SONY

OPEN-R SDK

Model Information for ERS-210

115-01

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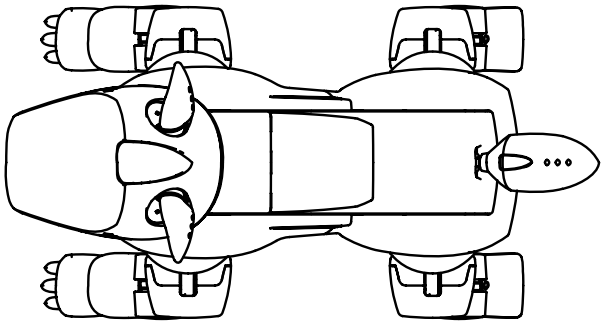
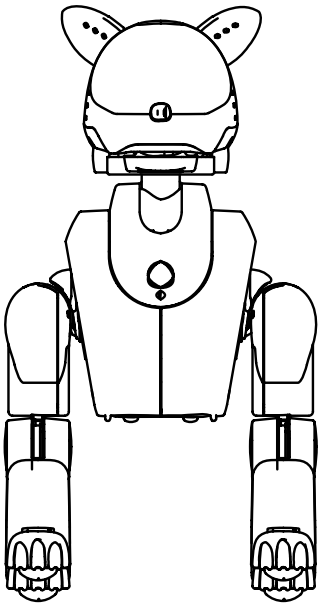
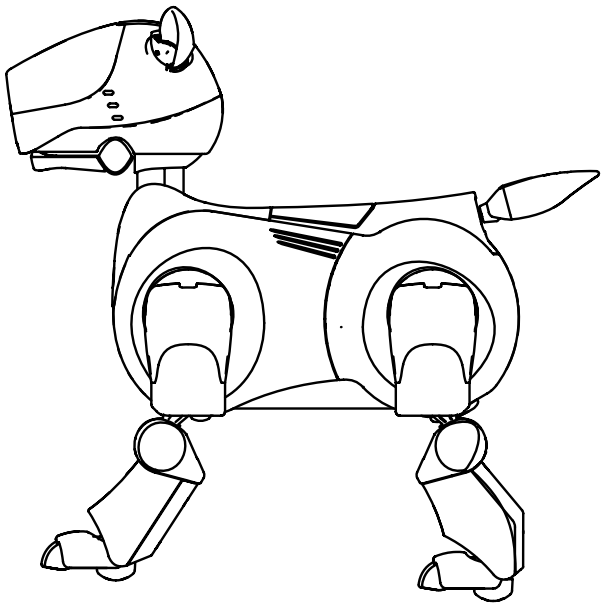
Chapter1 Outside Specifications

