OPTICAL DIMENSIONS™
2973 Harbor Blvd, #665, Costa Mesa, CA 92626
Phone: (831) 287-0495
info@optica-ldimensions.com
www.optical-dimensions.com

LASER CHECK®

Surface Roughness Measurement Gages

6212C Manual Version 15_22 Rev 07-19

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Operations and Specification Manual for the

Lasercheck 6212C System

Manual Revision 15.22 Rev 07-19

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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	7 to 18 VDC

Other Features

Factory Calibrated to Ra Ground Surface Standards
Works on any material/color (rubber, glass, steel, etc.)
ASCII format Serial Communication via RS232 Interface
Ability for external triggering / remote control

SAFETY

Electrical

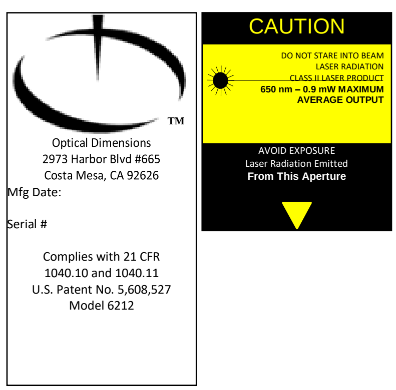
Lasercheck has been designed as a sealed and enclosed system. Voltages to operate the measurement sensor are low (0 to +5 Volts) to minimize shock hazard.

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:

OPTICAL DIMENSIONS
2973 Harbor Blvd, #665
Costa Mesa, CA 92626

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 and other measurement parameters are then available to be read from a serial connection on the electronics board. User software requests the measurement value from that serial connection via serial cabling to that connector.

Lasercheck has been designed for a nominal height standoff from the measurement surface. Minor motions and vibrations within that tolerance range will have minimal effect on measurement results. The Lasercheck head is delivered with flat fixture footplate that sets the standoff when the head is set on a flat or cylindrical surface. For other shaped surfaces, a custom footplate or fixture may be required to set the correct alignment and / or standoff distance. Please see the section on LASERCHECK ALIGNMENT PRINCIPLES AND PROCEDURES. Lasercheck can be configured so that surfaces may be positioned below the gage allowing measurements with no contacting of the surface.

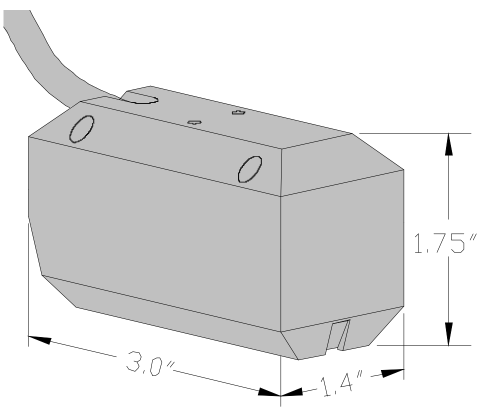
Setting up the Instrument

Unpacking Lasercheck

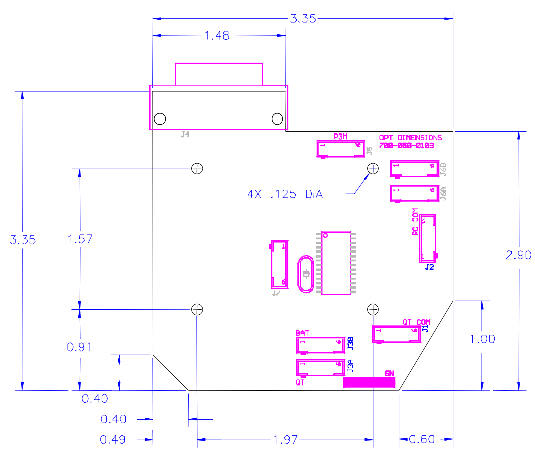
All components of Lasercheck have been inspected and tested individually and as a system before shipping. You should find the following items with your system:

1) Lasercheck measurement head.
2) Standoff (0.100”) plate (typically attached to measurement head)
3) Lasercheck control board
4) Wire harnesses, bare at one end, connector for serial and power to board at other end
5) CD or USB Memory Stick with Lasercheck Software Calibration & Setup Files, Plus Manual
6) Alignment feet for cylindrical surface measurement (optional).

Measurement Head



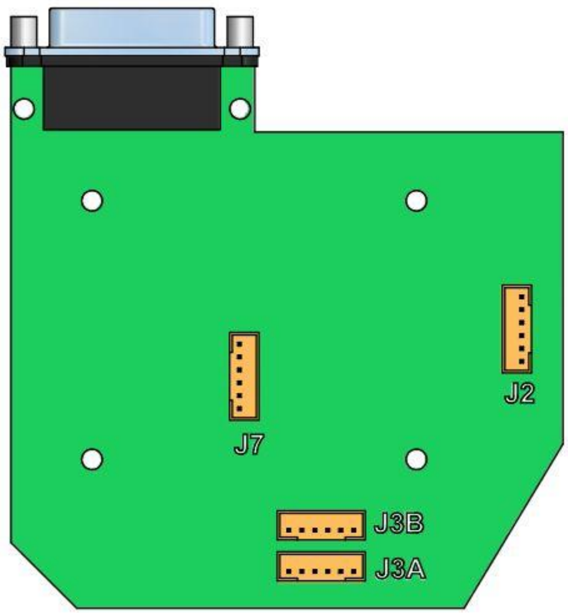
Control Board

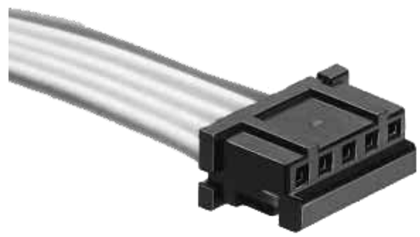


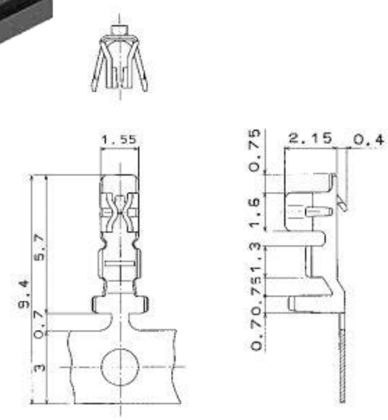
Basic Connections

The control board has a DB15 connector at the top which mates to the connector end of the measurement head cable. The cable should be secured with the thumbscrews on the cable.

The control board has several 6-position connectors labeled J1 through J7. Connections for basic functions are described below. Users can build connecting cables using compatible Hirose DF3-6S-2C Housings with Hirose DF3-2428SCF Tin Plated Crimp Sockets.



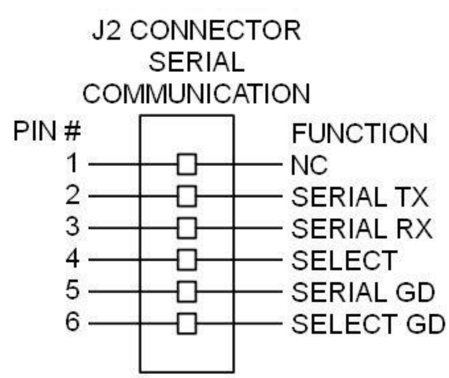




J1 and J2 Communication Connections

The control board has 2 communication connectors – J1 (5 volt buffered serial) for connection to a similar wired portable controller or J2 (standard RS232) for connection to a standard PC serial comm. port. Enable J2 by connecting SELECT (pin 4) to GND (pin 6). Note that both communication connectors provide identical communication. They differ only in wiring. When J2 is enabled, J1 becomes disabled.

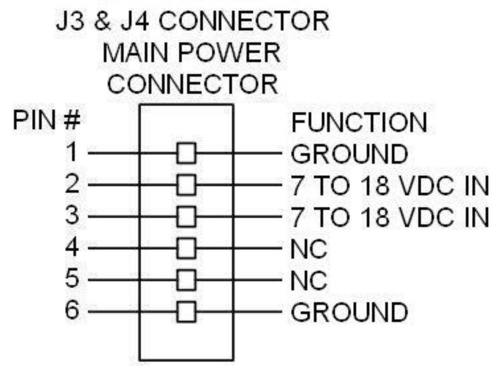
Pin	J1	J2
1	RX	-----
2	-----	TX
3	TX	RX
4	-----	Select
5	-----	SER GND
6	GND	GND



J3 and J4 Power Connections

The control board also has 2 power connectors, J3 and J4, which are powered by 7 to 18 volts DC at 100 mA. Pin 2 and Pin 3 both should be powered. Pin 2 is the main power to the board. Pin 3 powers a transistor switch providing other functions and 5 VDC to the board. Provide power to either connector, the second connector can be used as a tap to power external devices. See Appendix E for wiring examples.

Pin	J3 & J4
1	Ground
2	7 to 18 VDC
3	7 to 18 VDC
4	--------------
5	--------------
6	Ground



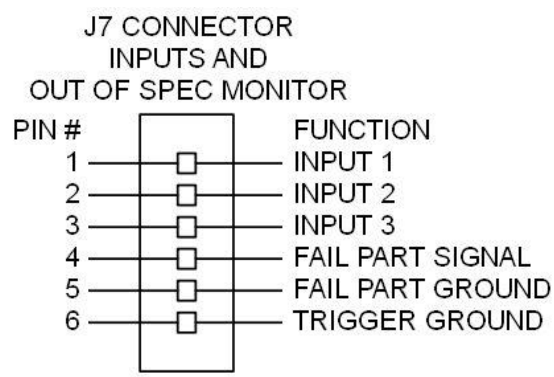
One connector can be used to provide power and the second can be used as a pass through to power other devices from the same power source.

J7 IO (Input / Output) Connections

The control board has an IO connector at location J7. The board can be configured to control measurements by closing Input Pin1 (INPUT 1) or Pin2 (INPUT2) to Pin 6 (ground). These are normally open. When command 03 is sent to the serial port, the measurement software will begin measurements as soon as Pin 1 and Pin 6 are closed. See Communications Protocol appendix for further functions.

Pin 4 and 5 indicate measurements in preset tolerance or out of tolerance (Failed Part Signal). These are normally open when measurements are in tolerance and will momentarily close after a measurement sequence if out of tolerance measurements are recorded.

Pin	J7
1	Input 1
2	Input 2
3	Input 3
4	Fail Part Signal
5	Fail Part Ground
6	Trigger Ground



Basic Operation

Once the cables are attached and measurement head is mounted and aligned, you are ready to perform a measurement. Lasercheck is run by specific requests (see the "Message Types" section under "Communication Protocol" in this manual) to the serial connection pins on the control board. The control board responds to these specific requests with measurement results to the same serial connection pins. Following is an abbreviated description for setup and alignment of a Lasercheck 6212C system and performance of a typical measurement.

Software Setup

The control board has software pre-loaded that initializes electronics, monitors the laser, reads detector signals, and calculates the alignment and surface roughness.

A CD or USB memory stick with a windows software program, calibration & setup files, plus the manual is provided. This software is installed on a separate computer.

To Install Lasercheck Software from Windows

1) Insert Lasercheck CD or USB memory stick 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 **6212C setup.exe.**

1)6)Finally, click on **Finish** button.

Running the System using Lasercheck Windows Software

Comm. port Baud rate

Connect comm. port connector J2 to an available comm. port on your computer. The defaul board comm. rate is 9600 (this is the only baud rate compatible with the included Lasercheck Windows software). If desired, use a secondary communications program and the following command to check:
Sending the following command checks the baud rate:

@20#<cr-lf>

You should see the following response:

@20,96,#<cr-lf>

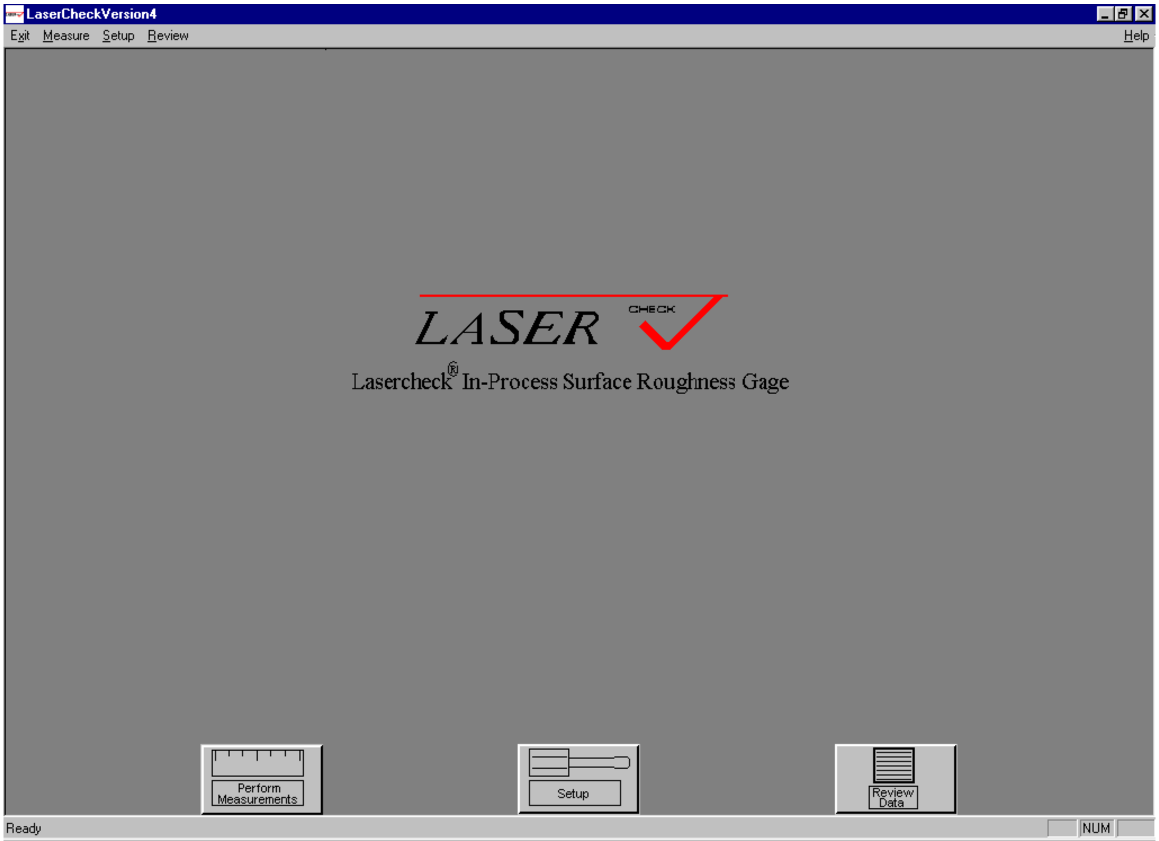
This indicates the baud rate has been correctly set at 9600. Sending the following command sets the baud rate to 9600 if it were ever changed and needed to be reset:

@20,96#<cr-lf>

Please see "Appendix A – Communication Protocol" for more details.

