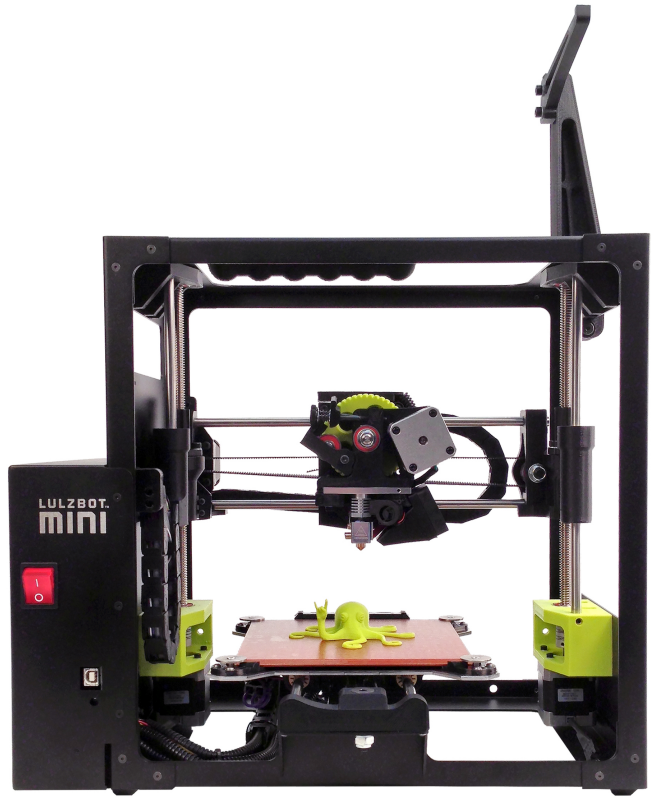
LULZBOT™

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
- Croton - Fourth Prototype
- Daffodil - First Production batch

1.3 Schedule

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

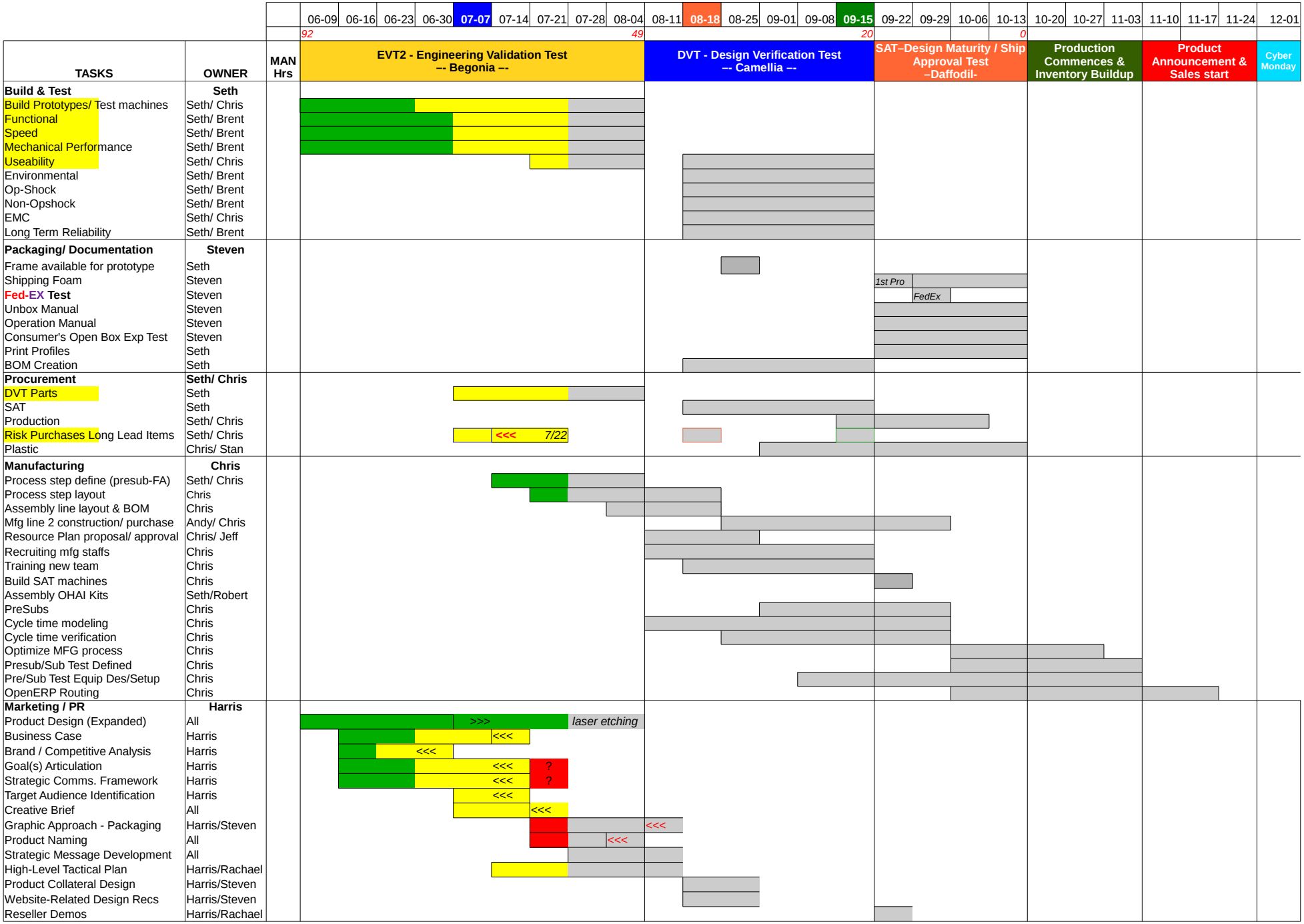
`http://devel.lulzbot.com/mini/program_management/`

Easy TAZ Mini - Work Breakdown Schedule _ v. 3.0

TASKS	OWNER	MAN Hrs	06-09	06-16	06-23	06-30	07-07	07-14	07-21	07-28	08-04	08-11	08-18	08-25	09-01	09-08	09-15	09-22	09-29	10-06	10-13	10-20	10-27	11-03	11-10	11-17	11-24	12-01
			92								49						20				0							
			EVT2 - Engineering Validation Test –- Begonia –-									DVT - Design Verification Test –- Camellia –-						SAT–Design Maturity / Ship Approval Test –Daffodil-				Production Commences & Inventory Buildup			Product Announcement & Sales start			Cyber Monday
Architect	**Seth**																											
Cube or Lulzbot? Decision	Seth																											
- CAD	Seth																											
- Build mockups	Seth																											
- Cost estimate	Seth/ Chris																											
Electronics- Controller & Comm	TBD																											
- Research features	Aaron																											
- Research Market trends	Aaron																											
- Pros & Cons on FW effort	Aaron																											
- Final Config/feature proposal	Seth																											
- Final Config Decision	All																											
Non-UL/UL Ready/ Full UL?	Seth & All																											
- Define what need to be done	Seth/ Chris																											
- Re cost estimate	Seth																											
Software	**Aaron/ Jeff**																											
UI Flow	Aaron/Jeff				<<<																							
UI Design	Steven																											
Kernel	Jeff									<<<																		
uBoot	Jeff									<<<																		
SD Image	Jeff									<<<																		
Package Slic3r,Octoprint,Custom	Aaron/Jeff																											
USB drive automount	Aaron/Jeff																											
Octo Web Daemon	Jeff																											
Slicing	Jeff/Sound																											
Slicing ini's	Brent																											
Octoprint UI	Aaron																											
Firmware																												
RAMBO – EZT HW	Aaron/Seth																											
Auto Leveling	Aaron/Seth																											
Code Release	**Aaron/Jeff**										DVT						SAT											
Video Production																												
Mechanical	**Seth**																											
Frame	Seth									<<<																		
X-Axis	Seth									<<<																		
Y-Axis	Seth									<<<																		
Z-Axis	Seth									<<<																		
Extruder	Seth/ Brent									<<<																		
Drive System	Seth									<<<																		
New Spool loc/feed	Seth																											
LCD Mount	Seth/ Aaron									<<<																		
Motor Selection	Seth																											
Nozzle Sel/ Design	Seth/ Brent						<<<																					
Heat bed	Seth/ Brent						<<<																					
Auto Bed Leveling	Seth/ Brent																											
Electronics/ Electrical	**Seth**																											
Mini-RAMBO	Chris																											
LCD	Seth/ Aaron																											
Baseboard	Aaron/ LkSp																											
Wiring (HW vs Conn)	Seth/ Chris																											
Power Supply	Seth/ Chris																											
Lights/LEDs	Seth																											
Grd/ EMI Shielding	Seth/ Chris																											
USB	Seth & All						<<<																					
Switches	Seth																											
Breadboard Testing	Seth																											

Des Comp

Samples


06-09
06-16
06-23
06-30
07-07
07-14
07-21
07-28
08-04
08-11
08-18
08-25
09-01
09-08
09-15
09-22
09-29
10-06
10-13
10-20
10-27
11-03
11-10
11-17
11-24
12-01
92
49
20
0
TASKS
OWNER
MAN Hrs
EVT2 - Engineering Validation Test –- Begonia –-
DVT - Design Verification Test –- Camellia –-
SAT–Design Maturity / Ship Approval Test –Daffodil-
Production Commences & Inventory Buildup
Product Announcement & Sales start
Cyber Monday
Build & Test
Seth
Build Prototypes/ Test machines
Seth/ Chris
Functional
Seth/ Brent
Speed
Seth/ Brent
Mechanical Performance
Seth/ Brent
Useability
Seth/ Chris
Environmental
Seth/ Brent
Op-Shock
Seth/ Brent
Non-Opshock
Seth/ Brent
EMC
Seth/ Chris
Long Term Reliability
Seth/ Brent
Packaging/ Documentation
Steven
Frame available for prototype
Seth
Shipping Foam
Steven
1st Pro
Fed-EX Test
Steven
FedEx
Unbox Manual
Steven
Operation Manual
Steven
Consumer's Open Box Exp Test
Steven
Print Profiles
Seth
BOM Creation
Seth
Procurement
Seth/ Chris
DVT Parts
Seth
SAT
Seth
Production
Seth/ Chris
Risk Purchases Long Lead Items
Seth/ Chris
<<< 7/22
Plastic
Chris/ Stan
Manufacturing
Chris
Process step define (presub-FA)
Seth/ Chris
Process step layout
Chris
Assembly line layout & BOM
Chris
Mfg line 2 construction/ purchase
Andy/ Chris
Resource Plan proposal/ approval
Chris/ Jeff
Recruiting mfg staffs
Chris
Training new team
Chris
Build SAT machines
Chris
Assembly OHAI Kits
Seth/Robert
PreSubs
Chris
Cycle time modeling
Chris
Cycle time verification
Chris
Optimize MFG process
Chris
Presub/Sub Test Defined
Chris
Pre/Sub Test Equip Des/Setup
Chris
OpenERP Routing
Chris
Marketing / PR
Harris
Product Design (Expanded)
All
>>>
laser etching
Business Case
Harris
<<<
Brand / Competitive Analysis
Harris
<<<
Goal(s) Articulation
Harris
<<<
?
Strategic Comms. Framework
Harris
<<<
?
Target Audience Identification
Harris
<<<
Creative Brief
All
<<<
Graphic Approach - Packaging
Harris/Steven
<<<
Product Naming
All
<<<
Strategic Message Development
All
High-Level Tactical Plan
Harris/Rachael
Product Collateral Design
Harris/Steven
Website-Related Design Recs
Harris/Steven
Reseller Demos
Harris/Rachael

EasyTAZ Mini – Product Development Cycle – v3.1_Draft

06-09	06-16	06-23	06-30	07-07	07-14	07-21	07-28	08-04	08-11	08-18	08-25	09-01	09-08	09-15	09-22	09-29	10-06	10-13	10-20	10-27	11-03	11-10	11-17	11-24	12-01
92								*49*						*20*				*0*							

EVT2 - Engineering Validation Test –- Begonia –-	DVT - Design Verification Test –- Camellia –-	SAT–Design Maturity / Ship Approval Test –Daffodil-	Production Commences & Inventory Buildup	Product Announcement & Sales start	Cyber Monday
Design **Validation** – **Functionally** focused	**Verification** – Reliability focused – RBF	**Qual** – MFG/ Quality	**Ramp**	***Sell, Sell, Sell!***	
11-15 machines	*25 machines*	*30-50 machines*	*120-140 machines*	*30-40/wk*	

6/09
Design Config LOCKED
auto bed leveling, hexagon nozzle
PcD-Core/Baseboard, LCD

6/24
LCD/T.Scr samples recv

7/01
BB Design completed

7/08
Order DVT frames

7/25
3 Core/BB EVT testing

8/08
DVT *Entry Review*

8/11
Build DVT machines
DVT Code release

8/18
Order Daffodil long lead & low risk parts

8/29
Foam prototype checkpoint

9/15
Order Production long lead & low risk parts

9/19
SAT *Entry Review*

9/22
Build SAT machines
SAT Code freeze
(except Video production)

10-17
Ship Approved

10-20
Start production

11-10
Announce product

Items to Validate:	**# of machine**
1) Printability	**5**
2) Repeatability	use above
3) Userablity	use above
4) Mechanical Spec	use above
5) Electrical spec	use above

Items to Verify:	**# machine**
1) Performance(speed,...)	**15**
2) Repeatability/Reliability	use above
3) Userability	use above
4) Environmental	3
5) Op Shock/ Vibration	3
6) Non-Opshock	use above
7) EMC/FCC	3

To Verify:	**Mach**
Manufacturability	**30**
Longterm Reliability	same

Type of Test
1) Can it print as well as Guava
2) Is bed leveling working
3) Frame Stiffness
4) Basic Electronics Function
5)

Type of Test	**How long?**
1) Print-Visual/Time measur	24 hr
2) Short print/Cal, 24hr print	3 hr/ea
3) Hot, Hot/wet, Cold	
4) Bu	
5) Drop test	
6) Near/far field test & FCC	

Type of Test	
Long term reliability	72hr
Assembly test run	

Test Acceptance or Pass/Fail Criteria
1)
2)
3)
4)

Test Acceptance or Pass/Fail Criteria
1)
2)
3)
4)

Test Accpt or P/F Criteria
No Calibration drift, visual/
Measurement, dimension
Accuracy, consistency,
visual printing quality

Rules: Design changes allowed - No architect-related changes After config "locked" date unless program risks such as schedule, cost, … are studied & approved by the Project Approval Committee (PAC-stakeholders)

- Minor changes/improvements from RBF cycles allowed, no design - config/architect- related changes unless approved by PAC

- MFG/ "Ship" config hence NO change unless last minute discovery renders machine not shippable, require PAC approval

PAC	**Seth:**
Signed Off	**Steven:**
	Chris:
	Jeff:

EasyTAZ Mini – Product Development Cycle_ Software & Firmware Functions & Features

06-09	06-16	06-23	06-30	07-07	07-14	07-21	07-28	08-04	08-11	08-18	08-25	09-01	09-08	09-15	09-22	09-29	10-06	10-13	10-20	10-27	11-03	11-10	11-17	11-24	12-01
92								*49*						*20*				*0*							

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6/09
Design Config LOCKED
auto bed leveling, hexagon nozzle
PcD-Core/Baseboard, LCD

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8/29
Foam prototype checkpoint

9/15
Order Production long lead & low risk parts

9/19
SAT *Entry Review*

9/22
Build SAT machines
SAT Code release
(except Video production)

10-17
Ship Approved

10-20
Start production

11-10
Announce product

Expected SW/FW Functions & Features

- Octoprint/Octoscript - Proof of concept UI Flow - - - - - - - - - - - - -	- Basic UI - Working custom SD Image - Repo with packages for Slic3r, Octoprint, Custom Software - Ability to load files from USB drive - Connect/configure wifi - Control LED Strips via software - Web Daemon frontend for system calls - Onboard Slicing / STL Repair - - - - - - -	- Polish UI Design - Incorporate Video/Help - Bug fixes - - - - - - - - - - - - -			

EasyTAZ Mini – Product Development Cycle_ ELECTRONICS CONFIGURATION

06-09	06-16	06-23	06-30	07-07	07-14	07-21	07-28	08-04	08-11	08-18	08-25	09-01	09-08	09-15	09-22	09-29	10-06	10-13	10-20	10-27	11-03	11-10	11-17	11-24	12-01
92								*49*						*20*				*0*							

EVT2 - Engineering Validation Test –- Begonia –-	**DVT - Design Verification Test –- Camellia –-**	**SAT–Design Maturity / Ship Approval Test –Daffodil-**	**Production Commences & Inventory Buildup**	**Product Announcement & Sales start**	**Cyber Monday**
Design **Validation** – **Functionally** focused	**Verification** – Reliability focused – RBF	**Qual** – MFG/ Quality	**Ramp**	***Sell, Sell, Sell!***	
11-15 machines	*25 machines*	*30-50 machines*	*120-140 machines*	*30-40/wk*	
6/09 ***Design Config LOCKED*** *auto bed leveling, hexagon nozzle* *PcD-Core/Baseboard, LCD*	**8/11** *Build DVT machines* *DVT Code release*	**9/22** *Build SAT machines* *SAT Code release* *(except Video production)*	**10-20** *Start production*	**11-10** *Announce product*	
6/24 *LCD/T.Scr samples recv*	**8/18** *Order Daffodil long lead & low risk parts*	**9/15** *Order Production long lead & low risk parts*	**10-17** *Ship Approved*		
7/01 *BB Design completed*					
7/08 *Order DVT frames*	**8/29** *Foam prototype checkpoint*	**9/19** ***SAT*** *Entry Review*			
7/25 *3 Core/BB EVT testing*					
8/08 ***DVT*** *Entry Review*					

Expected Electronic Configuration

Motion Controller	Rambo 1.3L/Mini RAMBo	Mini- Rambo, rev?	Mini- Rambo, rev?		
Comm Controller:	Olimex	Linksprite: Core + Baseboard, rev 1.0	Core/ Baseboard, rev?		
			-		
LCD:	Olimex	Linksprite LCD (1280x800) (rev ?)	Linksprite LCD (1280x800) (rev ?)		
USB:	Extension	Baseboard Ports (x4)	Baseboard Ports (x4)		
WiFi:	None as of now	Dongle	Dongle		
		LEDs	LEDs		
-		Speaker	Speaker		
-		-	-		
-		-	-		
-		-	-		
-		-	-		
-		-	-		
-		-	-		
-		-	-		

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)

