SWIMS BedBuddy FDR

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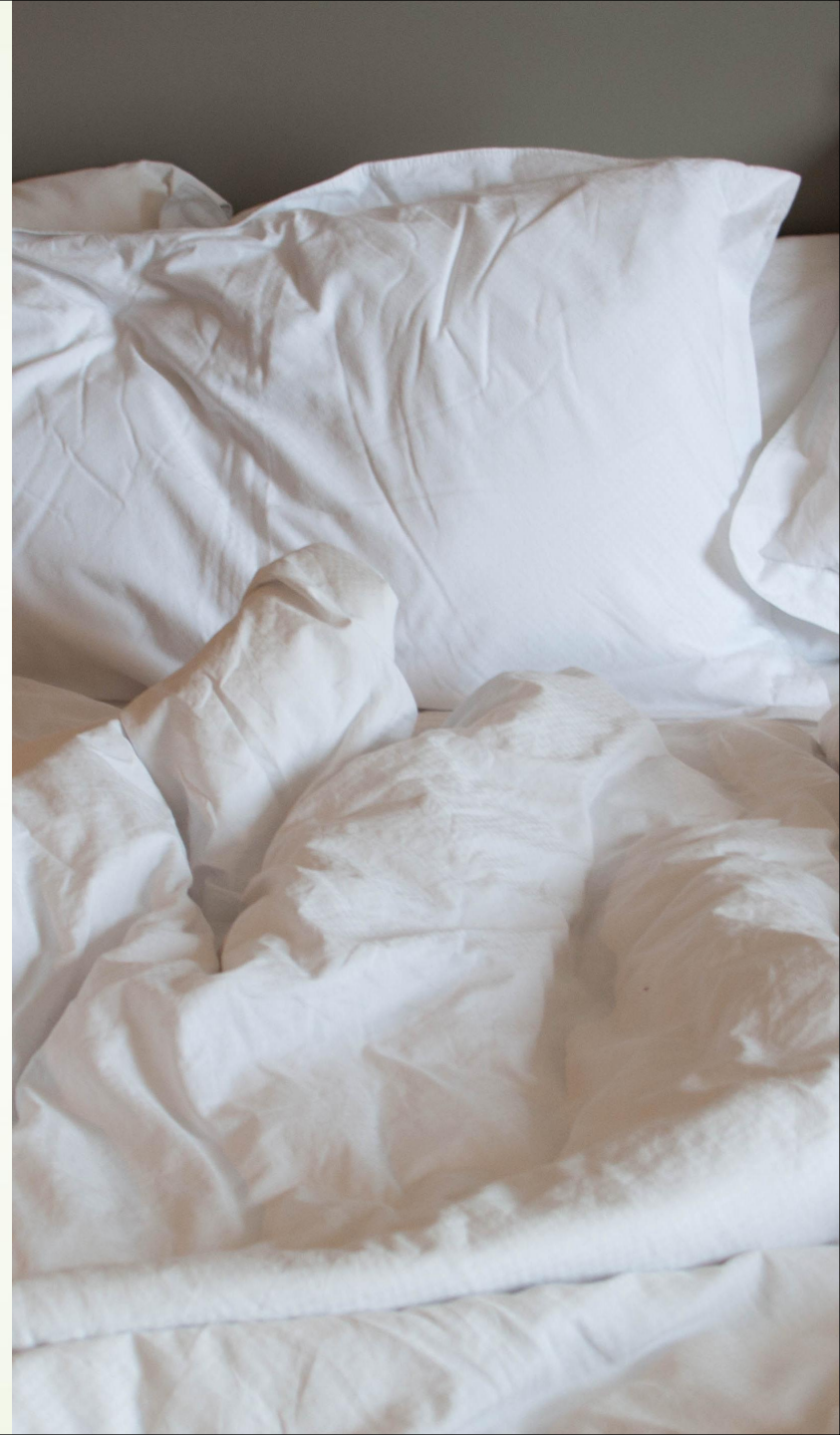
CDR Recap

Problem Definition

- One under looked aspect of daily life is making a bed and/or changing bedsheets.
- People who are affected the most:
  - Elderly
  - Caregivers
  - People with disabilities
  - People whose beds are in tight locations

- BedBuddy aims to ease the bed making process every day, providing a small quality of life improvement for many, while also being able to change bed sheets as desired by the consumer.



Key Stakeholders

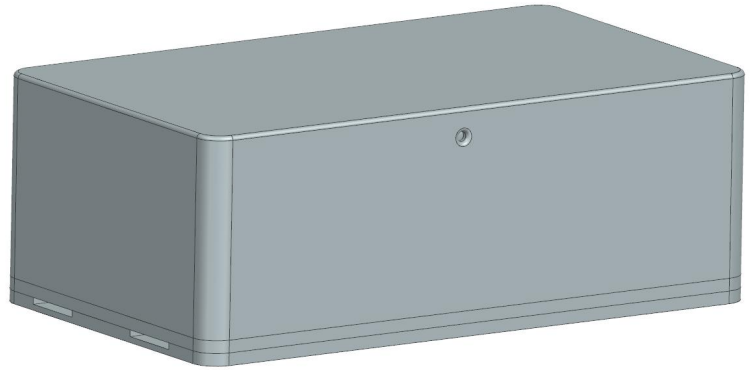
- **Primary Users:** Elderly individuals, people with disabilities, caregivers who benefit from automated bed-making
- **Commercial Stakeholders:** Nursing homes, hospitals, hotels, and cruises
- **Business and Market Interest:** Investors and manufacturers interested in innovative home and healthcare automation

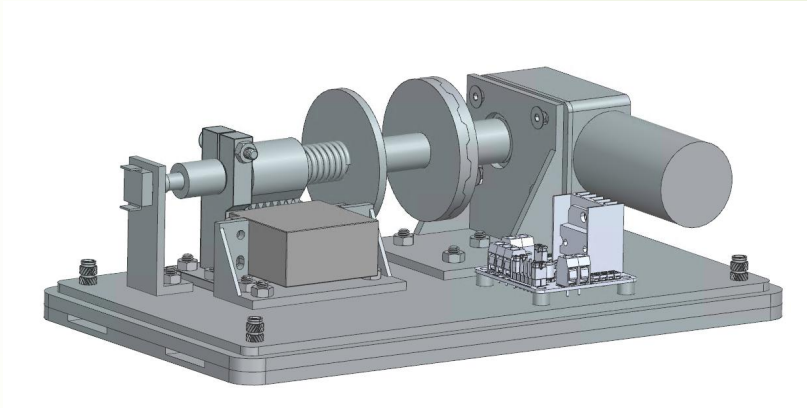
Competitors

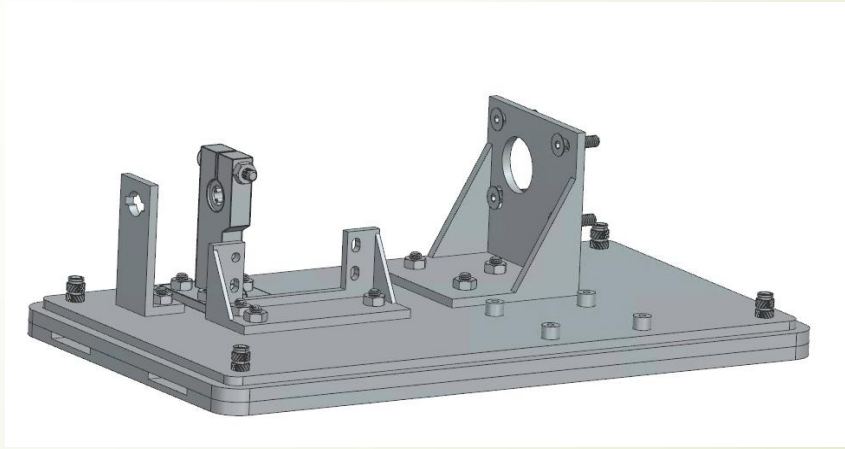
- **Existing Solutions**
  - **Bed MadeEZ** (Manual mattress lifter, requires physical effort)
  - **Smartduvet** (Expensive, uses air inflation for blanket placement only)
  - **OHEA Smart Bed** (Fully automated but requires a specialized bed)

Module

- Housing
  - 3D printed
- 12 V DC Motor
  - Self Locking
- Torque Limiter
  - To protect the motor and bed sheets
  - 3D printed
- Spool/Spindle
  - To store rope
  - 3D printed
- Spring Adjustment – to adjust amount of torque required to slip the motor
  - Spring
  - Servo
  - Rack and Pinion
- Rotary Encoder
  - Used to detect the torque limiter slipping

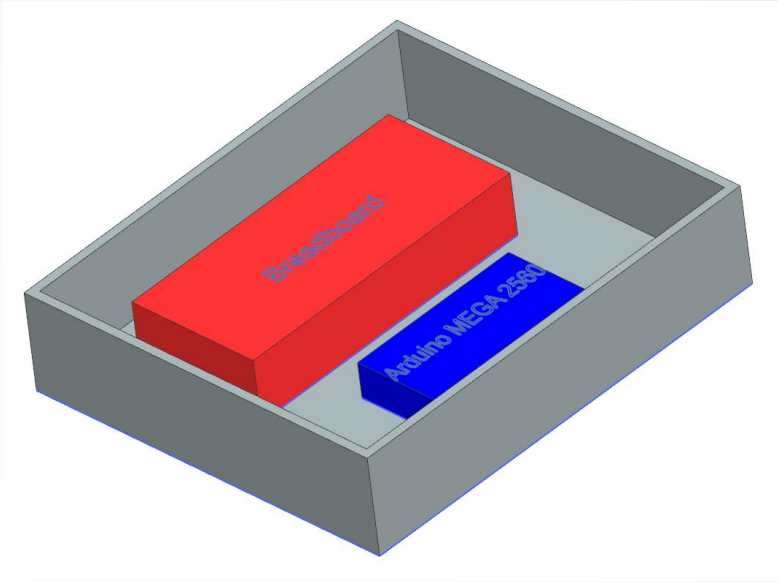


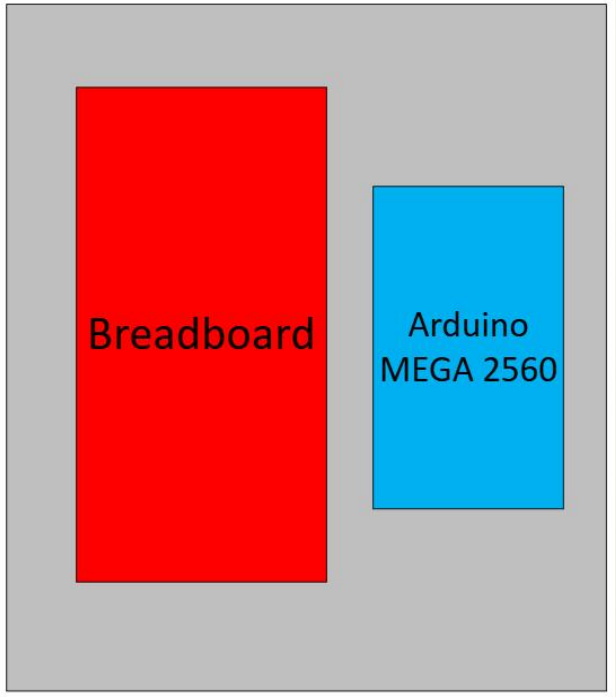




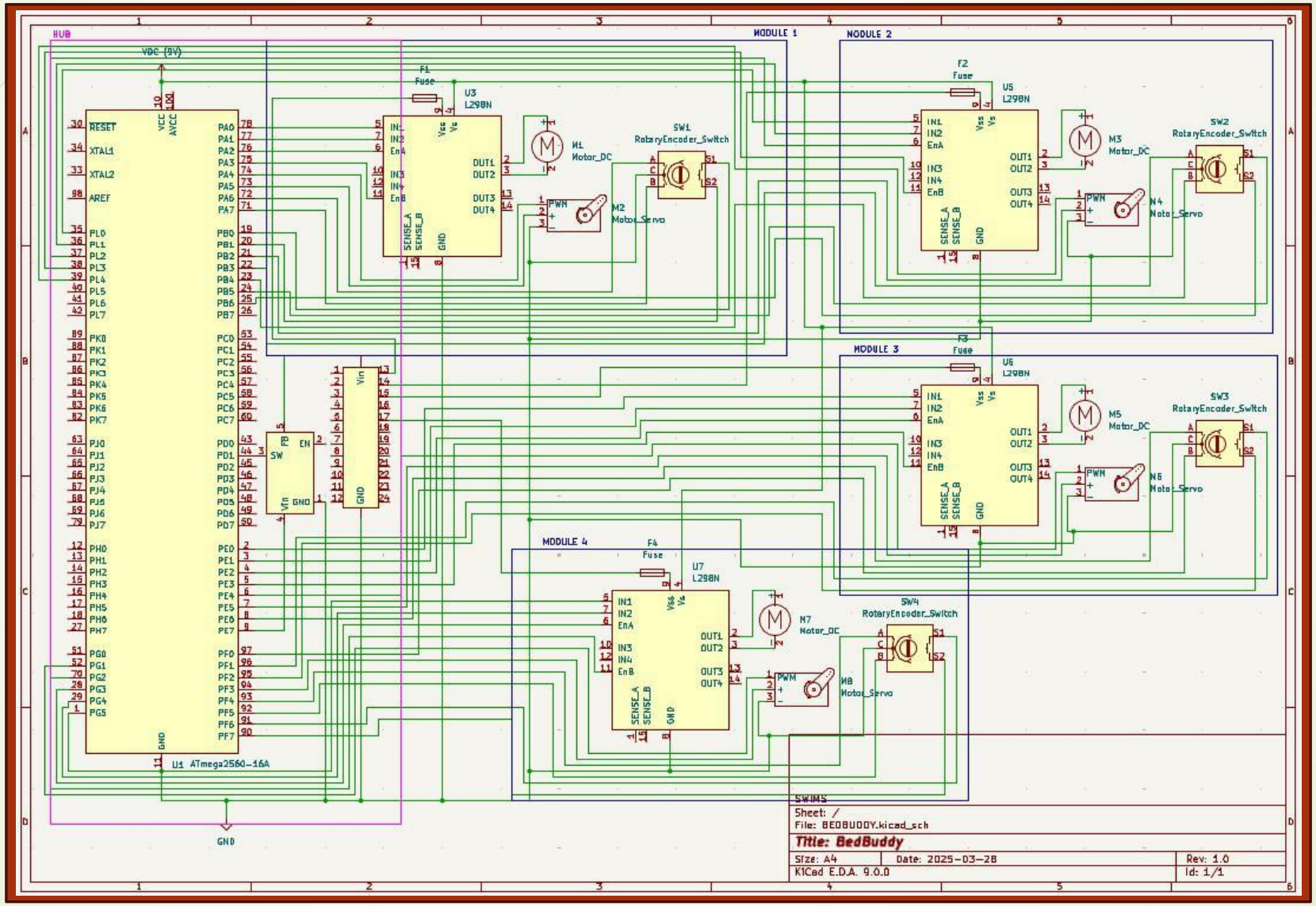
Hub

- Designed and printed to hold all parts in small size
  - 7.5 in. by 7.5 in. area and less than 3.5 in. tall
- Houses Arduino and Breadboard



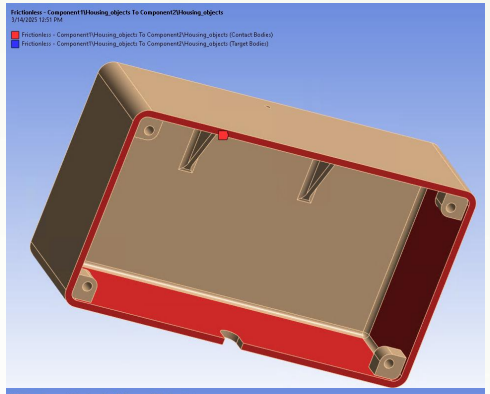


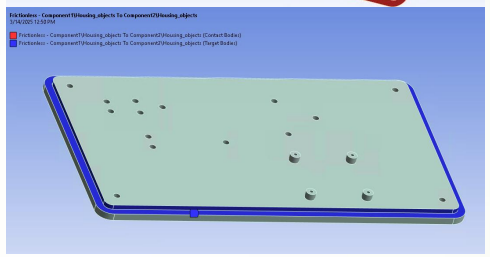
Electronics

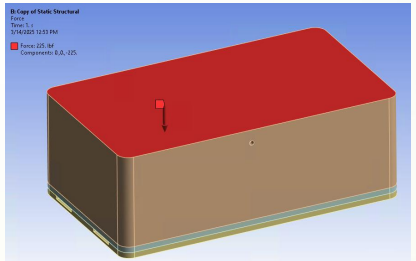


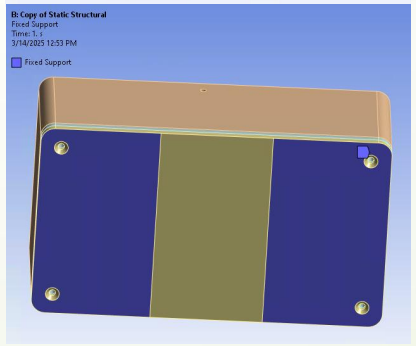
Module

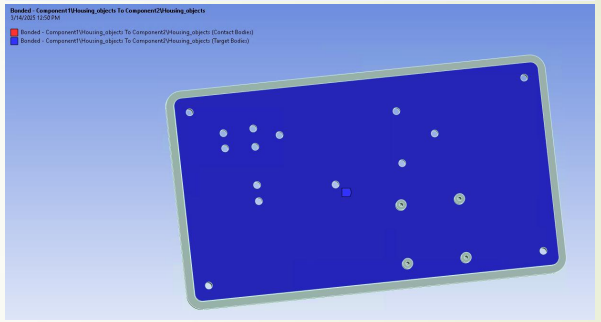
- Bonded Contact between area on shell were heat set inserts are and top of base plate
- Frictionless Contact between other faces of shell and base plate that touch to avoid clipping
- Bonded Contact between base plate and mounting plate
- 225lb Force Applied to top of shell
- Fixed Constraint on bottom of mounting plate with gap to represent standard bed frame slat spacing
- Mesh Size of .09375 (half of wall thickness)

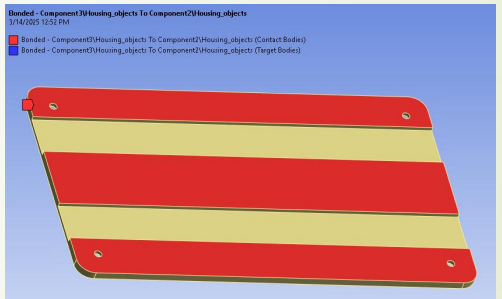


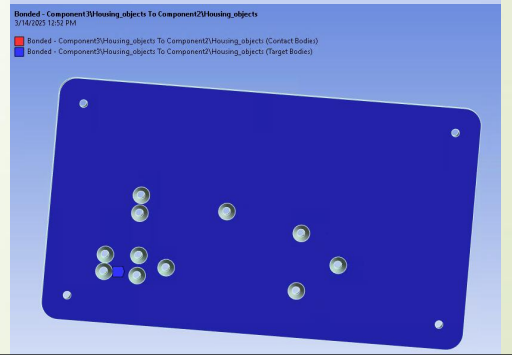






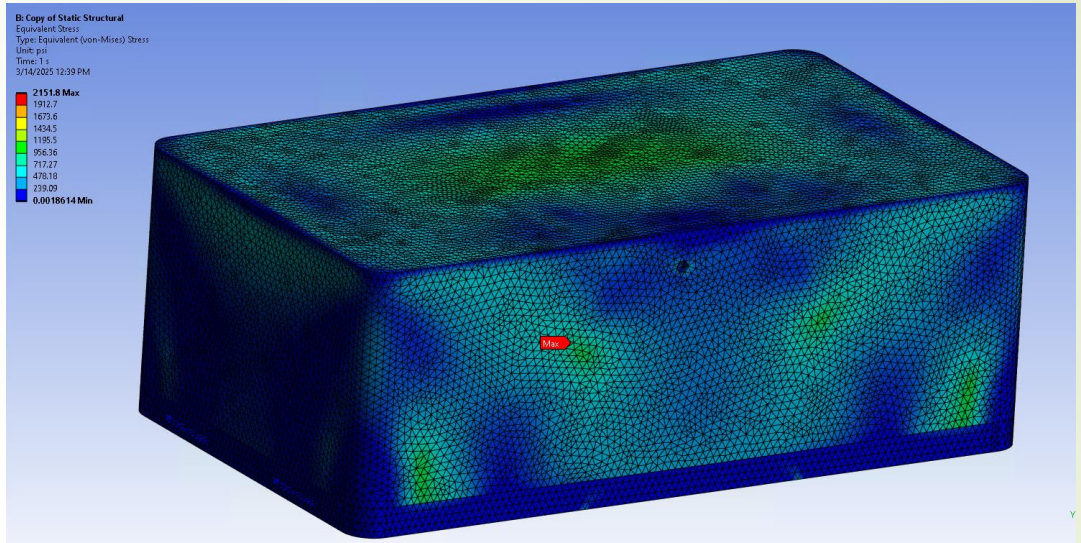


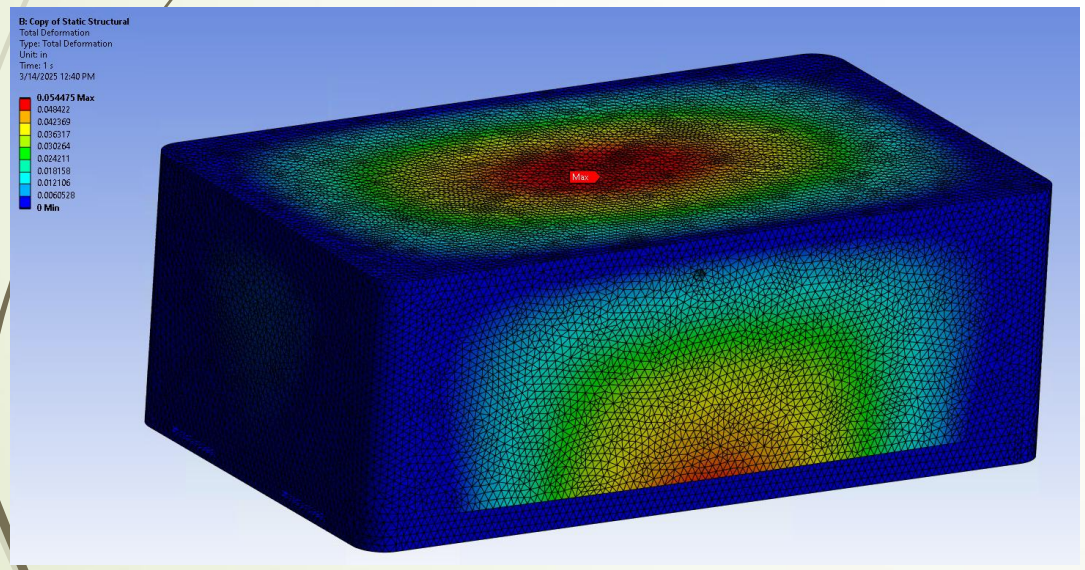


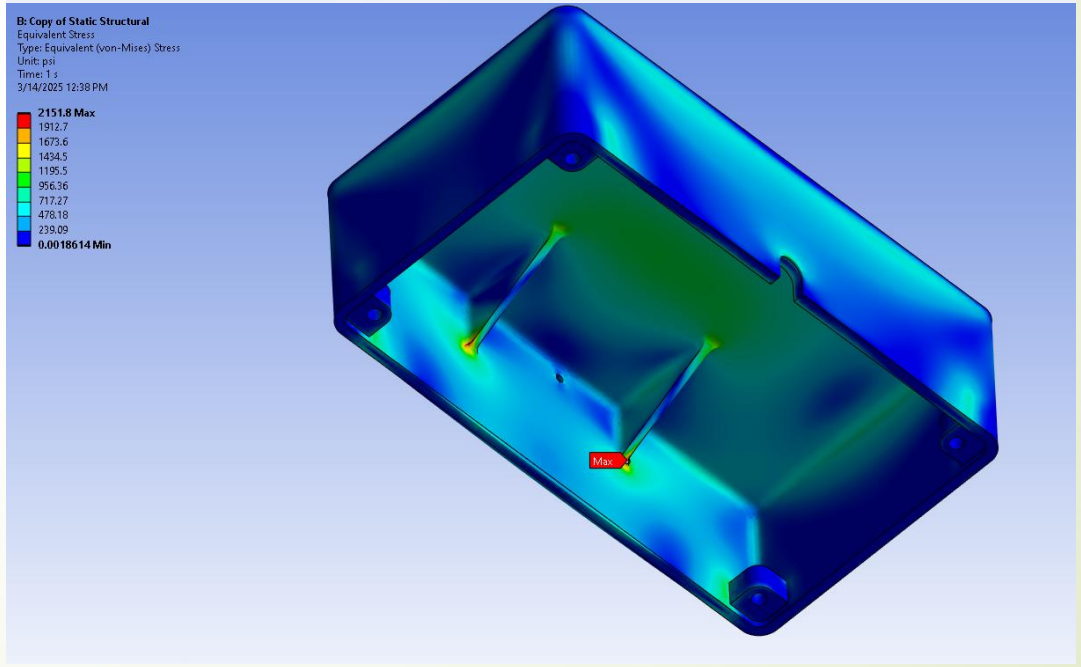


Results

- Max Stress: 2151.8 psi
  - PLA Yield Strength: 6556 psi
  - FOS: 3.05
- Max Deformation: .054"
  - Clearance between shell and internal components is .125"