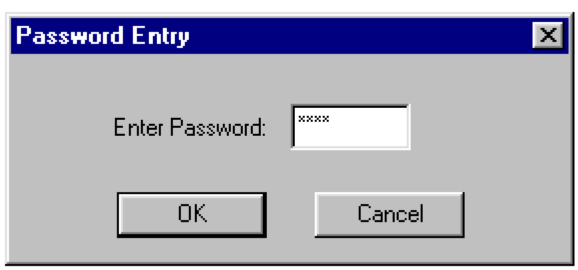
Turn on Lasercheck Windows Software

The LaserCheckVersion5.exe program was designed for advanced Lasercheck systems. It operates in a limited function with the 6212C system allowing initial testing. It will be installed in “C:\Program Files (x86)\Lasercheck 6212C\Lasercheck Program” folder. Running the program will bring up the main screen as follows:

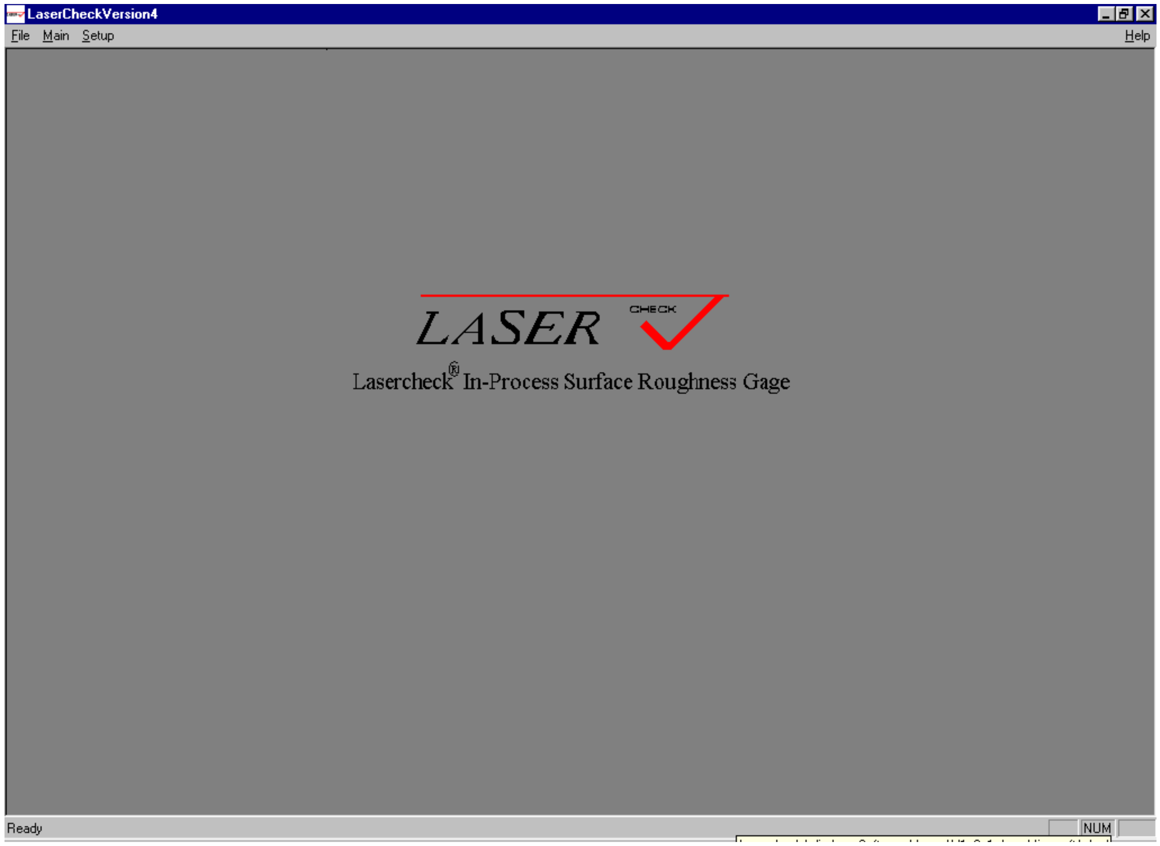


Set Comm Port on computer

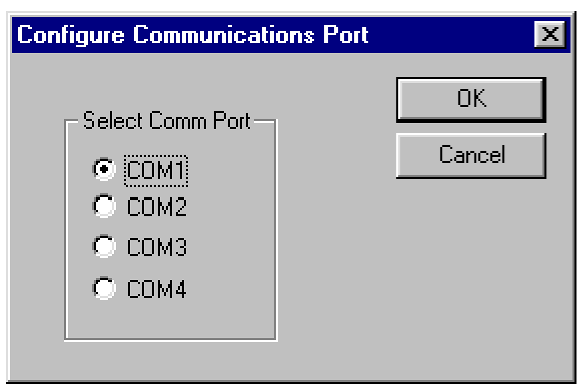
Select the “Setup” button. The following dialog box will appear:



Type in the password “4956” and the following setup screen will appear:



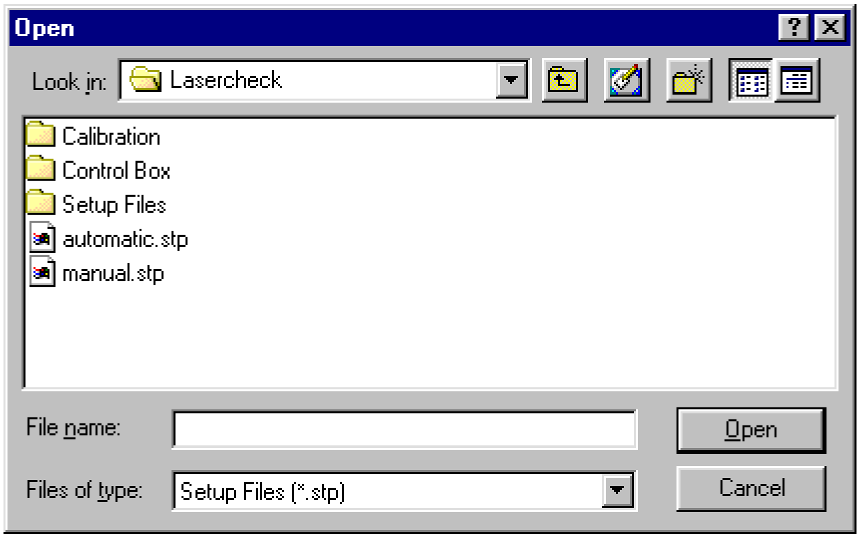
Select “Setup\Comm Port” and the following dialog box will appear:



Select the appropriate comm. port on your computer and select “OK”.

Review or Create Lasercheck Setup Files on computer

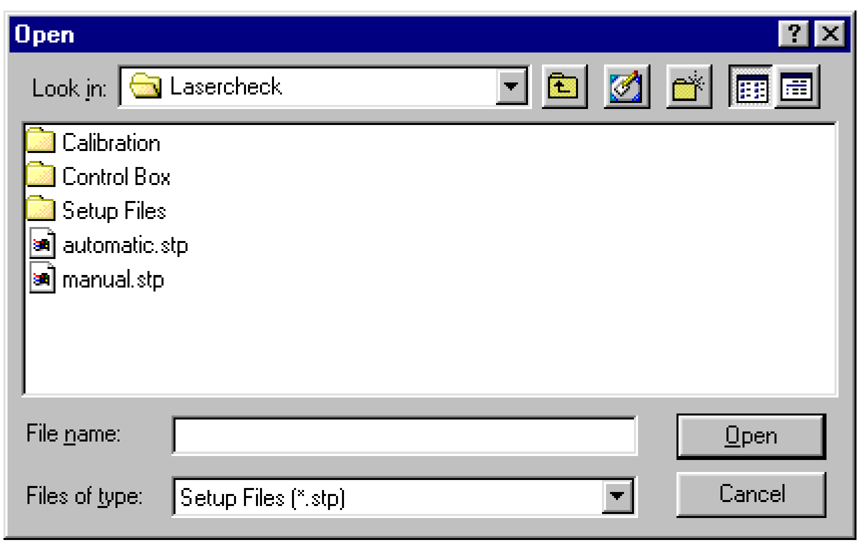
Select “Setup\Setup” and the following dialog box will appear:



When Lasercheck software is first installed on your computer, one or two sample setup files (*.STP) are loaded on your computer and will appear under the “C:\ProgramData\Lasercheck 6212C Files\Setup” directory. Navigate to this directory. You can open, review, edit, create new setup files and save them to this directory.

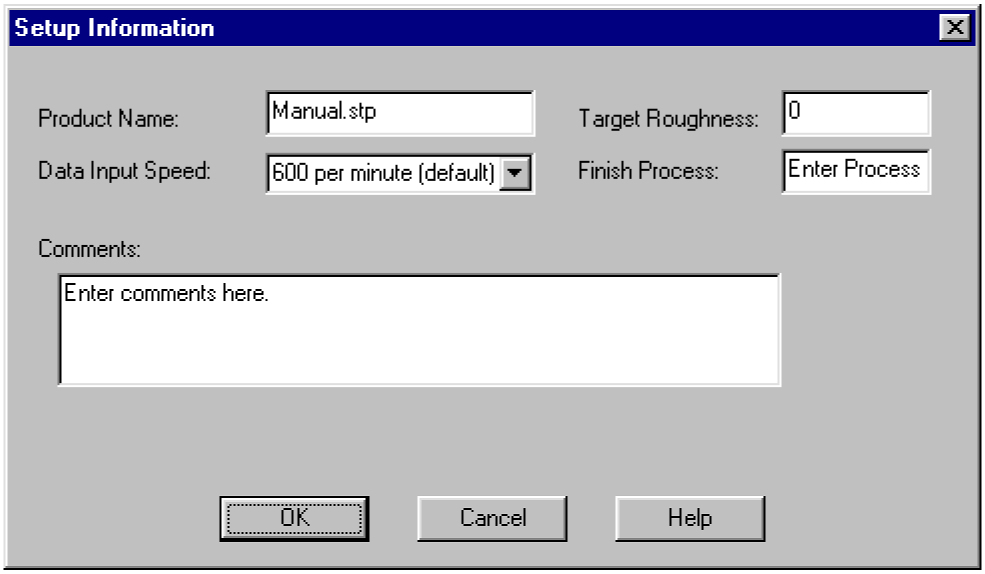
Perform Measurements

When returned to the “setup screen”, select “Main”. This will return you to the main screen. From there push the “Perform Measurements” button. Selecting the “Perform Measurements” push-button from the main window creates the “Open” dialog box.

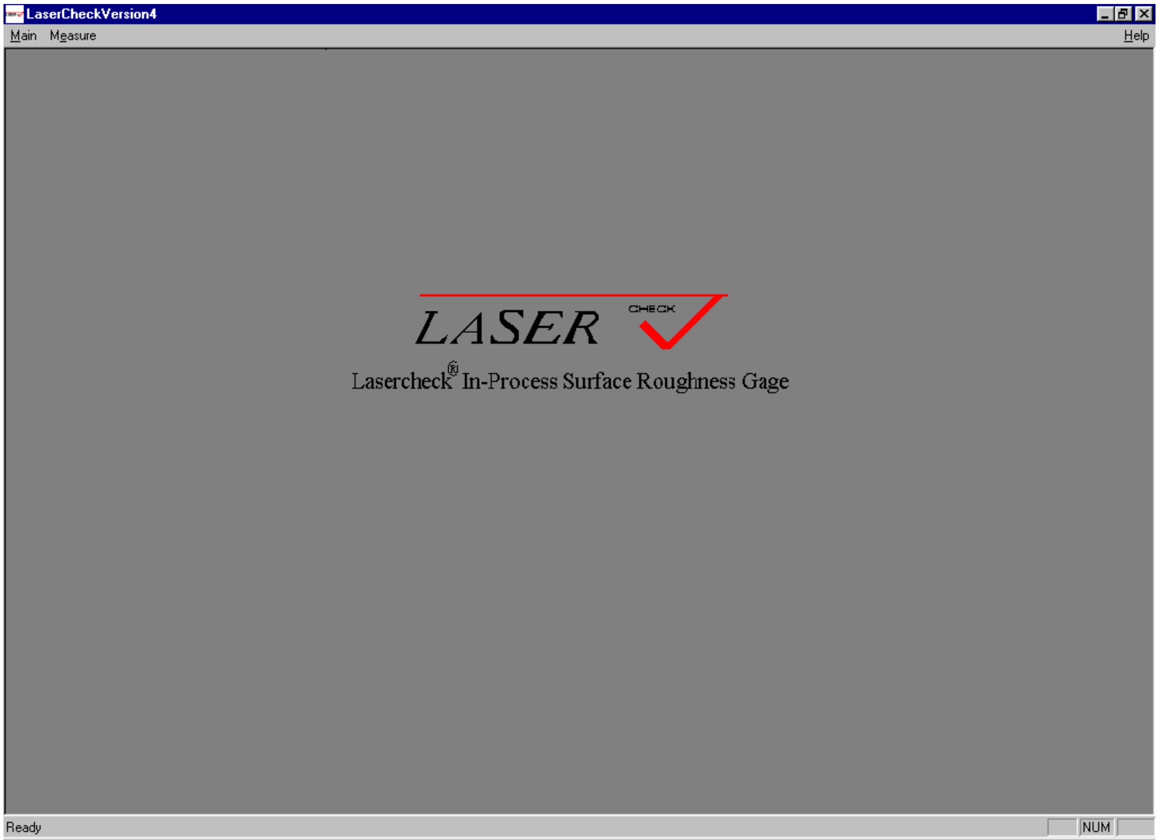


When Lasercheck software is first installed on your computer, one or two sample setup files (*.STP) are loaded on your computer and will appear under the “C:\ProgramData\Lasercheck 6212C Files\Setup” directory.

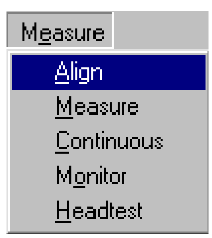
Navigate to this directory. For use with the 6212C Lasercheck system, select the “manual.stp” file. The following dialog box will appear:



If it is not the correct setup file select the “Cancel” push-button. This will return you to the “Main Measurement Window” where you can repeat the procedure of selecting a setup file. If the correct setup file appears, select the “OK” push-button. You will be presented with a Measurement Window:



Under the “Measure” selection, the following options appear:



Measure, Continuous, Monitor options will function and provide graphical, or digital measurements from the Lasercheck system. For a more detailed description of this software please refer to included archive “Lasercheck Windows Software Manual V1_6_1”. Test measurements can be saved to “C:\ProgramData\Lasercheck 6212C Files\Data” directory for review in the Review Data module found in the main startup screen.

Please note that the windows software was designed around a previously designed and now archived version of the model 6212A Lasercheck system. It is being provided as a test platform, but it is not fully functional and fully tested for use with the model 6212C system.

Physical Mounting

Manual Operation

The hand held version of the Lasercheck head is supplied with base plate 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.

