

# DARwin OP

# Assembly Manual



# DARwIn OP Assembly Manual

Created by RoMeLa at Virginia Tech

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Principal authors:

Stephen Rouleau  
Coleman Knabe  
Matthew Stanford  
Thanh Pham  
Nolawe Woldesemayat  
Mark Umansky  
Justin Siegel  
Austin Kim  
Allison McCormack  
Dante Branch  
Viktor Orekhov

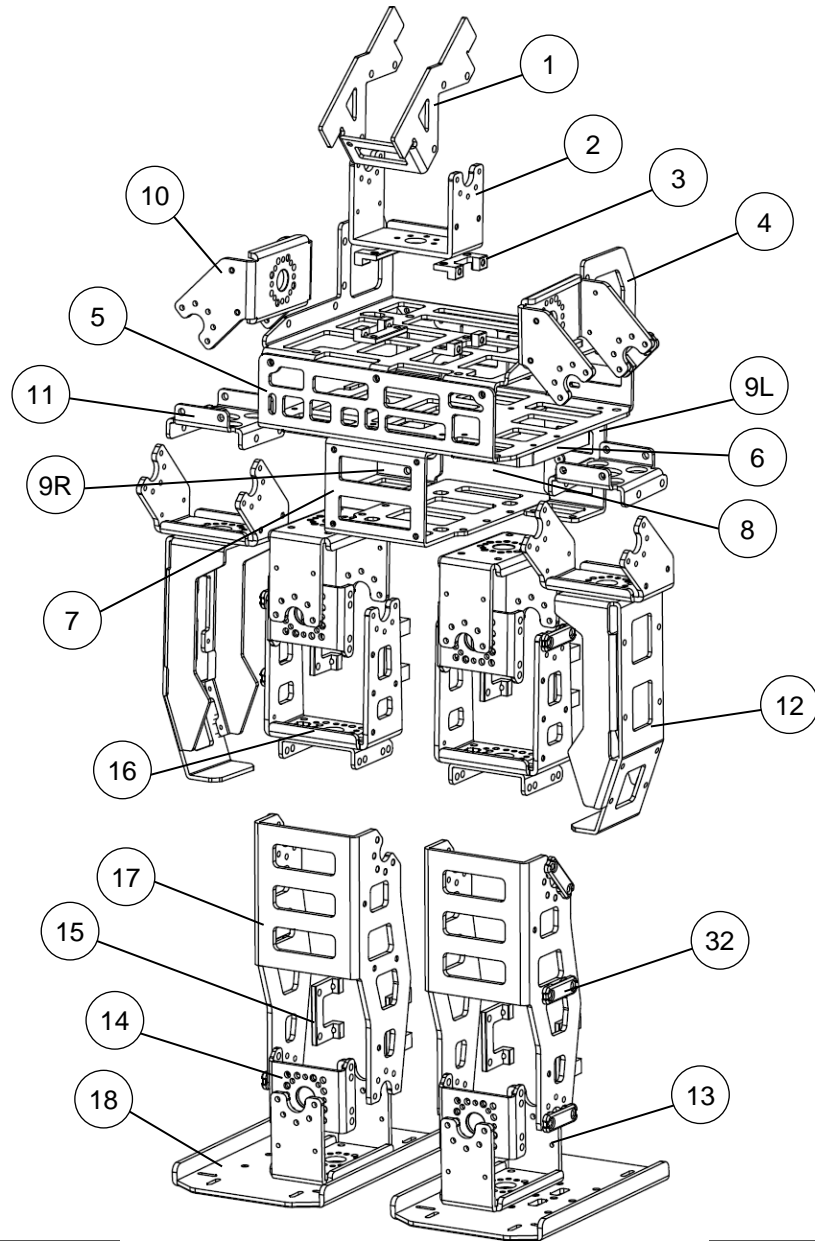
**THIS ASSEMBLY MANUAL IS TO BE USED IN  
CONJUNCTION WITH THE FOLLOWING DOCUMENTS:**

DARwIn OP Wiring Manual  
DARwIn OP Fabrication Manual



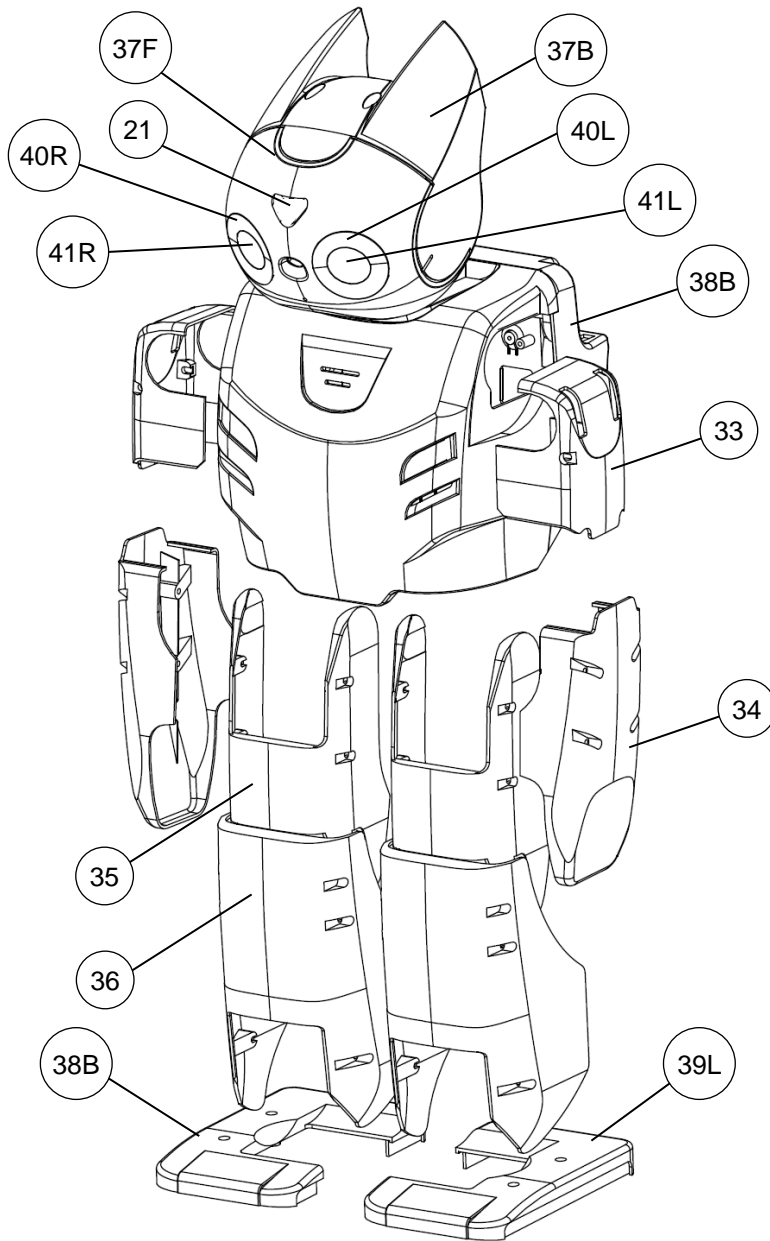
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# Parts List 1 – Frame



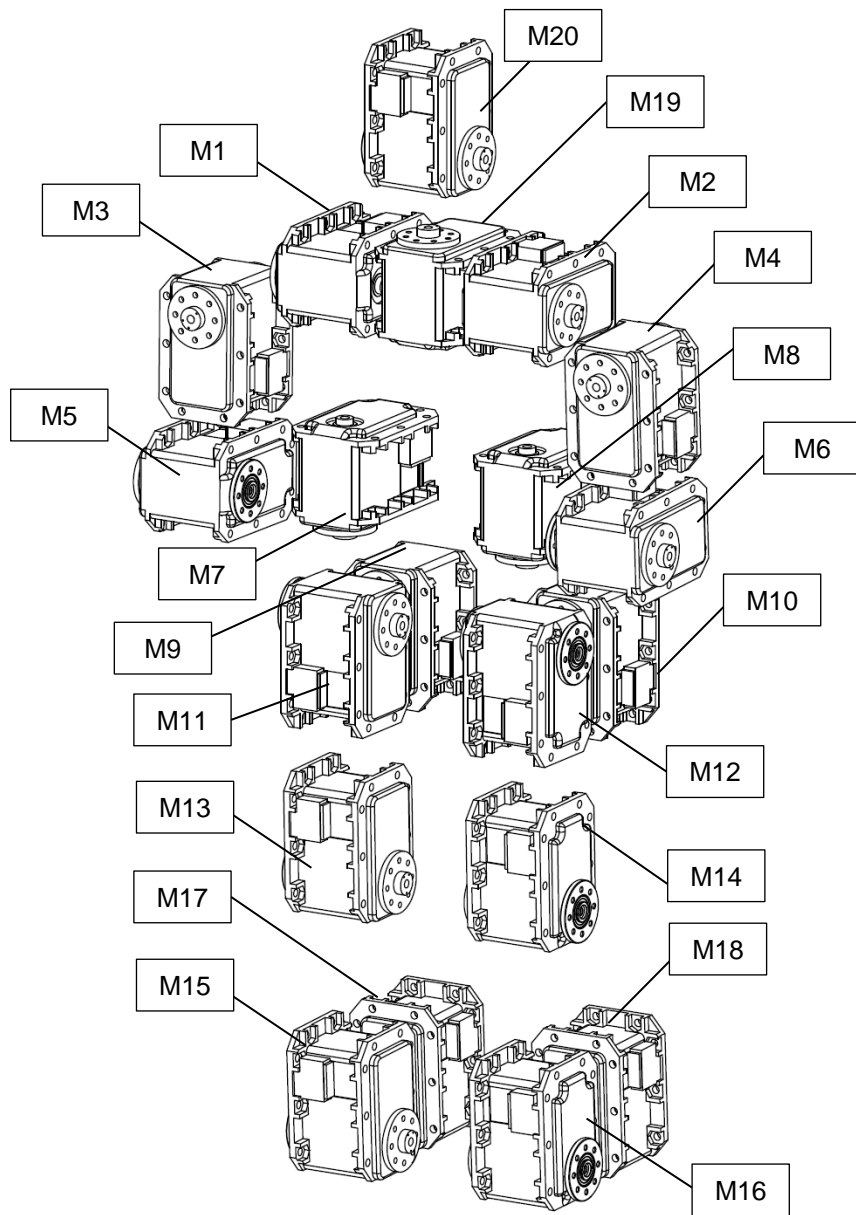
Part Number	Description	Part Name	Qty.
1	Head Bracket	PR13_B01_BRKT_CAM	1
2	Neck Bracket	FR07_H104	1
3	Chest Actuator Connectors	FR07_X101	4
4	Upper Chest Bracket	PR13_B01_FRM_PCB_MAIN_T	1
5	Lower Chest Bracket	PR13_B01_FRM_PCB_MAIN_B	1
6	Mounting Bracket	PR13_B_SPACER_PELV	2
7	Battery Bracket	FR07_E130	1
8	Battery Cover Bracket	PR13_B_FRM_CVR_BAT_ASM	1
9L	Back Left Pelvic Bracket	PR13_B_BRKT_PELV_L	1
9R	Back Right Pelvic Bracket	PR13_B_BRKT_PELV_R	1
10	Angled Actuator Bracket	FR07_H102	4
11	Arm Actuator Mount	FR07_SC101	2
12	Hand	FR07_E180	2
13	U-Actuator Bracket	FR07_H120	4
14	Leg Actuator Mount	FR07_S101	6
15	Actuator Connector	FR07_X102	8
16	Thigh Bracket	FR07_H132	2
17	Knee Bracket	FR07_H133	2
18	Foot	FR07_E160	2
32	Cable Holder	DC04_HOLDER_CABLE_PRM	10

# Parts List 2 - Covers



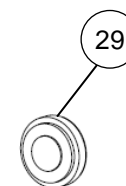
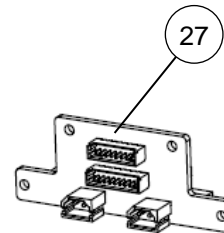
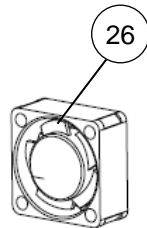
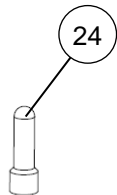
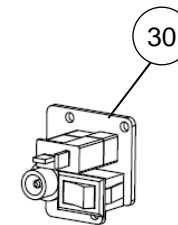
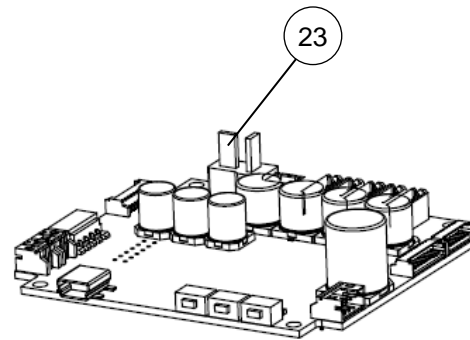
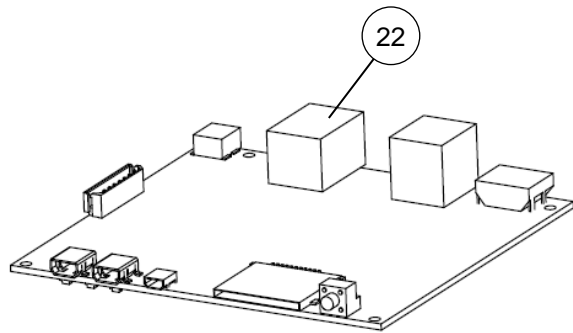
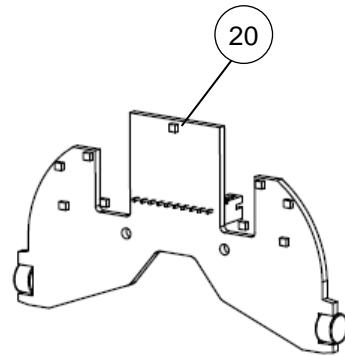
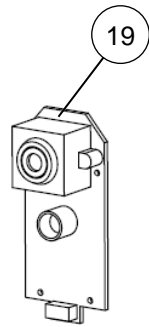
Part Number	Description	Qty.
21	Head LED Cover	1
33	Arm Cover Upper	2
34	Arm Cover Lower	2
35	Thigh Cover	2
36	Leg Cover	2
37B	Back Head Cover	1
37F	Front Head Cover	1
38B	Back Chest Cover	1
38F	Front Chest Cover	1
39L	Left Foot Cover	1
39R	Right Foot Cover	1
40L	Left Eye Cover	1
40R	Right Eye cover	1
41L	Left Pupil	1
41R	Right Pupil	1

# Parts List 3 - Actuators



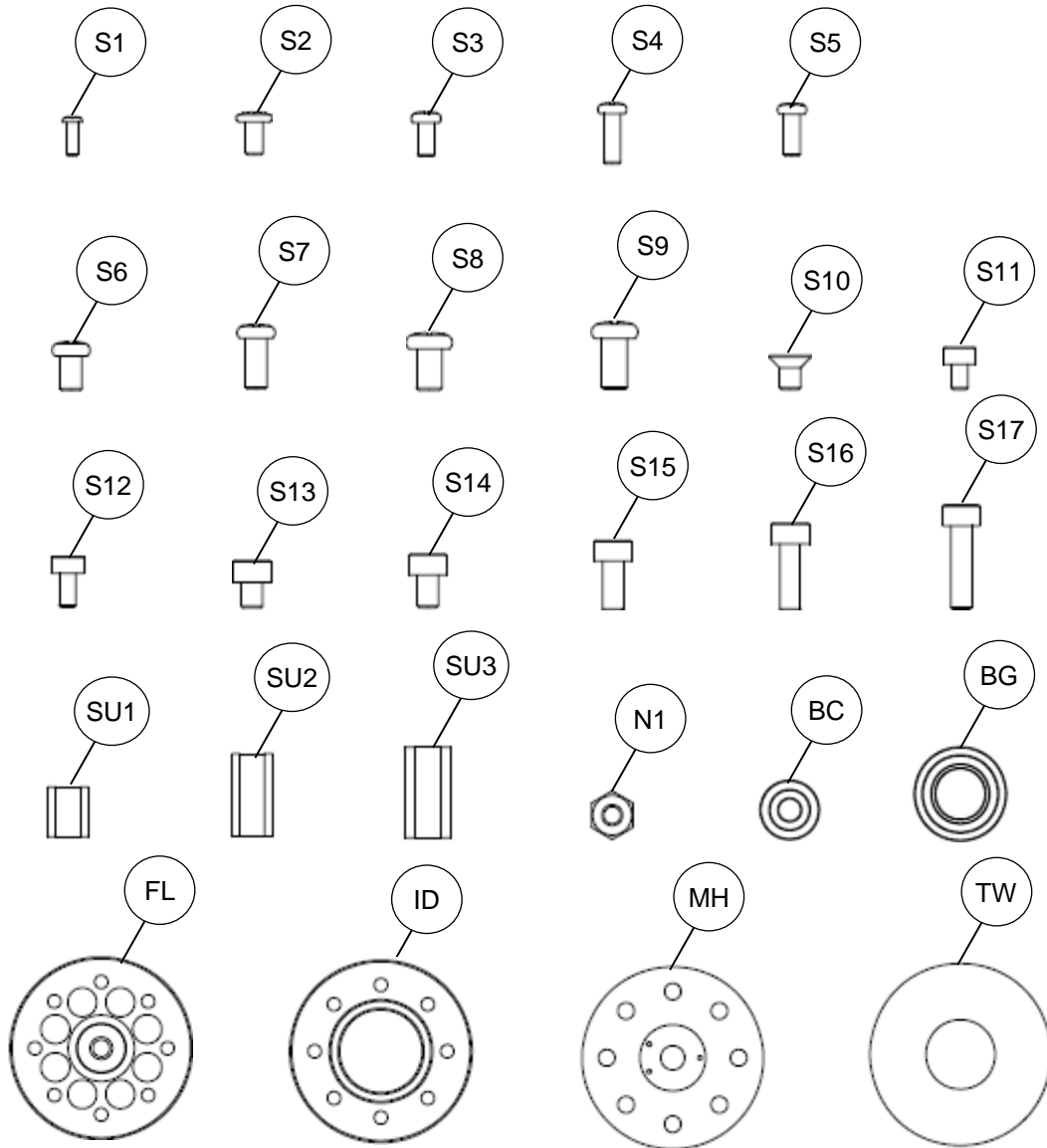
Actuator ID	Actuator Type	Bearing Required
M1	Dynamixel MX-28	No
M2	Dynamixel MX-28	No
M3	Dynamixel MX-28	Yes
M4	Dynamixel MX-28	Yes
M5	Dynamixel MX-28	Yes
M6	Dynamixel MX-28	Yes
M7	Dynamixel MX-28	No
M8	Dynamixel MX-28	No
M9	Dynamixel MX-28	No
M10	Dynamixel MX-28	No
M11	Dynamixel MX-28	Yes
M12	Dynamixel MX-28	Yes
M13	Dynamixel MX-28	Yes
M14	Dynamixel MX-28	Yes
M15	Dynamixel MX-28	Yes
M16	Dynamixel MX-28	Yes
M17	Dynamixel MX-28	No
M18	Dynamixel MX-28	No
M19	Dynamixel MX-28	No
M20	Dynamixel MX-28	Yes

# Parts List 4 - Electronics



Part Number	Description	Qty.
19	Camera	1
20	Head PCB	1
22	FitPC	1
23	CM730	1
24	Antenna	1
25	Antenna Connector	1
26	Fan	2
27	Back Cover PCB	1
29	Speaker	1
30	Power Switch	1
31	Battery	1

# Parts List 5 – Fasteners



Part Number	Description	Qty.
S1	M1.4x4	6
S2	Button Head M2x4	2
S3	Phillips Head M2x4	22
S4	Phillips Head M2x5	16
S5	Phillips Head M2x6	20
S6	Phillips Head M2.5x4	12
S7	Phillips Head M2.5x6	4
S8	Phillips Head M3x4	8
S9	Phillips Head M3x6	8
S10	Flat Head M2.5x4	4
S11	Hex Head M2x3	28
S12	Hex Head M2x4	143
S13	Hex Head M2.5x3	8
S14	Hex Head M2.5x4	48
S15	Hex Head M2.5x6	112
S16	Hex Head M2.5x8	33
S17	Hex Head M2.5x10	8
SU1	Spacer M2.5x6	4
SU2	Spacer M2.5x10	3
SU3	Spacer M3x11	4
N1	Nut M2.5	92
BC	Bearing Cap	15
BG	Bearing	15
FL	Flange Bearing	4
ID	Bearing Idler	15
MH	Horn	20
TW	Thrust Washer	20

# 0. Actuators

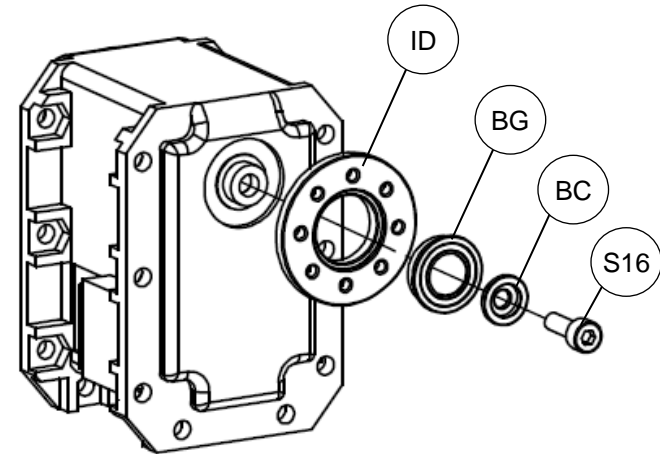
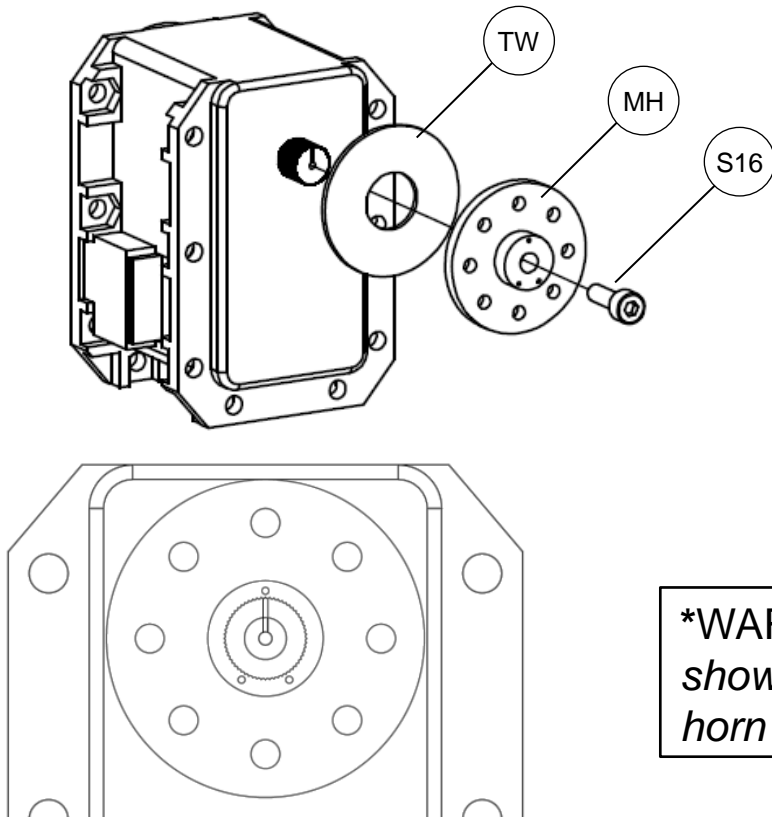
Dynamixel MX-28 Actuator ID's are recommended to be set prior to assembly. Refer to ROBOTIS e-Manual to set Actuator ID's using Dynamixel Wizard.

## Horn attachment

\*NOTE – All actuators require horn

## Actuator bearing attachment

\*NOTE – M1, M2, M7, M8, M9, M10, M17, M18, M19 do NOT require a bearing

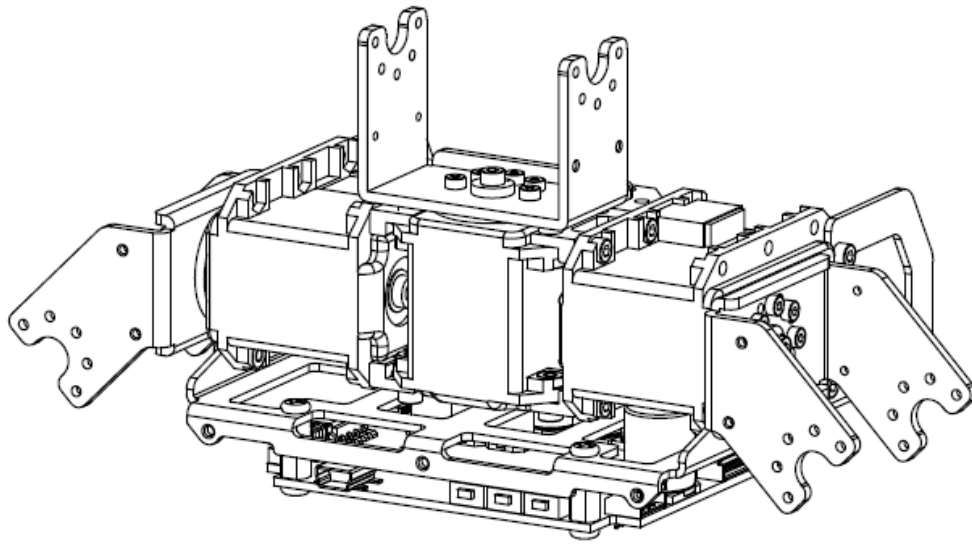


**\*WARNING** – Horns must align with actuator shaft as shown. Damage to actuators and/or robot may occur if horn is not properly aligned when attached to actuator.

