

Construction manual belt tensioner

made by Insert Coin

version 1.2

(original idea by Metalwood)

Version history of this document

- 1.2 There was an error in the screenshot of the SimFeedback AC profile: "Type: Pitch Effect" should be "Type: Standalone Motor 1". Thanks to Metalwood for pointing that out to me. This also has the advantage of not having to wind the belts manually before starting SimFeedback.
Changed servo drive parameter P97 to 0 so it winds the tube as shown in the pictures.
Added a section about adding hip belts (highly recommended!).
Changed the servo drive configuration and safety warning.
Added a few lines on how to setup the belts for the first time.
- 1.1 Hyperlinks added for the metal connection plates and tube clamps
Tuned the servo drive parameters: P98 to 2, P115 to 100, P8 to 75, P9 to -75
Added a 'Recommended' section: a 'belly' on the belts
Tuned SimFeedback: changed values of intensity, acceleration, min/max speed and clarified the screenshots.
- 1.0 Initial release of this document

Before you begin...

You will need some metal working skills to build this: drilling, filing and grinding. Making the slot for the servo key can be a bit tricky. To get the tube to slide through the bearings you must grind the inner side of the bearings to make them a bit wider (at least that's what I had to do).

Tools needed



Some hex tools and wrenches (17 and 10)



a high speed hobby drill (Dremel like)



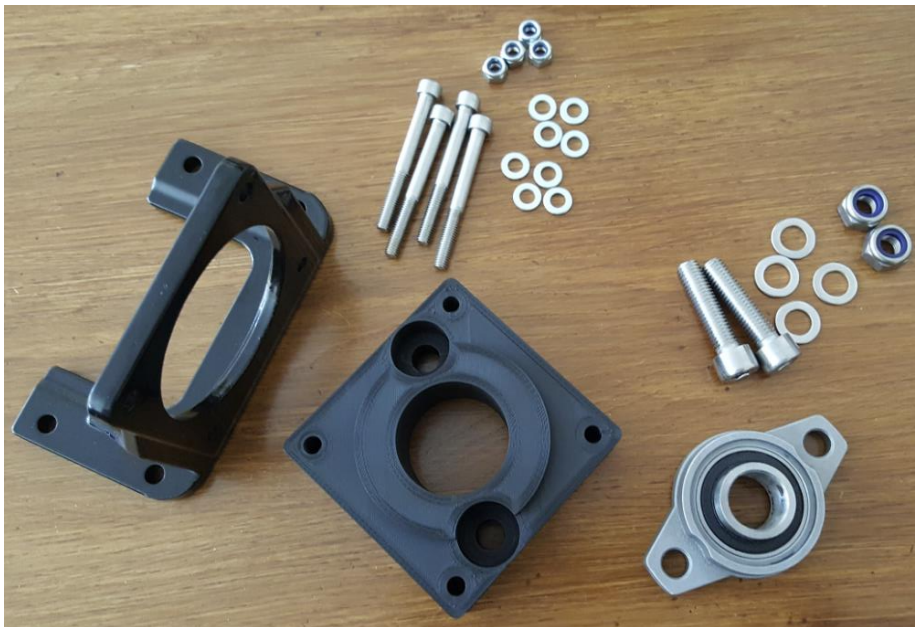
a center-punch



a hammer

and some sandpaper.

Parts list



2 x

(Nuts, bolts and rings for mounting the servo holder onto the actuator are not on this photo)

Nuts and flange bearing

Bought at <https://www.dold-mechatronik.de>



[Nutenstein mit Feder B-Typ](#)
[Nut 10,](#)
[Gewindedurchmesser M6](#)

8 x

0,49 EUR

(for mounting the servo holders to the actuators)



[Flanschlager 20mm](#)
[Aluminium Druckguss](#)
[KFL004](#)

2 x

8,00 EUR

Nuts and bolts

Bought at www.rvspaleis.nl

I can't link directly to the article unfortunately.



A2 m6x25mm / per stuk - cilinderkopschroef A2

Artnr. : 912-2-6X25_1

DIN 912

M6 x L 25mm

s (sleutelmaat) : zeskant 5mm
volledige draad

€ 0,19 excl. btw
€ 0,23 incl. btw

1 stuk

briefpost

Voorradig
(verzonden binnen 24 uur)

912-2-6x25_1

8 x 0,23 EUR

Used for mounting the servo holders onto the aluminium extrusions.