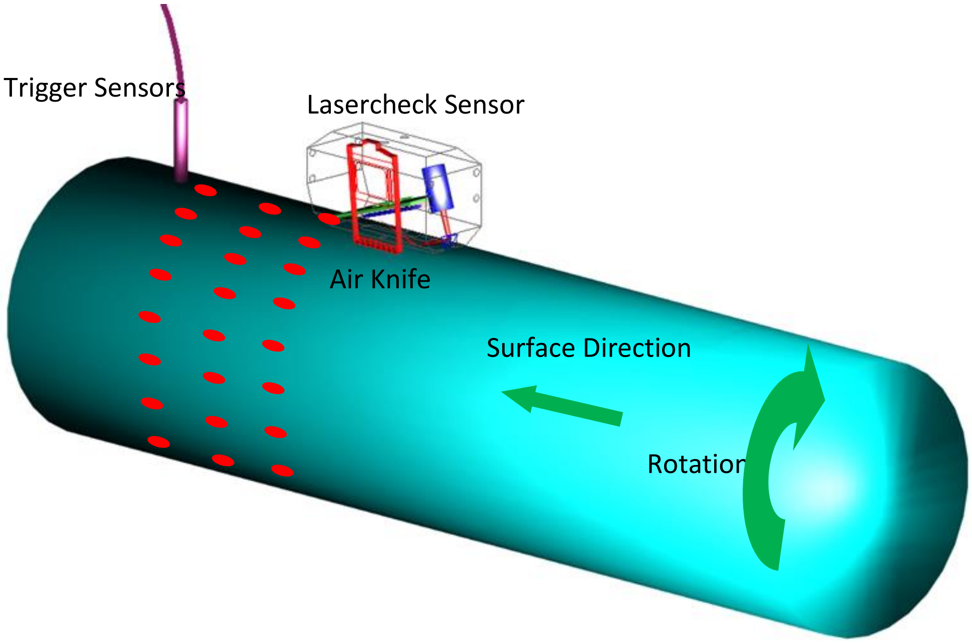
When performing measurements, set the rotational orientation so that the long axis of the head is perpendicular to the dominant "lay" of the surface that you wish to measure. The long axis of the head determines the direction of measurement in the same way that the direction of motion of a stylus on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

Automated Operation

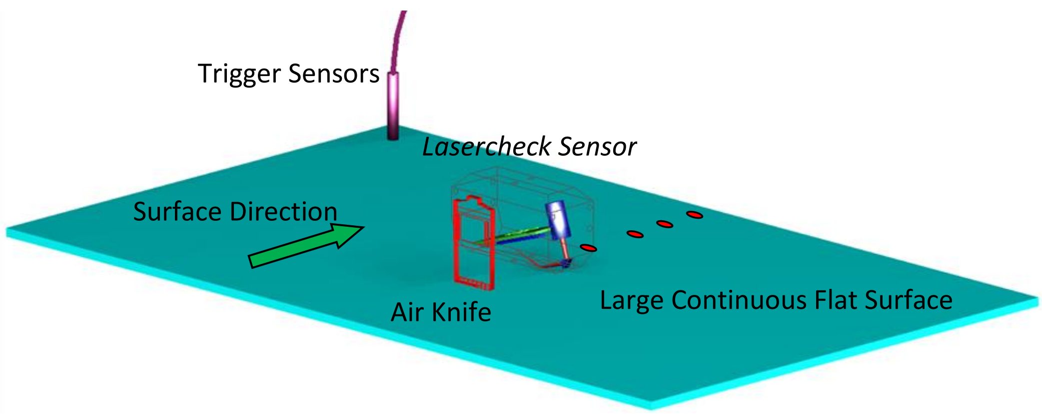
The Lasercheck can be used with external inputs to start and stop the measurements in an automated installation. Trigger input is Digital IN 1 or Pin 1 of connector J7. See the communications protocol section of this manual for detailed information on commands utilizing external triggering. Triggers can also be routed through external electronics, which use this information to time roughness requests to the Lasercheck system.

There are two common 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 sheets. All data points can be saved or displayed 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 would typically be averaged and only the single average of that part is saved and/or displayed; one average point for each start and stop input received.

Numerous Continuous Measurements



Lasercheck Sensor Mounted on Large Rotating Roll for Automated Continuous Inspection



Lasercheck Sensor Mounted on Large Flat Sheet for Automated Continuous Inspection

Lasercheck Head Mounted over Large Surfaces 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.

Individual Parts / Parts Inspection

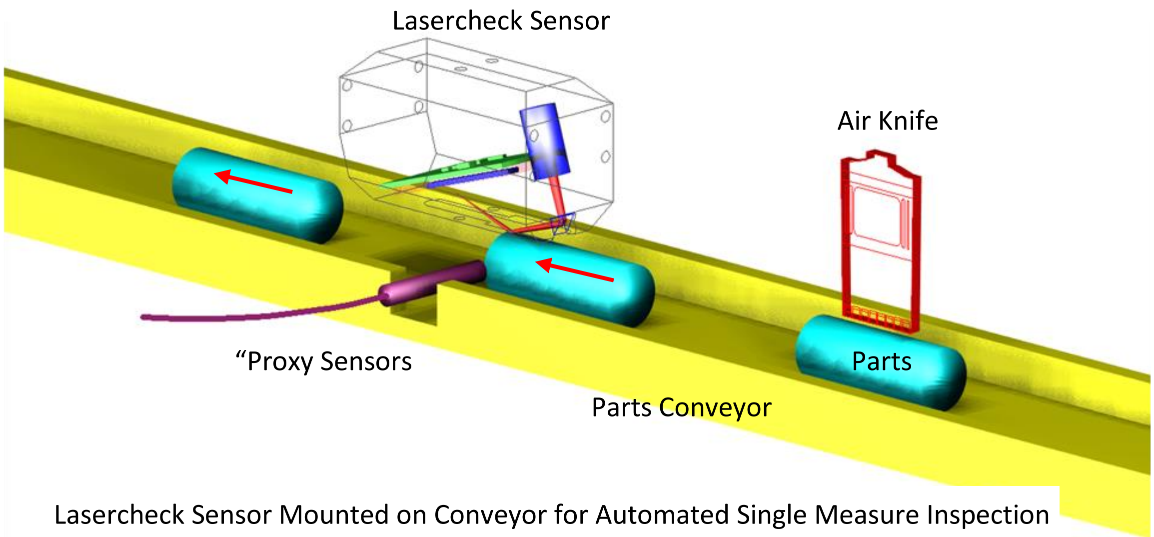
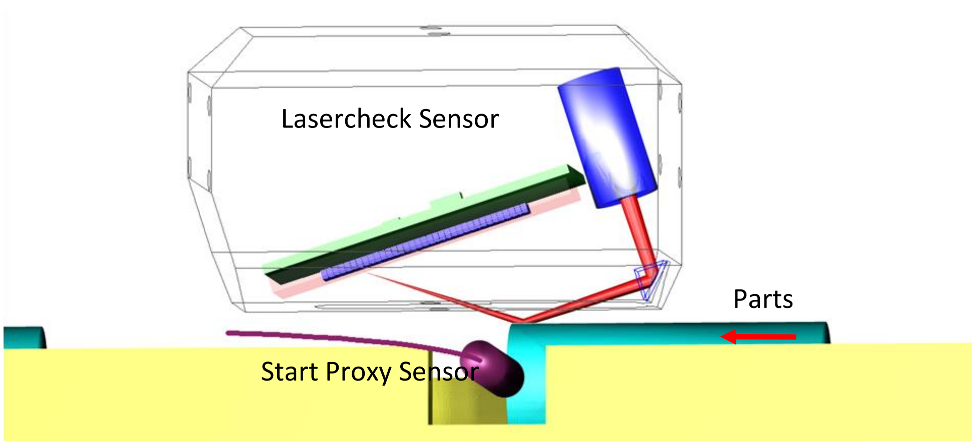


Figure 3 – Lasercheck Head Mounted on Conveyor for Automated Inspection

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



Proximity Sensor Trigger positioned to activate as surface reaches Measurement Position

Prox Sensor Positioned to Start as Parts Enter and Leave Measurement Position

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).

Setup and Alignment

Lasercheck head alignment is critical to accurate and repeatable Lasercheck measurements. The section labeled “Lasercheck Alignment Principles and Procedures” presented later in this manual explains alignment. Users must read and understand this section prior to designing alignment mounts and fixtures for the Lasercheck head.

Message Type 15

Message Type 15 returns all of the voltage values from each of the 35 individual sensors in the Lasercheck head during a measurement. These voltage values can be used to determine “Vertical” and “Horizontal” alignment accuracy of the Lasercheck head during a measurement.

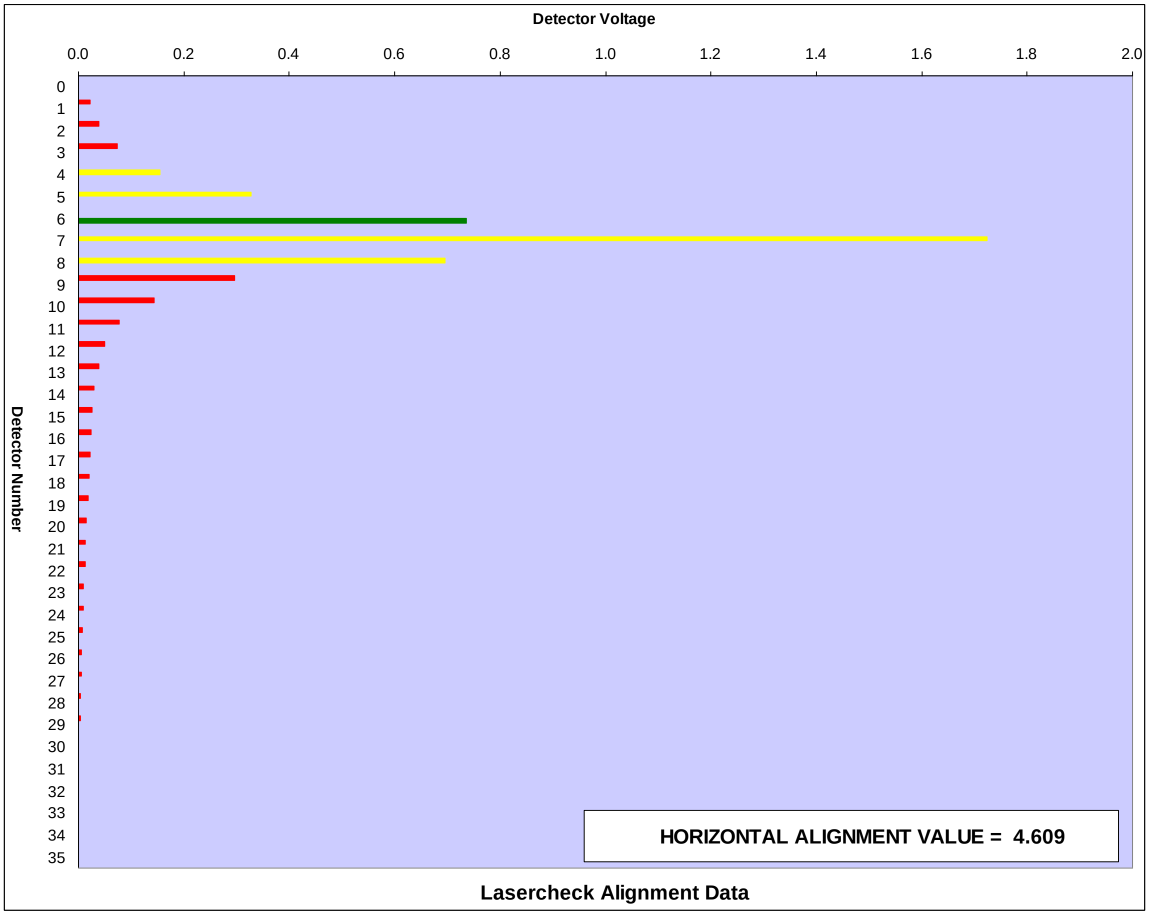
The first value returned after the 35 detector voltage values is the “voltages sum” which is just a mathematic summation of all voltage values from detectors 1 to 35. This value is used as an aid in horizontal alignment.

The last values returned in this measurement set are the “Max detector: location and value”. For optimal vertical alignment this “Max detector location” should be detector 6, but 4, 5, 7, or 8 are acceptable. Vertical alignment on detector 6 provides the optimal “+/-“ tolerance on vertical alignment, while alignment on 4, 5, 7, or 8 provide accurate roughness values, but less tolerance on vertical alignment. Vertical alignment can be interpreted via graphical display of all detector voltages, such as a bar graph display where it is easy to visualize which detector amongst the 35 has the highest value.

Sample Setup and Alignment Aid from Message Type 15

Note in the sample graph (Figure 5 below) that all 35 voltages from a Message Type 15 are graphed. In this example it is easy to see that the Max Detector Location is detector number 7 as indicated in the dialog box in the graph and the largest bar in the graph at the number 7 location. The graphic display and green, yellow, and red color-coding aid in guiding to optimal alignment location. The “voltages sum” is indicated as “HORIZONTAL ALIGNMENT VALUE” in the graph.

For a more detailed discussion on alignment of the Lasercheck system please see the appendix section labeled “Lasercheck Alignment Principles and Procedures”.



Sample Alignment Aid Graph

Performing Roughness Measurements

Message Type 02

Message Type 02 returns a “rough Ra value”, “smooth Ra value”, “error code”, and “max detector”.

Rough and Smooth Ra Value

Lasercheck uses two different calculation routines to calculate roughness. One routine is optimized and slightly more accurate for “relatively smooth” surfaces (less than approximately 10 to 12 microinches Ra). The other routine is optimized for “relatively rough” surfaces (greater than approximately 10 to 12 microinches). The “smooth Ra value” should be read and used if surfaces are anticipated / calculated to be less than approximately 10 to 12 microinches. The “rough Ra value” should be read and used if surfaces are anticipated / calculated to be more than approximately 10 to 12 microinches.

Common Error Codes

The “error code” generally applies to “smooth Ra” values. An error code of “ok” is typically returned on a relatively smooth surface that is correctly aligned (maximum signal found on acceptable detector location for measurement). An error code of “tc” or “tf” is returned if software calculates that the surface is “too close or “too far” (max signal found on detector location unacceptable for accurate measurement). These error codes should be used on surfaces known to be smoother than approximately 15 microinches; they should be ignored on surfaces known to be greater than approximately 15 microinches as the accuracy of these error messages declines as surfaces get rougher.

Max Detector

The “max detector” is the same value as “Max Detector Location” discussed above in the “Setup and Alignment” section and can be used to diagnose “tc” or “tf” alignment error codes.

Recommended Tests and Diagnostics

Negative Ra Value

A “rough” Ra roughness value will be returned so long as the Lasercheck is properly wired and powered. The only time it might not return a roughness value is if it calculates a negative roughness number. This can happen if there is a problem with the Lasercheck head or electronics or if there is no surface in position to perform a measurement. Any of these conditions will generate “noise” instead of actual signal from each of the electronic channels carrying the 35 detector signals. If enough of these noise signals are negative, a resulting negative roughness value will be generated. Obviously, a negative “rough” Ra value should always be interpreted as an error condition.

