

**SONY®**

# ***OPEN-R SDK***

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**Model Information for ERS-220**



115-01

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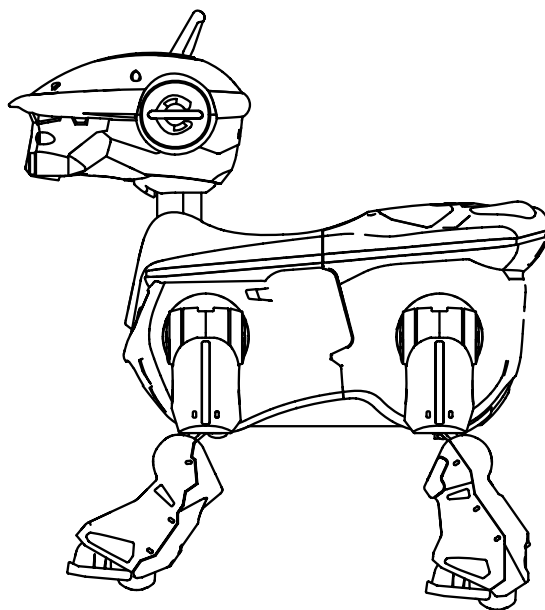
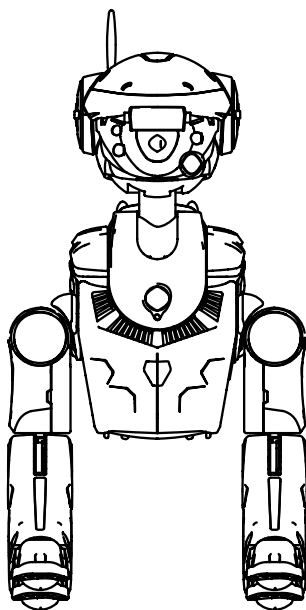
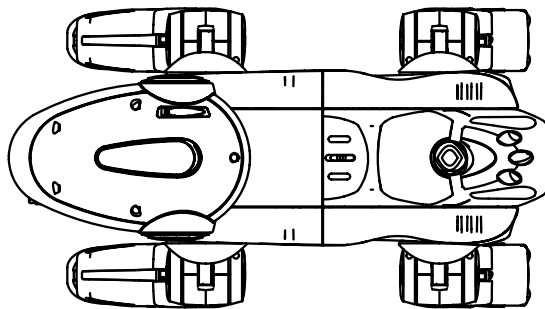
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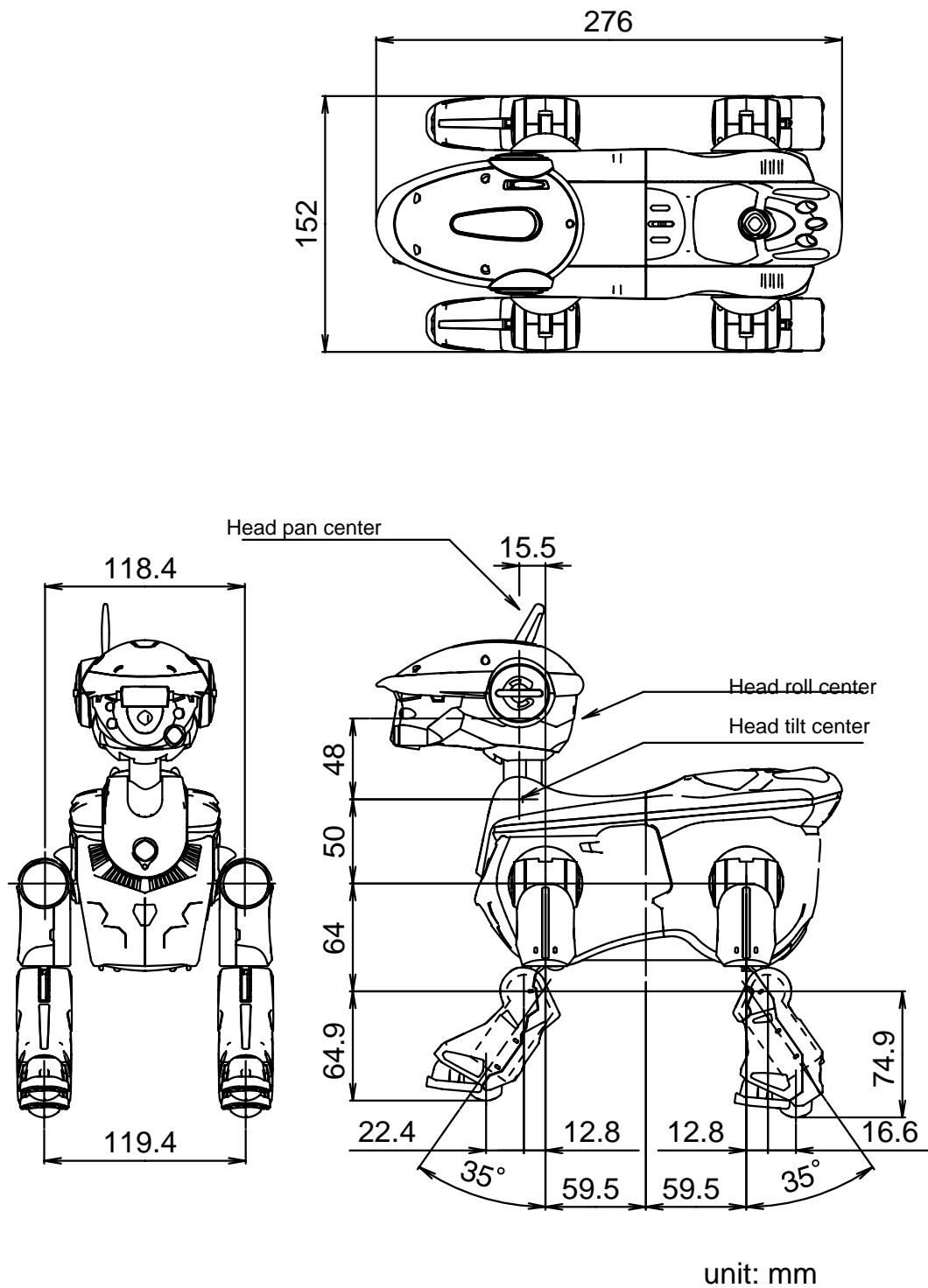
# Chapter1 Outside Specifications

