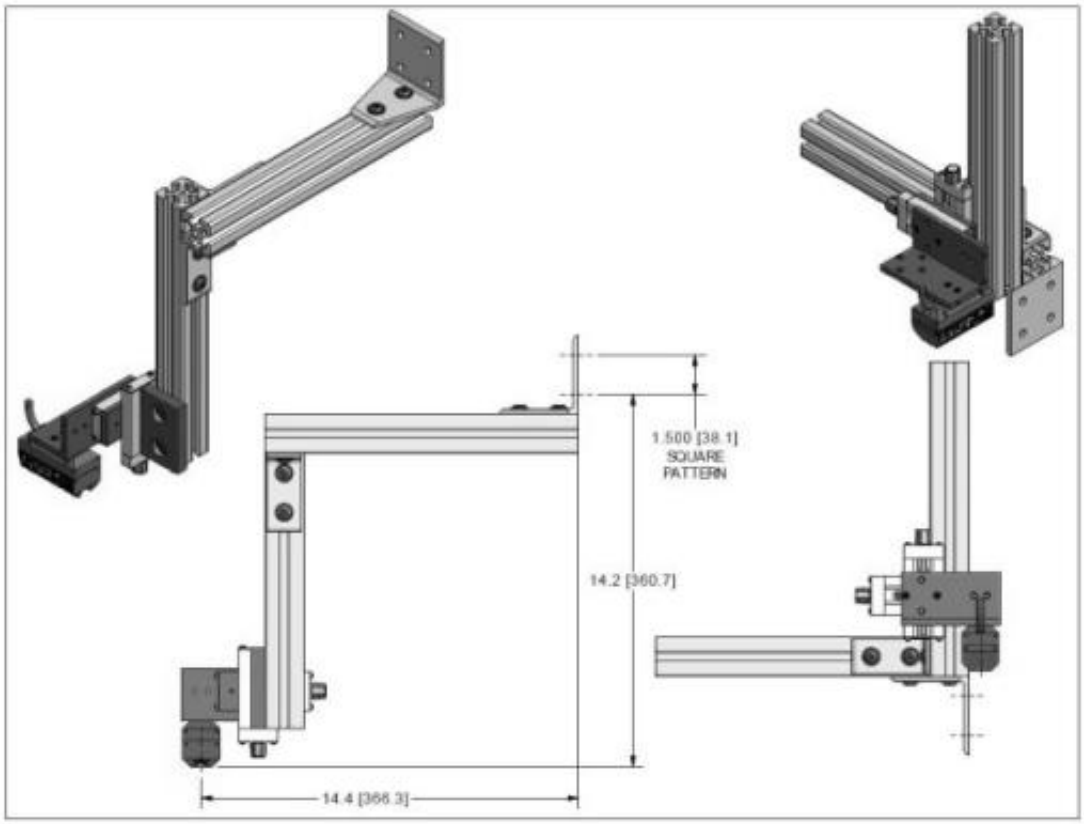
Check visually and with software that horizontal alignment has not changed during the process of performing vertical alignment.

As surfaces get rougher, resolution of Lasercheck decreases and sensitivity to misalignment increases. Mounting and alignment stability becomes more important to maintaining high repeatability from Lasercheck. The important issue to appreciate is that on smoother surfaces, Lasercheck has more tolerance to misalignment, shaking, vibrating, etc. On rougher surfaces, Lasercheck does not have as much tolerance for misalignment, shaking, or vibrating.