Phyiscal 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

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	anufactur	Manufacturer PN	Distributor	Distributor SKU	Qty Per	UOM	Price Per Unit	Price Total	Qty to Order
Hardware	HD-MS0054	Square Bumper			Advanced Antivibration co	V10R87-B08130	4	ea	$0.09	$0.35	42 Sheets of 98
Printed	PP-GP0189	Double bearing holder v1.2, Mini			Aleph Objects		2	ea	$3.010	$6.02	
Printed	PP-GP0188	Upper bearing holder v1.1, Mini			Aleph Objects		1	ea	$3.300	$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 Idler 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	Belt mount v1.0, Mini			Aleph Objects		2	ea	$1.260	$2.52	
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	$5.150	$5.15	
Printed	PP-GP0176	Bed corner v2.2, Mini			Aleph Objects		4	ea	$0.290	$1.16	
Printed	PP-GP0175	Y idler mount v1.2, Mini			Aleph Objects		1	ea	$2.230	$2.23	
Printed	PP-GP0174	Y rod mount v1.1, Mini			Aleph Objects		1	ea	$3.010	$3.01	
Printed	PP-GP0173	Spool hinge v1.3, Mini			Aleph Objects		1	ea	$0.870	$0.87	
Printed	PP-GP0172	Spool arm v1.0, Mini			Aleph Objects		1	ea	$1.550	$1.55	
Printed	PP-GP0171	Spool mount v1.2, Mini			Aleph Objects		1	ea	$7.090	$7.09	
Printed	PP-GP0170	Relief mount v1.3, Mini			Aleph Objects		1	ea	$1.070	$1.07	
Printed	PP-GP0169	Handle bar v2.4, Mini			Aleph Objects		1	ea	$2.040	$2.04	
Printed	PP-GP0168	Wiper mount v1.0, Mini			Aleph Objects		1	ea	$0.680	$0.68	
Printed	PP-GP0167	Fan Mount v1.3, Mini			Aleph Objects		1	ea	$1.170	$1.17	
Printed	PP-GP0190	Lower relief v1.0 Mini			Aleph Objects		1	ea	$0.190	$0.19	
Mechanical	HD-MS0211	Borosilicate Glass Bed 170mm x 170mm			Allen Scientific		1	ea	$6.750	$6.75	1020
Hardware	HD-MS0027	Spring, Extruder, 6mm OD, 0.8mm WD, 9.7mm FL			Associated Spring	C0240-032-0380-M	2	ea	$0.137	$0.27	2100
Mechanical	HD-BL0015	GT2, Single sided Neoprene Belt			B & B Manufacturing, Inc	744-2P-06 (2MR-744-06)	2	ea	$2.290	$4.58	1020
Mechanical	HD-MS0033	GT2 Timing Pulley, 5mm Bore Aluminum			B & B Manufacturing, Inc	3M6CA5 5MM BORE ALU	2	ea	$3.440	$6.88	1020
Electronic	EL-PS0025	POWER SUP 150W 24V 6.25A PNL MT	Delta	PMC-24V150W1AA	DELTA	PMC-24V150W1AA	1	ea	$28.600	$28.60	1020
Electronic	EL-MS0143	Conn Fast Receptacle14-16 AWG .250			TTI	22-26AWG .110	7	ea	$0.077	$0.54	7100
Electronic	EL-MS0205	CONN TERM MALE 22-24AWG TIN	Molex		Digikey	WM2517TR-ND	25	ea	$0.038	$0.96	2 reels
Electronic	EL-MS0212	CONN PIN 24-30AWG CRIMP TIN	Molex	16-02-0108	Heilind	MOL16-02-0108	2	ea	$0.056	$0.11	2500
Electronic	EL-MS0059	CONN TERM FEMALE 22-24AWG TIN	Molex Inc.	16-02-0102	Digikey	WM2510TR-ND	73	ea	$0.032	$2.36	4 reels
Electronic	EL-MS0061	Connector, 4 pin Male housing with latch	Molex	701070003	Digikey	WM2535-ND	3	ea	$0.140	$0.42	4050
Electronic	EL-MS0062	Connector, 4 pin Female housing with latch	Molex	50579404	Digikey	WM2902-ND	8	ea	$0.112	$0.90	9100
Electronic	PC-CN0001	CONN HOUSING 2POS .100 W/LATCH			TTI	WM2900-ND	5	ea	$0.062	$0.31	6100
Electronic	PC-CN0003	Connector Housing 3POS .100 W/Latch			TTI	WM2901-ND	6	ea	$0.060	$0.36	6100
Electronic	EL-MS0142	CONN RECEPT FASTON 22-26AWG .110			TTI	A27793-ND	12	ea	$0.109	$1.31	12100
Electronic	EL-MS0141	Term Ring Non Ins 26-22AWG #4		P22-4R-M	Heilind	P22-4R-M	6	ea	$0.087	$0.52	8200
Electronic	EL-MS0210	CONN RING UNINS 15-20AWG #M3			Digikey	A107160CT-ND	2	ea	$0.090	$0.18	**2050**
Electronic	**EL-SW0022**	**SWITCH BASIC SPDT 3A .110QC 125V**			**Digikey**	**SW766-ND**	**6**	**ea**	**$0.520**	**$3.12**	**6100**
Electronic	EL-WR0099	Shielded 4Cond 22AWG		C0762A.41.10	Digikey	W504-1000-ND	2470	mm	$0.001	$3.02	9000 ft
Electronic	**EL-WR0105**	**24AWG Stranded – Black**		**C2015A.21.01**	**Digikey**	**C2015B-1000-ND**	**6025**	**mm**	**$0.000**	**$1.54**	**22000 ft**
Electronic	EL-WR0107	24AWG Stranded – White		C2015A.21.02	Digikey	C2015W-1000-ND	1100	mm	$0.000	$0.28	4000 ft
Electronic	**EL-WR0109**	**24AWG Stranded – Yellow**		**C2015A.21.05**	**Digikey**	**C2015Y-1000-ND**	**2090**	**mm**	$0.000	**$0.54**	**8000 ft**
Electronic	EL-WR0103	24AWG Stranded – Red		C2015A.21.03	Digikey	C2015R-1000-ND	3825	mm	$0.000	$0.98	14000 ft
Electronic	**EL-WR0104**	**24AWG Stranded – Orange**		**C2015A.21.04**	**Digikey**	**C2015A-1000-ND**	**2820**	**mm**	$0.000	**$0.72**	**11000 ft**
Electronic	EL-WR0118	24AWG Stranded – Blue		C2015A.21.07	Digikey	C2015L-1000-ND	460	mm	$0.000	$0.14	2000 ft
Electronic	EL-WR0119	24AWG Stranded – Green		C2015A.21.06	Digikey	C2015G-1000-ND	520	mm	$0.000	$0.16	2000 ft
Electronic	EL-WR0120	24AWG Stranded – Purple		C2015A.21.19	Digikey	C2015V-1000-ND	1210	mm	$0.000	$0.31	5000 ft
Electronic	EL-WR0106	16AWG Stranded – Red		C2065A.21.03	Digikey	C2065R-1000-ND	400	mm	$0.007	$2.78	2000 ft
Electronic	**EL-WR0121**	**16AWG Stranded – Black**		**C2065A.21.01**	**Digikey**	**C2065B-1000-ND**	**1280**	**mm**	**$0.007**	**$8.89**	**4000 ft**

Electronic	**EL-WR0122**	**16AWG Stranded – Green**		**C2065A.21.06**	**Digikey**	**C2065G-1000-ND**	**125**	**mm**	**$0.007**	**$0.87**	**1000 ft**
Electronic	EL-WR0123	16AWG Stranded – White		C2065A.21.02	Digikey	C2065W-1000-ND	880	mm	$0.007	$6.11	2000 ft
Electronic	EL-WR0108	16AWG Stranded – Violet			Digikey	C2065V-1000-ND	1100	mm	$0.001	$1.38	4000 ft
Electronic	EL-MS0216	Ferrite Tubular Bead 19.00mm	Laird Tech	28B1142-100	Digikey	240-2314-ND	1	ea	$0.335	$0.34	
Electronic	PC-CN0046	Term Block Plug 4POS STR 5.08MM			Digikey	WM7953-ND	1	ea	$1.22	$1.22	1050
Electronic	PC-CN0032	Term Block Plug 2POS STR 5.08MM			TTI	WM7819-ND	2	ea	$0.46	$0.91	2050
Electronic	EL-MS0074	20-POS .100 Dual (Black)			TTI	WM2527-ND	2	ea	$0.600	$1.20	2040
Electronic	EL-MS0211	REEL – RING TONGUE CONN 16-22 AWG #10 PIDG	TE	2-36154-2	Digikey	A1062TR-ND	7	ea	$0.120	$0.84	7000
Hardware	HE-SH0031	Reprap Modified Hexagon Hotend, Lulzbot Edition, 3.0mm Filament			Reprapdiscount		1	ea	$23.000	$23.00	1020
Mechanical	**PP-FP0055**	**Left Plate,**			**EPOCS**		**1**	**ea**	**19.500**	**$19.50**	**200**
Mechanical	**PP-FP0052**	**Right Plate,**			**EPOCS**		**1**	**ea**	**12.750**	**$12.75**	**200**
Mechanical	**PP-FP0051**	**Top Plate,**			**EPOCS**		**1**	**ea**	**21.000**	**$21.00**	**200**
Mechanical	**PP-FP0053**	**Bottom Plate,**			**EPOCS**		**1**	**ea**	**32.250**	**$32.25**	**200**
Mechanical	**PP-FP0054**	**Bed Mount Plate,**			**EPOCS**		**1**	**ea**	**8.250**	**$8.25**	**200**
Mechanical	**PP-FP0056**	**Electronics cover,**			**EPOCS**		**1**	**ea**	**19.000**	**$19.00**	**200**
Mechanical	**PP-FP0055**	**Left Plate,**			**Rapid Sheet Metal**		**1**	**ea**	**19.500**		**810**
Mechanical	**PP-FP0052**	**Right Plate,**			**Rapid Sheet Metal**		**1**	**ea**	**12.750**		**810**
Mechanical	**PP-FP0051**	**Top Plate,**			**Rapid Sheet Metal**		**1**	**ea**	**21.000**		**810**
Mechanical	**PP-FP0053**	**Bottom Plate,**			**Rapid Sheet Metal**		**1**	**ea**	**27.750**		**810**
Mechanical	**PP-FP0054**	**Bed Mount Plate,**			**Rapid Sheet Metal**		**1**	**ea**	**8.250**		**810**
Mechanical	**PP-FP0056**	**Electronics cover,**			**Rapid Sheet Metal**		1	**ea**	**$19.00**		**810**
Hardware	**EL-MS0165**	**Snap-Together Cable and Hose Carrier, Feed-Through, 0.41" High x 0.39" Wide Interior S**			**IGUS**	**06-10-028-0**	**813**	**mm**	**$0.020**	**$16.47**	**2800 feet**
Hardware	**EL-MS0166**	**Mounting Brackets for .41" High x .39" Wide Interior Snap-Together Cable and Hose Carr**			**IGUS**	**060-10-12**	**3**	**ea**	**$3.330**	**$9.99**	**3030**
Mechanical	HD-BU0013	DryLin® R - Solid polymer bearing RJM-01, 8mm			IGUS	RJM-01-08	12	ea	$2.00	$24.00	12100
Electronic	EL-FA0011	FAN,24VDC,Sleeve,5.75CFM,40X40X10MM,60mA 6000RPM,1.44W,2		TF4010-24H-S	Kysan	69829	1	ea	$1.550	$1.55	1050
Electronic	EL-FA0012	FAN,24VDC,BALL,31.60CFM,80×80×15 MM,100mA		TF8015-24M-B	Kysan	69866	1	ea	$2.55	$2.55	1010
Mechanical	HD-RD0035	8mm Smooth rod, 315mm, 304 Stainless Steel			MBK		6	ea	$8.900	$53.40	6060
Mechanical	HD-RD0004	8mm Smooth Rod x 18-19mm			MBK		1	ea	$4.60	$4.60	1010
Hardware	HD-BT0108	Hobbed Bolt, M8 x 50mm Hex head, 26mm offset, Stainless Steel			Quattro		1	ea	$5.870	$5.87	1010
Hardware	PP-MP0082	Bed leveling washer, 303 SST			MBK		4	ea	$2.900	$11.60	4040
Electronic	TL-CS0083	EMI/RFI-Shield Heat-Shrink Tubing 3/16" ID Before, 3/32" ID Techflex		H2C0.19BK	Allcable	H2C0.19BK	450	mm	$0.01	$5.96	285x 4 ft pieces
Electronic	TL-CS0129	Interference-Shielding Heat-Shrink Tubing, 3/8" ID Before, 3/ Techflex		H2C0-38BK	Allcable	H2C0-38BK	125	mm	$0.02	$2.97	103x 4 ft pieces
Hardware	HD-WA0035	Metric 18-8 Stainless Steel External Serrated Lock Washer, M3 Screw Size, 6mm OD, 0.4mm			Mcmaster	91120A120	4	ea	$0.020	$0.08	4100
Hardware/tools	HD-MS0244	Firm White Polyester Felt Strip, 1/4" Thick, 1" Width, Plain Back			Mcmaster	88085K311	270	mm	$0.001	$0.38	900 ft
Hardware	HD-MS0235	Metric Aluminum Unthreaded Spacer, 4.5mm OD, 8mm Length, M3 Screw Size			Mcmaster	94669A615	4	ea	$0.350	$1.40	4050
Electronic	EL-MS0073	Tubing, Corrugated Loom .25"	Panduit	708161	Fastenal	708161	695	mm	$0.000	$0.20	24x 100ft rolls
Hardware	HD-BT0117	Black Alloy Steel Flat-Head Socket Cap Screw, Class 10.9, M8 Size, 40mm Length, 1.25mm Pi			Timberline		1	ea	$0.12	$0.12	1020
Hardware	HD-BT0131	Black Alloy Steel Flat-Head Socket Cap Screw, Class 10.9, M8 Size, 45mm Length, 1.25mm Pi			Timberline		1	ea	$0.13	$0.13	1020
Hardware	PP-MP0066	Metric Brass Heat-Set Insert for Plastics, Tapered, M2-.4 Internal Thread, 2.9MM Length			Mcmaster	94180A307	13	ea	$0.10	$1.34	13000
Hardware	HD-BT0107	Metric Class 12.9 Socket Head Cap Screw Alloy Steel, Black, M2 Thread, 10mm Length, 0.4m			Fastenal		12	ea	$0.02	$0.26	12000
Hardware	HD-WA0012	Steel Flat Washer, DIN 125 zinc-plated class 4,M2 screw sz, 5mm OD,		40350	Fastenal	40350	12	ea	$0.00	$0.02	12000
Hardware	HD-MS0230	M2 x 6 SHCS, Black-Oxide			Timberline		1	ea	$0.04	$0.04	1050
Hardware	**HD-MS0030**	**M3-.5 3.8mm Heatset Insert**		**11125995**	**Fastenal**	**11125995**	**79**	**ea**	**$0.06**	**$4.70**	79000
Hardware	**HD-MS0158**	**M5-.8 6.7mm Heatset Insert**		**11125997**	**Fastenal**	**11125997**	**13**	**ea**	**$0.15**	**$1.94**	13000
Hardware	HD-NT0001	M3 Nyloc Nut, Zinc Plated			Timberline		6	ea	$0.01	$0.07	6100
Hardware	HD-NT0004	M3 Nut, Zinc Plated			Timberline		3	ea	$0.01	$0.03	3000
Hardware	HD-BT0012	M3 Set Screw (Grub Screw)		NS0310-0306/met	Mcmaster	91390A100	7	ea	$0.02	$0.13	7000
Hardware	HD-WA0001	M3 Washer, Steel, Zinc Plated			Timberline	MTR-M3100321	61	ea	$0.00	$0.10	61000
Hardware	HD-BT0044	M3 x 5 Bolt, SHCS Black-Oxide	39501	39501	Fastenal	39501	4	ea	$0.02	$0.09	4000
Hardware	**HD-BT0128**	**M3 x 6 Bolt, FHCS Black-Oxide**			**mcmaster**	**91294A126**	**97**	**ea**	**$0.040**	**$3.88**	**98000**
Hardware	**HD-BT0104**	**M3 x 8 Bolt, BHCS, SST**			**mcmaster**	**92095A181**	**3**	**ea**	**$0.094**	**$0.28**	**3030**
Hardware	HD-BT0137	M3 x 8 Bolt, BHCS, Black-Oxide			Timberline		17	ea	$0.065	$1.10	18000
Hardware	HD-BT0039	M3 x 12 Bolt, SHCS Black-Oxide			Timberline	8050-0312	45	ea	$0.01	$0.53	45000
Hardware	**HD-BT0118**	**M3 x 14 Bolt FHCS, Black-Oxide**			**mcmaster**	**91294A133**	**2**	**ea**	**$0.061**	**$0.12**	**2050**
Hardware	HD-BT0136	M3 x 12 Bolt FHCS, SST			Timberline		4	ea	$0.060	$0.24	4100
Hardware	**HD-BT0135**	**M3 x 25 Bolt FHCS, Black-Oxide**			**mcmaster**	**91294A138**	**4**	**ea**	**$0.08**	**$0.32**	**4100**
Hardware	**HD-BT0041**	**M3 x 25 Bolt, SHCS Black-Oxide**			**Timberline**	**8050-0325**	**1**	**ea**	**$0.03**	**$0.03**	**1000**
Hardware	**HD-NT0011**	**M4 Nut,Zinc-Plated Steel**			**Timberline**	**8100-0040**	**4**	**ea**	**$0.01**	**$0.02**	**4000**

Hardware	**HD-WA0005**	**M4 Washer**			**Timberline**	**8200-0040**	**6**	**ea**	**$0.00**	**$0.02**	**6000**	
Hardware	**HD-MS0229**	**M4 x 25 Bolt, SHCS Black-Oxide**			**mcmaster**	**91290A176**	**2**	**ea**	**$0.137**	**$0.27**	**2020**	
Hardware	**HD-BT0052**	**M4 x 55 Bolt, SHCS Black-Oxide**			**Timberline**	**NS8050-0455**	**2**	**ea**	**$0.08**	**$0.16**	**2000**	
Hardware	**HD-WA0007**	**M5 Washer, Steel, Zinc Plated**			**mcmaster**	**91166A240**	**11**	**ea**	**$0.022**	**$0.24**	**11200**	
Hardware	HD-BT0048	M5 x 10 Bolt, SHCS Black-Oxide			Timberline	8050-0510	6	ea	$0.02	$0.13	6000	
Hardware	HD-BT0049	M5 x 14 Bolt, SHCS Black_Oxide			Timberline	NOR-M60051014SO	5	ea	$0.03	$0.13	5000	
Hardware	HD-NT0002	M8 Nyloc Nut, Zinc Plated			Timberline	GBO-986270004	3	ea	$0.05	$0.16	3000	
Hardware	HD-WA0006	M8 Washer, Steel, Zinc Plated			Timberline	8200-0080	9	ea	$0.01	$0.11	9100	
Hardware	HD-WA0008	Metric Spring Steel Shim - DIN 988 0.5mm Thick, 8mm ID, 14mm OD			Timberline		1	ea	$0.05	$0.05	1000	
Hardware	HD-WA0009	Metric Spring Steel Shim - DIN 988 1.0mm Thick, 8mm ID, 14mm OD			Timberline		1	ea	$0.06	$0.06	1000	
Hardware	HD-MS0031	Thumb Screw Knob for M4 SHCS, Black			Timberline		2	ea	$0.10	$0.19	2000	
Hardware	HD-BT0120	Alloy Steel Shoulder Screw, 6mm Diameter x 10mm Long Shoulder, M5 Thread		92981A100	Mcmaster	7130k32	2	ea	$1.030	$2.06	2020	
Hardware	HD-MS0058	Wire Tie, 8"			Timberline	AEH#02-00818-UVB	12	ea	$0.02	$0.28	12000	
Hardware	HD-MS0249	UV-Resistant Cable Tie Holder, Adhesive Back/Screw Mount, 4-Way, for.18" Maximum Tie, Bla			Mcmaster	7582k22	2	ea	$0.249	$0.50	2050	
Consumable	TL-CS0040	Extreme-Temperature Pipe Sealant & Threadlocker, 4 oz bottle, blue			Mcmaster	7604A55	0.5	g	$0.066	$0.03	5 bottles	
Mechanical	HD-RD0036	Drive Rod 10mm			Thomson		2	ea	$28.100	$56.20	2020	
Mechanical	HD-NT0047	10mm x 2mm Flange mount supernut		MTS10 x 2m	Thomson		2	ea	$6.780	$13.56	2020	
Mechanical	HD-MS0194	Coupling, Set Screw, Misumi GSASL16-5-5			Misumi	GSASL16-5-5	2	ea	$7.50	$15.00	2050	
Mechanical	HD-MS0255	Ultem PEI, 0.010" x 12" x 90ft rolls			Professional Plastics		160	mm	$0.034	$5.51	10 rolls	
Mechanical	HD-MS0254	S-13994 3M 468MP Adhesive Transfer Tape - 12" x 60 yards			Uline	S-13994	160	mm	$0.005	$0.78	5 rols	
Electronic	EL-CA0030	6ft 18AWG Power Cord Cable w/ 3 Conductor PC Power Connector Socket (C13/5-15P) – Bla			Monoprice	5279	1	ea	$1.65	$1.65	1010	
Electronic	EL-CA0001	6ft USB 2.0 A Male to B Male 28/24AWG Cable		3021007-06	Heilind	QTK3021007-06	1	ea	$1.05	$1.05	1010	
Electronic	PP-MP0028	AC Power Entry Modules SC MT FUSED .25" TAB			Mouser	161-PF0030/63	1	ea	$3.16	$3.16	1010	
Electronic	EL-MS0096	Cartridge Fuses 125V 7A 5X20 MA UL LBC			Mouser	576-0233007.MXP	2	ea	$0.45	$0.89	2050	
Electronic	EL-WR0040	Wire - Single Conductor 20AWG SOLID PTFE, RED			Mouser	602-2856/1-100-03	185	mm	$0.00	$0.72	8 rolls	
Electronic	EL-MS0008	Heavy Duty Power Connectors HOUSING ONLY, BLACK POWERPOLE 15/45			Mouser	879-1327G6-BK	2	ea	$0.16	$0.32	2050	
Electronic	EL-MS0010	Heavy Duty Power Connectors POWERPOLE 15A CONT			Mouser	879-1332-BK	2	ea	$0.10	$0.20	2050	
Electronics	PC-BD0029	Silicon Heater, 24V, 168mm x 168mm, Self Adhesive, w/ connectors			National Plastic Heater		1	ea	$27.95	$27.95	On Order	
Electronic	EL-FA0020	RFB2008 Micro Blower			Pelonis		1	ea	$6.68	$6.68	1050	
Electronic	EL-SW0023	SWITCH ROCKER DPST 20A 250V, illuminated red	E-Switch	R5BBLKREDFF2	Digikey	EG1535-ND	1	ea	$1.702	$1.70	1100	
Electronic	EL-MT0001	NEMA 17 Stepper Motors			Changzhou FTX Motors C(	SY42STH47-1504A	5	ea	$7.50	$37.50	On Order	
Electronic	PC-BD0049	Mini RAMBo, assembled board only with no LCD headers			UltiMachine		1	ea	$57.00	$57.00	1020	
Mechanical	HD-MS0204	Sealed Skateboard/inline/Rollerblade Skate Bearing Ball Bearings			vxb.com	Kit708	11	ea	$0.20	$2.20	11000	
Etching	PP-FP0058	Laser Engraving Designs					1	ea	$9.91	$9.91	810	
Packaging	SH-PG0075	1.5# RECY & 2# CROSSLINK W/ 10030 CH URETHANE			Shipper's Supply	20140922SA	1	ea	$20.53	$20.53	1010	
Packaging	SH-PG0076	22x17x19 275# dw white/ OUTSIDE PRINT 2 COLOR			Shipper's Supply		1	ea	$3.70	$3.70	1010	
Packaging	SH-PG0085	3" x 55 yards 3.1 Mil Uline Clear Carton Sealing Tape 24 rolls/case					0.018	pc	$4.95	$0.09		
Packaging	DC-LB0028	Label, Lulzbot Mini Barcode					1	ea	$0.14	$0.14		
Packaging	DC-LB0029	Mini v1 serial number sticker					1	ea	$0.01	$0.01		
Packaging	RM-HI0024	HIPS, 1 meter Sample, Random Color					1	ea	$0.03	$0.03		
Packaging	SH-PG0002	3 x 4" 2 Mil Reclosable Polypropylene Bags					1	ea	$0.02	$0.02		
Packaging	SH-PG0083	9 x 12" 8 Mil Reclosable Bags					1	ea	$0.29	$0.29		
Packaging	SH-PG0084	6 x 10" 6 Mil Reclosable Bags					1	ea	$0.18	$0.18		
Packaging	DC-MS0028	Packing List, Mini 1.0					1	ea	$0.24	$0.24		
Packaging	DC-MS0029	Quality assurance record Mini 1.0					1	ea	$0.72	$0.72		
Tools	TL-MS0020	.003 Stainless Steel/Straight Instrument Cleaner Brush			GORDON BRUSH MFG C	906501	1	ea	$5.29	$5.29	1020	
Tools	EL-MS0220	SWM Style USB Flash drive, 4gb, black			USB Memory Direct		1	ea	$4.15	$4.15	1020	
Tools	TL-HD0046	Pro Dental Pick, 5 3/4 in			Image Supply	(DP-19) M S V	1	ea	$1.87	$1.87	1010	
Tools	TL-HD0009	7 1/2" Nylon Handle Clam Knife			WEBstaurant Store	35340592	1	ea	$2.030	$2.03		
										$752.61		
									Total Lulz	1,000	Needs something	
											Good to Order	
											Ordered	

