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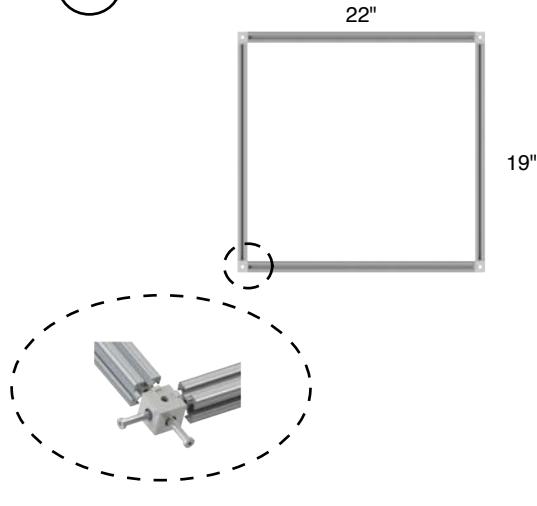
An Open-Source Plate reader

# GENERAL ASSEMBLY GUIDE

(Frame and Integration)

# General Assembly Guide (#'s refer to Parts List entries)

1



**!! Important Note !! :** See the 8020 manufacturer site for more detail on assembling T-slotted frames with their connectors. You will need hex key sets or ball drivers

## Begin Bottom and Side Frame Assembly:

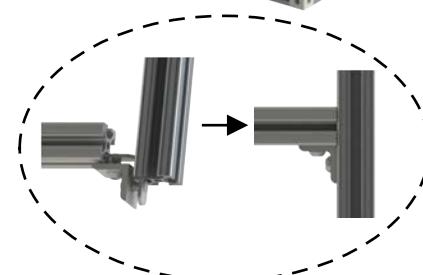
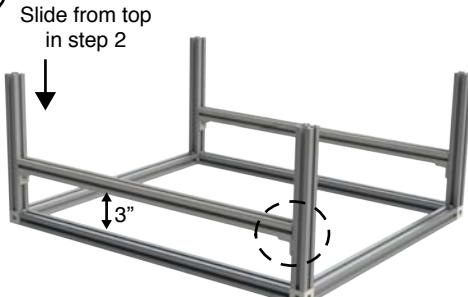
1. Attach a 19" 8020 bar (#F1) to a squared corner connector (#F6) using a screw (#F15).
2. Attach a 22" 8020 bar (#F3) to the other end of the squared corner connector, so that its remaining notches point upwards, using a screw (#F15).
3. Repeat for the other corners to complete the rectangular frame.

2



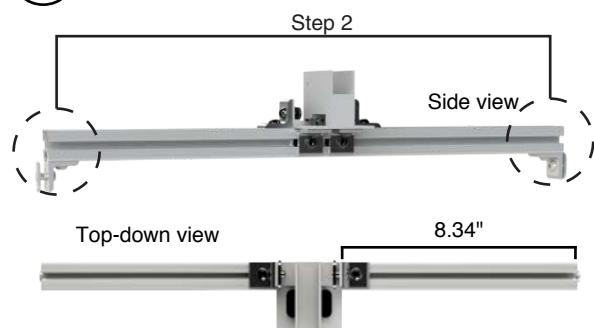
1. Attach a 10" 8020 bar (#F4) to each of the four squared corner connectors, using screws (#F15).

3



1. Attach an inside corner bracket (#F10) using a slide-in t-nut (#F17) and bolt (#F11) to both ends of a 22" 8020 bar (#F3). The L-brackets should be on the same side of the bar. Do not fully tighten.
2. Attach a t-nut/bolt to the brackets without fully tightening. Slide the bracketed ends of the 22" 8020 bar into the slots of the two 10" 8020 bars.
3. Tighten the connections so that the bottom surface of the 22" 8020 bar is approximately 3" above the top surface of the bottom frame.
4. Repeat the same procedure on the opposite side.

4



1. Attach the X-Axis Motor Holder (#P1) to a 19" 8020 bar (#F1) using four inside corner brackets (#F10) and t-nuts/screw (#F17, F11). Set the right wall (from a top-down view) of the motor holder is ~8.34" away from the end of the bar.