1.1 External Appearance

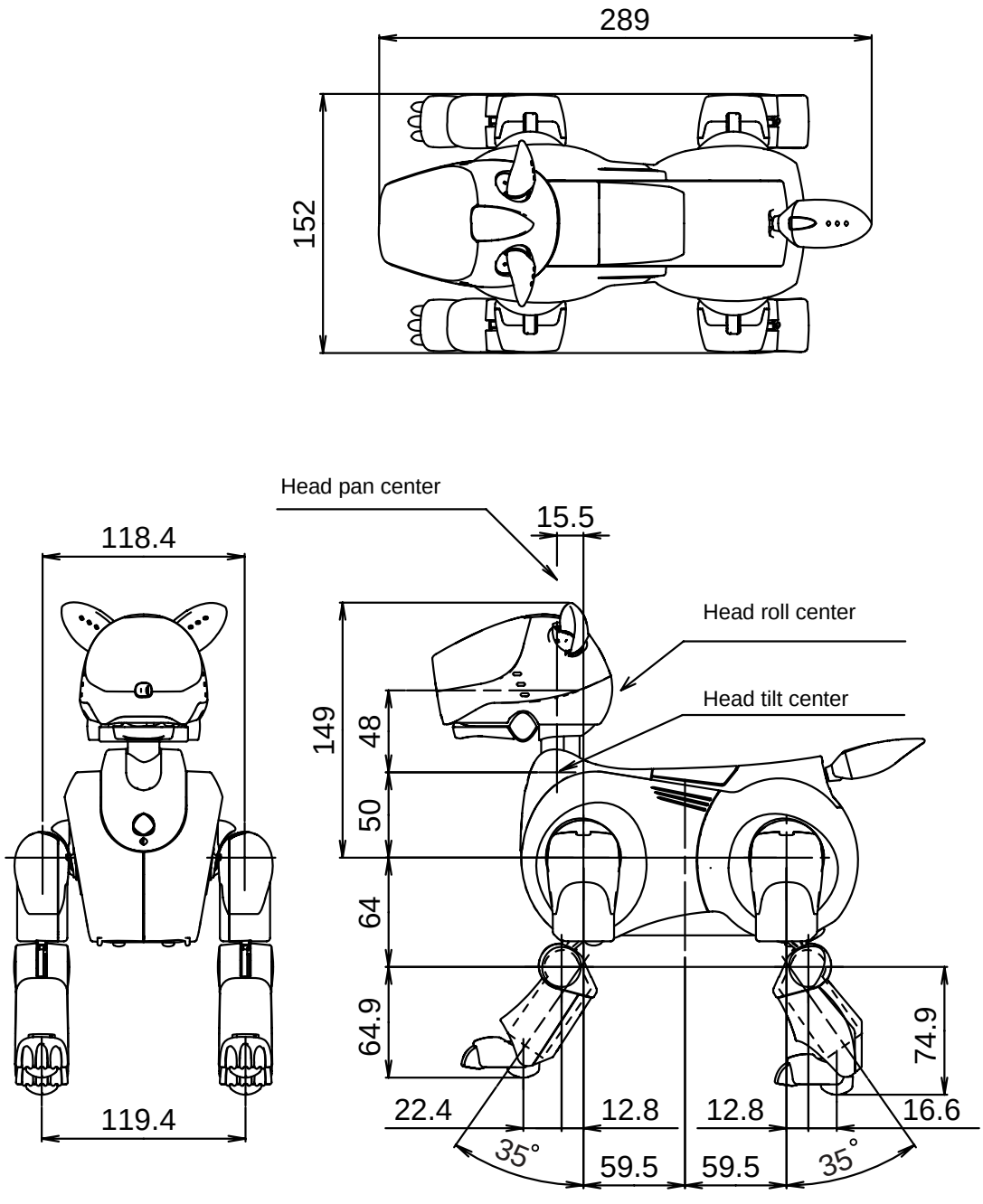
1.1.1 Drawings of External Appearance



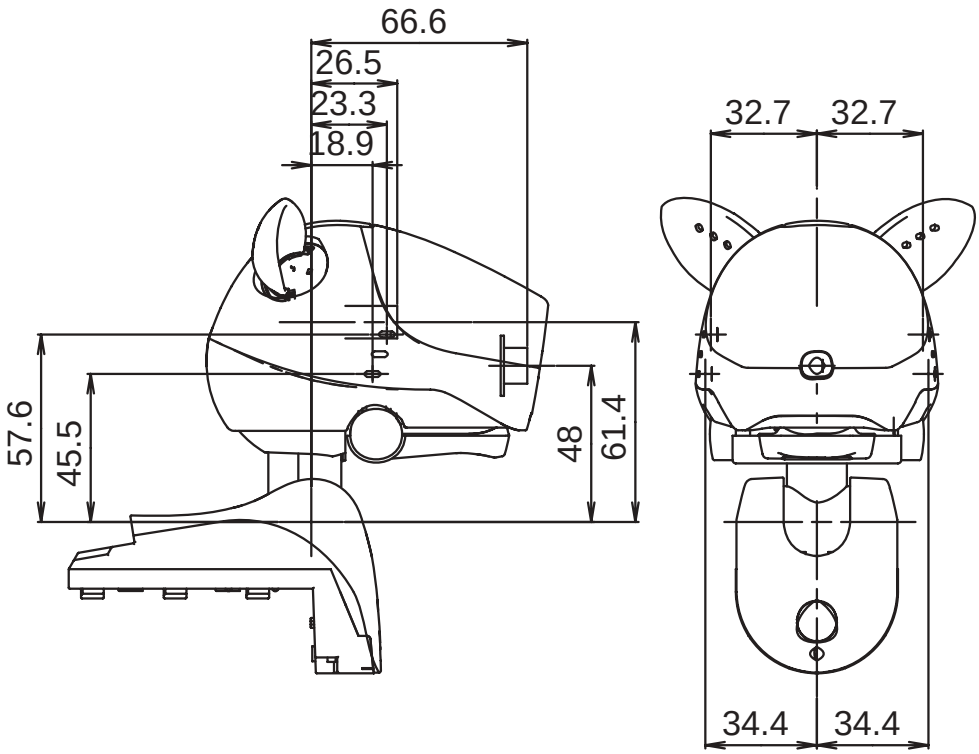




1.1.2 Measurements of External Appearance

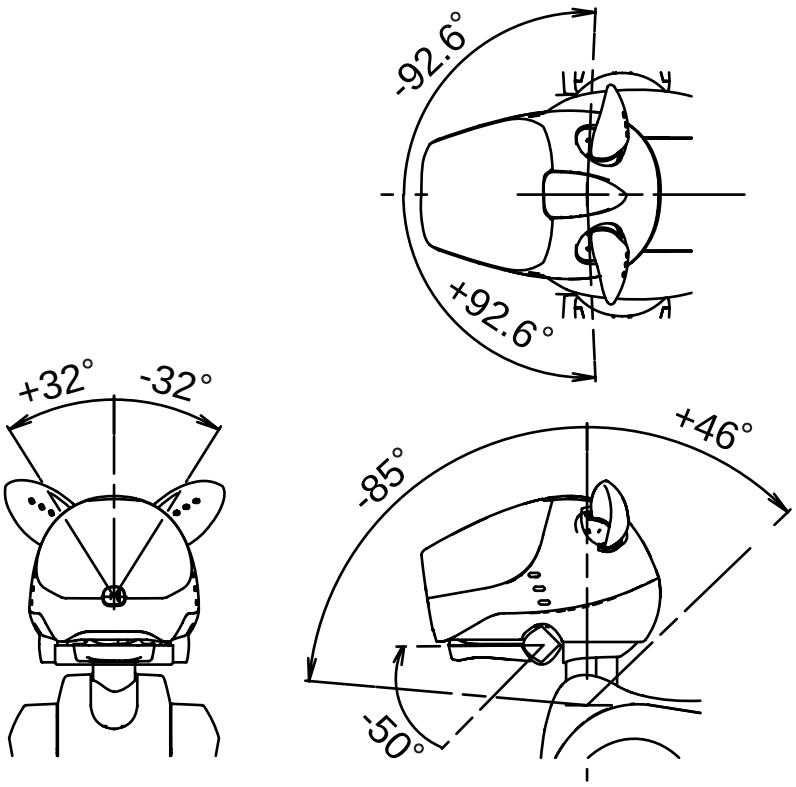


unit: mm


66.6
26.5
23.3
18.9
57.6
45.5
48
61.4
32.7
32.7
34.4
34.4

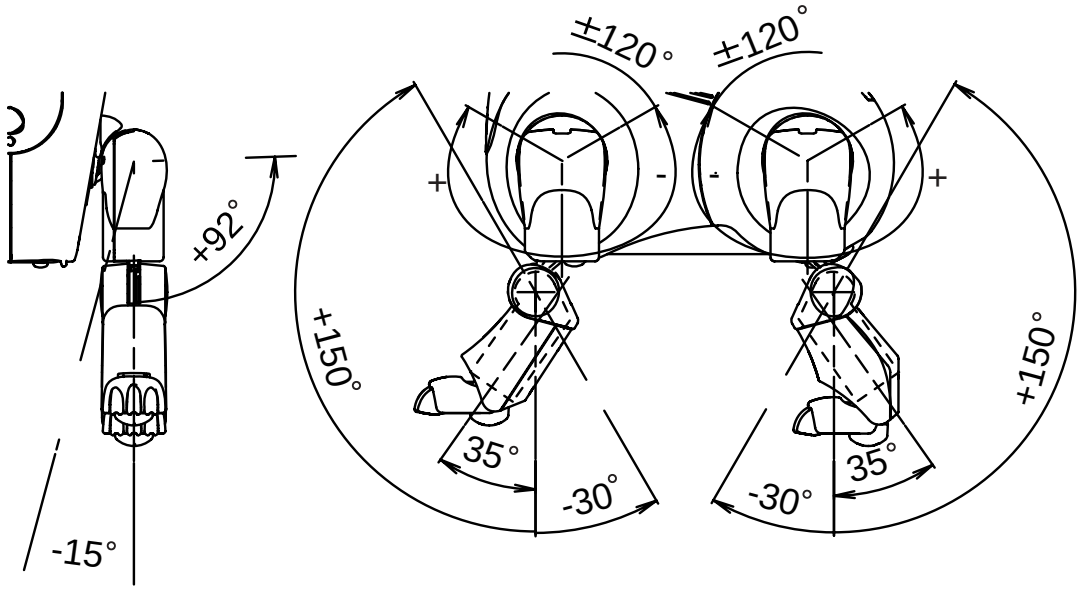
1.2 Operational Limits

1.2.1 Head



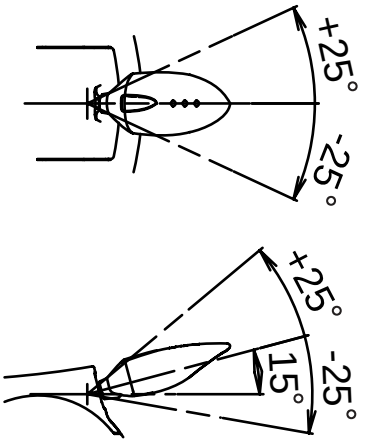
Part	Degree of freedom
Neck	3DOF(pan, tilt, and roll)
Ear	1DOF x 2
Chin	1DOF
Total	6 DOF

