

Foo Shing Wong

David C. Wynn

Supplementary material for the journal
article: A systematic approach for product
modelling and function integration to
support adaptive redesign of product
variants

September 2022

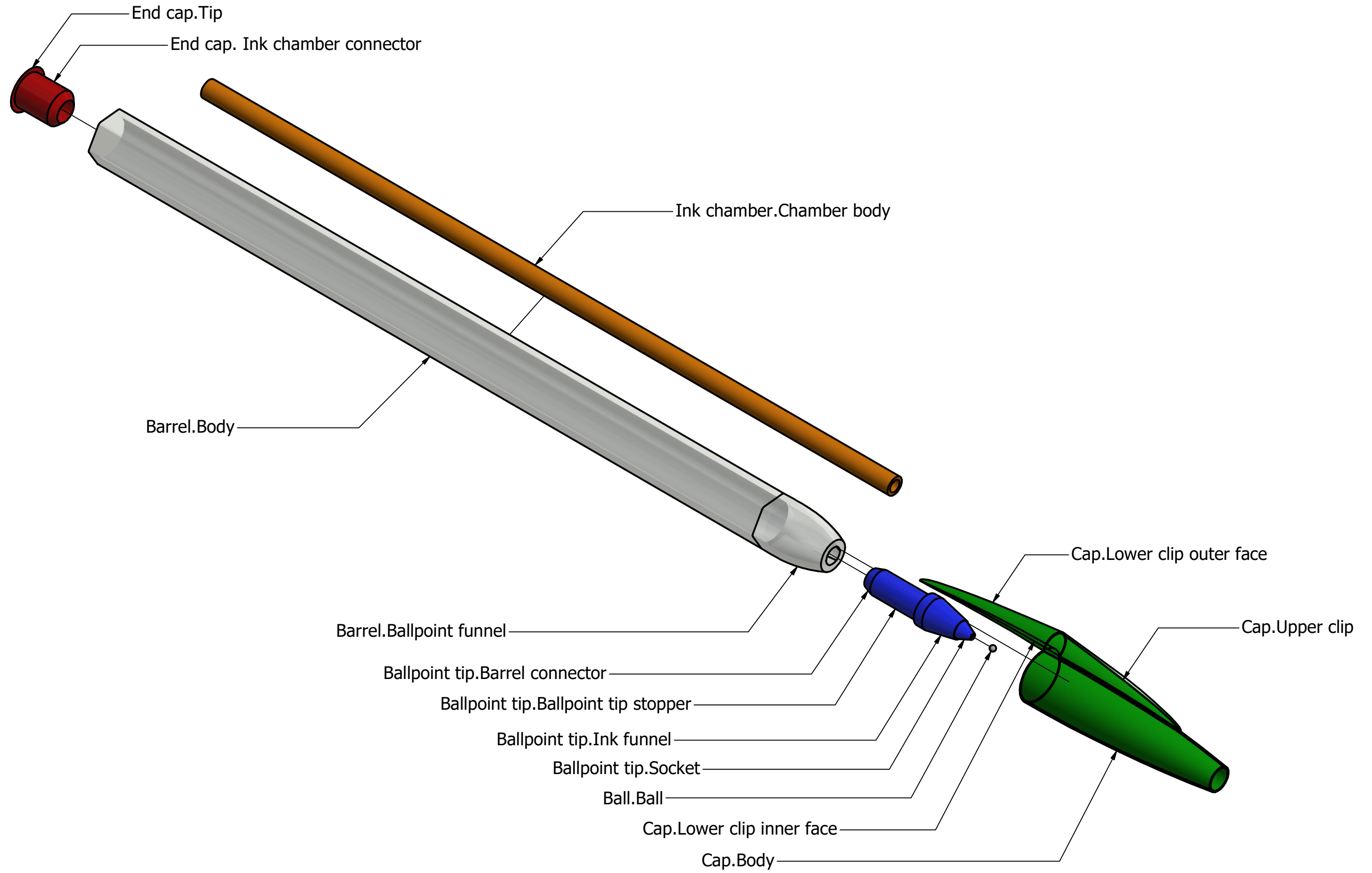
Supplementary material for the pen case study

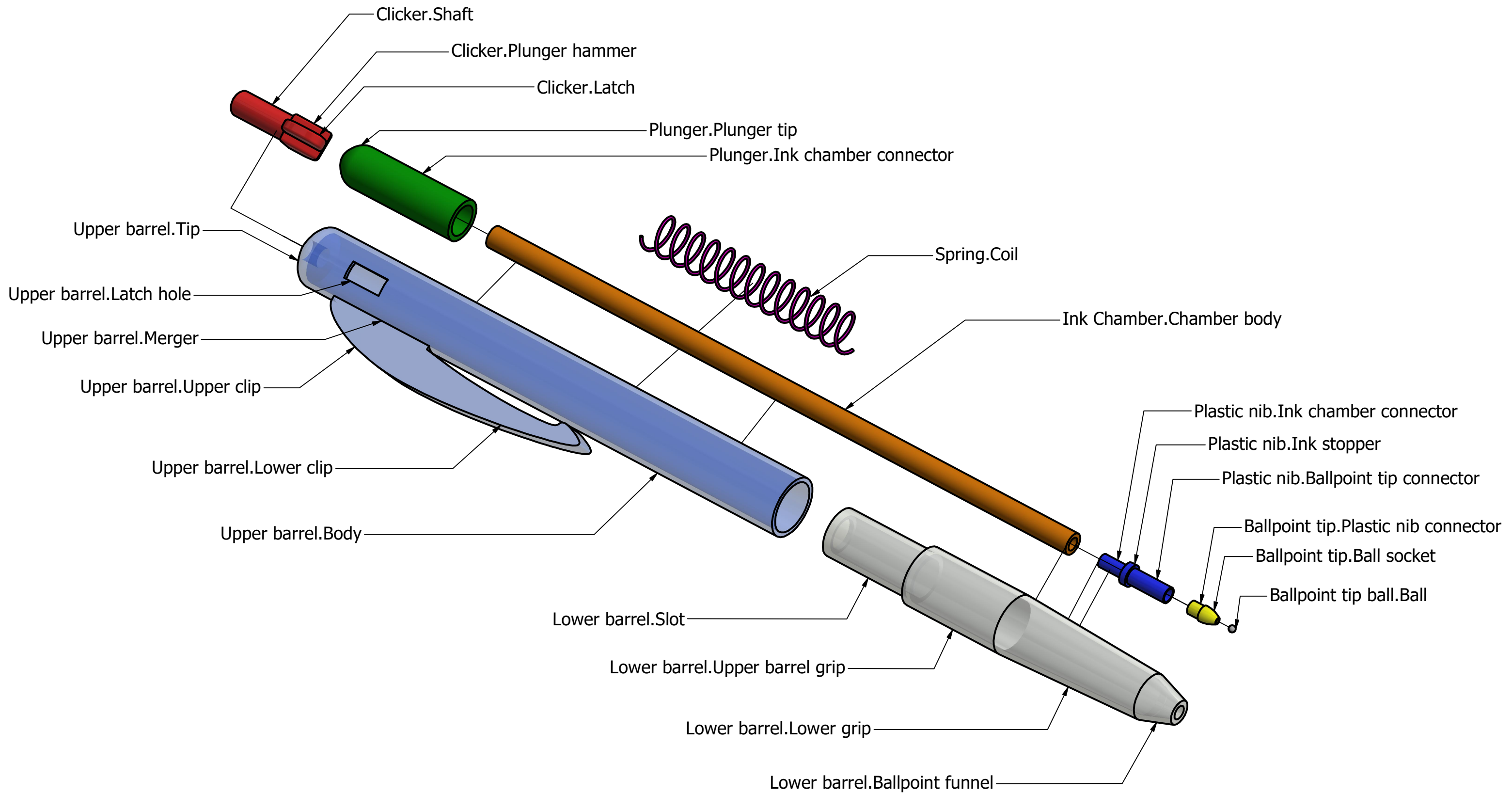
Page 3: Exploded view of the basic pen

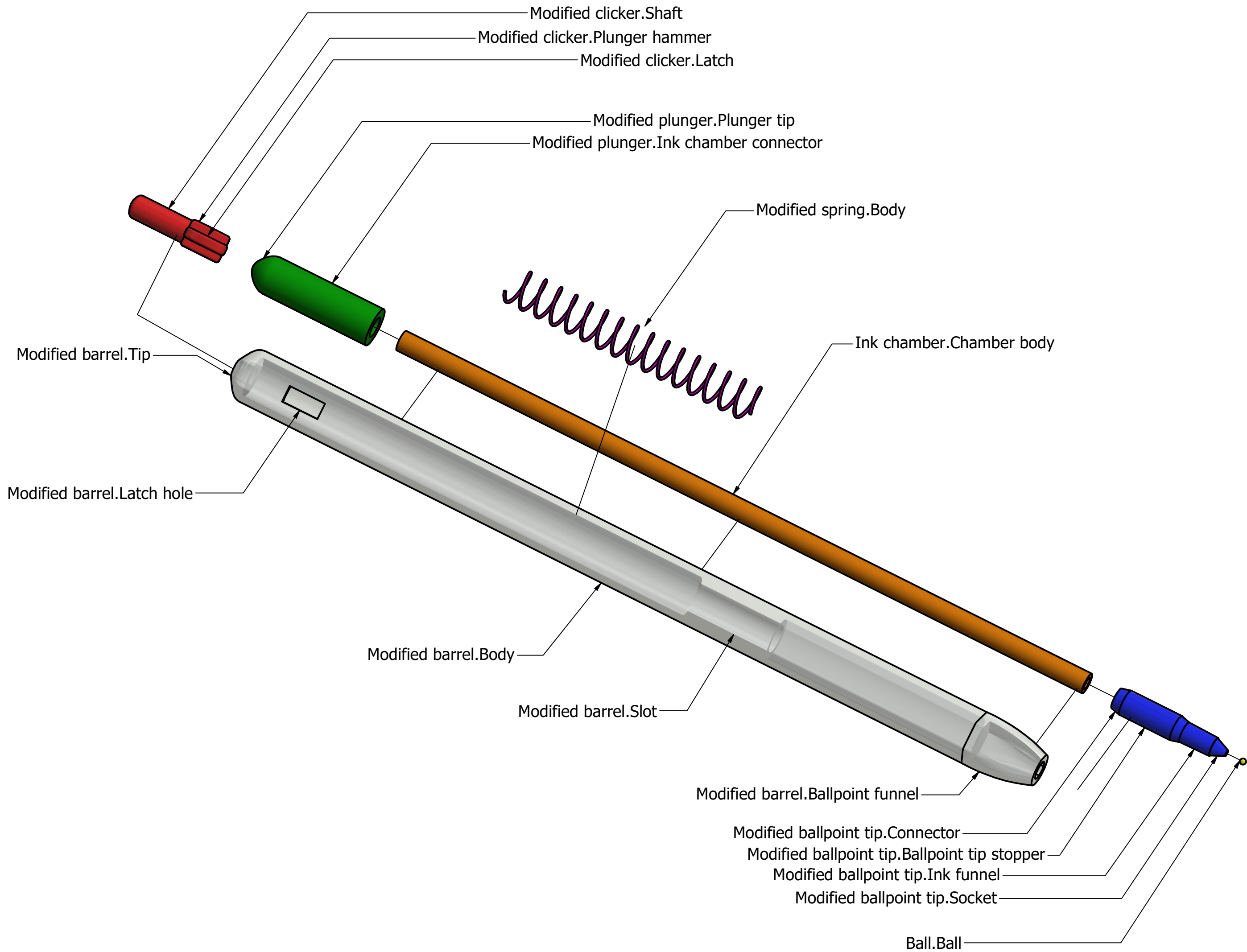
Page 4: Exploded view of the retracting pen