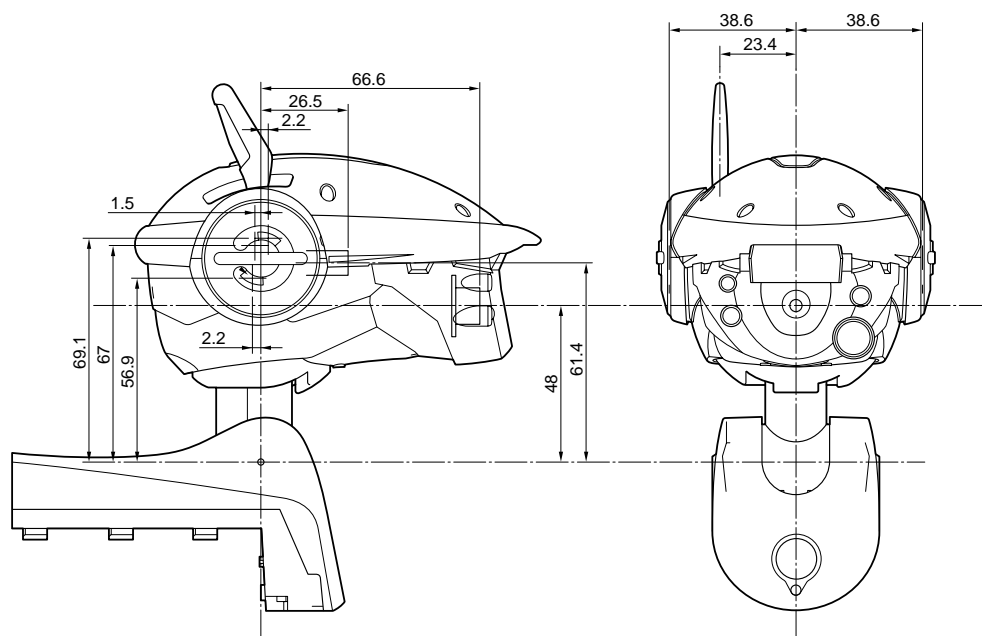
## 1.1 External Appearance

### 1.1.1 Drawings of External Appearance



## 1.1.2 Measurements of External Appearance

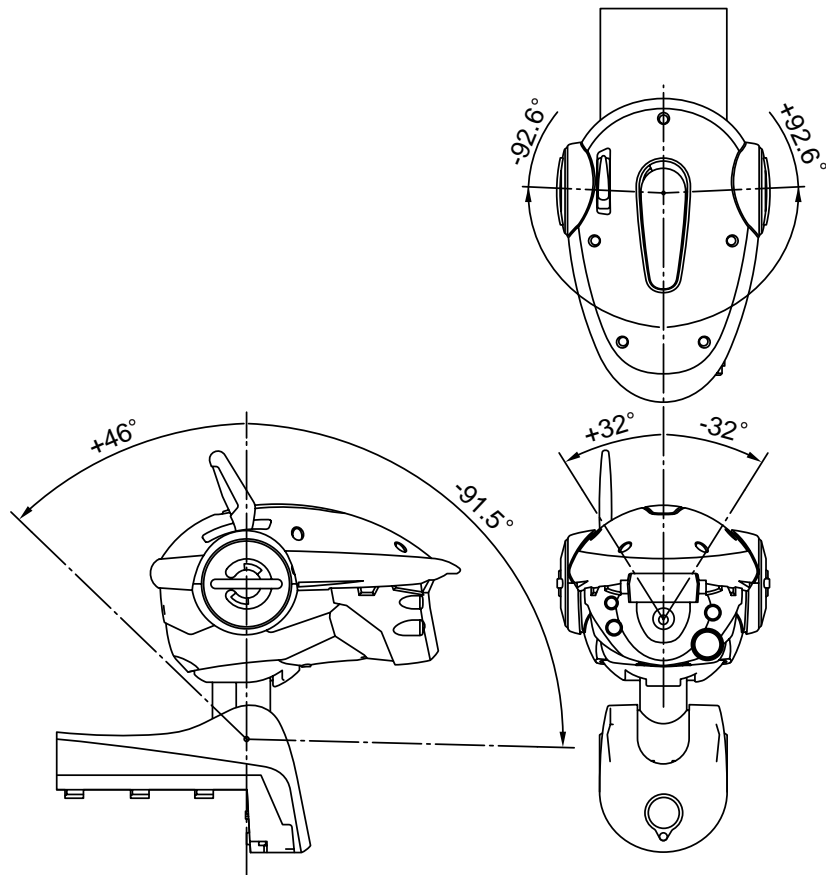




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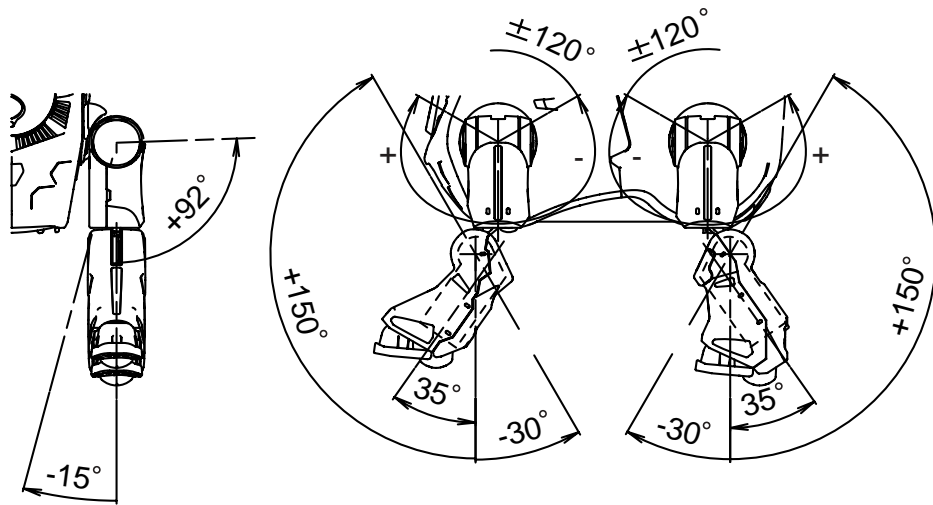
## 1.2 Operational Limits

### 1.2.1 Head



Part	Degree of freedom
Neck	3DOF(pan, tilt, and roll)
Retractable Head Light	1DOF
Total	6DOF