1.2.2 Legs



Part	Degree of freedom
Front leg	3DOF x 2
Rear leg	3DOF x 2
Total	12DOF

1.2.3 Tail

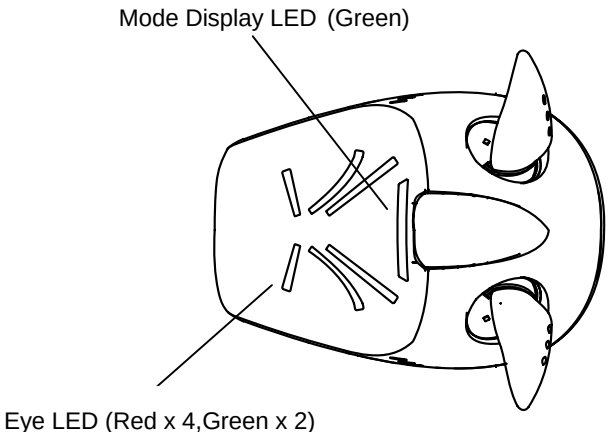


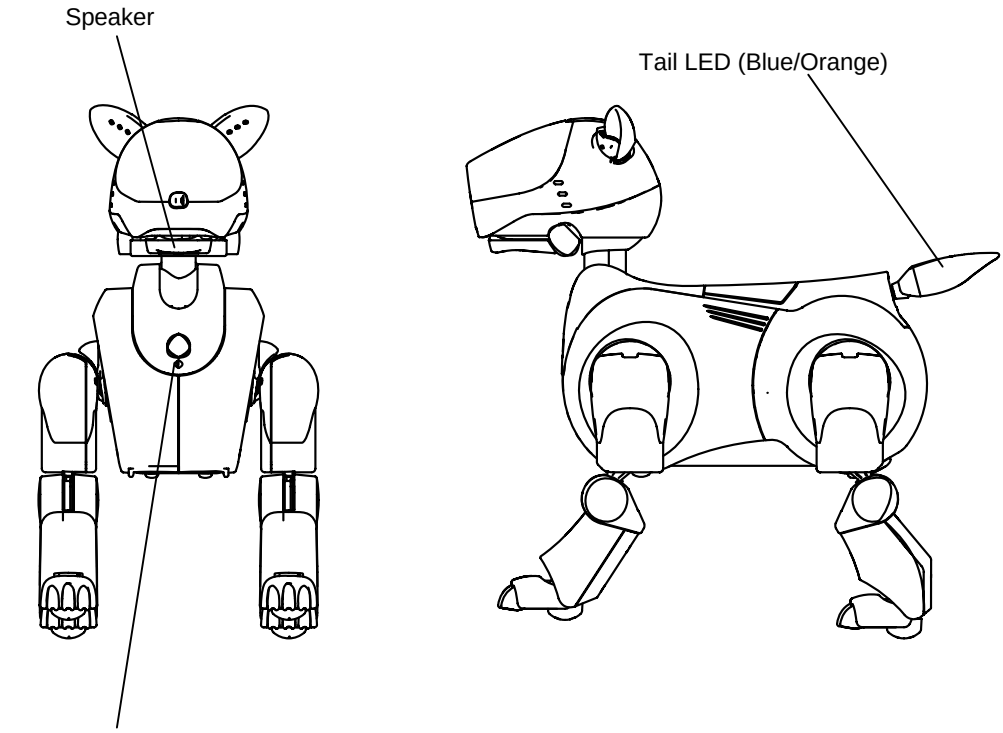
Default position is 15 degrees of elevation.