Page 5: Exploded view of the new pen variant

Please note: All drawings are approximate for the purpose of illustrating the modelling approaches presented in this research paper.







Supplementary material for the IP camera case study

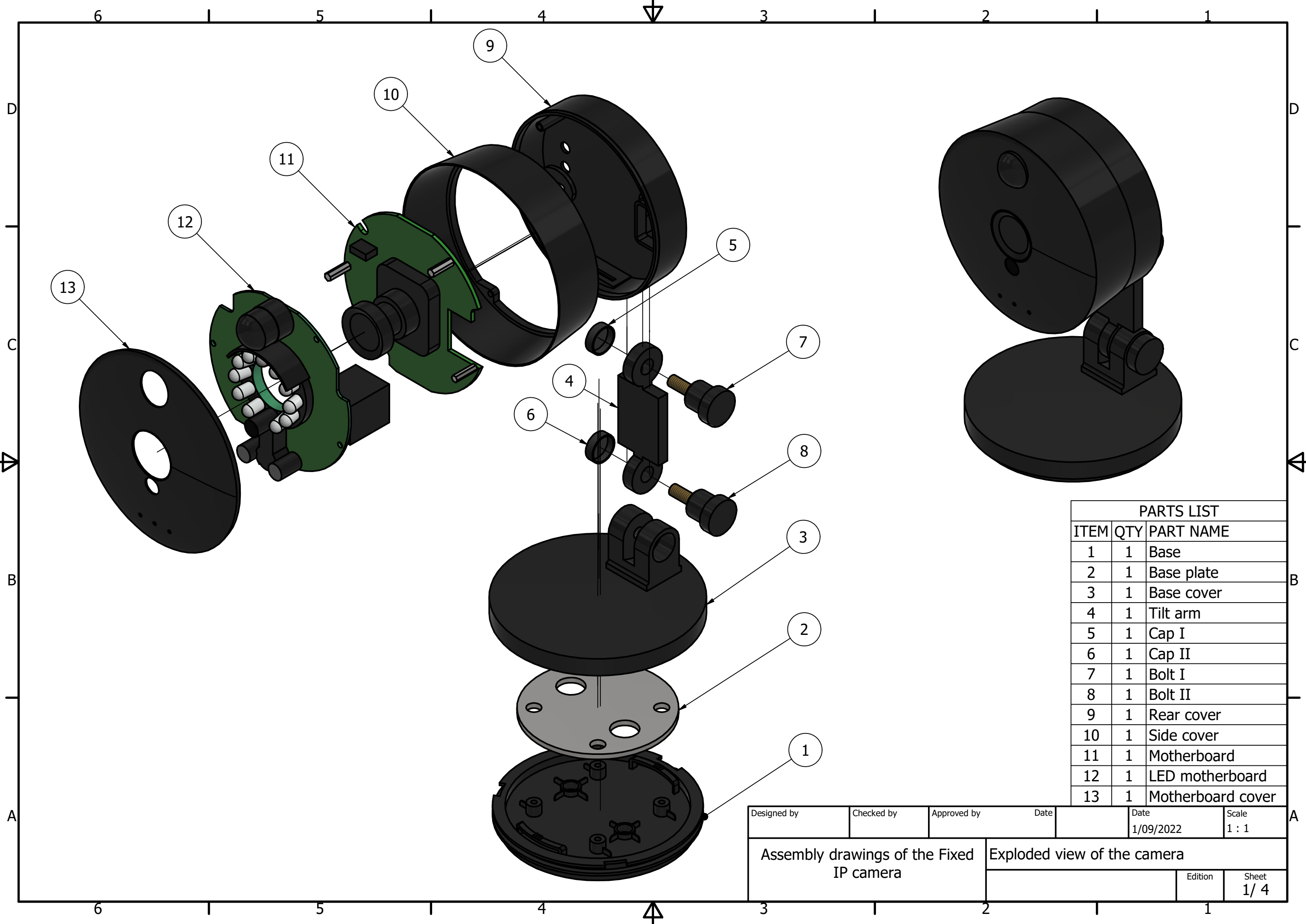
Page 7-10: Assembly drawings for the Fixed IP camera

Page 11-17: Assembly drawings for the PT IP camera

Page 18-21: DDM and ARM data for the IP cameras

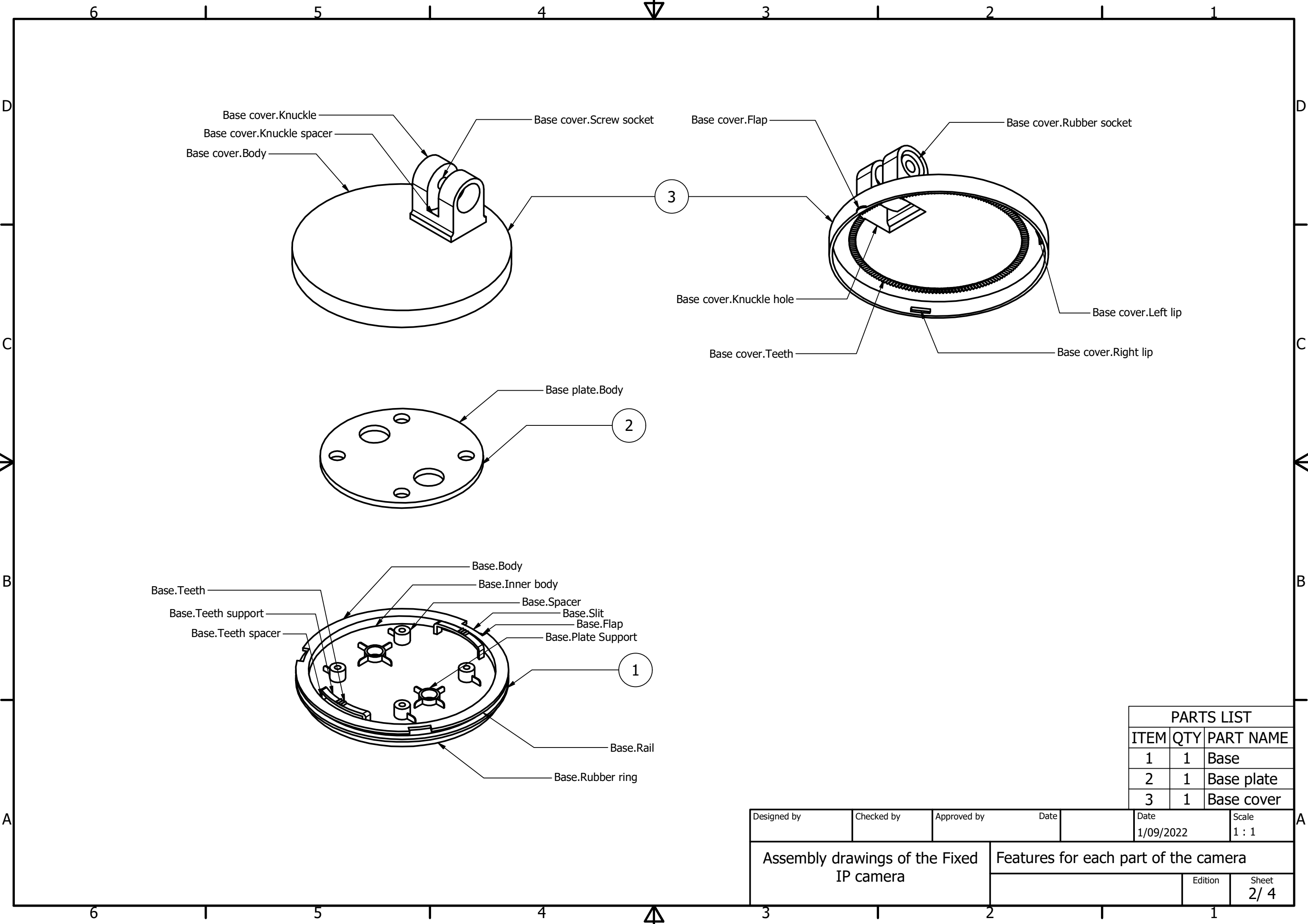
Page 22-23: Assembly drawings for the new IP camera variant

Please note: All drawings are approximate for the purpose of illustrating the modelling approaches presented in this research paper.