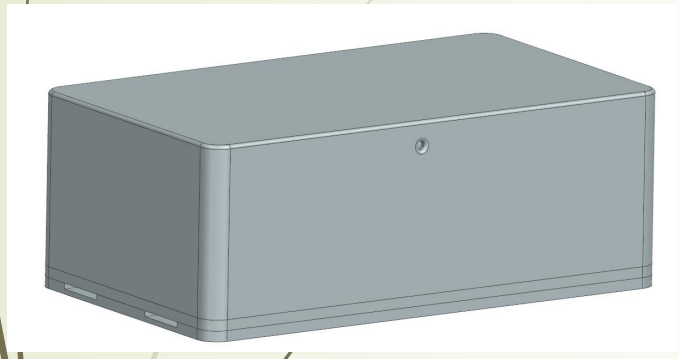




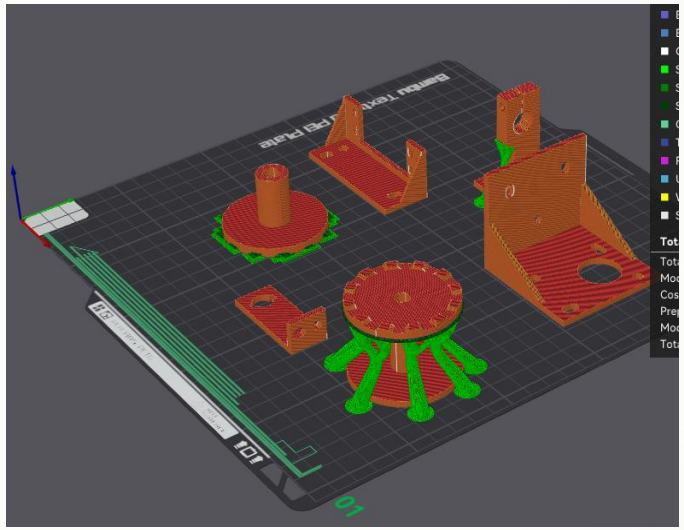
Manufacturing and Assembly

3D Printing

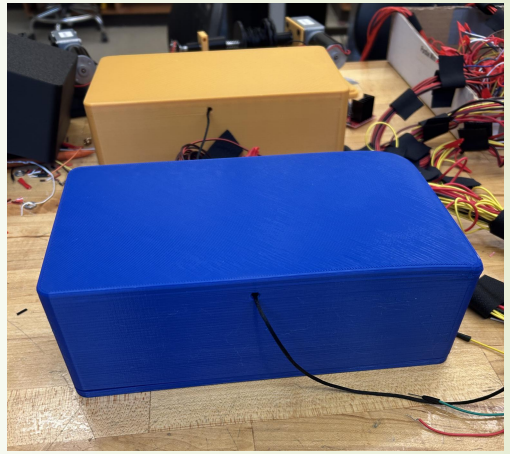
CAD Model

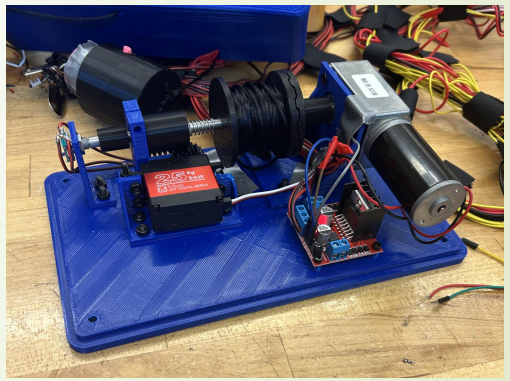


Slicing



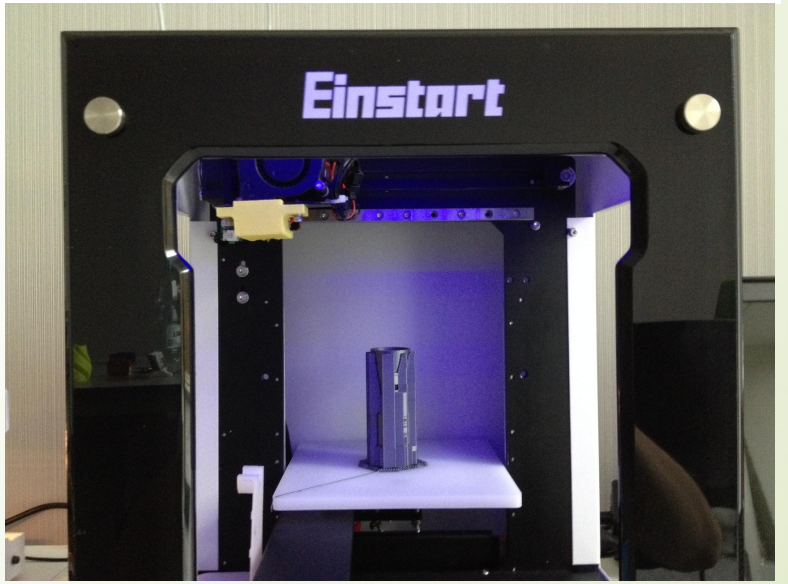
Final Prototype





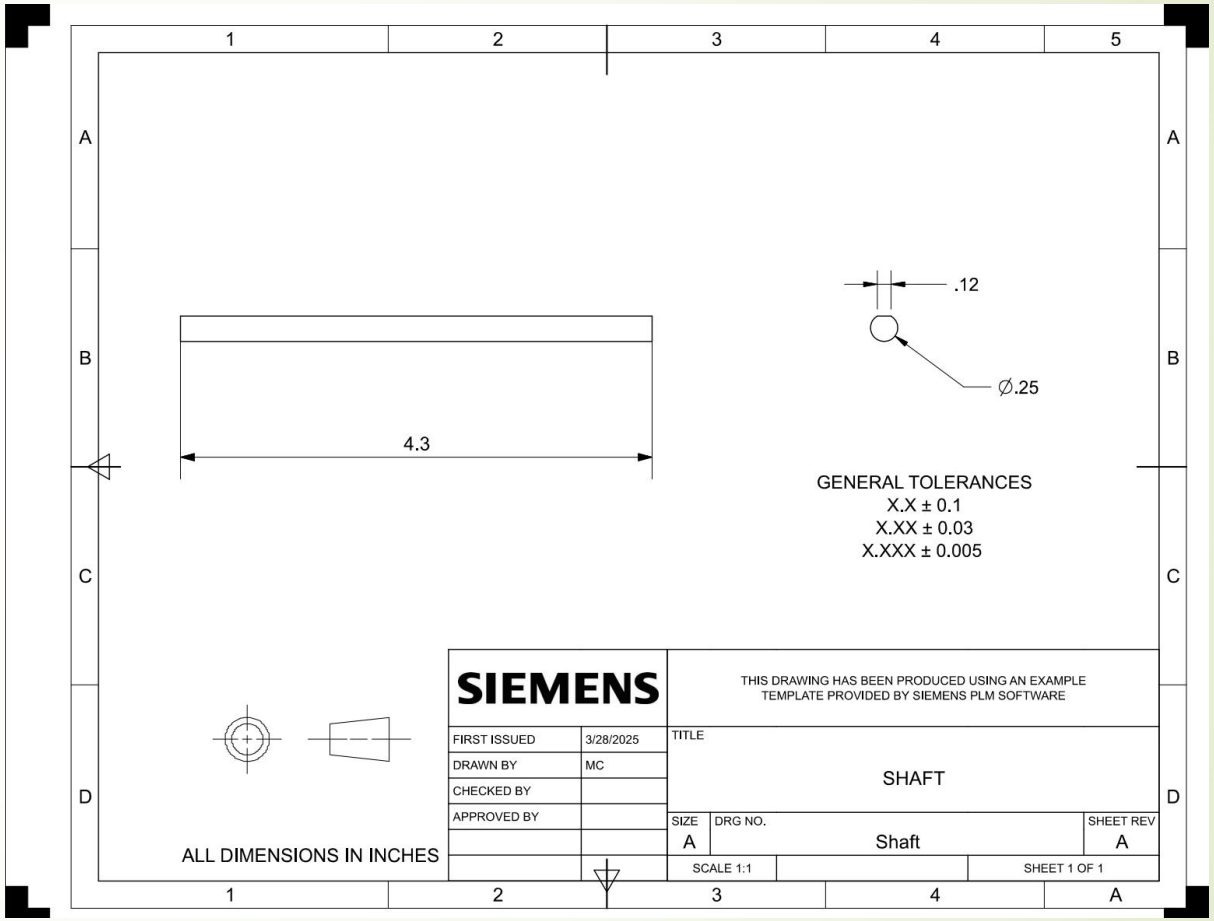
3D Printing Settings

- Printers
  - Einstart
  - TAZ-6 Pro
- Infill Density – 25%
  - Down from 100% to save time in prototyping process
- Infill Pattern – Grid
- Default Temperature Settings
- Default Speed Settings
- Default Travel Settings
- Default Cooling Settings
- Build Plate Adhesion
  - Brim
  - Skirt

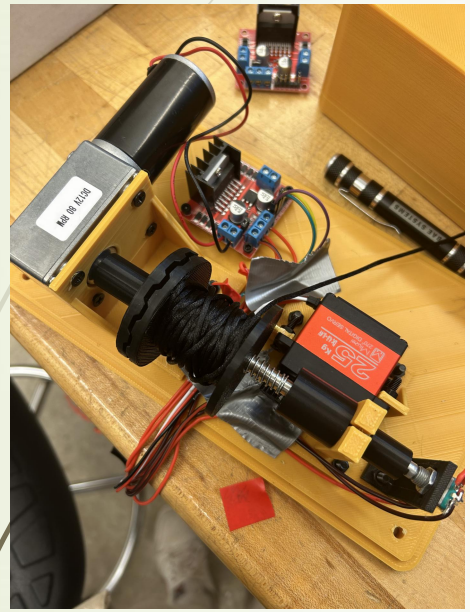


Machine Shop Operations

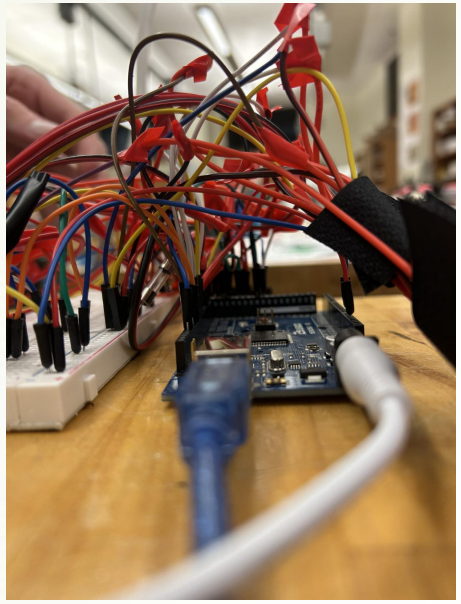
- Shaft in Modules (x4)
  - Cut to length
  - Turn down diameter to fit into spool

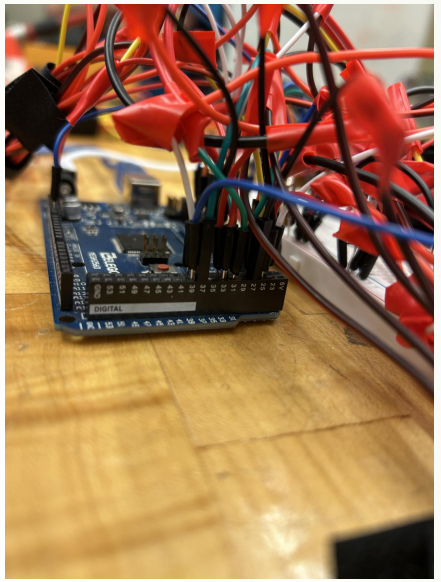


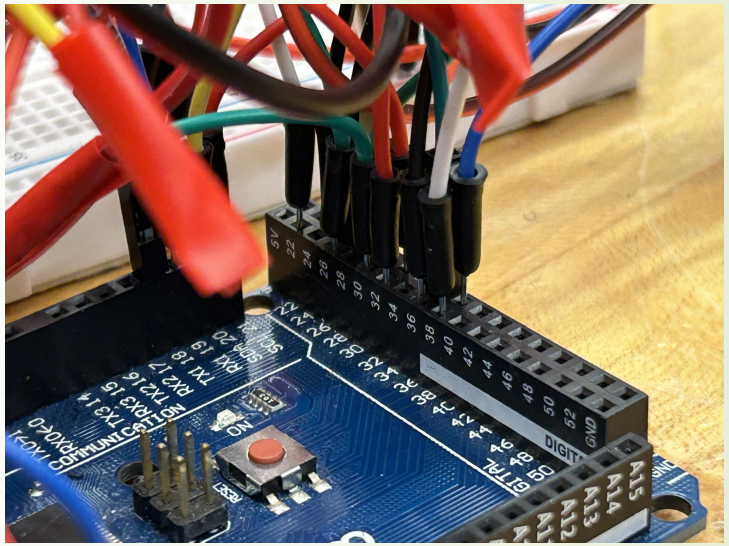
Electronics



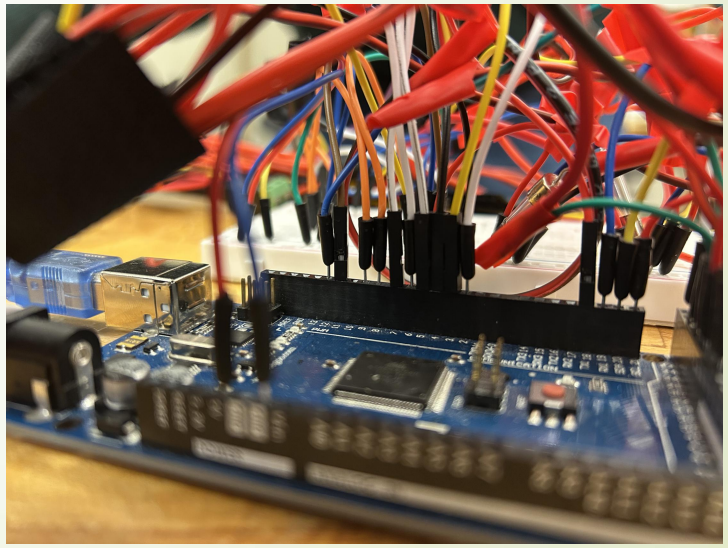
Module Wiring





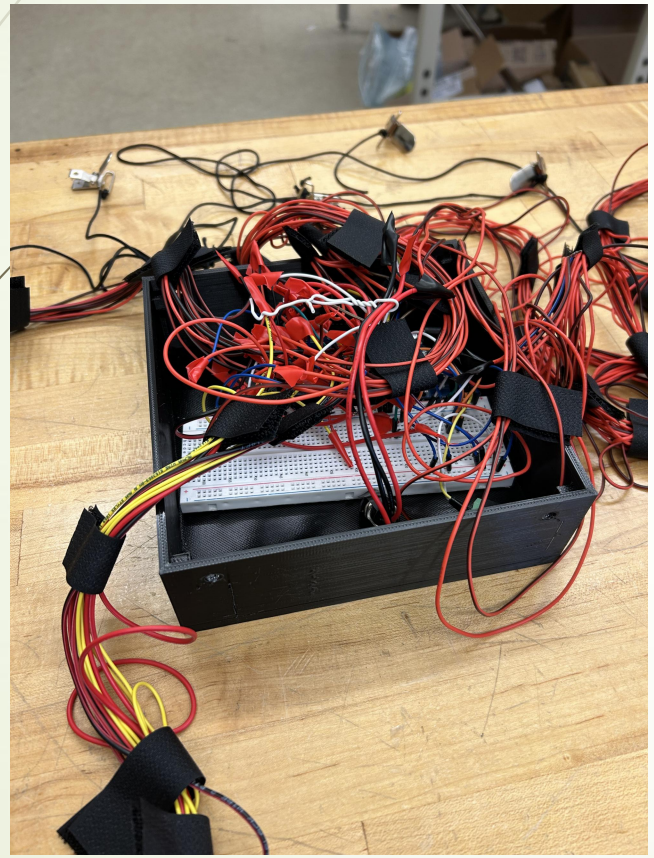


Arduino and Breadboard Wiring

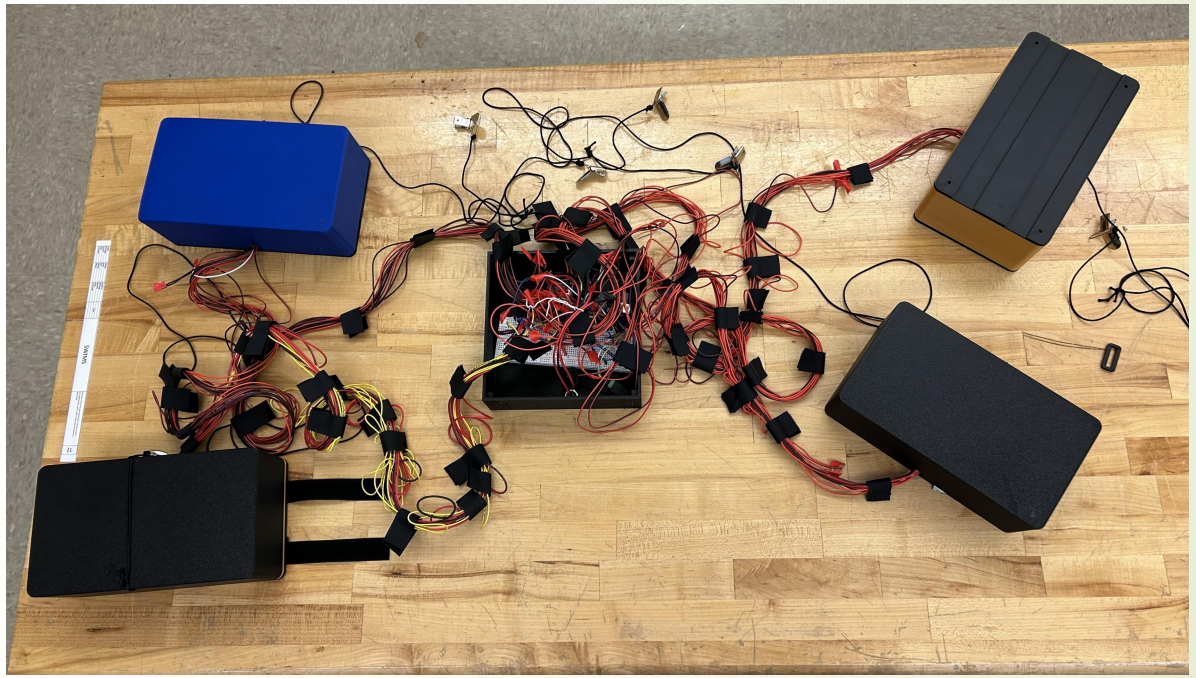


More images

Main Hub



Full Assembly



Testing and Validation

Engineering Requirements and Constraints

Engineering Requirements	Constraints
• Compatible with Twin to King Sized Beds • Compatible with 6-16" Mattresses • Power Input: 120V US Power Outlets • Cost Target: <$150 • Time Target: <2 minutes to remove and replace bed sheet • Weight: <10 lbs • Accuracy of Bed Sheet Placement: ± 3in • Noise Level: <70 dB under operation (<Vacuum Cleaner)	• Budget: $1000 • Final Design Deadline: 16 weeks • Safety for all consumers • No magnets to avoid issues with pacemakers

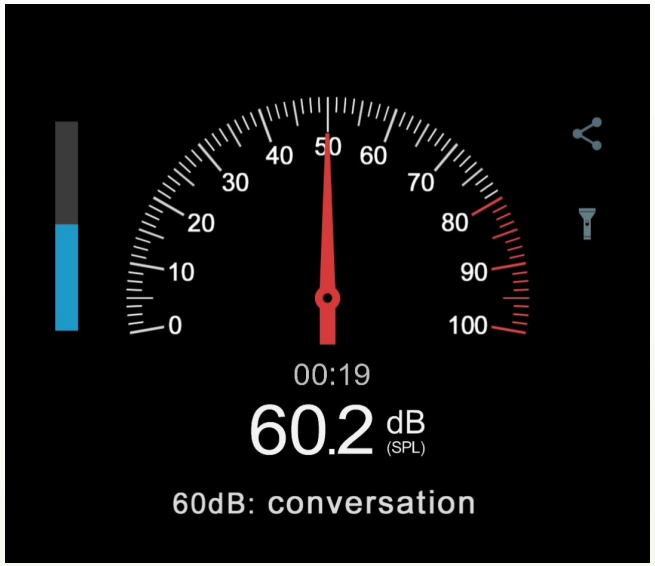
Engineering Requirements

Requirement	Testing Method	Result
Compatible with Twin to King Size Beds; 6"-16" thick mattresses	Set up modules under an actual bed	Couldn't source mattress larger than Twin Size
Power Input: 120V US Power Outlets	Power using wall outlet and see if prototype functions	Prototype functions solely using standard US Power Outlets
Does not damage or leave imprints on bedsheet	After testing, inspect bedsheets	Bedsheets weren't visibly damaged during testing
Weight Capacity: 225 pounds	Apply weight on top of module	Module was able to support the weight of a team member, but have yet to test max load case
Unit Weight: <10 lbs	Weigh each module	Modules weigh 2.5 lbs
Noise Level: <70 dB under operation (<Vacuum Cleaner)	Use decibel meter to measure noise level while operating	Under operation, max noise level was 60.2 dB
Time Target: <2 minutes to remove and replace bed sheet	Time while testing	Bedsheet testing inconclusive
Accuracy of Bed Sheet Placement: ± 3in	Measure bedsheet placements after testing	Bedsheet testing inconclusive

Validation

- We weighed one of the modules on a scale; each module was less than 10 pounds

- We measured the noise level of the module while operating using a decibel meter; the maximum noise level to be 60.2 dB



- We tested the weight the modules could hold; they can withstand someone directly on top of them as well as someone in the center of the bed.