2. Attach an inside corner bracket (#F10) to each end of the 8020 bar. The free end of the corner bracket should point downwards, or away from the motor holder.

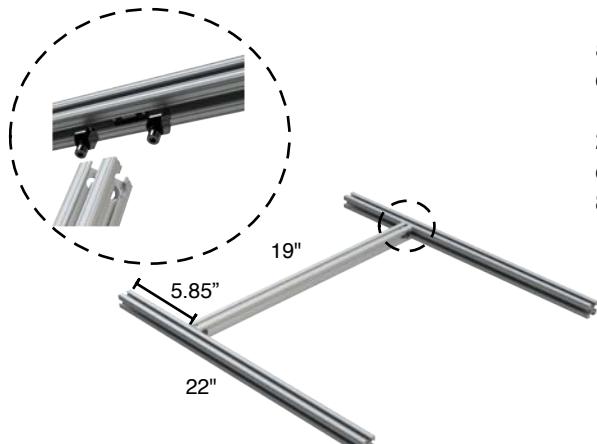
5



1. Slide the motor-attached 8020 bar between two 10" 8020 bars from the top, with the holder pointing inward.

2. Tighten the connections. The bottom of the motor-attached bar is ~2.16" from the top surface of the bottom frame bar.

6

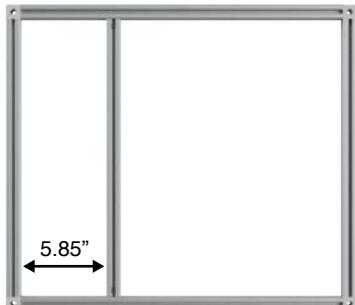


#### Begin Top Frame Assembly

1. Fasten the counter-bore 19" 8020 bar (#F2) and to two 22" 8020 bars (#F3) using the short double-anchor assembly joints (#F9).

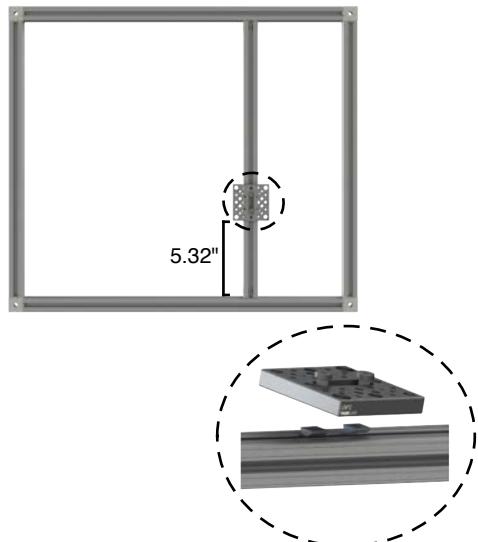
2. Tighten the connections with the outside face of the 19" 8020 bar ~5.85" from an end of the 22" 8020 bars.

(7)



1. Attach two more 19" 8020 bars (#F1) to the assembly from step 6 with squared corner connectors (#F6) and screws (#F15). The third, free slot-fitting tab of each corner connector is pointing down. Tighten the screws.

(8)



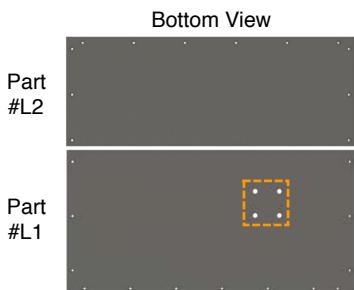
1. Flip frame-top upside down, and attach the Universal Base Plate (#O1) to the middle 19" 8020 bar with drop-in t-nuts (#O18) and screws (#O17). Position the base plate with the bottom end (as shown) ~5.32" from the inside of the 19" 8020 bar.

(9)



1. Add on the rest of the top-side optical train to the base plate. Refer to the "Top Optical Train Assembly Guide" for directions.