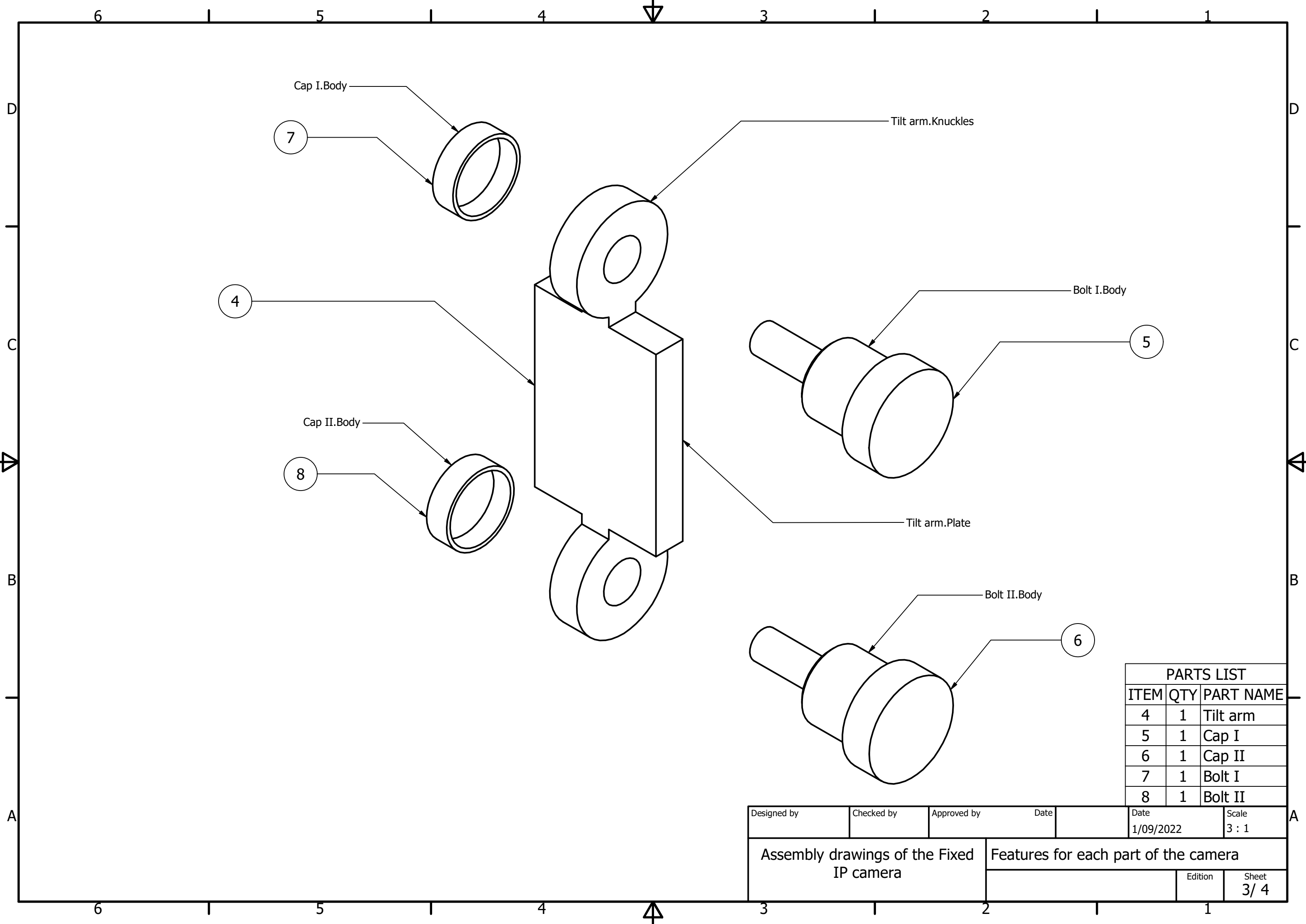
PARTS LIST		
ITEM	QTY	PART NAME
1	1	Base
2	1	Base plate
3	1	Base cover
4	1	Tilt arm
5	1	Cap I
6	1	Cap II
7	1	Bolt I
8	1	Bolt II
9	1	Rear cover
10	1	Side cover
11	1	Motherboard
12	1	LED motherboard
13	1	Motherboard cover

Designed by	Checked by	Approved by	Date	Date	Scale
				1/09/2022	1 : 1
Assembly drawings of the Fixed IP camera			Exploded view of the camera		
			Edition	Sheet	
				1/ 4	



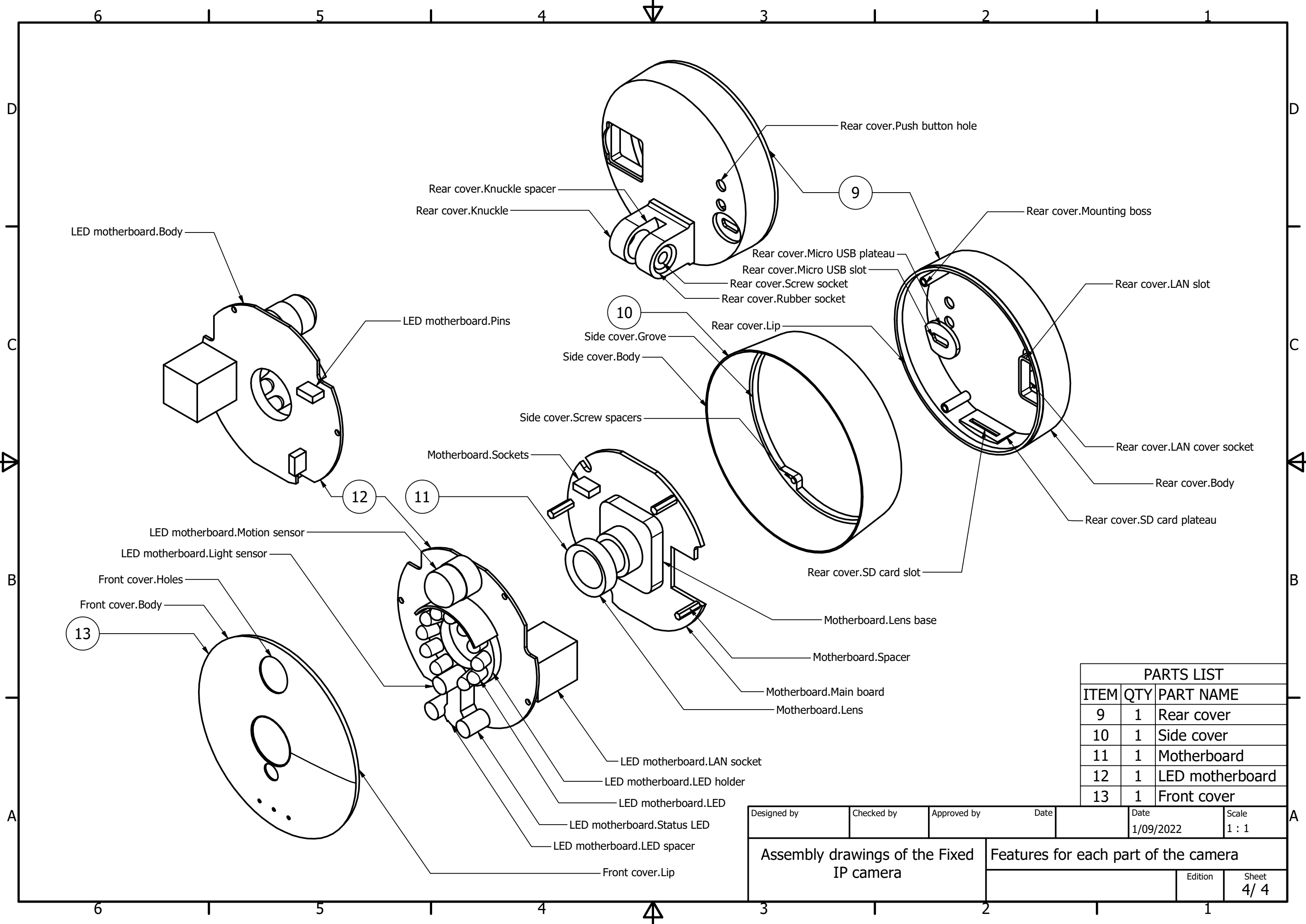
PARTS LIST		
ITEM	QTY	PART NAME
1	1	Base
2	1	Base plate
3	1	Base cover

Designed by	Checked by	Approved by	Date	Date	Scale
				1/09/2022	1 : 1
Assembly drawings of the Fixed IP camera			Features for each part of the camera		
			Edition	Sheet	
				2/ 4	



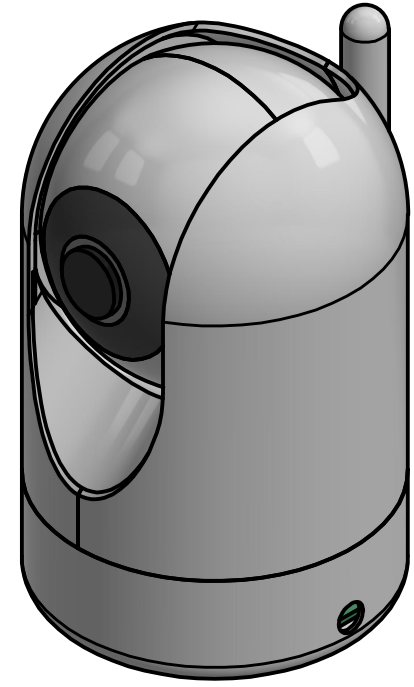
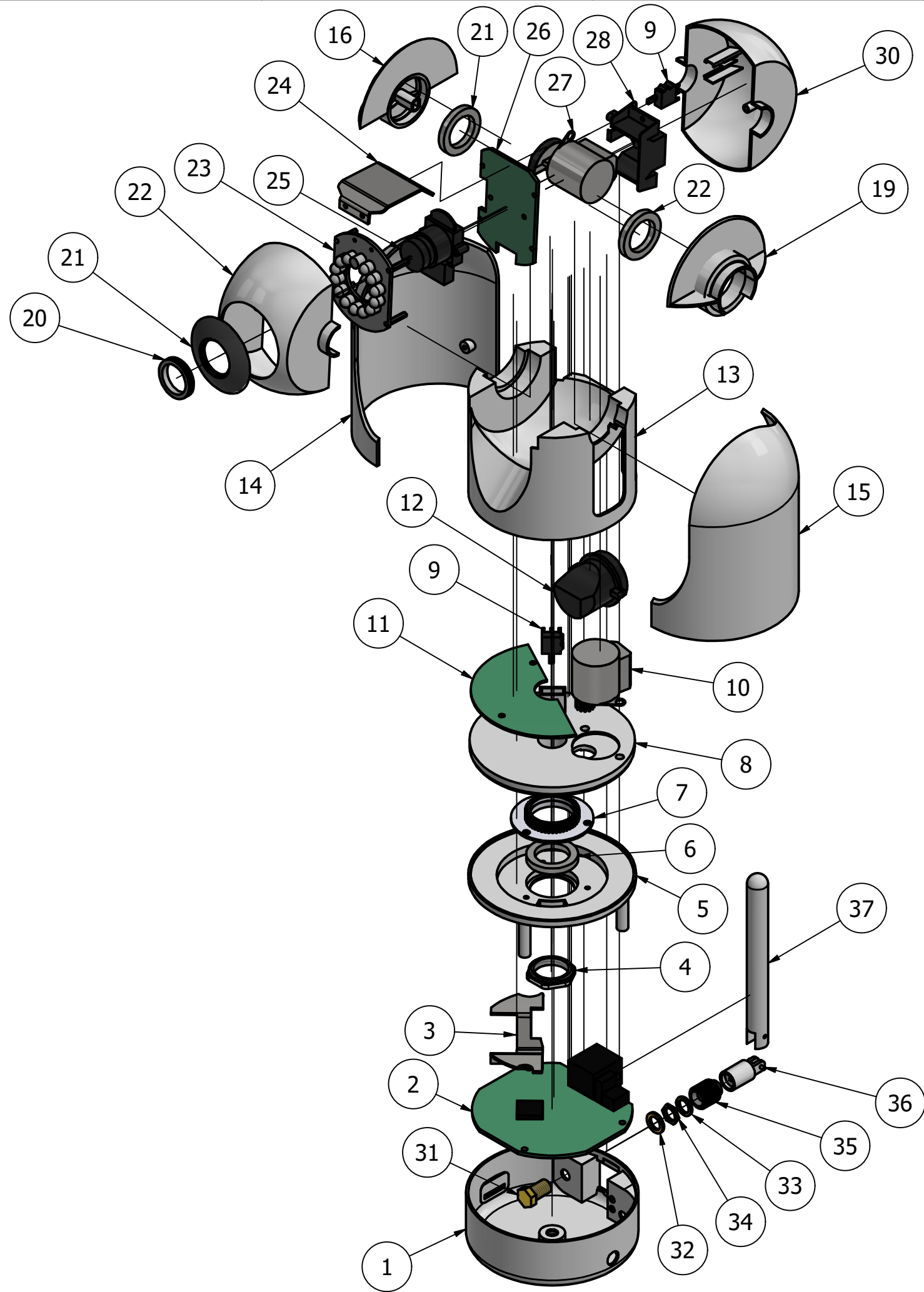
PARTS LIST		
ITEM	QTY	PART NAME
4	1	Tilt arm
5	1	Cap I
6	1	Cap II
7	1	Bolt I
8	1	Bolt II

