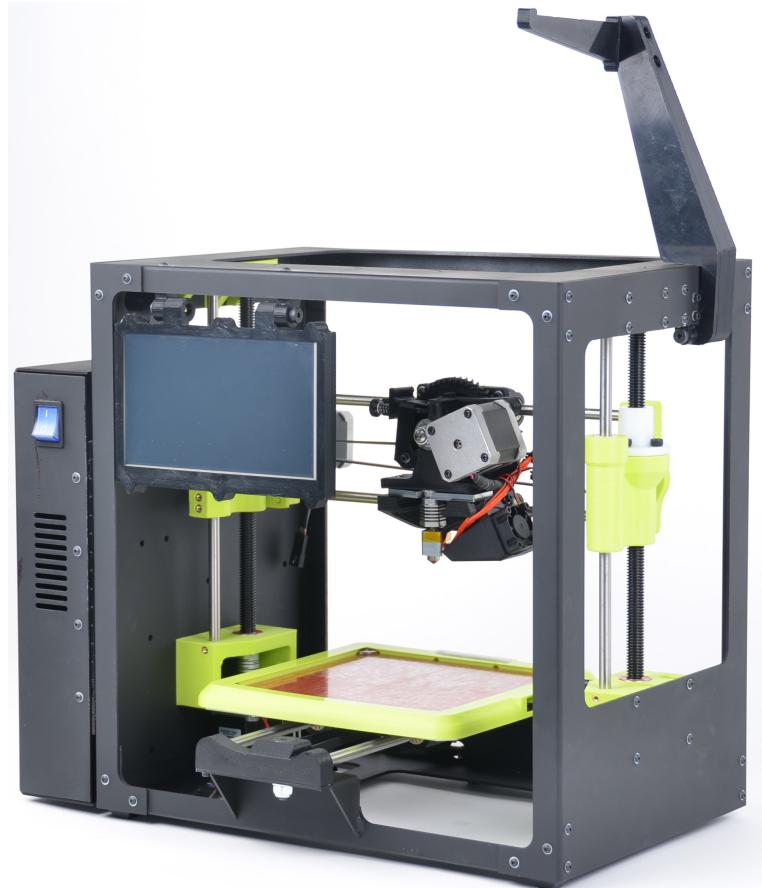


LULZBOT MINI DEVELOPER'S GUIDE



LulzBot Mini Developer's Guide

by Aleph Objects, Inc.

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Introduction

Welcome Aboard

Audience

This is a developer's guide to hacking on the LulzBot Mini 3D Printer. It is meant for developers, not users, of the printer.

Open Source Hardware, Free Software

Aleph Objects, Inc. is a Loveland, Colorado, USA company that manufactures Open Source Hardware using Free Software.

For more info, visit <http://www.alephobjects.com>.

LulzBot Mini

Developer Overview

1.1 LulzBot Mini

The LulzBot Mini is a 3D Printer currently under development. The abbreviated name is mini-dev.

The source files are available here:

<http://devel.lulzbot.com/mini/>

1.2 Versions

Each new version of the mini-dev has a new name, with the next letter in the alphabet.

- Azalea - First Prototype
- Begonia - Second Prototype, being built now
- Camellia - Third Prototype
- Daffodil - First Production batch

1.3 Begonia Photos

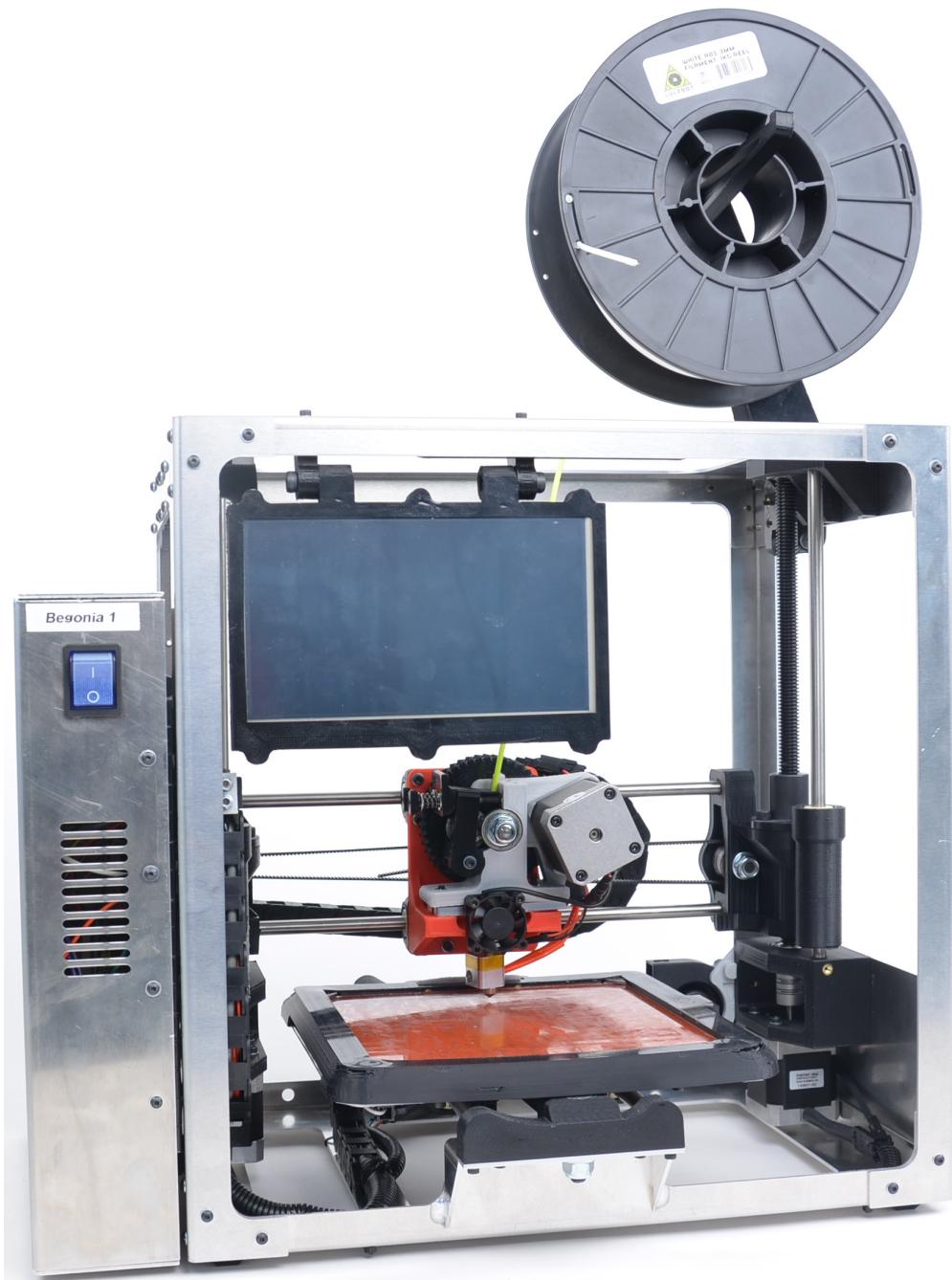


Figure 1.1: Begonia Front Photo

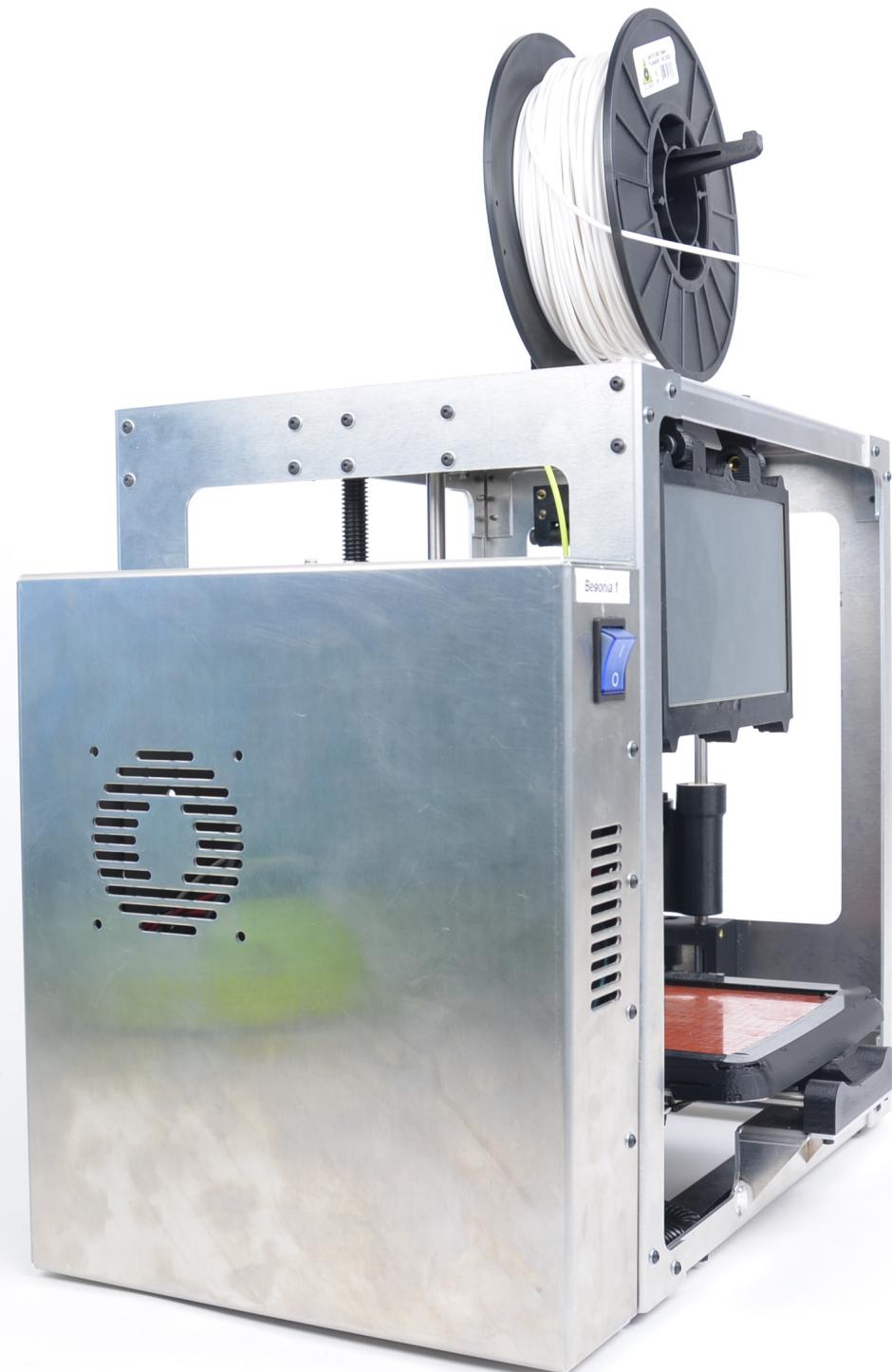


Figure 1.2: Begonia Left Photo

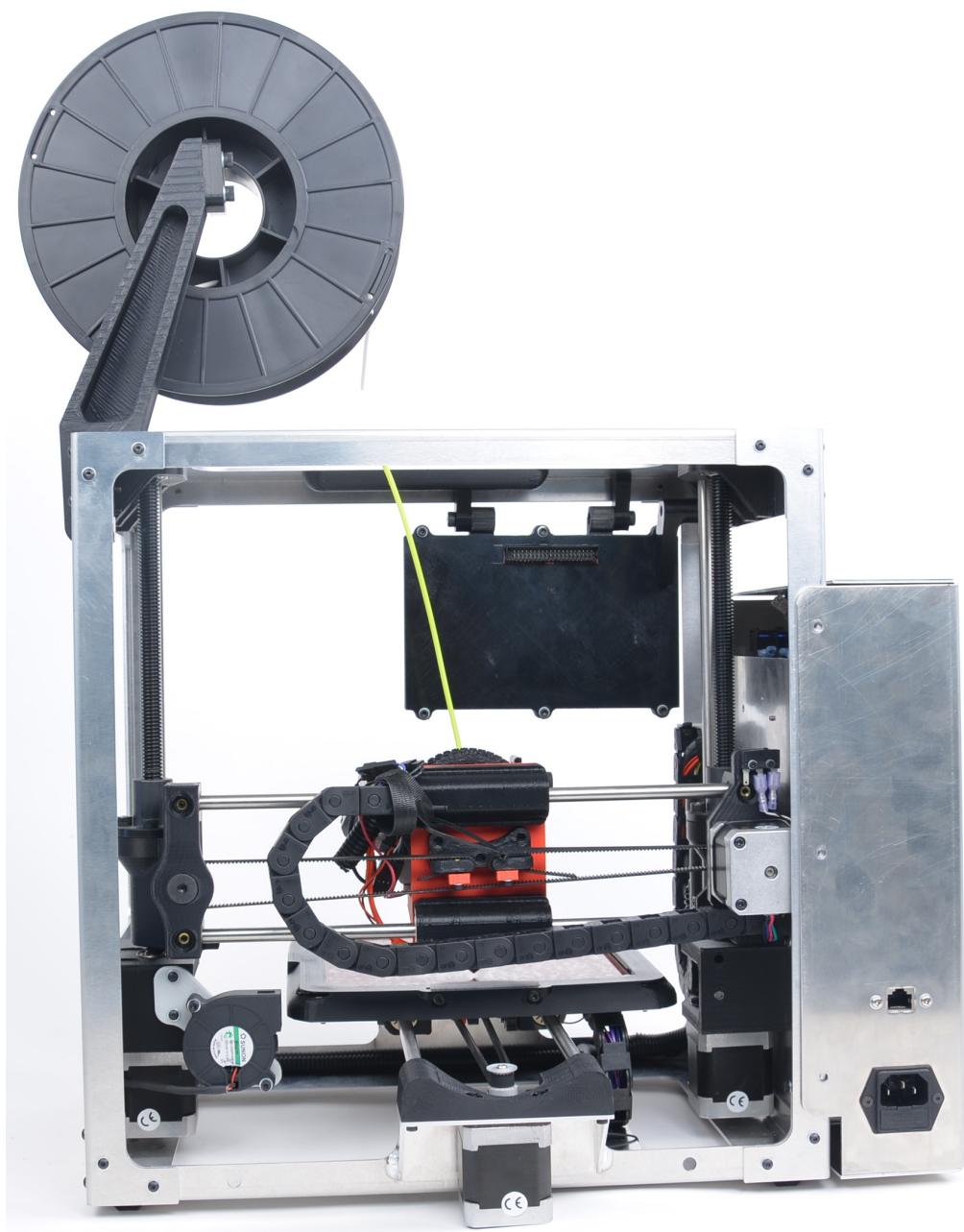


Figure 1.3: Begonia Back Photo

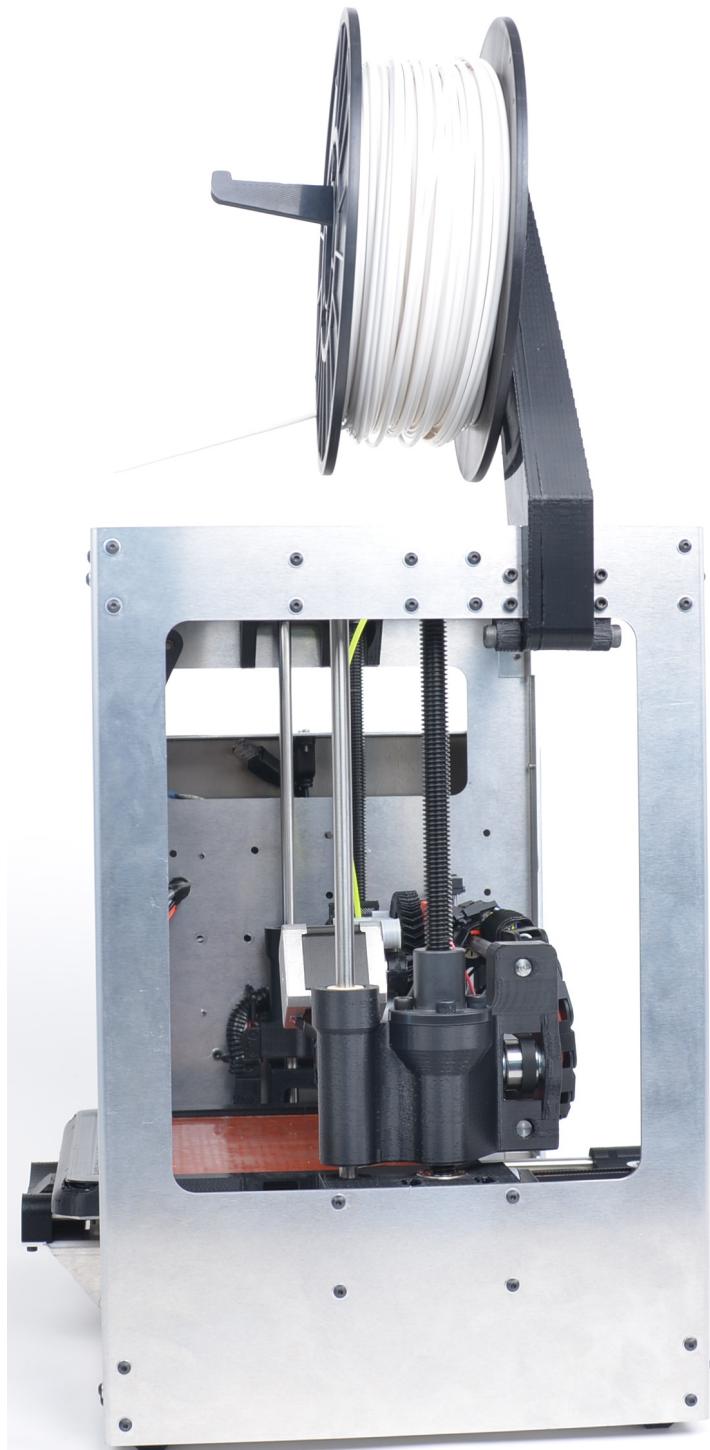


Figure 1.4: Begonia Right Photo

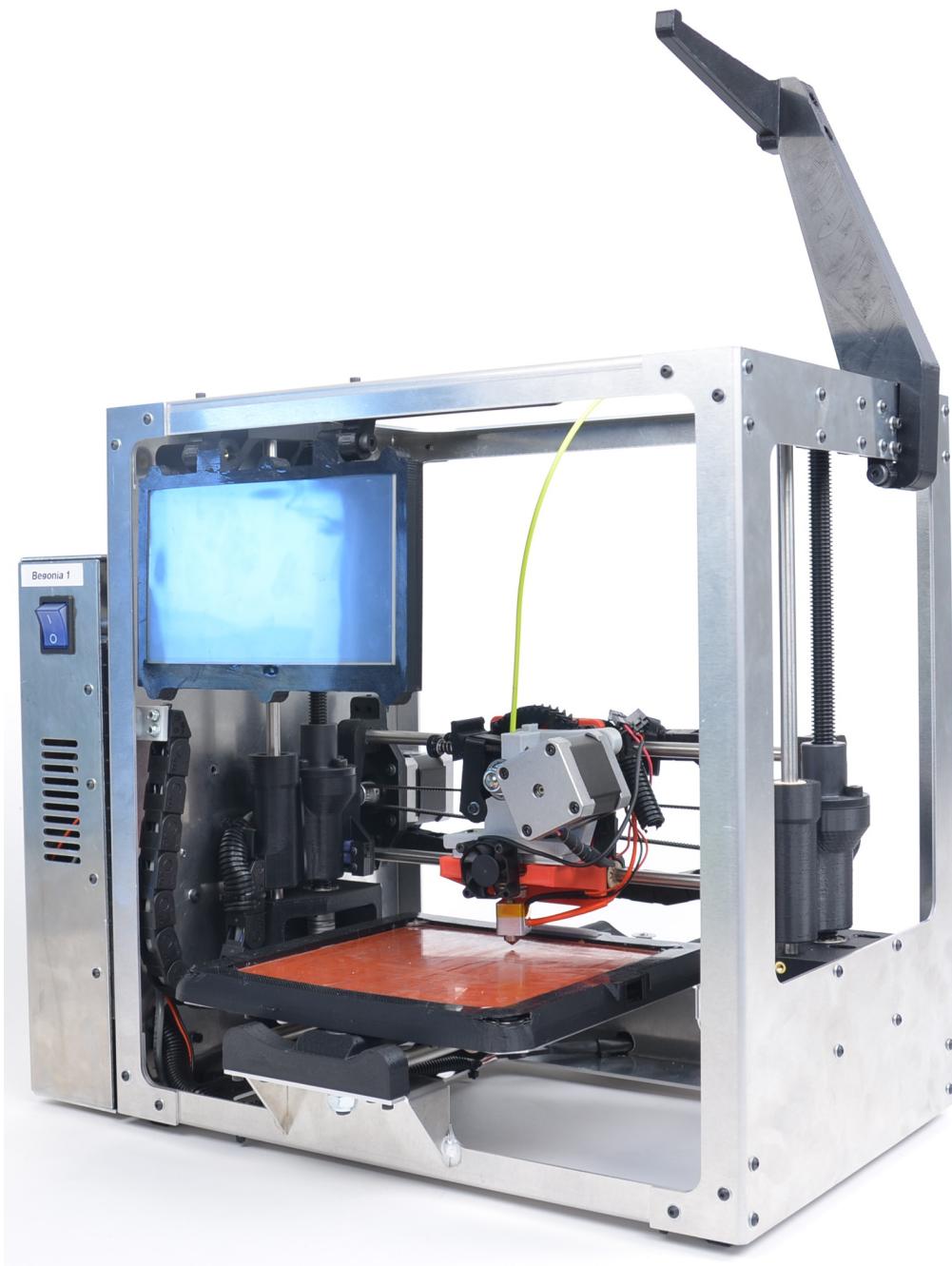


Figure 1.5: Begonia Spool Arm Up Photo

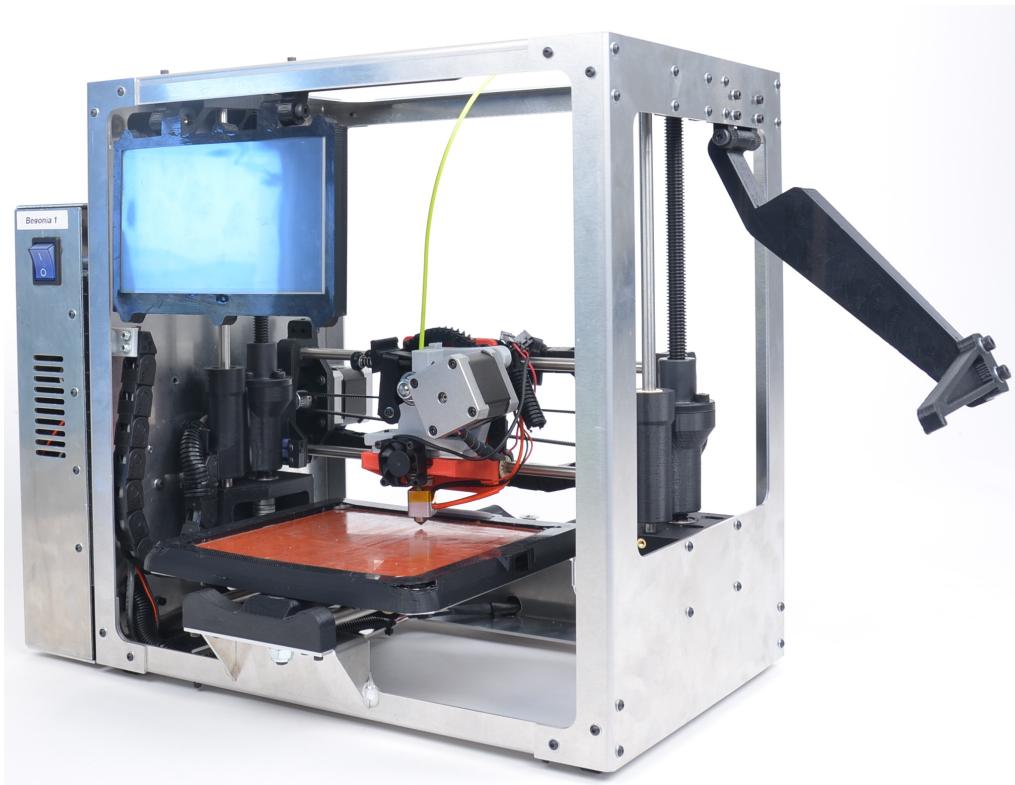


Figure 1.6: Begonia Spool Arm Down Photo



Figure 1.7: Begonia Green Color Scheme Photo

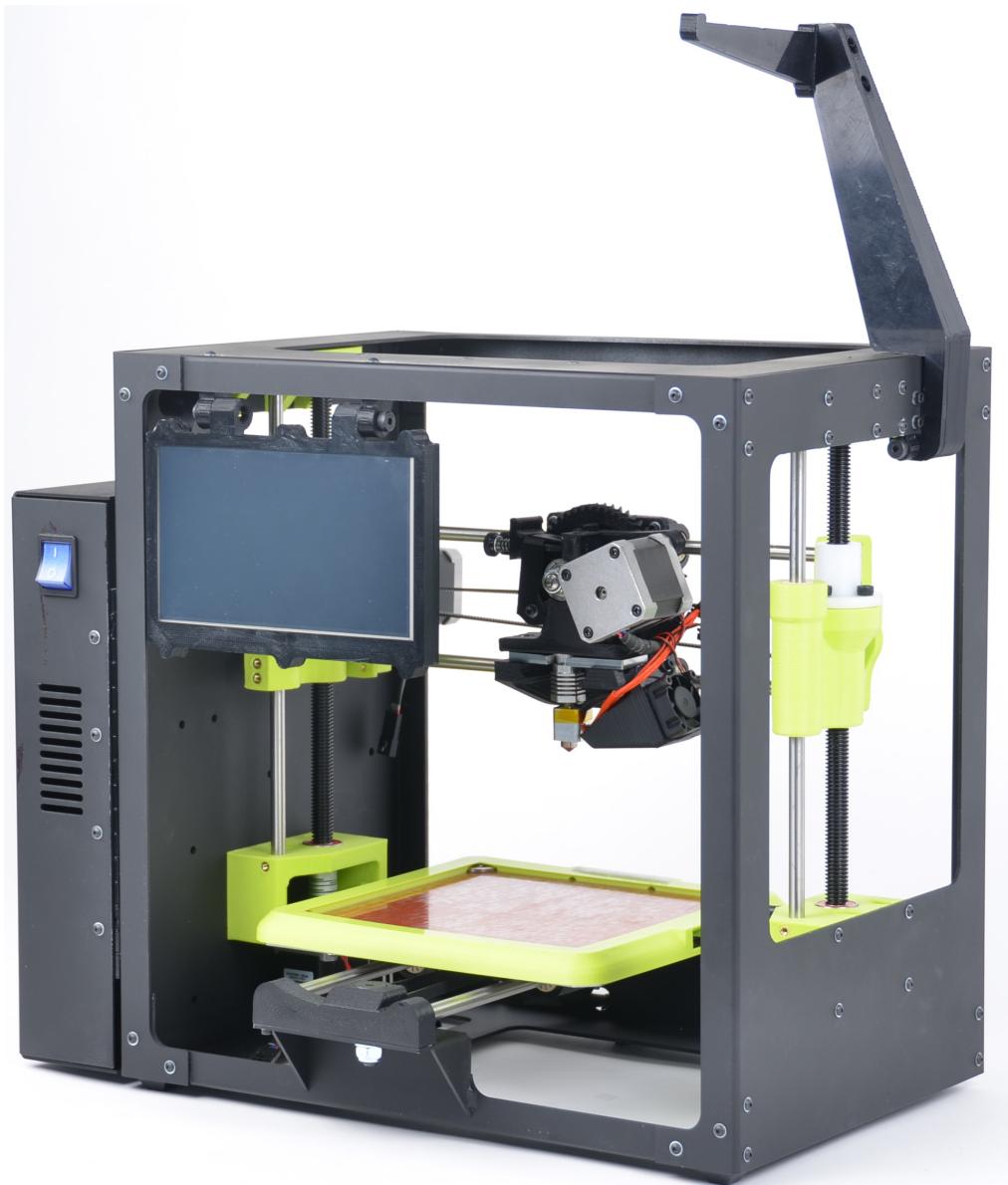


Figure 1.8: Begonia Black Green Color Scheme Photo

1.4. SCHEDULE

1.4 Schedule

The schedule is updated weekly. It is in Libre Office spreadsheet format.
The latest version is available here:

http://devel.lulzbot.com/mini/program_management/

Specs

Specifications

2.1 Specifications

Printing

- Print Surface: Heated Borosilicate glass bed covered with PEI film
- Print Area: 155mm x 155mm x 155mm (6.1in x 6.1in x 6.1in)
- Print Volume: 3,726cm³ (227.4 in³) of usable space
- Top Print Speed: 275mm/sec (10.8in/sec)
- Print Tolerance: 0.1mm (0.0039in) in X and Y axes. Z axis is dependent on layer thickness
- Layer Thickness: 0.075mm to 0.50mm (0.003in - 0.020in)
- Supported Materials: ABS, PLA, HIPS, PVA, wood filled filaments, Polyester (Tritan), PETT, filled PLA, Bronze and copper filled filaments, Polycarbonate, Nylon, PETG, Conductive PLA and ABS, UV luminescent filaments, PCTPE, PC-ABS, and more every day.
- Usable Filament Sizes: standard 3mm (0.1in)