Alignment of motor horn on actuator shaft



# 1. Upper Chest

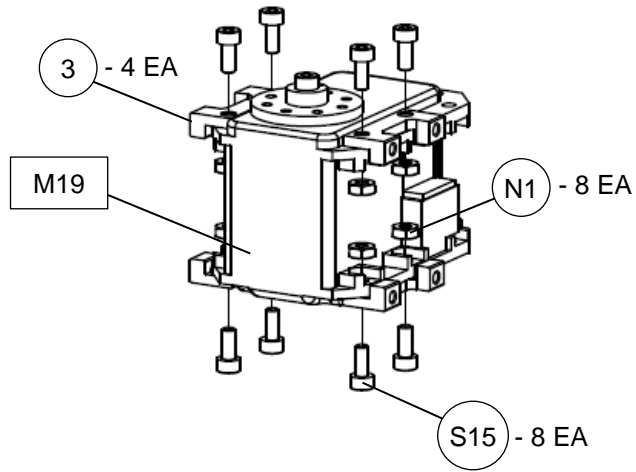


Part Number	Description	Qty.
2	Neck Bracket	1
3	Chest Actuator Connector	4
4	Upper Chest Bracket	1
10	Angled Actuator Bracket	2
23	CM730	1
24	Antenna	1
25	Antenna Connector	1
M1	Dynamixel MX-28	1
M2	Dynamixel MX-28	1
M19	Dynamixel MX-28	1
S8	Phillips Head M3x4	8
S12	Hex Head M2x4	21
S15	Hex Head M2.5x6	24
S16	Hex Head M2.5x8	3
N1	Nut M2.5	16
SU3	Spacer M3x11	4

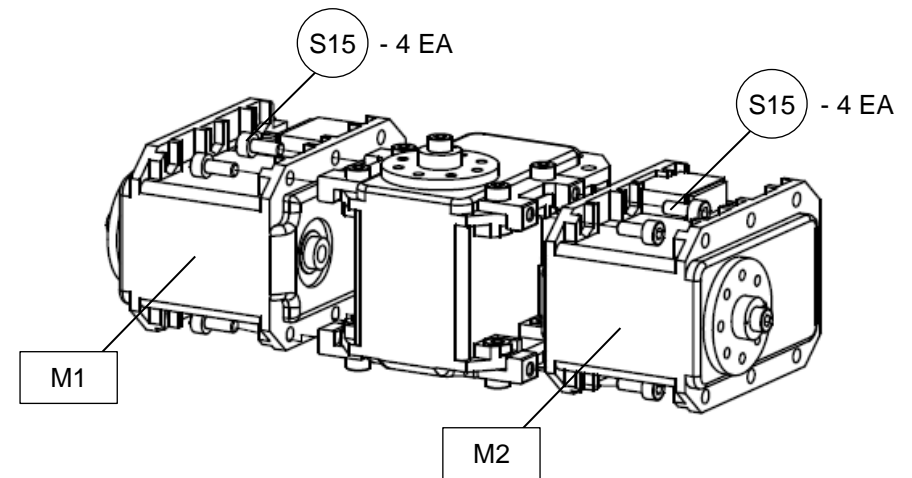
# 1. Upper Chest

## 1-1. Upper chest actuator assembly

1-1-1. Actuator connectors to M19



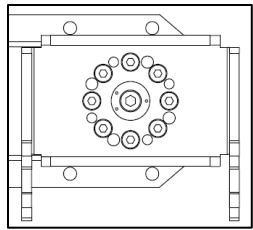
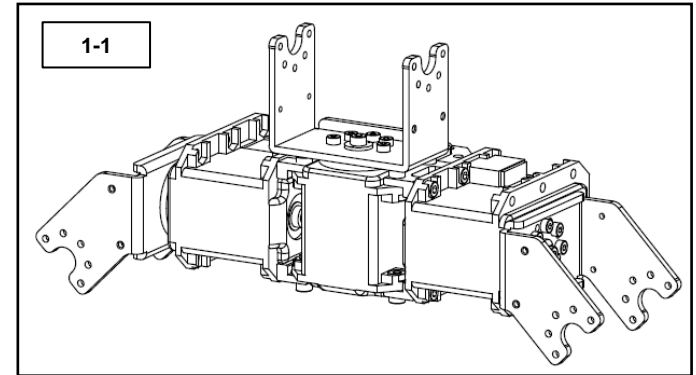
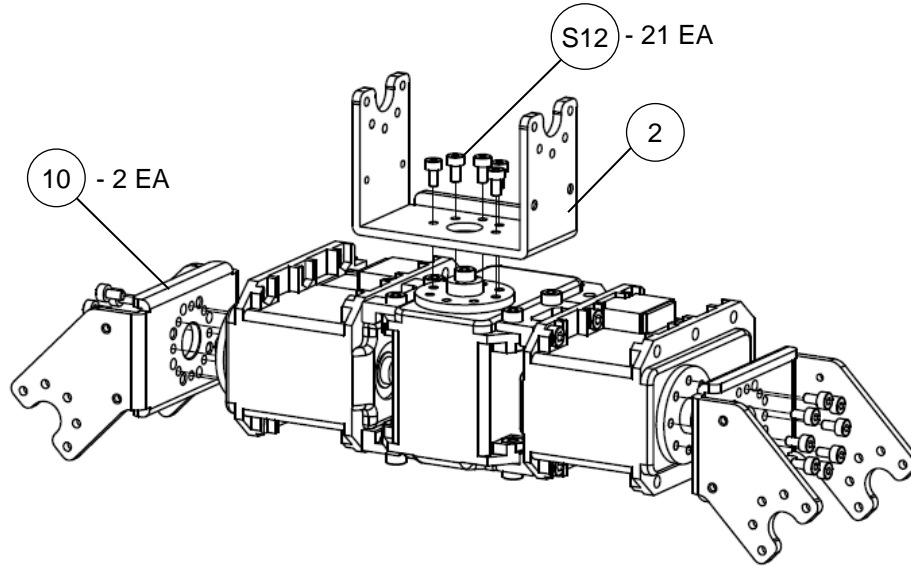
1-1-2. M1 and M2 to actuator connectors



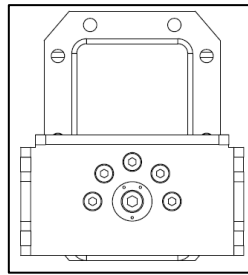
# 1. Upper Chest

## 1-1. Upper chest actuator assembly

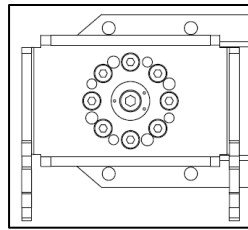
### 1-1-3. Upper chest bracket assembly



M1 horn orientation



M19 horn orientation

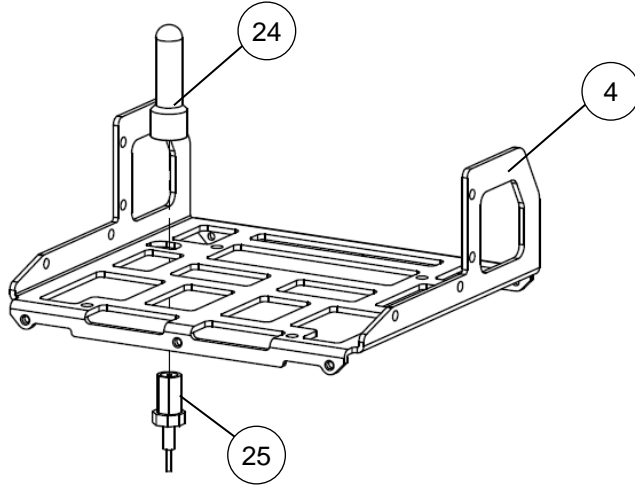


M2 horn orientation

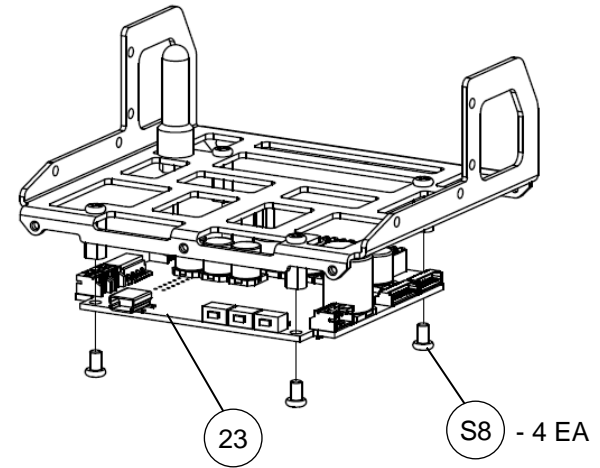
# 1. Upper Chest

## 1-2 Upper chest electronics assembly

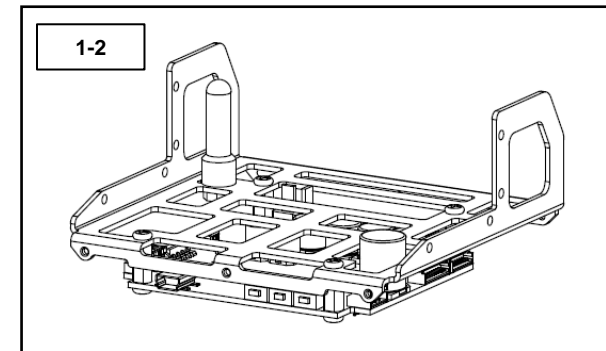
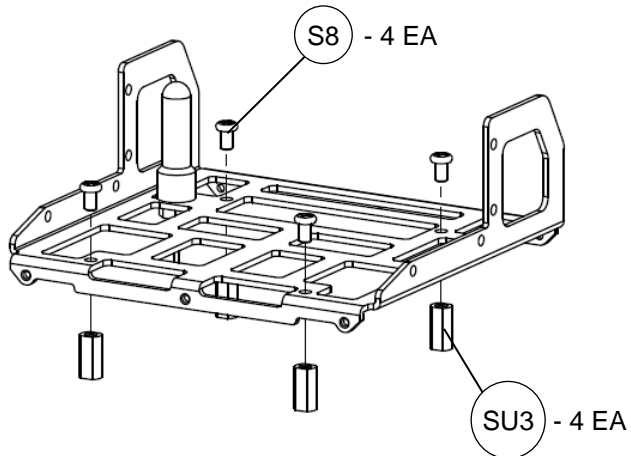
1-2-1. Antenna to upper chest bracket



1-2-3. Circuit board to upper chest bracket



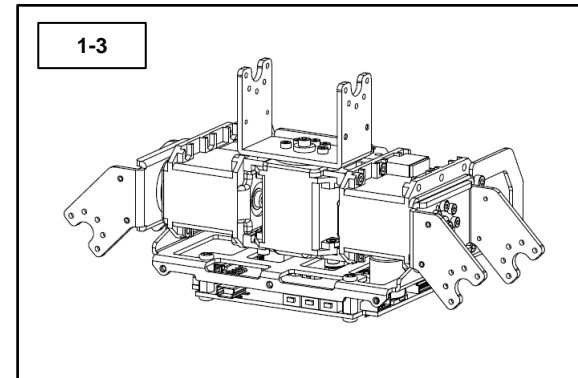
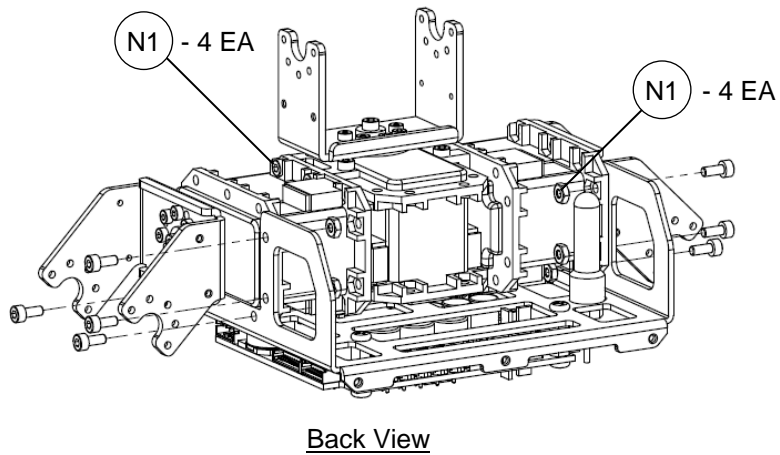
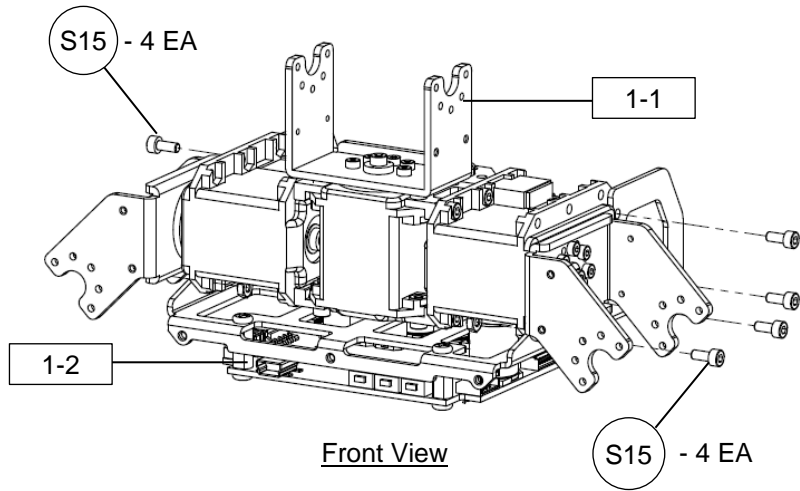
1-2-2. FitPC to upper chest bracket



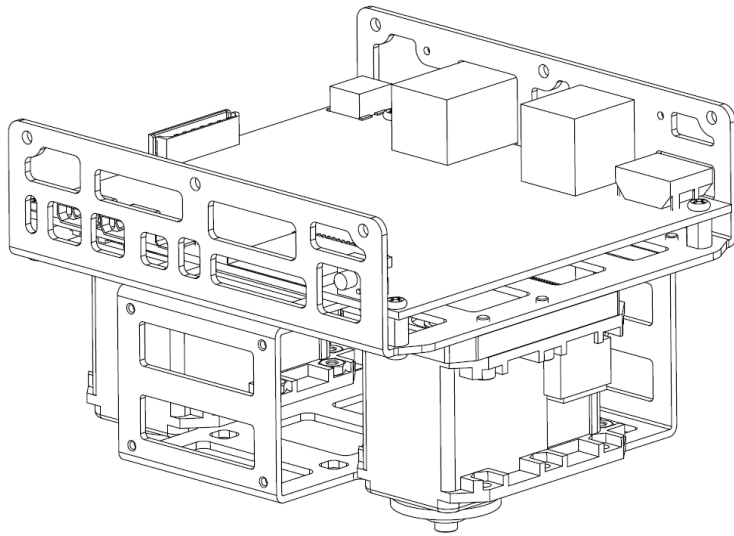
# 1. Upper Chest

## 1-3 Upper chest unit assembly

1-3-1. 1-1 to 1-2 assembly



## 2. Lower Chest

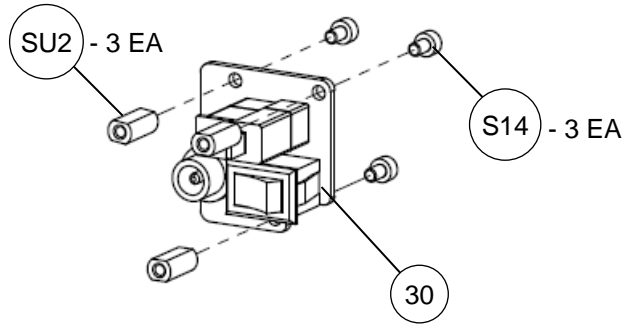


Part Number	Description	Qty.
5	Lower Chest Bracket	1
6	Mounting Bracket	2
7	Battery Bracket	1
8	Battery Cover Bracket	1
9R	Back Right Pelvic Bracket	1
9L	Back Left Pelvic Bracket	1
22	FitPC	1
30	Power Switch	1
31	Battery	1
M7	Dynamixel MX-28	1
M8	Dynamixel MX-28	1
S6	Phillips Head M2.5x4	8
S10	Flat Head M2.5x4	4
S14	Hex Head M2.5x4	10
S15	Hex Head M2.5x6	10
S16	Hex Head M2.5x8	2
S17	Hex Head M2.5x10	8
N1	Nut M2.5	10
SU1	Spacer M2.5x6	4
SU2	Spacer M2.5x10	3