Designed by	Checked by	Approved by	Date	Date	Scale
				1/09/2022	3 : 1
Assembly drawings of the Fixed IP camera			Features for each part of the camera		
			Edition	Sheet	
				3/ 4	



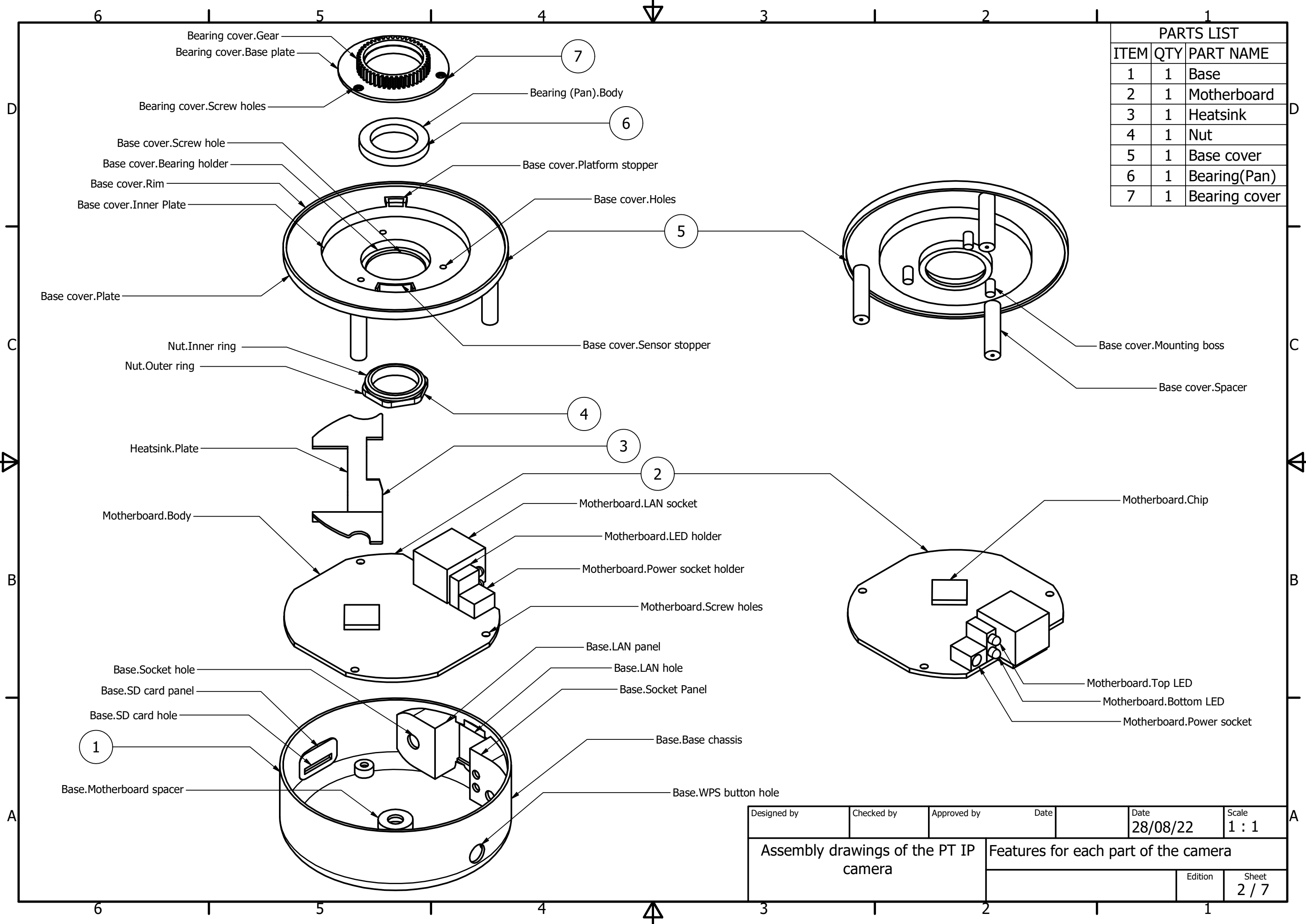
PARTS LIST		
ITEM	QTY	PART NAME
9	1	Rear cover
10	1	Side cover
11	1	Motherboard
12	1	LED motherboard
13	1	Front cover

Designed by	Checked by	Approved by	Date	Date	Scale
				1/09/2022	1 : 1
Assembly drawings of the Fixed IP camera			Features for each part of the camera		
			Edition	Sheet	
				4/ 4	



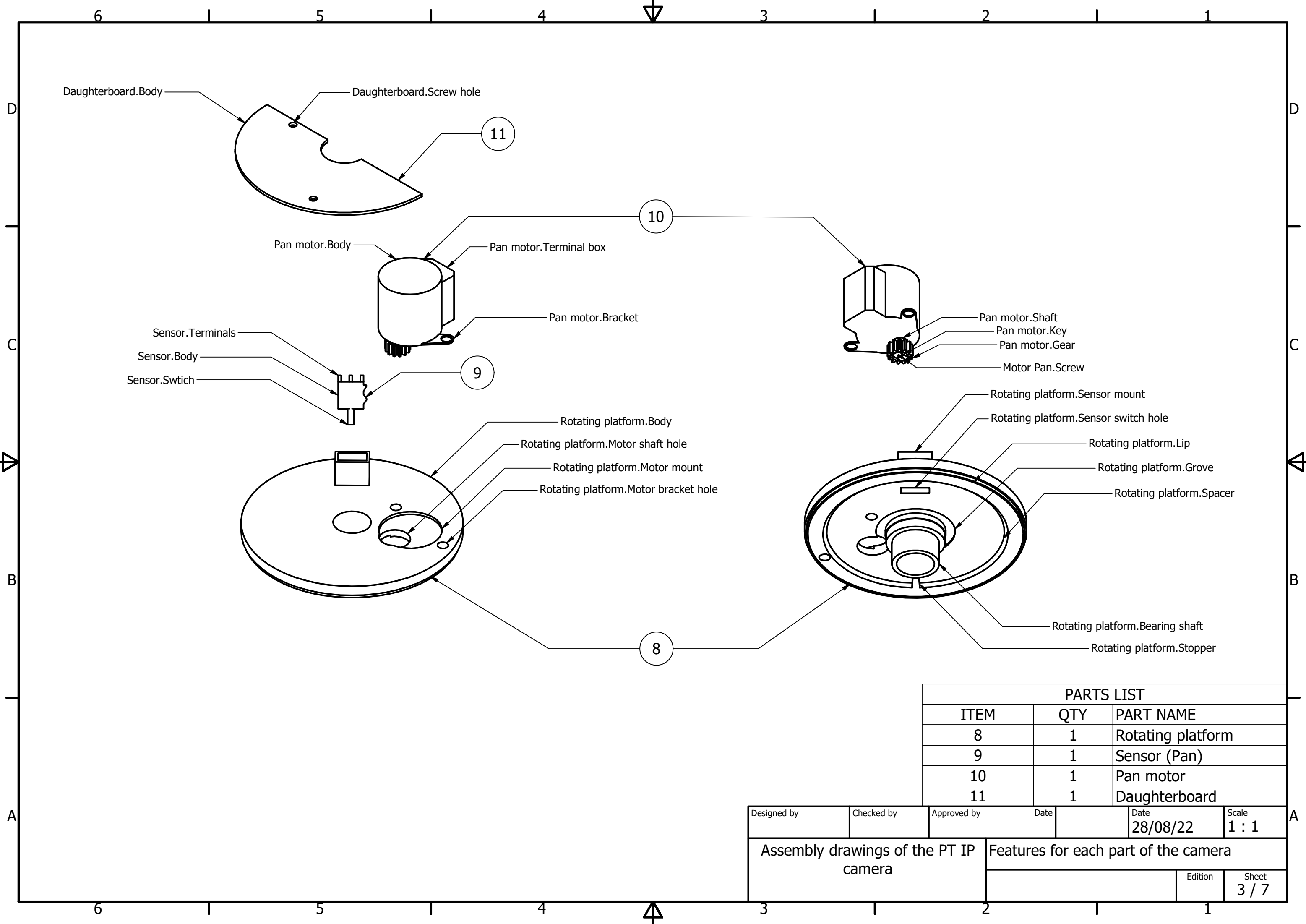
PARTS LIST			PARTS LIST		
ITEM	QTY	PART NAME	ITEM	QTY	PART NAME
1	1	Base	20	1	Camera seal
2	1	Motherboard	21	1	Led cover
3	1	Heatsink	22	1	Camera front shell
4	1	Nut	23	1	Led motherboard
5	1	Base Cover	24	1	Motherboard shield
6	1	Bearing (Pan)	25	1	Lens
7	1	Bearing Cover	26	1	Camera motherboard
8	1	Rotating platform	27	1	Tilt motor
9	1	Sensor (Pan)	28	1	Motor casing
10	1	Pan motor	29	1	Sensor (Tilt)
11	1	Daughter board	30	1	Camera rear shell
12	1	Speaker	31	1	WiFi SMA connector
13	1	Tilt base	32	1	WiFi SMA trim
14	1	LHS casing	33	1	WiFi SMA washer
15	1	RHS casing	34	1	WiFi SMA nut
16	1	Tilt LHS support	35	1	WiFi insert
17	1	Bearing (Tilt - left)	36	1	WiFi arm
18	1	Bearing (Tilt - right)	37	1	WiFi antenna
19	1	Tilt RHS support			