Part	Degree of freedom
Tail	2DOF x 1
Total	2DOF

1.3 Device Layout

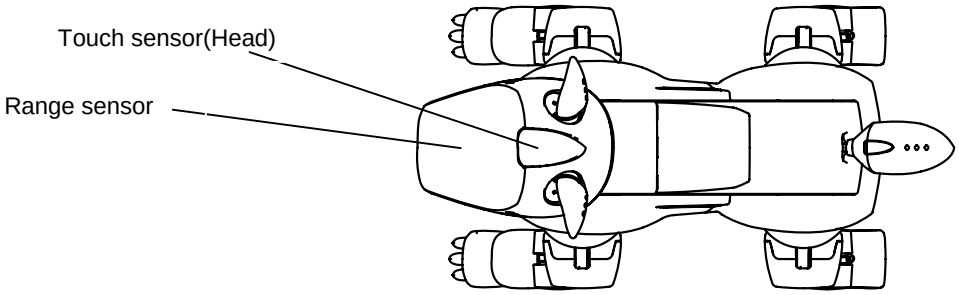
1.3.1 Output Devices

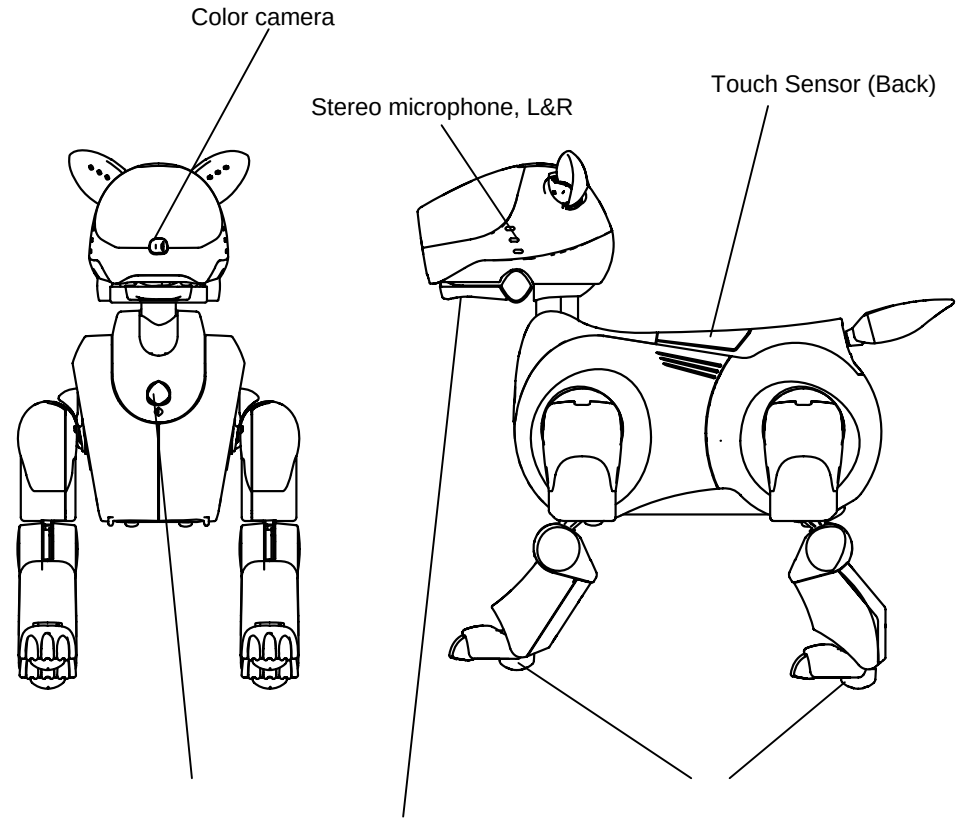




Inside body
-Clock Display LCD
-MS access lamp
-Piezoelectric buzzer (for boot sound and shutdown sound)

1.3.2 Input Devices

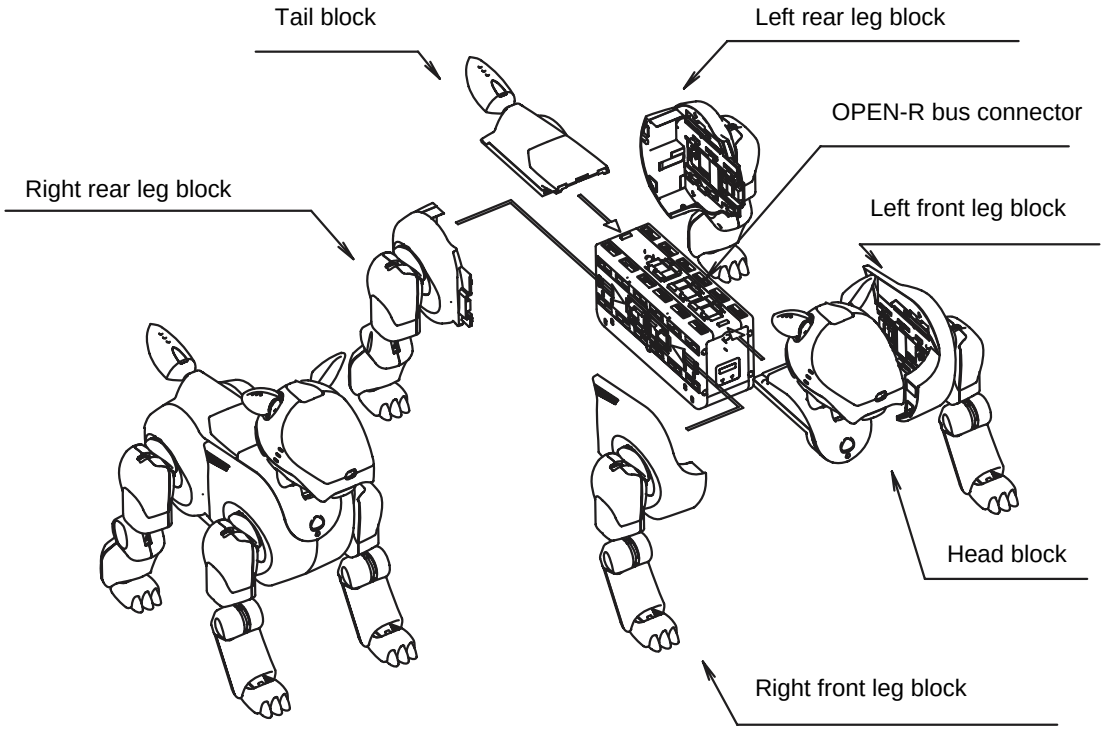




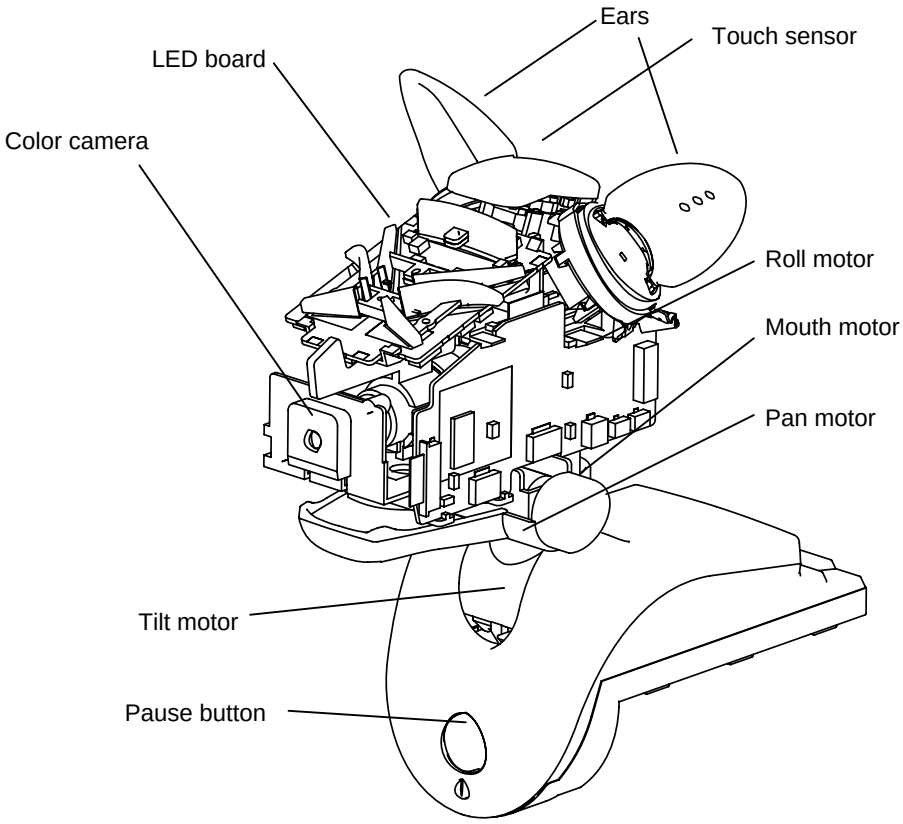
Inside body
- Acceleration Sensor
- Vibration Sensor
- Thermo Sensor
- Clock (and setting switch)
- PC Card slot (PCMCIA Type)
- Memory Stick Slot