Physical Dimensions

- Overall Dimensions: 435mm x 340mm x 385mm (17.1in x 13.4in x 15.2in)
- Weight: 8.55kg (18.85lbs)

Electrical

- Power Requirements: 100 - 240 VAC
- Power Supply: 24V 150W
- US, UK, and EU electrical plugs available

2.1. SPECIFICATIONS

Temperature

- Temperature: Maximum operating temperature (Extruder), 300C (572F)
- Temperature: Maximum operating temperature (Heated Bed), 120C (248F)

Mechanical

Cartesian Bot in X, Y, Z

3.1 Intro

Mechanical hardware specs and parts are in these subdirectories:

<http://devel.lulzbot.com/mini/>

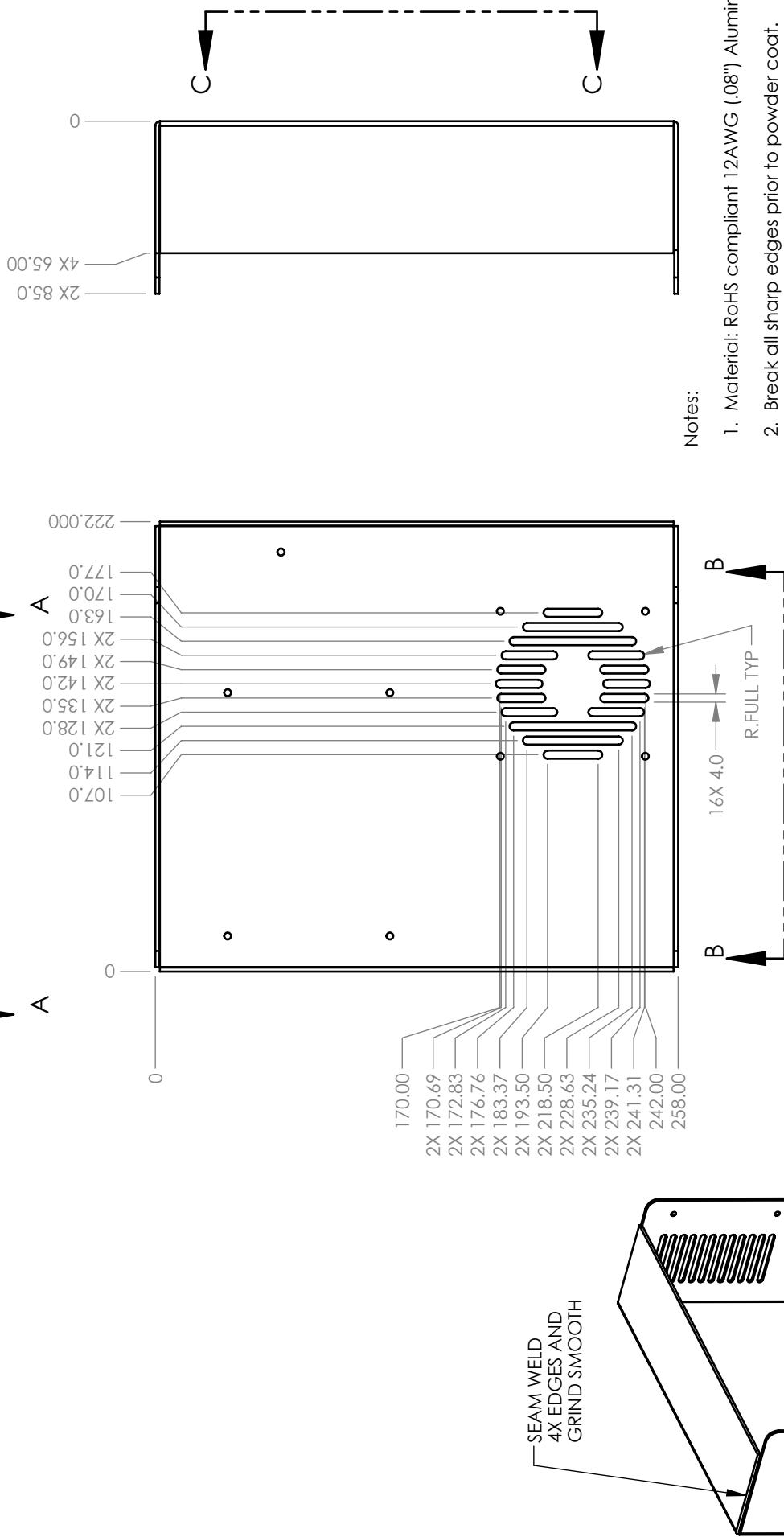
3.2 Bill of Materials

| Category | AO Part # | Description | Manufacturer | Manufacturer PN | Distributor | SKU | Distributor co | Advanced Antivibration co | Distributor | SKU | Qty Per | UOM | Price Per Unit | Price Total | Qty to Order | |
|-------------|-----------|--|--------------------------|-----------------|-------------|---------------|----------------|---------------------------|-------------|-----|---------|-----|----------------|-------------|-----------------|--|
| | | | | | | | | | | | | | | | | |
| Hardware | HD-MS054 | Square Bumper | | | | | | | | | 2 | ea | \$0.09 | \$0.35 | 42 Sheets of 98 | |
| Printed | PP-GP0189 | Double bearing holder v1.2, Mini | Aleph Objects | | | | | | | | 1 | ea | \$3.00 | \$6.02 | | |
| Printed | PP-GP0188 | Upper bearing holder v1.1, Mini | Aleph Objects | | | | | | | | 1 | ea | \$3.30 | \$3.30 | | |
| Printed | PP-GP0187 | X carriage cover v2.3, Mini | Aleph Objects | | | | | | | | 1 | ea | \$1.750 | \$1.75 | | |
| Printed | PP-GP0191 | Herringbone Large Gear, Lulzbot green | Aleph Objects | | | | | | | | 1 | ea | \$2.230 | \$2.23 | | |
| Printed | PP-GP0192 | Herringbone Small Gear, Lulzbot green | Aleph Objects | | | | | | | | 1 | ea | \$0.290 | \$0.29 | | |
| Printed | PP-GP0060 | Wade Reloaded Bearing Washer | Aleph Objects | | | | | | | | 1 | ea | \$0.020 | \$0.02 | | |
| Printed | PP-GP0186 | Wade extruder body for Hex nozzle v1.0 | Aleph Objects | | | | | | | | 1 | ea | \$3.790 | \$3.79 | | |
| Printed | PP-GP0059 | Wade Reloaded idle Block | Aleph Objects | | | | | | | | 1 | ea | \$0.900 | \$0.90 | | |
| Printed | PP-GP0091 | extruder_latch | Aleph Objects | | | | | | | | 1 | ea | \$0.260 | \$0.26 | | |
| Printed | PP-GP0185 | X end idler v2.3, Mini | Aleph Objects | | | | | | | | 1 | ea | \$7.870 | \$7.87 | | |
| Printed | PP-GP0184 | Extruder mount v2.4, Mini | Aleph Objects | | | | | | | | 1 | ea | \$3.690 | \$3.69 | | |
| Printed | PP-GP0183 | X carriage v1.0, Mini | Aleph Objects | | | | | | | | 1 | ea | \$5.150 | \$5.15 | | |
| Printed | PP-GP0182 | X end motor v1.6, Mini | Aleph Objects | | | | | | | | 1 | ea | \$8.740 | \$8.74 | | |
| Printed | PP-GP0181 | Beltmount v1.0, Mini | Aleph Objects | | | | | | | | 1 | ea | \$1.260 | \$1.26 | | |
| Printed | PP-GP0179 | Z upper left v1.2, Mini | Aleph Objects | | | | | | | | 1 | ea | \$3.010 | \$3.01 | | |
| Printed | PP-GP0180 | Z upper right v1.2, Mini | Aleph Objects | | | | | | | | 1 | ea | \$3.010 | \$3.01 | | |
| Printed | PP-GP0177 | Z lower left v1.1, Mini, Lulzbot green | Aleph Objects | | | | | | | | 1 | ea | \$5.150 | \$5.15 | | |
| Printed | PP-GP0178 | Z lower right v1.1, Mini, Lulzbot green | Aleph Objects | | | | | | | | 1 | ea | \$7.090 | \$7.09 | | |
| Printed | PP-GP0176 | Bed corner v2.2, Mini | Aleph Objects | | | | | | | | 1 | ea | \$1.070 | \$1.07 | | |
| Printed | PP-GP0175 | Bed corner v1.2, Mini | Aleph Objects | | | | | | | | 1 | ea | \$2.230 | \$2.23 | | |
| Printed | PP-GP0174 | Y idle mount v1.1, Mini | Aleph Objects | | | | | | | | 1 | ea | \$0.680 | \$0.68 | | |
| Printed | PP-GP0173 | Y rod mount v1.1, Mini | Aleph Objects | | | | | | | | 1 | ea | \$1.170 | \$1.17 | | |
| Printed | PP-GP0172 | Spool hinge v1.3, Mini | Aleph Objects | | | | | | | | 1 | ea | \$0.190 | \$0.19 | | |
| Printed | PP-GP0171 | Spool arm v1.0, Mini | Aleph Objects | | | | | | | | 1 | ea | \$6.750 | \$6.75 | | |
| Printed | PP-GP0170 | Spool mount v1.2, Mini | Aleph Objects | | | | | | | | 1 | ea | \$0.137 | \$0.27 | | |
| Printed | PP-GP0176 | Relief mount v1.3, Mini | Aleph Objects | | | | | | | | 1 | ea | \$2.290 | \$2.29 | | |
| Printed | PP-GP0169 | Handle bar v2.4, Mini | Aleph Objects | | | | | | | | 1 | ea | \$3.440 | \$3.44 | | |
| Printed | PP-GP0168 | Handle mount v1.4, Mini | Aleph Objects | | | | | | | | 1 | ea | \$10.220 | \$10.22 | | |
| Printed | PP-GP0167 | Wiper mount v1.0, Mini | Aleph Objects | | | | | | | | 1 | ea | \$2.450 | \$2.45 | | |
| Mechanical | HD-MS0211 | Lower relief v1.0, Mini | Alien Scientific | | | | | | | | 1 | ea | \$10.190 | \$10.19 | | |
| Mechanical | HD-MS0227 | Bonoblock Glass Rod 170mm x 170mm | Associated Spring | | | | | | | | 1 | ea | \$6.750 | \$6.75 | | |
| Mechanical | HD-BL0015 | Spring, Extruder, 6mm OD, 0.8mm WD, 9.7mm FL | B & B Manufacturing, Inc | | | | | | | | 1 | ea | \$0.137 | \$0.27 | | |
| Mechanical | HD-MS0033 | G72, Single sided Neoprene Belt | IM6-CAS 5MM BORE ALL | | | | | | | | 1 | ea | \$3.440 | \$6.88 | | |
| Electronics | EL-PS0025 | GT2 Timing Pulley, 5mm Bore Aluminum | PMC-24V150W1AA_DELTA | | | | | | | | 1 | ea | \$28.600 | \$28.60 | | |
| Electronics | EL-MS0143 | POWER SUPPLY 150W 24V 6.25A PNL MT | 22-28AWG | | | | | | | | 1 | ea | \$0.077 | \$0.077 | | |
| Electronics | EL-MS0205 | Conn Fast Receptione 1.6 AWG - 250 | WM25LT TR-ND | | | | | | | | 25 | ea | \$0.038 | \$0.96 | 2 reels | |
| Electronics | EL-MS0212 | CONN TERM MALE 22-24AWG TIN | MOL16-02-0108 | | | | | | | | 73 | ea | \$0.056 | \$3.26 | 4 reels | |
| Electronics | EL-MS0059 | CONN PIN 24-30AWG CRIMP TIN | WM25L0TR-ND | | | | | | | | 3 | ea | \$0.140 | \$0.42 | | |
| Electronics | EL-MS0061 | CONN TERM FEMALE 22-24AWG TIN | WM25S5-ND | | | | | | | | 8 | ea | \$0.112 | \$0.90 | | |
| Electronics | EL-MS0062 | Connector, 4 pin Female housing with latch | Digikey | | | | | | | | 5 | ea | \$0.31 | \$1.00 | | |
| Electronics | PC-CN0001 | CONN HOUSING 2POS 1.00 W/LATCH | TII | | | | | | | | 6 | ea | \$0.060 | \$0.36 | | |
| Electronics | PC-CN0003 | CONN HOUSING 3POS 1.00 W/LATCH | TII | | | | | | | | 12 | ea | \$0.109 | \$1.31 | | |
| Electronics | EL-MS0142 | CONN RECEPT FASTON 22-26AWG .110 | P22-4R-M | | | | | | | | 6 | ea | \$0.52 | \$2.00 | | |
| Electronics | EL-MS0141 | Term Ring Non Ins 26-22AWG #4 | Heilind | | | | | | | | 2 | ea | \$0.087 | \$0.18 | | |
| Electronics | EL-MS0210 | CONN RING UNINS 15-20AWG #43 | Digikey | | | | | | | | 2 | ea | \$0.090 | \$0.18 | | |
| Electronics | EL-SW0022 | SWITCH BASIC SPDT 3A .10QC 125V | SW768-ND | 6 | ea | \$3.12 | \$3.12 | 6,000 ft | | | | | | | | |
| Electronics | EL-WR0099 | Shielded 4Cond 22AWG | C0762A_41.10 | | | | | | | | 2470 | mm | \$0.001 | \$3.02 | 9000 ft | |
| Electronics | EL-WR0105 | 24AWG Stranded - Black | C2015A-21.01 | | | | | | | | 6025 | mm | \$0.000 | \$1.54 | 22000 ft | |
| Electronics | EL-WR0107 | 24AWG Stranded - White | C2015A-21.02 | | | | | | | | 1100 | mm | \$0.000 | \$0.28 | 40000 ft | |
| Electronics | EL-WR0109 | 24AWG Stranded - Yellow | C2015A-21.05 | | | | | | | | 2090 | mm | \$0.000 | \$0.54 | 8000 ft | |
| Electronics | EL-WR0103 | 24AWG Stranded - Red | C2015A-21.03 | | | | | | | | 3825 | mm | \$0.000 | \$0.98 | 14000 ft | |
| Electronics | EL-WR0104 | 24AWG Stranded - Orange | C2015A-21.04 | | | | | | | | 480 | mm | \$0.000 | \$0.72 | 11000 ft | |
| Electronics | EL-WR0118 | 24AWG Stranded - Blue | C2015A-21.07 | | | | | | | | 520 | mm | \$0.000 | \$0.14 | 20000 ft | |
| Electronics | EL-WR0119 | 24AWG Stranded - Green | C2015A-21.06 | | | | | | | | 1210 | mm | \$0.000 | \$0.16 | 20000 ft | |
| Electronics | EL-WR0120 | 24AWG Stranded - Purple | C2015A-21.10 | | | | | | | | 2060 | mm | \$0.000 | \$0.31 | 50000 ft | |
| Electronics | EL-WR0106 | 16AWG Stranded - Red | C206SA-21.03 | | | | | | | | 400 | mm | \$0.007 | \$2.78 | 20000 ft | |
| Electronics | EL-WR0121 | 16AWG Stranded - Black | C206SA-21.01 | | | | | | | | 1280 | mm | \$0.007 | \$8.89 | 40000 ft | |