3.3 Drawings

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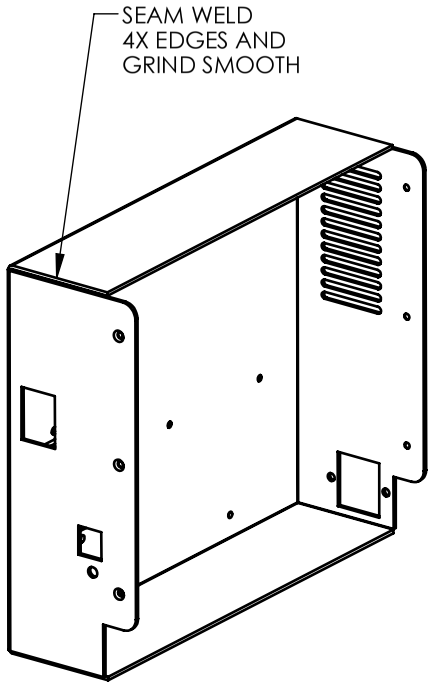

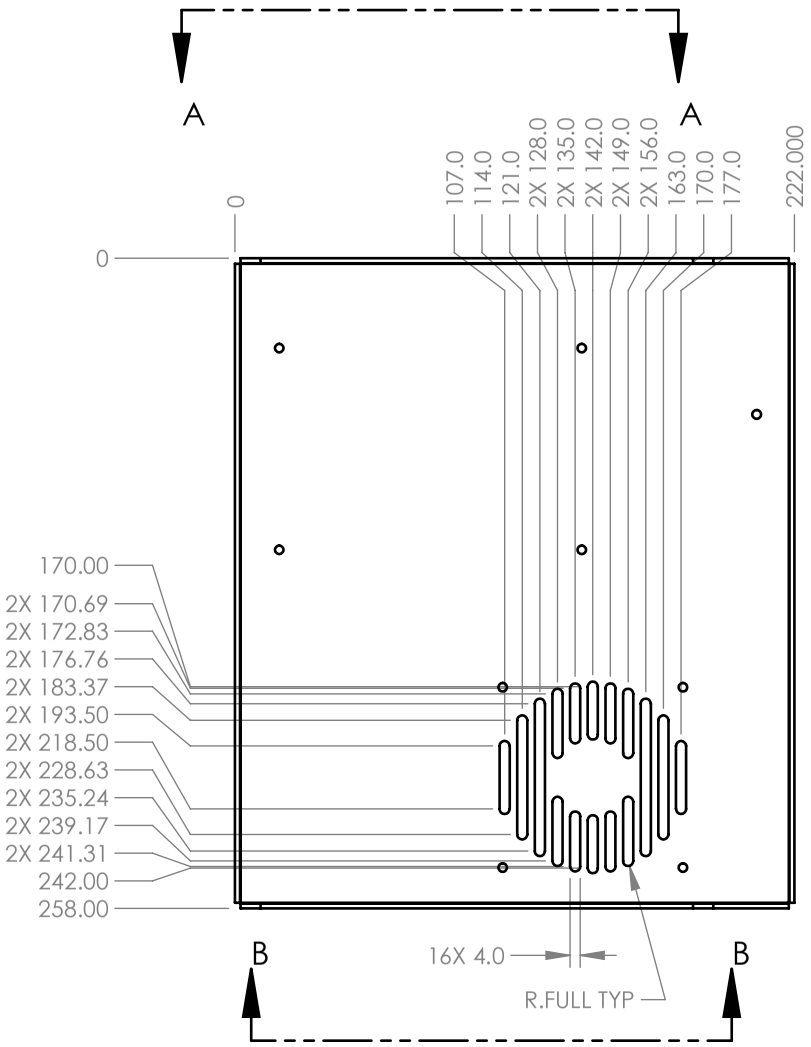

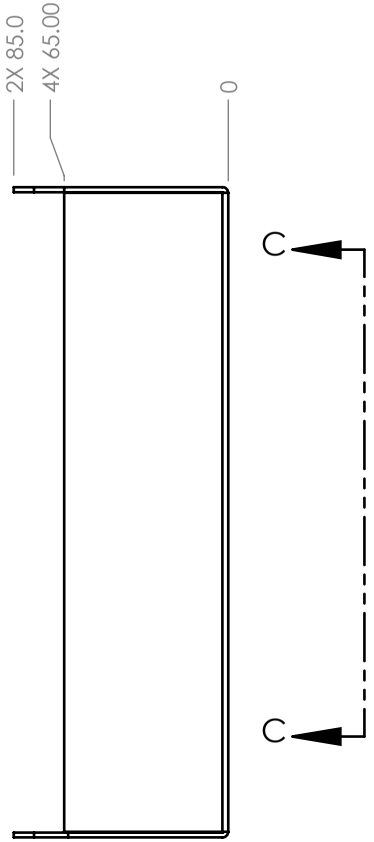

Notes:

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.

DRAWN BY	SINNEMA 7/18/14
MATERIAL	SEE NOTES
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MILLIMETERS. TOLERANCES ARE:	
DECIMALS	.X ±.75 .XX ±.25 .XXX ±.125 .XXXX ±.050
ANGLES	X° ±1°
63	
BREAK EDGES .005/.020 FILLET RADIUS .005/.020	

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

TITLE

Electronics Case, Mini

SIZE	DWG NO.	REV.
A	PP-FP0056	C
SCALE 1:3	DO NOT SCALE DRAWING	SHEET 1 OF 2

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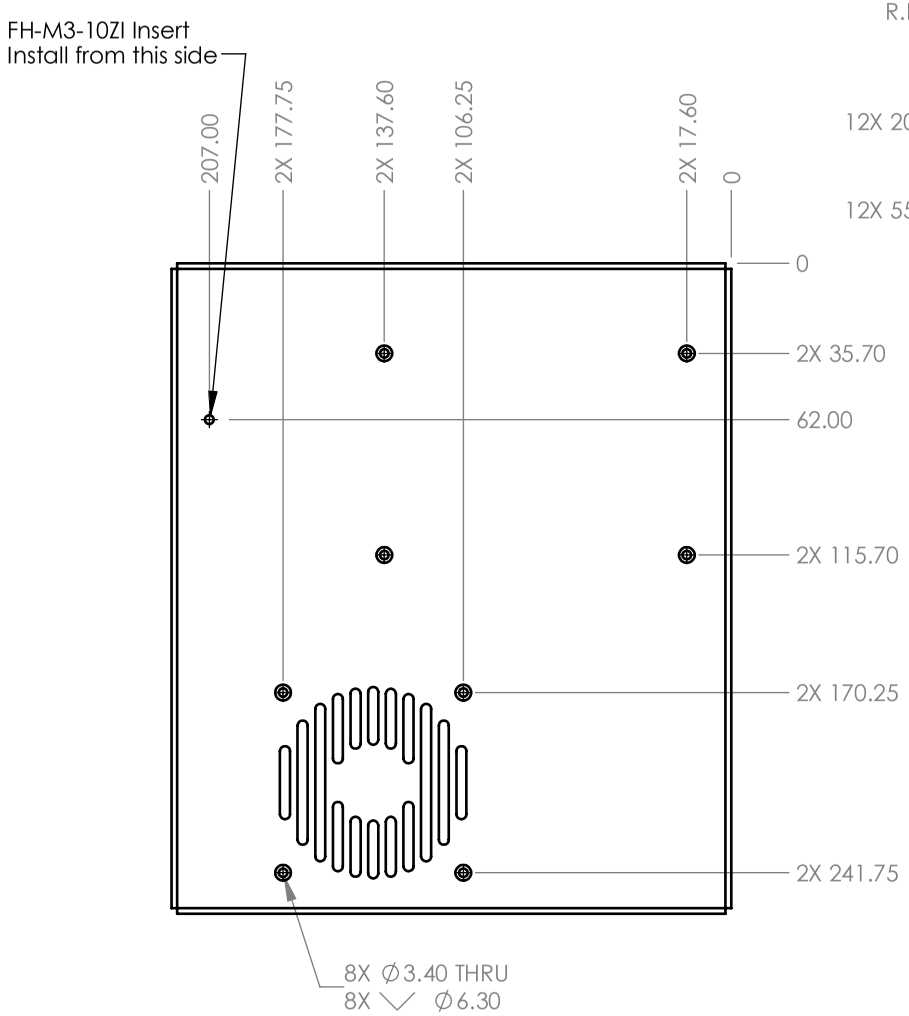
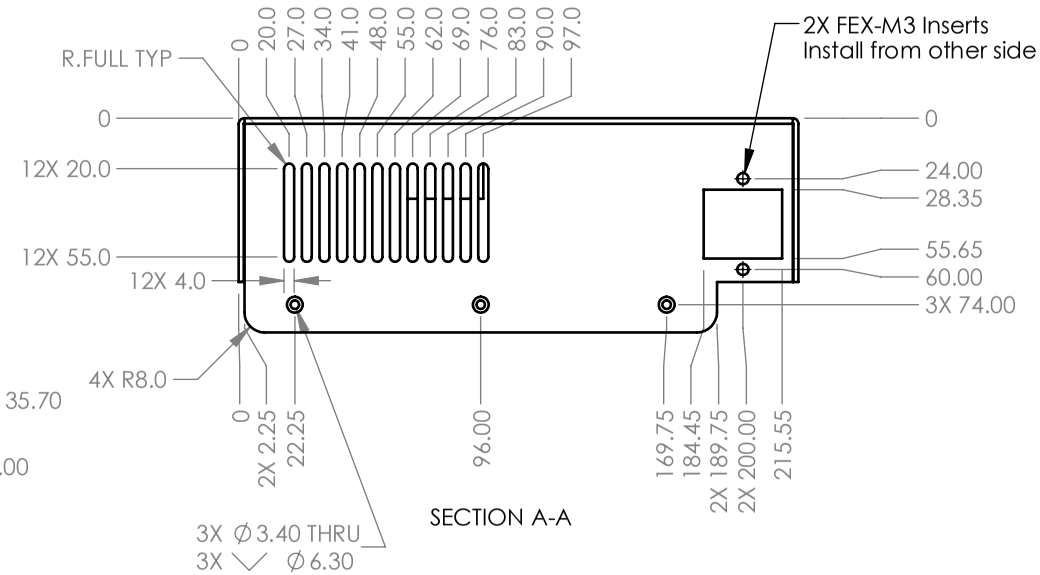
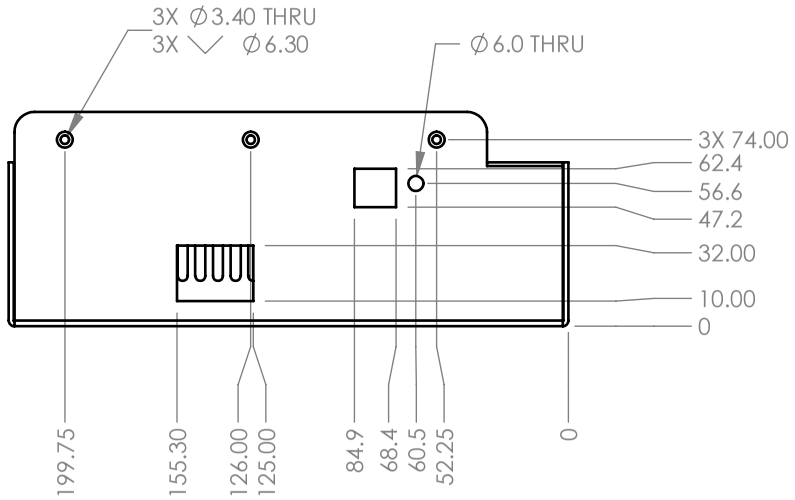


SECTION C-C



SECTION A-A



SECTION B-B

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

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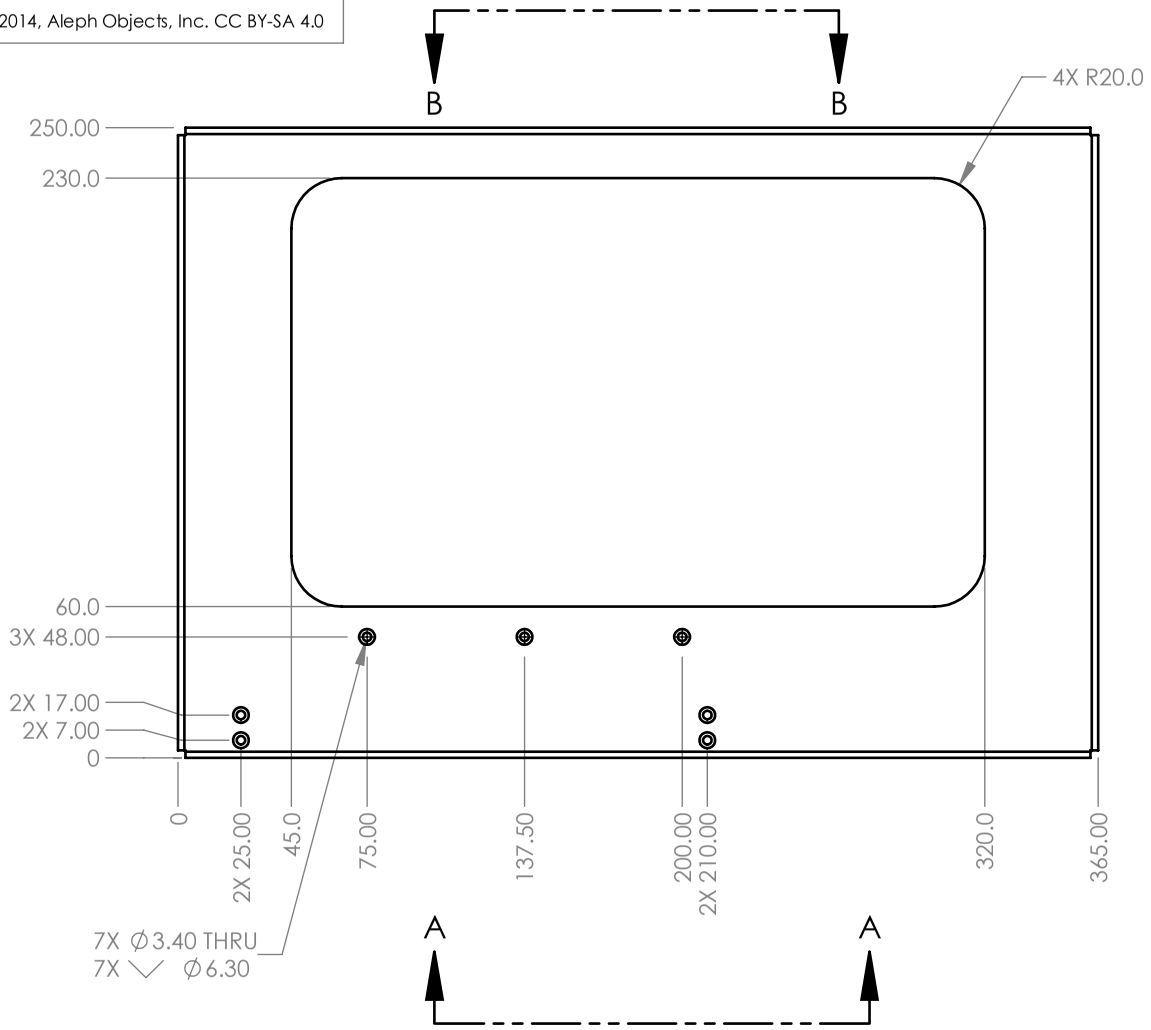
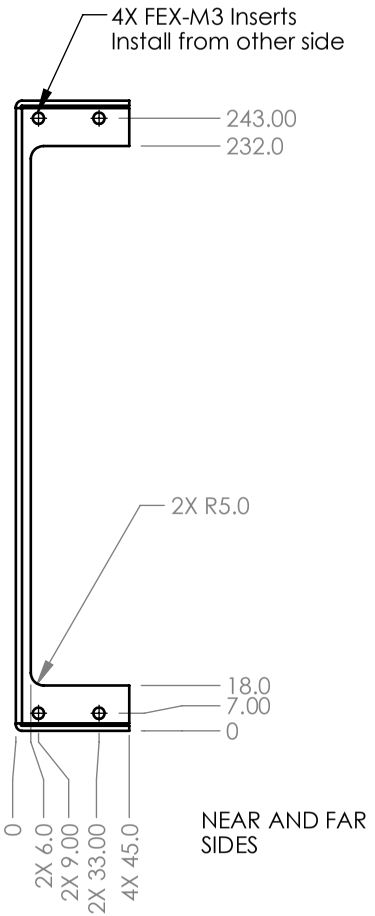
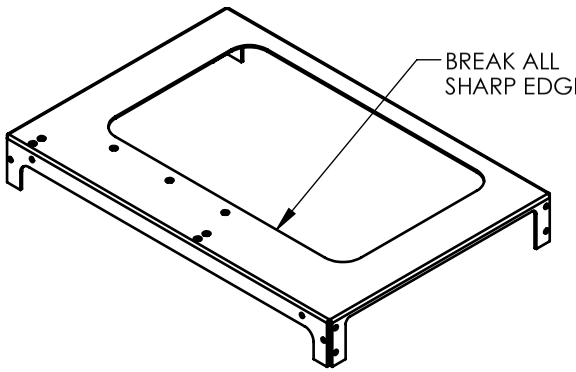




Notes:

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.