1.4 Configuration

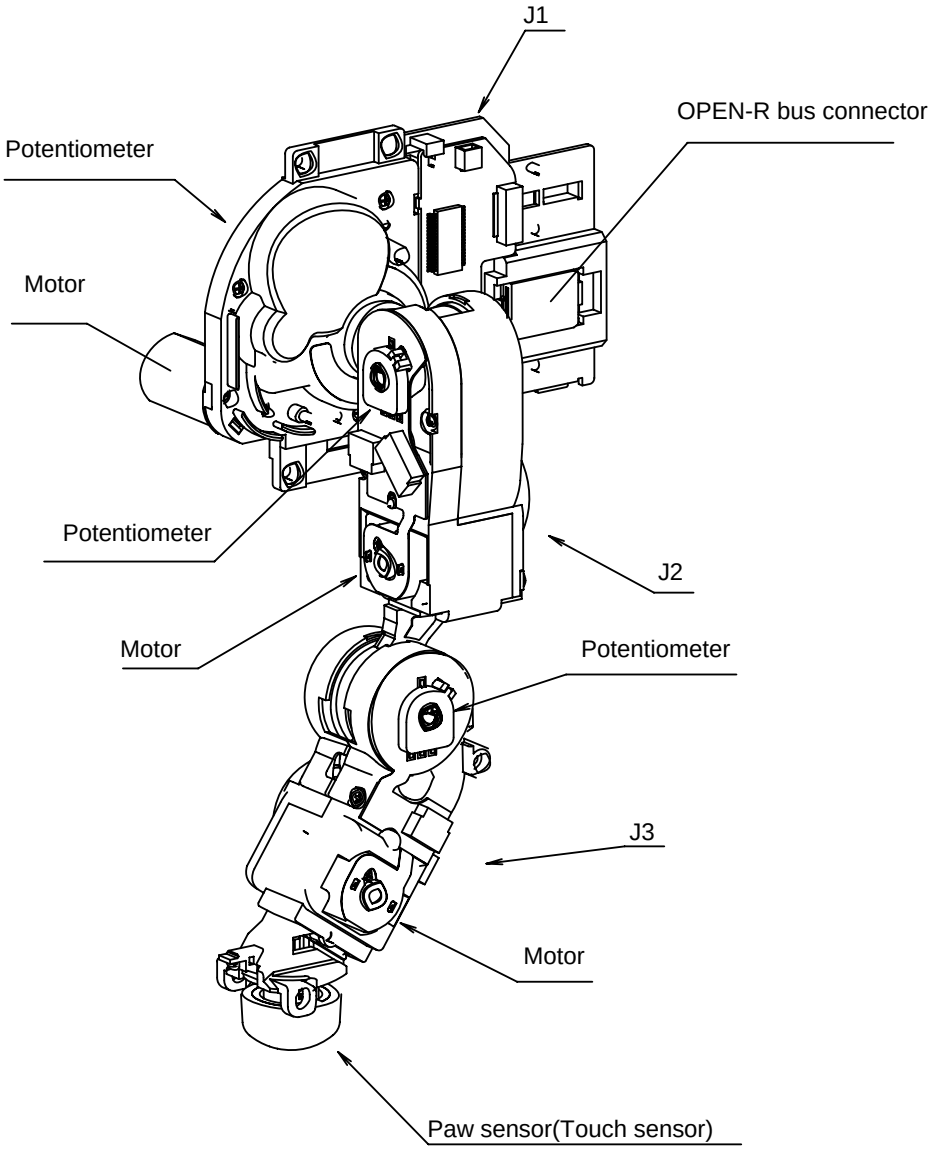
1.4.1 Block Overview



1.4.2 Head


Ears
Touch sensor
LED board
Color camera
Roll motor
Mouth motor
Pan motor
Tilt motor
Pause button

1.4.3 Leg


J1
OPEN-R bus connector
Potentiometer
Motor
Potentiometer
J2
Motor
Potentiometer
J3
Motor
Paw sensor(Touch sensor)

Chaper2 Joint

2.1 List of CPC Primitive Locator

The following are names of parts. They are used when you write a program.

	CPC Primitive Locator	Parts
Head		
	PRM:/r1/c1-Joint2:j1	Neck tilt
	PRM:/r1/c1/c2-Joint2:j2	Neck pan
	PRM:/r1/c1/c2/c3-Joint2:j3	Neck roll
	PRM:/r1/c1/c2/c3/c4-Joint2:j4	Mouth
	PRM:/r1/c1/c2/c3/f1-Sensor:f1	Head sensor (back)
	PRM:/r1/c1/c2/c3/f2-Sensor:f2	Head sensor (front)
	PRM:/r1/c1/c2/c3/c4/s5-Sensor:s5	Chin switch
	PRM:/r1/c1/c2/c3/p1-Sensor:p1	PSD(Position Sensing Device)
	PRM:/r1/c1/c2/c3/m1-Mic:M1	Microphone
	PRM:/r1/c1/c2/c3/s1-Speaker:S1	Speaker
	PRM:/r1/c1/c2/c3/i1-FbkImageSensor:F1	Color camera
	PRM:/r1/c1/c2/c3/e1-Joint3:j5	Left ear
	PRM:/r1/c1/c2/c3/e2-Joint3:j6	Right ear
	PRM:/r1/c1/c2/c3/l1-LED2:l1	Eye light (Lower left)
	PRM:/r1/c1/c2/c3/l2-LED2:l2	Eye light (Middle left)
	PRM:/r1/c1/c2/c3/l3-LED2:l3	Eye light (Upper left)
	PRM:/r1/c1/c2/c3/l4-LED2:l4	Eye light (Lower right)
	PRM:/r1/c1/c2/c3/l5-LED2:l5	Eye light (Middle right)
	PRM:/r1/c1/c2/c3/l6-LED2:l6	Eye light (Upper right)
	PRM:/r1/c1/c2/c3/l7-LED2:l7	Mode indicator
Left fore leg		
	PRM:/r2/c1-Joint2:j1	J1 joint
	PRM:/r2/c1/c2-Joint2:j2	J2 joint
	PRM:/r2/c1/c2/c3-Joint2:j3	J3 joint
	PRM:/r2/c1/c2/c3/c4-Sensor:s4	Paw sensor
Left hind leg		
	PRM:/r3/c1-Joint2:j1	J1 joint
	PRM:/r3/c1/c2-Joint2:j2	J2 joint
	PRM:/r3/c1/c2/c3-Joint2:j3	J3 joint
	PRM:/r3/c1/c2/c3/c4-Sensor:s4	Paw sensor
Right fore leg		
	PRM:/r4/c1-Joint2:j1	J1 joint
	PRM:/r4/c1/c2-Joint2:j2	J2 joint
	PRM:/r4/c1/c2/c3-Joint2:j3	J3 joint
	PRM:/r4/c1/c2/c3/c4-Sensor:s4	Paw sensor
Right hind leg		
	PRM:/r5/c1-Joint2:j1	J1 joint
	PRM:/r5/c1/c2-Joint2:j2	J2 joint
	PRM:/r5/c1/c2/c3-Joint2:j3	J3 joint
	PRM:/r5/c1/c2/c3/c4-Sensor:s4	Paw sensor
Tail		
	PRM:/r6/c1-Joint2:j1	Tail pan
	PRM:/r6/c2-Joint2:j2	Tail tilt
	RPM:/r6/l1-LED2:l1	Tail light (Blue)
	RPM:/r6/l2-LED2:l2	Tail light (Orange)
	PRM:/r6/t1-Sensor:t1	Thermo sensor
	PRM:/r6/s1-Sensor:s1	Back sensor

