ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Laboratoire d'Automatique

Semester Project

Automatic Babyfoot

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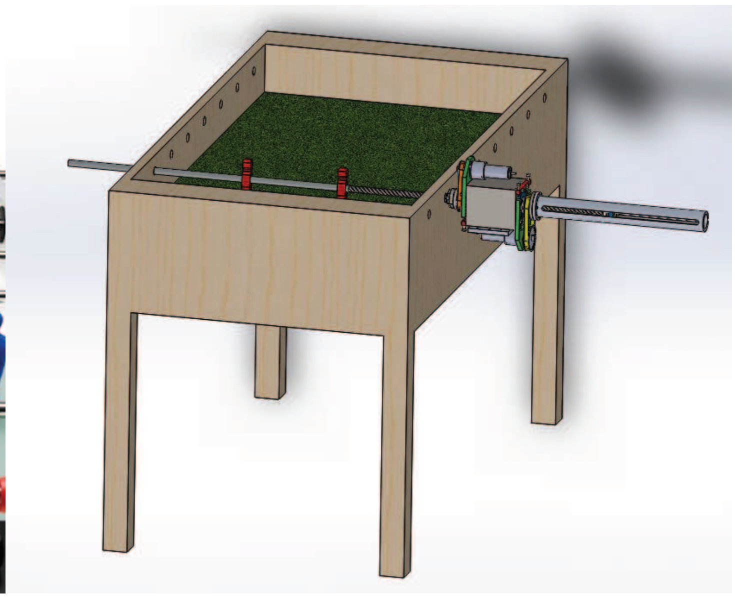

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1 Introduction :

From time immemorial, human have tried to imitate and replace themselves with robots. The automatic system should have the same or better behaviour than human skills.This time we want an automatic system that can play babyfoot and beat usual opponents. The goal of this semester project is to improve or redesign the system that already exists on the babyfoot now. It works well for the moment but we can improve it. Anyway, mine could always be improved as well.

2 Brief summary of existing work :

" Other laboratories in the world have already created solutions for this task. Many of these can be seen in action on video sharing websites. Their main goal is the design of the game analysis system and the actuators are only a small part of those projects.Nevertheless,we were able to make a first evaluation of the challenges we would have to face. In most of them, if the software seems effective, their mechanisms lack speed and acceleration. The human players dealing with the machine obviously do not play at full capacity. Furthermore, the installations are very heavy and often definitively attached to the babyfoot table. A good example though is the project developed at the FH Köln (Allied Vision Technologies ; FH Köln). It clearly shows the potential to create a good automatic opponent to any human player. As can be seen on their video (FH Köln) the performances of the system are pretty impressive. It also shows that a sophisticated installation is required.They used two motors per axis and the translation was done using a timing-belt. " [6]

3 Specifications :

Like in the first project[6], we have to satisfy some constraint. Here is the list of the past project :

3.1 Objective :

The goal of this project is to develop an actuator for an axis of a babyfoot.

3.2 Skills to achieve :

- Power a bar of a standard babyfoot in rotation and translation.
- Be easily mountable on any standard babyfoot.

- Position the bar correctly according the two coordinates (one position in rotation and a position in translation) given by an external system (human or algorithm).
- Match human speed performances in both translation and rotation.
- Reach the maximal amplitude for the selected bar in translation.
- Be able to make a full turn for the rotation.
- Perform a translation and a rotation motion simultaneously and independently.
- Be non-destructive for the structure of the babyfoot.
- The width of the system must not be greater than the distance between the bars of the babyfoot (15 cm in standard).This requirement guarantees that the mechanism can be installed on every bar.
- The system must be robust and long-lasting.

4 To be improved :

The first principal disadvantage of the actual system is that the rotation's motor is moving with the player bar. The second slightest disadvantage is that there is a small torque because the application force point is not in the axe of the displacement. Pulleys are a bit too small and there is to much power lost in the pulley.

5 Different solution :

5.1 Previous solutions :

In the previous project there was many other solutions, but most of them are solutions with moving motors. Like pneumatic, rack-and pinion, timing belt. To have more information please refers to the past project [6]

5.2 Ball spline shaft (axe cannelé à bille) :

We can use this type of transmission to rotate the player and in the same time translate the all system with an other motor. The best advantage of this is that translation system could be put under the actual system. Therefore, the system will not increase its size. But this type of solution includes too much parts and transmissions.

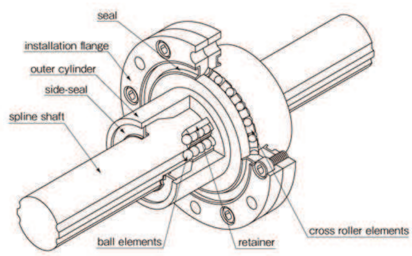


FIGURE 1 – Ball spline shaft [1]

5.3 Linear Motor :

The case of linear motor was already handled in the past report. Linear motor is the best translation system that exists. It could have hudge acceleration(up to 586 $\frac{m}{s^2}$) and a good stroke (course). That could perfectly fit to our specifications and "it would remove the need for a linear guide, since the motor is a linear guide itself "[6].

However the principal and not the slightest disadvantage is the price. A quick estimation of price was given : About 1500 CHF for the actuator and about 1000 CHF for the electronic command. A total of 2500 CHF.

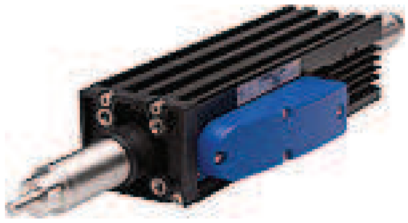


FIGURE 2 – Ball spline shaft [2]

6 Chosen Solution (Ball Screws) :

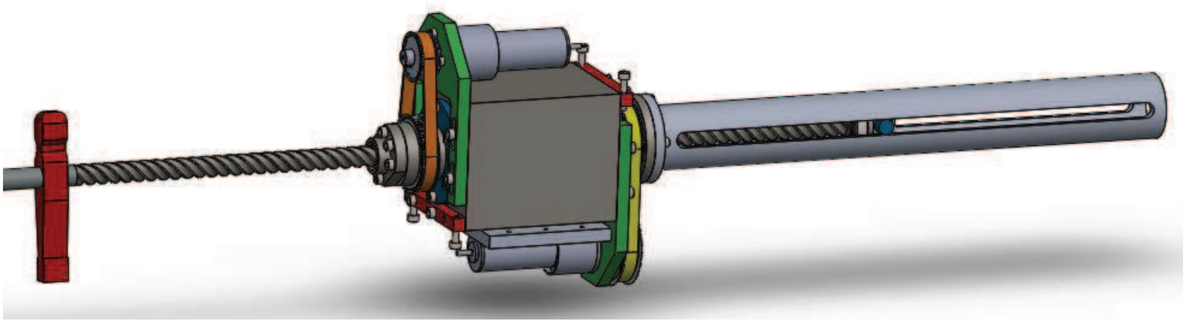


FIGURE 3 – Babyfoot actuator

The chosen solution is : Ball screw (vis à bille)

We have chosen this solution because it is not much expensive, there are not much friction because all part in contact have bearing contact(Ball screw, slide with cam follower and bearing.) And the force is putted on the axe so it entirely removes the torque of the translation force.

The Babyfoot player bar is fixed with the ball screw. For the translation motion, one have to turn the ball screw nut and in this time the rear slide doesn't rotate. (rotation of the slide =0). With the helicoidal system of the nut-screw system, the players will translate if the nut turn.

For the rotation of the players, one have to turn the whole rear slide. Then the two cam follower will turn and with it the screw and the players. When one shoots, we have to pay attention to synchronize the translation motor with the rotation one. Otherwise the players will have and linear translation when one shoots because of the helicoidal system. But if the two motors are well sync, if we turn the slide, the players will shoot the ball.

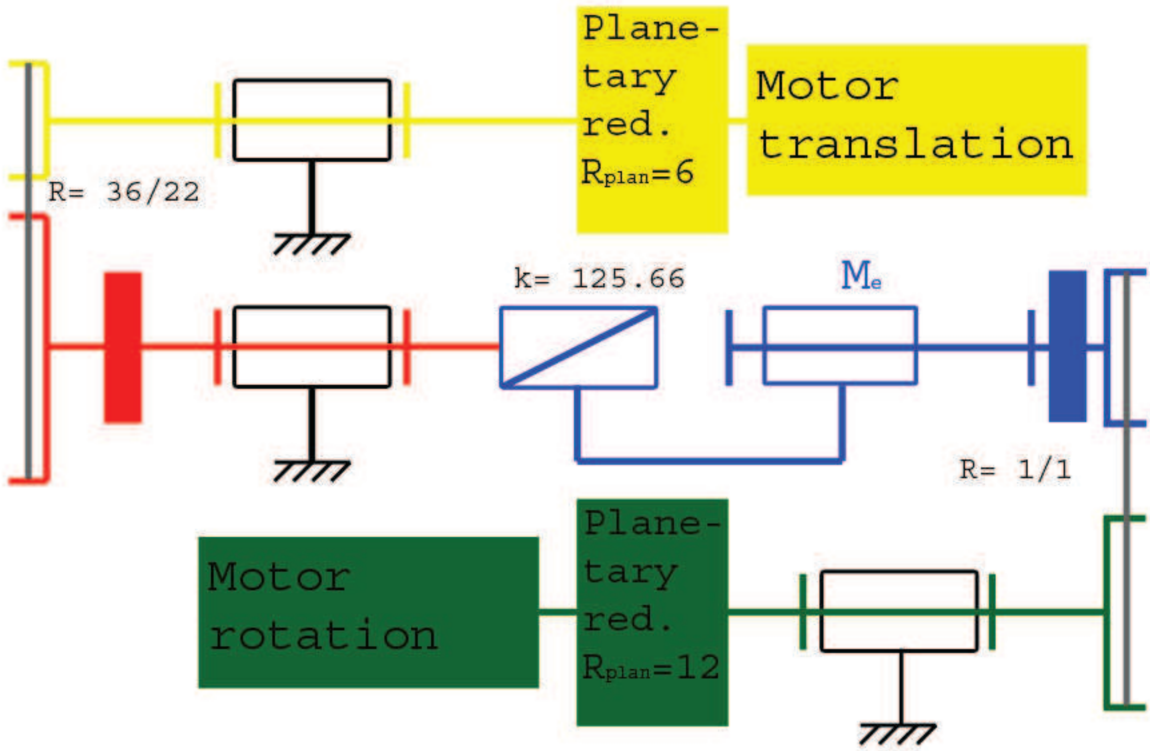


FIGURE 4 – Kinematic diagram for the whole system

7 Actuator skills :

7.1 Translation :

In the case of the translation I have to adapt the previous specifications in the past report. It's not useful to have the translation of 37 cm in 0.2 second because even a real player will not achieve to do such a movement(or he will but then looses the ball control). Therefore I consider the max translation is the width of the goal, that is 15 cm(Half of th goal width). (See further for 24 cm changing of players) The precison has to be the same, that's 3 mm.

7.2 Rotation :

In the case of the rotation, the only specification that we have now is to shoot two times per second.

Summary and revision of constraints table :

Constraints table :					
Translation			Rotation		
Longest translation	150	[mm]	Speed of the ball after the shoot	6	$\left[\frac{m}{s}\right]$
Duration	200	[ms]	Duration of a shoot	200	[ms]
Precision	3	[mm]			

TABLE 1 – Human performances to reach

8 Motor sizing :

NOTATION'S AGREEMENT :

ω for speed in $\left[\frac{rad}{s}\right]$

Ω for speed in $[rpm]$

8.1 Translation motor :

8.1.1 Displacement specifications :

translation max	x = 0.15	[m]
cycle time	t = 0.2	[s]
mass in translation	m = 2	[kg]
driven component's inertia	J_e = 2.58 e $^{-4}$	[kgm^2]

NB : Here J_e (Inertie de organe ***e****ntrainé) contains ball nut (écrou à bille), internal rings of bearings (bagues internes des roulements) ,the spacer (entretoise), the internal skid (cale), the retaining system and the driven pulley.*

After several tries, I have finally choose a screw ball of diameter 16 mm and a thread pitch (pas de vis) of 50 mm. (A small diameter to minimise the global inertia and a big thread to be able to reach wanted speeds.)

The transmission ratio k $= \dfrac{2 \cdot \pi}{thread}$ is equal to $\dfrac{2 \cdot \pi}{0.05} = 125.66$

8.1.2 Speed profile :

Trapezoidal speed profile has been chosen to minimise the thermal losses.

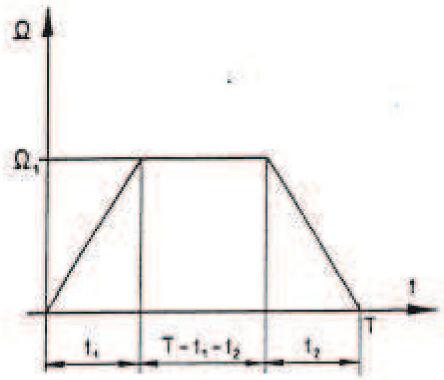


FIGURE 5 – trapezoidal profile $\frac{t}{3}$

$$v_{max} = \frac{3}{2} \cdot \frac{x}{t} = \frac{3}{2} \cdot \frac{0.15}{0.2} = 1.125 \left[\frac{m}{s}\right] \tag{1}$$

$$\omega_{max} = v_{max} \cdot k = 1.225 \cdot 125.66 = 141.4 \left[\frac{rad}{s}\right] \tag{2}$$

$$\Omega_{max} = \omega_{max} \cdot \frac{60}{2 \cdot \pi} = \; 1350 \; [rpm] \tag{3}$$

$$a_{max} = \frac{9}{2} \cdot \frac{x}{t^2} = \frac{9}{2} \cdot \frac{0.15}{0.04} = 16.875 \; \left[\frac{m}{s^2}\right] \tag{4}$$

$$\alpha_{max} = a_{max} \cdot k = 16.875 \cdot 125.66 = 2121 \left[\frac{rad}{s^2}\right] \tag{5}$$

8.1.3 Transmission ratio selection :

After several tries , the best motor corresponds to :

Maxon EC-4poles 30 ⊘ 200 [W].

Now that we have chosen the motor, we have to set the reduction ratio. To do this, we have to do either a speed adaptation (So that the motor won't exceed its maximum speed) or a torque minimisation (The derivative of M with respect to the parameter r)

Speed adaptation	Torque adaptation
$r_{max} = \frac{\Omega_{m,nom}}{\Omega_{e,max}}$	$r_{opt} = \sqrt{\frac{J_e}{J_m} + \frac{m_e}{J_m \cdot k^2}}$

Ω_{nom}	=	15700	[rpm]
J_m	=	33.3 e^{-7}	[kgm^2]

With the motor data and the value previously computed, we obtain :

$$r_{max} = \frac{\Omega_{m,nom}}{\Omega_{e,max}} = \frac{15700}{1350} = 11.63 \tag{6}$$

$$r_{opt} = \sqrt{\frac{J_e}{J_m} + \frac{m_e}{J_m \cdot k^2}} = \sqrt{\frac{2.58e^{-4}}{33.3e^{-7}} + \frac{2}{33.3e^{-7} \cdot 15790}} = 10.75 \tag{7}$$

r_{opt} must be corrected because we don't take the inertia of the drive pulley (poulie mortice) and of the planetary gearhead (réducteur planétaire) $r_{opt,corrected} = 10.03$

We are taking a ratio that must be under r_{max} and the closest of r_{opt}

Choose : r = 10 (Planetary gearhead 6 et belt-pulley 10/6)

According to the constraints in the existing pulleys, we have chosen a belt pulley reduction ratio of $\frac{36}{22}$ that make a final reduction ratio of 9.82.

8.1.4 Torque calculation with the chosen reduction ratio :

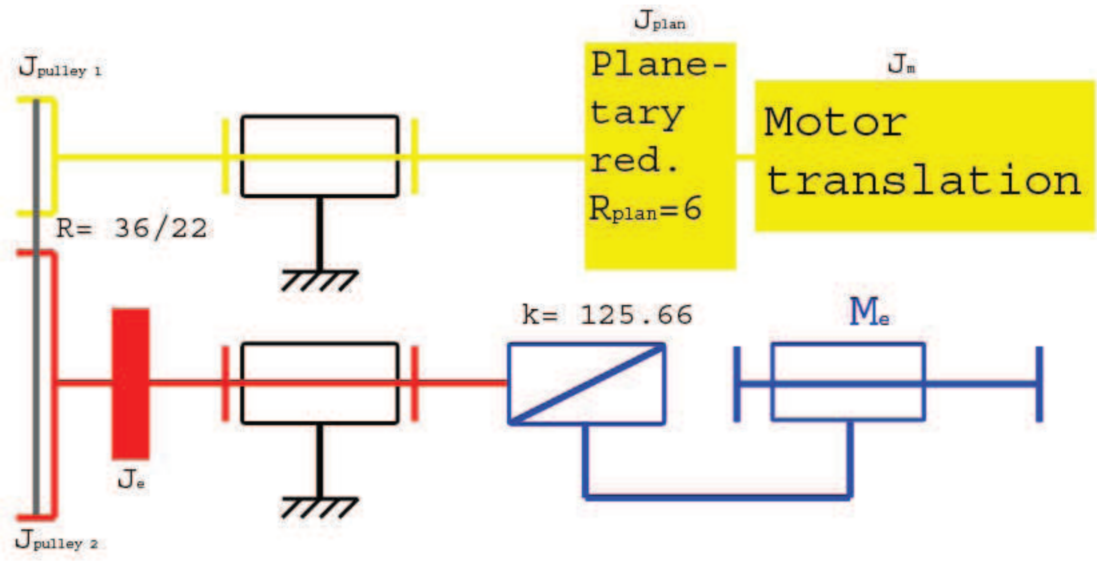


FIGURE 6 – Translation diagram

Total inertia relative to motor (Inertie totale réelle rapportée au moteur) :

$$J_{tot}' = J_m + J_{plan} + \frac{J_{pulley\ 1}}{r_{plan}^2} + \frac{J_{pulley\ 2} + J_e}{r_{plan}^2 \cdot r_2^2} + \frac{m_e}{r_{plan}^2 \cdot r_2^2 \cdot k^2} \tag{8}$$

(with $J_{plan} = 4.9e^{-7}$, $J_{pulley\ 1} = 2.4e^{-6}$, $r_{plan} = 6$, $r_2 = 36/22$, $J_{pulley\ 2} + J_e = 2.58e^{-4}$)

$$J_{tot}' = 33.3e^{-7} + 4.9e^{-7} + \frac{2.46e^{-6}}{6^2} + \frac{2.58e^{-4}}{100} + \frac{2}{100 \cdot 15790} = 7.735e^{-6} \tag{9}$$

$$M_{motor} = J_{tot}' \cdot \alpha_{motor} = J_{tot}' \cdot k \cdot r \cdot \frac{v_e}{t_{acc}} \tag{10}$$

$$M_{motor} = J_{tot}' \cdot \alpha_{motor} = J_{tot}' \cdot k \cdot r \cdot \frac{v_e}{t_{acc}} = 7.735e^{-6} \cdot 125.66 \cdot 10 \cdot \frac{1.125}{0.0666} = 0.164\ [Nm] \tag{11}$$

$$\boxed{\text{Required torque} = 0.164\ [Nm]}$$

However, the nominal torque of this motor is 0.132 [Nm]. We have now a torque 1.25 greater. There is an overload of 25%. To be sure and to include the different efficiencies, we take a **security factor of 1.2**. Therefore we have $1.25 \cdot 1.2 = 1.5$ more torque (50 % overload). In the next section we are going to show if this motor support the overload.

8.1.5 Characteristic profile of speed :

We consider that a typical set of translation can be summarized by :

- 4 translations of 15 cm en 0.2 second each (1,2,3,4 arrows on FIGURE 7)
- 16 translations of 5 cm en 0.5 second each (2x(5 .. 8, 9 .. 12) on FIGURE 7)
- a total time of 10 seconds (1.2 seconds of idle time)

Translation MAX :				
motion time	t_{max}	=	0.2	[s]
max translation	d_{max}	=	0.15	[m]
repetition number	n_{max}	=	4	-
Translation AVG :				
motion time	t_{avg}	=	0.5	[s]
average translation	d_{avg}	=	0.05	[m]
repetition number	n_{avg}	=	16	-
Total time :	t_{tot}	=	10	[s]

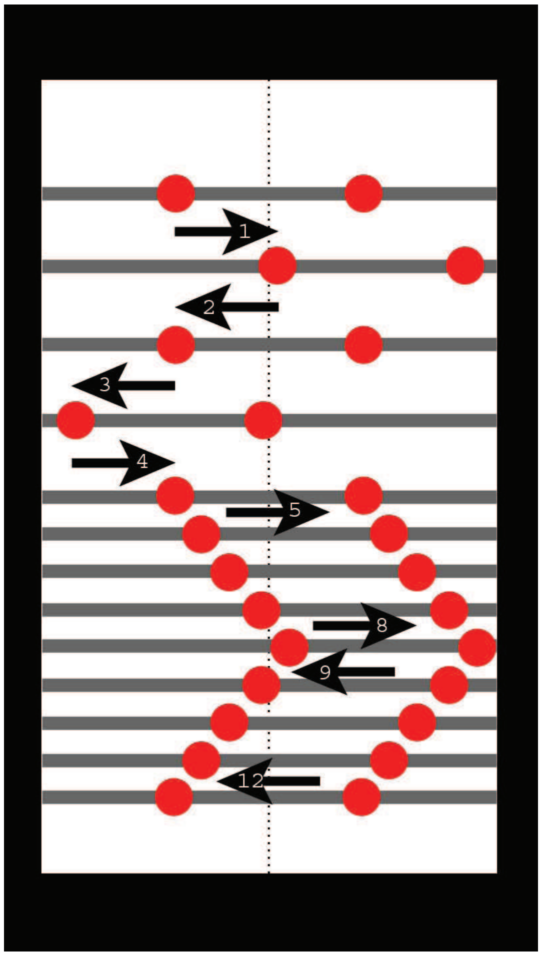


FIGURE 7 – Typical set

To be able to calculate losses by overheating, we have to calculate the current during the two stages (MAX and AVG).

MAX torque has already be calculated (equation (11)), so it remains the AVG torque.

$$v_{avg} = \frac{3}{2} \cdot \frac{x}{t} = \frac{3}{2} \cdot \frac{0.05}{0.5} = 0.15 \left[\frac{m}{s}\right] \tag{12}$$

$$M_{avg} = J_{tot}' \cdot k \cdot r \cdot \frac{v_{avg}}{t_{acc,avg}} = 7.735e^{-6} \cdot 125.66 \cdot 10 \cdot \frac{0.15}{0.1666} = 0.009 \, [Nm] \tag{13}$$

8.2 Power calculation :

I_{nom}	=	5.06	[A]	R	=	0.386	[Ω]
R_{th}	=	5.5	$\left[\frac{K}{W}\right]$	T_{max}	=	+155	[^{o}C]

MAX Translation :

$$M_{MAX} = S \cdot 0.164 = 1.2 \cdot 0.164 = 0.198\ [Nm] \tag{14}$$

$$I_{MAX} = \frac{M_{MAX}}{M_{nom}} \cdot I_{nom} = \frac{0.198}{0.132} \cdot 5.06 = 7.59\ [A] \tag{15}$$

$$Pj_{MAX} = R \cdot {I_{MAX}}^2 = 0.386 \cdot 7.59^2 = 22.23\ [W] \tag{16}$$

AVG translation :

$$M_{AVG} = S \cdot 0.009 = 0.011\ [Nm] \tag{17}$$

$$I_{AVG} = \frac{M_{AVG}}{M_{nom}} \cdot I_{nom} = \frac{0.011}{0.132} \cdot 5.06 = 0.42\ [A] \tag{18}$$

$$Pj_{AVG} = R \cdot {I_{MOY}}^2 = 0.386 \cdot 0.42^2 = 0.07\ [W] \tag{19}$$

$$\overline{PJ_{tot}} = \frac{2 \cdot (4 \cdot PJ_{MAX}) \cdot t_{acc,MAX} + 2 \cdot (16 \cdot PJ_{AVG}) \cdot t_{acc,AVG}}{t_{tot}} = \frac{11.9 + 0.4}{10} = 1.23\ [W] \tag{20}$$

Overheat :

$$\triangle T = R_{th} \cdot \overline{PJ_{tot}} = 5.5 \cdot 1.23 \approx 6.8 \tag{21}$$

This is quite well !

Actually the max translation is not the maximum translation. There is an other case where the player has to move on a bigger distance, it's when one player hit the board and we have to change of defender with the two player bar (24 cm translation).To simulate this non regular situation, we take two translation of 24 cm in 0.2 seconds and a total time of 1 s.

$$v_{ch} = \frac{3}{2} \cdot \frac{x}{t} = \frac{3}{2} \cdot \frac{0.24}{0.2} = 1.8\ \left[\frac{m}{s}\right] \tag{22}$$

$$M_{ch} = J_{tot}' \cdot k \cdot r \cdot \frac{v_{ch}}{t_{acc,ch}} = 7.735e^{-6} \cdot 125.66 \cdot 10 \cdot \frac{1.8}{0.0666} = 0.262\ [Nm]\ (2 \cdot M_{nom}!) \tag{23}$$

$$I_{ch} = \frac{M_{ch}}{M_{nom}} \cdot I_{nom} = 2.2 \cdot 5.06 = 11.13\ [A] \tag{24}$$

$$Pj_{ch} = R \cdot {I_{ch}}^2 = 0.386 \cdot 11.13^2 = 47.8\ [W] \tag{25}$$

$$\overline{PJ_{ch}} = \frac{2 \cdot (2 \cdot PJ_{ch}) \cdot 0.0666}{1} = \frac{12.74}{1} = 12.74\ [W] \tag{26}$$

$$\triangle T = R_{th} \cdot \overline{PJ_{totale}} = 5.5 \cdot 12.74 \approx 70 \tag{27}$$

There is here an overheat of 70 [^{o}C] in one second. It will not destruct the motor but we are playing with fire ! !