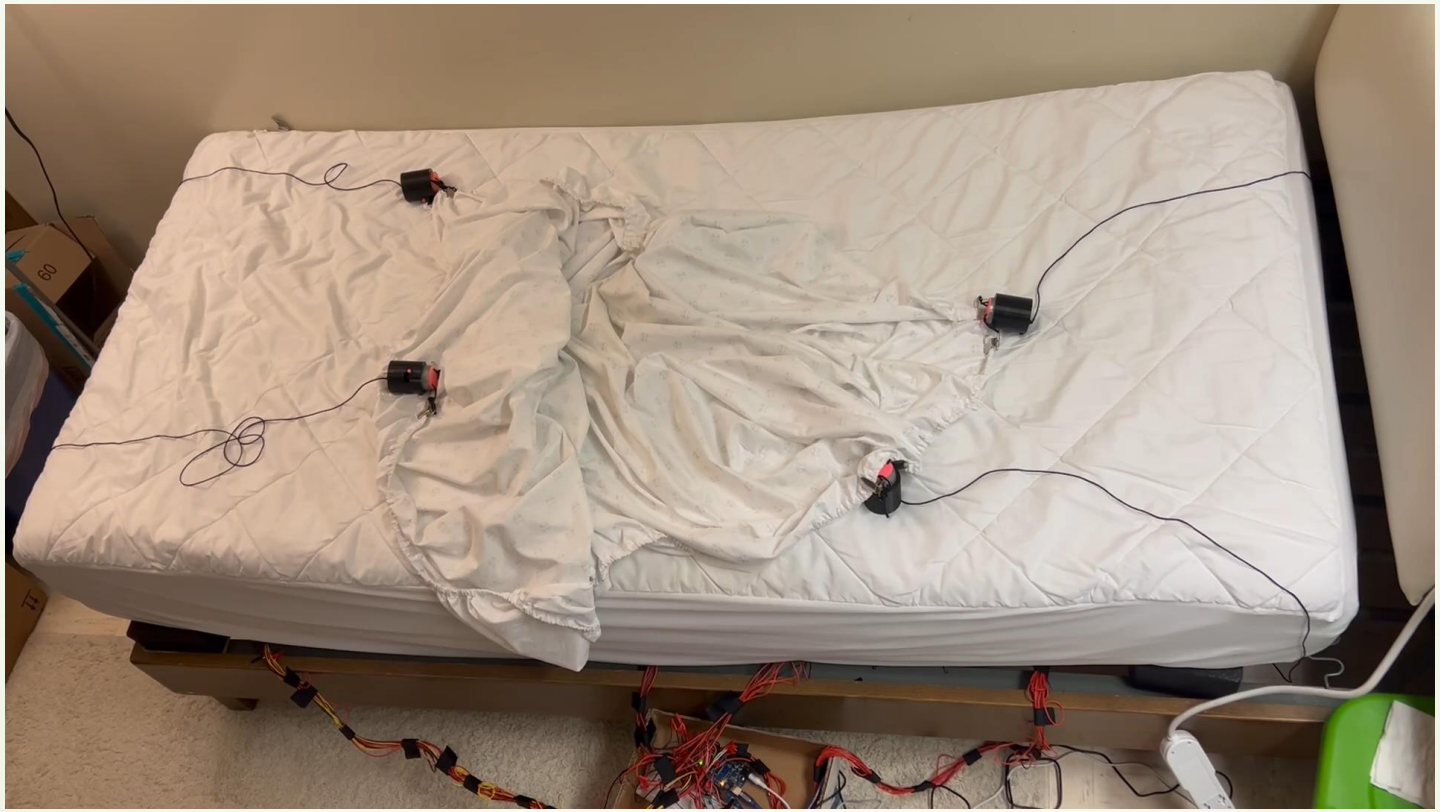
Validation Continued

- We placed the modules in their intended positions and discovered that there was more than enough space to accommodate larger beds

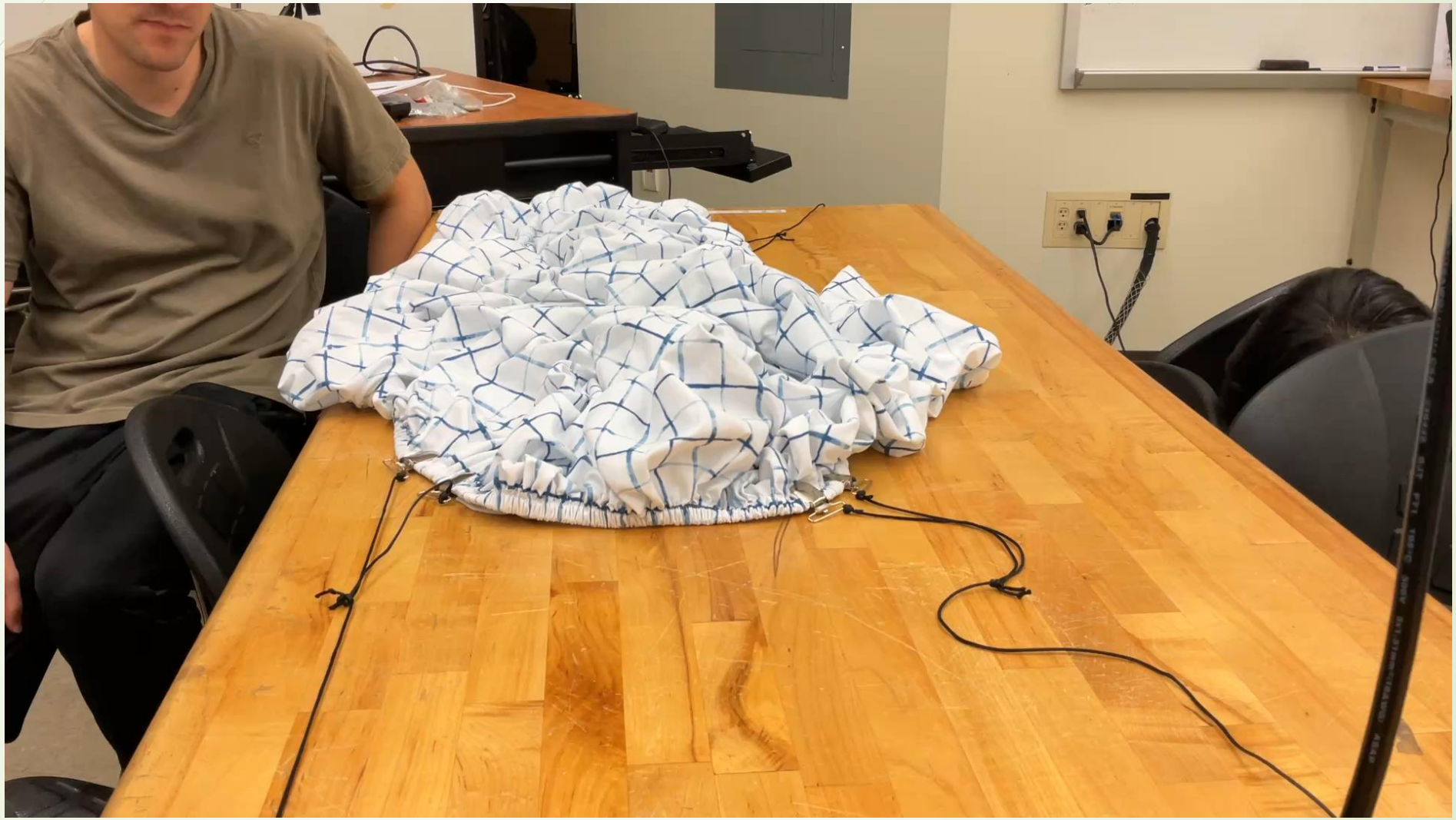
- We checked the corners of the bedsheet for any damage that might've been caused from the clips, finding none

Validation Continued

- We tested the functionality of the entire prototype on a real bed. Unfortunately, the prototype did not work entirely as intended



Validation Continued



Project Shortcomings

Sheet Uniformity

- The sheet is not as uniform as we wanted
  - This is because of our adapter, pulling with 2 cables is best but the adapter doesn't let the clips be far enough away from each other
- Having each module be circular and have 2 spools would have been better. This would fix the uniformity issue
- Unfortunately, this is a major design change and would have to be made early in the design process, and would take a significant amount of time

Motor Power

- We ran into an issue in our initial tests on an actual bed where the motors would stop without the torque limiter activating
- We discovered this was a current issue, we were able to counteract this in some tests by only running 2 motors at a time.
- Ideally given another week of time we could get a better power supply and all four motors would work simultaneously

Wiring

- While the wiring is correct, it also can get tangled very easily.
- This has led to many issues with mobility of the project where wires in the bread board will get disconnected
- A solution to this would be to use and make wiring connectors that go through the wall of the main hub
  - This means that we can simply unplug each module from the main hub and plug it back in without any issues
- Given 2 more weeks this issue would be solved

Business Proposition

Value Proposition

- 70 million US adults with physical disability
- 57.8 million elderly people in US aged 65+
  - Expected to grow to 80 million in 2040
- Approximately 145 million homes in United States (as of 2023), with an average of 3 beds per home
  - Amounts to almost 450 million beds
  - 2022 to 2023 was a 1.5% increase; housing is a growing market
- BedBuddy could capture only 0.01% of the 65+ market and sell 5,780 units per year

Cost Estimates

- All Purchased parts cost a total around **$654**
- All used parts are significantly cheaper, around **$100**
- Expecting a selling price of around **$200**
- Full scale production cost per unit should be at most **$40**
- If BedBuddy sells the projected volume we would see a profit of $924,800

Updated Bill of Materials

Item No.	Part Name	Units	Qty.	Material/Descirption	Source	Catalog No.	Cost/Unit
1	Cable Motor	N/A	8	DC Motor	BNYZWOT	B0DJ63LH75	$100.72
2	Electrical Wire	ft	1	Electronics Wiring	Haerkn	B07RRPFSZ1	$19.99
3	Cables	ft	1	Nylon Wire	TONIFUL	B08VHSCJ7F	$7.99
4	Arduino	N/A	2	Arduino Mega 2560	Arduino	A000067	$48.40
5	Power Adapter	ft	2	Outlet to arduino adapter	California JOS	UNO-R3-20	$8.79
6	Power Cord	ft	1	Extension Cord	Amazon	B076KFTT5B	$11.99
7	Motor Driver	N/A	8	Dual H bridge motor drive module	AITRIP	L298N	$19.99
8	Bread Board	N/A	6	Solderless bread board	BusBoard Prototype Systems	BB-400	$6.75
9	Servo	N/A	8	Servo for Torque limiter	ACEIRMC	B09MHJ9VKL	$16.99
10	Sheet Clip	N/A	20	Clip to hold bed sheets	RayTour	B07JM83NHR	$6.99
11	Fuse	N/A	4	Proetects circuit contents	Fielect	B08J7WN1BZ	$19.96
12	Nuts and Bolts	N/A	275	Fastens pieces	XujinSongg	B0CCPJTVL1	$8.77
13	Bearings	N/A	10	Reduces friction, improves rotational motion	uxcell	B08J43622W	$12.89
14	Screws	N/A	480	Ensures no movement of parts	qlwuhal	B0D1R21JRR	$9.99
15	Heat Set Insert	N/A	50	Hex nuts for 3D printed parts	ruthex	B07YSV66Y5	$11.99
16	Springs	N/A	4	For Torque limiter	PRIME-LINE	SP 9707	$13.93
17	Rotary Shaft	in	1	Used for all rotational motion	McMaster-CARR	8632T139	$10.86
18	Encoder	N/A	8	Tracks rotations of motor	WayinTop	B07T3672VK	$11.99
19	3D Printed PLA	kg	2	PLA to be used for various 3D pritned parts	ELEGOO	CA-EL-3D-PB01	$13.99
							$362.97

Conclusion

Conclusion and Next Steps

Overall, this went well given the time constraint. The product works as we want it to, and we can clearly identify exactly how to make it perform better

- **Next Steps**
  - Order new power supply
  - Order wire connectors
  - Begin designing and printing new modified module designs

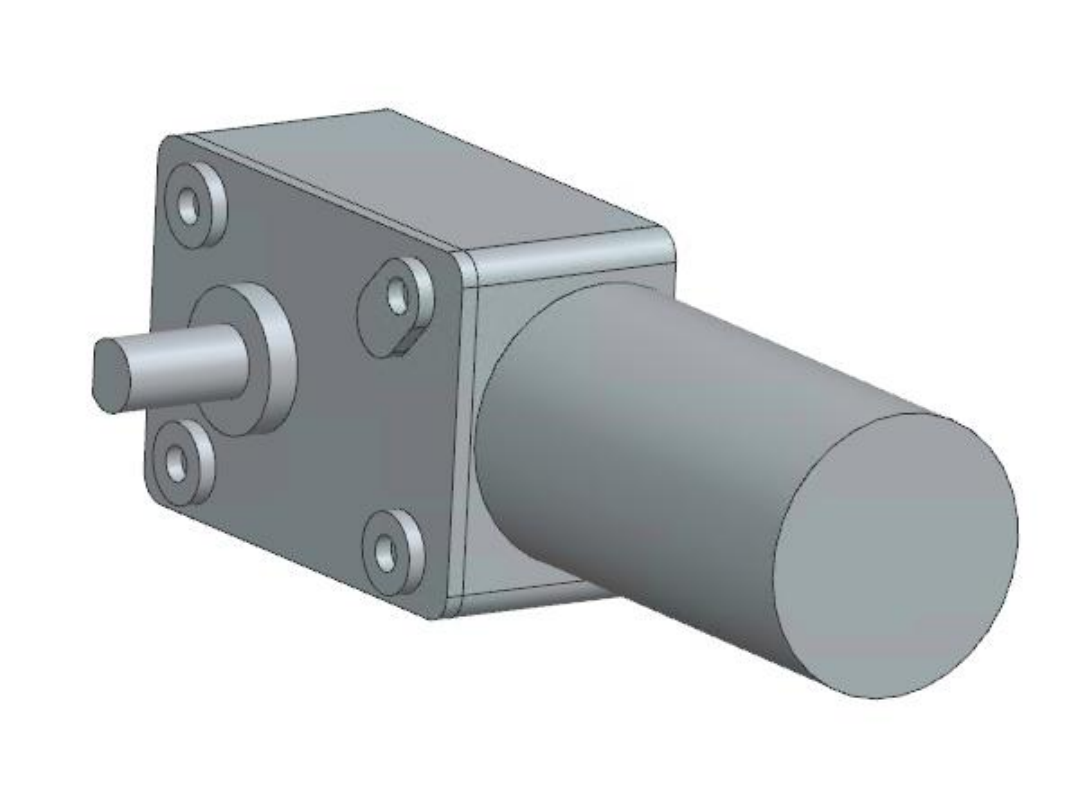
Thank You!

Questions?

