English Language V1.50

ROBONOVA-I

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16 Servo Edutainment Robot Box kit_Instruction Manual

English Manual

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ROBONOVA-I

I. Introduction

1. Easy to Build

Your ROBONOVA-1 kit was designed for easy assembly in 6 to 8 hour using only a screwdriver.

2. Servo Motors

Completely Designed Servo Only for Robot Operation

This fully articulating, 12" high, mechanical man is controlled with 16 powerful HSR-8498HB digital servos built specifically for the ROBONOVA-1 by Hitec. These custom servos feature "set pin" locking of the servo arms for easy assembly, over-voltage current protection, super strong Karbonite gear trains and "position feedback" technology for simple programming

3. Control Boards, MR-C3024

Micom Board with Flexible Interface

The control board is the heart of the ROBONOVA-1. Secured to the back of the robot under a strong plastic case, the control board can operate up to 24 servos and 16 accessory modules. Optional devices will eventually include gyro's, acceleration sensors, speech synthesis modules and operational devices such as Bluetooth controllers and R/C transmitters and receivers. This flexible and sophisticated interface allows the user to customize ROBONOVA-1 into the robot of their dreams. Firmware can be automatically upgraded when connected to a PC.

4. Metal Framework

The custom gold anodized metal servo brackets serve as a strong and lightweight exoskeleton. ROBONOVA-1 also features durable plastic body case components that protect the control board and battery from damage.

5. Battery and Charger

Powering the ROBONOVA-1 is a 5 cell, environmentally friendly NiMH rechargeable battery that delivers around 1 hour of operational time. The included D/C to D/C charger features a protection circuit to help prevent battery charging mishaps.

6. The Key - "Easy To Operate"

ROBONOVA-1, Robot Programming Made Easy. Users of this exciting robot package have an opportunity to learn robot technology first hand. Programming is simple with the supplied RoboScript and RoboBasic software via the included PC interface cable.

A. RoboScript & RoboRemocon

Beginners to robot programming technology will be pleased to use the supplied RoboScript programming software. Without knowing any programming language at all, users can create operational subroutines with the "click of a mouse". Use the RoboRemocon software to control your ROBONOVA-1 with the operational data created with RoboScript

B. RoboBasic

RoboBasic is a programming tool based on the BASIC programming language and is provided for the more advanced users. Containing specific commands for simple robot operation, RoboBasic can also be used in conjunction with RoboScript to increase the performance of the supplied Micom controller board.

C. HMI（Hitec Multi-protocol Interface）

- ●Upgrade firmware & various settings
- ●Parameters setting (2 types of Gains, Dead band etc.) and set value change during operation
- ●Compatible with PWM (Pulse Width Modulation) used in current radio control
- ●Control a maximum of 128 servo motors by daisy chaining them with a serial interface and PC
- ●Able to provide position feedback using the HMI

D. Catch & Play Function

Easy Programming Technique

The simplest way to program ROBONOVA-1 is with the "catch and play" function. Using RoboScript or RoboBasic, just move the robot into any position and click the mouse to "capture" that position. Move the robot into another position and repeat the process. The software then links these "captured" positions and once activated, smoothly transitions the robots movements through these programmed positions.

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7. Requirements and Specification

A. System Requirements:

- Windows * based PC
- 300MHz processor or higher
- 60MB of hard disk space
- 128MB of RAM
- Open COM port
- CD-ROM Drive 2x or greater

* Windows is the registered trademark of the Microsoft Corporation.

B. HSR-8498 Specifications:

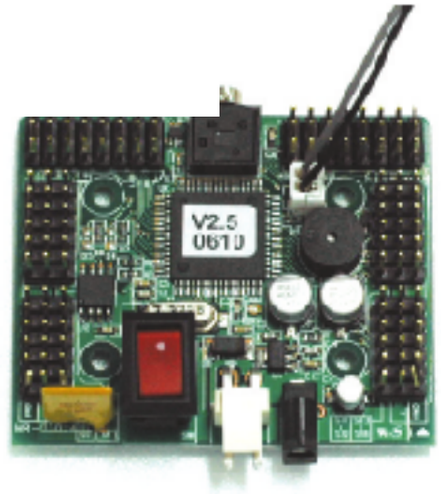
- Interface: HMI protocol, PWM
- Operating voltage: 4.8V to 6.0Vdc
- Speed: 0.20sec/ 60° at 6.0V
- Stall Torque: 10kg/cm (139oz/in) at 6.0V
- Operating angle: 180°
- Weight: 55g (1.94oz)
- Dimension: 40 x 20 x 47mm (1.57 x 0.78 x 1.85in)

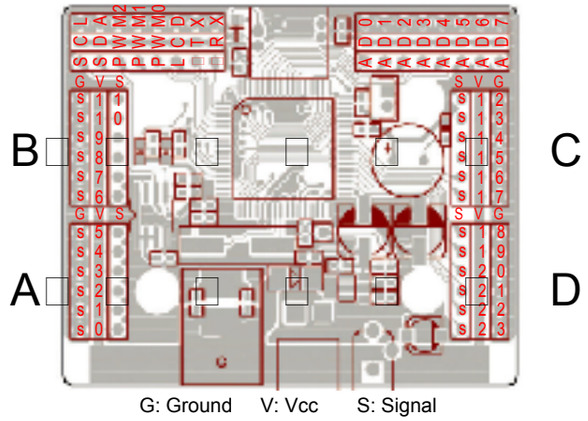
- Pulse specification:
- Neutral: 1500μs
- End to End travel (0 ~ 180°): 1100 ~ 1900μs
- Pulse duty cycle (refresh): 12 ~ 26ms (common = 21ms)

C. MR-C3024 Robot Controller Specifications

- CPU: Atmel ATMEGA128 8bit RISC
- I/O Ports: 24
- Servo Control: 24
- PWM DC Motor Control: 3
- A/D Conversion Channel: 8 ch
- Program Memory: 32Kbytes
- Ultrasonic Sensor: 12 ch
- IR Remote Control Reception: Yes
- RF Control Reception: Yes
- Common Features: 1. LCD Module Control
  - 2. 6 Octave Piezo (Music, Voice)
  - 3. RS-232 (UART) Serial Communication

- Misc: 1. Direct Serial Control (Using VB, VC++)
  - 2. Robot Programming : Requires ROBOBASIC v2.0 or above
  - 3. Download : Requires serial cable





MR-C3024 Layout

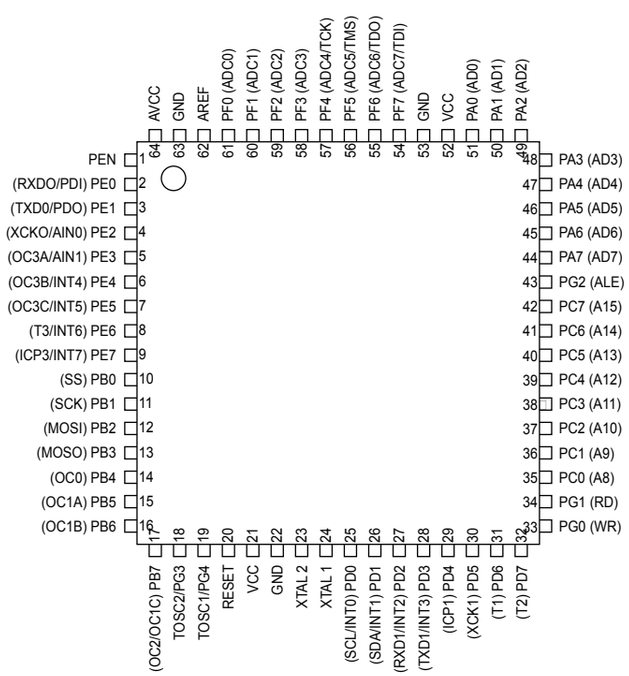
MR-C3024 pin configuration

SCL	SDA	PWM2	PWM1	PWM0	LCD	TX	RX	Interface Cable connector	ADC0	ADC1	ADC2	ADC3	ADC4	ADC5	ADC6	ADC7 / REMOCON
S11																S12
S10																S13
S9																S14
S8												PIEZO				S15
S7								ATMEGA 128								S16
S6																S17
S5																S18
S4																S19
S3					XTAL 7.3728Mhz											S20
S2																S21
S1					BATTERY CONNECTOR				CHARGING CONNECTOR							S22
S0																S23

Pinout Description

- Servo motor connection ports (S0-S23) : 24 servo motor signal terminals
- Analog to digital signal conversion ports (AD0-AD7) : 8 AD conversion terminals
- High speed independent PWM ports (PWM0-PWM2) : 3 PWM terminals
- High speed serial communication terminals (RX, TX)
- IR remote control reception terminal (REMOCON-AD7)
- Serial LCD module connection terminal (LCD)
- Piezo connection terminal (PIEZO)
- Serial communication (I2C) terminal (SCL, SDA) : External expansion module terminal
- Power terminal (VCC, GND) : DC 4.5-6.0V power input terminal

ATMEGA128 pin configuration



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Pin allocation chart

Pin I/O Port	ATMega 128 Externel Function	MR-C3024 Function
1. PEN	PEN ⟷ AVCC	NC
2. PE0	RXD0 / PDI	RX
3. PE1	TXD0 / PDO	TX
4. PE2	XCK0 / AIN0	LCD
5. PE3	OC3A / AIN1	PWM 0
6. PE4	OC3B / INT4	PWM 1
7. PE5	OC3C / INT5	PWM 2
8. PE6	T3 / INT6	NC
9. PE7	ICP3/INT7	NC
10. PB0	/SS	S8
11. PB1	SCK	S9
12. PB2	MOSI	S10
13. PB3	MISO	S11
14. PB4	OC0	S12
15. PB5	OC1A	S13
16. PB6	OC1B	S14
17. PB7	OC2/OC1C	S15
18. PG3	TOSC2	LED0
19. PG4	TOSC1	LED1
20. RESET	RESET	RESET
21. VCC	VCC	VCC
22. GND	GND	GND
23. XTAL2	XTAL2	XTAL2
24. XTAL1	XTAL1	XTAL1
25. PD0	SCL / INT0	SCL
26. PD1	SDA / INT1	SDA
27. PD2	RXD1 / INT2	RXD
28. PD3	TXD1 / INT3	TXD
29. PD4	ICP1	NC
30. PD5	XCK1	BUZZER
31. PD6	T1	NC
32. PD7	T2	NC
33. PG0	/WR	NC
34. PG1	/RD	NC
35. PC0	A8	S23
36. PC1	A9	S22
37. PC2	A10	S21
38. PC3	A11	S20
39. PC4	A12	S19
40. PC5	A13	S18
41. PC6	A14	S17
42. PC7	A15	S16
43. PG2	ALE	NOT
44. PA7	AD7	S7
45. PA6	AD6	S6
46. PA5	AD5	S5
47. PA4	AD4	S4
48. PA3	AD3	S3
49. PA2	AD2	S2
50. PA1	AD1	S1
51. PA0	AD0	S0
52. VCC	VCC	VCC
53. GND	GND	GND
54. PF7	ADC7 / TDI	ADC 7
55. PF6	ADC6 / TDO	ADC 6
56. PF5	ADC5 / TMS	ADC 5
57. PF4	ADC4 / TCK	ADC 4
58. PF3	ADC3	ADC 3
59. PF2	ADC2	ADC 2
60. PF1	ADC1	ADC 1
61. PF0	ADC0	ADC 0
62. AREF	VCC	VCC
63. GND	GND	GND
64. AVCC	AVCC is the supply voltage pin for Port F and	

***Note: NC = No Control**

II. Before You Begin

- This manual contains an explanation of the ROBONOVA-I hardware and its assembly, the MR-C3024 robot controller and the software used to program the robot.
- Please read this manual carefully and be aware of the products functions and usage. This manual is also provided in the PDF file format on the CD so a copy can be saved to hard disk or printed, whichever is required.
-The specifications may be changed without notice to improve the performance of the product or for other reasons. Check the Hitec homepage for the latest updates. (http://www.hitecrobotics.com)

1. Safety Precautions

Precautions are divided into three categories, Danger, Warning and Caution, according to their bearing on safety.
Read the precaution notes thoroughly before attempting to assemble the kit.

Danger: Applied when the risk of Death, severe injury, or the possibility of property damage may occur if the instructions are not followed

Warning: Applied when either user injury or equipment damage may occur when the instructions are not followed.

Caution: Applied when there is the possibility of injury or equipment damage.

A. Assembly Precautions

This manual contains information on safety to prevent bodily injury or property damage.

Danger

- Pay attention to proper safety while the robot is operating.
- Performance and operation is not guaranteed since this is an unassembled kit and if assembled incorrectly injury or damage may occur.
- Assemble the kit in an area with adequate ventilation.

Warning

- Keep away from children. Though the product appears to be a toy, it may hurt a small child if left attended.
- Shut down and unplug the battery immediately if a problem occurs. If the product is broken, or exposed to liquid, flame, or heat, shock may occur.
- Never disassemble or modify the battery charger and cables. (Cable repair is supported by customer service.)
- Unplug the battery charger when not in use.
- Never disassemble or modify the servo circuit boards.
- Do not use in hot, wet or cold conditions. This kit consists of precision components. If exposed to extreme conditions, failure may occur.
- Pay close attention to the construction of the robot. Since this is an unassembled kit, safety and performance is not guaranteed. If assembled incorrectly, damage or injury may occur.
- Always make sure the battery charge plug is secure when charging. Remove immediately when the charge process is complete.
- Please read the manual carefully. Note the direction of the servos and brackets when assembling. If assembled improperly, disassemble and reassemble correctly.

Caution

- The servos included in the kit require periodic maintenance to maintain optimum performance.
- Best performance is achieved when using the robot on a large, smooth, flat surface. If the surface is irregular or too small, the robot may fall and damage may occur.
- Do not hold the robot when turning it on or during operation.

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B. Battery Management Safety

This kit contains a NiMH battery for the power source. The NiMH battery is a high power rechargeable battery and requires careful handling and storage.

Danger

- Never turn the robot on while the charger is connected. Doing so will result in damage to the controller board and/or servos.

Warning

Battery management

- The battery included in this kit has a minimal charge. A NiMH battery must be stored with some remaining battery power. If the NiMH battery is fully discharged and left for a longtime, the battery's performance will decrease.
- The battery must be disconnected from the controller board or the battery charger when not in use.
- Store the battery in a cool, dry place.

Charging time

- The battery will fully charge in approximately 70 minutes. This time will vary depending on remaining battery power.
- Never leave the battery unattended while charging.
- Stop the charge process if the battery becomes abnormally hot.
- Overcharging may result in damage to the pack.

Caution

Battery handling

- Do not disassemble or modify the battery connector and wiring.
- Make sure that foreign objects do not get into the connector pins and that no bare wires are exposed.
- Do not subject the battery to extreme temperatures or a humid environment. Store the battery in a cool, dry place.
- Keep away from other conducting sources during transport or storage.
- If the battery wires become worn or frayed, replace the battery pack.

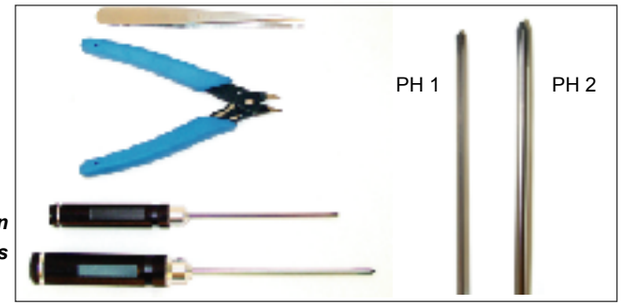
First aid and disposal

- In the event that the battery is damaged and vents causing the electrolyte to encounter an area of skin or the eyes, rinse the affected area with water.
- In the case of contact with the eyes, consult a physician a soon as convenient.
- The batteries electrolyte is a toxic substance. It is not only harmful to the human body but may also damage home and furnishings.
- If the NiMH batteries no longer hold a charge, dispose of them properly in the trash or according to your countries rules and regulations.
- Do not dispose of them in an incinerator.

C. Tools Required for Assembly

1) High Quality Phillips screwdrivers (PH1 and PH2)
2) Tweezers
3) Wire cutters
4) Thread screw lock

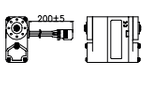
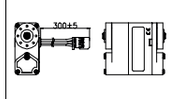
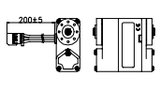
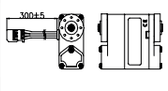
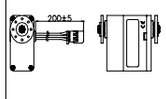
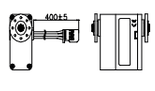
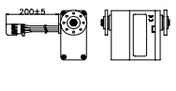
During the assembly process this icon will be used when thread screw lock is required.



ROBONOVA-I

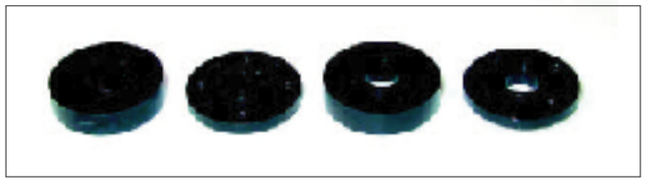
III. Assembly Notes

1. ROBONOVA-I KIT Parts List

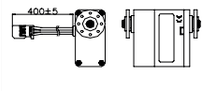
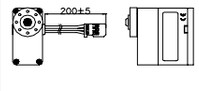
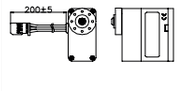
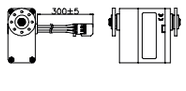
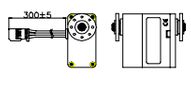
						
6 PCS	4 PCS	8 PCS	2 PCS	1 PCS	1 PCS	1 PCS
HR1B-0001	HR1B-0002	HR1B-0003	HR1B-0004	HR1B-0005	HR1B-0006	HR1B-0007
Tapped U Type Universal Bracket	Non-Tapped U Type Universal Bracket	I-Type Universal Bracket	H-Type Bracket	Back Body Frame	Front Body Frame	Top Body Frame
						
1 PCS	1 PCS	1 PCS	1 PCS	1 PCS	2 PCS	2 PCS
HR1C-0001	HR1C-0002	HR1C-0003	HR1C-0004	HR1C-0005	HR1C-0006 (Top Hand)	HR1C-0007 (Bottom Hand)
Front Body Cover	Back Body Cover	Goggle Cover	Front Head Cover	Back Head Cover	Top Hand Cover	Bottom Hand Cover
						
1 PCS	3 PCS	1 PCS	3 PCS	1PCS	1 PCS	1 PCS
HSR-8498HB1R200 (Sticker No.1)	HSR-8498HB1R300 (Sticker No.2)	HSR-8498HB1L200 (Sticker No.3)	HSR-8498HB1L300 (Sticker No.4)	HSR-8498HB2R200 (Sticker No.5)	HSR-8498HB2R400 (Sticker No.6)	HSR-8498HB2L200 (Sticker No.7)
130 PCS	28 PCS	6 PCS	2 PCS	40 PCS	12 PCS	4 PCS
PH/T-2 2 x 4 NI	PH/T-2 2 x 5 NI	PH/T-2 2 x 8 NI	PH/T-2 2 x 26 BK	PH/M 2 x 4 NI	PH/M 2.6 x 4 NI	PH/M 3 x 4 NI
Pan Head Tapping Screw	Pan Head Tapping Screw	Pan Head Tapping Screw	Pan Head Tapping Screw	Pan Head Screw	Pan Head Screw	Pan Head Sc rew

	
1 pc	1 pcs
Pin Cover	Battery Wire Protector
For MR-C3024	


Remocon and IR sensor
Optional (not in all kits)



Horns already installed on servos.

					
1 PCS	2 PCS	2 PCS	2 PCS	2 PCS	1 EA
HR1B-0008	HR1B-0009	HR1B-0010	HR1B-0011	HR1B-0012	MR-C3024
Bottom Body Frame	Shoulder Back Universal Bracket	Shoulder Front Universal Bracket	Hand Bracket	Foot Bracket	Controller
					
1 PCS	1 PCS	1 PACK	1 EA	1 EA	1 EA
HR1C-0008	HR1C-0009	Ni-Mh Battery (1,000mAh/ 6.0V/ 5 Cell)	CD-ROM	Interface Cable	Wall Charger
Right Foot Cover	Left F oot Cover	6.0 V 5Cell	ROBOBASIC & ROBONOVA-I User Manual	MR-C3024 Serial Interface Cable	6V/ 1,000mAh / 100~240V
					
1 PCS	1 PCS	1 PCS	1 PCS	1 PCS	2 PCS
HSR-8498HB2L400 (Sticker No.8)	HSR-8498HB3R200 (Sticker No.9)	HSR-8498HB3L200 (Sticker No.10)	HSR-8498HB2R300 (Sticker No.11)	HSR-8498HB2L300 (Sticker No.12)	Insert Bolt 3*4
					Insert Bolt
					
4 PCS	28 PCS	1 PCS	8 PCS	28 PCS	2 PCS
Support 3 x 5mm	FW 7.6 x 2.8 x 0.5 NI	HSR8498HA2	Cable Tie	Cable Clamp	Lug
Support	Flat Washer	Wheel Horn			

**Additional screws and washers can be found at local surplus retailers.

Difference between PH/M and PH/T screws.

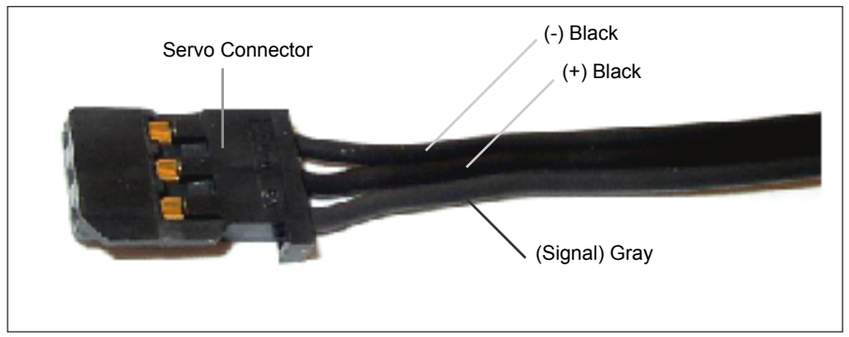
PH/M (Machined Screw)

PH/T (Tapping Screw)

2. Notes on the HSR-8498HB Servos

The HSR-8498 servos within the kit are assembled in a variety of configurations. Each configuration is optimized for a specific joint in the robot.

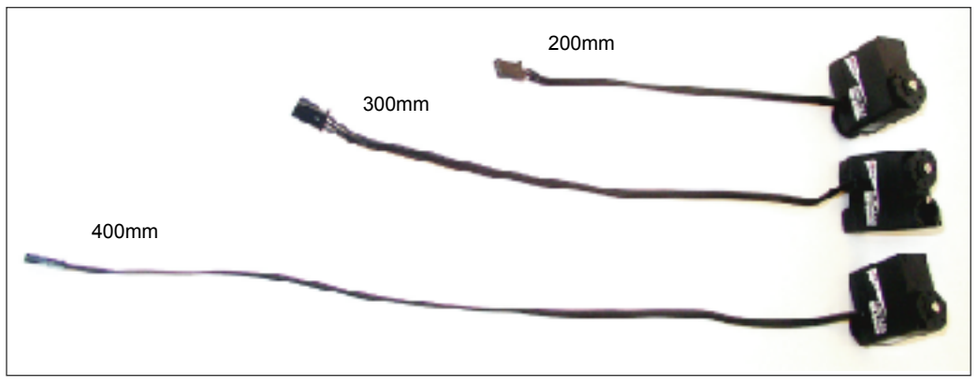
The servo cables exiting the servos are composed of three colored wires. Two are black and one is gray. At no time is it required to disassemble the cable nor is it suggested.



The following pictures give a visual example of the different servo configurations and wire lengths.
The HSR-8498HB servos are provided in the following configurations:

There are three different case types.

Three different cable lengths.

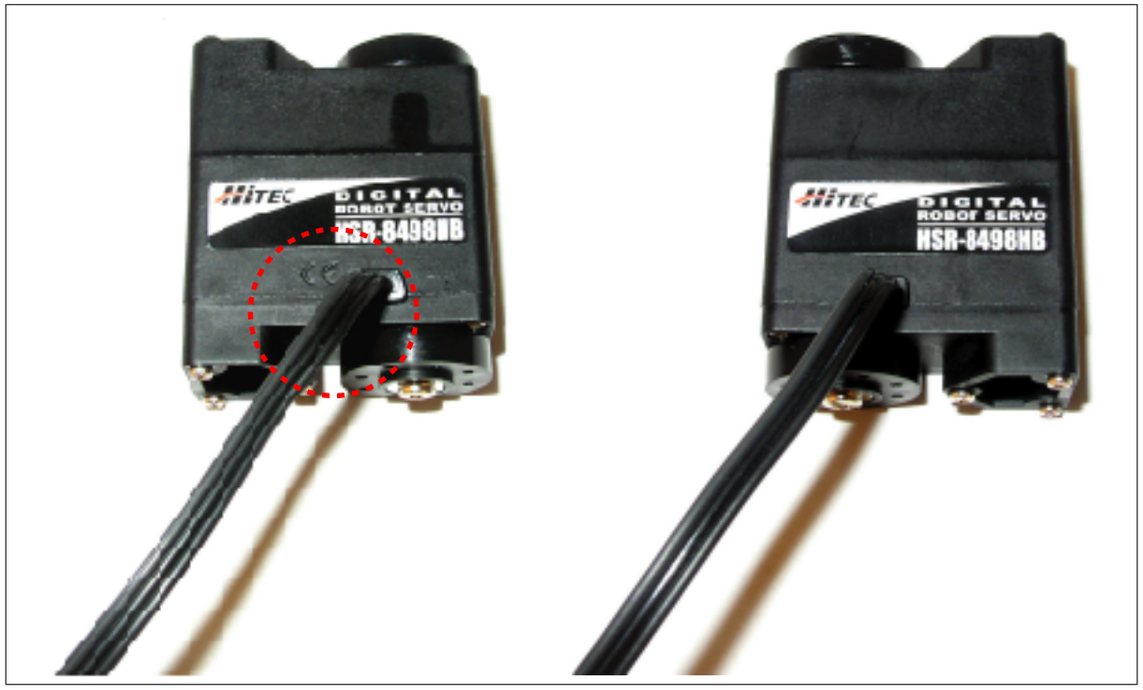


ROBONOVA-I

Two different cable orientations.

Left orientation has the "CE" mark.

Right orientation does not have the "CE" mark.

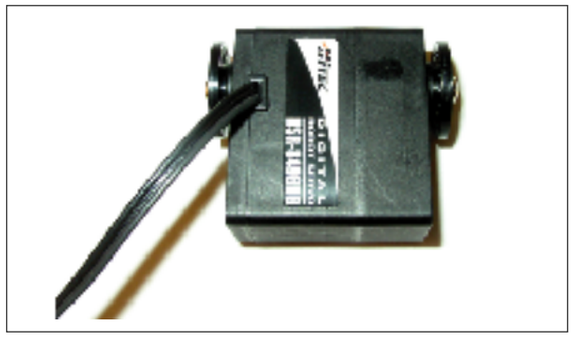


ROBONOVA-I

3. Notes on Kit Assembly

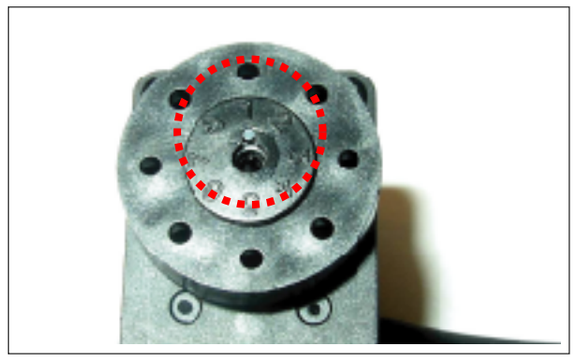
A. Servo Horns

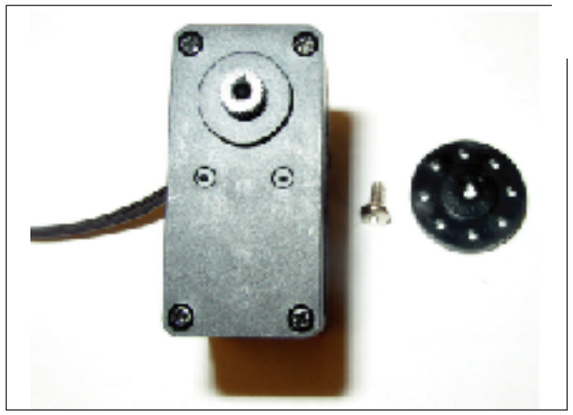
Included in the kit are four different types of horns. These are already attached to the servos. The following is for informational purposes.



The four horns are divided into two different groups. Two are given the name Splined horns and two Idler horns. Review the pictures to differentiate between the two groups.

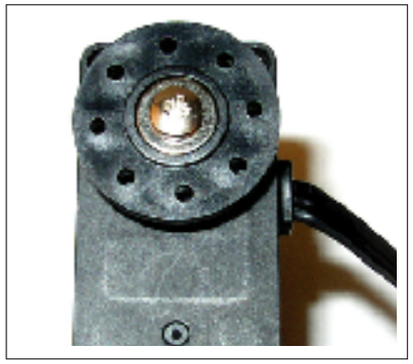
The splined horns have numbers embossed toward the center of the horn. These horns are also keyed to improve assembly accuracy.