DRAWN BY	SINNEMA 7/18/14
MATERIAL	See Notes

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MILLIMETERS. TOLERANCES ARE:

DECIMALS	ANGLES
.X ±.75	X° ±1°
.XX ±.25	
.XXX ±.125	63
.XXXX ±.050	

BREAK EDGES .005/.020
FILLET RADIUS .005/.020

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Phone: (303) 250-8218
Fax: 1-267-393-7872

TITLE: Top Plate, Mini

SIZE	DWG NO.	REV.
A	PP-FP0051	A

SCALE		SHEET
1:3	DO NOT SCALE DRAWING	1 OF 2

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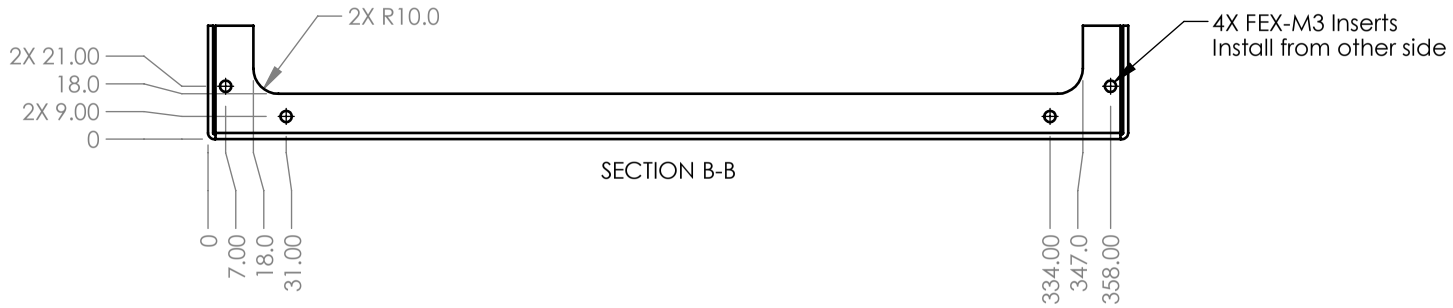
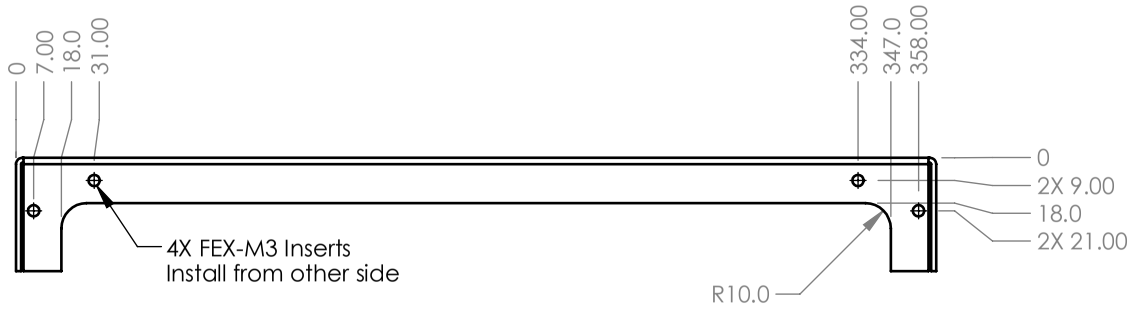


SECTION B-B



SECTION A-A

TITLE: Top Plate, Mini			
SIZE: A	DWG NO.: PP-FP0051		REV.: A
SCALE: 1:3	DO NOT SCALE DRAWING	SHEET: 2 OF 2	

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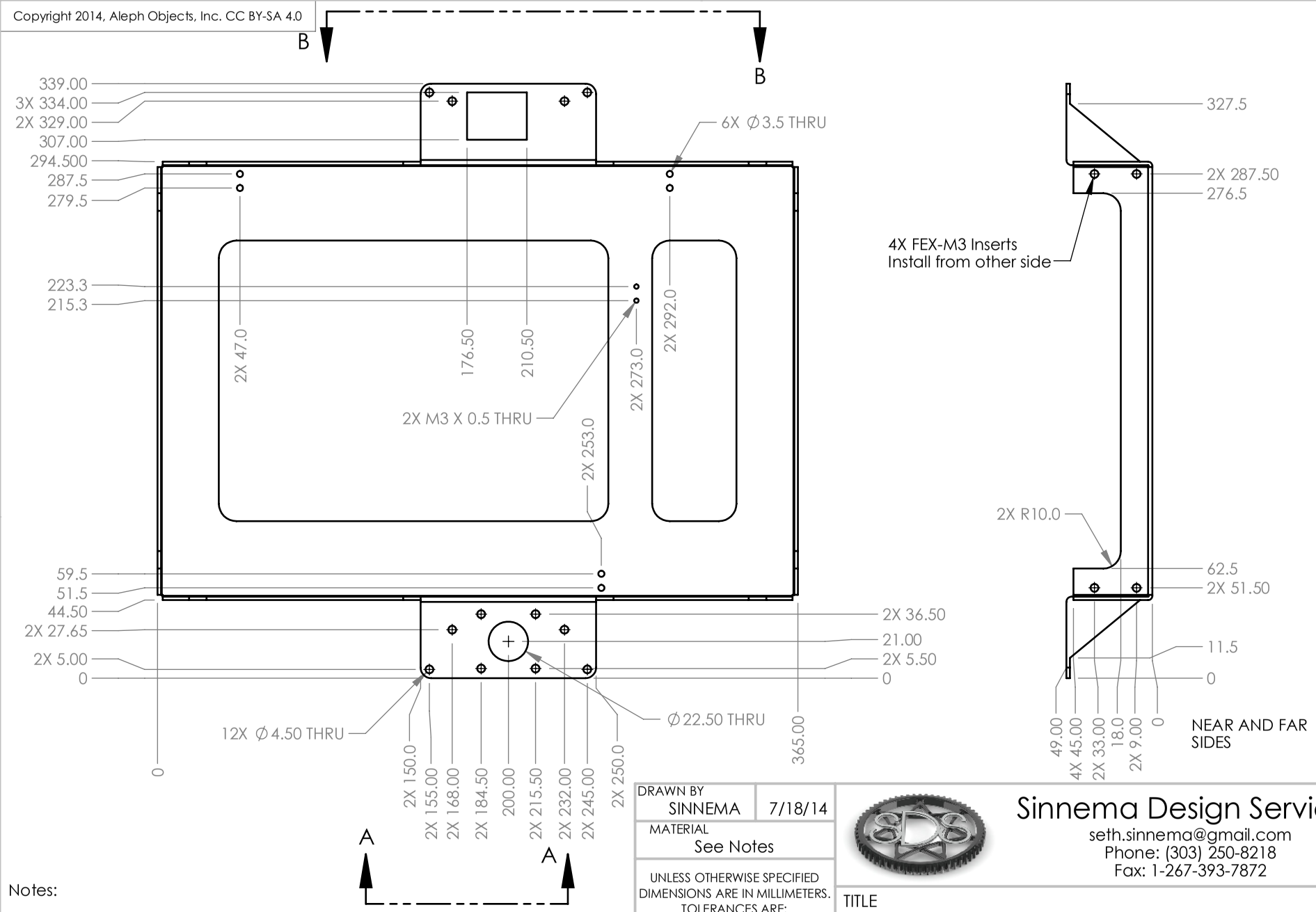

Notes:

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.

DRAWN BY	SINNEMA 7/18/14
MATERIAL	See Notes

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MILLIMETERS. TOLERANCES ARE:

DECIMALS	ANGLES
.X ± .75	X° ± 1°
.XX ± .25	
.XXX ± .125	63
.XXXX ± .050	

BREAK EDGES .005/.020
FILLET RADIUS .005/.020

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TITLE

Bottom Plate, Mini

SIZE	DWG NO.	REV.
A	PP-FP0053	A

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

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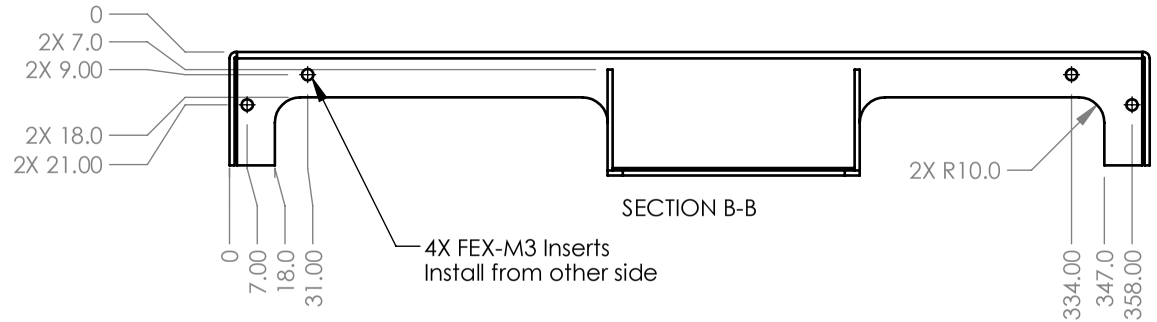

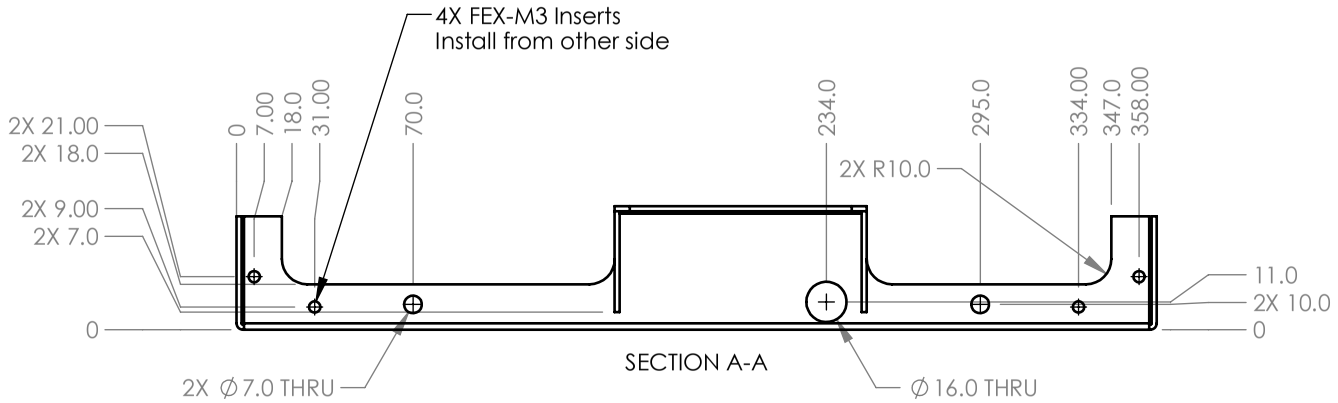

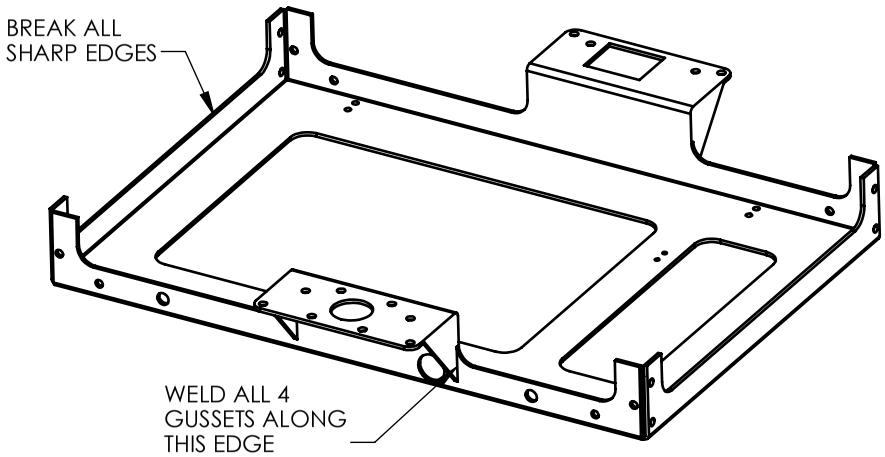

TITLE	Bottom Plate, Mini		
SIZE A	DWG NO. PP-FP0053		REV. A
SCALE 1:3	DO NOT SCALE DRAWING	SHEET 2 OF 3	

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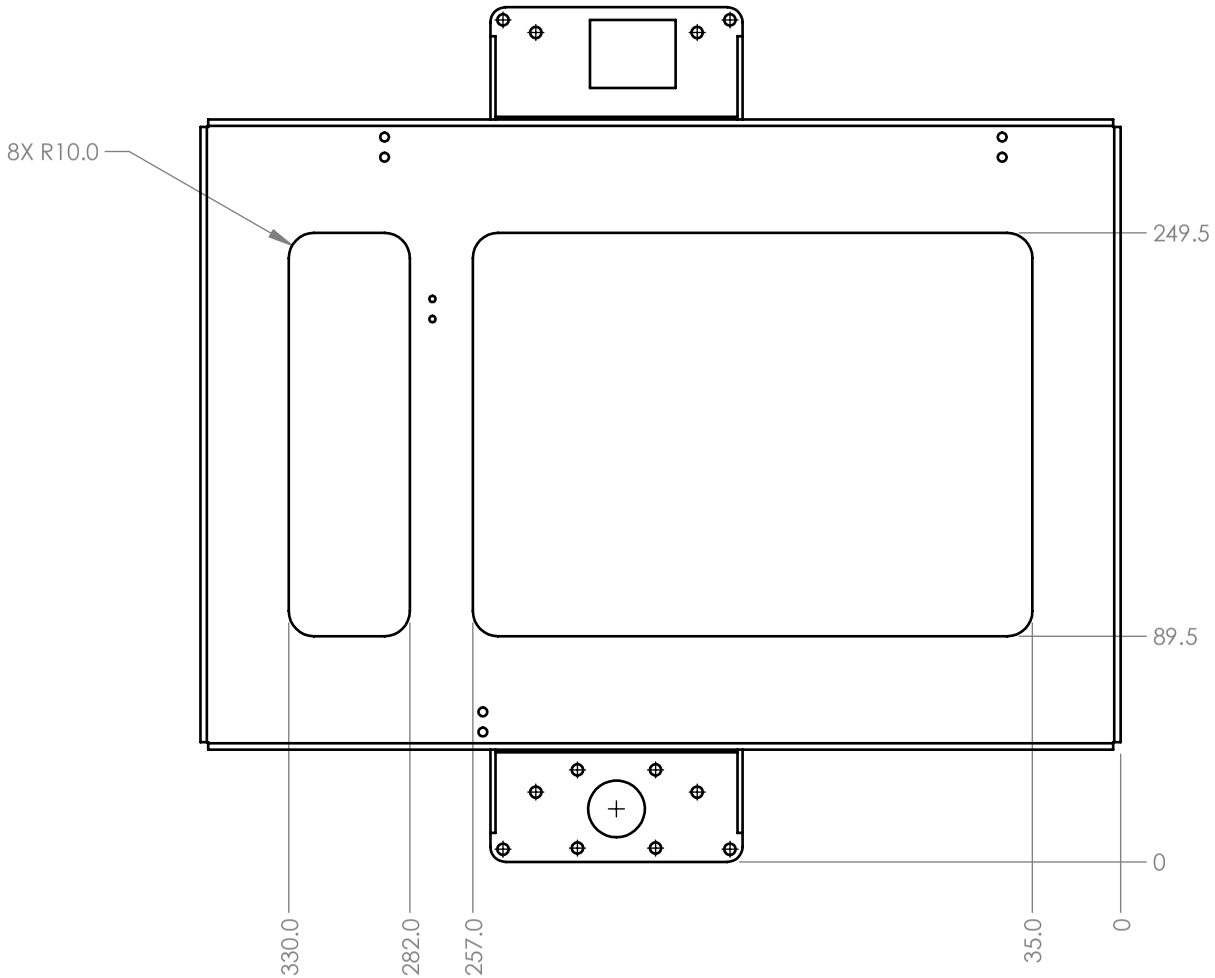

TITLE	Bottom Plate, Mini		
SIZE A	DWG NO. PP-FP0053		REV. A
SCALE 1:3	DO NOT SCALE DRAWING	SHEET 3 OF 3	

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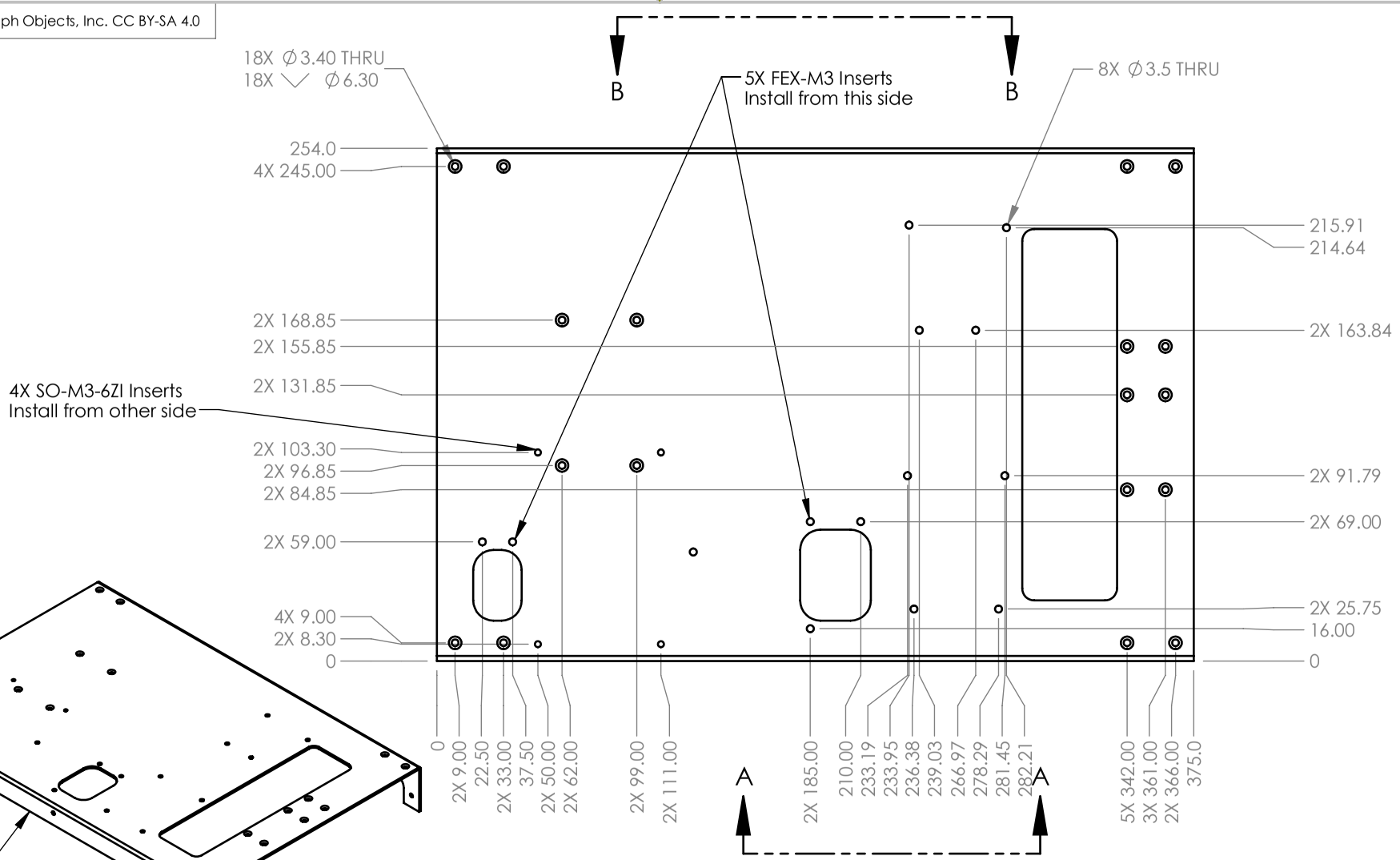

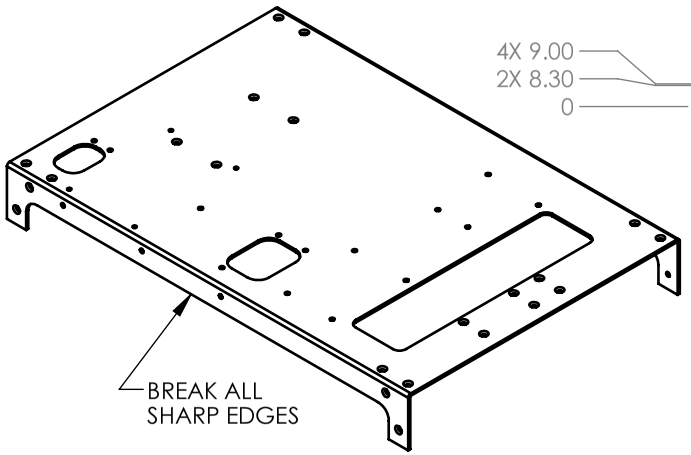

Notes:

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.