8.3 Rotation motor

8.3.1 "SHOOT" specifications :

wanted ball speed	v	=	6	$\left[\frac{m}{s}\right]$
angle limits	θ	$\in$	$[-\pi\,;\,\pi]$	[rad]
shoot time (whole cycle)	t	=	200	[ms]
player radius	R	=	6.75	[cm]
driven component inertia	J_e	=	7.8 e^{-4}	[kgm^2]

NB : Here J_e (Inertie de organe entrainé) contains the rear slide (glissière arrière), internal rings of bearings (bagues internes des roulements) ,the spacer (entretoise), the internal skid (cale), the retaining system and the driven pulley.

8.3.2 Speed profile :

Trapezoidal speed profile has been chosen to minimise the thermal losses.

$$t_{acc} = \frac{t}{3} = \frac{0.2}{3} = 0.066[s] \tag{28}$$

$$\omega_{max} = \frac{v_{max}}{R} = \frac{6}{6.75e^{-2}} = 88.89 \left[\frac{rad}{s}\right] \tag{29}$$

$$\Omega_{max} = \omega_{max} \cdot \frac{60}{2 \cdot \pi} = 850\ [rpm] \tag{30}$$

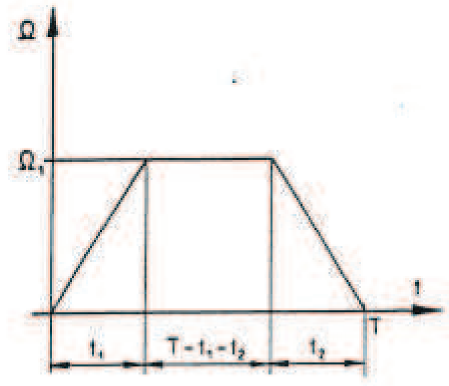


FIGURE 8 – Profil en trapèze

$$\alpha_{max} = \frac{\triangle\omega_{max}}{\triangle t} = \frac{w_{max} - 0}{t_{acc} - 0} = 1333 \left[\frac{rad}{s^2}\right] \tag{31}$$

8.3.3 Transmission ratio selection :

After several tries , the best motor corresponds to :

Maxon EC-4poles 30 ⊘ 200 [W].

Now that we have chosen the motor, we have to set the reduction ratio. To do this, we have to do either a speed adaptation (So that the motor won't exceed its maximum speed.) or a torque minimisation (The derivative of M with respect to the parameter r)

Speed adaptation	Torque adaptation
$r_{max} = \frac{\Omega_{m,nom}}{\Omega_{e,max}}$	$r_{opt} = \sqrt{\frac{J_e}{J_m}}$

With the motor data and the value previously computed, we obtain :

Ω_{nom}	=	15700	[rpm]
J_m	=	33.3 e^{-7}	[kgm^2]

$$r_{max} = \frac{\Omega_{m,nom}}{\Omega_{e,max}} = \frac{15700}{850} = 18.5 \tag{32}$$

$$r_{opt} = \sqrt{\frac{J_e}{J_m}} = \sqrt{\frac{7.8e^{-4}}{33.3e^{-7}}} = 15.3 \tag{33}$$

r_{opt} must be corrected because we don't take the inertia of the drive pulley (poulie mortice) and of the planetary gearhead (réducteur planétaire)

$$r_{opt,corrected} = \sqrt{\frac{7.8e^{-4} + \frac{2.18e-5}{12^2}}{(33.3+15)e^{-7}}} = 12.7 \tag{34}$$

We are taking a ratio that must be under r_{max} and the closest of r_{opt}

Choose : r = 12 (Planetary gearhead 12 et belt-pulley 1/1)

According to the constraints in the existing pulley, we have chosen a belt pulley reduction ratio of $\frac{36}{36}$ that make a final reduction ratio of 12.

8.3.4 Torque calculation with the chosen reduction ratio :

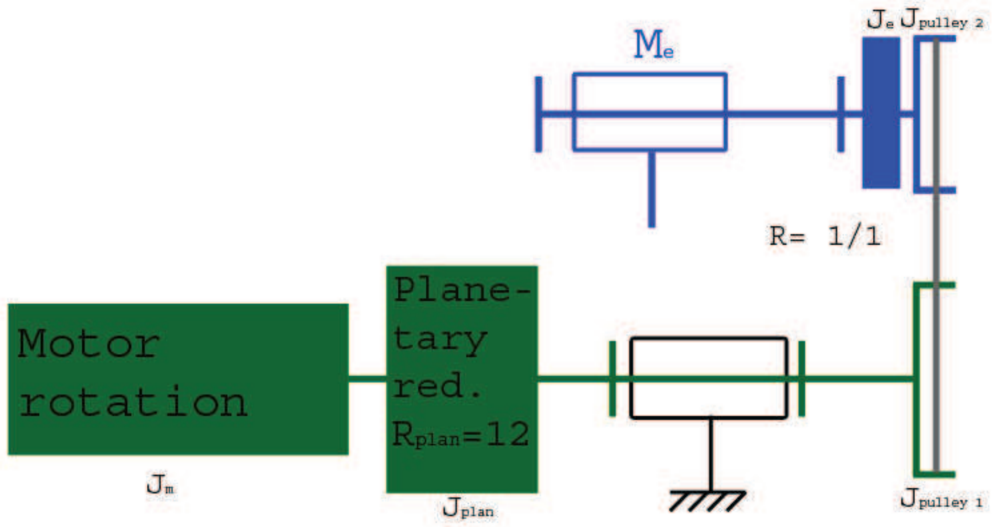


FIGURE 9 – Rotation diagram

Total inertia relative to motor (Inertie totale réelle rapportée au moteur) :

$$J_{tot}{}' = J_m + J_{plan} + \frac{J_{pulley\ 1}}{r_{plan}{}^2} + \frac{J_{pulley\ 2} + J_e}{r_{plan}{}^2 \cdot r_2{}^2} \tag{35}$$

(with $J_{plan} = 15\ e^{-7}$, $J_{pulley\ 1} = 3.45\ e^{-5}$, $r_{plan} = 12$, $J_{pulley\ 2} = 1.56e^{-4}$, $r_2^2 = 1$)

$$J_{tot}{}' = 33.3e^{-7} + 15e^{-7} + \frac{3.45e^{-5}}{12^2} + \frac{7.8e^{-4}}{12^2} = 1.0486e^{-5} \tag{36}$$

$$M_{moteur} = J_{tot}{}' \cdot \alpha_{motor} = J_{tot}{}' \cdot r \cdot \alpha_{player} \tag{37}$$

$$M_{motor} = J_{tot}{}' \cdot r \cdot \alpha_{player} = 1.0486\ e^{-5} \cdot 12 \cdot 1347 = 0.168\ [Nm] \tag{38}$$

$$\boxed{\text{Required torque} = 0.168\ [Nm]}$$

However, the nominal torque of this motor is 0.132 [Nm]. We have now a torque 1.25 greater. There is an overload of 25%. To be sure and to include the different efficiencies, we take a **security factor of 1.2**. Therefore we have $1.25 \cdot 1.2 = 1.5$ more torque (50 % overload). In the next section we are going to show if this motor support the overload.

8.3.5 Characteristic profile of speed :

We consider that a typical set of rotation can be summarized by :
- 2 shoot in 0.2 second each
- a total time of 2 seconds (1.6 seconds of idle time,that is 2 shoot per second and one second of pause)

To be able to calculate losses by overheating, we have to calculate the current during the acceleration stage.

I_{nom}	=	5.06	[A]	R	=	0.386	[Ω]
R_{th}	=	5.5	$\left[\frac{K}{W}\right]$	T_{max}	=	+155	[^{o}C]

SHOOT :

$$M_{MAX} = S \cdot 0.168 = 1.2 \cdot 0.168 = 0.2\ [Nm] \tag{39}$$

$$I_{MAX} = \frac{M_{MAX}}{M_{nom}} \cdot I_{nom} = \frac{0.2}{0.132} \cdot 5.06 = 7.67\ [A] \tag{40}$$

$$Pj_{MAX} = R \cdot {I_{MAX}}^2 = 0.386 \cdot 6.9^2 = 22.7\ [W] \tag{41}$$

$$\overline{PJ_{total}} = \frac{2 \cdot (2 \cdot PJ_{MAX}) \cdot t_{acc,MAX}}{t_{tot}} = \frac{12.1}{2} = 3.03[W] \tag{42}$$

Overheat :

$$\triangle T = R_{th} \cdot \overline{PJ_{total}} = 5.5 \cdot 6.05 \approx 17$$

As said before, we have to pay attention of the synchronisation of the two motors : The rotation motor will turn with an acceleration $\left[\frac{rad}{s^2}\right]$, it's correspond to a translation of 10 [cm] in 0.2 second. In seen of this, the translation motor will achieve to synchronise with the rotation motor.

9 Timing belt sizing (transaltion) :

	Prime Motor	Planetary gearbox 6 :1	Driven Machine 10 :1
Torque	0.132	0.792	1.32
Speed	15700	2617	1570

Specifications :

– d_{w2} max (driven pulley max diameter) : 58 [mm]

– a mean (mean drive center distance) = 84 [mm]

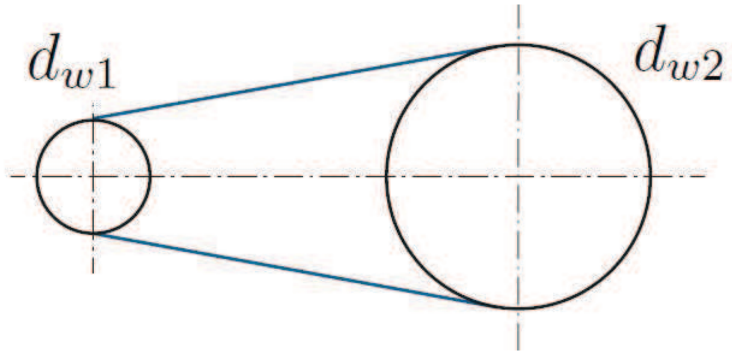


FIGURE 10 – belt design

Total drive service factor :	$c_2 = c_0 + c_6 + c_8 = 2.2 + 0.2 + 0.5 = 2.9\ [-]$
Design Power :	$P_b = P_{input} \cdot c_2 = 0.2 \cdot 2.9 = 0.58\ [kW]$
Belt preselection :	AT5
Timing pulleys :	$z_2 = \frac{d_{w2} \cdot \pi}{t} = \frac{58 \cdot \pi}{5} = 36.44 \Rightarrow z_2 = 36 \Rightarrow d_{w2} = 57.3\ [mm]$ $z_1 = z_2 \cdot \frac{n_2}{n_1} = 36 \cdot \frac{22}{36} = 19.63 \Rightarrow z_1 = 22 \Rightarrow d_{w1} = 35.01\ [mm]$
Effective ratio :	$i_{eff} = \frac{z_2}{z_1} = \frac{36}{22} = 1.6364 \Rightarrow n_{2,eff} = 2617/1.63 = 1600\ [-]$
Effective Length :	$L_{eff} = 2 \cdot a + \frac{\pi}{2} \cdot (dw1 + dw2) + \frac{(dw2 - dw1)^2}{4a}$

	$= 160 + \frac{\pi}{2} \cdot (57.3 + 35.01) + \frac{(57.3 - 35.01)^2}{4 \cdot 80} = 314.4789\ [mm]$ We choose L = 300 [mm]
Eff. center drive distance :	$K = \frac{L_{eff}}{4} - \frac{\pi}{8} \cdot (d_{w2} + d_{w1}) = 38.7449\ [mm]$ $a_{eff} = K + \sqrt{K^2 - \frac{(d_{w2} - d_{w1})^2}{8}} = 76.6901\ [mm]$
Eff. engaged tooth number :	$z_e = \frac{z_1}{6} \cdot (3 - \frac{d_{w1} - d_{w2}}{a_{eff}}) = 16.2561\ [-]\ \ (z_{e,max} = 12)$
Effective belt width :	$b_{width} = \frac{P_B \cdot 10^3}{P_{Nspec} \cdot z_1 \cdot z_e \cdot c_3} = 6.1250\ [mm]$
Effective C_2 coeff :	$C_{2eff} = c_2 \cdot \frac{b_{catalog}}{b_{width}} = 4.74\ [-]$
Circumferential force :	$v_{eff} = \frac{d_{w1} \cdot n_1}{19100} = 4.79\ \left[\frac{m}{s}\right]$ $F_U = \frac{1000 \cdot P}{v_{eff}} = 41.7\ [N]$ $c_v = \frac{C_{2eff} - 1}{10} + 1 = 1.37\ [-]$
Static belt tension :	$Ft = 0.55 \cdot c_v \cdot F_U = 31.5\ [N]$ $Fa = 2 \cdot F_t = 63\ [N]$

We have a length of belt of 300 [mm], a center distance (entraxe) of 76.69 [mm] and a belt tension of 63 [N]

Materials :

- Polyurethane timing belt AT5 width 10mm Lw 300mm 60 teeth 10 AT5/300
- Timing belt pulley AT5 material aluminium 22 teeth for belt width 10mm 21 AT5/22-2
- Timing belt pulley AT5 material aluminium 36 teeth for belt width 10mm 21 AT5/36-2

10 Timing belt sizing (rotation) :

	Prime Motor	Planetary gearbox 12 :1	Driven Machine 1 :1
Torque	0.132	1.584	1.584
Speed	15700	1308	1308

Specifications :

- d_{w2} max (driven pulley max diameter) : 58 [mm]
- a mean (mean drive center distance) = 80 [mm]

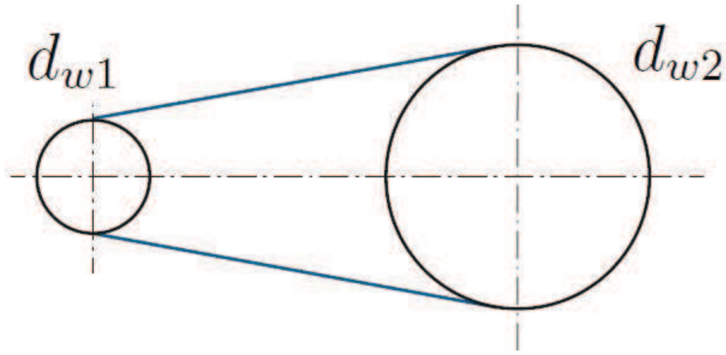


FIGURE 11 – belt design

Total drive service factor :	$c_2 = c_0 + c_6 + c_8 = 2.2 + 0.2 + 0.5 = 2.9\ [-]$
Design Power :	$P_b = P_{input} \cdot c_2 = 0.2 \cdot 2.9 = 0.58\ [kW]$
Belt preselection :	AT5
Timing pulleys :	$z_2 = \frac{d_{w2} \cdot \pi}{t} = \frac{58 \cdot \pi}{5} = 36.44 \Rightarrow z_2 = 36 \Rightarrow d_{w2} = 57.3\ [mm]$ $z_1 = z_2 \cdot \frac{n_2}{n_1} = 36 \cdot \frac{1}{1} = 36 \Rightarrow z_1 = 36 \Rightarrow d_{w1} = 57.3\ [mm]$
Effective ratio :	$i_{eff} = \frac{z_2}{z_1} = \frac{36}{36} = 1 \Rightarrow n_{2,eff} = 1308/1 = 1308\ [rpm]$
Effective Length :	$L_{eff} = 2 \cdot a + \frac{\pi}{2} \cdot (dw1 + dw2) + \frac{(dw2 - dw1)^2}{4a}$

	$= 160 + \frac{\pi}{2} \cdot (57.3 + 35.01) + \frac{(57.3 - 35.01)^2}{4 \cdot 80} = 340\ [mm]$ We choose L = 340 [mm]
Eff. center drive distance :	$K = \frac{L_{eff}}{4} - \frac{\pi}{8} \cdot (d_{w2} + d_{w1}) = 40\ [mm]$ $a_{eff} = K + \sqrt{K^2 - \frac{(d_{w2} - d_{w1})^2}{8}} = 80\ [mm]$
Eff. engaged tooth number :	$z_e = \frac{z_1}{6} \cdot (3 - \frac{d_{w1} - d_{w2}}{a_{eff}}) = 18\ [-]\ \ (z_{e,max} = 12)$
Effective belt width :	$b_{width} = \frac{P_B \cdot 10^3}{P_{Nspec} \cdot z_1 \cdot z_e \cdot c_3} = 9.8\ [mm]$
Effective C_2 coeff :	$C_{2eff} = c_2 \cdot \frac{b_{catalog}}{b_{width}} = 2.93\ [-]$
Circumferential force :	$v_{eff} = \frac{d_{w1} \cdot n_1}{19100} = 3.92\ \left[\frac{m}{s}\right]$ $F_U = \frac{1000 \cdot P}{v_{eff}} = 51\ [N]$ $c_v = \frac{C_{2eff} - 1}{10} + 1 = 1.19\ [-]$
Static belt tension :	$Ft = 0.55 \cdot c_v \cdot F_U = 33.5\ [N]$ $Fa = 2 \cdot F_t = 67\ [N]$

We have a length of belt of 340 [mm], a center distance (entraxe) of 80 [mm]and a belt tension of 67 [N]

Materials :

- Polyurethane timing belt AT5 width 10mm Lw 340mm 68 teeth 10 AT5/340
- Timing belt pulley AT5 material aluminium 36 teeth for belt width 10mm 21 AT5/36-2

11 Bearing Selection :

To be sure that our bearing system don't suffer from clearance (jeu), R_{B1} must be greater than 0. In this diagram we have F = $F_{Prestressed}$ = $F_{Precontrainte}$ of the bearing, P is here equal to the static belt tension, and $\alpha = 25\,°$

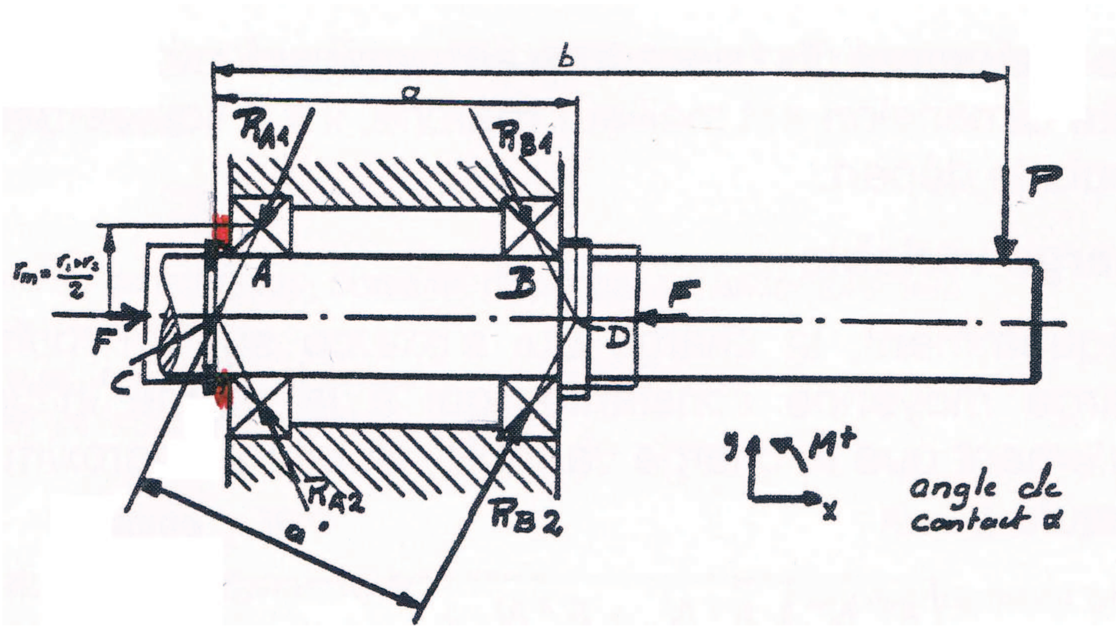


FIGURE 12 – Bearing diagram [8, p. 4.24]

$$R_{A1} = \frac{F}{2 \cdot \sin(\alpha)} + P \cdot \frac{b-a}{2 \cdot a \cdot \cos(\alpha)} \tag{43}$$

$$R_{A2} = \frac{F}{2 \cdot \sin(\alpha)} - P \cdot \frac{b-a}{2 \cdot a \cdot \cos(\alpha)} \tag{44}$$

$$R_{B1} = \frac{F}{2 \cdot \sin(\alpha)} - P \cdot \frac{b}{2 \cdot a \cdot \cos(\alpha)} \tag{45}$$

$$R_{B2} = \frac{F}{2 \cdot \sin(\alpha)} + P \cdot \frac{b}{2 \cdot a \cdot \cos(\alpha)} \tag{46}$$

$$F > P \cdot \frac{b}{a} \cdot \tan\alpha \tag{47}$$

11.1 Translation bearing :

a	52 [cm]	b	76 [cm]
F'	61 or 209 [N]	P	80 [N]

We must substract the mass-in-translation force ;

$$F_1 = F_1' - m \cdot a = 61 - 2 \cdot 16.875 = 27.25 \quad (48)$$

$$F_2 = F_2' - m \cdot a = 209 - 2 \cdot 16.875 = 175.25 \quad (49)$$

with equation (48),

$$R_{B1} = -20[N] \quad (50)$$

with equation (49),

$$R_{B1} = 155[N] \quad (51)$$

We have to choose the bearing with a prestress of 209 [N], therefore we choose an angular (25°) brush bearing. We take directly four bearings because for the rotation, there isn't a mass-in-translation force, and the bearing calculation will give good results (upward error, erreur par excès).

4 X REF : B71907-E-T-P4S-UM from FAG(reseller : Rollin SA, Renens)

12 Assembly guide :

(Some pieces are not strictly the same in reality !)

Step 1 : Assemble the fixation plate with the base with 4 screws (M5x16)

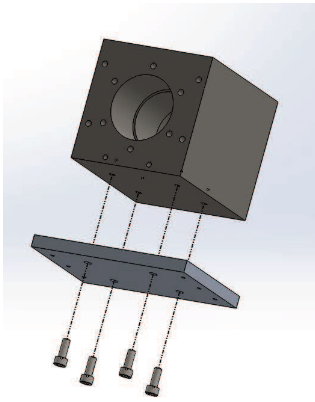


FIGURE 13 – Step 1

Step 2 : Assemble the motor fixation plate (green) with the base with 4 srews (M5x16). Add the tensioner (red) vis 2 screws (M5x16). Be sure that the recess (dégagement) of the motor fixation plate is in the direction of the center. Be careful to put the motor plate to be in the minimal position (in the slide) to adjust the belt tension after.

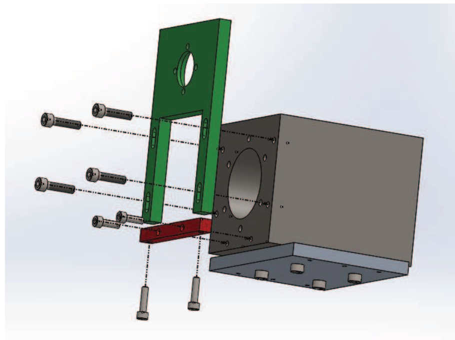


FIGURE 14 – Step 2

Step 3 : Do the same thing as in the step 2 but in the other direction. (The second fixation plate must have an offset of 5cm compared with the first ; the two belt aren't the same)

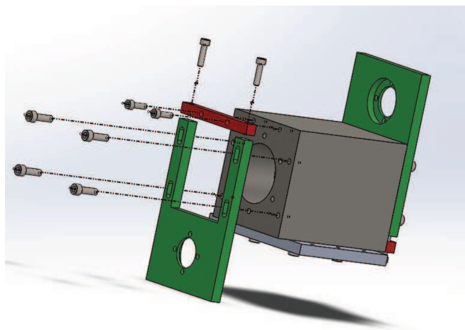


FIGURE 15 – Step 3

Step 4 : Assemble then the 2 motors with its respective gear. Then add the two motor blocks (motor + gear) with 4 screws. (M4X8, low head cap screw, vis à tête basse ! !).

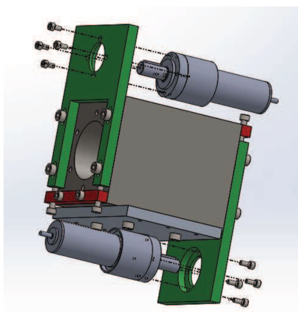


FIGURE 16 – Step 4

Step 5 : Add now the driving pulley (22 teeth) for the translation. Screw (M3x5 , headless) the fixation screw and be careful that the center of the pulley must be at 12 mm of the plane of the motor fixation plate (See technical data of gearbox for more details).

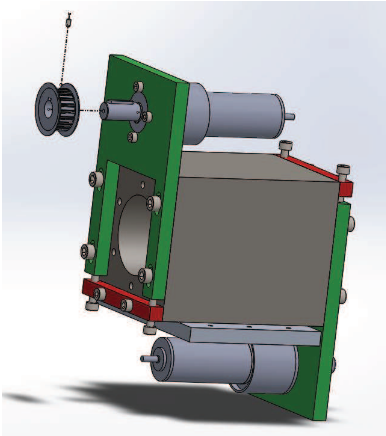


FIGURE 17 – Step 5

Step 6 : Do the same as in step 5 but this time with the driving pulley for the rotation (36 teeth), (M3x10 , headless)

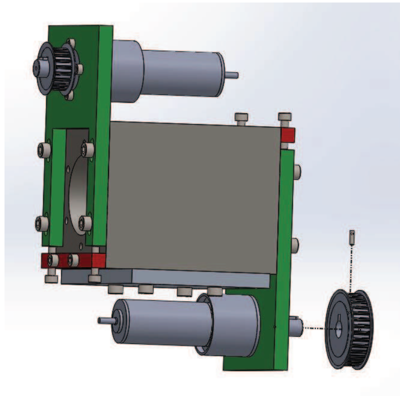


FIGURE 18 – Step 6

Step 7 :Assemble the spacer (entretoise) with the nut with 6 screws (M5x16). Add the parallel key (clavette parallèle, DIN 6885-A 6x6x12) and then assemble the driven pulley for the translation. (M3x4, headless)

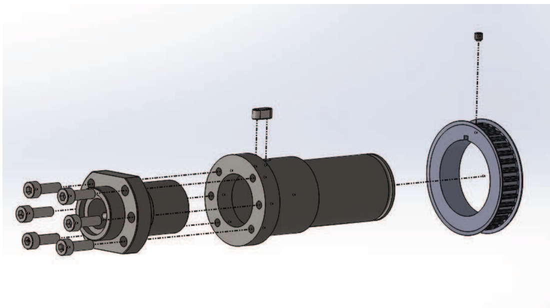


FIGURE 19 – Step 7

Step 8 : Assemble then the cap (blue), the first angular bearing, the inner skid (cale)(red), the outer skid (green) and the second angular bearing. Pay attention to the orientation of the bearing because here we want them to be mounted X (montage en ”X”)
Reference for the bearing :
FAG B71907-E-T-P4S-UM

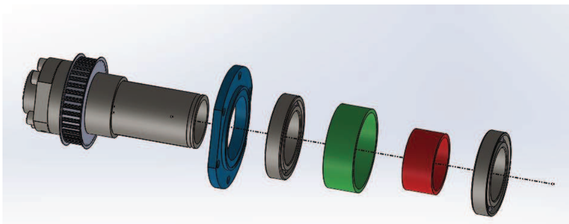


FIGURE 20 – Step 8

Step 9 : Here we are holding the whole previous parts together. To do this, put the yellow ring against the second bearing. Add then the retaining ring (pink). Mount now the snap ring (jonc d'arrêt) and add 6 headless screw (M3x10) and tight uniformly the 6 screws.