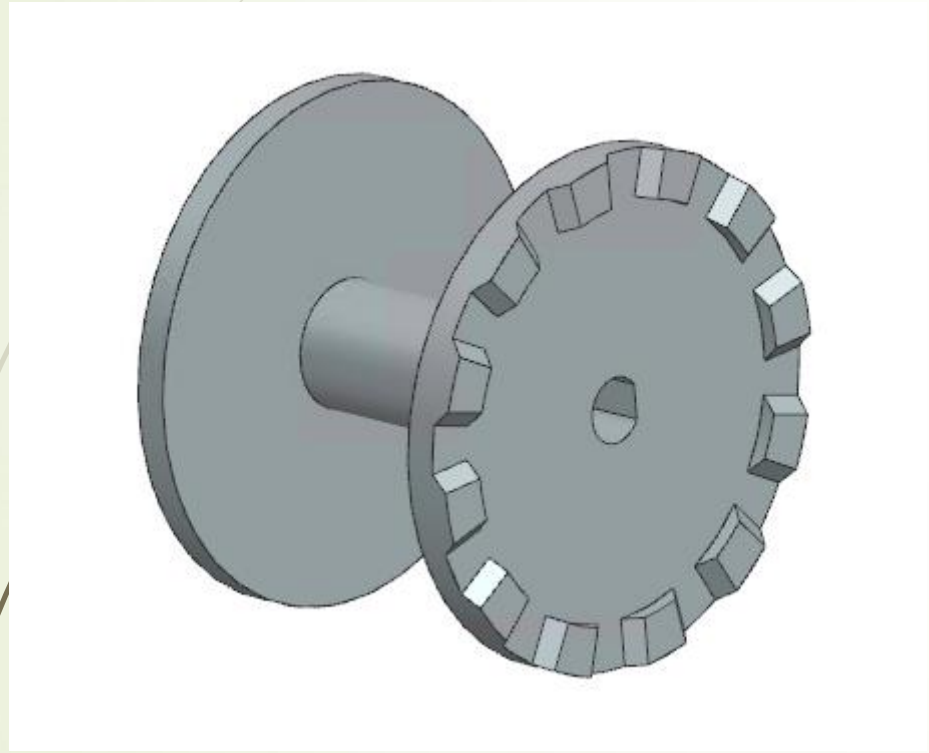
Appendices

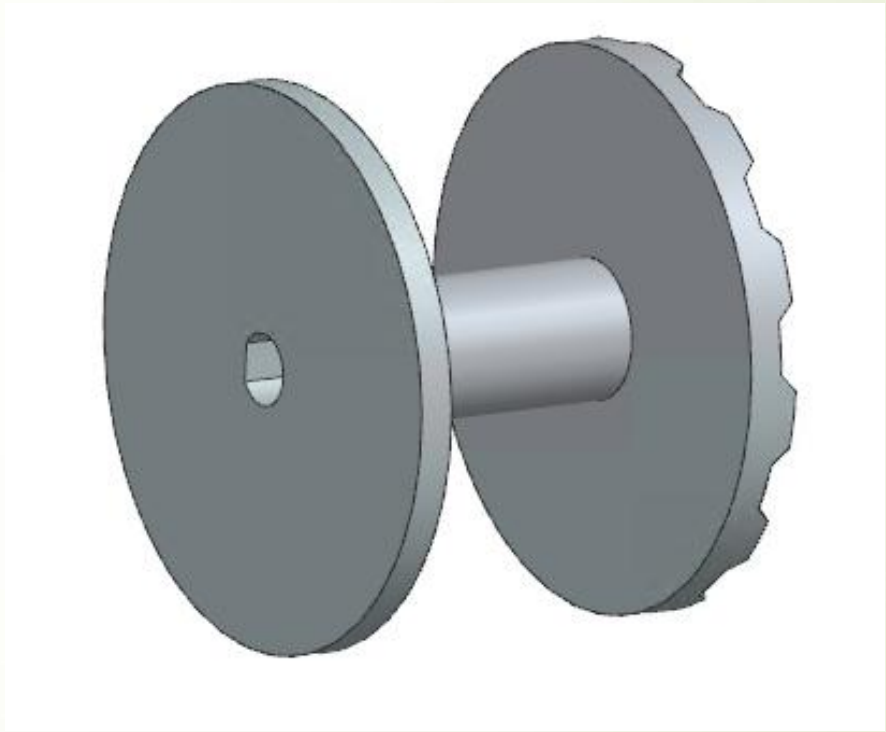
Appendix A: CAD

Motor

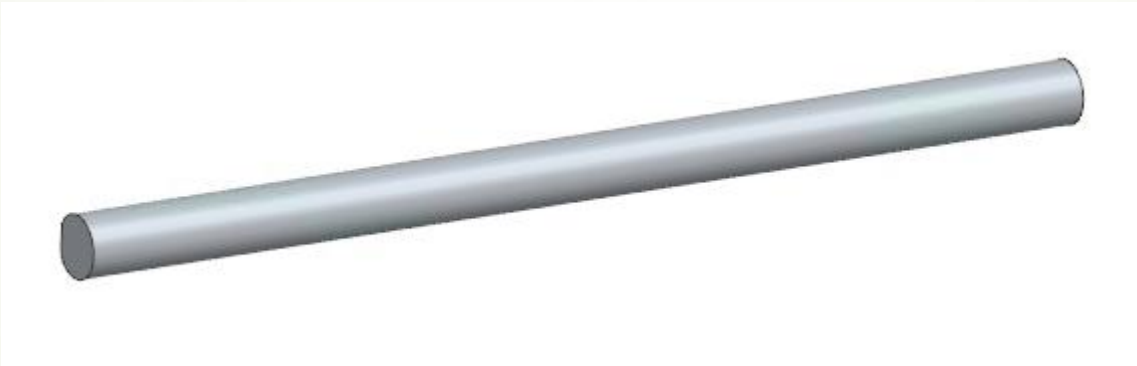


Spool

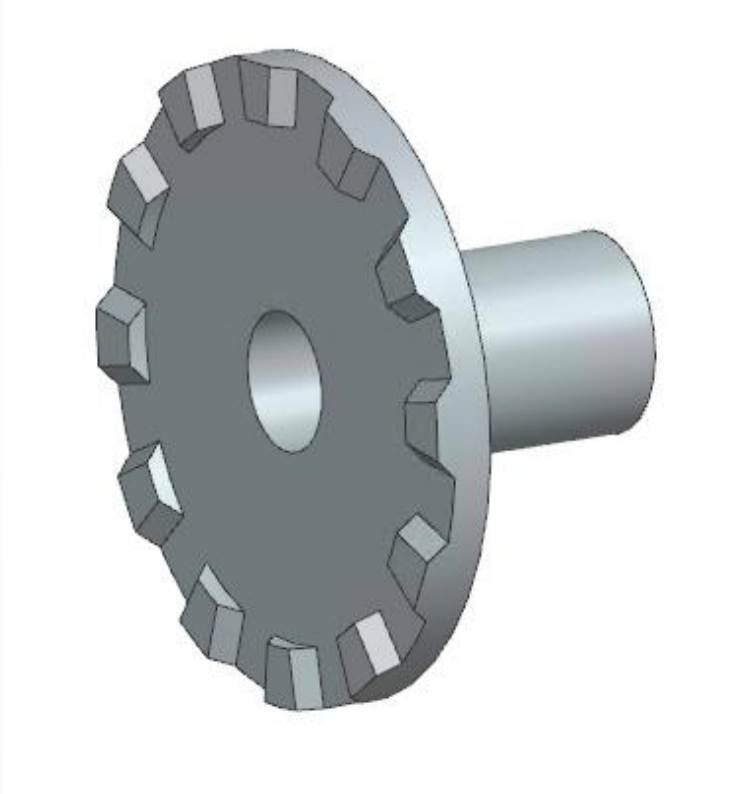




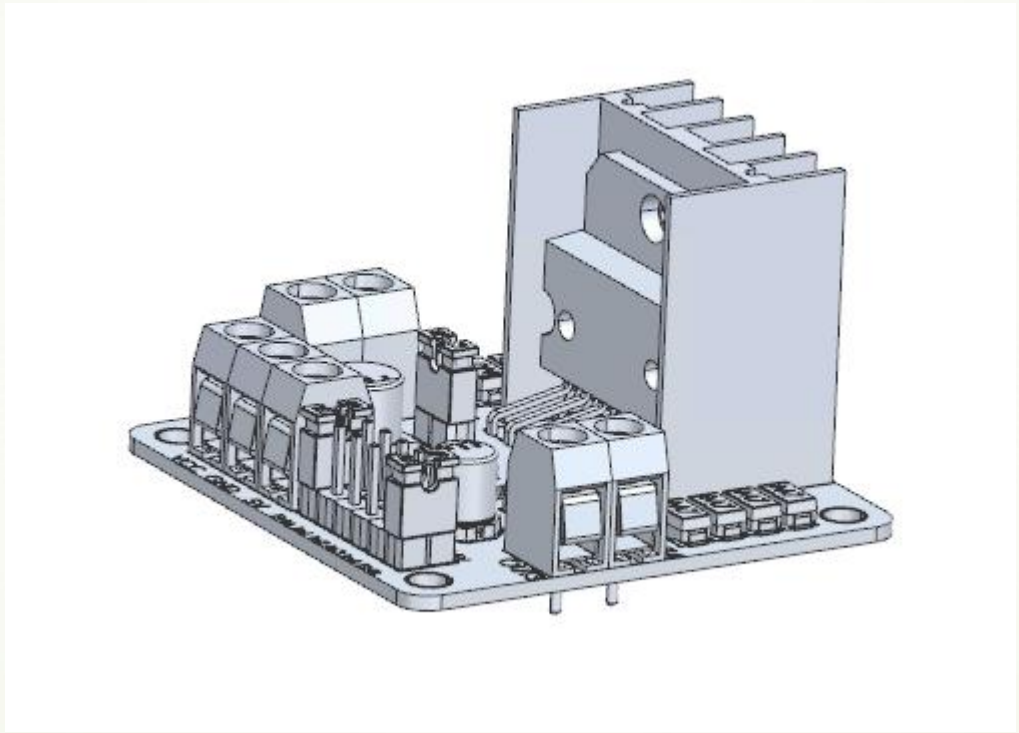
Shaft



Motor Limiter

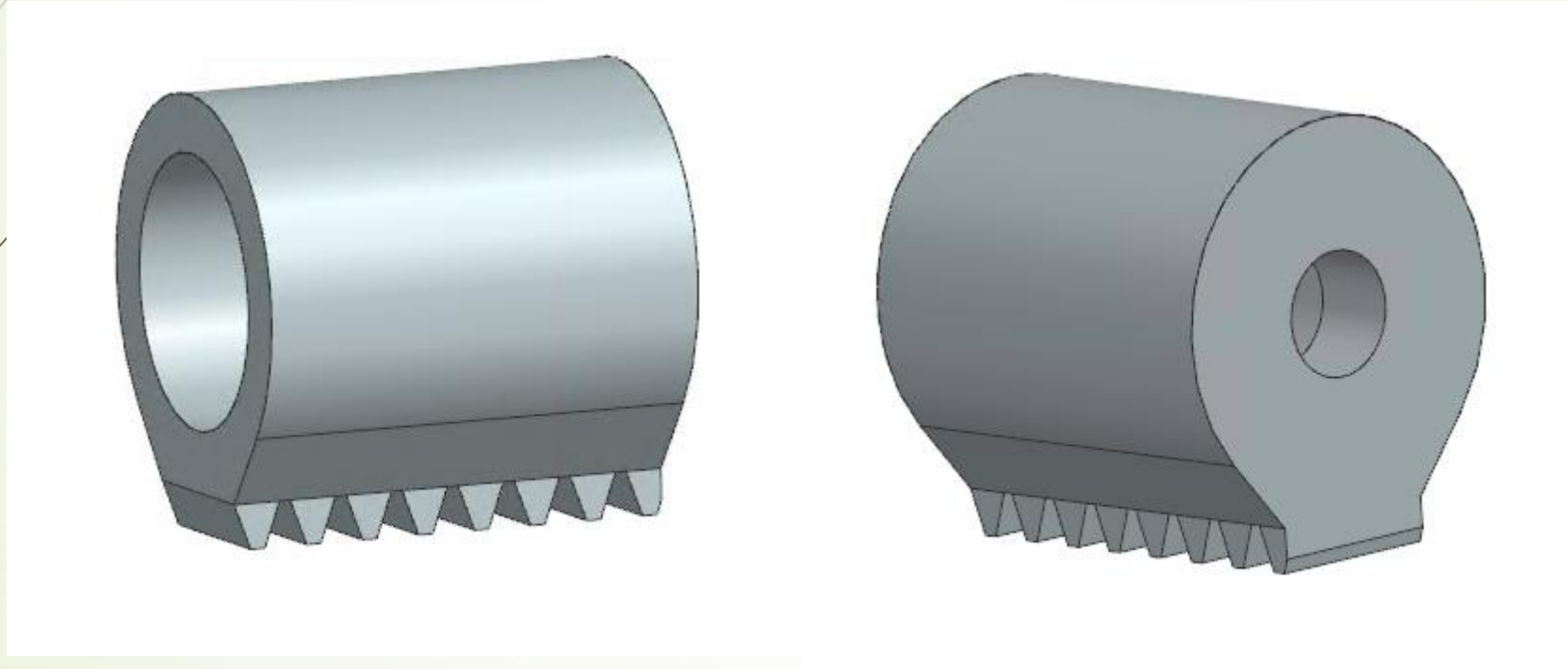


Motor Driver

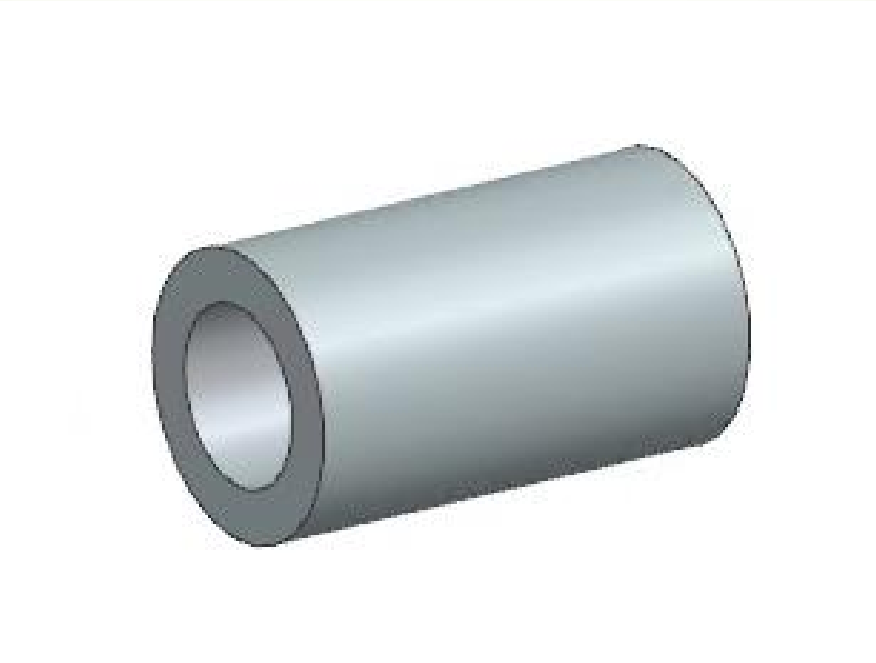


Spring Adjuster Pinion

Spring Adjuster Rack

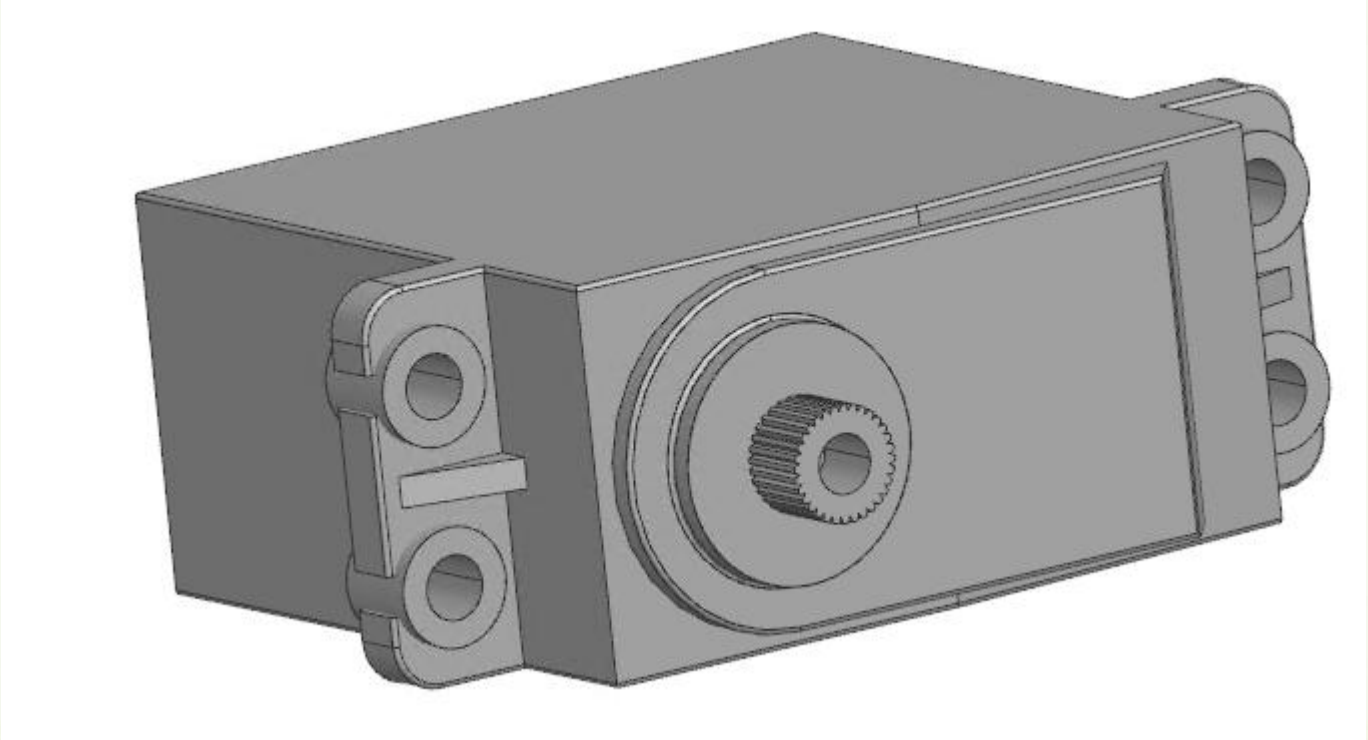


Spring Bushing

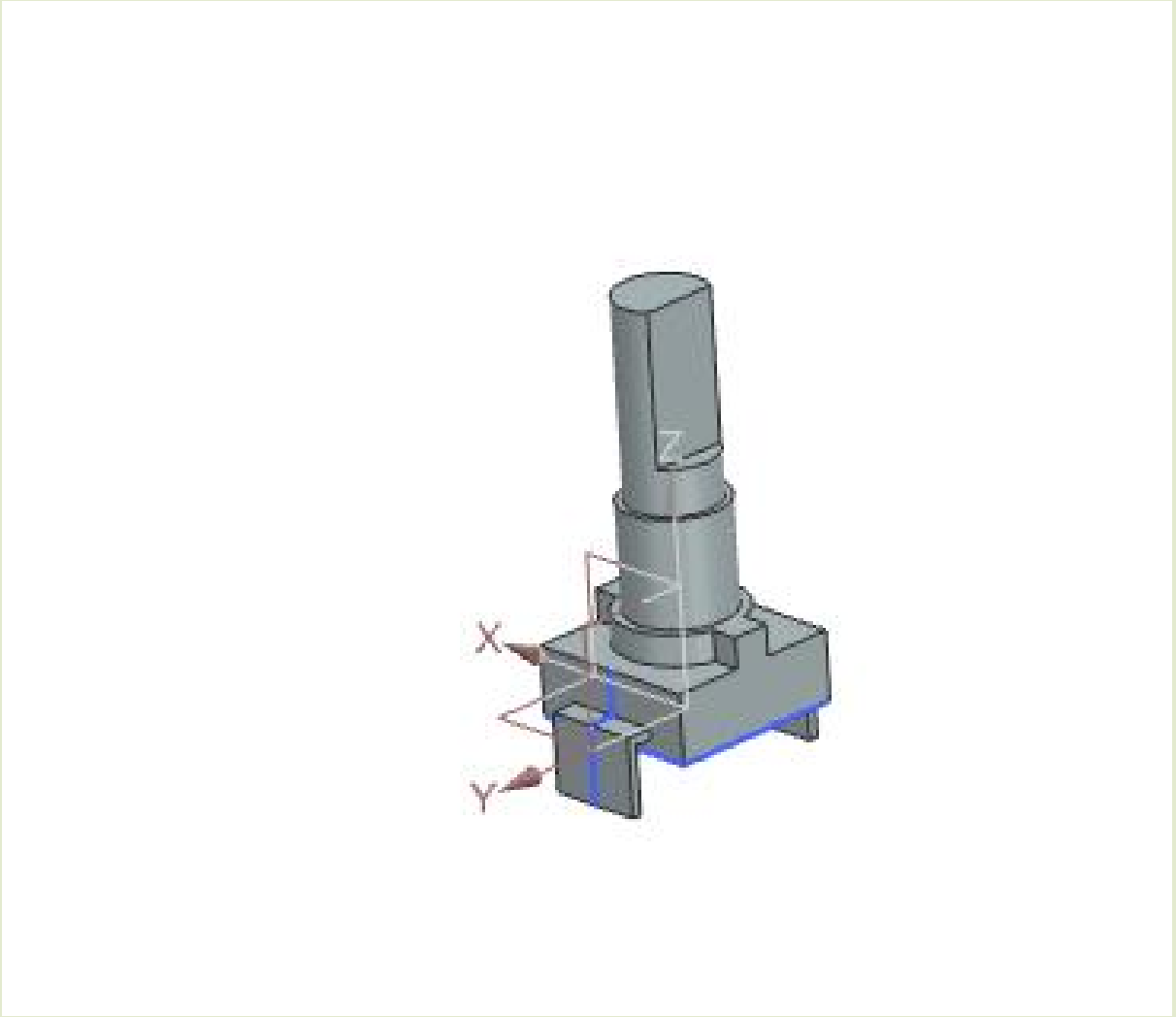


Spring

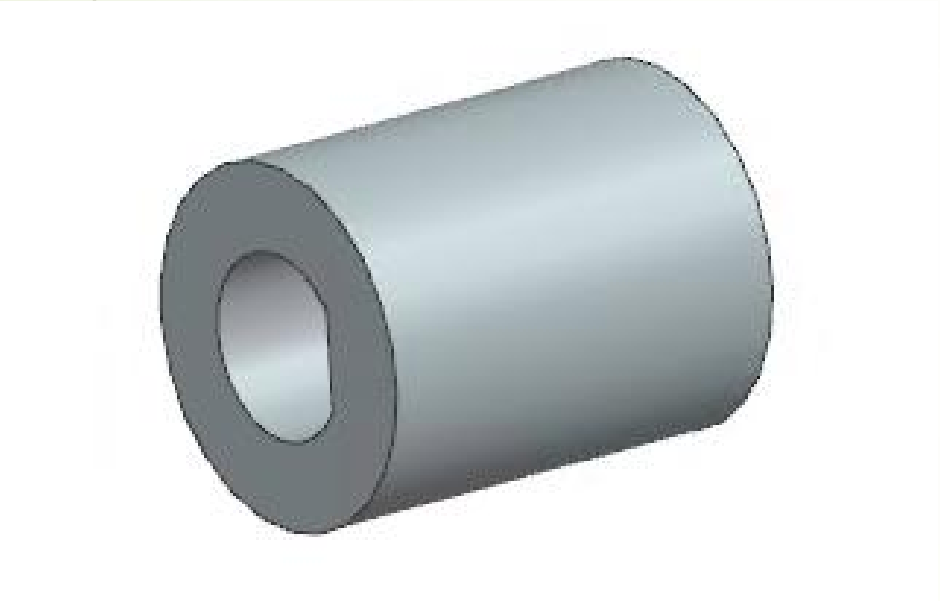
Servo

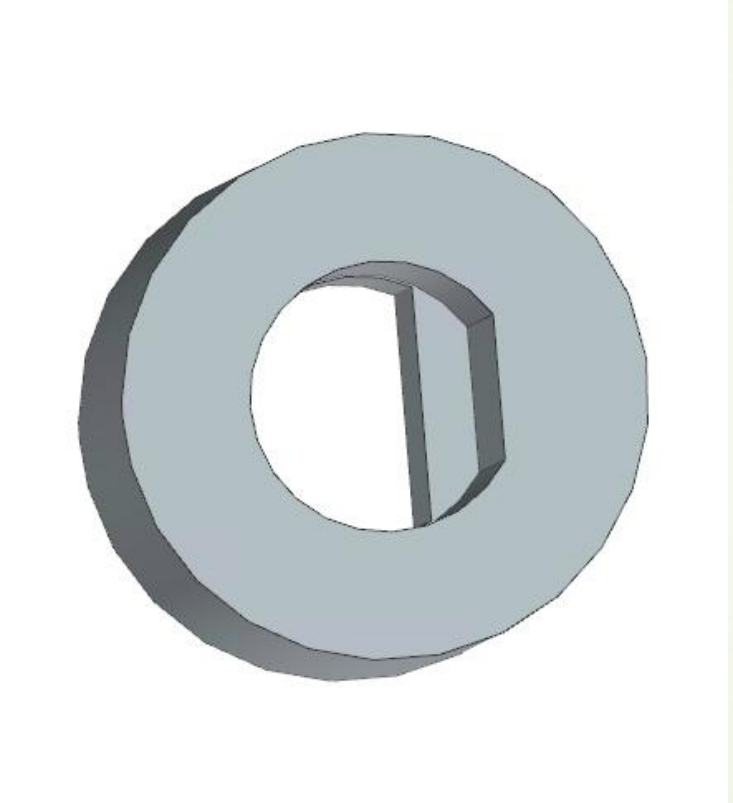


Rotary Encoder

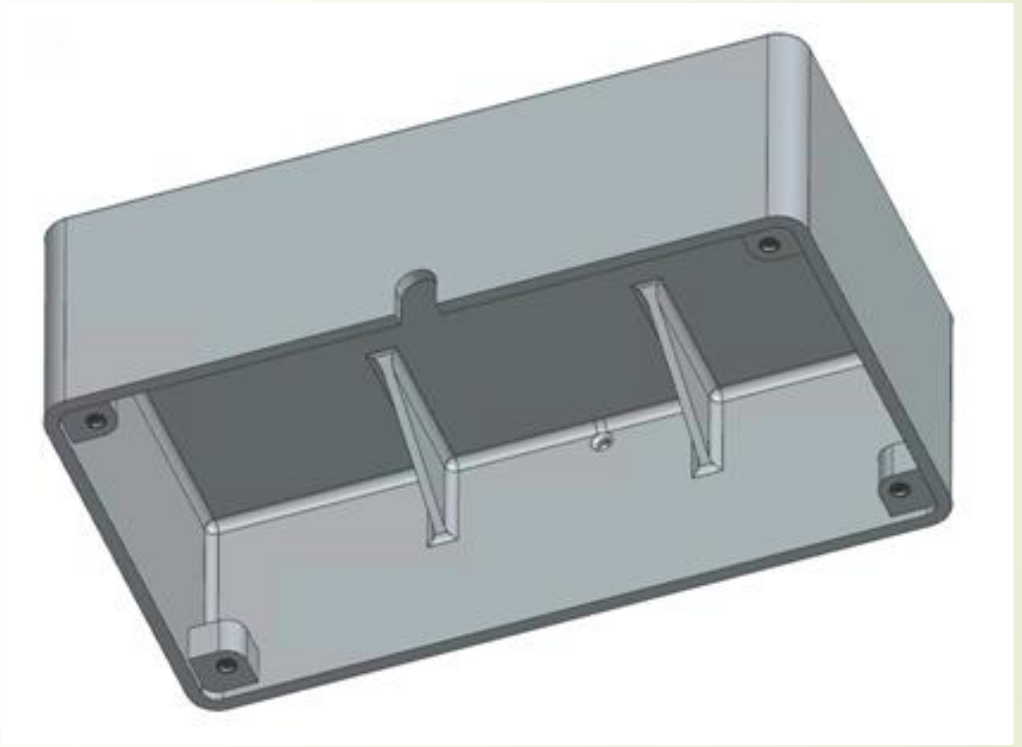


Encoder Coupler

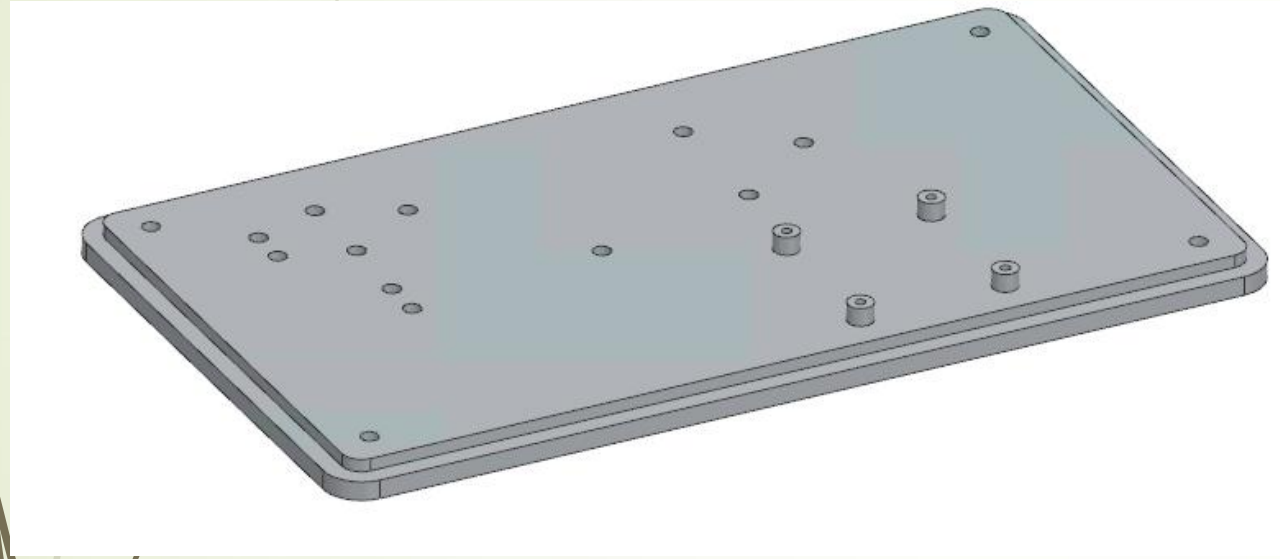


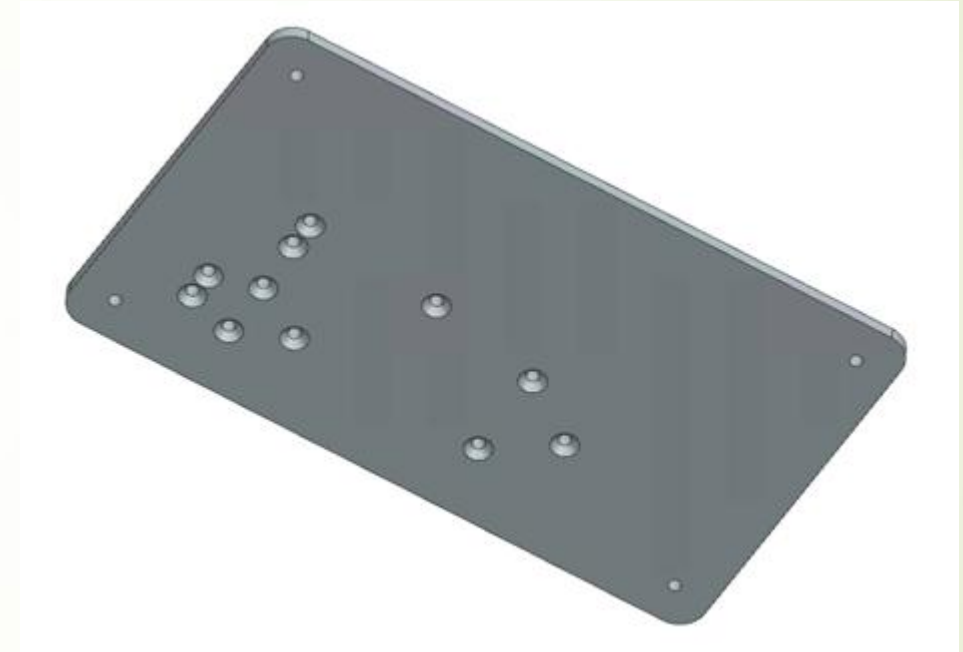


Module Shell

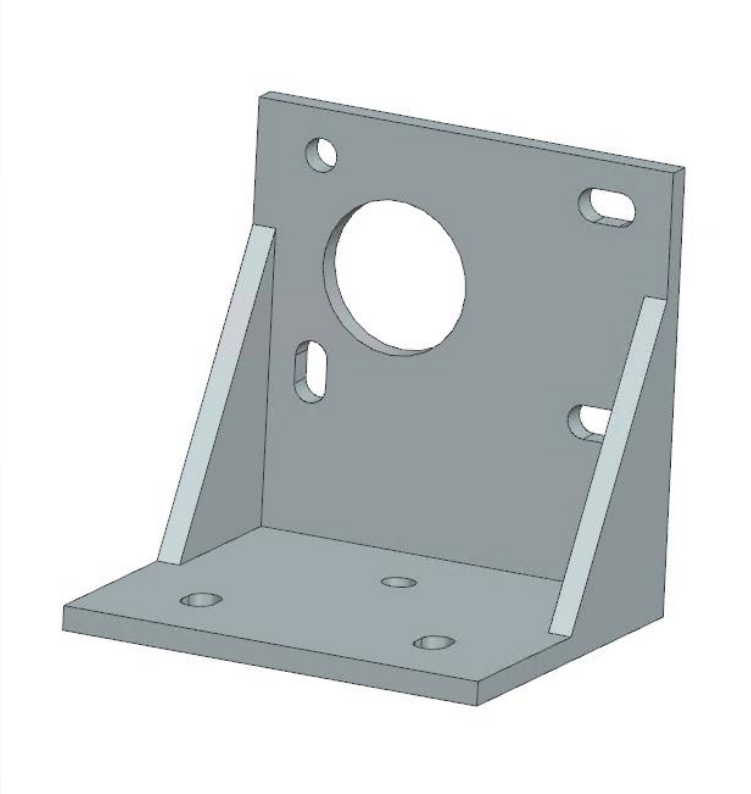


Base Plate

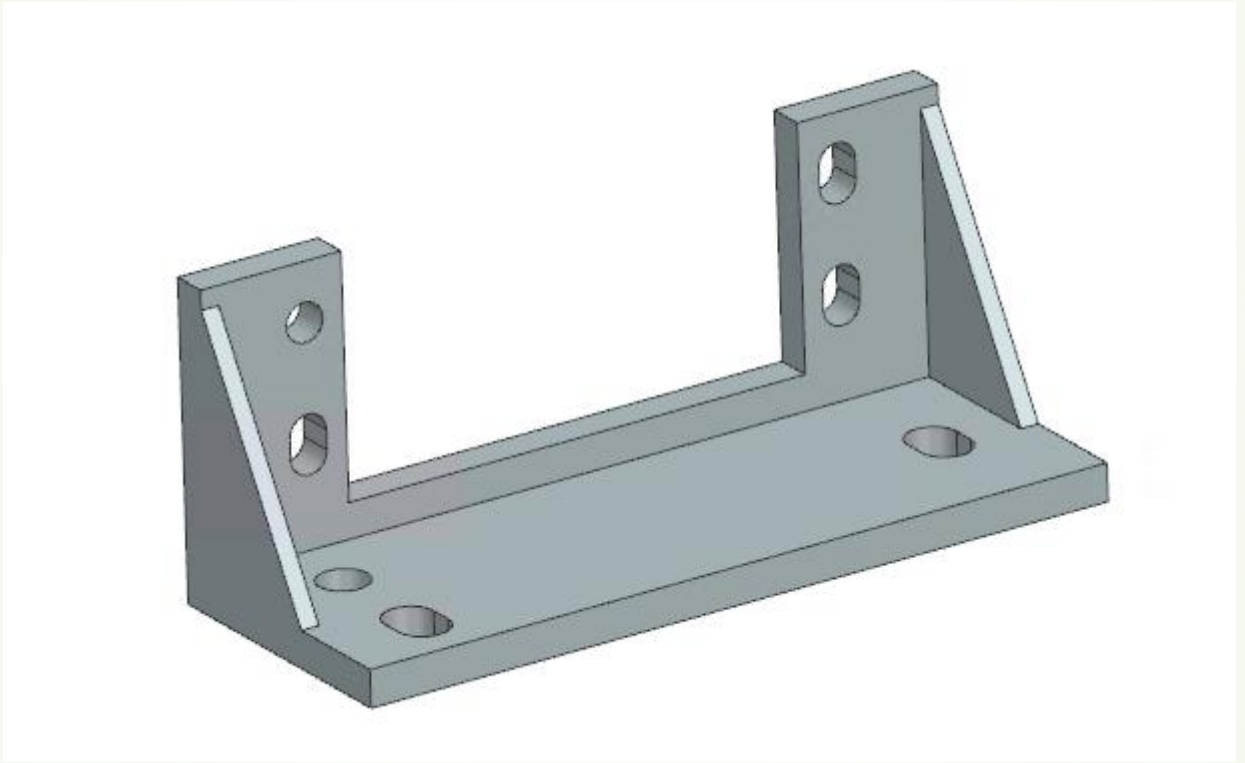




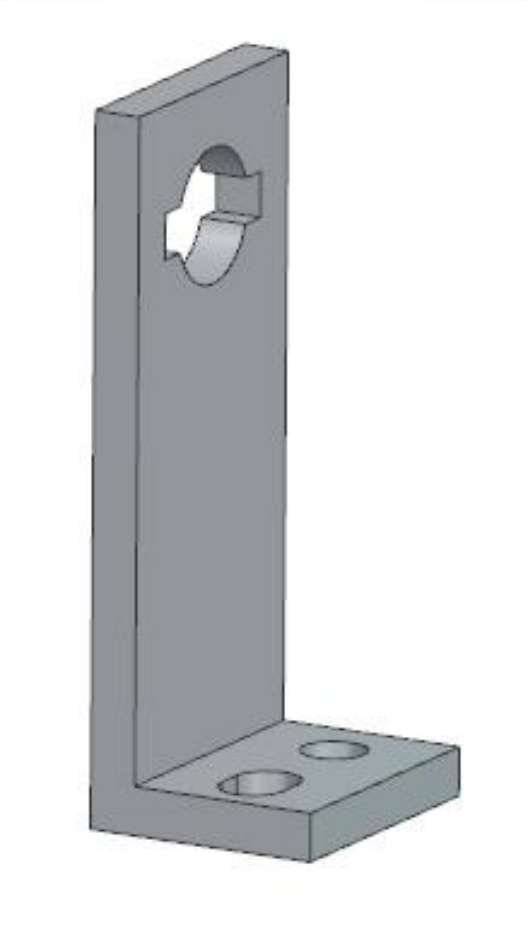
Motor Mount



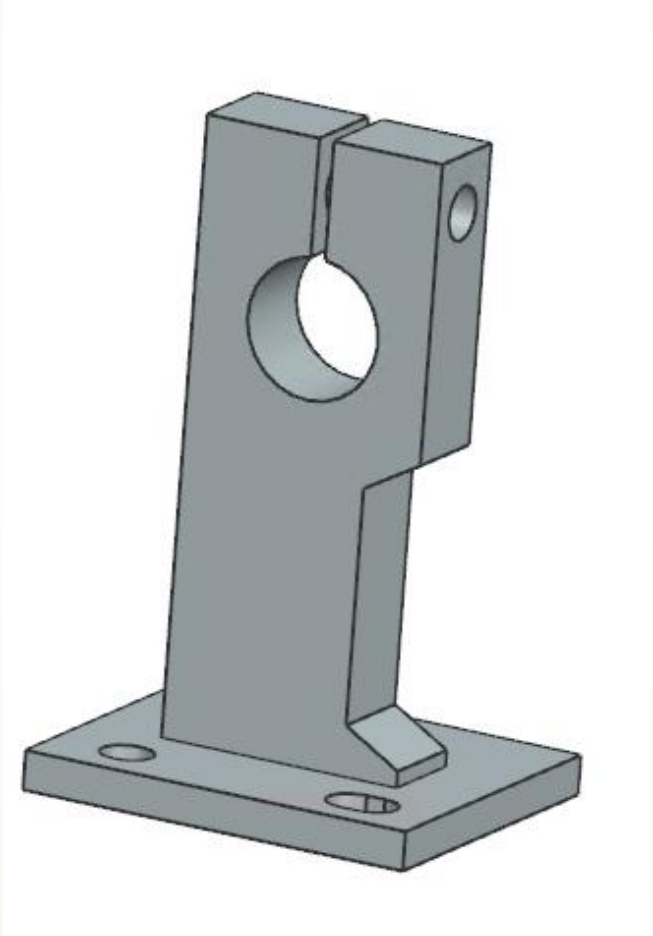
Servo Bracket



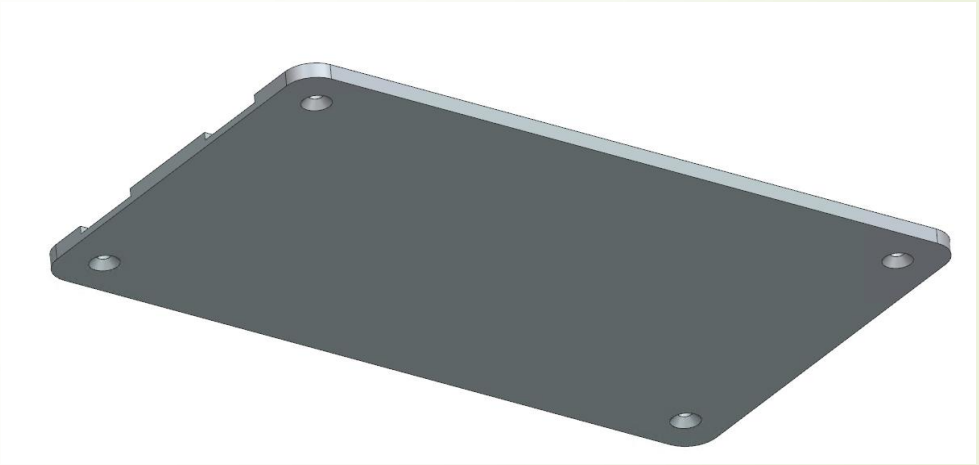
Encoder Bracket



Bearing Block



Mounting Plate



Appendix B: Analysis

Rack and Pinion Calculator

inputs			
k	1	-	depth of teeth (1=full depth, 0.8 = stub)
phi	20	degrees	pressure angle
min num of teeth	17.09726434	-	minimum number of teeth without interference and undercutting
num of teeth	18	-	
pitch diameter	0.75	in	diameter of contact points of pinion

pinion gear parameters			
diametral pitch	24	1/in	how spaced out the teeth are
addendum	0.041666667	in	distance from pitch diameter to outer diameter
dedendum	0.052083333	in	distance from pitch diameter to innermost diameter
circular pitch	0.130899694	in	distance between center to center of tooth at pitch diameter
clearance	0.010416667	in	distance between bottom of tooth and dedendum circle
radius of curvature	0.128257554	in	radius of curvature at each individual tooth at the intersection of tooth face and pitch diameter circle
tooth thickness	0.065449847	in	thickness of each tooth measured at pitch diameter
outer diameter	0.833333333	in	outermost diameter

rack parameters			
tooth spacing	0.123005476	in	distance between equivalent points on teeth of rack
tooth thickness	0.061502738	in	thickness of each tooth measured at tangency line