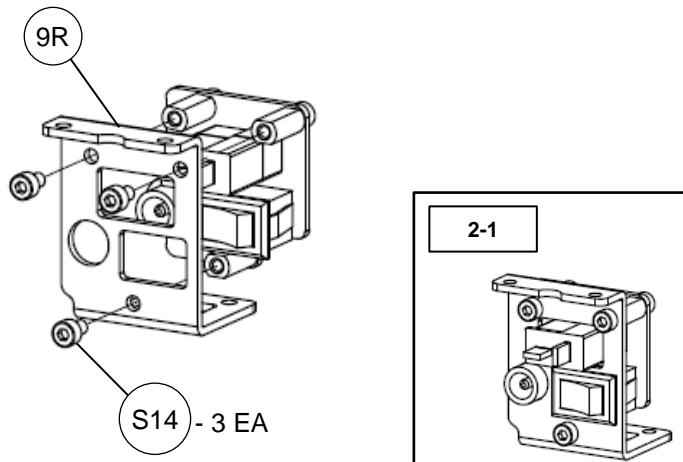
# 2. Lower Chest

## 2-1 Switch assembly

### 2-1-1. Power switch spacer assembly

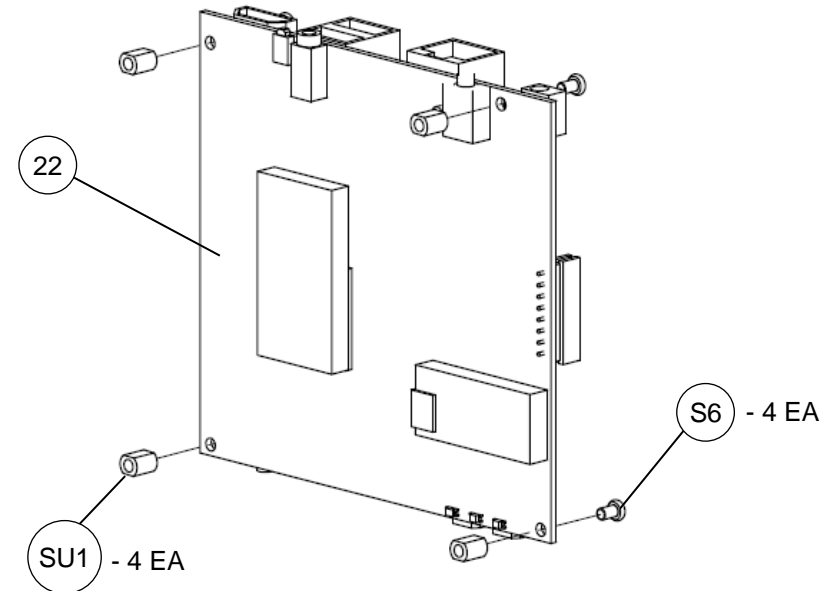


### 2-1-2. Switch to back right pelvic bracket



## 2-2. Lower chest unit assembly

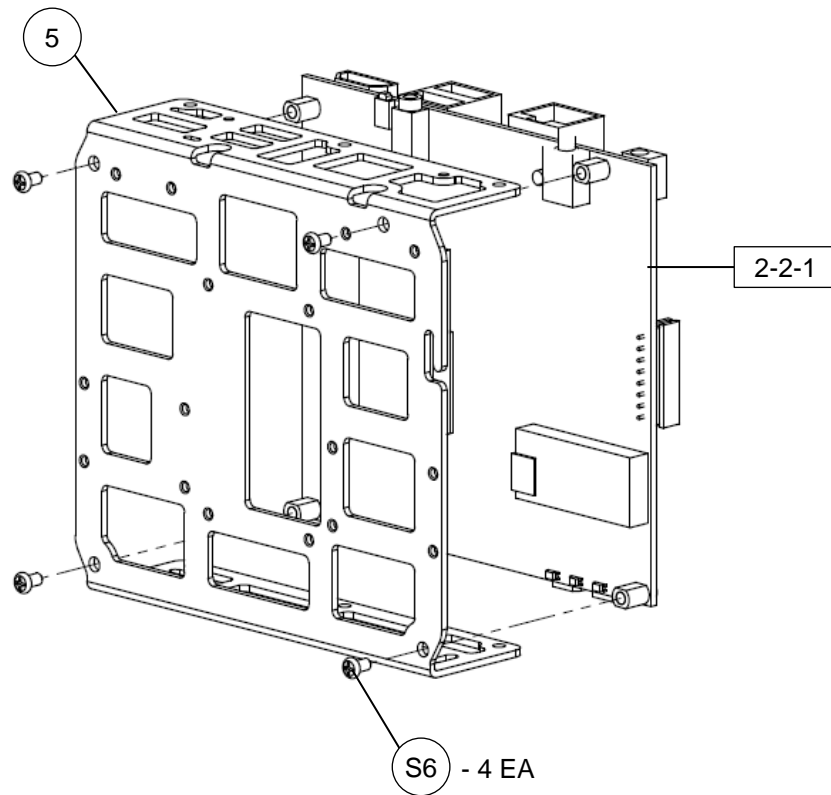
### 2-2-1. FitPC spacer assembly



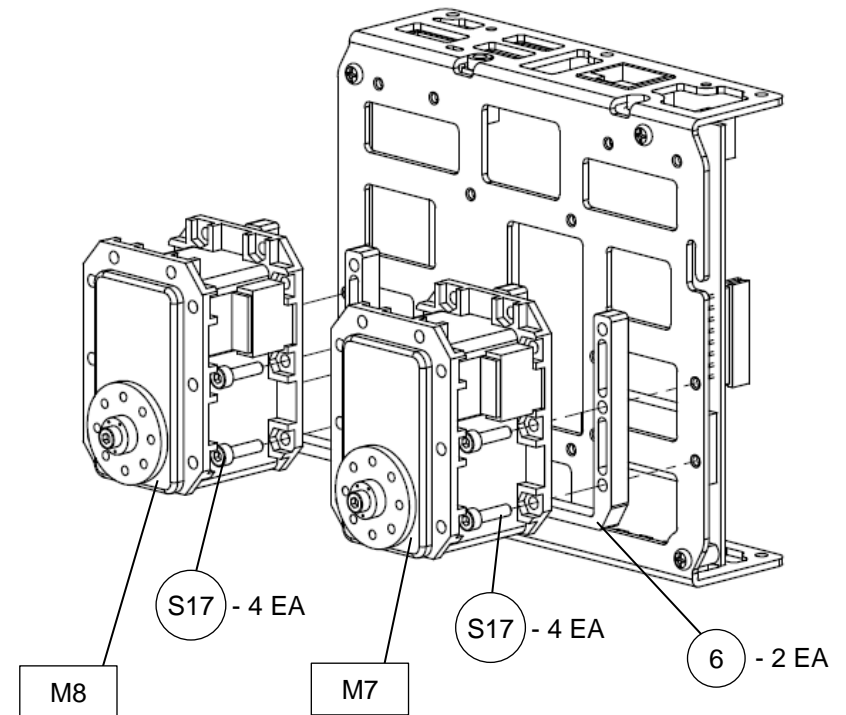
# 2. Lower Chest

## 2-2. Lower chest unit assembly

2-2-2. FitPC to lower chest bracket



2-2-3. M7 and M8 to lower chest bracket

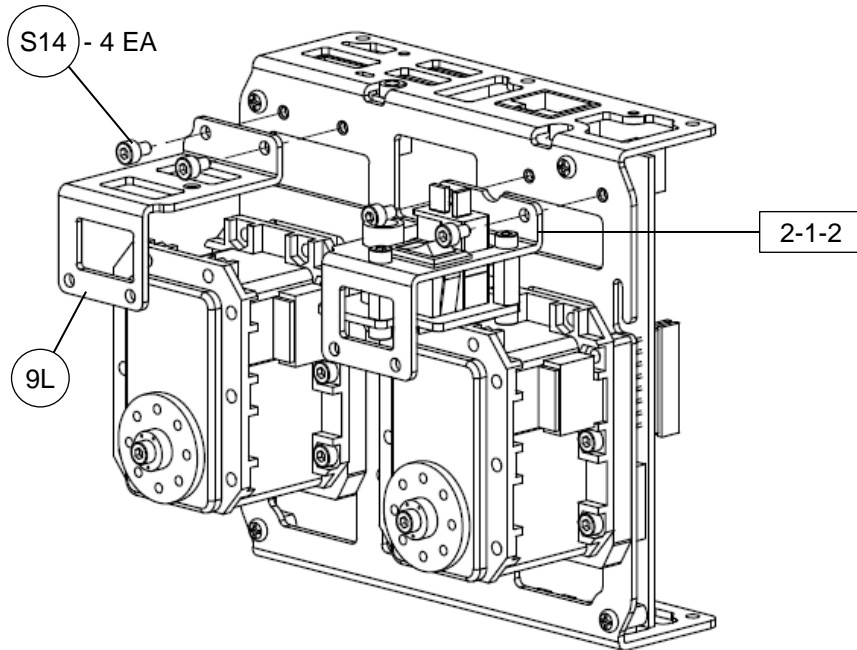




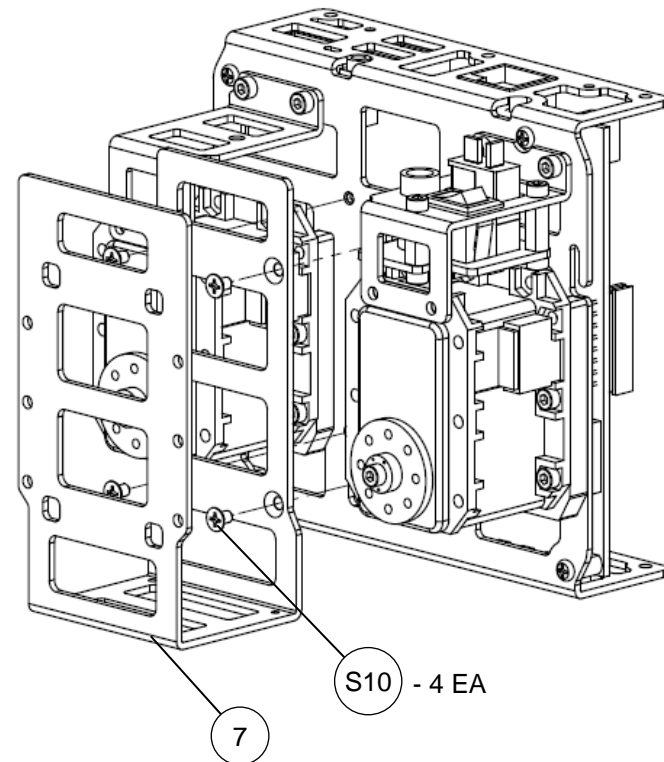
# 2. Lower Chest

## 2-2. Lower chest unit assembly

2-2-4. FitPC to lower chest bracket



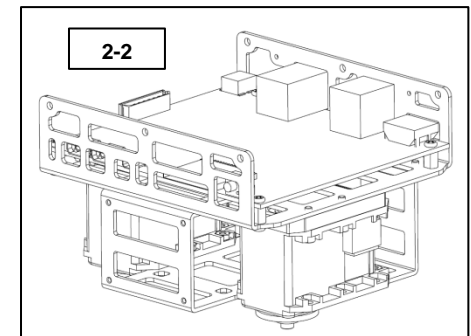
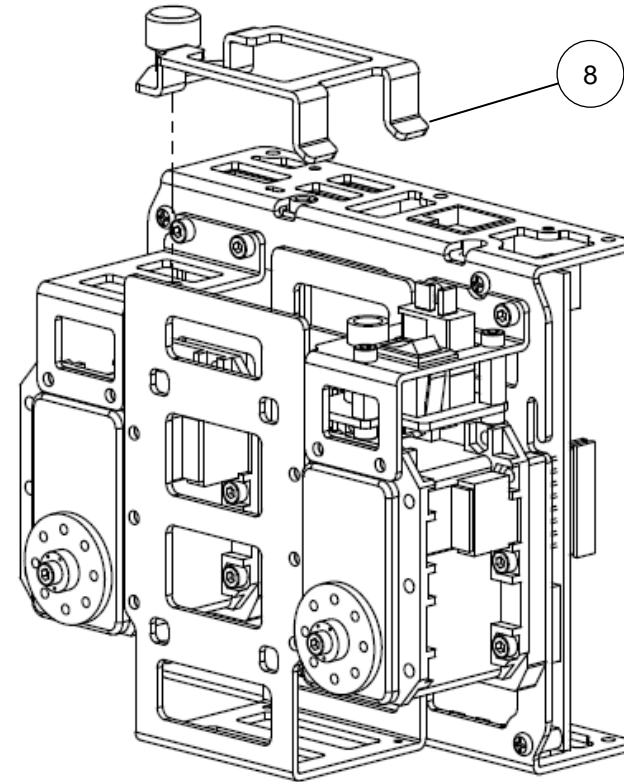
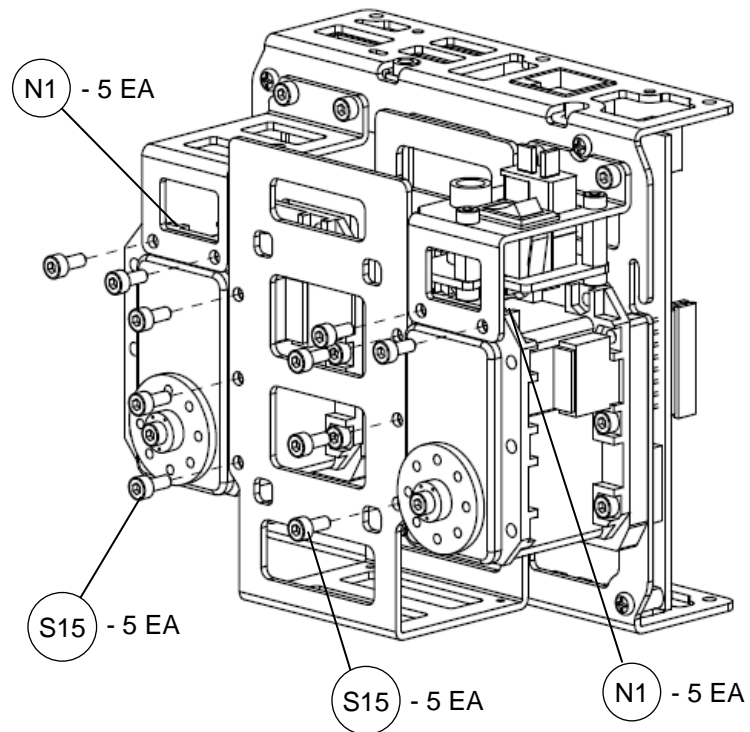
2-2-5. Battery bracket to lower chest bracket



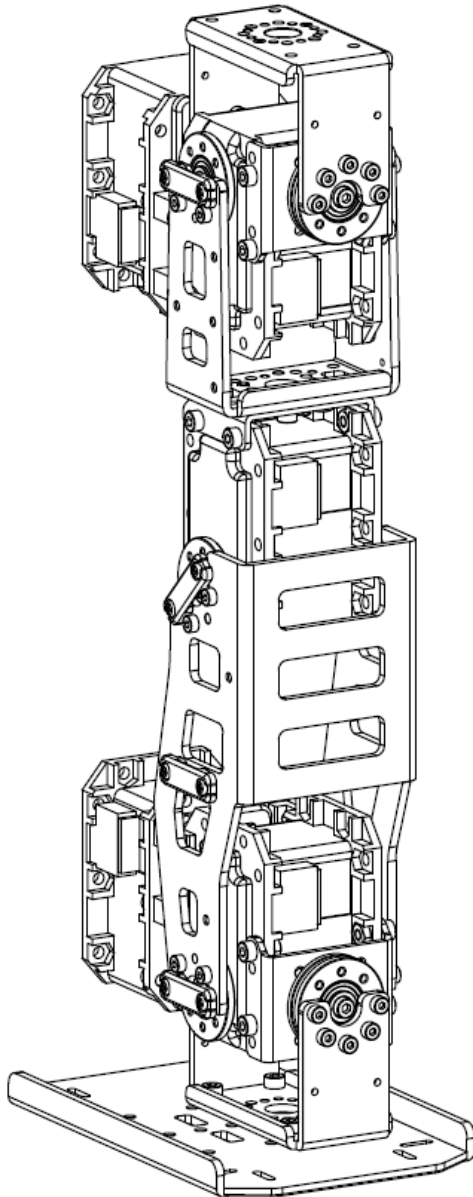
# 2. Lower Chest

## 2-2. Lower chest unit assembly

### 2-2-6. Lower chest unit assembly



# 3. Right Leg

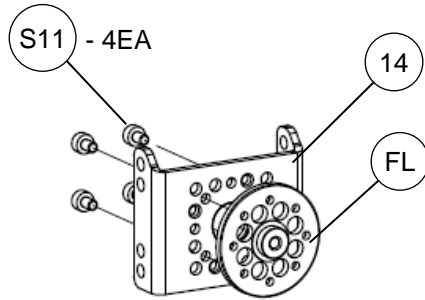


Part Number	Description	Qty.
13	U-Actuator Bracket	2
14	Actuator Mount	3
15	Actuator Connector	4
16	Thigh Bracket	1
17	Knee Bracket	1
18	Foot	1
22	FitPC	1
32	Cable Holder	4
M11	Dynamixel MX-28	1
M13	Dynamixel MX-28	1
M15	Dynamixel MX-28	1
M17	Dynamixel MX-28	1
M19	Dynamixel MX-28	1
S3	Phillips Head M2x4	2
S4	Phillips Head M2x5	6
S11	Hex Head M2x3	8
S12	Hex Head M2x4	41
S13	Hex Head M2.5x3	4
S14	Hex Head M2.5x4	4
S15	Hex Head M2.5x6	28
S16	Hex Head M2.5x8	10
N1	Nut M2.5	20
BC	Bearing Cap	2
BG	Bearing	2
FL	Flange Bearing	2
ID	Bearing Idler	2

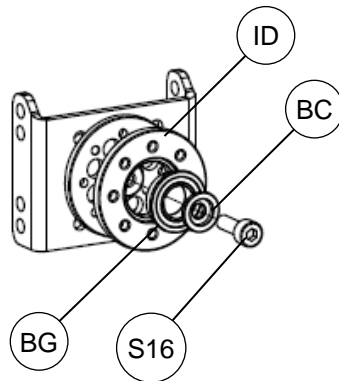
# 3. Right Leg

## 3-1. Right lower leg

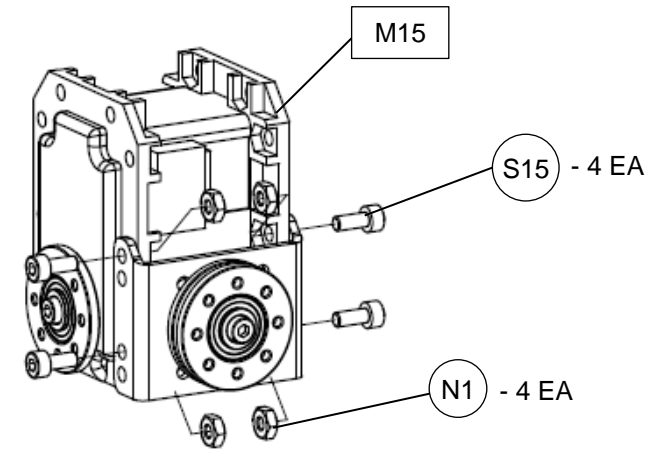
3-1-1. Lower leg actuator mount assembly



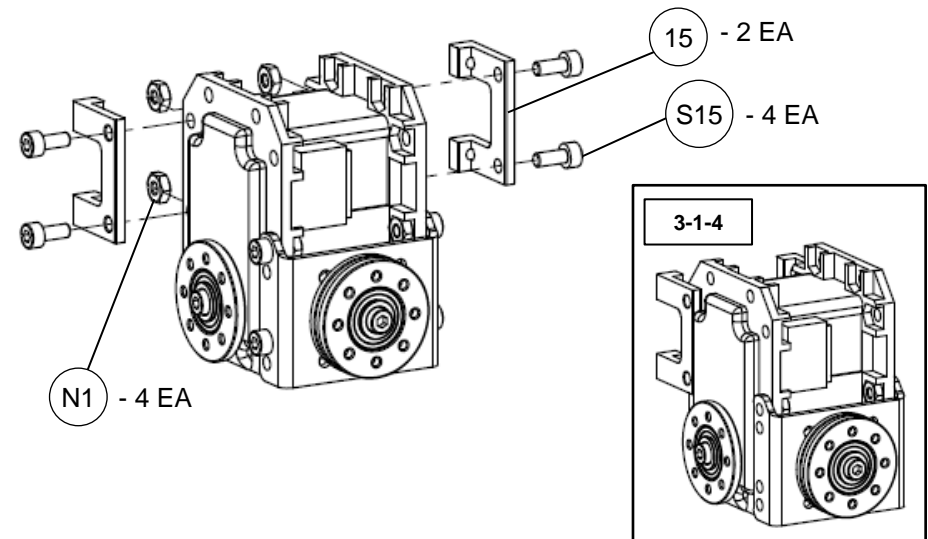
3-1-2. Lower leg actuator mount bearing assembly



3-1-3. M15 to lower leg actuator mount



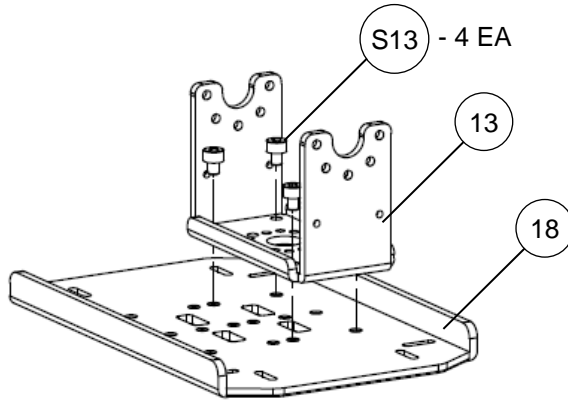
3-1-4. Actuator connectors to M15



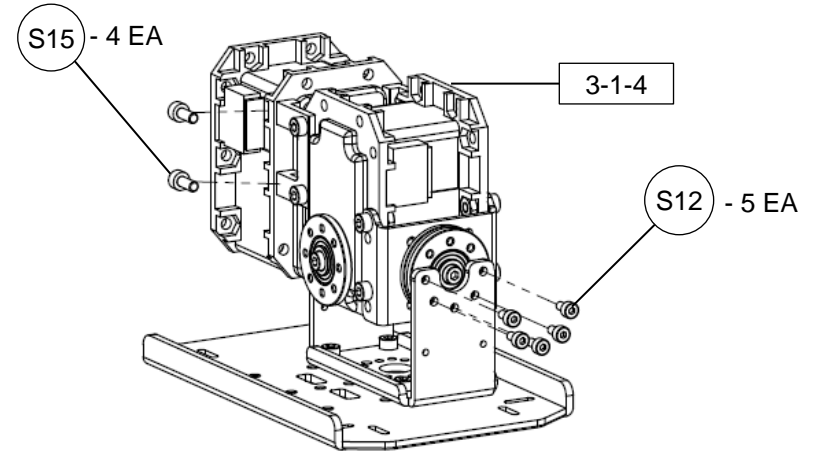
# 3. Right Leg

## 3-1. Right lower leg

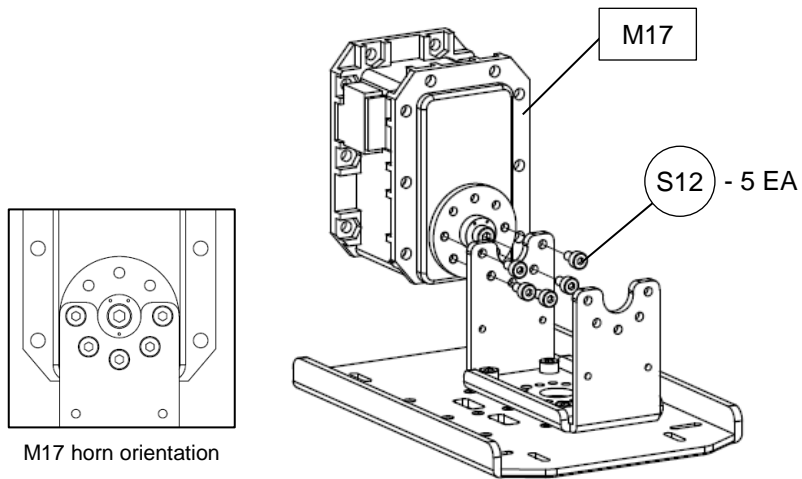
3-1-5. U-actuator bracket to foot



3-1-7. 3-1-4 to U-actuator bracket



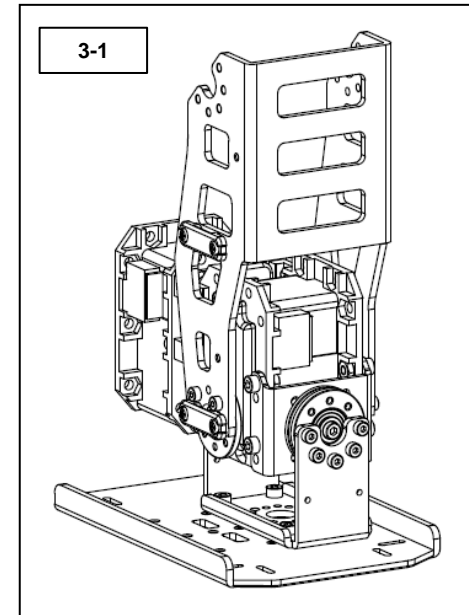
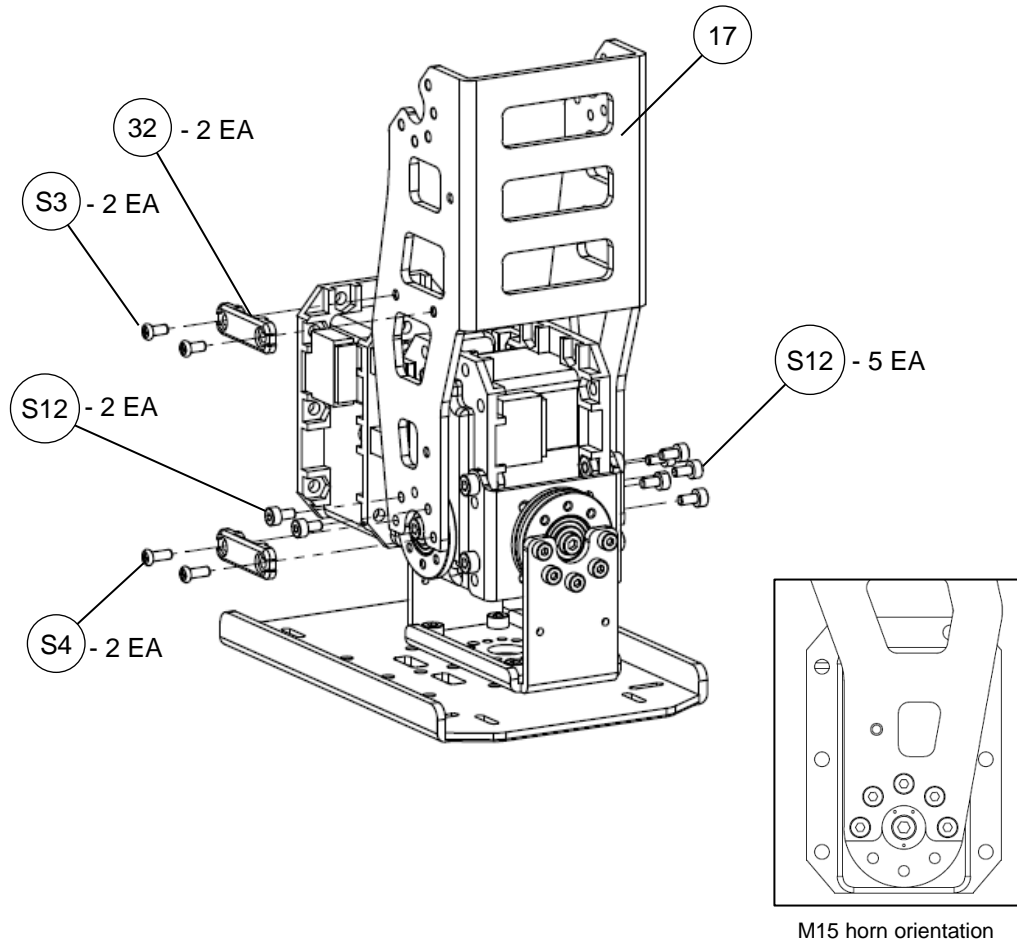
3-1-6. M17 to U-actuator bracket



# 3. Right Leg

## 3-1. Right lower leg

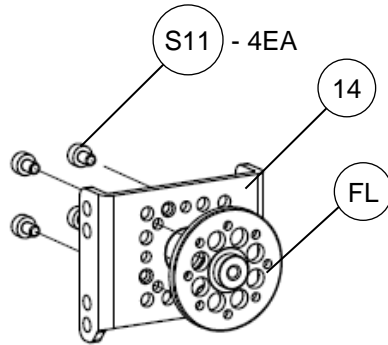
### 3-1-8. Knee bracket to foot



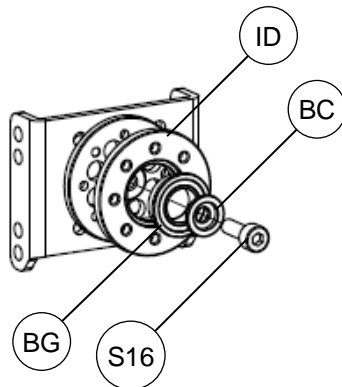
# 3. Right Leg

## 3-2. Right upper leg

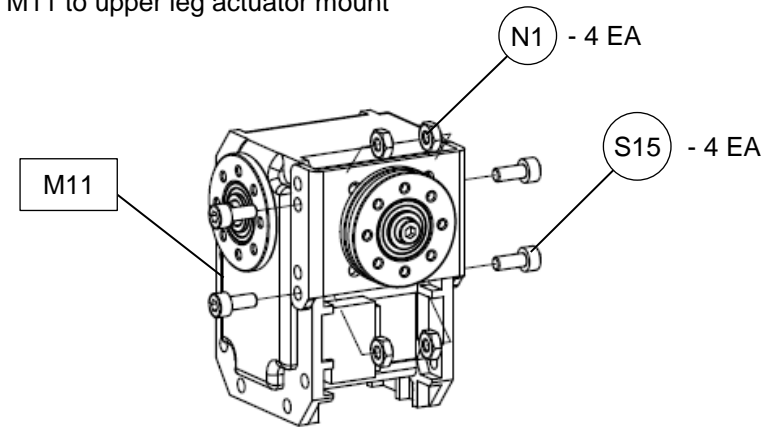
3-2-1. Upper leg actuator mount assembly



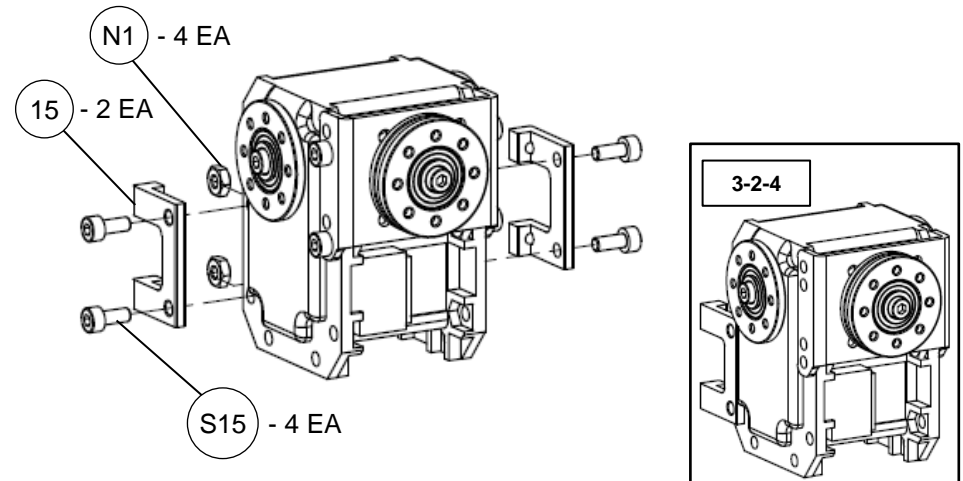
3-2-2. Upper leg actuator mount bearing assembly