Designed by	Checked by	Approved by	Date	Date	Scale
				28/08/22	7 : 10
Assembly drawings of the PT IP camera			Exploded view of the PT IP camera		
			Edition	Sheet	
				1 / 7	



PARTS LIST		
ITEM	QTY	PART NAME
1	1	Base
2	1	Motherboard
3	1	Heatsink
4	1	Nut
5	1	Base cover
6	1	Bearing(Pan)
7	1	Bearing cover

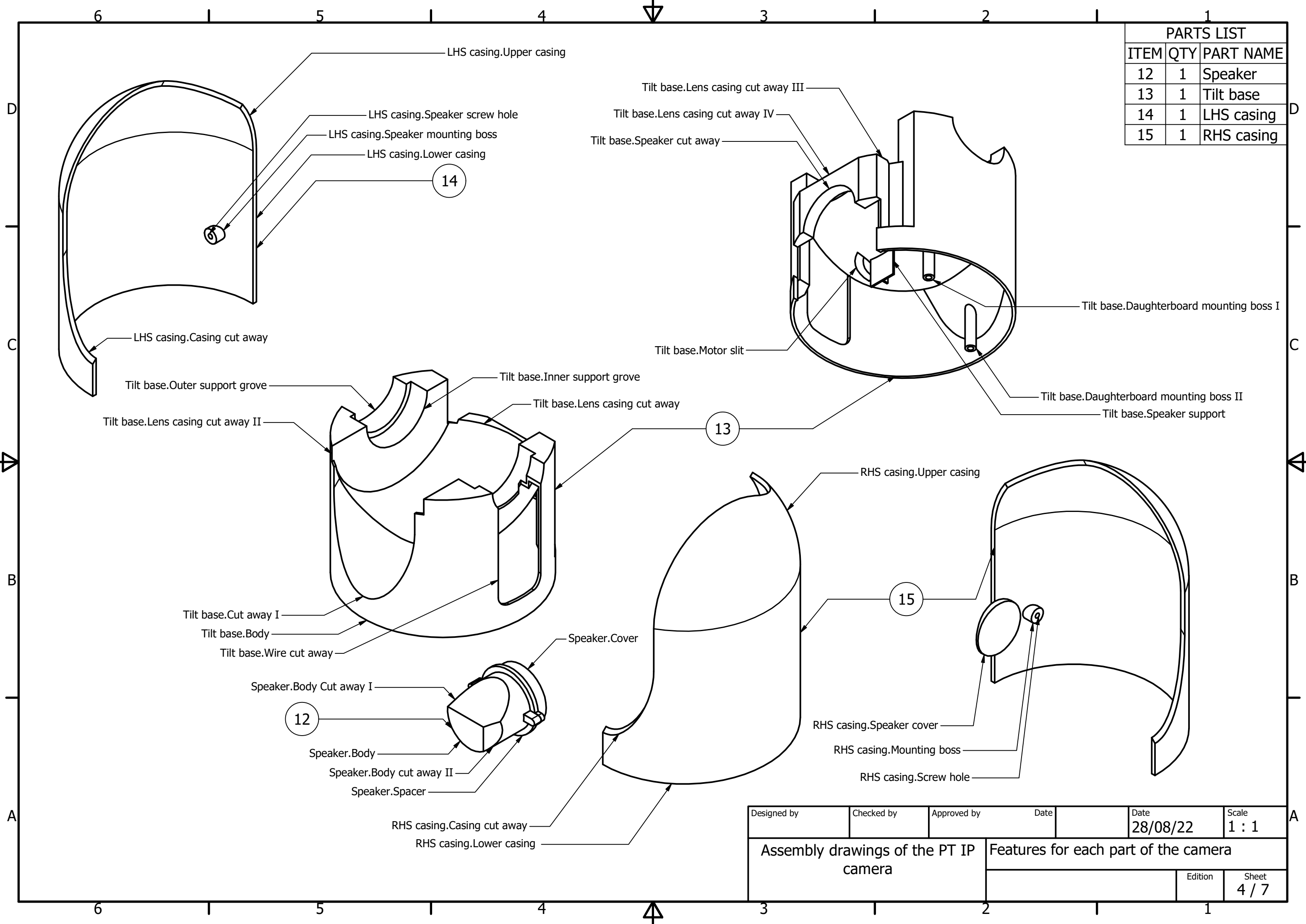
Designed by	Checked by	Approved by	Date	Date	Scale
				28/08/22	1 : 1
Assembly drawings of the PT IP camera			Features for each part of the camera		
			Edition	Sheet	
				2 / 7	



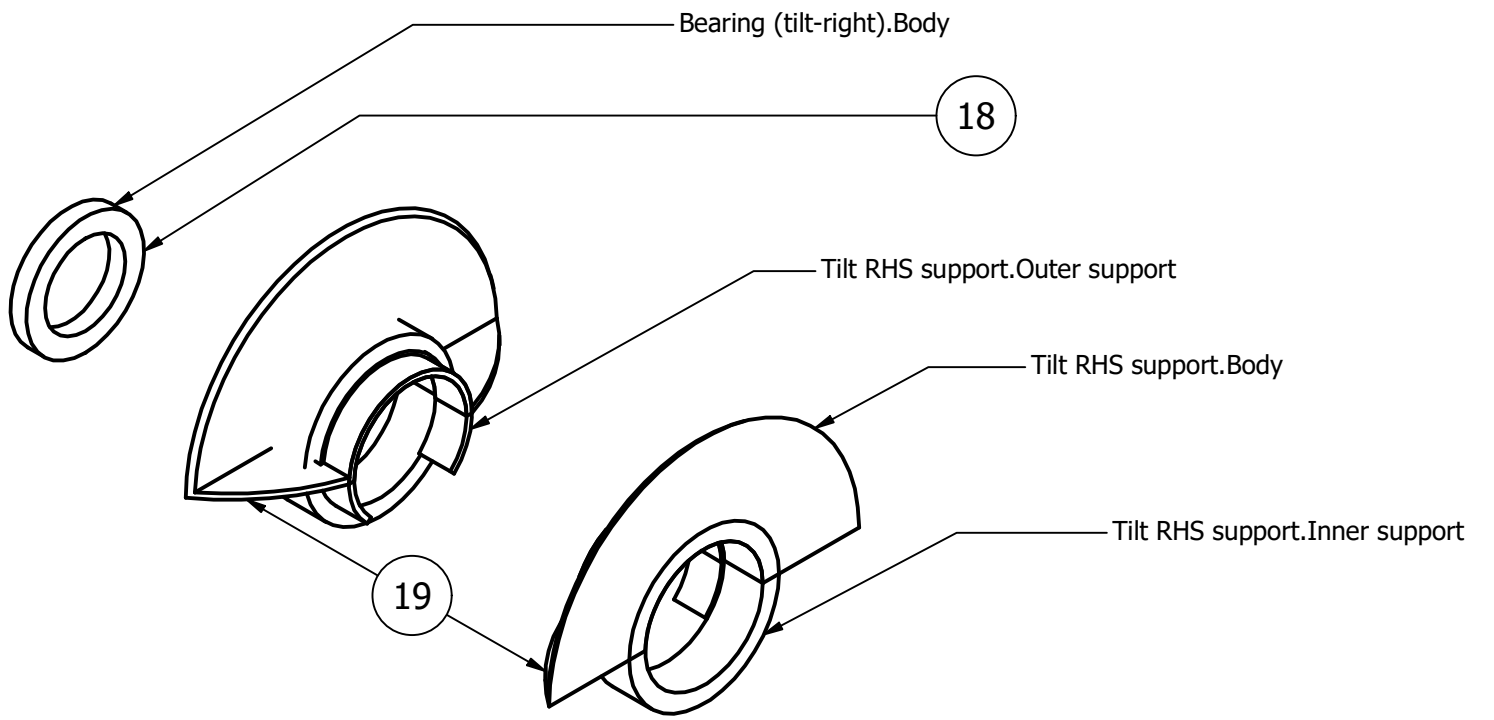
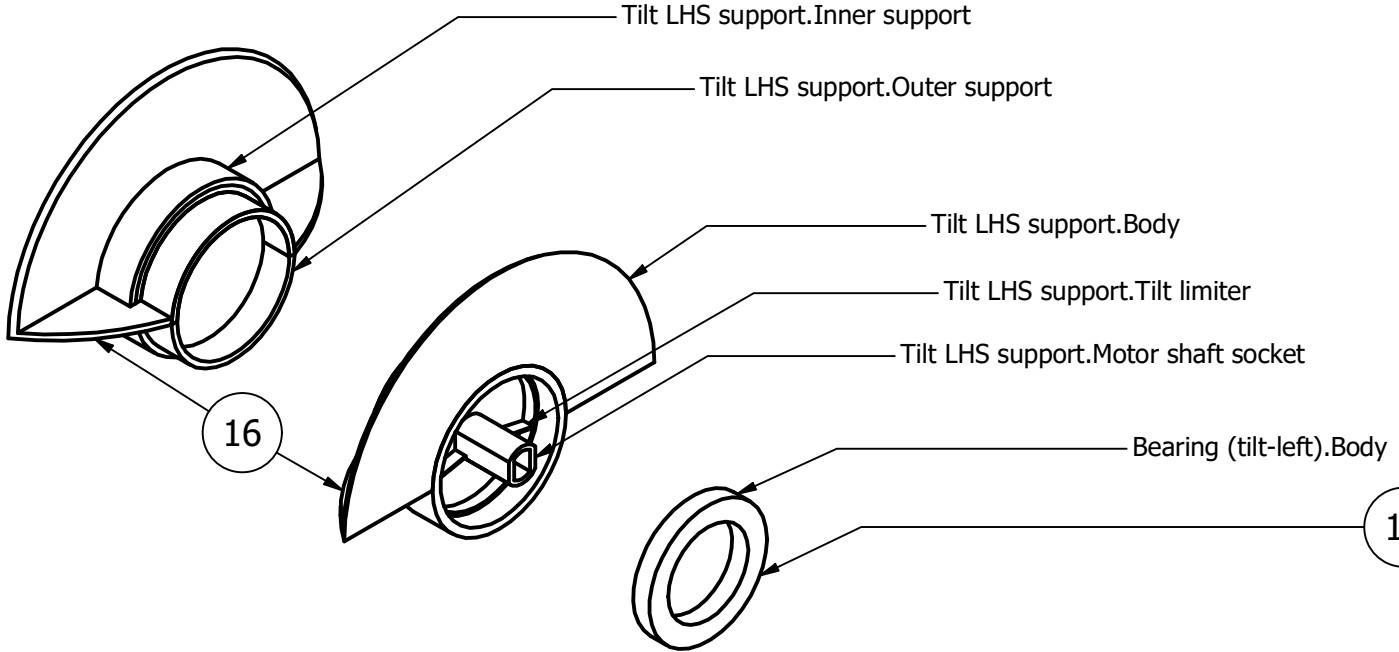
PARTS LIST		
ITEM	QTY	PART NAME
8	1	Rotating platform
9	1	Sensor (Pan)
10	1	Pan motor
11	1	Daughterboard