| | | | | | | | | |
|-------------------|-----------------------|---|--------------------|----------------|---------------|---------|----------------|----------------|
| Electronic | EL-WR0122 | 16AWG Stranded - Green | C2065A21.06 | Digikey | C2065A21.02 | \$6.11 | \$0.87 | 1000 ft |
| Electronic | EL-WR0123 | 16AWG Stranded - White | | Digikey | | \$0.007 | | |
| Electronic | EL-WR0108 | 16AWG Stranded - Violet | | Digikey | | \$0.001 | | |
| Electronic | EL-MS0216 | Ferrite Tubular Bead 19.0mm | | Digikey | | | | |
| Electronic | PC-CN0046 | Term Block Plug 4PQS STR 5.08MM | | TII | 240-2314-ND | 1 | | |
| Electronic | PC-CN0032 | Term Block Plug 2PQS STR 5.08MM | | TII | WN7953-ND | 1 | | |
| Electronic | EL-MS0074 | 20-POS_1.00 Dual (Black) | | TII | WN7819-ND | 2 | | |
| Electronic | EL-MS0211 | REEL - RING TONGUE CONN 16-22 AWG 410 PIDS | TE | Digikey | WN2527-ND | 2 | | |
| Hardware | HE-SH0031 | Repli-Modifed Hexagon Holed, Luzbot Edition, 3.0mm Filament | | Repli-discount | A1062TR-ND | 7 | | |
| Mechanical | PP-FP0055 | Left Plate, | EPOCS | | | | | |
| Mechanical | PP-FP0052 | Right Plate, | EPOCS | | | | | |
| Mechanical | PP-FP0051 | Top Plate, | EPOCS | | | | | |
| Mechanical | PP-FP0053 | Bottom Plate, | EPOCS | | | | | |
| Mechanical | PP-FP0054 | Bed Mount Plate, | EPOCS | | | | | |
| Mechanical | PP-FP0056 | Electronics cover, | Rapid Sheet Metal | | | | | |
| Mechanical | PP-FP0055 | Left Plate, | Rapid Sheet Metal | | | | | |
| Mechanical | PP-FP0052 | Right Plate, | Rapid Sheet Metal | | | | | |
| Mechanical | PP-FP0051 | Top Plate, | Rapid Sheet Metal | | | | | |
| Mechanical | PP-FP0053 | Bottom Plate, | Rapid Sheet Metal | | | | | |
| Mechanical | PP-FP0054 | Bed Mount Plate, | Rapid Sheet Metal | | | | | |
| Mechanical | PP-FP0056 | Electronics cover, | Rapid Sheet Metal | | | | | |
| Hardware | EL-MS0165 | Snaps-Together Cable and Hose Carrier, Feed-Through, 0.41" High x 0.39" Wide Interior SIGS | Rapid Sheet Metal | | | | | |
| Hardware | EL-MS0166 | Mounting Brackets for .41" High x .39" Wide Interior Snap-Together Cable and Hose Carriers | Rapid Sheet Metal | | | | | |
| Mechanical | HD-BU00143 | EMI/RFI-Shield Heat-Shrink Tubing - Solid polymer bearing R/W:0L_8mm | IGUM | | | | | |
| Electronic | EL-FA0011 | FAN 24VDC, Sleeve 5.75CFM,10x40x10MM,60mA 6000RPM,1.44W/2 | Kysan | | | | | |
| Electronic | EL-FA0012 | FAN 24VDC,BAL 31.60CFM,80x80x15 MM,100mA | TF8015-24M-B | | | | | |
| Mechanical | HD-RB0035 | 8mm Smooth Rod, 31.5mm | Kyocera | | | | | |
| Mechanical | HD-RB0044 | 304 Stainless Steel | MBK | | | | | |
| Hardware | HD-BT0108 | Holurbed Bolt, M8 x 50mm Hex head, 26mm offset, Stainless Steel | Quattro | | | | | |
| Hardware | PP-MF0082 | Bed leveling washer, 2013 SST | MBK | | | | | |
| Electronics | TL-CS0083 | EMI/RFI-Shield Heat-Shrink Tubing, 3/16" ID Before, 3/32" ID After, 3/16" ID Before, 3/16" ID After | TECflex | | | | | |
| Electronics | TL-CS0129 | Interference-Shielding Heat-Shrink Tubing, 3/8" ID Before, 3/8" ID After | TECflex | | | | | |
| Hardware | HD-WA0035 | Metric 18-8 Stainless Steel External Serrated Loc. Washer, M3 Screw Size, 6mm OD, 0.4mm ID | McMaster | | | | | |
| Hardware/tools | HD-MS0244 | Firm White Polyester Felt Strip, 1/4" Thick, 1" Width, Plain Back | McMaster | | | | | |
| Hardware | HD-MS0235 | Metric Aluminum Unthreaded Spacer, 4.5mm OD, 8mm Length | McMaster | | | | | |
| Electronics | EL-MS0273 | Tubing, Corrugated Loom, 25" | Fastenal | | | | | |
| Hardware | HD-BT0117 | Black Alloy Steel Flat-Head Socket Cap Screw, Class 10.9, M8 Size, 40mm Length | Timberline | | | | | |
| Hardware | HD-BT0131 | Black Alloy Steel Flat-Head Socket Cap Screw, Class 10.9, M8 Size, 45mm Length | Timberline | | | | | |
| Hardware | PP-MF0066 | Metric Brass Heat-Set-Inserter for Plastics, Tapered, M2-4 Internal Thread, 2.96MM Length | McMaster | | | | | |
| Hardware | HD-BT0107 | Metric Class 12.9 Socket Head Cap Screw Alloy Steel, Black, M2 Thread, 10mm Length, 0.4mm Fastener | McMaster | | | | | |
| Hardware | HD-WA0012 | Steel Flat Washer, DIN 125 zinc-plated class 4/N2 screw sz, 5mm OD, 40350 | Fastenal | | | | | |
| Hardware | HD-MS0230 | M2 x 6 SHCS, Black-Oxide | Timberline | | | | | |
| Hardware | HD-MS0030 | M3-.5 3.8mm Heatset Insert | Fastenal | | | | | |
| Hardware | HD-MS0158 | M5-.8 6.7mm Heatset Insert | Fastenal | | | | | |
| Hardware | HD-NT0004 | M3 Nyloc Nut, Zinc Plated | Timberline | | | | | |
| Hardware | HD-NT0004 | M3 Nut, Zinc Plated | Timberline | | | | | |
| Hardware | HD-BT0012 | M3 Set Screw (Grub Screw) | Timberline | | | | | |
| Hardware | HD-WA0001 | M3 Washer, Steel, Zinc Plated | Timberline | | | | | |
| Hardware | HD-BT0044 | M3 x 5 Bolt, SHCS Black-Oxide | Timberline | | | | | |
| Hardware | HD-BT0128 | M3 x 6 Bolt, FHCS Black-Oxide | Timberline | | | | | |
| Hardware | HD-BT0104 | M3 x 8 Bolt, BHCS SST | Timberline | | | | | |
| Hardware | HD-BT0137 | M3 x 8 Bolt, BHCS, Black-Oxide | Timberline | | | | | |
| Hardware | HD-BT0039 | M3 x 12 Bolt, SHCS Black-Oxide | Timberline | | | | | |
| Hardware | HD-BT0118 | M3 x 14 Bolt FHCS, Black-Oxide | Timberline | | | | | |
| Hardware | HD-BT0136 | M3 x 12 Bolt FHCS, SST | Timberline | | | | | |
| Hardware | HD-BT0135 | M3 x 8 Bolt FHCS, Black-Oxide | Timberline | | | | | |
| Hardware | HD-BT0041 | M3 x 25 Bolt, SHCS Black-Oxide | Timberline | | | | | |
| Hardware | HD-NT0011 | M4 Nut,Zinc-Plated Steel | Timberline | | | | | |
| | | | | | | | | |
| Electronic | C2065G-1000-ND | 16AWG Stranded - Green | C2065A21.06 | Digikey | C2065W-100-ND | 880 | \$0.007 | 1000 ft |
| Electronic | EL-MS0216 | Ferrite Tubular Bead 19.0mm | | Digikey | C2065V-100-ND | 1100 | | |
| Electronic | PC-CN0046 | Term Block Plug 4PQS STR 5.08MM | | TII | 240-2314-ND | 1 | | |
| Electronic | PC-CN0032 | Term Block Plug 2PQS STR 5.08MM | | TII | WN7953-ND | 1 | | |
| Electronic | EL-MS0074 | 20-POS_1.00 Dual (Black) | | TII | WN7819-ND | 2 | | |
| Hardware | HE-SH0031 | Repli-Modified Hexagon Holed, Luzbot Edition, 3.0mm Filament | | Digikey | WN2527-ND | 2 | | |
| Mechanical | PP-FP0055 | Left Plate, | EPOCS | | | | | |
| Mechanical | PP-FP0052 | Right Plate, | EPOCS | | | | | |
| Mechanical | PP-FP0051 | Top Plate, | EPOCS | | | | | |
| Mechanical | PP-FP0053 | Bottom Plate, | EPOCS | | | | | |
| Mechanical | PP-FP0054 | Bed Mount Plate, | EPOCS | | | | | |
| Mechanical | PP-FP0056 | Electronics cover, | EPOCS | | | | | |
| Mechanical | PP-FP0055 | Left Plate, | Rapid Sheet Metal | | | | | |
| Mechanical | PP-FP0052 | Right Plate, | Rapid Sheet Metal | | | | | |
| Mechanical | PP-FP0051 | Top Plate, | Rapid Sheet Metal | | | | | |
| Mechanical | PP-FP0053 | Bottom Plate, | Rapid Sheet Metal | | | | | |
| Mechanical | PP-FP0054 | Bed Mount Plate, | Rapid Sheet Metal | | | | | |
| Mechanical | PP-FP0056 | Electronics cover, | Rapid Sheet Metal | | | | | |
| Hardware | EL-MS0165 | Snaps-Together Cable and Hose Carrier, Feed-Through, 0.41" High x 0.39" Wide Interior SIGS | Rapid Sheet Metal | | | | | |
| Hardware | EL-MS0166 | Mounting Brackets for .41" High x .39" Wide Interior Snap-Together Cable and Hose Carriers | Rapid Sheet Metal | | | | | |
| Mechanical | HD-BU00143 | EMI/RFI-Shield Heat-Shrink Tubing - Solid polymer bearing R/W:0L_8mm | IGUM | | | | | |
| Electronic | EL-FA0011 | FAN 24VDC, Sleeve 5.75CFM,10x40x10MM,60mA 6000RPM,1.44W/2 | Kysan | | | | | |
| Electronic | EL-FA0012 | FAN 24VDC,BAL 31.60CFM,80x80x15 MM,100mA | TF8015-24M-B | | | | | |
| Mechanical | HD-RB0035 | 8mm Smooth Rod, 31.5mm | Kyocera | | | | | |
| Mechanical | HD-RB0044 | 304 Stainless Steel | MBK | | | | | |
| Hardware | HD-BT0108 | Holbed Bolt, M8 x 50mm Hex head, 26mm offset, Stainless Steel | Quattro | | | | | |
| Hardware | PP-MF0082 | Bed leveling washer, 2013 SST | MBK | | | | | |
| Electronics | TL-CS0083 | EMI/RFI-Shield Heat-Shrink Tubing, 3/16" ID Before, 3/32" ID After, 3/16" ID Before, 3/16" ID After | TECflex | | | | | |
| Electronics | TL-CS0129 | Interference-Shielding Heat-Shrink Tubing, 3/8" ID Before, 3/8" ID After | TECflex | | | | | |
| Hardware | HD-WA0035 | Metric 18-8 Stainless Steel External Serrated Loc. Washer, M3 Screw Size, 6mm OD, 0.4mm ID | McMaster | | | | | |
| Hardware/tools | HD-MS0244 | Firm White Polyester Felt Strip, 1/4" Thick, 1" Width, Plain Back | McMaster | | | | | |
| Hardware | HD-MS0235 | Metric Aluminum Unthreaded Spacer, 4.5mm OD, 8mm Length | McMaster | | | | | |
| Electronics | EL-MS0273 | Tubing, Corrugated Loom, 25" | Fastenal | | | | | |
| Hardware | HD-BT0117 | Black Alloy Steel Flat-Head Socket Cap Screw, Class 10.9, M8 Size, 40mm Length | Timberline | | | | | |
| Hardware | HD-BT0131 | Black Alloy Steel Flat-Head Socket Cap Screw, Class 10.9, M8 Size, 45mm Length | Timberline | | | | | |
| Hardware | PP-MF0066 | Metric Brass Heat-Set-Inserter for Plastics, Tapered, M2-4 Internal Thread, 2.96MM Length | McMaster | | | | | |
| Hardware | HD-BT0107 | Metric Class 12.9 Socket Head Cap Screw Alloy Steel, Black, M2 Thread, 10mm Length, 0.4mm Fastener | McMaster | | | | | |
| Hardware | HD-WA0012 | Steel Flat Washer, DIN 125 zinc-plated class 4/N2 screw sz, 5mm OD, 40350 | Fastenal | | | | | |
| Hardware | HD-MS0230 | M2 x 6 SHCS, Black-Oxide | Timberline | | | | | |
| Hardware | HD-MS0030 | M3-.5 3.8mm Heatset Insert | Fastenal | | | | | |
| Hardware | HD-MS0158 | M5-.8 6.7mm Heatset Insert | Fastenal | | | | | |
| Hardware | HD-NT0004 | M3 Nyloc Nut, Zinc Plated | Timberline | | | | | |
| Hardware | HD-NT0004 | M3 Nut, Zinc Plated | Timberline | | | | | |
| Hardware | HD-BT0012 | M3 Set Screw (Grub Screw) | Timberline | | | | | |
| Hardware | HD-WA0001 | M3 Washer, Steel, Zinc Plated | Timberline | | | | | |
| Hardware | HD-BT0044 | M3 x 5 Bolt, SHCS Black-Oxide | Timberline | | | | | |
| Hardware | HD-BT0128 | M3 x 6 Bolt, FHCS Black-Oxide | Timberline | | | | | |
| Hardware | HD-BT0104 | M3 x 8 Bolt, BHCS SST | Timberline | | | | | |
| Hardware | HD-BT0137 | M3 x 8 Bolt, BHCS, Black-Oxide | Timberline | | | | | |
| Hardware | HD-BT0039 | M3 x 12 Bolt, SHCS Black-Oxide | Timberline | | | | | |
| Hardware | HD-BT0118 | M3 x 14 Bolt FHCS, Black-Oxide | Timberline | | | | | |
| Hardware | HD-BT0136 | M3 x 12 Bolt FHCS, SST | Timberline | | | | | |
| Hardware | HD-BT0135 | M3 x 6 Bolt FHCS, Black-Oxide | Timberline | | | | | |
| Hardware | HD-BT0041 | M3 x 25 Bolt, SHCS Black-Oxide | Timberline | | | | | |
| Hardware | HD-NT0011 | M4 Nut,Zinc-Plated Steel | Timberline | | | | | |
| | | | | | | | | |
| Electronic | C2065G-1000-ND | 16AWG Stranded - Green | C2065A21.06 | Digikey | C2065W-100-ND | 880 | \$0.007 | 1000 ft |
| Electronic | EL-MS0216 | Ferrite Tubular Bead 19.0mm | | Digikey | C2065V-100-ND | 1100 | | |
| Electronic | PC-CN0046 | Term Block Plug 4PQS STR 5.08MM | | TII | 240-2314-ND | 1 | | |
| Electronic | PC-CN0032 | Term Block Plug 2PQS STR 5.08MM | | TII | WN7953-ND | 1 | | |
| Electronic | EL-MS0074 | 20-POS_1.00 Dual (Black) | | TII | WN7819-ND | 2 | | |
| Hardware | HE-SH0031 | Repli-Modified Hexagon Holed, Luzbot Edition, 3.0mm Filament | | Digikey | WN2527-ND | 2 | | |
| Mechanical | PP-FP0055 | Left Plate, | EPOCS | | | | | |
| Mechanical | PP-FP0052 | Right Plate, | EPOCS | | | | | |
| Mechanical | PP-FP0051 | Top Plate, | EPOCS | | | | | |
| Mechanical | PP-FP0053 | Bottom Plate, | EPOCS | | | | | |
| Mechanical | PP-FP0054 | Bed Mount Plate, | EPOCS | | | | | |
| Mechanical | PP-FP0056 | Electronics cover, | EPOCS | | | | | |
| Mechanical | PP-FP0055 | Left Plate, | Rapid Sheet Metal | | | | | |
| Mechanical | PP-FP0052 | Right Plate, | Rapid Sheet Metal | | | | | |
| Mechanical | PP-FP0051 | Top Plate, | Rapid Sheet Metal | | | | | |
| Mechanical | PP-FP0053 | Bottom Plate, | Rapid Sheet Metal | | | | | |
| Mechanical | PP-FP0054 | Bed Mount Plate, | Rapid Sheet Metal | | | | | |
| Mechanical | PP-FP0056 | Electronics cover, | Rapid Sheet Metal | | | | | |
| Hardware | EL-MS0165 | Snaps-Together Cable and Hose Carrier, Feed-Through, 0.41" High x 0.39" Wide Interior SIGS | Rapid Sheet Metal | | | | | |
| Hardware | EL-MS0166 | Mounting Brackets for .41" High x .39" Wide Interior Snap-Together Cable and Hose Carriers | Rapid Sheet Metal | | | | | |
| Mechanical | HD-BU00143 | EMI/RFI-Shield Heat-Shrink Tubing - Solid polymer bearing R/W:0L_8mm | IGUM | | | | | |
| Electronic | EL-FA0011 | FAN 24VDC, Sleeve 5.75CFM,10x40x10MM,60mA 6000RPM,1.44W/2 | Kysan | | | | | |
| Electronic | EL-FA0012 | FAN 24VDC,BAL 31.60CFM,80x80x15 MM,100mA | TF8015-24M-B | | | | | |
| Mechanical | HD-RB0035 | 8mm Smooth Rod, 31.5mm | Kyocera | | | | | |
| Mechanical | HD-RB0044 | 304 Stainless Steel | MBK | | | | | |
| Hardware | HD-BT0108 | Holbed Bolt, M8 x 50mm Hex head, 26mm offset, Stainless Steel | Quattro | | | | | |
| Hardware | PP-MF0082 | Bed leveling washer, 2013 SST | MBK | | | | | |
| Electronics | TL-CS0083 | EMI/RFI-Shield Heat-Shrink Tubing, 3/16" ID Before, 3/32" ID After | TECflex | | | | | |
| Electronics | TL-CS0129 | Interference-Shielding Heat-Shrink Tubing, 3/8" ID Before, 3/8" ID After | TECflex | | | | | |
| Hardware | HD-WA0035 | Metric 18-8 Stainless Steel External Serrated Loc. Washer, M3 Screw Size, 6mm OD, 0.4mm ID | McMaster | | | | | |
| Hardware/tools | HD-MS0244 | Firm White Polyester Felt Strip, 1/4" Thick, 1" Width, Plain Back | McMaster | | | | | |
| Hardware | HD-MS0235 | Metric Aluminum Unthreaded Spacer, 4.5mm OD, 8mm Length | McMaster | | | | | |
| Electronics | EL-MS0273 | Tubing, Corrugated Loom, 25" | Fastenal | | | | | |
| Hardware | HD-BT0117 | Black Alloy Steel Flat-Head Socket Cap Screw, Class 10.9, M8 Size, 40mm Length | Timberline | | | | | |
| Hardware | HD-BT0131 | Black Alloy Steel Flat-Head Socket Cap Screw, Class 10.9, M8 Size, 45mm Length | Timberline | | | | | |
| Hardware | PP-MF0066 | Metric Brass Heat-Set-Inserter for Plastics, Tapered, M2-4 Internal Thread, 2.96MM Length | McMaster | | | | | |
| Hardware | HD-BT0107 | Metric Class 12.9 Socket Head Cap Screw Alloy Steel, Black, M2 Thread, 10mm Length, 0.4mm Fastener | McMaster | | | | | |
| Hardware | HD-WA0012 | Steel Flat Washer, DIN 125 zinc-plated class 4/N2 screw sz, 5mm OD, 40350 | Fastenal | | | | | |
| Hardware | HD-MS0230 | M2 x 6 SHCS, Black-Oxide | Timberline | | | | | |
| Hardware | HD-MS0030 | M3-.5 3.8mm Heatset Insert | Fastenal | | | | | |
| Hardware | HD-MS0158 | M5-.8 6.7mm Heatset Insert | Fastenal | | | | | |
| Hardware | HD-NT0004 | M3 Nyloc Nut, Zinc Plated | Timberline | | | | | |
| Hardware | HD-NT0004 | M3 Nut, Zinc Plated | Timberline | | | | | |
| Hardware | HD-BT0012 | M3 Set Screw (Grub Screw) | Timberline | | | | | |
| Hardware | HD-WA0001 | M3 Washer, Steel, Zinc Plated | Timberline | | | | | |
| Hardware | HD-BT0044 | M3 x 5 Bolt, SHCS Black-Oxide | Timberline | | | | | |
| Hardware | HD-BT0128 | M3 x 6 Bolt, FHCS Black-Oxide | Timberline | | | | | |
| Hardware | HD-BT0104 | M3 x 8 Bolt, BHCS SST | Timberline | | | | | |
| Hardware | HD-BT0137 | M3 x 8 Bolt, BHCS, Black-Oxide | Timberline | | | | | |
| Hardware | HD-BT0039 | M3 x 12 Bolt, SHCS Black-Oxide | Timberline | | | | | |
| Hardware | HD-BT0118 | M3 x 14 Bolt FHCS, Black-Oxide | Timberline | | | | | |
| Hardware | HD-BT0136 | M3 x 12 Bolt FHCS, SST | Timberline | | | | | |
| Hardware | HD-BT0135 | M3 x 6 Bolt FHCS, Black-Oxide | Timberline | | | | | |
| Hardware | HD-BT0041 | M3 x 25 Bolt, SHCS Black-Oxide | Timberline | | | | | </td |

| | | | | | | | | | |
|-----------------|------------------|--|---|------------------------|----------------|-----------|-----------|---------------|-------------|
| Hardware | HD-WA0005 | M4 Washer | Timberline | 8206-0040 | \$0.00 | 6 | ea | \$0.02 | 6000 |
| Hardware | HD-MS0229 | M4 x 25 Bolt, SHCS Black-Oxide | mcmaster | 91290A176 | \$0.137 | 2 | ea | \$0.16 | 2020 |
| Hardware | HD-BT0052 | M4 x 55 Bolt, SHCS Black-Oxide | mcmaster | NS050-055 | \$0.08 | 2 | ea | \$0.24 | 11200 |
| Hardware | HD-WA0007 | M5 Washer, Steel, Zinc Plated | mcmaster | 91166A240 | \$0.022 | 11 | ea | \$0.02 | 6000 |
| Hardware | HD-BT0048 | M5 x 10 Bolt, SHCS Black-Oxide | Timberline | 8050-0510 | \$0.02 | 6 | ea | \$0.13 | 5000 |
| Hardware | HD-BT0049 | M5 x 14 Bolt, SHCS Black_Oxide | Timberline | NOR-M600510145O | \$0.03 | 3 | ea | \$0.16 | 3000 |
| Hardware | HD-NT0002 | M8 Nyloc Nut, Zinc Plated | Timberline | GBO-946270004 | \$0.05 | 9 | ea | \$0.11 | 9100 |
| Hardware | HD-WA0006 | M8 Washer, Steel, Zinc Plated | Timberline | 8206-0080 | \$0.01 | 1 | ea | \$0.05 | 1000 |
| Hardware | HD-WA0008 | Metric Spring Steel Shim - DIN 988 0.5mm Thick, 8mm ID, 14mm OD | Timberline | 1 | ea | \$0.06 | 1000 | \$0.06 | 1000 |
| Hardware | HD-WA0009 | Metric Spring Steel Shim - DIN 988 1.0mm Thick, 8mm ID, 14mm OD | Timberline | 1 | ea | \$0.10 | 2000 | \$0.19 | 2000 |
| Hardware | HD-MS0381 | Thumb Screw Knob for M4 SHCS, Black | McMaster | 7130k32 | \$1.030 | 2 | ea | \$2.06 | 2020 |
| Hardware | HD-BT0120 | Alloy Steel Shoulder Screw, 6mm Diameter x 10mm Long | McMaster | AEH#02-00818-UVB | \$0.02 | 12 | ea | \$0.28 | 12000 |
| Hardware | HD-MS058 | Shoulder, M5 Thread | Timberline | 7526k22 | \$0.249 | 2 | ea | \$0.50 | 2050 |
| Hardware | HD-MS0249 | Wire Tie, 8" | McMaster | 7604A55 | \$0.066 | 0.5 | g | \$0.03 | 5 bottles |
| Hardware | TL-CS0040 | UV-Resistant Cable Tie Holder, Adhesive Back/Screw Mount, 4-Way, for 4.8" Maximum Tie, Blk | McMaster | 7604A55 | \$0.066 | 2 | ea | \$23.00 | 2020 |
| Consumable | HD-RB0036 | Extreme-Temperature Pipe Sealant & Threadlocker, 4 oz bottle, blue | Thomson | 767.80 | \$7.50 | 10 | mm | \$13.56 | 2050 |
| Mechanical | HD-NT0047 | Drive Rod 10mm | MTS10 x 2m | GSASL16-5-5 | \$0.034 | 160 | mm | \$0.51 | 10 rolls |
| Mechanical | HD-MS0194 | 10mm x 2mm Flange mount supermount | McMaster | S-139394 | \$0.078 | 160 | mm | \$0.78 | 51 rolls |
| Mechanical | HD-MS0255 | Coupling, Set Screw, Misumi GSASL16-5-5 | Professional Plastics | 5279 | \$1.65 | 1 | ea | \$1.65 | 1010 |
| Mechanical | HD-MS0254 | Ultim PEI 0.010" x 12" x 30ft rolls | Uline | QTK21007-06 | \$1.05 | 1 | ea | \$1.05 | 1010 |
| Electrical | EL-CA0030 | S-139394 3M 468MP Adhesive Transfer Tape - 12" x 60 yards | Ba Monoprice | 161-PF003063 | \$3.16 | 1 | ea | \$3.16 | 1010 |
| Electrical | EL-CA0001 | 6t 18AWG Power Cord Cable w/ 3 Conductor PC Power Connector Socket (C1345-1SP) – Blk | Heilind | 576-023007.MXP | \$0.45 | 2 | ea | \$0.89 | 2050 |
| Electronics | PP-MP0028 | 6ft USB 2.0 A-Male to B Male 28/24AWG Cable | Mooser | 602-29561-100-03 | \$0.00 | 185 | mm | \$0.72 | 8 rolls |
| Electronics | EL-MS0096 | AC Power Entry Modules SC MT FUSED 25' TAB | Mooser | 879-1327G5-BK | \$0.16 | 2 | ea | \$0.32 | 2050 |
| Electronics | EL-WP0240 | Cartridge Fuses 125V 7A 6X20 MA ULBC | National Plastic Heater | 879-1332-BK | \$0.10 | 2 | ea | \$0.20 | 2050 |
| Electronics | EL-MS0098 | Wire - Single Conductor 20AWG SOLID PTFE, RED | Peltons | KLT078 | \$27.95 | 1 | ea | \$27.95 | On Order |
| Electronics | EL-MS0010 | Heavy Duty Power Connectors POWERPOL 15A CONT | Digkey | EG1535-ND | \$6.68 | 1 | ea | \$6.68 | 1050 |
| Electronics | PC-BD0029 | Silicon Heater, 24V, 168mm x 168mm, Self Adhesive, w/ connectors | Changzhou FTX Motors Cr | SY425TH7-150AA | \$1.702 | 1 | ea | \$1.70 | 1100 |
| Electronics | EL-FP0020 | RFB200 Micro flower | UltiMachine | vbx.com | \$7.50 | 1 | ea | \$7.50 | On Order |
| Electronics | EL-SW0023 | SWITCH H ROCKER DPST 20A 250V, illuminated red | Shipper's Supply | 20140922SA | \$7.00 | 1 | ea | \$7.00 | 10200 |
| Electronics | EL-MT0001 | NEEMA 17 Stepper Motors | Shipper's Supply | 0.018 | \$20.53 | 1 | ea | \$20.53 | 1010 |
| Electronics | PC-BB0049 | PC-BB0049 Mini FAMBo, assembled board only with no LCD headers | Digikey | SY425TH7-150AA | \$7.00 | 1 | ea | \$7.00 | 11000 |
| Mechanical | HD-MS0204 | Sealed Skateboardline/Rollerblade Skate Bearing Ball Bearings | Minilabel | Minilabel Mini Barcode | \$0.09 | 1 | ea | \$0.14 | 1010 |
| Etching | PP-FP0058 | Laser Engraving Designs | HIPS | Minilabel Mini Barcode | \$0.01 | 1 | ea | \$0.01 | 1010 |
| Packaging | SH-PG0075 | 1.5# RECYCLING | 3 x 4" 2 MI Redlosable Polypropylene Bags | Minilabel Mini Barcode | \$0.03 | 1 | ea | \$0.03 | 1010 |
| Packaging | SH-PG0076 | 22x17x4.275ft dw/ OUTSIDE PRINT 2 COLOR | 9 x 12" 3 MI Redlosable Polypropylene Bags | Minilabel Mini Barcode | \$0.02 | 1 | ea | \$0.02 | 1010 |
| Packaging | SH-PG0085 | 3" x 55 yards 3.1 MI Uline Clear Carton Sealing Tape 24 rolls/case | 6 x 10" 6 MI Redlosable Polypropylene Bags | Minilabel Mini Barcode | \$0.29 | 1 | ea | \$0.29 | 1010 |
| Packaging | DC-LB0028 | Label Labelbot Mini Barcode | 6 x 10" 6 MI Redlosable Polypropylene Bags | Minilabel Mini Barcode | \$0.18 | 1 | ea | \$0.18 | 1010 |
| Packaging | DC-LB0029 | Minilabel Mini Barcode | Packing List, Mini 1.0 | Minilabel Mini Barcode | \$0.24 | 1 | ea | \$0.24 | 1010 |
| Packaging | RW-HB0024 | HIPS, 1 meier Sample, Random Color | Quality Assurance Record Mini 1.0 | Minilabel Mini Barcode | \$0.72 | 1 | ea | \$0.72 | 1020 |
| Packaging | SH-PG0002 | 3 x 4" 2 MI Redlosable Polypropylene Bags | 0.03 Stainles Steel/Straight Instrument Cleaner Brush | USB Memory Direct | \$5.29 | 1 | ea | \$5.29 | 1020 |
| Packaging | SH-PG0083 | 9 x 12" 3 MI Redlosable Polypropylene Bags | SWM Style USB Flash drive, 4gb, black | Image Supply | \$4.15 | 1 | ea | \$4.15 | 1020 |
| Packaging | SH-PG0084 | 6 x 10" 6 MI Redlosable Polypropylene Bags | Pro Dental Pick, 5 3/4 in | WEBstaurant Store | \$1.87 | 1 | ea | \$1.87 | 1010 |
| Packaging | DC-MS0028 | Packing List, Mini 1.0 | 7.1/2" Nylon Handle Clam Knife | Total Lutz | \$2.03 | 1 | ea | \$2.03 | |
| Packaging | DC-MS0029 | Quality Assurance Record Mini 1.0 | | | \$72.61 | | | | |
| Tools | TL-MS0020 | 0.03 Stainless Steel/Straight Instrument Cleaner Brush | | | 1.00 | | | | |
| Tools | EL-NS0020 | SWM Style USB Flash drive, 4gb, black | | | Good to Order | | | | |
| Tools | TL-HD0046 | Pro Dental Pick, 5 3/4 in | | | Ordered | | | | |

3.3 Drawings



| | |
|--|----------------------|
| Sinnema Design Services | |
| seth.sinnema@gmail.com | REV. C |
| Phone: (303) 250-8218 | |
| Fax: 1-267-393-7872 | |
| Electronics Case, Mini | |
| DRAWN BY SINNEMA | 7/18/14 |
| MATERIAL SEE NOTES | |
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MILLIMETERS. TOLERANCES ARE: DECIMALS ANGLES $X \pm .75$ $X^\circ \pm 1^\circ$ | |
| .XXX ± .25 | 63 |
| .XXXX ± .050 | |
| BREAK EDGES .005/.020 FILLET RADIUS .005/.020 | |
| SIZE A | DWG NO. |
| SCALE 1:3 | DO NOT SCALE DRAWING |
| SHEET | 1 OF 2 |

FH-M3-10ZI Insert
Install from this side—

SECTION B-B

This section shows a top-down view of the component's top surface. The overall width is 170.25. The left edge features three circular holes labeled "3X Ø3.40 THRU" and three inverted V-shaped slots labeled "3X √Ø6.30". The right edge has a vertical profile with dimensions: 0, 32.00, 47.2, 56.6, 62.4, and 74.00 from bottom to top. A central rectangular cutout contains a small square hole and a U-shaped slot. The total height of the component is 199.75.