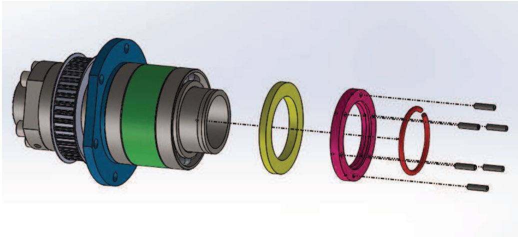


FIGURE 21 – Step 9

Step 10 : Assemble now the second pulley for the rotation(36 teeth) with the parallel key (DIN 6885-A 6x6x12) (clavette parallèle). Fix all together with the headless screw(M3x4)

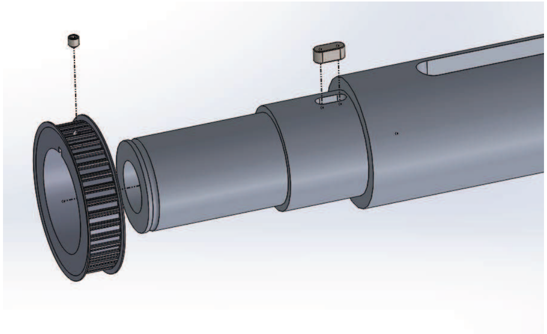


FIGURE 22 – Step 10

Step 11 : Same as step 8, but this time on the rear slide.

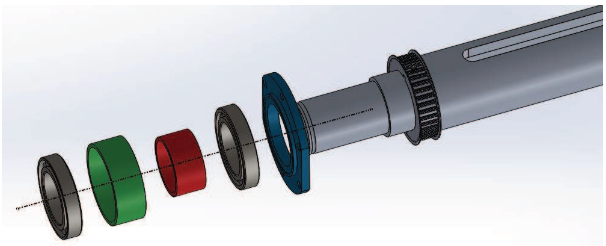


FIGURE 23 – Step 11

Step 12 :Hold the 11th step together with the retaining ring (pink) and 6 screws (M3x10).

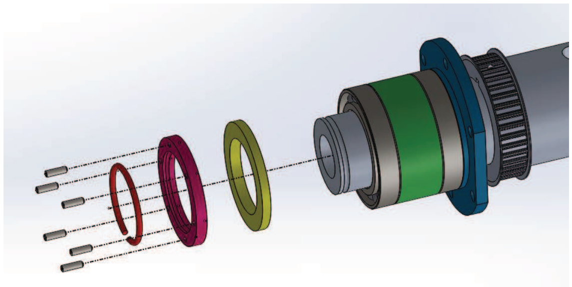


FIGURE 24 – Step 12

Step 13 : Assemble the nut part with the base with 6 screws (M5x16)

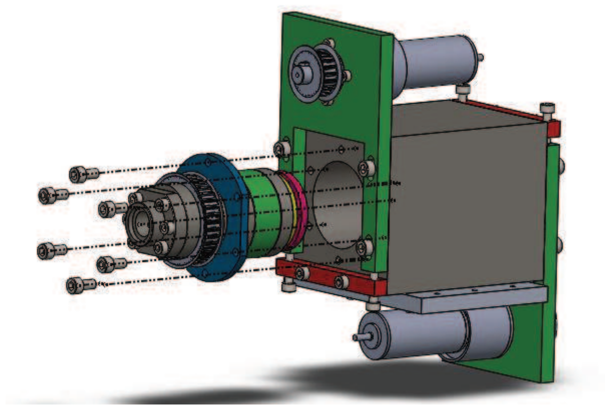


FIGURE 25 – Step 13

Step 14 : Add the srew

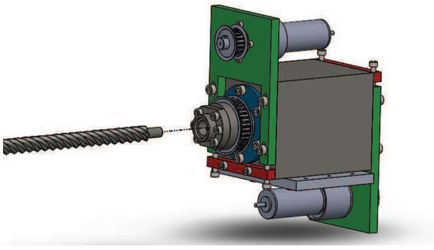


FIGURE 26 – Step 14

Step 15 : Assemble the slide part with the base with 6 screws (M5x16)

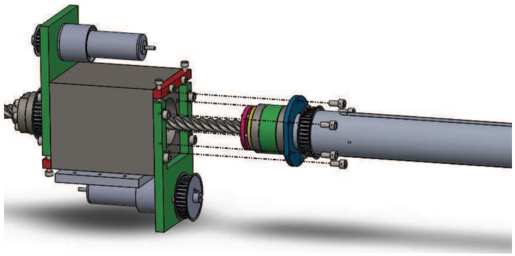


FIGURE 27 – Step 15

Step 16 : Add the parallel key (DIN 6885-A 3x3x12). Then assemble the POM ring on the screw adapter with the circlips. Assemble then the adapter with the screw.

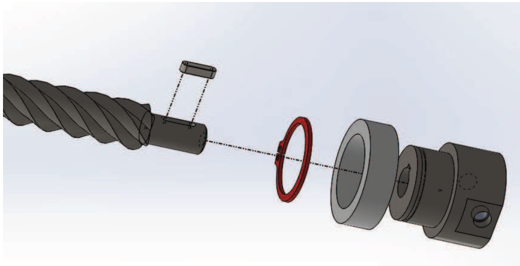


FIGURE 28 – Step 16

Step 17 : Hold together the screw and the adapter with the screw (M5x25)

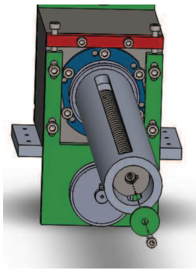


FIGURE 29 – Step 17

Step 18 : Add the two cam follower (galet de came) iniside the slot (fente) of the slide.

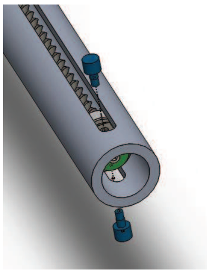


FIGURE 30 – Step 18

Step 19 : To finish add the two belt and tighten the belt with the appropriate belt tension. (Cf. section 9-10)

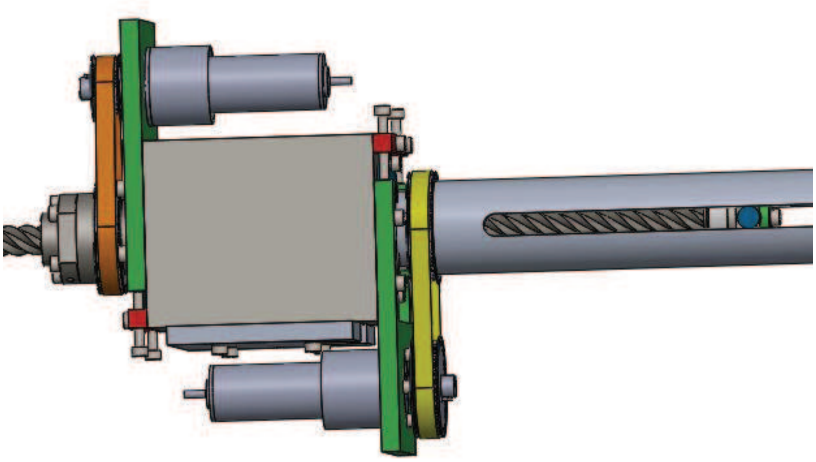
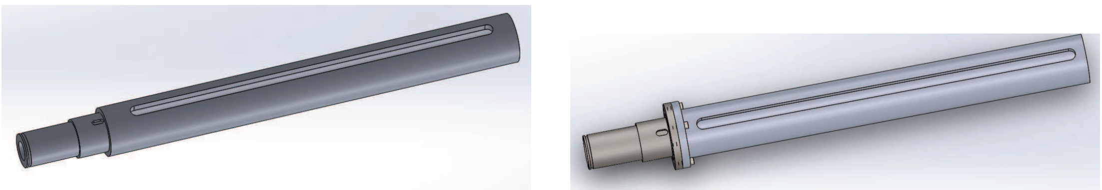


FIGURE 31 – Step 19

13 Modification :

Last minutes modifcation : We can't manufacture the slide in one piece, so I have to cut it in two part.



(a) Old part

(b) New parts

FIGURE 32 – Last-minutes modification

It's increase a little bit he inertia of the slide because one part is in steel. But If we compute again the overheat, we will get 20 [^{o}C]

14 Concusion :

I can't wait to do this theoretical system in the reality.

15 Thanks :

I really appreciate to thanks M.Koechli Christian, M.Salzmann Christophe and M. Tschantz Francis for they support and help. M. Jeanneret Marc for the supervision of the mechanical design. As well as M. Korda Milan , M. Gorecki Tomasz and M. Jones Collin.

16 Parts :

Name and description :	N°	#	item price [CHF]	Total [CHF]
Meadler :				
Polyurethane timing belt AT5 width 10mm Lw 300mm 60 teeth 10 AT5/300	43	1	14.81	14.81
Polyurethane timing belt AT5 width 10mm Lw 340mm 68 teeth 10 AT5/340	44	1	15.39	15.39
Timing belt pulley AT5 material alu. 36 teeth for belt width 10mm 21 AT5/36-2	5,26	3	16.02	48.06
Timing belt pulley AT5 material alu. 22 teeth for belt width 10mm 21 AT5/22-2	25	1	10.78	10.78
Rollin :				
Roulement de broche (B71907-E-T-P4S-UM)	7	4	184	736.-
Eichenberger-Gewinde :				
Vis à bille (KGE 16x50 RH 663 E G)	15	1	87.20	87.20
Ecrou à bille (KGE FBE RH 3 S A G)	16	1	313.60	313.60
Maxon :				
Moteur EC-4pole 30 ∅ 30 mm , à commutation électronique, 200W (REF : 305015)	41	2	710.-	1420.-
Réducteur planétaire 6 :1 GP 42 C ∅ 42 mm , 3-15 Nm (REF : 260551)	23	1	240.9	240.9
Réducteur planétaire 12 :1 GP 42 C ∅ 42 mm , 3-15 Nm (REF : 203115)	24	1	271.4	271.4
ESCON 70/10, 4-QServocontroller for DC/EC, 10/30A, 10-70 VDC(REF :422969)	-	2	336.8	673.6
MISUMI :				
Poussoir de came miniature(REF : CFFAN 6-12)	19	2	35.76	71.52
Colliers d'arbre end deux partie (REF : SCSPK16-10)	-	1	11.16	11.16
TOTAL :				38554.42

Références

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[8] Reymond Clavel. Composants de la microtechnique. pages 4.23–4.24, 2010.

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Site web : http://la.epfl.ch

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Lausanne, octobre 2013

Projet de semestre M1
Automne 2013

Candidat : **ZUFFEREY Florent Blaise**
Section de Microtechnique

Sujet : **Mechanical Redesign / Improvement**

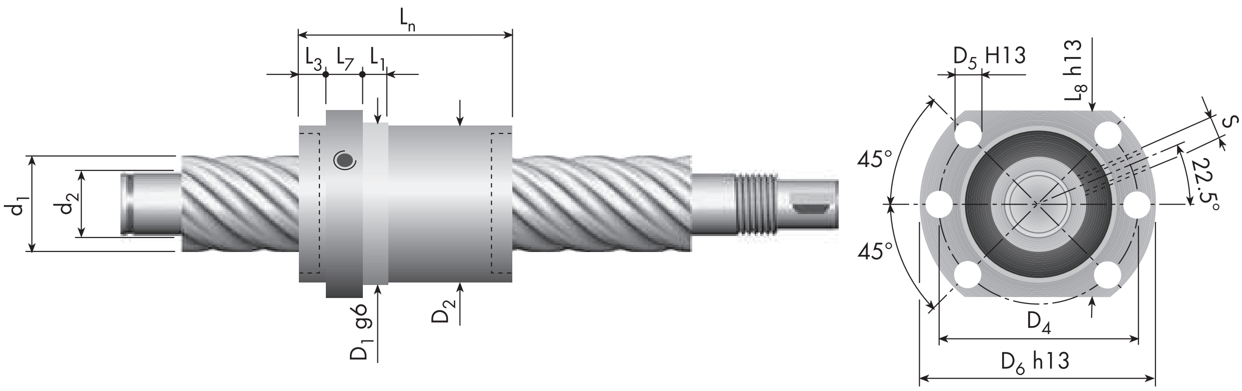
The aim of this project is to redesign the existing mechanical design for the bar actuator. The new solution should outperform the existing solution and mitigate the current limitations of the system (speed limit, vibrations). The design will have to include reliable mechanical safeties to protect the system itself and its users. The new version of the system should be built for at least one bar.

Le nombre de crédits réservés au plan d'études pour ce projet est de **douze**.

Dr. Christophe Salzmann
Prof. Colin Jones

Assistants responsables :
KORDA Milan (tél. int. 3 10 59)
GORECKI Tomasz (tél. int. 3 42 20)

Carry Speed-line type «FBE» (2/2)



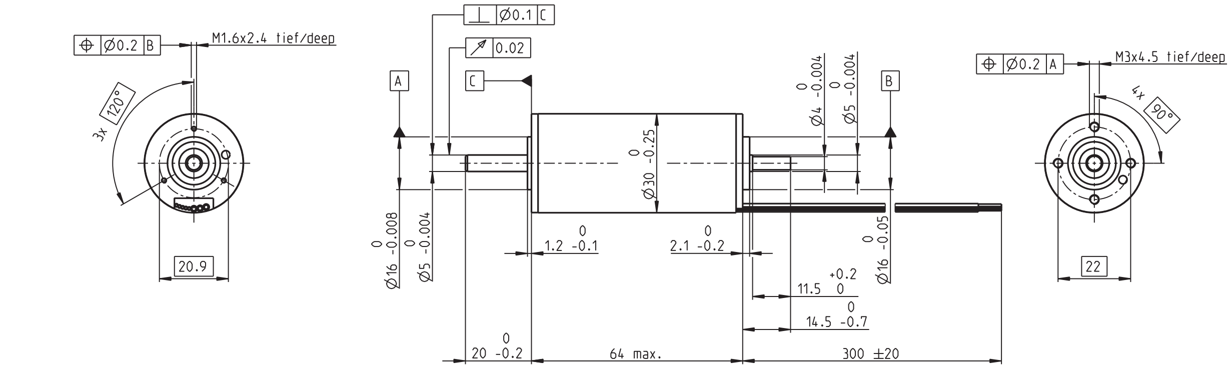
Carry S-line type «FBE»	Dimensions																	Capacité de charge	
	Vis		Ecrou																
d_0 x p	d_1	d_2	D_1 g6	D_2	D_4 Cp	D_5 H13	D_6 h13	L_n	L_1	L_3	L_7	L_8 h13	i	D_W	S	SA	T	C_{dyn}	C_{stat}
mm	mm		mm															N	
filets à droite																			
16 x 10	16.0	13.4	28	27.8	38	5.5	48	42	10	10	10	40	2x2.9	3.00	ø 4	K	0.07	12 500	26 000
16 x 16	15.5	13.2	28	27.8	38	5.5	48	42	10	10	10	40	2x1.9	3.00	ø 4	K	0.07	7 800	15 500
16 x 50	16.0	13.2	28	27.8	38	5.5	48	55	10	10	10	40	3x0.9	3.00	ø 4	K	0.06	4 800	11 000
20 x 20	20.0	17.3	36	35.5	47	6.6	58	50	10	10	12	44	4x1.9	3.00	M6	K	0.06	17 900	44 600
25 x 25	24.5	21.2	40	39.8	51	6.6	62	60	10	10	10	48	4x1.9	3.50	ø 4	K	0.06	23 300	68 000

Les fichiers CAD pour les types susmentionnés sont disponibles sous **www.gewinde.ch**

Carry Speed-line vis à billes à pas rapide maxon EC-4pole

EC-4pole 30 ∅30 mm, brushless, 200 Watt

High Power



M 1:2

Stock program
Standard program
Special program (on request)

Part Numbers

Motor Data (provisional)		305013	305014	305015
Values at nominal voltage				
1 Nominal voltage	V	24	36	48
2 No load speed	rpm	16700	16700	16500
3 No load current	mA	728	485	356
4 Nominal speed	rpm	15900	15900	15700
5 Nominal torque (max. continuous torque)	mNm	135	134	132
6 Nominal current (max. continuous current)	A	10.5	6.96	5.06
7 Stall torque	mNm	3220	3510	3430
8 Starting current	A	236	171	124
9 Max. efficiency	%	89	90	90
Characteristics				
10 Terminal resistance phase to phase	Ω	0.102	0.21	0.386
11 Terminal inductance phase to phase	mH	0.0163	0.0368	0.0653
12 Torque constant	mNm/A	13.6	20.5	27.6
13 Speed constant	rpm/V	700	466	346
14 Speed/torque gradient	rpm/mNm	5.21	4.78	4.83
15 Mechanical time constant	ms	1.82	1.67	1.69
16 Rotor inertia	gcm²	33.3	33.3	33.3

Specifications

Thermal data

17 Thermal resistance housing-ambient	5.3 K/W
18 Thermal resistance winding-housing	0.209 K/W
19 Thermal time constant winding	2.11 s
20 Thermal time constant motor	848 s
21 Ambient temperature	-20…+100°C
22 Max. permissible winding temperature	+155°C

Mechanical data (preloaded ball bearings)

23 Max. permissible speed	25000 rpm
24 Axial play at axial load < 8.0 N	0 mm
> 8.0 N	0.14 mm
25 Radial play	preloaded
26 Max. axial load (dynamic)	5.5 N
27 Max. force for press fits (static)	73 N
(static, shaft supported)	1300 N
28 Max. radial loading, 5 mm from flange	25 N

Other specifications

29 Number of pole pairs	2
30 Number of phases	3
31 Weight of motor	300 g

Values listed in the table are nominal.

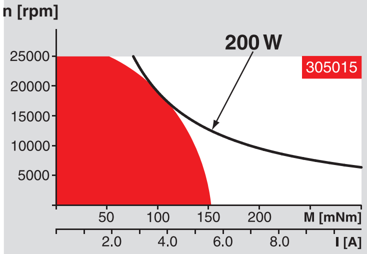
Connection motor (Cable AWG 18)

black	Motor winding 2
white	Motor winding 3
red	Motor winding 1

Connection sensors (Cable AWG 26)

black/grey	Hall sensor 2
blue	GND
green	V_{Hall} 3…24 VDC
red/grey	Hall sensor 1
white/grey	Hall sensor 3

Operating Range



Comments

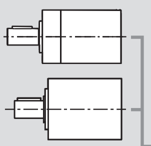
Continuous operation
In observation of above listed thermal resistance (lines 17 and 18) the maximum permissible winding temperature will be reached during continuous operation at 25°C ambient.
= Thermal limit.

Short term operation
The motor may be briefly overloaded (recurring).

Assigned power rating

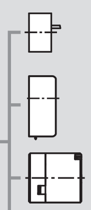
maxon Modular System

Overview on page 20 - 25



Planetary Gearhead
∅32 mm
8 Nm
Page 266

Planetary Gearhead
∅42 mm
3 - 15 Nm
Page 271



Encoder MR
128 - 1000 CPT,
3 channels
Page 302

Encoder HEDL 5540
500 CPT,
3 channels
Page 309

Brake AB 20
24 VDC
0.1 Nm
Page 346

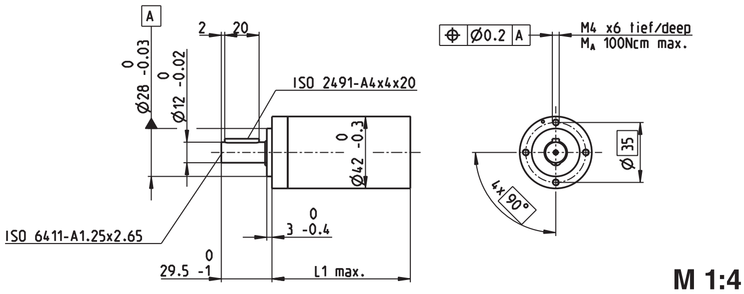
Recommended Electronics:

ESCON 50/5	Page 321
ESCON Module 50/5	321
ESCON 70/10	321
DECS 50/5	324
EPOS2 50/5	331
EPOS2 70/10	331
EPOS3 70/10 EtherCAT	337
Notes	**24**

maxon gear

Planetary Gearhead GP 42 C ∅42 mm, 3–15 Nm

Ceramic Version



M 1:4

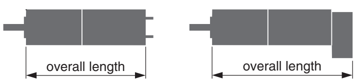
Technical Data

Planetary Gearhead	straight teeth
Output shaft	stainless steel
Bearing at output	preloaded ball bearings
Radial play, 12 mm from flange	max. 0.06 mm
Axial play at axial load < 5 N	0 mm
> 5 N	max. 0.3 mm
Max. permissible axial load	150 N
Max. permissible force for press fits	300 N
Sense of rotation, drive to output	=
Recommended input speed	< 8000 rpm
Recommended temperature range	-40…+100°C
Number of stages	1 2 3 4
Max. radial load, 12 mm from flange	120 N 240 N 360 N 360 N

Stock program
Standard program
Special program (on request)

Part Numbers			203113	203115	203119	203120	203124	203129	203128	203133	203137	203141
Gearhead Data												
1	Reduction		3.5 : 1	12 : 1	26 : 1	43 : 1	81 : 1	156 : 1	150 : 1	285 : 1	441 : 1	756 : 1
2	Reduction absolute		7/2	49/4	26	343/8	2197/27	156	2401/16	15379/54	441	756
10	Mass inertia	gcm²	14	15	9.1	15	9.4	9.1	15	15	14	14
3	Max. motor shaft diameter	mm	10	10	8	10	8	8	10	10	10	10
	Part Numbers		203114	203116	260552*	203121	203125	260553*	203130	203134	203138	203142
1	Reduction		4.3 : 1	15 : 1	36 : 1	53 : 1	91 : 1	216 : 1	186 : 1	319 : 1	488 : 1	936 : 1
2	Reduction absolute		13/3	91/6	36/1	637/12	91	216/1	4459/24	637/2	4394/9	936
10	Mass inertia	gcm²	9.1	15	5.0	15	15	5.0	15	15	9.4	9.1
3	Max. motor shaft diameter	mm	8	10	4	10	10	4	10	10	8	8
	Part Numbers		260551*	203117		203122	203126		203131	203135	203139	260554*
1	Reduction		6 : 1	19 : 1		66 : 1	113 : 1		230 : 1	353 :1	546 : 1	1296 : 1
2	Reduction absolute		6/1	169/9		1183/18	338/3		8281/36	28561/81	546	1296/1
10	Mass inertia	gcm²	4.9	9.4		15	9.4		15	9.4	14	5.0
3	Max. motor shaft diameter	mm	4	8		10	8		10	8	10	4
	Part Numbers			203118		203123	203127		203132	203136	203140	
1	Reduction			21 : 1		74 : 1	126 : 1		257 : 1	394 : 1	676 : 1	
2	Reduction absolute			21		147/2	126		1029/4	1183/3	676	
10	Mass inertia	gcm²		14		15	14		15	15	9.1	
3	Max. motor shaft diameter	mm		10		10	10		10	10	8	
4	Number of stages		1	2	2	3	3	3	4	4	4	4
5	Max. continuous torque	Nm	3.0	7.5	7.5	15.0	15.0	15.0	15.0	15.0	15.0	15.0
6	Intermittently permissible torque at gear output	Nm	4.5	11.3	11.3	22.5	22.5	22.5	22.5	22.5	22.5	22.5
7	Max. efficiency	%	90	81	81	72	72	72	64	64	64	64
8	Weight	g	260	360	360	460	460	460	560	560	560	560
9	Average backlash no load	°	0.6	0.8	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0
11	Gearhead length L1	mm	41.0	55.5	55.5	70.0	70.0	70.0	84.5	84.5	84.5	84.5

*no combination with EC 45 (150 W and 250 W)



maxon Modular System

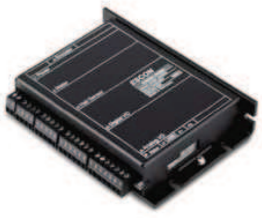
+ Motor	Page	+ Sensor	Page	Brake	Page	Overall length [mm] = Motor length + gearhead length + (sensor/brake) + assembly parts									
RE 35, 90 W	104					112.1	126.6	126.6	141.1	141.1	141.1	155.6	155.6	155.6	155.6
RE 35, 90 W	104	MR	303			123.5	138.0	138.0	152.5	152.5	152.5	167.0	167.0	167.0	167.0
RE 35, 90 W	104	HED_ 5540	305/307			132.8	147.3	147.3	161.8	161.8	161.8	176.3	176.3	176.3	176.3
RE 35, 90 W	104	DCT 22	315			130.2	144.7	144.7	159.2	159.2	159.2	173.7	173.7	173.7	173.7
RE 35, 90 W	104			AB 28	348	148.2	162.7	162.7	177.2	177.2	177.2	191.7	191.7	191.7	191.7
RE 35, 90 W	104	HED_ 5540	305/307	AB 28	348	165.4	179.9	179.9	194.4	194.4	194.4	208.9	208.9	208.9	208.9
RE 40, 150 W	105					112.1	126.6	126.6	141.1	141.1	141.1	155.6	155.6	155.6	155.6
RE 40, 150 W	105	MR	303			123.5	138.0	138.0	152.5	152.5	152.5	167.0	167.0	167.0	167.0
RE 40, 150 W	105	HED_ 5540	305/307			132.8	147.3	147.3	161.8	161.8	161.8	176.3	176.3	176.3	176.3
RE 40, 150 W	105	HEDL 9140	310			166.2	180.7	180.7	195.2	195.2	195.2	209.7	209.7	209.7	209.7
RE 40, 150 W	105			AB 28	348	148.2	162.7	162.7	177.2	177.2	177.2	191.7	191.7	191.7	191.7
RE 40, 150 W	105			AB 28	349	156.2	170.7	170.7	185.2	185.2	185.2	199.7	199.7	199.7	199.7
RE 40, 150 W	105	HED_ 5540	305/307	AB 28	348	165.4	179.9	179.9	194.4	194.4	194.4	208.9	208.9	208.9	208.9
RE 40, 150 W	105	HEDL 9140	310	AB 28	349	176.7	191.2	191.2	205.7	205.7	205.7	220.2	220.2	220.2	220.2
EC 40, 170 W	181					121.1	135.6	135.6	150.1	150.1	150.1	164.6	164.6	164.6	164.6
EC 40, 170 W	181	HED_ 5540	306/308			144.5	159.0	159.0	175.5	175.5	175.5	188.0	188.0	188.0	188.0
EC 40, 170 W	181	Res 26	316			148.3	162.8	162.8	177.3	177.3	177.3	191.8	191.8	191.8	191.8
EC 40, 170 W	181			AB 32	350	163.8	178.3	178.3	192.8	192.8	192.8	207.3	207.3	207.3	207.3
EC 40, 170 W	181	HED_ 5540	306/308	AB 32	350	187.2	201.7	201.7	216.2	216.2	216.2	230.7	230.7	230.7	230.7
EC 45, 150 W	182					152.3	166.8	166.8	181.3	181.3	181.3	195.8	195.8	195.8	195.8
EC 45, 150 W	182	HEDL 9140	310			167.9	182.4	182.4	196.9	196.9	196.9	211.4	211.4	211.4	211.4
EC 45, 150 W	182	Res 26	316			152.3	166.8	166.8	181.3	181.3	181.3	195.8	195.8	195.8	195.8
EC 45, 150 W	182			AB 28	349	159.7	174.2	174.2	188.7	188.7	188.7	203.2	203.2	203.2	203.2
EC 45, 150 W	182	HEDL 9140	310	AB 28	349	176.7	191.2	191.2	205.7	205.7	205.7	220.2	220.2	220.2	220.2
EC 45, 250 W	183					185.1	199.6	199.6	214.1	214.1	214.1	228.6	228.6	228.6	228.6
EC 45, 250 W	183	HEDL 9140	310			200.7	215.2	215.2	229.7	229.7	229.7	244.2	244.2	244.2	244.2
EC 45, 250 W	183	Res 26	316			185.1	199.6	199.6	214.1	214.1	214.1	228.6	228.6	228.6	228.6
EC 45, 250 W	183			AB 28	349	192.5	207.0	207.0	221.5	221.5	221.5	236.0	236.0	236.0	236.0
EC 45, 250 W	183	HEDL 9140	310	AB 28	349	209.5	224.0	224.0	238.5	238.5	238.5	253.0	253.0	253.0	253.0

http://pdf.directindustry.com/pdf/maxon-motor/program-2013-14/7173...