Appendix B – Mounting/Fixturing Lasercheck

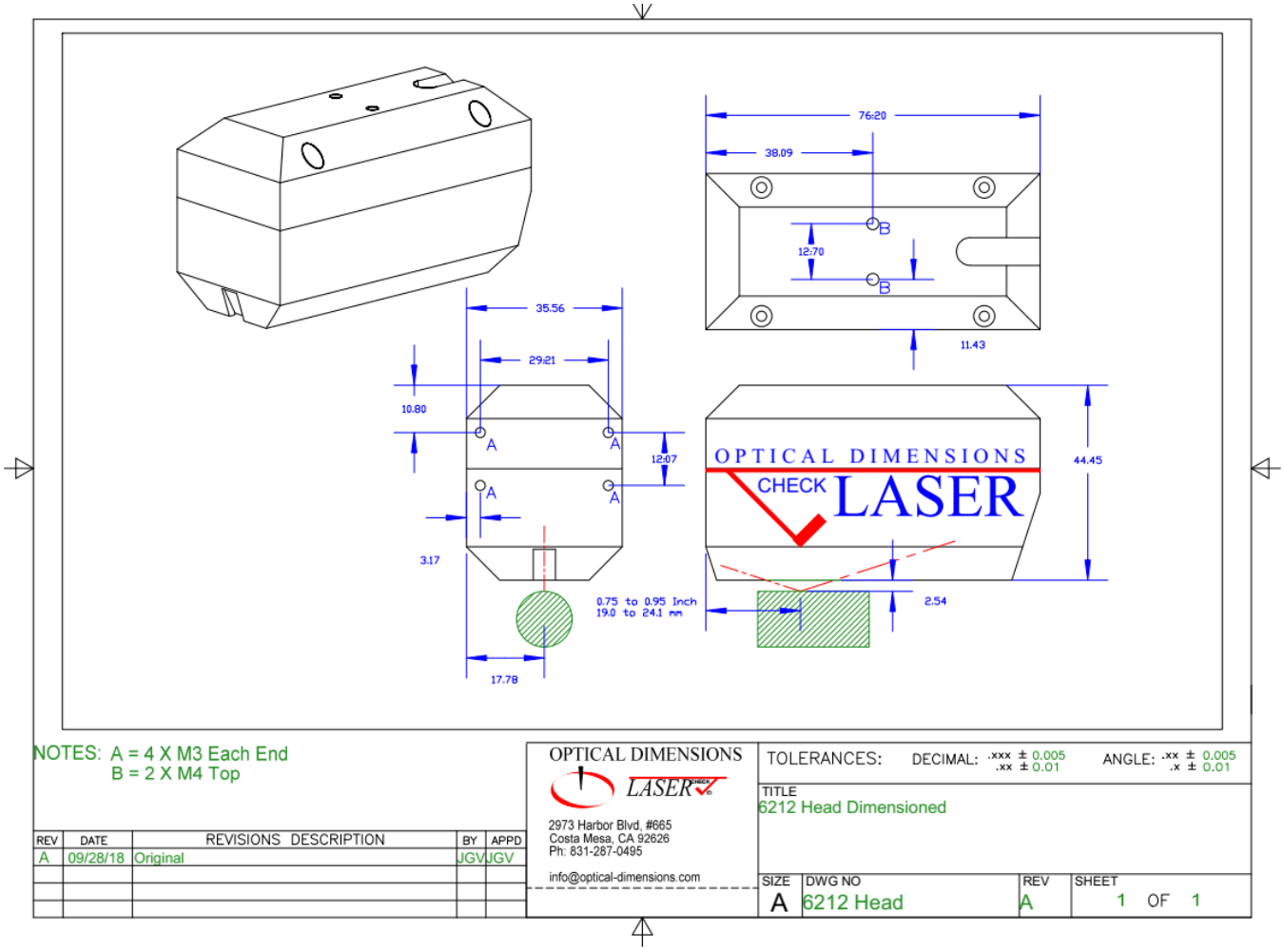
There are drilled and tapped holes on the Lasercheck sensor that can be used for mounting and installing the Lasercheck in an automated inspection application. The sensor should be positioned at a location where surface will be at the correct vertical and horizontal position relative to the gage sensor. The Lasercheck sensor must be precision adjusted over the surface in 2 axes (X and Z position) for optimal mounting / alignment.

Optical Dimensions provides an optional adjustable mounting fixture (model 706200) that provides necessary adjustment of sensor position in an on-line measurement application.