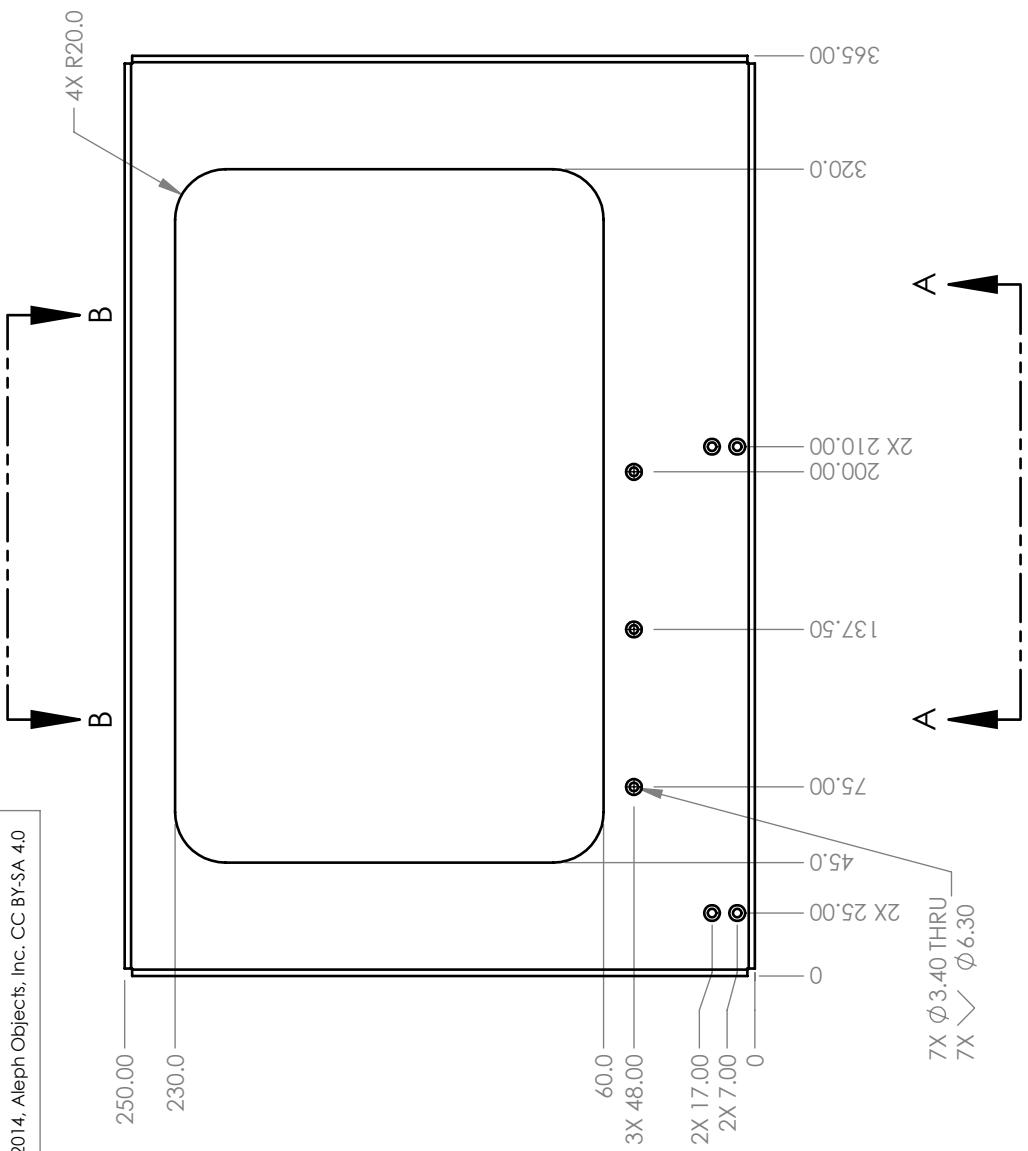
SECTION C-C

This section shows a side view of the component. The total height is 199.75. The top edge has two circular holes labeled "2X Ø3.40 THRU" and two inverted V-shaped slots labeled "2X √Ø6.30". The bottom edge has a vertical profile with dimensions: 0, 32.00, 47.2, 56.6, 62.4, and 74.00 from bottom to top. The left side shows a series of concentric, semi-circular slots forming a stepped profile. The total width of the component is 241.75.

SECTION B-B

Electronics Case, Mini

| | | | | | |
|-------|---------|------------------------|----------------------|-------|--------|
| TITLE | | Electronics Case, Mini | | REV. | C |
| SIZE | DWG NO. | PP-FP0056 | | SHEET | 2 OF 2 |
| A | | 1:3 | DO NOT SCALE DRAWING | | |



- Notes:
1. Material: RoHS compliant 12AWG (.08") Aluminum
 2. Break all sharp edges prior to powder coat.
 3. Part is to be powder coated with Cardinal color C241-BK109. Mask all threads prior to coating.

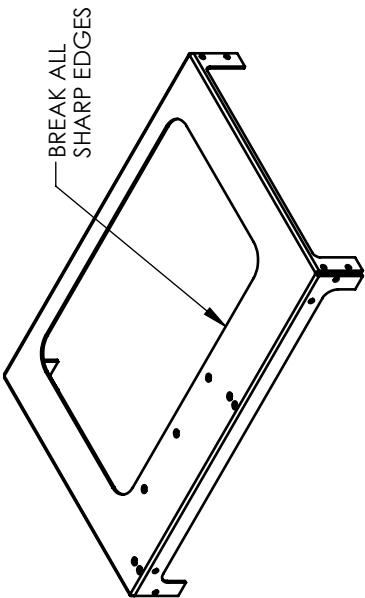
Sinnema Design Services
seth.sinnema@gmail.com
Phone: (303) 250-8218
Fax: 1-267-393-7872

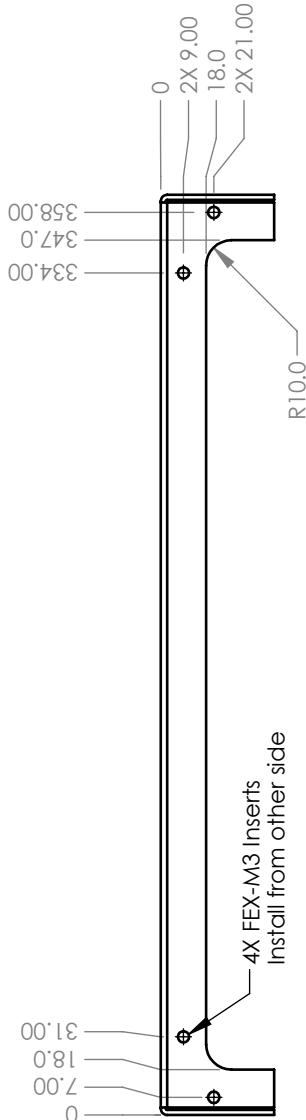
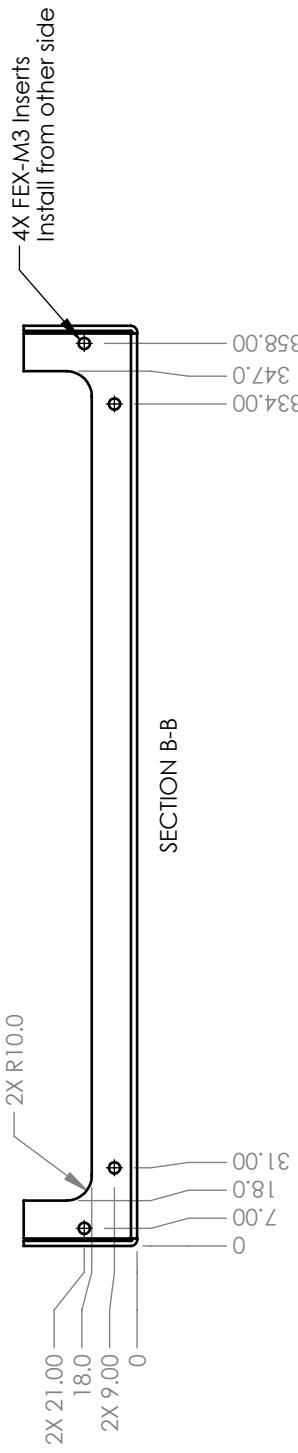


Top Plate, Mini

| SIZE | DWG NO. | TITLE |
|------|-----------|-----------------|
| A | PP-FP0051 | Top Plate, Mini |

REV.
A
1 OF 2

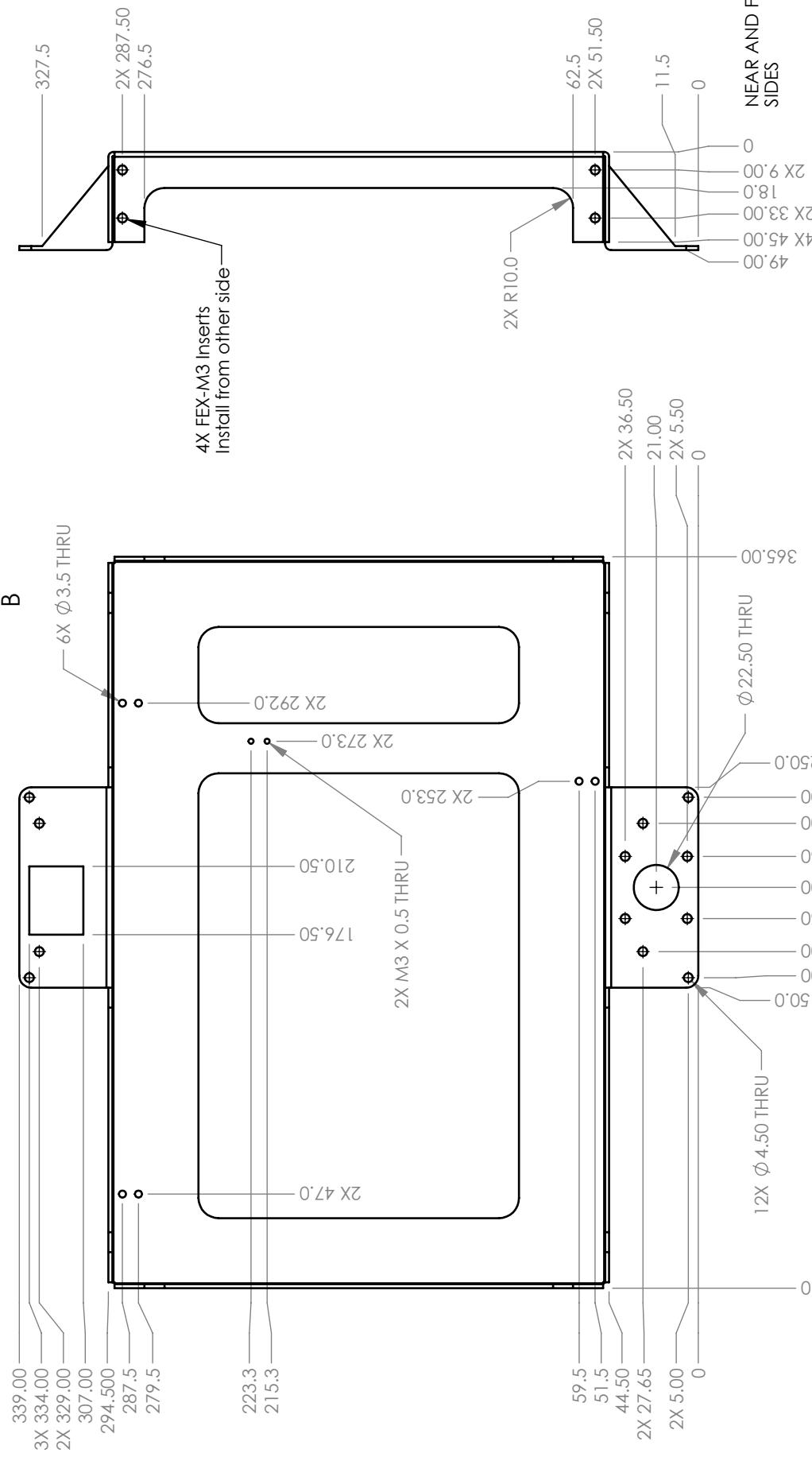




Top Plate, Mini

| | | | |
|-------|-----------|-------|----------------------|
| TITLE | PP-FP0051 | | |
| SIZE | DWG NO. | SCALE | SHEET |
| A | PP-FP0051 | 1:3 | DO NOT SCALE DRAWING |

REV.
A
2 OF 2



Sinnema Design Services

seth.sinnema@gmail.com
Phone: (303) 250-8218
Fax: 1-267-393-7872



| TITLE | |
|---|-----------------------|
| DRAWN BY SINNEMA | 7/18/14 |
| MATERIAL See Notes | |
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MILLIMETERS. TOLERANCES ARE: | |
| DECIMALS X±.75 XX±.25 XXX±.050 | ANGLES X°±1° 63 |
| BREAK EDGES .005/.020 FILLET RADIUS .005/.020 | |

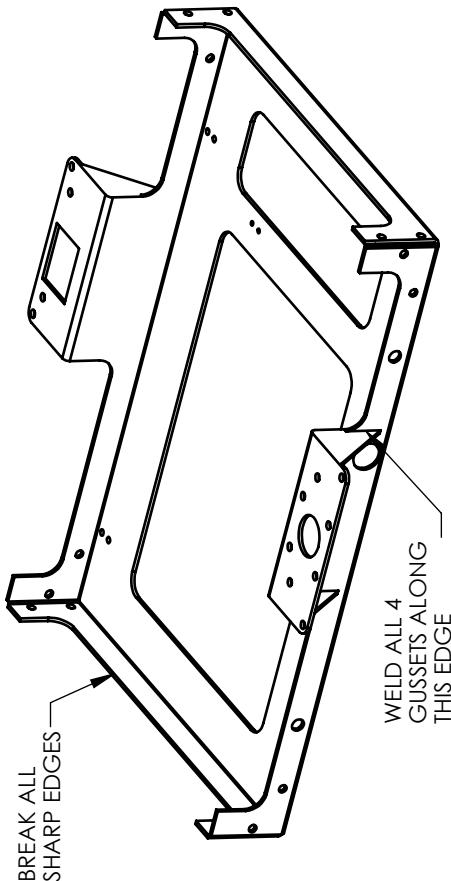
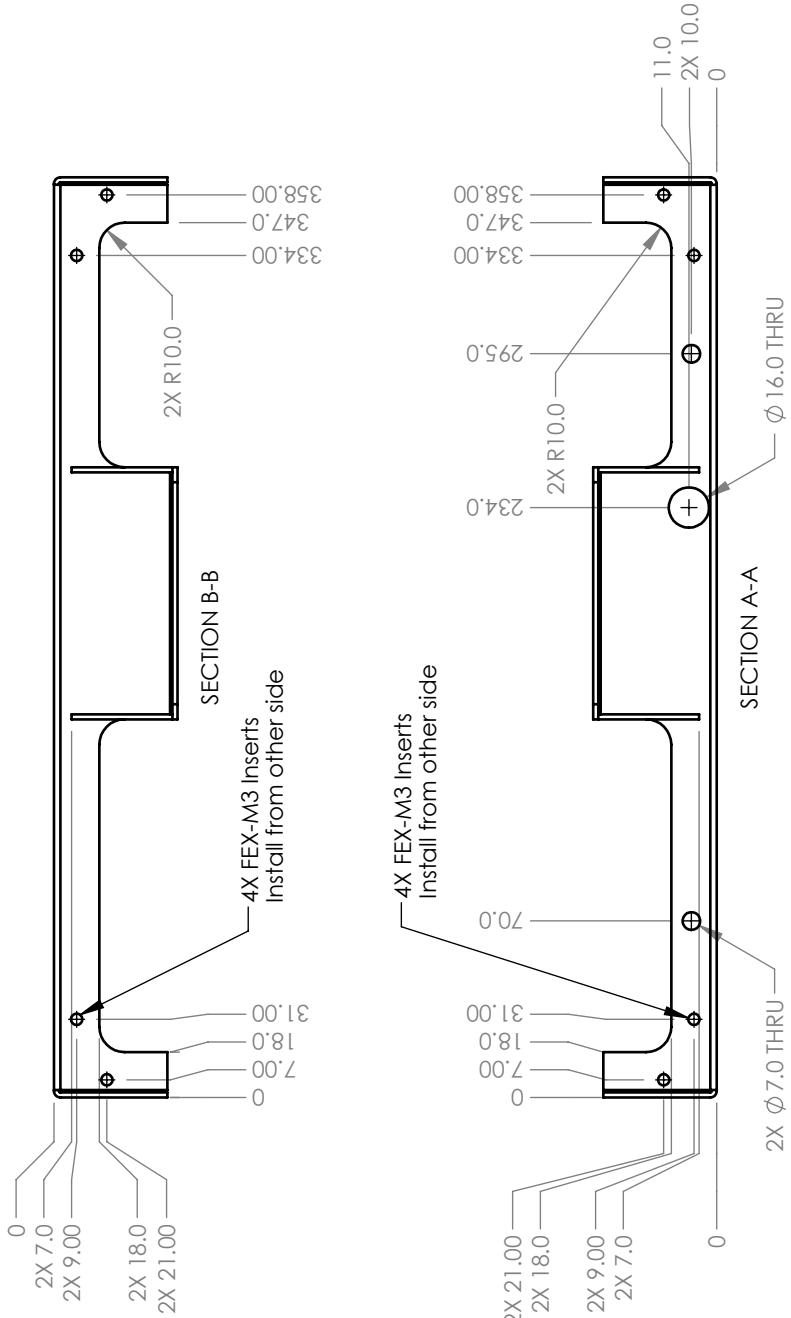
- Notes:
1. Material: RoHS compliant 12AWG (.08") Aluminum
 2. Break all sharp edges prior to powder coat.
 3. Part is to be powder coated with Cardinal color C241-BK109. Mask all threads prior to coating.

Bottom Plate, Mini

PP-FP0053

REV. A

| | | | | |
|-------|-----|----------------------|-------|--------|
| SCALE | 1:3 | DO NOT SCALE DRAWING | SHEET | 1 OF 3 |
|-------|-----|----------------------|-------|--------|



Bottom Plate, Mini

TITLE

DWG NO.

PP-FP0053

REV.

A

SIZE

SCALE

A

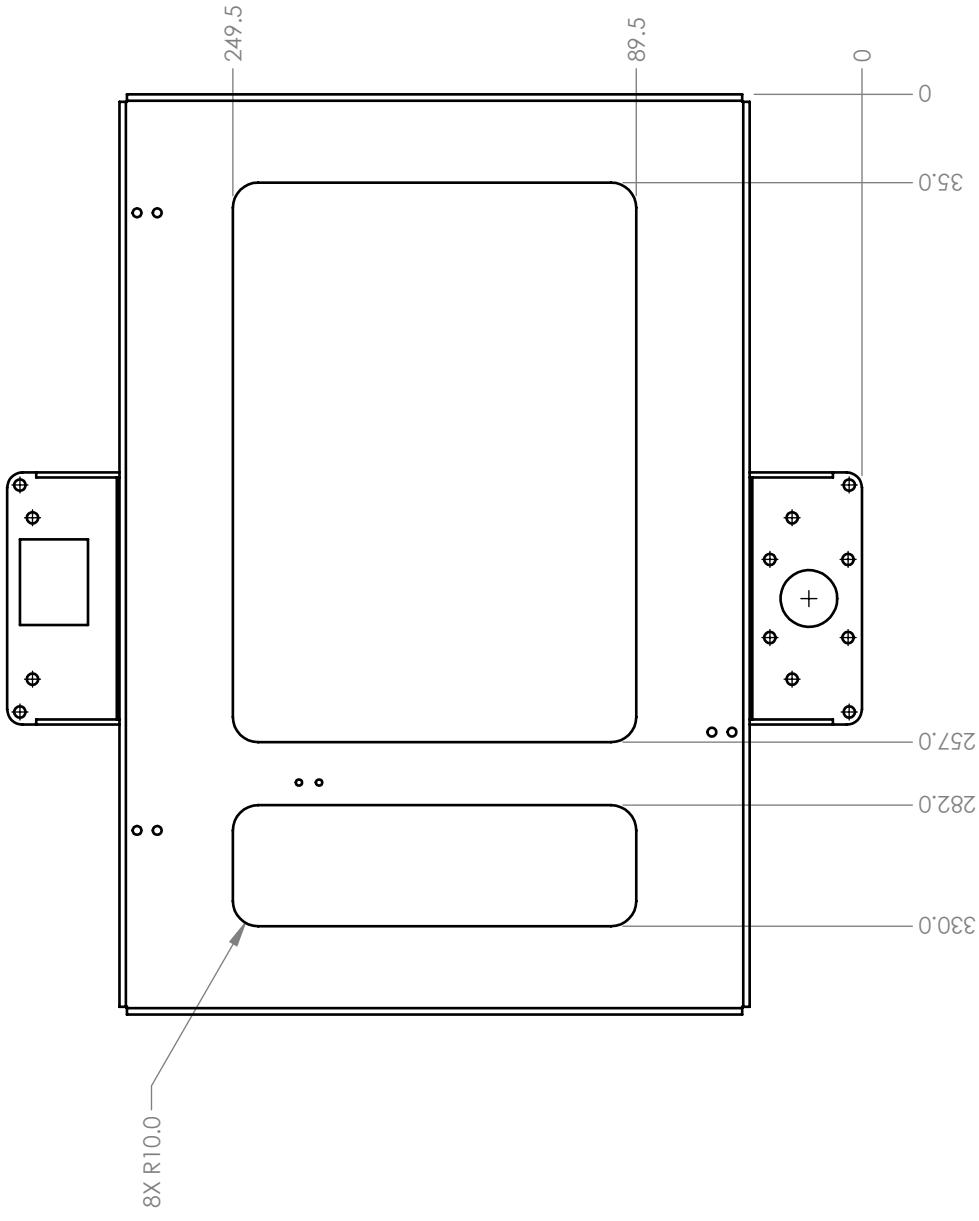
1:3

SCALE

DO NOT SCALE DRAWING

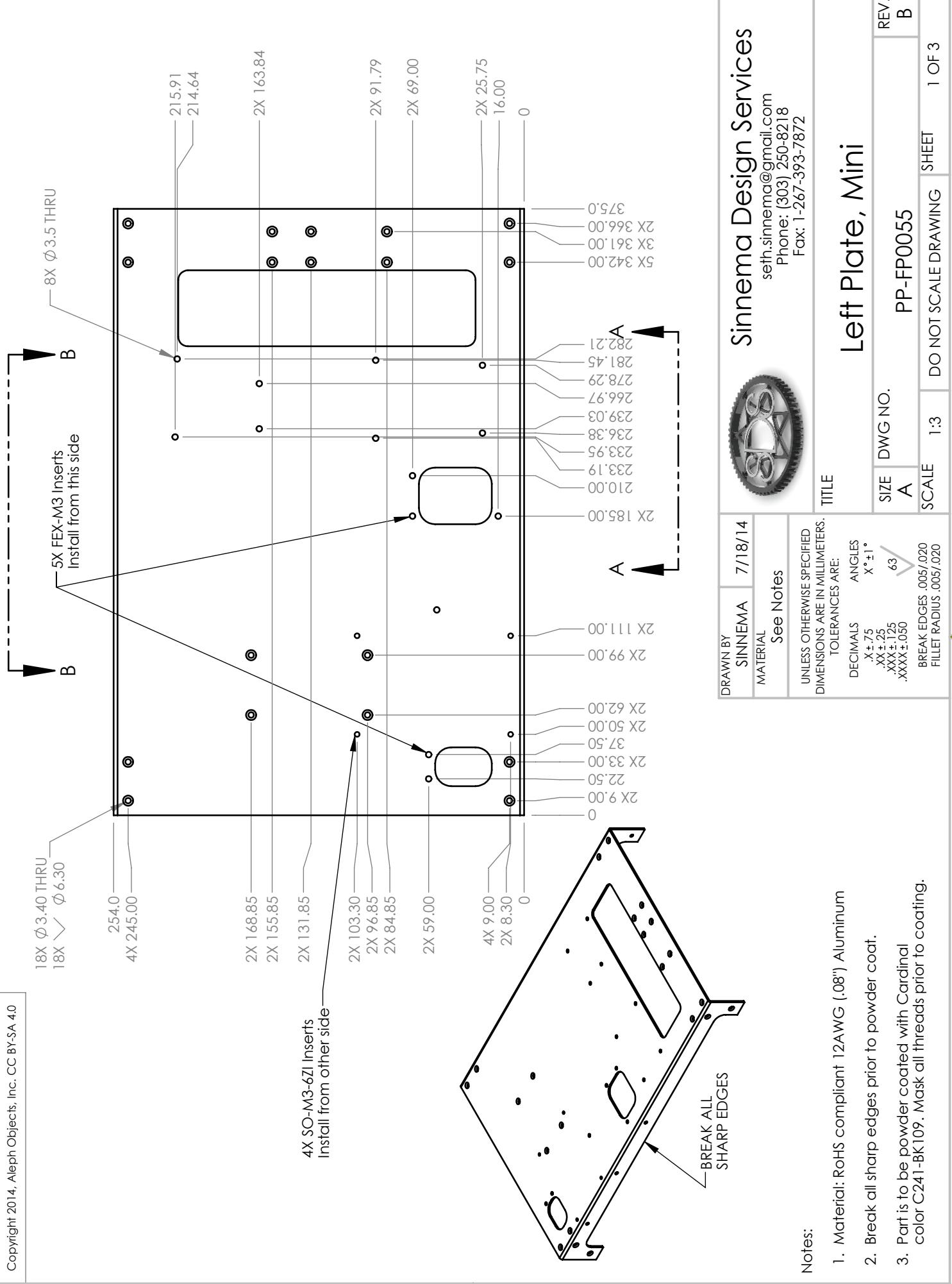
SHEET

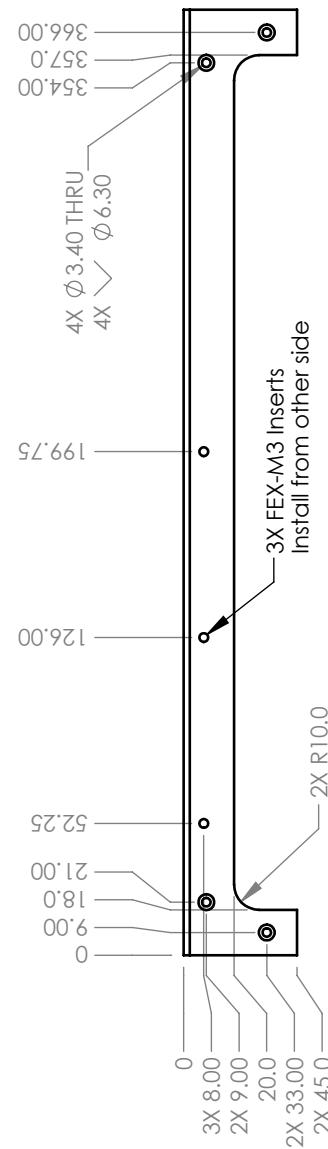
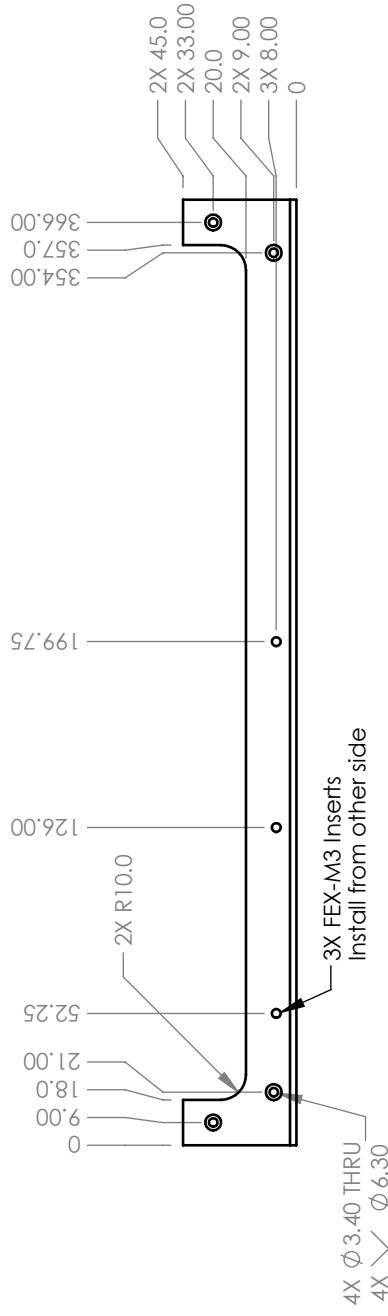
2 OF 3