A2 m10x40mm / per stuk - cilinderkopschroef A2

Artnr. : 912-2-10X40_1

DIN 912

M10 x L 40mm

s (sleutelmaat) : zeskant 8mm
volledige draad

Kwaliteit : RVS / INOX A2

€ 0,56 excl. btw
€ 0,67 incl. btw

1 stuk

briefpost

Voorradig
(verzonden binnen 24 uur)

Voorraad: 944

912-2-10x40_1

4 x 0,67 EUR

A2**m6****m6 / per stuk - sluitring A2**

Artnr. : 433-2-6_1

M6

DIN 433

Toepassing : cilinderschroeven

Kwaliteit : RVS / INOX A2

€ 0,19 excl. btw

€ 0,23 incl. btw

433-2-6_1

 stuk

24 x

0,23 EUR

briefpost

Voorradig

(verzonden binnen 24 uur)

A2**m10****m10 / per stuk - sluitring A2**

Artnr. : 433-2-10_1

M10

DIN 433

Toepassing : cilinderschroeven

Kwaliteit : RVS / INOX A2

€ 0,19 excl. btw

€ 0,23 incl. btw

433-2-10_1

 stuk

8 x

0,23 EUR

briefpost

Voorradig

(verzonden binnen 24 uur)

A2**m10****m10 / per stuk - borgmoer A2**

Artnr. : 985-2-10_1

M10

DIN 985

Zelfborgende zeskantmoer

Kwaliteit : RVS / INOX A2

€ 0,22 excl. btw

€ 0,26 incl. btw

985-2-10_1

 stuk

4 x

0,26 EUR

briefpost

Voorradig

(verzonden binnen 24 uur)

A2**m6****m6 / per stuk - borgmoer A2**

Artnr. : 985-2-6_1

M6

DIN 985

Zelfborgende zeskantmoer

Kwaliteit : RVS / INOX A2

€ 0,19 excl. btw

€ 0,23 incl. btw

985-2-6_1

 stuk

8 x

0,23 EUR

briefpost

Voorradig

(verzonden binnen 24 uur)

A2**m6x60****m6x60mm / per stuk - cilinderkopschroef A2**

Artnr. : 912-2-6X60_1

DIN 912

M6 x L 60mm

s (sleutelmaat) : zeskant 5mm

Kwaliteit : RVS / INOX A2

€ 0,32 excl. btw

€ 0,38 incl. btw

1 stuk

briefpost

Voorradig
(verzonden binnen 24 uur)

912-2-6x60_1

8 x 0,38 EUR

Note: for simplicity I chose the same bolt length for both bearing blocks, but for the non-servo side you can use a 10 mm shorter bolt if aesthetics is important to you. So 4 x 50mm and 4 x 60 mm, M6.

Bought at the local hardware shop:

[Metal connection plate 80 x 15 mm](#)

2 x 0,45 EUR

for shoulder belts only (without hip belts)

- or -[Metal connection plate 160 x 15 mm](#)

2 x 0,65 EUR

for shoulder belts and hip belts

[Tube clamps 16 – 25 mm](#)

4 x 1,15 EUR

Servo holder and servo

Bought at AliExpress



[CNC Parts 90ST Mounting Servo Motor Horizontal Bracket Holder fitted Black Alloy for DIY AC 90st M02430/M04025/M03520 servomotor](#)

2 x 8,73 EUR + 9,70 EUR shipping

90ST SERIES



[90ST-M02430 220V 750W AC Servo motor 3000RPM 2.4 N.M. 0.75KW servomotor Single-Phase ac drive permanent magnet Matched Driver](#)

1 x 187,74 EUR + 69,47 EUR shipping + 56,61 EUR import duty

90ST-M02430

Arduino and D-sub cable

Bought at <https://www.reichelt.de>

Before you ask: an Arduino UNO does not work, it needs to be a Leonardo.