ESCON Feature Comparison Chart

maxon motor control

NEW



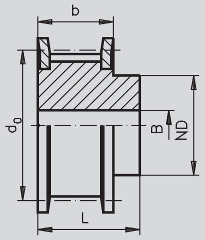
NEW

ESCON Module 50/5	**ESCON 50/5**	**ESCON 70/10**
250 W	250 W	700 W
250 W	250 W	700 W
Digital Incremental Encoder (2 channel with or without Line Driver)	Digital Incremental Encoder (2 channel with or without Line Driver)	Digital Incremental Encoder (2 channel with or without Line Driver)
DC Tacho	DC Tacho	DC Tacho
Without sensor (DC motors)	Without sensor (DC motors)	Without sensor (DC motors)
Digital Hall Sensors (EC motors)	Digital Hall Sensors (EC motors)	Digital Hall Sensors (EC motors)
Current controller (torque control), Speed controller (closed and open loop)	Current controller (torque control), Speed controller (closed and open loop)	Current controller (torque control), Speed controller (closed and open loop)
10 - 50 VDC	10 - 50 VDC	10 - 70 VDC
0.98 x V_{CC}	0.98 x V_{CC}	0.95 x V_{CC}
15 A (<20 s)	15 A (<20 s)	30 A (<20 s)
5 A	5 A	10 A
53.6 kHz	53.6 kHz	53.6 kHz
53.6 kHz	53.6 kHz	53.6 kHz
5.36 kHz	5.36 kHz	5.36 kHz
98%	95%	98%
limited by max. permissible speed (motor) and max. output voltage (controller)	limited by max. permissible speed (motor) and max. output voltage (controller)	limited by max. permissible speed (motor) and max. output voltage (controller)
150000 rpm	150000 rpm	150000 rpm
–	3 x 30 µH / 5 A	3 x 15 µH / 10 A
H1, H2, H3	H1, H2, H3	H1, H2, H3
A, A\, B, B\	A, A\, B, B\	A, A\, B, B\
1 MHz (100 kHz)	1 MHz (100 kHz)	1 MHz (100 kHz)
1	2	2
2	2	2
2	2	2
2 12-bit, -10…+10 V, differential	2 12-bit, -10…+10 V, differential	2 12-bit, -10…+10 V, differential
2 12-bit, -4…+4 V	2 12-bit, -4…+4 V	2 12-bit, -4…+4 V
+5 VDC (IL ≤10 mA)	+5 VDC (IL ≤10 mA)	+5 VDC (IL ≤10 mA)
+5 VDC (IL ≤30 mA)	+5 VDC (IL ≤30 mA)	+5 VDC (IL ≤30 mA)
+5 VDC (IL ≤70 mA)	+5 VDC (IL ≤70 mA)	+5 VDC (IL ≤70 mA)
Operation: green LED / Error: red LED	Operation: green LED / Error: red LED	Operation: green LED / Error: red LED
-30…+45°C	-30…+45°C	-30…+45°C
+45…+75°C; Derating: -0.167 A/°C	+45…+85°C; Derating: -0.113 A/°C	+45…+82°C; Derating: -0.270 A/°C
-40…+85°C	-40…+85°C	-40…+85°C
20…80%	20…80%	20…80%
Approx. 12 g	Approx. 204 g	Approx. 259 g
43.2 x 31.8 x 12.7 mm	115 x 75.5 x 24 mm	125 x 78.5 x 27 mm
Pluggable (socket headers with 2.54 mm pitch)	for screws M4	for screws M4
438725 ESCON Module 50/5	**409510** ESCON 50/5	**422969** ESCON 70/10
Order accessories separately, page 339/340	Order accessories separately, from page 339	Order accessories separately, from page 339

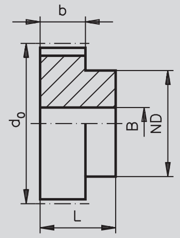
June 2013 edition / subject to change

maxon motor control 321

Poulies dentées AT, pas 5 mm en aluminium



Exécution 1F



Exécution 2

Matériau : aluminium 6082-T6, UNI 9006. Flasques en acier galvanisé.

Profil AT 5, largeur de courroie 10 mm

N° art. Largeur de courroie dentée 10 mm	Type	Nombre de dents	Exécution	Ø extérieur poulie dentée mm	Ø extérieur flasque mm	d_0 mm	ND mm	b mm	L mm	Préalésage B mm	Poids g
166 212 00	21 AT5/12-2	12	1F	17,85	23	19,10	10	15	21	-	16
166 214 00	21 AT5/14-2	14	1F	21,05	25	22,28	13	15	21	-	19
166 215 00	21 AT5/15-2	15	1F	22,65	28	23,87	16	15	21	-	21
166 216 00	21 AT5/16-2	16	1F	24,20	32	25,46	18	15	21	-	25
166 218 00	21 AT5/18-2	18	1F	27,40	32	28,65	20	15	21	-	31
166 219 00	21 AT5/19-2	19	1F	29,00	36	30,24	22	15	21	-	36
166 220 00	21 AT5/20-2	20	1F	30,60	36	31,88	23	15	21	-	38
166 222 00	21 AT5/22-2	22	1F	33,85	38	35,01	24	15	21	-	46
166 224 00	21 AT5/24-2	24	1F	37,00	42	38,20	26	15	21	-	54
166 225 00	21 AT5/25-2	25	1F	38,60	44	39,79	26	15	21	-	58
166 226 00	21 AT5/26-2	26	1F	40,20	44	41,38	26	15	21	-	62
166 227 00	21 AT5/27-2	27	1F	41,80	48	42,97	30	15	21	8	64
166 228 00	21 AT5/28-2	28	1F	43,35	48	44,56	32	15	21	8	71
166 230 00	21 AT5/30-2	30	1F	46,55	51	47,75	34	15	21	8	75
166 232 00	21 AT5/32-2	32	1F	49,70	54	50,93	38	15	21	8	88
166 236 00	21 AT5/36-2	36	1F	56,05	64	57,30	38	15	21	8	114
166 240 00	21 AT5/40-2	40	1F	62,45	66	63,66	40	15	21	8	138
166 242 00	21 AT5/42-2	42	1F	65,60	71	66,84	40	15	21	8	180
166 244 00	21 AT5/44-0	44	2	68,80	-	70,03	45	15	21	8	185
166 248 00	21 AT5/48-0	48	2	75,15	-	76,39	50	15	21	8	200
166 260 00	21 AT5/60-0	60	2	94,25	-	95,49	65	15	21	8	307

Profil AT 5, largeur de courroie 16 mm

N° art. Largeur de courroie dentée 16 mm	Type	Nombre de dents	Exécution	Ø extérieur poulie dentée mm	Ø extérieur flasque mm	d_0 mm	ND mm	b mm	L mm	Préalésage B mm	Poids g
166 312 00	27 AT5/12-2	12	1F	17,85	23	19,10	10	21	27	-	22
166 314 00	27 AT5/14-2	14	1F	21,05	25	22,28	13	21	27	-	26
166 315 00	27 AT5/15-2	15	1F	22,65	28	23,87	16	21	27	-	29
166 316 00	27 AT5/16-2	16	1F	24,20	32	25,46	18	21	27	-	35
166 318 00	27 AT5/18-2	18	1F	27,40	32	28,65	20	21	27	-	43
166 319 00	27 AT5/19-2	19	1F	29,00	36	30,24	22	21	27	-	49
166 320 00	27 AT5/20-2	20	1F	30,60	36	31,88	23	21	27	-	53
166 322 00	27 AT5/22-2	22	1F	33,85	38	35,01	24	21	27	-	54
166 324 00	27 AT5/24-2	24	1F	37,00	42	38,20	26	21	27	-	76
166 325 00	27 AT5/25-2	25	1F	38,60	44	39,79	26	21	27	-	81
166 326 00	27 AT5/26-2	26	1F	40,20	44	41,38	26	21	27	-	85
166 327 00	27 AT5/27-2	27	1F	41,80	48	42,97	30	21	27	8	90
166 328 00	27 AT5/28-2	28	1F	43,35	48	44,56	32	21	27	8	92
166 330 00	27 AT5/30-2	30	1F	46,55	51	47,75	34	21	27	8	105
166 332 00	27 AT5/32-2	32	1F	49,70	54	50,93	38	21	27	8	123
166 336 00	27 AT5/36-2	36	1F	56,05	64	57,30	38	21	27	8	160
166 340 00	27 AT5/40-2	40	1F	62,45	66	63,66	40	21	27	8	193
166 342 00	27 AT5/42-2	42	1F	65,60	71	66,84	40	21	27	8	205
166 344 00	27 AT5/44-0	44	2	68,80	-	70,03	45	21	27	8	228
166 348 00	27 AT5/48-0	48	2	75,15	-	76,39	50	21	27	8	280
166 360 00	27 AT5/60-0	60	2	94,25	-	95,49	65	21	27	8	430

Courroies dentées AT

Matériau : polyuréthane (PU) avec cordes de traction en acier.

Exemple de commande : n° art. 166 601 00, courroie dentée PU, profil AT 5, 225 mm, largeur de courroie 10 mm, 45 dents

Métrique

Profil AT 5, pas dentaire 5 mm

N° art. Largeur 10mm	N° art. Largeur 16mm	N° art. Largeur 25mm	Long. prim. mm	Nombre de dents
166 601 00	166 701 00	166 801 00	225	45
166 602 00	166 702 00	166 802 00	255	51
166 603 00	166 703 00	166 803 00	275	55
166 604 00	166 704 00	166 804 00	280	56
166 605 00	166 705 00	166 805 00	300	60
166 606 00	166 706 00	166 806 00	340	68
166 607 00	166 707 00	166 807 00	375	75
166 608 00	166 708 00	166 808 00	390	78
166 609 00	166 709 00	166 809 00	420	84
166 610 00	166 710 00	166 810 00	455	91
166 611 00	166 711 00	166 811 00	500	100
166 612 00	166 712 00	166 812 00	545	109
166 613 00	166 713 00	166 813 00	600	120
166 614 00	166 714 00	166 814 00	610	122
166 615 00	166 715 00	166 815 00	630	126
166 616 00	166 716 00	166 816 00	660	132
166 617 00	166 717 00	166 817 00	720	144
166 618 00	166 718 00	166 818 00	750	150
166 619 00	166 719 00	166 819 00	780	156
166 620 00	166 720 00	166 820 00	825	165
166 621 00	166 721 00	166 821 00	975	195
166 622 00	166 722 00	166 822 00	1050	210
166 623 00	166 723 00	166 823 00	1125	225
166 624 00	166 724 00	166 824 00	1500	300
166 600 00	166 700 00	166 800 00	March. au mètre	

Profil AT 10, pas dentaire 10 mm

N° art. Largeur 16mm	N° art. Largeur 25mm	N° art. Largeur 32mm	N° art. Largeur 50mm	Long. prim. mm	Nombre de dents
168 601 00	168 701 00	168 801 00	168 831 00	500	50
168 602 00	168 702 00	168 802 00	168 832 00	560	56
168 603 00	168 703 00	168 803 00	168 833 00	610	61
168 604 00	168 704 00	168 804 00	168 834 00	660	66
168 605 00	168 705 00	168 805 00	168 835 00	700	70
168 606 00	168 706 00	168 806 00	168 836 00	730	73
168 607 00	168 707 00	168 807 00	168 837 00	780	78
168 608 00	168 708 00	168 808 00	168 838 00	800	80
168 609 00	168 709 00	168 809 00	168 839 00	810	81
168 610 00	168 710 00	168 810 00	168 840 00	840	84
168 611 00	168 711 00	168 811 00	168 841 00	890	89
168 612 00	168 712 00	168 812 00	168 842 00	920	92
168 613 00	168 713 00	168 813 00	168 843 00	960	96
168 614 00	168 714 00	168 814 00	168 844 00	980	98
168 615 00	168 715 00	168 815 00	168 845 00	1010	101
168 616 00	168 716 00	168 816 00	168 846 00	1050	105
168 617 00	168 717 00	168 817 00	168 847 00	1080	108
168 618 00	168 718 00	168 818 00	168 848 00	1150	115
168 619 00	168 719 00	168 819 00	168 849 00	1210	121
168 620 00	168 720 00	168 820 00	168 850 00	1250	125
168 621 00	168 721 00	168 821 00	168 851 00	1320	132
168 622 00	168 722 00	168 822 00	168 852 00	1400	140
168 623 00	168 723 00	168 823 00	168 853 00	1500	150
168 624 00	168 724 00	168 824 00	168 854 00	1600	160
168 625 00	168 725 00	168 825 00	168 855 00	1700	170
168 626 00	168 726 00	168 826 00	168 856 00	1800	180
168 600 00	168 700 00	168 800 00	168 860 00	March. au mètre	

Exécution sans fin à partir de marchandise au mètre, longueurs spéciales au gré livrables sur demande.

Voir pages 160 – 161 pour la marchandise au mètre et les plaques de serrage.

Voir page 122 pour le tableau de puissance.

Voir page 119 pour les forces de traction admissibles des courroies.

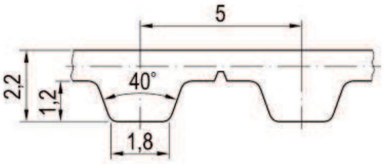
Technisches Datenblatt
optibelt ALPHA TORQUE T5 - ST
Zahnriemen aus Gieß-Polyurethan, endlos

Abmessungen, Toleranzen

Profil:	T5
Zahnteilung t:	5 mm
Gesamthöhe:	2,2 mm
Zahnhöhe:	1,2 mm
Zahnkopfbreite:	1,8 mm
Zahnflankenwinkel:	40 °
Längentoleranz:	Siehe Tabelle
Breitentoleranz, b ≤ 25 mm:	± 0,5 mm
Höhentoleranz:	± 0,15 mm

Aufbau

Polyurethan:	Duroplast, 86 Shore A, transparent
Zugträger:	Stahl, Ø 0,3 mm



Je Zahn übertragbare, spezifische Nennleistung

Drehzahl, kl. Scheibe n_k [1/min]	Spez. Nenn-Leistung $P_{N\,spez}$ [W/mm]	Drehzahl, kl. Scheibe n_k [1/min]	Spez. Nenn-Leistung $P_{N\,spez}$ [W/mm]	Drehzahl, kl. Scheibe n_k [1/min]	Spez. Nenn-Leistung $P_{N\,spez}$ [W/mm]
0 [1]	0,000	1200	0,152	3600	0,347
20	0,004	1300	0,162	3800	0,361
40 [2]	0,008	1400	0,171	4000	0,374
60	0,011	1500	0,181	4500	0,406
80 [3]	0,015	1600 [7]	0,190	5000	0,436
100	0,018	1700	0,199	5500	0,465
200 [4]	0,034	1800	0,208	6000	0,492
300	0,048	1900	0,217	6500	0,519
400 [5]	0,062	2000	0,225	7000	0,544
500	0,074	2200	0,242	7500	0,568
600	0,087	2400	0,258	8000	0,591
700	0,098	2600	0,274	8500	0,614
800 [6]	0,110	2800	0,290	9000	0,636
900	0,121	3000	0,304	9500	0,656
1000	0,131	3200 [8]	0,319	10000	0,677
1100	0,142	3400	0,333	v_{max} = 80 m/s	

[1] $F_{N\,spez}$ [N/mm] 2,450 [2] 2,317 [3] 2,222 [4] 2,035 [5] 1,852 [6] 1,646 [7] 1,425 [8] 1,196

Nennleistung P_N

$$P_N = P_{N\,spez} \cdot z_k \cdot z_{eB} \cdot b / 10^3 \quad \text{[kW]}$$

$P_{N\,spez}$	Je Zahn übertragbare, spezifische Nennleistung [W/mm]
z_k	Zähnezahl, kleine Scheibe
z_{eB}	Eingreifende Zähnezahl an der kleinen Scheibe, begrenzt auf $z_{eB\,max}$
$z_{eB\,max}$	12, maximal zulässige Zähnezahl
b	Riemenbreite [mm]

Nennmoment M_N

$$M_N = P_N \cdot 9{,}55 \cdot 10^3 / n_k \quad \text{[Nm]}$$

n_k	Drehzahl, kleine Scheibe [1/min]

Nennzugkraft F_N

$$F_N = F_{N\,spez} \cdot z_{eB} \cdot b \quad \text{[N]}$$

$$F_{N\,spez} = P_{N\,spez} \cdot 6 \cdot 10^4 / (n_k \cdot t) \quad \text{[N/mm]}$$

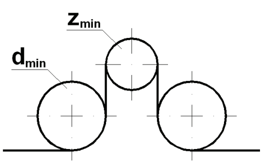
$F_{N\,spez}$	Je Zahn übertragbare, spezifische Nennzugkraft [N/mm]
t	Zahnteilung [mm]

Cord-Zugkräfte, Riemengewicht

Riemenbreite [1] b [mm]	**6**	**10**	**12**	**16**	**20**	**25**	**32**	**50**	**75**	**100**
Zulässige Zugkraft [2] F_{zul} [N]	220	375	470	660	840	1060	1375	2150	3300	4400
Bruchkraft F_{Br} [N]	880	1500	1880	2640	3360	4240	5500	8600	13200	17600
Metergewicht [kg/m]	0,013	0,022	0,026	0,035	0,044	0,055	0,070	0,110	0,165	0,220

[1] Weitere und Zwischenbreiten möglich [2] Zulässige Zugkraft F_{zul} entspricht 25% der Bruchkraft F_{Br} der Corde

Zahnscheiben, Innen- und Außenrollen



Zähnezahl: z_{min} = 10
Wirk-Ø: $d_{w\,min}$ = 15,92 mm

Glatte, zylindrische Rollen, Ø
Innenrolle: d_{min} = 22 mm
Außenrolle: d_{min} = 30 mm

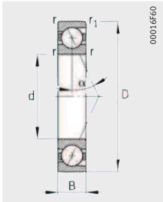
Längentoleranzen, als Achsabstandstoleranzen

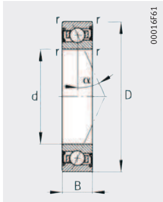
Länge L_w [mm]		Toleranz a_{LTol} [mm]	Länge L_w [mm]		Toleranz a_{LTol} [mm]
	≤ 305	± 0,14	> 780	≤ 990	± 0,28
> 305	≤ 390	± 0,16	> 990	≤ 1250	± 0,32
> 390	≤ 525	± 0,18	> 1250	≤ 1560	± 0,38
> 525	≤ 630	± 0,21	> 1560	≤ 1960	± 0,44
> 630	≤ 780	± 0,24	> 1960	≤ 2350	± 0,52

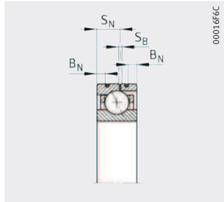
Wir beraten Sie gerne über die Produkteigenschaften und -anpassungen bei besonderen Anforderungen. Bitte beachten Sie auch die Hinweise in den OPTIBELT Dokumentationen.

Roulements de broche

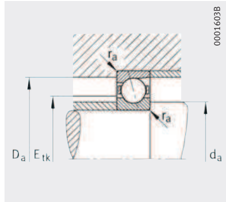
A grandes ou à petites billes
Billes en acier ou en céramique
Bagues en acier ou en Cronidur
Avec ou sans étanchéité
Exécution DLR



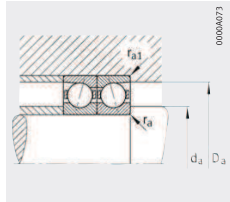




Exécution DLR[5)]



Cotes de montage



Cotes de montage

38

Tableau de dimensions (suite) (en mm)