10



Begin Bottom Integration of Components:

1. Laser cut parts #L1 and #L2 out of 1/4" black acrylic sheets (#F21). The optics alignment holes (marked with orange dashed box) should be vector cut.
2. The boundary holes are counter-sunk. The narrow diameter thru-hole is vector cut, and the larger diameter circle is raster etched ~3/32 or 2mm deep to create the bore. This is to ensure that the screw head to be used sits flush with the acrylic face.
3. Vector cut the edges.

11



1. Use screws (#F19) and drop-in t-nuts (#F13) to fasten both the acrylic floor pieces to the frame bottom as shown.

12



1. Place screws (#F15) into the optics alignment holes such that the cap of the screw is flush with the underside of the acrylic floor. The screws are meant to be press fit into the holes, using a mallet to set them into place tightly.
2. Feed the screws through the thru-holes of the baseplate of the pre-assembled bottom optical train (See "Bottom Optical Train Assembly Guide"). Tighten the entire structure into place with hex nuts (#F22).

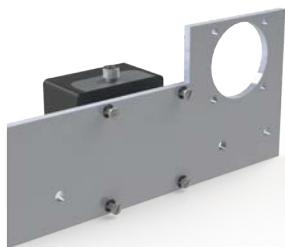
(13)



Begin Detector Wall Mount Assembly:

1. Laser cut part #L12, the detector wall mount out of 1/8" black acrylic sheets (#F20). First, vector cut all the holes.
2. Vector cut the edges.

(14)



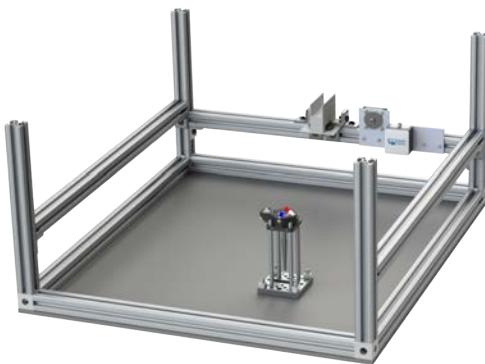
1. Remove the screws from the bottom base of the STS-VIS (#O25). When all screws are removed, do not take off the actual bottom base.
2. Attach the STS-VIS to the detector wall mount with screws (#F33).

(15)



1. Attach the pre-assembled photodiode mount assembly to the detector mount (see 'Photodiode Mount Assembly Guide').

(16)

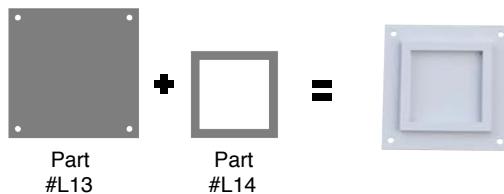


1. Attach the detector wall mount with all parts attached (Photodiode mount & STS-VIS) to the inside of the 19" 8020 piece, using drop-in t-nuts (#F13) and screws (#F19).

(17)

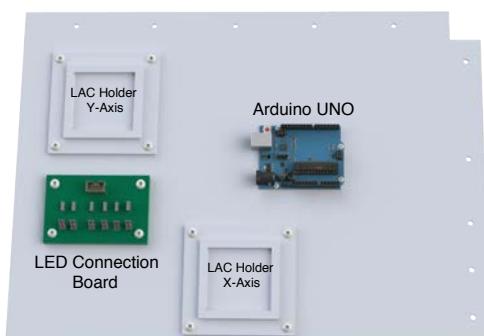


Begin Electronics Board Mounts:



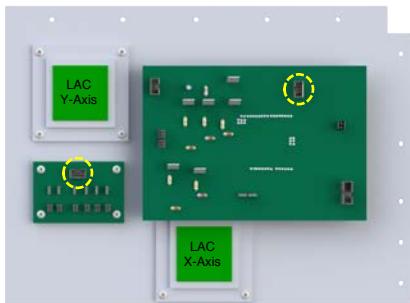
1. Laser cut the primary electronics mount (#L11).
2. Laser cut the LAC Board Panel mounts (#L13) and the LAC Alignment frames (#L14).
3. Attach an alignment frame to a LAC mount as shown. Repeat to make another set.