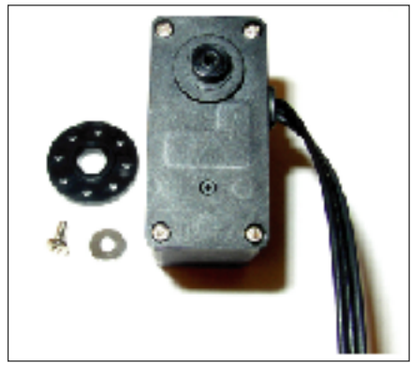




This picture shows the servo with the splined horn removed. The screw used to attach the horn is a BH/T 2.6 x 6mm.

The idler horns are not keyed nor do they have numbers embossed on them. These horns are designed to spin freely when attached to the servos.



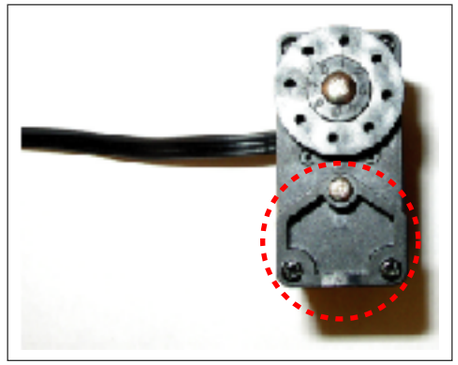


This picture shows the servo with the idler horn removed. The horn is attached to the servo with a BH/T 2.6 x 6mm screw and a 2.8 x 7.6mm washer.

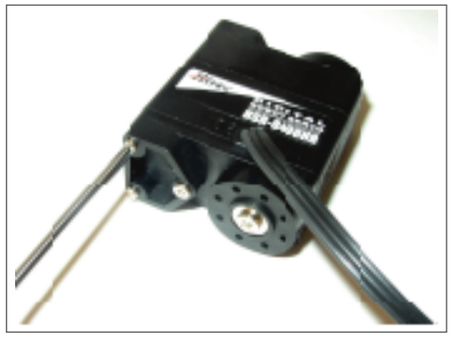
B. Attaching Brackets to the Servos

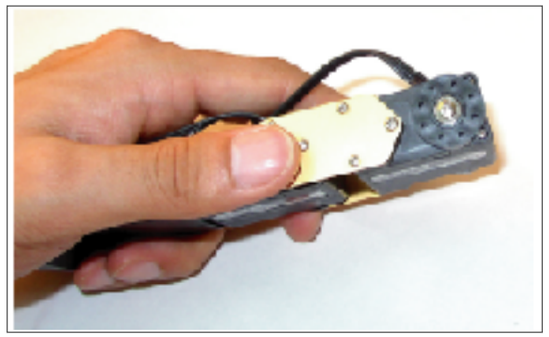
There are a different ways to attach brackets to the servos. Some brackets attach to the servo case and others attach to the horns.

On some of the HSR-8498HB servos the case has pentagonal sections.

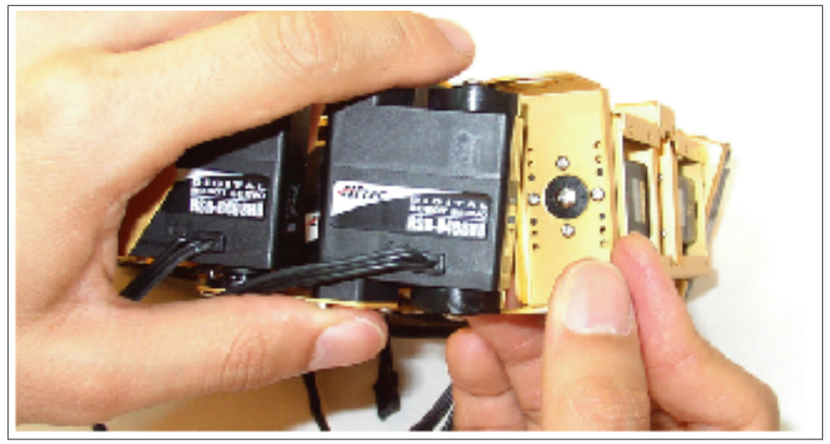


To attach a bracket to these sections, it is necessary to remove the three screws, place the bracket over the section, and reinstall the screws.

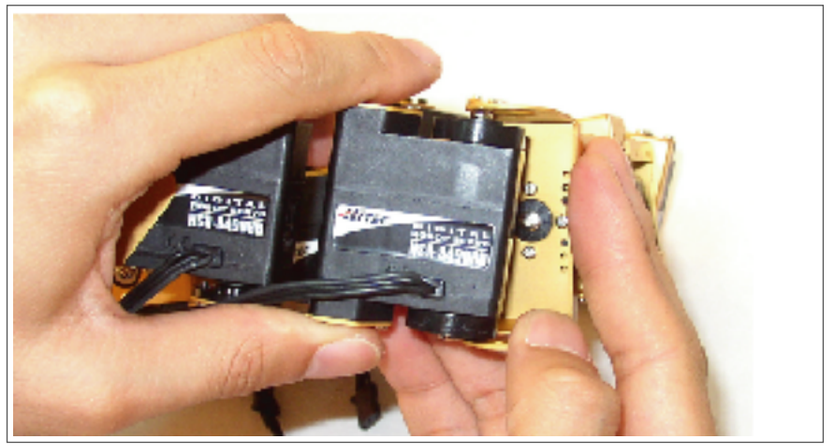




To attach a bracket to the horns it may be necessary to bend the bracket slightly.



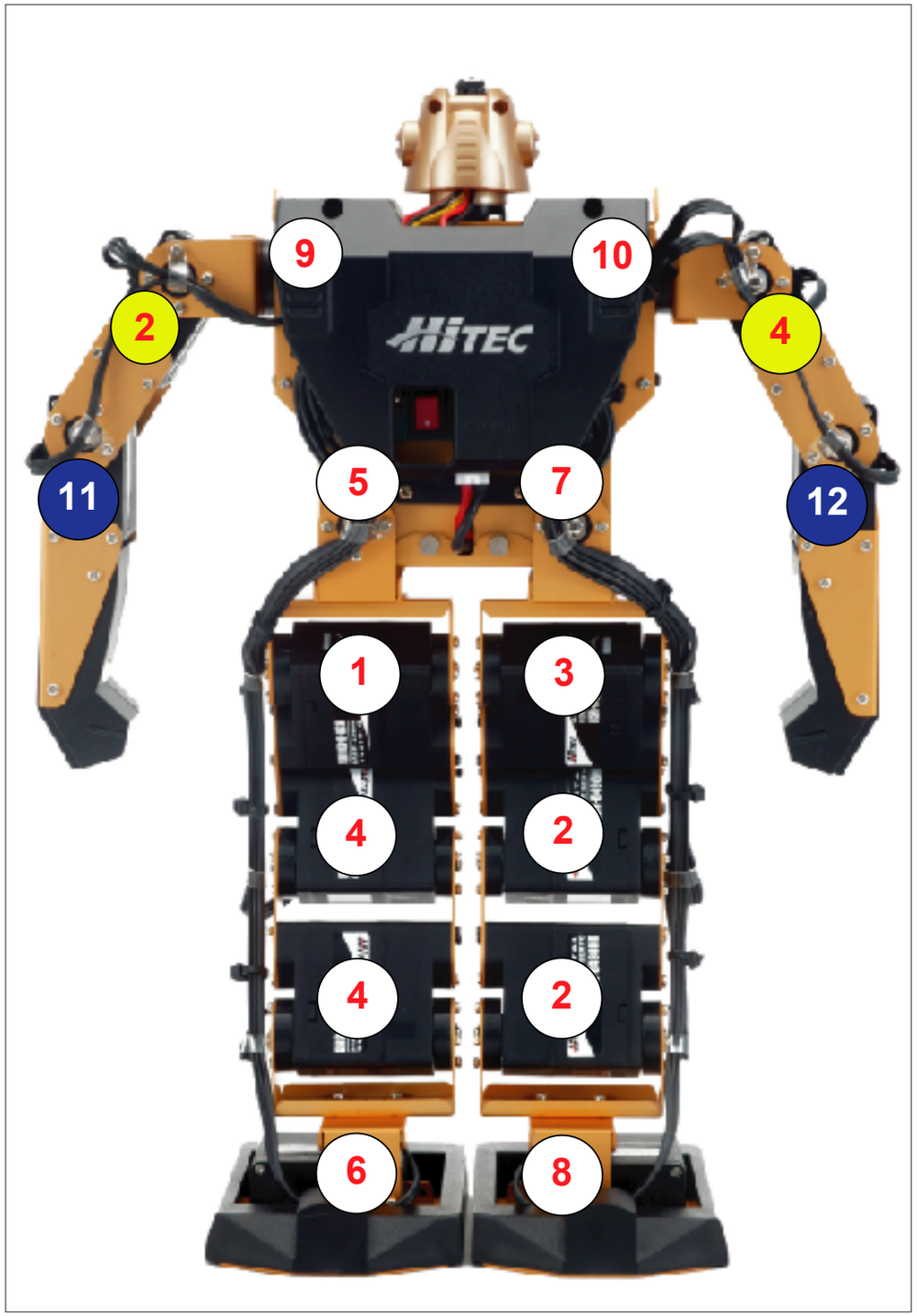
Once the screws are inserted, the bracket will move back into shape.



IV. Assembly

1. Servo Placement

Each servo has been given a number that corresponds to its case, wire length and direction. This picture shows the servo numbers and placement within the robot. View is from the back.



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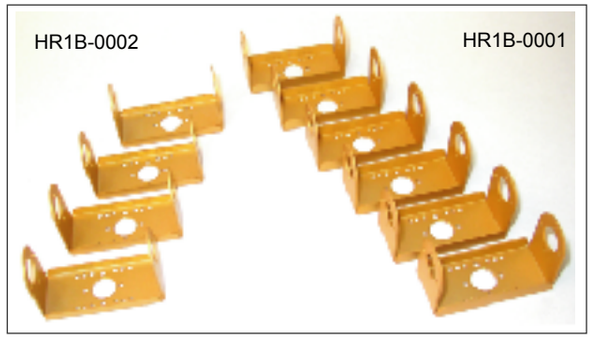
2. Leg Assembly

A. Ankle and Thigh Bracket Assembly

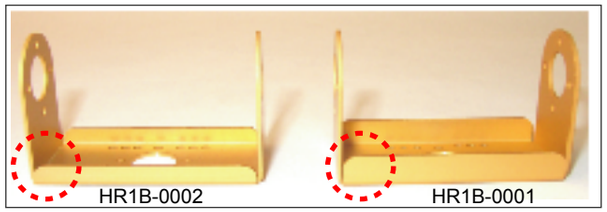
Parts Required:

		
HR1B-0001	HR1B-0002	PH/M 2 x 4mm
4 pcs	4 pcs	16 pcs

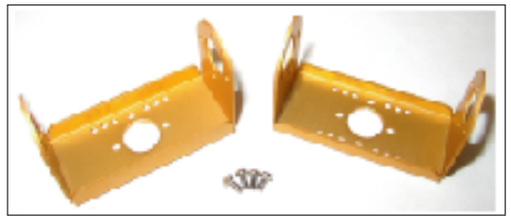
Within the kit there are two different U-shaped brackets. There are four HR1B-0002 and six HR1B-0001. To distinguish between the two types refer to the following pictures and text.



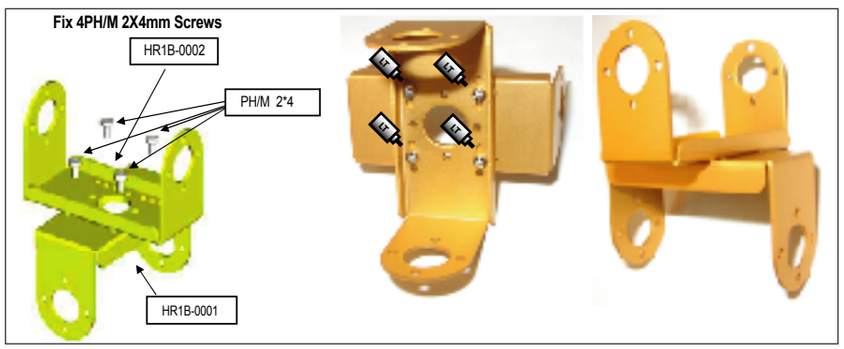
The first difference is that the six brackets on the right have twelve tapped holes each. The four brackets on the left do not.



The second difference is the HR1B-0001 has a wider flange than the HR1B-0002.



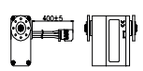
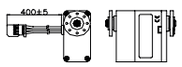
To assemble the ankle and thighs, use one HR1B-0001 and one 0002 bracket and attach them together with four PH/M 2 x 4mm screws.



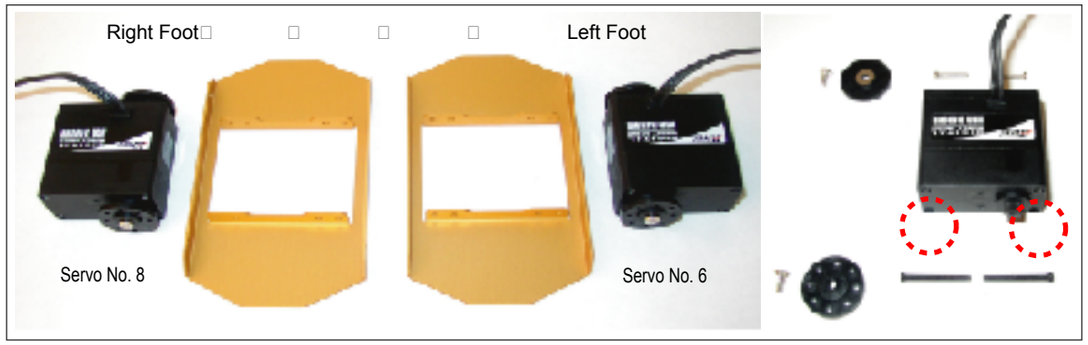
Using the picture as a guide, place the two brackets together and insert the screws.

B. Right and Left Foot Assembly

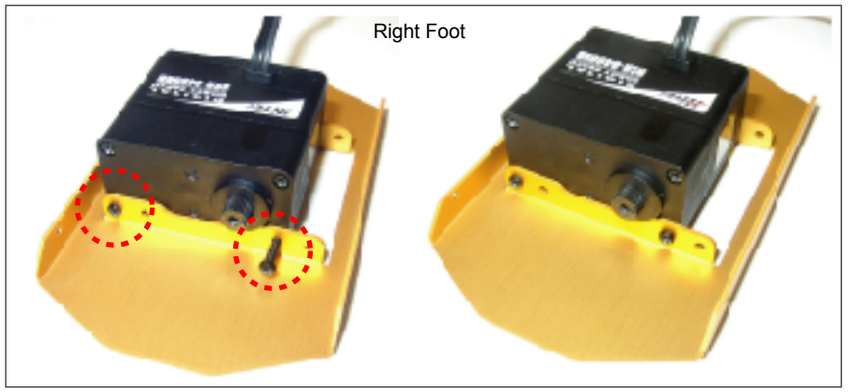
Parts required:

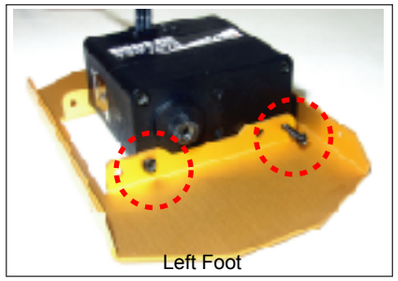
(Sticker No. 6) 	(Sticker No. 8) 	
HSR-8498HB2R400	HSR-8498HB2L400	HR1B-0012
1 pc	1 pc	2 pcs

Layout the parts to be used as shown in the picture. Remove both the spline and idler horns from the servos. Remove the two black screws from the lower half of the servos on the splined horn side and the two silver screws from the lower half on the idler horns side.



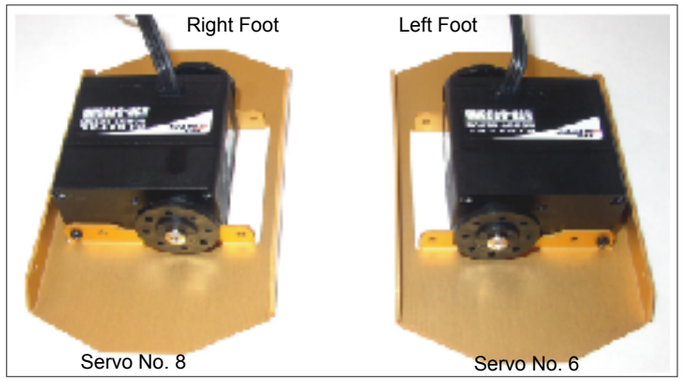
Starting with the right foot, place the No. 8 servo into the a foot bracket and reinstall the removed screws. Make special note of the black and silver screw locations and that they are inserted into the correct side of the servos. They are not interchangeable.





Use the same method to assemble the left foot.

Completed foot assemblies.

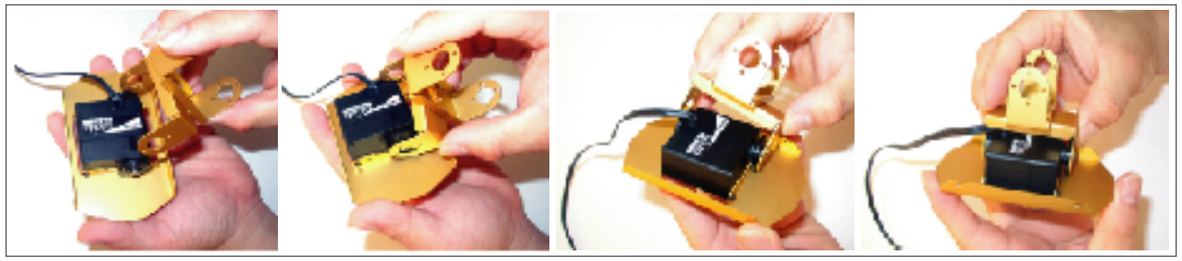


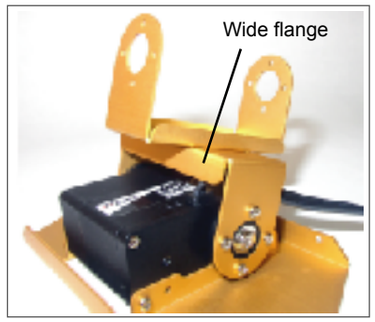
C. Attaching the Right and Left Ankle Assembly

Parts required:

		
Assembled feet	Ankle bracket	PH/T-2 2 x 4mm
2 sets	2 sets	14 pcs

Begin with the right foot. Place the ankle bracket over the foot servo horns. It might be necessary to bend the bracket to fit over the horns. When the screws are tightened the bracket will bend back into shape.





Before inserting the screws, make sure that the HR1B-0001 bracket of the ankle is facing down toward the servo.

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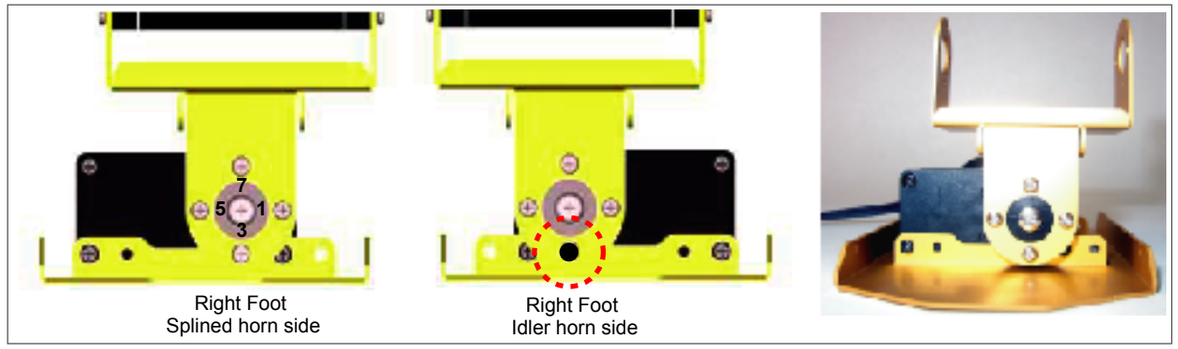
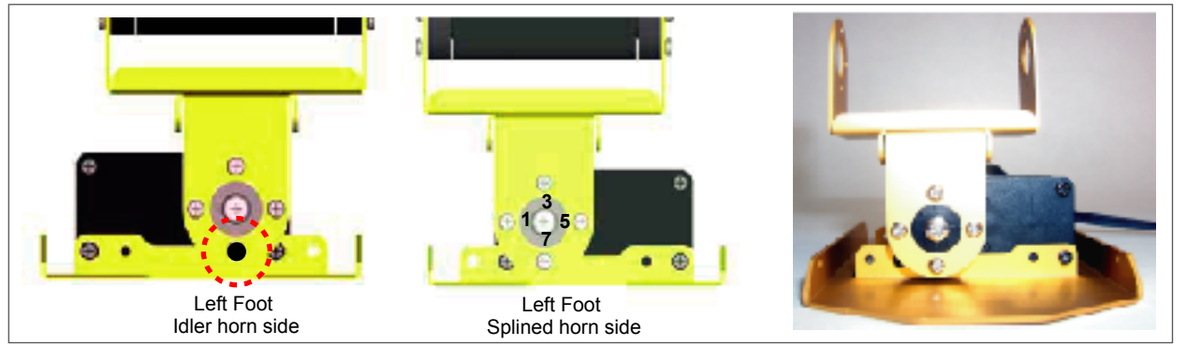
Position the ankle over the right foot so the number 7 on the splined horn is at 12 o'clock in relation to the ankle. Install four PH/T 2 x 4mm screws into the splined and three into idler horns. At this time do not install a screw in the 6 o'clock position of the idler horn. The completed right foot will appear as the picture.

Note on the "O'Clock" termenology: This term relates to the numbers on a clock. 12 o'clock is at the top and 6 o'clock is at the bottom. This term will be used throughout the manual.



The left foot and ankle are attached in a similar fashion as the right foot. When positioning the ankle over the foot, the number 3 on the splined horn will be at the 12 o'clock position. Install the screws into the splined and idler horns. Again do not install a screw at the 6 o'clock position of the idler horn.

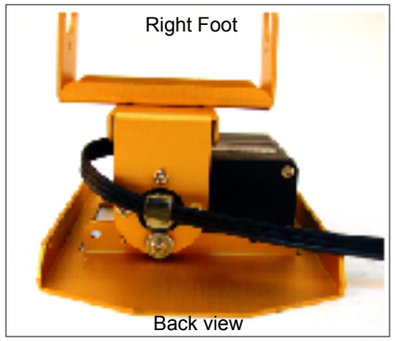


D. Cable Arrangement and Foot Covers

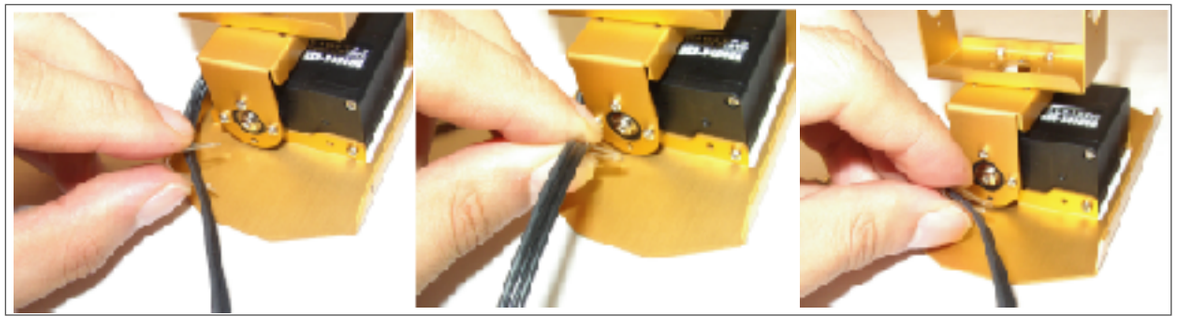
Parts required:

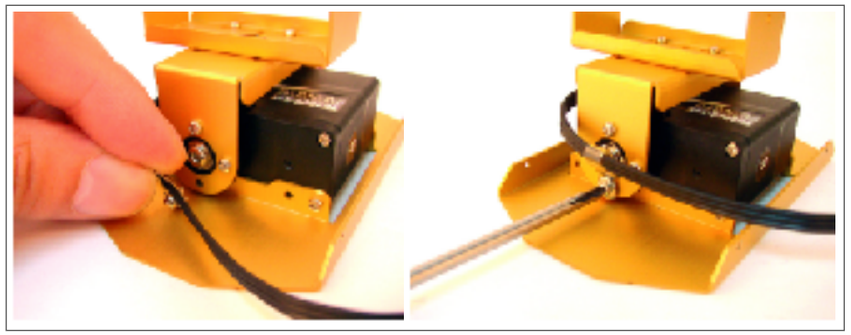
				
Foot assemblies	HR1C-0008	HR1C-0009	PH/M 2 x 4mm	FW 6 x 2.2 x 0.5mm
2 sets	1 pc	1 pc	8 pcs	2 pcs
Cable clamp	PH/T-2 2 x 4mm			
2 pcs	2 pcs			

Arrange the cable for the right foot so it is in the same position as the one in the picture.



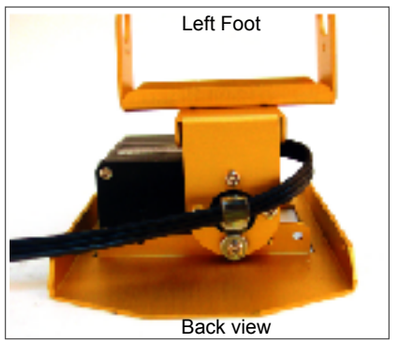
Bend the cable clamp around the cable.

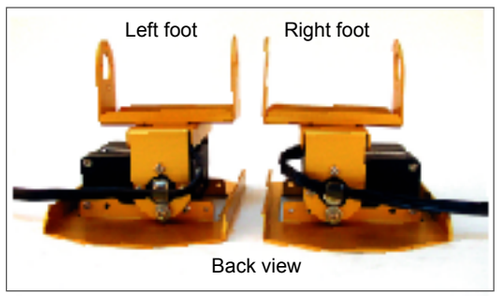




Slide the washer onto a PH/T-2 2x4mm screw. Insert the screw into the holes of the cable clamp and install in the 6 o'clock position of the idler horn.

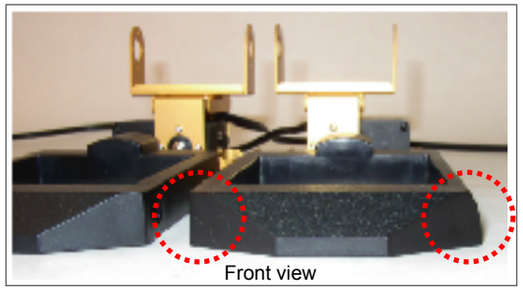
Assemble the left foot in the same manner.

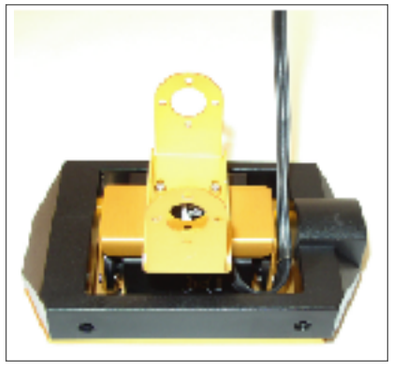




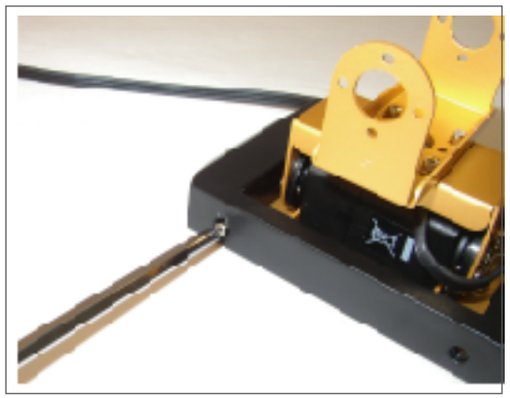
The completed feet will match those in the picture.

Slide a HR1C-0008 foot cover over the right foot. The correct orientation is for the flat side of the cover to face toward the inside of the foot and the beveled side to face the outside. Use the picture as a reference.



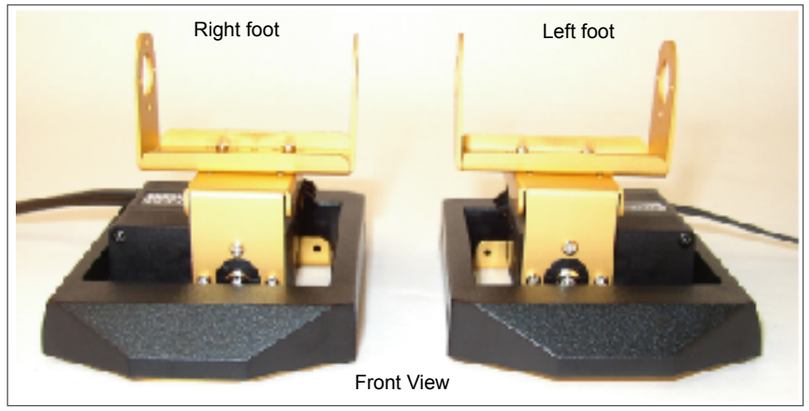


Double check the servo cable to make sure it is not crimped or caught up in the cover.