Acceleration sensor

PRM:/a1-Sensor:a1	y-axis (Front-back direction (Front positive))
PRM:/a2-Sensor:a2	x-axis (Right-left direction (Right positive))
PRM:/a3-Sensor:a3	z-axis (Up-down direction (Up positive))

Correspondence between the index number of OSensorFrameVectorData and CPC Primitive Locator

Index number	CPC Primitive Locator
0	PRM:/r1/c1-Joint2:j1
1	PRM:/r1/c1/c2-Joint2:j2
2	PRM:/r1/c1/c2/c3-Joint2:j3
3	PRM:/r1/c1/c2/c3/f1-Sensor:f1
4	PRM:/r1/c1/c2/c3/f2-Sensor:f2
5	PRM:/r1/c1/c2/c3/p1-Sensor:p1
6	PRM:/r1/c1/c2/c3/c4-Joint2:j4
7	PRM:/r1/c1/c2/c3/c4/s5-Sensor:s5
8	PRM:/r2/c1-Joint2:j1
9	PRM:/r2/c1/c2-Joint2:j2
10	PRM:/r2/c1/c2/c3-Joint2:j3
11	PRM:/r2/c1/c2/c3/c4-Sensor:s4
12	PRM:/r3/c1-Joint2:j1
13	PRM:/r3/c1/c2-Joint2:j2
14	PRM:/r3/c1/c2/c3-Joint2:j3
15	PRM:/r3/c1/c2/c3/c4-Sensor:s4
16	PRM:/r4/c1-Joint2:j1
17	PRM:/r4/c1/c2-Joint2:j2
18	PRM:/r4/c1/c2/c3-Joint2:j3
19	PRM:/r4/c1/c2/c3/c4-Sensor:s4
20	PRM:/r5/c1-Joint2:j1
21	PRM:/r5/c1/c2-Joint2:j2
22	PRM:/r5/c1/c2/c3-Joint2:j3
23	PRM:/r5/c1/c2/c3/c4-Sensor:s4
24	PRM:/r6/c1-Joint2:j1
25	PRM:/r6/c2-Joint2:j2
26	PRM:/r6/t1-Sensor:t1
27	PRM:/r6/s1-Sensor:s1
28	PRM:/a1-Sensor:a1
29	PRM:/a2-Sensor:a2
30	PRM:/a3-Sensor:a3

2.2 Limitation of Joint Motion

2.2.1 Limitation of Single Joints

- Max/Min value in leg's software limitation

	min	max	mechanical limit
J1	-117	117	-120 <--> 120
J2	-11	89	-14 <--> 92
J3	-27	147	-30 <--> 150

- Max/Min value in head's software limitation

	min	max	mechanical limit
tilt	-82	43	-85 <--> 46
pan	-89.6	89.6	-92.6 <--> 92.6
roll	-29	29	-32 <--> 32
mouth	-47	-3	-50 <--> 0

- Max/Min value in tail's software limitation

	min	max	mechanical limit
pan	-22	22	-25 <--> 25
tilt	-22	22	-25 <--> 25

Unit:degree

2.2.2 Software limitation of Two Joints of Leg

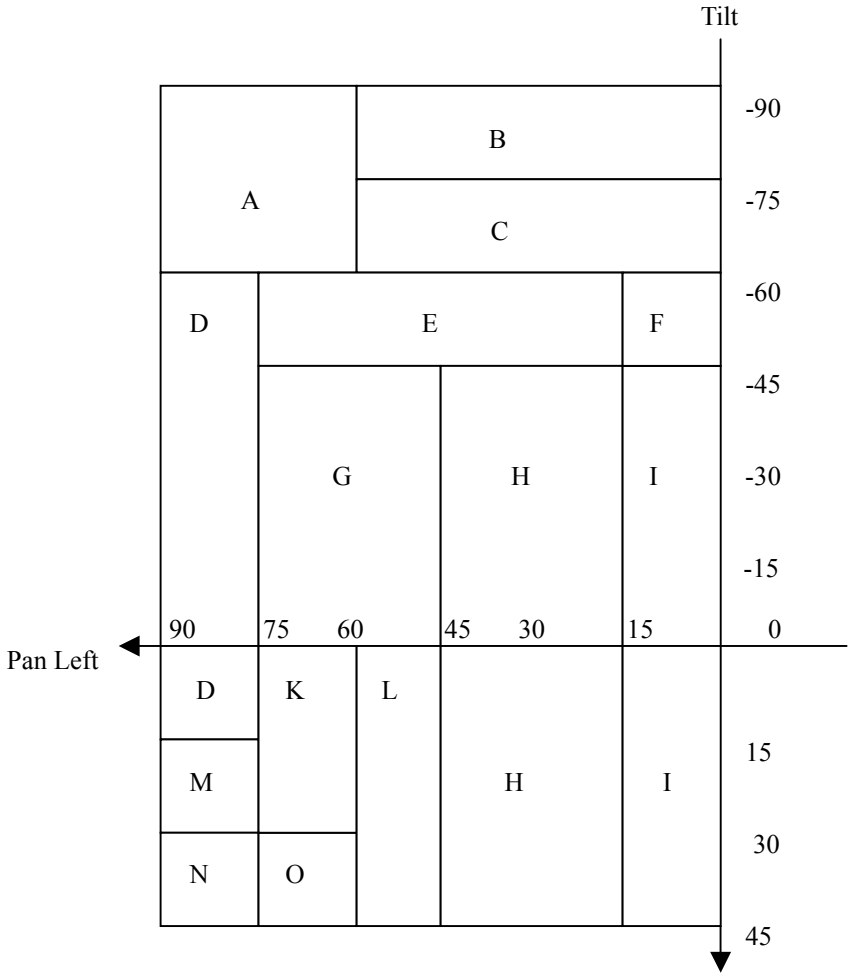
The following are the minimum value of the angle of front leg's J2 and the angle of backward leg's J2 when J1 varies.