(18)



1. Screw the Arduino UNO (#E3) down to the primary electronics mount using screws (#F31) and hex nuts (#F24).
2. After soldering all the components onto the LED connection board (see "PCB Assembly Guide"), attach it to the primary electronics mount using the drop-in t-nuts (#F13) and screws (#F19).
3. Attach the LAC Holder boards to the primary electronics mount using the drop-in t-nuts (#F13) and screws (#F19).
4. Connect the USB-A to USB cable to the Arduino UNO.

(19)

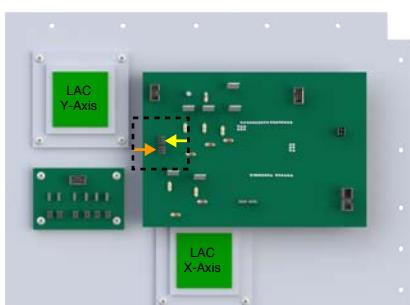


1. After assembling the Main Power Board, connect it to the Arduino UNO's female headers (See "PCB Assembly Guide").

2. Place the LAC Boards into their holders.

3. Use the 2x3 IDC Dual Row Sockets (#E13) to crimp a 6-wire ribbon cable, and attach a socket to each end. Ensure that the cable is long enough to connect the headers in the yellow dashed circles, to provide power to the LED connection board.

(20)

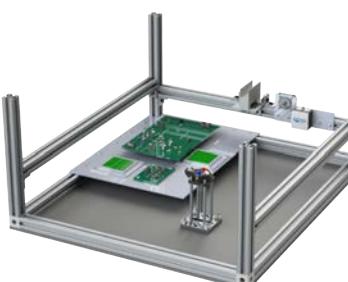


1. Use the JST-Connector kit (#E12) to assemble two 4-wire cables (it is recommended to use threaded wire) with each attached to a 4-pin JST Header.

2. Attach the wires from the JST header marked by the yellow line (boxed) to the X-Axis LAC board at the X3 terminal's pins 1, 2, 3 and X4 terminal's pin 2. Refer to the manufacturer data sheet for a pin out of the LAC control board.

3. Attach the wires from the JST header marked by the orange line (boxed) to the Y-Axis LAC board at the X3 terminal's pins 1, 2, 3 and X4 terminal's pin 2.

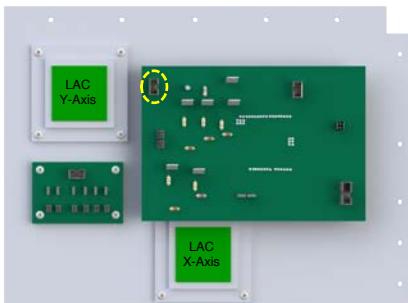
(21)



1. Attach the primary electronics mount to the bottom frame of the assembly with t-nuts (#F13) and screws (#F19) in the shown position.

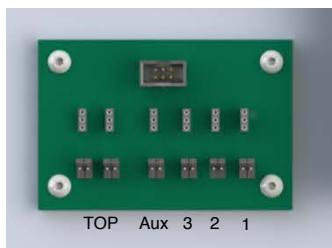
2. 3D-print three stabilizing feet (#P4) and attach them to the bottom of the Primary Electronics Mount with adhesive (e.g. super glue) to support the board that cantilevers off the frame. Alternatively, any 1" thick or tall support material can be used instead of the printed piece, like a wood dowel.

(22)



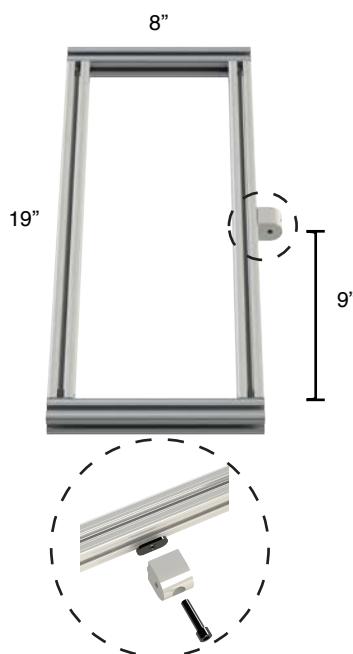
1. Use the 2x3 IDC Dual Row Sockets (#E13) to crimp a 6-wire ribbon cable and attach a socket to each end. Ensure that the cable is long enough to connect the header in the yellow dashed circle to the header of the photodiode PCB (not shown, See Photodiode Mount Assembly guide).