Insert four PH/M 2 x 4mm screws into the cover and secure it to the foot.

Assemble the left foot in the same manner as the right.



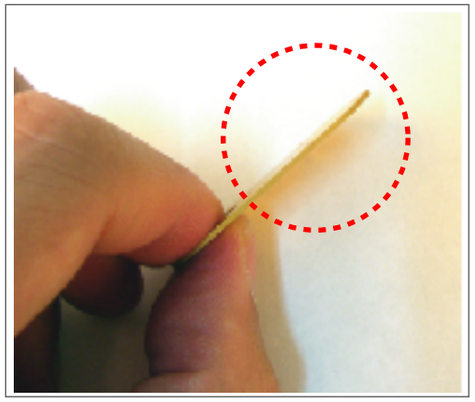
When complete the feet will match the picture.

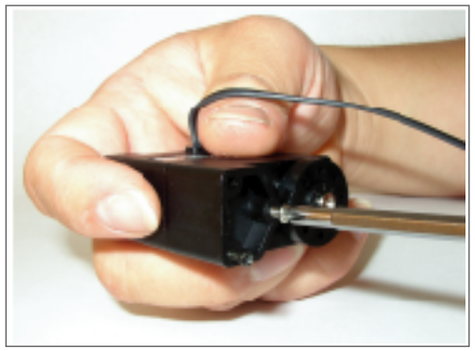
E. Shin Assembly

Parts Required:

No. 2	No. 4	
HSR-8498HB1R300	HSR-8498HB1L300	HR1B-0002
1 pc	1 pc	4 pcs

Begin by taking a close look at the HR1B-0003 brackets. One edge of the bracket is smooth and the other is sharp. For safety purposes, the smooth edge should face toward the outside of the servo.



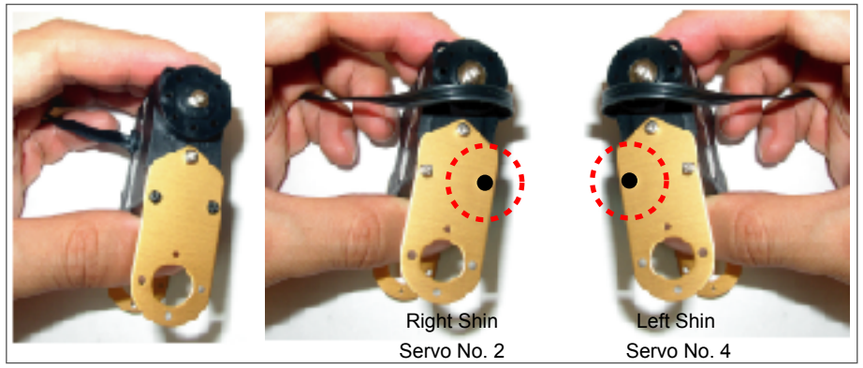


Remove the screws from the pentagonal portion of the servos. Note their placement during this process. For reference, the splined side of the servo has two black screws and one silver screw. The idler side has three silver screws.

Lay one bracket against the servo as shown in the picture and reinsert the screws. Read the note below before finishing. Do this until each servo has one bracket on the splined side and one on the idler side. Again take care to place the soft edge of the bracket so it is facing out.

Note:

At this time do not reinstall one of the long silver screws on the idler horn side of each shin. The position of each screw has been circled in the picture. Set the screws aside for use at later time.



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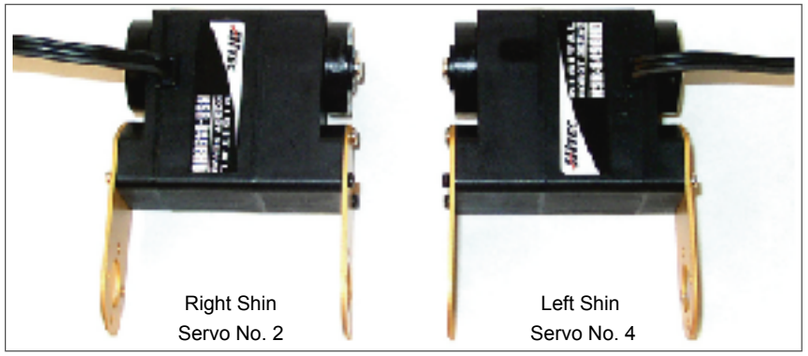
When complete, the shins will match the picture.

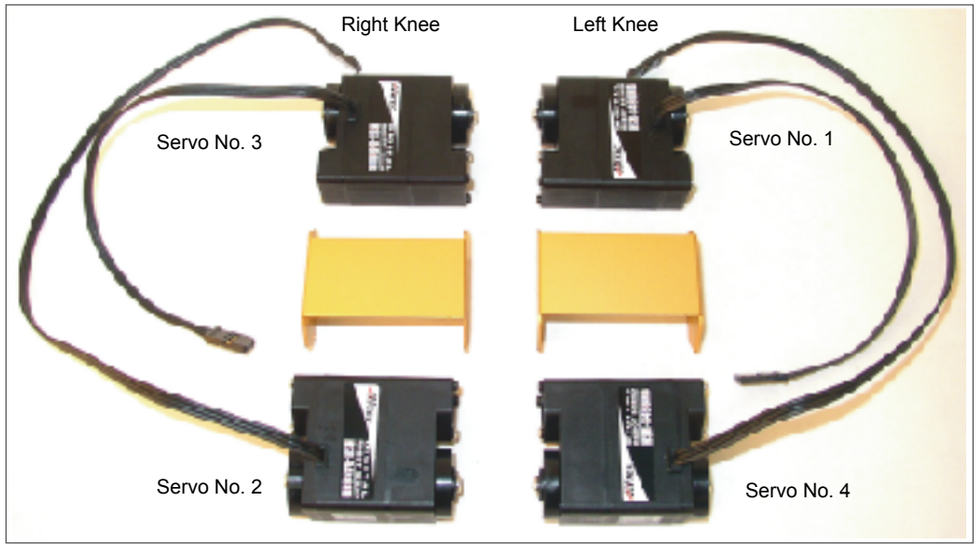


F. Knee Assembly

Parts required:

No. 1	No. 2	No. 3	No. 4	
HSR-8498HB1R200	HSR-8498HB1R300	HSR-8498HB1L200	HSR-8498HB1L300	HR1B-0004
1 pc	1 pc	1 pc	1 pc	2 pcs

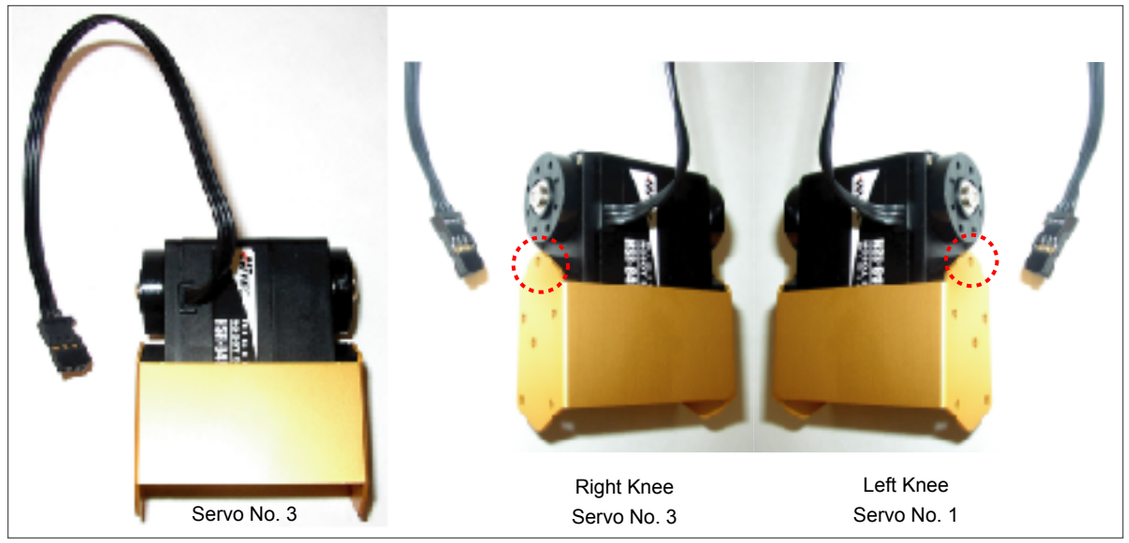
To simplify construction, lay out the parts so they match the picture.



Remove the screws from the pentagonal portion of all the servos. Note their placement during this process. For reference, the splined side of the servo has two black screw and one silver screws. The idler side has three silver screws.

Starting with the right upper knee, place the bracket over the pentagonal section of servo No. 3. Use the picture as reference. Install the previously removed screws. Read the note below before finishing. Assemble the left upper knee in the same manner using servo No. 1.

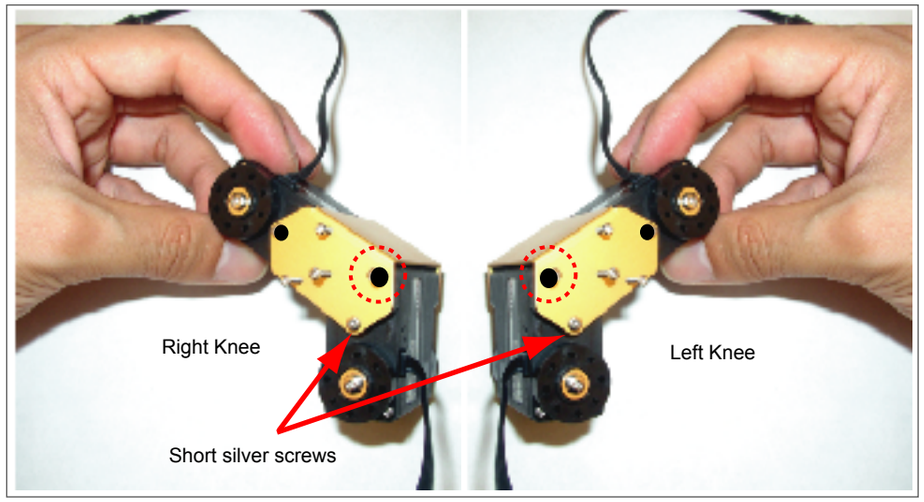
Note: At this time do not reinstall the short silver screws on the idler side of each upper knee. The position of each screw has been circled in the picture. Set the screws aside for use at later time.



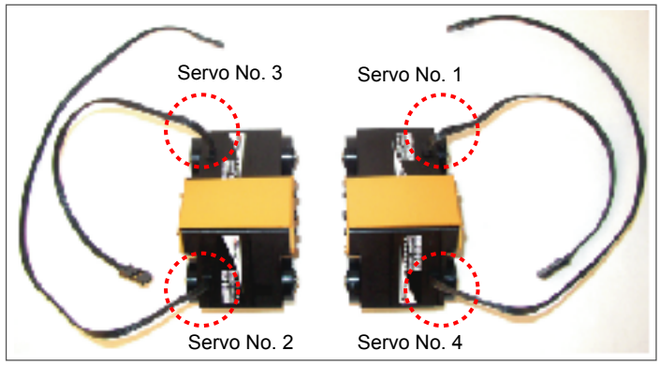
Again, starting with the right knee, place the bracket over servo No. 2. Note the orientation of the bracket to the servo in the picture.

Reinstall the previously removed screws. Read the note below before finishing. Assemble the left knee in the same manner using servo No. 4

Note: At this time do not reinstall one of the long silver screws on the idler side of each lower knee. The position of each screw has been circled in the picture. Set the screws aside for use at later time.



Double check the completed assembly against the picture to insure the cable direction matches.

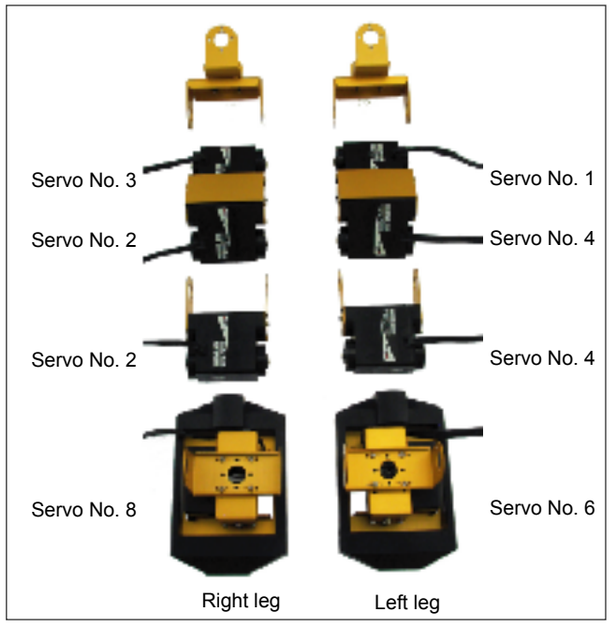


G. Assembling the Whole Leg

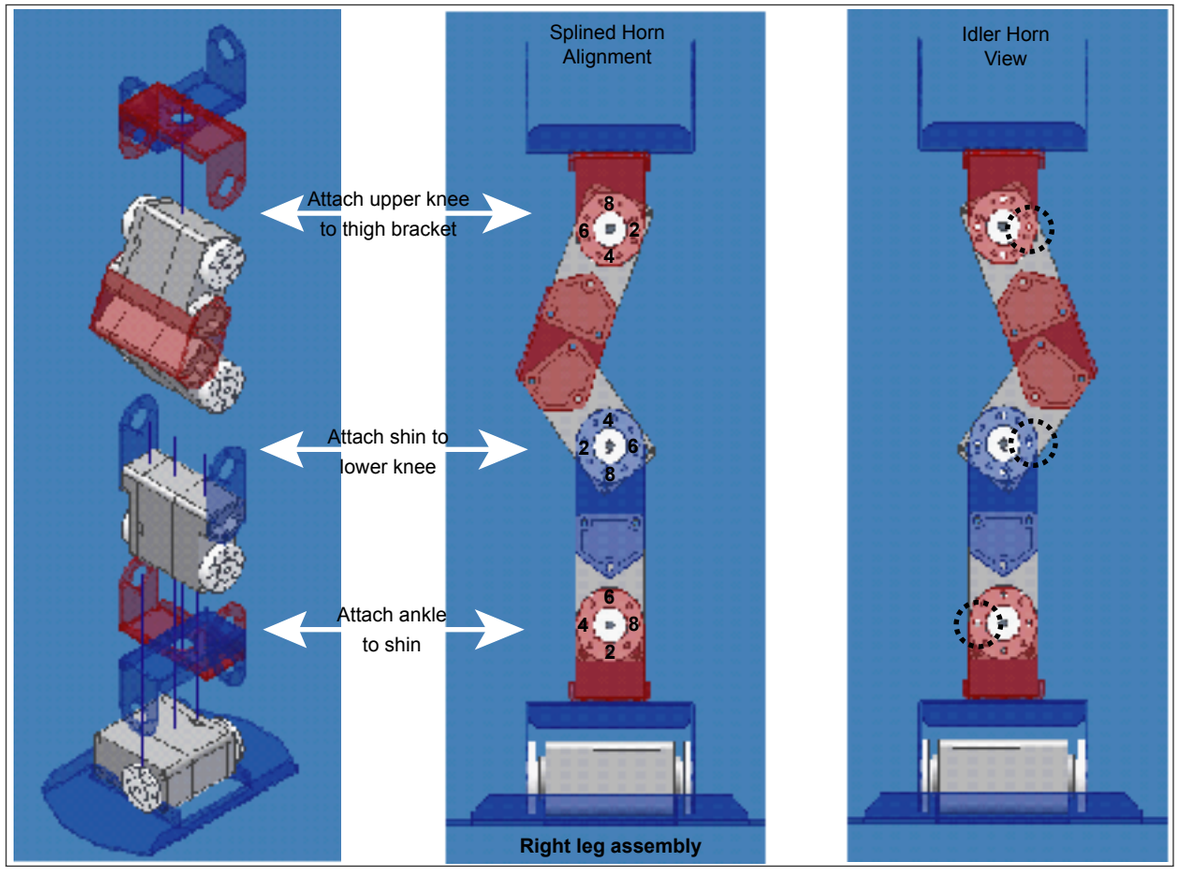
Parts required:

				
Foot assembly	Shin assembly	Knee assembly	Thigh assembly	PH/T-2 2 x 4mm
2 sets	2 sets	2 sets	2 sets	21 pcs

For this step, gather the previously assembled components and lay them out so they match the picture.



Use this picture as a reference for general assembly and the splined horn alignment of the right leg. Do not install screws at the marked locations in the Idler Horn view.

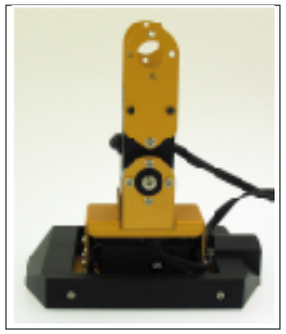


Step 1.

Attach the ankle to the shin:

Attach the lower shin servo to the upper ankle bracket. The number 6 on the splined horn is at 12 o'clock. Insert four screws in the splined horn and three into the idler horn.

Do not install a screw at the 9 o'clock position of the idler horn.



Step 2.

Attach the shin to the lower knee:

Attach the lower knee servo to the upper shin bracket. The number 4 on the splined horn is at 12 o'clock. Insert four screws in the splined horn and three in the idler horn.

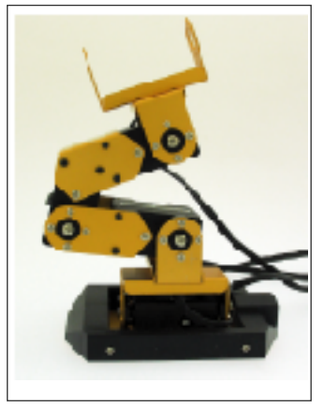
Do not install a screw at the three o'clock position of the idler horn.

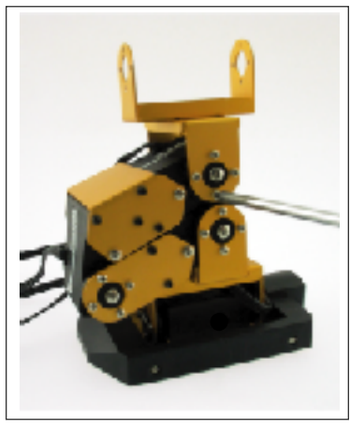
Step 3.

Attach the upper knee to the thigh bracket:

Slide the thigh bracket over the upper knee servo. Use the picture to align the thigh bracket with the splined horn. Make sure that the number 8 on the splined horn is at 12 o'clock and mated to the HR1B-0002 bracket of the thigh (thin flange). Insert four screws in the splined horn and three into the idler horn.

Do not install a screw at the 3 o'clock position of the idler horn.





If the leg has been assembled correctly, each servo will have full range of motion. To test this, collapse the leg fully by hand.

If the leg does not collapse, double-check the splined horn alignment. If misaligned, remove the screws from the horns and reposition the brackets.

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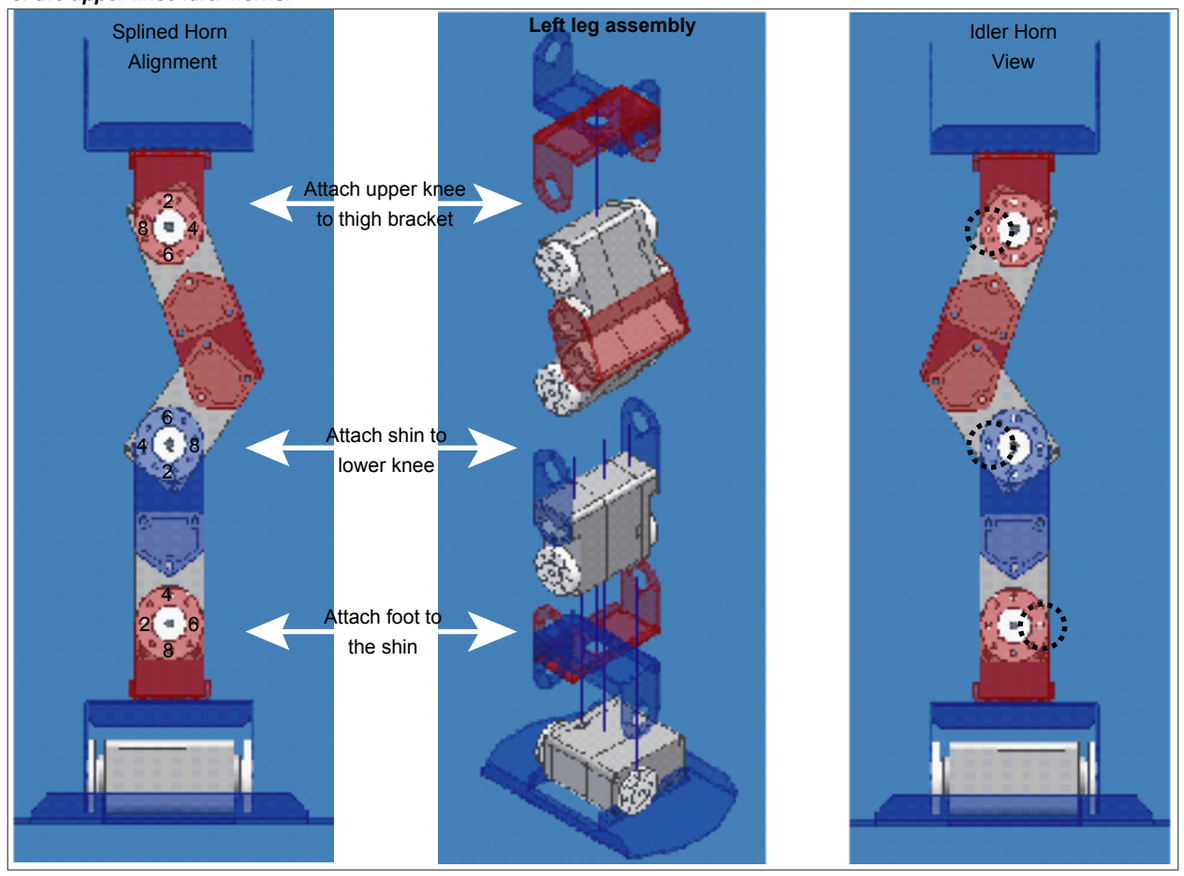
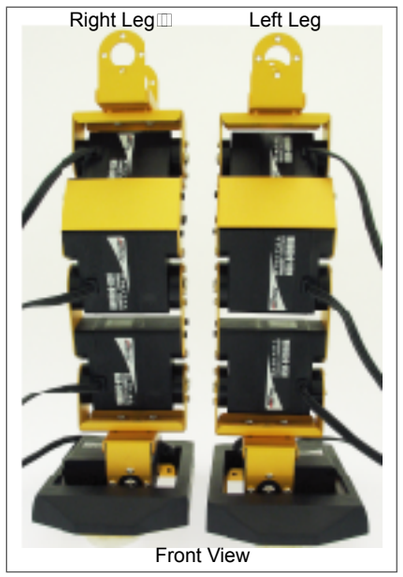
Use this picture as a reference for the splined horn alignment of the left leg. To assemble the left leg, attach the components in the same order as the right.

Do not install screws at the 3 o'clock postion of the shin, the 9 o'clock postion of the lower knee and the 9 o'clock position of the upper knee idler horns.



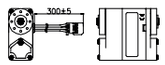
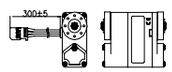
When complete, the legs will match those in the picture.



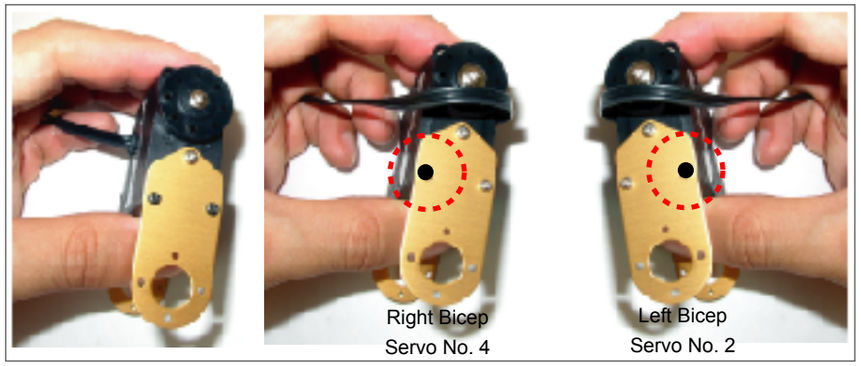
3. Arm Assembly

A. Bicep Assembly

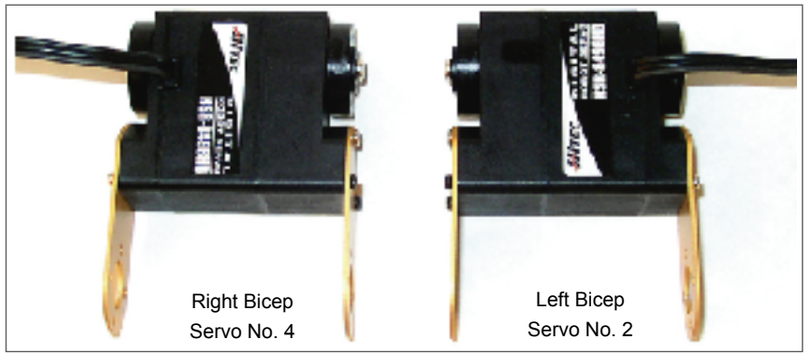
Parts required:

No. 2	No. 4	
		
HSR-8498HB1R300	HSR-8498HB1L300	HR1B-0002
1 pc	1 pc	4 pcs

The shoulders are assembled in the same manner as the shins. Remove the screws from the pentagonal sections of the servo cases and attach the brackets by reinstalling the screws. Do not reinstall one of the long silver screws in each idler side of the bracket.
The locations are marked in the picture.

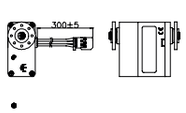
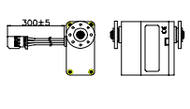


When complete the two biceps will match the picture.



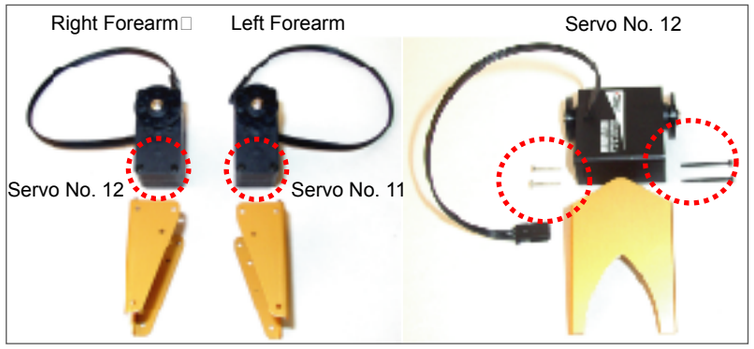
B. Forearem and Hand Assembly

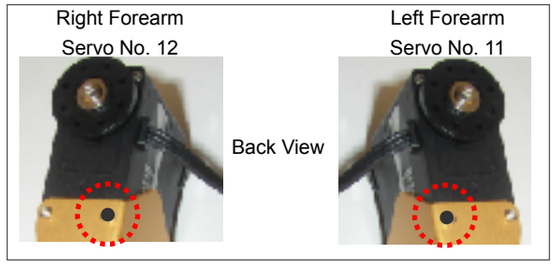
Parts required:

No. 11	No. 12			
				
HSR-8498HB2R300	HSR-8498HB2L300	HR1C-0006	HR1C-0007	HR1B-0011
1 pc	1 pc	2 pcs	2 pcs	2 pcs

PH/T-2 2 x 5mm
8 pcs

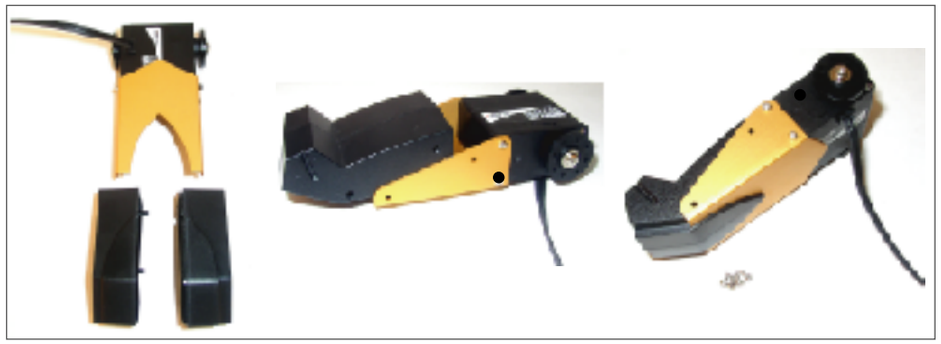
Remove the screws that are furthest away from the splined and idler horns. Remove the two black screws on the splined horn side and the two silver screws on the idler horns side. Attach the brackets as shown in picture.





Reinstall all the screws except for one silver screw in each forearm. Set this screw aside for use at a at later time. Pay particular attention that the black and silver screws are inserted into the correct side of the servos, as they are not interchangeable.

Snap the two halves of the each hand together and secure to each forearm bracket with four PH/T 2 x 5mm screws each.