3-2-3. M11 to upper leg actuator mount



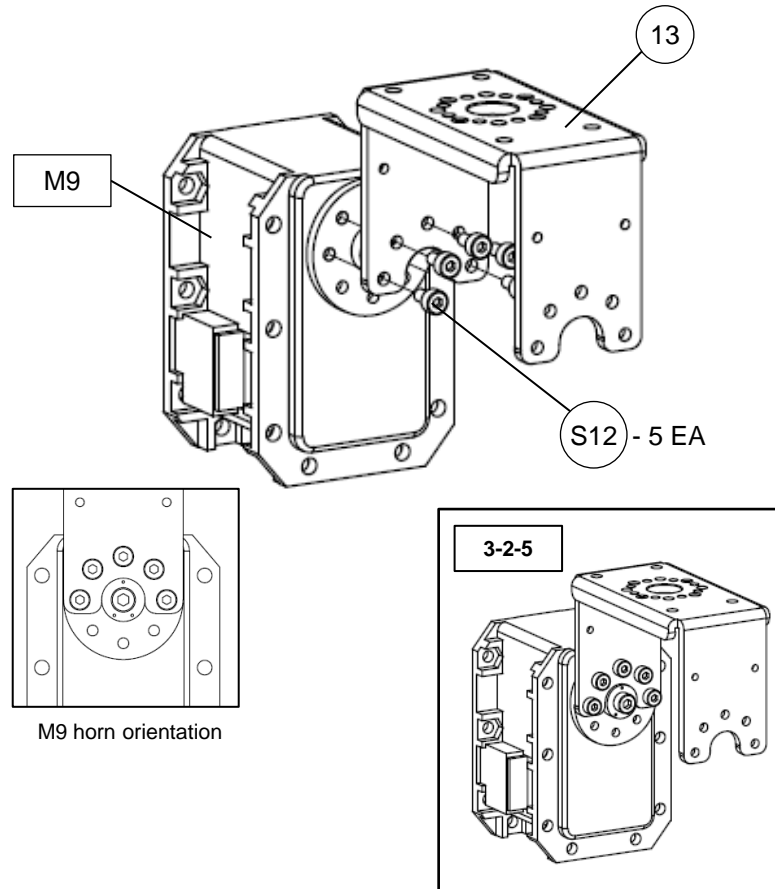
3-2-4. Actuator connectors to M11



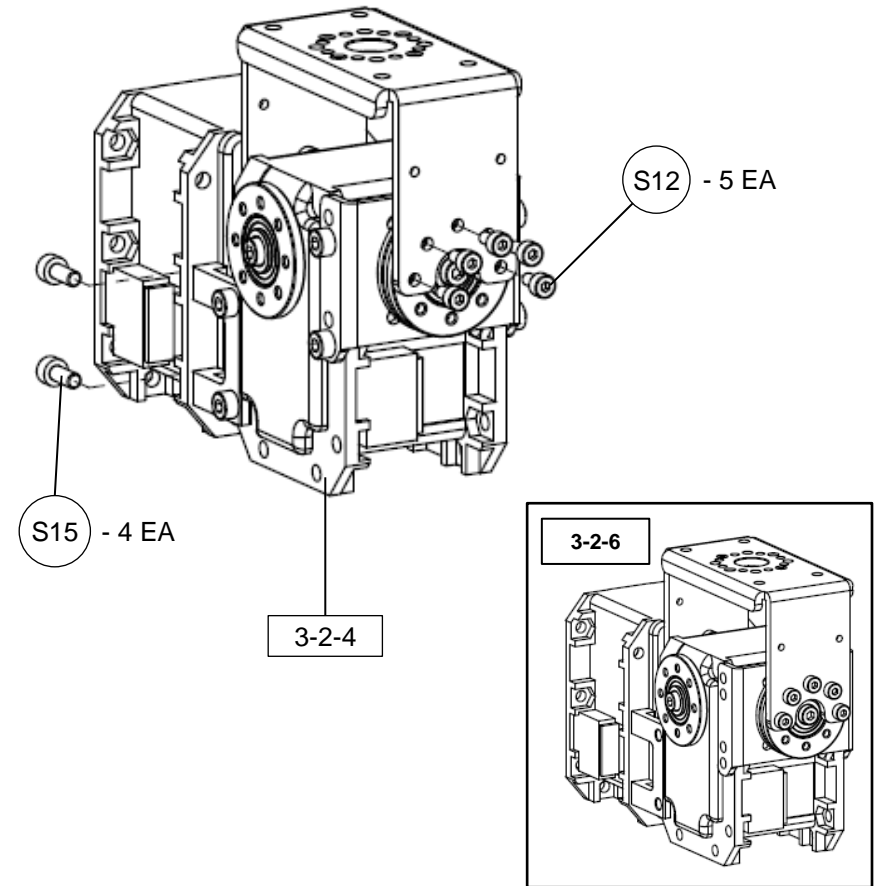
# 3. Right Leg

## 3-2. Right upper leg

3-2-5. M9 to U-actuator bracket



3-2-6. 3-2-4 to 3-2-5 assembly

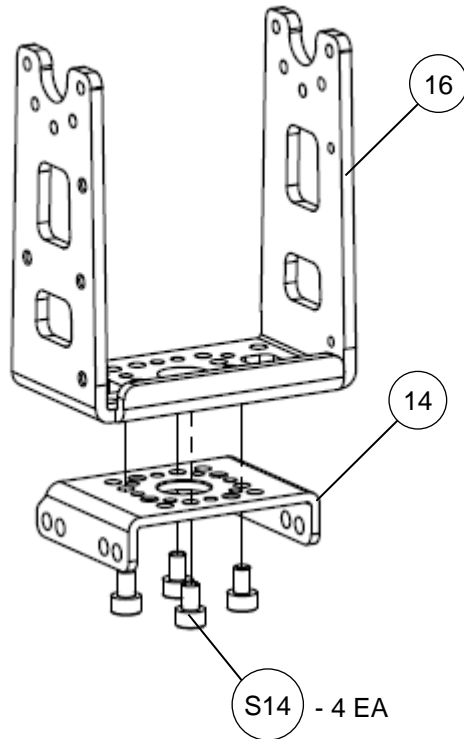




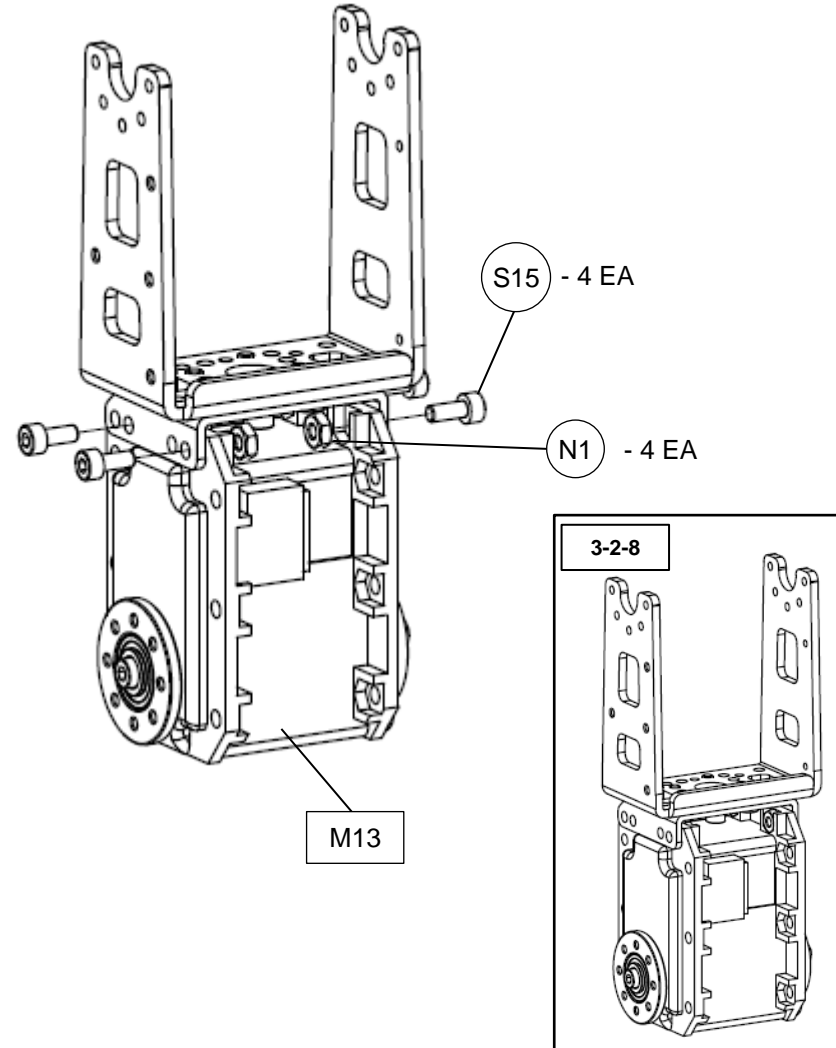
# 3. Right Leg

## 3-2. Right upper leg

3-2-7. Thigh bracket to actuator mount



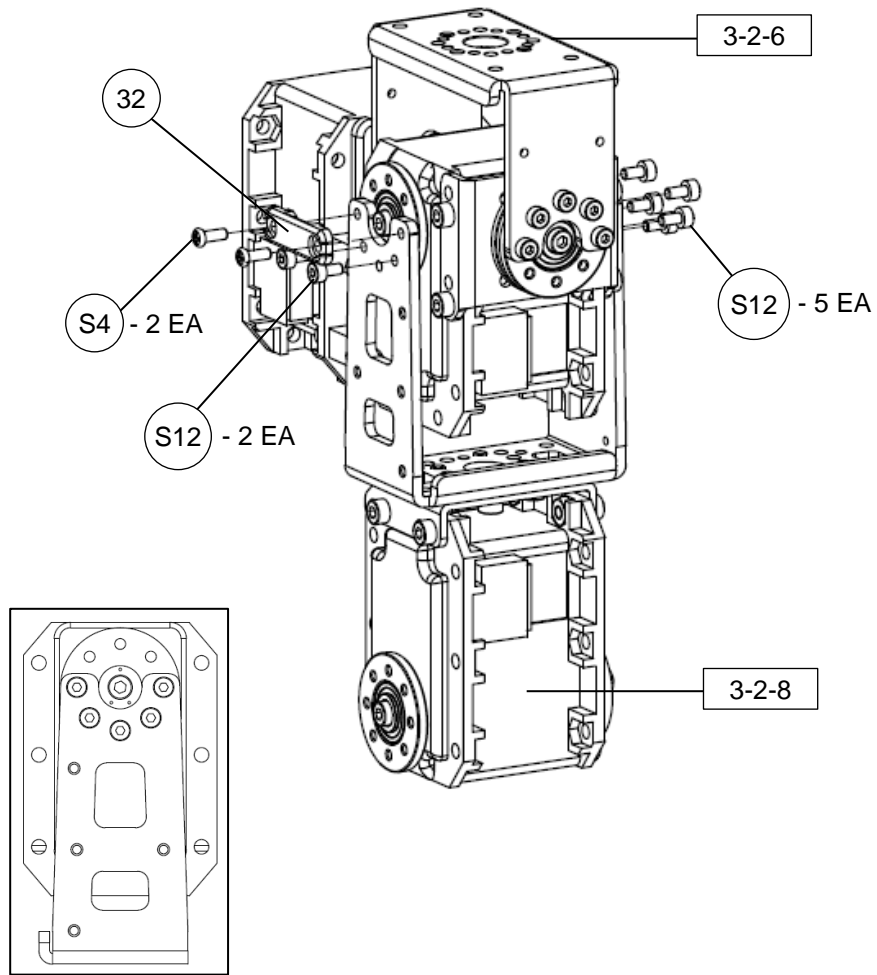
3-2-8. M13 to actuator mount



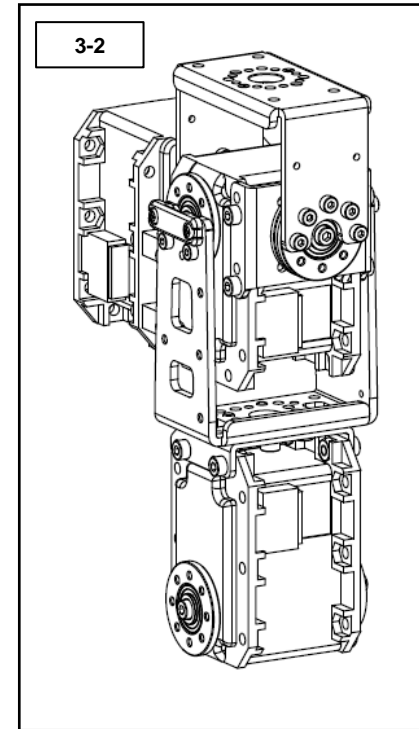
# 3. Right Leg

## 3-2. Right upper leg

3-2-9. 3-2-6 to 3-2-8 assembly



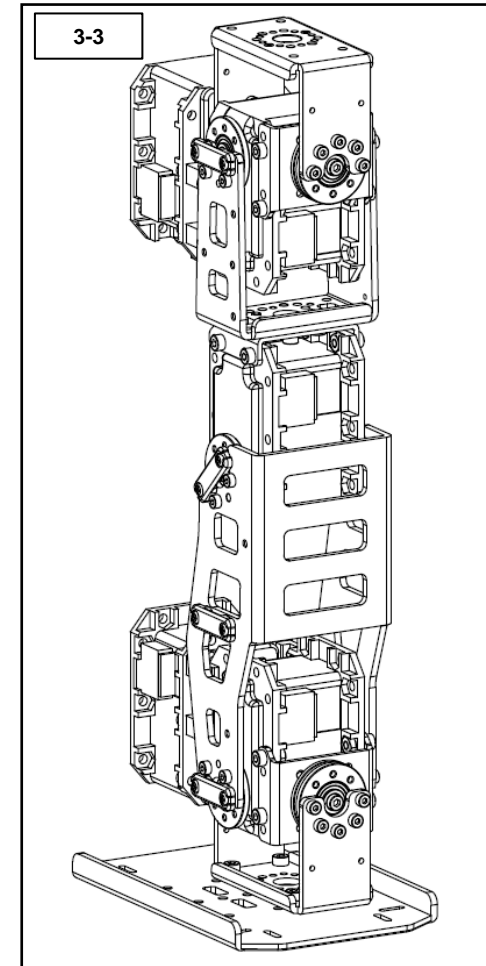
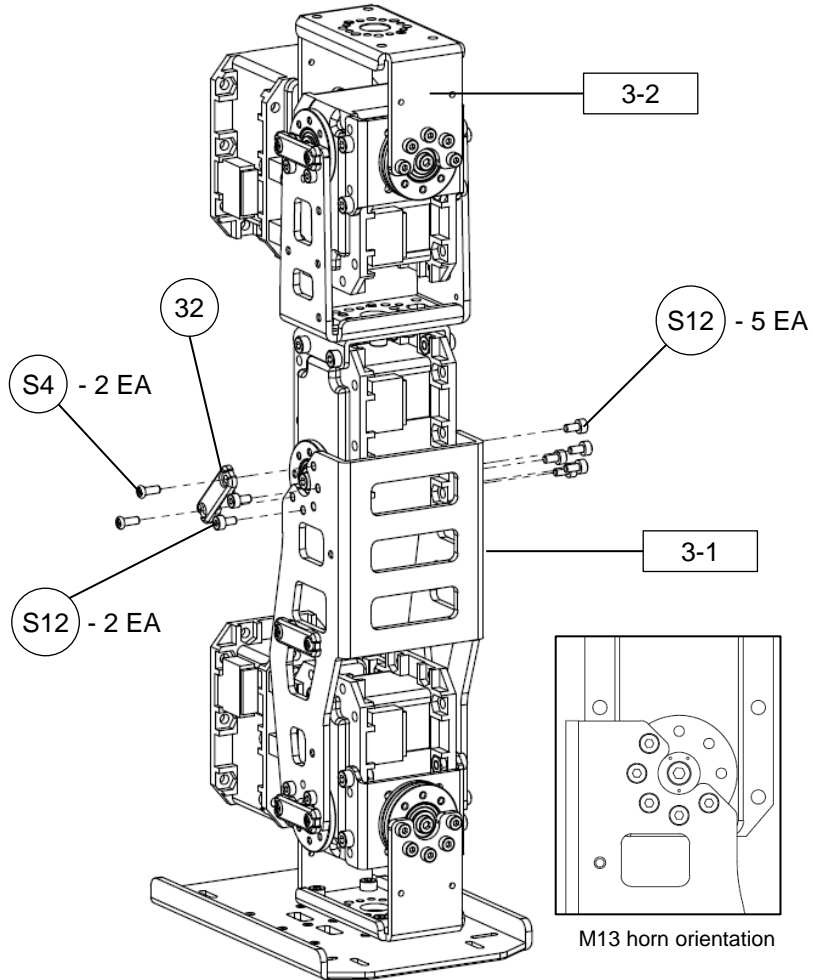
M11 horn orientation



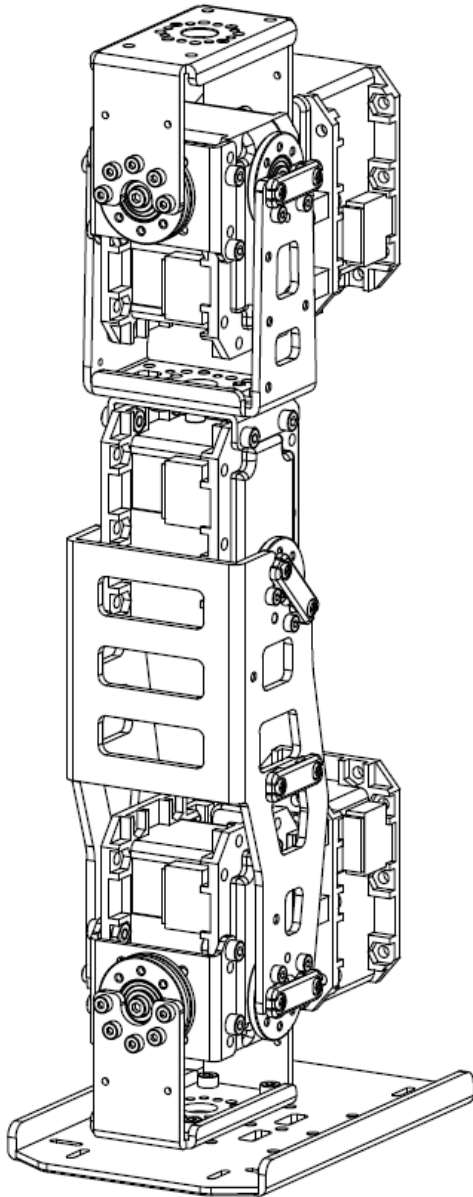
# 3. Right Leg

## 3-3. Right leg unit assembly

3-3-1. 3-1 to 3-2 assembly



# 4. Left Leg

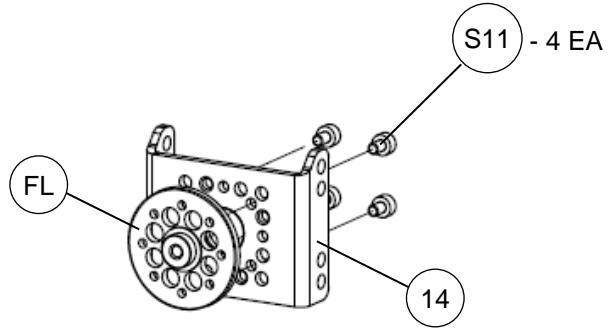


Part Number	Description	Qty.
13	U-Actuator Bracket	2
14	Actuator Mount	3
15	Actuator Connectors	4
16	Thigh Bracket	1
17	Knee Bracket	1
18	Foot	1
22	FitPC	1
32	Cable Holder	4
M10	Dynamixel MX-28	1
M12	Dynamixel MX-28	1
M14	Dynamixel MX-28	1
M16	Dynamixel MX-28	1
M18	Dynamixel MX-28	1
S3	Phillips Head M2x4	2
S4	Phillips Head M2x5	6
S11	Hex Head M2x3	8
S12	Hex Head M2x4	41
S13	Hex Head M2.5x3	4
S14	Hex Head M2.5x4	4
S15	Hex Head M2.5x6	28
S16	Hex Head M2.5x8	10
N1	Nut M2.5	20
BC	Bearing Cap	2
BG	Bearing	2
FL	Flange Bearing	2
ID	Bearing Idler	2

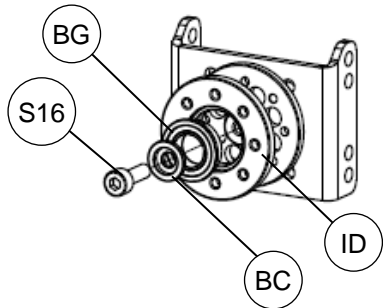
# 4. Left Leg

## 4-1. Left lower leg

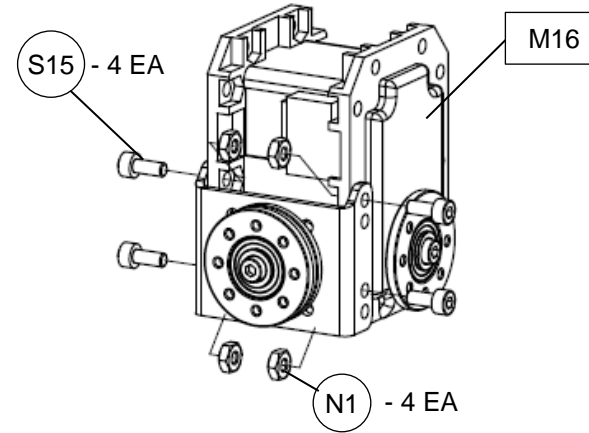
4-1-1. Lower leg actuator mount assembly



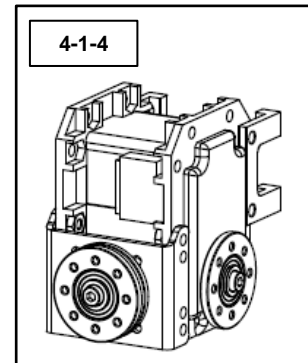
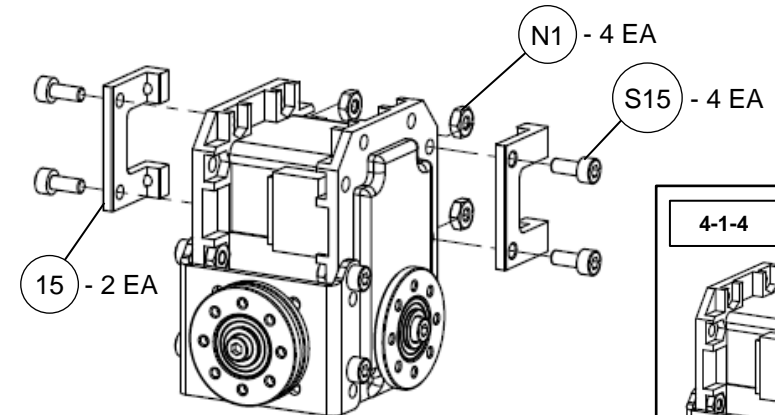
4-1-2. Lower leg actuator mount bearing assembly