Bottom Plate, Mini

| | | | |
|-------|--------------------|----------------------|--------------|
| TITLE | Bottom Plate, Mini | | |
| SIZE | DWG NO. | PP-FP0053 | REV. |
| A | | | A |
| SCALE | 1:3 | DO NOT SCALE DRAWING | SHEET 3 OF 3 |





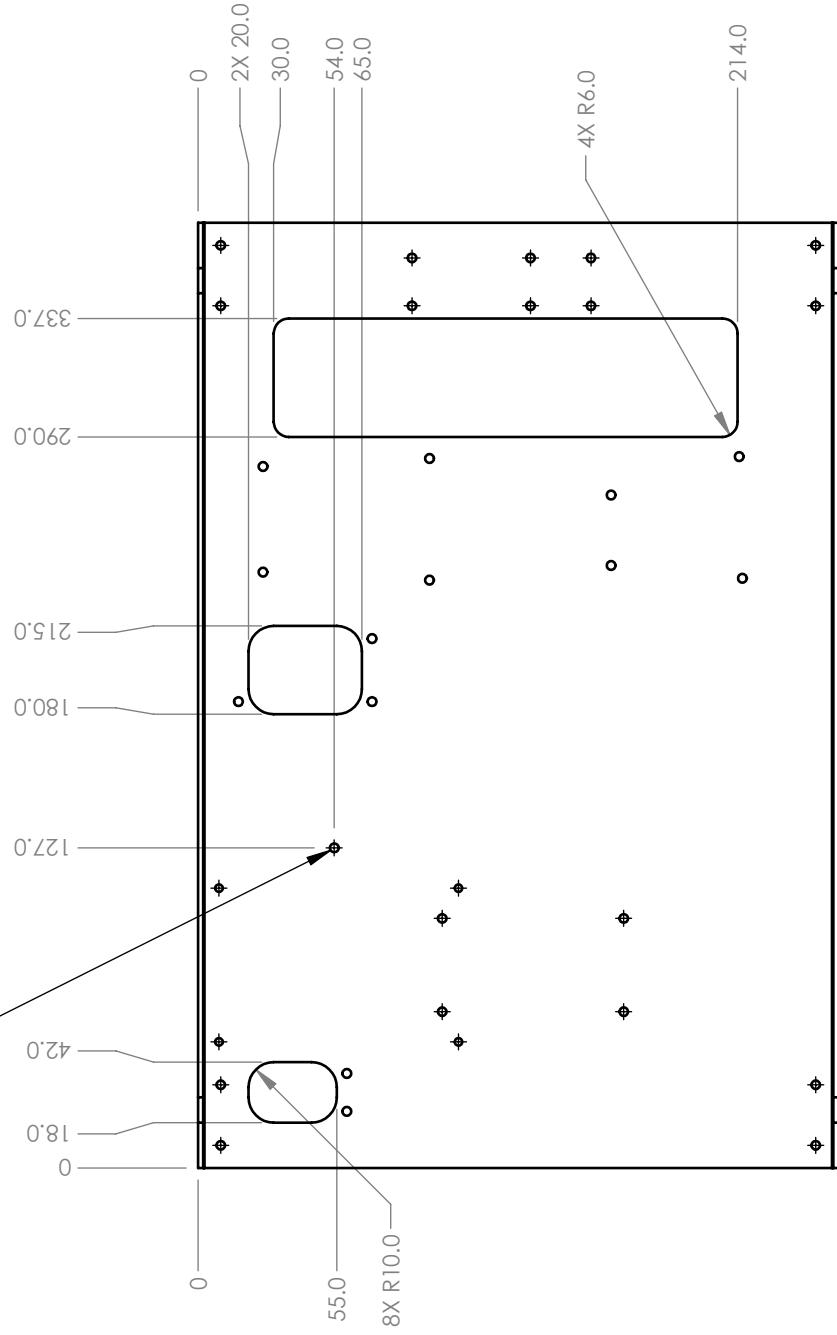
Left Plate, Mini

| | | | |
|-------|-----------|-------|----------------------|
| TITLE | PP-FP0055 | | |
| SIZE | DWG NO. | SCALE | SHEET |
| A | | 1:3 | DO NOT SCALE DRAWING |

REV.
B

2 OF 3

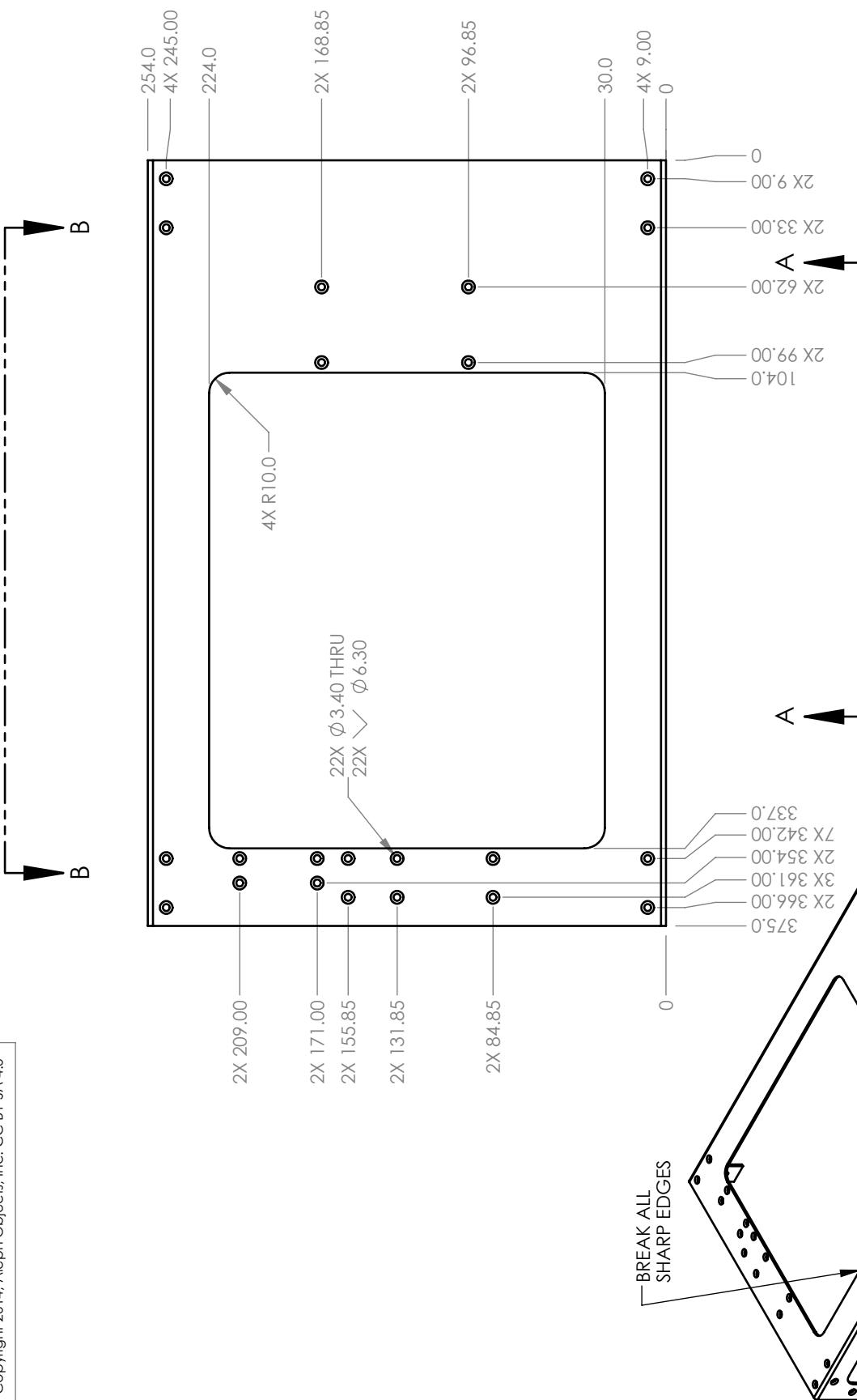
FH-M3-10ZI Insert
Install from this side



Left Plate, Mini

| TITLE | |
|-------|-----------|
| SIZE | DWG NO. |
| A | PP-FP0055 |

| REV. | B |
|----------------------|--------|
| SCALE | 1:3 |
| DO NOT SCALE DRAWING | SHEET |
| | 3 OF 3 |



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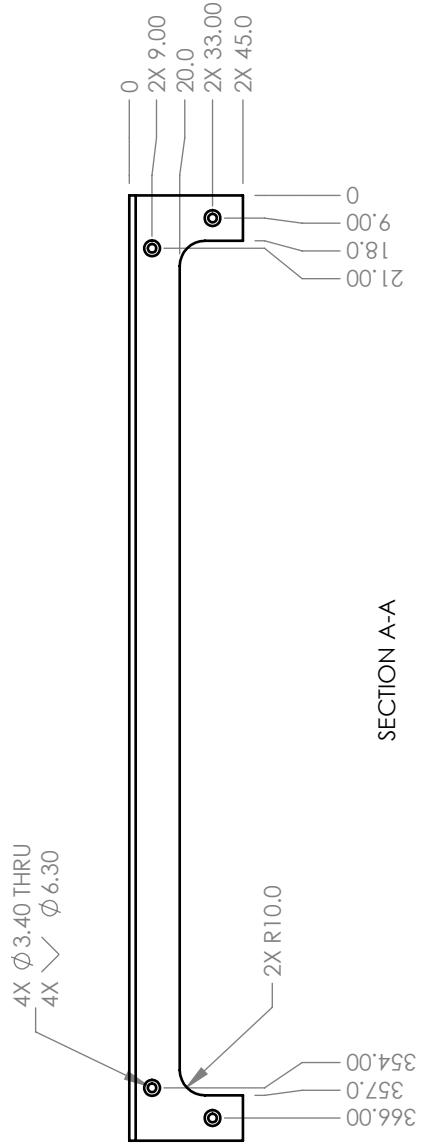
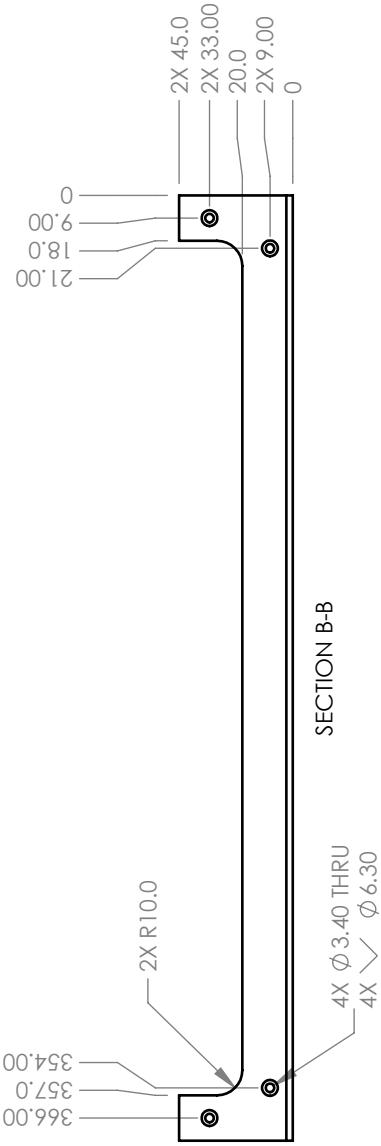


| | | | | | | | | | |
|--|-----------------|------------|-----------------|-------------|----|---------------|--|----------------|--|
| DRAWN BY SINNEMA | 7/18/14 | | | | | | | | |
| MATERIAL | See Notes | | | | | | | | |
| <p>UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MILLIMETERS.</p> <p>TOLERANCES ARE:</p> <p>DECIMALS</p> <table style="margin-left: auto; margin-right: auto;"> <tr><td>$.X\pm.75$</td><td style="text-align: right;">$X\pm1^{\circ}$</td></tr> <tr><td>$.XX\pm.25$</td><td style="text-align: right;">63</td></tr> <tr><td>$.XXX\pm.050$</td><td style="text-align: right;"></td></tr> <tr><td>$.XXXX\pm.050$</td><td></td></tr> </table> <p>BREAK EDGES .005/.020</p> <p>FILLET RADIUS .005/.020</p> | | $.X\pm.75$ | $X\pm1^{\circ}$ | $.XX\pm.25$ | 63 | $.XXX\pm.050$ | | $.XXXX\pm.050$ | |
| $.X\pm.75$ | $X\pm1^{\circ}$ | | | | | | | | |
| $.XX\pm.25$ | 63 | | | | | | | | |
| $.XXX\pm.050$ | | | | | | | | | |
| $.XXXX\pm.050$ | | | | | | | | | |

Right Plate, Mini

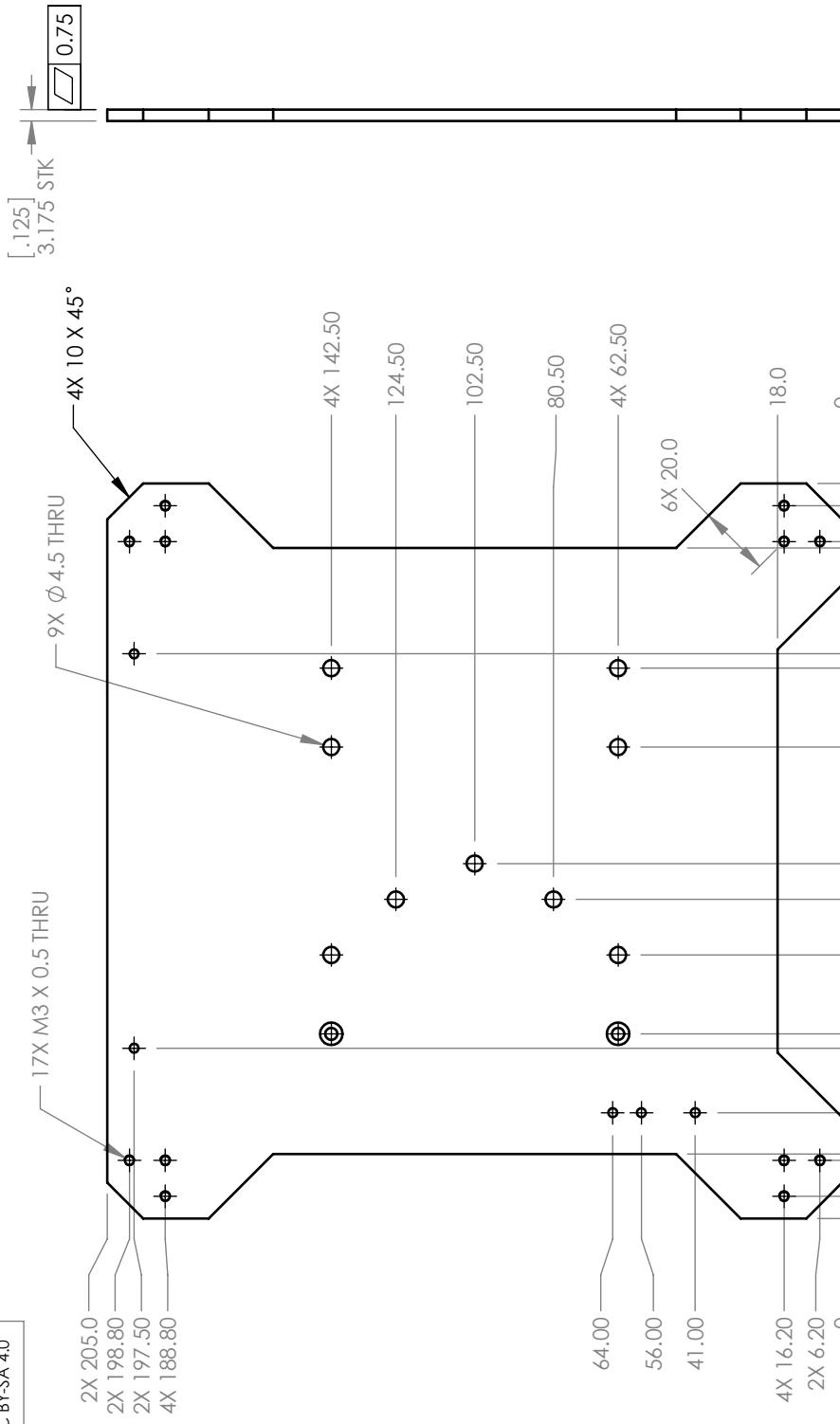
PP-FP0052 1 OF 2 SHEET A REV.

1. Material: Korn's Compilant 12AWG (.06") Aluminum
 2. Break all sharp edges prior to powder coat.
 3. Part is to be powder coated with Cardinal color C241-BK109. Mask all threads prior to coating.



Right Plate, Mini

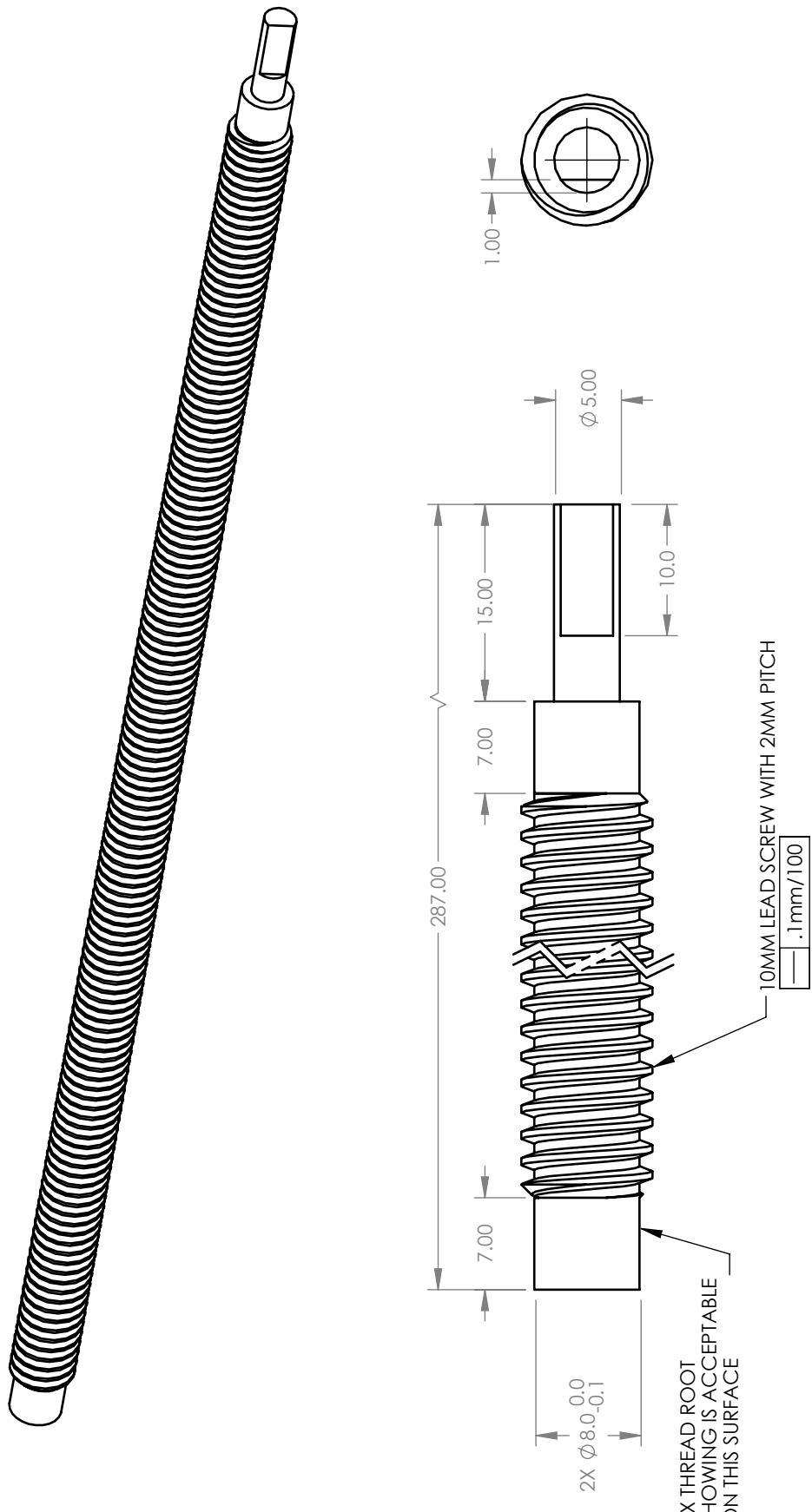
| TITLE | PP-FP0052 | | |
|-------|----------------------|-------|--------|
| SIZE | DWG NO. | SCALE | REV. |
| A | | 1:3 | A |
| | DO NOT SCALE DRAWING | SHEET | 2 OF 2 |



NOTES:

1. Parts must be RoHS compliant.
 2. Material: 5052 H-32 Aluminum
 3. Break all sharp edges.

| | | | |
|--|--|--|-----------------|
| DRAWN BY SINNEMA | 7/18/14 | Sinnema Design Services | |
| MATERIAL See Notes | | seth.sinnema@gmail.com Phone: (303) 250-8218 Fax: 1-267-393-7872 | |
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MILLIMETERS. TOLERANCES ARE: DECIMALS ANGLES | X±.75 X±.25 XXX±.125 .XXXX±.050 | TITLE Bed Mount Plate, Mini | |
| | X°±1° 63° | DWG NO. PP-FP0054 | SCALE A |
| | | DO NOT SCALE DRAWING | SHEET 1 OF 1 |
| | | REV. A | |
| | | BREAK EDGES .005/.020 FILLET RADIUS .005/.020 | |



| | | |
|---|------------------------|--|
| DRAWN BY SINNEMA | 9/1/14 | Sinnema Design Services |
| MATERIAL | Stainless Steel | seth.sinnema@gmail.com Phone: (303) 250-8218 Fax: 1-267-393-7872 |
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MILLIMETERS. TOLERANCES ARE: | | |
| DECIMALS | X [±] .75 | ANGLES |
| | XX [±] .25 | X [°] [±] 1° |
| | XXXX [±] .050 | 63° |
| | | BREAK EDGES .005/.020 |
| | | FILLET RADIUS .005/.020 |
| TITLE | Drive Rod 10mm | |
| SIZE | DWG NO. | |
| A | HD-RD0036 | |
| SCALE | 2:1 | DO NOT SCALE DRAWING |
| | | SHEET |
| | | 1 OF 1 |