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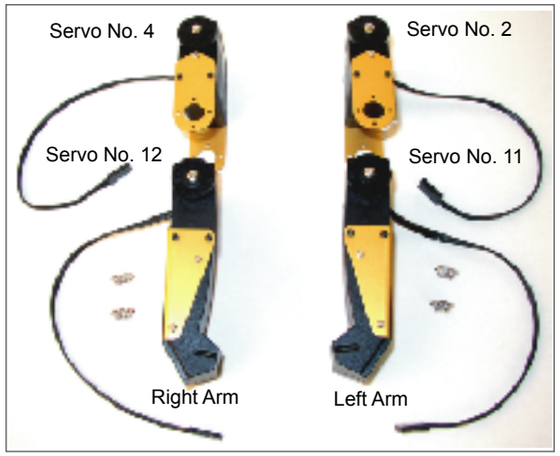
When complete the forearms will match the picture.

C. Completing the Arm Assembly

Parts required:

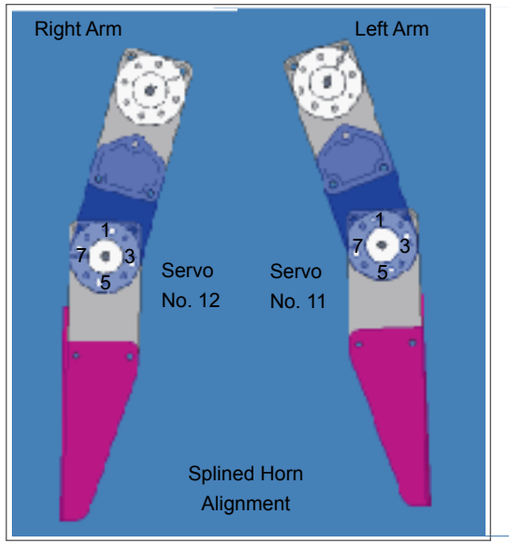
		
Bicep Assembly	Forearm Assembly	PH/T-2 2 x 4mm
2 sets	2 sets	14 pcs

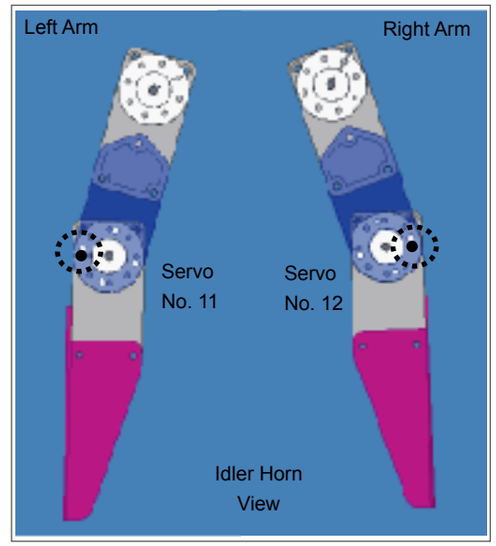
Line up the components that make up the arm as shown in the picture.



Using the picture as a guide, connect the forearm to the shoulder with four screws in the splined horns and 3 in the idler horns. For both forearms, the number 1 on the splined horn should be a 12 o'clock.

Do not insert screws at the 3 o'clock position on the idler horn side of servo No. 12 and the 9 o'clock position of servo No. 11.





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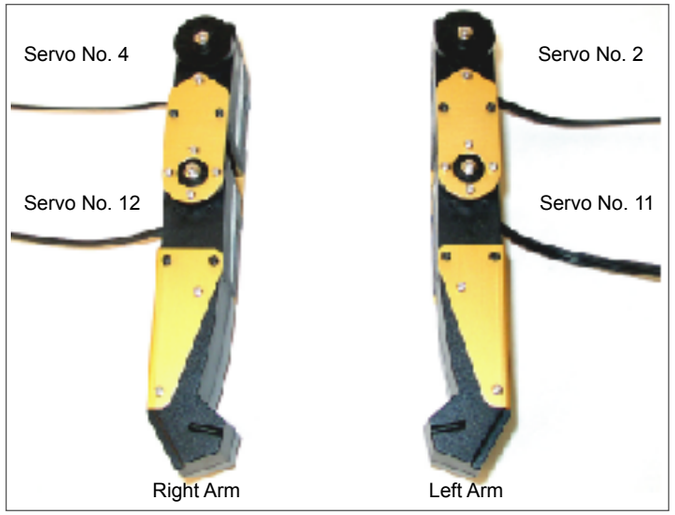
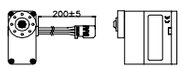
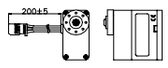


When complete the arms will match the picture.

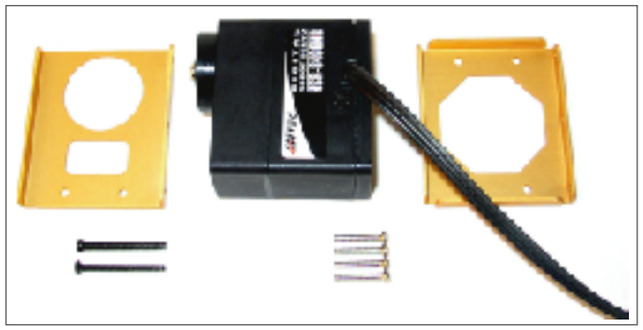
4. Body Assembly

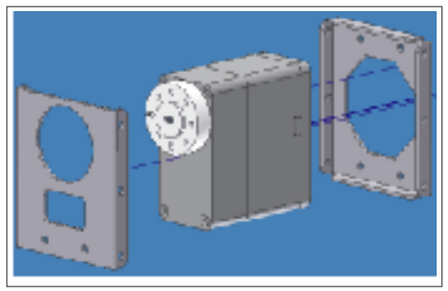
A. Shoulder Assembly

Parts required:

No. 9	No. 10		
			
HSR-8498HB3R200	HSR-8498HB3L200	HR1B-0009	HR1B-0010
1 pc	1 pc	2 pc	2 pc

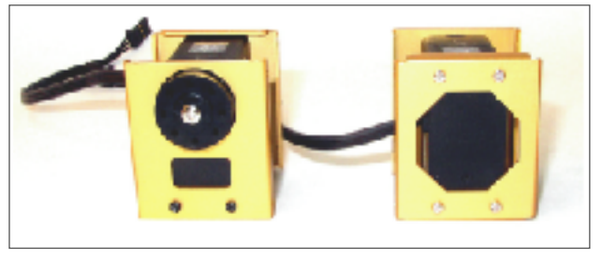
Remove the four silver screws from the hornless side of each servo and the two black screws furthest away from the splined horn on the splined horn side.





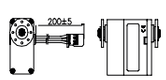
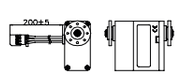
Use this picture as an example of proper bracket placement.

Using the removed black screws, attach the HR1B-0010 bracket to the splined horn side of the each servo. Attach the HR1B-0009 bracket with the previously removed silver screws to the hornless side of each servo. Assemble both shoulders in the same manner. Use the picture as reference.

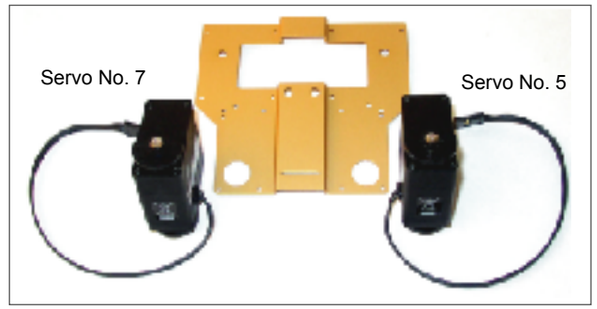


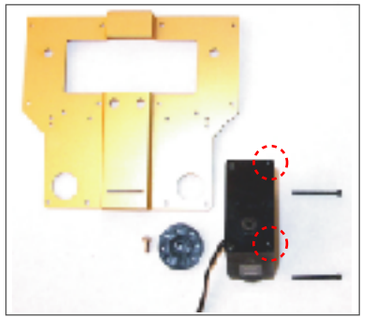
B. Attach Pelvis Servos to Front Body Bracket

Parts required:

No. 5	No. 7	
		
HSR8498HB2R200	HSR8498HB2L200	HR1B-0006
1 pc	1 pc	1 pc

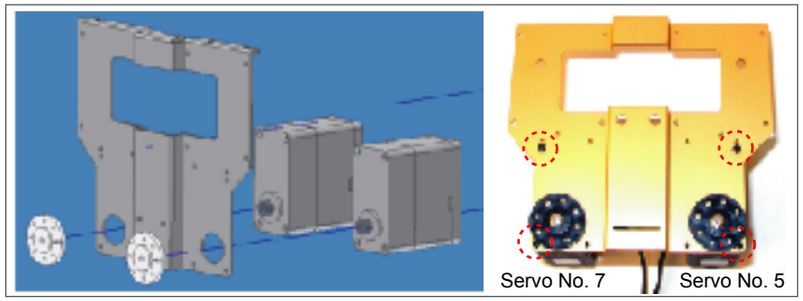
Place the components so they match the picture.





Remove the splined horn from each servo. Remove the two outside black screws from the splined horn side of each servo.

Attach the front body bracket to the servos using the previously removed screws. Once in place, reinstall the splined horns.



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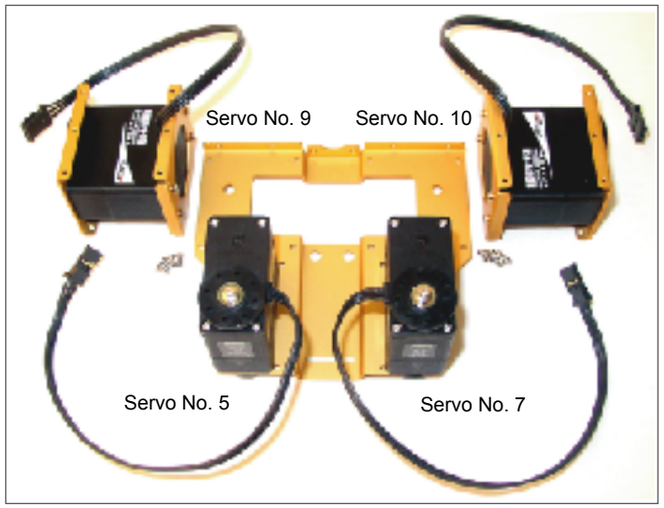
C. Attaching the Shoulder to the Front Body Bracket

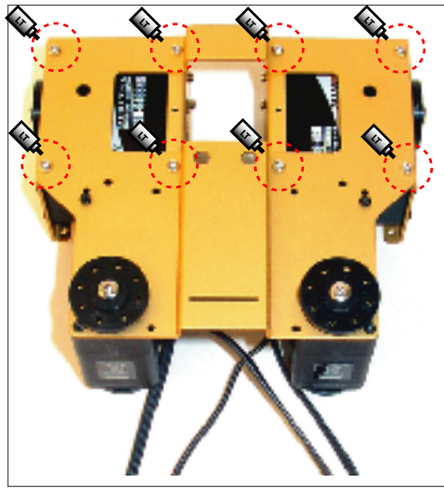
Parts required:

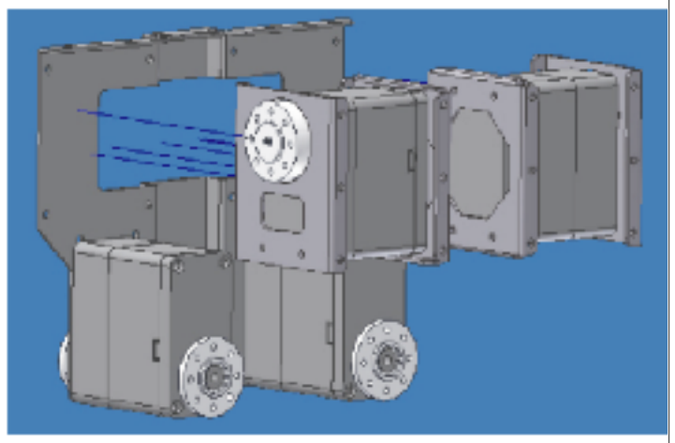
		
Shoulder assembly	Pelvis assembly	PH/M 2 x 4mm
2 sets	1 set	8 pcs

Layout the parts so they match the picture.
Notice the orientation of the servo cables.



Connect the two shoulders to the front body bracket using four PH/M 2 x 4mm screws per shoulder. Use the picture for proper screw placement.



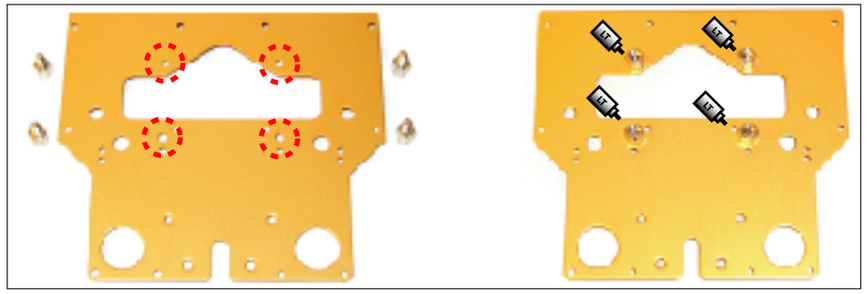


D. Attaching the Back Body Bracket to the Front Body Assembly

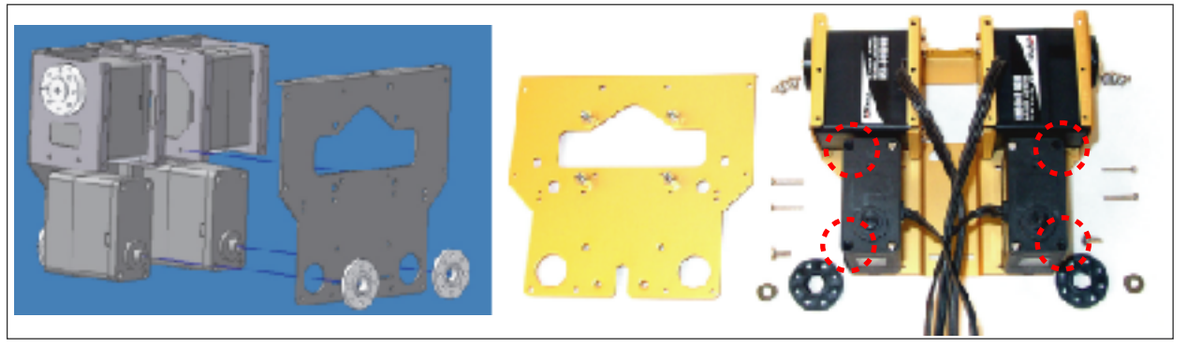
Parts required:

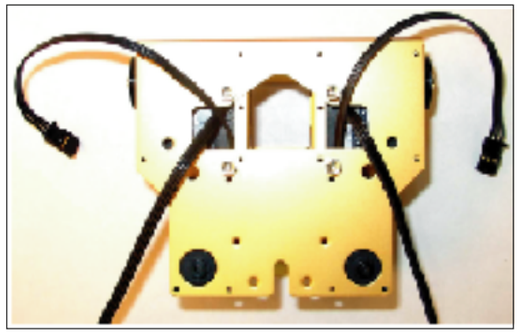
			
Front body assembly	HR1B-0005	Support 3 x 5mm	PH/M 2 x 4mm
1 set	1 pc	4 pcs	6 pcs

Install the four controller supports at the locations shown in the picture.

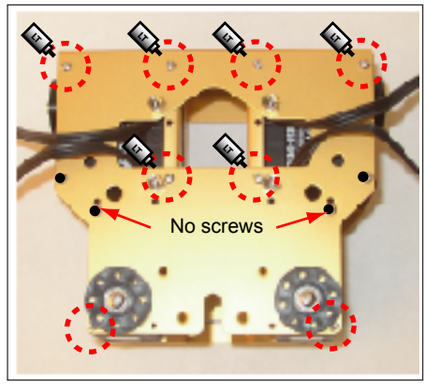


Remove the idler horns from the pelvis servos. Remove the two silver screws from the outer edge of each pelvis servo. Set two screws aside for later use.





Place the back body bracket over the front body assembly and route the cables as shown in the picture.



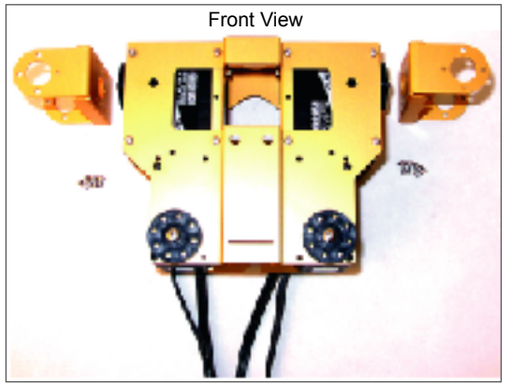
Using the picture as a guide, attach the back body cover to the front assembly with six PH/M 2 x 4mm screws. Reinstall two of silver case screws previously removed. Do not install screws at the locations noted in the picture. Reattach the idler horns to the pelvis servos.

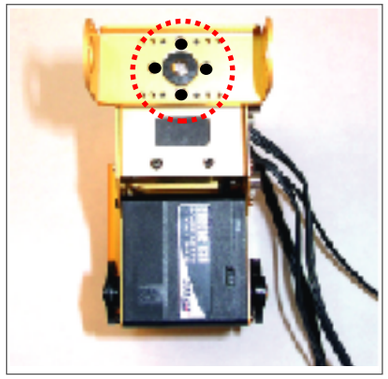
E. Outer Shoulder Assembly

Parts required:

		
Body assembly	HR1B-0001	PH/T-2 2 x 4mm
1 set	2 pcs	8 pcs

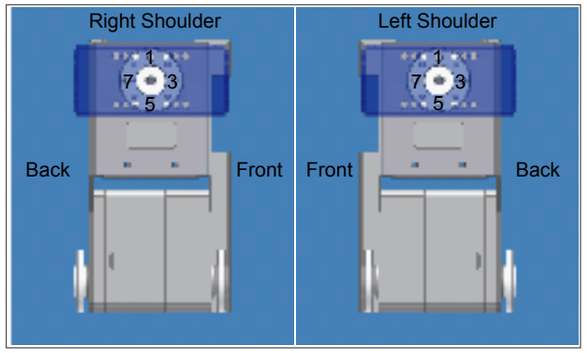
This picture shows the position of the outer shoulder brackets to the body.

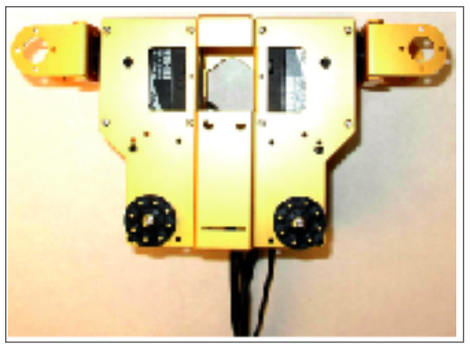




Place the brackets as shown in the picture. Note the hole locations.

Using the picture as a guide, attach the brackets to the splined horns of the inner shoulders with four screws each. The number 1 on the splined horn is at 12 o'clock for both shoulders.



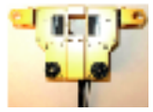


The completed shape of the body.

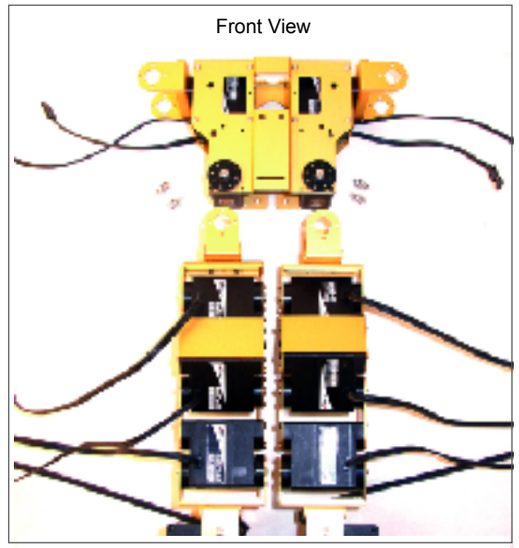
5. Attaching the Legs and Arms to the Body

A. Attaching the Legs to the Body

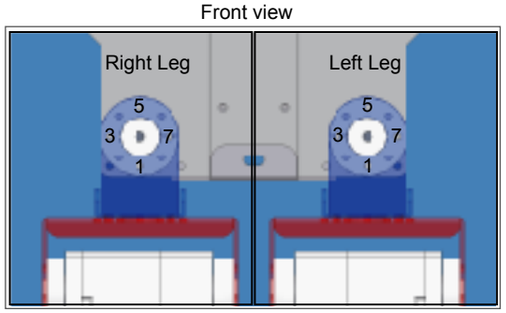
Parts required:

		
Body assembly	Leg assembly	PH/T-2 2 x 4mm
1 set	2 sets	14 pcs

Arrange the body and legs so they match the picture.

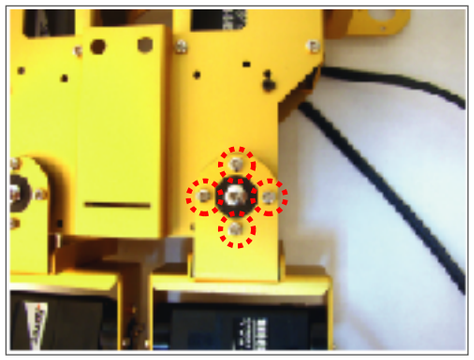


Front view

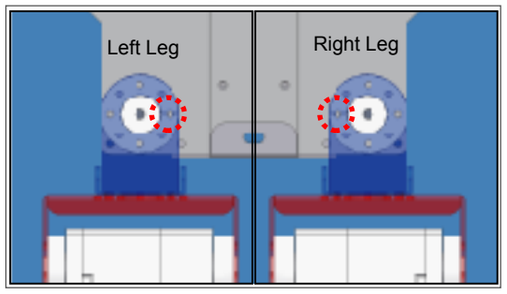


Using the picture as a reference, align the thigh bracket over the pelvis horns. The number 5 on the splined horn of both servos is at 12 o'clock.

Attach the legs by inserting screws in the splined and idler horns.



Back view



Do not place screws in the idler horns at the 9 o'clock position of the right leg and the 3 o'clock position of the left leg.

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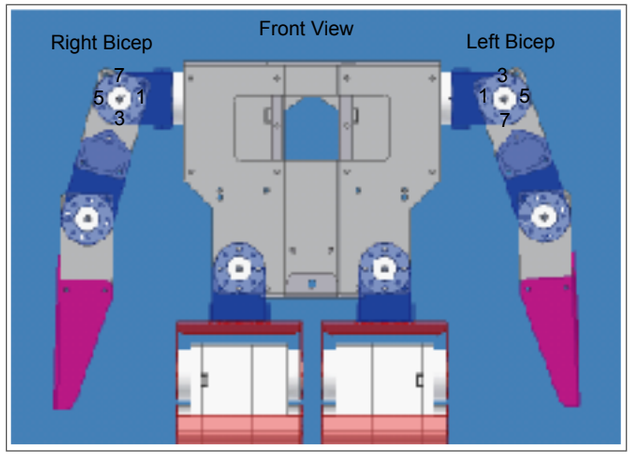
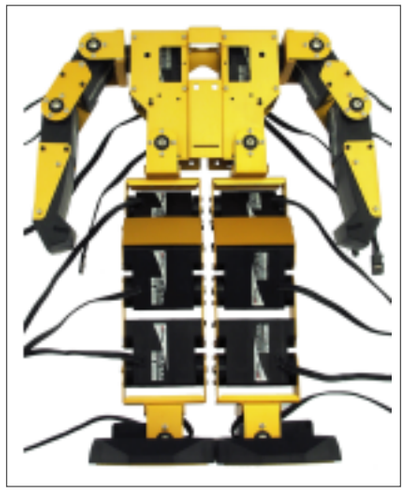
B. Attaching the Arms to the Body

Parts required:

		
Body assembly	Arm Assembly	PH/T-2 2 x 4mm
1 set	2 sets	14 pcs

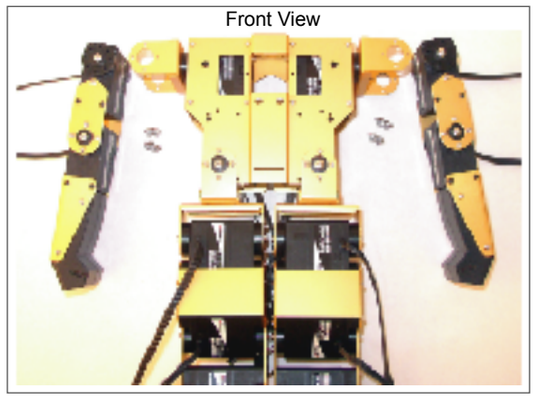


Secure the bracket to biceps with four PH/T-2 2 x 4mm screws in each splined horn and three in each idler horn. Do not insert a screw at the 12 o'clock position of the idler horn.

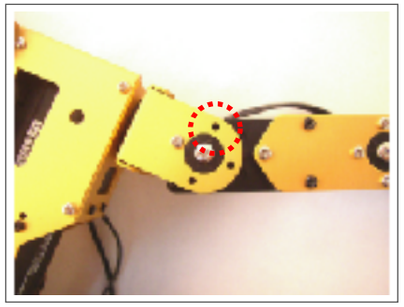


Completed body.

Arrange the body and arms so they are match the picture.



Using the picture as a reference, align the shoulder bracket over the splined and idler horns of the bicep. For the right bicep, the number 7 on the splined horn is a 12 o'clock. The number 3 is at 12 o'clock on the left bicep.

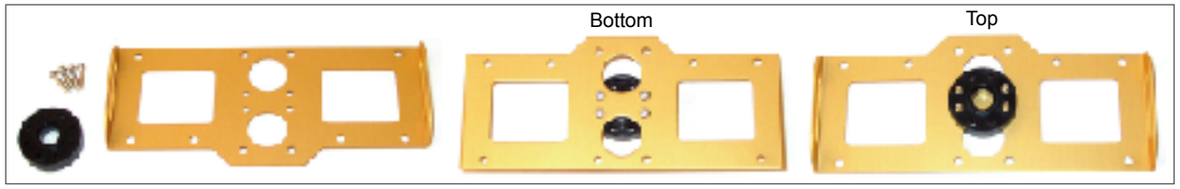


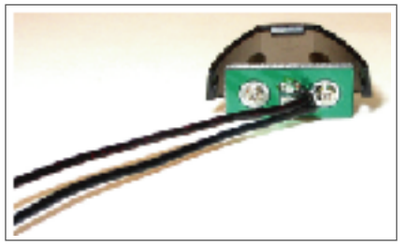
6. Attaching the Head to the Body

Parts required:

				
HR1B-0007	HR1C-0003	HR1C-0004	HR1C-0005	LED Module
1 pc	1 pc	1 pc	1 pc	1 pc
				
HSR8498HA2	PH/M-2 2 X 4mm	PH/T-2 2 X 5mm	PH/M 2.6 x 4mm	PH/T-2 2 x 8mm
1 pc	2 pcs	2 pcs	10 pcs	6 pcs

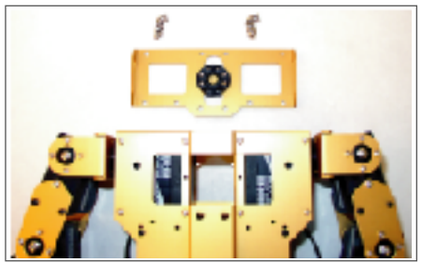
Attach the HSR8498HA2 servo horn to the upper body bracket with four PH/T-2 2 x 8mm screws using the pictures as a reference.



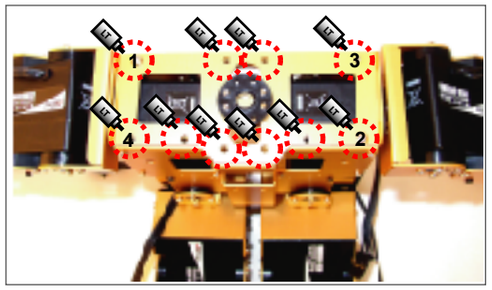


Disconnect the LED board from the controller and attach it to the back of the visor with the two PH/M-2 2 x 4mm screws.

Snap the visor into the front half of the head. Use the pictures as a guide.

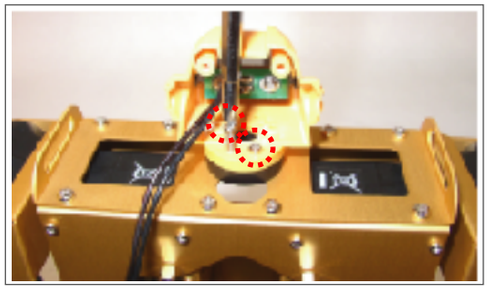


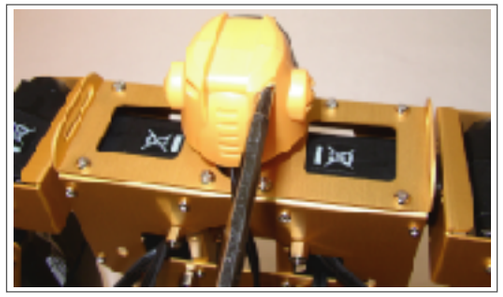
Secure the upper body bracket to the body using the ten PH/M 2.6 x 4mm screws.



To insure a proper fit, start in the corners first, then move on to the other hole positions.