Désignation[1) 4)]			Masse	Dimensions								Angle de contact	Cotes de montage					Charges de base		Vitesses limites		Précharge[2)] F_v			Effort de séparation[2)] K_{aE}			Rigidité axiale[2)] c_a		
Série 719	Série 70	Série 72	m	d	D	B	r	r_1	B_N	S_N	S_B	α	d_a h12	D_a H12	r_a	r_{a1}	E_{tk}	dyn. C_r	stat. C_{0r}	n_G graisse	n_G huile[3)]	L	M	H	L	M	H	L	M	H
			≈kg				min.					°			max.		nom.	kN	kN	min^{-1}	min^{-1}	N	N	N	N	N	N	N/μm	N/μm	N/μm
B71907-C-T-P4S	–	–	0,07	**35**	55	10	0,6	0,6	–	–	–	15	40	51,5	0,6	0,6	44	11,8	9,5	26 000	40 000	61	209	481	190	711	1 782	36,3	64,1	99,3
B71907-E-T-P4S	–	–	0,07	**35**	55	10	0,6	0,6	–	–	–	25	40	51,5	0,6	0,6	44	11	9	24 000	36 000	61	276	619	178	835	1 945	73,5	129,4	180,6
HCB71907-C-T-P4S	–	–	0,06	**35**	55	10	0,6	0,6	1,6	5,8	1,4	15	40	51,5	0,6	0,6	44	8,15	6,55	36 000	56 000	21	96	217	63	309	741	26,7	49,7	72,4
HCB71907-E-T-P4S	–	–	0,06	**35**	55	10	0,6	0,6	1,6	5,8	1,4	25	40	51,5	0,6	0,6	44	7,65	6,3	32 000	50 000	44	127	316	129	380	968	74,1	108,9	154
XCB71907-C-T-P4S	–	–	0,06	**35**	55	10	0,6	0,6	1,6	5,8	1,4	15	40	51,5	0,6	0,6	44	18	6,55	40 000	60 000	21	96	217	63	309	741	26,7	49,7	72,4
XCB71907-E-T-P4S	–	–	0,06	**35**	55	10	0,6	0,6	1,6	5,8	1,4	25	40	51,5	0,6	0,6	44	17	6,3	36 000	56 000	44	127	316	129	380	968	74,1	108,9	154
RS71907-D-T-P4S	–	–	0,07	**35**	55	10	0,6	0,6	–	–	–	20	40	51,5	0,6	0,6	44	11,4	9,3	30 000	48 000	52	156	311	156	484	997	50	76,7	102,5
HCRS71907-D-T-P4S	–	–	0,06	**35**	55	10	0,6	0,6	1,6	5,8	1,4	20	40	51,5	0,6	0,6	44	8	6,55	38 000	60 000	36	109	218	107	332	681	49,3	74,6	98,4
HS71907-C-T-P4S	–	–	0,08	**35**	55	10	0,6	–	–	–	–	15	40	51,5	0,6	0,6	43,3	6,95	6,2	36 000	56 000	24	71	142	72	224	471	24,8	38,9	53,6
HS71907-E-T-P4S	–	–	0,08	**35**	55	10	0,6	–	–	–	–	25	40	51,5	0,6	0,6	43,3	6,55	5,85	32 000	50 000	38	115	230	110	339	690	61,4	91,7	119,6
HC71907-E-T-P4S	–	–	0,08	**35**	55	10	0,6	–	1,6	5,8	1,4	25	40	51,5	0,6	0,6	43,3	4,5	4,05	40 000	63 000	26	79	159	75	233	476	60,5	90,4	117,1
XC71907-E-T-P4S	–	–	0,08	**35**	55	10	0,6	–	1,6	5,8	1,4	25	40	51,5	0,6	0,6	43,3	10	4,05	45 000	70 000	26	79	159	75	233	476	60,5	90,4	117,1
–	**B7007-C-T-P4S**	–	0,15	**35**	62	14	1	1	–	–	–	15	41	56	1	0,3	45,6	19	13,7	24 000	38 000	97	333	697	303	1 132	2 548	38,7	67,8	99,5
–	**B7007-E-T-P4S**	–	0,15	**35**	62	14	1	1	–	–	–	25	41	56	1	0,3	45,6	18,3	12,9	22 000	34 000	136	518	1 116	400	1 577	3 525	88,4	146,9	202,1
–	**HCB7007-C-T-P4S**	–	0,13	**35**	62	14	1	1	2,8	8	1,4	15	41	56	1	0,3	45,6	13,2	9,5	34 000	53 000	46	177	382	140	574	1 312	32,2	56,2	80,5
–	**HCB7007-E-T-P4S**	–	0,13	**35**	62	14	1	1	2,8	8	1,4	25	41	56	1	0,3	45,6	12,5	9	30 000	45 000	54	255	581	159	767	1 789	72,4	126,2	173,3
–	**XCB7007-C-T-P4S**	–	0,13	**35**	62	14	1	1	2,8	8	1,4	15	41	56	1	0,3	45,6	29	9,5	38 000	56 000	46	177	382	140	574	1 312	32,2	56,2	80,5
–	**XCB7007-E-T-P4S**	–	0,13	**35**	62	14	1	1	2,8	8	1,4	25	41	56	1	0,3	45,6	28	9	34 000	53 000	54	255	581	159	767	1 789	72,4	126,2	173,3
–	**RS7007-D-T-P4S**	–	0,15	**35**	62	14	1	1	–	–	–	20	41	56	1	0,3	45,6	18,6	13,4	28 000	43 000	85	254	508	255	791	1 634	54,9	84,2	113
–	**HCRS7007-D-T-P4S**	–	0,13	**35**	62	14	1	1	2,8	8	1,4	20	41	56	1	0,3	45,6	12,9	9,5	36 000	56 000	59	176	352	175	537	1 102	54,2	81,6	107,7
–	**HS7007-C-T-P4S**	–	0,17	**35**	62	14	1	–	–	–	–	15	41	56	1	0,3	46,5	9,3	8,3	34 000	50 000	32	95	190	96	300	632	27,4	43,1	59,5
–	**HS7007-E-T-P4S**	–	0,17	**35**	62	14	1	–	–	–	–	25	41	56	1	0,3	46,5	8,8	7,8	30 000	45 000	51	154	308	147	453	926	67,8	101,5	132,7
–	**HC7007-E-T-P4S**	–	0,17	**35**	62	14	1	–	2,8	8	1,4	25	41	56	1	0,3	46,5	6,1	5,4	38 000	60 000	36	107	214	105	316	642	68,5	100,6	130,2
–	**XC7007-E-T-P4S**	–	0,17	**35**	62	14	1	–	2,8	8	1,4	25	41	56	1	0,3	46,5	13,7	5,4	43 000	67 000	36	107	214	105	316	642	68,5	100,6	130,2
–	–	**B7207-C-T-P4S**	0,28	**35**	72	17	1,1	1,1	–	–	–	15	44	63	1	1	50,7	25,5	18	20 000	34 000	136	454	942	427	1 555	3 475	45,3	79,1	116
–	–	**B7207-E-T-P4S**	0,28	**35**	72	17	1,1	1,1	–	–	–	25	44	63	1	1	50,7	24,5	17	19 000	32 000	197	714	1 521	580	2 185	4 825	103,9	170,4	234,1
–	–	**HCB7207-C-T-P4S**	0,24	**35**	72	17	1,1	1,1	–	–	–	15	44	63	1	1	50,7	17,6	8,8	26 000	40 000	66	241	514	202	786	1 777	37,9	65,1	93,2
–	–	**HCB7207-E-T-P4S**	0,24	**35**	72	17	1,1	1,1	–	–	–	25	44	63	1	1	50,7	16,6	8,5	22 000	36 000	84	362	804	247	1 091	2 489	86,9	147,5	201,3

1) Description de la désignation, voir paragraphe Désignation des roulements, page 84, *figure 9*.
2) Description, voir chapitre Bases techniques.
3) Lubrification avec débit d'huile minimum.
4) Les roulements sont également livrables avec une étanchéité par passage étroit.
Exemples de commande : **B7007-C-2RSD-T-P4S-UL**
HSS7007-E-T-P4S-UL.
5) Exemples de commande pour une exécution Direct Lube : **HCB7007-EDLR-T-P4S-UL**
HC7007-EDLR-T-P4S-UL.

DATASHEET

F. Zufferey

NEW

Vis d'assemblage à tête basse à six pans creux/Vis d'assemblage à tête basse à six pans creux, de longueur configurable

-Haute résistance-

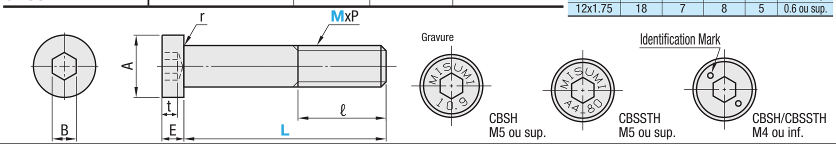
Données CAO

Les pièces CBSST peuvent être commandées par boîtes économiques. P.159

■Vis d'assemblage à tête basse à six pans creux RoHS

Type	M Matériau	H Dureté	S Traitement de surface	Niveau de résistance
CBSH(haute résistance)	1.7220/34CrMo4	32~39HRC	Oxydation noire	10.9
CBS	1.1191/C45E (1.7220/34CrMo4~8, M12) SCM435 (M10)	22~32HRC	Oxydation noire	8.8
CBSSTH(haute résistance)	1.4404/X2CrNiMo17-12-2	-	-	A4-80 (équivalent de 8.8)
CBSST	1.4567/X3CrNiCu18-9-4	-	-	A2-50

MxP	A	E	B	t max.	r
2x0.4	3.8	1.3	1.3	1	0.1 ou sup.
2.5x0.45	4.5	1.6	1.5	1.3	0.1 ou sup.
3x0.5	5.5	2	2	1.5	0.1 ou sup.
4x0.7	7	2.8	2.5	2.3	0.2 ou sup.
5x0.8	8.5	3.5	3	2.7	0.2 ou sup.
6x1.0	10	4	4	3	0.25 ou sup.
8x1.25	13	5	5	3.8	0.4 ou sup.
10x1.5	16	6	6	4.5	0.4 ou sup.
12x1.75	18	7	8	5	0.6 ou sup.



Réf. pièce Type	M-L	ℓ CBSH CBS	ℓ CBSSTH CBSST	Prix unitaire en € CBS	CBSST	CBSH	CBSSTH
CBSST	2-4, 5, 6	-	Vis à filetage complet				
CBSST	2.5-4, 5, 6, 8, 10	-	Vis à filetage complet				
CBS CBSST CBSH CBSSTH	3-5, 6, 8, 10, 12, 16	Vis à filetage complet	Vis à filetage complet				
	20	12	Vis à filetage complet				
CBS CBSST CBSH CBSSTH	4-5, 6, 8, 10, 12, 16, 20, 25	Vis à filetage complet	Vis à filetage complet				
CBS CBSST CBSH CBSSTH	5-5, 6, 8, 10, 12, 16, 20, 25	Vis à filetage complet	Vis à filetage complet				
	30	16	24				
CBS CBSST CBSH CBSSTH	6-8, 10, 12, 16, 20, 25, 30, 35	Vis à filetage complet	Vis à filetage complet				
	40, 45	18	26				
CBS CBSST CBSH	8-10, 12, 16, 20, 25, 30	Vis à filetage complet	Vis à filetage complet				
	35, 40, 45, 50	22	30				

Réf. pièce Type	M-L	ℓ CBS	ℓ CBSST	Prix unitaire en € CBS	CBSST	CBSH	CBSSTH
CBS CBSST	10-16, 20, 25, 30, 35, 40, 45	Vis à filetage complet	Vis à filetage complet				
	50	32	36				
CBS CBSST	12-20, 25, 30, 35, 40, 45	Vis à filetage complet	Vis à filetage complet				
	50	30	40				

Spécification non disponible pour les tailles sans notification de prix.

Exemple de commande: Réf. pièce CBSST4-10

Délai de livraison (jours): 6 Jours, 2 Jours P.87

Prix

■Remise sur volume (Arrondir au centime inférieur.) P.87

•CBS

Qté	1~199	200~300
Applicable	Prix unitaire en € Liste des prix	Remise sur volume 5%

Pour les commandes supérieures aux quantités indiquées, demander un devis.

•CBSST

Qté	1~199	200~300
Applicable	Prix unitaire en € Liste des prix	Remise sur volume 5%

Pour les commandes supérieures aux quantités indiquées, demander un devis.

•CBSH CBSSTH

Qté	1~19	20~99	100~199	200~300
Remise	Prix unitaire en €	20%	40%	45%

Pour les commandes supérieures aux quantités indiquées, demander un devis.

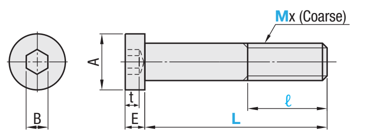
■Propriétés mécaniques (référence)

Type	Résistance à la traction (N/mm²)	Contrainte d'essai de 0.2% (N/mm²)	Résistance à la corrosion	Non magnétique
CBSH	1040	900	Δ	X
CBS	800	640	Δ	X
CBSSTH	800	640	◎	◎
CBSST	500	210	○	○

◎ : Excellent ○ : Bon Δ : Douteux X : Inutilisable

■Longueur configurable Vis d'assemblage à tête basse à six pans creux RoHS

Type	M Matériau	S Surface	Niveau de résistance
FCBS	1.1191/C45E	Oxydation noire	8.8
FCBSM	1.1191/C45E	Placage autocatalytique au nickel	8.8
FCBSST	1.4567/ X3CrNiCu18-9-4	-	A2-50



Réf. pièce Type	M (normal)	L Incrément de 1mm	ℓ Incrément de 1mm	A	E	B	t max.	Prix unitaire en € L10~50 FCBS	FCBSM	FCBSST	51~L max. FCBS	FCBSM	FCBSST
FCBS FCBSM FCBSST	4	10~50	10~40 ℓ≤L	7	2.8	2.5	2.3						
	5	10~60		8.5	3.5	3	2.7						
	6	10~80		10	4	4	3						
	8	10~90		13	5	5	3.8						

Exemple de commande: Réf. pièce - L - ℓ : FCBS8 - 38 - 10

Délai de livraison (jours): 8 Jours; - FCBSM 10 Jours

Prix

■Remise sur volume (Arrondir au centime inférieur.) P.87

Qté	1~19	20~24	25~29	30~49
Remise	Prix unitaire en €	5%	10%	18%

Pour les commandes supérieures aux quantités indiquées, demander un devis.

Protocole de calcul

Protocole de calcul 09.01.14 03:20 Heure

Mädler GmbH
Tränkestr. 8
D – 70597 Stuttgart
Tél. : +49 (711) 7 20 95-0
Téléfax : +49 (711) 7 20 95-33

Détails de la courroie dentée

Désignation	AT5	
Pas	5.0	mm
Largeur	10.0	mm
Poids au m	0.04	kg
Force de précontrainte requise	65.51	N
Force de précontrainte requise pour entraînements linéaires	131.01	N
Entraxe	76.69	mm
Longueur de courroie	300.0	mm
Poids de la courroie	0.01	kg
Nombre de dents	60	
Numéro d'article	16660500	

Détails du calcul de la puissance

Puissance motrice	0.2	kW
Puissance de sortie	0.2	kw
Roue d'entraînement	2	
Sécurité	3.91	

Détails poulies dentées

N° poulie dentée : 1

Position X	0.0	mm
Position Y	0.0	mm
Nombre de dents	36	
actives Nombre de dents	19	
Diamètre extérieur	56.05	mm
Diamètre primitif	57.3	mm
Largeur	10.0	mm
Angle d'enlacement	196.71	°
Vitesse de rotation	1599.28	1/min
Entrée / sortie	Sortie	
Couple	1.19	Nm
Puissance	0.2	kW
puissance max. autorisée	0.88	kW
Sécurité	4.4	
Numéro d'article	16623600	

N° poulie dentée : 2

Position X	0.0	mm
Position Y	76.69	mm
Nombre de dents	22	
actives Nombre de dents	9	
Diamètre extérieur	33.85	mm
Diamètre primitif	35.01	mm
Largeur	10.0	mm
Angle d'enlacement	163.29	°
Vitesse de rotation	2617.0	1/min
Entrée / sortie	Entraînement	
Couple	0.73	Nm
Puissance	0.2	kW
puissance max. autorisée	0.78	kW
Sécurité	3.91	
Numéro d'article	16622200	

Remarques techniques

Tenez compte du tableau suivant pour la prise en compte des surcharges de la transmission par courroies. Vous devez diviser le facteur de sécurité provenant du calcul par le facteur de surcharge (selon issu du tableau ci-dessous. Ce calcul vous indique la sécurité correspondant à votre système de transmission par courroies.

Protocole de calcul

Protocole de calcul 09.01.14 03:54 Heure

Mädler GmbH
Tränkestr. 8
D – 70597 Stuttgart
Tél. : +49 (711) 7 20 95-0
Téléfax : +49 (711) 7 20 95-33

Détails de la courroie dentée

Désignation	AT5	
Pas	5.0	mm
Largeur	10.0	mm
Poids au m	0.04	kg
Force de précontrainte requise	80.06	N
Force de précontrainte requise pour entraînements linéaires	160.11	N
Entraxe	80.0	mm
Longueur de courroie	340.0	mm
Poids de la courroie	0.01	kg
Nombre de dents	68	
Numéro d'article	16660600	

Détails du calcul de la puissance

Puissance motrice	0.2	kW
Puissance de sortie	0.2	kw
Roue d'entraînement	2	
Sécurité	3.84	

Détails poulies dentées

N° poulie dentée : 1

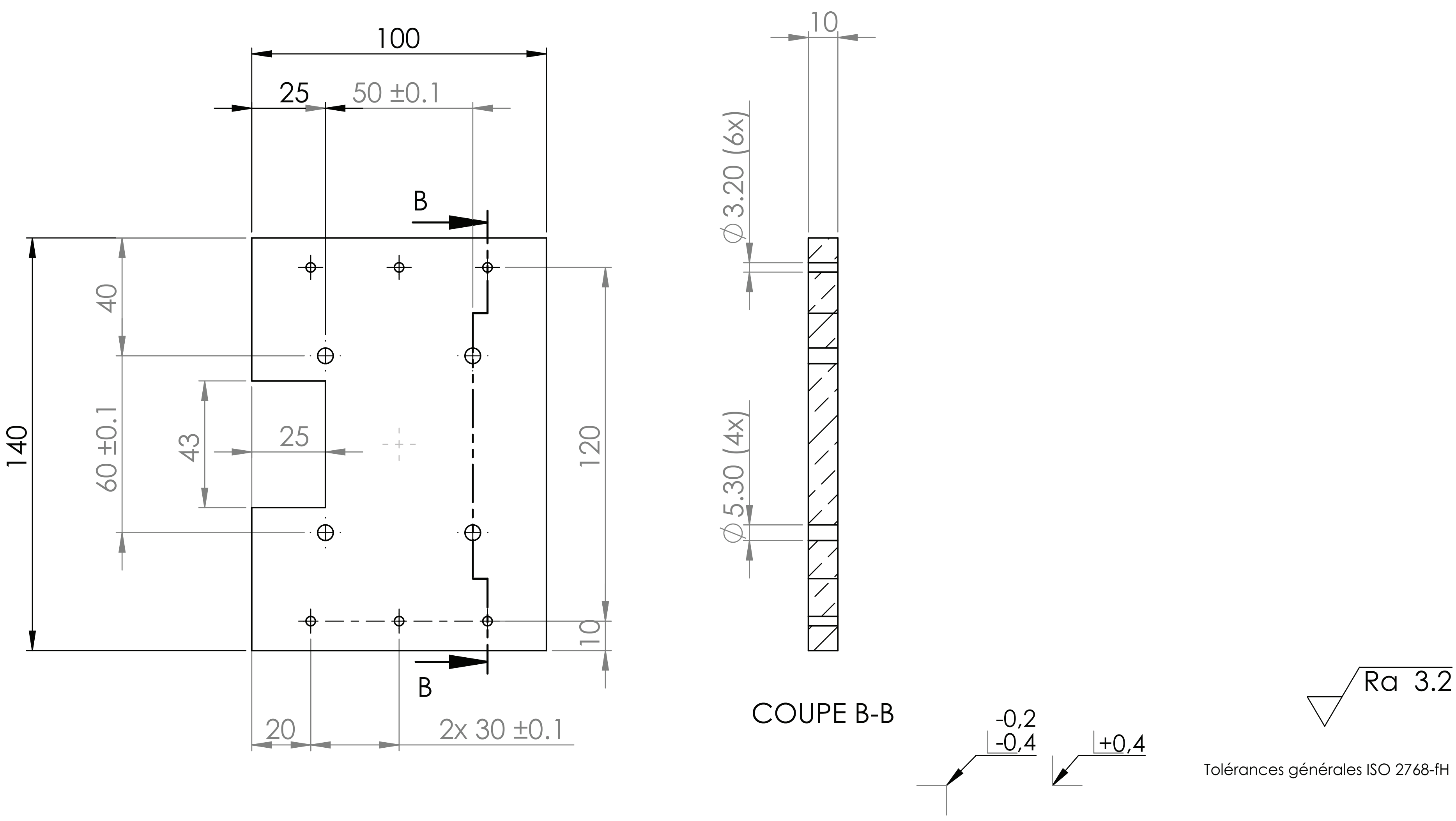
Position X	0.0	mm
Position Y	0.0	mm
Nombre de dents	36	
actives Nombre de dents	18	
Diamètre extérieur	56.05	mm
Diamètre primitif	57.3	mm
Largeur	10.0	mm
Angle d'enlacement	180.0	°
Vitesse de rotation	1308.0	1/min
Entrée / sortie	Sortie	
Couple	1.46	Nm
Puissance	0.2	kW
puissance max. autorisée	0.77	kW
Sécurité	3.84	
Numéro d'article	16623600	

N° poulie dentée : 2

Position X	0.0	mm
Position Y	80.0	mm
Nombre de dents	36	
actives Nombre de dents	18	
Diamètre extérieur	56.05	mm
Diamètre primitif	57.3	mm
Largeur	10.0	mm
Angle d'enlacement	180.0	°
Vitesse de rotation	1308.0	1/min
Entrée / sortie	Entraînement	
Couple	1.46	Nm
Puissance	0.2	kW
puissance max. autorisée	0.77	kW
Sécurité	3.84	
Numéro d'article	16623600	

Remarques techniques

Tenez compte du tableau suivant pour la prise en compte des surcharges de la transmission par courroies. Vous devez diviser le facteur de sécurité provenant du calcul par le facteur de surcharge (selon
issu du tableau ci-dessous. Ce calcul vous indique la sécurité correspondant à votre système de transmission par courroies.



1	1	Plaque fixation socle	Alu Alplan	140x100x10
Rep	Quantité	Denomination	Matiere	Dimension

Nom Resp.			Nom	Date
Téléphone		Projet	Babyfoot 3	
Laboratoire	Labo automatique	Dessiné	Zufferey	09.01.14
Prof. resp.		Modifié		

Echelle 1:2

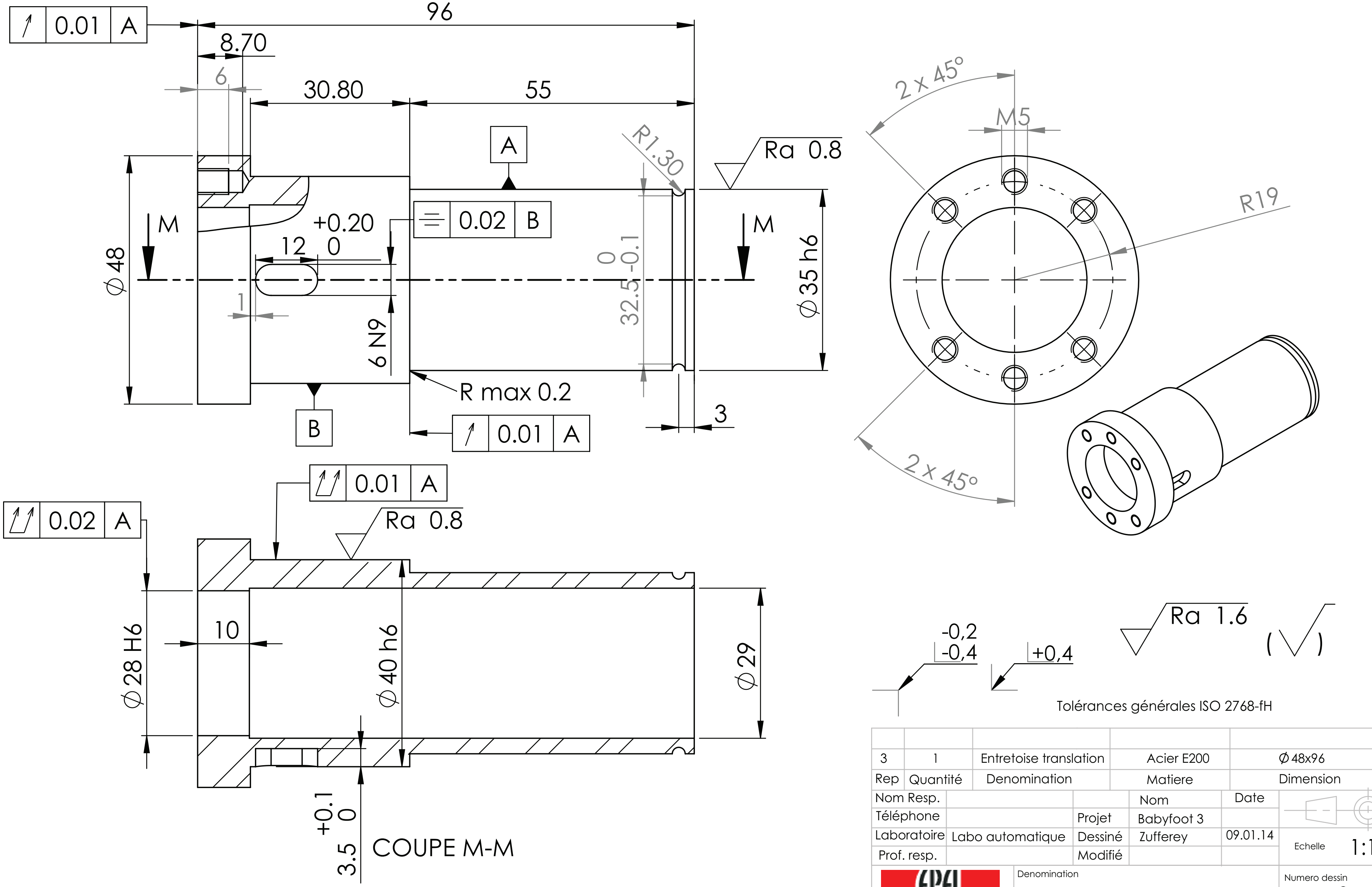
EPFL STI-ATME

Denomination: Plaque fixation socle

Numero dessin: 1

13-LACO-FZ-01

F. Zufferey



Tolérances générales ISO 2768-fH

3	1	Entretoise translation	Acier E200	⌀48x96
Rep	Quantité	Denomination	Matiere	Dimension

Nom Resp.			Nom	Date
Téléphone		Projet	Babyfoot 3	
Laboratoire	Labo automatique	Dessiné	Zufferey	09.01.14
Prof. resp.		Modifié		

Echelle 1:1

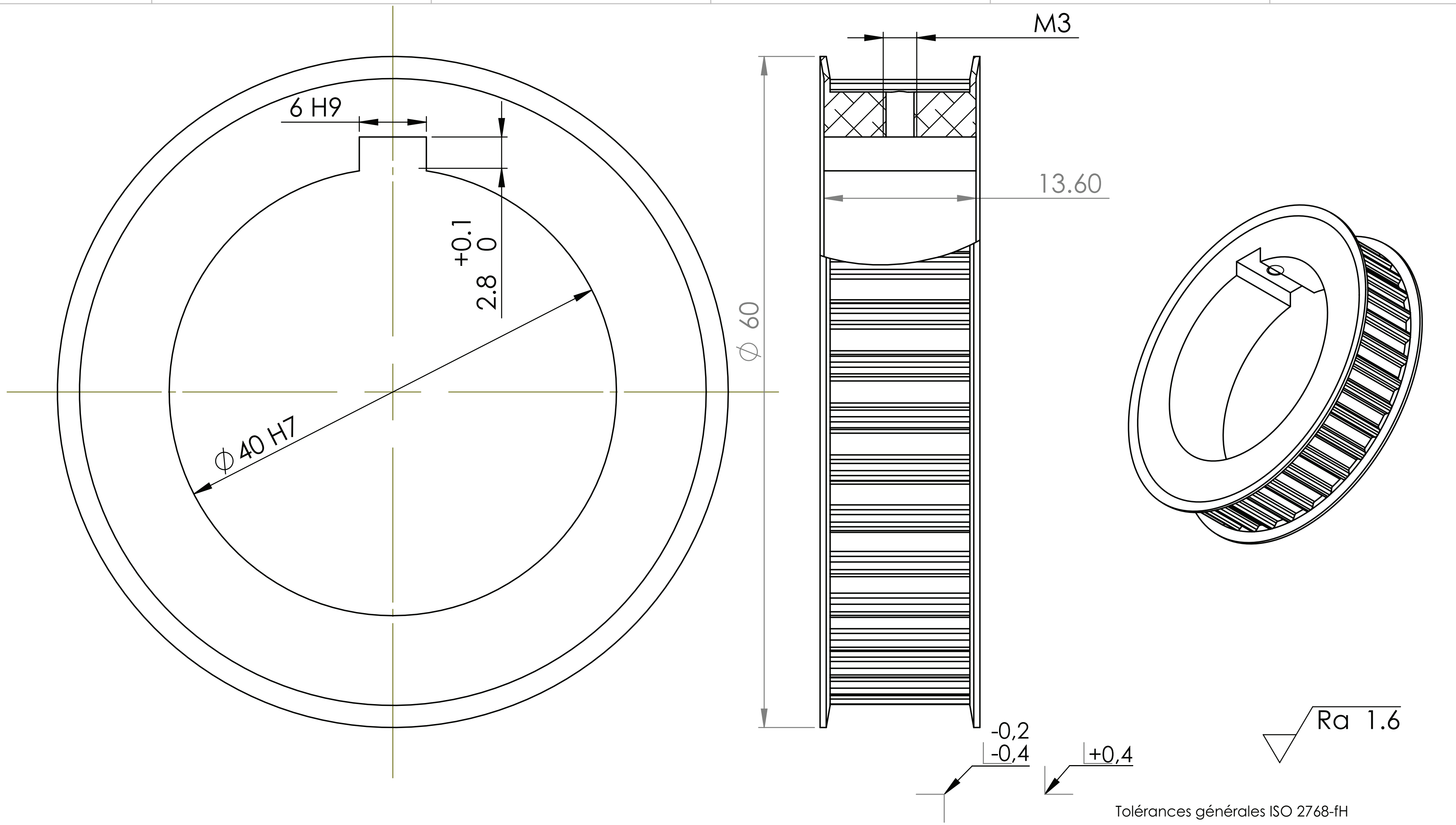
EPFL STI-ATME

Denomination: Entretoise translation

Numero dessin: 3

13-LACO-FZ-01

F. Zufferey



Tolérances générales ISO 2768-fH

A modifier tel que sur le dessin
Ref: 21 AT5/36-2 (Meadler)
(! les flanges sont raccourcies!)