3.4. BEGONIA RENDERS

3.4 Begonia Renders

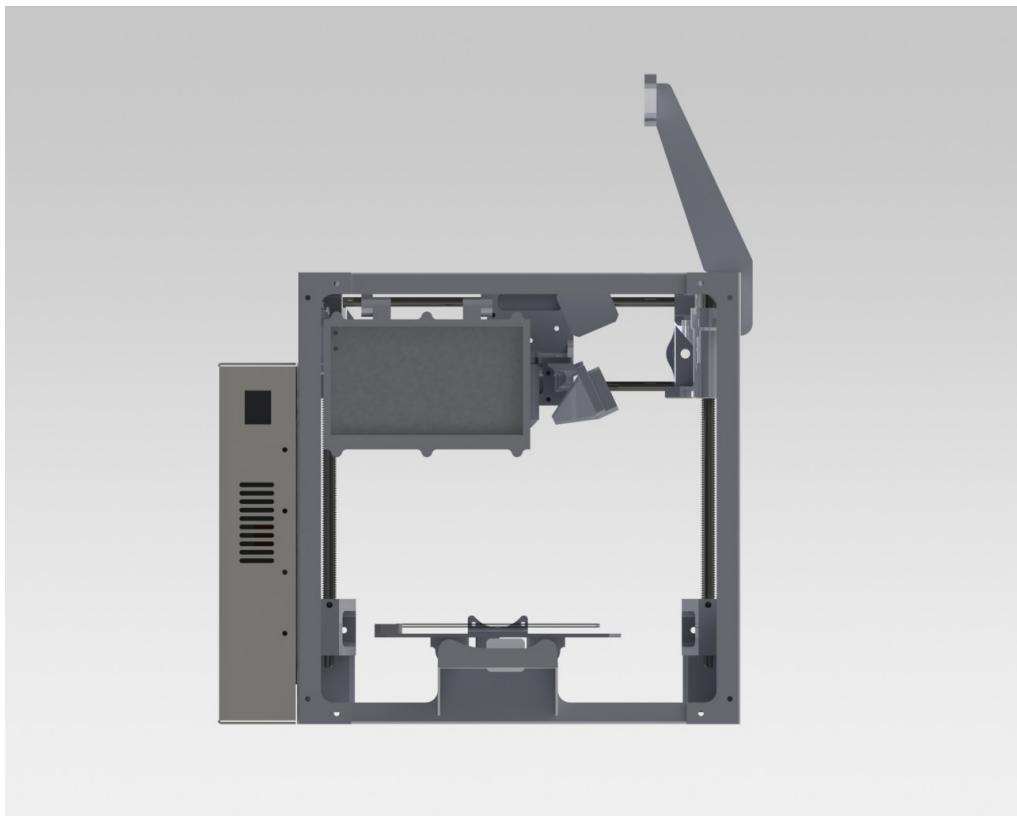


Figure 3.9: Begonia Front Render

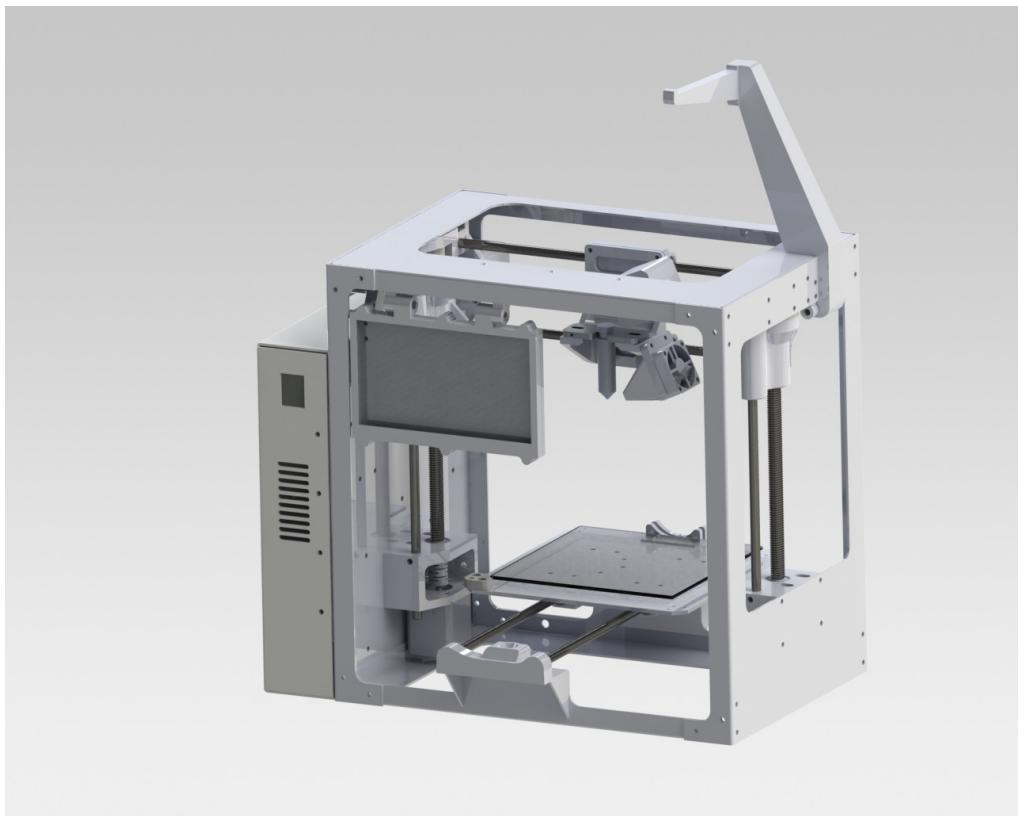


Figure 3.10: Begonia ISO Render

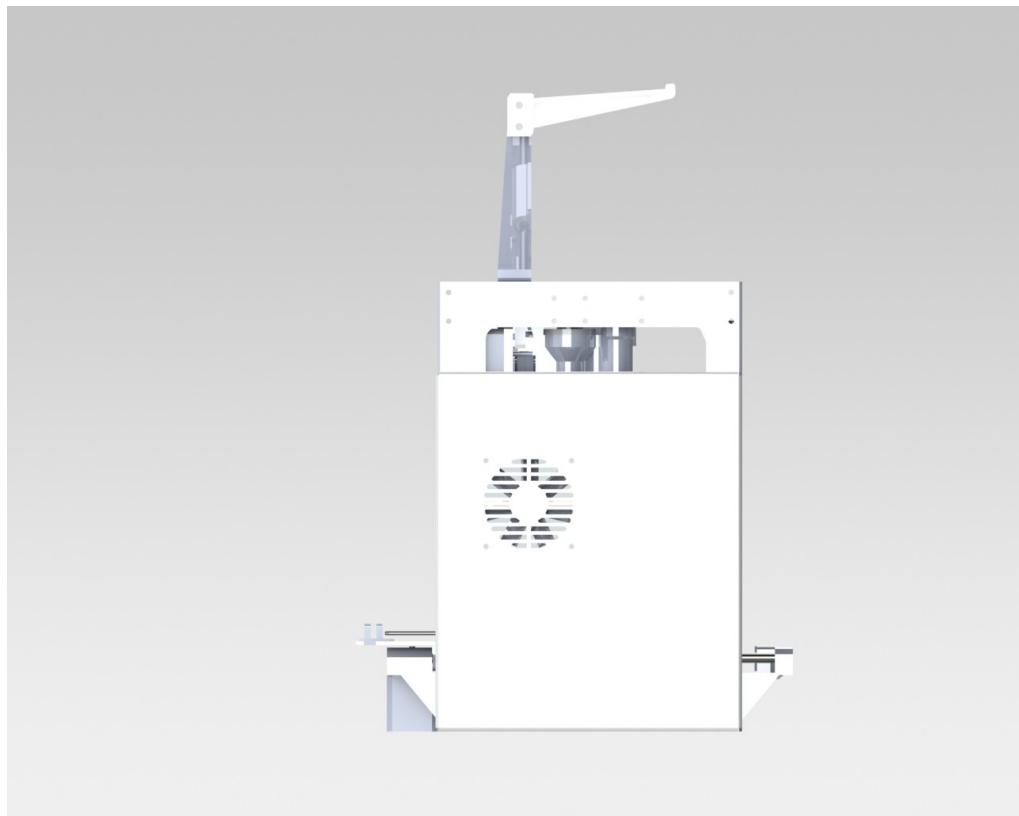


Figure 3.11: Begonia Left Render

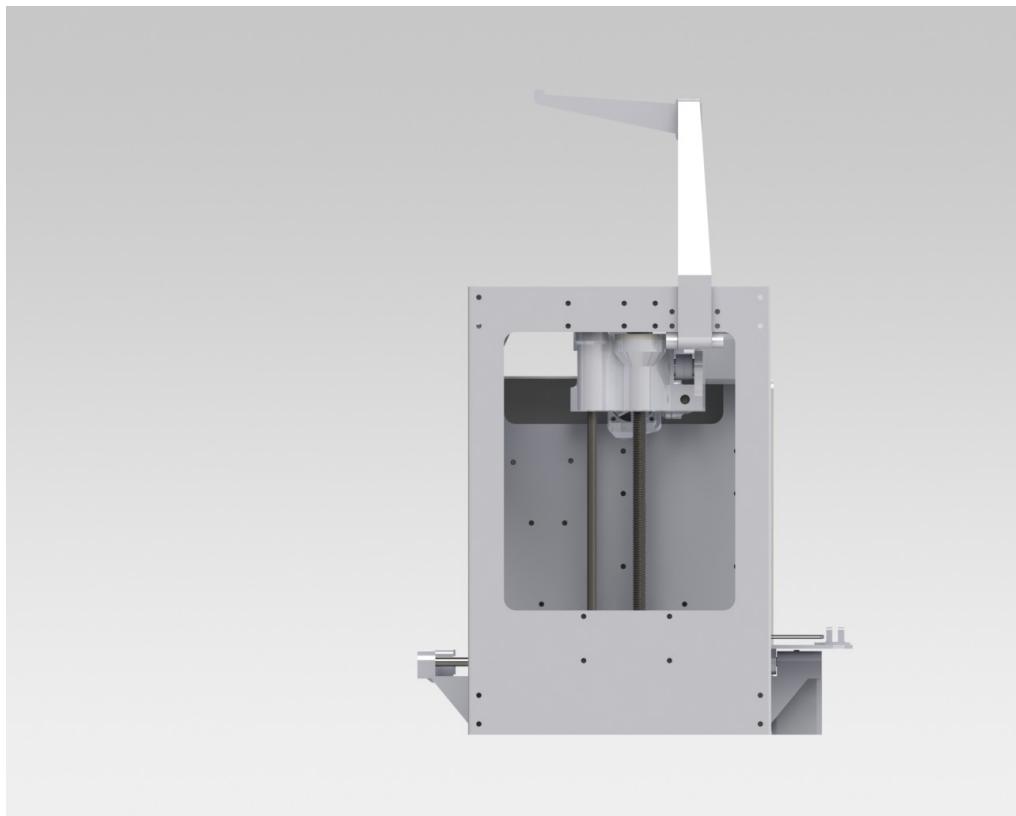


Figure 3.12: Begonia Right Render

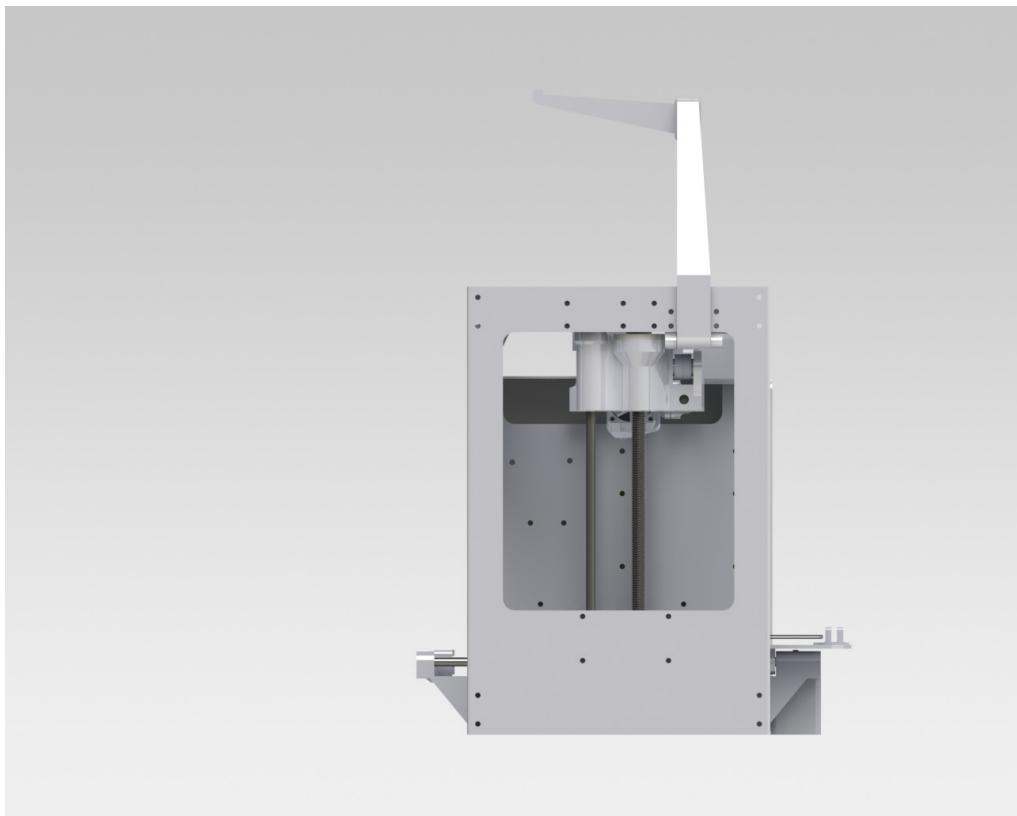


Figure 3.13: Begonia Right Render

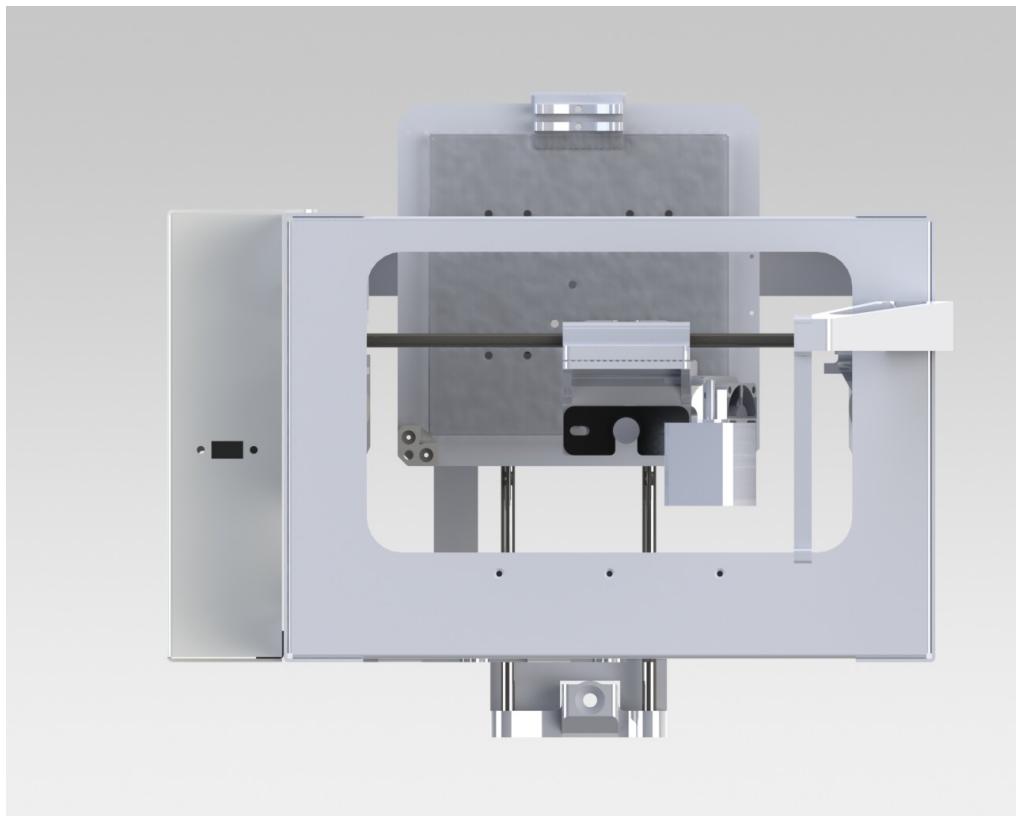


Figure 3.14: Begonia Top Render

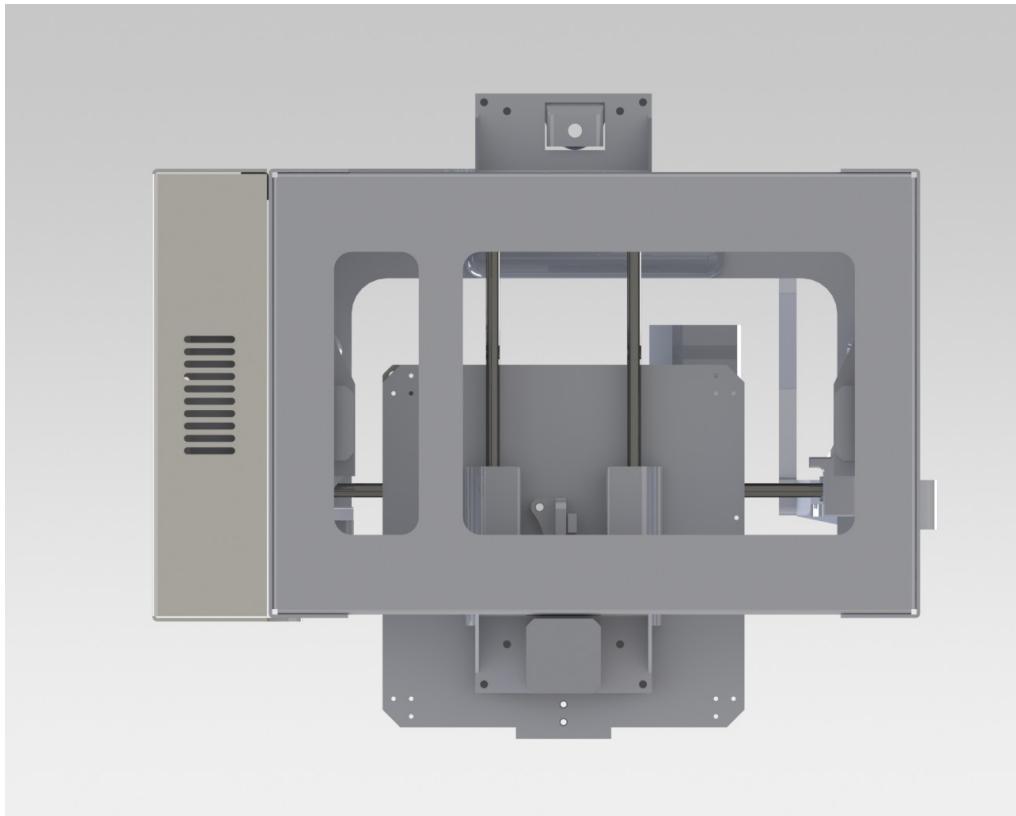


Figure 3.15: Begonia Bottom Render

3.5. BEGONIA 3D PRINTED PARTS

3.5 Begonia 3D Printed Parts

3.6 Begonia Bed

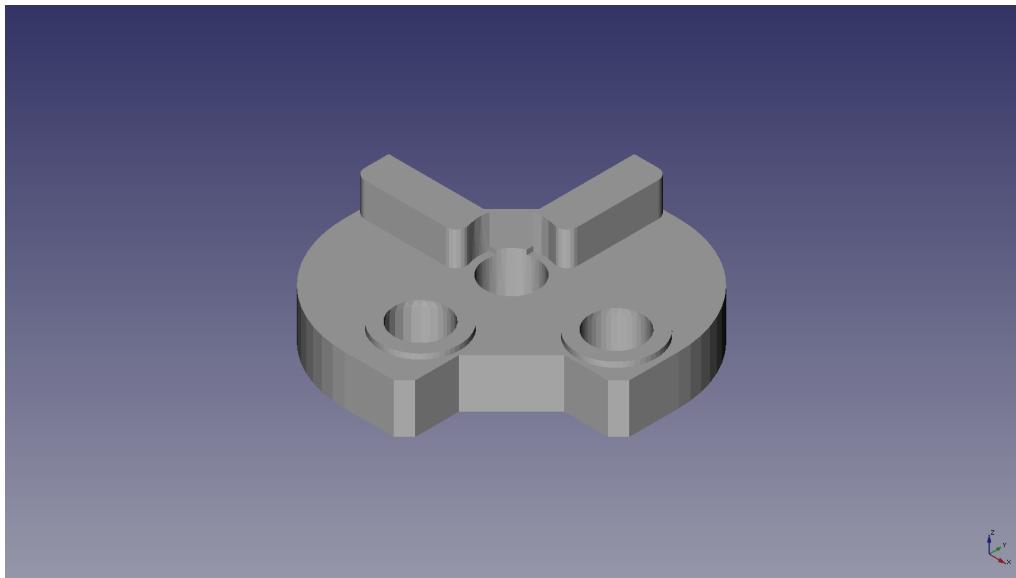


Figure 3.16: Begonia 3D Printed Bed Corner Render

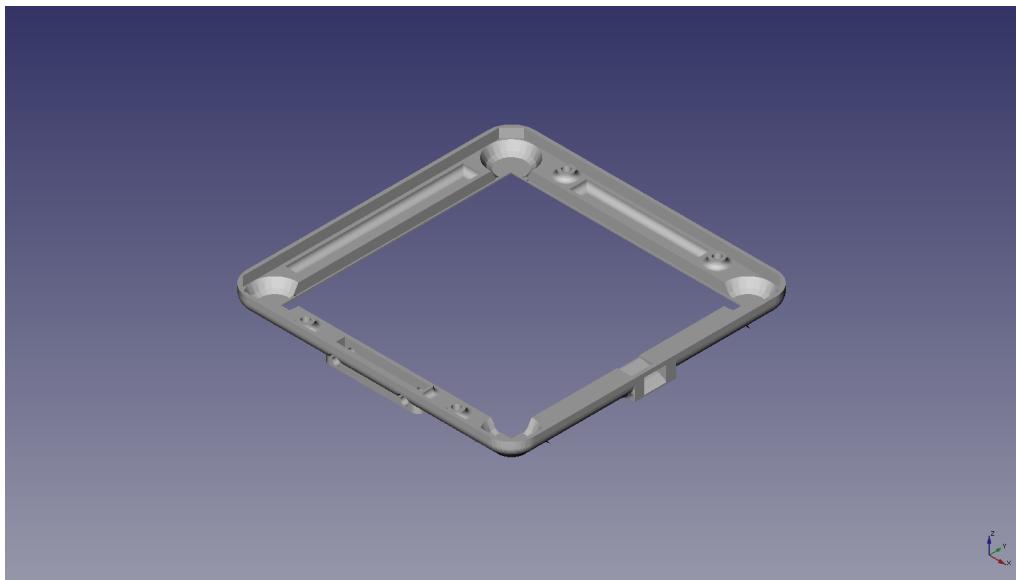


Figure 3.17: Begonia 3D Printed Bed Cover Render

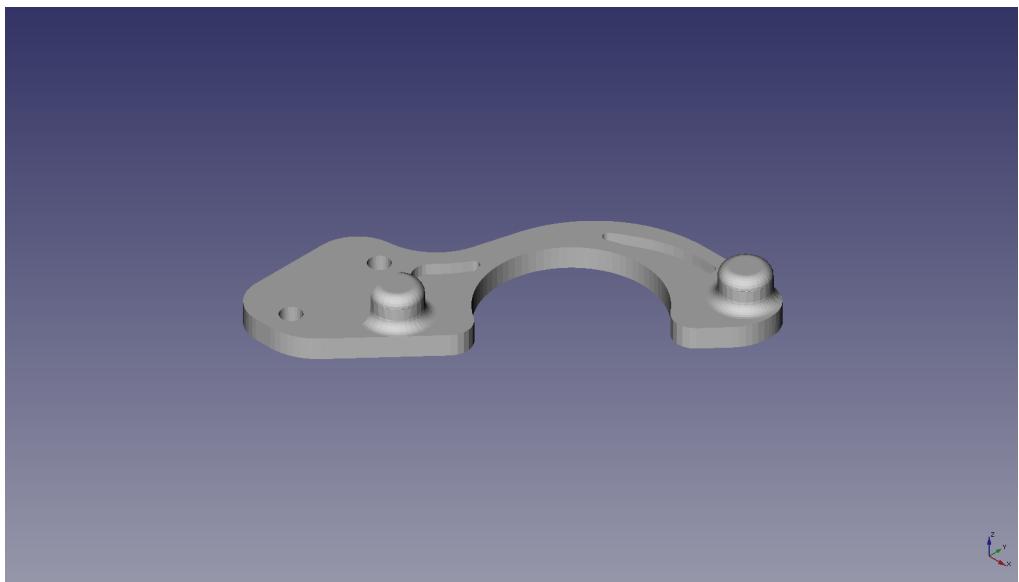


Figure 3.18: Begonia 3D Printed Bed Fan Mount Render

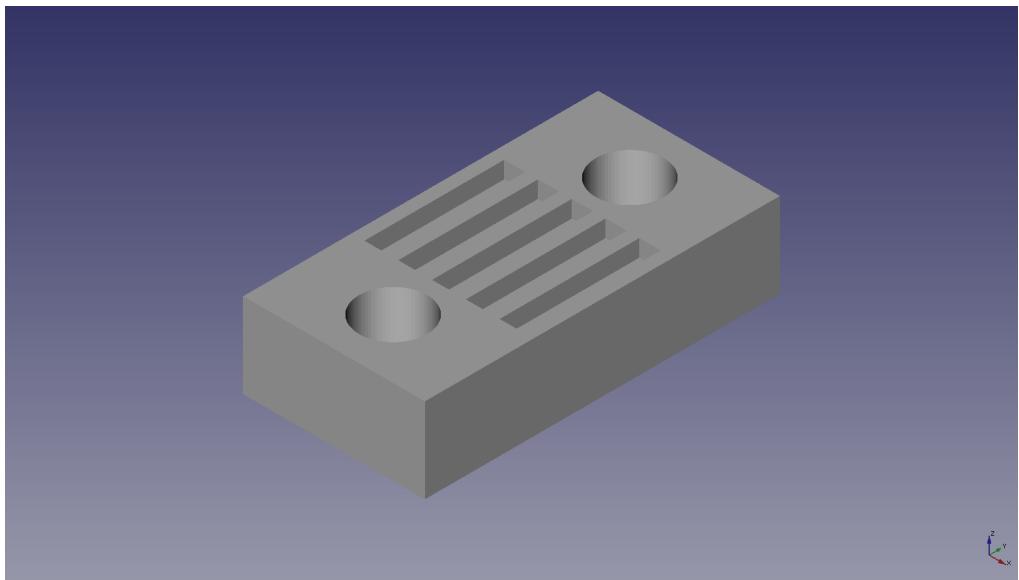


Figure 3.19: Begonia 3D Printed Belt Clamp Render

3.7 Begonia Extruder

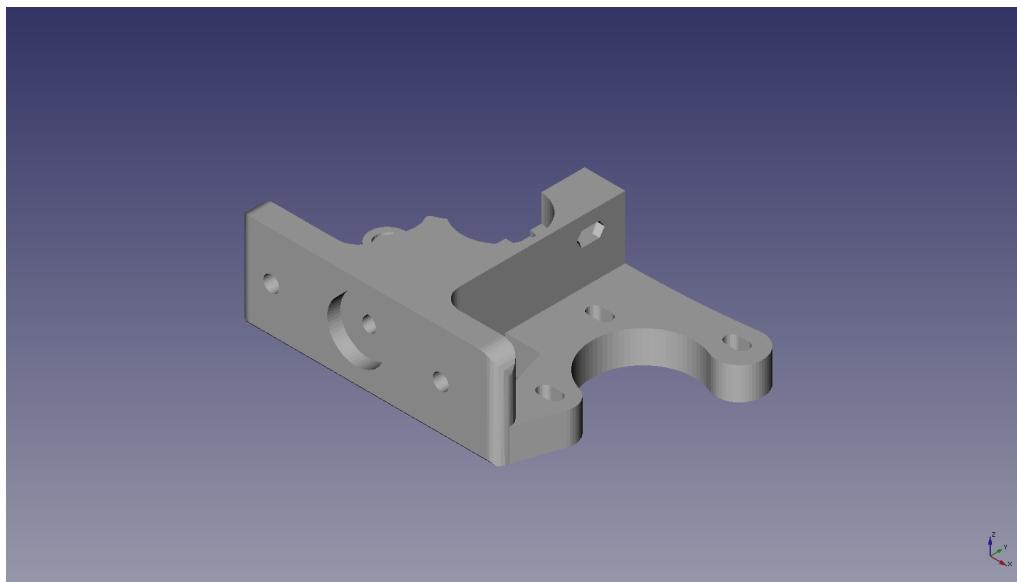


Figure 3.20: Begonia 3D Printed Extruder Body Hex Render

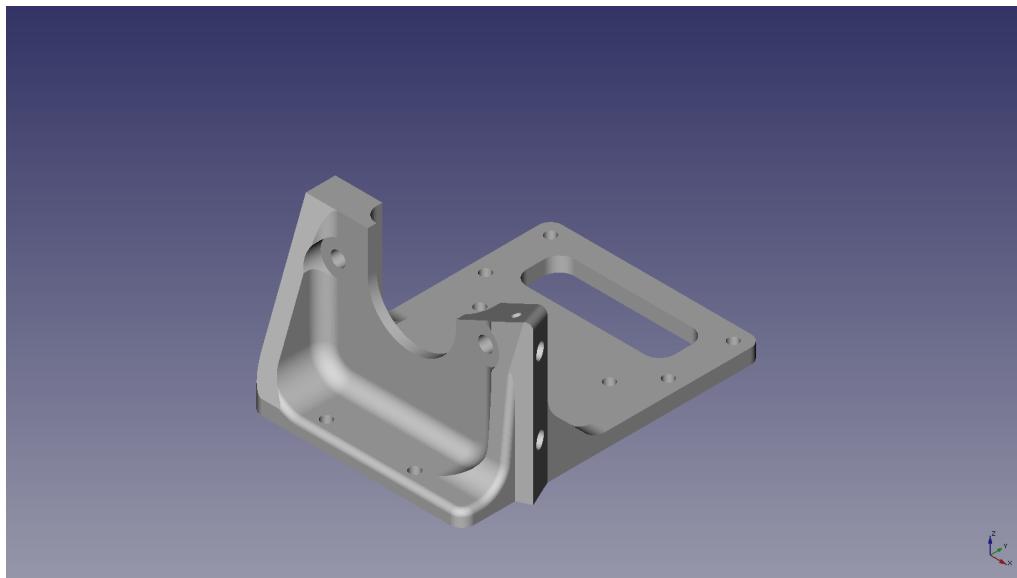


Figure 3.21: Begonia 3D Printed Extruder Mount Render

3.8 Begonia LCD

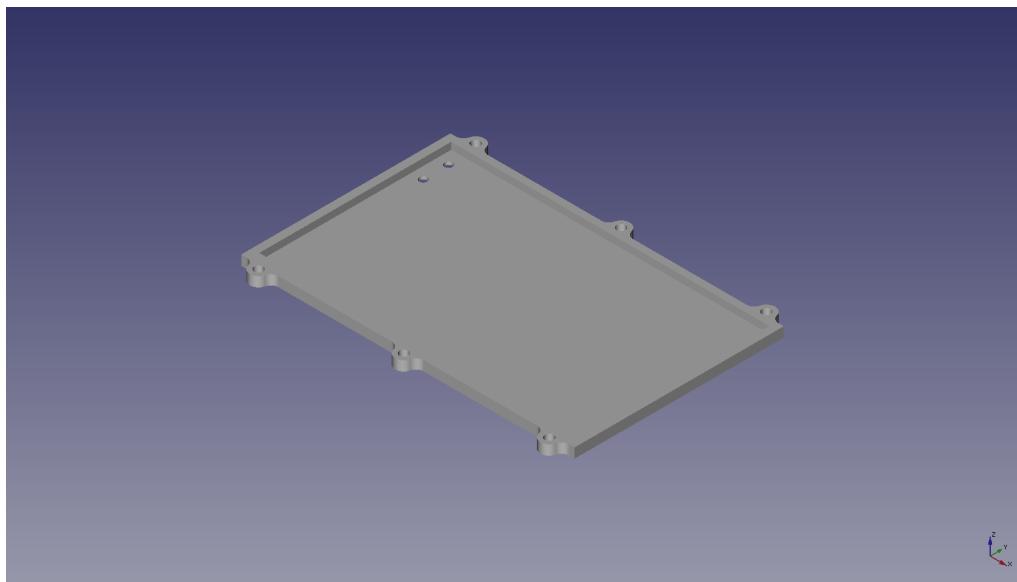


Figure 3.22: Begonia 3D Printed LCD Back Cover Render

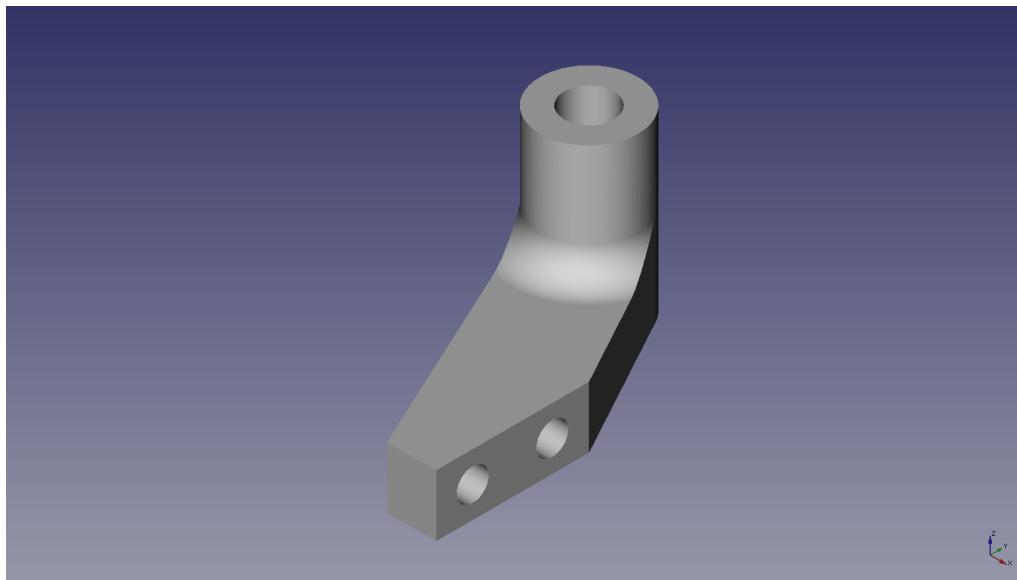


Figure 3.23: Begonia 3D Printed LCD Catch Render

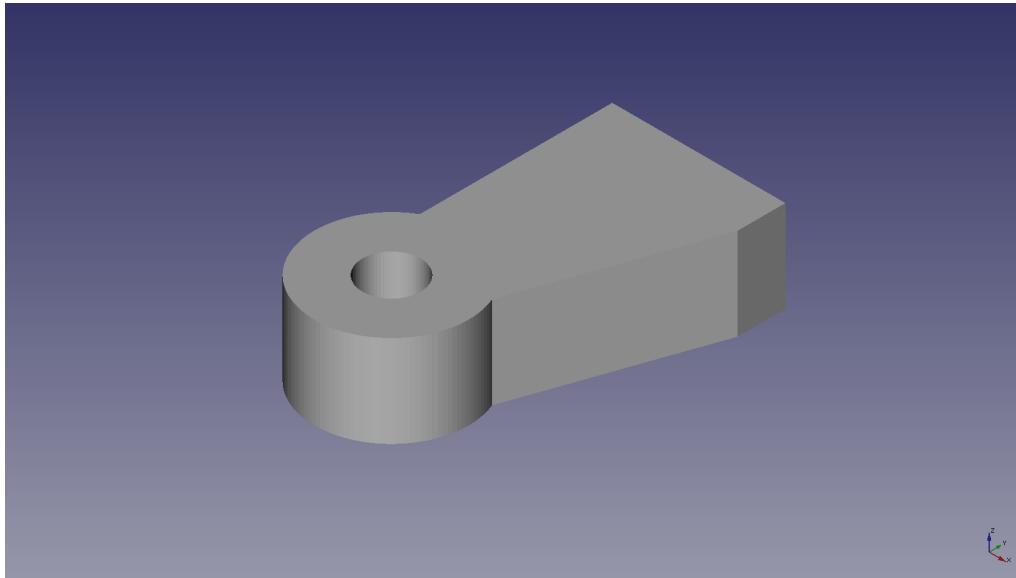


Figure 3.24: Begonia 3D Printed LCD Hinge Render

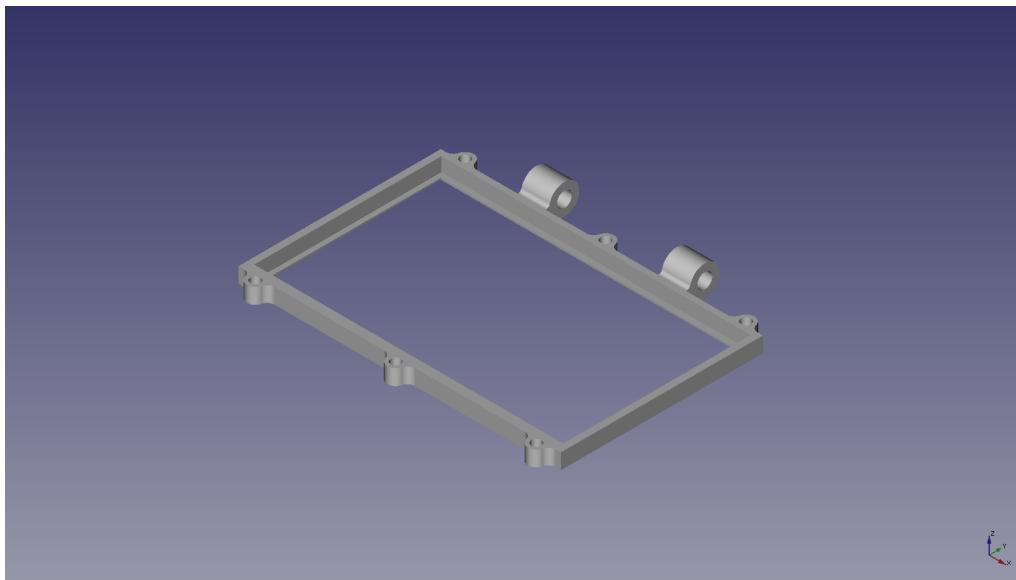


Figure 3.25: Begonia 3D Printed LCD Mount Render

3.9 Begonia Spool

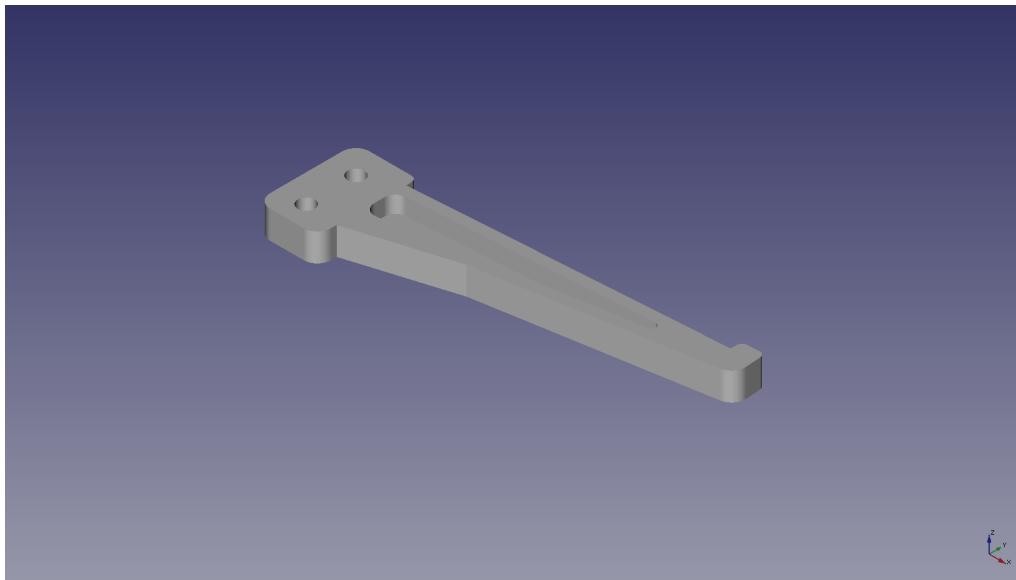


Figure 3.26: Begonia 3D Printed Spool Arm Render

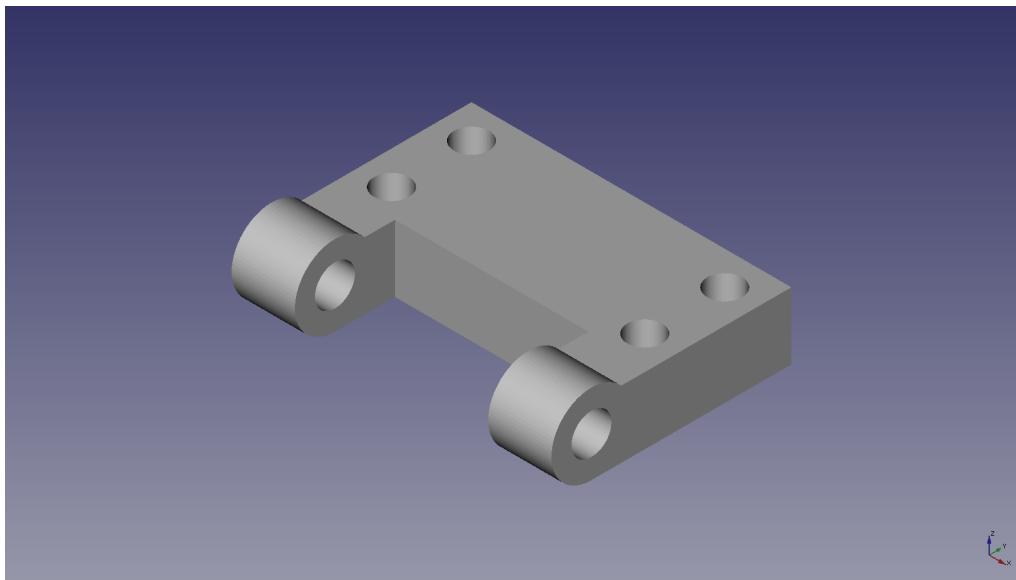


Figure 3.27: Begonia 3D Printed Spool Hinge Render

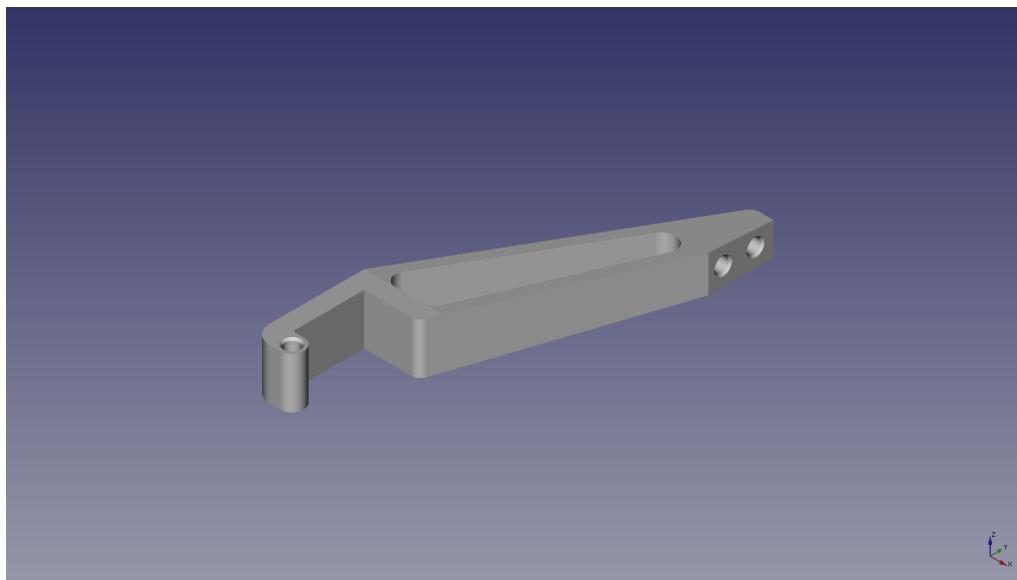


Figure 3.28: Begonia 3D Printed Spool Mount Render

3.10 Begonia X

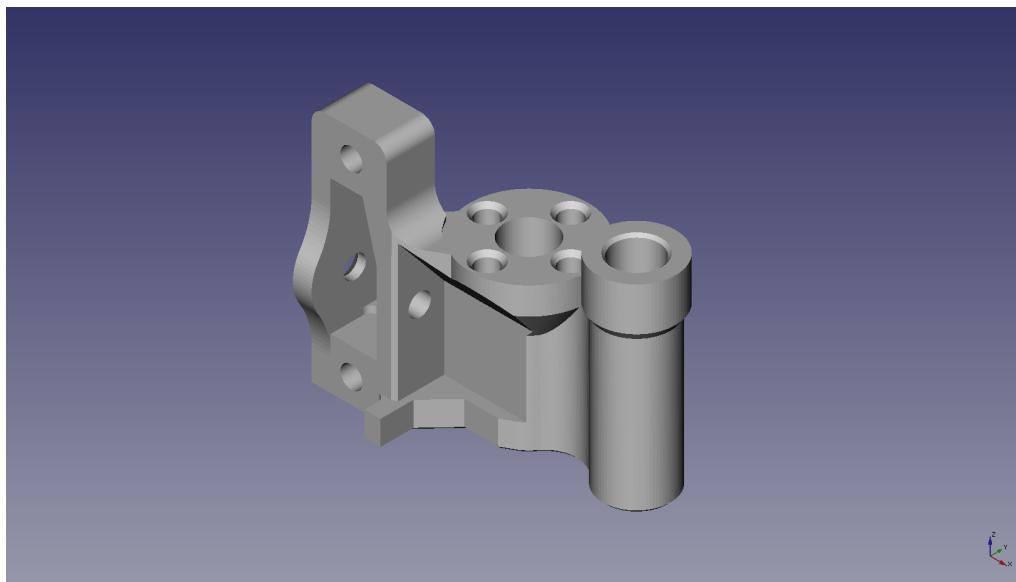


Figure 3.29: Begonia 3D Printed X End Idler Render

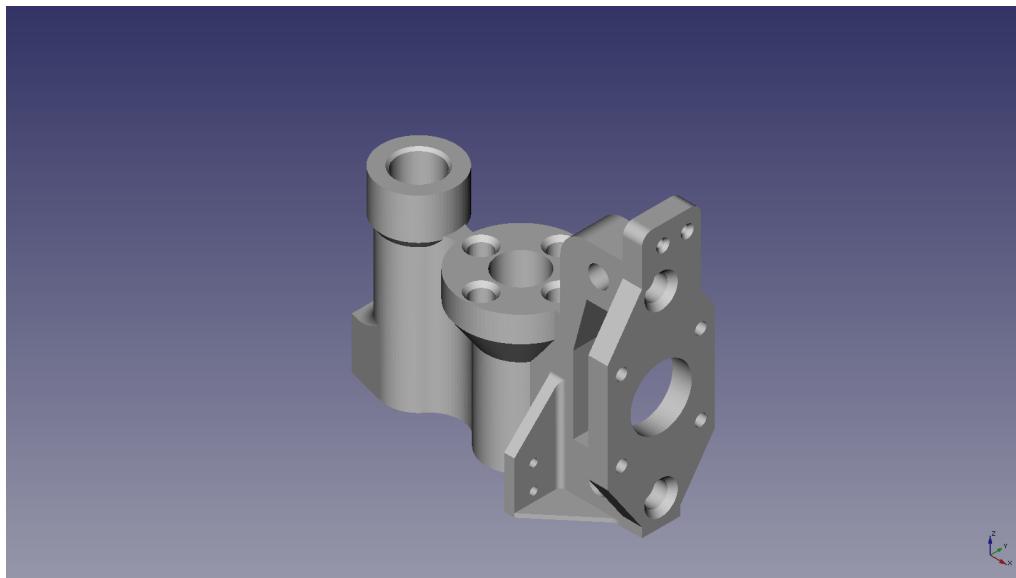


Figure 3.30: Begonia 3D Printed X End Motor Render

3.11 Begonia Y

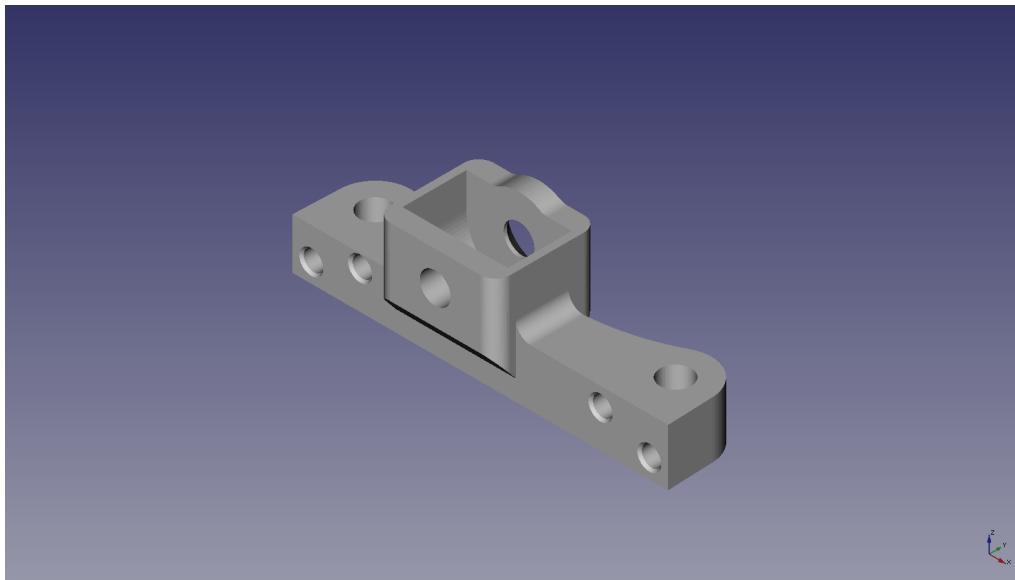


Figure 3.31: Begonia 3D Printed Y End Idler Render

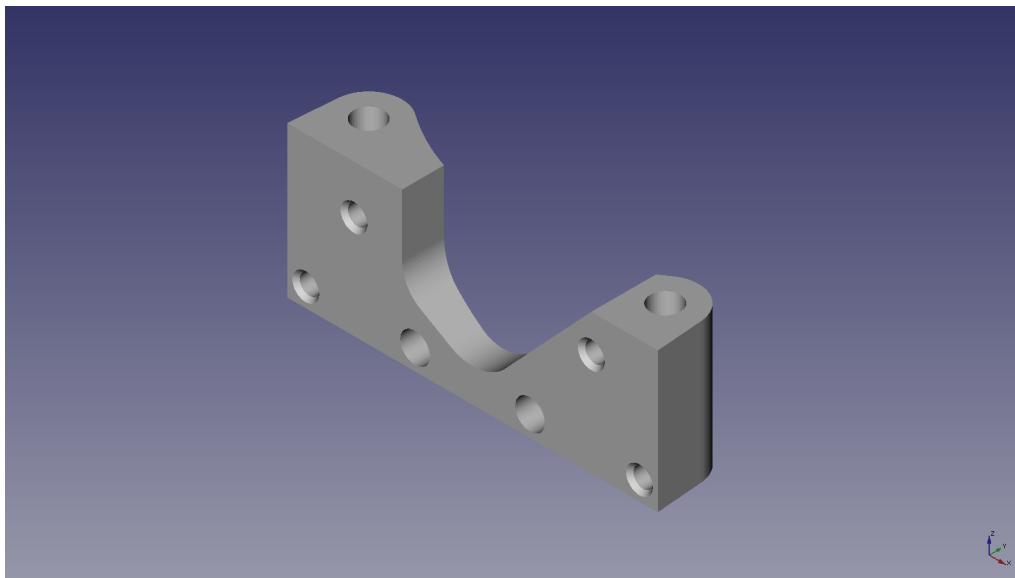


Figure 3.32: Begonia 3D Printed Y Rod Mount Render

3.12 Begonia Z

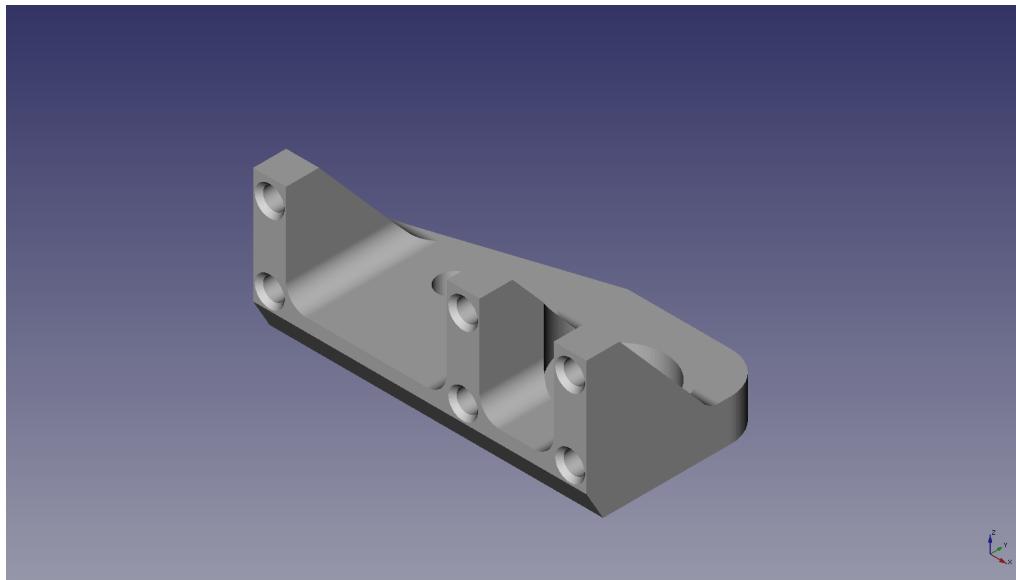


Figure 3.33: Begonia 3D Printed Upper Z Left Render

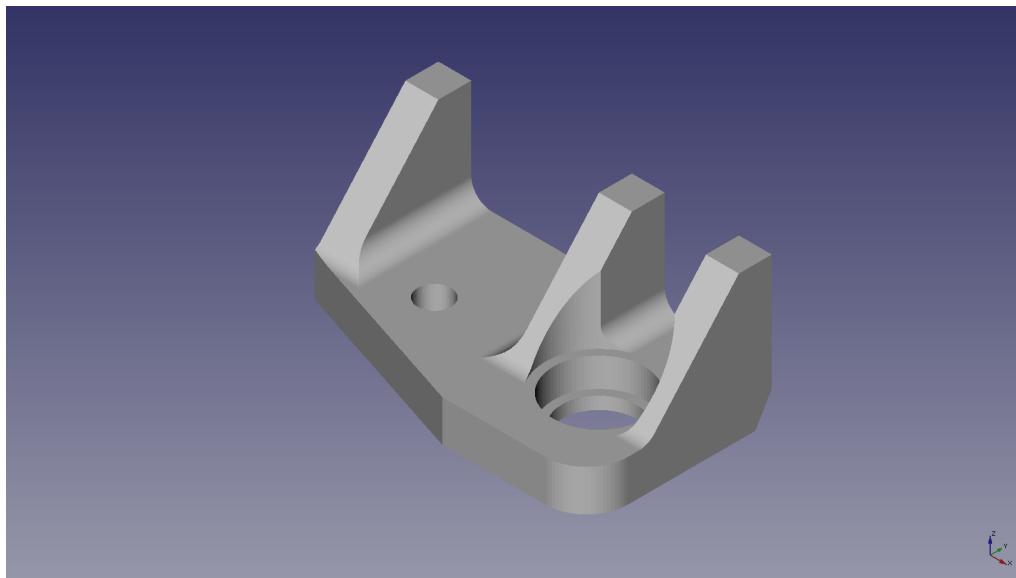


Figure 3.34: Begonia 3D Printed Upper Z Right Render

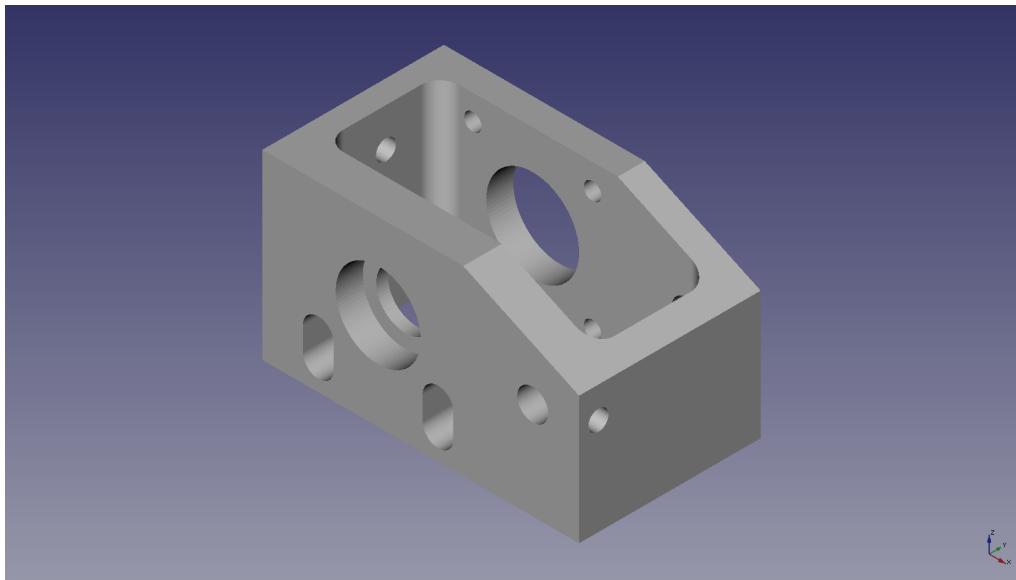


Figure 3.35: Begonia 3D Printed Lower Z Left Render

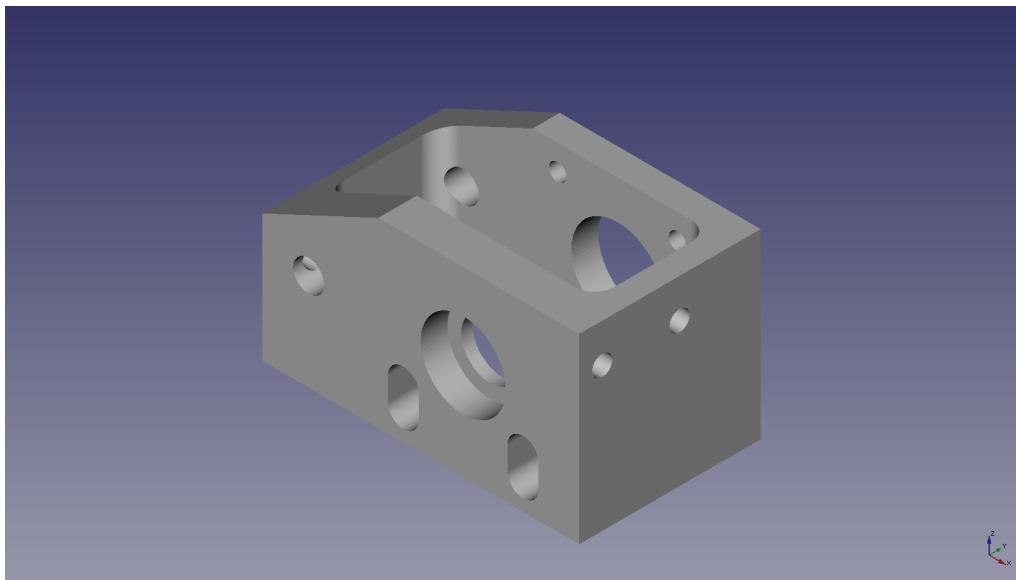


Figure 3.36: Begonia 3D Printed Lower Z Right Render

3.13 Begonia Misc

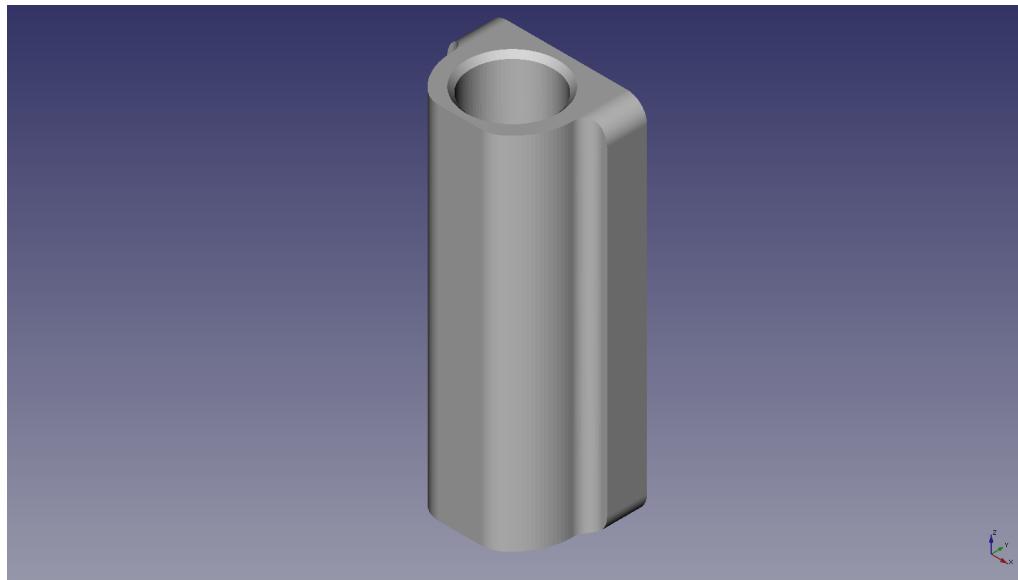


Figure 3.37: Begonia 3D Printed Double Bearing Holder Render

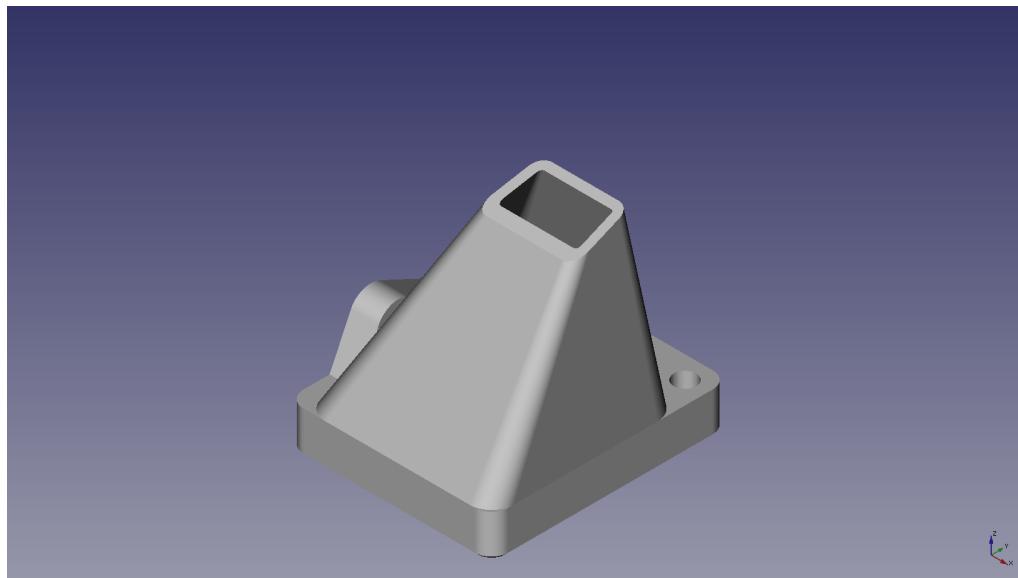


Figure 3.38: Begonia 3D Printed Fan Mount Render

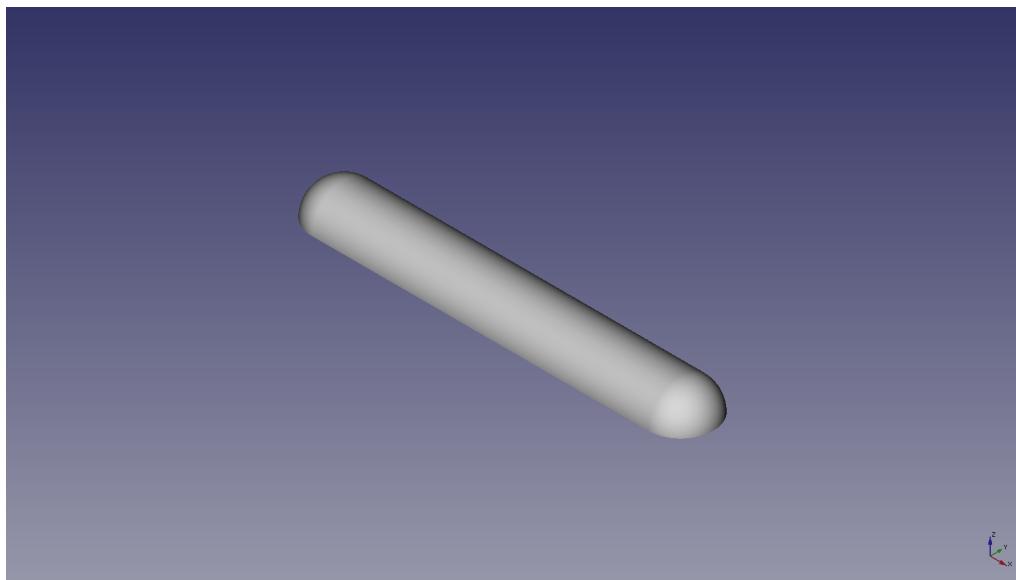


Figure 3.39: Begonia 3D Printed Handle Bar Render

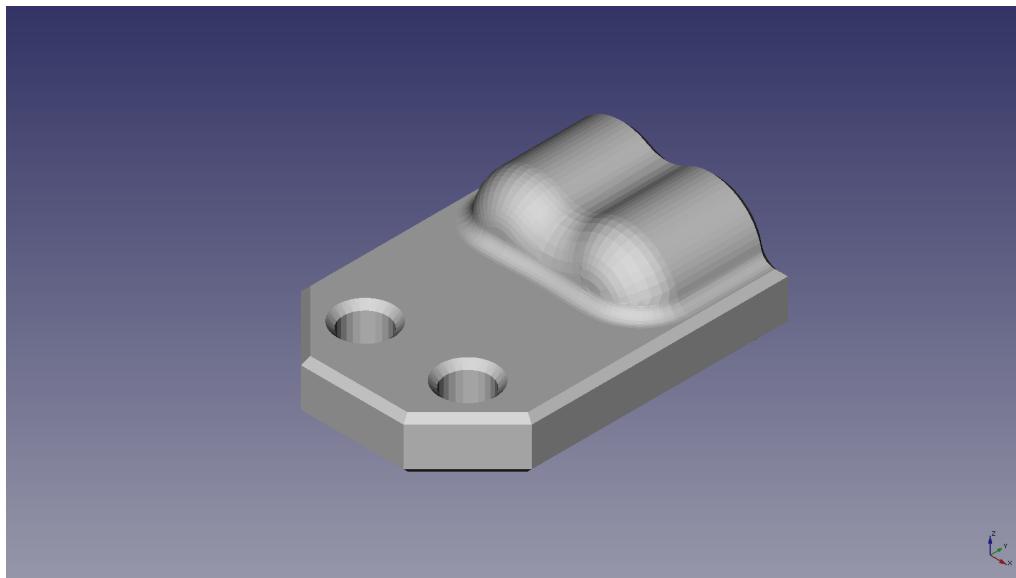


Figure 3.40: Begonia 3D Printed Cable Carrier Mount Render

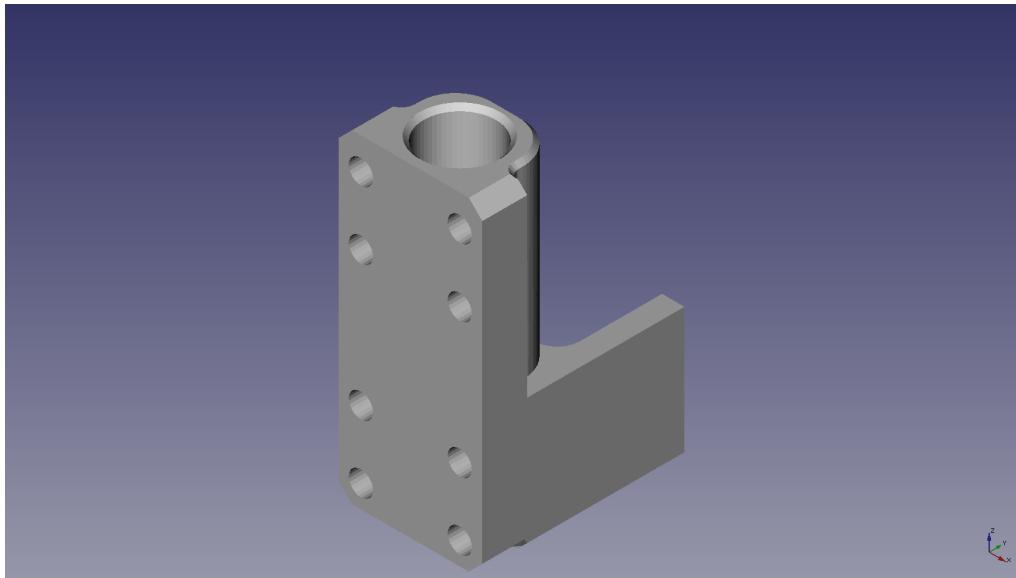


Figure 3.41: Begonia 3D Printed Extruder Mt Top Double Bearing Holder Render

3.14. BEGONIA DRAWINGS

3.14 Begonia Drawings

3.15 Camillia Drawings

Electrical

Power Supply, wiring

4.1 Electrical Layout

4.2 Wire Harness List

Camellia Wire List - V1.0

| Harness | Program # | Type | Length | Strip Left | Strip Right | Quantity | Notes |
|----------------------|-----------|--------------------|--------|--|--|----------|---|
| X/Extruder Harness | | Blue 24 AWG | 500 | 6 | 4 | 1 | upped from 460 for better reach |
| | | Black 24 AWG | 500 | 6 | 4 | 1 | upped from 460 for better reach |
| | | Grey 4 cond | 500 | 50 | 30 | 1 | upped from 470 for better reach |