[ARDUINO LEONARDO Arduino Leonardo, ATmega 32u4, USB](#)

1 x 22,50 €



[AK 4010 D-SUB Kabel, 1:1, 25-pol., Stecker/Stecker, 1,8 m - 2,0 m](#)

1 x 2,95 €

Emergency stop

Bought at Amazon



[Not Aus Taster Schalter Notaus 1 Öffner + 1 Schließer rastend inklusive Gehäuse](#)

1 x 10,90 EUR

Steel tube

Bought at <https://www.ijzershop.nl>

Steel tube ('stalen buis') 20 x 2mm



Cut A length: 630 mm | remaining length 1365 mm (± 5 mm)

You need to measure the length you need for your rig, in my case I needed a tube length of 63 cm. The total length of 2 meter will be delivered, but in two pieces (630 and 1365 mm).

Zaagmenu voor stalen buis 20 x 2mm

1. Selecteer gewenste zaaglengtes en typ lengte per deel i

Zaaglengte A	<input type="text" value="630"/>	<input type="text" value="mm"/>	gratis
Zaaglengte B	<input type="text"/>	<input type="text" value="mm"/>	gratis
Zaaglengte C	<input type="text"/>	<input type="text" value="mm"/>	€ 1,26
Zaaglengte D	<input type="text"/>	<input type="text" value="mm"/>	€ 1,26
Zaaglengte E	<input type="text"/>	<input type="text" value="mm"/>	€ 1,26
Zaaglengte F	<input type="text"/>	<input type="text" value="mm"/>	€ 1,26
Zaaglengte G	<input type="text"/>	<input type="text" value="mm"/>	€ 1,26

Restlengte (± 5 mm) i

2. Controleer uw gezaagde eindproduct

3. Kies een aantal en voeg toe aan winkelwagen

Aantal	Prijs per stuk	Prijs (incl. btw)
<input type="text" value="1"/>	€ 8,81	€ 10,66

Recommended

[Arduino shield](#) – see links on that page or ask on a SimFeedback Discord channel



with a 3D-printed [Arduino SFX-100 Shield Enclosure](#).

Netfilter

Bought at <https://www.sinuss.nl>



The filter is recommended to prevent spikes being transmitted from the servo drivers to the 230V power lines: without the filter other equipment on the 230V lines may suffer from the spikes. See [here](#) for more information.

[FN2090-4-06 FILTER, 1 PH, 4A, CHASSIS MOUNT SCHAFFNER](#)

1 x € 33,17

Anti EMI shielding tape

Bought at AliExpress



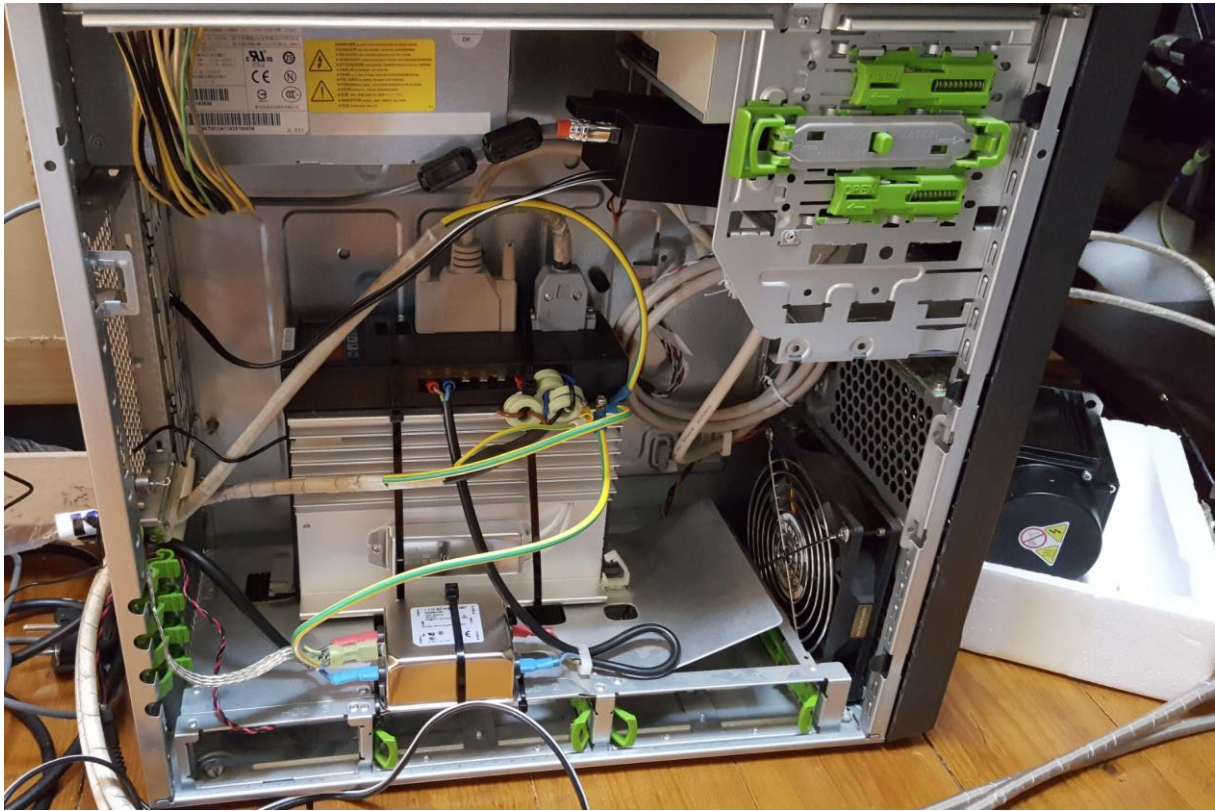
Wrap it around the servo cables (or at least the 4 pole power cable) and connect the shielding tape to the ground of the servo driver. See [here](#) for more information.