4-1-3. M16 to lower leg actuator mount



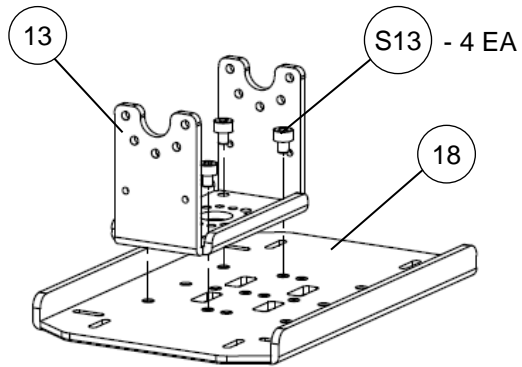
4-1-4. Motor bracket assembly



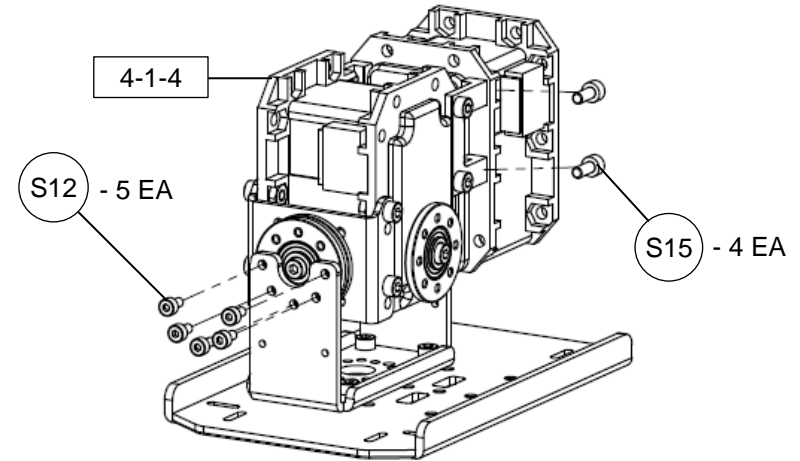
# 4. Left Leg

## 4-1. Left lower leg

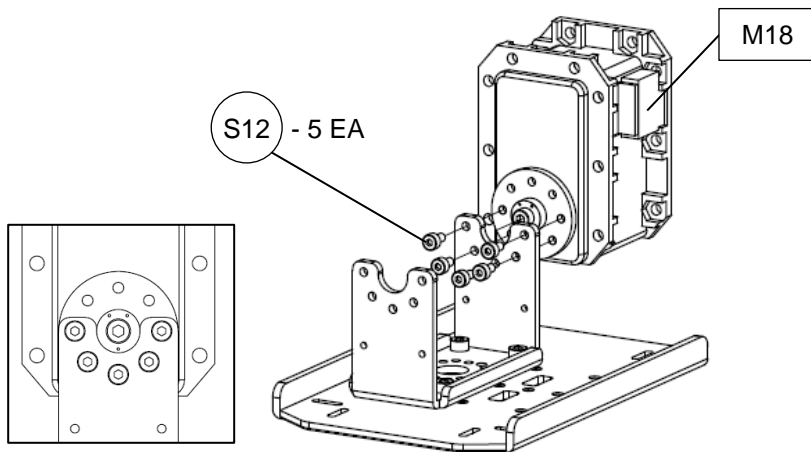
4-1-4. U-actuator bracket to foot



4-1-7. 4-1-4 to U-actuator bracket



4-1-6. M18 to U-actuator bracket

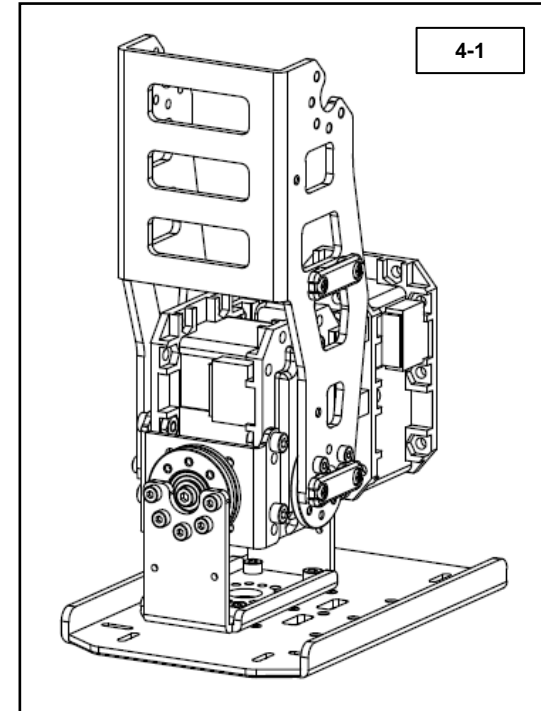
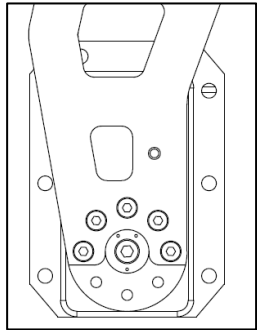
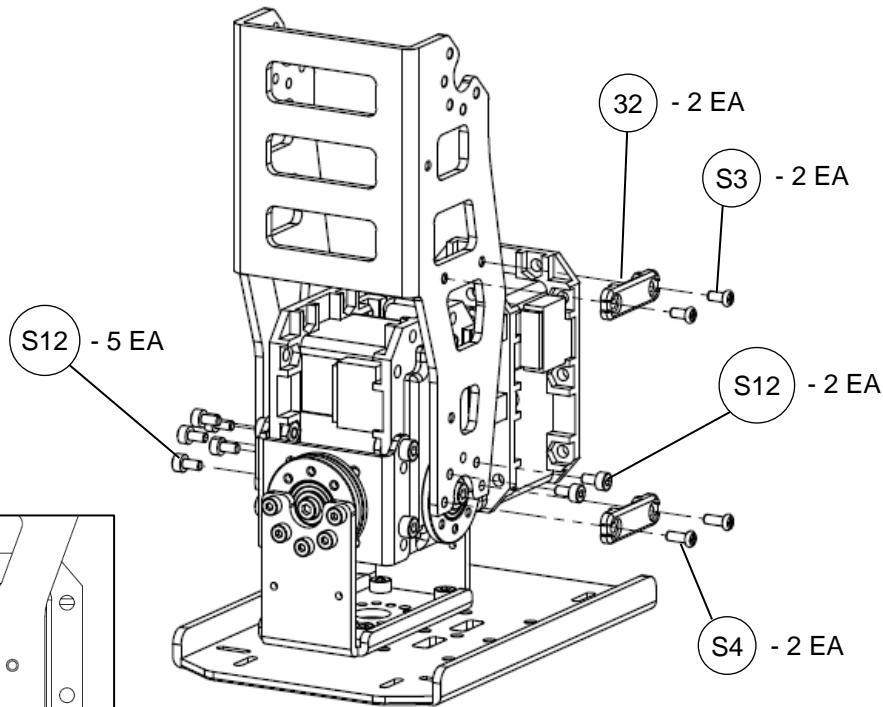


M18 horn orientation

# 4. Left Leg

## 4-1. Left lower leg

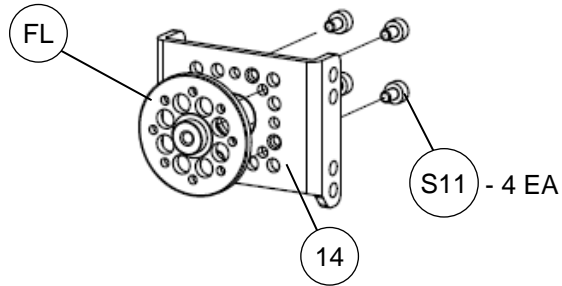
4-1-8. Knee bracket to foot



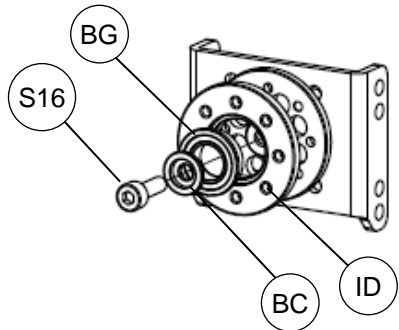
# 4. Left Leg

## 4-2. Left upper leg

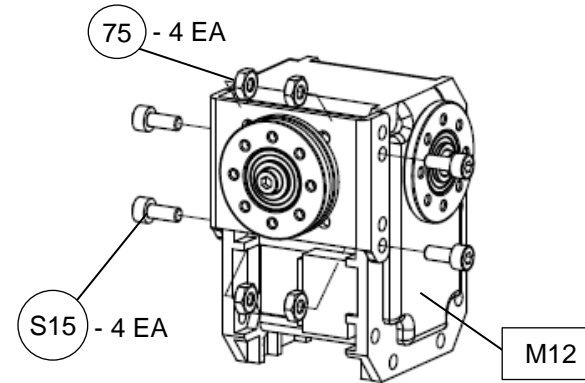
4-2-1. Upper leg actuator mount assembly



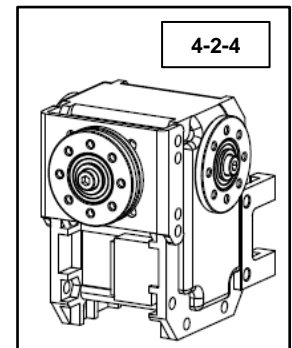
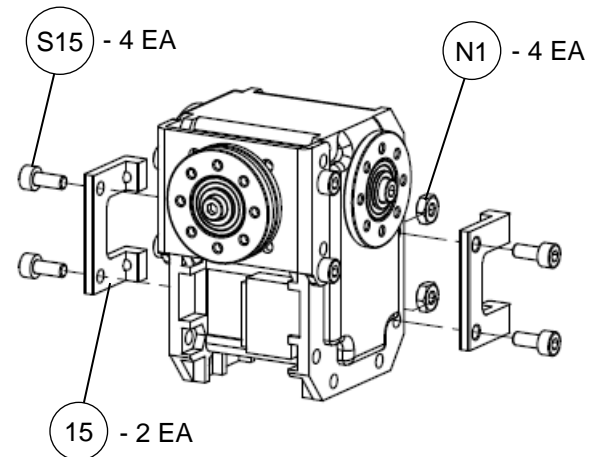
4-2-2. Upper leg actuator mount bearing assembly



4-2-3. M12 to upper leg actuator mount



4-2-4. Actuator connectors to M12



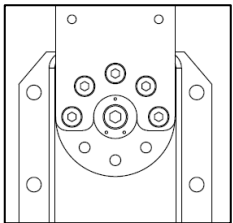
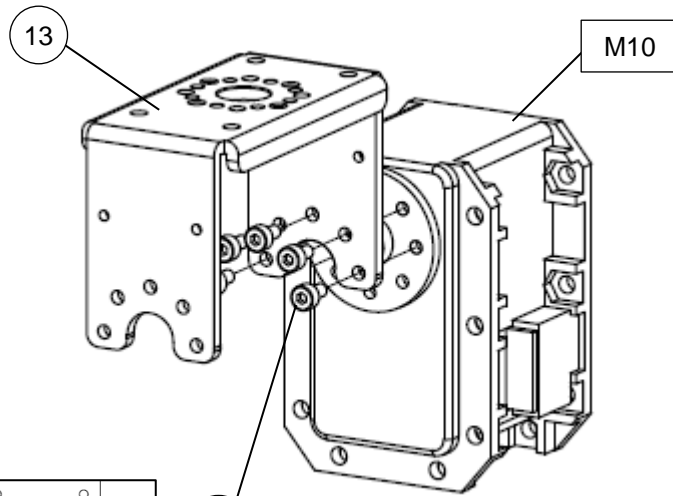


# 4. Left Leg

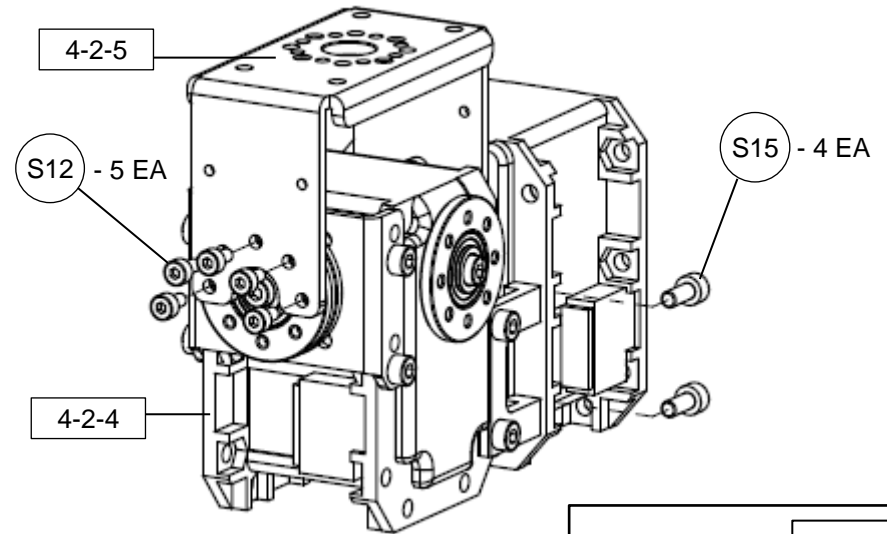
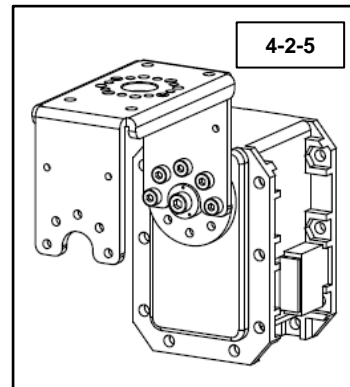
## 4-2. Left upper leg

4-2-5. M9 to U-actuator bracket

4-2-6. 4-2-4 to 4-2-5 assembly



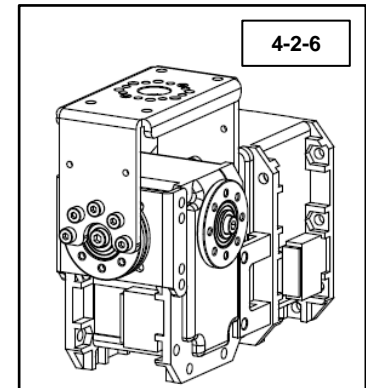
S12 - 5 EA



S12 - 5 EA

S15 - 4 EA

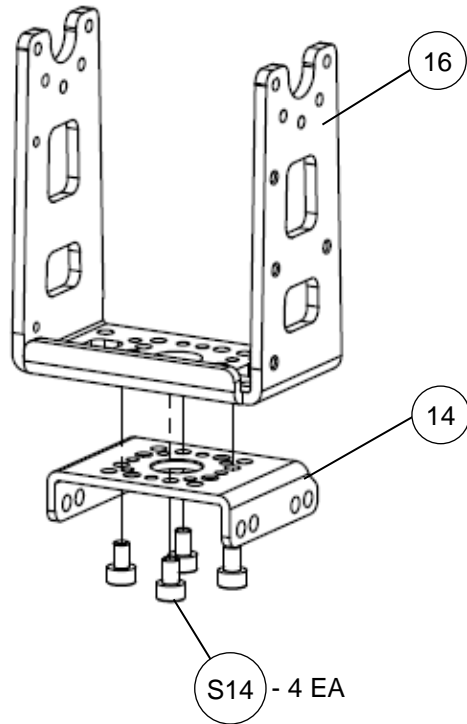
4-2-4



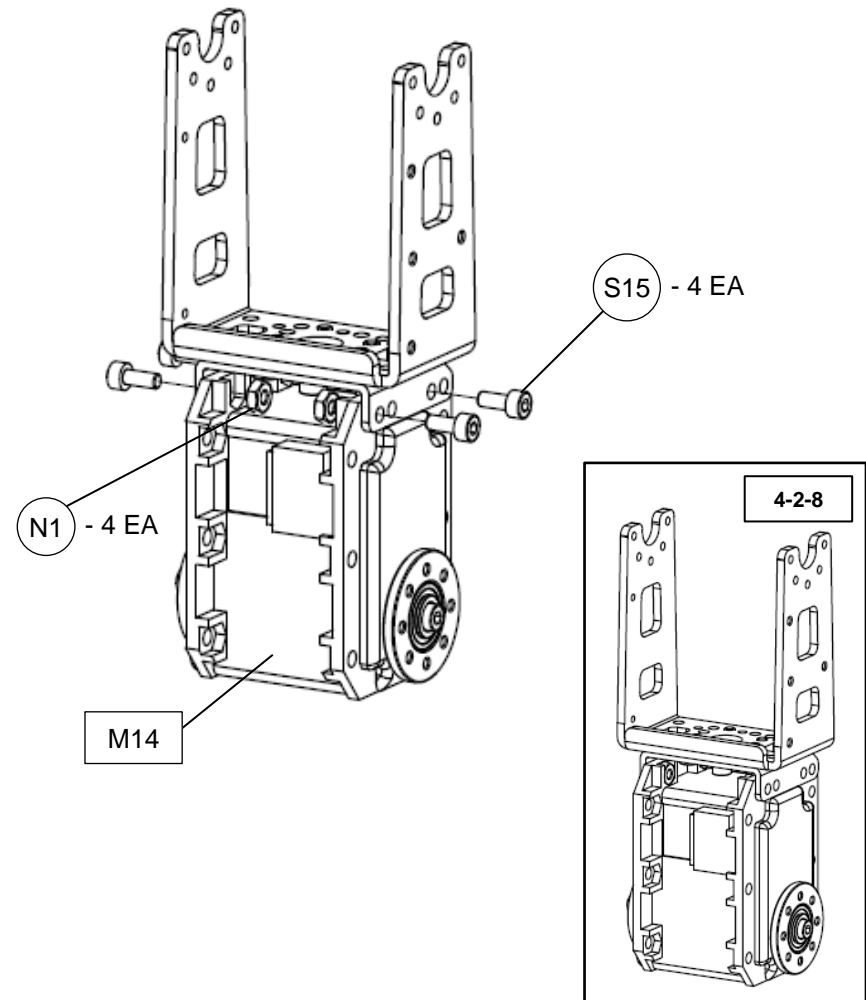
# 4. Left Leg

## 4-2. Left upper leg

4-2-7. Thigh bracket to actuator mount



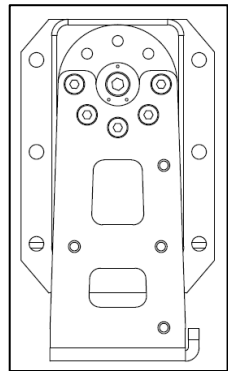
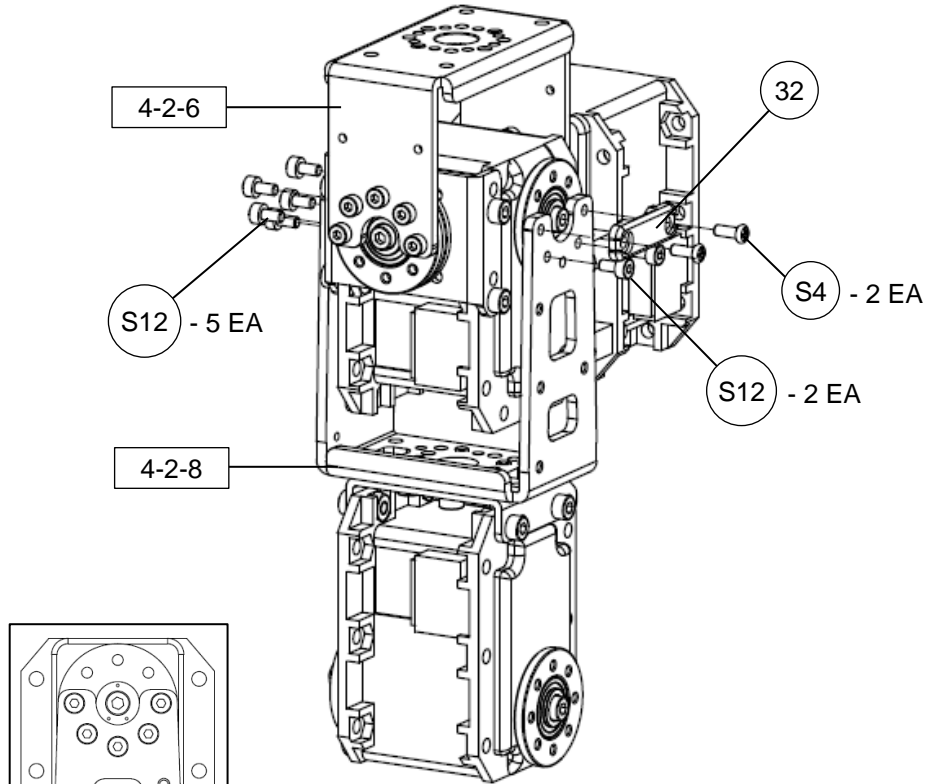
4-2-8. M14 to actuator mount



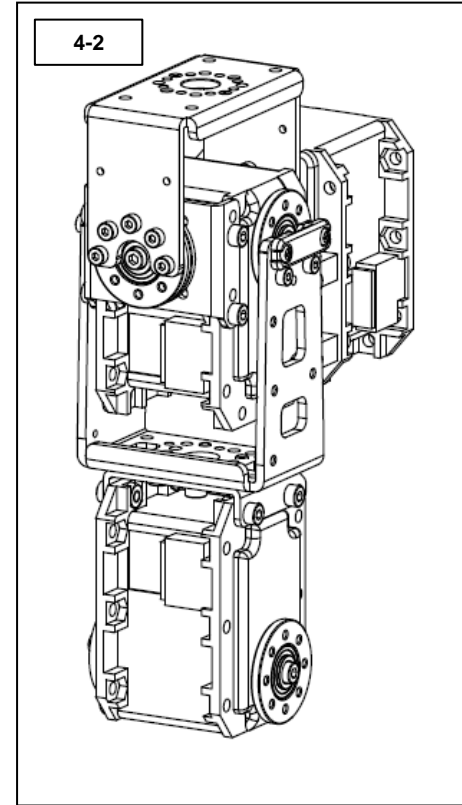
# 4. Left Leg

## 4-2. Left upper leg

4-2-9. 4-2-6 to 4-2-8 assembly



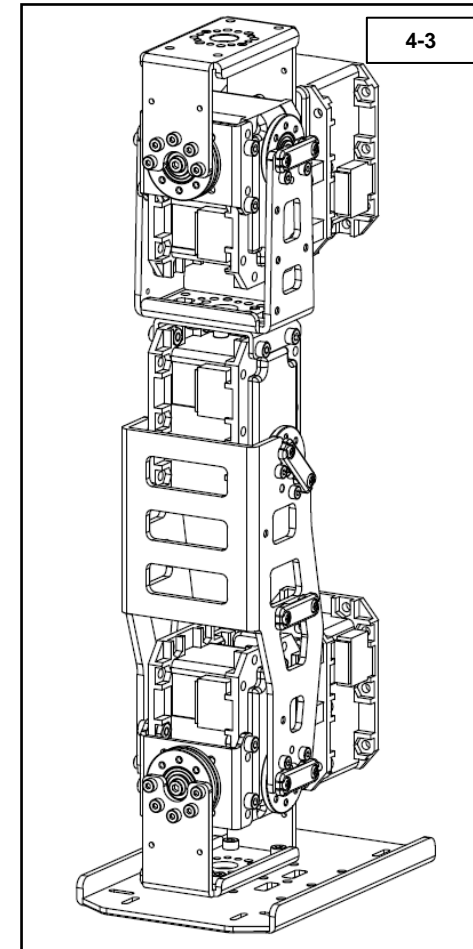
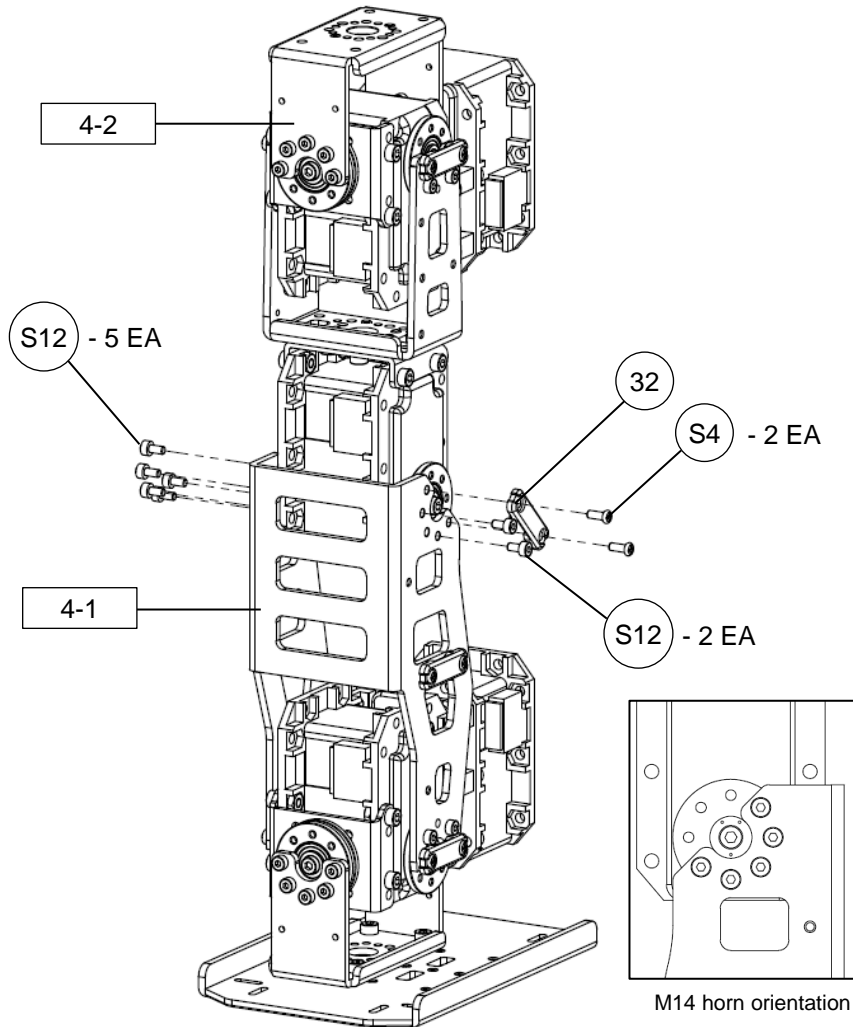
M12 horn orientation