706200 Adjustable XZ Mount

Existing Mounting Holes on Lasercheck Sensor



The CAD image above provides dimensional information for mounting of Lasercheck sensor over a cylindrical surface. IMPORTANT: the position of the measurement sensor relative to the surface is an approximate value. All mounting designs must incorporate fine positioning adjustment of the Lasercheck sensor in the X and Z axis to set correct alignment using Lasercheck software aids.

Appendix C - Setup Files

Setup file format

```
RECEIVE_NAME=          example.set
FILENAME=      example
START_INPUT=  MEAS / SERIAL / EXTERNAL1
RA_UNITS=      MICROINCHES / MICRONS
RA_LIMITS=     15.00   20.00
LOW_ANALOG=15.00
HIGH_ANALOG=           20.00
RA_THRESHOLD=          12.00
CAL_TYPE=      POWER / EXPONENTIAL
CAL1=   -11.90  14.81   0.00    0.46
CAL2=   0.00    3.90    2.50    4.70
CAL3=   1.10    -6.44   26.80   MAX
CAL4=
CAL5=
PCAL1= 12.791  0.6404  MAX
EOF
```

RECEIVE_NAME

This is the name that will be saved in the control box and displayed on the control box LCD screen. The name must be any number of characters up to eight in length.

FILENAME

This is the prefix of the filename to which the data is saved. The prefix must be five characters that are used to create an incremental data file; abcde will create files named abcde001.txt, abcde002.txt, etc. If “DATE” is used, then the system date will be used to start the file name (i.e. 0428_001.txt).

START_INPUT

MEAS

Responds only to front panel pushbutton. Single value response only sent to front panel LCD and to serial port.

SERIAL

Responds to front panel LCD and to Windows software through serial port.

EXTERNAL1

Respond to front panel LCD and to Windows software through serial port. See the Appendix – Input and Output Pinouts for the details of wiring the inputs.

RA_UNITS

This sets which units the Ra is displayed on the LCD screen.

The RA_UNITS options are microinches, microns, or nanometers.

RA_LIMITS

This option accepts two numbers; the first is the minimum and the second is the maximum Ra value of the surface specification. This sets the specification range for Ra values. If a measured Ra is outside (lower than the minimum or higher than the maximum) these values pins on the control box output port (Ra_Limit) momentarily close. An “out of spec” indicator, or automated part rejecter can be connected to these pins to alert operators and / or reject parts when they are outside of specification.

ANALOG_OUTPUT

LOW_ANALOG

This option is used to configure the low current or voltage setting of the Analog_Out pin of the output connector. This number shall determine the Ra value that will generate 0 Volts or 4 milliamps output at the pins.

HIGH_ANALOG

This option is used to configure the high current or voltage setting of the Analog_Out pin of the output connector. This number shall determine the Ra value that will generate 10 Volts or 20 milliamps output at the pins.

Jumper Settings for Setting Analog Output to 4-20 mA or 0-10 V

Jumpers JP2 and JP3 on top board inside of control box must be set to configure 0-10V voltage or 4-20 mA current output. Set JP2 and JP3 to “C” for 4-10 mA current output or to “V” for 0-10V voltage output.

RA_THRESHOLD

The Ra threshold set by factory for optimizing calibrations on low or high Ra surfaces. Default is -1.

CAL_TYPE

Set by factory for optimizing calibrations. Options include:

- POWER
- EXPONENTIAL
- “CAL1, CAL2, CAL3, CAL4, and CAL5”.

CALIBRATION

Set by factory for optimizing calibrations. See discussion in Appendix C - Calibration Procedures.