DRAWN BY	SINNEMA 7/18/14
MATERIAL	See Notes

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN MILLIMETERS.
TOLERANCES ARE:

DECIMALS	ANGLES
.X ±.75	X° ±1°
.XX ±.25	
.XXX ±.125	63
.XXXX ±.050	

BREAK EDGES .005/.020
FILLET RADIUS .005/.020

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TITLE

Left Plate, Mini

SIZE	DWG NO.	REV.
A	PP-FP0055	B

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

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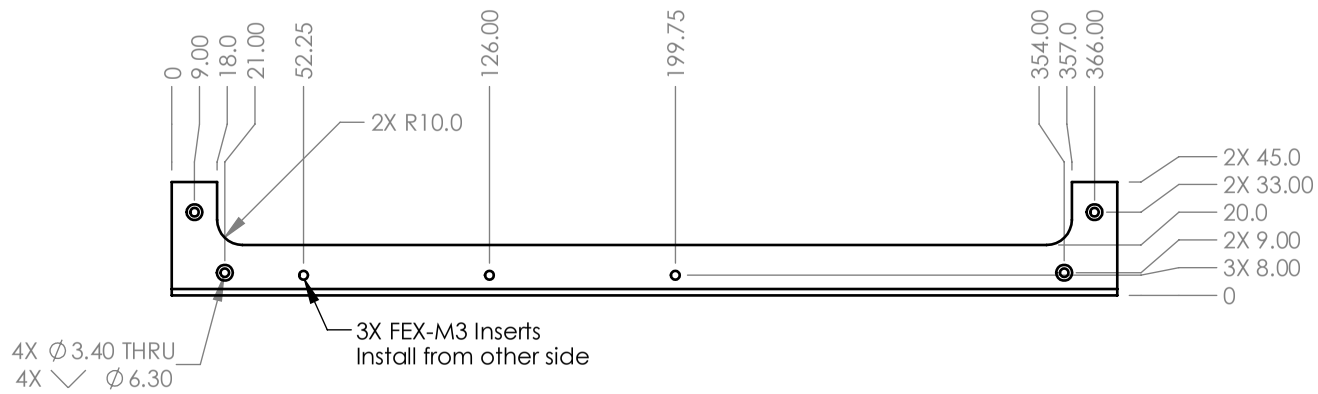
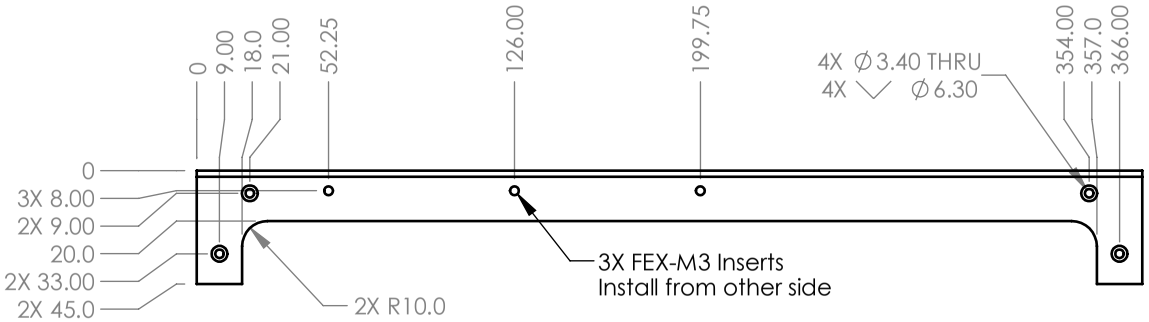


SECTION B-B



SECTION A-A

TITLE	Left Plate, Mini		
SIZE A	DWG NO. PP-FP0055		REV. B
SCALE 1:3	DO NOT SCALE DRAWING	SHEET 2 OF 3	

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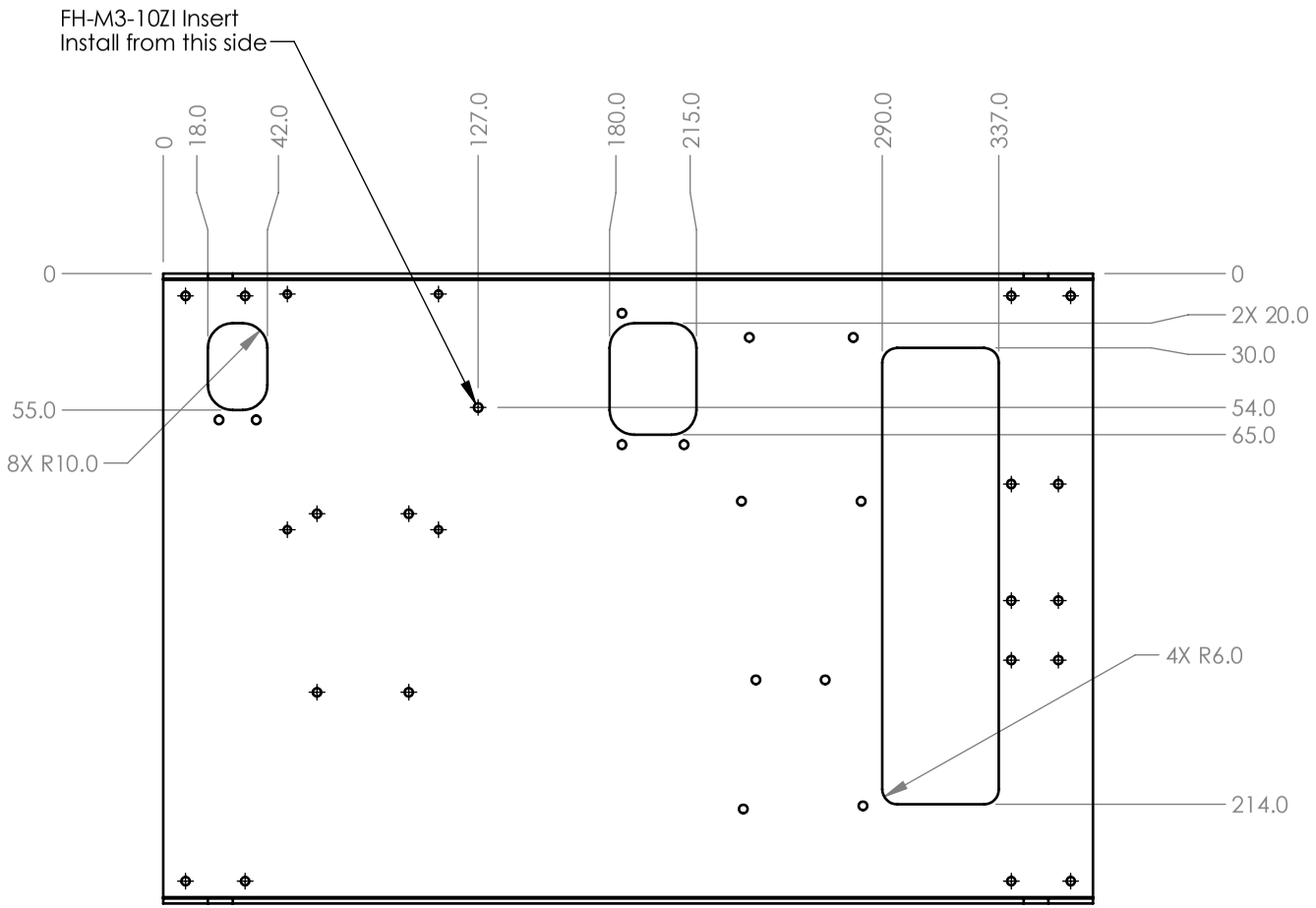

TITLE	Left Plate, Mini		
SIZE A	DWG NO. PP-FP0055		REV. B
SCALE 1:3	DO NOT SCALE DRAWING	SHEET 3 OF 3	

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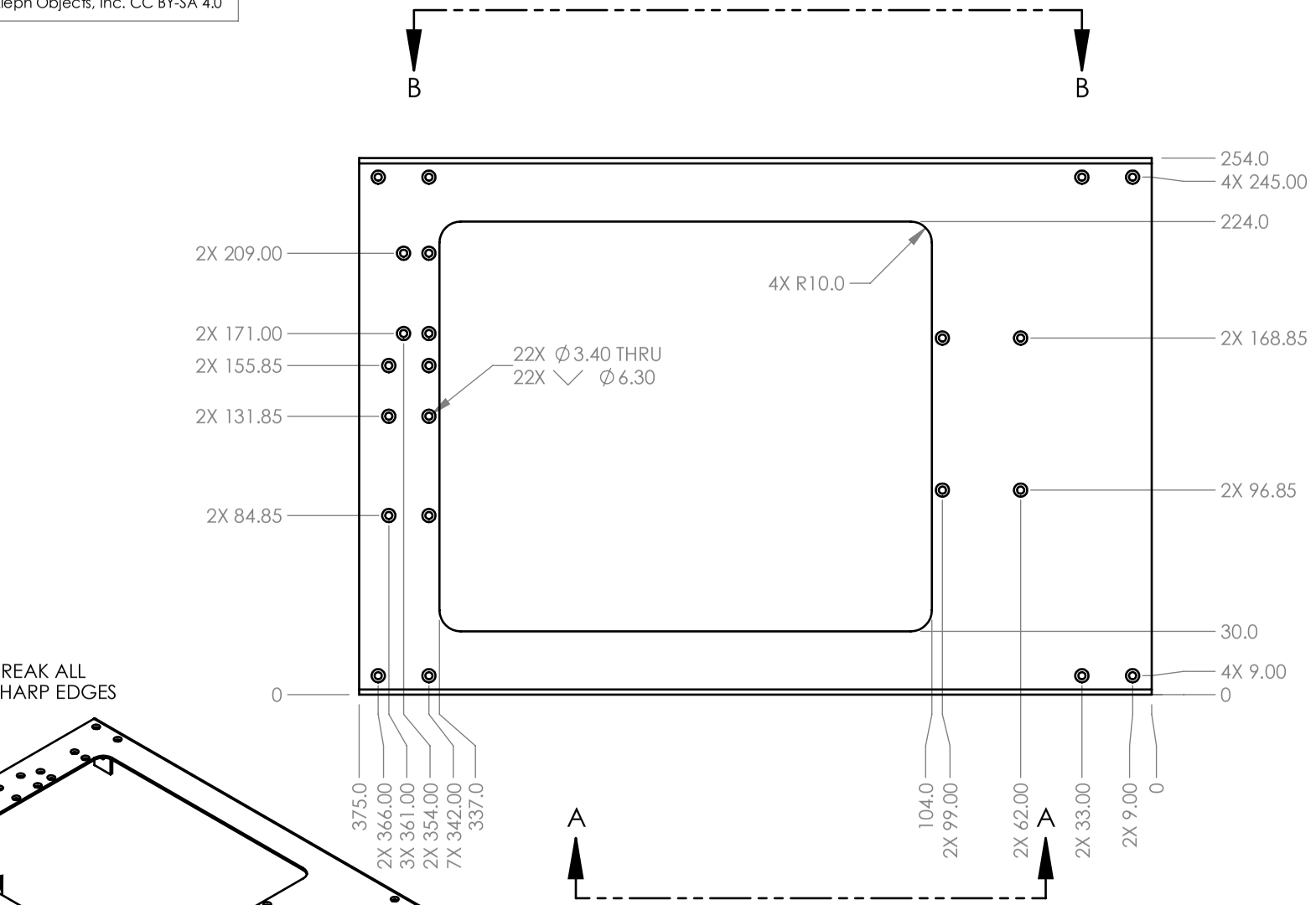

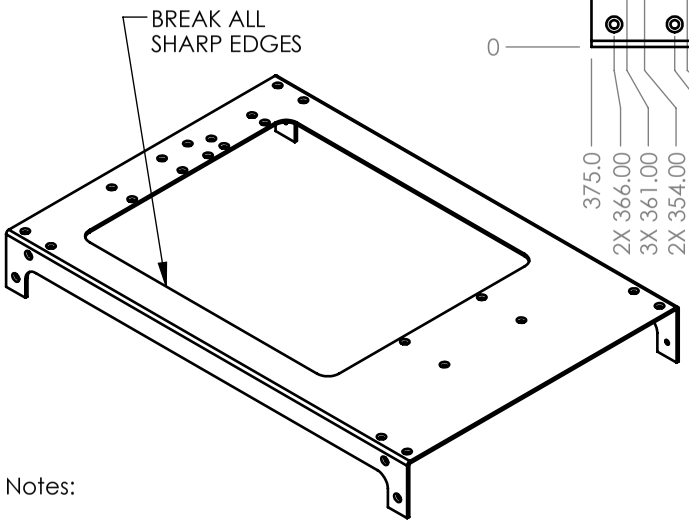

Notes:

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.

DRAWN BY	SINNEMA 7/18/14
MATERIAL	See Notes

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN MILLIMETERS.
TOLERANCES ARE:

DECIMALS	ANGLES
.X ±.75	X° ±1°
.XX ±.25	
.XXX ±.125	63
.XXXX ±.050	

BREAK EDGES .005/.020
FILLET RADIUS .005/.020

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TITLE

Right Plate, Mini

SIZE	DWG NO.	REV.
A	PP-FP0052	A

SCALE		SHEET
1:3	DO NOT SCALE DRAWING	1 OF 2

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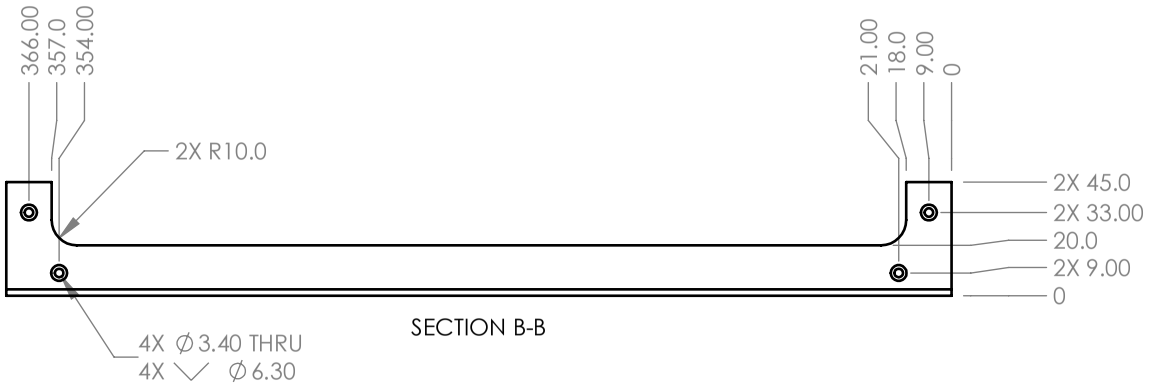
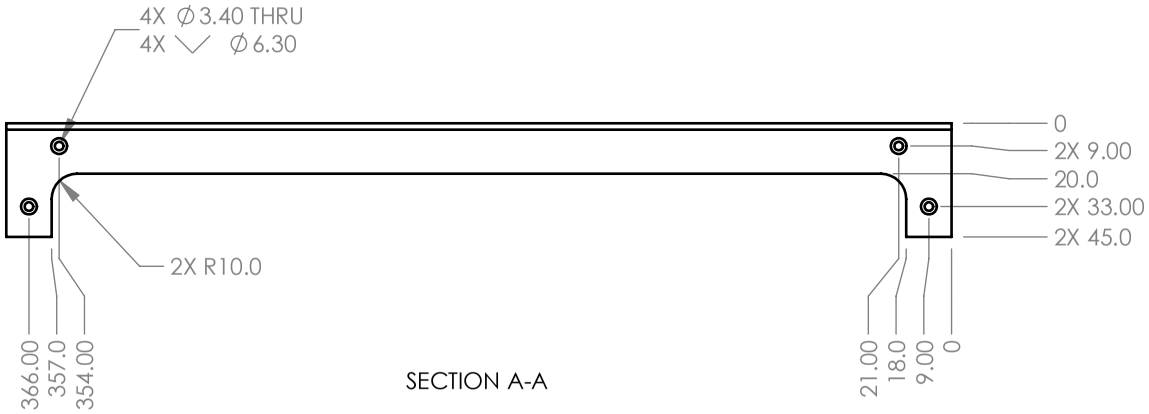


SECTION B-B



SECTION A-A

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

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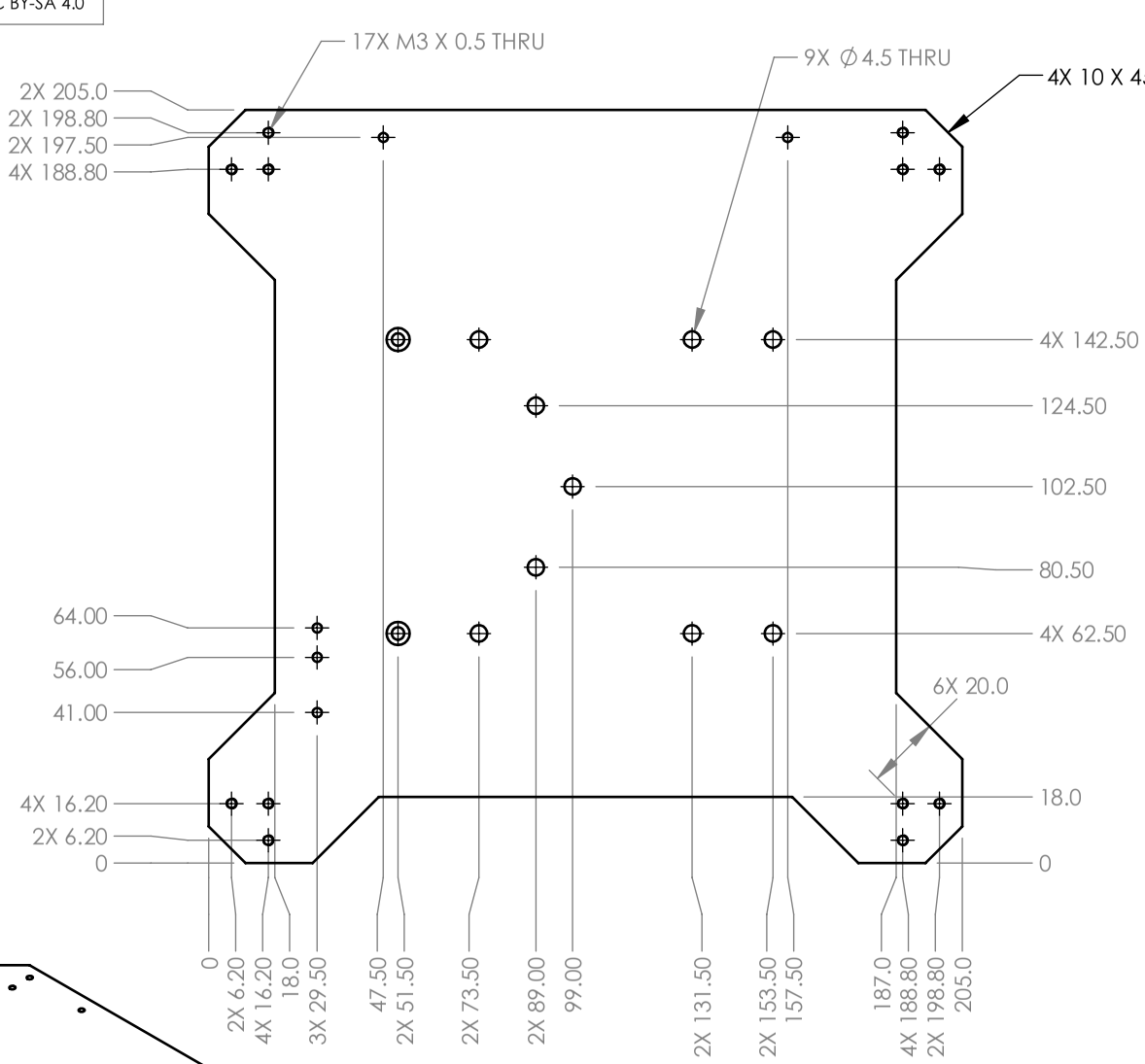
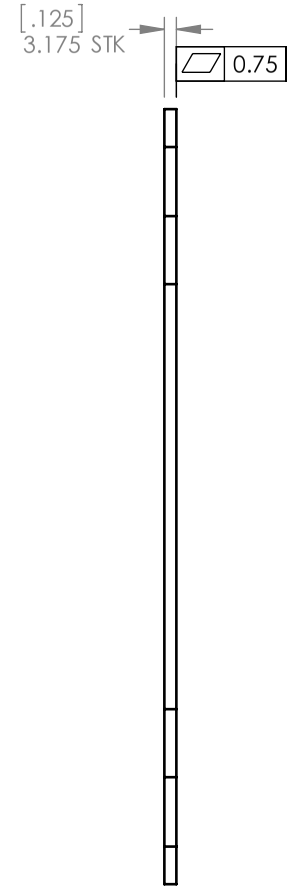
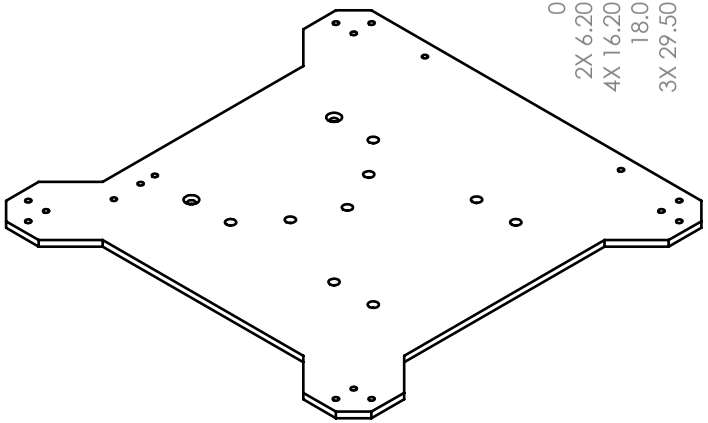