Low sum_voltages and “lv” Error Code

Sometimes, even when a head is not connected, or a surface is not in measurement position, random noise readings can cause calculation routines to generate a positive Ra value even though it is really just a “noise” number. Monitoring the “sum_voltages” value, which is a sum of all voltages from the 35 sensors, as well as the “lv” error code, can assess this. The "lv” error code will appear when the sum_voltages value is below 300 mV.

There are very few surfaces or conditions that would produce such a low value. This should be interpreted as possible problem with Lasercheck electronics, gross misalignment, or poor cable connections. As a reference, Lasercheck should return values of several volts for the sum_voltage values on steel or aluminum surfaces that have been turned, ground or similarly finished.

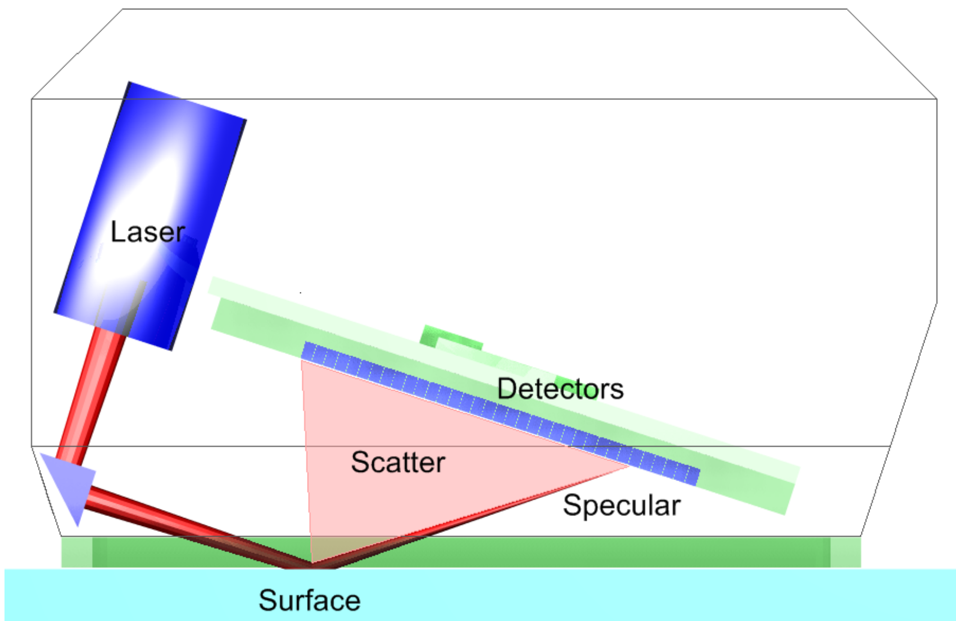
There are many other materials and surface types that can produce lower values and still be well aligned, operating and calculating correctly, but 300 mV is minimal under most circumstances. This value depends somewhat on roughness – low voltage is an increasingly greater problem on rough surfaces. For example 300 mV for “sum_voltages” will cause several microinches of “noise” and lack of repeatability on a 50 microinch surface and would generally be considered unacceptable performance on this surface. On a 10 microinch surface, Lasercheck will exhibit less than 0.5 microinches of noise and repeatability with the same 300 mV for “sum_voltages”, which may be acceptable. The “lv” error should therefore be interpreted as a warning condition and not necessarily a fatal error condition.

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.



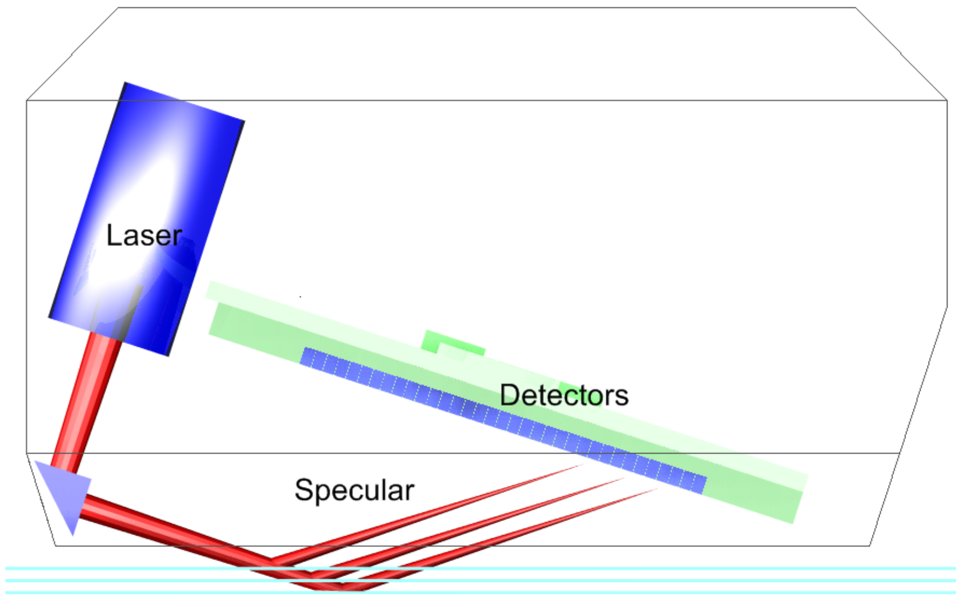
Schematic Diagram of Lasercheck Instrument

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.



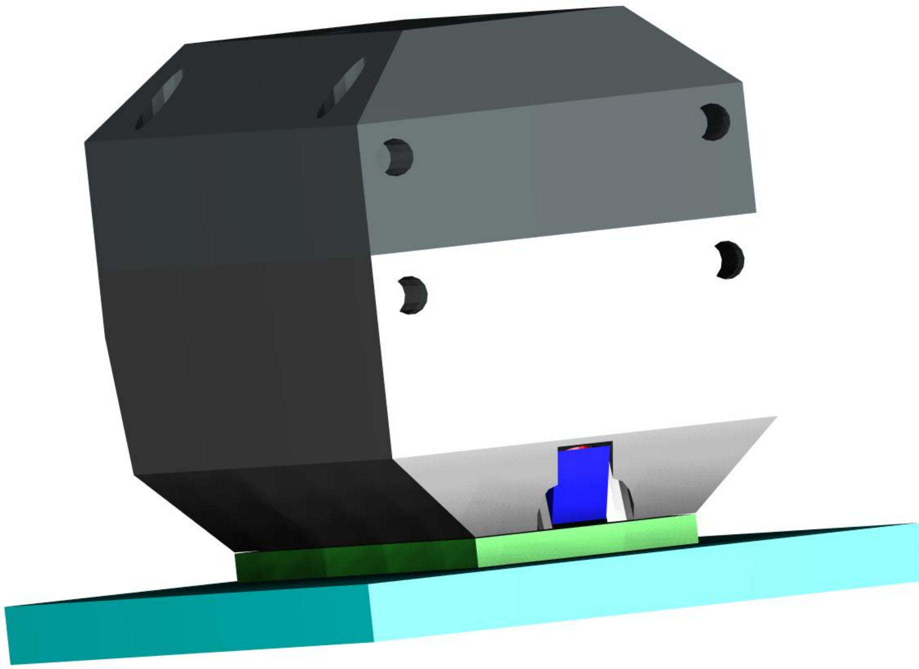
Three Surface Locations – Too Close, Correct, Too Far

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

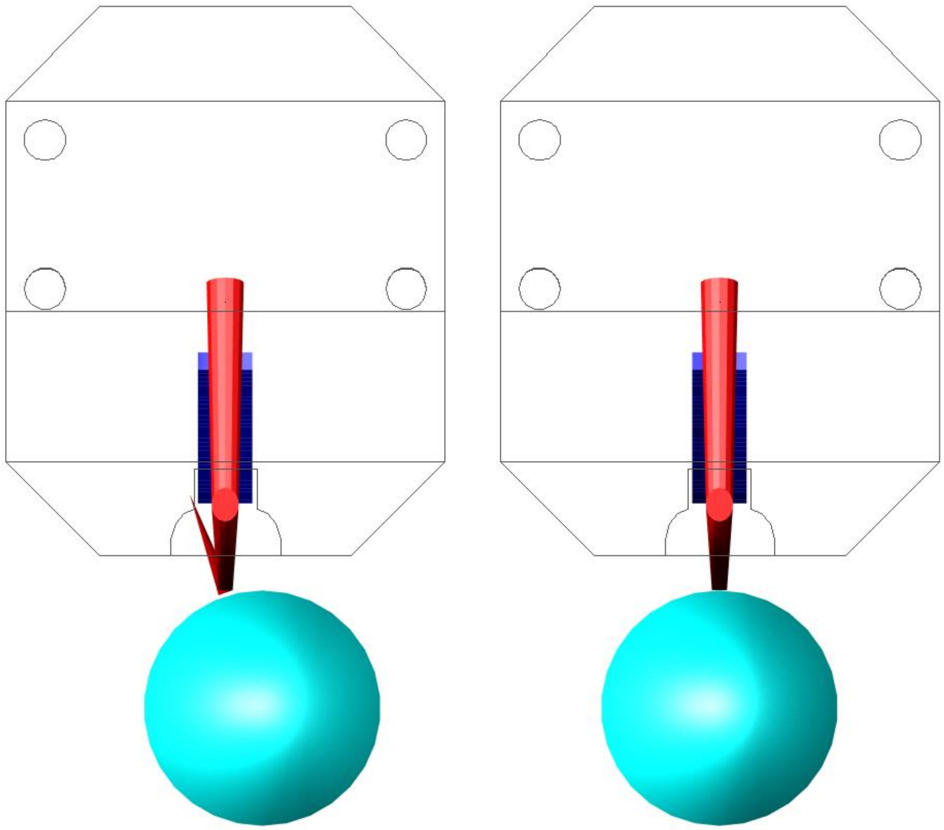
Lasercheck is shipped with base plate that is pre-aligned to set correct vertical positioning on flat parts. This base will set vertical position of the head so that the specular reflected laser beam will strike close to or on detector 6 in the middle of the detectors 4 to 8.



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.

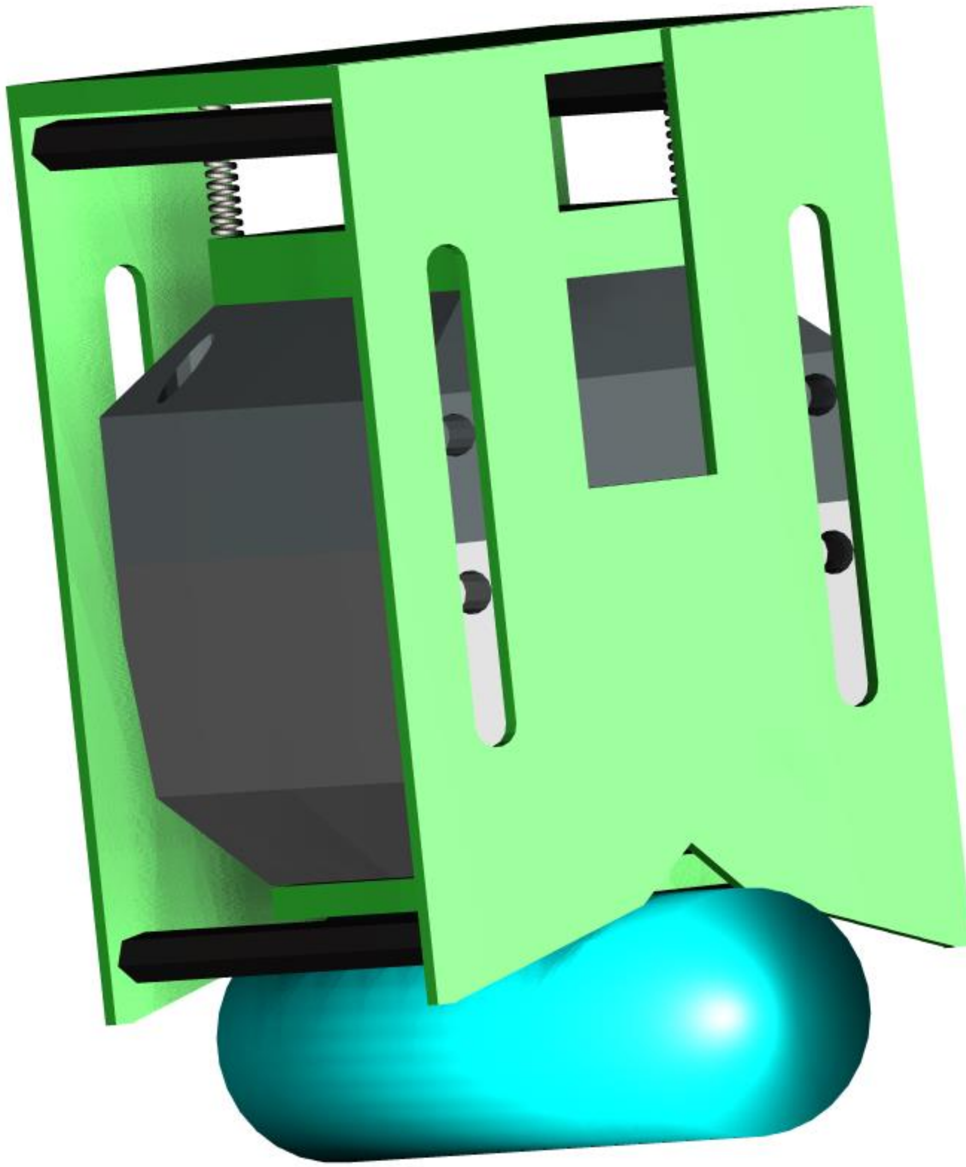


6212 End View showing misaligned and aligned cylindrical surfaces

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.