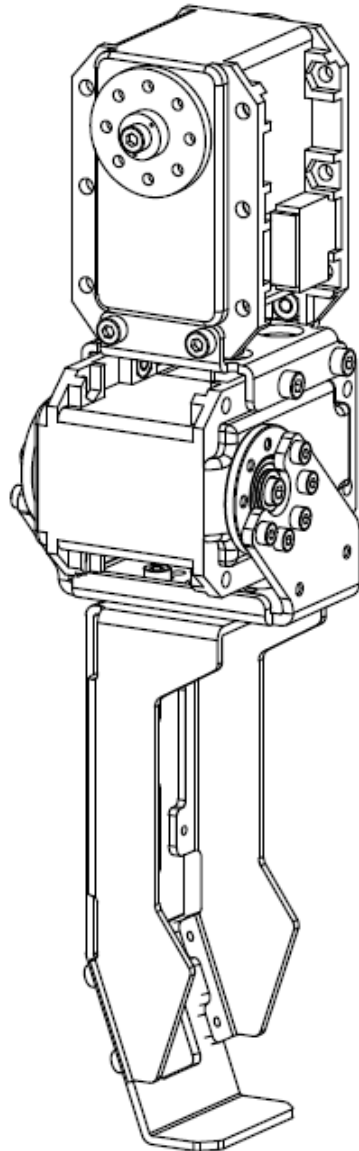
# 4. Left Leg

## 4-3. Left leg unit assembly

4-3-1. 4-1 to 4-2 assembly



# 5. Right Arm

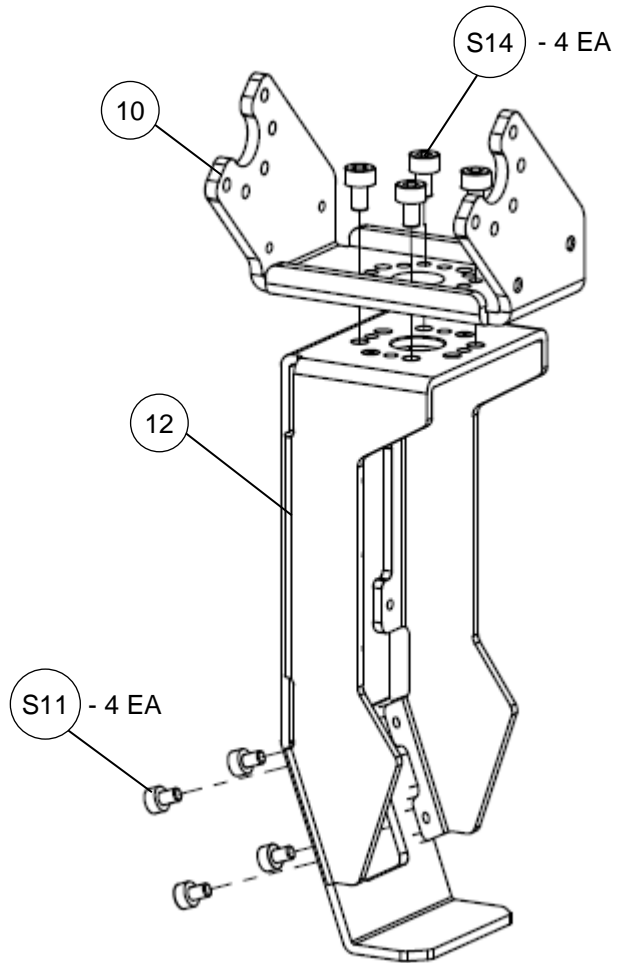


Part Number	DESCRIPTION	QTY.
10	Angled Actuator Bracket	1
11	Actuator Mount	1
12	Hand	1
M3	Dynamixel MX-28	1
M5	Dynamixel MX-28	1
S11	Hex Head M2x3	4
S12	Hex Head M2x4	10
S14	Hex Head M2.5x4	4
S15	Hex Head M2.5x6	8
S16	Hex Head M2.5x8	4
N1	Nut M2.5	8

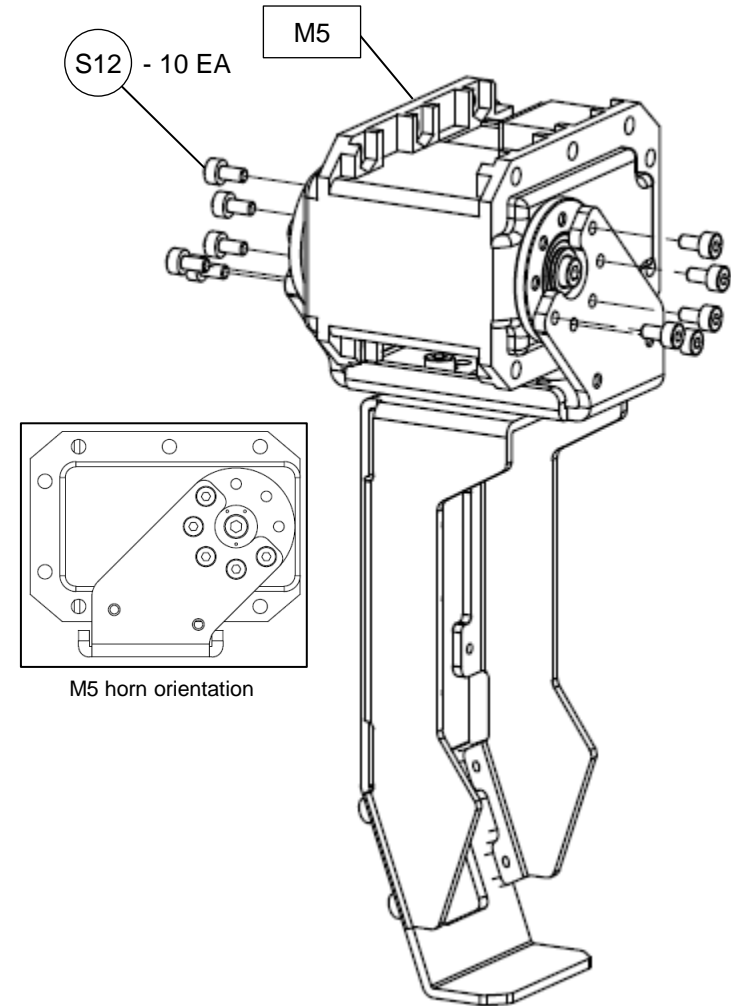
# 5. Right Arm

## 5-1. Right arm unit assembly

### 5-1-1. Angled actuator bracket to hand



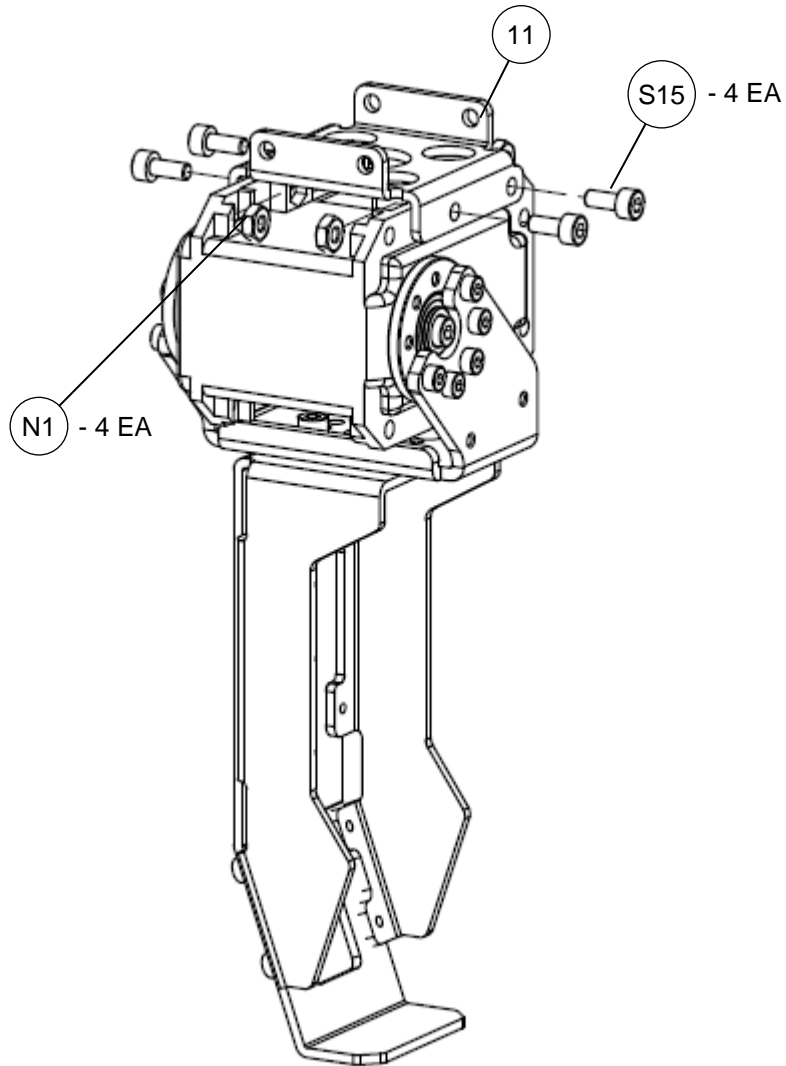
### 5-1-1. M5 to angled actuator bracket



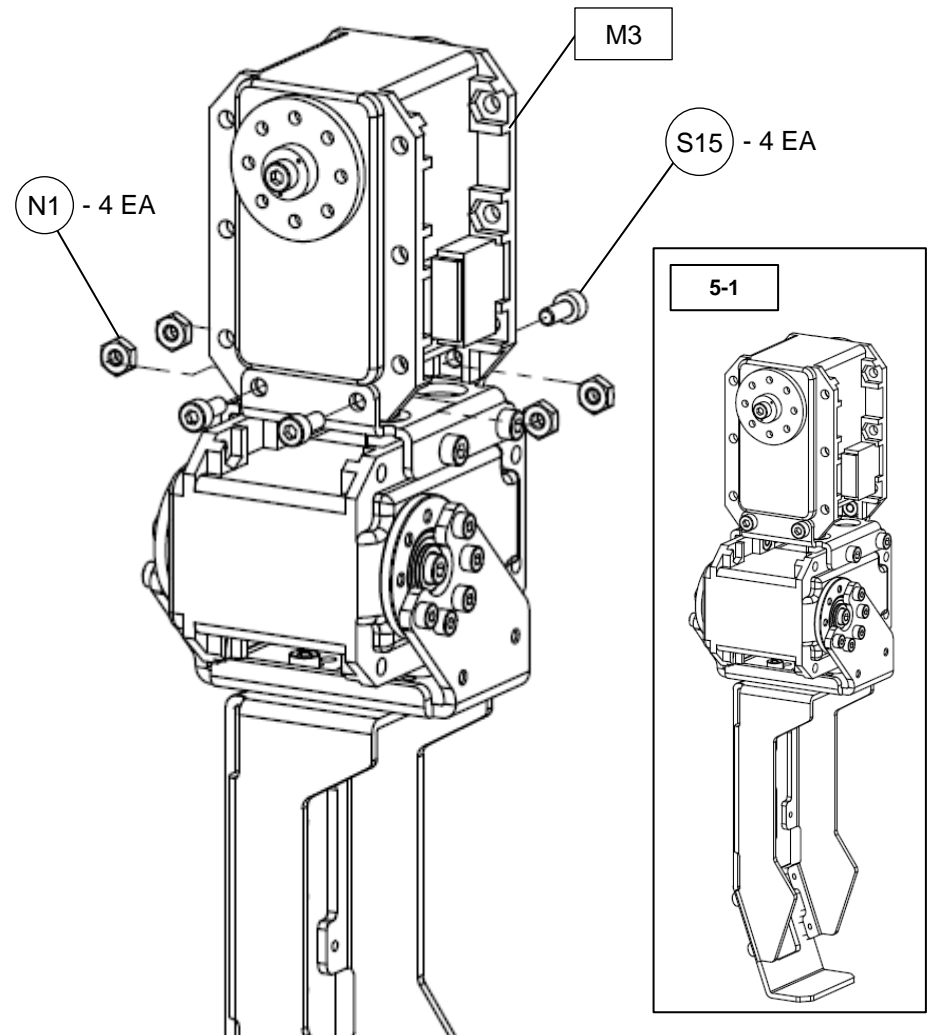
# 5. Right Arm

## 5-1. Right arm unit assembly

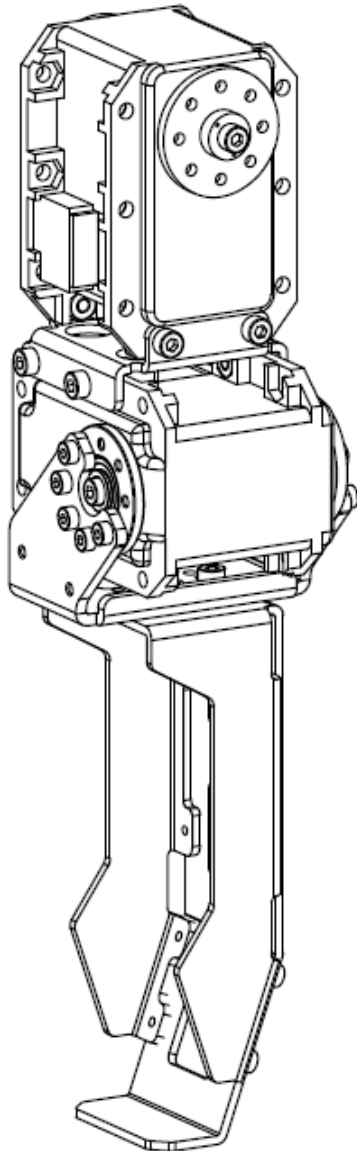
5-1-3. Actuator mount to M5



5-1-4. M3 to actuator mount



# 6. Left Arm



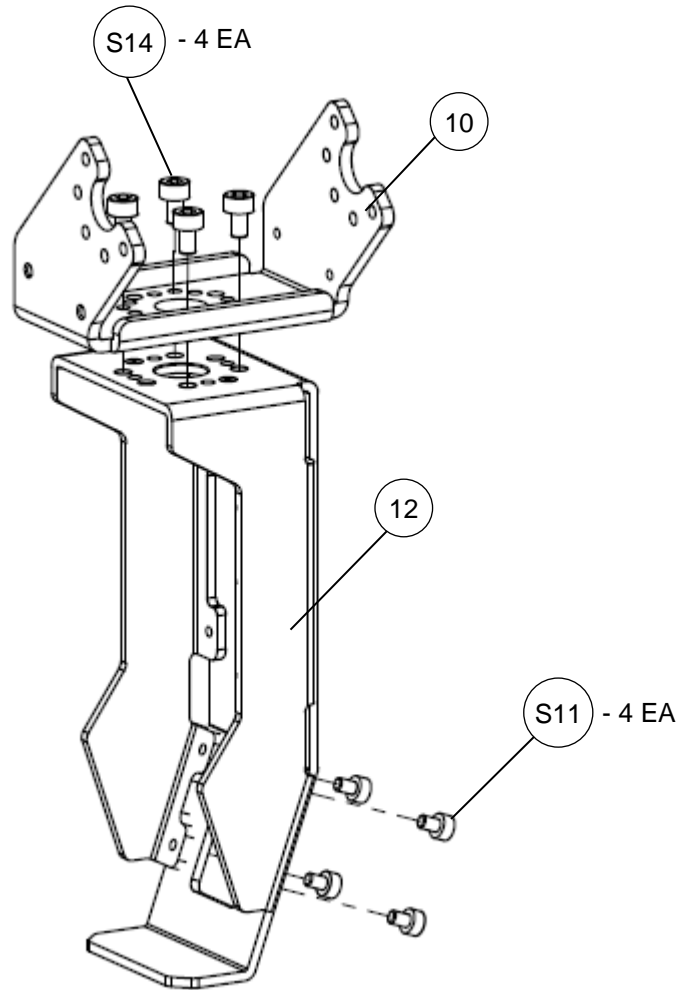
Part Number	DESCRIPTION	QTY.
10	Angled Actuator Bracket	1
11	Actuator Mount	1
12	Hand	1
M4	Dynamixel MX-28	1
M6	Dynamixel MX-28	1
S11	Hex Head M2x3	4
S12	Hex Head M2x4	10
S14	Hex Head M2.5x4	4
S15	Hex Head M2.5x6	8
S16	Hex Head M2.5x8	4
N1	Nut M2.5	8



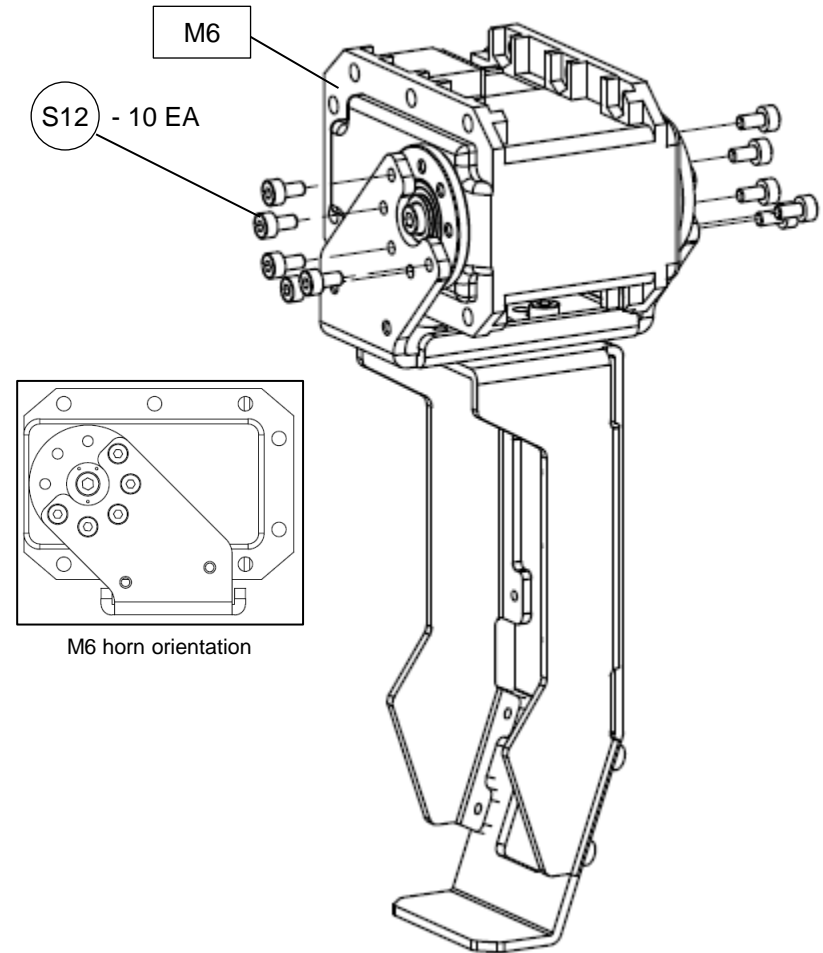
# 6. Left Arm

## 6-1. Left arm unit assembly

6-1-1. Angled actuator bracket to hand



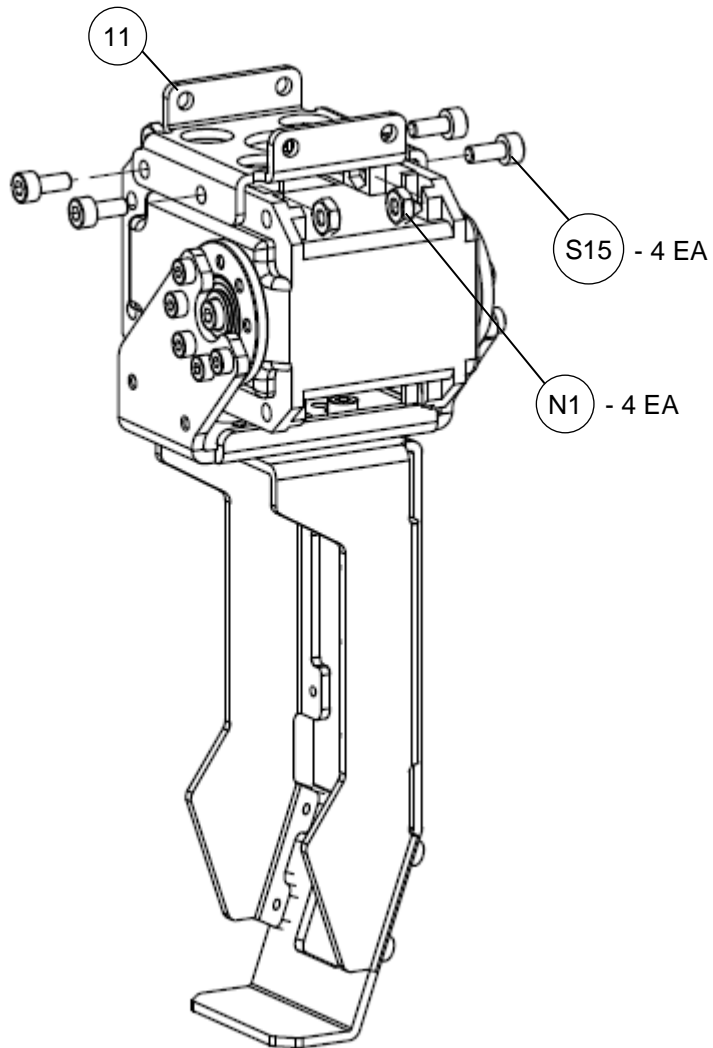
6-1-2. M6 to angled actuator bracket



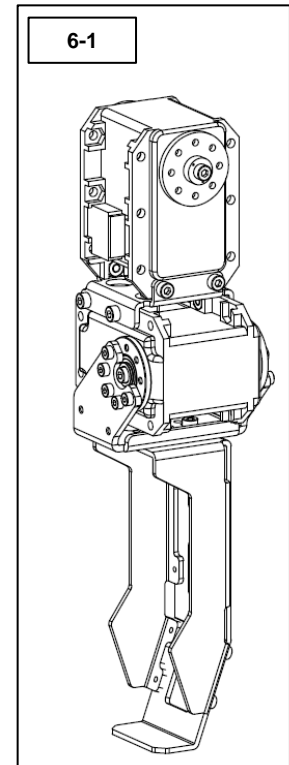
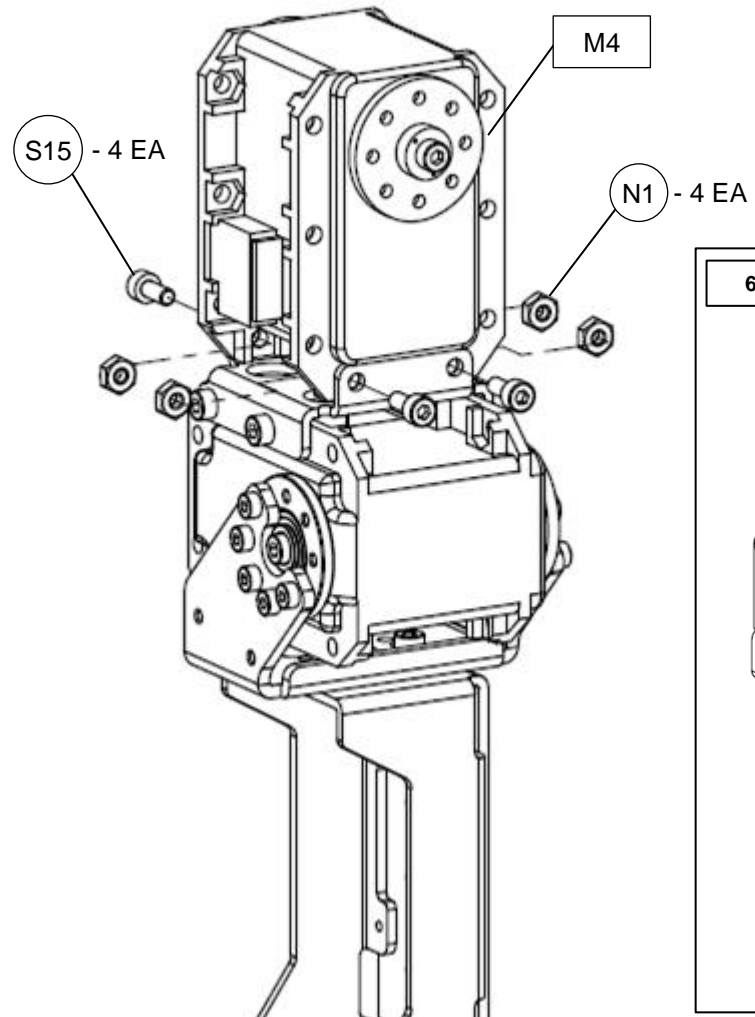
# 6. Left Arm

## 6-1. Left arm unit assembly

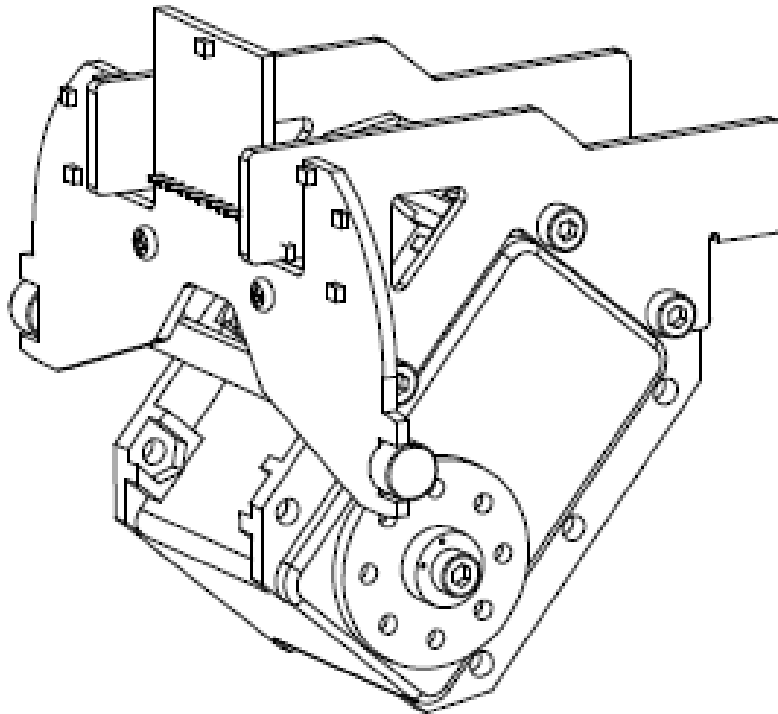
6-1-3. Actuator mount to M6



6-1-4. M4 to actuator mount



# 7. Head

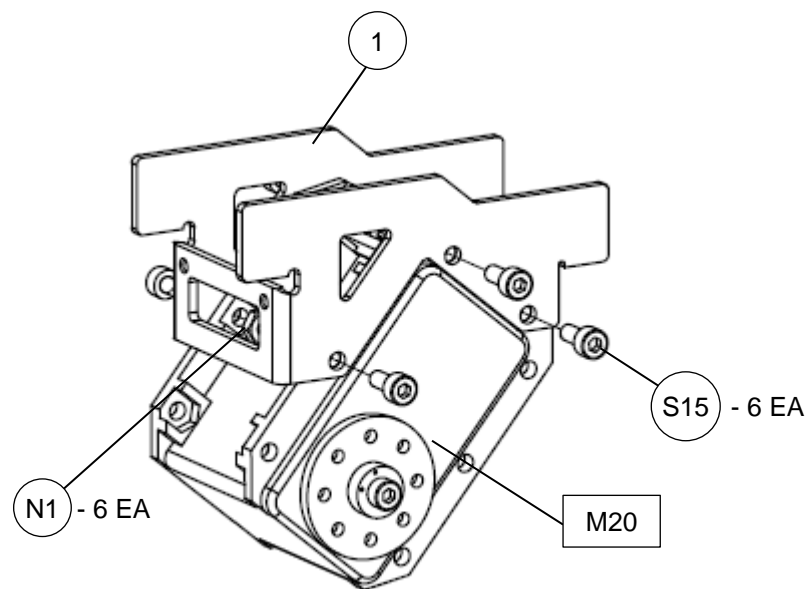


Part Number	DESCRIPTION	QTY.
1	Head Bracket	1
20	Head PCB	1
S3	Phillips Head M2x4	2
S15	Hex Head M2.5x6	6
N1	Nut M2.5	6