(23)



1. Use the JST-Connector kit (#E12) to assemble 2-wire cables (it is recommended to use threaded wire) with each attached to a LED socket (#O10), if not done already.
2. Attach each JST female header to one of the male headers on the shown LED connection board. Make note of which wires correspond to which LED sockets.

(24)



#### Begin Stage Assembly:

1. Attach the Pivot Nub (#F14), using the hardware provided with the part, to a 19" 8020 bar with counter-bores (#F2). The nub should be ~9" away from the bottom of the attached bar.
2. Fasten the bar to two 8" 8020 bars (#F5) using the short double anchor assembly parts (#F9).
3. Attach another 19" 8020 bar to the assembly using another short double anchor assembly parts to create the rectangular plate track as shown.

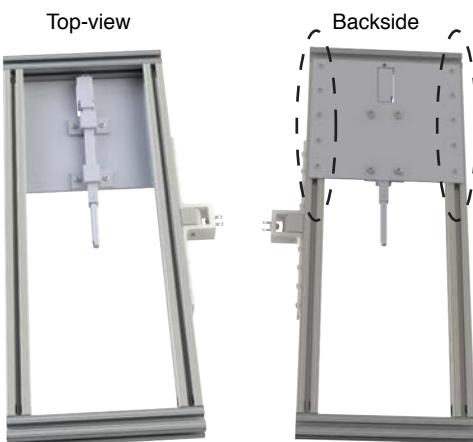
(25)



1. Attach the motor connector bracket (comes with the motors) to the X-Motor Stabilizer (#P11) using a screw (#F19) and hex nut (#F25).

2. Attach the X-Motor Stabilizer (#P10) to the pivot nub of the plate track. Use (#F19) screws with the standard drop-in t-nuts (#F13) to connect the part to the plate track. Use screws (#F11) to connect the part to the pivot nub.

(26)



1. Laser cut and attach the Y-Motor Floor (#L10) to the assembled plate track as shown on the backside, using screws (#F19) and drop-in t-nuts (#F13).

2. Place a L16-P linear actuator (#E2) onto the Y-Motor Floor and screw it into place by pressing the 3D-printed Motor Tabs (#P2) over it. Screw the tabs into place using screws and t-nuts

(27)



1. Attach a unibearing pad (#F18) to each corner of the bottom of the plate track as shown, using screws (#F19) and drop-in t-nuts (#F13). The pads allow one axis of the stage to slide along the tracks of the other.

(28)



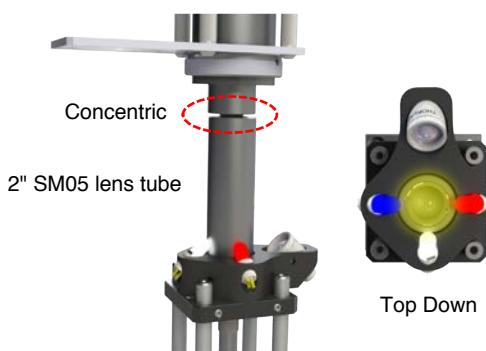
1. Add the assembled plate track into the general assembly as shown. The unibearing pads should snap into the t-slot and glide smoothly within the tracks while remaining level.

(29)



1. Add the assembled top frame (with the top optics) to the general frame. Attach it to the corner connector with screws (#F15).