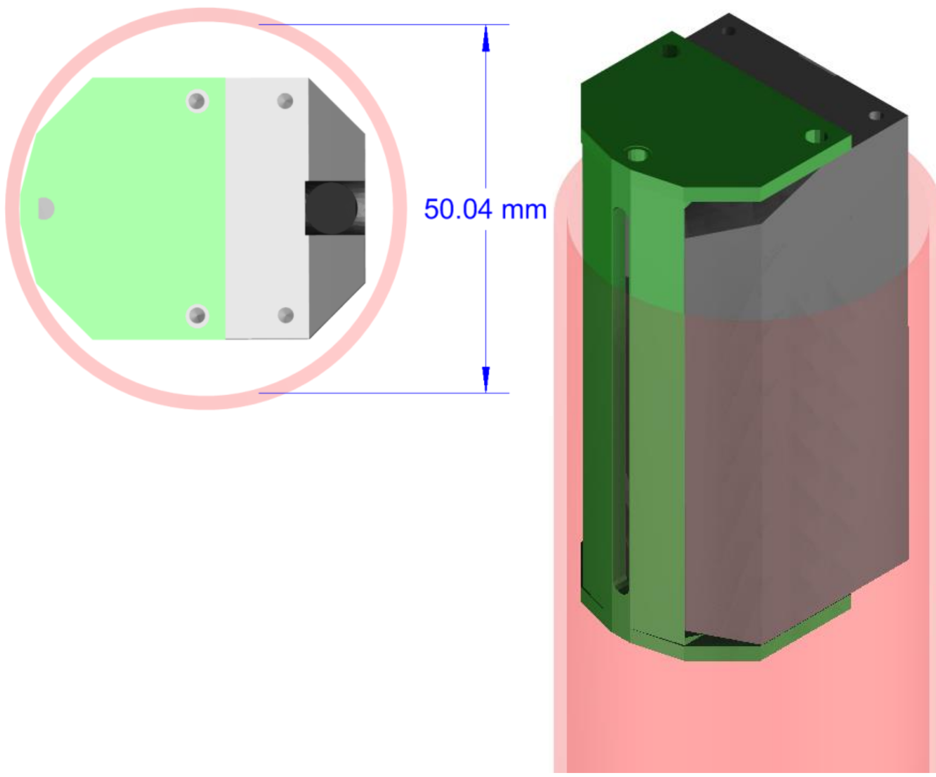


6212 on Cylinder Surface with Alignment Fixture Setting Correct Horizontal Position

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

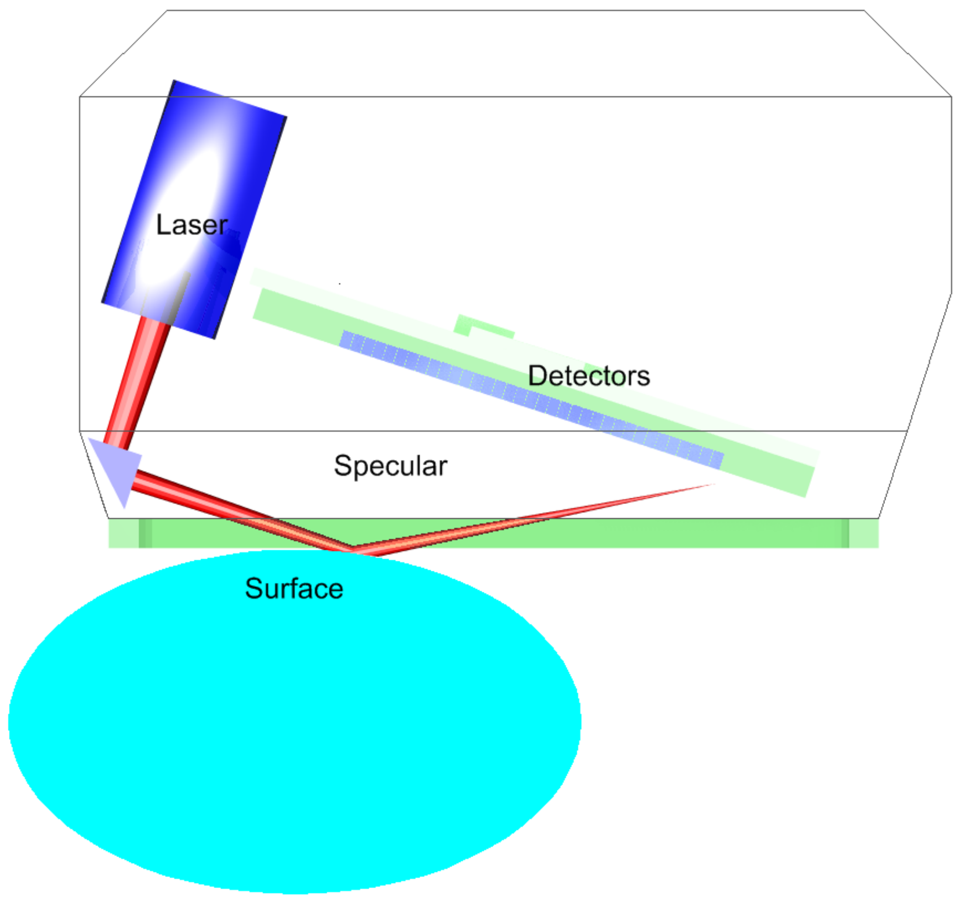
Many machined surfaces have a dominant direction of roughness. The length of the Lasercheck head must be oriented perpendicular to the direction of roughness so that the scatter strikes the detectors, which are oriented in a line down the middle of the head. Well-designed mounting hardware will ensure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

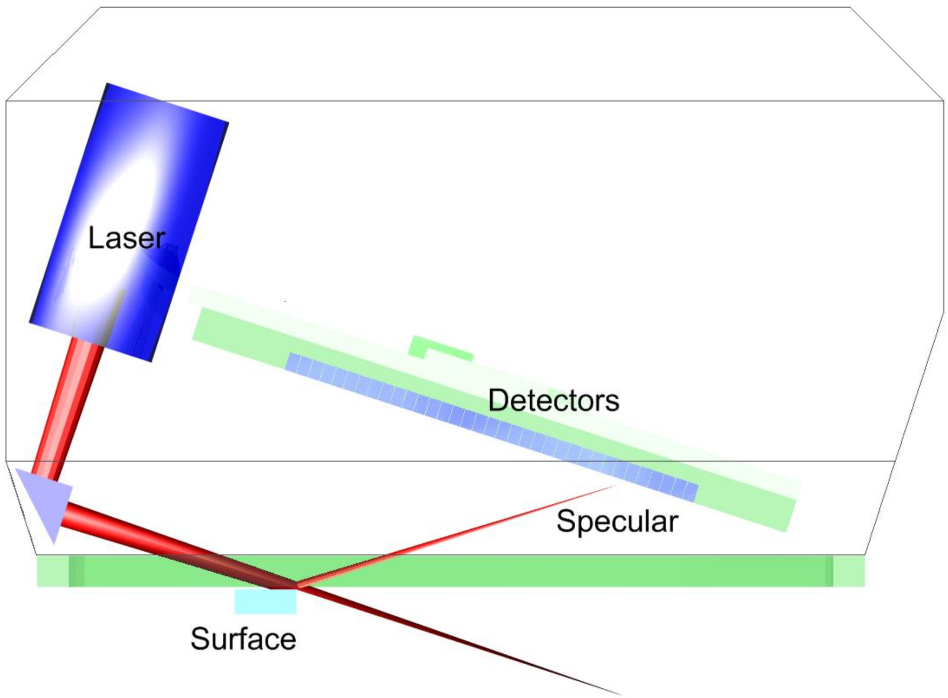
3-Dimensional curvatures and shapes cause Lasercheck to become easily misaligned either in the vertical or horizontal axis. Fixturing must be designed to carefully and repeatably control positioning in both axes so that the specular reflected beam strikes in the middle of the first 11 detectors and the 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

Checking Alignment Using the Lasercheck Diagnostics Option

1) Prepare Software to Receive Alignment Measurement

Turn on terminal program such as HyperTerminal, or software you have developed to communicate with Lasercheck board. Prepare for execution of Message Type 15 to the Lasercheck board.

2) Prepare Sample and Fixture

Set the measurement head on the part (or put the part on the fixture or measurement head)

3) Perform Measurement

Execute Message Type 15. The Lasercheck should respond with a text file containing measurement data as in the example file below in the following format:

@15
0.0003
0.0011
0.0056
0.0242
0.0968
0.1502
0.1420
0.1106
0.0851
0.0627
0.0482
0.0435
0.0308
0.0254
0.0188
0.0202
0.0180
0.0152
0.0118
0.0117
0.0112
0.0089
0.0083
0.0093
0.0078
0.0058
0.0048

0.0040
0.0036
0.0036
0.0022
0.0025
0.0026
0.0025
0.0020
sum_voltages,01.0013
Ra,00.6534,00.8867,ok
Sums,00.5849,00.5240
Sum3,07,00.4029
MaxD,06,0.1502
#

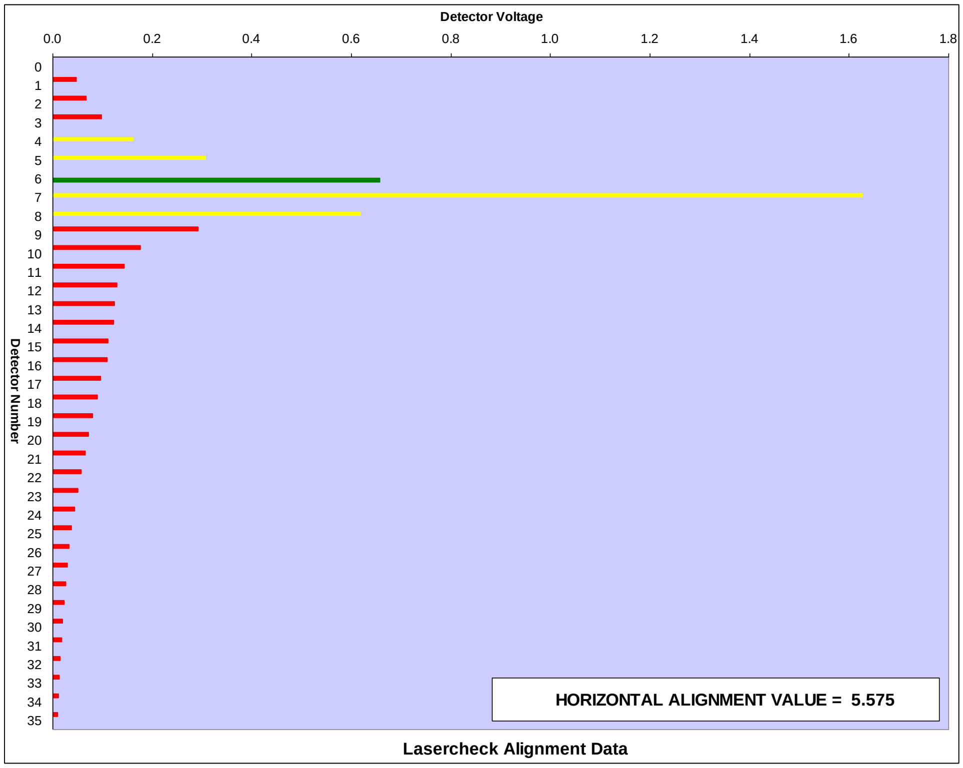
4) Save Measurement Data for Input to Lasercheck Align Graph.xls Spreadsheet

Save the data to the filename "laseralign.txt" in the directory "C:\Program Files\Lasercheck" created by the installation program. Only this filename and directory will import correctly into the spreadsheet.

5) Graphing the Lasercheck Data Measurements in Excel Spreadsheet

The alignment measurement can now be graphed for visual display in the included Excel spreadsheet.

- Open "Lasercheck Align Graph.xls" by clicking on the icon in the Start Menu under "Start/Programs/Lasercheck/Lasercheck Align Data". This will start Microsoft Excel and open the graph.
- If prompted about "Enabling Macros" select the "Enable Macros" button. (Note: macros have to be enabled for the graph to work automatically.)
- Once the program is open, push the "Insert Lasercheck Values" button. It will import and graph all of the values from the "laseralign.txt" file.
- ***Optionally***, save the new graph by selecting the "File" menu and choosing "Save As". In the Save As dialog box enter a different file name. For example "File Name: 01jan2003 alignment 1.xls"
- ***Optionally*** rename the downloaded data file from "laseralign.txt" to a different filename similar to the saved graph. For Example "01jan2003 alignment 1.txt" to keep it from being overwritten



Typical Spreadsheet Alignment Curve Showing Specular Centered on Detector 7

5) Determining Alignment using the Lasercheck Alignment Graph Excel Spreadsheet

Vertical Alignment

The Vertical portion of the alignment graph is a horizontal bar graph representing relative voltages from all of the 35 detectors. The largest bar on the graph is the specular reflection. There are 5 detectors in the center of the first eleven that are color coded yellow and green. Ideally the fixture should be positioned so that the large specular reading is on the green detector 6. Acceptable performance will be achieved if the large specular reading is on one of the yellow detectors 4, 5, 7, or 8. Note in the example graph above that specular is centered on the yellow detector 7, which is an acceptable, but not quite perfect alignment. If the large specular reading is on one of the red detectors, Lasercheck will not perform accurately.

If the largest reading is below the green detector 6 on the graph, then the head/fixture combination should be adjusted so that the surface is moved further away from the head. If the largest reading is above the green detector 6 on the graph, then the head/fixture combination should be adjusted so that the surface is moved closer to the head.

Horizontal Alignment

The Horizontal label of the alignment graph is a number shown in the lower portion of the graph labeled “HORIZONTAL ALIGNMENT VALUE = 12345”. This is the “sum_voltage” value. There is no “perfect” number for this value. It depends on material, size of surface, and many other factors. The idea is to take several measurements while incrementally adjusting horizontal position with fixturing to determine the highest possible value for that part. Once that highest value has been achieved, then the fixture should be secured at that location.

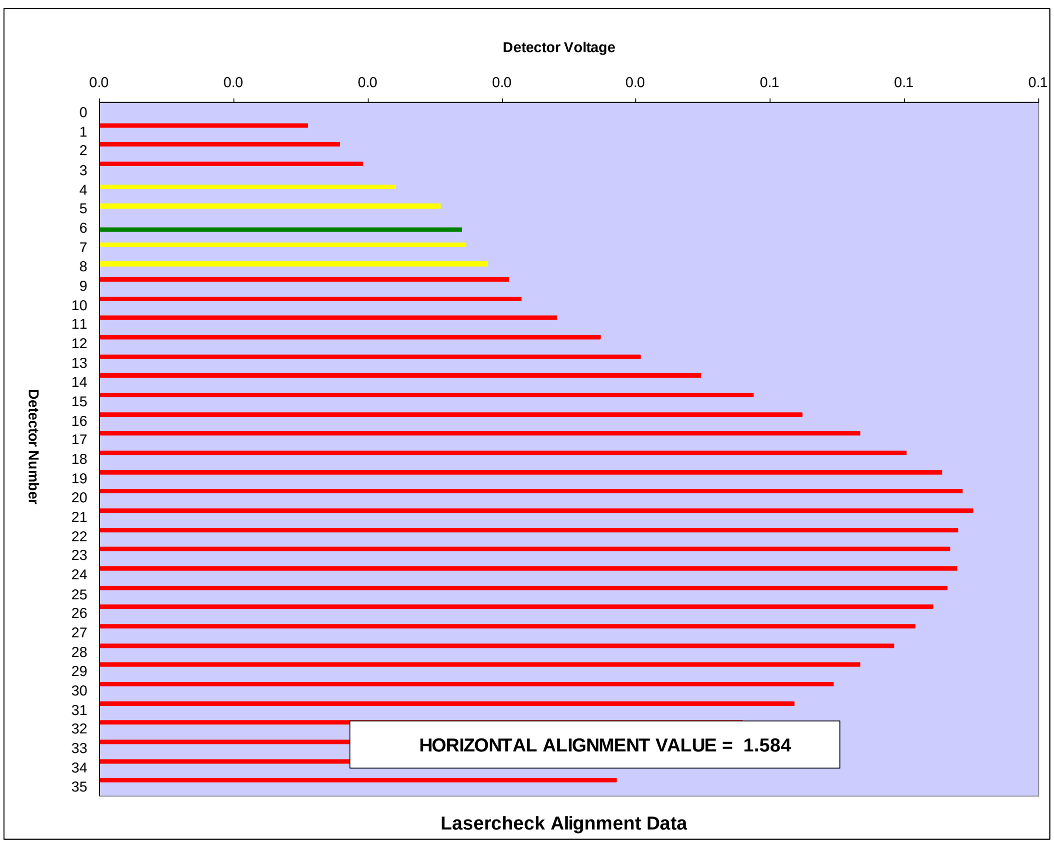
You must be sure to pass the head back and forth over the surface one or two times so that the maximum possible value for sum_voltage can be found. Once it is found, then the head must be positioned to achieve a value as close to that maximum as possible.

