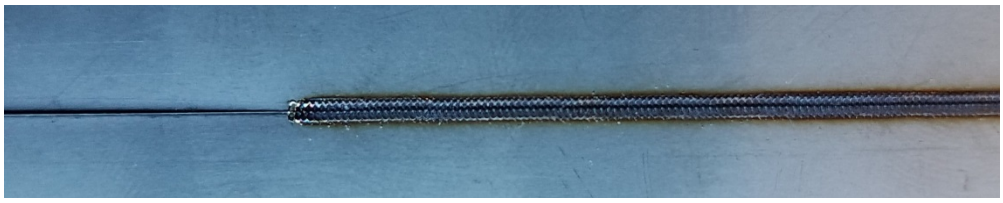
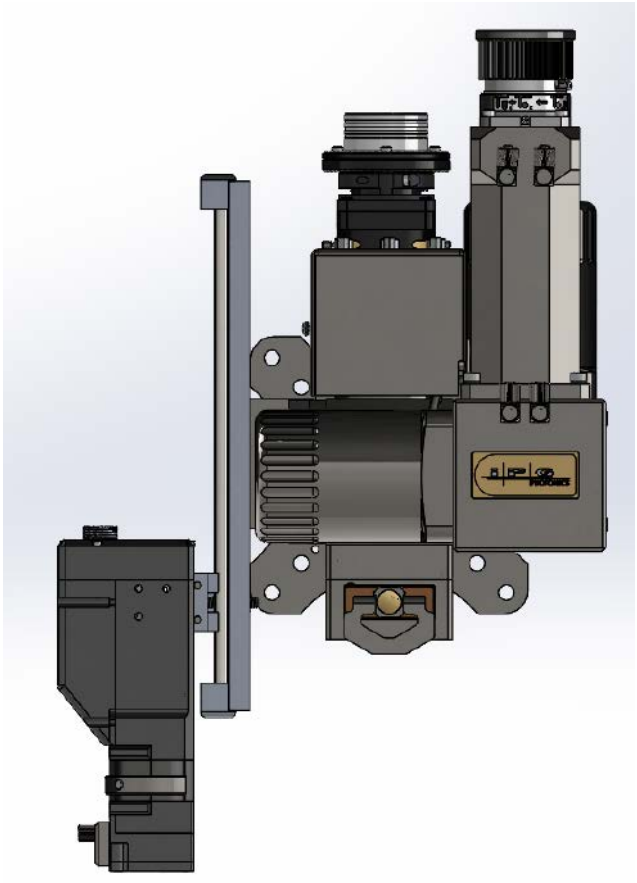
User Guide
Wobbler Seam Track





Part Number: DOCOXUGCOMXX0002
Published: October 2017
Revision 0.2

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Preface:
Please take time to read and understand this User's Guide in its entirety and familiarize yourself with the operating and maintenance instructions that we have compiled for you before you use the product. We strongly recommend that all operators of the product read and pay particular attention to all safety information contained herein prior to operating the product.

This User's Guide should stay with the product to provide you and all future operators, users and owners of the product with important operating, safety and other information.
For technical assistance concerning the product, contact IPG Customer Service.

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1 Safety Information

1.1 Safety Conventions

IPG Photonics use various words and symbols in this User's Guide that are designed to call your attention to hazards or important information. These include:

WARNING: 

Warning refers to a potential *personal* hazard. **(***Electrical)* **(***Laser radiation***)** It requires a procedure that, if not correctly followed, may result in bodily harm to you and/or others. Do not proceed beyond the WARNING sign until you completely understand and meet the required conditions.

CAUTION: 

Caution refers to a potential *product* hazard. It requires a procedure that, if not correctly followed, may result in minor personal injury or damage or destruction to the product or components. Do not proceed beyond the CAUTION sign until you completely understand and meet the required conditions.

IMPORTANT

Important refers to any information regarding the operation of the product. Please do not overlook this information.

1.2 General Safety Instructions

WARNING: 

This product is intended to be used with a laser and cutting head. Read and observe all safety instructions provided with the laser and cutting head.

CAUTION: 

Hot or molten pieces of metal may be present when cutting metal. Exercise caution if debris is being generated in your application.

CAUTION: Use of controls or adjustments, or performance of procedures other than those specified herein, may result in hazardous radiation exposure.

1.3 Electrical Safety

CAUTION:

The Wobbler Controller operates on 24V DC input.

The "User Ethernet" connector is intended for connection to a network, PLC, or PC.

Always Earth Ground the control box and the mechanical stage that mounts the weld Head. Do not open the enclosure as there may be hazardous switching voltages inside. Do not operate in a wet environment.

1.4 Laser Safety

See the welding head manual for locations of laser safety labels on your particular model welding head.



Safety Label 1



Safety Label 2

1.5 Scope of Document

This document covers the connection, configuration, calibration, and safe use of the Wobbler based Seam Track camera and application software. The seam track is intended to be implemented by a system integrator with knowledge about laser welding and control software.

For details on Wobbler, refer to the P21-010225 *User Guide: D30 & D50 Wobble Module.* For detailed information on the use of IPG Photonics D30 or D50 Welding heads, please also refer to the *FLW D30 Series User Guide* or the *FLW D50 Series User Guide*. The companion 'WHAM' Weld Head Alarm Monitor is also covered in a separate manual.

2 Product Description

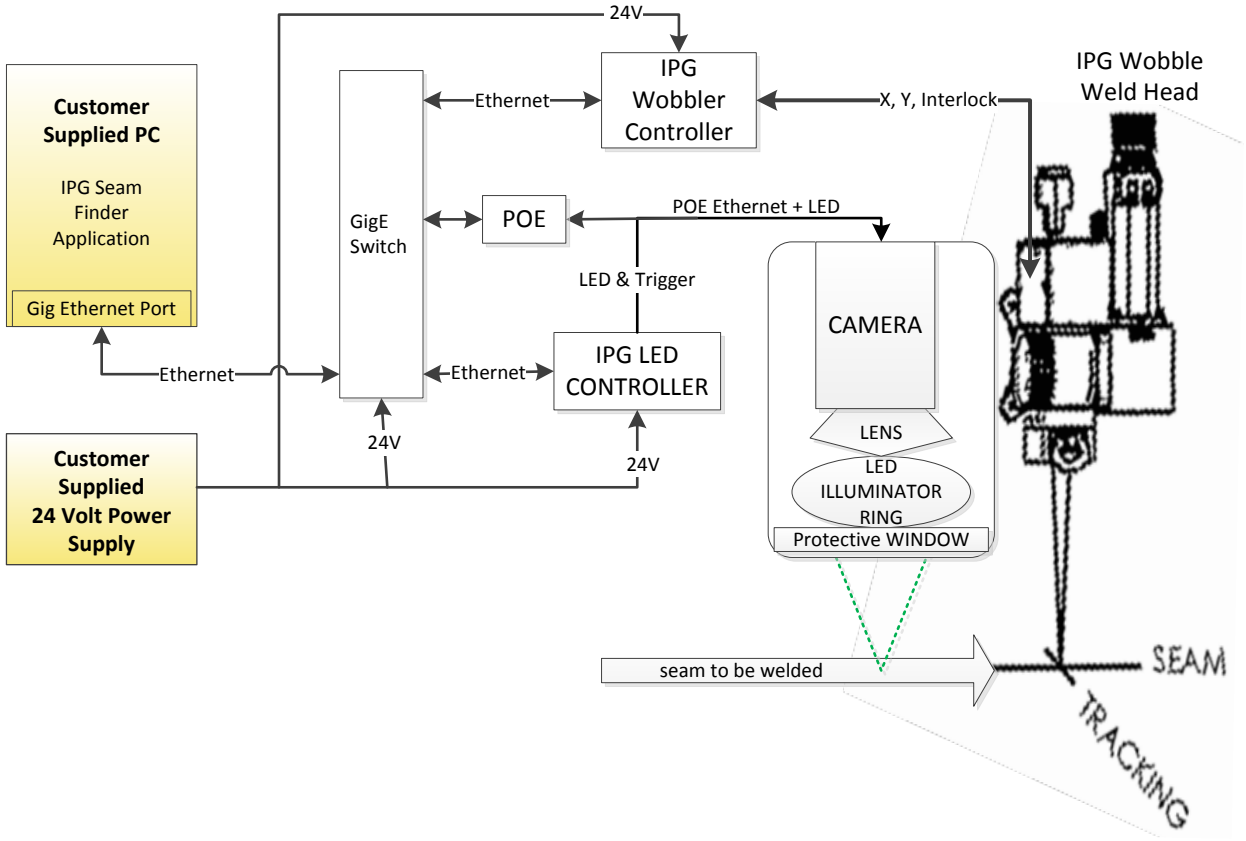
A camera based seam finder has been designed to use with IPG Wobbler Weld heads as a way of tracking a linear seam (single direction).

The Customer supplied PC will run the IPG Seam Find application. Connections are shown in the block diagram below. The PC will have a Gig Ethernet port that is connected to a GigE switch and communicates with IPG Wobbler Controller, IPG LED Controller, and the vision camera. The LED Controller sets brightness of illumination LED and trigger of camera images. Images from the camera are sent to the PC using GigE and analyzed for linear seam location. The Seam Finder Application will output calculated seam track data to the wobbler controller via Ethernet at up to ~120Hz. A digital output on wobbler controller will indicate when seam finder is locating seam. Material speed programmed in the wobbler delays the tracking information the appropriate time.

2.1 Definition of Terms

X-axis:	The axis is parallel to the mounting flange of the welding head
Y-axis:	The axis is perpendicular to the mounting flange of the welding head
Orientation:	Relationship of weld head mounting flange to seam direction.
Wobble:	Periodic motion of laser beam used to produce better welds.
Frequency:	The rate in Hz that the wobble pattern repeats for linear or circle. On figure 8 or infinity it is the rate of the faster axis or half the full pattern.
Amplitude	The size of the wobble excursion specified in mm.
Track:	Motion used to follow a weld seam. The signal to track is derived from our camera machine vision and processed.
Track Axis:	X or Y may be designated as the tracking axis.
Offset:	Purposeful spot position change perpendicular to seam. For example, may allow welding above or below center of seam.
In Axis Offset:	Purposeful spot position change along seam direction.
Trim:	Gain factor applied to both X and Y axis for fine tuning two or more heads amplitude while maintaining otherwise same process parameters.

2.2 Functional Block Diagram



2.3 Environmental (operating)

Operating temperature:	10 to 40 °C
Storage Temperature:	-20 to +70 °C
Humidity:	30 to 90% non-condensing

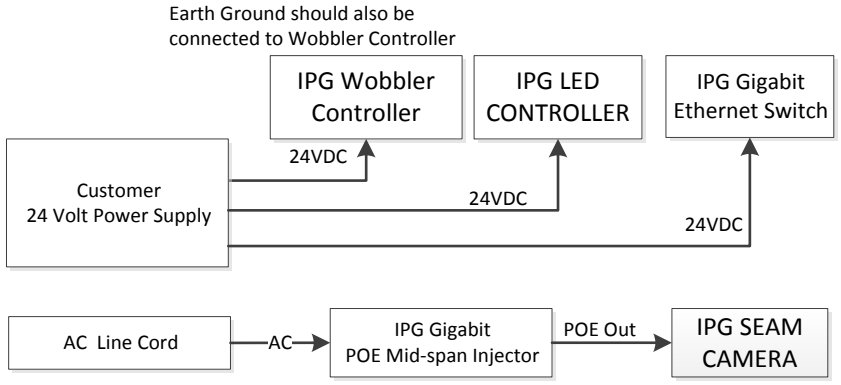
3 Installation

3.1 Software

The Seam track application and drivers must be installed in a Window 7 or later PC. Follow Software installation instructions included in the provided document: "IPG_WobbleSeamTrack_Software_Installation_Guide.docx".