## 1.2.2 Leg

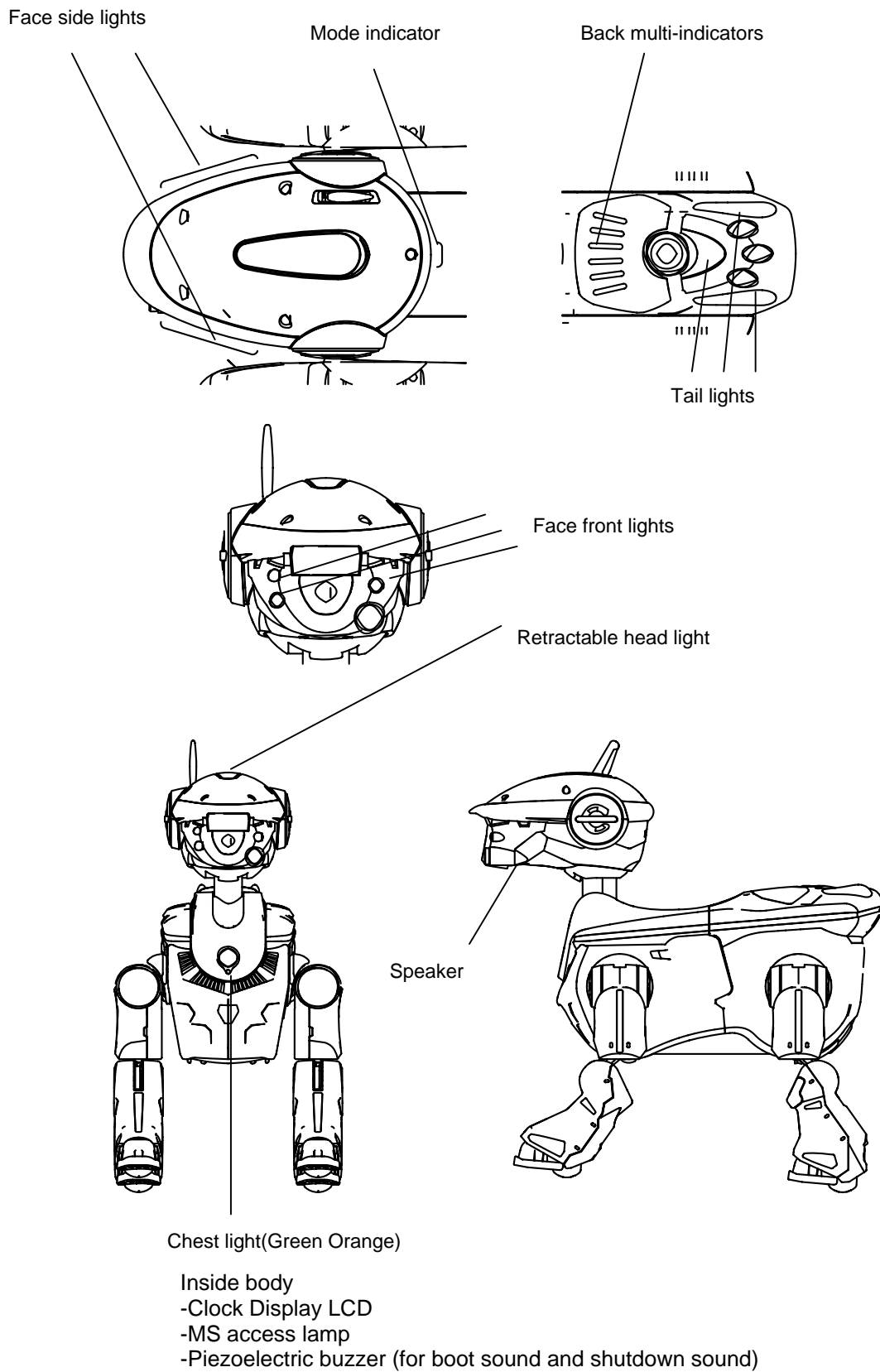


Part	Degree of freedom
Front leg	3DOF x 2
Rear leg	3DOF x 2