NOTE: *Do not assume that the first reading is correct if the voltage seems "reasonably high". Always move the head back and forth to find and update a true maximum 100% value.*

Notes to Using the Lasercheck Diagnostics Option for Alignment

Vertical Alignment

If the surface is relatively rough, the specular beam will be lost as it bounces off the surface into Lasercheck and there will be no obvious large voltage anywhere in the array. Note on the graph below; this data is from a well-aligned rougher surface, Ra of about 45 microinches.



Spreadsheet Alignment Curve of Example File on Rough Surface

On these rougher surfaces, we cannot do height alignment with Laserchecks' 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 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.

Horizontal Alignment

You should also note that the maximum reading observed on sum_voltage will typically be lower on rough or non-metallic surfaces than on smooth and metallic surfaces because less light is reflected and scattered into our detectors on rough or non-metallic surfaces.

Recommended Alignment Diagnostics

Since alignment is critical to reliable Lasercheck measurements, alignment aids built into user software are recommended for systems so customers can check Lasercheck alignment of custom fixtures or mounts used in automated and OEM equipment. Instructions and alignment aids should guide users through the following procedures:

Verifying Alignment Procedures

Set Head Close to Correct Position

Horizontal and vertical alignment should be close before performing any alignment with any software alignment aid. 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 an alignment aid, set the horizontal alignment as close to optimal as possible. Maximizing the value of sum_voltage displayed on software does this.

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 a software alignment aid to position the specular beam on detector # 4, 5, 6, 7, or 8 (ideally on detector #6).

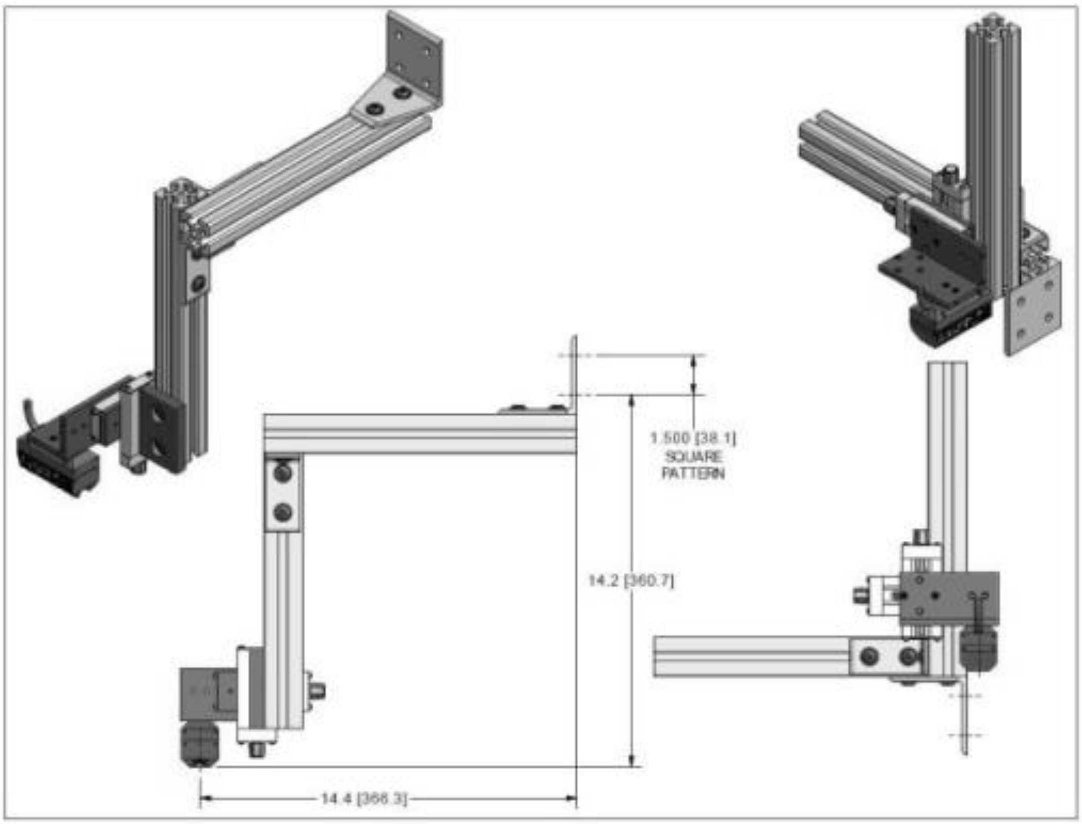
Verify Alignment

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

As surfaces get rougher (greater than 20 microinches), 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.

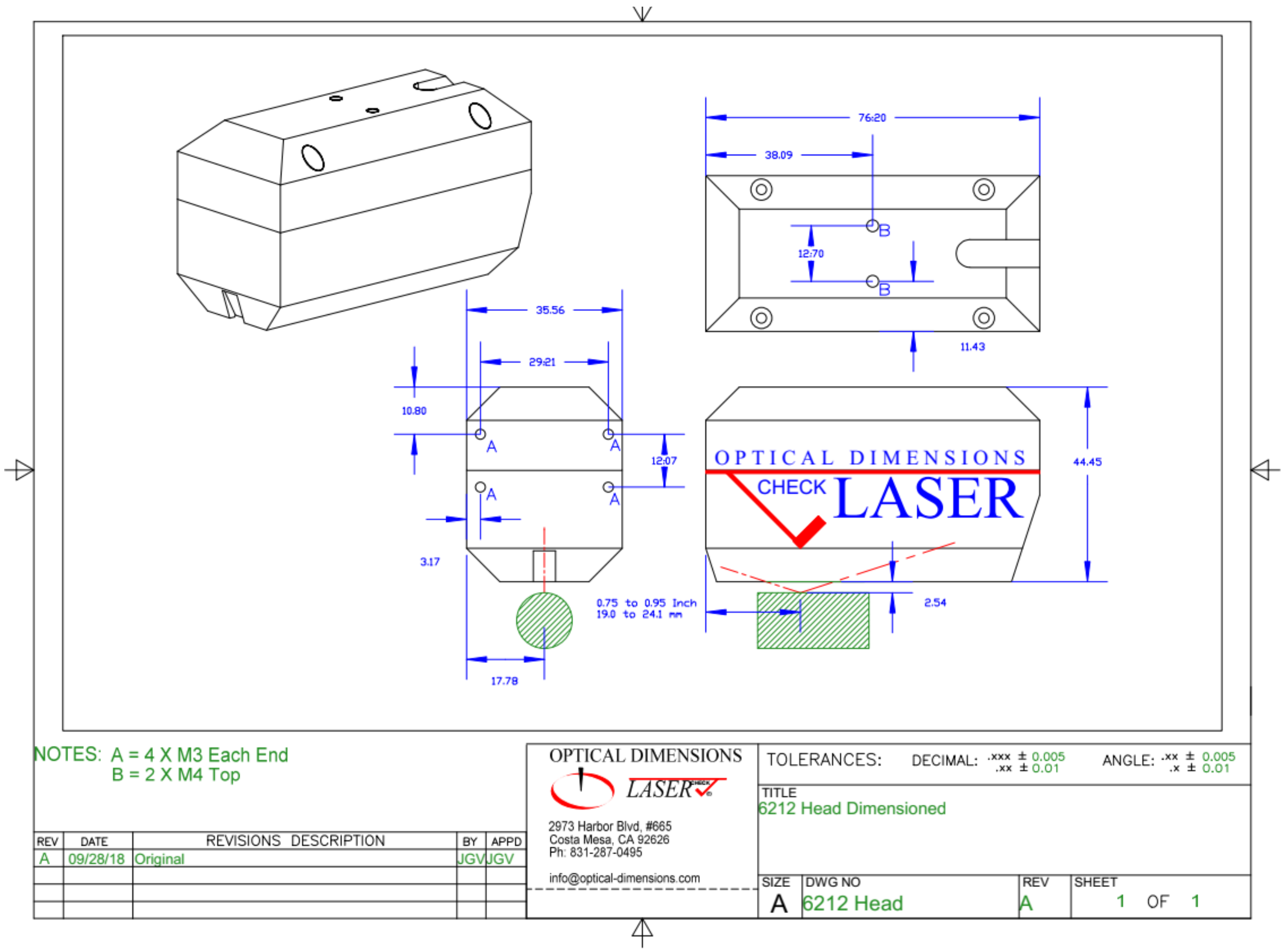
Appendix B – Mounting/Fixturing Lasercheck

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



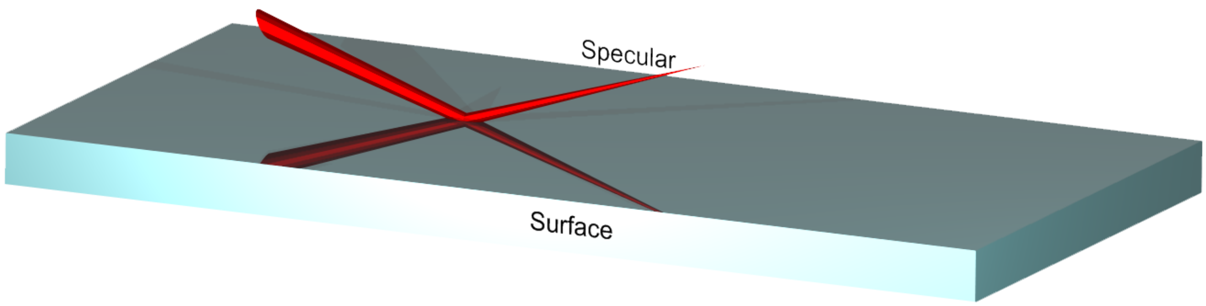
The CAD image above provides dimensional information for mounting of Lasercheck sensor over a cylindrical surface. IMPORTANT: the position of the measurement sensor relative to the surface is an approximate value. All mounting designs must incorporate fine positioning adjustment of the Lasercheck sensor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

Appendix C - Calibration Procedures

Theory - Measurement and Calibration

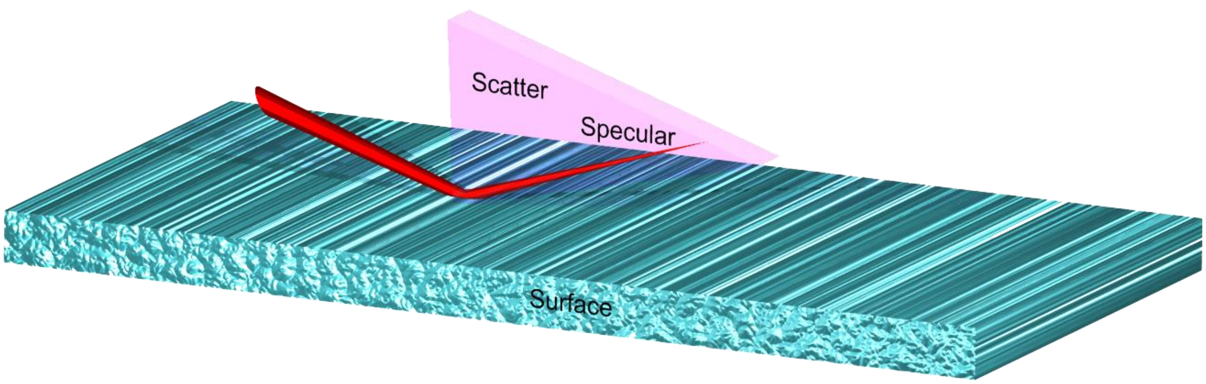
Measurement of Roughness

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.

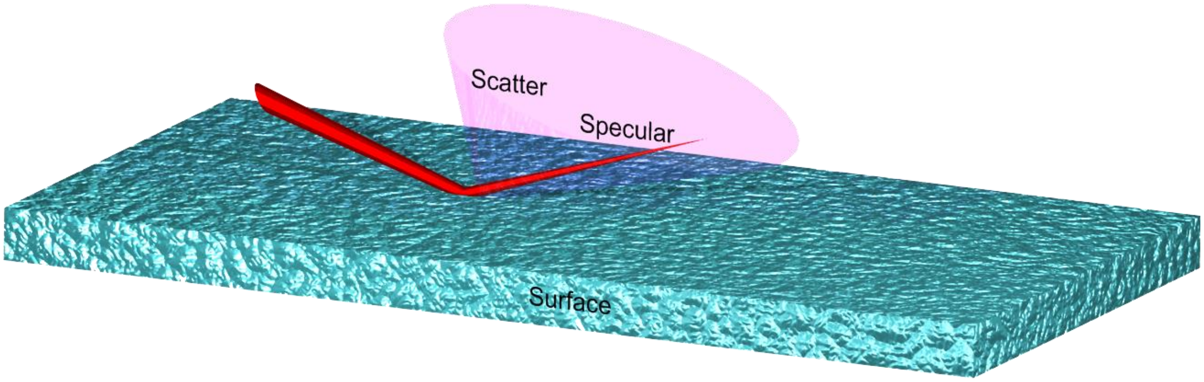


If a surface is not perfectly smooth and has some roughness the laser reflection will contain some diffuse reflection (scatter) in addition to the specular reflection. The “shape” of the pattern of scattered light is affected by the microscopic surface roughness pattern created by the machining operation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

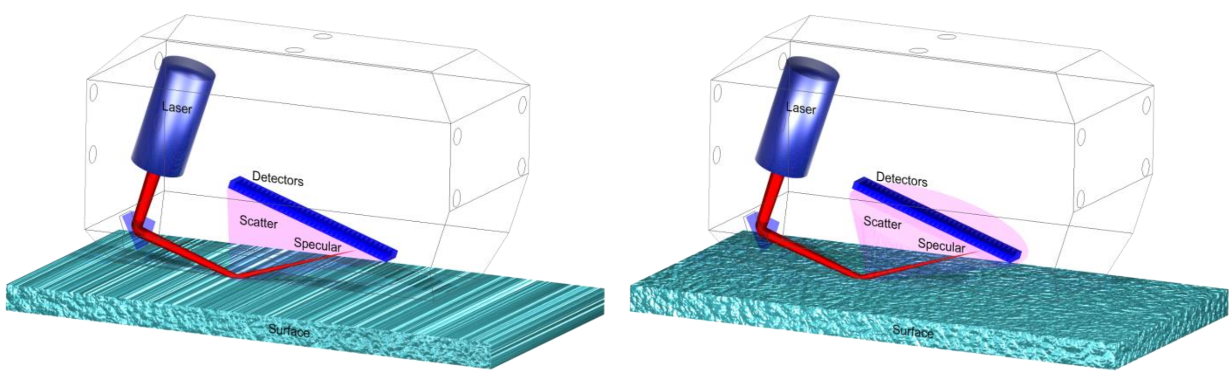


There are other examples of unique surface roughness pattern from various machining operations (swirl pattern, repeating groves, random / fractal, predominant peaks, predominant valleys) that uniquely affect the shape of the scattered light pattern.