addendum	0.041666667	in	distance from tangency line to top of tooth
dedendum	0.052083333	in	distance from tangency line to bottom of tooth

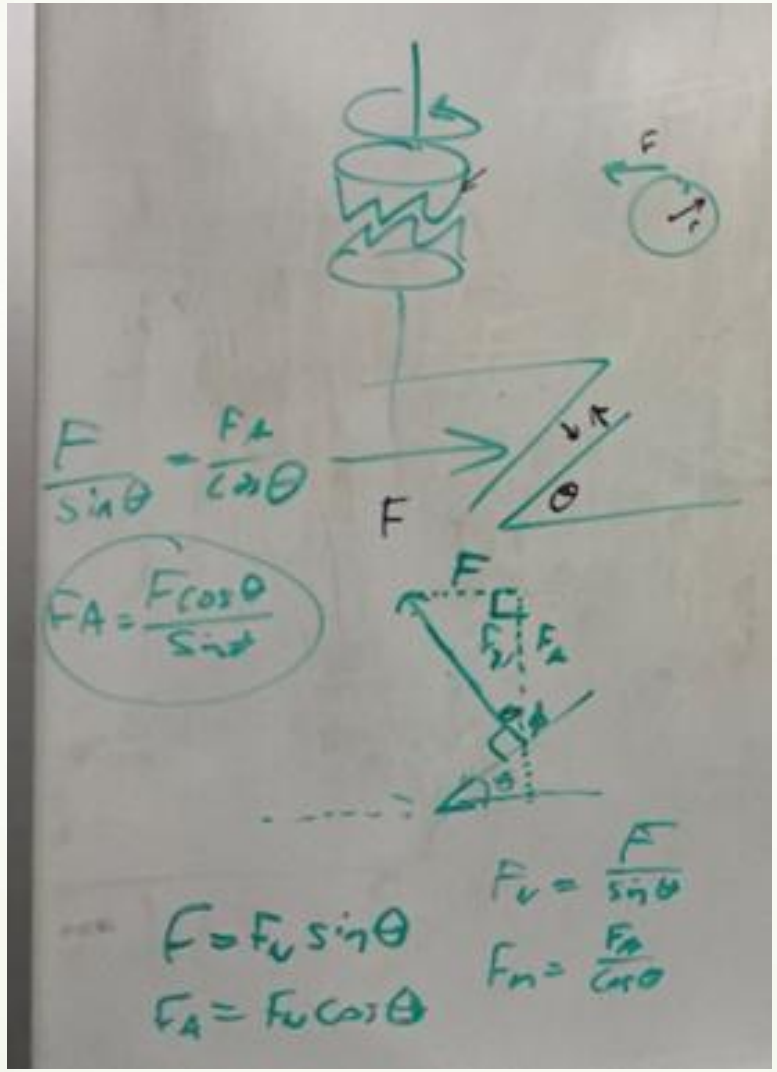
The smallest spur pinion that will operate with a rack without interference is

$$N_P = \frac{2(k)}{\sin^2 \phi} \qquad (13\text{–}13)$$

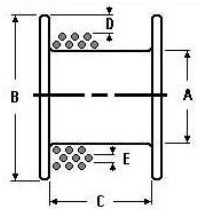
We have already noted that the first evidence of wear occurs near the pitch line. The radii of curvature of the tooth profiles at the pitch point are

$$r_1 = \frac{d_P \sin \phi}{2} \qquad r_2 = \frac{d_G \sin \phi}{2} \qquad (14\text{–}12)$$

Torque Limiter Calculations



Spool Sizing Calculations



A	Barrel Diameter:	.5	inch
B	Flange Diameter:	2	inch
C	Drum Length:	1.25	inch
D	Freeboard:	.25	inch
		Other - specify	
E	Cable Diameter:	English / Metric	= inches .0787
Unit of Measure:		(•) English ( ) Metric	
Drum surface:		(•) Smooth ( ) Grooved	

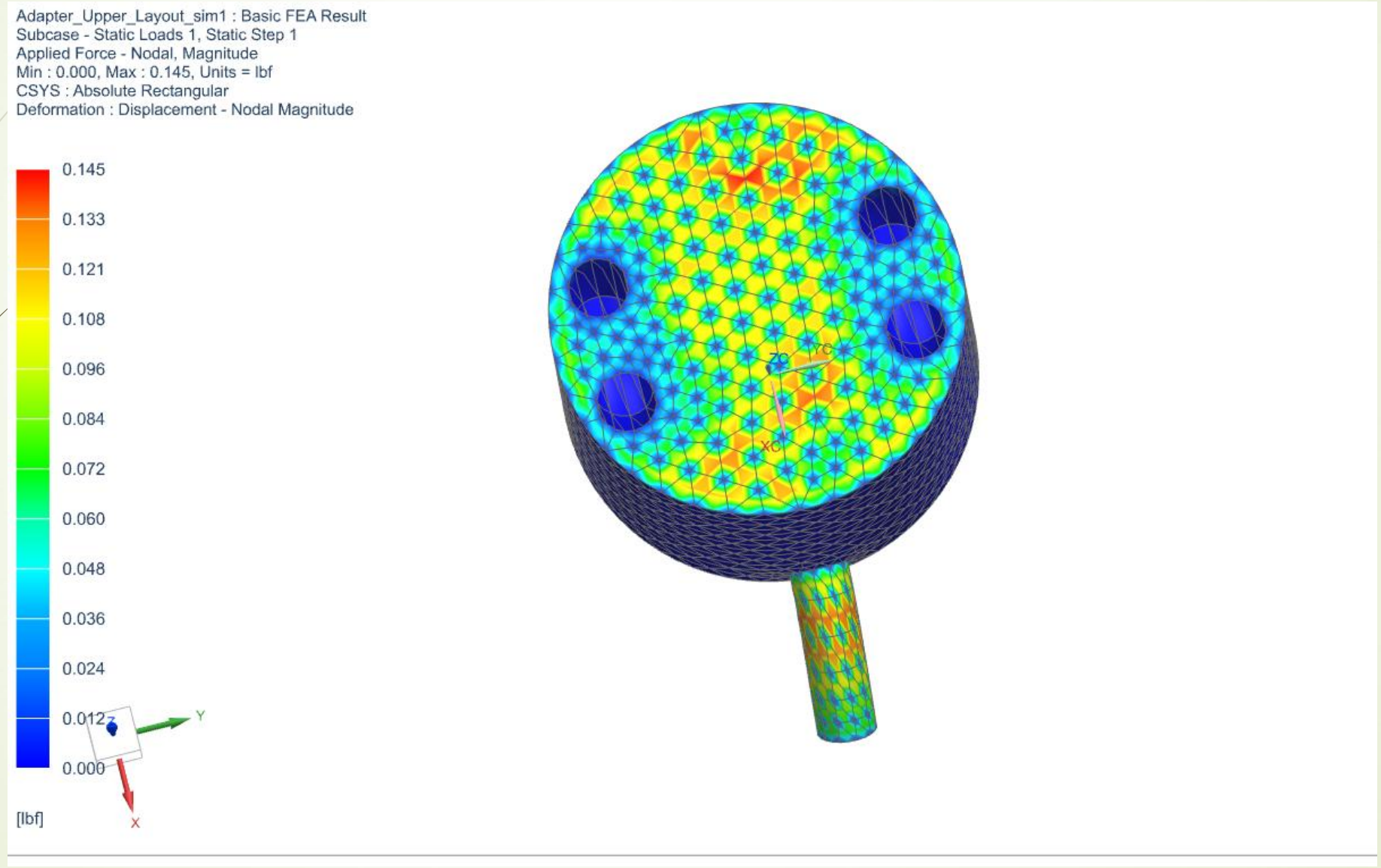
Calculate Clear

Layer 1 = 2 feet
Layer 2 = 5 feet
Layer 3 = 8 feet
Layer 4 = 12 feet
Layer 5 = 17 feet
Layer 6 = 22 feet

Total Drum Capacity:	22	feet
Total Working Drum Capacity:	21	feet
Recommended Working Capacity:	17	feet
D / d ratio:	7.3,532	
Minimum distance to lead sheave:	2	feet
Maximum distance to lead sheave:	5	feet

Appendix C: FEA

Adapter: Upper Half



Torque Limiter Calculations

- Hand Calcs to determine relationship between slipping torque and applied axial force
  - Inputs are desired torque and tooth angle, output is necessary axial force
- Used equations from Shigley's to determine rack and pinion geometry

inputs			
k	1	-	depth of teeth (1=full depth, 0.8 = stub)
phi	20	degrees	pressure angle
min num of teeth	17.09726434	-	minimum number of teeth without interference and undercutting
num of teeth	18	-	
pitch diameter	0.75	in	diameter of contact points of pinion

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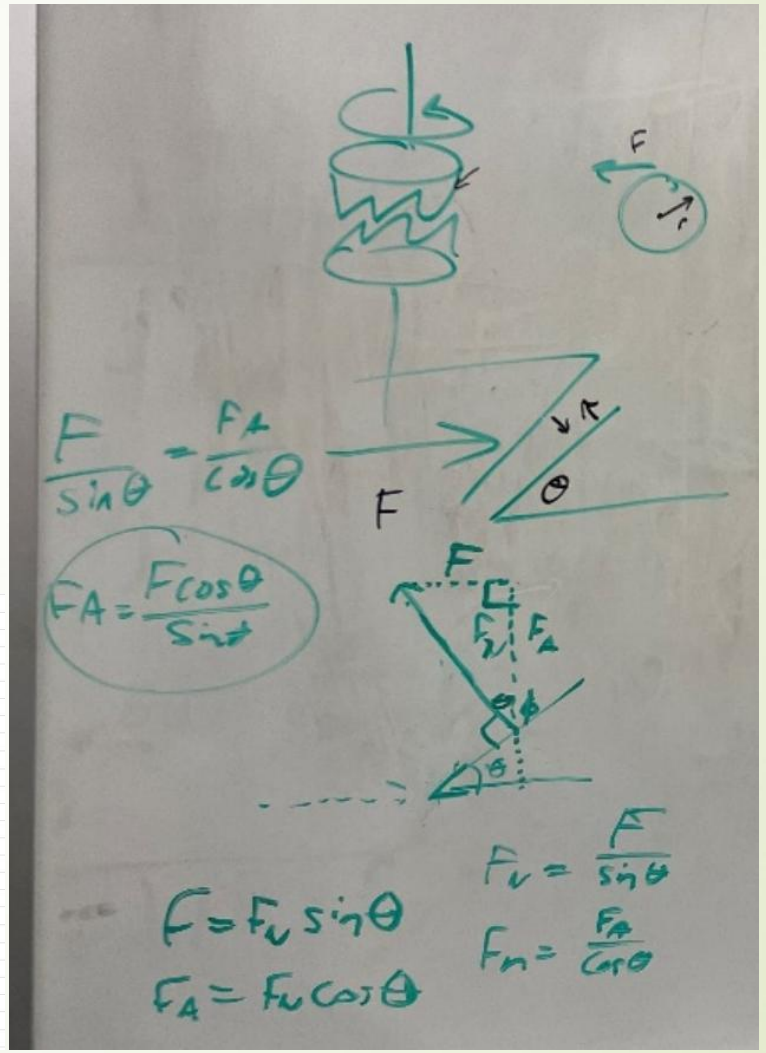
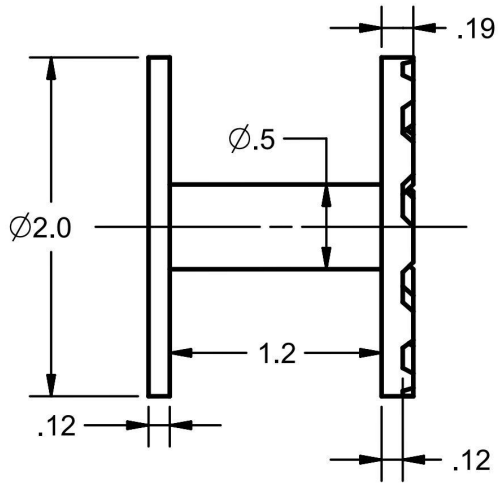
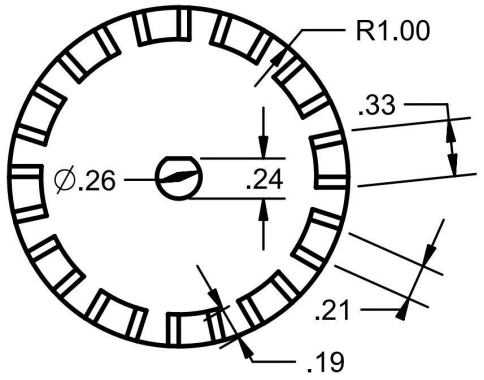
We have already noted that the first evidence of wear occurs near the pitch line. The radii of curvature of the tooth profiles at the pitch point are

$$r_1 = \frac{d_P \sin\phi}{2} \qquad r_2 = \frac{d_G \sin\phi}{2} \qquad (14\text{–}12)$$