Designed by	Checked by	Approved by	Date	Date	Scale
				28/08/22	1 : 1
Assembly drawings of the PT IP camera			Features for each part of the camera		
			Edition	Sheet	
				3 / 7	

PARTS LIST		
ITEM	QTY	PART NAME
12	1	Speaker
13	1	Tilt base
14	1	LHS casing
15	1	RHS casing

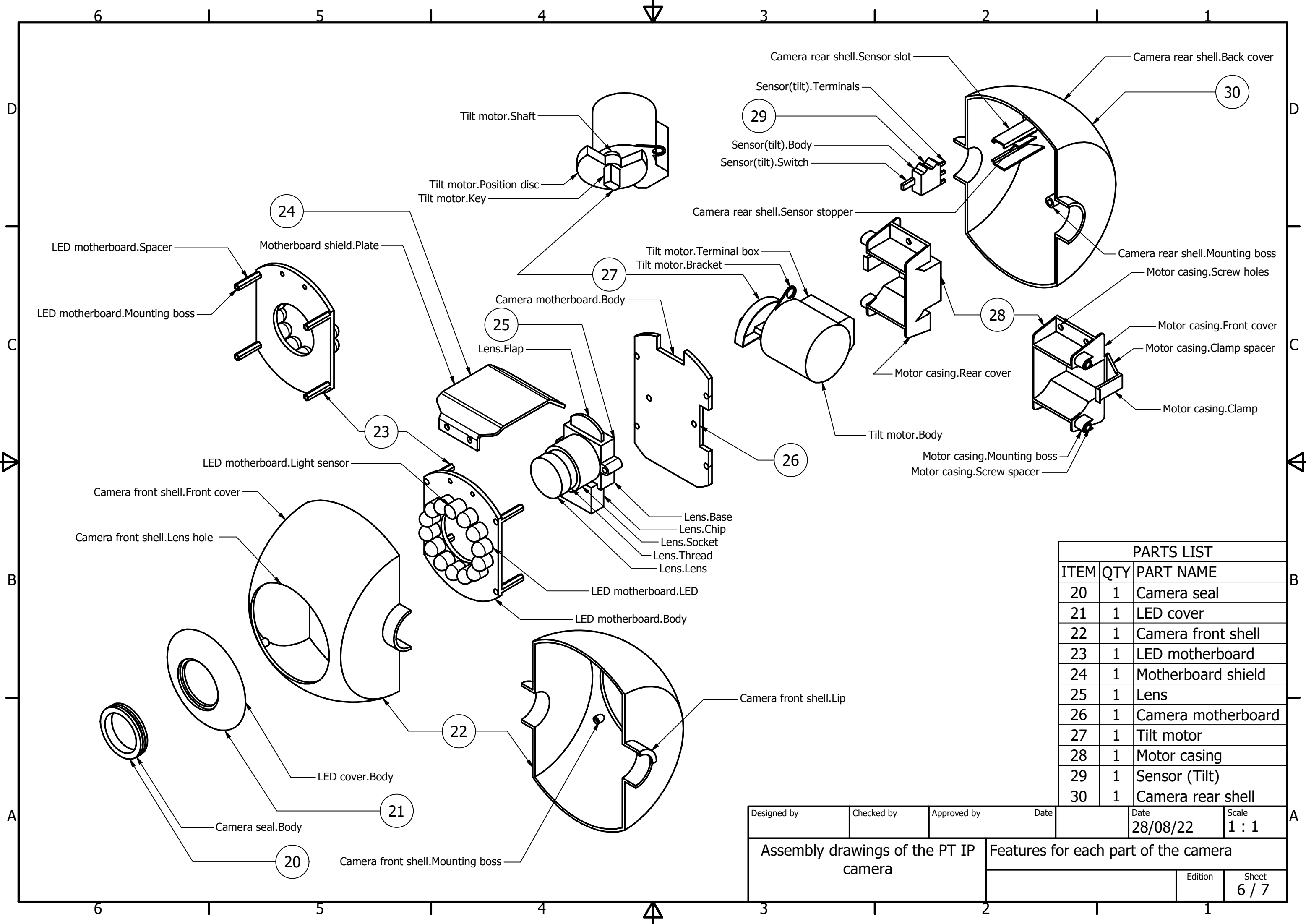


Designed by	Checked by	Approved by	Date	Date	Scale
				28/08/22	1 : 1
Assembly drawings of the PT IP camera			Features for each part of the camera		
			Edition	Sheet	
				4 / 7	



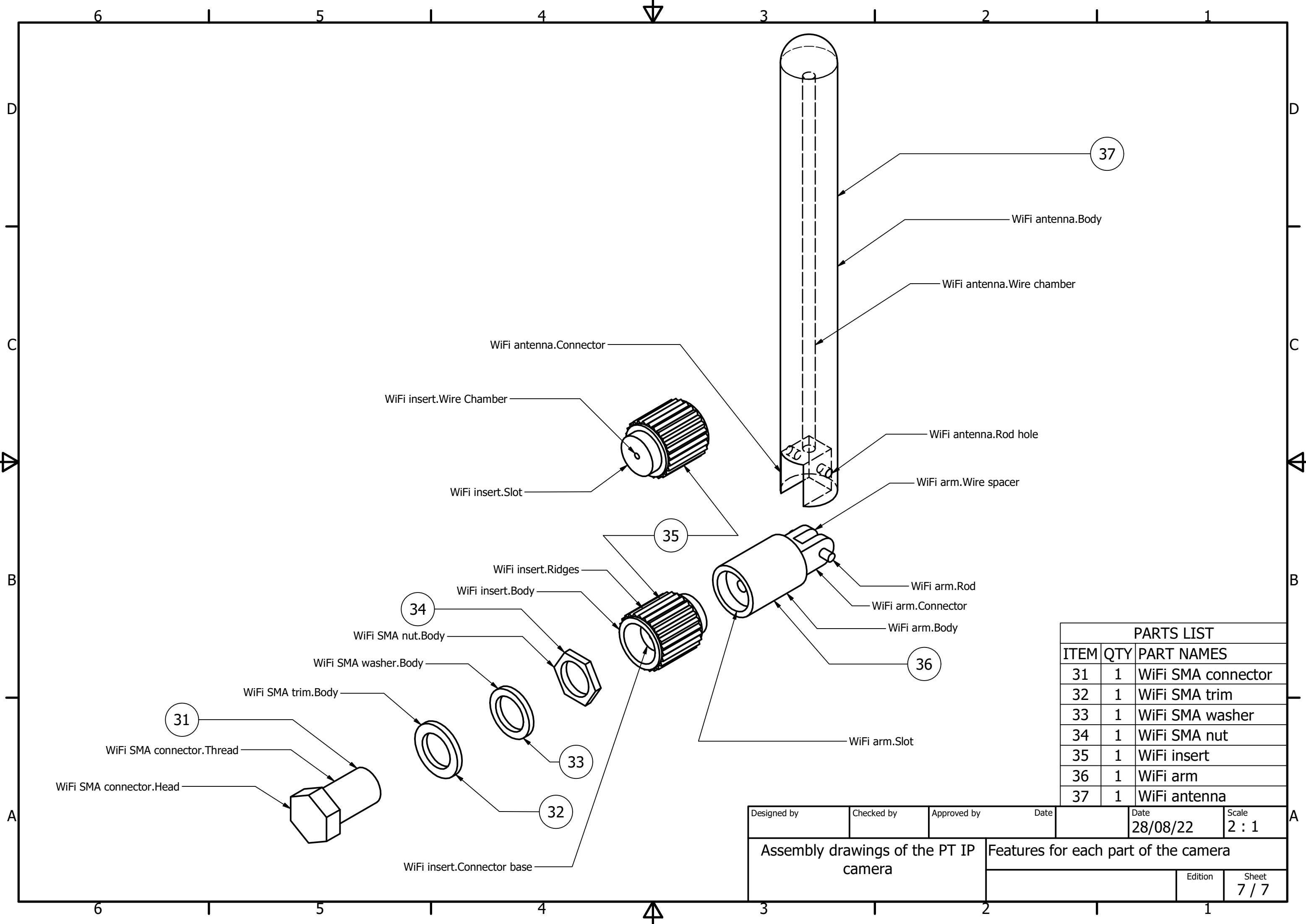
PARTS LIST		
ITEM	QTY	PART NAME
16	1	LHS casing
17	1	Bearing (Tilt - left)
18	1	Bearing (Tilt - right)
19	1	RHS casing