3.2 Power

24 Volt DC Power must be supplied to Wobbler Control Box, Light Control Box, Gig Ethernet Switch. The POE injector is connected to AC Mains.



3.2.1 Wobbler Controller



Follow User Guide: Wobble Module.

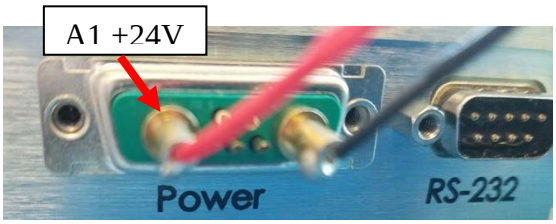
Connector: Power D Sub 3W3 type:

Pin	Name	Function	Current, Maximum Amps
A1	+24	+24 VDC +/- 10%;	4 A operation; < 8 A inrush
A2	GND	Return for 24 Volts	
A3	Chassis	Earth Ground	Important! Always connect

Always connect A3 to good Earth Ground. There are also screw lugs available on cover.

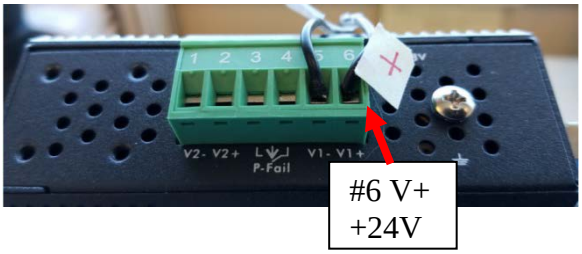
3.2.2 LED Controller

Connector: D Sub 7W2 style.
Mate Connector included.
+24 Volts to Pin A1
Return to Pin A2



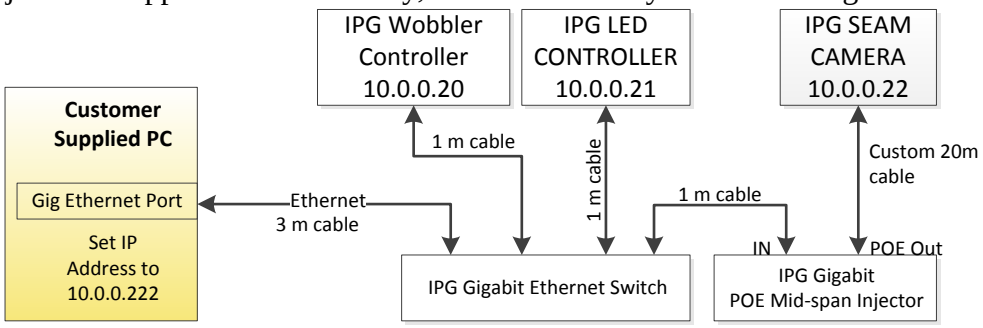
3.2.3 Ethernet Switch

"Pwr 1" 24VDC at ~100ma
+24V to V1+ (pin 6)
Return to V1- (pin 5)



3.3 Network

The PC, Wobbler Controller, LED control box, and Seam Camera must be on the same network connection. This is accomplished using dedicated Gigabit Ethernet port on the PC connected to a Gigabit Ethernet Switch. Only Gig E should be used for seam track due to the speed of image data. The camera needs POE (Power over Ethernet) to operate. A mid span injector is supplied. Alternatively, the customer may use a POE Gig Ethernet Switch.



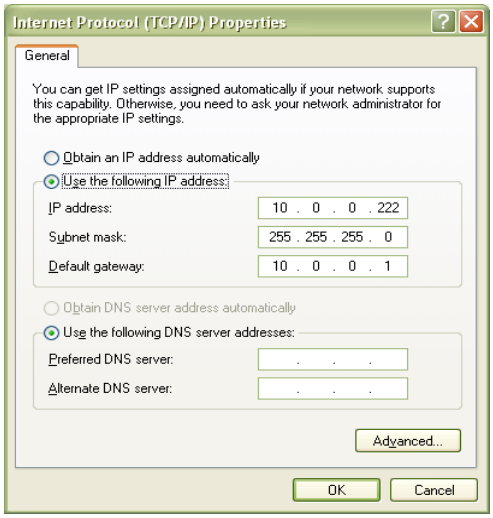
3.3.1 Computer Ethernet Interface Setup

The Wobbler Controller Ethernet port has a default fixed IP address of 10.0.0.20, the LED Controller 10.0.0.21, and the Seam Camera 10.0.0.22 and it is recommended that you use those addresses unless you need to change them. The process for changing the IP address in the controllers is covered in their manuals.

Configure the Ethernet interface of the host computer or laptop Internet Protocol (TCP/IP) properties to have a fixed IP address of 10.0.0.xxx where xxx can be any number between 30 and 250.

Host Computer Example:

IP address:	10.0.0.222
Subnet Mask	255.255.255.0
Default gateway	10.0.0.1



Note a second Ethernet Adapter such as a USB to Ethernet adapter may be necessary or convenient should you want to retain a network connection using the primary port. Use a GigE port for Seam Tracker. If you use a USB Adapter, be sure to use a USB-3 port on computer or tracking rate must be reduced below 40Hz. It is better to use a dedicated GigE port or card in computer and use adapters for other network traffic.

3.3.2 Web Interface

IPG provides a web page with the Wobbler Controller and LED controller available via Ethernet for Configuration, Status, and Operation. The Seam Track interface uses the web interface to send commands to the wobbler controller and LED controller for Seam tracking. **Refer to the wobbler controller manual for more details on using it.**

Supported Browsers for Windows:

Internet Explorer 9, 10, 11; Chrome V.35 or higher; Firefox 27 or higher.

Use of unsupported browser versions may show refresh issues or reduced functionality.

Using a browser such as Internet Explorer or Chrome, the user selects the current IP address of the Wobbler Controller. To connect to the web interface:

1. Configure your Ethernet adapter as show in section 3.2.1
2. Start web browser – see supported browsers list.
3. Type **http://10.0.0.20/** into your browser address window

The home page will open to the User Menus Status Page. The 'Service' menu tab is for IPG use only. Navigate through User web pages by selecting the name on the Tabs.

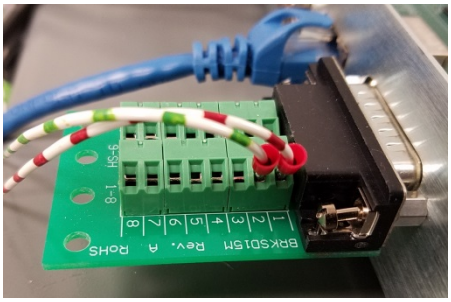
If you use Digital Inputs for Wobble Enable, Program Select, and Seam Enable then those functions will not be changeable thru application programs, only through PLC control. User may change enables individually for these three functions to select between digital input and web/command input.

3.4 Signal Connections

3.4.1 LED Connection

The LED Signal must be connected to the I/O connector on the Light Controller Box.
15 pin male D-sub connector on cable; female on box. Adapter included for convenience.

Red/White Pin 1	LED Ring+
Green/ White Pin 2	LED Ring -



3.4.2 Tracking Signal available on Wobbler I/O

This version of wobbler control has used a spare digital output (pin #13) to provide a "Track Good" signal. Logic High is tracking. Logic Low is a problem in finding the seam.
The 25 pin D-SUB connector is used to connect the Wobbler Controller to customer electronics. The pin assignment of the connector is specified in the table below.

Pin #	I/O	Signal Name	Function
1	IN	Wobble Frequency	Unipolar analog signal proportional to speed of the wobble
14	-	GND	Return for analog inputs (ground)
2	IN	Wobble Amplitude	Unipolar analog signal proportional to amplitude of the wobble
15	-	GND	Return for inputs (ground)
3	IN	Seam Track	Bipolar analog input signal for seam tracking
16	-	GND	Return for analog input (ground)
4	IN	Program 0 (LSB)	Three digital signals to select one of the eight pre-setup configuration tables 0-7. Used with Select Program latch. Program 2 is MSB of binary count.
5	IN	Program 1	
6	IN	Program 2 (MSB)	
7	IN	Select Program	Digital (latch) input to set the selected table based on Program 2-0
17	IN	Wobble Enable	Digital signal to turn the wobble on when high.
18	IN	Seam Track Enable	Digital signal to turn the seam tracking on when high.
19	IN	Seam Latch	Digital strobe (latch) for the seam track analog signal (optional)
20	IN	Modulation Enable	Enables the optional Analog Laser Modulation signal when high.
8	-	IN COMM (Logic Return)	Common line for the input digital signals. Normally Logic Ground on most PLC systems
9	-	OUT COMM (+V Logic)	Common line for the output digital signals. Normally +24Volts on most PLC Systems.
10	OUT	Wobble Active	Digital output high when wobbling is enabled and operating
11	OUT	Ready	Digital output high when no alarms
12	OUT	Wobble Sync	Digital output pulse represents each cycle of the wobbler
13	OUT	Track Good	Digital output high when Seam Track App reports it is finding seam
21	-	NC	Not connected
22	-	NC	Not connected
23	-	NC	Not connected
24	-	NC	Not connected
25	-	NC	Not connected
Shell	-	Earth Ground	The shield of the external cable

4 Application Software

Double click on screen shortcut to start application:

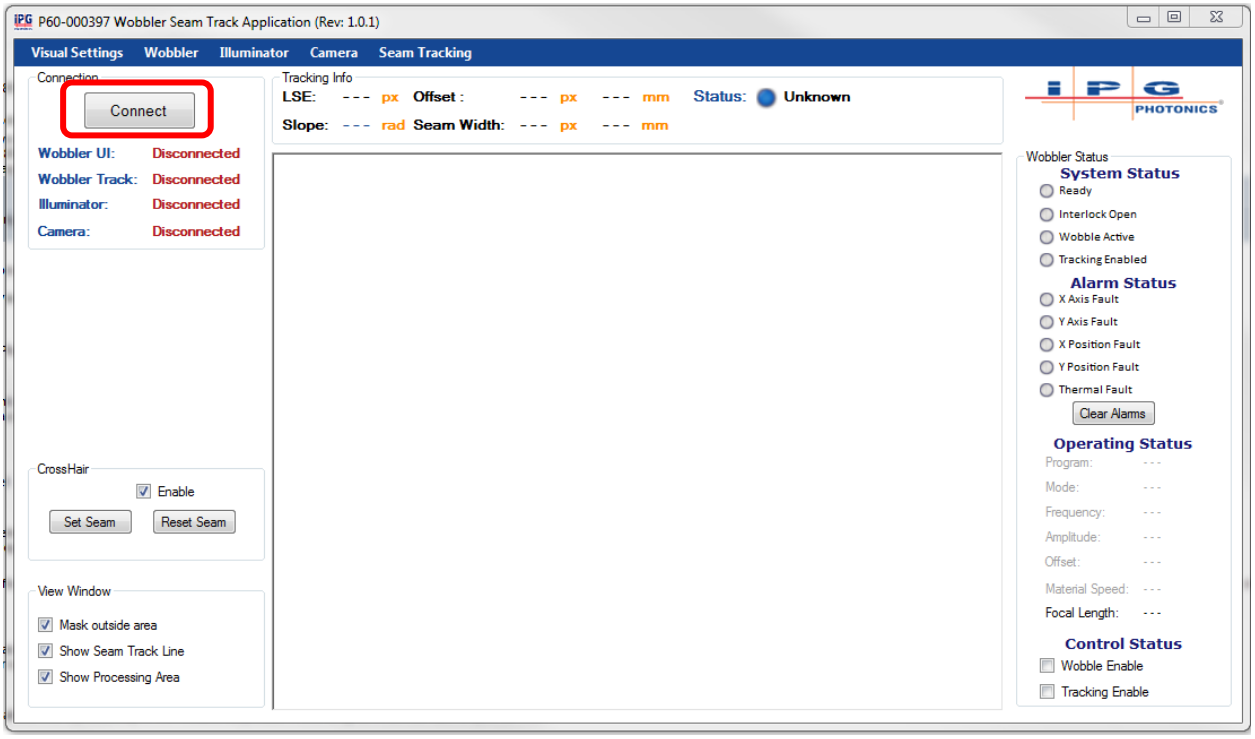


Or run the application from the following folder:
“C:\Program Files (x86)\IPG Photonics\WobblerSeamTracker”.
The executable file is “WobblerSeamTracker.exe”.

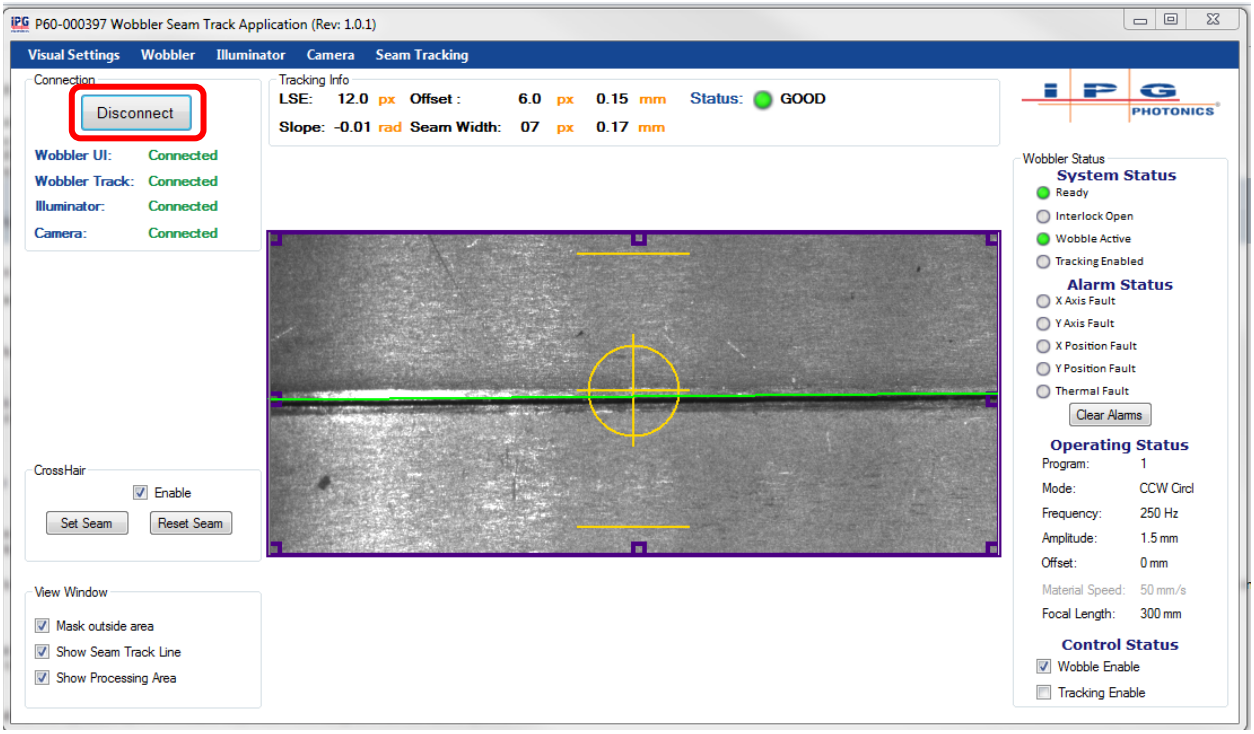
4.1 Main Page

This window appears on the screen after application starts. The Main page has Connection, Tracking Information, Cross Hair, View Window, and Wobbler Status sections as well as 5 selectable menus for Visual Settings, Wobbler, Illuminator, Camera, and Seam Tracking. When a camera is connected, the image is displayed on the screen.

4.1.1 Connection



If the system is connected and powered on, the next step is to click “Connect” button on a left-upper corner of application window. Connection takes 2-5 seconds, with the camera taking the longest. If it fails to connect, check power and Ethernet connection to Camera, Wobbler Controller, and Illuminator Controller. Upon successful connection, the Connect button turns to a Disconnect button as seen in the window below:



The “Disconnect” button provides a way to disconnect the Ethernet connection if application is going to be terminated or temporarily stopped. It is suggested to disconnect prior to exiting application.

The connection box shows the status of Ethernet connections to Wobbler (both user interface and seam track data port), the illuminator controller, and the camera.

4.1.2 Cross Hair and View Window Settings

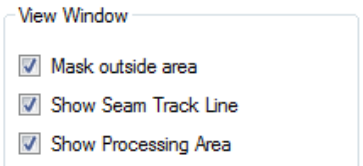
The Cross Hair settings allow:

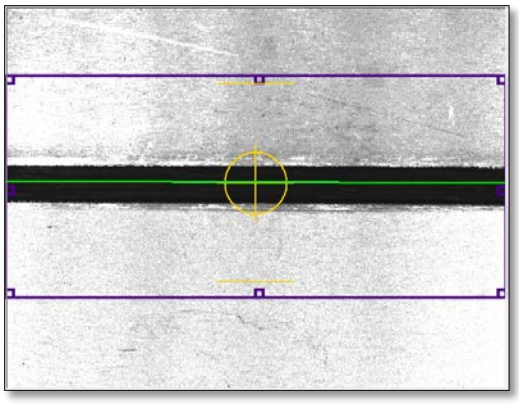
- Disable/Enable the Cross Hair and symbol on image
- Set Seam: Places Cross Hair in a middle of current Seam Track Line
  - Set Seam makes the current location of the seam zero wobbler offset
- Reset Seam: Places Cross Hair on a middle (X&Y)of Processing Area



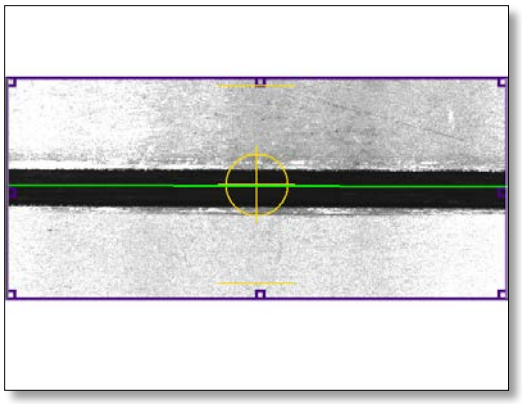
The View Window settings allow:

- Mask area of image outside of active processing area from view.
- Show calculated Seam Track Line on image
- Show a rectangle on the border of the processing area





Mask is off

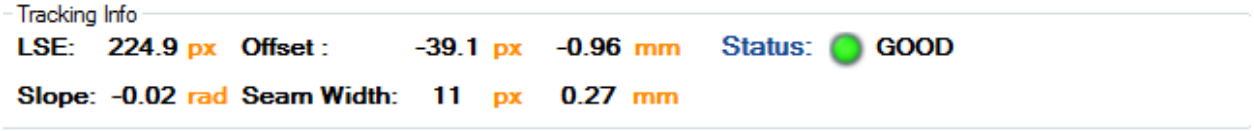


Mask is on

The active area may be changed by grabbing on of the 9 small squares on the processing area rectangle with your mouse and dragging. It may also be adjusted numerically on the Seam track settings window.

4.1.3 Tracking Information

The "Tracking Info" area shows current values for Seam Tracking Procedure.
If not tracking, the Status and message will be Red.

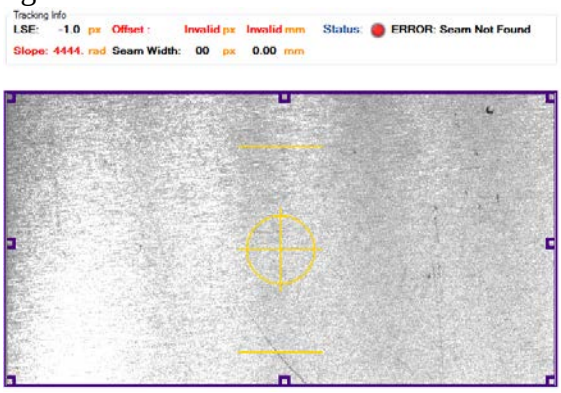


- LSE (Least Square Error)
- Offset in pixels and mm (Distance to track seam from seam zero offset)
- Slope value (tangent of angle in radians)
- Seam width in pixels and mm
- Status- Good, Errors, or Alarms.

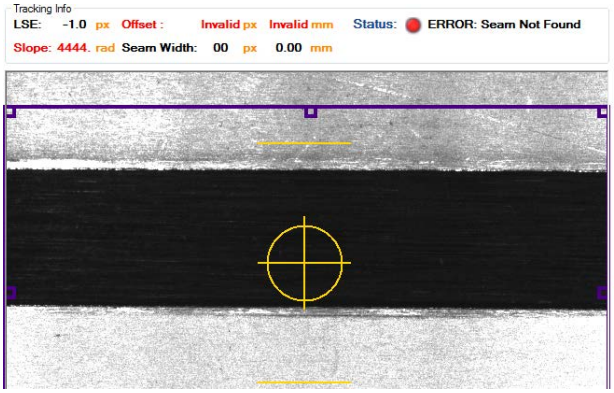
The Status "GOOD" or "ERROR: reason" provides information about Seam Tracking status. Note the tracking good signal is available for customer PLC as a 24 Volt digital output from wobbler controller IO Pin 13 as described in Installation section. When the seam is being found to be within limits that are selected, the Status is GOOD and Tracking good output bit is high.

ERROR: Seam Not Found

The tracker is not able to locate a seam. This could be because the seam is not visible that results in too few seam values being found. It can also happen when the seam is wider than the allowed setting.