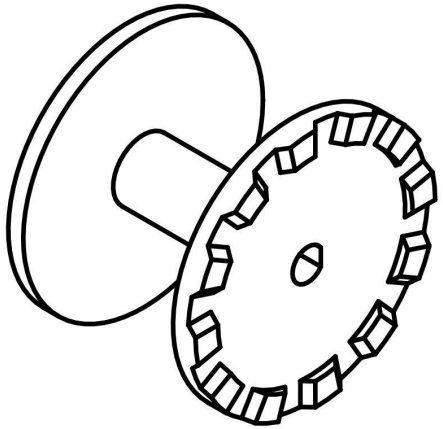


Appendix D: Manufacturing Drawings

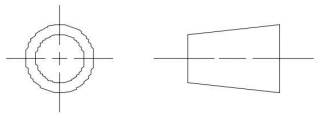




NOTES
1. MATERIAL PLA
2. 3D Print



GENERAL TOLERANCES
X.X ± 0.1
X.XX ± 0.03
X.XXX ± 0.005



ALL DIMENSIONS IN INCHES

SIEMENS

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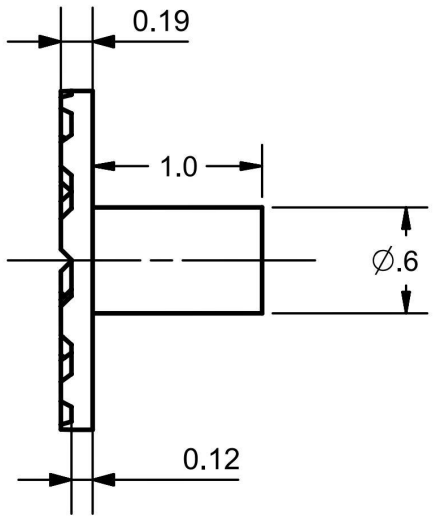
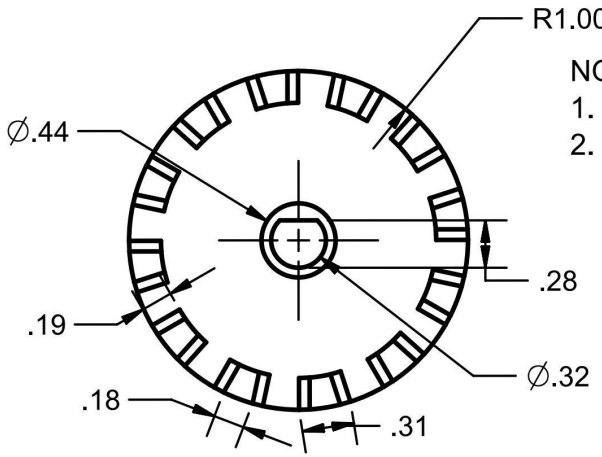
FIRST ISSUED	3/26/25
DRAWN BY	IM
CHECKED BY	SC
APPROVED BY	IM

TITLE: SPOOL

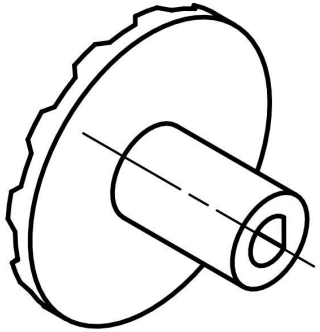
SIZE	DRG NO.	SHEET REV
A	Spool	A

SCALE 1:1 | SHEET 1 OF 1





NOTES
1. MATERIAL PLA
2. 3D Print



GENERAL TOLERANCES
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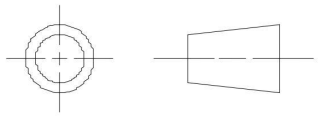
X.XX ± 0.03
X.XXX ± 0.005



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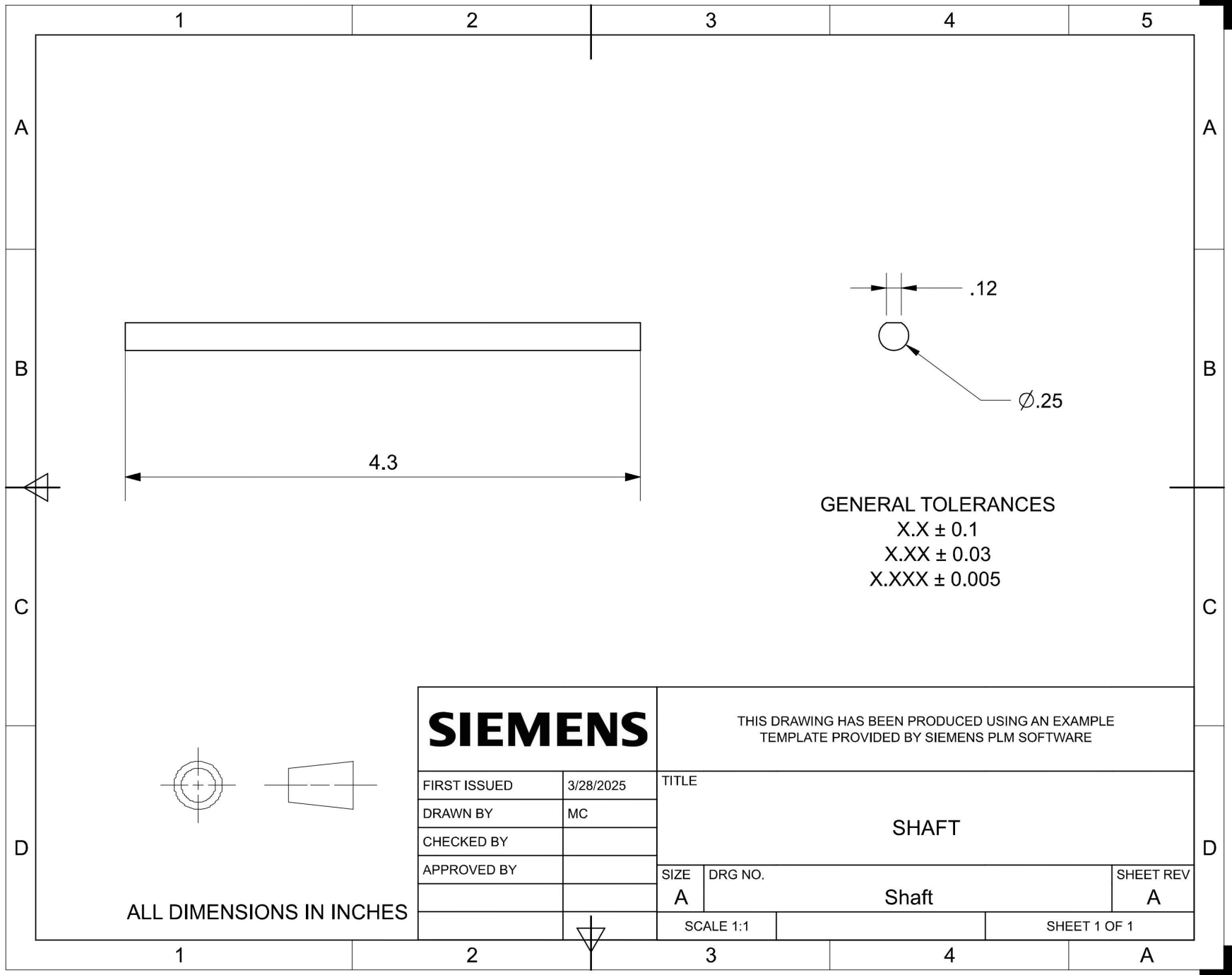
APPROVED BY	IM

TITLE: MOTOR LIMITER

SIZE	DRG NO.	SHEET REV
A	Motor Limiter	A

SCALE 1:1 | SHEET 1 OF 1


1
2
3
4
5
A
B
C
D
4.3
.12
Ø.25
GENERAL TOLERANCES
X.X ± 0.1
X.XX ± 0.03
X.XXX ± 0.005
ALL DIMENSIONS IN INCHES
SIEMENS
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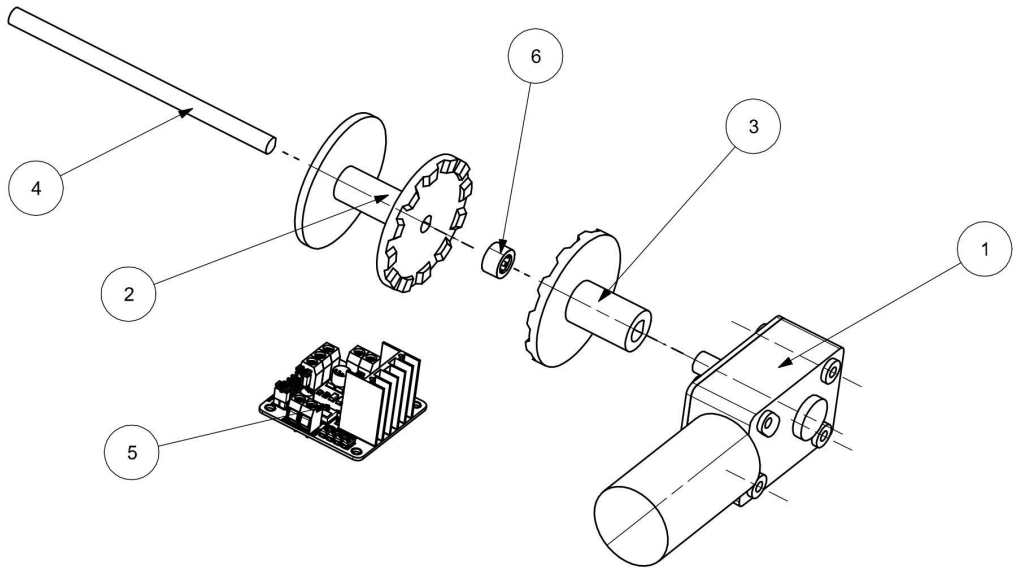
FIRST ISSUED 3/28/2025
DRAWN BY MC
CHECKED BY
APPROVED BY
TITLE
SHAFT
SIZE A
DRG NO. Shaft
SHEET REV A
SCALE 1:1
SHEET 1 OF 1



PC NO	PART NAME	QTY
6	5905K493_NEEDLE-ROLLER BEARING_STEP	1
5	L298N MOTOR DRIVER	1
4	SHAFT	1
3	MOTOR LIMITER	1
2	SPOOL	1
1	MOTOR	1

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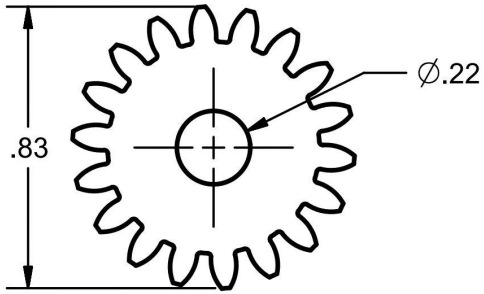
CHECKED BY	IM
APPROVED BY	IM

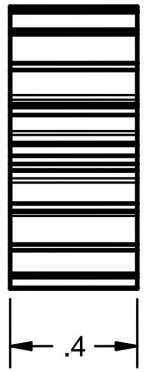
TITLE: TORQUE LIMITER ASSEMBLY

SIZE	DRG NO.	SHEET REV
B	Torque Limiter	A

SCALE 1:1 | SHEET 1 OF 1

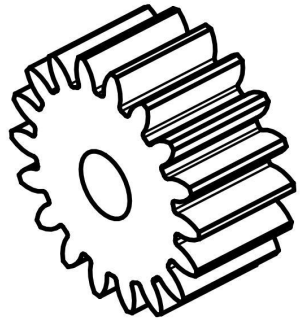
ALL DIMENSIONS IN INCHES





NOTES
1. MATERIAL PLA
2. 3D Print

Gear Parameter	Value
Pitch Diameter	.75
Diametral Pitch	24
Addendum	.042
Dedendum	.052



GENERAL TOLERANCES
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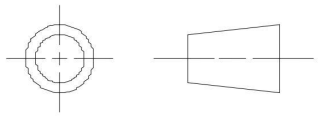
X.XX ± 0.03
X.XXX ± 0.005



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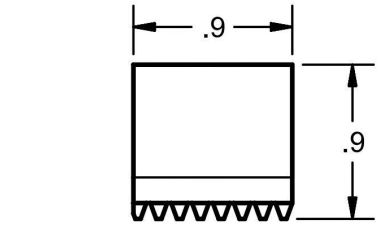
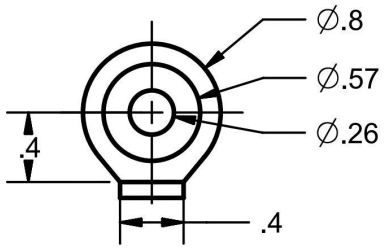
APPROVED BY	IM

TITLE: SPRING ADJUSTER PINION

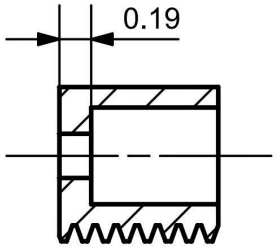
SIZE	DRG NO.	SHEET REV
A	Spring Adjuster Pinion	A

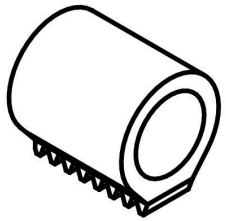
SCALE 2:1 | SHEET 1 OF 1





NOTES
1. MATERIAL PLA
2. 3D Print





GENERAL TOLERANCES
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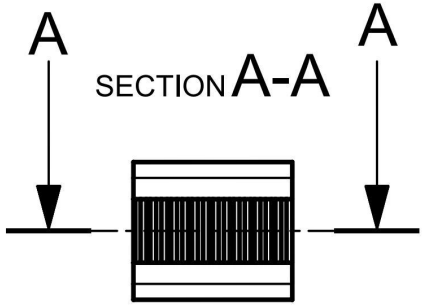
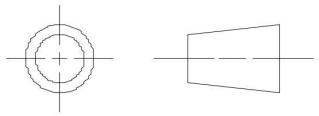
X.XX ± 0.03
X.XXX ± 0.005



Rack Parameter	Value
Tooth Spacing	.123
Tooth Thickness at Tangency Line	.062
Addendum	.042
Dedendum	.052



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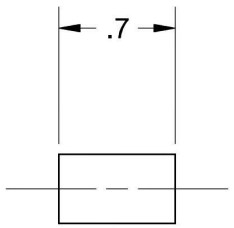
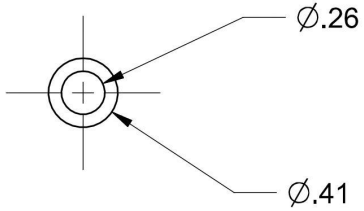
APPROVED BY	

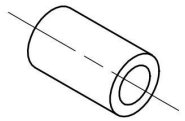
TITLE: SPRING ADJUSTER RACK

SIZE	DRG NO.	SHEET REV
A	Spring Adjuster Rack	A

SCALE 1:1 | SHEET 1 OF 1

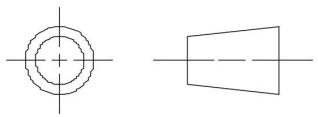






NOTES
1. MATERIAL PLA
2. 3D PRINT

GENERAL TOLERANCES
X.X ± 0.1
X.XX ± 0.03
X.XXX ± 0.005



ALL DIMENSIONS IN INCHES

SIEMENS

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FIRST ISSUED	3/28/2025
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APPROVED BY	

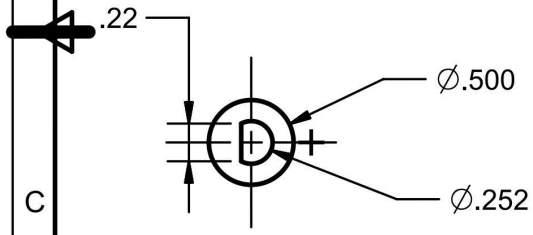
TITLE: SPRING BUSHING

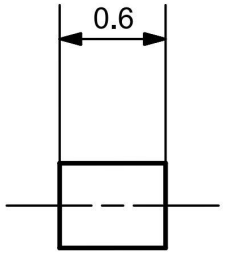
SIZE	DRG NO.	SHEET REV
A	Spring Bushing	A

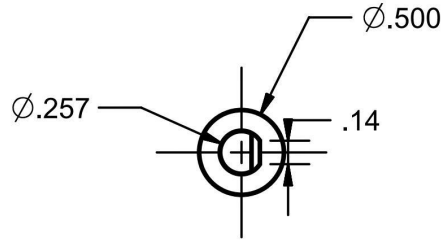
SCALE 1:1 | SHEET 1 OF 1

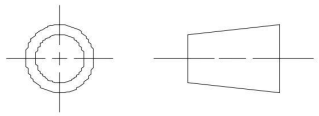
NOTES
1. MATERIAL PLA
2. 3D Print

GENERAL TOLERANCES
X.X ± 0.1
X.XX ± 0.03
X.XXX ± 0.005









ALL DIMENSIONS IN INCHES

FIRST ISSUED	3/28/2025
DRAWN BY	MC
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APPROVED BY	SC

SIEMENS

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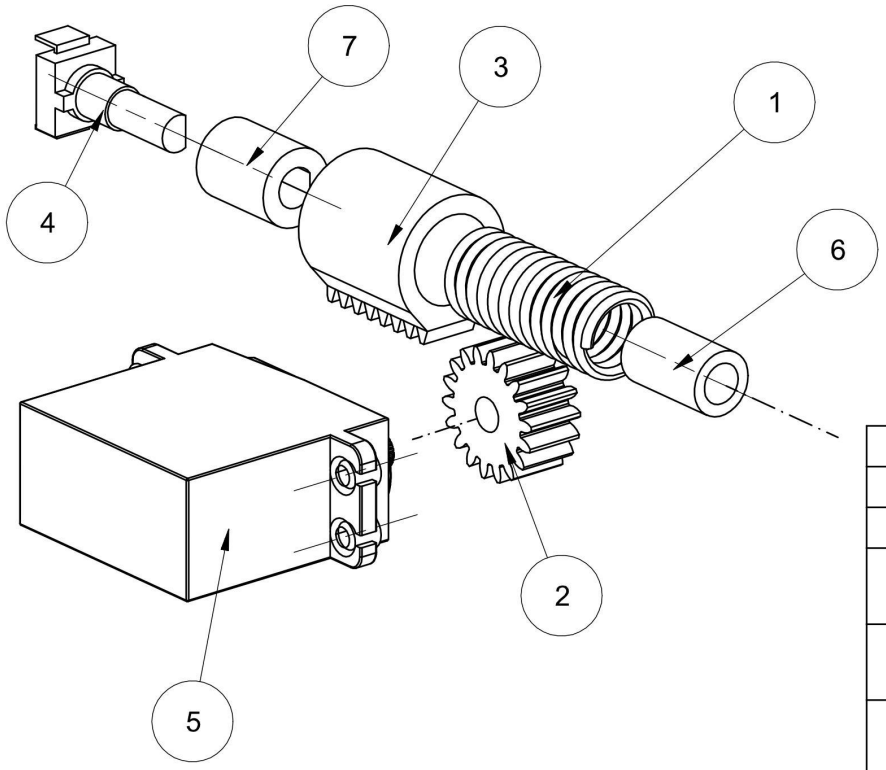
TITLE: ENCODER COUPLER

SIZE	DRG NO.	SHEET REV
A	Encoder Coupler	A

SCALE 1:1 | SHEET 1 OF 1



PC NO	PART NAME	QTY
7	ENCODER COUPLER	1
6	SPRING BUSHING	1
5	MIUZEI 25KG SERVO	1
4	EC11 ROTARY ENCODER	1
3	SPRING ADJUSTER RACK	1
2	SPRING ADJUSTER PINION	1
1	SPRING	1

SIEMENS

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FIRST ISSUED	3/28/2025
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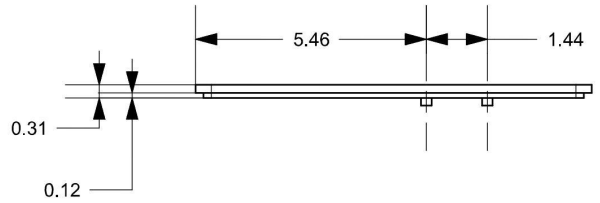
APPROVED BY	IM

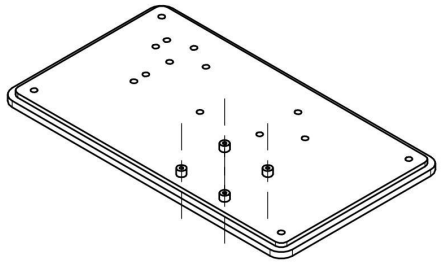
TITLE: SPRING ADJUSTMENT ASSEMBLY

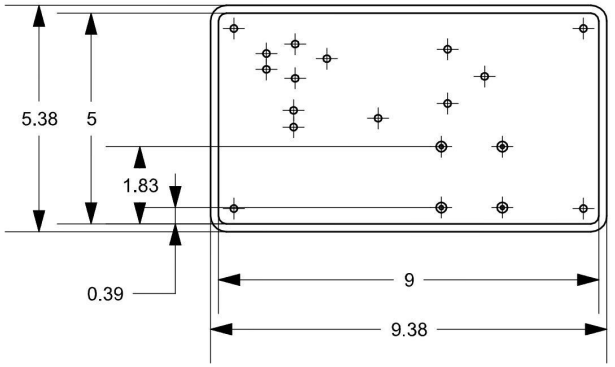
SIZE	DRG NO.	SHEET REV
A	Spring Adjustment	A