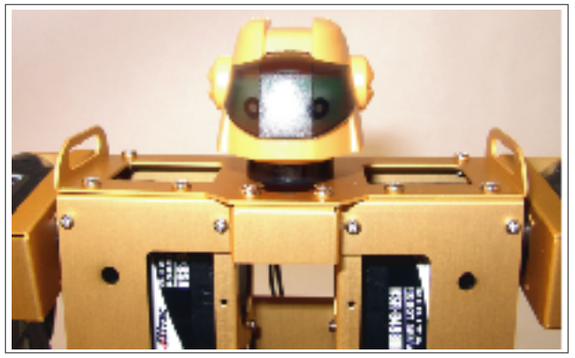
Attach the front head half to the horn on the upper body with two PH/T 2 x 8mm screws. This picture shows the general screw locations.





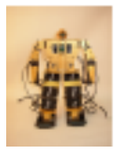
Attach the back head half to the front with the two PH/T-2 2 x 5mm screws

The completed head assembly.

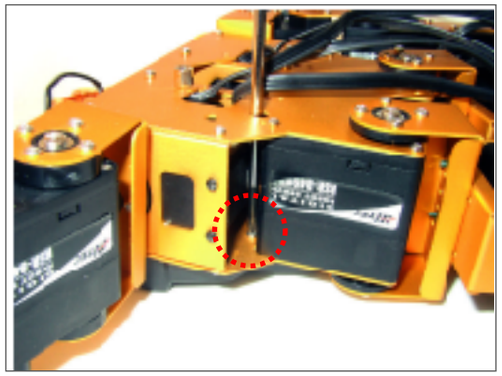


7. Attaching the Front Body Cover

Parts required:

		
Robot Assembly	HR1C-0001	PH/T-2 2 x 5mm
1 set	1 pc	2 pcs

The front body cover is attached to the main body with the two PH/T-2 2 x 5mm screws. This picture shows the hole locations of the front body cover.



Place the front body cover over the front of the body and using a long phillips head screwdriver, insert the screws through the back of the robot.

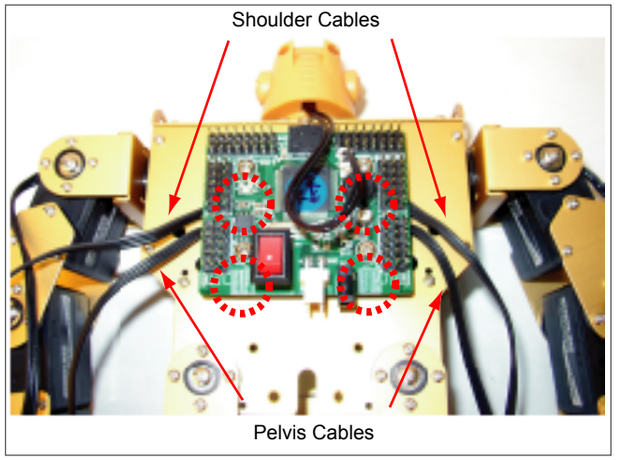
Assembled front body cover.

8. Attaching the Controller to the Robot:

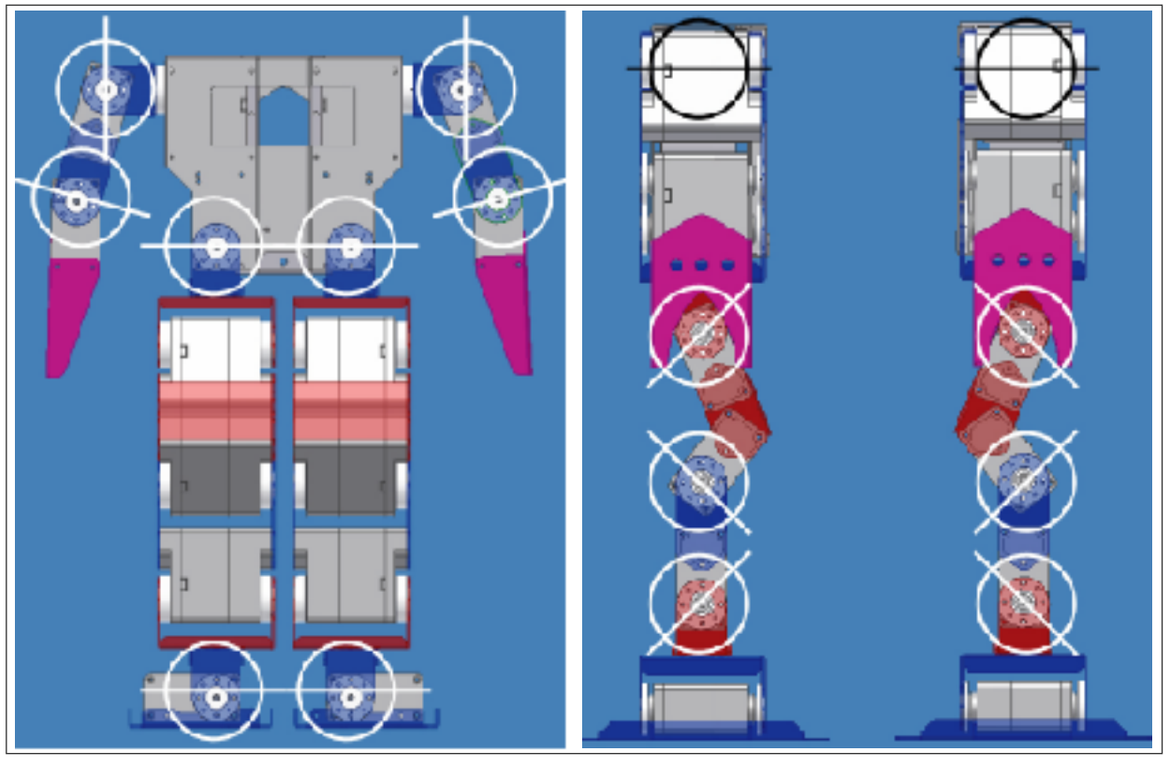
Parts required:

		
Robot assembly	MR-C3024	PH/M 3 x 4mm
1 set	1 pc	4 pcs

Use the PH/M 3 x 4mm screws to secure the MR-C3024 controller to the already installed stand offs in the back of the robot. Before installing, lay the shoulder and pelvis servo cables to each side.



At this time it would be a good idea to double check all joints for proper movement. By hand, move each joint to check for 180 degrees of travel.



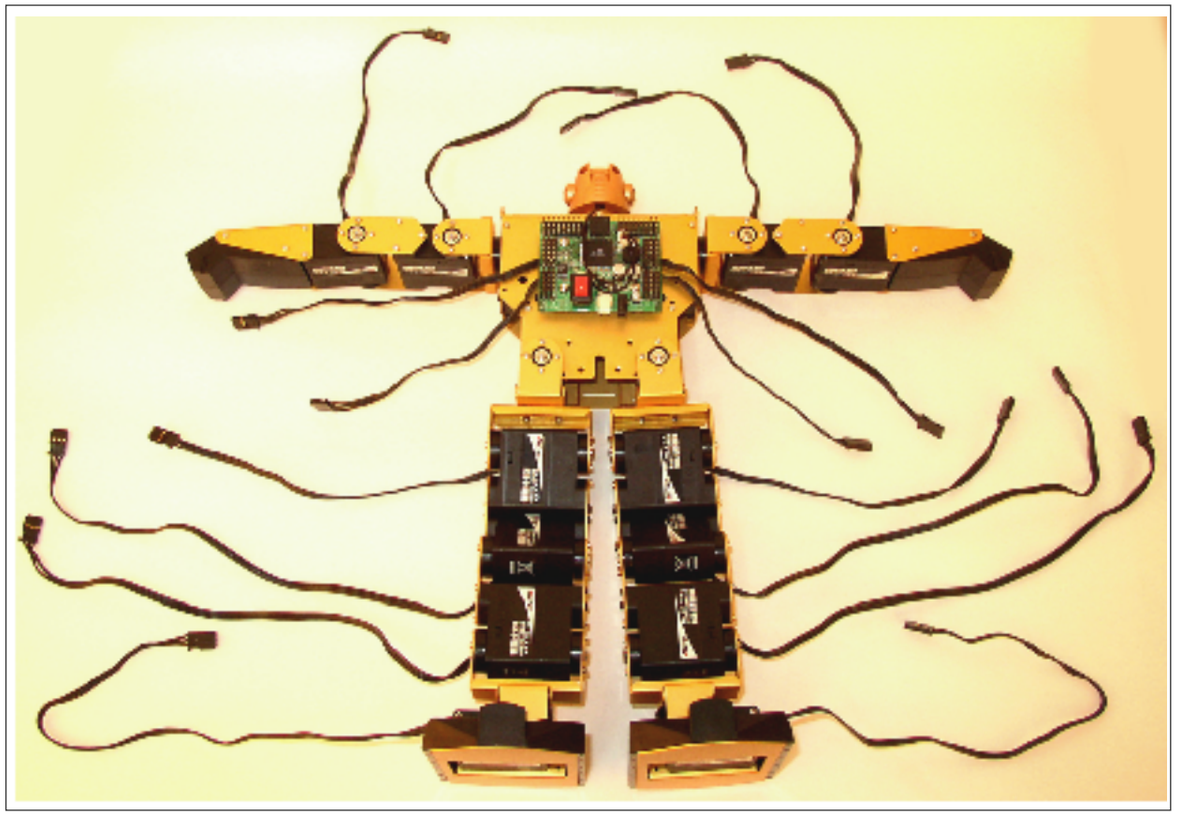
ROBONOVA-I

9. Cable Arrangement

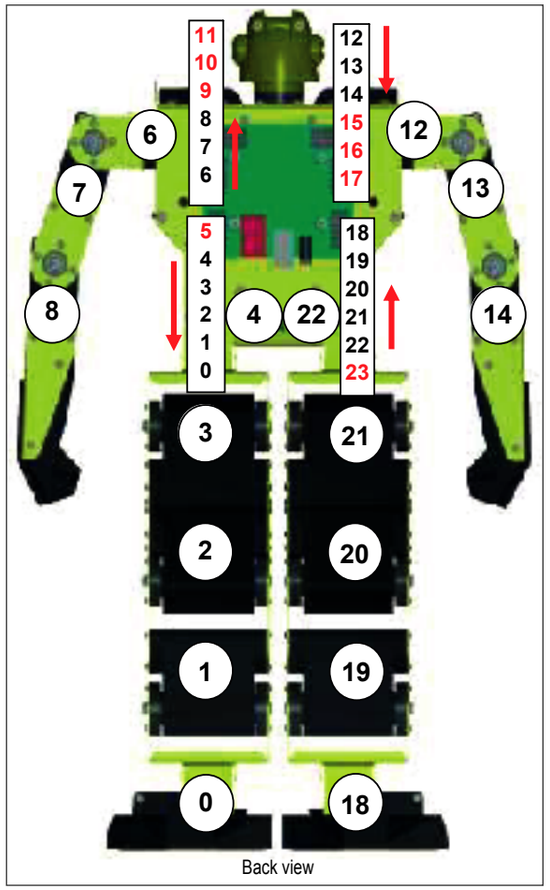
The Robonova-1 has 16 cables that must be connected to the controller. To prevent mishaps and for proper operation, it is important that the cables are secured neatly to the body. This section will describe the cable installation and the use of the cable clamps and ties.

A. Insert Cables into the Controller

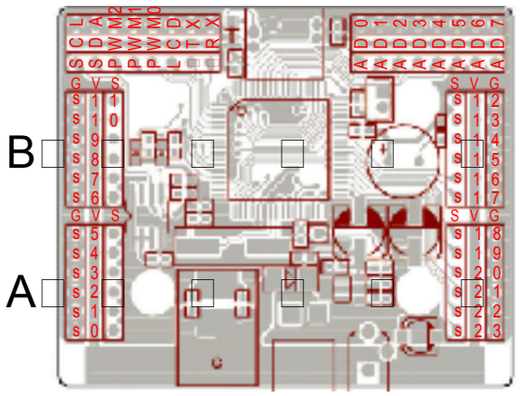
Lay the robot carefully on its front and separate the cables to ease installation.



This picture details the servo cable placement. The numbers on the servos represent their assigned slot in the controller.

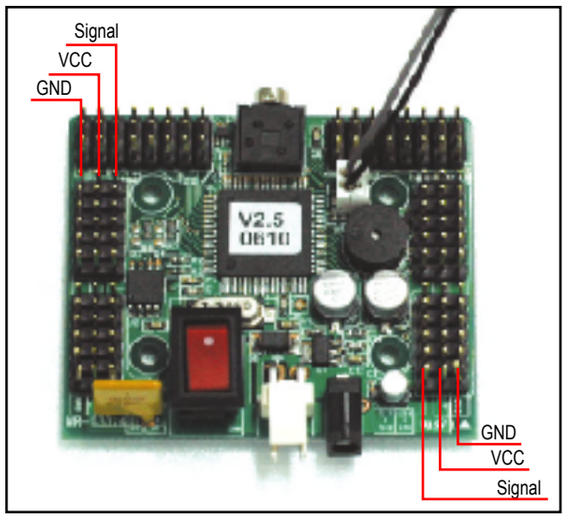


Back view

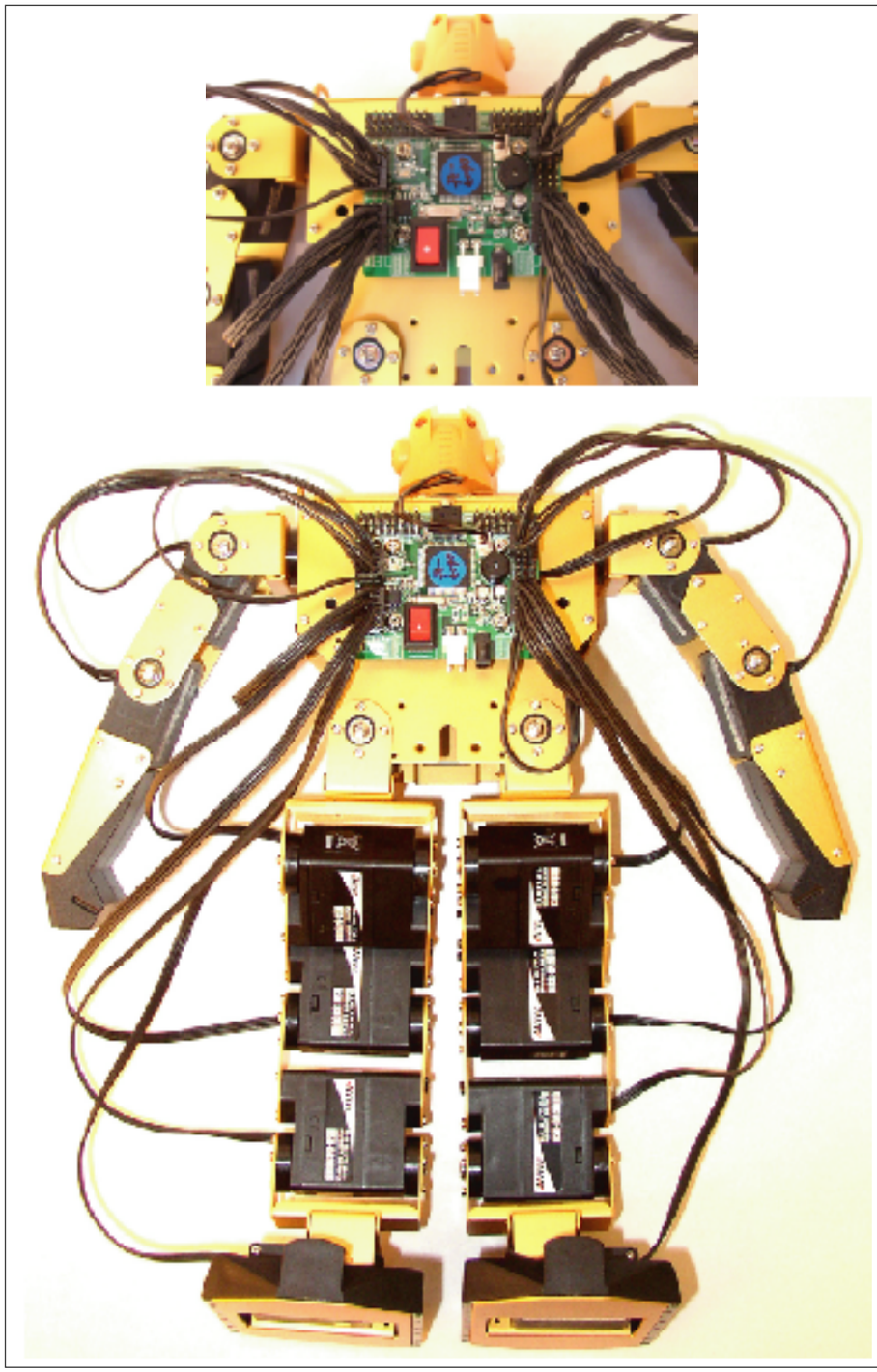


Here is a detailed diagram showing the assigned pins in the controller.

It is important that the cables are connected to the controller board with the correct polarity. The gray wire on the cable is the signal wire and should always face in towards the center of the board. The plastic pin housing of the cable is keyed on the signal wire side to assist in assembly.



Insert the cables into the controller board.



ROBONOVA-I

B. Installing the Cable Clamps

The cable clamps protect the cables from damage when the robot is moving and prevents them from interfering with any movement.

Completely review this section before beginning.

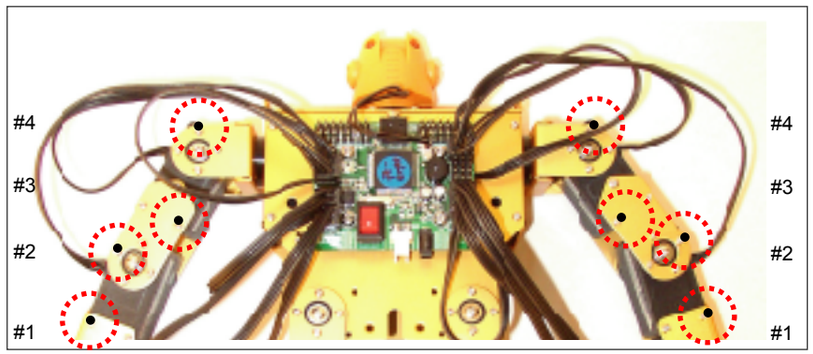
Parts required:

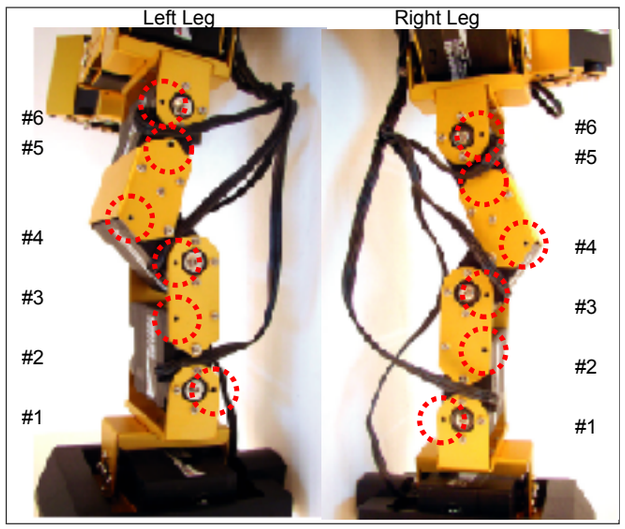
				
Robot Assembly	PH/T-2 2 x 4mm	Washer	PH/M 2 x 4mm	Lug
1 set	12 pcs	24 pcs	2 pcs	2 pcs


Cable Clamp
24 pcs

The screws used are:
#1 = Removed long silver servo case screw. (These were set aside earlier during construction.)
#2 = PH/T-2 2 x 4mm
#3 = Removed long silver servo case screw.
#4 = PH/T-2 2 x 4mm

Exam the picture of the arms and note the locations marked. Each location will have a cable clamp attached.

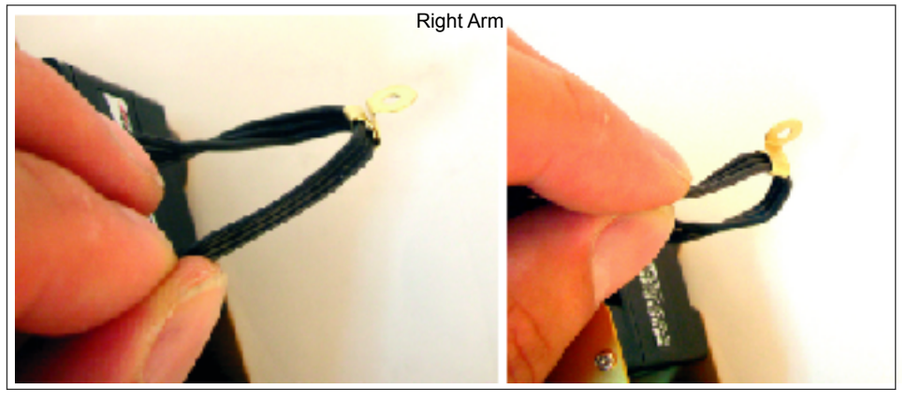




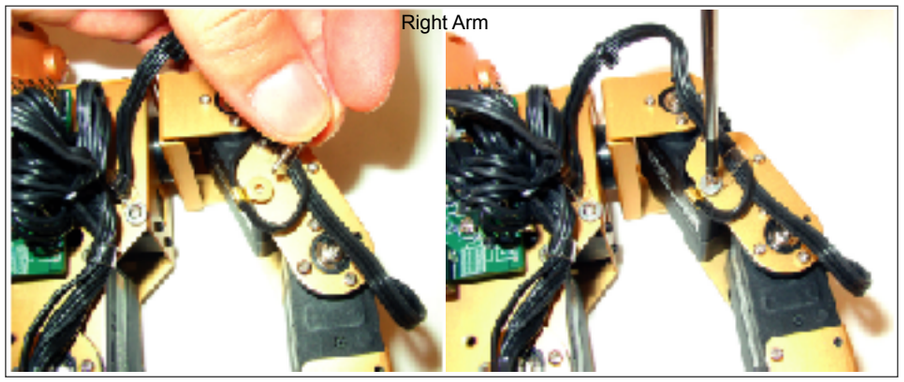
The leg screw locations are shown in the pictures. The screws used are:
#1 = PH/T-2 2 x 4mm
#2 = Removed long silver servo case screw.
#3 = PH/T-2 2 x 4mm
#4 = Removed long silver servo case screw.
#5 = Removed short silver servo case screw.
#6 = PH/T-2 2 x 4mm

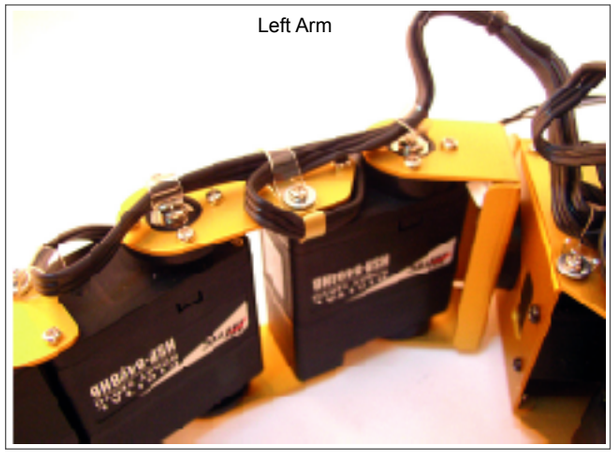
Add the cable clamps to the legs first. Begin at the number one location on the left leg. Slide a washer over the screw. Then wrap the clamp around the cable and insert the screw into the holes of the clamp. Insert the screw into location number one and tighten. Continue the same process through location number six. Perform the same steps for the right leg. .

On the arms add a clamp to the number one and two locations. Before adding a clamp to the number three position, it is necessary to add a lug to the bicep servo cables. On the right arm this is servo No. 4 and on the left arm this is servo No. 2. Following the pictures, loosely bend the lug around the cable.



Once the lug is in place, complete the clamp assembly using the pictures as a reference.



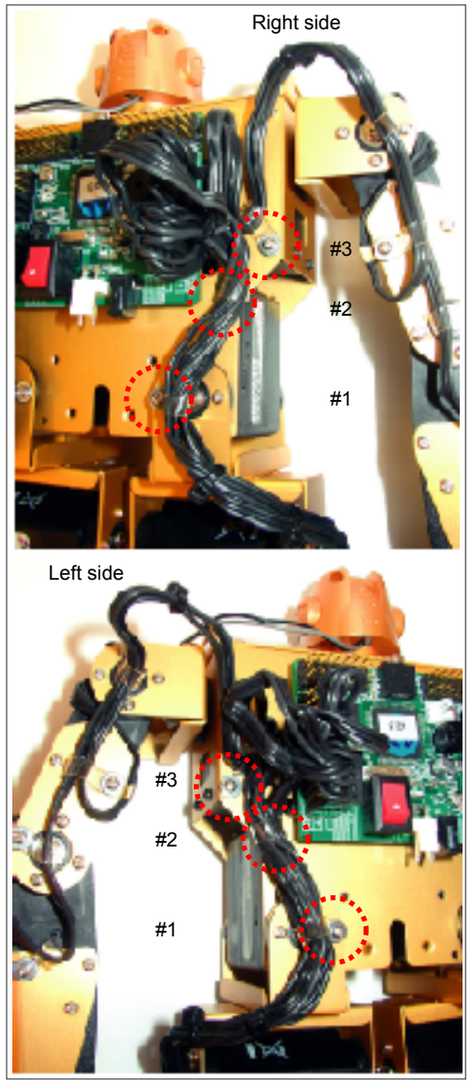


Completed lug and clamp assembly for the number three position. Finish the arms by adding a clamp to the number four position.

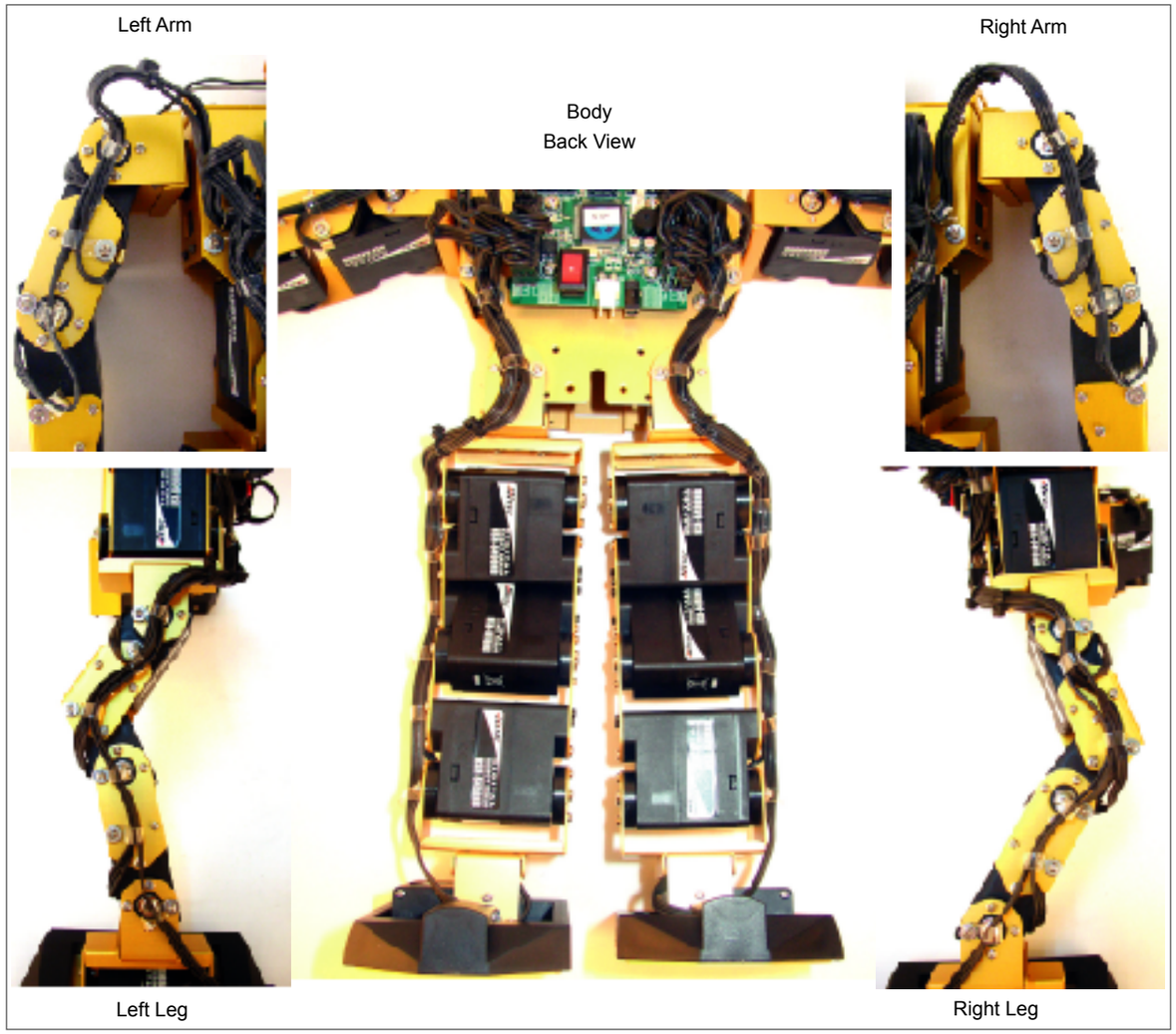
Add clamps to the main body at the locations shown in the pictures. At the number one position use a PH/T-2 2 x 4mm screw. All cables from the leg are held with this clamp.

The number two position uses the removed silver servo case screws. This clamp also holds the cables from the leg.

The number three position uses a PH/M 2 x 4mm screw. Use this clamp to hold the cables from the arm.