(30)

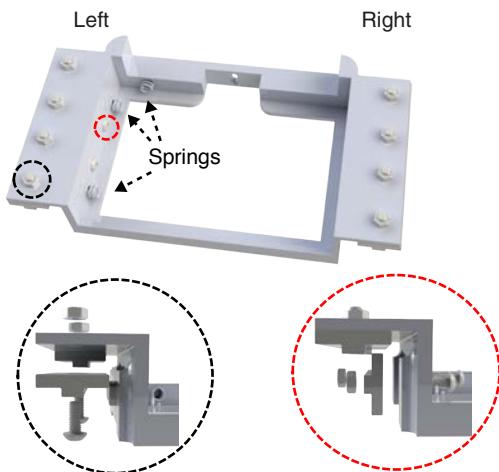


1. Attach a 2" SM05 lens tube (#O20) to the bottom optics as shown.

2. Align the top optics assembly so that the two lens tubes (top and bottom) are concentric.

3. To further check the alignment, power the top LEDs, which should project centered (shown in yellow on Top Down view) onto bottom detector after removing the 2" lens tube.

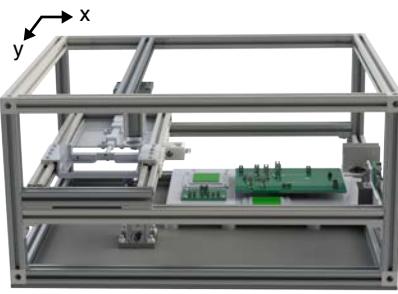
(31)



#### Begin Plate Holder Assembly

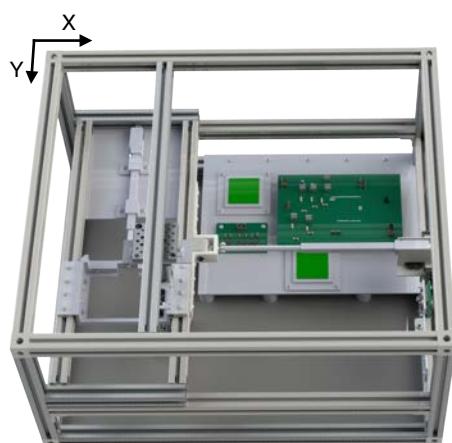
1. After aligning the optics, hot-glue three springs into the 3D printed plate holder (#P3) in the positions shown. Cut the 7/32" springs (#F36) to ~1/2" length using a wire cutter or utility shear.
2. Using screws (#F19) and hex nuts (#F25), add unibearing pads to the plate holder as shown. There is a total of three unibearing pads on the left side of the plate holder and a total of two on the right side.

(32)



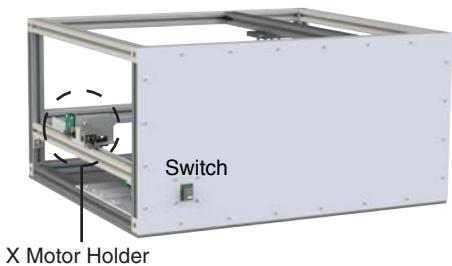
1. Add the assembled plate holder into the general assembly.
2. Attach the motor connector bracket (comes with the motor) to the back of the plate holder using a screw (#F19) and hex nut (#F25).
3. Connect the Y-Motor to the motor connector bracket using a screw (#F26) and hex nut (#F27).

(33)



1. Place the X-Axis Motor into the X-Axis Motor holder as shown. Screw it into the holder using a screw (#F30) and t-nut (#F13).
2. Connect the motor to the motor connector bracket attached to the X-Motor Stabilizer. Use screw (#F26) and hex nut (#F27).

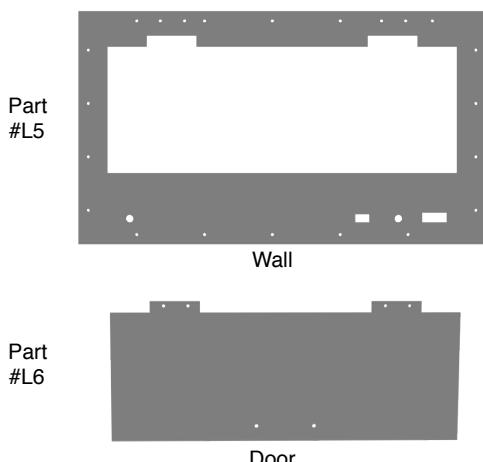
34



Begin Back Panel Assembly:

1. Laser-cut the back wall (#L4) of the OSP from 1/8" black acrylic (#F20).
2. Solder components to the Power Switch PCB (#E27) and attach it to the back wall (with the switch sticking out of the cut-out as shown) using screws (#F19) and drop-in t-nuts (#F13).
3. Attach the back wall piece to the back of the OSP as shown using screws and t-nuts.