NOTES:

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



DRAWN BY	SINNEMA 7/18/14
MATERIAL	See Notes

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MILLIMETERS. TOLERANCES ARE:

DECIMALS	ANGLES
.X ±.75	X° ±1°
.XX ±.25	
.XXX ±.125	63
.XXXX ±.050	

BREAK EDGES .005/.020
FILLET RADIUS .005/.020

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TITLE

Bed Mount Plate, Mini

SIZE	DWG NO.	REV.
A	PP-FP0054	A

SCALE		SHEET
1:2	DO NOT SCALE DRAWING	1 OF 1

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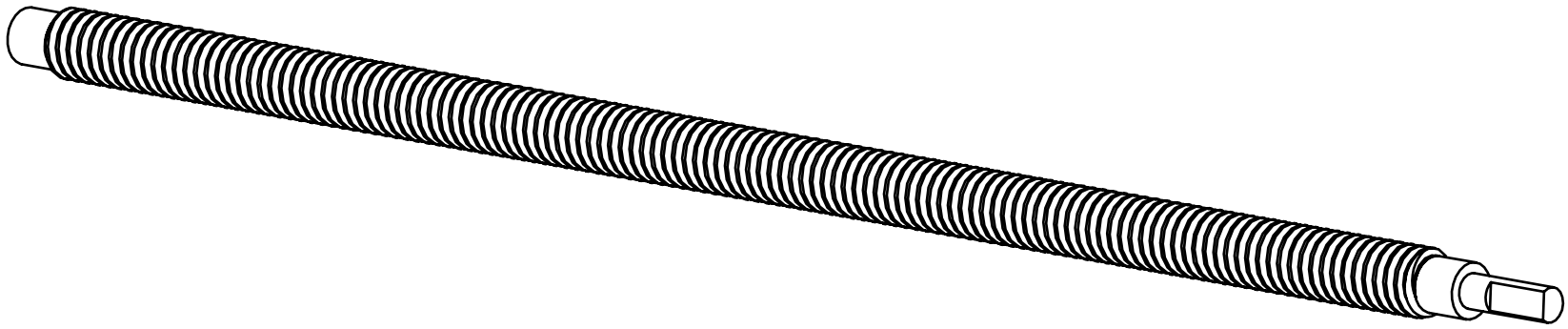

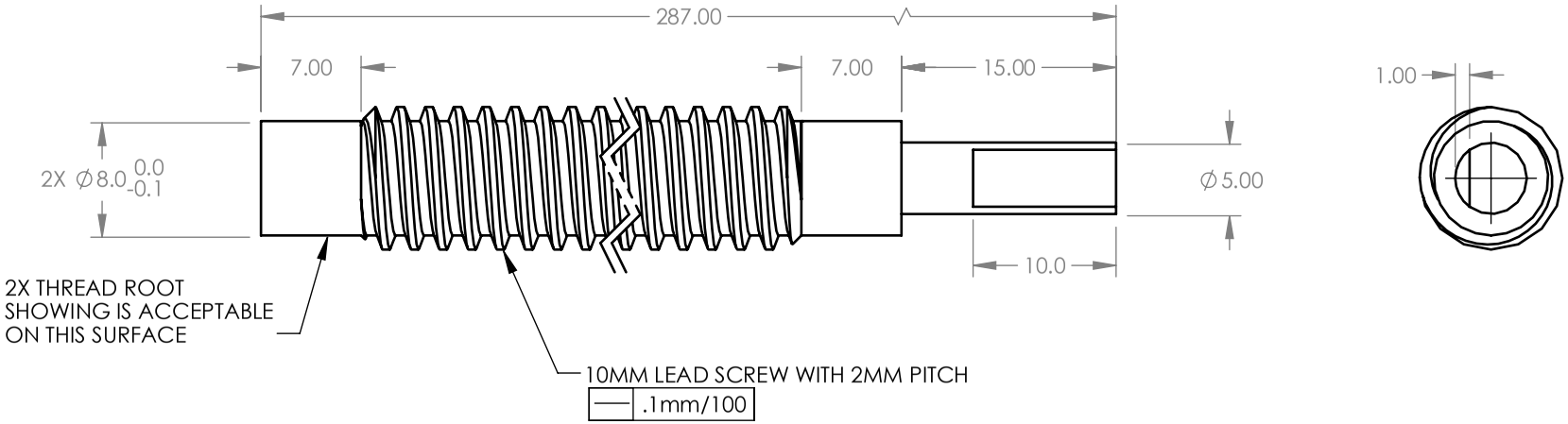

DRAWN BY	SINNEMA 9/1/14
MATERIAL	Stainless Steel

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN MILLIMETERS.
TOLERANCES ARE:

DECIMALS	ANGLES
.X ±.75	X° ±1°
.XX ±.25	
.XXX ±.125	63
.XXXX ±.050	

BREAK EDGES .005/.020
FILLET RADIUS .005/.020

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TITLE

Drive Rod 10mm

SIZE	DWG NO.	REV.
A	HD-RD0036	A

SCALE		SHEET
2:1	DO NOT SCALE DRAWING	1 OF 1

3.4 3D Printed Parts

3.5 Bed

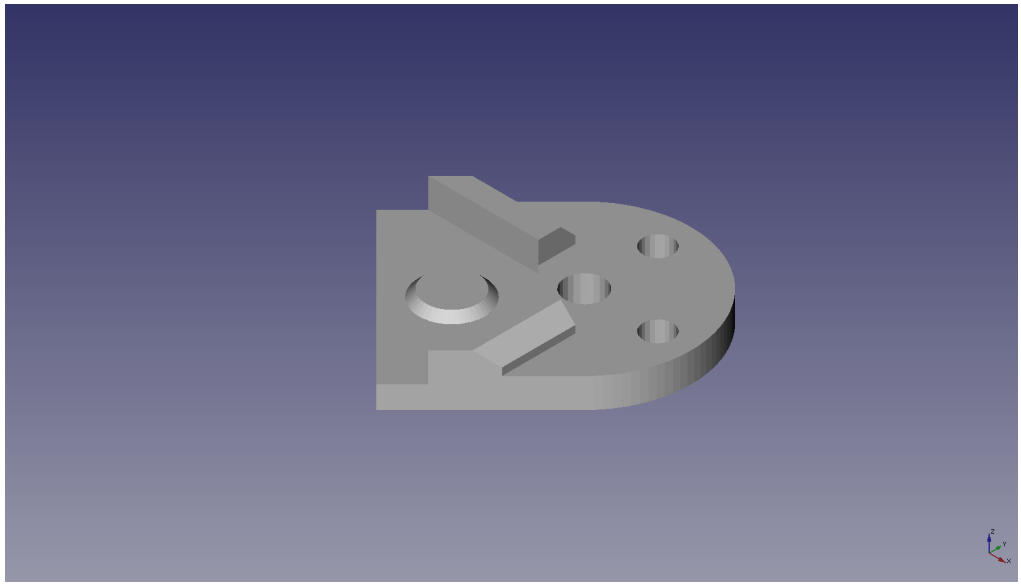

Figure 3.9: 3D Printed Bed Corner Render

3.6 Extruder

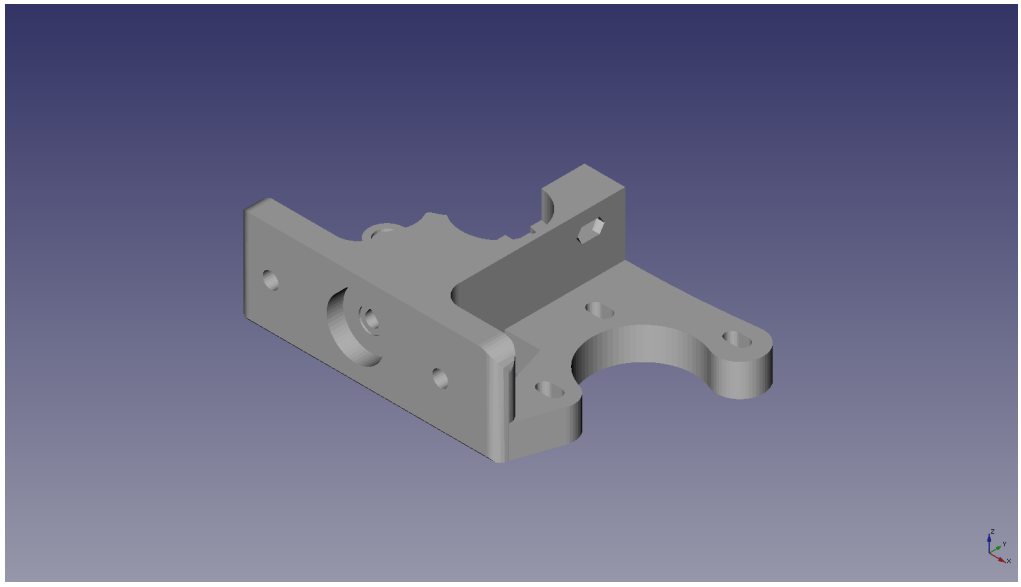

Figure 3.10: 3D Printed Extruder Body Render

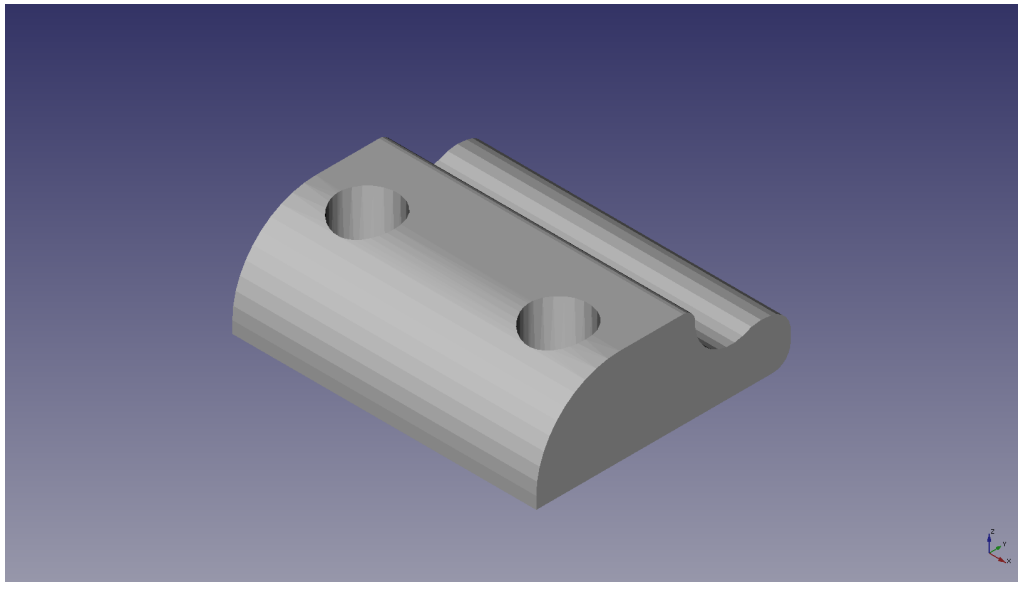

Figure 3.11: 3D Printed Extruder Latch Render

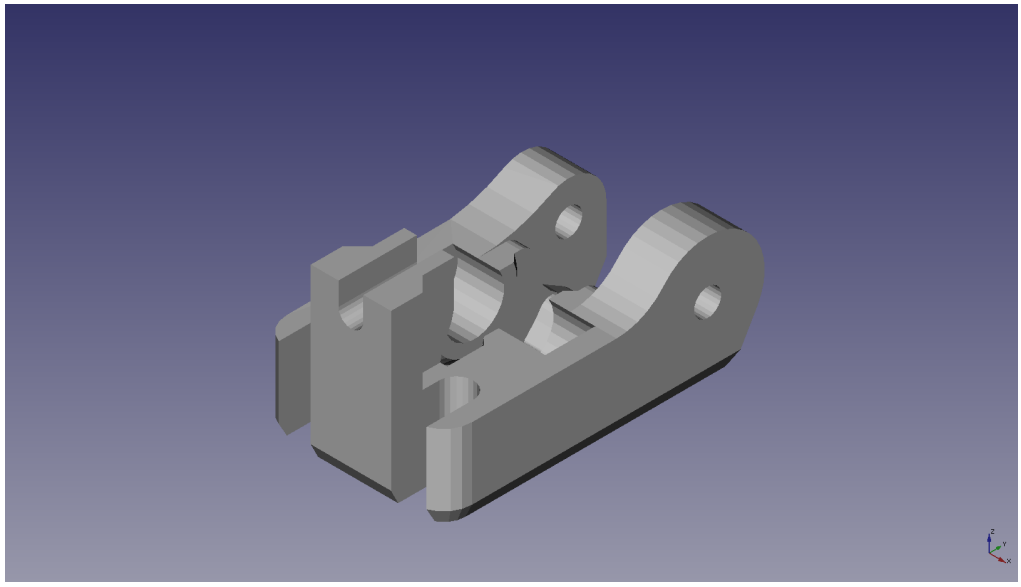

Figure 3.12: 3D Printed Idler Render

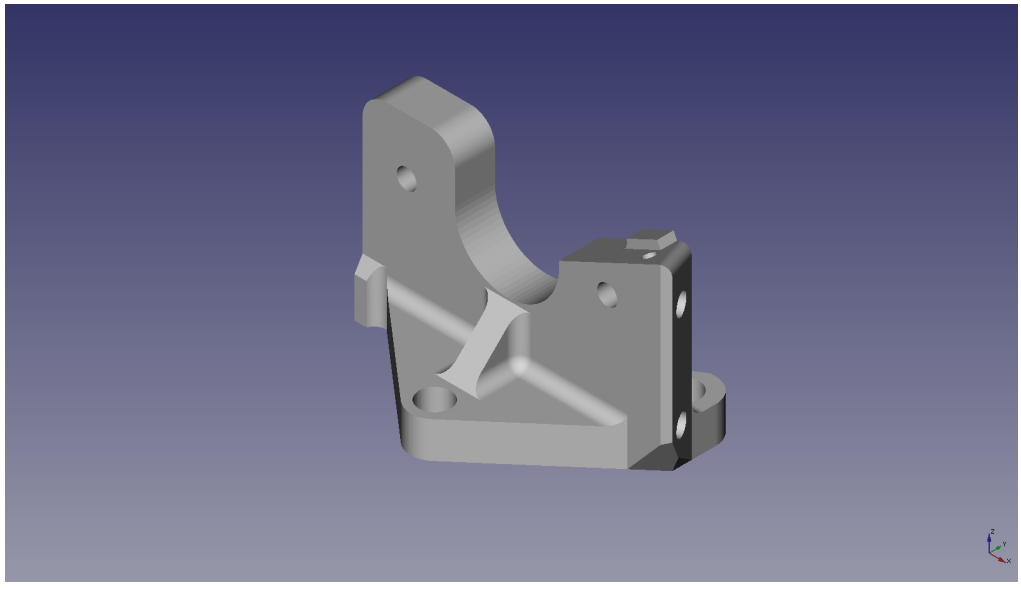

Figure 3.13: 3D Printed Extruder Mount Render

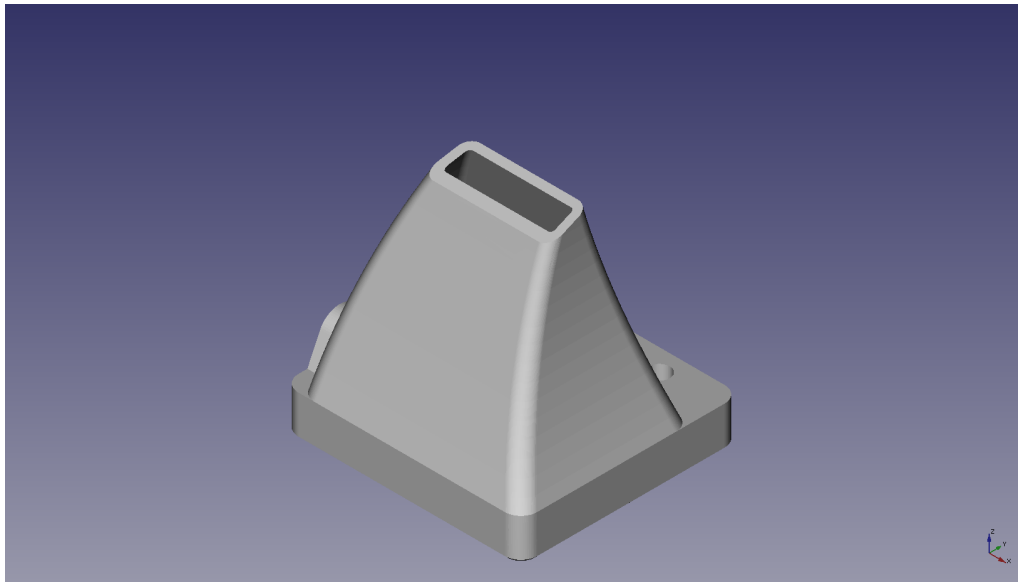

Figure 3.14: 3D Printed Fan Mount Render

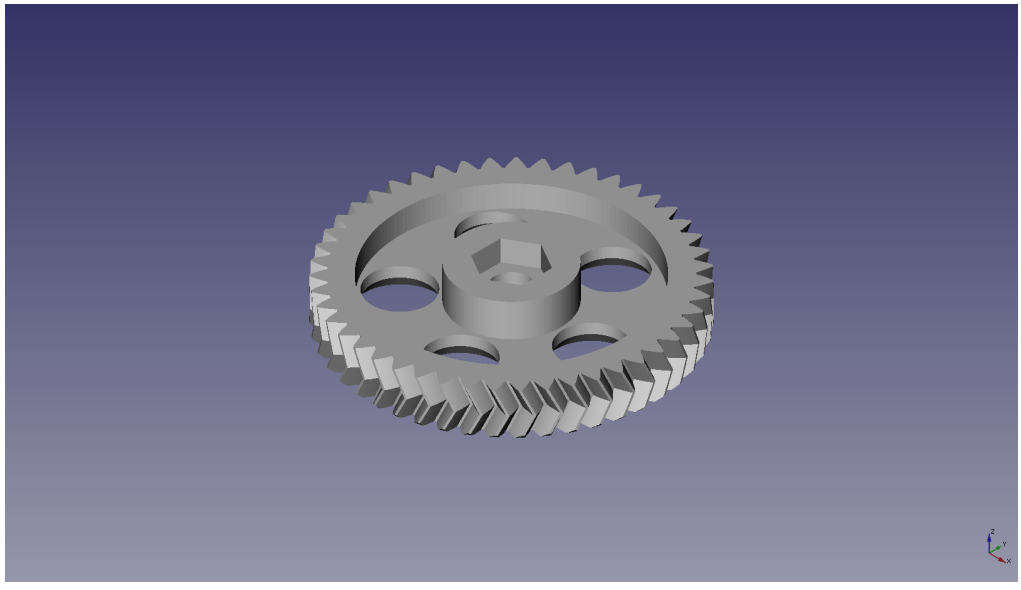

Figure 3.15: 3D Printed Large Gear Render

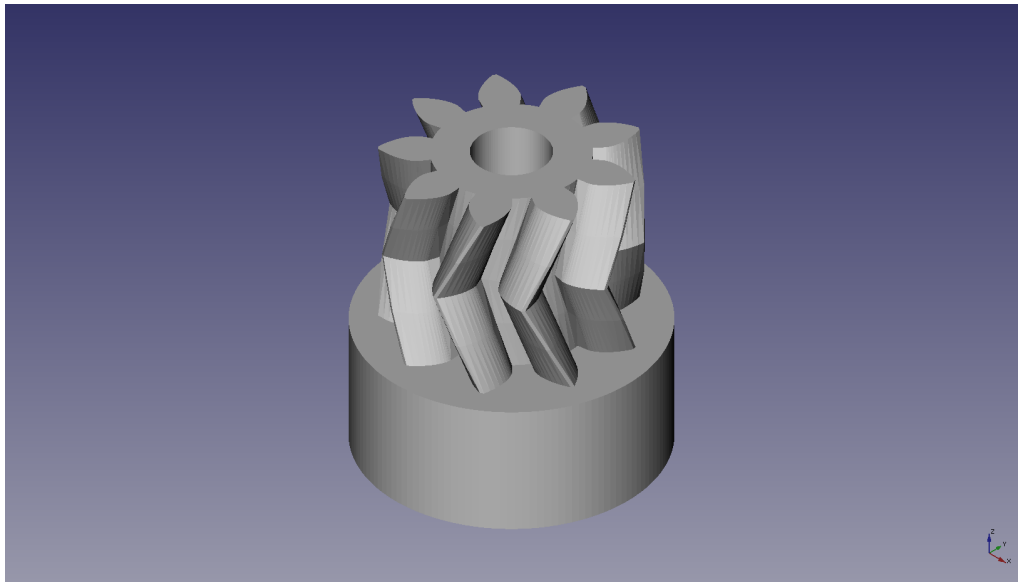

Figure 3.16: 3D Printed Small Gear Render

3.7 Spool

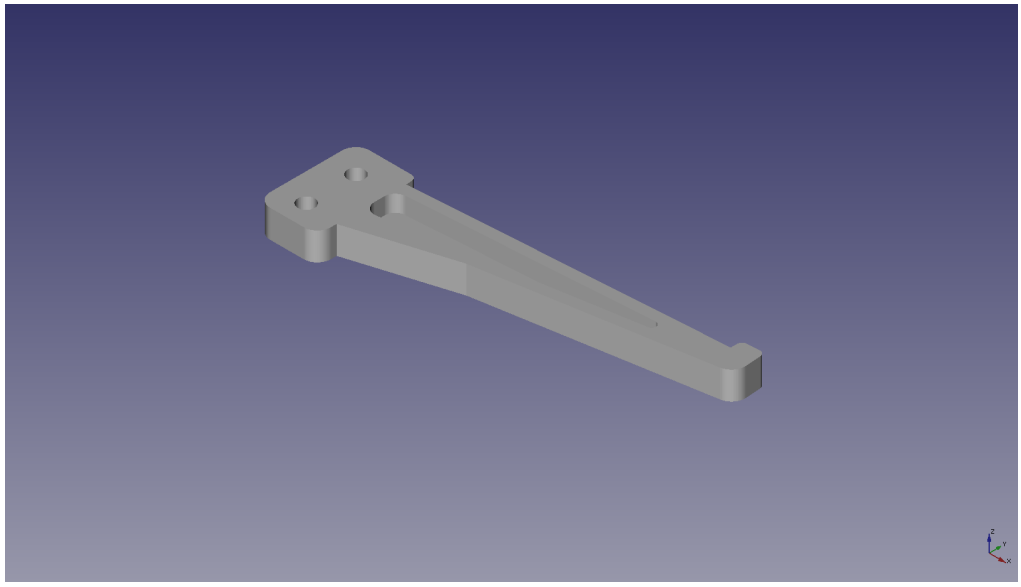

Figure 3.17: 3D Printed Spool Arm Render

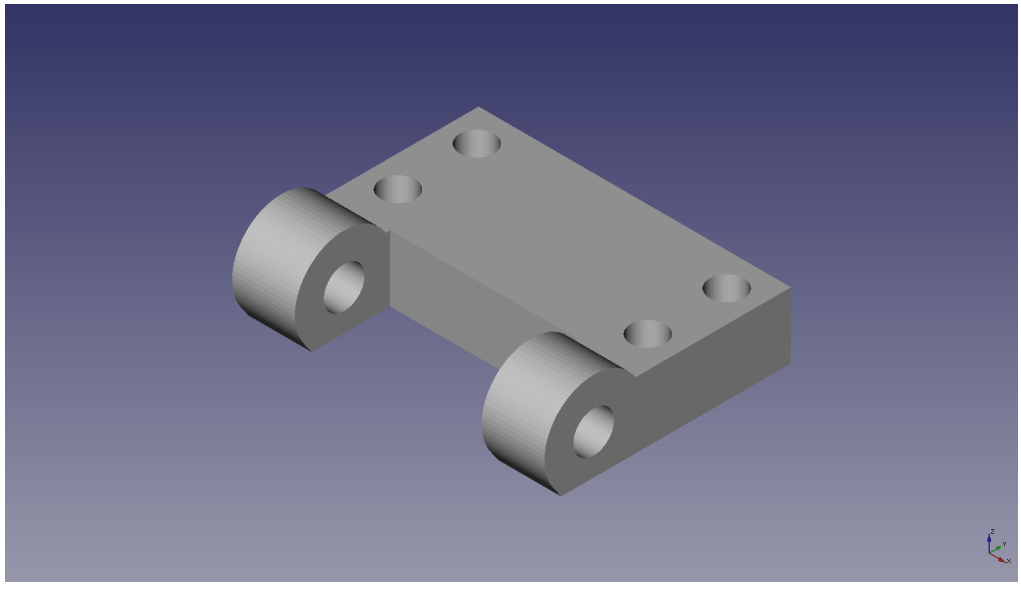

Figure 3.18: 3D Printed Spool Hinge Render

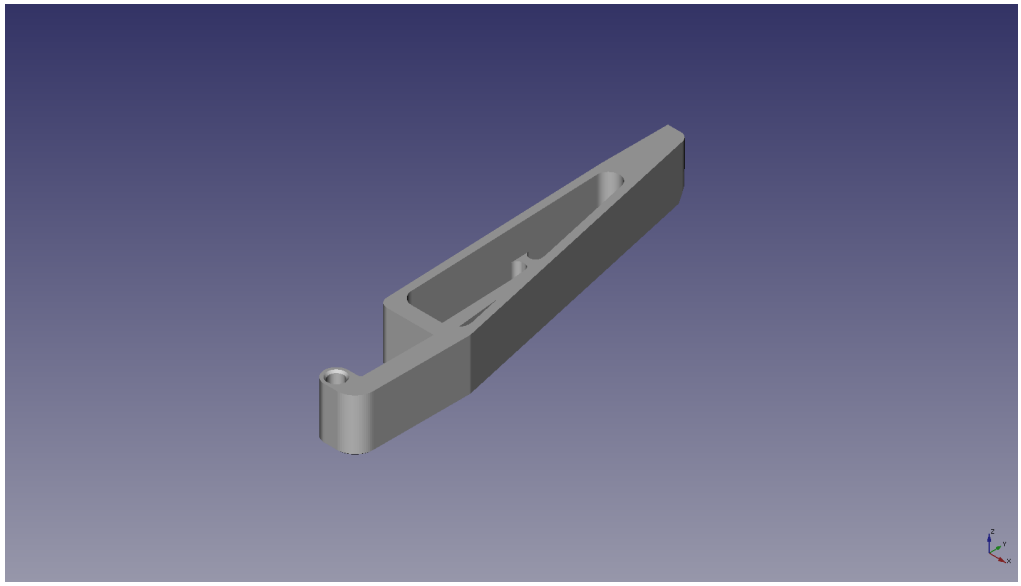

Figure 3.19: 3D Printed Spool Mount Render

3.8 X

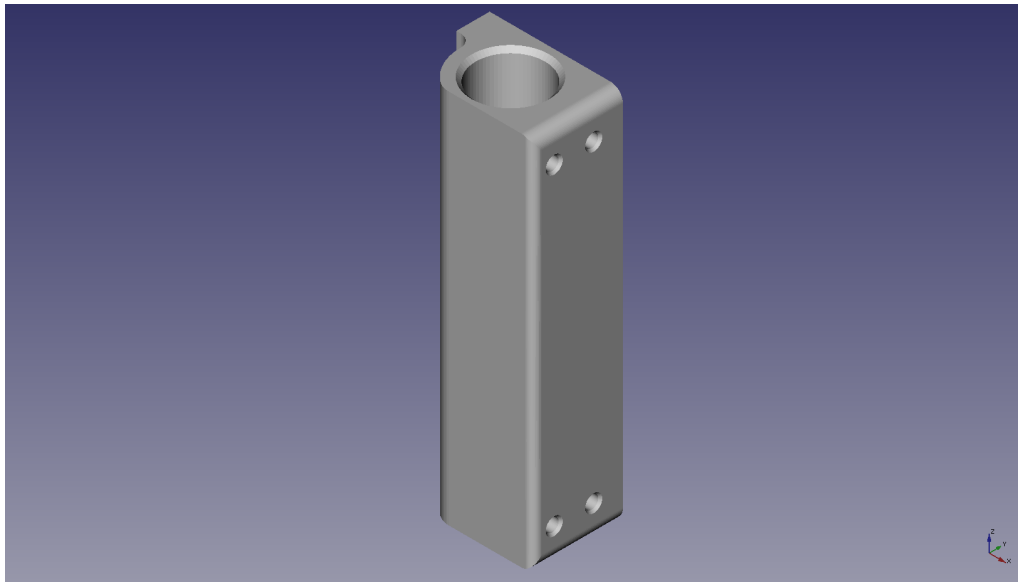

Figure 3.20: 3D Printed Double Bearing Holder Render

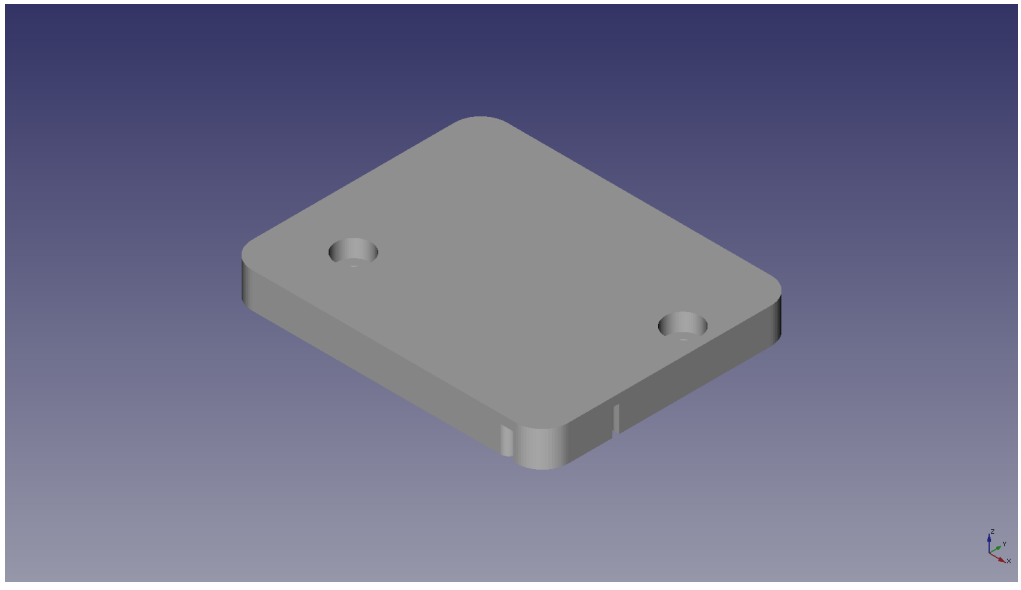

Figure 3.21: 3D Printed X Carriage Cover Render

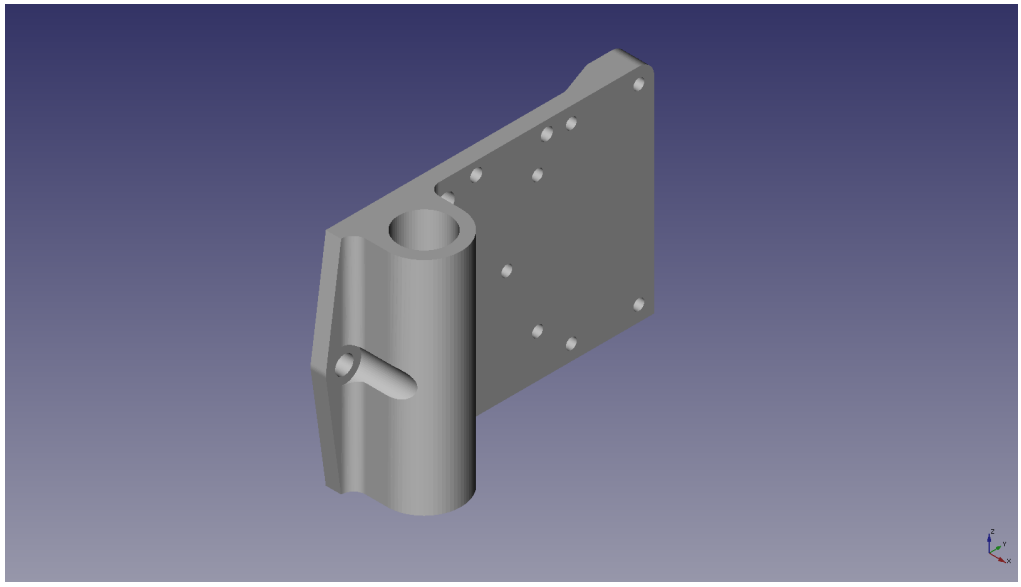

Figure 3.22: 3D Printed X Carriage Render

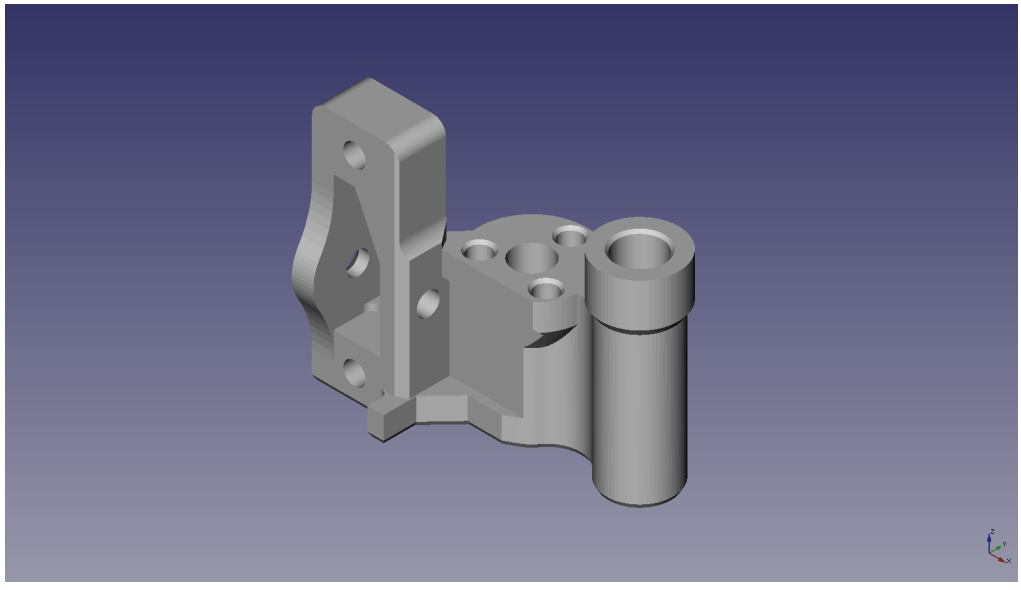

Figure 3.23: 3D Printed X End Idler Render

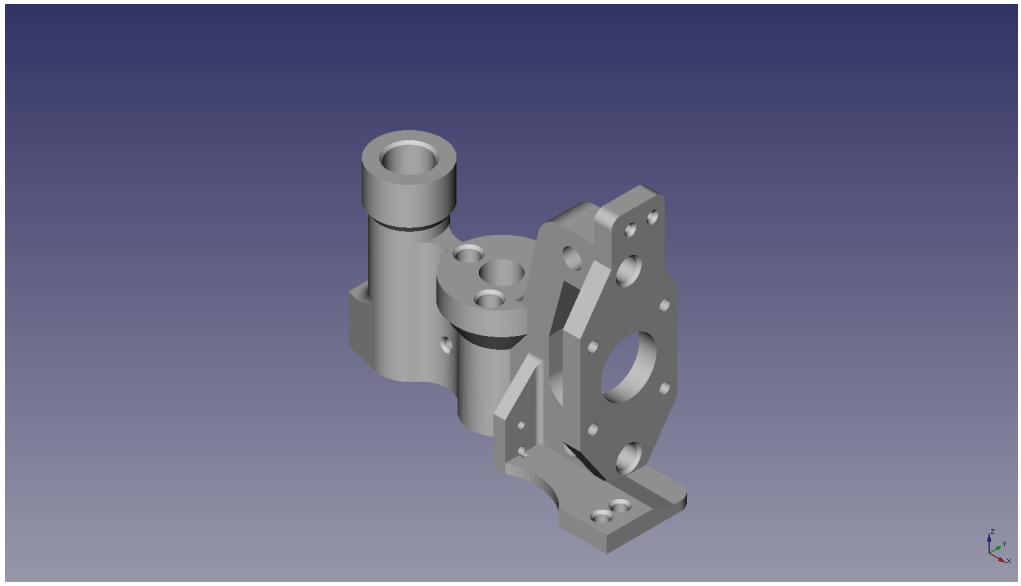

Figure 3.24: 3D Printed X End Motor Render

3.9 Y

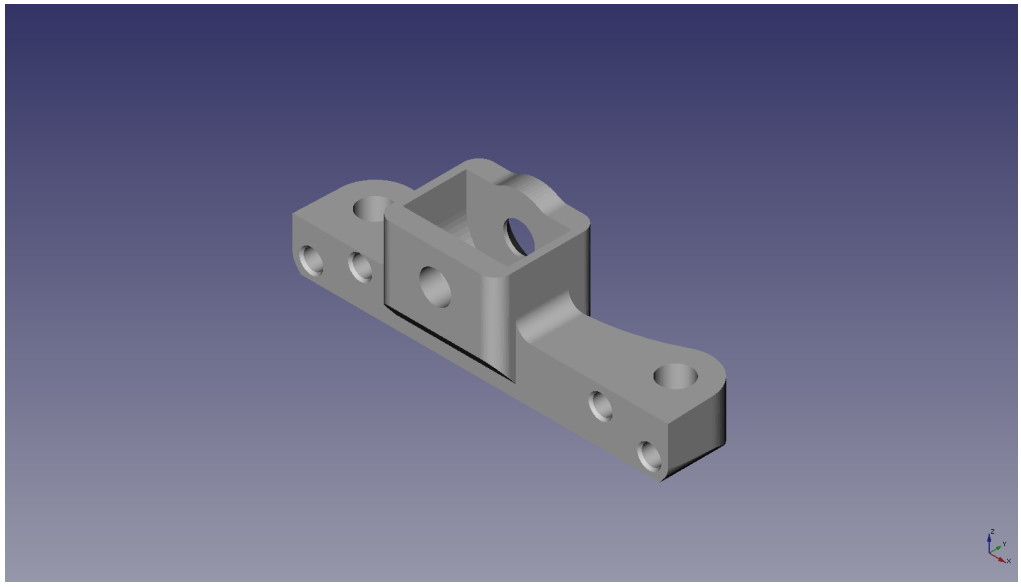

Figure 3.25: 3D Printed Y End Idler Render

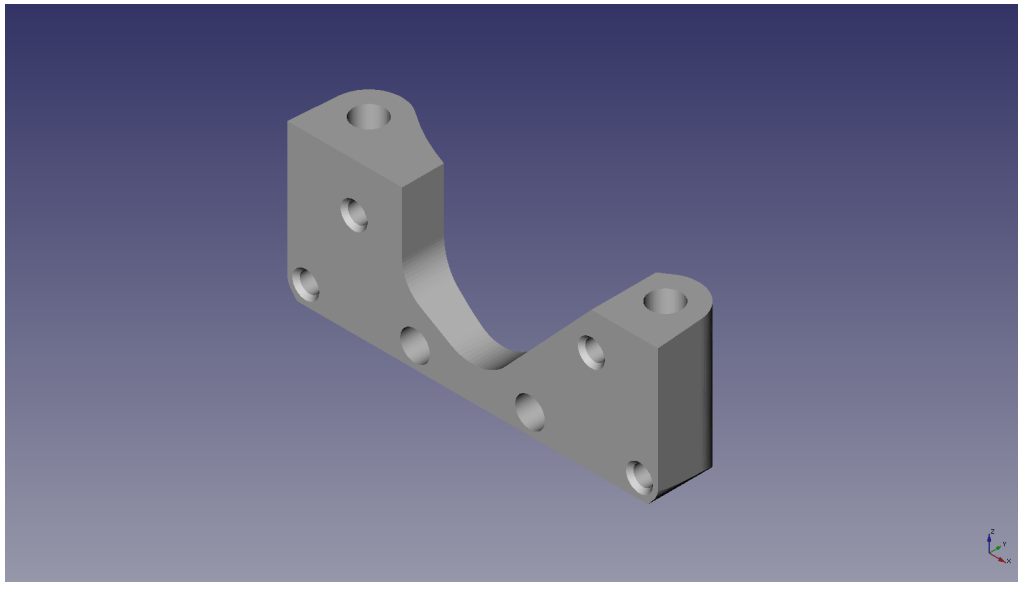

Figure 3.26: 3D Printed Y End Rod Mount Render

3.10 Z