[40mm x 20M 65ft Conductive Cloth Fabric Adhesive Tape For Laptop Cellphone LCD Cable Shielding](#)

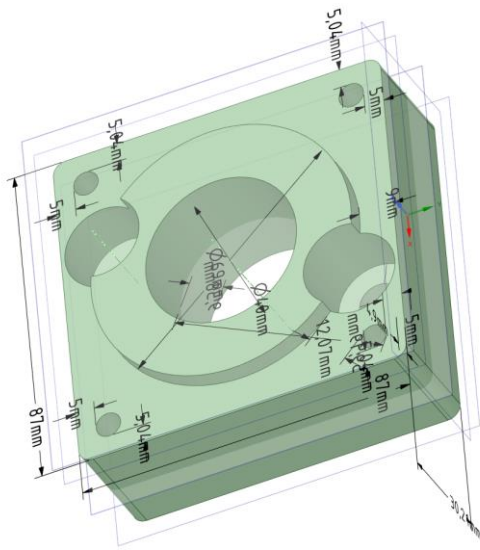
1 x 19,29 EUR

Example

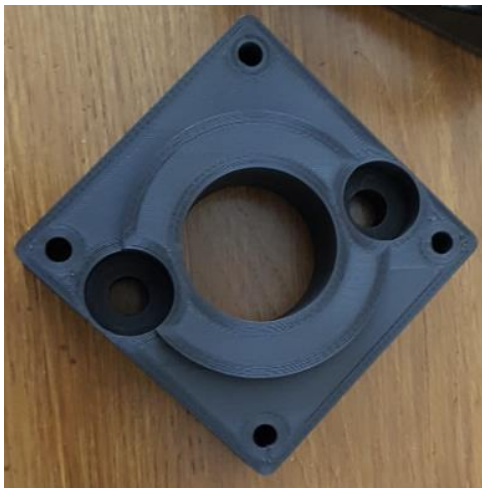
I have built the servo driver into an old PC case (left the old power supply and CD-ROM player unused to avoid holes in the case).



Flange bearing holder



You need to 3D-print two of these blocks:



2 x

See the uploaded STL file.

I'm using an Ender 3 Pro printer; tips [here](#).

Printing settings are the same as the 3D-printed parts for the actuators, see [here](#).

Printing time: about 11 hours per bearing block.

Top rolls (top of the chair)

Look at the Discord SimFeedback Belt tensioner channel for examples of the top rolls of the belt tensioner. You need this to prevent the belts from pulling you down at the shoulders.

Mine looks like this (M10 rod and bolts, M10 bearings, big rings, 3D-printed parts):



(Don't mind the orange straps)

More info: see the top of the Discord SimFeedback Belt tensioner channel and A.B.Elawad's post on 05-11-2019.

I glued the rolls to the back of the chair to avoid drilling, more info [here](#).