Total	12DOF

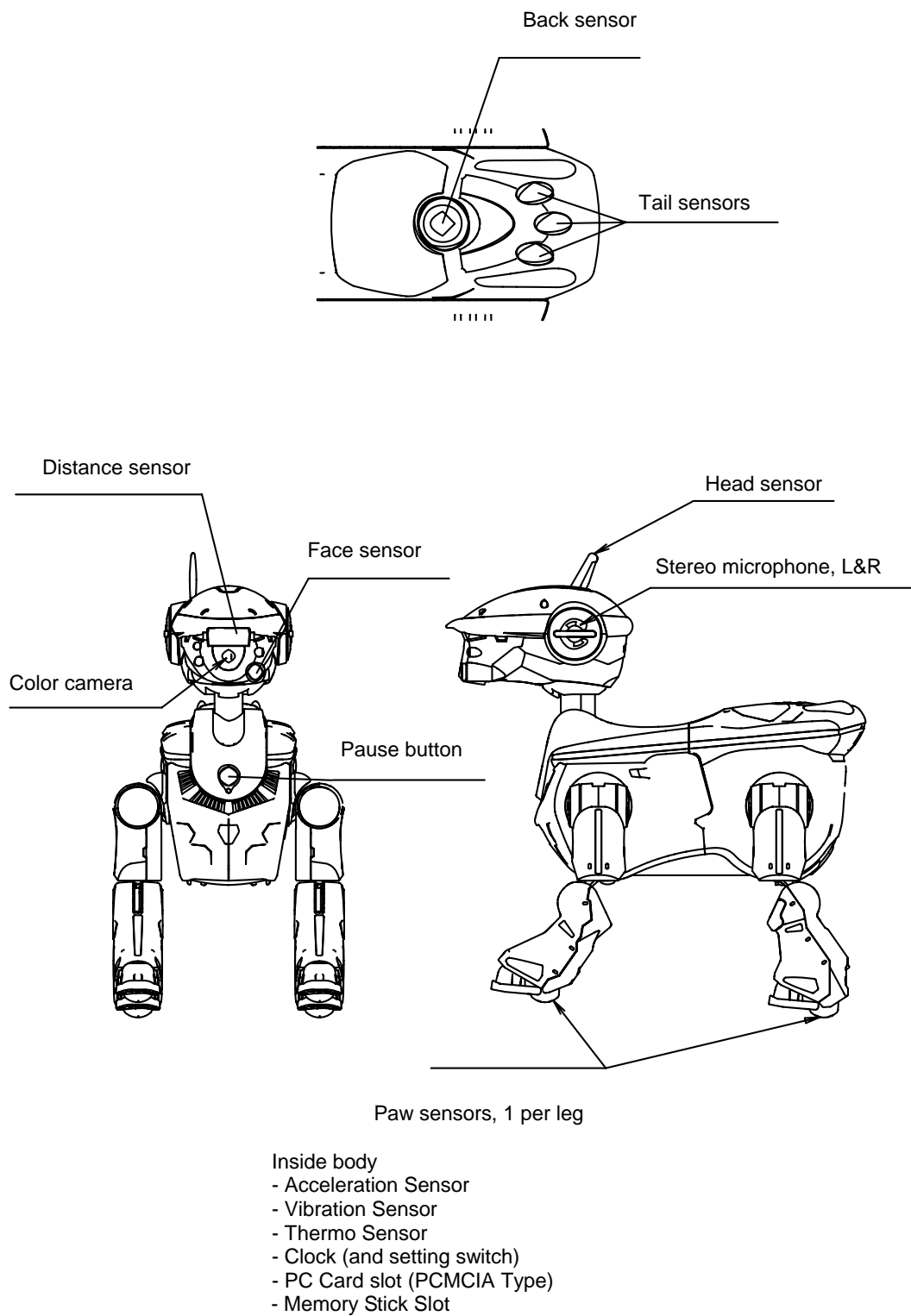
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## 1.3 Device Layout