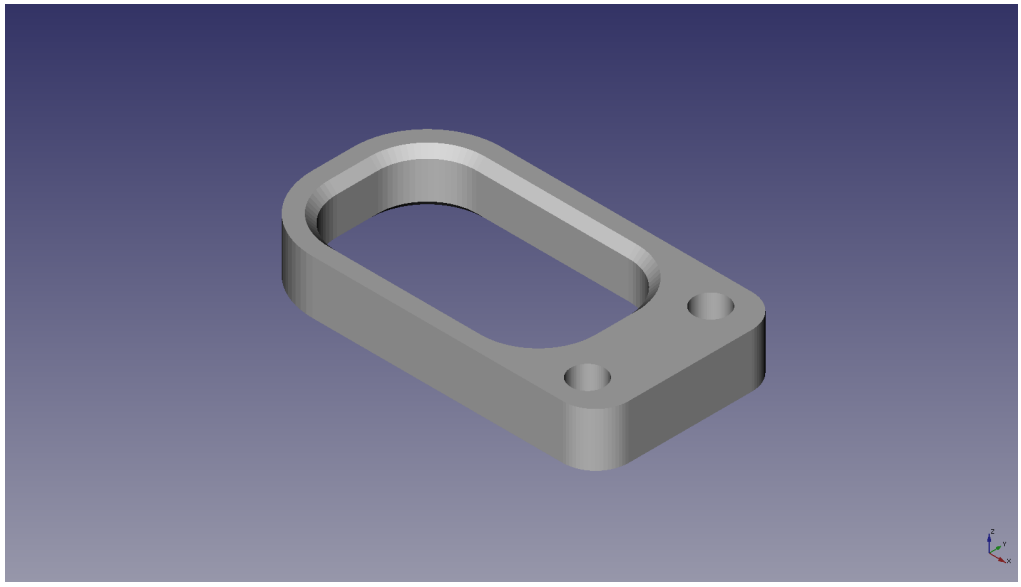

Figure 3.27: 3D Printed Lower Relief Render

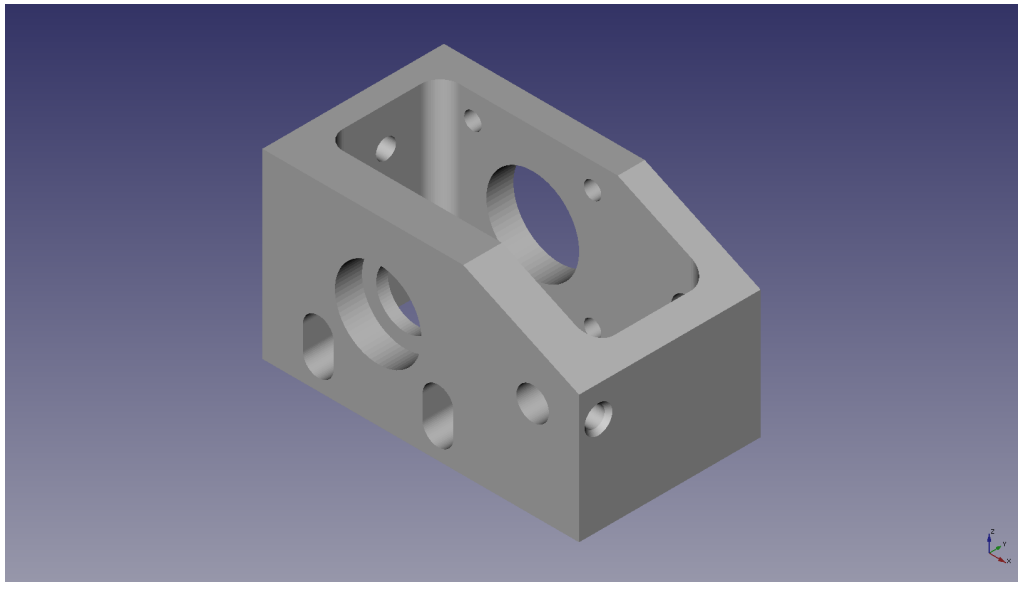

Figure 3.28: 3D Printed Lower Z Left Render

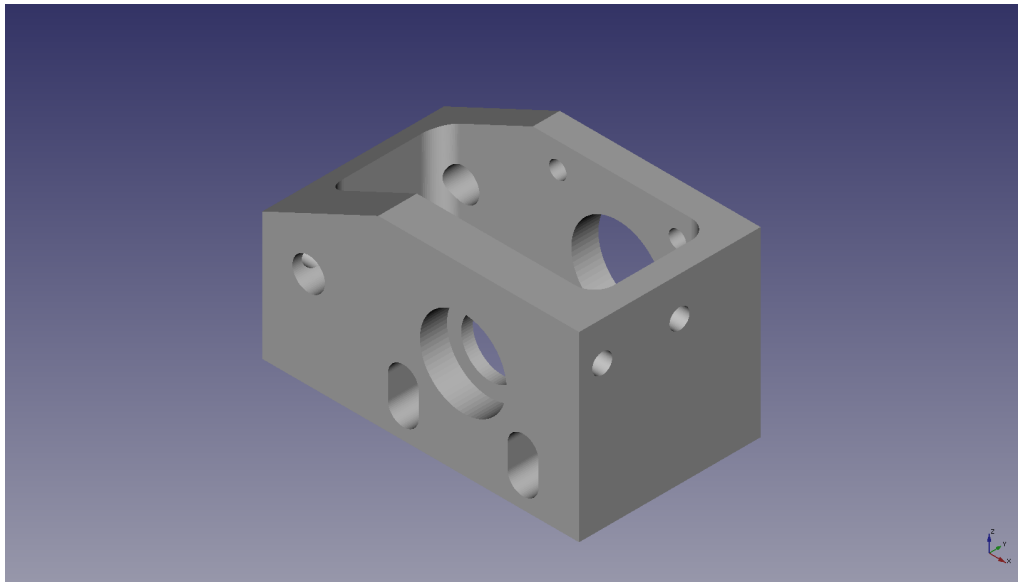

Figure 3.29: 3D Printed Lower Z Right Render

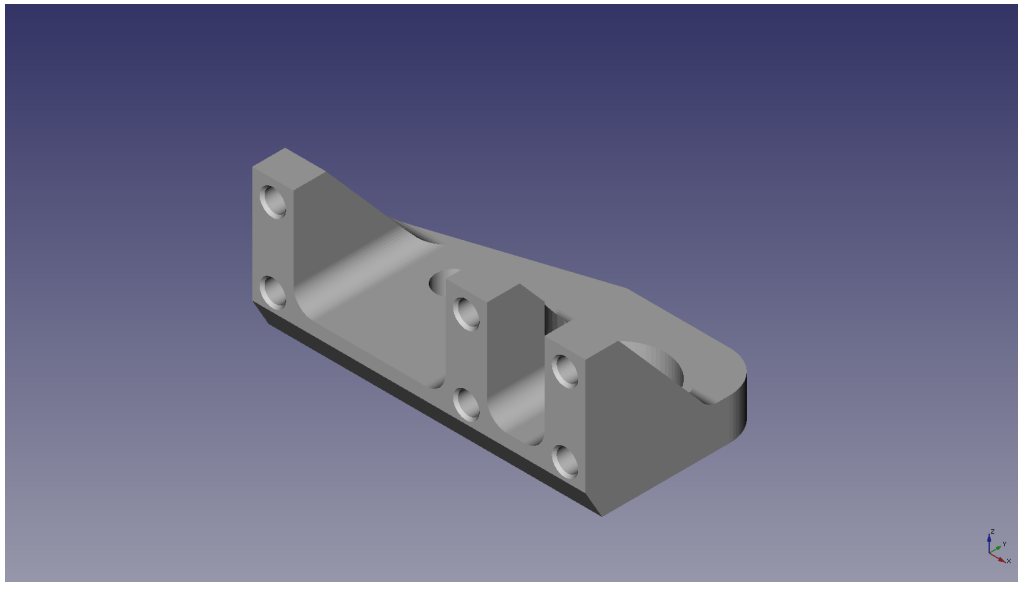

Figure 3.30: 3D Printed Upper Z Left Render

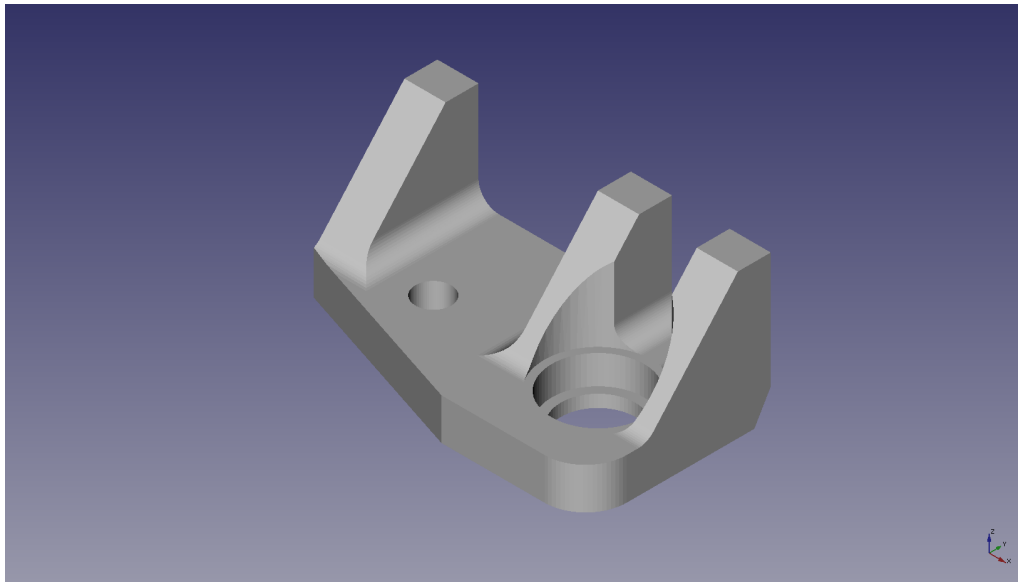

Figure 3.31: 3D Printed Upper Z Right Render

3.11 Misc

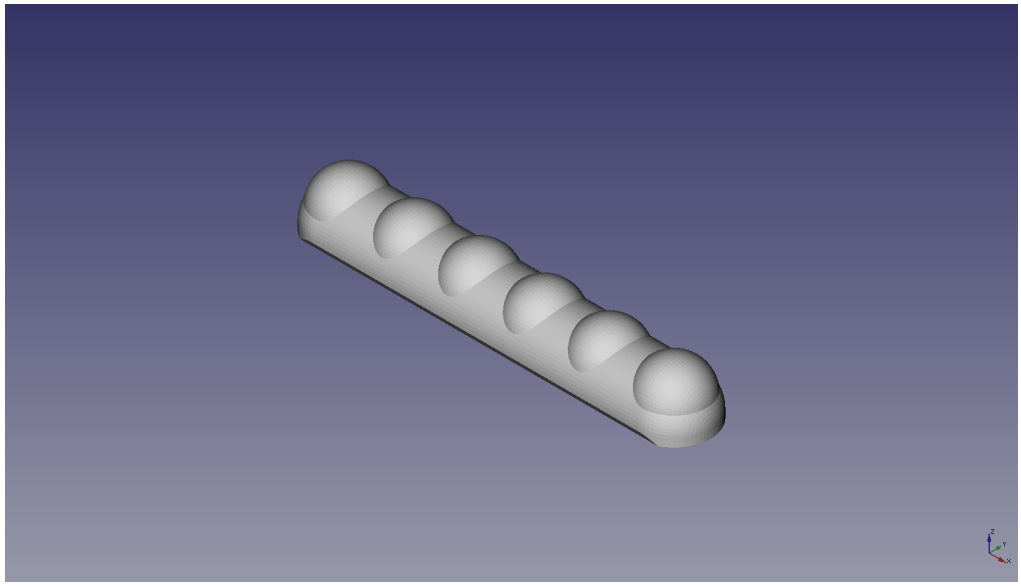

Figure 3.32: 3D Printed Handle Bar Render

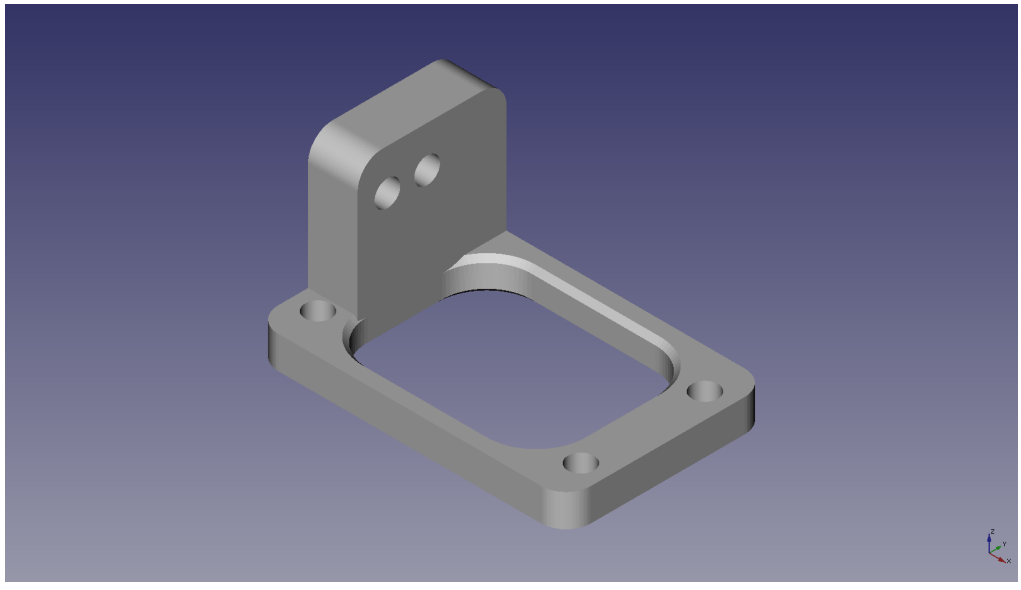

Figure 3.33: 3D Printed Relief Mount Render

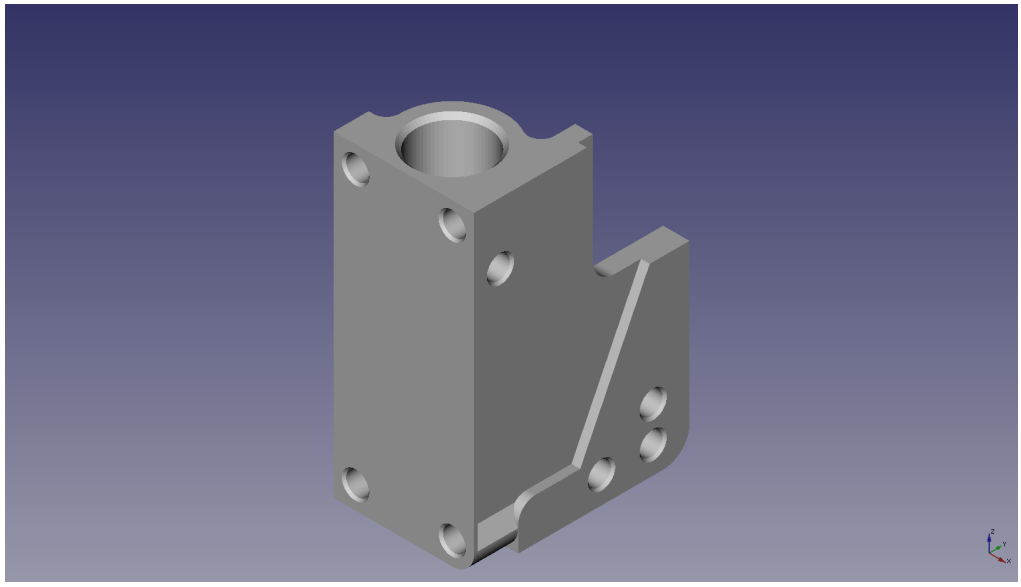

Figure 3.34: 3D Printed Upper Bearing Holder Render

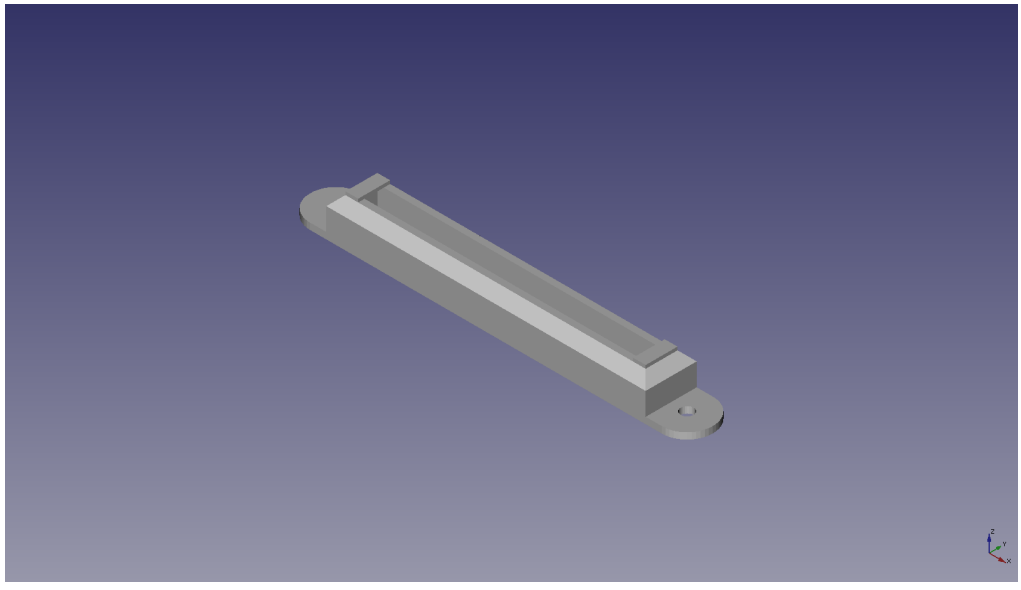

Figure 3.35: 3D Printed Wiper Mount Render

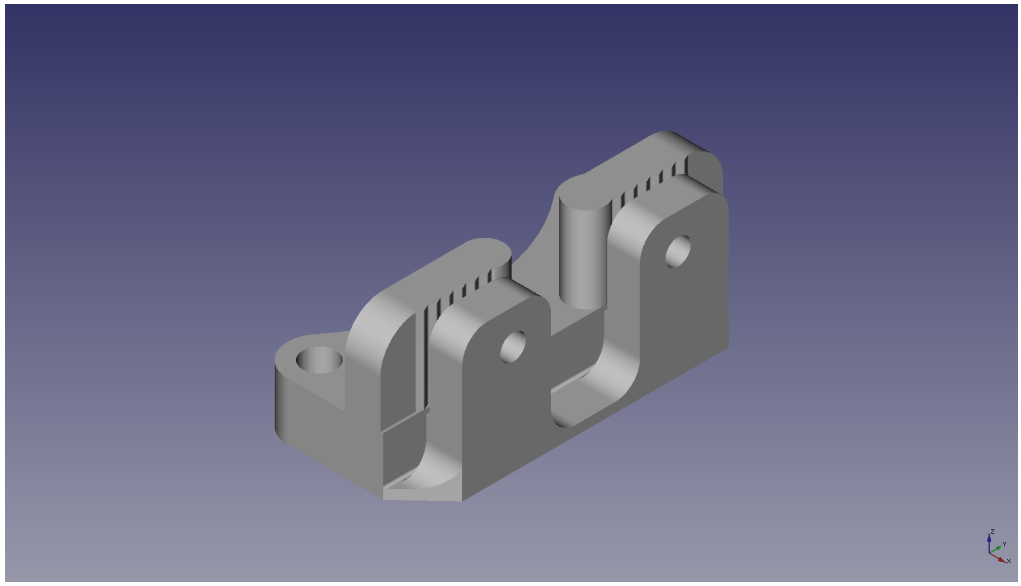

Figure 3.36: 3D Printed Belt Mount Render

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 panduit wrap
Y-motor		Grey 4 cond	410	Trim shielding 20mm, all wires 4mm	Trim shielding 55 with lug, all wires 4mm	1	305 panduit 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

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?

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?

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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Packing

If It Shakes It Breaks

7.1 Packing List

Pack it well.

PACKING LIST

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

*Rocktopus by Kent Johnson is licensed under CC BY-SA 4.0 and derived from work by dietz1 and yeoldebrian - lulzbot.com/rocktopus

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8.2 Sales

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8.3 Websites

Aleph Objects, Inc.
http://www.alephobjects.com
LulzBot 3D Printers
http://www.lulzbot.com

Colophon

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GNU/Linux

LaTeX Memoir