Default.set setup files

Many different setup files can reside on the controller so users can scroll to, and use these different setups for different applications. The first setup file to “load” when the controller is started is typically the most recent setup file that was loaded onto the controller. If desired, one setup file can be configured to always load whenever the system is turned on by naming the setup file “Default.set”. The first two lines will read:

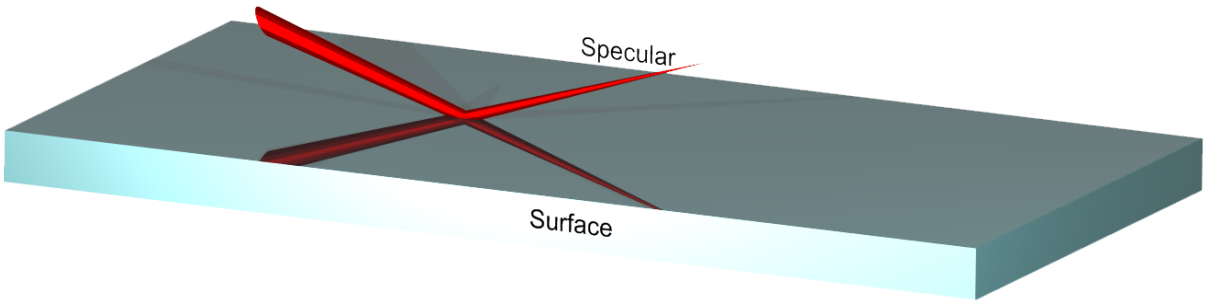
RECEIVE_NAME= default.set
FILENAME= default

Appendix D - Calibration Procedures

Theory - Measurement and Calibration

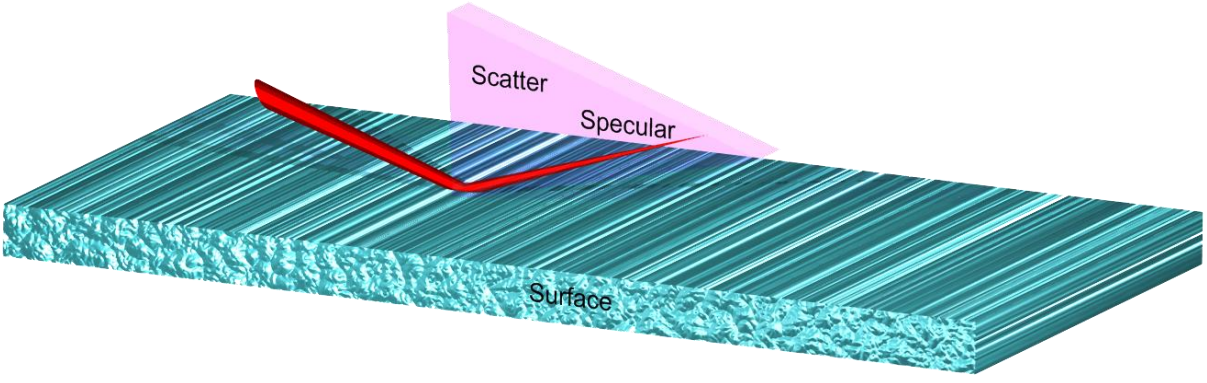
Measurement of Roughness

Lasercheck technology is based on measuring change in properties of a laser beam reflecting from a surface. When a laser is shone on a perfectly smooth mirror like surface there will be a clean “specular” laser reflection off that surface.