The completed clamp assembly.

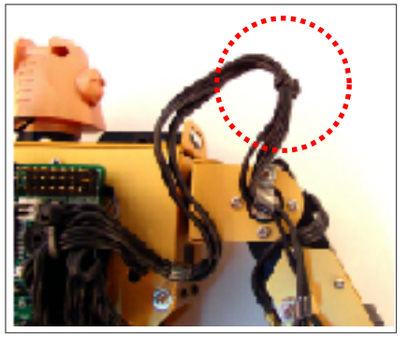


C. Cable Tie Assembly

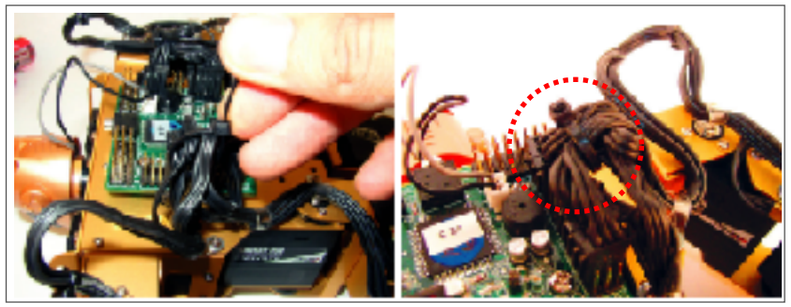
Parts required:

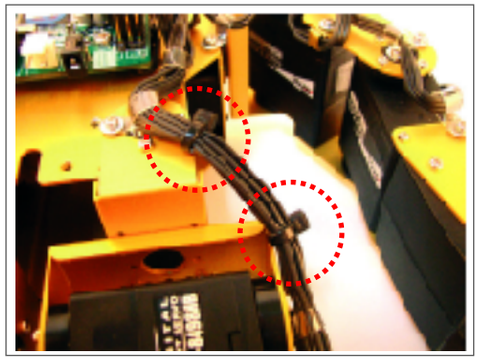
	
Robot Assembly	Cable Tie
1 set	8 pcs

To reduce stress to individual cables it is necessary to add cable ties at key locations. Add a cable tie to each arm section as shown in the picture.

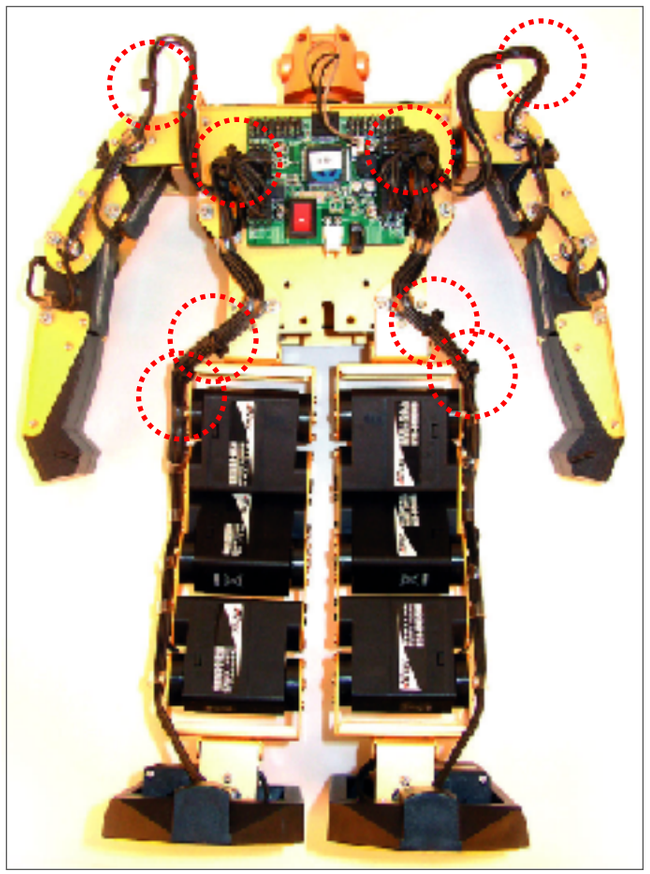


Bundle the wires close to the controller and use a cable tie to keep them together. Use the picture as an example.





Add cable ties to each leg at the locations shown in the picture.



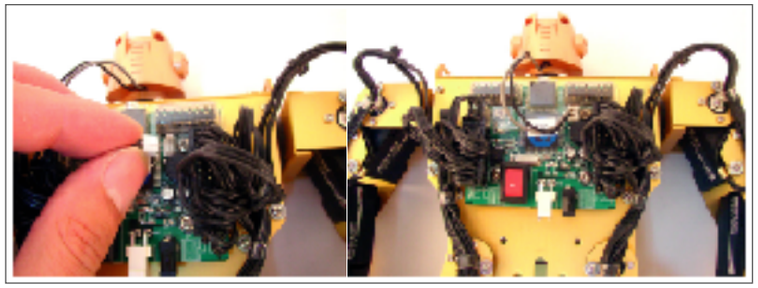
Completed cable tie assembly.

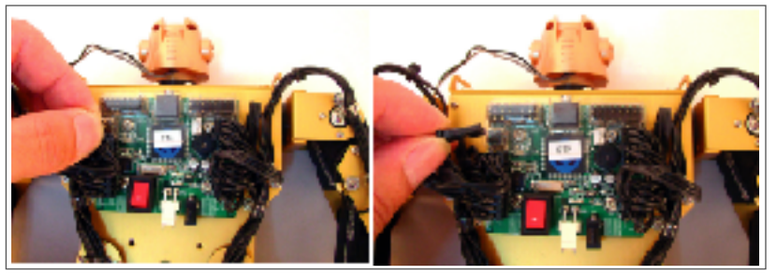
10. LED and IR Connection

Parts required:

	
Robot assembly	IR Sensor
1 set	1 pc

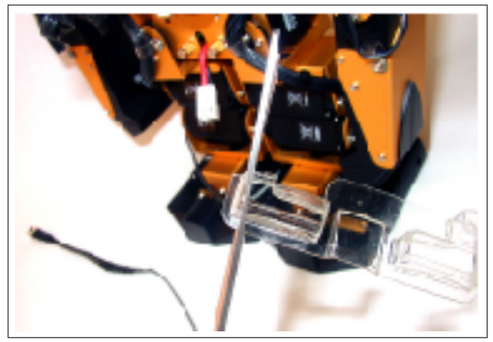
Plug the LED's white plug into the controller as shown in the picture.

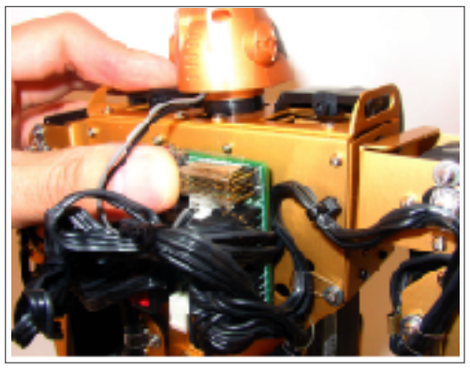




Disconnect the servo cable plugged into the number 8 slot of the controller. Remove the pin cover from the controller. At this time, do not reinstall the servo cable.

To add the IR sensor it is necessary to cut a slot in the protective pin cover for the sensor plug. The slot should be cut so the sensor can plug into the AD 7 port.

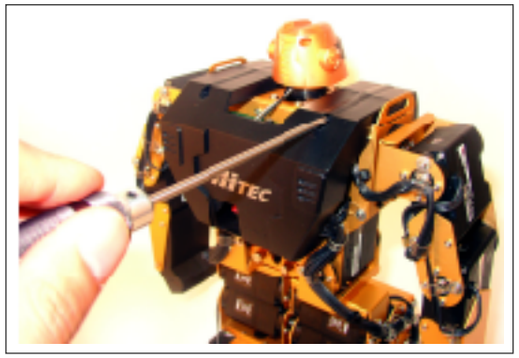




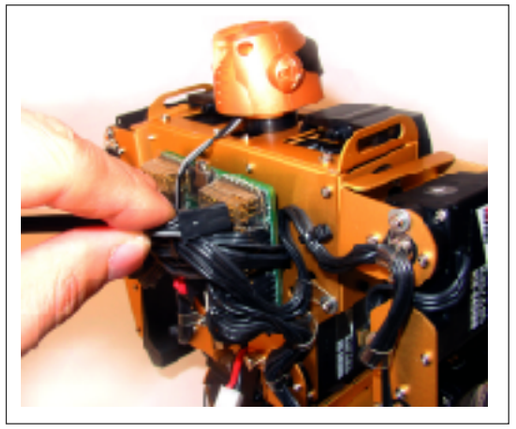
Once the cover is cut, place the cover back onto the controller.

For the solid fix of IR sensor, you can use 5-minute Epoxy (Araldite) adhesive.

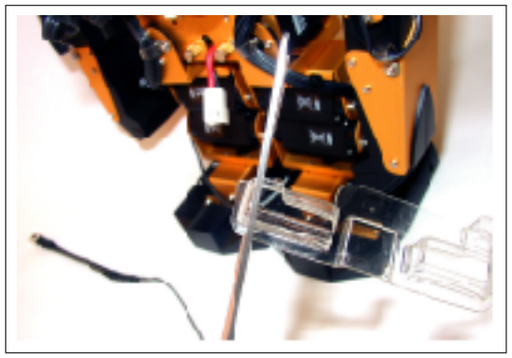
Open the back body cover at the RN-1



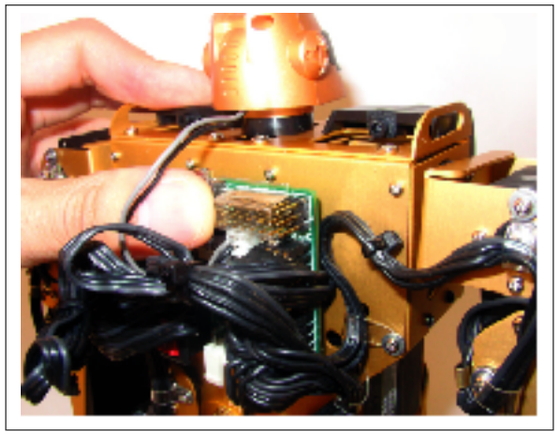
Insert the connector of the IR Sensor into "AD7" port which located in upper right side of MR-C3024 controller.



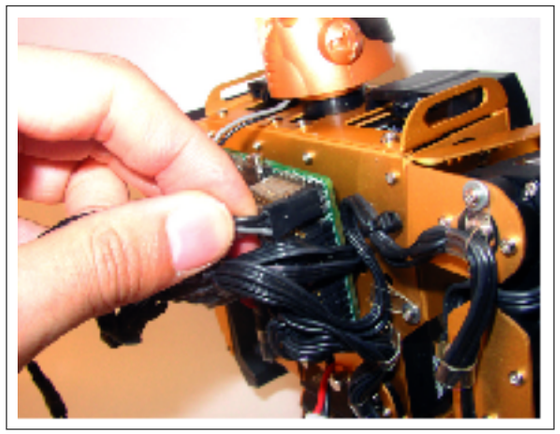
Before inserting the connector, remove the pin cover from the MR-C3024 and cut away part of the pin cover.



Reattach the pin cover.

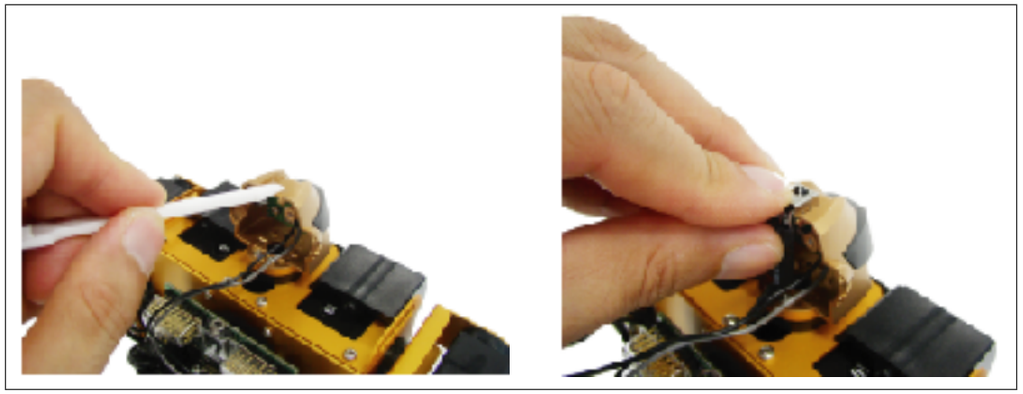


Connect the IR Sensor to the MR-C3024.
The Dark gray wire of the connector must be at the bottom.



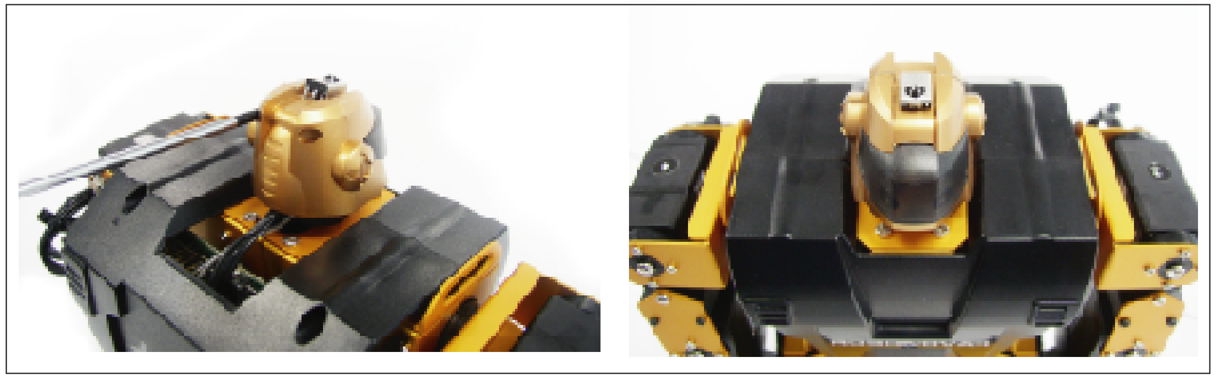
Open the back head cover with removing 2 screws and cut 1 X 8mm(0.04 X 0.3in.) sized rectangular hole on the upper side of front head cover with art knife or file (Refer to photo).

With Epoxy adhesive, apply mix to joint surface (between IR sensor and upper side of front head cover) and assemble parts.
Read "How to use" instruction of Epoxy glue in advance.



After assemble parts, hold together with Tape or Rubber band for 10~15 minutes.

Reattach the back head cover to the front head cover with two PH/T 2X5mm screws. The shape of IR sensor.



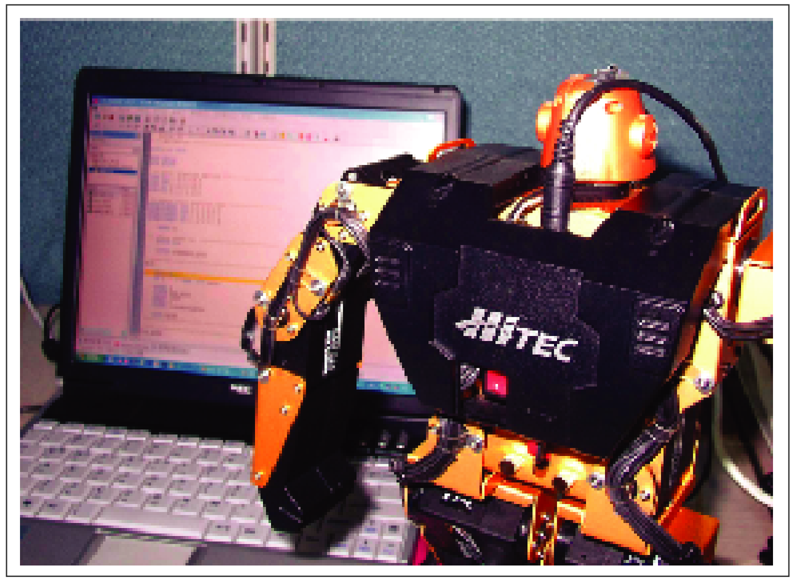
The next step is the remocon programming setup. Open roboBASIC and either create a new file or open action_auto.bas found in the templet folder of the CD.

In the template program find 'A = REMOCON(0) and change it to A = REMOCON(1)

```
'-----------------------------------
MAIN1:
A = REMOCON(1)
A = A - 10
ON A GOTO MAIN,K1,K2,K3,K4,K5,K6,K7,K8,K9,K10,K11,K12,K13,K14,K15,K16,K17,K18,K19,K20
GOTO MAIN1
'
```


ROBONOVA-I

Connect the ROBONOVA-I to a PC with the Serial Interface cable.



Click the "Run All" (integrated execution) button to upload to the controller.

```
' action_LC
'-- Boy motion -----------------------------------

DIM A AS BYTE

PTP SETON
PTP ALLON

'-- motor direction setting ----------------------
DIR G6A,1,0,0,1,0,0
DIR G6B,1,1,1,1,1,1
DIR G6C,0,0,0,0,0,0
DIR G6D,0,1,1,0,1,0

'== motor start position read ====================
GETMOTORSET G6A,1,1,1,1,1,0
GETMOTORSET G6B,1,1,1,0,0,0
GETMOTORSET G6C,1,1,1,0,0,0
GETMOTORSET G6D,1,1,1,1,1,0
```

ROBONOVA-I

11. Final Assembly

A. Install Back Body Cover

Parts required:

			
Robot assembly	HR1C-0002	PH/T-2 2 x 26mm	PH/M 2.6 x 4mm
1 set	1 pc	2 pcs	2 pcs

Place the back body cover over the controller. Make sure that there are no pinched wires. For a proper fit, snap the top of the front cover into the back cover. Install the two PH/T 2 x 26mm screws in the top holes of the cover and tighten. Use the two PH/M 2.6 x 4mm screws to secure the lower body cover to the robot frame.

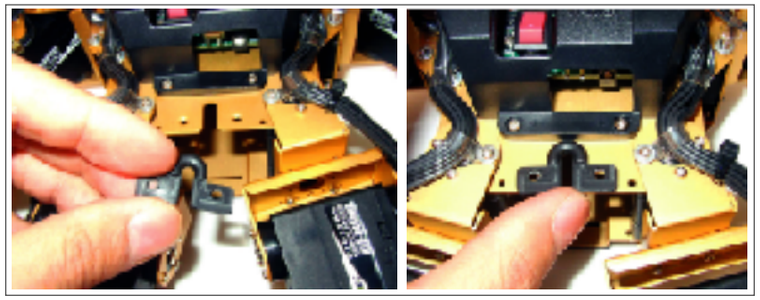
Completed back cover.

B. Battery Installation

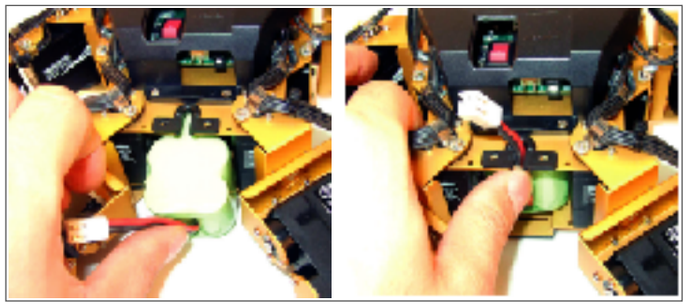
Parts required:

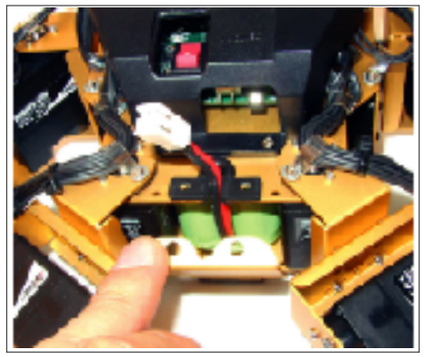
				
Robot Assembly	HR1B-0008	NiMH Battery Pack	Thumb Screw	Battery Wire Protector
1 set	1 pc	1 pack	2 pcs	1 pc

Slide the battery wire protector into place as shown in the pictures.

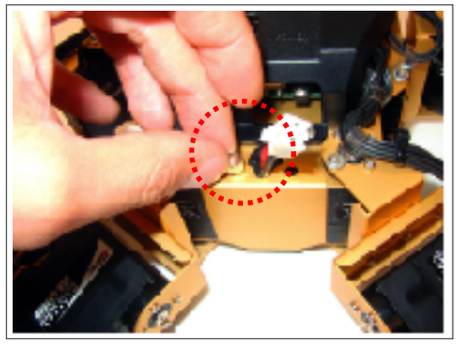


Insert the battery into the bottom of the robot as shown in the picture.



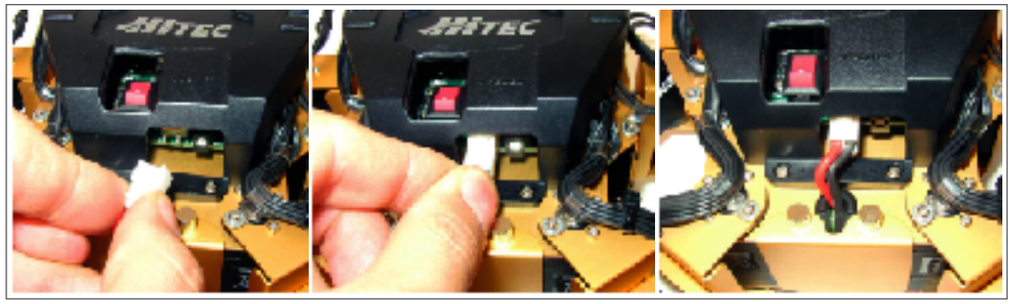


Attach the battery cover plate as shown.



Install the two thumbscrews through the holes in the battery plate to secure it to the robot frame.

Plug the battery into the battery terminal of the controller.



Completed Robonova-1

12. Charging

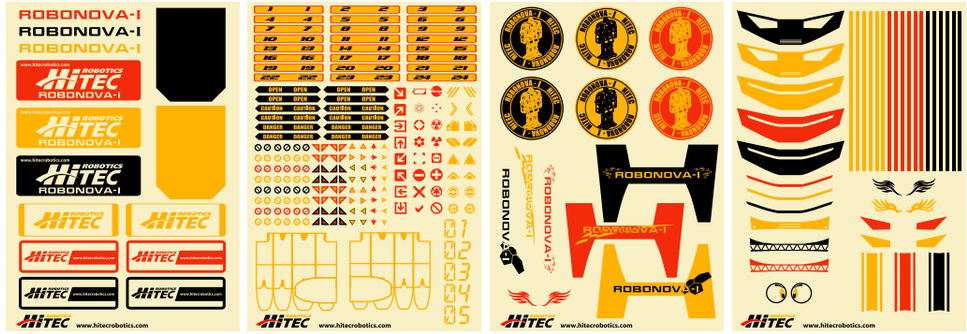
To charge the battery, plug the charger's charge connector into the controller and then into a wall socket.

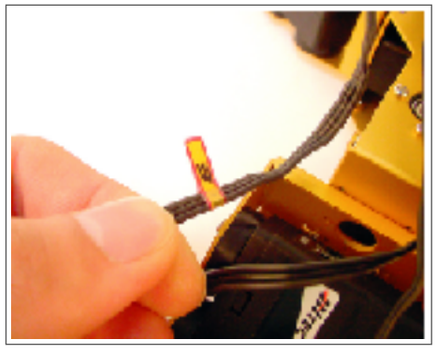
The charger has a red LED indicating that it is charging. When finished (roughly 1 hour) the LED will turn green. At this time it is ok to disconnect the charger from the robot and the wall socket.

******While the charger is plugged into the robot, do not switch the robot on. Running the robot while the charger is connected may result in damage to the controller or servos.******

13. Personalizing

The Robonova-1 kit comes with four different sets of stickers to personalize the robot.





The sticker sets include number stickers that can be used to label each servo cable for quick identification.

V. Quickstart

To get the robot up and running quickly, using the following quickstart guide. This guide will demonstrate how to set the Robonova-1 up for use with the remocon. More in depth details of the software can be found in section VI

1. About RoboBASIC.

RoboBASIC is an educational language based on the BASIC programming language. It is designed to be specifically used with the MR-C family of robot controllers. Through enhancements, it allows for the control and operation of robots.

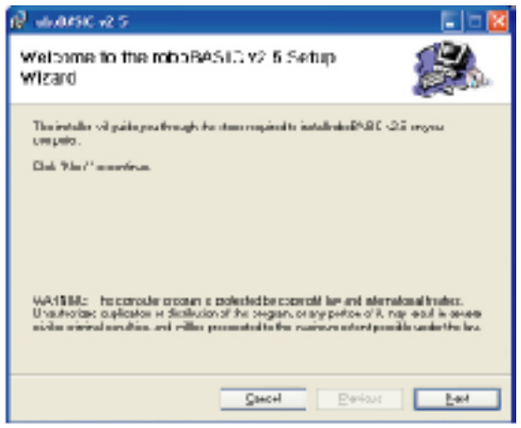
RoboBASIC is compatible with Windows™ 98, ME, 2000 and XP.

The software version on the CD may vary from previous versions. The software, along with the manual may be changed without notice. To obtain the latest version, go to the Hitec Robotics website at www.hitecrobotics.com.

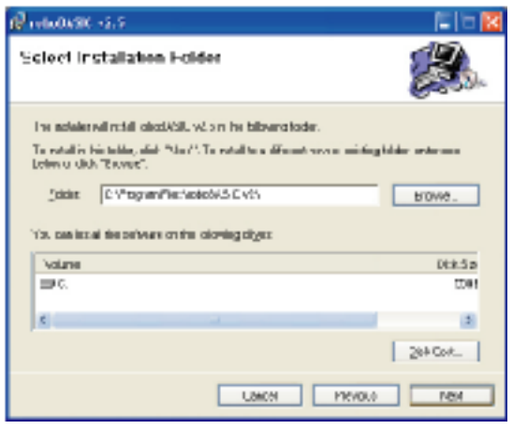
RoboBASIC, RoboSCRIPT, and RoboREMOCON are registered software, making it illegal to reproduce or distribute the software or manual without permission.

2. Installing the software

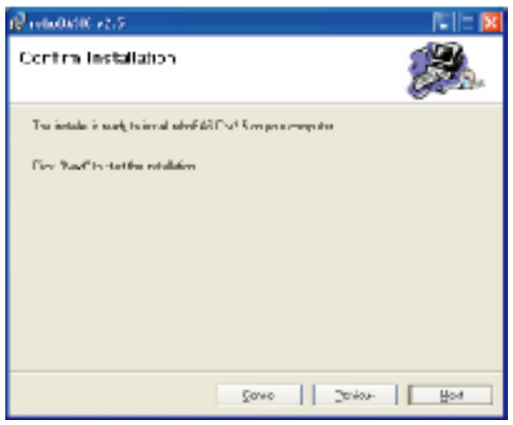
A. Installation Procedure



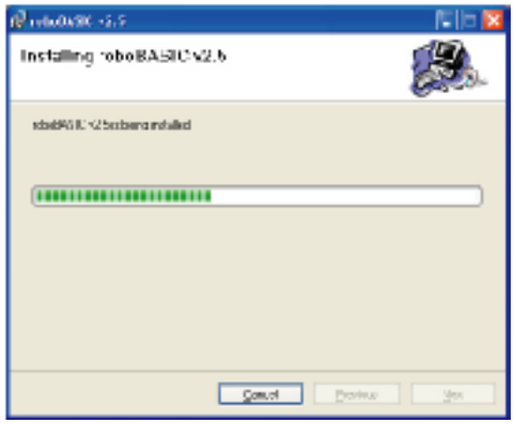
Open the RoboBASIC folder found on the CD. Select the proper language folder and run the "setup.exe" program. When RoboBASIC is installed, the programs RoboREMOCON and RoboSCRIPT will also be installed.



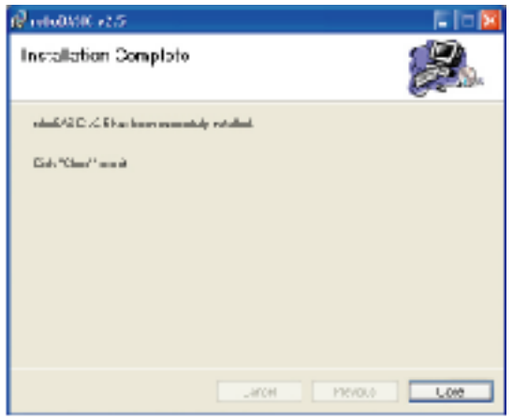
The setup program will ask for a destination folder. Either accept the default destination or create an alternative one. Click the "Next" button to proceed.



Click "Next" to continue the installation or "Cancel" to stop.



The installation progress.

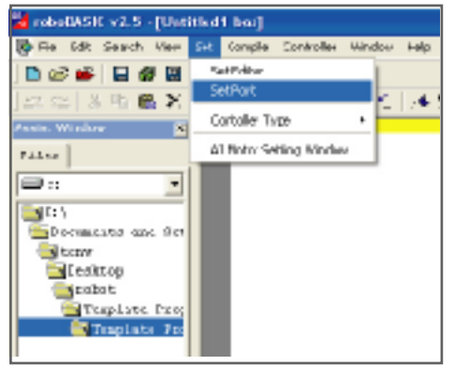


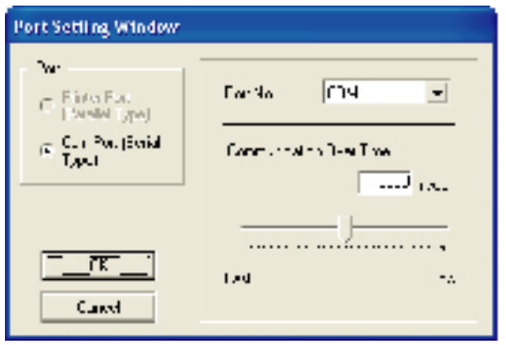
Installation complete. Select "Close" to exit.