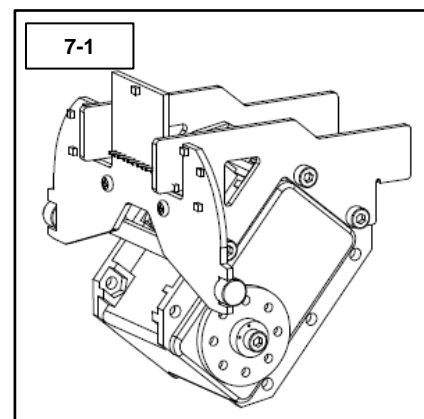
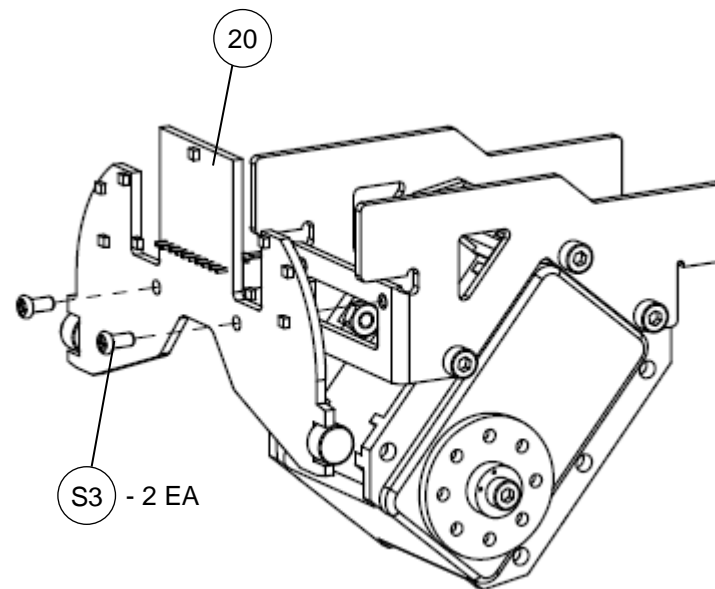
# 7. Head

## 7-1. Head unit assembly

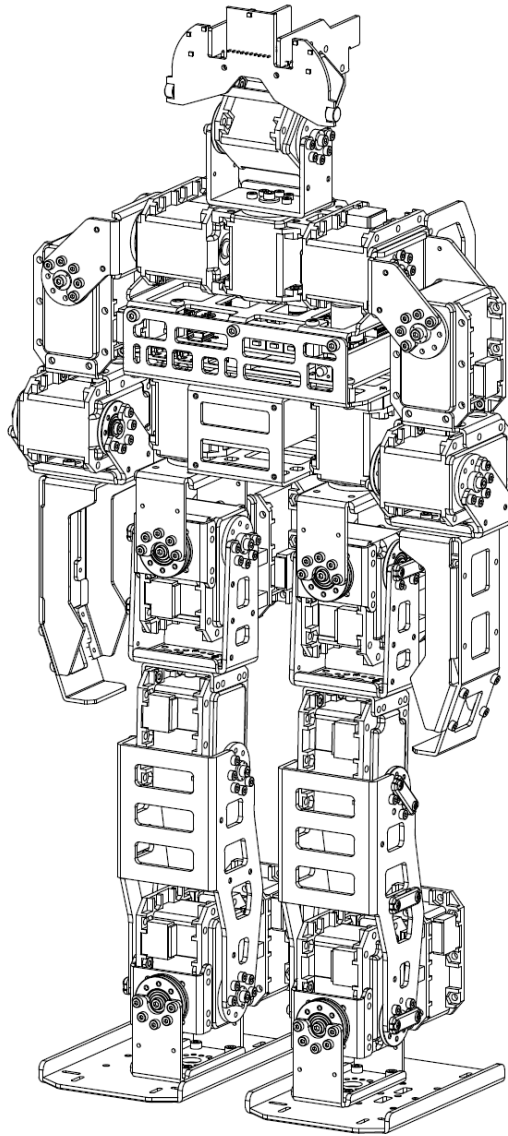
7-1-1. Head bracket to M20



7-1-2. Head PCB to head bracket



# 8. Full Assembly

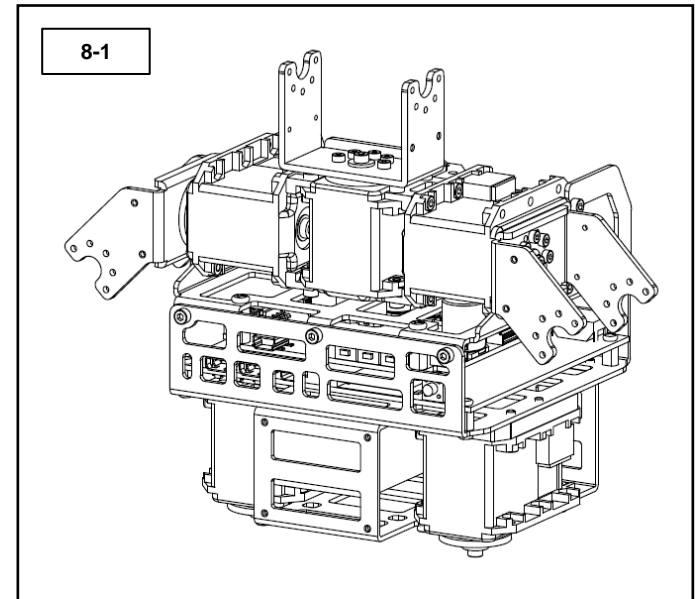
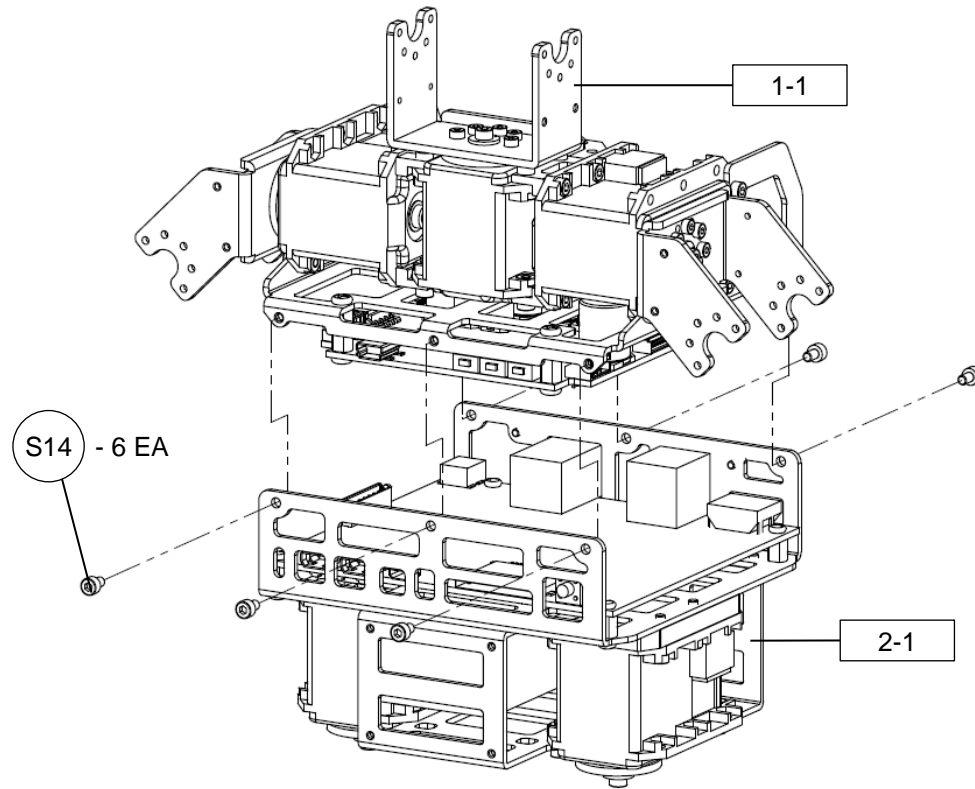


Part Number	Description	Qty.
32	Cable Holder	2
S4	Phillips Head M2x5	4
S11	Hex Head M2x3	4
S12	Hex Head M2x4	20
S14	Hex Head M2.5x4	22

# 8. Full Assembly

## 8-1. Chest unit assembly

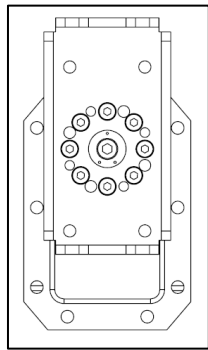
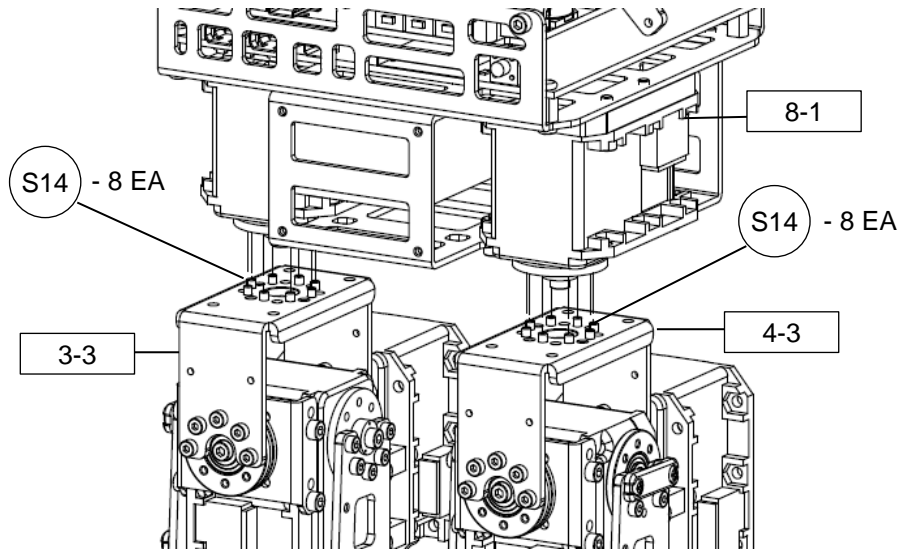
8-1-1. 1-1 to 2-1 assembly



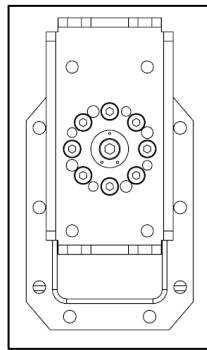
# 8. Full Assembly

## 8-2. Legs to body assembly

8-2-1. [3-3] and [4-3] to [8-1] assembly



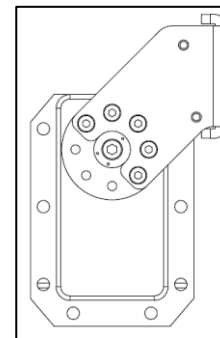
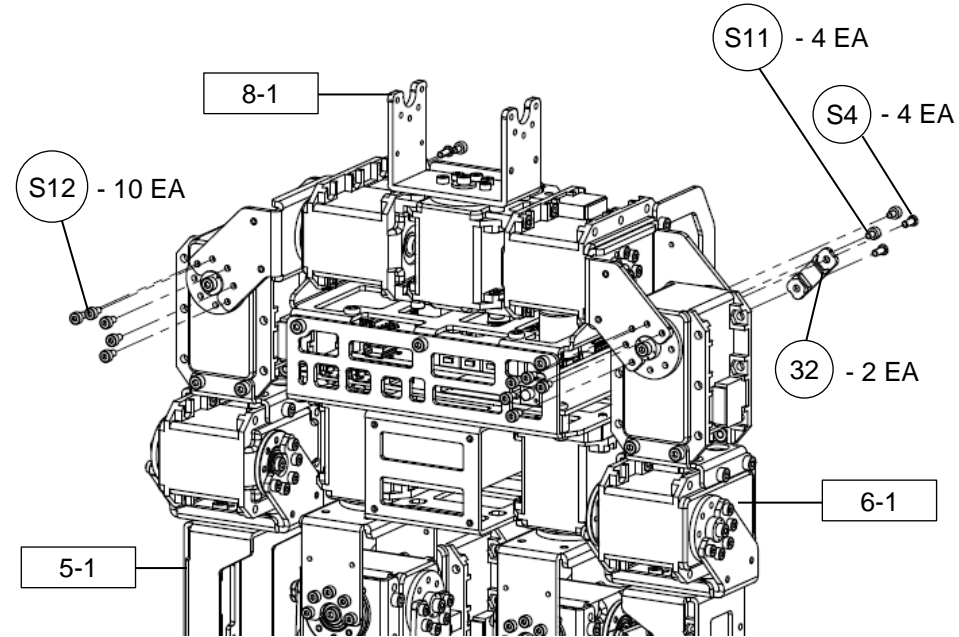
M9 horn orientation



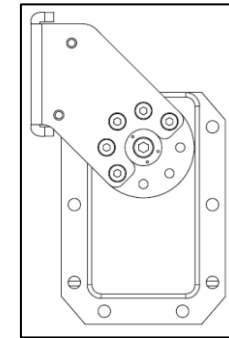
M10 horn orientation

## 8-3. Arms to body assembly

8-3-1. [5-1] and [6-1] to [8-1] assembly



M3 horn orientation

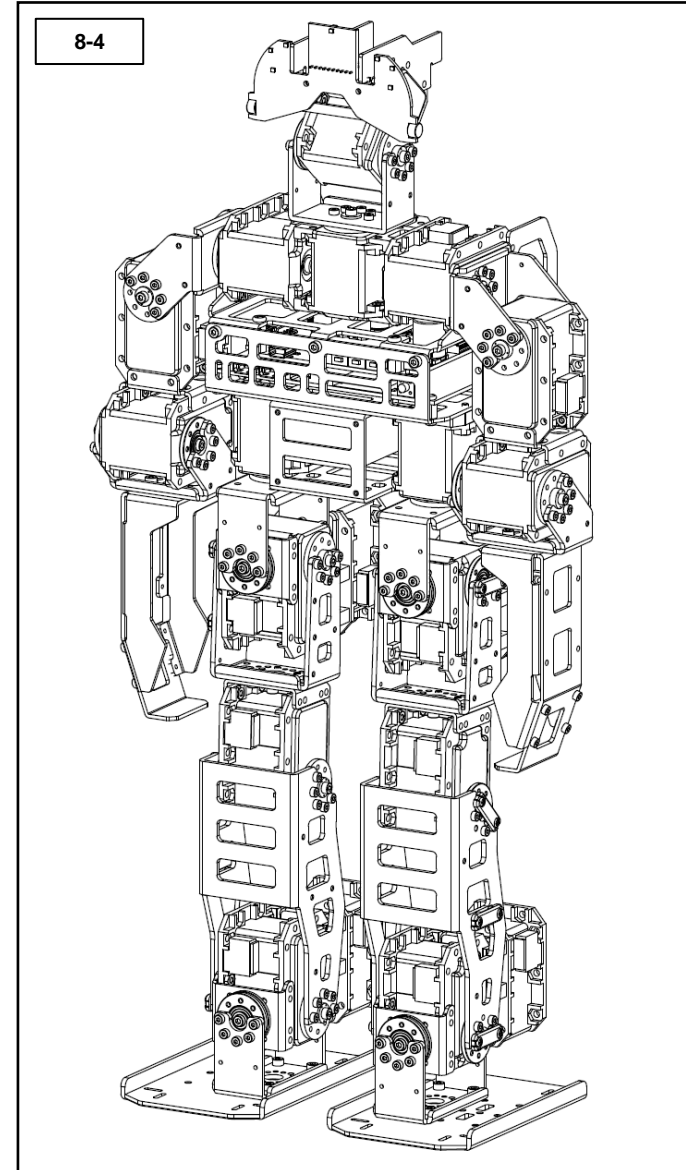
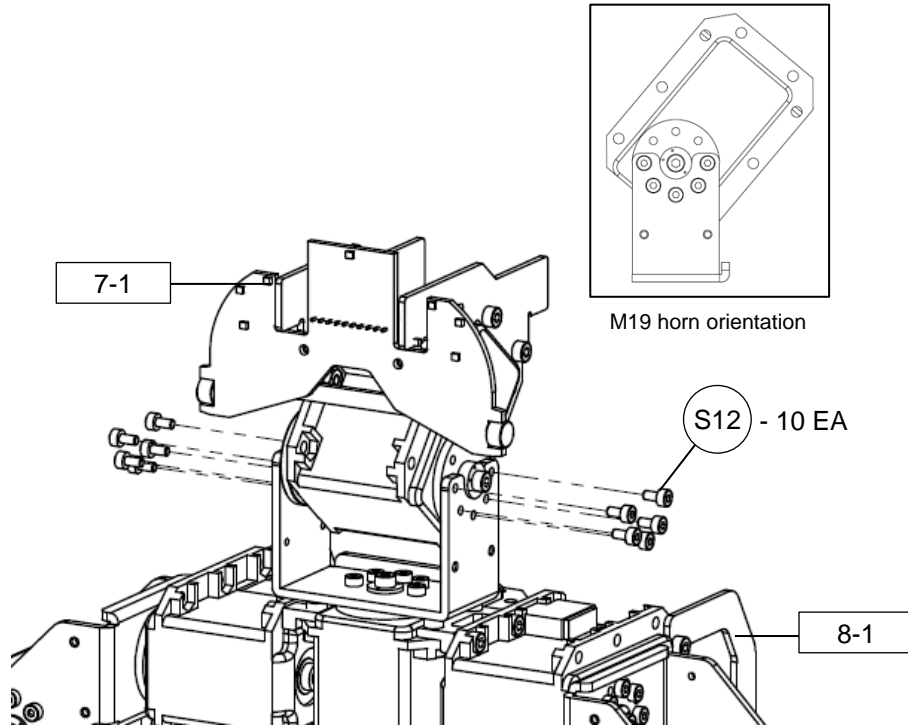


M4 horn orientation

# 8. Full Assembly

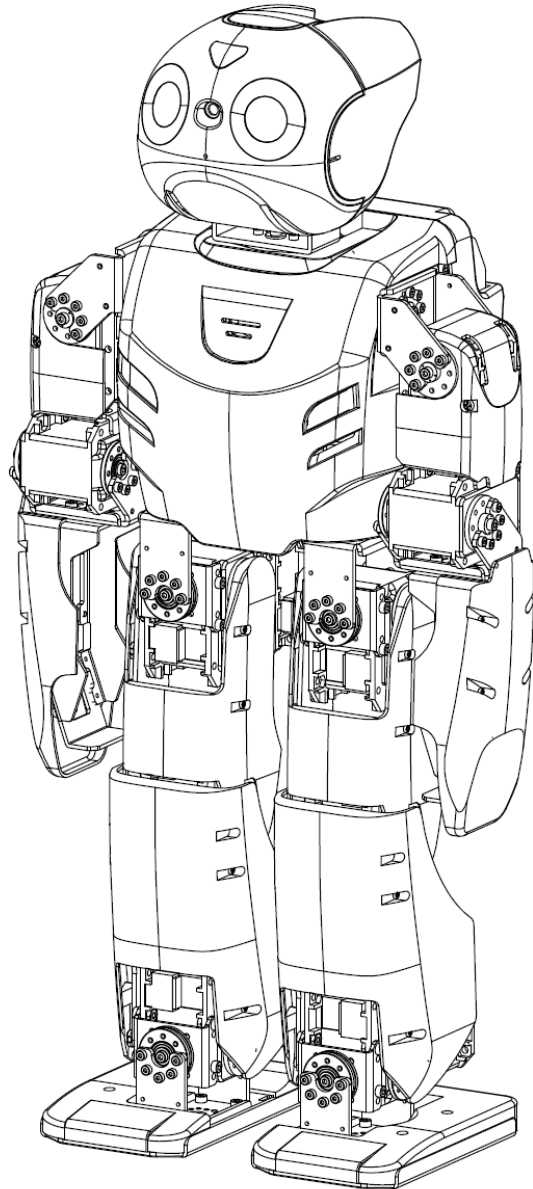
## 8.4 Head to body assembly

8-4-1. 7-1 to 8-1 assembly





# 9. Covers

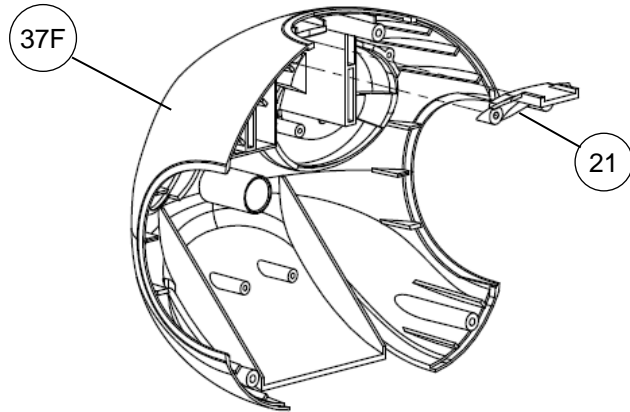


Part Number	Part Description	Quantity
19	Camera	1
21	Head LED Cover	1
26	Fan	2
27	Back Cover PCB	1
29	Speaker	1
33	Arm Cover Upper	2
34	Arm Cover Lower	2
35	Thigh Cover	2
36	Leg Cover	2
37B	Back Head Cover	1
37F	Front Head Cover	1
38B	Back Chest Cover	1
38F	Front Chest Cover	1
39L	Left Foot Cover	1
39R	Right Foot Cover	1
40L	Left Eye Cover	1
40R	Right Eye Cover	1
41L	Left Pupil	1
41R	Right Pupil	1
S1	M1.4x4	6
S2	Button Head M2x4	2
S3	Phillips Head M2x4	16
S5	Phillips Head M2x6	20
S6	Phillips Head M2.5x4	4
S7	Phillips Head M2.5x6	4
S9	Phillips Head M3x6	8

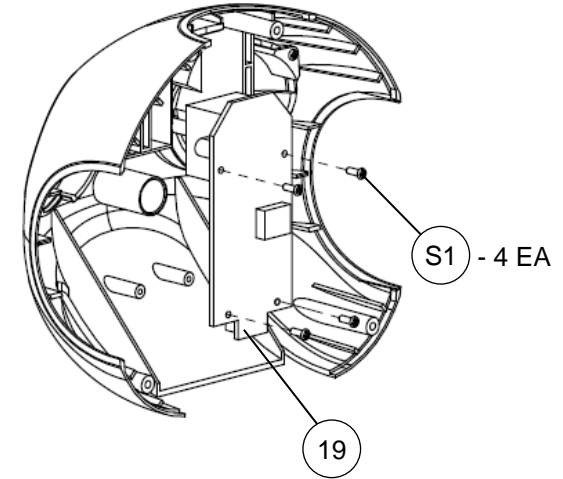
# 9. Covers

## 9-1. Head covers

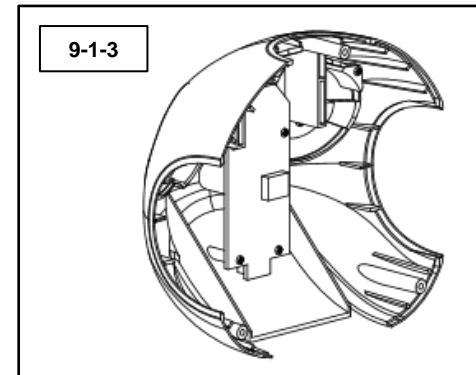
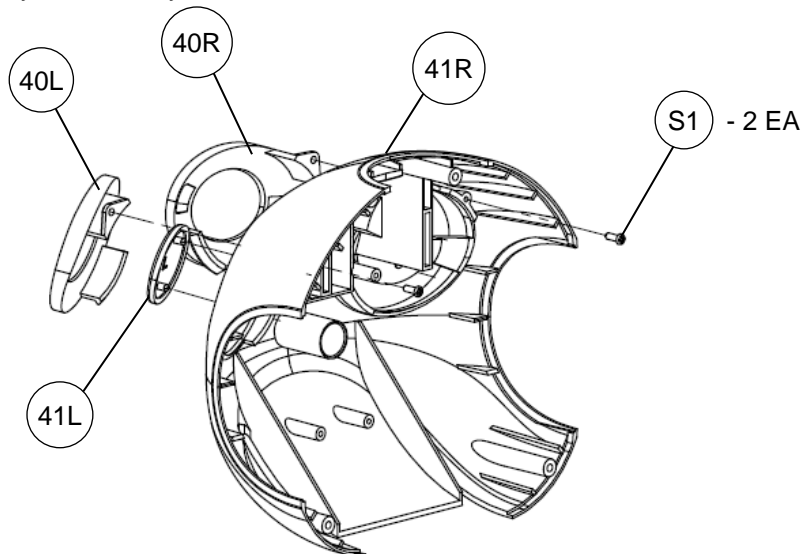
9-1-1. Head led cover to front head cover