No seam in view

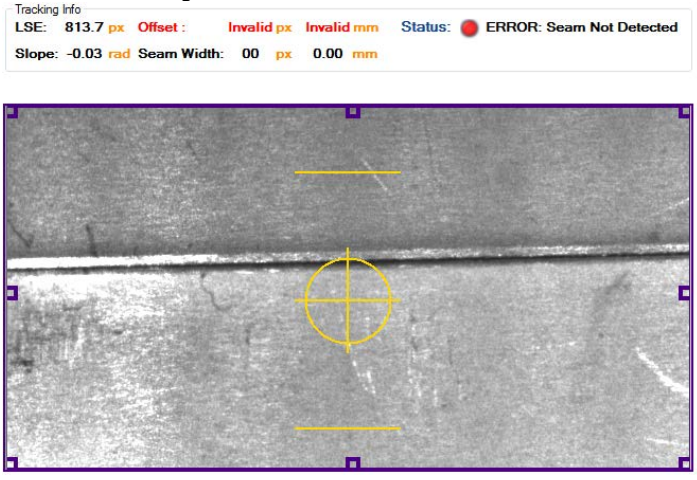


Seam exceeding current max seam setting

The user should mitigate the issue with the seam image through location, focus, lighting, and other adjustments. If the issue is seam width the user should set the maximum seam width to the new desired value or reduce the seam on part to the correct value.

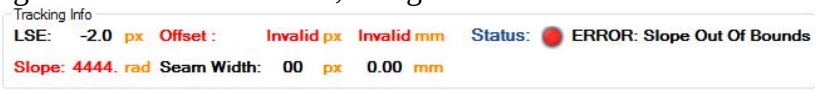
ERROR: LSE above limit

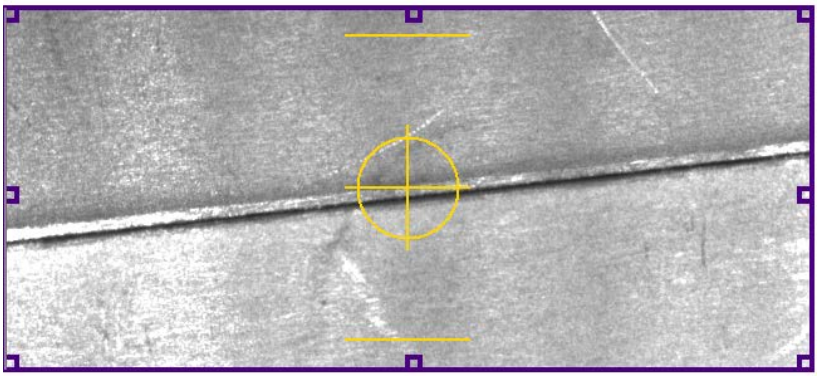
The tracker found a seam, but there is a quality issue that causes the LSE is above range
If it is a narrow seam try reducing step size setting. Generally try and improve image changing brightness or reducing processing area to improve LSE or increase allowed LSE if it is set too low for a scratchy surface for example.



ERROR: Slope Out of Bounds

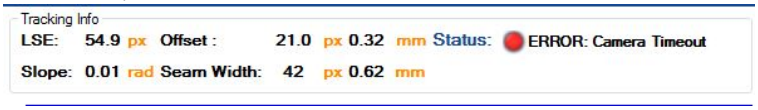
The slope of the seam is at an angle greater than the limit set. If this is ok for your material, then increase the setting of the limit. Otherwise, straighten material relative to head.





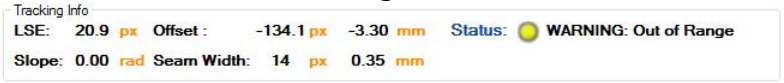
ERROR: Camera Timeout.

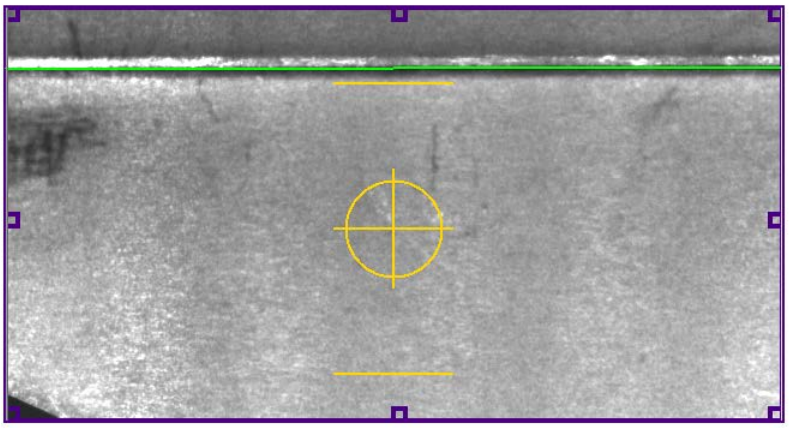
This error will occur if no communication with camera for example the camera is not connected, mid-span POE injector is off, or Ethernet Switch is not on.



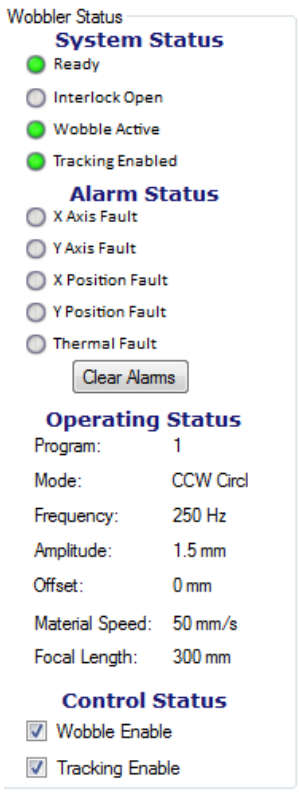
WARNING: Out of Range

This warning happens when the seam is found and valid but it is outside of the range for the wobbler to correct the location. The head or material must be relocated to be in range. Range marks are shown as horizontal lines above and below the cross hair to indicate maximum correction range based on the wobbler focal length.





4.1.4 Wobbler Status

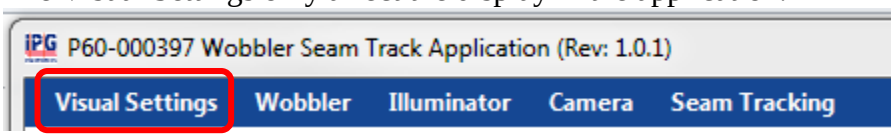


On the right Side of the main page the Wobbler Status is displayed.
Refer to the *User Guide: D30 & D50 Wobble Module* for details.
The user may enable Wobble or Tracking here or
Clear a wobbler alarm if the condition is now resolved.
There are three sections

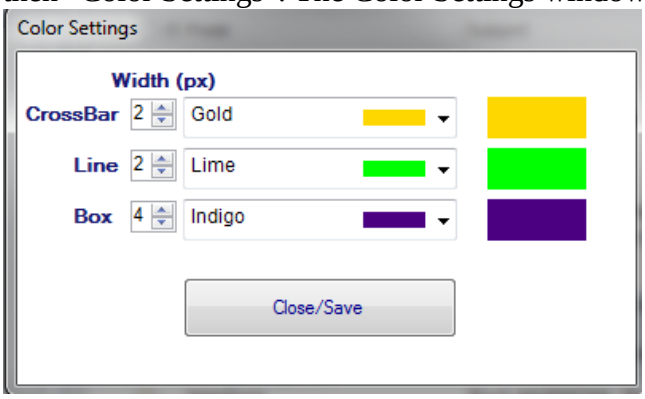
- System Status,
- Alarm Status,
- Operating Status
- Control Status

4.2 Visual Settings

The Visual Settings only affect the display in the application.



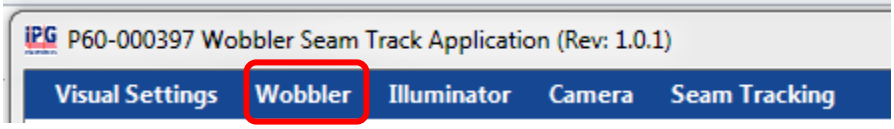
Click “Visual Settings” on the application pulldown menu,
then “Color Settings”. The Color Settings window appears:



The user may select different colors for CrossBar, Line and active area Box, as well as thickness in pixels from 1 to 4. After setting is done click “Close/Save” button. The Color Settings window disappears. All color and thickness settings will be saved.

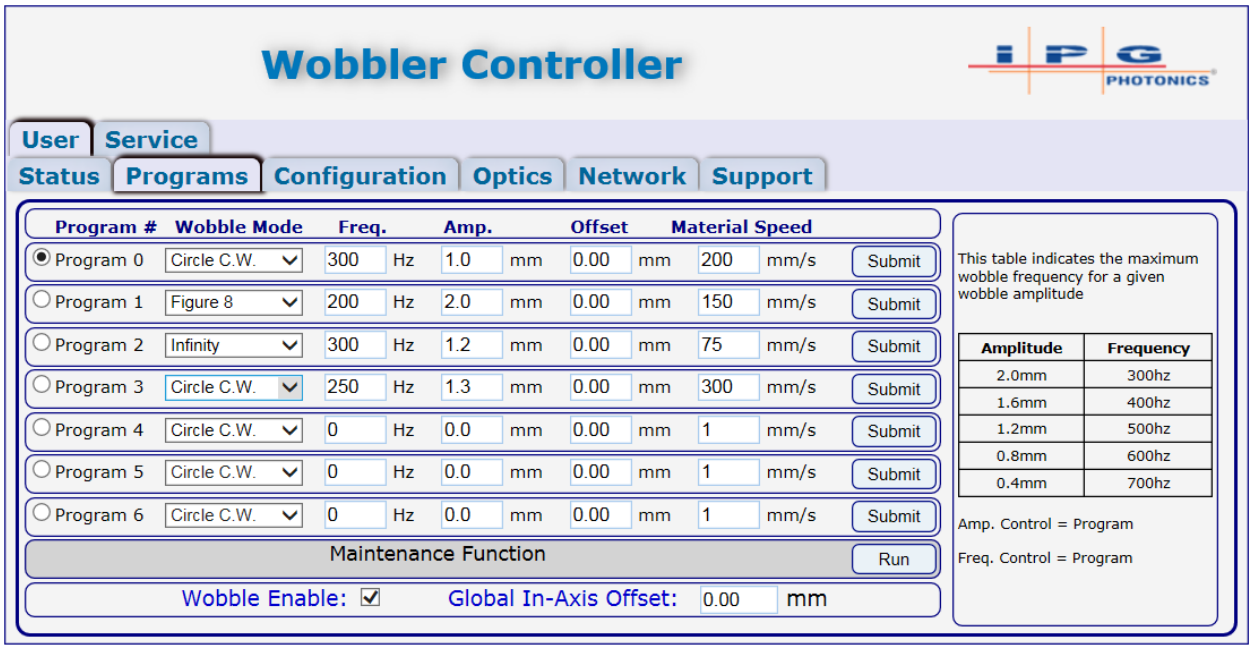
4.3 Wobbler

Wobbler-Program and Wobbler-settings are described in *User Guide: D30 & D50 Wobble Module.* Refer to that manual for description of wobbler function and settings.