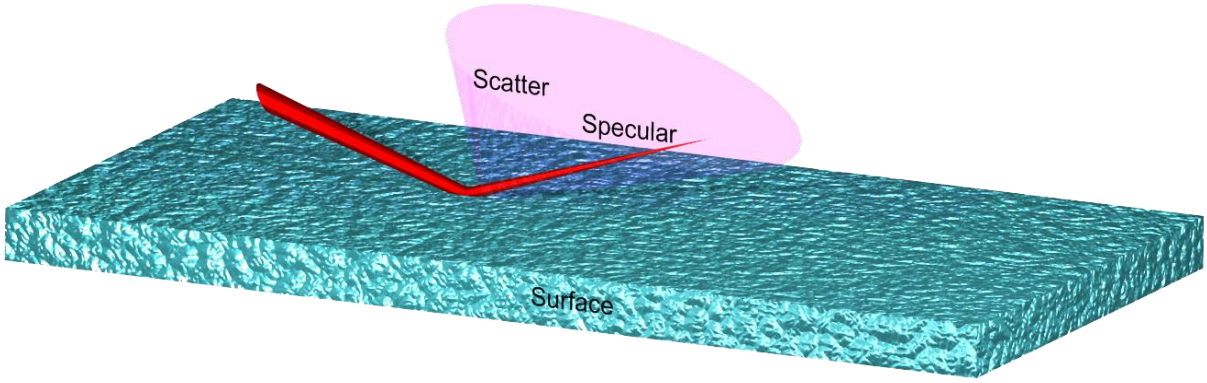


If a surface is not perfectly smooth and has some roughness the laser reflection will contain some diffuse reflection (scatter) in addition to the specular reflection. The “shape” of the pattern of scattered light is affected by the microscopic surface roughness pattern created by the machining operation used on the surface. Two simple examples to illustrate surface pattern affecting roughness pattern:

1) A directional belt sanding operation creates a roughness pattern on a surface that is highly directional. This directional roughness pattern generates a scattered light reflection pattern that is also highly directional, visually appearing like a 2D “stripe” of scattered light.



2) A sand blasting operation creates a roughness pattern on a surface that is non-directional or isotropic. This non-directional roughness pattern generates a scattered light reflection pattern that is also non-directional, visually appearing like a 3D “cone” of scattered light.

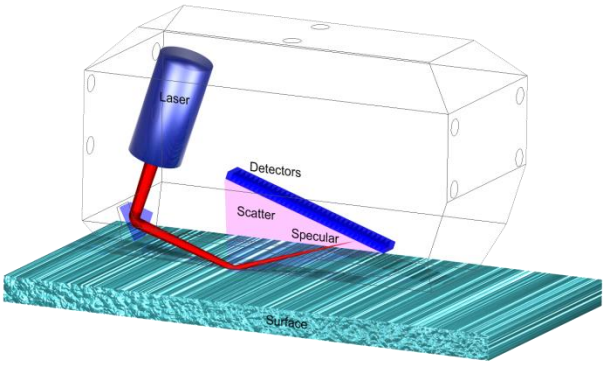


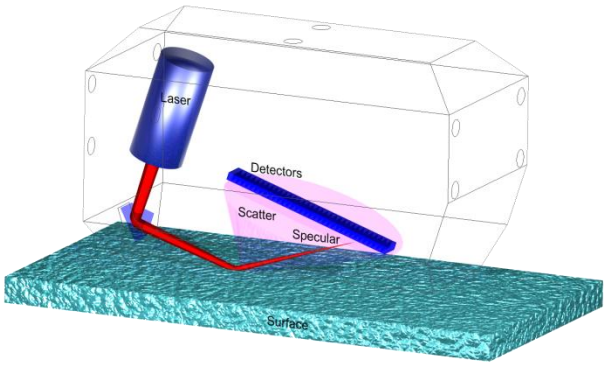
There are other examples of unique surface roughness pattern from various machining operations (swirl pattern, repeating groves, random / fractal, predominant peaks, predominant valleys) that uniquely affect the shape of the scattered light pattern.

Within any machining operation, as surface roughness increases, the specular portion of reflection decreases in intensity and the scatter portion of reflection increases in intensity. Lasercheck measures that entire pattern of specular and scatter reflection to determine roughness of a surface.

Requirement for Calibration of Lasercheck to Specific Machining Operation

The images below are basic optical schematics of Lasercheck showing laser source, beam reflecting optics, and layout of detectors. In both cases Lasercheck is on surfaces with the same Ra roughness value, but different surface pattern from different machining operation. Note the detectors are arranged in a line. They measure all of the scattered light from the directional surface. They measure only a portion of the scattered light from the non-directional surface.





Lasercheck will measure different signals and calculate different roughness for these two surfaces with identical Ra. The surface roughness pattern (machining operation) and resulting scatter pattern therefore must be an integral part of any Lasercheck calibration.