35



Begin Right-side Access Panel Assembly:

1. Laser cut parts #L5 and #L6 to assemble the right-side wall panel and access panel door.

36



1. Place the DB9 header (#E8), DC Barrel Jack Adapter (#E20), and USB-Adapter (#E10) into the wall panel as shown. Use hot glue to stabilize them after press fitting.

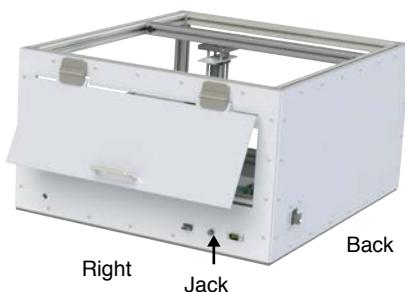
(37)



1. Attach the steel door handle (#F16) to the access panel door using the screws that are provided with the part.

2. Attach the door panel to the wall panel using two detent hinges (#F7) connected with screws (#F19) and drop-in t-nuts (#F13).

(38)



1. Attach the assembled right side wall panel to the right side of the OSP device.

2. Plug the Amazon 4-Port USB hub (#E11) into the USB adapter inside the frame.

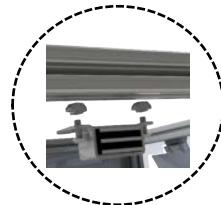
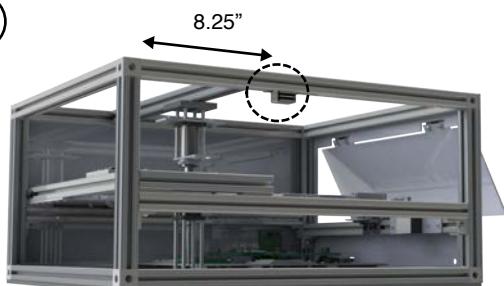
3. Plug the USB cables for the Arduino and STS-VIS into the USB hub.

4. Connect a wire from the (+) terminal of the DC barrel jack (#E20) to the corresponding terminal on the power switch board (see Power Switch Board Assembly).

5. Connect a wire from ground of the jack to the GND terminal on the main power board(see Main Power Board Assembly).

5. Connect a wire from the second terminal of the power switch board to the 12 V (+) terminal on the main power board.

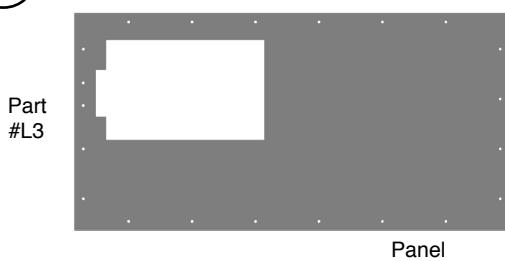
(39)



#### Begin Front Panel Assembly:

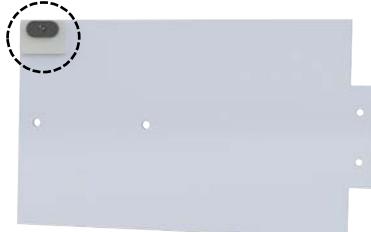
1. Attach the magnetic door catch (#F8) to the top frame front bar on the underside as shown using screws and drop-in t-nuts. The left face of the door catch is ~8.25" away from the inside-face of the 10" 8020 bar to the left of it.

(40)



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1. Laser cut the parts for the front wall panel (#L3) and door (#L7).

(41)



1. Attach the magnet that comes with the magnetic door catcher (#F8) to the back side of the door as shown, using the screw and nut that come with the part.