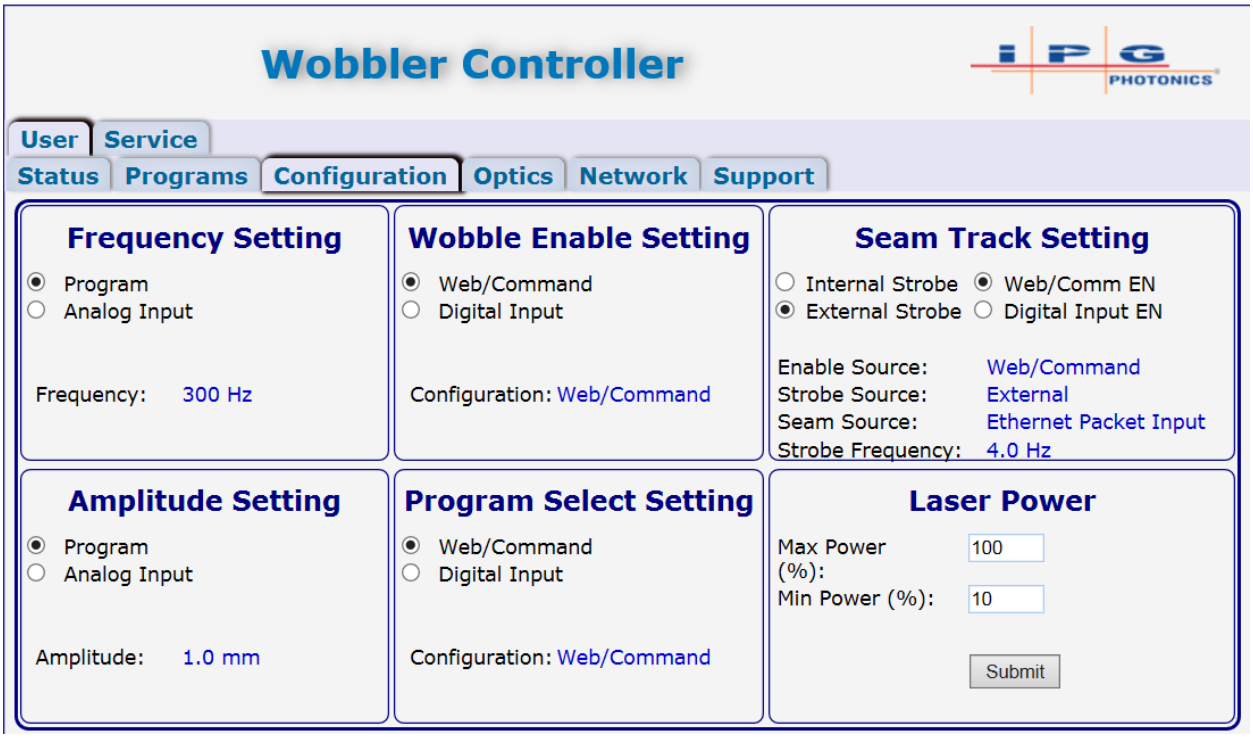
4.3.1 Wobbler Program

From the Seam Track Application window, selecting the Wobbler then "Program" will bring up the Programs web page from the wobbler controller as a convenience. You may also access the web page directly. Wobbler Program settings are described in *User Guide: D30 & D50 Wobble Module.*



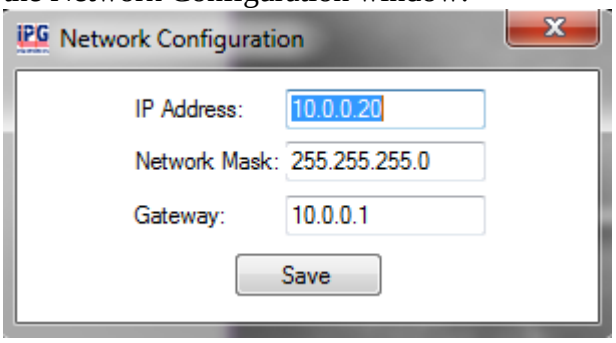
4.3.2 Wobbler Settings

From the Wobble Seam Track Application window, selecting the Wobbler then "Settings" will bring up the "Configuration" web page from the wobbler controller as a convenience. You may also access the web page directly. Wobbler Configuration settings are described in *User Guide: D30 & D50 Wobble Module.*



4.3.3 Wobbler IP Address

If you have changed the IP address of wobbler*, before the application is connected, (before clicking "Connect" button) click the "Wobbler" pull-down menu, then "Network". You will see the Network Configuration window:

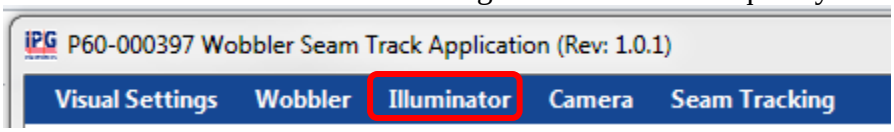


The default IP address is "10.0.0.20", Network Mask "255.255.255.0", and Gateway "10.0.0.1". These are recommended settings. It is possible to change all these values and click "Save" button.

*NOTE: This only changes the address the Seam Track Application will look for the Wobbler Controller. The IP Address of the Wobbler Controller must have been set in the Wobbler Controller.

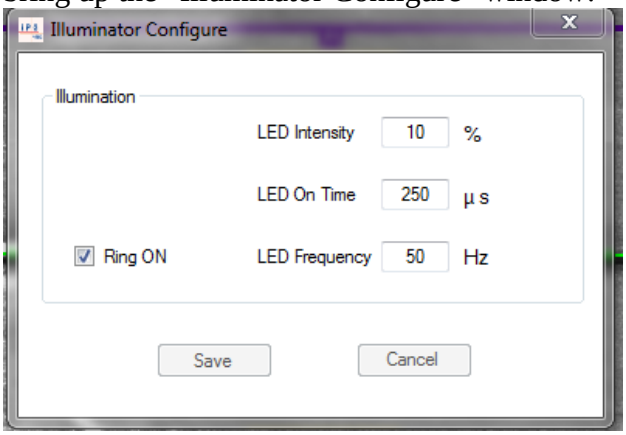
4.4 Illuminator

The Illuminator controls the LED ring and the camera frequency so they are synchronized.



4.4.1 Illuminator Settings

From the Wobble Seam Track Application window, selecting the Illuminator then "Settings" will bring up the "Illuminator Configure" window:



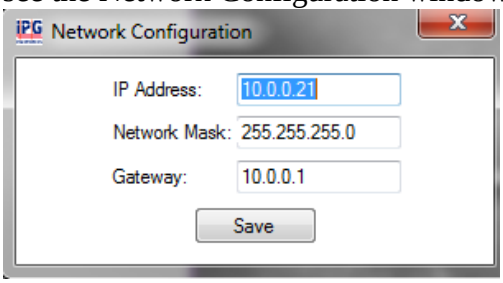
The Settings of all parameters can be done using this window.

If "Ring On" is checked the LEDs will turn on. If not checked, the LEDs will be off. Adjustments to LED Intensity, LED On Time, and LED Frequency may be made here. Please hit the "Enter" button after each change. You will be able to save or cancel all changes.

To increase brightness of image, increase the LED Intensity in percent. Range is 1 to 100%. Larger percent will make image brighter. Set brightness to minimize LSE.
The LED On time should be selected based on camera shutter time. It should be at least 10us larger than shutter time. The camera shutter time also affects brightness. Use a short time that allows good image. LED time should not exceed 10% of Frequency time. That means at 100Hz (10ms) never set LED on time to be greater than 1ms. Typical Shutter times are 100us or 200 us. The frequency will decide how often the seam track is updated. It may be adjusted up to 120 Hz for short shutter times. Typical shutter frequency is 100 Hz.

4.4.2 Illuminator IP Address

If you have changed the IP address of Illuminator*, before the application is connected, (before clicking "Connect" button) click the "Illuminator" pull-down menu, then "Network". You will see the Network Configuration window:

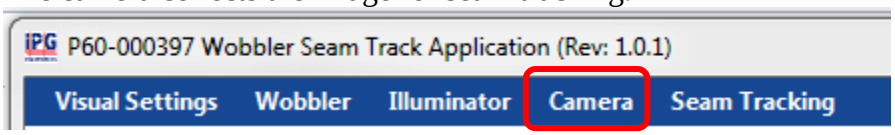


The default IP address is "10.0.0.21", Network Mask "255.255.255.0", and Gateway "10.0.0.1". These are recommended settings. It is possible to change all these values and click "Save" button.

*NOTE: This only changes the address the Seam Track Application will look for the Illuminator Controller. The new IP Address of the Illumination Controller must have been set in the Illuminator Controller.

4.5 Camera

The camera collects the image for seam tracking.



4.5.1 Camera Settings

When the application is connected, please click "Camera" from top pull-down menu and the "Setting". The following small "Camera" window appears:



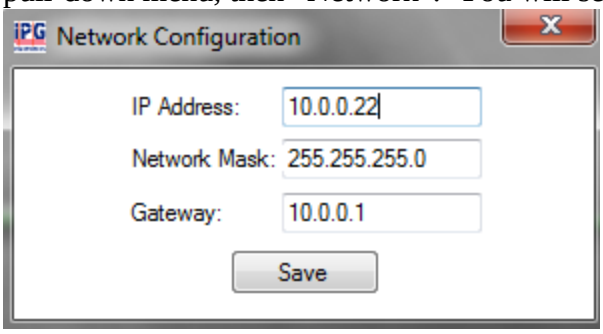
Typical Shutter times are 100-300 us. You can change the camera exposure time – Fixed Shutter in microseconds (us) from 100 up to 30,000 microseconds. The exposure time should be as short as practical. It must be << period of shutter exposure. The camera shutter time must be at least 8ms shorter than the period of the trigger frequency. E.g. at 100 Hz (10ms) shutter should be less than 2 ms. Note set the LED on time to 10 or more microseconds longer than shutter time if you make adjustments to Fixed Shutter.

The Shutter time entered will be used and stored for the next session.

The Camera Offset adjusts in increments of 16. **128 is no offset and is nominal value**. The offset may be moved down to 0 or up to 240. The offset will use additional pixels in camera. We use only 592 of the 832 pixels in the camera in that direction. The offset will move the image in the cross seam direction. This can be used to fine adjust the center of the camera to the laser beam. This is discussed in the calibration section in the next chapter.