B. Setup

After the program has been installed, it is necessary to select the serial port and controller type being used.

Open the RoboBASIC program by either double clicking the desktop icon or selecting it from the start menu. Once open move to "Set" on the menu bar. Select "Set Port".



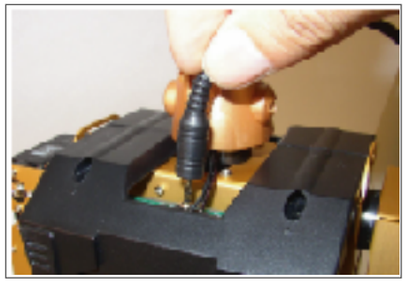


Set the port to the one specified in the Windows™ operating system and click on OK.

3. Upload the Template Program

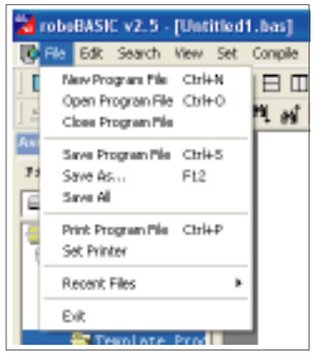
Included on the CD is a program named "Overall_Template_Program.bas". This program contains many routines and commands that allows the robot to be controlled immediately after it is uploaded. The program is located in the "template Program for roboBASIC" folder.

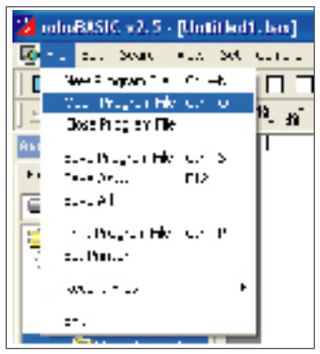
If the CD is not already loaded in the CD drive of the PC, do so now. Attach the 9 pin DIN plug of the included serial cable to the serial port of the PC. Plug the mini jack into the Robonova-1. At this time, do not turn the robot on.



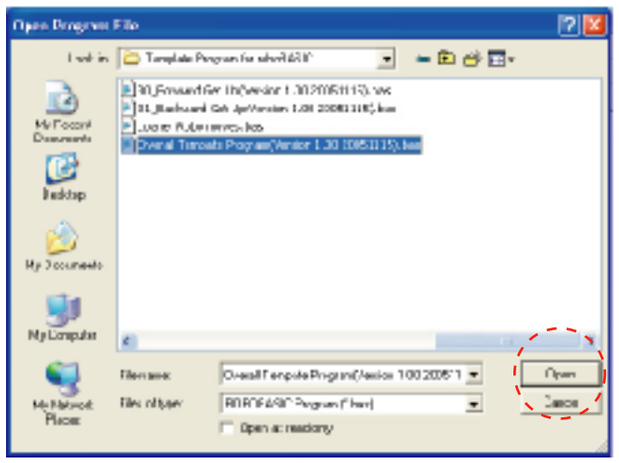
Open RoboBasic by clicking on the desktop icon or selecting Start/All Programs/RoboBASIC.

Select file on the menu bar.



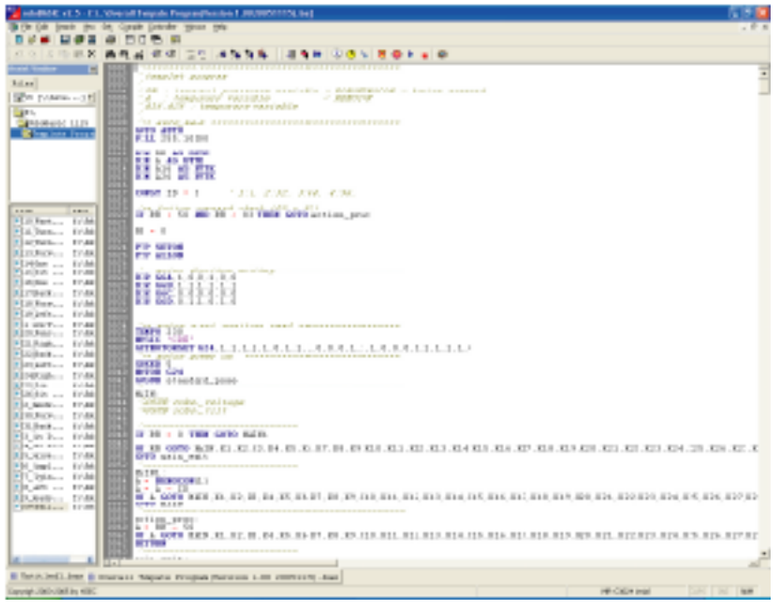


Click on "Open Program File"



In the Open Program File window go to the CD drive and open the "template Program for roboBASIC" folder. In the file list select Overall Template Program.bas and click on the open button.

The template will open in the Editor window.



Run All Button

Place the robot face down on a flat surface and turn it on. When turned on, the robot will play a melody and move to the standard position. The blue head LED will be on indicating that it is receiving power. Click the "Run All" button on the RoboBASIC tool bar.

The Compiling window will open and show the program's compiling status.

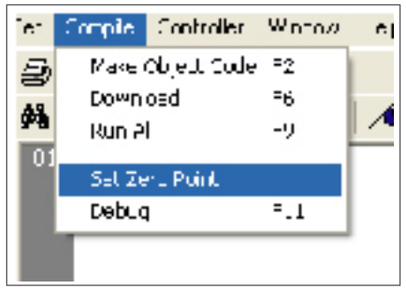
Once compiled, the Download window will appear. Click on the ok button.

The Download window will change to show the status of the upload.
When complete, the Robonova-1 will reboot and play the music.

4. Zero Settings

After the template program has been loaded into the controller of the robot, it might be noticed that some of the servos are slightly out of alignment. To correct this, it is necessary to adjust their zero points settings. The robot must be connected to the serial cable and turned on during this process.

Begin by selecting "Set Zero Point" under the header "Compile" in the menu bar.

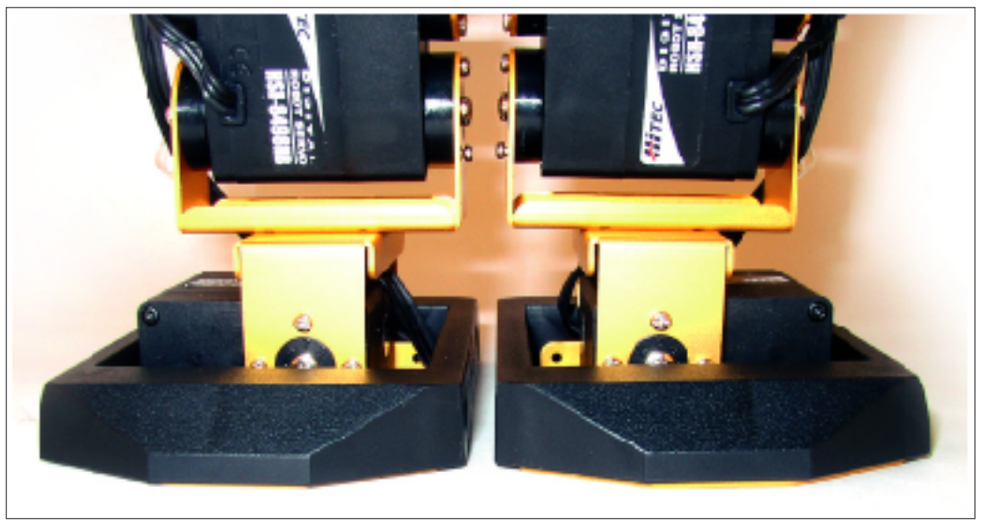


This opens the Robonova Zero Set widow. The window contains a picture of the robot with numbers and arrows near each joint.

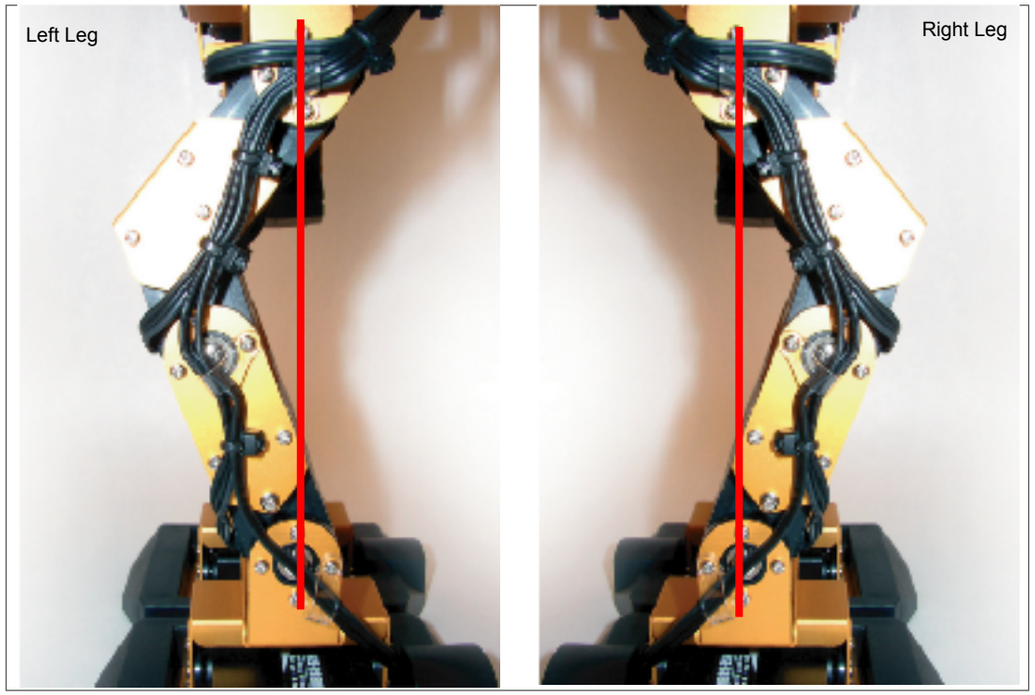
Click on the "Read Settings" button. Be careful when performing this operation because the robot will immediately begin moving to the same position as the one in the window. It is best to lay the robot on its back before clicking on the button. After the robot initializes, stand it up on a flat surface.

The RoboNova-1 is set properly when it matches the following pictures.

The feet should be flat on the surface.

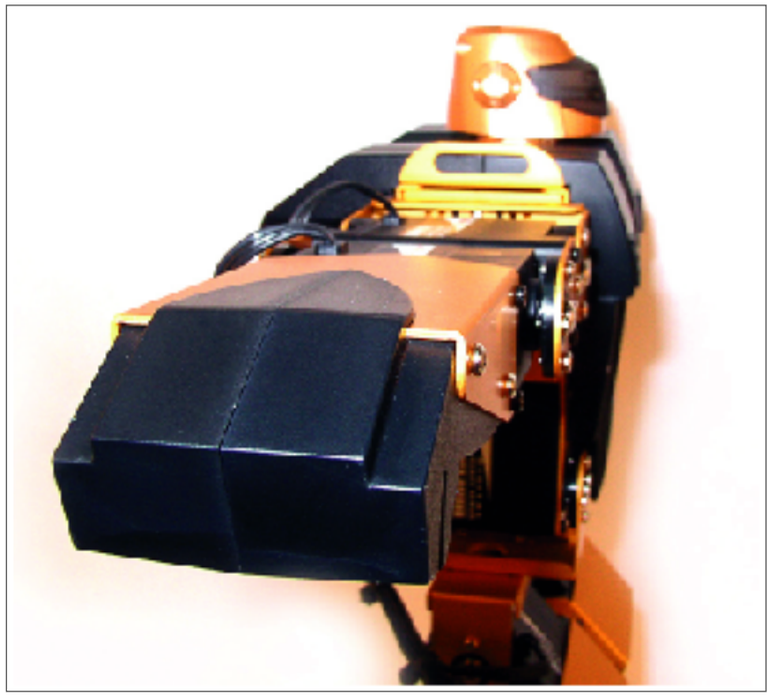


The ankle and hip brackets should be in a straight line.



The legs should be 8mm apart and the hip bracket in line with the body.

The arms should be in a flat horizontal position.



If a servo is no aligned properly, locate it in the Zero Set window and make adjustments using the up or down arrows.

When all the servos are in the correct position, click on the "Write Settings" button. This will install the zero settings into the controller's RAM bypassing the template program. Regardless of any changes to the template or when creating a personal program, the zero settings will be saved.

The progress line gives a visual representation of the upload.

When complete, close the window and turn the robot off then back on. It should now resemble the pictures.

5. Operating the ROBONOVA-1

The kit includes an IR remocon to control the robot remotely(Kit W/Remocon & RTW only).
The template program that was previously loaded contains motions that are assigned to each button of the remocon.
The following table lists the motions and their key assignments.

Key	Motion
Power	On: Motor on ➔ Basic Position / Off: Sitting position ➔ Motor off
1	Bow
2	Raise Arms
3	Sit
4	Sit ➔ Raise Arms
5	Raise Leg
6	Spread Legs ➔ Extend Arms ➔ Right/Left Tilt
7	Flap like a bird
8	Kick
9	Handstand
0	Fast Forward Walk
*	Turn Left
#	Turn Right
▲	Walk Forward
◀	Step Left
■	Sit ←→Stand up
▶	Step Right
▼	Walk Backward
△	Front Tumble
◁	Left Cartwheel
□	Front Punch
▷	Right Cartwheel
▽	Backward Tumble
A	Attack Left
B	Attach Right
C	Left Front Attack
D	Right Front Attack
E	Play 'C' Note (spare)
F	Play 'D' Note (spare)
G	Play 'E' Note (spare)

To get the Robonova-1 to perform a motion, point the remocon at the IR receiver and press the corresponding button.
Range may be affected by ambient light, so it is best not to operate the robot in bright conditions.

ROBONOVA-I

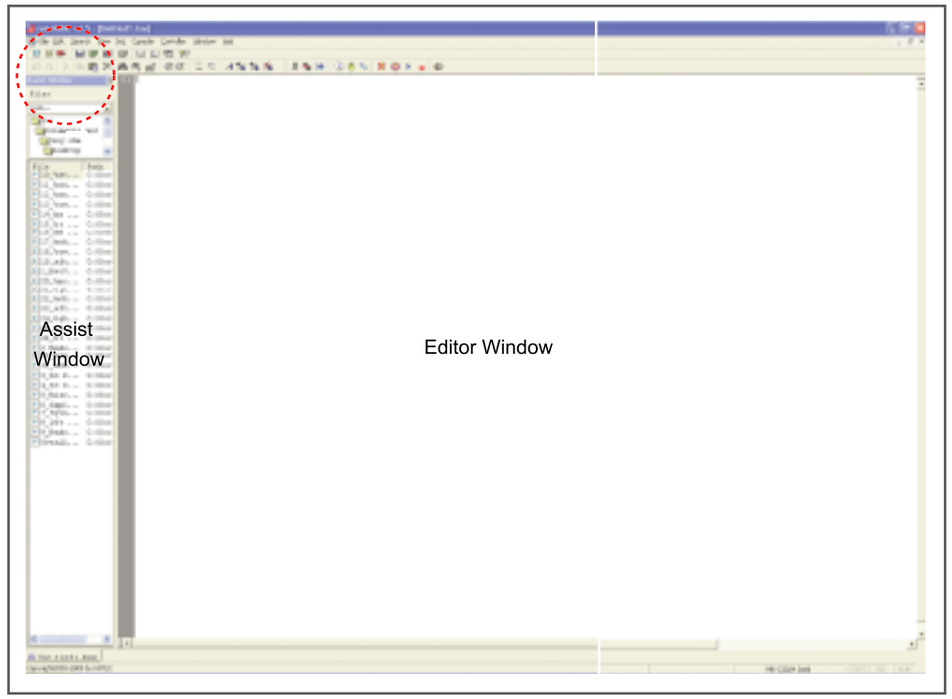
VI. Software Overview

The following sections are designed to provide the beginner with a general understanding of the included software.

1. Operational Overview of RoboBASIC

A. RoboBASIC Windows

When RoboBASIC is opened there are two windows opened by default. One is the Assist Window the other is the Editor Window.
The Assist Window is a PC file directory. Use the directory to locate previously created programs or to open a program from the CD.
Only files with the extension *.bas and *.rsf can be opened and saved. All codes and routines are created and viewed within the Editor Wind



B. Menu and Tool Bars

All operations can be performed by using the menu bar.

The tool bars perform most of the functions of the menu bar. By placing the mouse pointer over a button, its function will be displayed.

ROBONOVA-I

C. Program Creation

All programming takes place within the Editor Window. With RoboBASIC, it is possible to type specific codes for sensors, remote control, and motions. Explanations of all the commands used in RoboBASIC are found on the CD in the "RoboBASIC Command Instruction Manual" folder.

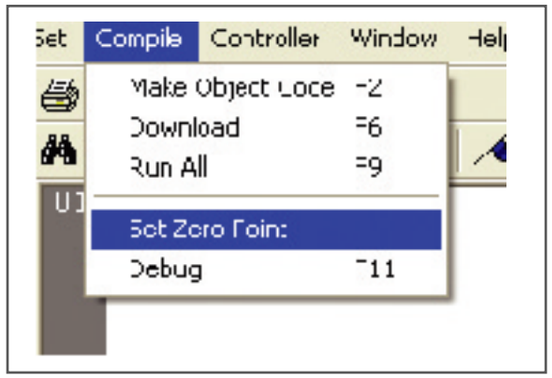
The tools most helpful to beginners with little programming experience are the "Servo Motor Real-Time Control" and "Robonova Motor Control". These tools allow the creation of movements. No programming experience is required.

Template.bas as shown in the Editor window.

1) Servo Motor Real-Time Control

To create a movement with the Servo Motor Real-Time Control window, select it from either the menu bar or the tool bar. Unless the robot is turned on and connected to the serial port this window will not open.

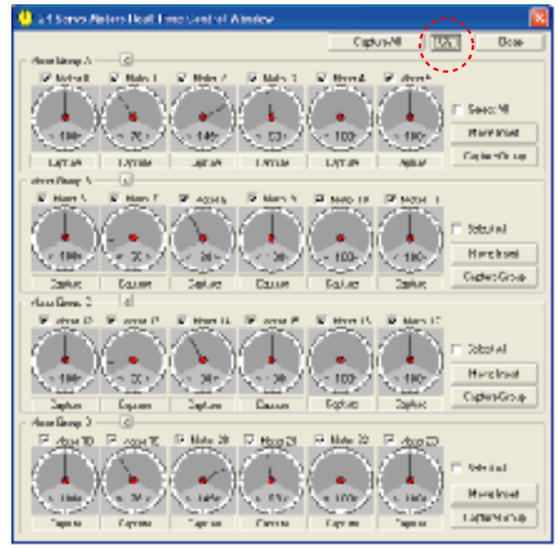
Servo Motor Real-Time Control button.



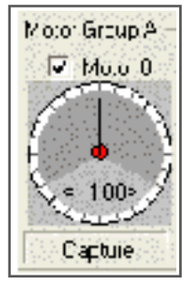
Select from the Menu bar

The Servo Motor Real-Time Control window allows the user to control the servos in the robot with the dials. When opened the window will have either four groups of six dials or three groups of eight dials. To switch between the two, select the grouping button.

Since the Robonova is separated into four motor groups, use the G6 screen.

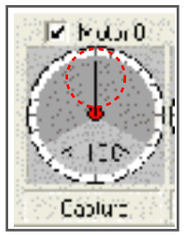


The dials correspond to each servos position on the controller. Each row of dials is a motor group. Each dial has a range from 10~190 representing 180 degrees of servo throw.

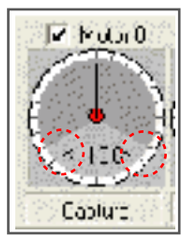


This picture shows Motor 0, which is the servo plugged into the S0 pins of the controller. It is also in motor group A.

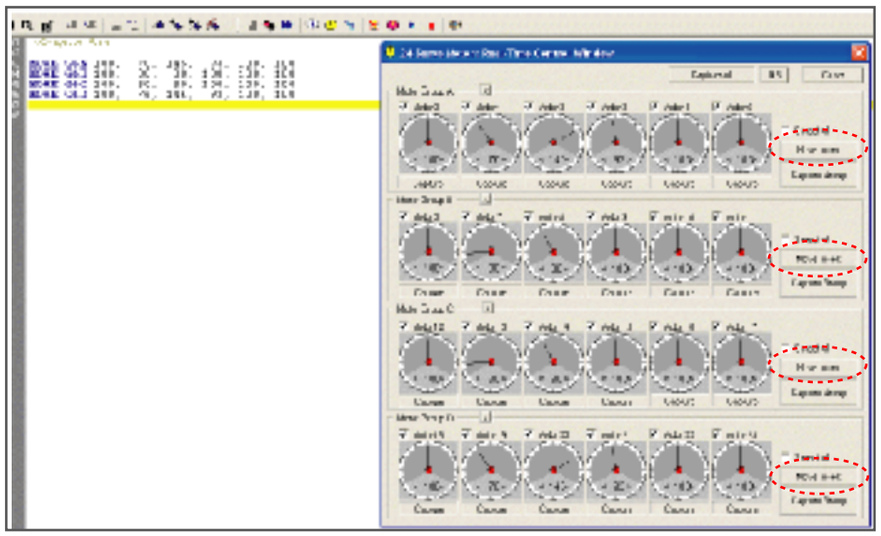
There are a two ways to control the servos directly. The first is to click and hold the left mouse button on the needle of a dial. By moving the mouse left or right the needle will follow, which in turn will move that specific servo.



The second way is to click on the arrows to the right and left of the numeral under the dial.



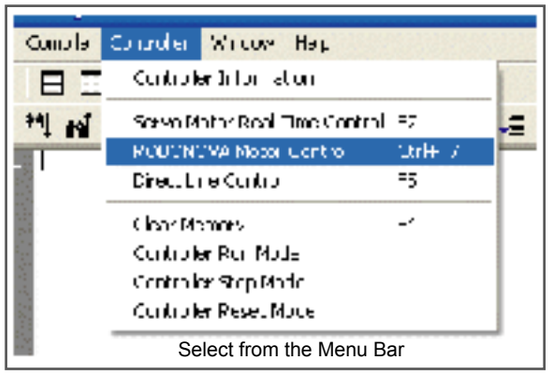
When all dials have been moved to the desired position, click on the "Move Insert" button for each group. This will insert the command **MOVE** with the motor groups position into the editor window. Example: MOVE G6A, 100, 76, 145, 93, 100,100



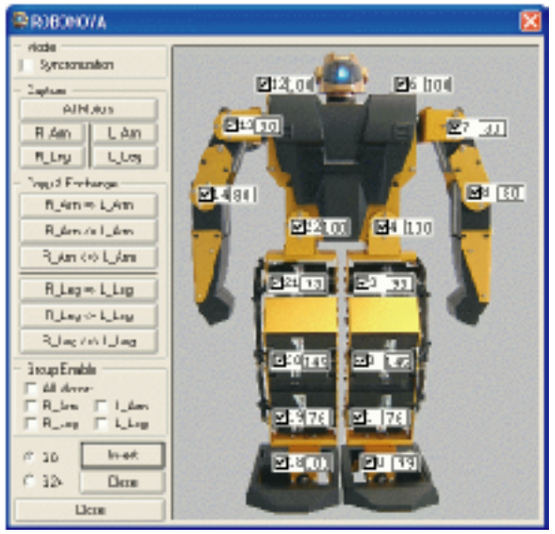
2) Robonova Motor Control

The Robonova Motor Control is specifically designed for use with the Robonova-1 robot. To open the window, select it from the Menu Bar or the tool bar. Unless the robot is turned on and connected to the serial port this window will not open.

Robonova Motor Control Button

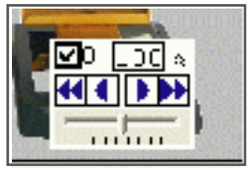


Select from the Menu Bar



The window that pops up has a picture of the robot and buttons to the left of the picture. Each joint of the robot is labeled with the servo number and current position.

By moving the mouse pointer over the joint, a drop down box will appear. Within the box are the controls for moving that servo.



The single arrows move the servo in single increments and the dual in increments of five. The slider below the arrows also moves the servo.

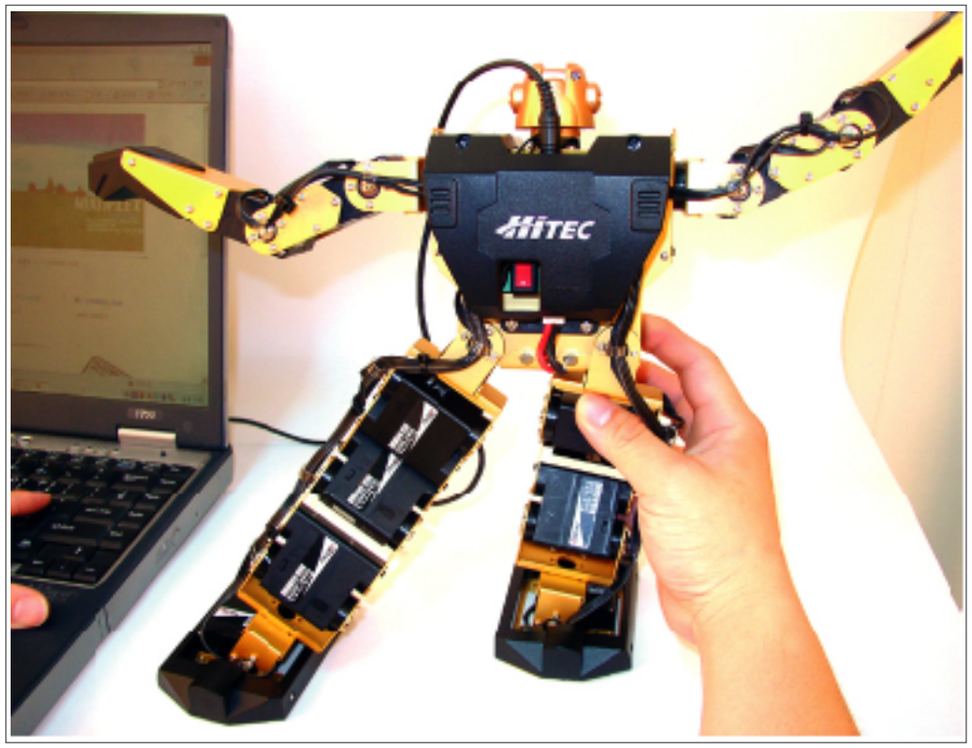
The buttons to the left of the Robonova allow positions to be copied from one arm or leg to the other, enabling or disabling the servos, and capturing the servo positions. The latter two functions will be covered in the next section.

The important buttons at the moment are the ones located at the bottom. These are the MOVE insert and Close buttons. They function in the same manner as the Servo Motor Real Time Control except for some minor differences. To the left of the Insert button are two check boxes. This allows the choice of either inserting the MOVE command in servo groups of six or one twenty-four servo group.

The smaller Close button inserts the WAIT command. This command should be inserted after the Move commands. A further explanation for the command can be found on the CD in the RoboBASIC Command Instruction Manual folder. The larger Close button exits the window.

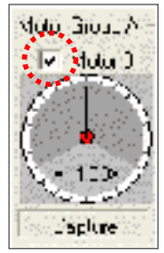
D. Catch and Play

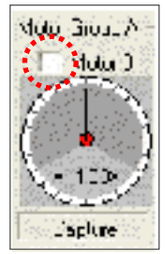
One of the most exciting features of RoboBASIC is "Catch and Play". This function is similar to key framing used in animation. The robot is moved to a position by hand, the position saved and then the robot is moved to the next position. Each position creates a key. When the keys are put together, the in-between movements are automatically added, creating fluid motion.

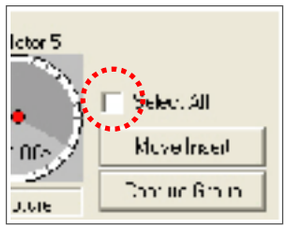


To perform the "Catch and Play" functions, the robot must be connected to the serial adapter and RoboBASIC running. Then either the "Servo Motor Real-Time Control" or the "Robonova Motor Control" window must be opened.

In the "Servo Motor Real-Time Control" window each servo number has a check box next to it. If the box is checked, then the servos are directly controlled by the program. If the box is unchecked, then that particular servo moves freely and can be positioned by hand. Once the box is rechecked, the dial will go directly to the position the servo was moved to.



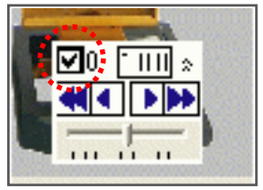




The boxes for an entire servo group can also be checked or unchecked using the "Select All" box.

Once all the servo groups have been moved to the desired position, follow the steps previously mentioned to insert the positions into the editor window.