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.



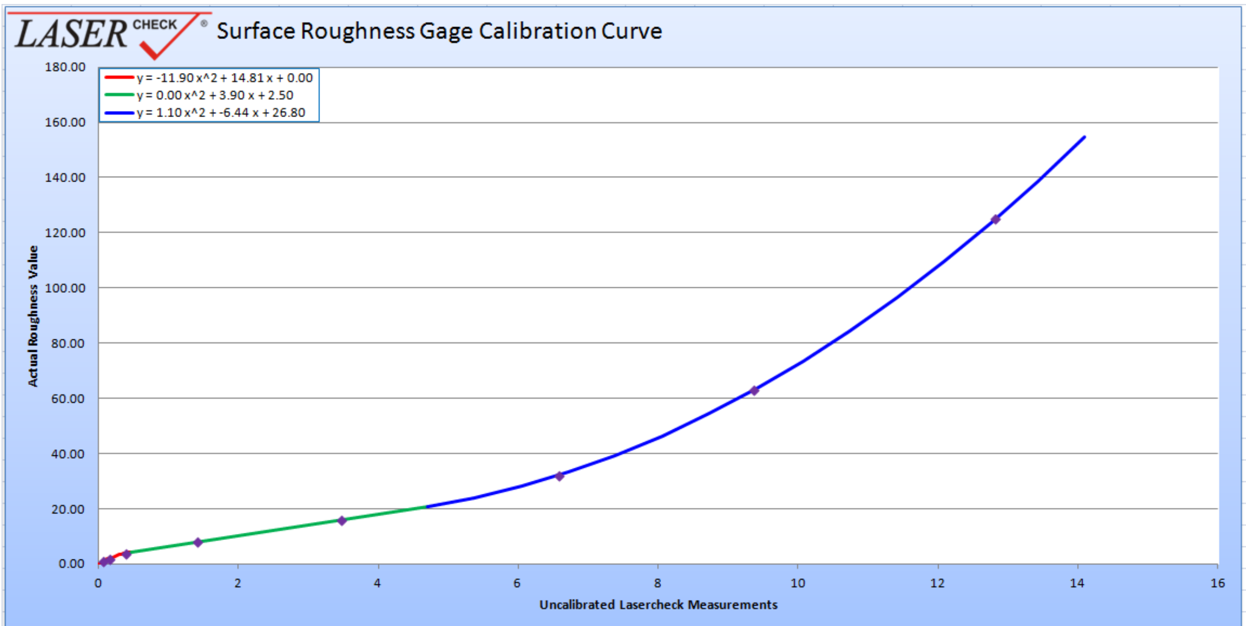
Lasercheck will measure different signals and calculate different roughness for these two surfaces with identical Ra. The surface roughness pattern (machining operation) and resulting scatter pattern therefore must be an integral part of any Lasercheck calibration.

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 D – Communication Protocol

The AD board has a PIC processor that communicates thru a serial port on J1 or J2. J1 is a 5 volt buffered port for integration into a portable unit. J2 is for communication to a standard PC com port. Communications for both will be at 57600 baud, 8N1.

The communication protocol is designed to be simple and is only printable characters to be readable from a terminal program such as HyperTerminal.

Messages are in the form:
@xx#<cr-lf>

The parts are:
@ - beginning of message
xx - is the message type
- end of message
<cr-lf> - is a carriage return / line feed at end of message

Message Types:

@02 Request Ra Value

@02#<cr-lf> Returns a single @02 response. If continuous mode was running, it now quits

Response
@02,00.1234,01.1234,ok,dd,12.3456,#<cr-lf>
Ra rough, Ra smooth, Error Code, Max Detector, Sum Voltage of Detectors 1-37

@02,00#<cr-lf> Returns continuous @02 response. Will continue making measurements until a @02#<cr-lf> command stops it.

Response
@02,00.1234,01.1234,ok,dd,12.3456,#<cr-lf>
@02,00.1234,01.1234,ok,dd,12.3456,#<cr-lf>
@02,00.1234,01.1234,ok,dd,12.3456,#<cr-lf>
continuous until @01#<cf-lf> received
Ra rough, Ra smooth, Error Code, Max Detector, Sum Voltage of Detectors 1-37

@02,dd#<cr-lf> Returns continuous @02 response. Will continue making measurements until "dd" number of measurements have occurred (dd = 01 to 99).

Response
@02,00.1234,01.1234,ok,dd,12.3456,#<cr-lf>
@02,00.1234,01.1234,ok,dd,12.3456,#<cr-lf>
repeats "dd" times
@02,00.1234,01.1234,ok,dd,12.3456,#<cr-lf>

Response Details:

The response from the interconnect board will be the rough then the smooth roughness values. The 2 roughness values will always be 7 characters in length (including the decimal point character) with padding zeros on either end when necessary, and always followed by a comma.

Ra rough, Ra smooth, Error Code, Max Detector, Sum Voltage of Detectors 1-37

The error codes will be 2 letters followed by a comma.

ok – for measurement completed successfully.
tc – for smooth measurement “too close”
tf – for smooth measurement “too far”

or – for detector “out of range”. Occurs if error in defining detectors in configuration file
lv – for possible too low sum_voltages for reliable Ra calculation (less than 100 mVolts)
rr - for rough "range error". Occurs if error in defining detectors in configuration file

Note: it is important to interpret the “tc” and “tf” messages as alignment aids (head “too close” or “too far” for accurate measurements) only on known smooth surfaces (typically less than 10 to 12 microinches Ra). Lasercheck may generate a “smooth” Ra value on surfaces rougher than 10 to 12 microinches. On surfaces rougher than these values the “tc” and “tf” messages should be ignored.

max_detector is the integer value of the detector with the maximum voltage on it. This value will always be 2 digits and can range from 01 to 35. The location of the maximum detector voltage is useful for determining vertical alignment on smooth surfaces only. Refer to the alignment section in the manual.

sum_voltages is the sum of all voltages from detectors 01 to 35. The value will be 7 characters in length (including the decimal point character) with padding zeros on either end when necessary, and always followed by a comma.

@03 Request Ra Value

Start conversions when Start trigger input is activated.

Cmd @03# will execute and provide a single Ra value when the start input pin is in the trigger state.
When the start trigger goes inactive, Cmd @03# will remain active waiting to execute a new Ra value when the input pin triggers again
Sending any other command will make Cmd @03# go inactive

Response
@03,000.1234,001.1234,ok,dd,12.3456,#<cr-lf>

Ra rough, Ra smooth, Error Code, Max Detector, Sum Voltage of Detectors 1-37

@03,00#<cr-lf> Returns continuous stream of Ra values when the start input pin is in the trigger state.
When the start trigger goes inactive, the Ra stream will stop. Cmd @03,00# will remain active waiting to execute a new Ra stream when the start input pin triggers again
Sending any other command will make Cmd @03,00# go inactive

Response
@03,000.1234,001.1234,ok,dd,12.3456,#<cr-lf>
@03,000.1234,001.1234,ok,dd,12.3456,#<cr-lf>
@03,000.1234,001.1234,ok,dd,12.3456,#<cr-lf>
continuous until any other command received or trigger goes inactive

Ra rough, Ra smooth, Error Code, Max Detector, Sum Voltage of Detectors 1-37

@03,dd#<cr-lf> Returns continuous stream of Ra values when the start input pin is in the trigger state until "dd" number of measurements have occurred (dd = 01 to 99).
When the start trigger goes inactive, the Ra stream will stop. Cmd @03,d# will remain active waiting to execute a new Ra stream when the input pin triggers again
Sending any other command will make Cmd @03,dd# go inactive

Response
@03,000.1234,001.1234,ok,dd,12.3456,#<cr-lf>
@03,000.1234,001.1234,ok,dd,12.3456,#<cr-lf>
repeats "dd" times
@03,000.1234,001.1234,ok,dd,12.3456,#<cr-lf>

Ra rough, Ra smooth, Error Code, Max Detector, Sum Voltage of Detectors 1-37

Response Details:

The response from the interconnect board will be the rough then the smooth roughness values. The 2 roughness values will always be 7 characters in length (including the decimal point character) with padding zeros on either end when necessary, and always followed by a comma.

Ra rough, Ra smooth, Error Code, Max Detector, Sum Voltage of Detectors 1-37

The error codes will be 2 letters followed by a comma.

ok – for measurement completed successfully.
tc – for smooth measurement “too close”
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or – for detector “out of range”. Occurs if error in defining detectors in configuration file
lv – for possible too low sum_voltages for reliable Ra calculation (less than 100 mVolts)
rr - for rough "range error". Occurs if error in defining detectors in configuration file

Note: it is important to interpret the “tc” and “tf” messages as alignment aids (head “too close” or “too far” for accurate measurements) only on known smooth surfaces (typically less than 10 to 12 microinches Ra). Lasercheck may generate a “smooth” Ra value on surfaces rougher than 10 to 12 microinches. On surfaces rougher than these values the “tc” and “tf” messages should be ignored.

max_detector is the integer value of the detector with the maximum voltage on it. This value will always be 2 digits and can range from 01 to 35. The location of the maximum detector voltage is useful for determining vertical alignment on smooth surfaces only. Refer to the alignment section in the manual.

sum_voltages is the sum of all voltages from detectors 01 to 35. The value will be 7 characters in length (including the decimal point character) with padding zeros on either end when necessary, and always followed by a comma.

@04#<cr-lf> Specular Values Request

Response

@04<cr-lf>

00.1234,00.1234<cr-lf>	Spec sums Rough, Smooth used for Ra calculation
06,00.1234<cr-lf>	Location, Sum of 3 max used to find specular
07,0.1234<cr-lf>	Max Detector Loc, Max Det Value within "Sum of 3 max"

#<cr-lf>

@05 Request Ra Value

Returns Ra values when the start input pin is activated, waiting for stop input.
Stop trigger input is Digital IN 2 or Pin 2 of connector J7. Stop conversions when pin is activated.

@05#<cr-lf> Returns a single @05 response. If continuous mode was running, it now quits

Response

@05,000.1234,001.1234,ok,dd,12.3456,#<cr-lf>

Ra rough, Ra smooth, Error Code, Max Detector, Sum Voltage of Detectors 1-37

@05,00#<cr-lf> Returns continuous stream of Ra values when the start input pin is activated until stop input pin is activated.

Response

@05,000.1234,001.1234,ok,dd,12.3456,#<cr-lf>
@05,000.1234,001.1234,ok,dd,12.3456,#<cr-lf>
@05,000.1234,001.1234,ok,dd,12.3456,#<cr-lf>

When the stop input is activated, the Ra stream will stop.

Ra rough, Ra smooth, Error Code, Max Detector, Sum Voltage of Detectors 1-37

@05,01#<cr-lf> Returns average of all Ra values from when the start input pin is activated until stop input pin is activated.

Response
@05,000.1234,001.1234,ok,dd,12.3456,#<cr-lf>
When the stop input is activated after a start input, a single Ra value representing average of all will be sent.

Ra rough, Ra smooth, Error Code, Max Detector, Sum Voltage of Detectors 1-37

Response Details:

The response from the interconnect board will be the rough then the smooth roughness values. The 2 roughness values will always be 7 characters in length (including the decimal point character) with padding zeros on either end when necessary, and always followed by a comma.

Ra rough, Ra smooth, Error Code, Max Detector, Sum Voltage of Detectors 1-37

The error codes will be 2 letters followed by a comma.

ok – for measurement completed successfully.
tc – for smooth measurement “too close”
tf – for smooth measurement “too far”
or – for detector “out of range”. Occurs if error in defining detectors in configuration file
lv – for possible too low sum_voltages for reliable Ra calculation (less than 100 mVolts)
rr - for rough "range error". Occurs if error in defining detectors in configuration file

Note: it is important to interpret the “tc” and “tf” messages as alignment aids (head “too close” or “too far” for accurate measurements) only on known smooth surfaces (typically less than 10 to 12 microinches Ra). Lasercheck may generate a “smooth” Ra value on surfaces rougher than 10 to 12 microinches. On surfaces rougher than these values the “tc” and “tf” messages should be ignored.

max_detector is the integer value of the detector with the maximum voltage on it. This value will always be 2 digits and can range from 01 to 35. The location of the maximum detector voltage is useful for determining vertical alignment on smooth surfaces only. Refer to the alignment section in the manual.

sum_voltages is the sum of all voltages from detectors 01 to 35. The value will be 7 characters in length (including the decimal point character) with padding zeros on either end when necessary, and always followed by a comma.

@07<cr-lf> Set/Query Failed Part Operation

Sends signal to Specify Failed Part Parameters
Failed Part trigger output is Digital OUT Pin of connector J7. Save measurements response when pin is activated.