4.5.2 Camera IP Address

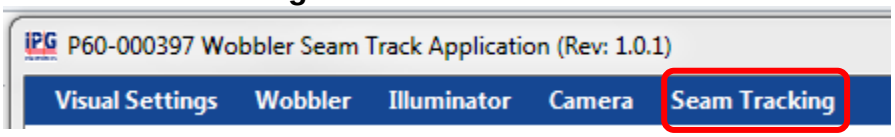
Before the application is connected, i.e. before clicking "Connect" button, click the "Camera" pull-down menu, then "Network". You will see the following small window:



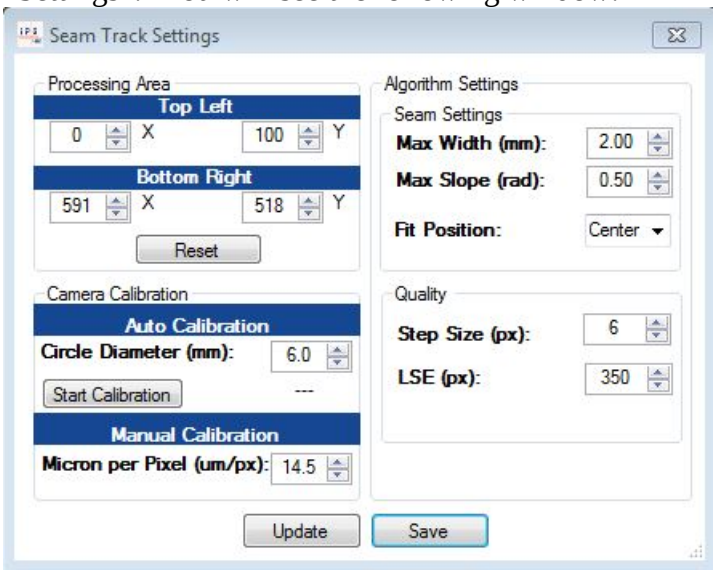
Make sure that IP address is "10.0.0.22" as shown as well as Network Mask "255.255.255.0" and Gateway "10.0.0.1". These are recommended settings. It is possible to change all this values and click "Save" button.

*NOTE: This only changes the address the Seam Track Application will look for the Camera. The new IP Address of the Camera must have been set in the Camera.

4.6 Seam Tracking



When application is connected or disconnected click the "Seam tracking" pull-down menu, then "Settings". You will see the following window:



4.6.1 Processing Area

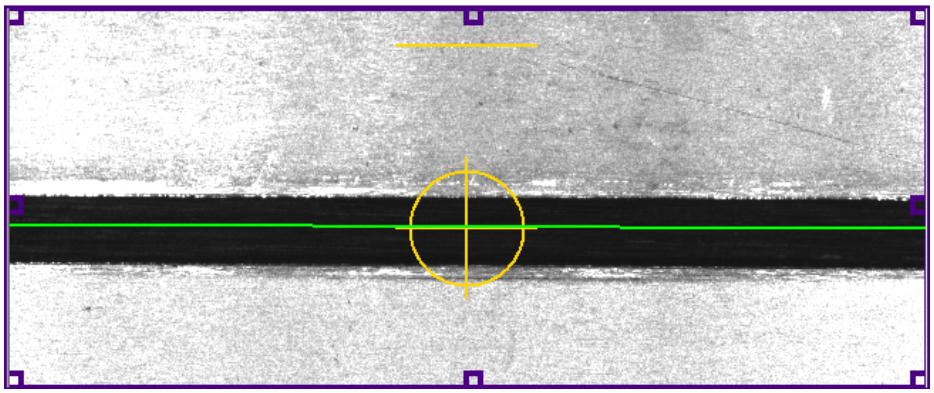
Change the size (in pixels) of processing area, the maximum resolution of the camera is 592 (vertical) x 592 (horizontal) pixels. If click the button "Reset", initial maximum resolution values will appear in windows. Click "Update" and "Save" buttons to keep values for the next session.

The processing area may also be set by the main window if the Seam Track settings window is closed,

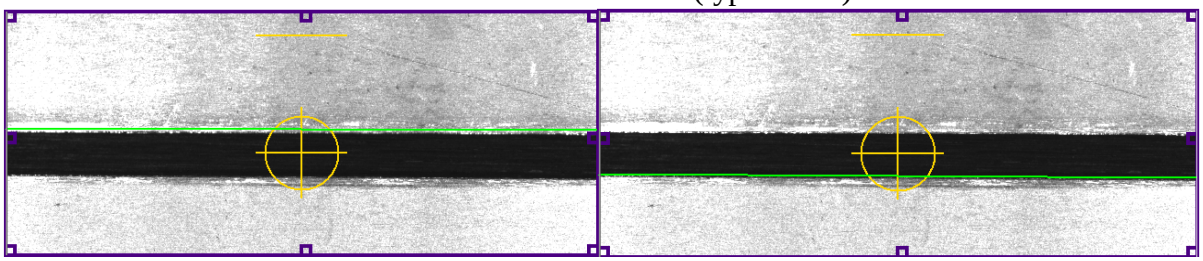
4.6.2 The Algorithm settings

- Quality- Step Size: Range is 1 to 20 pixels. Speeds algorithm by looking every step size pixels for initial location of seam. Step size 8 (recommended for typical seams). On narrow seams try a lower number to reduce LSE. Frequency may need to be reduced for small numbers on very thin seams.
- Quality- LSE (Least Square Error): range 1 to 1000. 200-400 recommended.
    - Sets LSE Error if LSE is greater than limit
    - The tracking is modeled to a straight line. The LSE is a measure of the quality of the fit of all the points.
- Seam Settings- Maximum Width: Range is 1.00 to10.00 mm
    - Seam not found Error if seam is wider in than limit.

- Seam Settings- Maximum Slope: Range is 0 to 0.9 Please remember for the small angles the value of angle in radians approximately equals to angle's tangent, i.e. slope. For example tangent of 0.2 radians (11.46°) equals to 0.203.
  - Error if seam is at too great an angle than ± limit.
- Seam Settings- Fit Position: Location of the seam - bottom, top, central.
  - Models seam location to top of seam center, or bottom.
  - Used if one edge is very rough or jagged.



Seam Fit set to Center (typical use)



Seam Fit Position at Top Seam Fit Position at Bottom

4.6.3 Camera Calibration

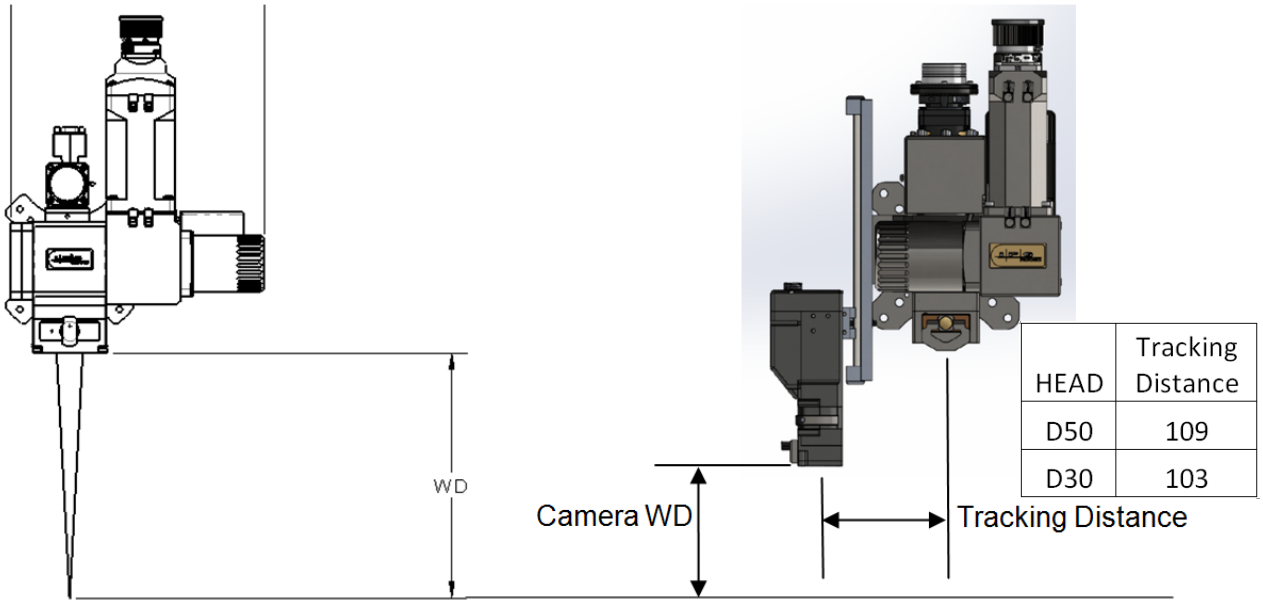
Camera calibration is setting the location of the camera to the seam and the magnification (ratio of pixels on camera image to actual size of seam). These are covered in chapter 5.

5 Operation, Adjustments, and Calibration

5.1 Adjustments

5.1.1 Weld Head Working Distance

Set the weld head to the proper **working distance**. Nominal distances are in the *User Guide: D30 & D50 Wobble Module*, however note that the **actual working distance for your head is marked on the side of your head**. Note working distance is shorter than focal length. It is distance from bottom of weld head to work surface.



HEAD	Tracking Distance
D50	109
D30	103

5.1.2 Weld Head cross axis location.

The weld head should be positioned directly above the seam to be welded so the full range of the wobbler may be used for tracking and fine adjustments. Refer to the wobbler manual for details on how to set up the wobbler weld head.

- Power should be on wobbler weld head
- Offset in table should be set to 0.
- Seam Tracking should be off.
- It is optional whether you have wobble on or off or what shape.

Turn on guide beam and move the head mechanically so that the beam is directly centered on seam as close as possible. You may also use a laser pulse to see where beam is hitting.

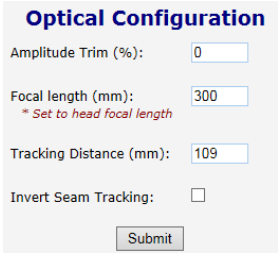
5.1.3 Tracking Distance

Set the tracking distance on the wobbler controller optics web page.

D50 Tracking nominal distance is 109 mm

D30 Tracking nominal distance is 103 mm

This is the distance from center of camera image to weld.



You may check tracking distance by putting guide beam or laser pulse to mark a spot.
Move the material or head until center crosshair of camera is over the mark and note the distance travelled.

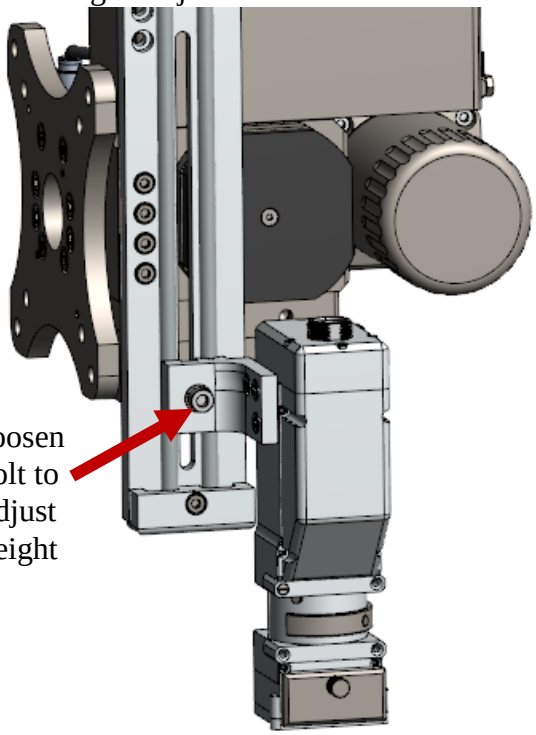
5.1.4 Material Speed

Be sure to put correct material speed into table for proper tracking delay in mm/s. This may be entered in web page of Wobbler Controller or sent by serial command from PLC. It is essential speed is correct or tracking will be delayed or ahead of proper operation.