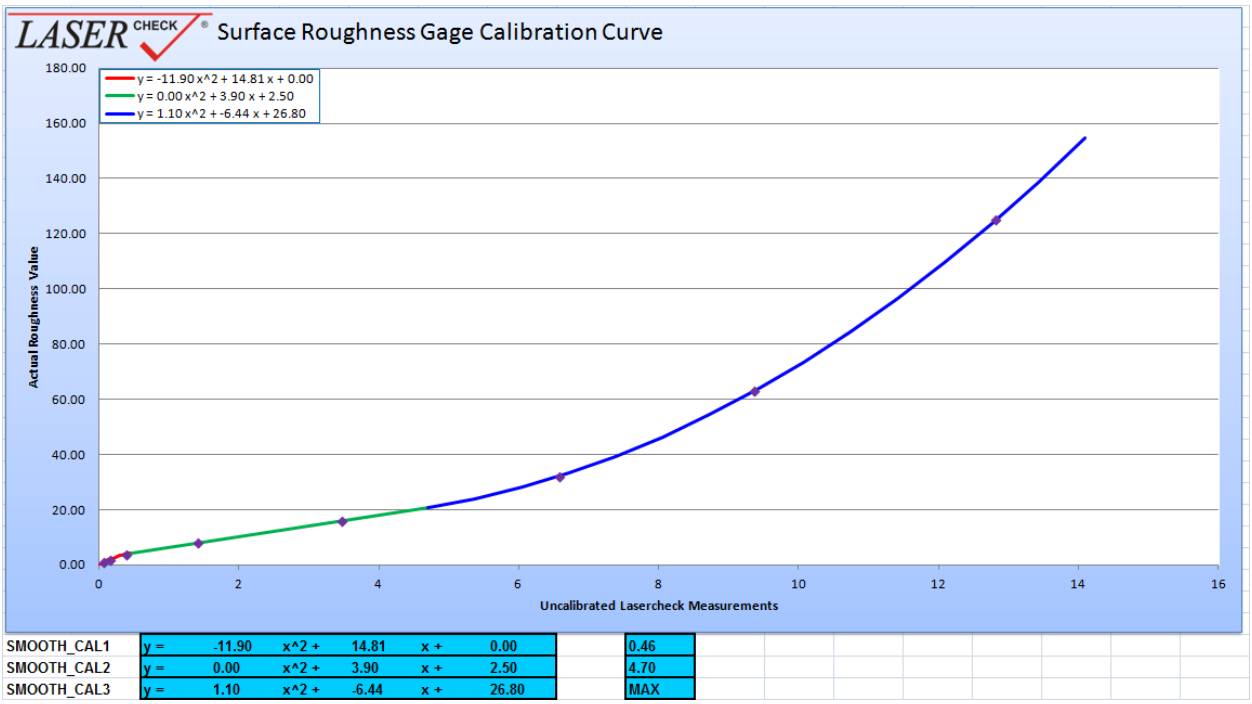
Base Calibration

Lasercheck is shipped calibrated to traceable standards for measurement of directional ground and sanded surfaces. Lasercheck can be calibrated for other surface finishing processes using an Excel spreadsheet calibration tool provided to generate a machining / surface pattern specific calibration file.

Overview of Calibration Process

Calibration of the Lasercheck gage involves customer testing known surfaces with the Lasercheck.

Lasercheck factory engineers use a custom excel spreadsheet tool to create a calibration file using those customer test values. Software in the Lasercheck instrument uses the new calibration file when it performs a measurement to provide users with roughness values calibrated to their finishing process.



SMOOTH_CAL1	y =	-11.90	x^2 +	14.81	x +	0.00	0.46
SMOOTH_CAL2	y =	0.00	x^2 +	3.90	x +	2.50	4.70
SMOOTH_CAL3	y =	1.10	x^2 +	-6.44	x +	26.80	MAX

Graph of directional ground surfaces from Lasercheck Excel Calibration Tool

Once a calibration is performed, Lasercheck never requires re-calibration for a specific surface finishing process; calibration never changes.