J1	front leg's J2	backward leg's J2
117	2.0	1.0
105	2.0	2.3
90	-0.7	-0.5
75	-3.5	-3.0
60	-5.5	-5.0
45	-7.5	-7.5
30	-9.0	-9.5
15	-11.0	-10.5
0	-11.0	-11.0
-15	-11.0	-11.0
-30	-10.5	-9.5
-45	-9.5	-8.0
-60	-6.3	-6.0
-75	-4.3	-2.3
-90	-2.0	-1.3
-105	0.3	1.7
-117	2.6	3.0

Unit:degree

2.2.3 Software Limitation of 4 Joints in Head

Roll and mouth angles are limited to certain ranges in respective areas defined by tilt and pan angles. Pan is also symmetric on the right side. Please note that the relationship between the roll direction and the positive/negative sign of the roll angle.



A -25 <= roll <= 0 and mouth = -3

B roll = 0 and mouth = -3

C -15 <= roll <= 10 and mouth = -3

D -29 <=roll <= 20 and -30 <= mouth <=-3

E -20 <=roll <=29 and -20 <=mouth <=-3

F -20 <=roll <=20 and -30 <=mouth <=-3

G -20 <=roll <=29 and -30 <=mouth <=-3

H -20 <=roll <=29 and -47 <=mouth <=-3

I -29 <=roll <=29 and -47 <=mouth <=-3

K -15 <=roll <=29 and -30 <=mouth <=-3

L -13 <=roll <=29 and -30 <=mouth <=-3

M -15 <=roll <=20 and -10 <=mouth <=-3

N 2 <=roll <=20 and -10 <=mouth <=-3

O -7 <=roll <=29 and -30 <=mouth <=-3

Unit:degree

2.3 Servo Gain

The following are the standard servo gains in joints for ERS-210. PSHIFT, ISHIFT, DSHIFT are fixed values and do not change the values.

ERS-210

CPC Primitive Locator	PGAIN	IGAIN	DGAIN	PSHIFT	ISHIFT	DSHIFT
PRM:/r1/c1-Joint2:j1	0x0A	0x08	0x0C	0x0E	0x02	0x0F
PRM:/r1/c1/c2-Joint2:j2	0x0D	0x08	0x0B	0x0E	0x02	0x0F
PRM:/r1/c1/c2/c3-Joint2:j3	0x0A	0x08	0x0C	0x0E	0x02	0x0F
PRM:/r1/c1/c2/c3/c4-Joint2:j4	0x0E	0x08	0x10	0x0E	0x02	0x0F
PRM:/r2/c1-Joint2:j1	0x16	0x04	0x08	0x0E	0x02	0x0F
PRM:/r2/c1/c2-Joint2:j2	0x14	0x04	0x06	0x0E	0x02	0x0F
PRM:/r2/c1/c2/c3-Joint2:j3	0x23	0x04	0x05	0x0E	0x02	0x0F
PRM:/r3/c1-Joint2:j1	0x16	0x04	0x08	0x0E	0x02	0x0F
PRM:/r3/c1/c2-Joint2:j2	0x14	0x04	0x06	0x0E	0x02	0x0F
PRM:/r3/c1/c2/c3-Joint2:j3	0x23	0x04	0x05	0x0E	0x02	0x0F
PRM:/r4/c1-Joint2:j1	0x16	0x04	0x08	0x0E	0x02	0x0F
PRM:/r4/c1/c2-Joint2:j2	0x14	0x04	0x06	0x0E	0x02	0x0F
PRM:/r4/c1/c2/c3-Joint2:j3	0x23	0x04	0x05	0x0E	0x02	0x0F
PRM:/r5/c1-Joint2:j1	0x16	0x04	0x08	0x0E	0x02	0x0F
PRM:/r5/c1/c2-Joint2:j2	0x14	0x04	0x06	0x0E	0x02	0x0F
PRM:/r5/c1/c2/c3-Joint2:j3	0x23	0x04	0x05	0x0E	0x02	0x0F
PRM:/r6/c1-Joint2:j1	0x0A	0x00	0x18	0x0E	0x02	0x0F
PRM:/r6/c2-Joint2:j2	0x07	0x00	0x11	0x0E	0x02	0x0F

2.4 Relations between the polarity of PWM and the polarity of rotation angle of joints

In OPEN-R SDK 1.1.3 r1, rotation angle of some of the joints had opposite polarity to the corresponding PWM duty. In OPEN-R SDK 1.1.3 r2, polarities of rotation angle and PWM duty are aligned for all of the joints.

Polarity of rotation angle of joint to the positive direction of PWM

	(The version of OPEN-R SDK 1.1.3)	r1	r2
PRM : /r1/c1-Joint2:j1	Neck tilt	-	+
PRM : /r1/c1/c2-Joint2:j2	Neck pan	-	+
PRM : /r1/c1/c2/c3-Joint2:j3	Neck roll	-	+
PRM : /r1/c1/c2/c3 /c4-Joint2:j4	Mouth	+	+
PRM : /r2/c1-Joint2:j1	Left fore Leg, J1 joint	-	+
PRM : /r2/c1/c2-Joint2:j2	Left fore Leg, J2 joint	-	+
PRM : /r2/c1/c2/c3-Joint2:j3	Left fore Leg, J3 joint	+	+
PRM : /r3/c1-Joint2:j1	Left hind leg, J1 joint	-	+
PRM : /r3/c1/c2-Joint2:j2	Left hind leg, J2 joint	-	+
PRM : /r3/c1/c2/c3-Joint2:j3	Left hind leg, J3 joint	+	+
PRM : /r4/c1-Joint2:j1	Right fore leg, J1 joint	-	+
PRM : /r4/c1/c2-Joint2:j2	Right fore leg, J2 joint	-	+
PRM : /r4/c1/c2/c3-Joint2:j3	Right fore leg, J3 joint	+	+
PRM : /r5/c1-Joint2:j1	Right hind leg, J1 joint	+	+
PRM : /r5/c1/c2-Joint2:j2	Right hind leg, J2 joint	-	+
PRM : /r5/c1/c2/c3-Joint2:j3	Right hind leg, J3 joint	+	+
PRM : /r6/c1-Joint2:j1	Tail pan	-	+
PRM : /r6/c2-Joint2:j2	Tail tilt	-	+