| | | Green 24 AWG | 550 | 6 | 4 | 1 | upped from 520 |
| | | Black 24 AWG | 550 | 6 | 4 | 1 | upped from 520 |
| | | Orange 24 AWG | 650 | 6 | 4 | 1 | upped from 620 |
| | | Black 24 AWG | 650 | 6 | 4 | 1 | upped from 620 |
| | | Grey 4 cond | 1080 | 50 | 30 | 1 | |
| | | Red 24 AWG | 1100 | 6 | 4 | 2 | |
| | | Orange 24 AWG | 1100 | 4 | 4 | 2 | |
| | | Yellow 24 AWG | 1100 | 4 | 4 | 1 | |
| | | Black 24 AWG | 1100 | 4 | 4 | 1 | |
| | | White 24 AWG | 1100 | 4 | 4 | 1 | |
| | | Black 24 AWG | 1100 | 4 | 4 | 1 | |
| | | Purple 24 AWG | 1100 | 4 | 4 | 1 | |
| | | Black 24 AWG | 1100 | 4 | 4 | 1 | |
| | | Red 24 AWG | 1125 | 4 | 4 | 1 | upped from 1100 |
| Bed Harness | | Black 24 AWG | 525 | 6 | 4 | 3 | |
| | | Red 24 AWG | 525 | 6 | 4 | 1 | |
| | | Yellow 24 AWG | 500 | 4 | 4 | 2 | upped from 495 |
| | | Black 24 AWG | 500 | 4 | 4 | 1 | upped from 490 |
| | | Purple 16 AWG | 550 | 6 | 6 | 2 | upped from 525 |
| Hexagon Hotend wires | | Cartridge wires | 180 | 4 | 4 | 2 | |
| | | Thermistor wires | 180 | 4 | 4 | 2 | |
| | | 5V nozzle lead | 200 | 4 | 4 | 1 | |
| X-max switch | | Purple 24 AWG | 160 | 6 | 4 | 1 | |
| | | Black 24 AWG | 160 | 6 | 4 | 1 | |
| Fans | | Mini 5V blower | 180 | blower attached | 4 | 2 | |
| | | 40mm extrusion fan | 120 | fan attached | 4 | 2 | |
| | | Case fan | 160 | fan attached | 4 | 2 | |
| Motors | | Z-left motor | 220 | motor | 4 | 4 | 200mm small shielding, 30mm large shielding |
| | | Ext motor | 200 | motor | 4 | 4 | 70mm small shielding |
| | | X motor | 120 | motor | 4 | 4 | 105mm small shielding, 30mm large shielding |
| | | Z-right, Ymotor | 60 | motor | 4 | 8 | 45 small shielding, 35 large shielding |
| Motor Extensions | | | | | | | |
| Z-right motor | | Grey 4 cond | 500 | Trim shielding 20mm, all wires 4mm | Trim shielding 55 with lug, all wires 4mm | 1 | 390 conduit wrap |
| Y-motor | | Grey 4 cond | 410 | Trim shielding 20mm, all wires 4mm | Trim shielding 55 with lug, all wires 4mm | 1 | 305 conduit wrap |
| Power Box | | | | | | | |
| | | Red 16 AWG | 200 | 6 | 6 | 2 | PS to rambo |
| | | Black 16 AWG | 200 | 6 | 6 | 2 | PS to rambo |
| | | Green 16 AWG | 80 | 6 | 4 | 1 | Ground plug to post |
| | | Green 16 AWG | 50 | 6 | 4 | 1 | Post to PS ground |
| | | Black 16 AWG | 320 | 6 | 6 | 1 | Plug to switch |
| | | White 16 AWG | 320 | 6 | 6 | 1 | Plug to switch |
| | | Black 16 AWG | 250 | 6 | 6 | 1 | Switch to PS |
| | | White 16 AWG | 250 | 6 | 6 | 1 | Switch to PS |

3D Printer Controller

Mini-RAMBo

5.1 Intro

The printer controller will be the RAMBo-Mini.

Quality Assurance

Quality Assurance

6.1 Quality Assurance



QUALITY ASSURANCE RECORD

Model: LulzBot Mini 1.0 3D Printer

Page 1 of 3

Serial Number: _____

Date Completed: _____

Tested by: _____

Configuration:

Electronics: Mini-RAMBo 1.0a

Firmware: Marlin for Mini 2014-Q4

Nozzle: 0.5mm diameter nozzle

Settings: _____

| Stepper Motor | Steps/mm | Max Length | Microstep Mode | Digipot |
|---------------|----------|------------|----------------|---------|
| X | 100.5 | 155 | 16 | 175 |
| Y | 100.5 | 155 | 16 | 175 |
| Z | 1600 | 155 | 16 | 220 |
| E0 | 833 | NA | 16 | 135 |

General:

- Are all the screws and zip ties tight?
- Are the current version of parts being used?
- Is the Spool Mount properly mounted so it flips up and sits securely?
- Is the Finger Clip properly mounted with the taller side on the left?
- Are the switches tight? They shouldn't wiggle side to side.
- Are all 4 rubber feet installed?
- Is the PEI tape free of bubbles and wrinkles?
- Is the heat bed adhesive smooth and consistent with no finger prints?

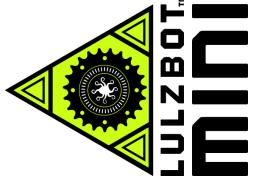
Y Axis:

- Does the Y bed move freely back and forth?
- Is the belt mounted in the correct orientation?
- Is the Y bed tight side to side from motion and twisting?