5	2	Poulie réceptrice	Aluminium	
Rep	Quantité	Denomination	Matiere	Dimension

Nom Resp.			Nom	Date	
Téléphone		Projet	Babyfoot 3		
Laboratoire	Labo automatique	Dessiné	Zufferey	09.01.14	Echelle 2:1
Prof. resp.		Modifié			

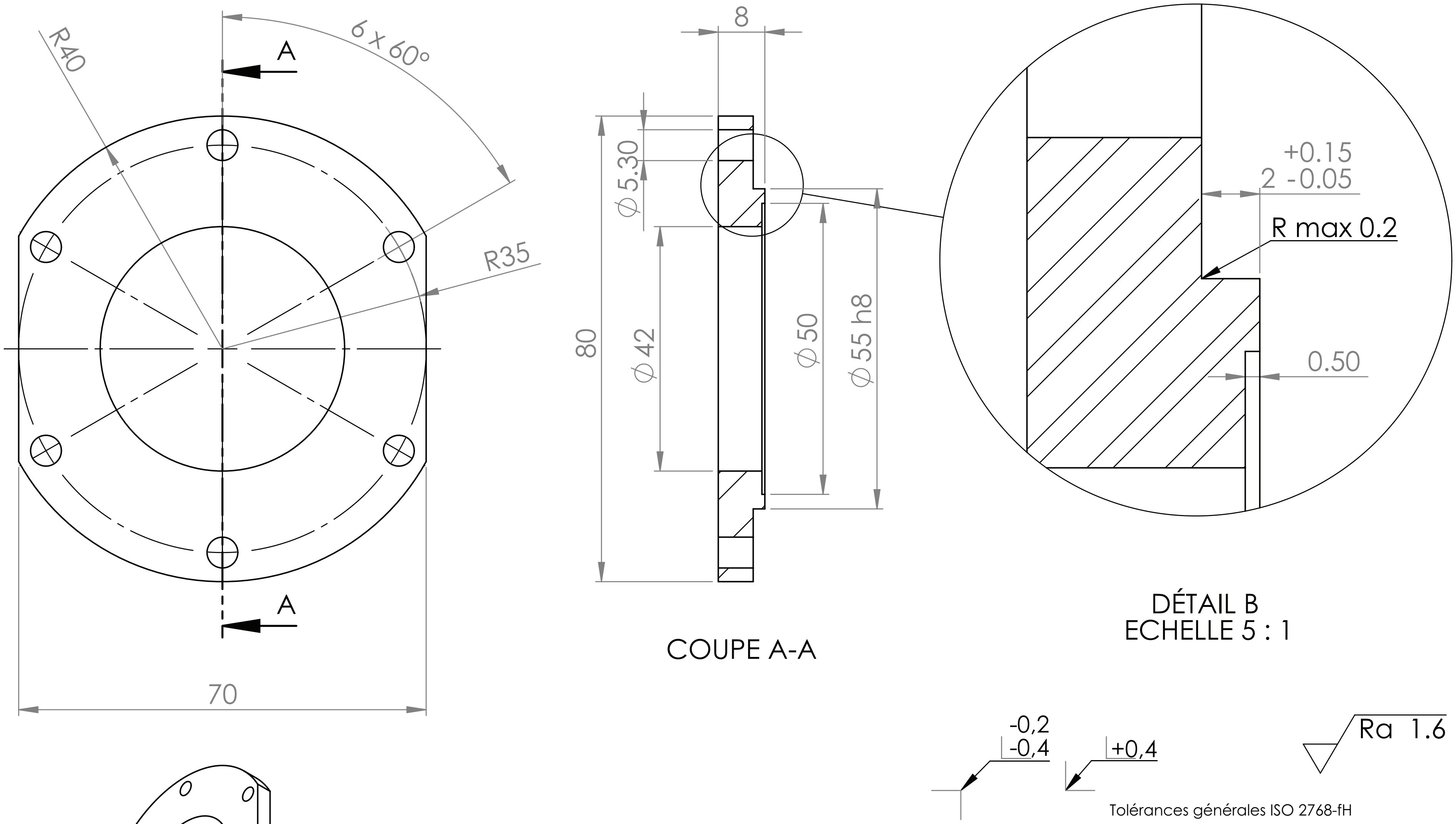
EPFL STI-ATME

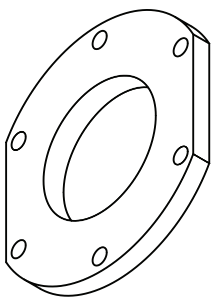
Denomination: Poulie réceptrice

Numero dessin: 5

13-LACO-FZ-01

F. Zufferey





45

13-LACO-FZ-01

6	2	Bouchon translation	Alu. Certal 7075	⌀80 x8
Rep	Quantité	Denomination	Matiere	Dimension

Nom Resp.			Nom	Date
Téléphone		Projet	Babyfoot 3	
Laboratoire	Labo automatique	Dessiné	Zufferey	09.01.14
Prof. resp.		Modifié		

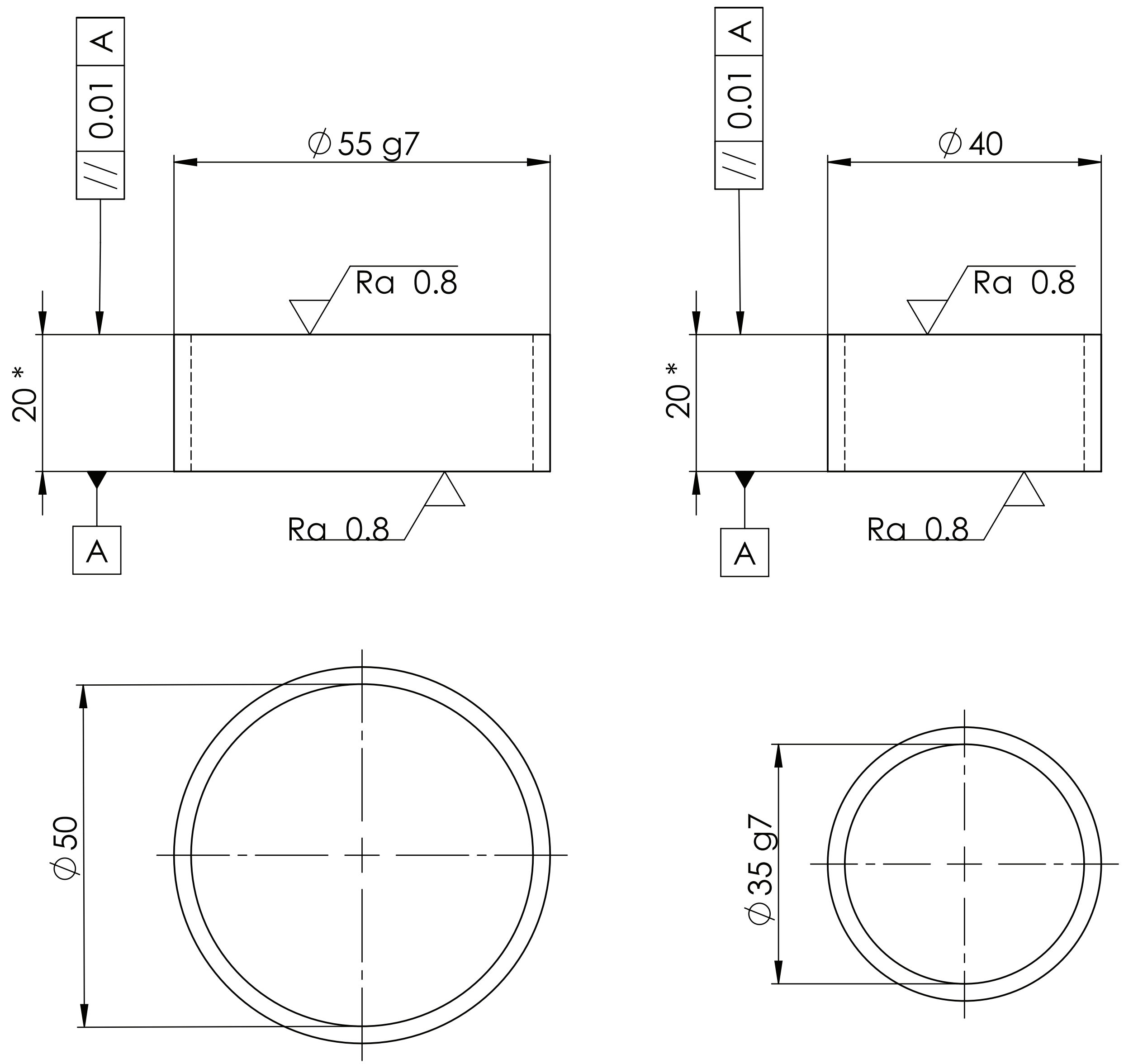
Echelle 1:1

EPFL STI-ATME

Denomination
Bouchon translation

Numero dessin
6

F. Zufferey



* A planer les deux pièces ensembles 20 ± 0.02

-0,2
-0,4
+0,4
Ra 1.6 (√)
Ra 0.8

Tolérances générales ISO 2768-fH

Rep	Quantité	Denomination	Matiere	Dimension
8-9	2 paires	Cale (2paires)	Acier E200	35x40x20 et 50x55x20

			Nom	Date
Nom Resp.				
Téléphone		Projet	Babyfoot 3	
Laboratoire	Labo automatique	Dessiné	Zufferey	09.01.14
Prof. resp.		Modifié		

Echelle 1:1

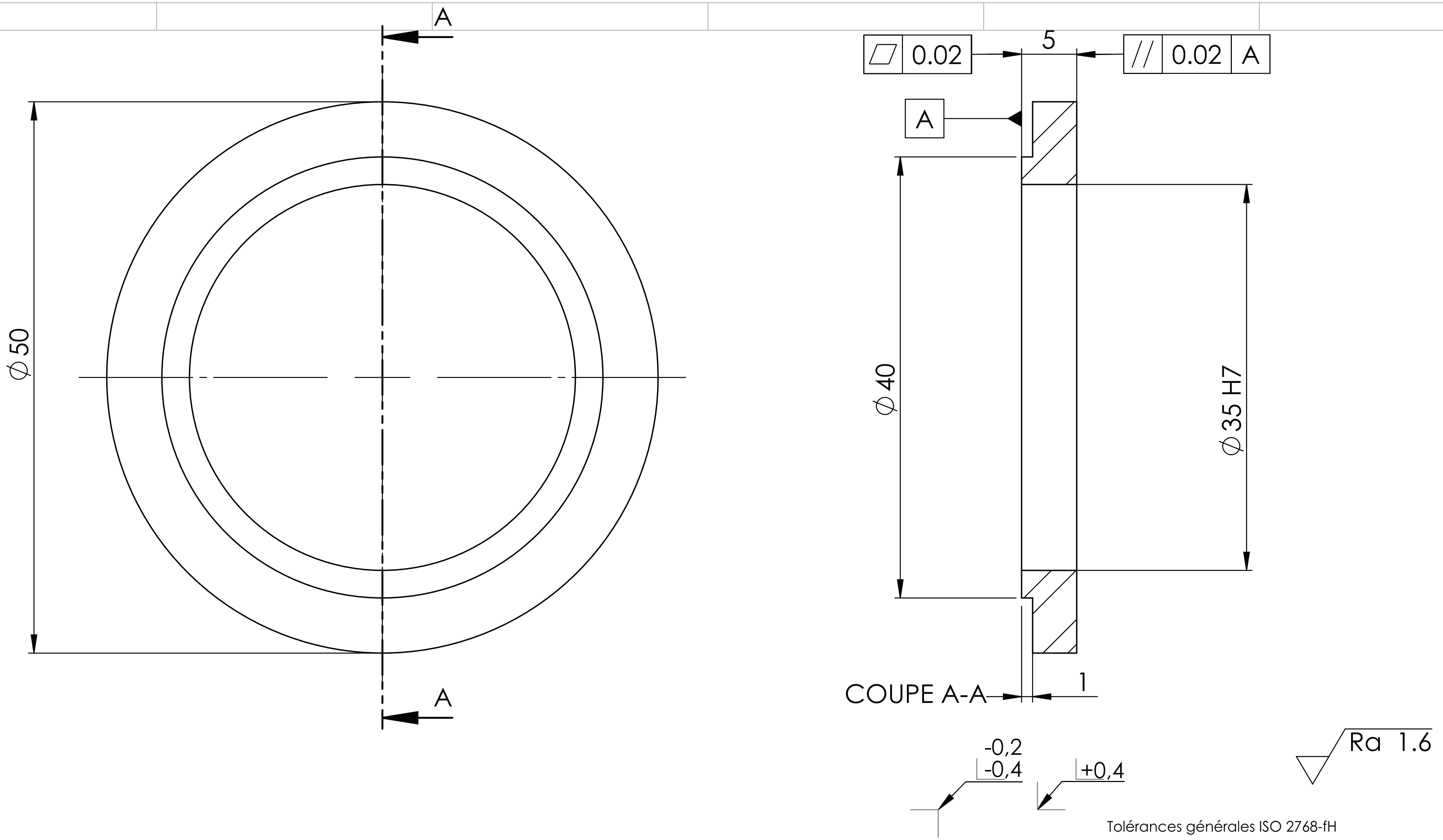
EPFL STI-ATME

Denomination: Cale intérieure et extérieure

Numero dessin: 8-9

13-LACO-FZ-01

F. Zufferey



Tolérances générales ISO 2768-fH

10	2	Butée roulement	Acier E200	35x50x4
Rep	Quantité	Denomination	Matiere	Dimension

			Nom	Date
Nom Resp.				
Téléphone		Projet	Babyfoot 3	
Laboratoire	Labo automatique	Dessiné	Zufferey	09.01.14
Prof. resp.		Modifié		

Echelle 2:1

STI-ATME

Denomination

Butée roulement

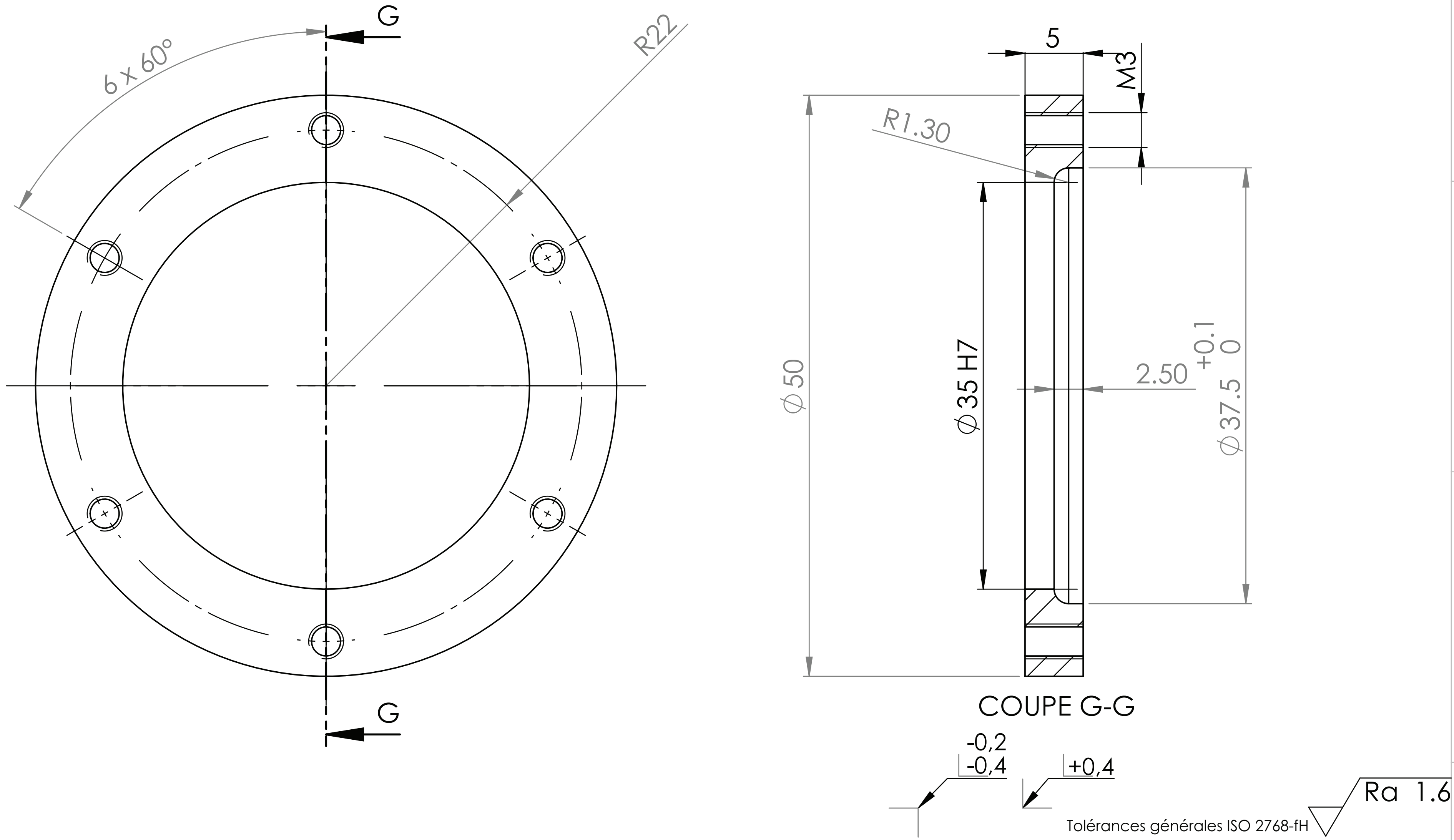
Numero dessin

10

13-LACO-FZ-01

47

F. Zufferey



11	2	Butée jonc	Acier E200	35x50x5
Rep	Quantité	Denomination	Matiere	Dimension

Nom Resp.			Nom	Date
Téléphone		Projet	Babyfoot 3	
Laboratoire	Labo automatique	Dessiné	Zufferey	09.01.14
Prof. resp.		Modifié		

Echelle 2:1

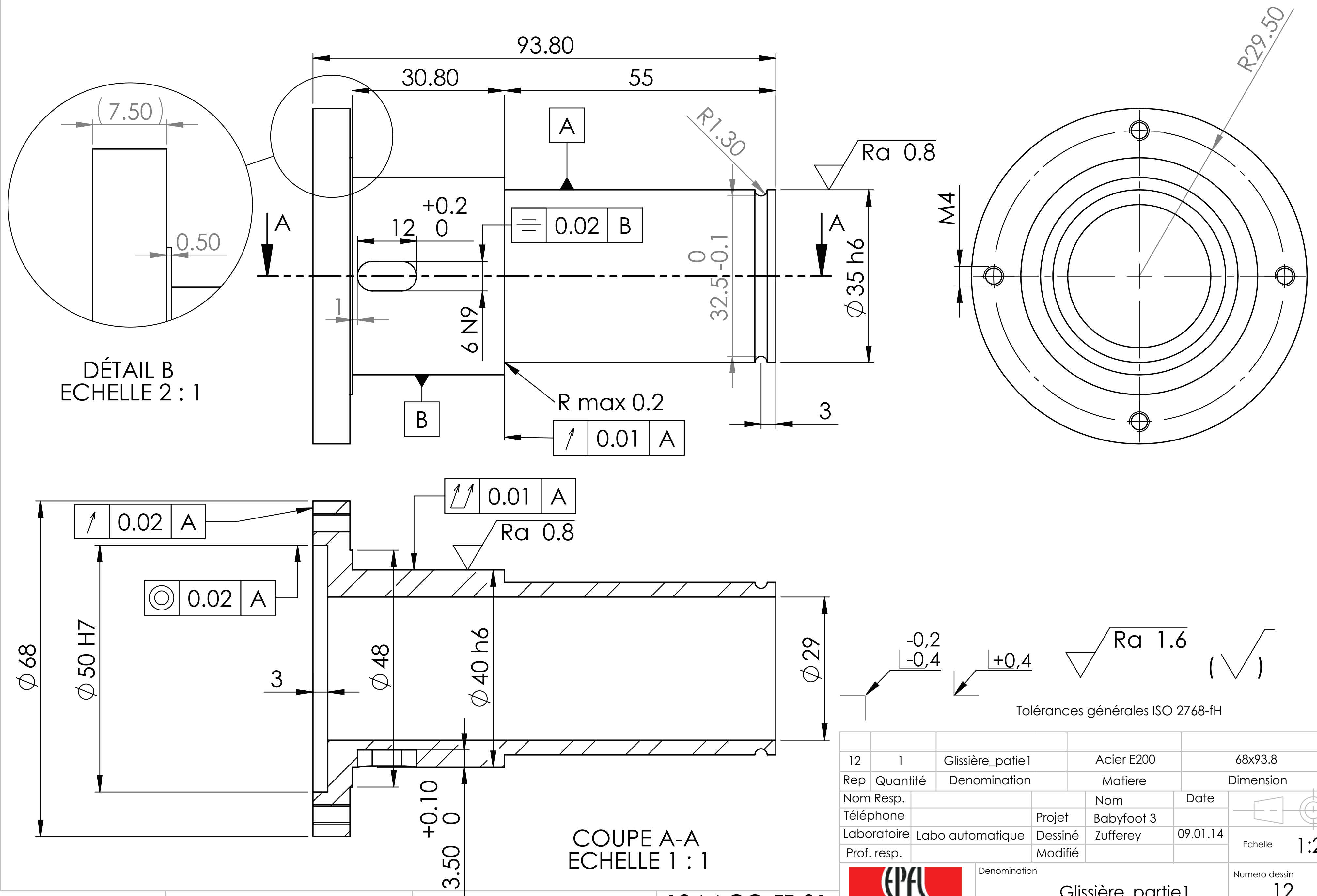
EPFL STI-ATME

Denomination
Butée jonc

Numero dessin
11

13-LACO-FZ-01

F. Zufferey



12	1	Glissière_patie1	Acier E200	68x93.8
Rep	Quantité	Denomination	Matiere	Dimension

Nom Resp.			Nom	Date	
Téléphone		Projet	Babyfoot 3		
Laboratoire	Labo automatique	Dessiné	Zufferey	09.01.14	Echelle 1:2
Prof. resp.		Modifié			