### 1.3.1 Output Devices



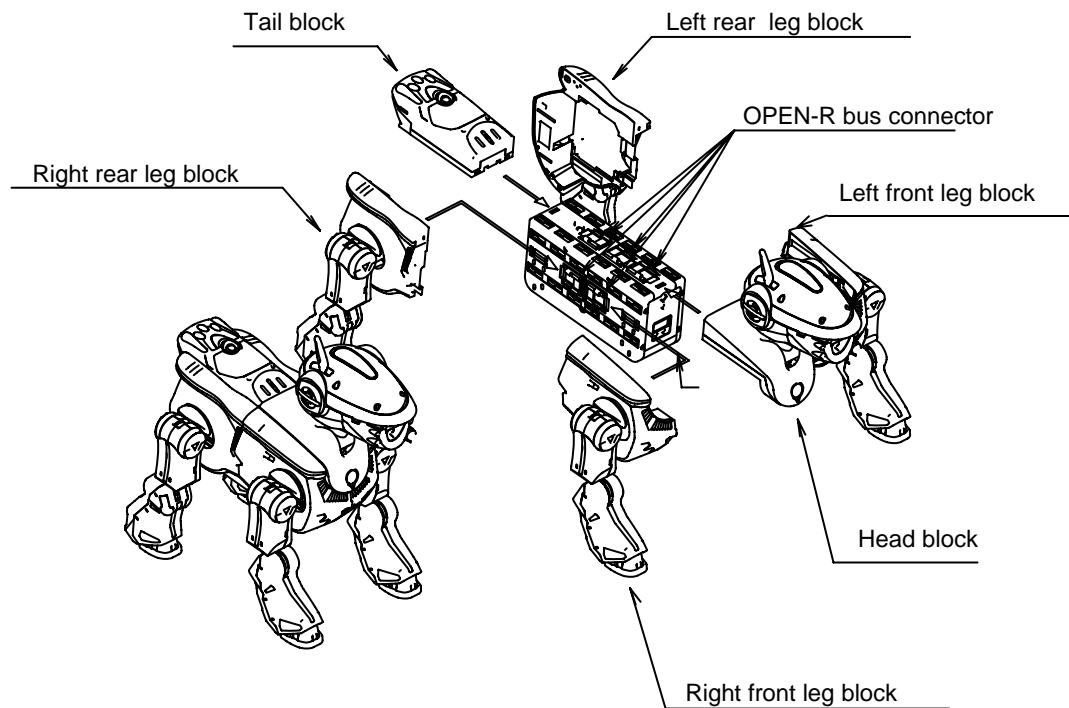
### 1.3.2 Input Devices



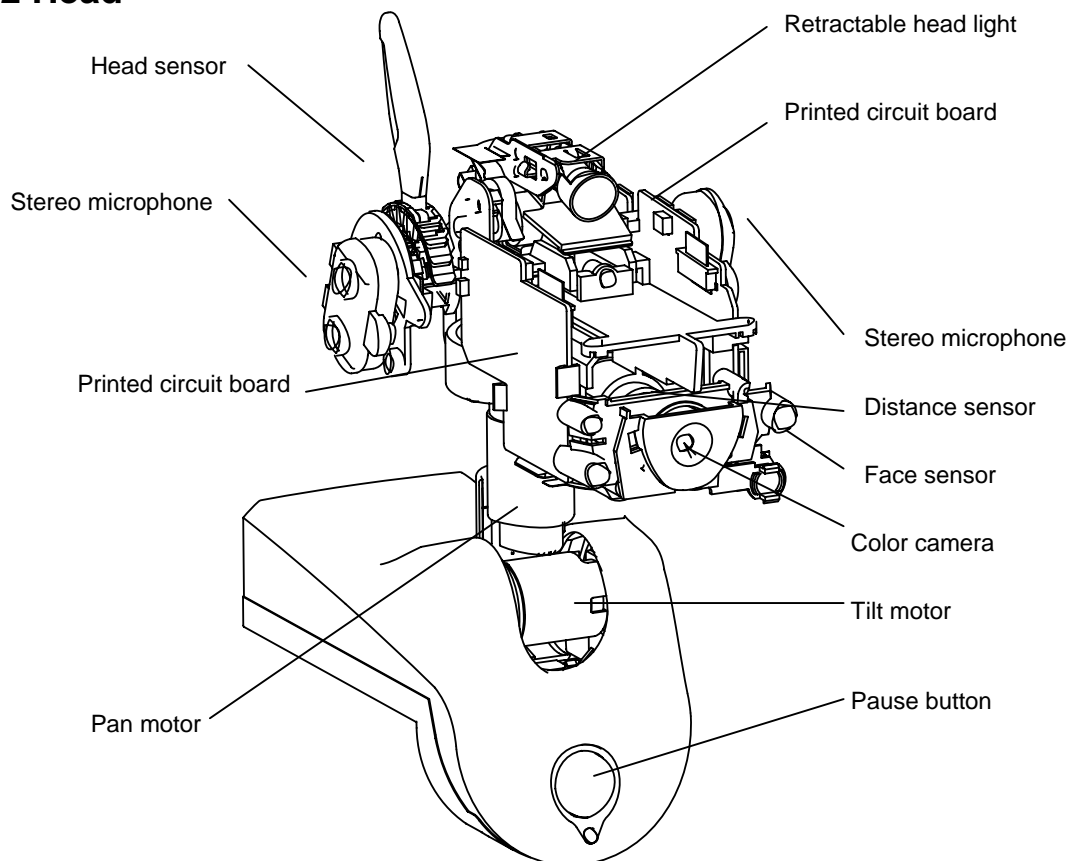
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## 1.4 Configuration