Assembly instructions

Tube

Sand the edges of the tube so there are no sharp edges.

Clean the tube (I used IPA and some cloth).



If you look very closely you can see the tube is welded and not perfectly round. At the weld there is a 'flat spot': that's one of the reasons it won't fit on the servo spindle. The other reason is the tolerances may be a bit different – the inner diameter of the tube can be a tiny bit too small.



Draw a line on the tube to mark the length of the spindle (26 mm) and the spindle key.

Make sure the line has a 90 degree angle with the end of the tube.



Grind the inside of the tube for the length of the servo spindle so the tube will fit on the spindle.



The width of the key is 5 mm.



Use the center-punch tool to punch indents along the line, to prevent the drill from walking.





Start drilling holes with a 3 mm drill. Then use a 5,5 or 6 mm drill to make a slot for the servo key.

Grind the edges (also check the inside of the tube).



Test if it fits. Do not press too hard on the servo. It's not a problem if it doesn't go all the way down on the servo (see picture, this is good enough).

Bearing



The tube is 20 mm and the inner diameter of the bearing is also 20 mm. Due to very narrow tolerances it may not fit onto the tube, so you'll need to grind the bearing to make it a bit wider.

Take care not to overheat the bearing: let it cool down and grind it again.

When grinding the bearing may start to rotate; make sure it doesn't rotate too fast, this may damage the bearing.

Test if the bearing can slide onto the tube.

Repeat this exercise for the second bearing.



If you are as lucky as I was, you may get a skewed bearing. I have asked Dold to replace it, but the reply was "The manufacturer doesn't take any effort to align the bearing unfortunately. The user has to align it himself."

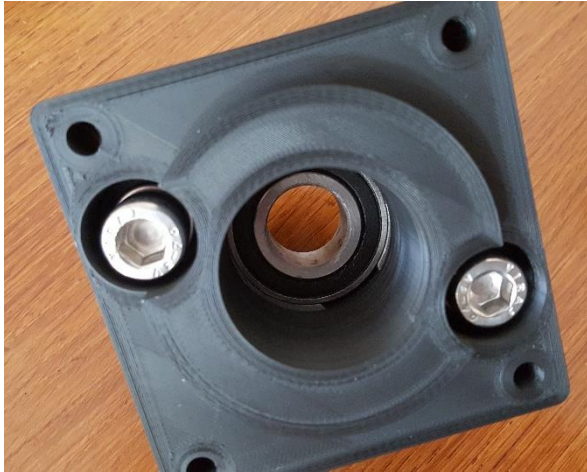


Stick the tube into the bearing, place the bearing on the floor and stand on the bearing with your two feet. Pull the tube so the bearing is aligned.

The outer edges of the bearing should be at the same height around the full circle of the bearing. Picture on the left shows the skewed bearing.



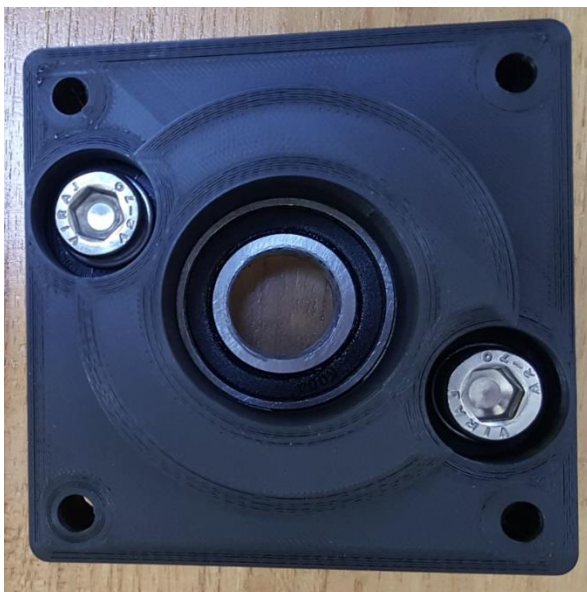
Place the flange bearing onto the flat side of the bearing block.



Put the M10 rings and bolts into the block.



Place the M10 rings and nuts.



When fastening the M10 bolts make sure the bearing is perfectly aligned with the hole.



Place the bearing block onto the servo holder.



Put the M6 bolts and rings into the servo holder and bearing block.