Designed by	Checked by	Approved by	Date	Date	Scale
				28/08/22	1 : 1
Assembly drawings of the PT IP camera			Features for each part of the camera		
			Edition	Sheet	
				5 / 7	



PARTS LIST		
ITEM	QTY	PART NAME
20	1	Camera seal
21	1	LED cover
22	1	Camera front shell
23	1	LED motherboard
24	1	Motherboard shield
25	1	Lens
26	1	Camera motherboard
27	1	Tilt motor
28	1	Motor casing
29	1	Sensor (Tilt)
30	1	Camera rear shell

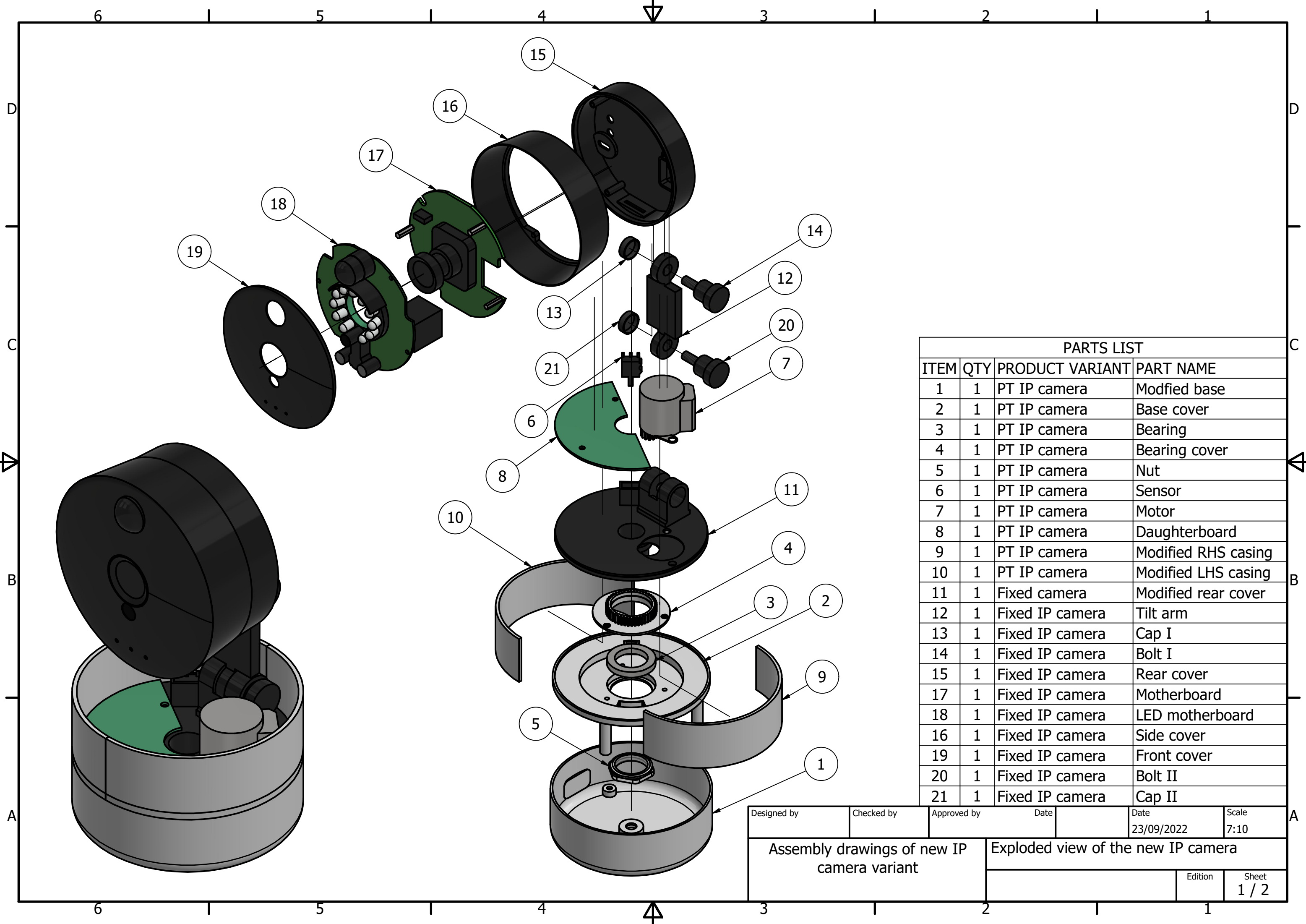
Designed by	Checked by	Approved by	Date	Date	Scale
				28/08/22	1 : 1
Assembly drawings of the PT IP camera			Features for each part of the camera		
			Edition	Sheet	
				6 / 7	



PARTS LIST		
ITEM	QTY	PART NAMES
31	1	WiFi SMA connector
32	1	WiFi SMA trim
33	1	WiFi SMA washer
34	1	WiFi SMA nut
35	1	WiFi insert
36	1	WiFi arm
37	1	WiFi antenna

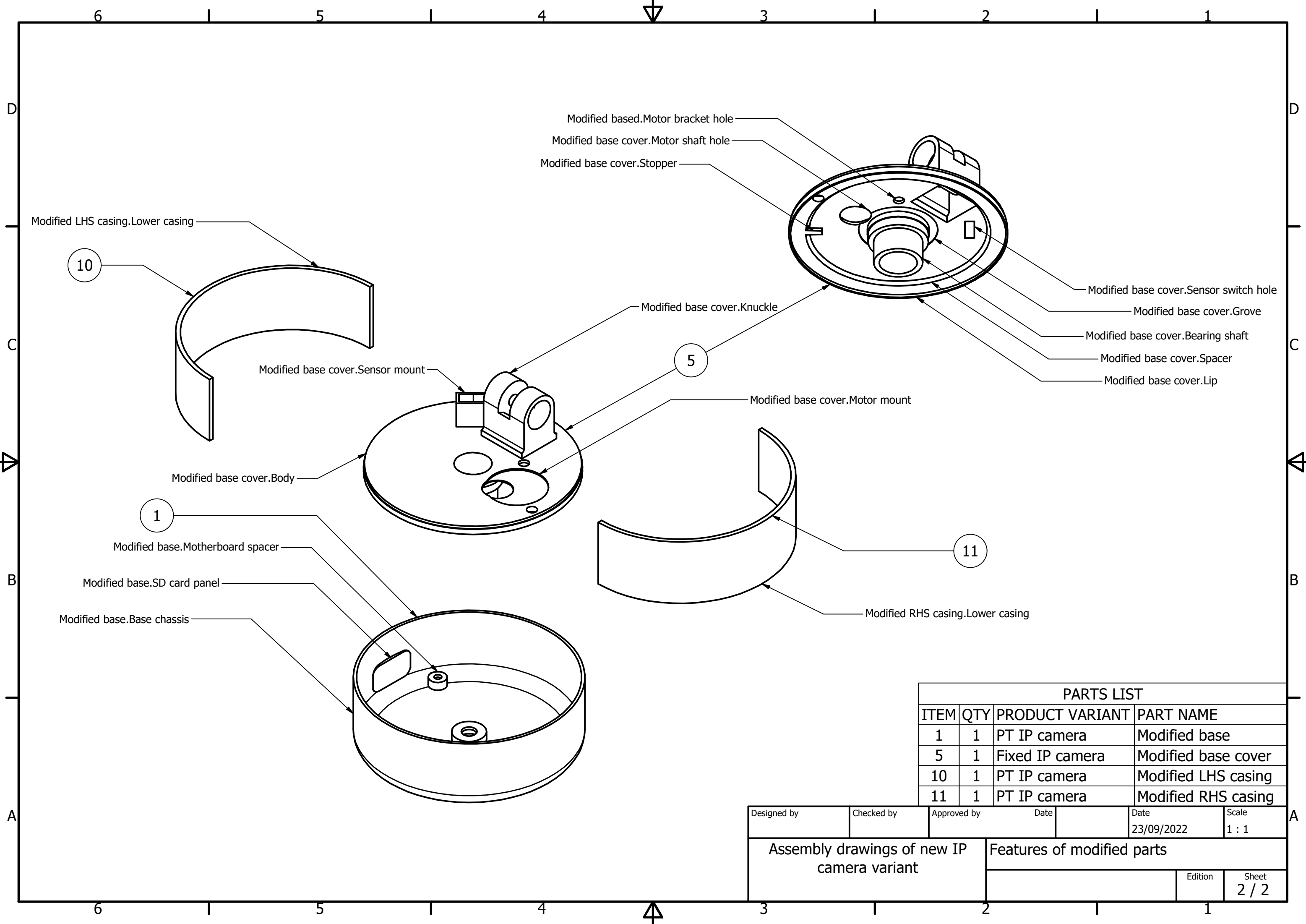
Designed by	Checked by	Approved by	Date	Date	Scale
				28/08/22	2 : 1
Assembly drawings of the PT IP camera			Features for each part of the camera		
			Edition	Sheet	
				7 / 7	