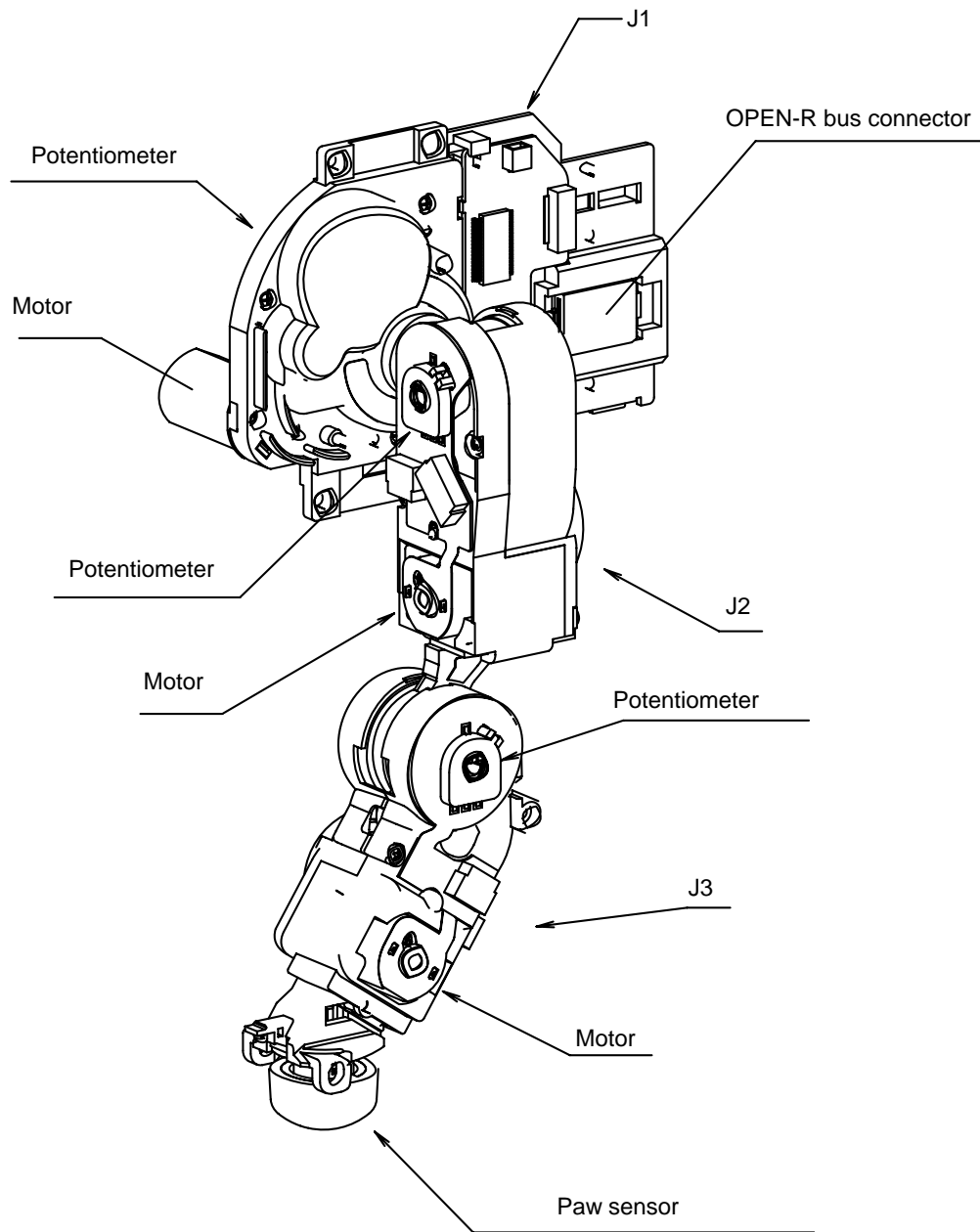
### 1.4.1 Block Overview



### 1.4.2 Head



### 1.4.3 Leg



# 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	Part
<b>Head</b>	PRM:/r1/c1-Joint2:j1	Head tilt
	PRM:/r1/c1/c2-Joint2:j2	Head pan
	PRM:/r1/c1/c2/c3-Joint2:j3	Head roll
	PRM:/r1/c1/c2/c3/l1-LED2:l1	Head Face side light(Front left)
	PRM:/r1/c1/c2/c3/l2-LED2:l2	Head Face side light(Center left)
	PRM:/r1/c1/c2/c3/l3-LED2:l3	Head Face side light(Back left)
	PRM:/r1/c1/c2/c3/l4-LED2:l4	Head Face side light(Front right)
	PRM:/r1/c1/c2/c3/l5-LED2:l5	Head Face side light(Center right)
	PRM:/r1/c1/c2/c3/l6-LED2:l6	Head Face side light(Back right)
	PRM:/r1/c1/c2/c3/l7-LED2:l7	Head indicator
	PRM:/r1/c1/c2/c3/l8-LED2:l8	Face front light B
	PRM:/r1/c1/c2/c3/l9-LED2:l9	Face front light A
	PRM:/r1/c1/c2/c3/la-LED2:la	Face front light C
	PRM:/r1/c1/c2/c3/lb-LED2:lb	Retractable head light
	PRM:/r1/c1/c2/c3/f1-Sensor:f1	Head sensor
	PRM:/r1/c1/c2/c3/f2-Sensor:f2	Head sensor
	PRM:/r1/c1/c2/c3/c4/s5-Sensor:s5	Face sensor
	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
<b>Left fore leg</b>	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
<b>Left hind leg</b>	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
<b>Right fore leg</b>	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
<b>Right hind leg</b>	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
<b>Tail</b>	PRM:/r6/s1-Sensor:s1	Back sensor
	PRM:/r6/t1-Sensor:t1	Temperature sensor
	PRM:/r6/s2-Sensor:s2	Tail sensor(Left from behind)
	PRM:/r6/s3-Sensor:s3	Tail sensor(Center from behind)
	PRM:/r6/s4-Sensor:s4	Tail sensor(Right from behind)