Appendix E – Input and Output Pinouts

Input: 9-Pin Female D-sub Connector

Internal Opto relay:

Pin 1, 6, 2 = Opto relay 1, 2, 3
Optically Isolated. **Must be connected to power (can use control box voltage – Pin 9).**
Pulls low to activate.
Voltage Range: 3VDC to 50VDC, ideal 5VDC
Max Ratings: 60 mA
Internal part: QT Optoelectronics MCT9001

Do NOT reverse input voltage!

Trigger pins:

Pin 3, 8, 4 = Trigger inputs 1, 2, 3 (Start, stop, save measurements)
Normally open, "switch" low (close) to ground to activate

Pin 7 = Ground of internal power supply (Connect to input triggers)

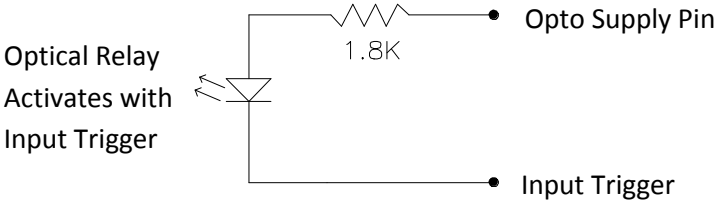
Power pins:

Pin 9 = 12 to 13 VDC from internal power supply
Pin 7 = Ground of internal power supply

Use only for powering external triggering devices that require power (such as inductive proximity sensors) and as Internal Opto relay supply voltage.

Pin	Signal	Function Inspect Continuous Surface	Function Inspect Individual Parts
1	Opto Supply 1	Power to Opto relay 1	
2	Opto Supply 3	Power to Opto relay 3	
3	Input 1	Initialize System to Begin	Start
4	Input 3	Start	Initialize System to Begin; Save
5	No Connection	No Function	
6	Opto Supply 2	Power to Opto relay 2	
7	GND (power supply ground)	Ground for Inputs 1, 2, 3	
8	Input 2	Stop and Save	Stop
9	+12 VDC (power supply)	Power for external trigger device and Internal Opto relay	

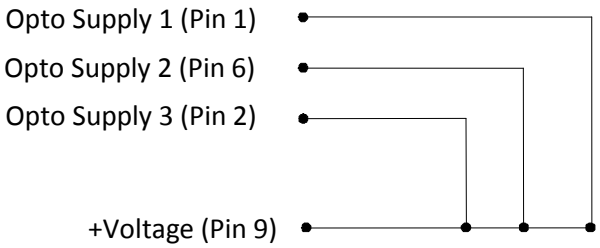
Internal Opto relay Schematic:



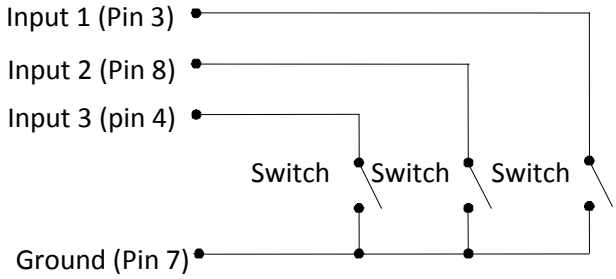
Typical Wiring Example:

1) Using Unpowered Switches for inputs:

a) Connect Power for Opto relays using Control Box Voltage (Pin 9)