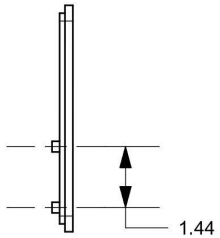
SCALE 1:1 | SHEET 1 OF 1

ALL DIMENSIONS IN INCHES



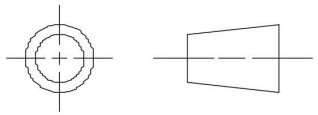






NOTES
1. MATERIAL PLA
2. 3D PRINT

GENERAL TOLERANCES
X.X ± 0.1
X.XX ± 0.03
X.XXX ± 0.005



ALL DIMENSIONS IN INCHES

SIEMENS

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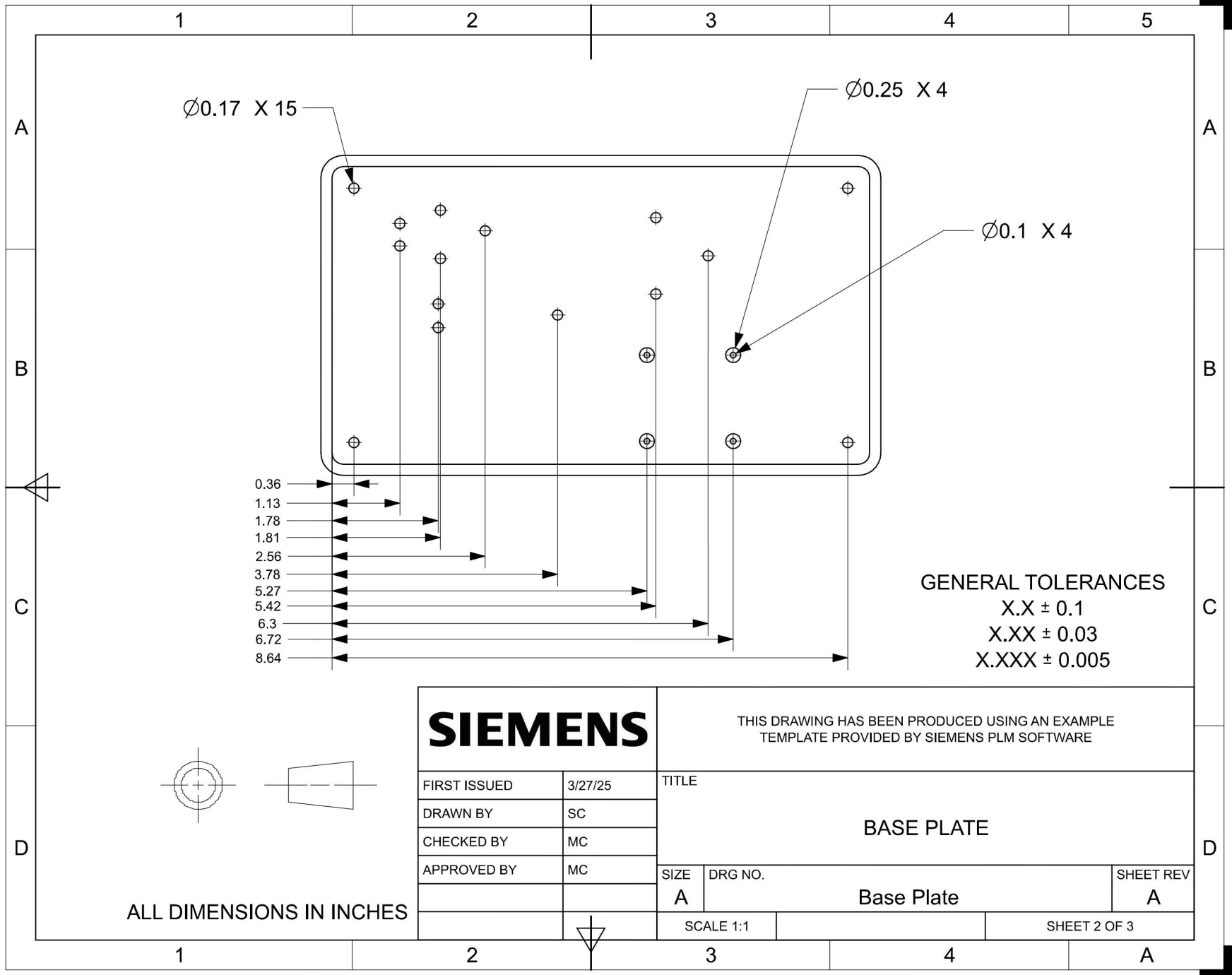
APPROVED BY	MC

TITLE: BASE PLATE

SIZE	DRG NO.	SHEET REV
A	Base Plate	A

SCALE 1:1 | SHEET 1 OF 3


Ø0.17 X 15
Ø0.25 X 4
Ø0.1 X 4
0.36
1.13
1.78
1.81
2.56
3.78
5.27
5.42
6.3
6.72
8.64
GENERAL TOLERANCES
X.X ± 0.1
X.XX ± 0.03
X.XXX ± 0.005
SIEMENS
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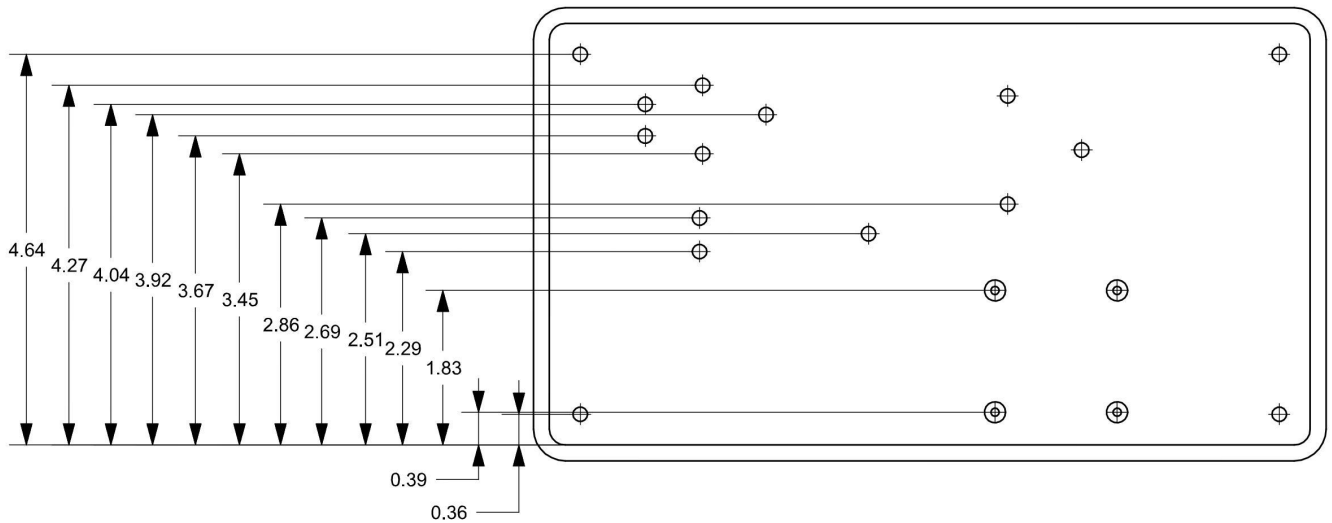
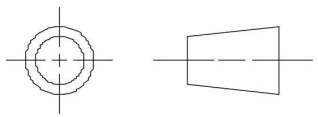
FIRST ISSUED 3/27/25
DRAWN BY SC
CHECKED BY MC
APPROVED BY MC
TITLE
BASE PLATE
SIZE A
DRG NO. Base Plate
SHEET REV A
SCALE 1:1
SHEET 2 OF 3
ALL DIMENSIONS IN INCHES



GENERAL TOLERANCES
X.X ± 0.1
X.XX ± 0.03
X.XXX ± 0.005



ALL DIMENSIONS IN INCHES

SIEMENS

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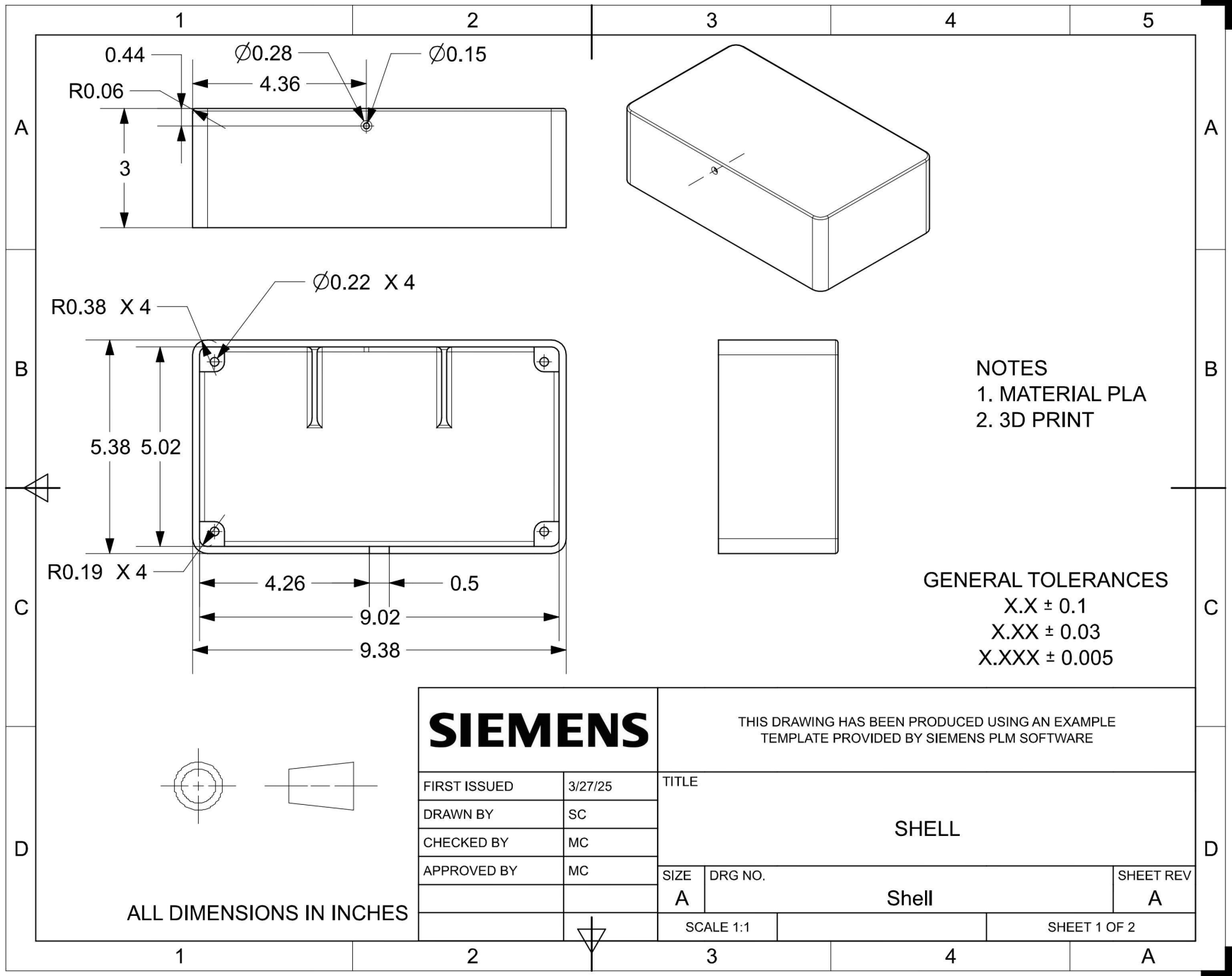
TITLE: BASE PLATE

SIZE	DRG NO.	SHEET REV
A	Base Plate	A

SCALE 1:1 | SHEET 3 OF 3


0.44
Ø0.28
Ø0.15
4.36
R0.06
3
Ø0.22 X 4
R0.38 X 4
5.38
5.02
R0.19 X 4
4.26
0.5
9.02
9.38
NOTES
1. MATERIAL PLA
2. 3D PRINT
GENERAL TOLERANCES
X.X ± 0.1
X.XX ± 0.03
X.XXX ± 0.005
ALL DIMENSIONS IN INCHES
SIEMENS
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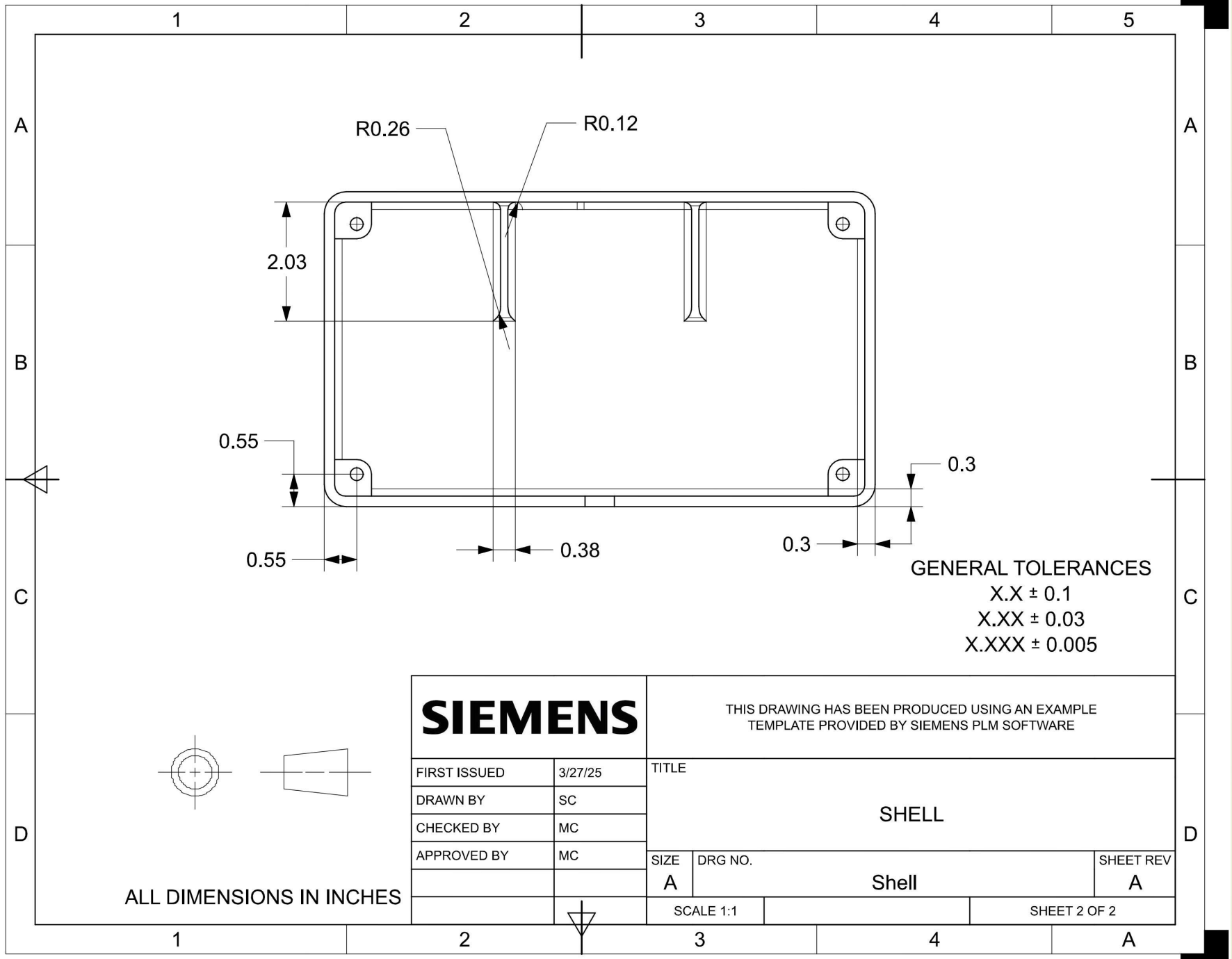
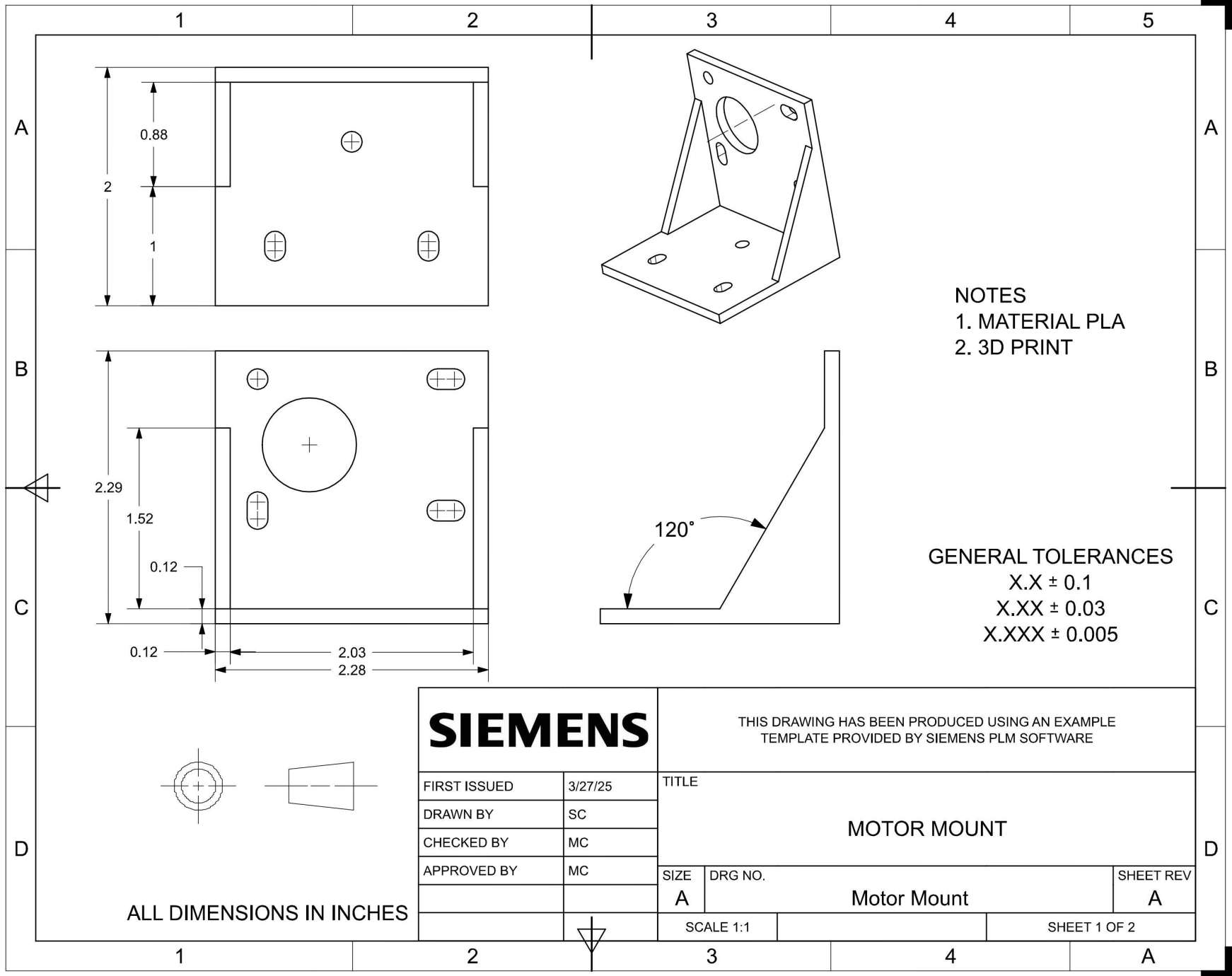
FIRST ISSUED 3/27/25
DRAWN BY SC
CHECKED BY MC
APPROVED BY MC
TITLE
SHELL
SIZE A
DRG NO. Shell
SHEET REV A
SCALE 1:1
SHEET 1 OF 2


1
2
3
4
5
A
B
C
D
R0.26
R0.12
2.03
0.55
0.55
0.38
0.3
0.3
GENERAL TOLERANCES
X.X ± 0.1
X.XX ± 0.03
X.XXX ± 0.005
ALL DIMENSIONS IN INCHES
SIEMENS
THIS DRAWING HAS BEEN PRODUCED USING AN EXAMPLE TEMPLATE PROVIDED BY SIEMENS PLM SOFTWARE
FIRST ISSUED 3/27/25
DRAWN BY SC
CHECKED BY MC
APPROVED BY MC
TITLE
SHELL
SIZE A
DRG NO. Shell
SHEET REV A
SCALE 1:1
SHEET 2 OF 2


1
2
3
4
5
A
B
C
D
0.88
2
1
2.29
1.52
0.12
0.12
2.03
2.28
120°
NOTES
1. MATERIAL PLA
2. 3D PRINT
GENERAL TOLERANCES
X.X ± 0.1
X.XX ± 0.03
X.XXX ± 0.005
ALL DIMENSIONS IN INCHES
SIEMENS
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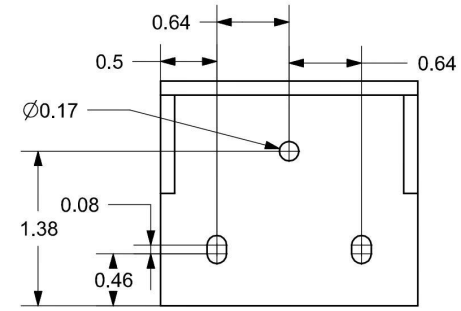
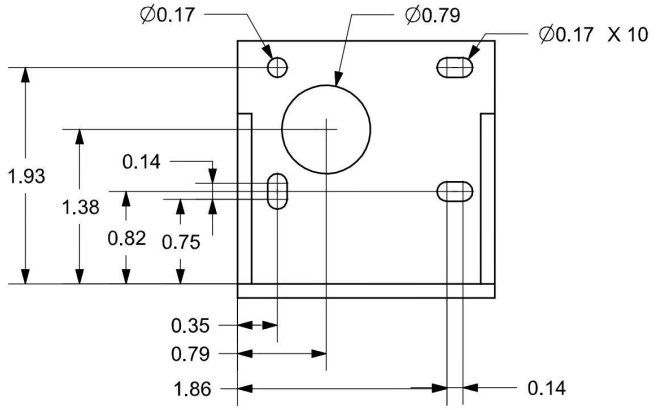
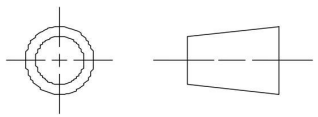
FIRST ISSUED 3/27/25
DRAWN BY SC
CHECKED BY MC
APPROVED BY MC
TITLE
MOTOR MOUNT
SIZE A
DRG NO. Motor Mount
SHEET REV A
SCALE 1:1
SHEET 1 OF 2





GENERAL TOLERANCES
X.X ± 0.1
X.XX ± 0.03
X.XXX ± 0.005



ALL DIMENSIONS IN INCHES

SIEMENS

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FIRST ISSUED	3/27/25
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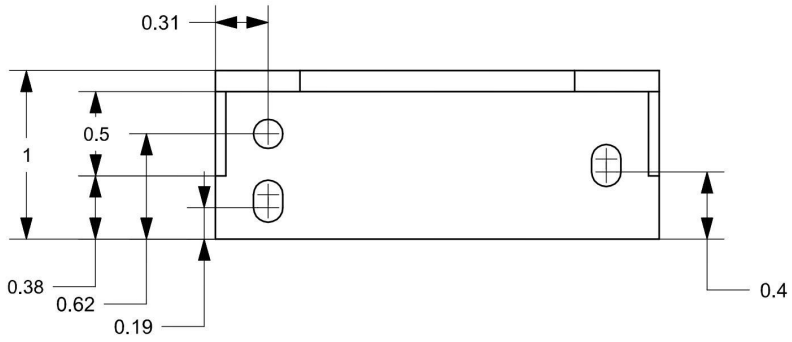
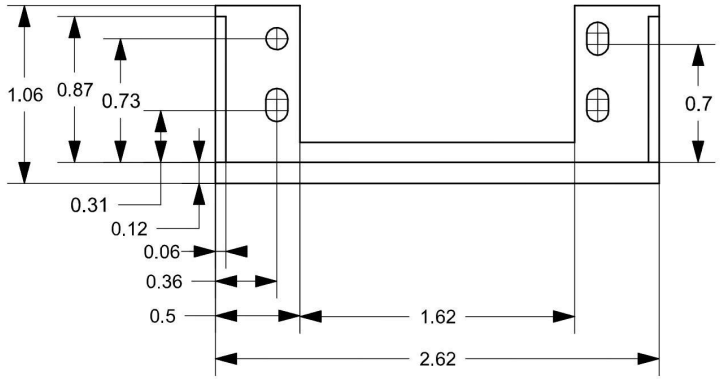
APPROVED BY	MC