Chapter 3 Output Devices

3.1 LED

CPC Primitive Locator	Parts
PRM:/r1/c1/c2/c3/l1-LED2:l1	Eye light (Lower left)
PRM:/r1/c1/c2/c3/l2-LED2:l2	Eye light (Middle left)
PRM:/r1/c1/c2/c3/l3-LED2:l3	Eye light (Upper left)
PRM:/r1/c1/c2/c3/l4-LED2:l4	Eye light (Lower right)
PRM:/r1/c1/c2/c3/l5-LED2:l5	Eye light (Middle right)
PRM:/r1/c1/c2/c3/l6-LED2:l6	Eye light (Upper right)
PRM:/r1/c1/c2/c3/l7-LED2:l7	Mode indicator
RPM:/r6/l1-LED2:l1	Tail light (Blue)
RPM:/r6/l2-LED2:l2	Tail light (Orange)

3.2 Speaker

CPC Primitive Locator
PRM:/r1/c1/c2/c3/s1-Speaker:S1

Sampling frequency	8000Hz
Quantized bit length	8bits linear PCM
Channel	1 Channel (monaural)

Parameters which can be set to OPENR::ControlPrimitive()

oprmreqSPEAKER_SET_VOLUME

volume	0xf600 - 0x8000	0x100 per 1dB of volume
	0xf600	-10dB (maximum volume)
	0x8000	-∞dB (minimum volume)

oprmreqSPEAKER_MUTE_ON
oprmreqSPEAKER_MUTE_OFF

oprmreqSPEAKER_GET_SOUND_TYPE
oprmreqSPEAKER_SET_SOUND_TYPE

Sound types which can be set
ospksndMONO8K8B(default)
ospksndMONO16K16B

3.3 LCD

It displays the current time, the battery life remaining, and the sound volume.

Chapter 4 Input Devices

4.1 External

4.1.1 Head Sensor

CPC Primitive Locator	Sensor
PRM:/r1/c1/c2/c3/f1-Sensor:f1	Head sensor (back)
PRM:/r1/c1/c2/c3/f2-Sensor:f2	Head sensor (front)

Range of value

min:0 (0.0N = 0gf)
max:980665 (0.980665N = 100gf)

Notes

The return values that are much different from the real value of the pressure on the head, because of different effects in dispersion of mechanical parts such as a spring.

4.1.2 Color Camera

CPC Primitive Locator

PRM:/r1/c1/c2/c3/i1-FbkImageSensor:F1

Specification of color camera

CMOS part

1/6 inch
The number of picture elements 352(H) x 288(V)
25FPS

Lens

F 2.0
f = 2.18mm

Angle of view

Horizontal angle	57.6 degrees
Vertical angle	47.8 degrees

Default

White balance	4300K fixed
Shutter speed	1/100 sec fixed
Gain	0dB fixed

Parameters which can be set to OPENR::ControlPrimitive()

White balance

oprmreqCAM_SET_WHITE_BALANCE

ocamparamWB_INDOOR_MODE	: 2800K
ocamparamWB_FL_MODE	: 4300K
ocamparamWB_OUTDOOR_MODE	: 7000K

Shutter speed

oprmreqCAM_SET_SHUTTER_SPEED

ocamparamSHUTTER_SLOW	: 1/50sec
ocamparamSHUTTER_MID	: 1/100sec
ocamparamSHUTTER_FAST	: 1/200sec

Gain

oprmreqCAM_SET_GAIN

ocamparamGAIN_LOW	: 0dB
ocamparamGAIN_MID	: 0dB
ocamparamGAIN_HIGH	: 6dB

4.1.3 Distance Sensor

CPC Primitive Locator
PRM:/r1/c1/c2/c3/p1-Sensor:p1

Range of value

100000	10cm
900000	90cm

4.1.4 Pause Switch

The pause switch is connected to a battery control microcomputer. The system starts by pushing the pause switch when the power is off.

When the pause switch is pressed while booting, your application program must detect the status of the pause switch and shutdown the robot itself.

4.1.5 Microphone

CPC Primitive Locator	**Device**
PRM:/r1/c1/c2/c3/m1-Mic:M1	Microphone

Sampling frequency	16000Hz
Quantized bit length	16bits Linear PCM
Channel	2 channel (stereo)

Parameters which can be set to OPENR::ControlPrimitive
Selection of Omnidirectional (OMNI) / Single directional (UNI)
(Direction: Front direction of the head along the microphone hole on the robot face.)
oprmreqMIC_UNI
oprmreqMIC_OMNI

ALC(Automatic Limit Control) Selection of ALC ON / OFF
oprmreqMIC_ALC_ON
oprmreqMIC_ALC_OFF

4.1.6 Switches

CPC Primitive Locator	**Switch**
PRM:/r1/c1/c2/c3/c4/s5-Sensor:s5	Chin sensor
PRM:/r2/c1/c2/c3/c4-Sensor:s4	Paw sensor (left fore leg)
PRM:/r3/c1/c2/c3/c4-Sensor:s4	Paw sensor (Left hind leg)
PRM:/r4/c1/c2/c3/c4-Sensor:s4	Paw sensor (Right fore leg)
PRM:/r5/c1/c2/c3/c4-Sensor:s4	Paw sensor (Right hind leg)
PRM:/r6/s1-Sensor:s1	Back sensor

4.2 Inside

4.2.1 Acceleration Sensor

CPC Primitive Locator	**xyz axis**
PRM:/a1-Sensor:a1	y-axis (Front-back direction (Front positive))
PRM:/a2-Sensor:a2	x-axis (Right-left direction (Right positive))
PRM:/a3-Sensor:a3	z-axis (Up-down direction (Up positive))

Range of value

-19613300	-19.6133 m/s2	-2.0G
+19613300	+19.6133 m/s2	+2.0G

4.2.2 Vibration Sensor

The vibration sensor is connected to a battery control microcomputer.
The system starts when the battery control microcomputer detects vibration in the case that the boot condition obcbVIBRATION_DETECTED is set.