- Are all the screws on the bearing holders tight?
- Does the Y belt rub the bottom of the y-idler by the bearings?
- Is the Y pulley tight?
- Is one of the set screws on the Y pulley aligned with the flat on the motor shaft?
- Are both pulley set screws tightened?
- Is the level of the Y pulley at the same height as where the belt mounts on the belt holder?
- Is the Y belt tight?
- Are the four bed leveling washers tight?
- Are the belts trimmed far enough to not interfere with the pulley or bearing?



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QUALITY ASSURANCE RECORD

X Axis:

- Is the X pulley tight?
- Is one of the set screws on the X pulley aligned with the flat on the motor shaft?
- Are both pulley set screws tightened?
- Is the belt mounted in the correct orientation?
- Is the belt free from rubbing anywhere during motion?
- Is the X belt tight?
- Does the X axis move freely end to end?
- Are the X bars flush with the right side?
- Are the set screws that hold the X bars tight?
- Are the belts trimmed far enough to not interfere with the pulley or bearing?

Z Axis:

- Do the Z drive rods rotate smoothly with no up and down movement between the bearings?
- Are the set screws that hold the Z bars tight?
- Are the coupler set screws tight?
- Are the drive rods and motor shafts aligned so the couplers are not bent?

Extruder:

- Can you adjust the extruder springs?
- Are the V grooves on the extruder gears lined up?
- Is the extruder mount secure on the X carriage?
- Is the extrusion fan mounted correctly?
- Is the extruder blower mounted correctly?
- Does the idler bearing stick out of the idler block?
- Is the hobbing aligned to the hole in the extruder?
- Is the set screw in the small gear tight and on the flat of the motor shaft?
- Can you feed filament about 100mm from the top of the extruder?
- Are the gears tight with no back-lash?
- Do the extruder gears turn smoothly for several rotations?

Electronics:

- Are all connections to the Mini-Rambo plugged in correctly?
- Can you plug in USB cable from the outside of the enclosure?
- Is the case fan plugged in?
- Are all cables free from contacting any moving parts?



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QUALITY ASSURANCE RECORD

Test and Verification Results:

- Verify case fan is running.
- Verify extruder blower is running.
- Verify control of the extrusion fan.
- Nozzle temperature control verified.
- Nozzle re-tightened during first heat cycle.
- Extruder control verified.
- X, Y, and Z min and max stop switches verified.
- X and Y homing are making contact with bed leveling washer.
- Bed leveling is functioning properly.
- Bed temperature control verified.
- Bearing conditioning complete.
- X, Y, and Z motion smooth over full range and speeds.
- Test print (Rocktopus*) successful.
- Print head moved to shipping position.

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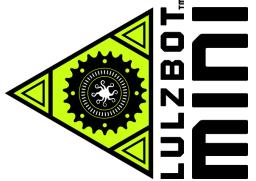
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Packing

If It Shakes It Breaks

7.1 Packing List

Pack it well.



PACKING LIST

Page 1 of 1

Model: LulzBot Mini 1.0 3D Printer

Serial Number: _____
Date Completed: _____
Completed by: _____

Items to include:

Printer and Cables:

- LulzBot Mini 1.0 3D printer
- 6ft 18AWG Power Cord Cable (5279)
- 6ft 18AWG England Power Cord Cable (7691) (If applicable)
- 6ft 18AWG European Power Cord Cable (7692) (If applicable)
- USB cable

Supplies:

- USB drive with source files
- 3 meter sample of LulzBot HIPS 3D printer filament
- Dental pick
- Brush
- Clam knife
- 5x replacement wiping pads

Final Print:

- Rocktopus* printed by this LulzBot Mini 3D Printer

Documentation:

- Quick Start Guide
- Quality Assurance Record document
- Packing List document

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Colophon

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