9-1-3 Camera to front head cover



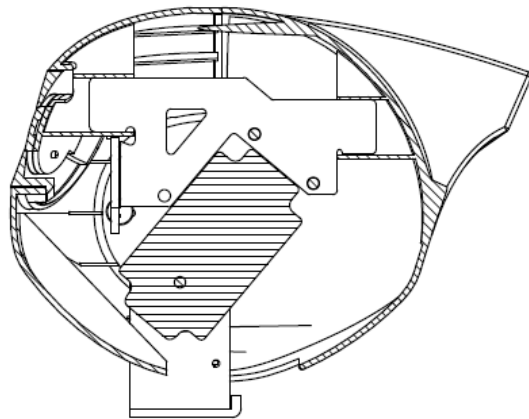
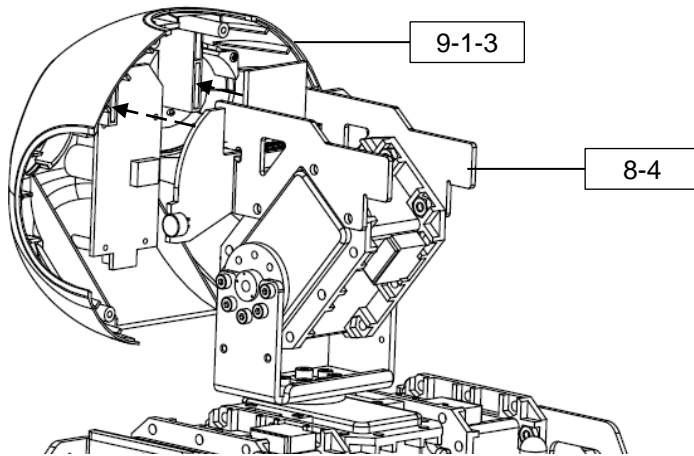
9-1-2. Eyes assembly



# 9. Covers

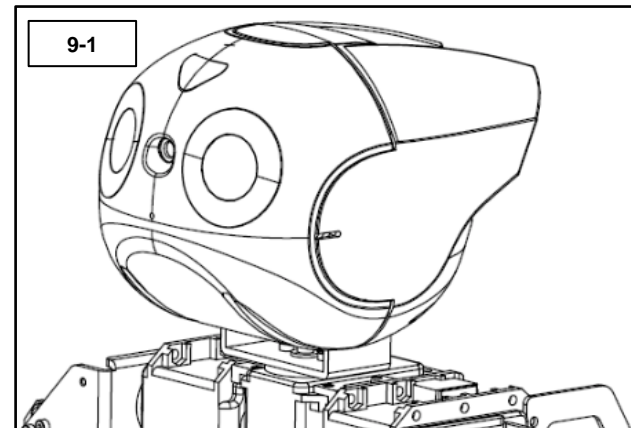
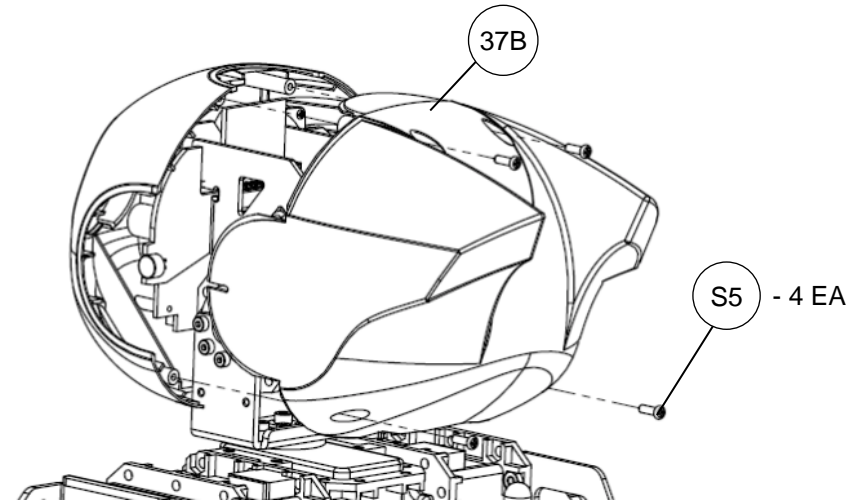
## 9-1. Head covers

9-1-4. Front head cover location on head



Section View

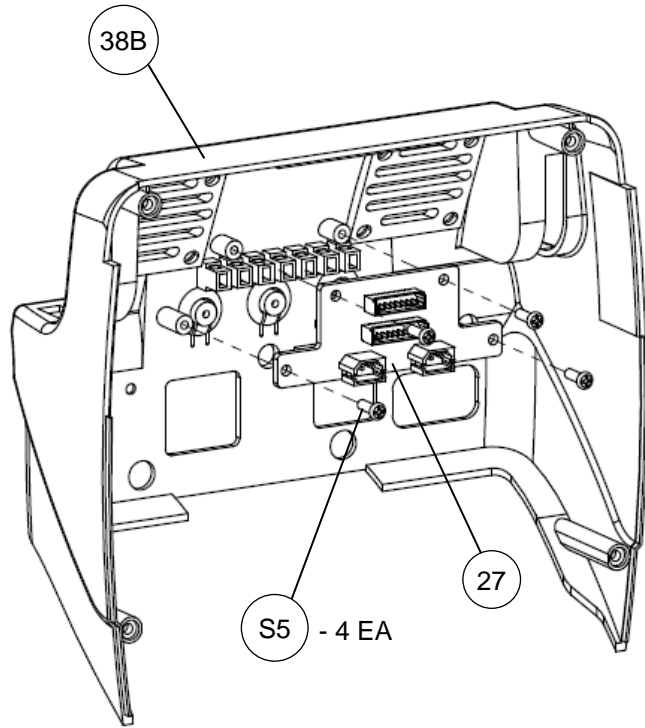
9-1-5. Front head cover to back head cover assembly



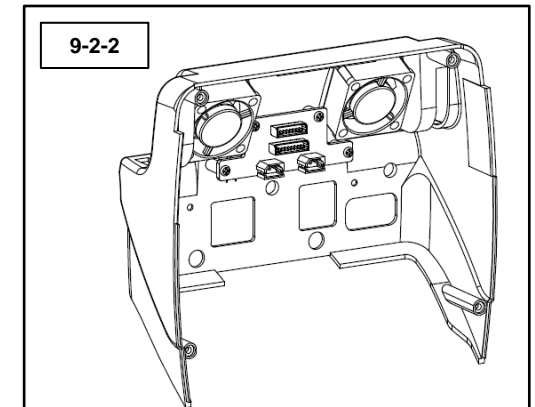
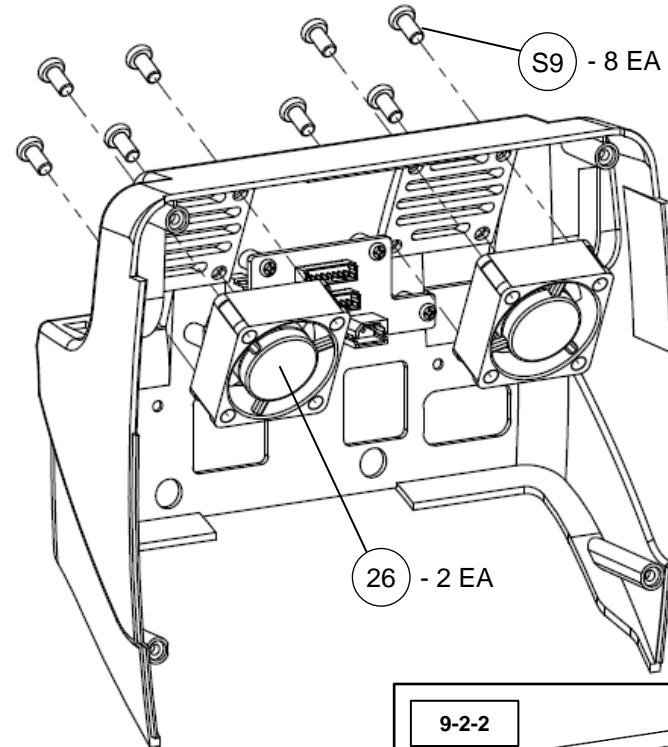
# 9. Covers

## 9-2. Chest covers

9-2-1. Back cover PCB to back chest cover



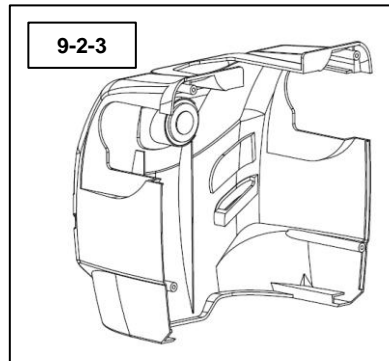
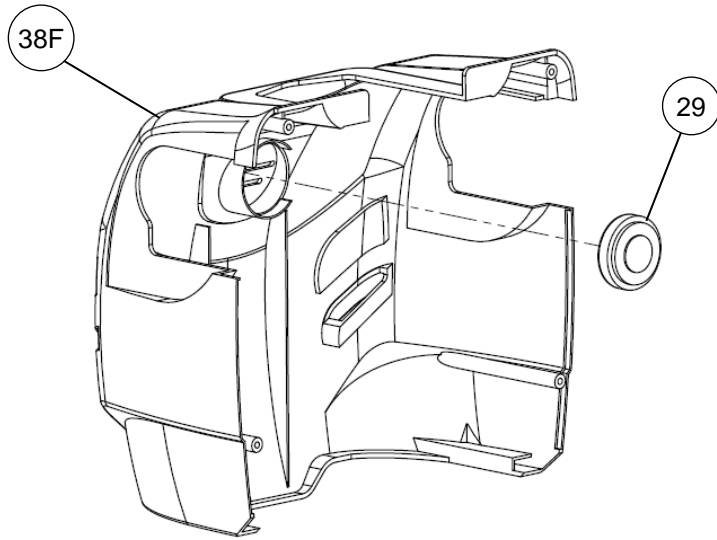
9-2-2. Fans to back cover assembly



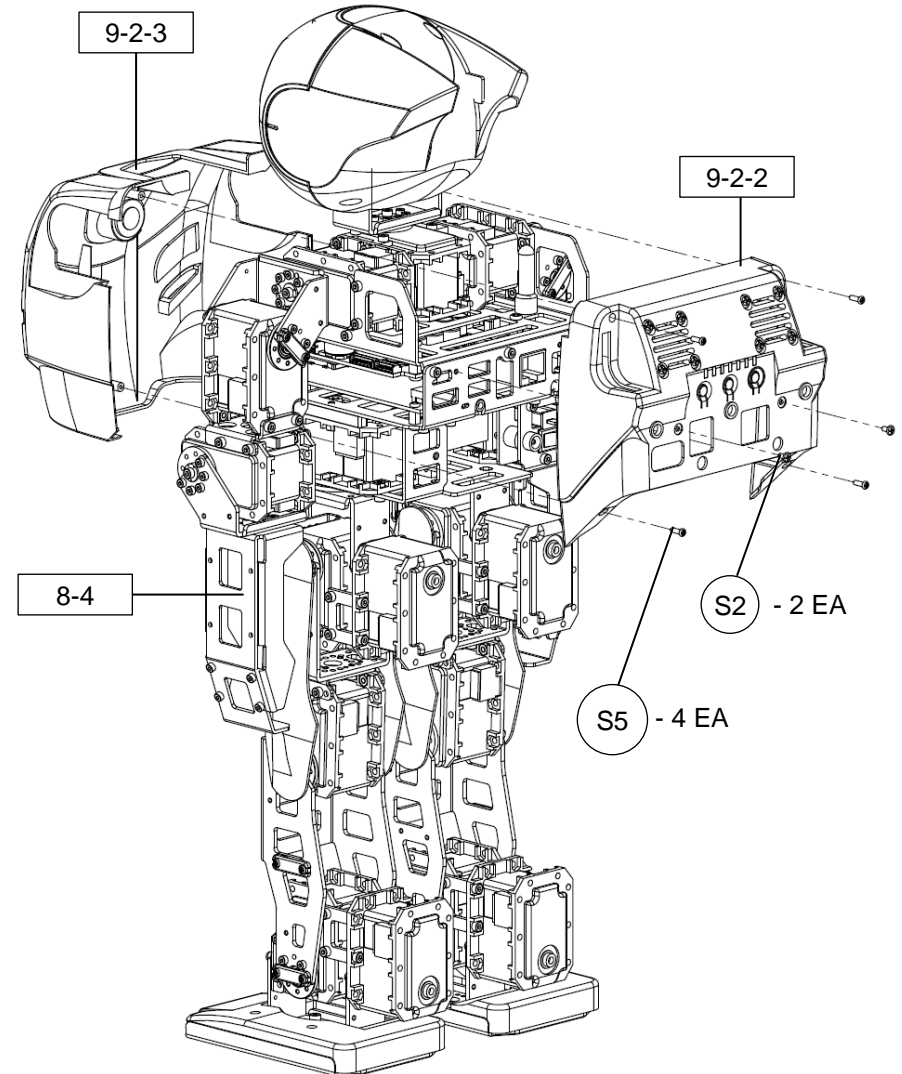
# 9. Covers

## 9-2. Chest covers

9-2-3. Speaker to front cover



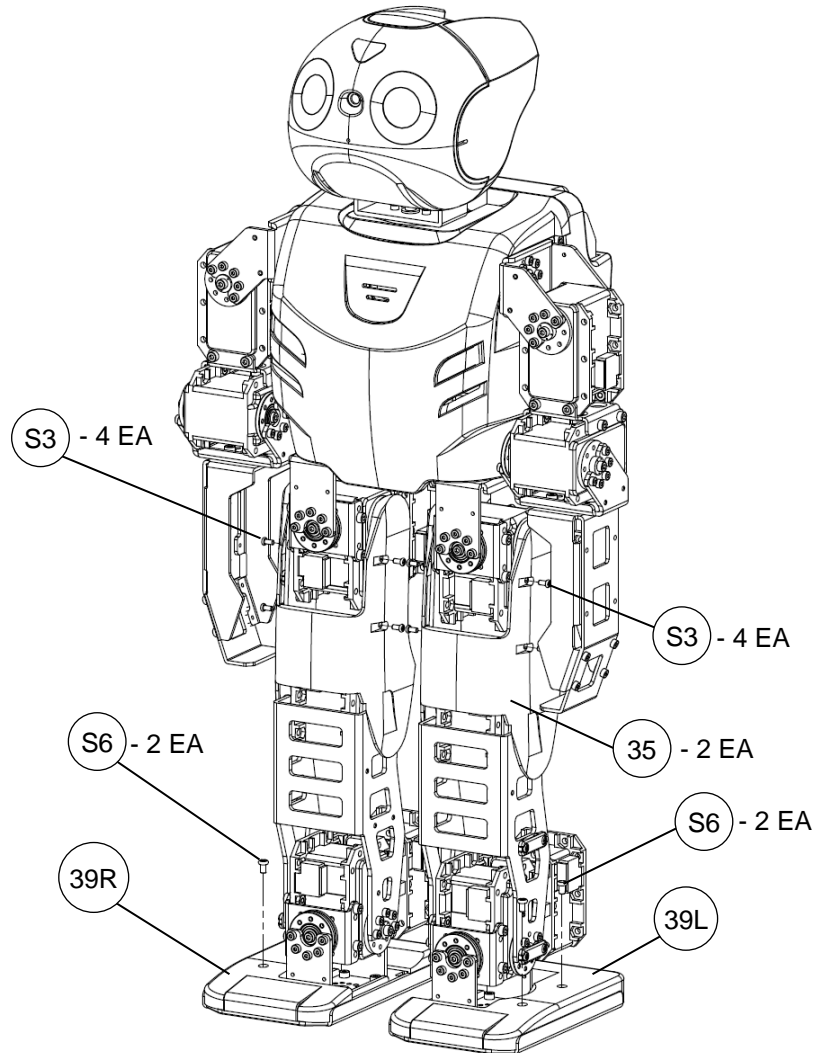
9-2-4. 9-2-2 and 9-2-3 to 8-4 assembly



# 9. Covers

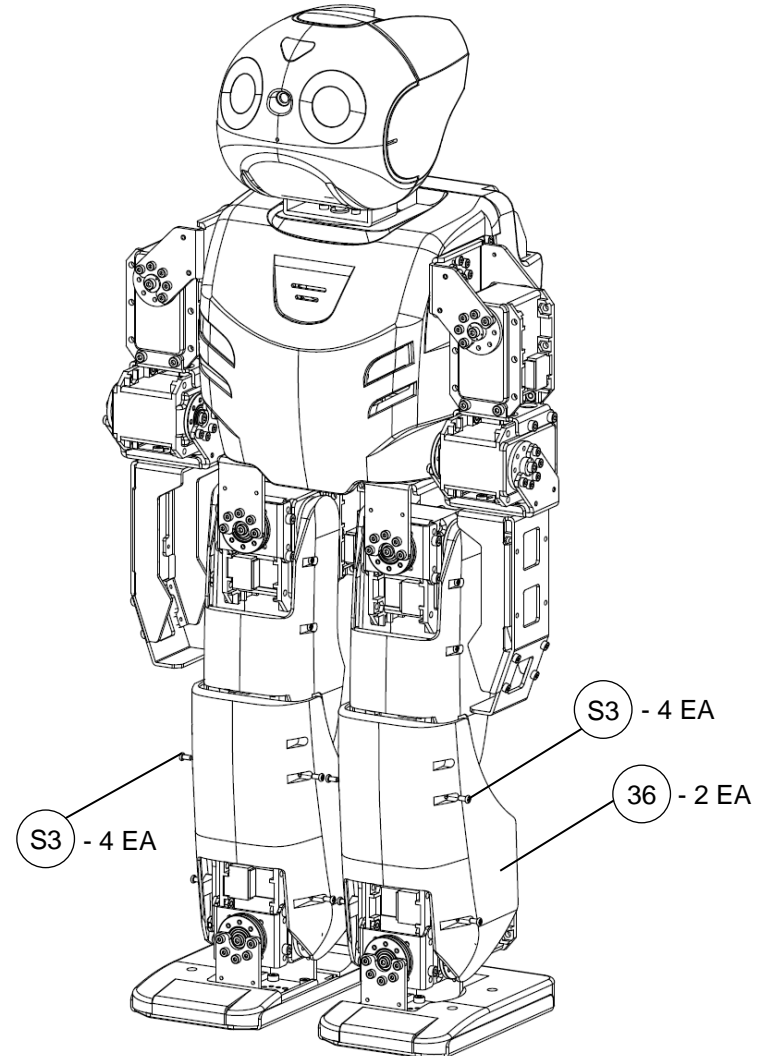
## 9-3. Thigh and foot covers

9-3-1. Thigh covers and foot covers assembly



## 9-4. Shin covers

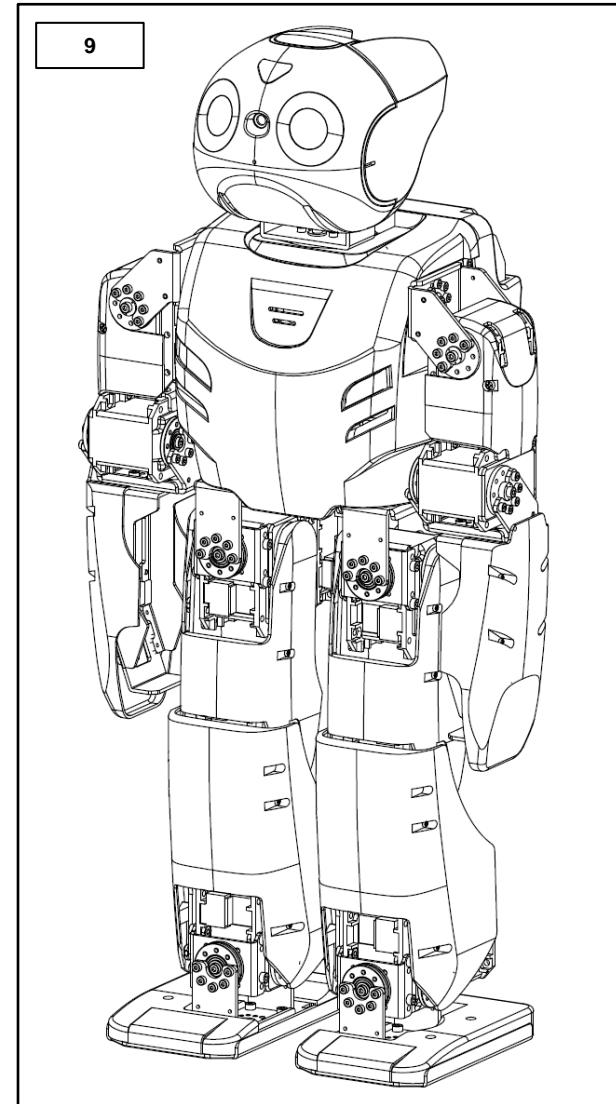
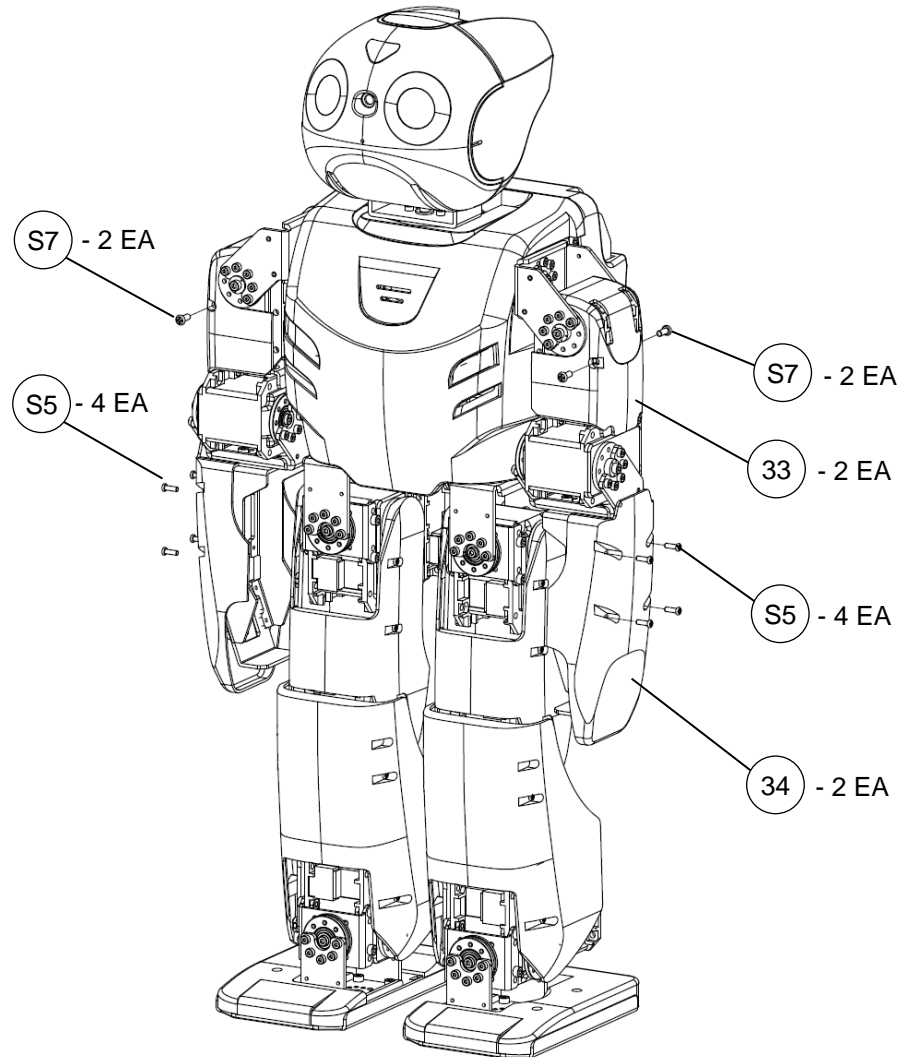
9-4-1 Shin covers assembly



# 9. Covers

## 9-5. Arm covers

### 9-5-1. Arm covers assembly



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