Activate Failed Part Output Options
Set Values
xx = subfunction

Request Values
@07#<cr-lf>
Response
@07<cr-lf>

Set xx subfunctions

@07,xx#<cr-lf>

00# Turn off failed part output.
01# Any value above max roughness or below min roughness encountered between start and stop, contact closes after stop received
02# All values above max roughness or below min roughness encountered during start and stop, contact closes and opens with bad and good values
03# Average value above max roughness or below min roughness encountered between start and stop, contact closes after stop received

@10#<cr-lf> Laser on Voltages: used to request just laser on voltages. Only for testing purposes

Response:
@10<cr-lf>

0.123456<cr-lf>	Detector 1 volts
0.123456<cr-lf>	Detector 2 volts
Same for Detectors 3-37	Detector 3-37 volts
12.3456<cr-lf>	Sum Voltage of Detectors 1-37

#<cr-lf>

@11#<cr-lf> Convert Light & subtract Dark, correct and send processed voltages

Note:
Responses should be background subtracted and have gain resistor correction
Responses should NOT have any other corrections

Response:
@11<cr-lf>

0.123456<cr-lf>	Detector 1 volts
0.123456<cr-lf>	Detector 2 volts
Same for Detectors 3-37	Detector 3-37 volts
12.3456<cr-lf>	Sum Voltage of Detectors 1-37

#<cr-lf>

@15<cr-lf> Combine Cmd 11, 02, and 04

Response:

	@15<cr-lf>	
Resp 11	0.123456<cr-lf>	Detector 1 volts
	0.123456<cr-lf>	Detector 2 volts
	Same for Detectors 3-37	Detector 3-37 volts
	12.3456<cr-lf>	Sum Voltage of Detectors 1-37
Resp 02	00.1234,01.1234,ok,dd,12.3456<cr-lf>	
	Ra rough, Ra smooth, Error Code, Max Detector, Sum Voltage of Detectors 1-37	
Resp 04	00.1234,00.1234<cr-lf>	Spec sums Rough, Smooth used for Ra calculation
	06,00.1234<cr-lf>	Location, Sum of 3 max used to find specular
	07,0.1234<cr-lf>	Max Detector Loc, Max Det Value within "Sum of 3 max"
	#<cr-lf>	

@20,xx#<cr-lf>, Set/Query baud rate

Set Baud Rate

xx = baud rate	48 for 4800 Baud
	96 for 9600 Baud
	19 for 19200 Baud
	57 for 57600 Baud
	11 for 115200 Baud

Defaults

96 head.hex program

Query Baud Rate

@20#<cr-lf>

Response

@20,96,#<cr-lf>

@21#<cr-lf>, Query Revision Number

Note: Factory Set

Query Command:

@21#<cr-lf>

Response:

@21,xx.xx,#<cr-lf> xx.xx is revision number

@22,xx,vvv#<cr-lf> Set/Query Configuration Values

Set Values

xx = subfunction

vvv = subfunction value

xx subfunction	vvv Default	Sub Command details:
01,LIMIT_LOW, set min roughness value	2	LIMIT_LOW, set min roughness value for failed part output
02,Laser Settling	18	Laser Settling 55.56uS Steps
03,Head Mux Settling	2	Ext. Mux Settling 55.56us per step
04,Number of ON sweeps	2	Number of ON sweeps
05,Number of OFF sweeps	2	Number of OFF sweeps
06,First Detector in Rough Specular Sum	4	First Detector in Rough Specular Sum
07,Last Detector in Rough Specular Sum	8	Last Detector in Rough Specular Sum
08,First Dectector in Rough Ra Calculation	9	First Detector in Rough Ra Calculation
09,Last Detector in Rough Ra Calculation	32	Last Detector in Rough Ra Calculation
10,First Detector in Smooth Specular Sum	2	First Detector in Smooth Specular Sum
11,Last Detector in Smooth Specular Sum	2	Last Detector in Smooth Specular Sum
12,First Detector in Smooth Ra Calculation	3	First Detector in Smooth Ra Calculation
13,Last Detector in Smooth Ra Calculation	26	Last Detector in Smooth Ra Calculation
14,AD Mux Settling Time	2	Internal A/D Delay Loop Count 10 us per step
15,Head Type,5872, 6212, 8826	6212	Head Type Assigns # Detectors in Ra Calculation, 0=5872, 1=6212, 2=8826
16,LIMIT_HIGH, set max roughness value	10	LIMIT_HIGH, set max roughness value for failed part output
17,Latch Relay Duration	1	Latch Relay Duration for failed part output (1 - 100, each # is 10 ms. A value of 10 = 100 ms)
18.Peak Percent Fine Alignment Value (2 digit percent)	10	Percent comparison fine alignment test values for voltages either side of peak voltage
19.Failed Part Output / Fine Align Output Toggle	1	Toggles output trigger (pin 5 of PIC processor) between Failed Part (default 1) or Fine Align obtained (2)
20,Low Voltage Threshold, two digit precision - xx.xx	**0**	Sets Sum Voltage Threshold Check

Query Values

A request of @22#<cr-lf> will give a response that includes all sub-commands

@23,xxxxx#<cr-lf>, Set/Query Head Serial Number

Note: Factory Set

Set Command:

@23,xxxxx#<cr-lf>, Set/Query Head Serial Number

Query Command:

@23#<cr-lf>

Query Response:

@23,C11xxxxx,#<cr-lf>

@26,b,xxx.xxV#<cr-lf>, Set/Query resistor values

Note: Factory Set

Set command:

@26,b,xxx.xxV#<cr-lf>

b is the Bank Number. Range is 1-5.
xxx.xx is the resistor value. Default is 1.0K.
V is the multiplier, either K for kilohm or M for Megohm.
Values are in ASCII with a required 2 digits to the right of the decimal point and 1 to 3 digits to the left.

Example
Set bank2 to 3.0K resistor from default 1.0K
@26,2,3.00K#<cr-lf>

Query
@26#<cr-lf>
Response
@26#<cr-lf>
001.00K#<cr-lf>
003.00K#<cr-lf>
001.00K#<cr-lf>
001.00K#<cr-lf>
001.00K#<cr-lf>
#<cr-lf>

@29,xx,vv.vv#<cr-lf> Set/Query Ra Calibration Values

Set command:

@29,xxxxx,wwwww.wwwww#<cr-lf>

xxxxxx is alpha/numeric up to 6 character parameter

NAME,UNITS,THRESH,A1,B1,C1,BP1,A2,B2,C2,BP2,A3,B3,C3,

wwwww.wwwww is the alpha/numeric up to 11-chacter value 2 decimal place precision. A Minus sign is optional.

Example:

Set A1 to -11.90, B1 to 14.81, C1 to 0.00, and BP! To 0.46 (as in 6212Gd file)

@29,A1,-11.90#<cr-lf>

@29,B1,14.81#<cr-lf>

@29,C1,0.00#<cr-lf>

@29,BP1,0.46#<cr-lf>

Query command:

@29#<cr-lf>

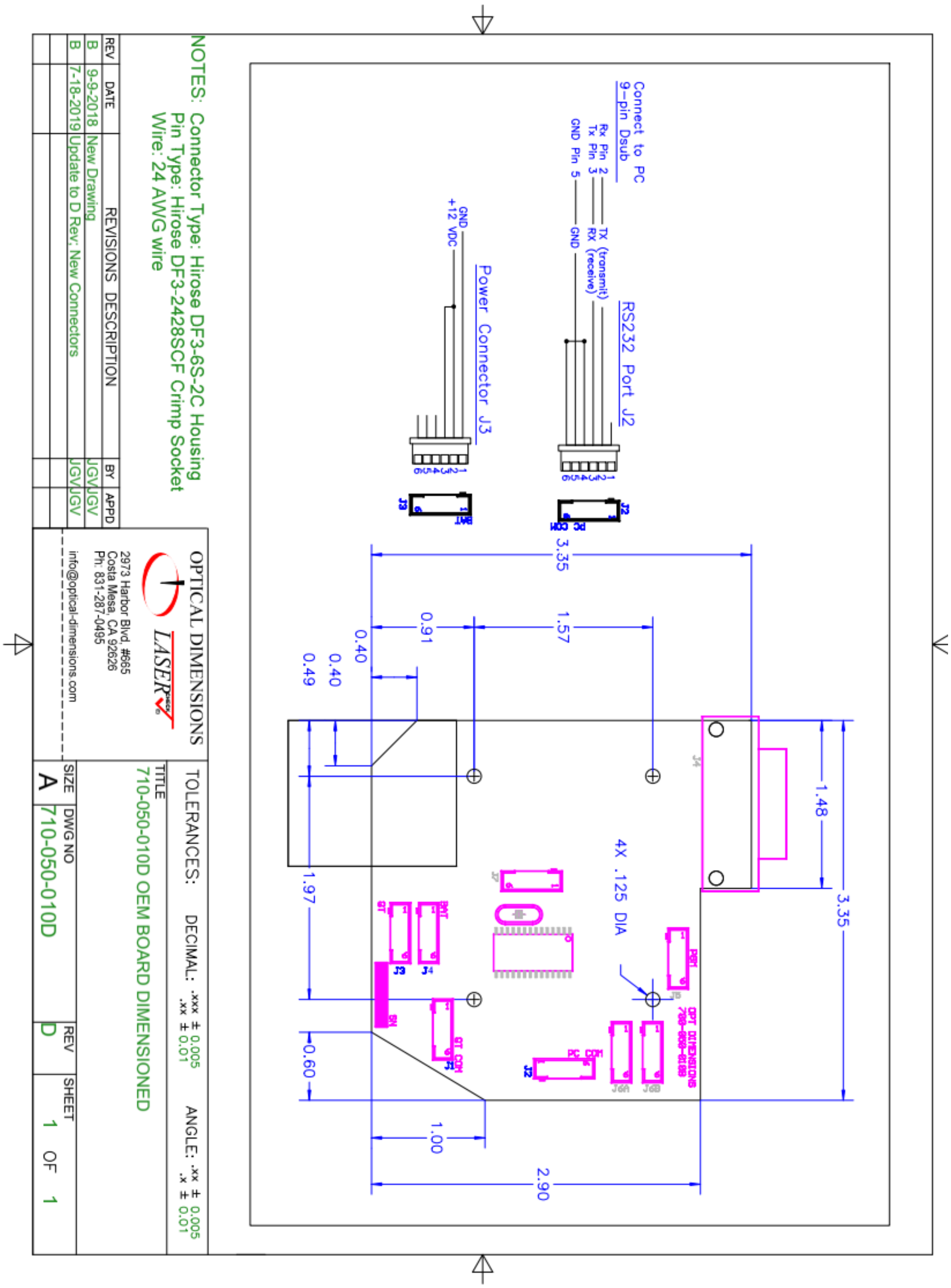
Query Response:

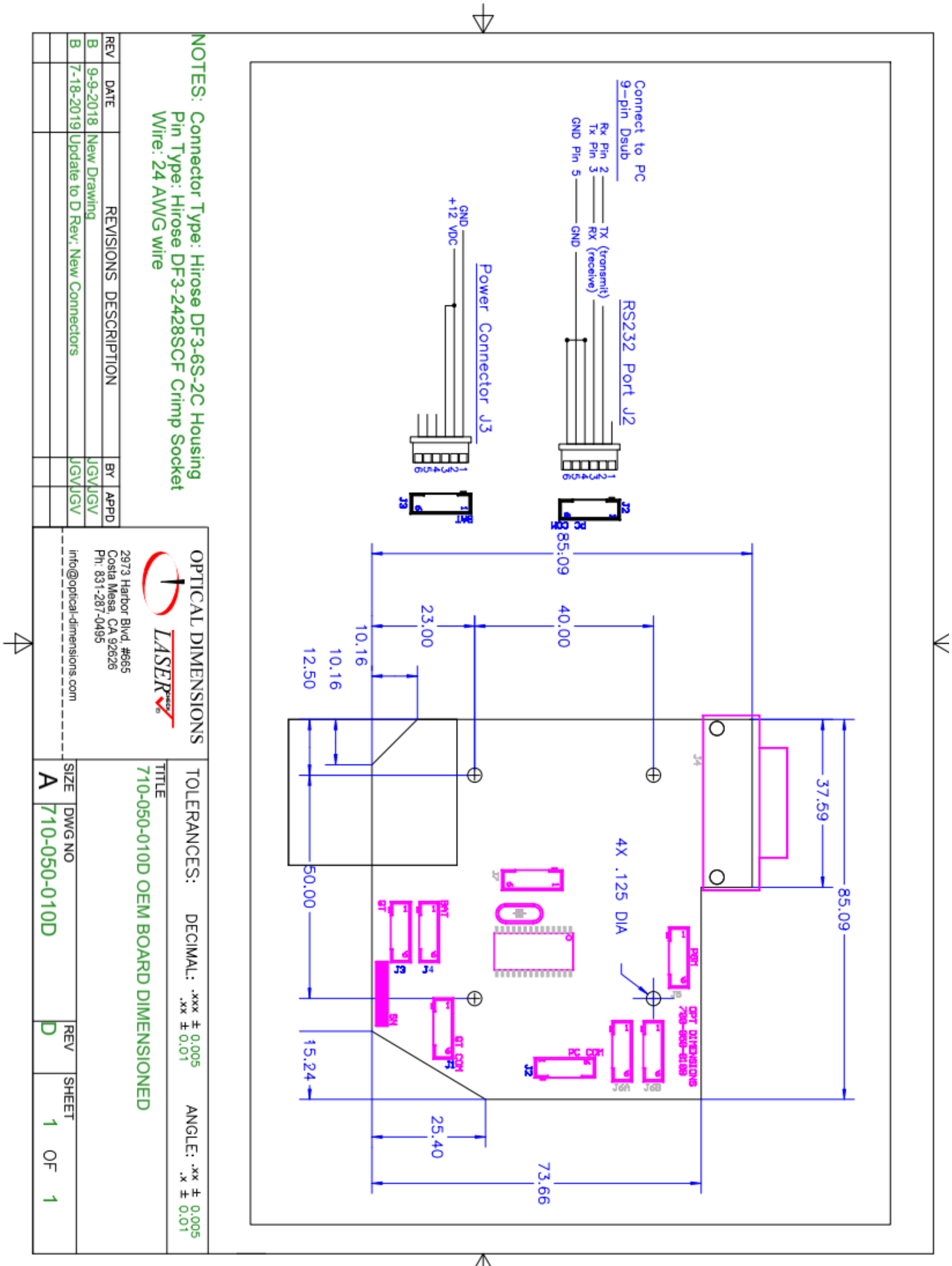
@29<cr-lf>

aaaaaa<cr-lf>	FILENAME=	uncal	6212Gd	8826GRD
bbbbbb<cr-lf>	RAUNITS=	microinches	microinches	microinches
ddd.dd<cr-lf>	A1=	0.00	-11.90	-1.00
eee.ee<cr-lf>	B1=	1.00	14.81	7.39
fff.ff<cr-lf>	C1=	0.00	0.00	0.00
ggg.gg<cr-lf>	BP1=	1.00	0.46	1.10
hhh.hh<cr-lf>	A2=	0.00	0.00	0.00
iii.ii<cr-lf>	B2=	1.00	3.90	5.20
jjj.jj<cr-lf>	C2=	0.00	2.50	1.20
kkk.kk<cr-lf>	BP2=	2.00	4.70	3.50
lll.ll<cr-lf>	A3=	0.00	1.10	1.40
mmm.mm<cr-lf>	B3=	1.00	-6.44	-4.60
nnn.nn<cr-lf>	C3=	0.00	26.80	18.35

#<cr-lf>

Appendix E – Wiring and Dimensions American and Metric Versions





NOTES: Connector Type: Hirose DF3-6S-2C Housing
Pin Type: Hirose DF3-2428SCF Crimp Socket
Wire: 24 AWG wire
REV
DATE
REVISIONS DESCRIPTION
BY
APPD
B
9-9-2018
New Drawing
JGV
JGV
B
7-18-2019
Update to D Rev: New Connectors
JGV
JGV
OPTICAL DIMENSIONS
LASER
2973 Harbor Blvd. #665
Costa Mesa, CA 92626
Ph: 831-287-0495
info@optical-dimensions.com
TOLERANCES:
DECIMAL: .xxx ± 0.005
.xx ± 0.01
ANGLE: .xx ± 0.005
.x ± 0.01
TITLE
710-050-010D OEM BOARD DIMENSIONED
SIZE
A
DWG NO
710-050-010D
REV
D
SHEET
1 OF 1
Connect to PC
9-pin Dsub
Rx Pin 2
Tx Pin 3
GND Pin 5
TX (transmit)
RX (receive)
GND
RS232 Port J2
GND
+12 VDC
Power Connector J3
85.09
23.00
40.00
10.16
10.16
12.50
37.59
85.09
4X .125 DIA
50.00
15.24
25.40
73.66