(42)



1. Attach the steel door handle (#F16) to the front door using the screws provided with the part.
2. Attach the door to the wall panel using one detent hinge (#F7) connected with screws (#F19) and drop-in t-nuts (#F16).

(43)



1. Attach the assembled front wall panel to the front of the frame using screws (#F19) and the standard drop-in t-nuts (#F13).

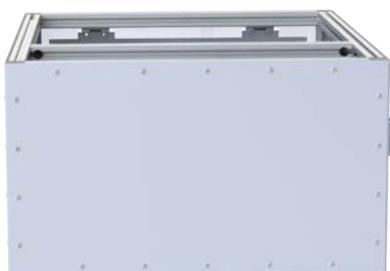
(44)



Begin Left Wall Assembly:

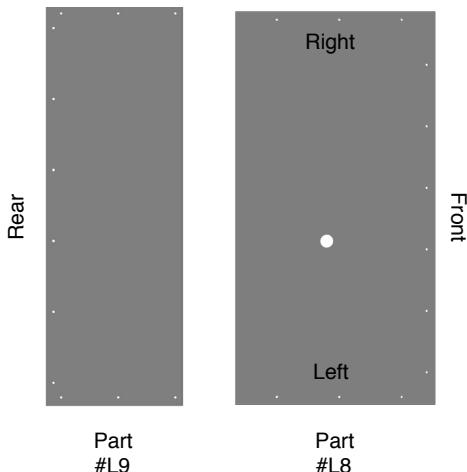
1. Laser cut the part for the left side wall panel (#L20).

(45)



1. Add the left side wall panel to the frame of the device using screws (#F19) and the standard drop-in t-nuts (#F13).

46



Begin Top Panel Assembly:

1. Laser cut part #L8 and #L9 for the top wall panels.

47

1. Attach the top wall panels to the top of the device using screws (#F19) and drop-in t-nuts (#F13). Panel #L8 should be towards the front of the device.
2. Place the 3D-printed auxiliary device plug / grommet (#P6) into the hole of the top panel (#L8).
3. Plug in power supply (#E7) into the DC barrel jack on the right side.
4. Plug a computer or Raspberry-Pi (#E5) to the device female USB port on the right side with a standard male-to-male USB cable. The Arduino and STS-VIS spectrophotometer will draw power from the (micro)computer. If using the Raspberry Pi, set the touch screen on its stand (#E6).
5. We recommend organizing the wires within the device using a 3D printed part (#P7) or commercial wire clips.



**The Open Source Plate Reader frame is now assembled.**  
See next page to assemble calibration lid, then move on to Software User Guide.

# Calibration Lid Assembly

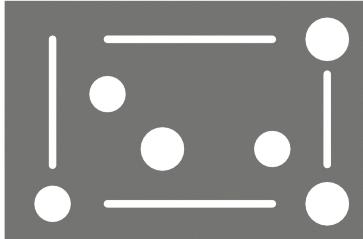
#'s refer to Parts List

!! Important Note !!

These plate calibration lids were designed to fit into CellVis 24-well (P24-X-X) and 96 (P96-X-X) well plates.  
The dimensions may need to be adjusted if you choose to use other plates.

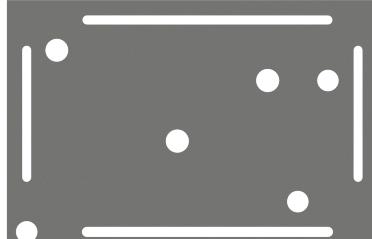
24 well

Top View of #L18



96 well

Top View of #L19



Laser cut the 24-well and 96-well plate calibration lids (Parts #L18 and #L19, respectively).

3D print the calibration lid plugs for both the 24 well (#P8) and 96 well (#P9) plates. You will need 3 plugs per calibration lid.

Hot glue the plugs into positions shown in the diagrams to the left. Hot glue the lip of the the plugs onto the top-side of the lid. White text denotes the well alignment.



Diagram demonstrating how calibration plugs sit within the 24-well plate lid. They should fit similarly in the 96-well plate lid.