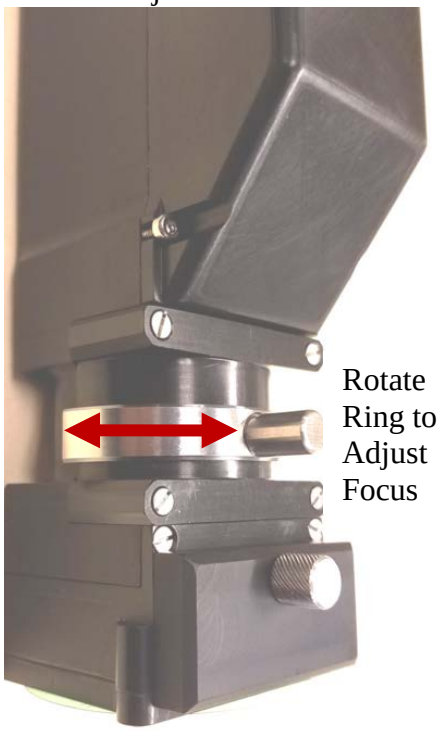
5.1.5 Camera Working Distance Adjustment

The camera is adjusted vertically nominally to 105mm above the seam. The camera may be adjusted from about 95 to 120 mm above seam and still be able to be focused. The focus ring on camera may be twisted to adjust focus. View the image on the Seam Track Application to determine best focus.
Height of camera is adjusted by sliding rails up or down after loosening the M5 bolt. Bottom of Camera should be 105 mm ±10mm above seam.

Height Adjust M5 bolt



Focus Adjustment knob



5.1.6 Camera Focus Adjustment

Adjust the focus after camera moving rail. Focus adjustment is made by rotating the ring with the knob

5.1.7 Camera Brightness Adjustment

The image brightness may be adjusted by changing exposure time or by changing brightness of LED Ring. Image becomes brighter with longer exposure time and increased LED intensity

setting. Image becomes dimmer with reduced exposure time and reduced LED intensity setting Note the LED on time should change to be a bit longer (10-100us) than exposure time.

5.1.8 LED adjustment

The LED is adjustable in intensity from 0 to 100%. The LED on time should never be set for >10% duty cycle at high intensity settings. Example, at 100 Hz, (10ms) the LED on time should not be set for >1000 us. Image becomes brighter with longer exposure time and increased LED intensity setting. Image becomes dimmer with reduced exposure time and reduced LED intensity setting Note the LED on time should change to be a bit longer (10-50us) than exposure time.

LED Frequency controls the exposure rate.

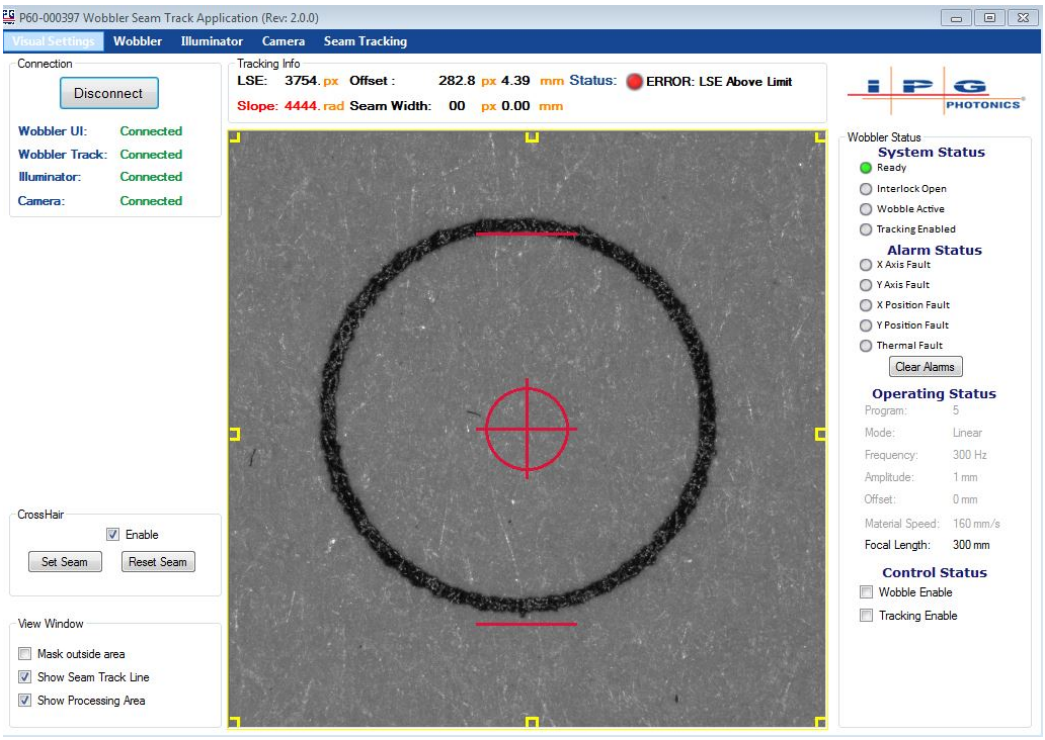
5.2 Calibration

Calibration of the image size in pixels to physical field dimension (magnification) is necessary in order to provide the proper seam correction. Magnification varies with the height adjustment of the camera. The camera is set from 95 to 115 mm above the seam. At the nominal height of 105mm above the seam, the typical magnification is 15 microns per pixel. The range of magnification is 13.5 (at 95mm) to 16.1 (at 115mm).

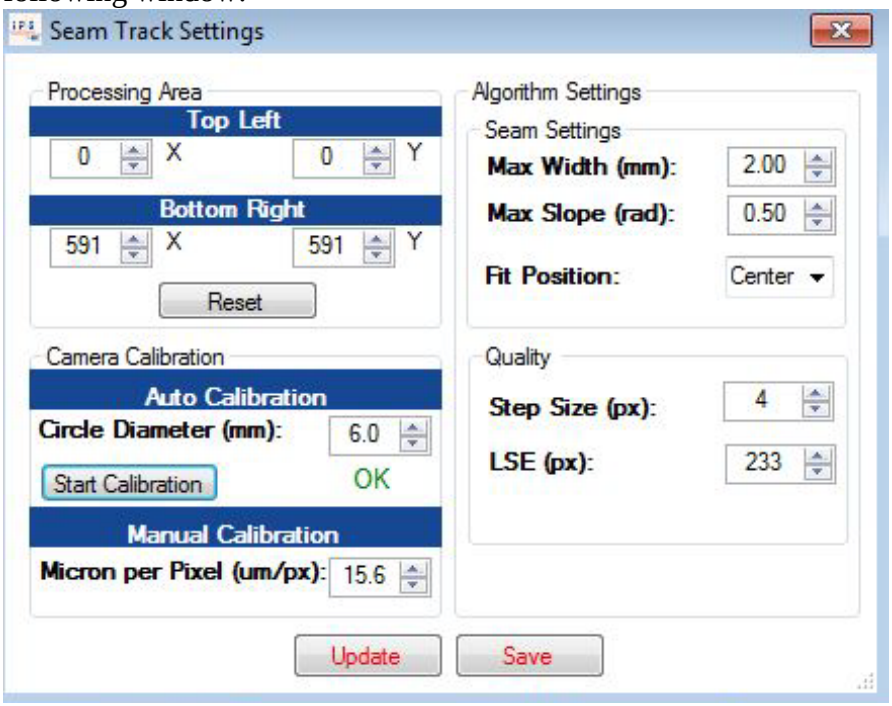
Calibration is necessary to have the correct amount of seam correction. There are two main methods of calibration, auto and manual.

5.2.1 Auto Camera Calibration

A circle of known size such as for example 6 mm (black circle on white background) is placed on image plane (at the height of the material being welded). The whole circle must be in a camera view. Note: The checkbox “Mask outside area” must be UNCHECKED.



Then click the “Seam tracking” pull-down menu, then “Settings”. You will see the following window:



Enter correct diameter in mm. It is 6.0 mm for this example. Press “Start Calibration” button. Program will calculate and fill in micron per pixel:

The label "OK" means good result of calibration. But if the label is "Failed" repeat the calibration procedure using "Start Calibration" button again until a good result of calibration..
Then click "Update" and "Save" buttons.

5.2.2 Manual Camera calibration

Place a 1mm grid graph paper or place a metal scale at the image plane (at the height of the material being welded).
Note: The checkbox "Mask outside area" must be UNCHECKED.

Image using 1mm grid graph paper

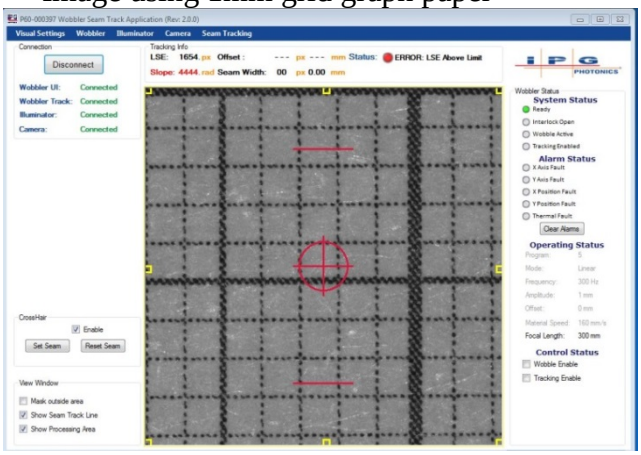
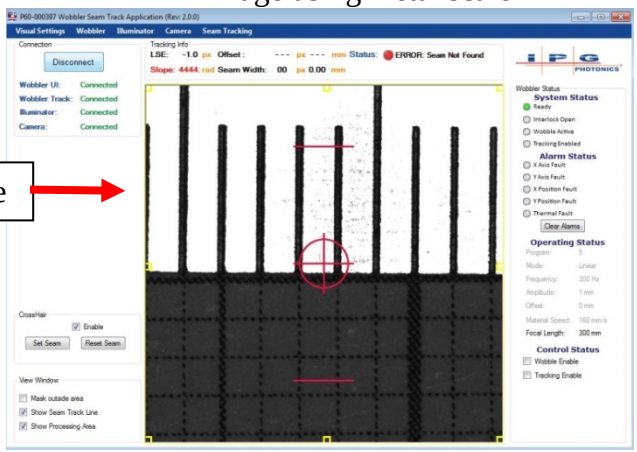
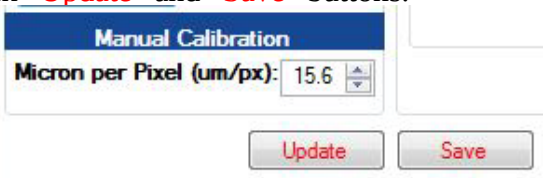


Image using metal scale



- Look at the image and determine how many mm are visible.
- Calculate microns/pixel by dividing number of mm seen by 592.
- Example: See 9.2 mm on scale on horizontal axis. That is 9200 microns.
- Camera calibration is 9200 microns / 592 pixels ≈ 15.5 microns per pixel.
- Enter that value into "Micron per Pixel" Camera Calibration window and press "Enter" button on a keyboard or use up/down arrows to change the value.
- Then click "Update" and "Save" buttons.