---

PRM:/r6/l1-LED2:l1	Back multi-indicator (The first from the left)
PRM:/r6/l2-LED2:l2	Back multi-indicator (The second from the left)
PRM:/r6/l3-LED2:l3	Back multi-indicator (The third from the left)
PRM:/r6/l4-LED2:l4	Back multi-indicator (The third from the right)
PRM:/r6/l5-LED2:l5	Back multi-indicator (The second from the right)
PRM:/r6/l6-LED2:l6	Back multi-indicator (The first from the right)
PRM:/r6/l7-LED2:l7	Tail light(Center)
PRM:/r6/l8-LED2:l8	Tail light(Right)
PRM:/r6/l9-LED2:l9	Tail light(Left)

**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/p1-Sensor:p1
4	PRM:/r1/c1/c2/c3/f1-Sensor:f1
5	PRM:/r1/c1/c2/c3/f2-Sensor:f2
6	PRM:/r1/c1/c2/c3/c4/s5-Sensor:s5
7	PRM:/r2/c1-Joint2:j1
8	PRM:/r2/c1/c2-Joint2:j2
9	PRM:/r2/c1/c2/c3-Joint2:j3
10	PRM:/r2/c1/c2/c3/c4-Sensor:s4
11	PRM:/r3/c1-Joint2:j1
12	PRM:/r3/c1/c2-Joint2:j2
13	PRM:/r3/c1/c2/c3-Joint2:j3
14	PRM:/r3/c1/c2/c3/c4-Sensor:s4
15	PRM:/r4/c1-Joint2:j1
16	PRM:/r4/c1/c2-Joint2:j2
17	PRM:/r4/c1/c2/c3-Joint2:j3
18	PRM:/r4/c1/c2/c3/c4-Sensor:s4
19	PRM:/r5/c1-Joint2:j1
20	PRM:/r5/c1/c2-Joint2:j2
21	PRM:/r5/c1/c2/c3-Joint2:j3
22	PRM:/r5/c1/c2/c3/c4-Sensor:s4
23	PRM:/r6/t1-Sensor:t1
24	PRM:/r6/s1-Sensor:s1
25	PRM:/r6/s2-Sensor:s2
26	PRM:/r6/s3-Sensor:s3
27	PRM:/r6/s4-Sensor:s4
28	PRM:/a1-Sensor:a1
39	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

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

- Max/Min value in head's software limitation

	<b>min</b>	<b>max</b>	<b>mechanical limit</b>
tilt	-82	43	-85 <--> 46
pan	-89.6	89.6	-92.6 <--> 92.6
roll	-29	29	-32 <--> 32

Unit:degree

### 2.2.2 Limitation of Two Joints of Leg

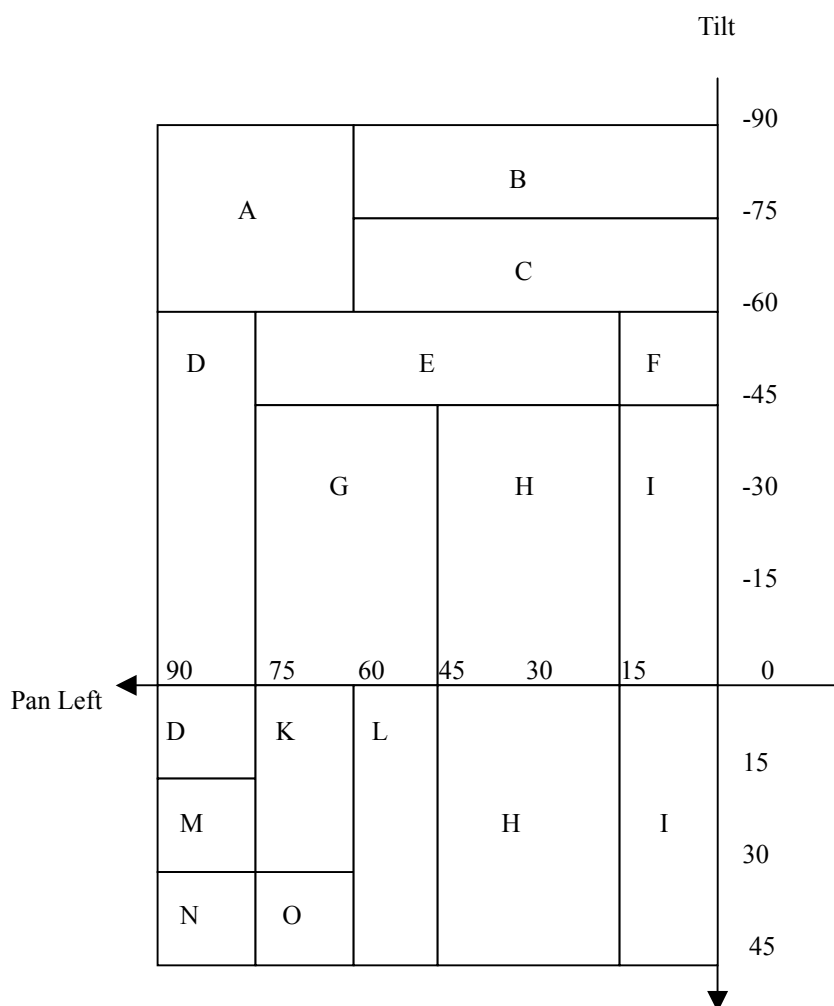
The following are the minimum value of the angle of front leg's J2 and the angle of backward leg's J2 when J1 varies.