Task number	Redesign task	Feature type	Variant Type	Variant Name	Part	Feature	Additional notes
1	Remove	Uf	Base	Fixed camera	Base	Body	Remove base
2	Remove	Usf	Base	Fixed camera		Inner body	
3	Remove	Usf	Base	Fixed camera		Spacer	
4	Remove	Usf	Base	Fixed camera		Plate Support	
5	Remove	Usf	Base	Fixed camera		Plate Support II	
6	Remove	Uf	Base	Fixed camera		Slit	
7	Remove	Uf	Base	Fixed camera		Rail	
8	Remove	Usf	Base	Fixed camera		Rubber Ring	
9	Remove	Uf	Base	Fixed camera		Flap	
10	Remove	Usf	Base	Fixed camera		Teeth Support	
11	Remove	Usf	Base	Fixed camera		Teeth Spacer	
12	Remove	Uf	Base	Fixed camera		Teeth	
13	Retain	Df	Base	Fixed camera	Base cover	Body	Is this feature needed to support the other desired features of the existing base variant?
14	Retain	Df	Base	Fixed camera		Knuckle	
15	Retain	Df	Base	Fixed camera		Knuckle spacer	
16	Retain	Df	Base	Fixed camera		Screw socket	
17	Examine	Dsf	Base	Fixed camera		Rubber socket	
18	Remove	Uf	Base	Fixed camera		Rear lip	
19	Remove	Uf	Base	Fixed camera		Right lip	
20	Remove	Uf	Base	Fixed camera		Left lip	
21	Remove	Uf	Base	Fixed camera		Flap	
22	Remove	Uf	Base	Fixed camera		Teeth	
23	Retain	Df	Base	Fixed camera		Knuckle hole	
24	Remove	Usf	Base	Fixed camera	Base plate	Body	Remove base plate
25	Retain	Df	Base	Fixed camera	Bolt I	Body	
26	Retain	Df	Base	Fixed camera	Bolt II	Body	
27	Retain		Base	Fixed camera	Cap I	Body	
28	Retain		Base	Fixed camera	Cap II	Body	
29	Retain		Base	Fixed camera	Front cover	Body	
30	Retain		Base	Fixed camera		Lip	
31	Retain		Base	Fixed camera		Holes	
32	Examine		Base	Fixed camera	LED motherboard	Body	Does this feature meet the desired technical functions from the features of the Camera Motherboard, Daughterboard and Motherboard?
33	Examine		Base	Fixed camera		Motion Sensor	Does this feature meet the desired technical functions from the features of the Camera Motherboard, Daughterboard and Motherboard?
34	Retain		Base	Fixed camera		LED holder	
35	Retain		Base	Fixed camera		Light cover	
36	Examine		Base	Fixed camera		LED	Does this feature meet the desired technical functions from the features of the Camera Motherboard, Daughterboard and Motherboard?
37	Examine		Base	Fixed camera		LED circular	Does this feature meet the desired technical functions from the features of the Camera Motherboard, Daughterboard and Motherboard?
38	Retain		Base	Fixed camera		LED spacer	
39	Examine		Base	Fixed camera		Light sensor	Does this feature meet the desired technical functions from the features of the Camera Motherboard, Daughterboard and Motherboard?
40	Examine		Base	Fixed camera		Status LED	Does this feature meet the desired technical functions from the features of the Camera Motherboard, Daughterboard and Motherboard?
41	Examine		Base	Fixed camera		LAN socket	Does this feature meet the desired technical functions from the features of the Camera Motherboard, Daughterboard and Motherboard?
42	Examine		Base	Fixed camera		Pins	Does this feature meet the desired technical functions from the features of the Camera Motherboard, Daughterboard and Motherboard?
43	Examine		Base	Fixed camera	Motherboard	Mainboard	Does this feature meet the desired technical functions from the features of the Camera Motherboard, Daughterboard and Motherboard?
44	Retain		Base	Fixed camera		Spacer	
45	Examine		Base	Fixed camera		Lens base	Does this feature meet the desired technical functions from the features of the Camera Motherboard, Daughterboard and Motherboard?
46	Examine		Base	Fixed camera		Lens	Does this feature meet the desired technical functions from the features of the Camera Motherboard, Daughterboard and Motherboard?
47	Examine		Base	Fixed camera		Socket	Does this feature meet the desired technical functions from the features of the Camera Motherboard, Daughterboard and Motherboard?
48	Retain	Df	Base	Fixed camera	Rear cover	Body	Is this feature needed to support the other desired features of the existing base variant?
49	Examine	Dsf	Base	Fixed camera		Lip	
50	Examine	Dsf	Base	Fixed camera		SD card plateau	
51	Examine	Dsf	Base	Fixed camera		Micro USB plateau	
52	Examine	Dsf	Base	Fixed camera		LAN cover socket	
53	Examine	Dsf	Base	Fixed camera		LAN slot	
54	Retain	Df	Base	Fixed camera		Knuckle	
55	Retain	Df	Base	Fixed camera		Knuckle spacer	
56	Examine	Dsf	Base	Fixed camera		SD card slot	
57	Examine	Dsf	Base	Fixed camera		Micro USB slot	
58	Examine	Dsf	Base	Fixed camera		Push button hole	
59	Examine	Dsf	Base	Fixed camera		Mounting boss	
60	Retain	Df	Base	Fixed camera		Screw socket	
61	Examine	Dsf	Base	Fixed camera		Rubber socket	
62	Retain		Base	Fixed camera	Side cover	Body	
63	Retain		Base	Fixed camera		Grove	
64	Retain		Base	Fixed camera		Screw spacers	
65	Retain	Df	Base	Fixed camera	Tilt arm	Plate	
66	Retain	Df	Base	Fixed camera		Knuckles	
67	Carry over	Df	Source	PT camera	Base	Base chassis	Is this feature needed to support the other desired features of the existing base variant?
68	Examine	Dsf	Source	PT camera		Socket Panel	
69	Examine	Dsf	Source	PT camera		LAN Panel	
70	Examine	Dsf	Source	PT camera		Motherboard spacer	
71	Examine	Dsf	Source	PT camera		SD card hole	
72	Examine	Dsf	Source	PT camera		WPS button hole	
73	Carry over	Df	Source	PT camera	Base cover	Plate	Is this feature needed to support the other desired features of the existing base variant?
74	Examine	Dsf	Source	PT camera		Rim	
75	Examine	Dsf	Source	PT camera		Inner plate	
76	Examine	Dsf	Source	PT camera		Bearing Holder	
77	Carry over	Df	Source	PT camera		Screw hole	
78	Examine	Dsf	Source	PT camera		Spacer	
79	Examine	Dsf	Source	PT camera		Mounting boss	
80	Examine	Dsf	Source	PT camera		Holes	
81	Carry over	Df	Source	PT camera		Sensor stopper	
82	Carry over	Df	Source	PT camera		Platform stopper	
83	Carry over	Df	Source	PT camera		Bearing (Pan)	
84	Examine	Dsf	Source	PT camera	Bearing Cover	Base plate	Is this feature needed to support the other desired features of the existing base variant?
85	Carry over	Df	Source	PT camera		Gear	
86	Examine	Dsf	Source	PT camera		Screw holes	
87	Carry over	Df	Source	PT camera	LHS casing	Lower casing	Is this feature needed to support the other desired features of the existing base variant?
88	Examine	Dsf	Source	PT camera		Upper casing	
89	Examine	Dsf	Source	PT camera		Casing cut away	
90	Examine	Dsf	Source	PT camera		Speaker mounting boss	
91	Examine	Dsf	Source	PT camera		Speaker screw hole	
92	Carry over	Df	Source	PT camera	Daughter board	Body	Is this feature needed to support the other desired features of the existing base variant?
93	Examine	Dsf	Source	PT camera		Screw holes	
94	Carry over	Df	Source	PT camera	Nut	Outer ring	Carry over Nut
95	Carry over	Df	Source	PT camera		Inner ring	
96	Examine	Dsf	Source	PT camera	Pan motor	Body	Is this feature needed to support the other desired features of the existing base variant?
97	Carry over	Df	Source	PT camera		Terminal box	
98	Carry over	Df	Source	PT camera		Shaft	
99	Carry over	Df	Source	PT camera		Key	
100	Examine	Dsf	Source	PT camera		Bracket	
101	Carry over	Df	Source	PT camera		Gear	
102	Carry over	Df	Source	PT camera		Screw	
103	Carry over	Df	Source	PT camera		RHS casing	
104	Examine	Dsf	Source	PT camera	Upper casing		
105	Examine	Dsf	Source	PT camera	Casing cut away		
106	Examine	Dsf	Source	PT camera	Speaker mounting boss		
107	Examine	Dsf	Source	PT camera	Speaker screw hole		
108	Examine	Dsf	Source	PT camera	Speaker cover		
109	Examine	Dsf	Source	PT camera	Rotating platform	Spacer	Is this feature needed to support the other desired features of the existing base variant?
110	Carry over	Df	Source	PT camera		Lip	
111	Carry over	Df	Source	PT camera		Grove	
112	Examine	Dsf	Source	PT camera		Motor shaft hole	
113	Carry over	Df	Source	PT camera		Bearing shaft	
114	Carry over	Df	Source	PT camera		Stopper	
115	Examine	Dsf	Source	PT camera		Sensor switch hole	
116	Examine	Dsf	Source	PT camera		Sensor mount	
117	Examine	Dsf	Source	PT camera		Motor mount	
118	Examine	Dsf	Source	PT camera		Motor bracket hole	
119	Examine	Dsf	Source	PT camera	Sensor (Pan)	Body	Is this feature needed to support the other desired features of the existing base variant?
120	Carry over	Df	Source	PT camera		Switch	
121	Examine	Dsf	Source	PT camera		Terminals	



PARTS LIST			
ITEM	QTY	PRODUCT VARIANT	PART NAME
1	1	PT IP camera	Modified base
2	1	PT IP camera	Base cover
3	1	PT IP camera	Bearing
4	1	PT IP camera	Bearing cover
5	1	PT IP camera	Nut
6	1	PT IP camera	Sensor
7	1	PT IP camera	Motor
8	1	PT IP camera	Daughterboard
9	1	PT IP camera	Modified RHS casing
10	1	PT IP camera	Modified LHS casing
11	1	Fixed camera	Modified rear cover
12	1	Fixed IP camera	Tilt arm
13	1	Fixed IP camera	Cap I
14	1	Fixed IP camera	Bolt I
15	1	Fixed IP camera	Rear cover
17	1	Fixed IP camera	Motherboard
18	1	Fixed IP camera	LED motherboard
16	1	Fixed IP camera	Side cover
19	1	Fixed IP camera	Front cover
20	1	Fixed IP camera	Bolt II
21	1	Fixed IP camera	Cap II

Designed by	Checked by	Approved by	Date	Date	Scale
				23/09/2022	7:10
Assembly drawings of new IP camera variant			Exploded view of the new IP camera		
			Edition	Sheet	
				1 / 2	



PARTS LIST			
ITEM	QTY	PRODUCT VARIANT	PART NAME
1	1	PT IP camera	Modified base
5	1	Fixed IP camera	Modified base cover
10	1	PT IP camera	Modified LHS casing
11	1	PT IP camera	Modified RHS casing

Designed by	Checked by	Approved by	Date	Date	Scale
				23/09/2022	1 : 1
Assembly drawings of new IP camera variant			Features of modified parts		
			Edition	Sheet	
				2 / 2	