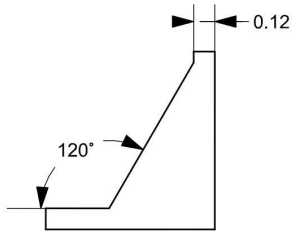
TITLE: MOTOR MOUNT

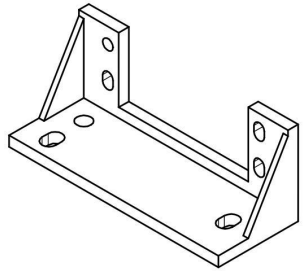
SIZE	DRG NO.	SHEET REV
A	Motor Mount	A

SCALE 1:1 | SHEET 2 OF 2



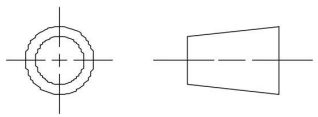






NOTES
1. MATERIAL PLA
2. 3D PRINT

GENERAL TOLERANCES
X.X ± 0.1
X.XX ± 0.03
X.XXX ± 0.005



ALL DIMENSIONS IN INCHES

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FIRST ISSUED	3/27/25
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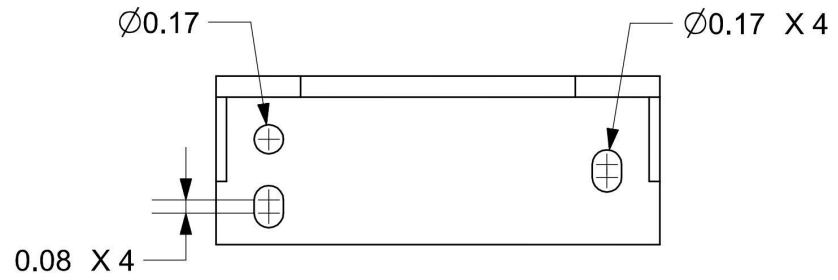
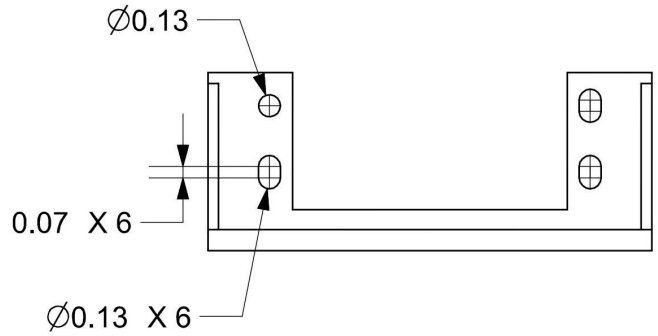
APPROVED BY	MC

TITLE: SERVO BRACKET

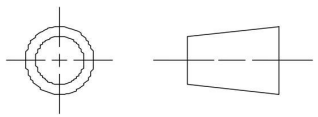
SIZE	DRG NO.	SHEET REV
A	Servo Bracket	A

SCALE 1:1 | SHEET 1 OF 2





GENERAL TOLERANCES
X.X ± 0.1
X.XX ± 0.03
X.XXX ± 0.005



ALL DIMENSIONS IN INCHES

SIEMENS

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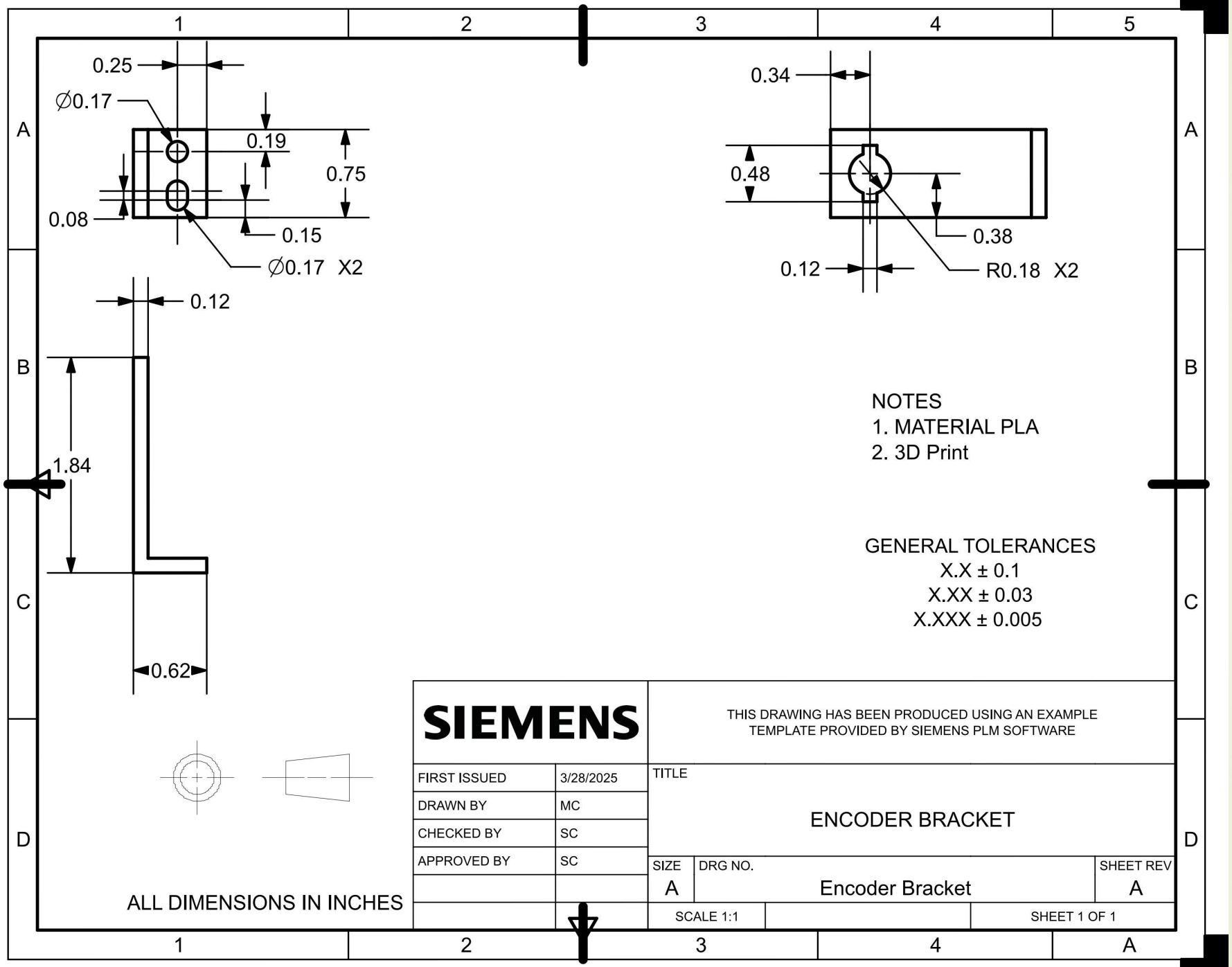
FIRST ISSUED	3/27/25
DRAWN BY	SC
CHECKED BY	MC
APPROVED BY	MC

TITLE: SERVO BRACKET

SIZE	DRG NO.	SHEET REV
A	Servo Bracket	A

SCALE 1:1 | SHEET 2 OF 2


0.25
Ø0.17
0.19
0.75
0.08
0.15
Ø0.17 X2
0.34
0.48
0.38
0.12
R0.18 X2
0.12
1.84
0.62
NOTES
1. MATERIAL PLA
2. 3D Print
GENERAL TOLERANCES
X.X ± 0.1
X.XX ± 0.03
X.XXX ± 0.005
SIEMENS
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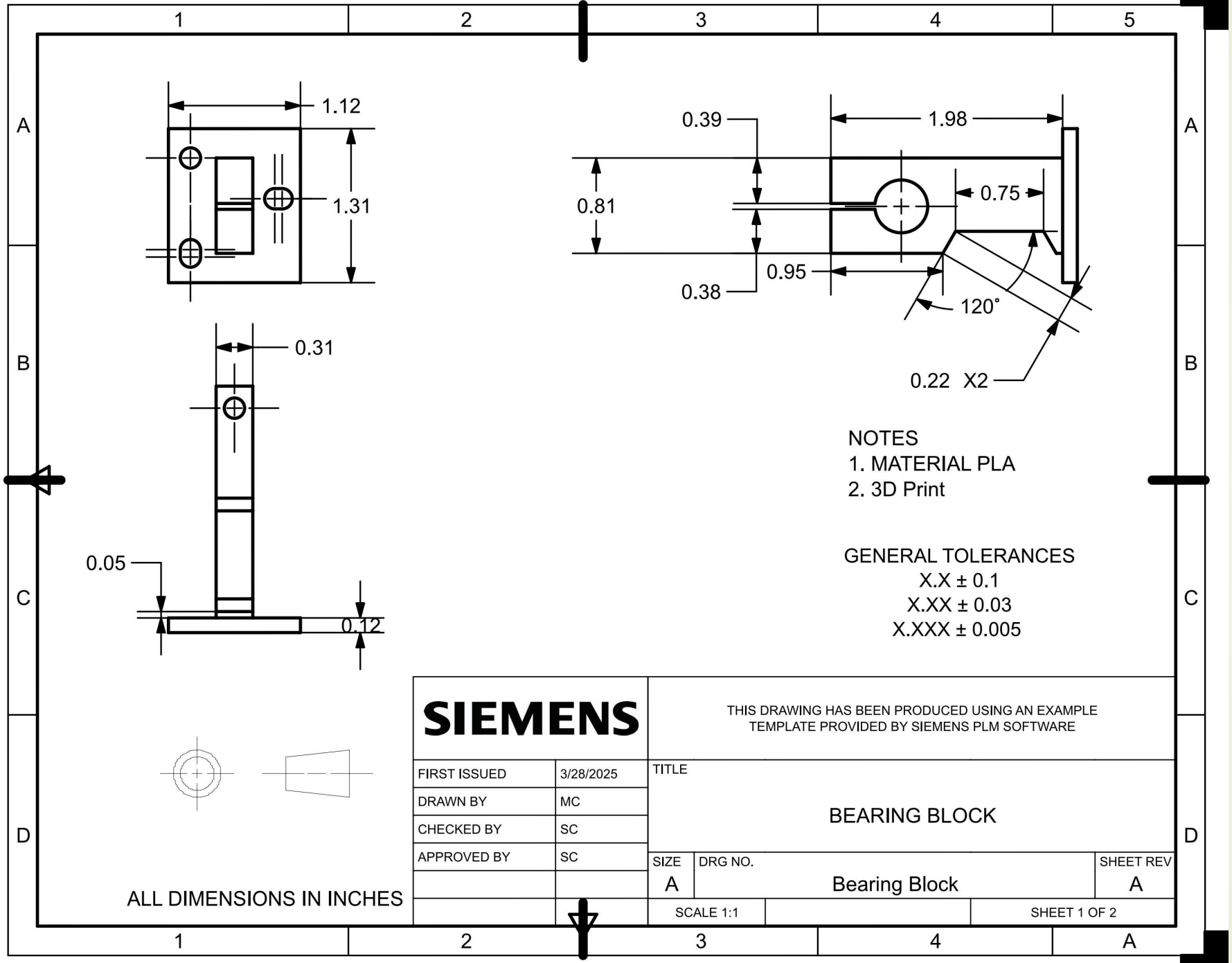
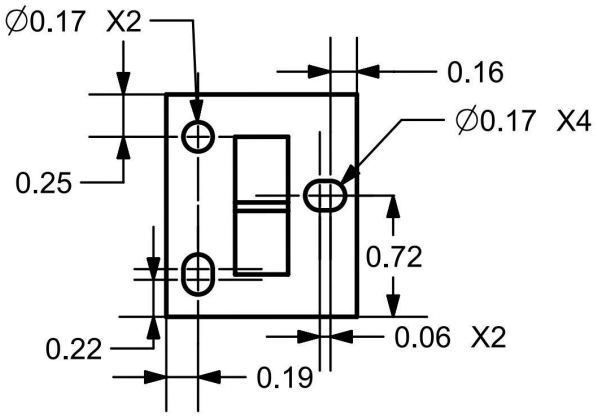
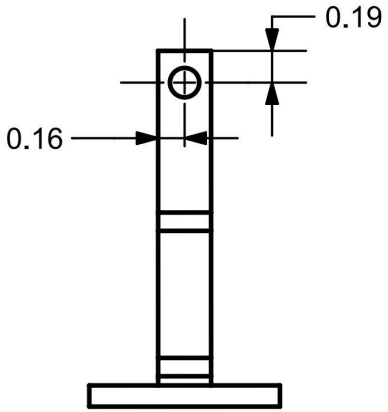
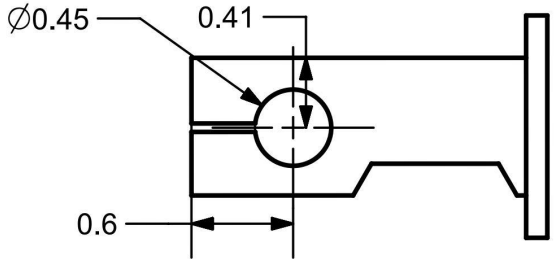
FIRST ISSUED 3/28/2025
DRAWN BY MC
CHECKED BY SC
APPROVED BY SC
TITLE
ENCODER BRACKET
SIZE A
DRG NO. Encoder Bracket
SHEET REV A
SCALE 1:1
SHEET 1 OF 1
ALL DIMENSIONS IN INCHES


1.12
1.31
0.31
0.05
0.12
0.39
0.81
0.38
1.98
0.75
0.95
120°
0.22 X2
NOTES
1. MATERIAL PLA
2. 3D Print
GENERAL TOLERANCES
X.X ± 0.1
X.XX ± 0.03
X.XXX ± 0.005
ALL DIMENSIONS IN INCHES
SIEMENS
THIS DRAWING HAS BEEN PRODUCED USING AN EXAMPLE TEMPLATE PROVIDED BY SIEMENS PLM SOFTWARE
FIRST ISSUED 3/28/2025
DRAWN BY MC
CHECKED BY SC
APPROVED BY SC
TITLE
BEARING BLOCK
SIZE A
DRG NO. Bearing Block
SHEET REV A
SCALE 1:1
SHEET 1 OF 2

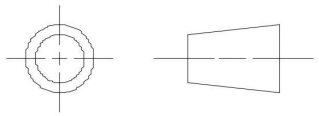






NOTES
1. MATERIAL PLA
2. 3D Print

GENERAL TOLERANCES
X.X ± 0.1
X.XX ± 0.03
X.XXX ± 0.005



ALL DIMENSIONS IN INCHES

SIEMENS

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FIRST ISSUED	3/28/2025
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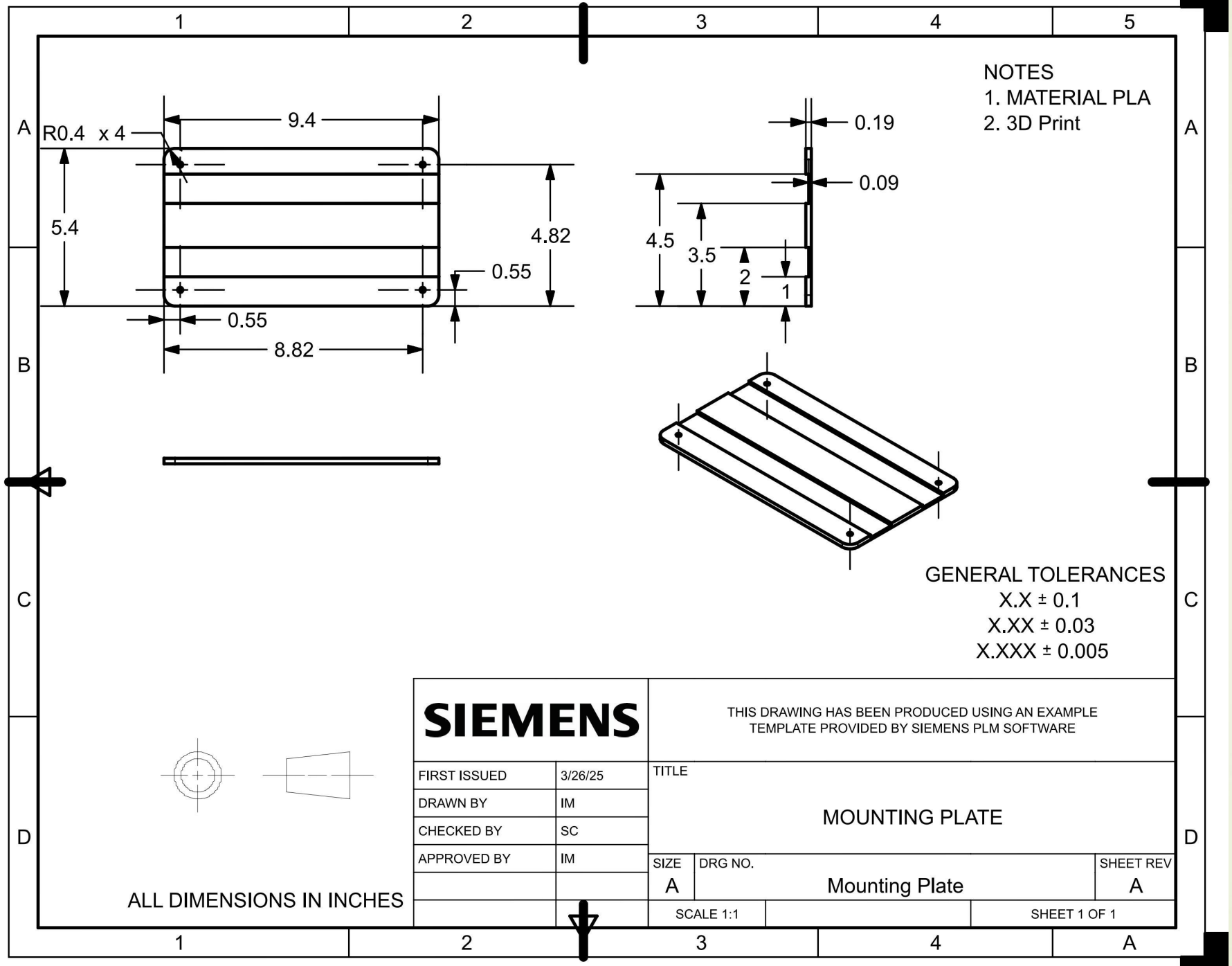
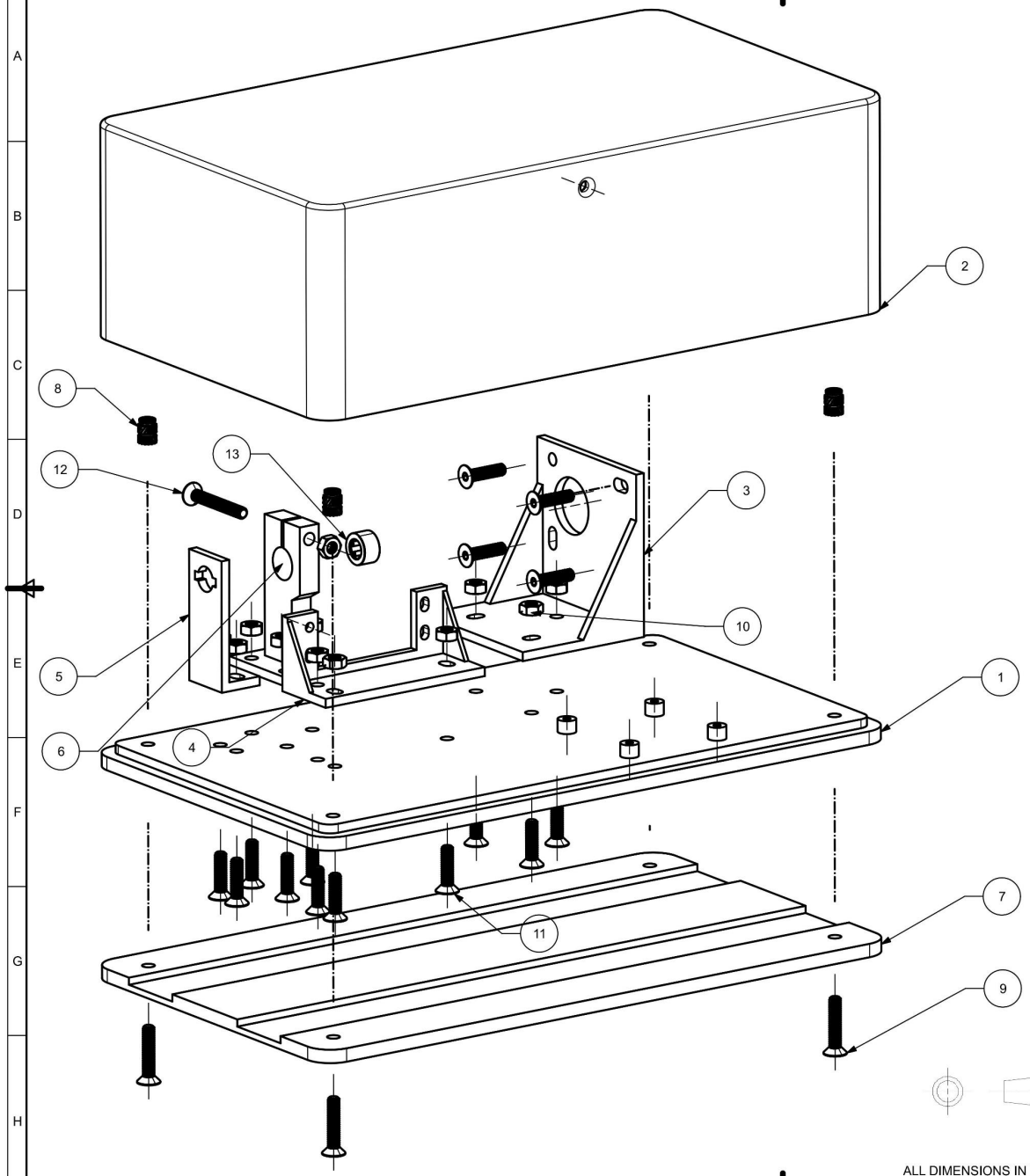
TITLE: BEARING BLOCK

SIZE	DRG NO.	SHEET REV
A	Bearing Block	A

SCALE 1:1 | SHEET 2 OF 2


NOTES
1. MATERIAL PLA
2. 3D Print
R0.4 x 4
9.4
5.4
4.82
0.55
0.55
8.82
0.19
0.09
4.5
3.5
2
1
GENERAL TOLERANCES
X.X ± 0.1
X.XX ± 0.03
X.XXX ± 0.005
SIEMENS
THIS DRAWING HAS BEEN PRODUCED USING AN EXAMPLE TEMPLATE PROVIDED BY SIEMENS PLM SOFTWARE
FIRST ISSUED 3/26/25
DRAWN BY IM
CHECKED BY SC
APPROVED BY IM
TITLE
MOUNTING PLATE
SIZE A
DRG NO. Mounting Plate
SHEET REV A
SCALE 1:1
SHEET 1 OF 1
ALL DIMENSIONS IN INCHES



PC NO	PART NAME	QTY
13	5905K493_NEEDLE-ROLLER BEARING_STEP	1
12	91294A200_BLACK-OXIDE ALLOY STEEL HEX DRIVE FLAT HEAD SCREW_STEP	1
11	91294A194_BLACK-OXIDE ALLOY STEEL HEX DRIVE FLAT HEAD SCREW_STEP	15
10	90591A255_ZINC-PLATED STEEL HEX NUT_STEP	12
9	91294A196_BLACK-OXIDE ALLOY STEEL HEX DRIVE FLAT HEAD SCREW_STEP	4
8	94459A170_HEAT-SET INSERTS FOR PLASTIC_STEP	4
7	MOUNTING PLATE	1
6	BEARING BLOCK	1
5	ENCODER BRACKET	1
4	SERVO BRACKET	1
3	MOTOR MOUNT	1
2	SHELL	1
1	BASE PLATE	1

ALL DIMENSIONS IN INCHES

SIEMENS

THIS DRAWING HAS BEEN PRODUCED USING AN EXAMPLE TEMPLATE PROVIDED BY SIEMENS PLM SOFTWARE

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TITLE: HOUSING ASSEMBLY

SIZE C | DRG NO. Housing Assembly | SHEET REV A

SCALE 1:1 | SHEET 1 OF 1