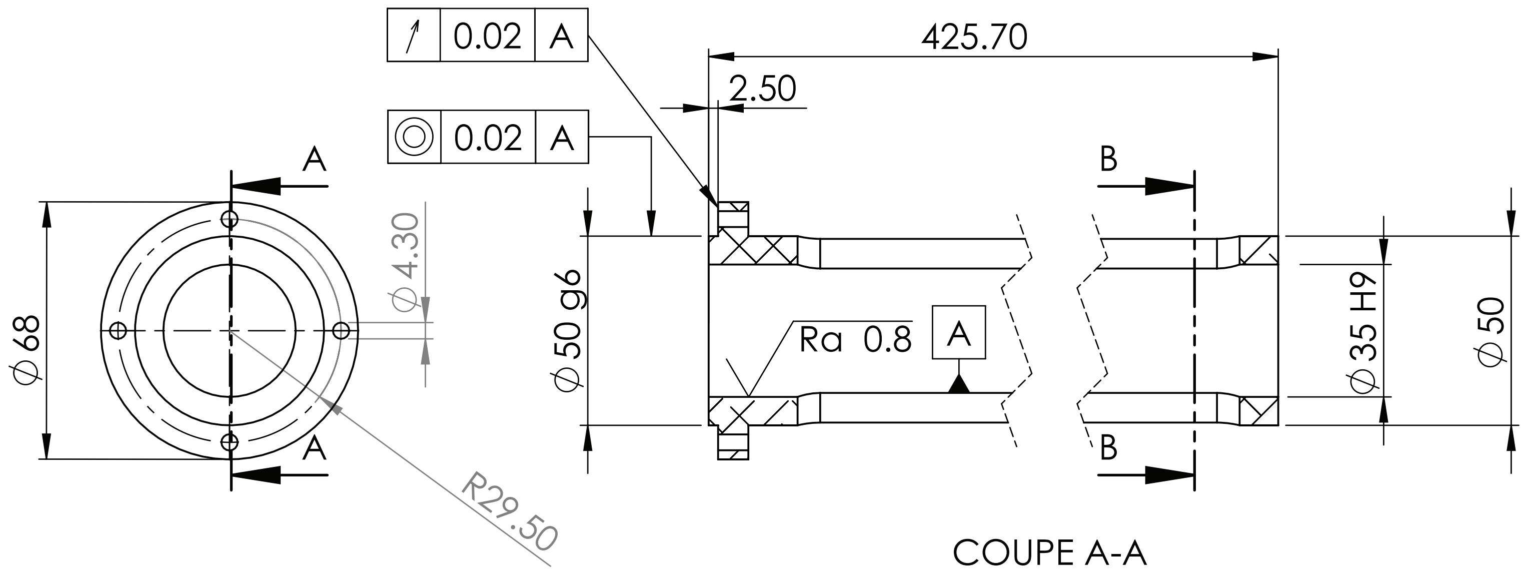
EPFL STI-ATME

Denomination: Glissière_partie1

Numero dessin: 12

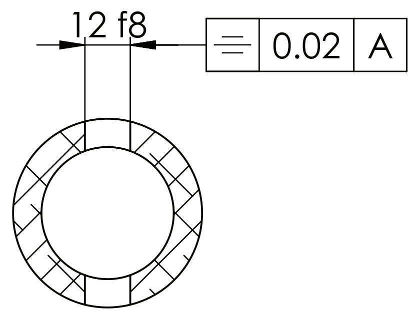
13-LACO-FZ-01

F. Zufferey

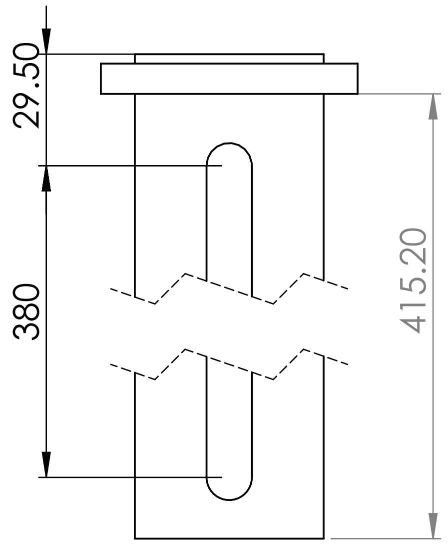


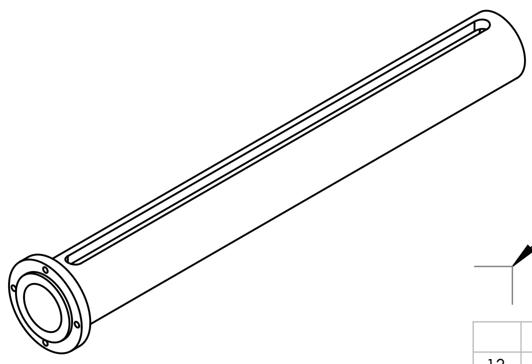
COUPE A-A

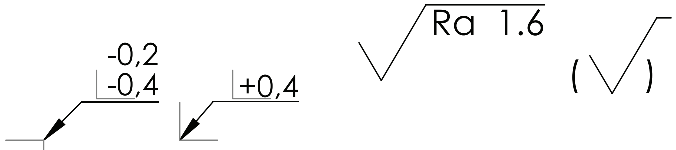
ECHELLE 1 : 2



COUPE B-B
ECHELLE 1 : 2







Tolérances générales ISO 2768-fH

13	1	Glissière_partie2	Alu Certal 7075	68x425.7
Rep	Quantité	Denomination	Matiere	Dimension

Nom Resp.			Nom	Date
Téléphone		Projet	Babyfoot 3	
Laboratoire	Labo automatique	Dessiné	Zufferey	09.01.14
Prof. resp.		Modifié		

Echelle 1:5

EPFL STI-ATME

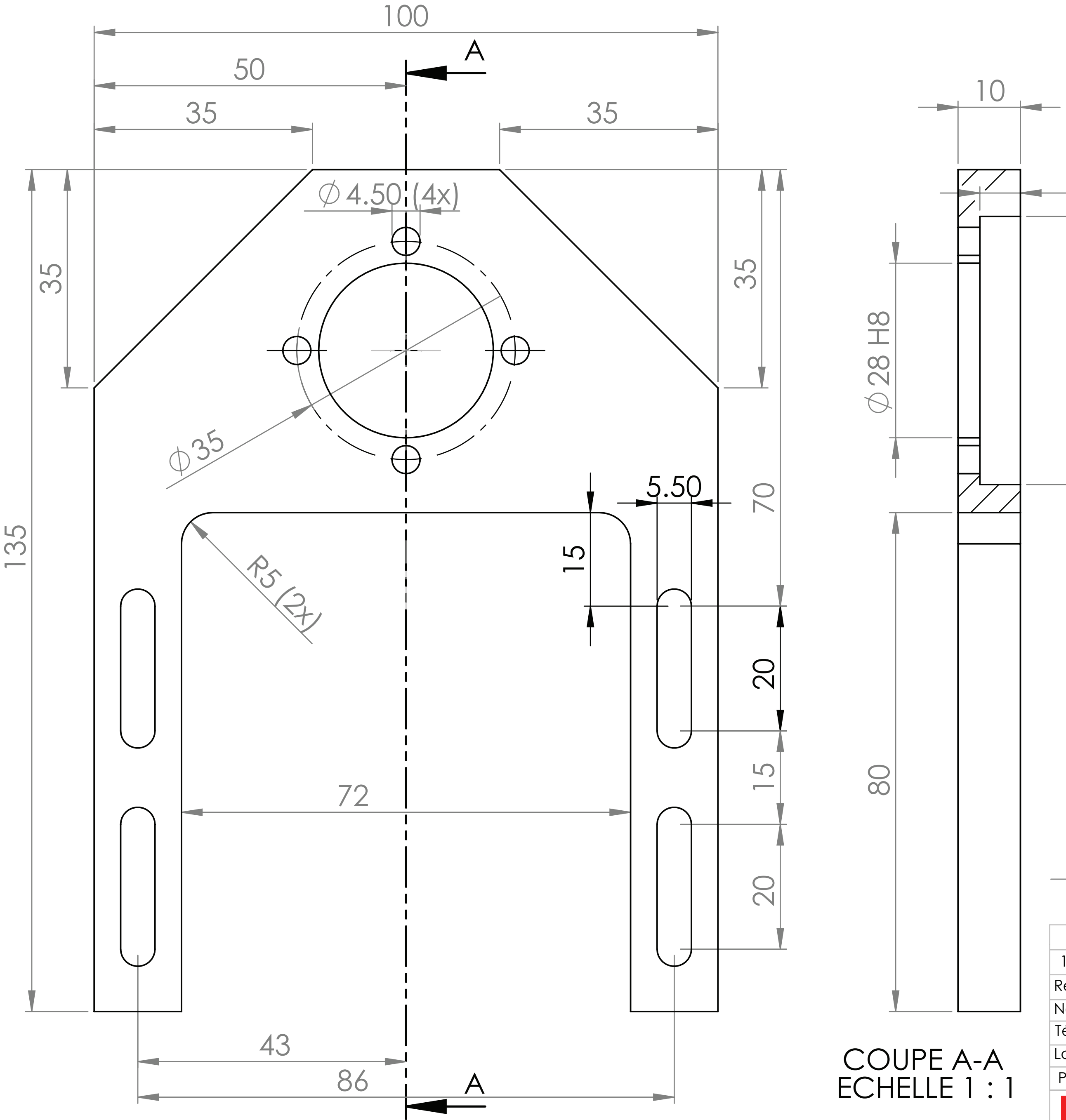
Denomination
Glissière_partie2

Numero dessin
13

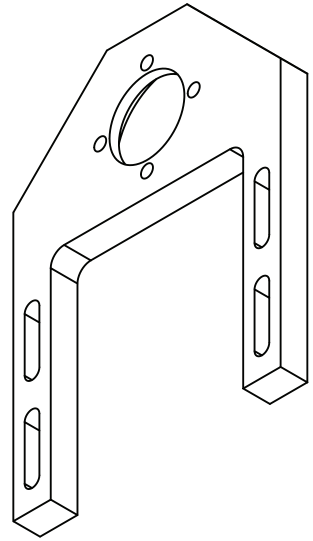
13-LACO-FZ-01

50

F. Zufferey



COUPE A-A
ECHELLE 1 : 1



-0,2
-0,4

+0,4

Ra 1.6

Tolérances générales ISO 2768-fH

14	2	Tendeur+fixation réd.	Alu Alplan	100x135x10
Rep	Quantité	Denomination	Matiere	Dimension

Nom Resp.			Nom	Date
Téléphone		Projet	Babyfoot 3	
Laboratoire	Labo automatique	Dessiné	Zufferey	09.01.14
Prof. resp.		Modifié		

Echelle 1:1

STI-ATME

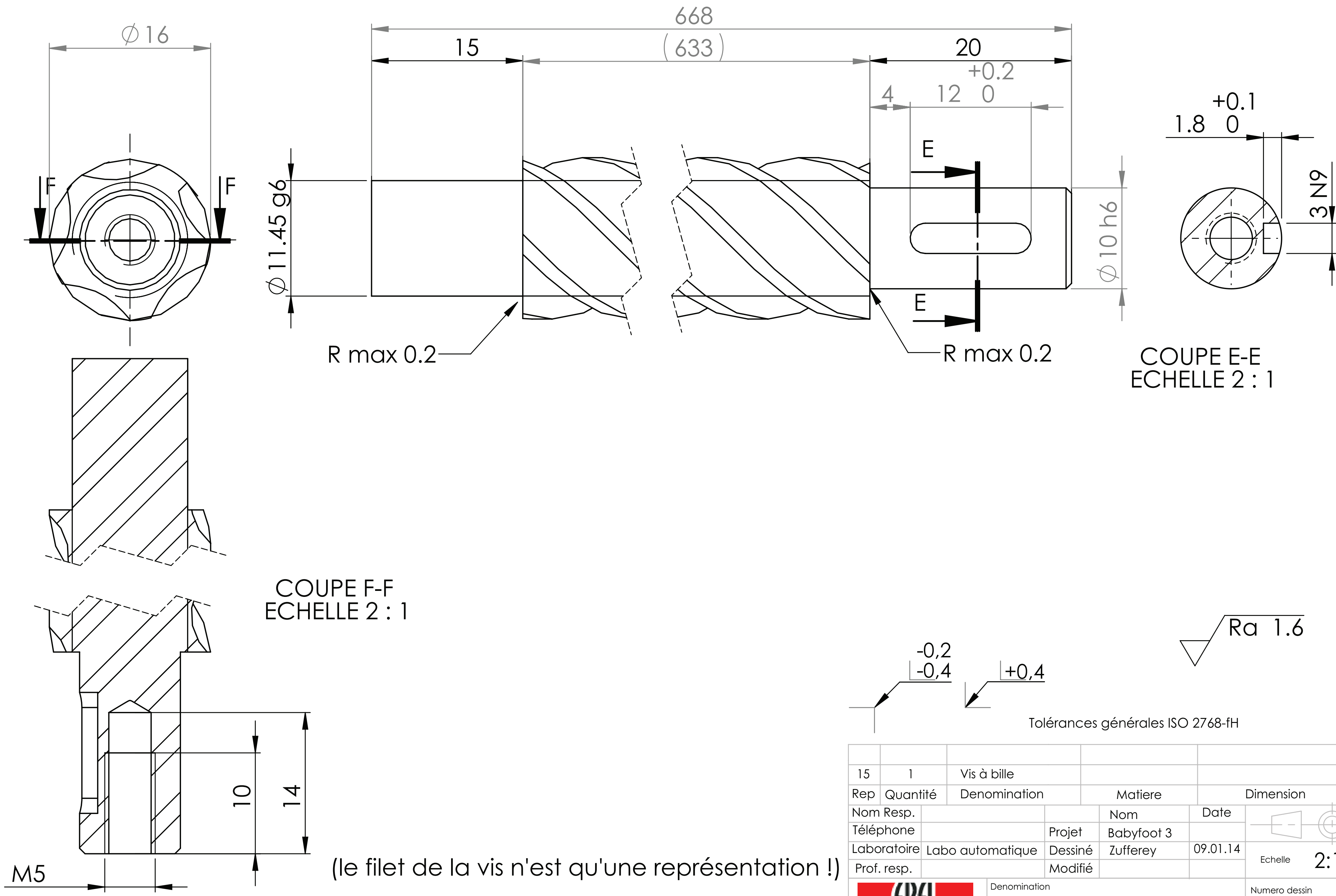
Denomination
Fixation réducteur

Numero dessin
14

13-LACO-FZ-01

51

F. Zufferey



(le filet de la vis n'est qu'une représentation !)

Tolérances générales ISO 2768-fH

15	1	Vis à bille			
Rep	Quantité	Denomination		Matiere	Dimension
Nom Resp.			Nom	Date	
Téléphone		Projet	Babyfoot 3		
Laboratoire	Labo automatique	Dessiné	Zufferey	09.01.14	Echelle 2:1
Prof. resp.		Modifié			

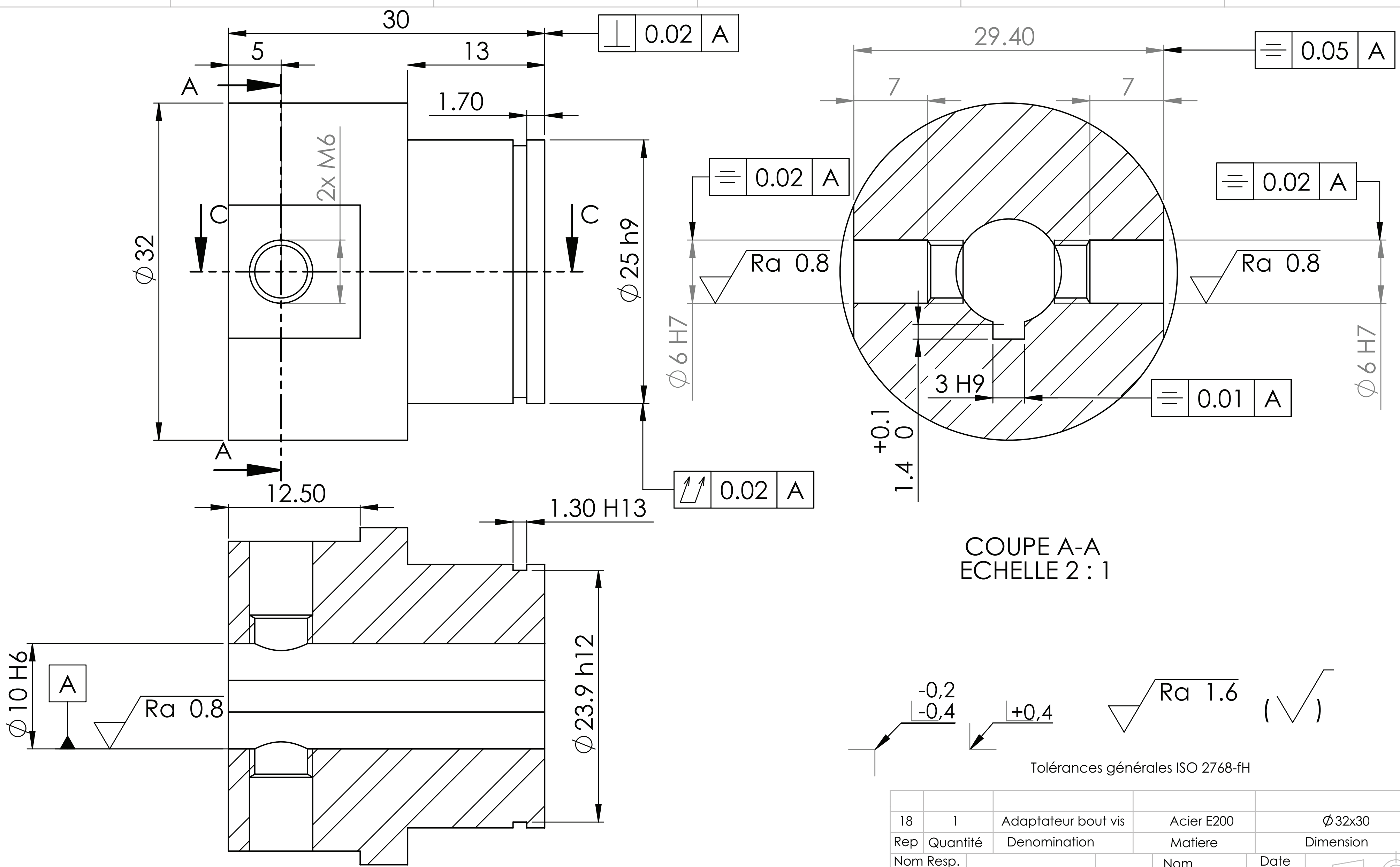
EPFL STI-ATME

Denomination: Vis KGE 16x50 RH 633 G9 E G

Numero dessin: 15

13-LACO-FZ-01

F. Zufferey



COUPE A-A
ECHELLE 2 : 1

COUPE C-C
ECHELLE 2 : 1

Tolérances générales ISO 2768-fH

18	1	Adaptateur bout vis	Acier E200	⌀32x30
Rep	Quantité	Denomination	Matiere	Dimension

			Nom	Date
Nom Resp.				
Téléphone		Projet	Babyfoot 3	
Laboratoire	Labo automatique	Dessiné	Zufferey	09.01.14
Prof. resp.		Modifié		

Echelle 2:1

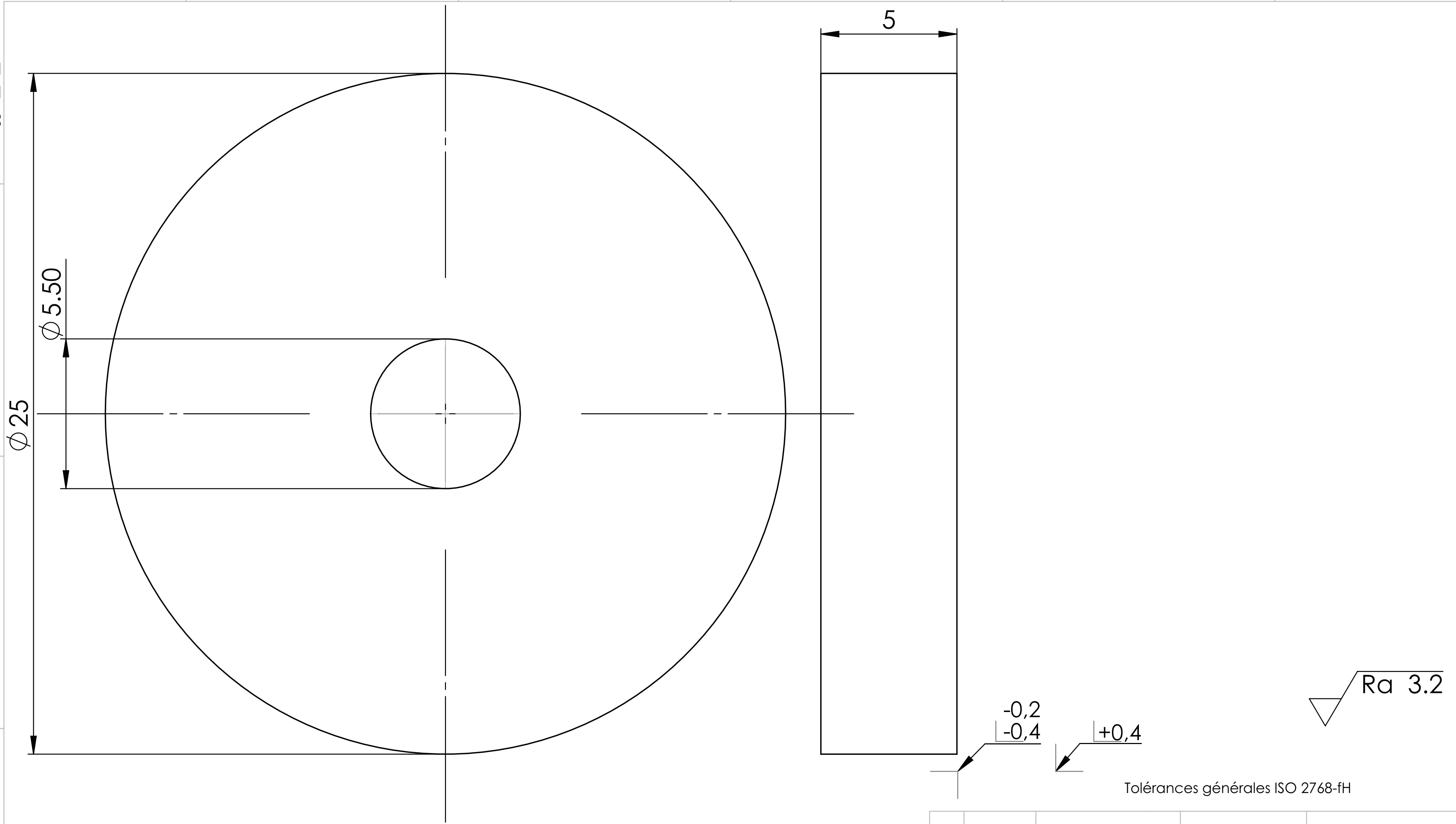
STI-ATME

Denomination
Adaptateur bout vis à bille

Numero dessin
18

13-LACO-FZ-01

F. Zufferey



Tolérances générales ISO 2768-fH

20	1	Rondelle adapt.	Aluminium	Ø25x5
Rep	Quantité	Denomination	Matiere	Dimension

Nom Resp.			Nom	Date
Téléphone		Projet	Babyfoot 3	
Laboratoire	Labo automatique	Dessiné	Zufferey	09.01.14
Prof. resp.		Modifié		

Echelle 5:1

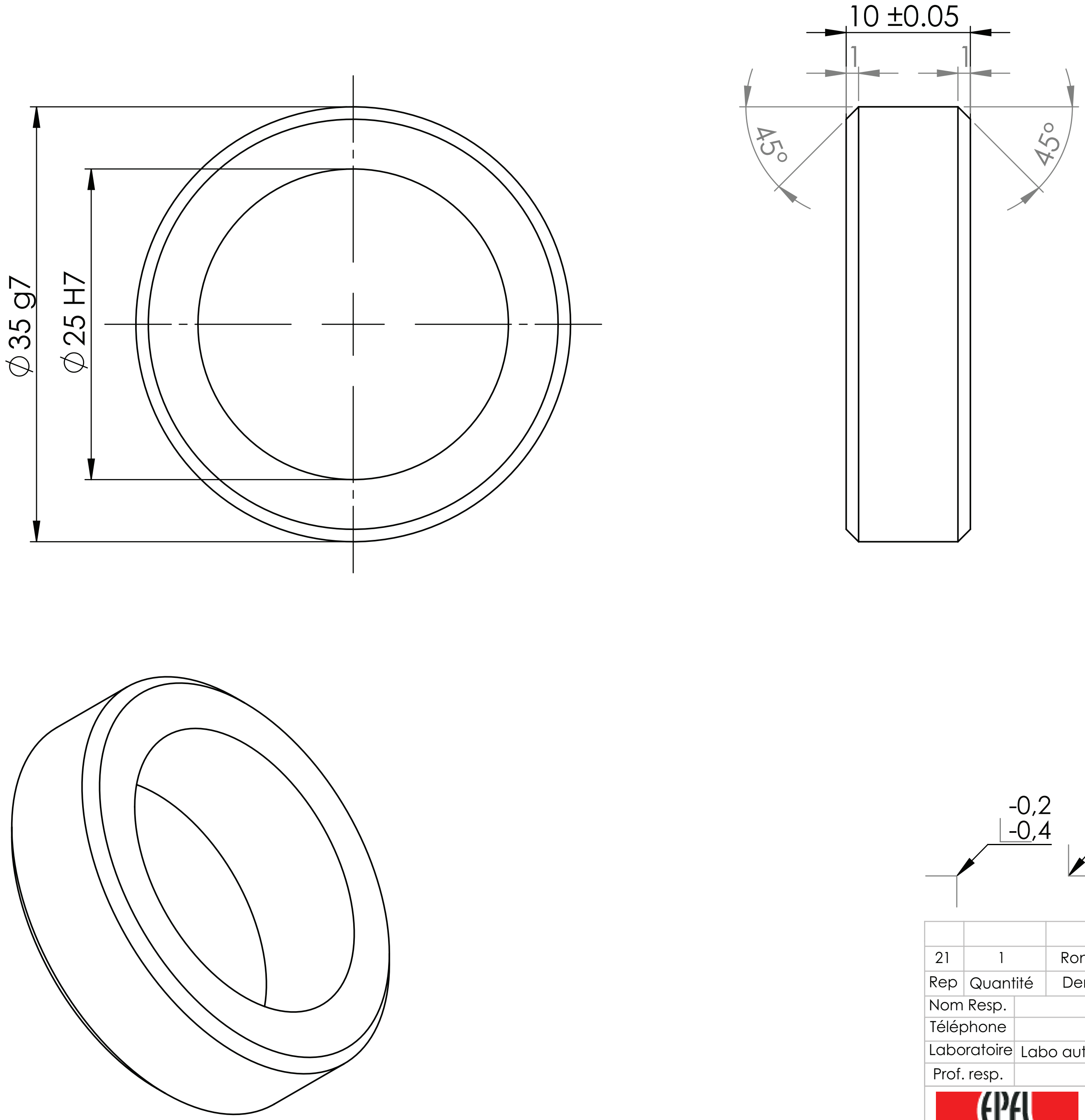
EPFL STI-ATME

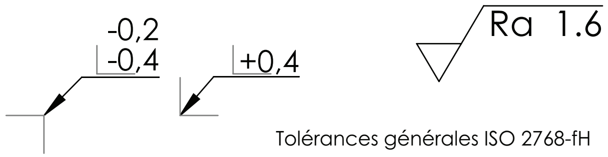
Denomination
Rondelle fixation adaptateur

Numero dessin
20

13-LACO-FZ-01

F. Zufferey





Tolérances générales ISO 2768-fH

21	1	Rondelle POM	POM	∅35x10
Rep	Quantité	Denomination	Matiere	Dimension

Nom Resp.			Nom	Date	
Téléphone		Projet	Babyfoot 3		
Laboratoire	Labo automatique	Dessiné	Zufferey	09.01.14	Echelle 2:1
Prof. resp.		Modifié			