b) Connect Switches between Ground (Pin 7) and Input Pin

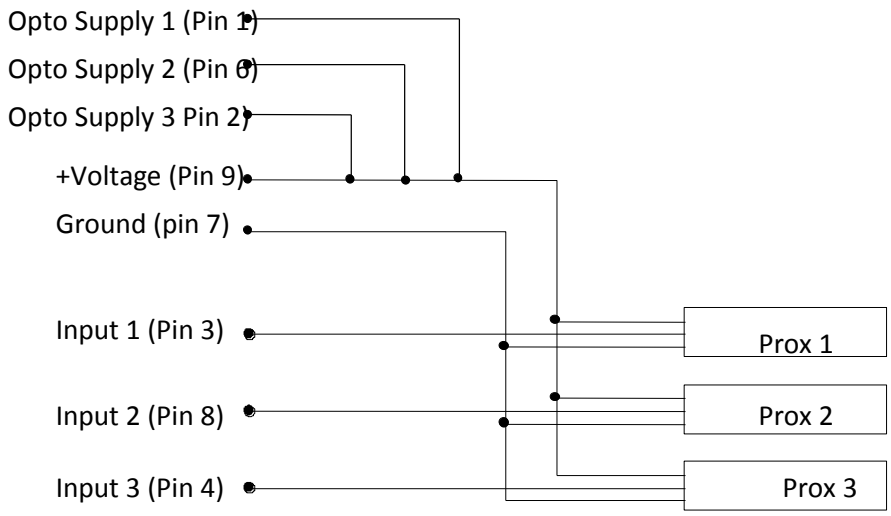


2) Using Powered Triggering Device (e.g. Proximity Sensors) for Inputs:

a) Connect Power for Opto relays and for Triggering Devices using Control Box Voltage (Pin 9)
b) Connect Triggering Devices between Ground (Pin 7) and Input Pin

Recommended Proximity Sensor Specifications:

- DC, NPN (short to ground to activate), shielded (for most applications), normally open output



Output: 9-Pin Female D-sub Connector

Failed part output. Closes when measurement is out of software specified range.

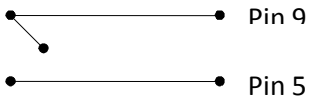
SPDT Relay, Resistive load Max: 200mA
Max Ratings: 30VDC @ 1A, 125VAC @ 0.1A
Internal parts: Omron G6E, connected internally with 28AWG ribbon cable

Pin	Signal
1*	Analog_Out + (0-10V / 4-20mA)
2	Not Used
3	Not Used
4	GND (system ground)
5	Ra_Limit (Closed if Out of Spec)
6	Analog_Out Ground (0-10V / 4-20mA)
7	Not Used
8	Not Used
9	Ra_Limit (Closed if Out of Spec)

*** NOTE:** Jumpers JP2 and JP3 on top board inside of control box must be set to configure 0-10V voltage or 4-20 mA current output. Set JP2 and JP3 to "C" for 4-20 mA current output or to "V" for 0-10V voltage output.

1) Output Schematic Ra_Limit

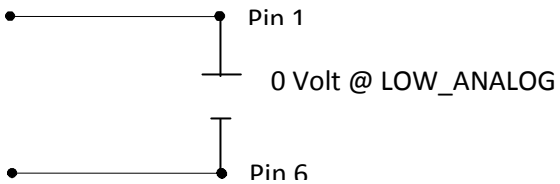
a) Normal State – Surface Within Ra_Limit – in Spec



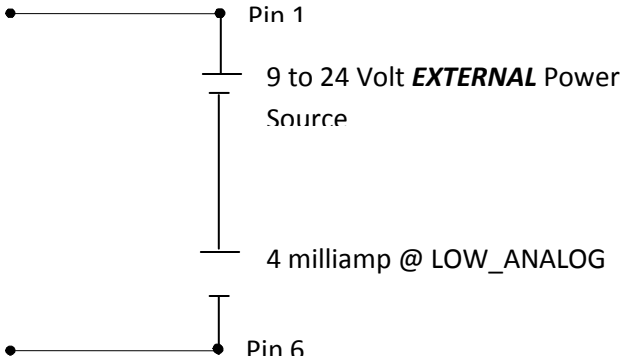
b) Surface Outside Ra_Limit – out of Spec

2) Output Schematic Analog_Out

a) 0-10V



b) 4-20mA



NOTE: 9 to 24 Volt power must be connected in series with Current Monitor (*Must be **External** power source*):