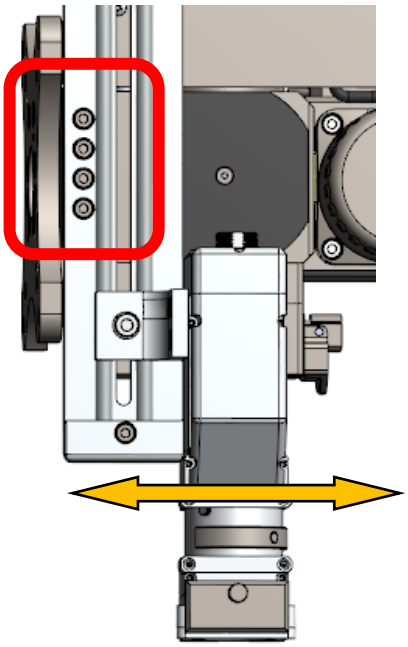


5.3 Alignment of Camera to weld head

The located seam must be aligned to the weld spot in the tracking axis. The camera and weld head are nominally aligned as delivered. The bolts holding the camera may be adjusted to provide about 1mm of mechanical adjustment of camera center to laser center. In the procedure below, initial tuning is done by setting the seam in the software. The camera offset may be changed to adjust the center of the camera to the head. Fine tuning may also be done by moving the wobbler offset in the table. Refer to the procedure below in section 5.4

.

The four bolts on the adjustable camera mount may be loosened and the camera may be adjusted left or right for better alignment of camera to laser output if needed.

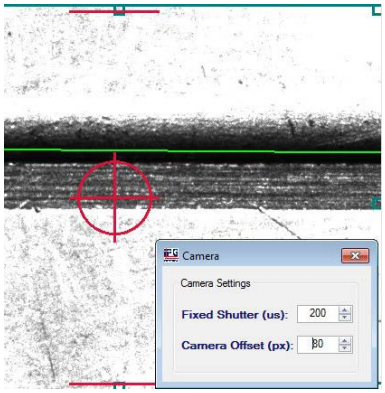




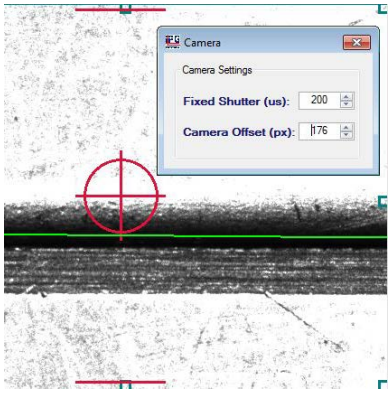
OFFSET = 128



OFFSET =80

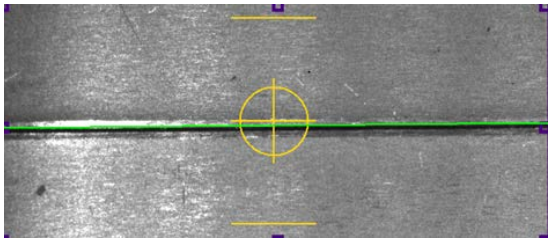


OFFSET =176



5.4 Alignment Procedure for seam found to weld:

- Adjust head location in height and cross axis location as shown in section 5.1
- Follow camera calibration procedure section 5.2.
- Start with wobbler controller powered up by tracking and wobble not enabled and zero offset. Provide a straight seam under the weld head. (A seam could be gap in metal or dark line).
- Using guide beam to locate the laser beam. Move the seam until it is under guide beam.
- Follow the Alignment of Camera in section 5.3. There are several options described to have the camera seam at the same location as the spot.
- Move the stage or material controller in the Y axis only so that the seam is now under the track camera.
- Once tracker has found seam, 'Set seam'* so that cross hair is now at seam location.





*Set Seam: Places Cross Hair in a middle of current Seam Track Line
Set Seam makes the current location of the seam to zero wobbler offset
Note that 'Reset Seam' places Cross Hair on middle (X&Y) of Processing Area

- Test welding with tracking on, small adjustments may need to be done. The Guide beam may be slightly off from the weld beam. **Fine tune may be done using Offset in wobbler table or iterative Camera offset adjustment.**
- Remember to adjust material speed in wobbler table to match material speed changes.

6 Maintenance

6.1.1 Camera Window Replacement

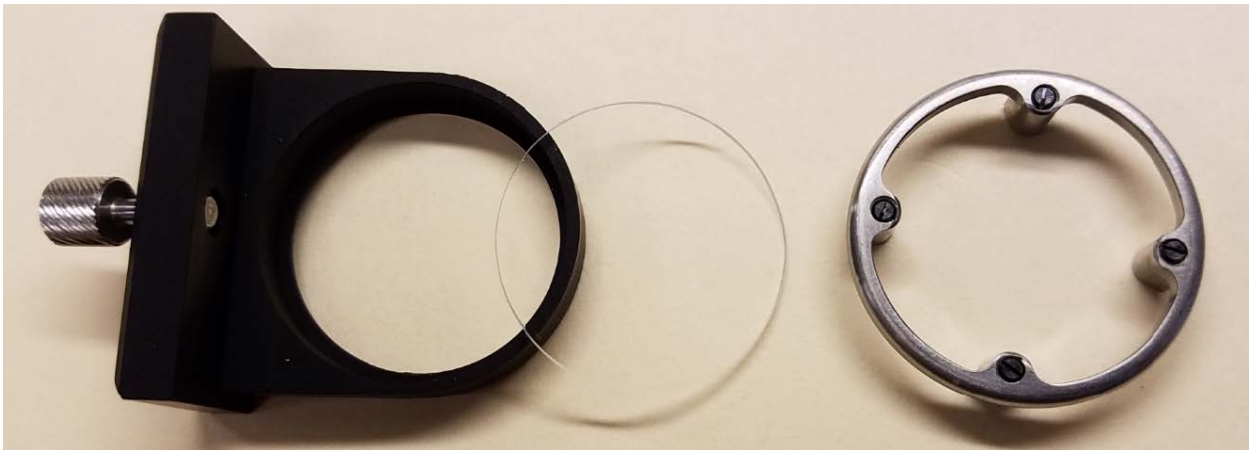
A protective window is included in the camera assembly to keep the Camera Lens and LED Ring clean. It is replaceable and should be replaced if image is degraded by dirt on window.

The camera window is removed by turning knurled knob on window tray counter-clockwise to remove drawer that holds the window.

CAUTION: Once the window drawer is removed from camera, the window and holder may fall out if turned upside down.

Remove the metal ring on top of the window by lifting it, there is no fastener. Remove the window from the holder shelf.



Place new window in drawer. Place metal ring with 4 balls side down (screw head up) as shown in pictures. Slide drawer back into head. Tighten knurled knob clockwise.

A spare window has been included with your camera. Additional spare windows may be purchased from IPG Photonics. **Spare window part number is COPWXXXXXXXX001X.**

7 Warranty

7.1 Limited Express Product Warranties

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7.2 Warranty Limitations

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7.5 Product Return

Product Returns

Returns to the United States

All product returns require a Return Merchandise Authorization (RMA) from IPG.

To obtain an RMA, call the Customer Service department of IPG Photonics Corporation at 508-373-1100 (US) or +49 2736 44 20 451 (Germany).

If you return a product with a RMA, perform the following procedure:

1. Products must be carefully packed in a suitable shipping container(s). Buyer assumes all responsibility for products damaged in shipment to IPG.
2. Buyer must issue a purchase order for the value of the replaced parts/service items and IPG will issue credit or invoice when the parts/service is received. Speak to IPG Service Manager for the amount authorized under the required purchase order.
3. All requests for repair or replacement under this warranty must be made to IPG within 30 days after discovery of the defect (but not later than 7 days after warranty expiration).
4. All products returned to IPG but which meet applicable specifications, not defectively manufactured or used not in accordance with this User's Guide, will result in the Buyer being charged IPG's standard examination charge.
5. Complete packing list with product model and serial number will ensure prompt repair.
6. Be sure to include with the returned product your 'ship to' address for the return of the serviced product.

Product Returns
Returns to the United States

Shipping Instructions:

Warranty Returns

Domestic & International Buyers* pay for one-way freight costs and insurance to IPG. IPG will pay for freight return cost and insurance back to the Buyer.

Non-Warranty Returns

Domestic & International Buyers* pay for two-way freight costs and insurance to IPG. If shipment consists of returns that are both warranty and non-warranty, the shipment will be considered as non-warranty.

Shipping Address for Returns to US

IPG Photonics Corporation
50 Old Webster Road
Oxford, MA 01540
Attn: Product Returns
Tel: 508-373-1100

Returns to Germany

Shipping address for returns to Germany:
IPG Laser GmbH
Siemensstrasse 7
D-57299 Burbach, Germany
Attn: Product Returns
Tel: +49-(0)2736-44-20-451

1. IPG Laser GmbH will only accept returns for which an approved Return Material Authorization (RMA) has been issued by IPG Laser GmbH. You should address to the customer support team at +49-(0)2736-44-20-451 or support.europe@ipg-photonics.com to discuss the return and request an RMA number. You must return defective products freight prepaid and insured to IPG Laser at the address shown herein. All products which have returned to IPG Laser but which are found to meet all previously applicable specifications for such products or which indicate damage to the fiber connectors not resulting from defect manufacturing, shall be subject to IPG Laser' standard examination charge in effect at the time and these costs shall be charged to the Buyer. All products returned to IPG Laser which are not accompanied by an itemized statement of defects, shall be returned to the Buyer at the Buyer's expense and IPG Laser shall not carry out any evaluation of such products. IPG Laser warrants to Buyer that its services, labor and replacement parts, assemblies and modules will be free of defects in material and workmanship for ninety (90) days from the date of shipment or performance of services.

2. Warranty Returns - Domestic & *International Buyers should pay for one-way freight costs to IPG Laser. IPG Laser will reimburse Buyers for applicable reasonable third-party freight costs and IPG Laser will pay for freight return cost back to the Buyer.

3. Non-Warranty Returns - Domestic & *International Buyers are responsible for two-way freight costs. If shipment consists of returns that are both warranty and non-warranty, the shipment will be considered as non-warranty. Any UNAUTHORIZED shipments billed to IPG Laser without authorization will be re-invoiced to the Buyer. Confirming purchase orders are required for non-warranty returns.

Product Returns
Returns to Germany

4. *International Returns must include applicable DUTIES AND TAXES, and you must mark air bills with "RETURNED FOR REPAIR." In any event, where IPG Laser accepts a shipment, IPG Laser will invoice to the Buyer for any charges as stated above.
5. Returns for credit will not be accepted unless authorized in advance, in writing by IPG Laser, in accordance with IPG Laser' Terms and Condition, including the warranty provisions. In most cases, restocking fees will apply.
6. All returns must be packaged adequately to avoid damage during shipment.
7. Complete packing list with product model and serial number will insure prompt repair, if the other terms of this form are followed.
8. See the IPG Terms and Conditions for the applicable warranty for the products before you request the return of the products.
9. RMA number will expire 31 days after the date of issue. Thereafter, units received in under the expired RMA number will result in a longer turnaround time. Include a copy of the completed RMA form with the return of your unit(s).

User Guide: Wobbler Seam Track
Part Number: DOCOXUGCOMXX0002
Published: October 2017
Revision 0.2



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