<b>J1</b>	<b>front leg's J2</b>	<b>backward leg's J2</b>
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

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



**A**  $-25 \leq \text{roll} \leq 0$

**B**  $\text{roll} = 0$

**C**  $-15 \leq \text{roll} \leq 10$

**D**  $-29 \leq \text{roll} \leq 20$

**E**  $-20 \leq \text{roll} \leq 29$

**F**  $-20 \leq \text{roll} \leq 20$

**G**  $-20 \leq \text{roll} \leq 29$

**H**  $-20 \leq \text{roll} \leq 29$

**I**  $-29 \leq \text{roll} \leq 29$

**K**  $-15 \leq \text{roll} \leq 29$

**L**  $-13 \leq \text{roll} \leq 29$

---

**M**     -15 <=roll <=20

**N**     2 <=roll <=20

**O**     -7 <=roll <=29

Unit:degree

## 2.3 Servo Gain

The following are the standard gains in joints for ERS-220. PSHIFT, ISHIFT, DSHIFT are fixed values and do not change the values.

### ERS-220

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:/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

## 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 : /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	+	+

---

# Chapter 3 Output Devices

## 3.1 LED

### CPC Primitive Locator

PRM:/r1/c1/c2/c3/l1-LED2:l1  
PRM:/r1/c1/c2/c3/l2-LED2:l2  
PRM:/r1/c1/c2/c3/l3-LED2:l3  
PRM:/r1/c1/c2/c3/l4-LED2:l4  
PRM:/r1/c1/c2/c3/l5-LED2:l5  
PRM:/r1/c1/c2/c3/l6-LED2:l6  
PRM:/r1/c1/c2/c3/l7-LED2:l7  
PRM:/r6/l1-LED2:l1

PRM:/r6/l2-LED2:l2

PRM:/r6/l3-LED2:l3

PRM:/r6/l4-LED2:l4

PRM:/r6/l5-LED2:l5

PRM:/r6/l6-LED2:l6

PRM:/r6/l7-LED2:l7

PRM:/r6/l8-LED2:l8

PRM:/r6/l9-LED2:l9

PRM:/r1/c1/c2/c3/lb-LED2:lb

PRM:/r1/c1/c2/c3/l8-LED2:l8

PRM:/r1/c1/c2/c3/l9-LED2:l9

PRM:/r1/c1/c2/c3/la-LED2:la

### Part

Head Face side light(Front left)  
Head Face side light(Center left)  
Head Face side light(Back left)  
Head Face side light(Front right)  
Head Face side light(Center right)  
Head Face side light(Back right)  
Head indicator  
Back multi-indicator  
(The first from the left)  
Back multi-indicator  
(The second from the left)  
Back multi-indicator  
(The third from the left)  
Back multi-indicator  
(The third from the right)  
Back multi-indicator  
(The second from the right)  
Back multi-indicator  
(The first from the right)  
Tail light(Center)  
Tail light(Right)  
Tail light(Left)  
Retractable head light  
Face front light B  
Face front light A  
Face front light C

## 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()

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

oprmmreqSPEAKER\_MUTE\_ON  
oprmmreqSPEAKER\_MUTE\_OFF

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.

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# 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 1
PRM:/r1/c1/c2/c3/f2-Sensor:f2	Head sensor 2

Range of value		
Direction	Head sensor1	Head sensor2
Forward	989062	0
Normal	0	0
Backward1	198825	0
Backward2	0	0
Backward3	0	199217

When you move a head sensor backward, the above value changes in the following sequence:

Normal → Backward1 → Backward2 → Backward3 → Backward2 → Backward1 → Normal

#### Notes

The above values varies a little when the voltage applied to a sensor drops.

### 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 1/100sec fixed

Gain 0dB fixed

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

##### White balance

oprmmreqCAM\_SET\_WHITE\_BALANCE

ocamparamWB\_INDOOR\_MODE : 2800K

ocamparamWB\_FL\_MODE : 4300K

ocamparamWB\_OUTDOOR\_MODE : 7000K

##### Shutter speed

oprmmreqCAM\_SET\_SHUTTER\_SPEED

ocamparamSHUTTER\_SLOW : 1/50sec

---

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

#### Gain

oprmmreqCAM_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.

### 4.1.5 Microphone

#### CPC Primitive Locator

PRM:/r1/c1/c2/c3/m1-Mic:M1

#### Device

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)

oprmmreqMIC_UNI
oprmmreqMIC_OMNI

Direction: Front direction of the head along the microphone hole on the robot face.

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

oprmmreqMIC_ALC_ON
oprmmreqMIC_ALC_OFF

### 4.1.6 Switches

#### CPC Primitive Locator

PRM:/r1/c1/c2/c3/c4/s5-Sensor:s5  
 PRM:/r2/c1/c2/c3/c4-Sensor:s4  
 PRM:/r3/c1/c2/c3/c4-Sensor:s4  
 PRM:/r4/c1/c2/c3/c4-Sensor:s4  
 PRM:/r5/c1/c2/c3/c4-Sensor:s4  
 PRM:/r6/s1-Sensor:s1  
 PRM:/r6/s2-Sensor:s2  
 PRM:/r6/s3-Sensor:s3  
 PRM:/r6/s4-Sensor:s4

#### Switch

Face sensor  
 Paw sensor(Left fore leg)  
 Paw sensor(Left hind leg)  
 Paw sensor(Right fore leg)  
 Paw sensor(Right hind leg)  
 Back sensor  
 Tail sensor (Left from behind)  
 Tail sensor (Center from behind)  
 Tail sensor (Right from behind)

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## 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/s <sup>2</sup>	-2.0G
+19613300	+19.6133 m/s <sup>2</sup>	+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.