EPFL STI-ATME

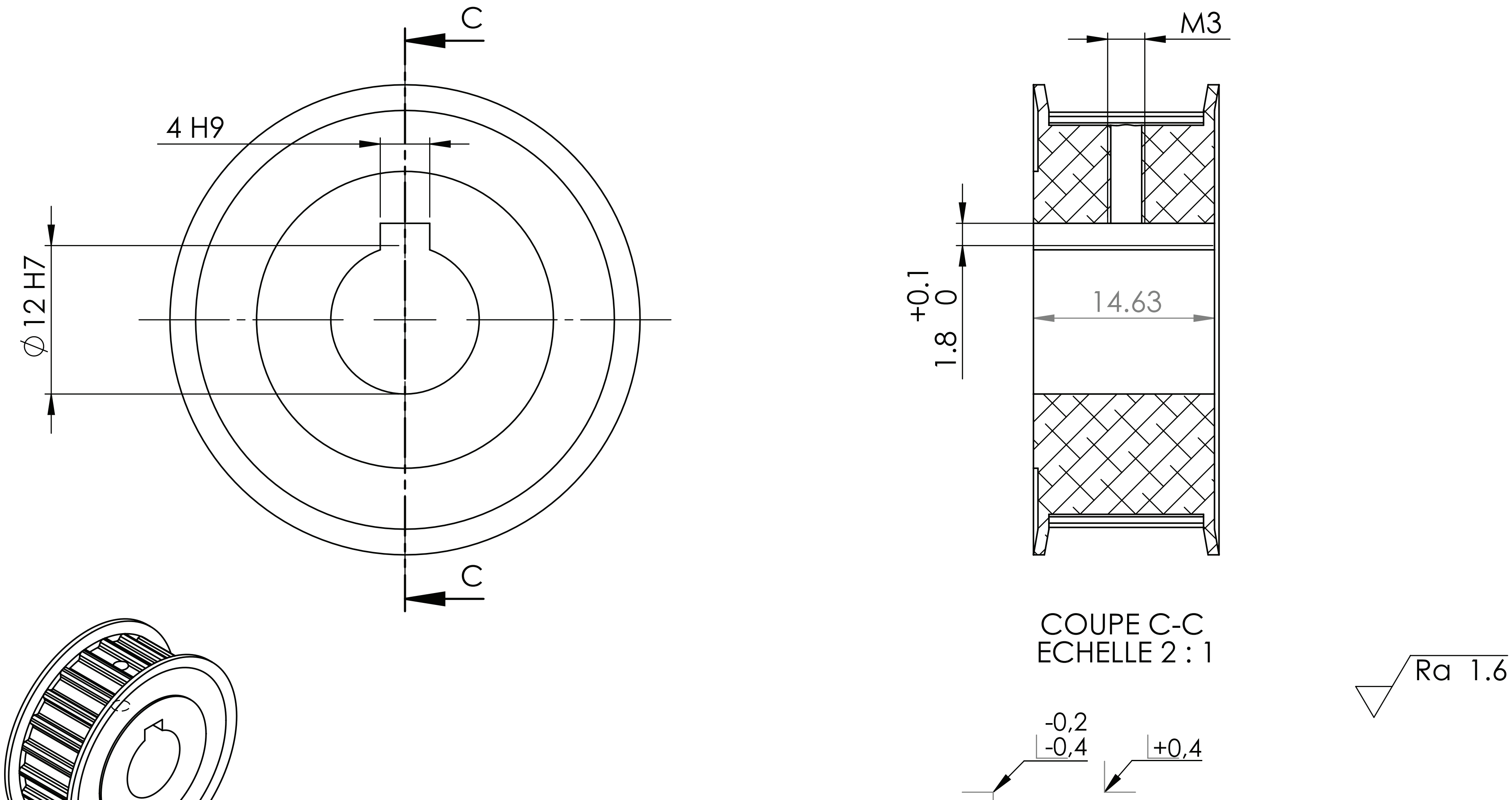
Denomination: Rondelle POM

Numero dessin: 21

13-LACO-FZ-01

55

F. Zufferey



Tolérances générales ISO 2768-fH

A modifier tel que sur le dessin
Ref: 21 AT5/22-2 (Meadler)

25	1	Poulie translation	Aluminium	
Rep	Quantité	Denomination	Matiere	Dimension

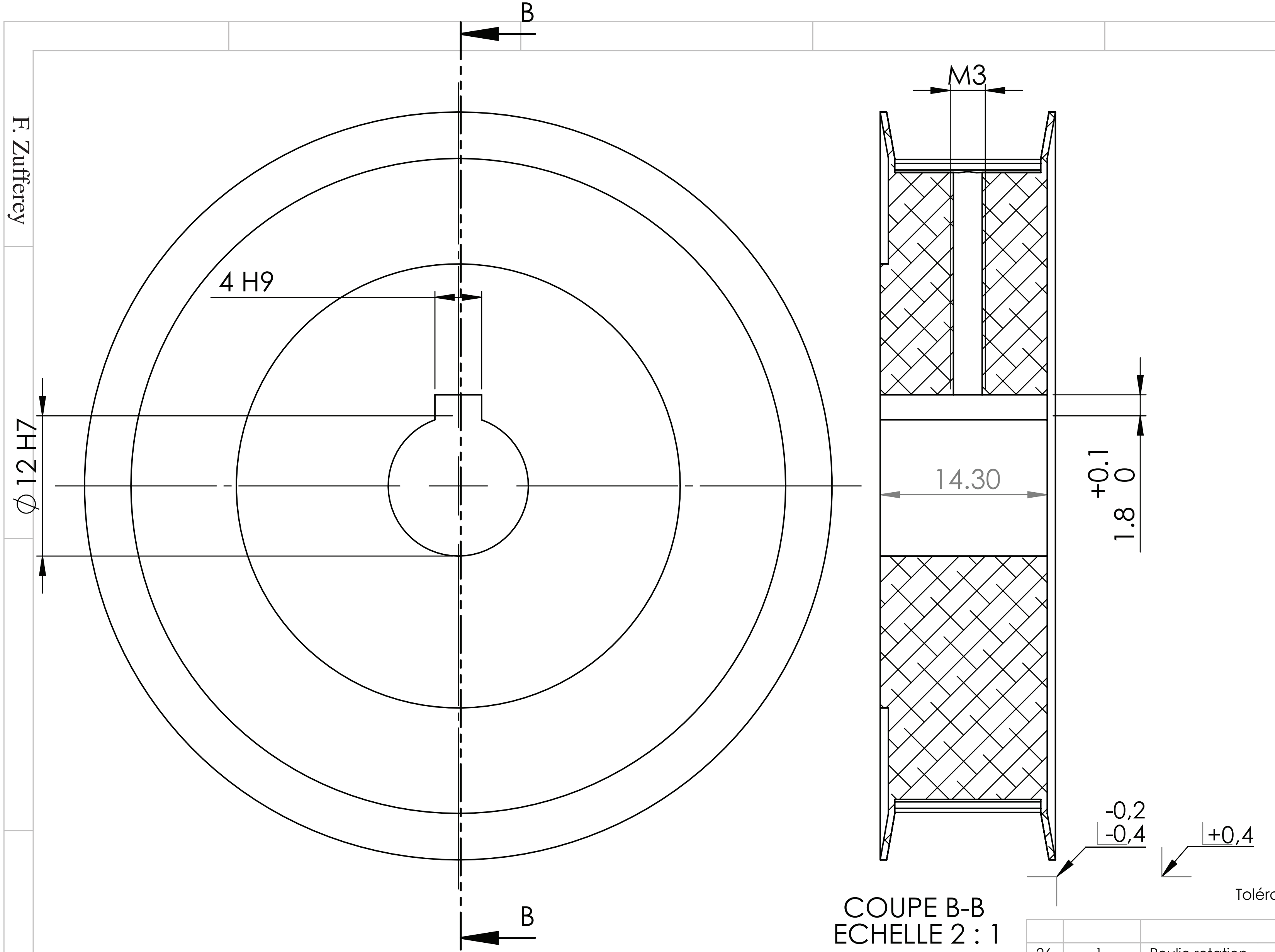
Nom Resp.			Nom	Date	
Téléphone		Projet	Babyfoot 3		
Laboratoire	Labo automatique	Dessiné	Zufferey	09.01.14	Echelle 2:1
Prof. resp.		Modifié			

EPFL STI-ATME

Denomination: Poulie translation (moteur)

Numero dessin: 25

13-LACO-FZ-01



COUPE B-B
ECHELLE 2 : 1

Tolérances générales ISO 2768-fH

A modifier tel que sur le dessin
Ref: 21 AT5/36-2 (Meadler)

F. Zufferey

57

13-LACO-FZ-01

26	1	Poulie rotation	Aluminium	
Rep	Quantité	Denomination	Matiere	Dimension

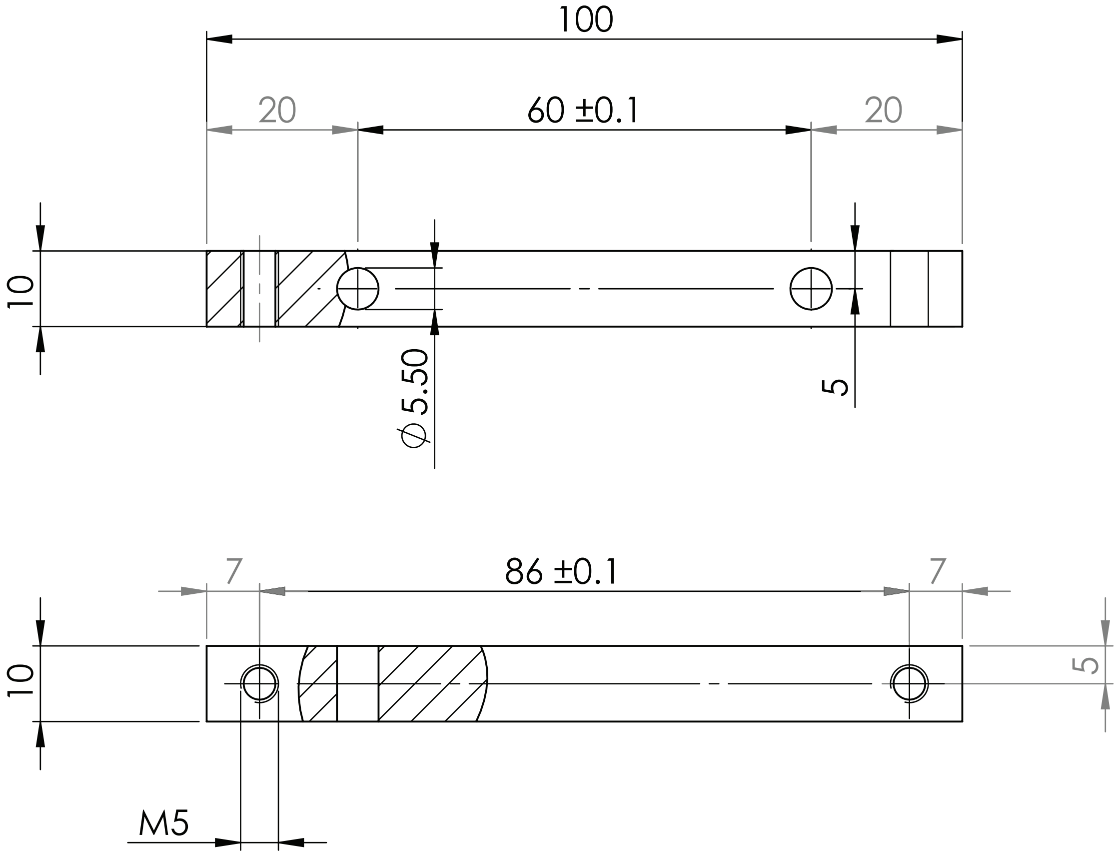
Nom Resp.			Nom	Date	
Téléphone		Projet	Babyfoot 3		
Laboratoire	Labo automatique	Dessiné	Zufferey	09.01.14	Echelle 2:1
Prof. resp.		Modifié			

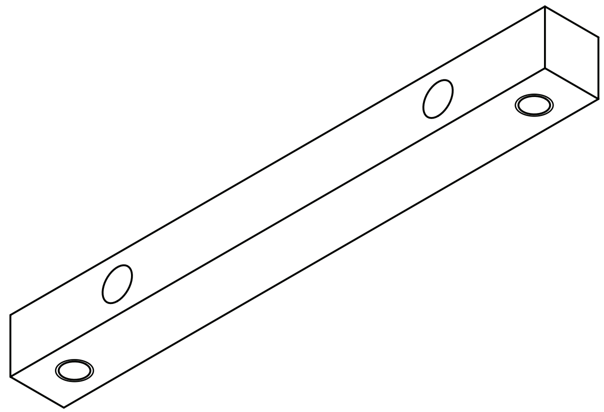
EPFL STI-ATME

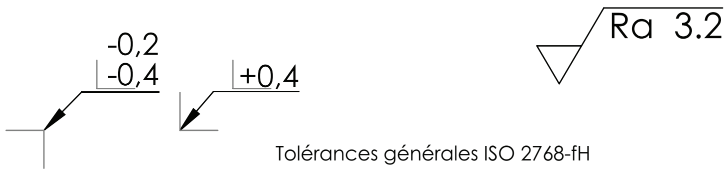
Denomination: Poulie rotation (moteur)

Numero dessin: 26

F. Zufferey





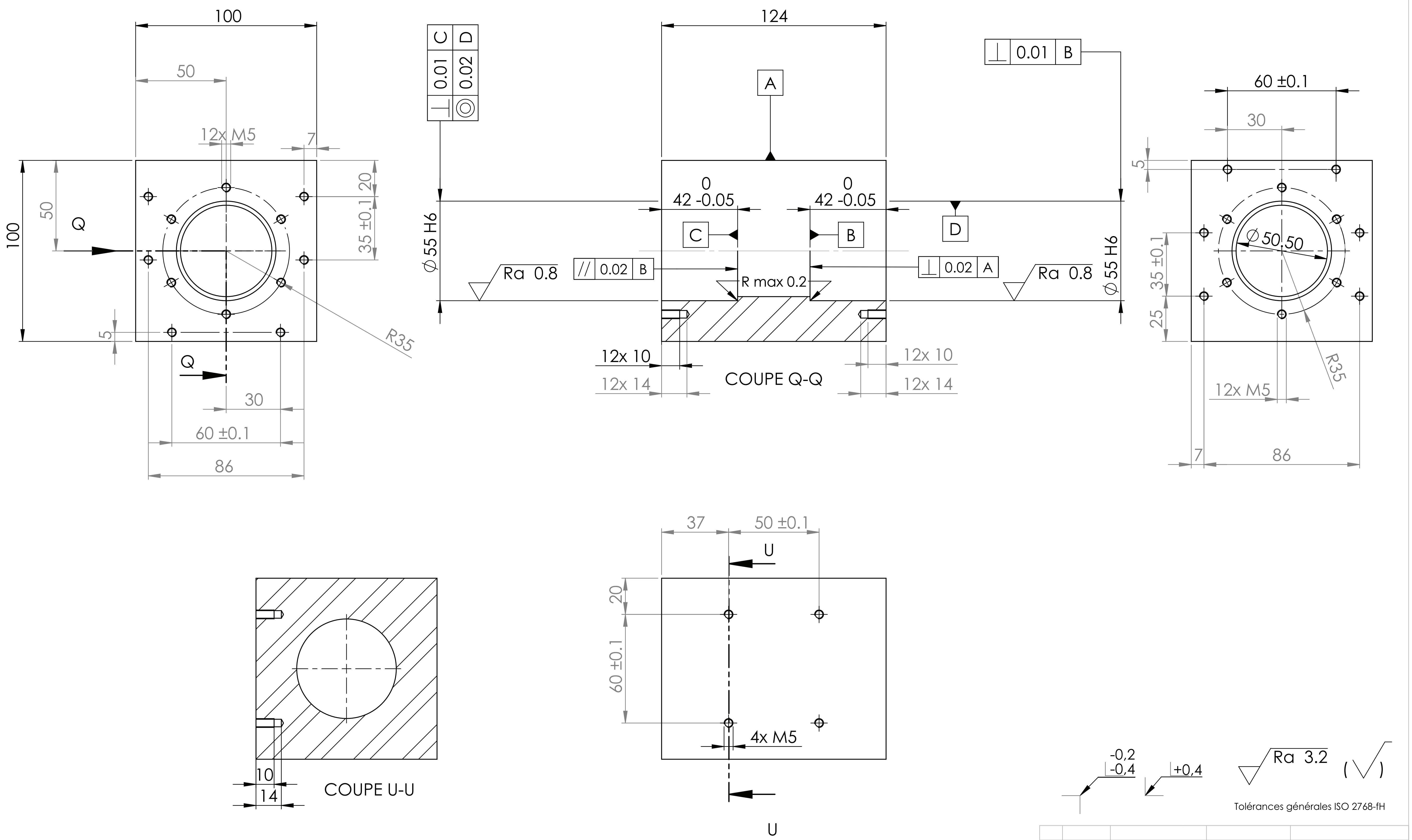


Tolérances générales ISO 2768-fH

38	2	Tendeur	Alu	100x10x10	
Rep	Quantité	Denomination	Matiere	Dimension	
Nom Resp.			Nom	Date	
Téléphone		Projet	Babyfoot 3		
Laboratoire	Labo automatique	Dessiné	Zufferey	09.01.14	Echelle 1:1
Prof. resp.		Modifié			
EPFL STI-ATME	Denomination Tendeur				Numero dessin 38

13-LACO-FZ-01

58



Tolérances générales ISO 2768-fH

2	1	Socle	Alu. Certal 7075	100x100x124
Rep	Quantité	Denomination	Matiere	Dimension

			Nom	Date
Nom Resp.				
Téléphone		Projet	Babyfoot 3	
Laboratoire	Labo automatique	Dessiné	Zufferey	09.01.14
Prof. resp.		Modifié		

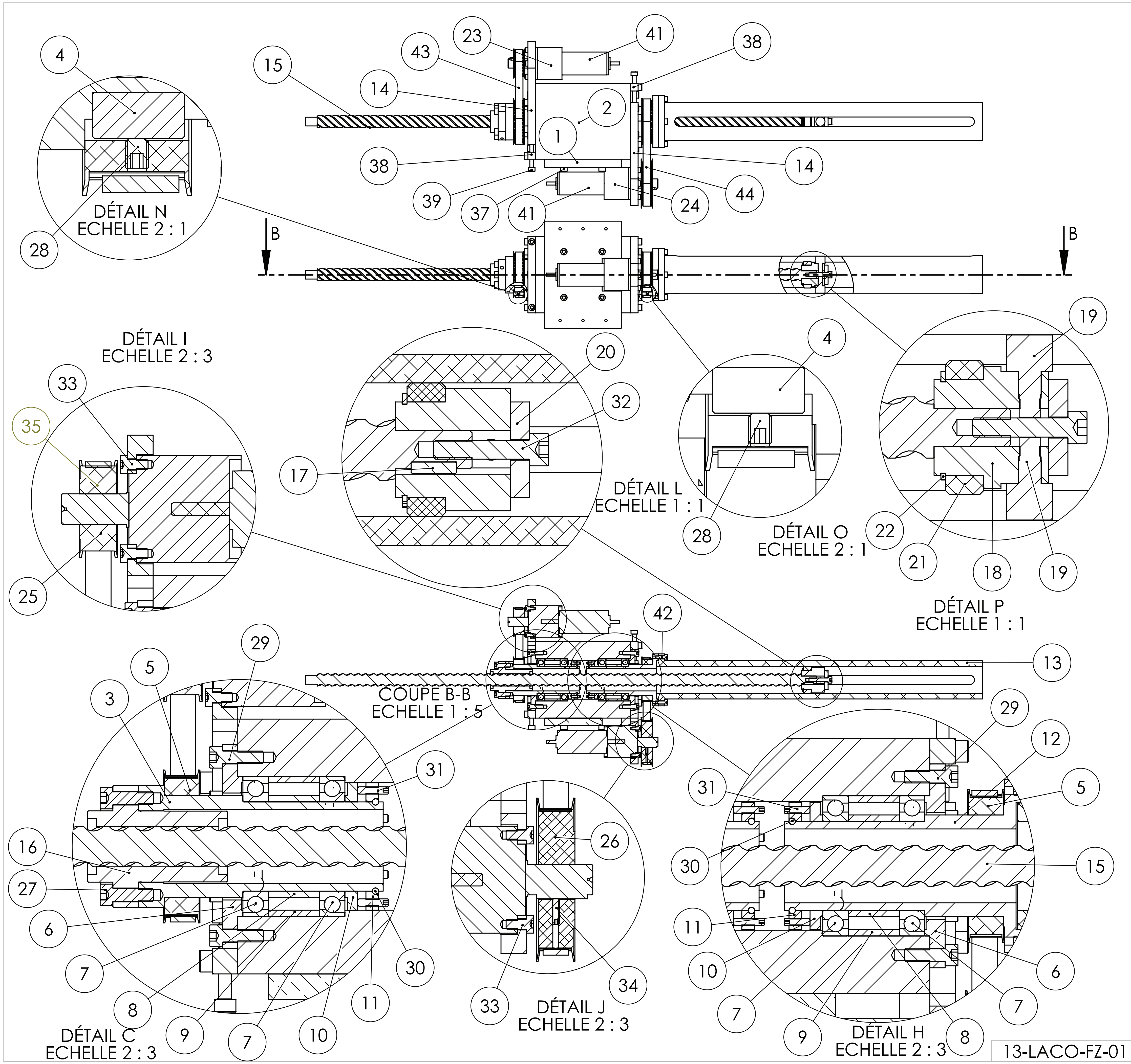
Echelle 1:2

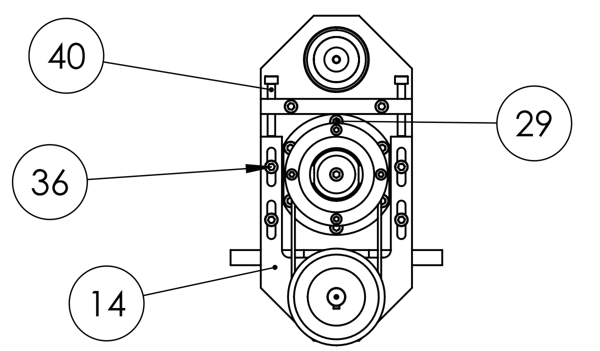
13-LACO-FZ-01

EPFL STI-ATME

Denomination: Socle

Numero dessin: 2





44	1	Courroie rotation	Optibelt Courroies AT5, 10mm, 12 T 5/340	
43	1	Courroie translation	Optibelt Courroies AT5, 10mm, 12 T 5/300	
42	4	Vis glissière	Vis t cy ISO 4762 - M4x12 - 8.8	
41	2	Moteur	Maxon EC-4pole 30 (200W,Ref: 305015)	
40	2	Vis tendeur rotation	Vis t cy ISO 4762 - M5x16 - 8.8	
39	2	Vis tendeur translation	Vis t cy ISO 4762 - M5x16 - 8.8	
38	2	Tendeur	Alu	100x10x10
37	4	Vis fixation chassis	Vis t cy ISO 4762 - M3x16 - 8.8	
36	8	Vis plaque fixation socle	Vis t cy ISO 4762 - M5x16- 8.8	
35	1	Vis poulie moteur translation	Vis s t 6p c SN EN ISO 4026 - M3x5 - 45H	
34	1	Vis poulie moteur rotation	Vis s t 6p c SN EN ISO 4026 - M3x10 - 45H	
33	8	Vis fixation réducteur	Vis t cy ISO 4762 - M4x8 - 8.8 (tête basse!)	
32	1	Vis fixation embout	Vis t cy ISO 4762 - M5x25 - 8.8	
31	12	Vis butée et jonc	Vis s t 6p c SN EN ISO 4026 - M3x10 - 45H	
30	2	Jonc d'arrêt	DIN 7993 RW 35	
29	12	Vis bouchon	Vis t cy ISO 4762 - M5x16 - 8.8	
28	2	Vis poulie receptrice	Vis s t 6p c SN EN ISO 4026 - M3x4 - 45H	
27	6	Vis ércou a bille	Vis t cy ISO 4762 - M5x16 - 8.8	
26	1	Poulie rotation (moteur)	21 AT5/19-2 (modifiée selon plan)	
25	1	Poulie translation (moteur)	21 AT5/22-2 (modifiée selon plan)	
24	1	Réd. plan. rotation (12:1)	Planetary Gearhead GP 42C (Ref: 203115)	
23	1	Réd. plan. translation (6:1)	Planetary Gearhead GP 42C (Ref: 260551)	
22	1	Cirlcips	Clip arb ext DIN 471 - 25x1.2	
21	1	Rondelle POM	POM	Ø35x10
20	1	Rondelle fixation adapt.	Aluminium	Ø25x5
19	2	Galet de came	Poussoir de came miniature: CFFAN 6-12	
18	1	Adaptateur bout vis	Acier E200	Ø32x30
17	1	Clavette vis à bille	Clavette parallèle DIN 6885-A 3x3x12	
16	1	Ecrou à bille	CARRY speed-line (KGE FBE RH 3 S A G)	
15	1	Vis à bille (plan extrémités!)	CARRY speed-line (KGE 16x50 RH 633 E G)	
14	2	Fixation réducteur	Alu Alplan	100x135x10
13	1	Glissière_partie2	Alu Certal 7075	68x425.7
12	1	Glissière_partie1	Acier E200	68x93.8
11	2	Butée jonc	Acier E200	Ø50x4
10	2	Butée roulement	Acier E200	Ø50x4
9	2	Cale extérieure	Acier E200	Ø55x20
8	2	Cale intérieure	Acier E200	Ø40x20
7	4	Roulement de broche	Roulement FAG B71907-E-T-P4S-UM (25°)	
6	2	Bouchon translation	Alu Certal 7075	Ø80x8
5	2	Poulie réceptrice	Poulie dentée 21 AT5/36-2 (modifiée !)	
4	2	Clavette	Clavette parallèle DIN 6885-A 6x6x12	
3	1	Entretoise translation	Acier E200	Ø48x96
2	1	Socle	Alu Certal 7075	124x100x100
1	1	Plaque fixation socle	Alu Alplan	140x100x10
Rep	Qté	Denomination	Matiere	Dimension/référence

Nom Resp.			Nom	Date	
Téléphone		Projet	Babyfoot		
Laboratoire	Labo automatique	Dessiné	Zufferey	09.01.14	
Prof. resp.		Modifié			Echelle 1:10

13-LACO-FZ-01

STI-ATME

Denomination

Liste Pièces

Numero dessin

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