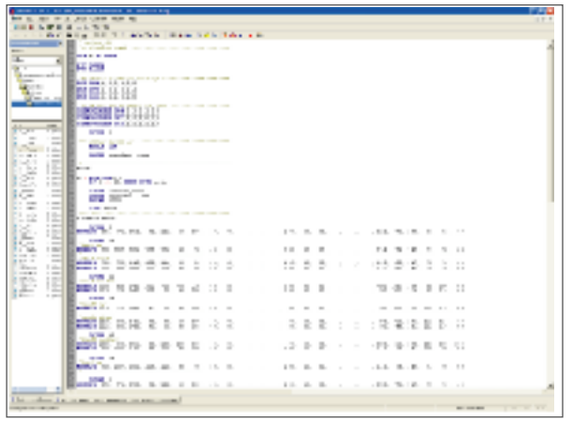
Performing "Catch and Play" in the "Robonova Motor Control" window is very similar. Next to each servo number in the picture are the same check boxes.

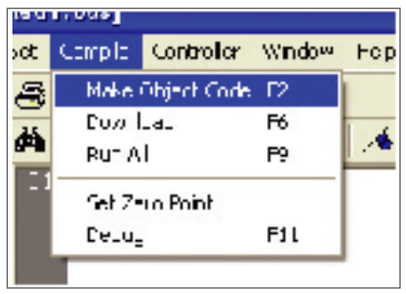


The "Group Enable" functions the same as the "Select All" mentioned before.

E. Uploading a File

Once a routine is finished it is time to upload the program into the controller. To do this the program must first be compiled into object code. Only then can it be uploaded.



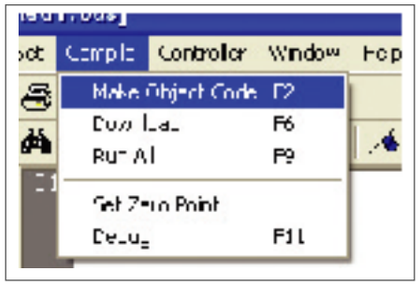


With the program loaded into the Editor window, it can be compiled by selecting "Compile" from the menu bar or by clicking on the "Make Object Code" button.

Compile tool bar button

The program will show the status of the process. If there is an error in the code, RoboBASIC will switch to Debug mode and show the line requiring correction.

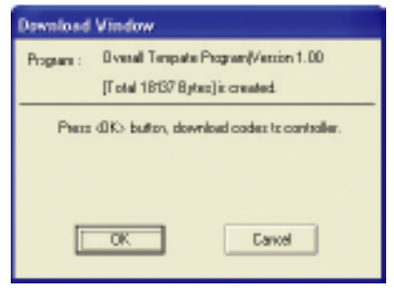
More information on Debugging can be found on the CD in the RoboBASIC Command Instruction Manual folder.

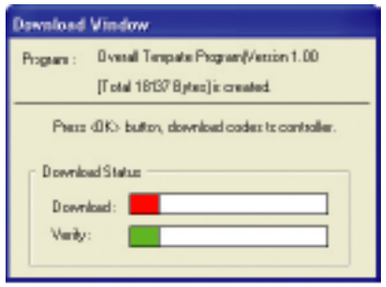


After the program has been compiled, it is time to upload to the controller. This is accomplished by either selecting "Download" from the menu bar header "Compile" or clicking on the "Download" button in the tool bar.

Download tool bar button

Click on OK to continue in the Download window.

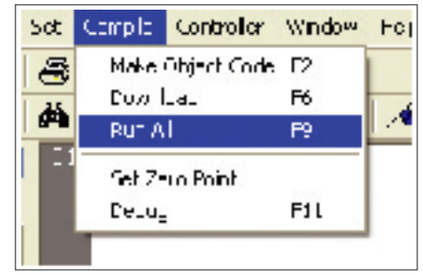




The program will show the progress of the upload.

Both the compiling and upload can be simultaneously started by either clicking on the "Run All" button on the tool bar or selecting this option under the header "Compile" in the menu bar.

Run All tool bar button



F. Further Resources

It is highly recommended that the RoboBASIC Command Instruction Manual found on the CD be reviewed. The Manual will explain all the commands used in RoboBASIC and provide brief examples.

This operational overview section explained in basic terms how to get around and use RoboBASIC. Some functions were not mentioned at all. These functions with more detailed explanations will be found in following sections, but first it is important to become familiar with the two other programs that were installed at the same time as RoboBASIC.

ROBONOVA-I

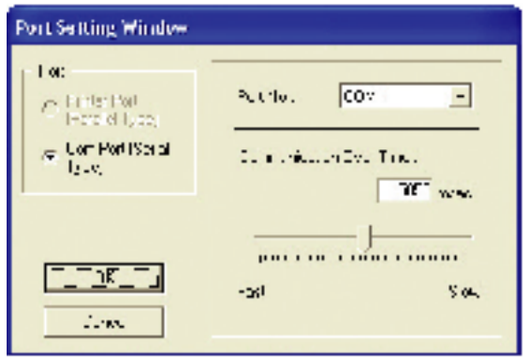
4. RoboSCRIPT

RoboSCRIPT allows routines to be created without any programming experience. Once a motion routine is created, it can be saved and uploaded to the robot controller.

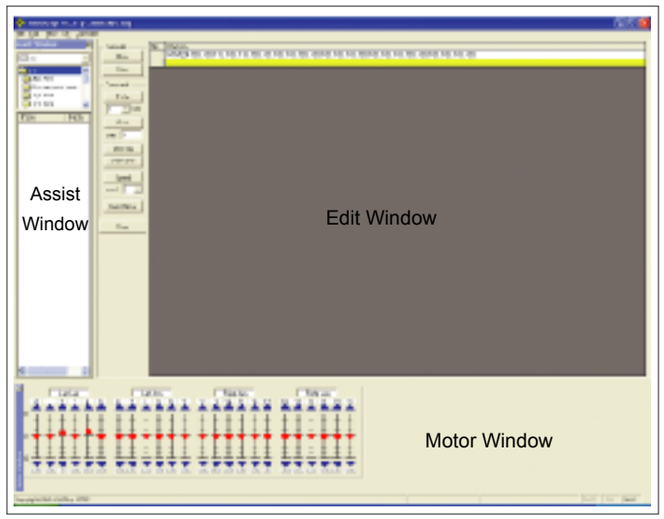
A. Initial Setup

RoboSCRIPT is setup in the same manner as RoboBASIC. On the menu bar, go to the header "Set" and click on "Set Port".

The port setting window is identical to RoboBASIC. Select the COM port currently being used and click OK.



B. RoboSCRIPT Windows



There are three main windows in RoboSCRIPT.

The Assist window is a PC file directory. Use the directory to locate previously created programs or to open a program from the CD. Only files with the extension *.rsf can be opened and saved.

The Motor Window is composed of sliders that directly control the servos. For ease of operation, the sliders are grouped according to their location in the robot.

The Edit window is where motions are saved and basic controls are set.

On the left hand side of the Edit window are command buttons that allow movements to be slightly modified. Detailed explanations of each command are found in the RoboBASIC Command Instruction Manual on the CD.

Run a created script.

Stop a running script.

Add a delay to the script.

Goto a Line.

Turn PTP on or off.

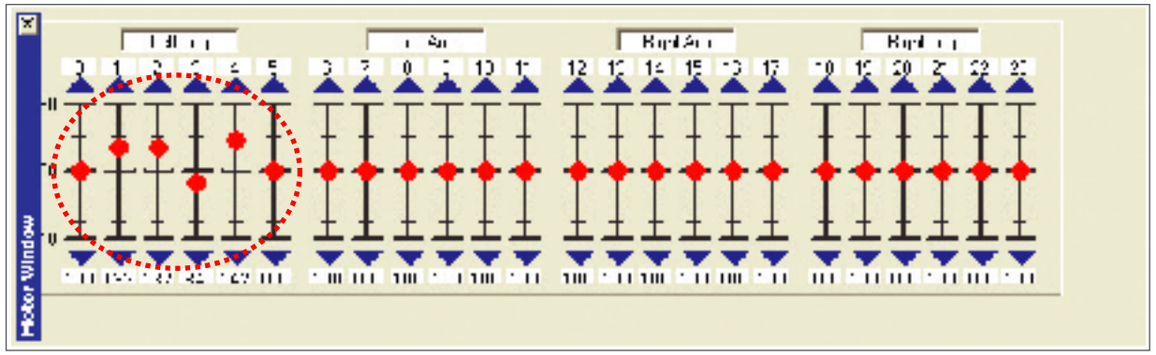
Set the Speed of a movement.

Insert a movement created in the Motor window.

Copy entire script for use in RoboBASIC.

C. Script Creation

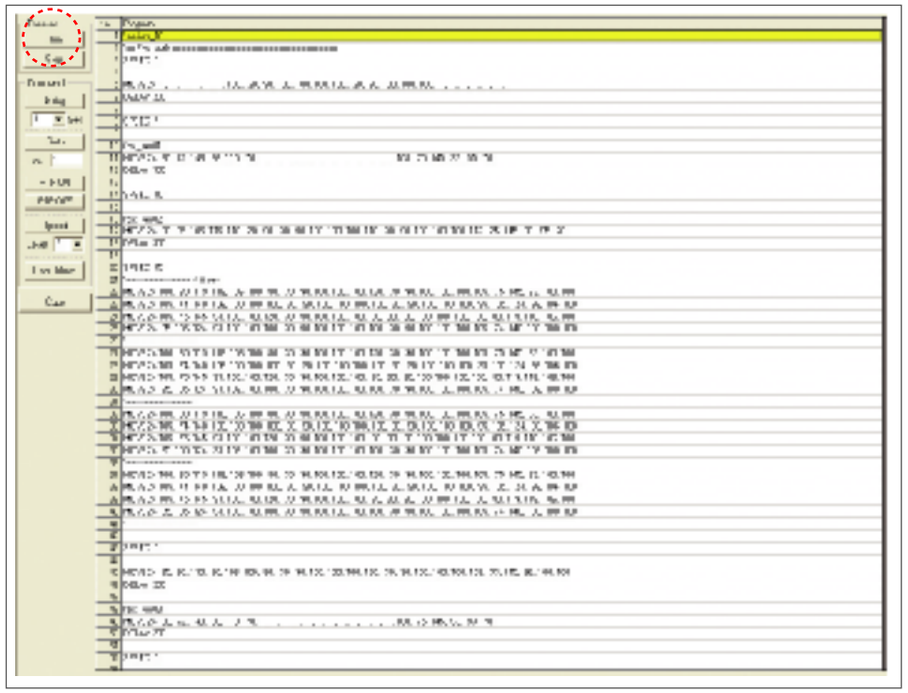
Creating a script for the robot is as simple as moving the sliders for each corresponding servo.



After the servos have been positioned, click on the "Insert Move" button. This will create a new line in the Edit window.

During the creation, delays and servo speeds can be added. For more information on Delay and Speed refer to the CD in the RoboBASIC Command Instruction Manual folder. Continues this process until the entire routine has been created.

To test the routine, click on the "Run" button.



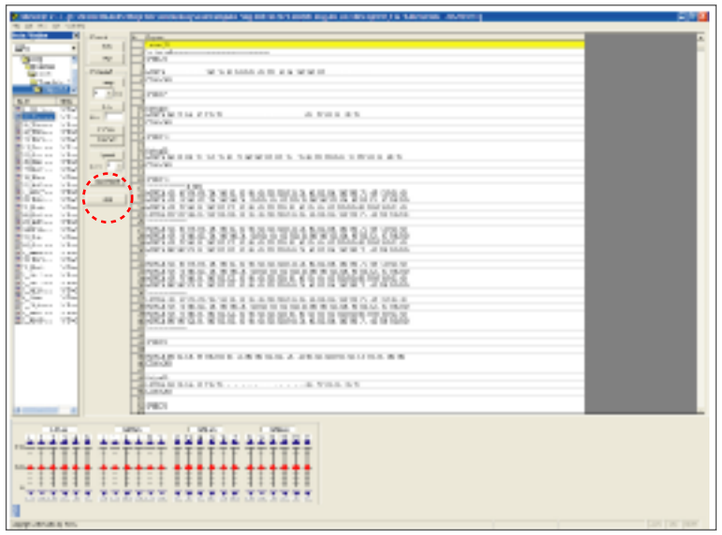
D. Uploading and Saving a Script

To upload an open routine, go to the header "Controller" on the menu bar and select "download". This will install the routine to the controller.

The download window will pop up. Select OK to begin the upload.

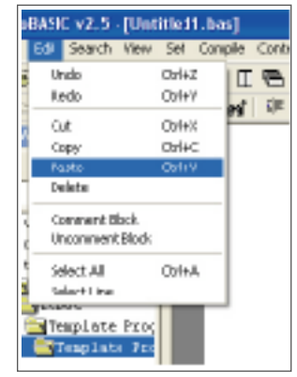
To save a script to disk go to the header "File" on the menu bar and selecting either "Save Program File" or "Save As…".

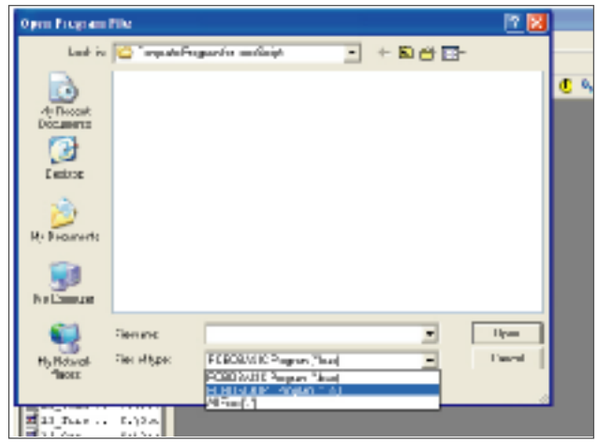
E. Using a RoboSCRIPT File in RoboBASIC



After a routine has been created in RoboSCRIPT, it can be copied and pasted into RoboBASIC. To do this, with the script open, click on the Copy button.

Once copied, it can be pasted into RoboBASIC by going to the "Edit" header on the menu bar and selecting "paste". This will paste the routine into the edit window of RoboBASIC.





It is also possible to open saved script files directly within RoboBASIC with "Open Program File" under the "File" header. Once the window appears, change the file type to "ROBOSCRIPT Program (*.rsf)" and select the file to open.

Before the pasted or opened script can be used in roboBASIC, the following commands must be added:
GETMOTORSET G24,1,1,1,1,1,0,1,1,1,0,0,0,1,1,1,0,0,0,1,1,1,1,1,0
SPEED 5
MOTOR G24

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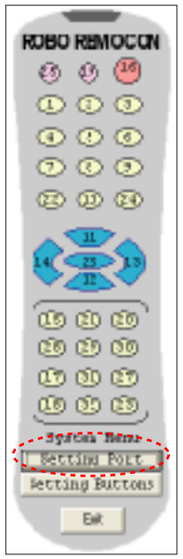
3. RoboREMOCON

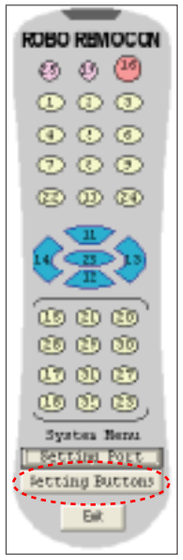
The RoboREMOCON allows direct control of the robot from a PC via the included serial adapter. The buttons correspond to the assigned keys found in the template program previously uploaded. If desired, RoboSCRIPT files can be assign to a particular button instead.



A. Port Setting

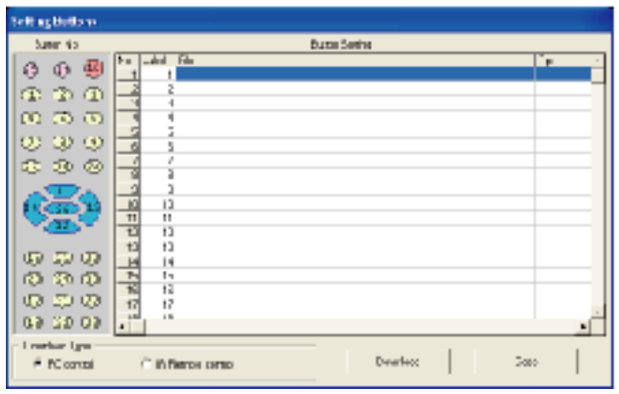
Before the robot can be controller, a COM port must be selected. Click on the "Setting Port" button and the "Port Setting Window" will open. Follow the steps mentioned in previous sections to set the port.

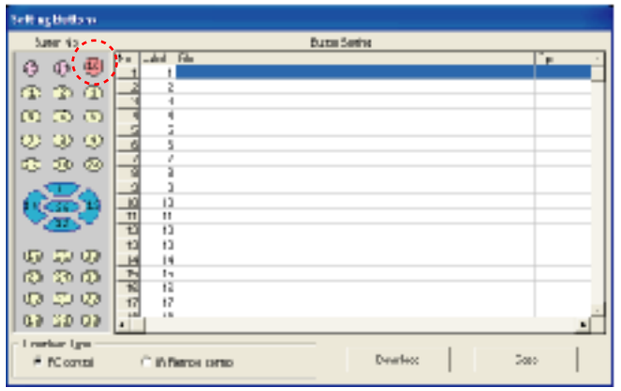
B. Setting Buttons



The RoboREMOCON has 32 different buttons that can be setup to control different routines within the robot. To assign a button to a specific routine, click on the "Setting Buttons" button.

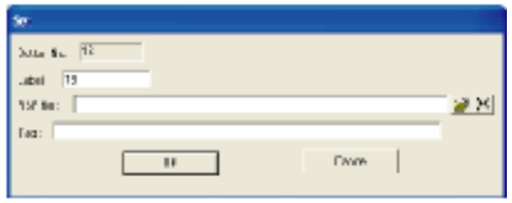
This will open Setting Buttons window. In this window, each button can be assigned a Label, File and brief description.

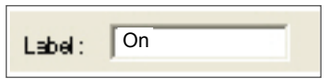




Click on one of the buttons to the left of the window.

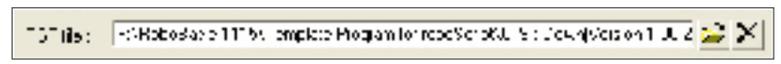
When clicked the "Set" widow will appear.





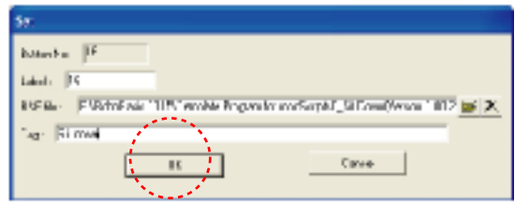
The label changes the button display from the number to whatever is typed in the label box. If the label is too large, only a portion of it will appear. For ease of use, match the label to the remocon. For example: The #16 button on the remocon is the power button. So it could be called "On".

In the RSF file box, select the routine that the button will control. Only files with the *.rsf extension can be used.



In the Tag box, a description can be added if so desired. This will create a pop-up box when the mouse pointer is moved over a button.

When finished, click on the OK button to close.



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C. Uploading to the Controller

After RoboREMOCON has been set up, the instructions can be uploaded to the controller.

In the Setting Buttons window, two download types are listed. Select PC control if the robot is to be controlled directly via RoboREMOCON from a PC. For this to work, the robot must be connected to the serial cable.

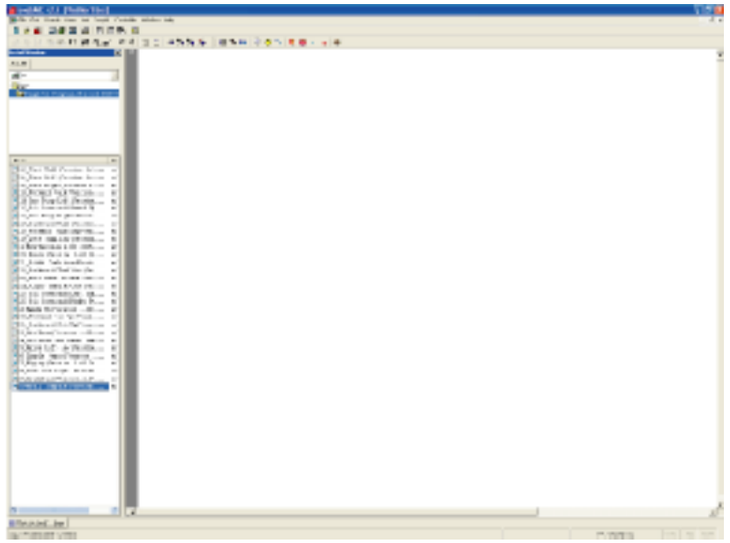
If the Hitec remocon is being used, select "IR Remote control".

Click on the "Download" button to upload to the controller.

VII. Programming the ROBONOVA-1

1. Template Program

Included on the CD is a file called the "overall_template_program.bas". This file contains many factory set routines and commands that can be used immediately after it is uploaded to the controller without any extra programming required. The file is found on the CD in the "Template Program for roboBASIC" folder.



A. Overview of the Template Program

The program is broken into different sections for ease of use. The sections are the basic program commands, Main, and the motion routines. Only general explanations will be given here, further details are found in the RoboBASIC Command Instruction Manual found on the CD.

1) Commands, Varibles and Constants

This section contains the commands necessary for the robot to operate properly.

GOTO AUTO

This command tells the controller to move to the template program

DIM declarations

These declarations set the variables used within the program.

CONST ID

This is the ID assigned to the Robonova-1 and is used in conjunction with the REMOCON command found in the Main1 subroutine.

It is possible to have four Robonovas and remocons in use at the same time. To do this each is given a separate ID, between 1 and 4, so they do not interfere with each other. To change the Robot ID, use the code in the table.

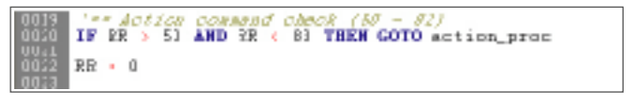
CONST_ID	Remocon
0	1
32	2
64	3
96	4

The remocon must also be set to the right ID. To change the ID in the remocon, press the P1 button and the correct ID number (1 ~ 4) and hold for two seconds.

Example, CONST_ID = 32 will work with a remocon set to channel 2.

IF…THEN, RR variable

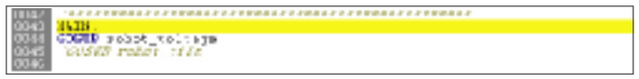
These lines are for use with RoboREMOCON. If the serial adapter is attached to the robot, the robot turned on, and RoboRemocon is open on the PC, it is possible to control the robot directly from the PC.



There is no need to setup RoboREMOCON first. It will operate in the same manner as the remocon.

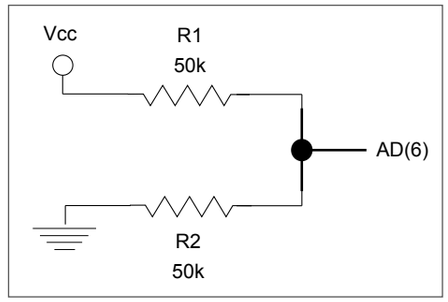
PTP, DIR, GETMOTORSET, and MOTOR
These commands set controls for the servos in the robot. Refer to the RoboBASIC Command Instruction Manual found on the CD for more information on their usage.

2) MAIN
The MAIN routine controls the flow of the program.



GOSUB robot_voltage
This line tells the program to go to the subroutine robot_voltage. This subroutine is a low voltage warning.

To use the routine, a special circuit must be made and installed into the AD(6) port. Here is the circuit schematic.



The routine will make the LED in the head blink when the voltage of the battery pack drops below 5.8V.
This is found in the line:
IF A < 148 THEN
The number 148 indicates the voltage.

To change this value, follow this equation:
Value = voltage * 256 / 10

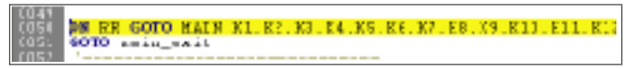
For example to change the value so the light blinks when the voltage is below 6.0V the equation would be:
Value = 6 * 256/10 or Value = 153.6
Since RoboBASIC cannot calculate decimal points use: value = 153

If this subroutine will not be used, remark the line out by placing an apostrophe before the call to the subroutine in MAIN.

GOSUB robot_tilt
If a tilt sensor is attached to the AD(5) port of the controller, this subroutine will allow it to stand back up after it has fallen. If not used, remark this line out.

IF RR
If RoboREMOCON is not found, the program will jump to MAIN1 so the standard handheld remocon can be used instead.

ON RR
If the RoboREMOCON is found, then it will control the robot. Each button is assigned to a motion found in the program and is represented by K1 ~ K32. A breakdown of the routines each button controls can be found on the table below.



RoboREMOCON and the remocon use the same key assignments.

Action	Key	Motion	Vairable	Code
0	Power	On: Motor on ➜ Basic Position / Off: Sitting position ➜ Motor off	A16	16
1	1	Bow		1
2	2	Raise Arms		2
3	3	Sit		3
4	4	Sit ➜ Raise Arms		4
5	5	Raise Leg		5
6	6	Spread Legs ➜ Extend Arms ➜ Right/Left Tilt		6
7	7	Flap like a bird		7
8	8	Kick		8
9	9	Handstand		9
10	0	Fast Forward Walk		10
11	*	Turn Left		22
12	#	Turn Right		24
13	▲	Walk Forward		11
14	◀	Step Left		14
15	➜	Sit ←→Stand up	A26	26
16	▶	Step Right		13
17	▼	Walk Backward		12
18	△	Front Tumble		21
19	◁	Left Cartwheel		28
20	↑	Front Punch		29
21	▷	Right Cartwheel		30
22	▽	Backward Tumble		31
23	A	Attack Left		15
24	B	Attach Right		20
25	C	Left Front Attack		17
26	D	Right Front Attack		27
27	E	Play 'C' Note (spare)		18
28	F	Play 'D' Note (spare)		23
29	G	Play 'E' Note (spare)		32

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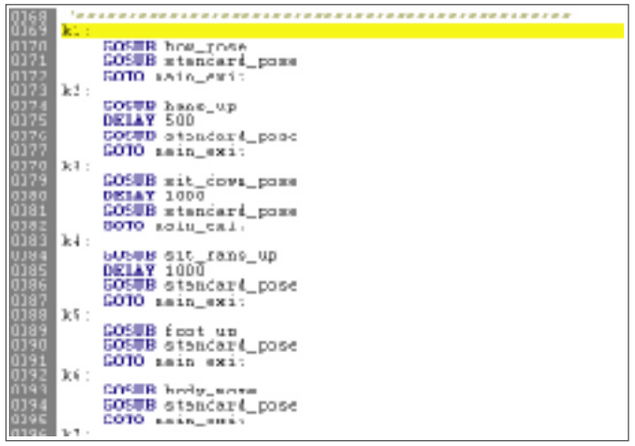
3) MAIN1

MAIN1 sets the controls for the hand held remocon. If the RoboREMOCON program is not detected then the subroutine MAIN1 sets the controls for the robot. Within the routine is the command REMOCON that is discussed in more detail in the RoboBASIC Command Instruction Manual found on the CD.

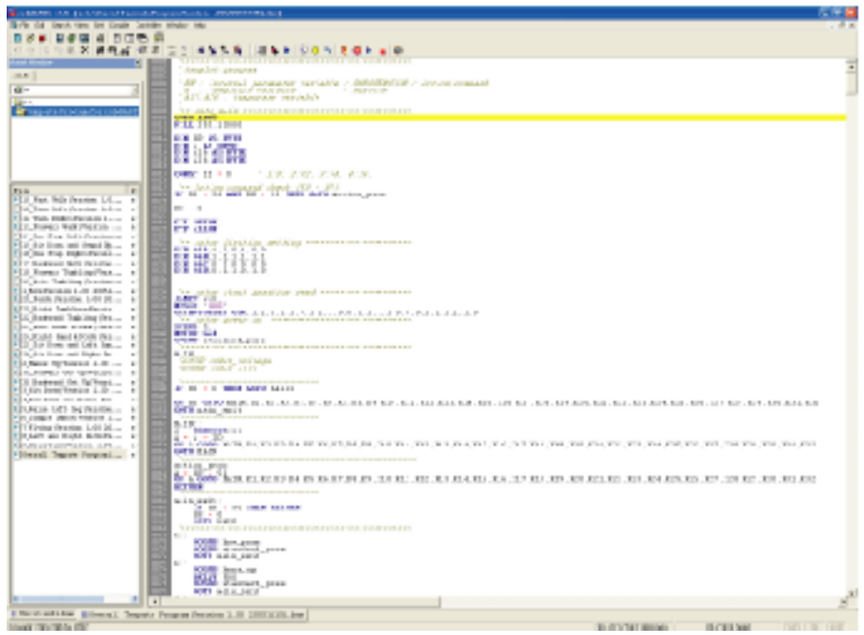
4) Key Assignments and Motions

The remainder of the program relates to individual motions and the key assignments of the remocon.

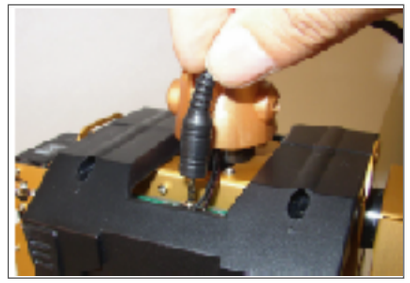


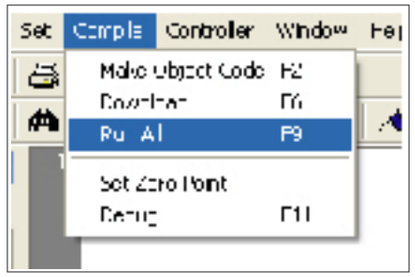
B. Upload the Template Program

Start RoboBASIC and open the template program.



Connect the RoboNova-1 to the serial adapter and make sure it is turned on.

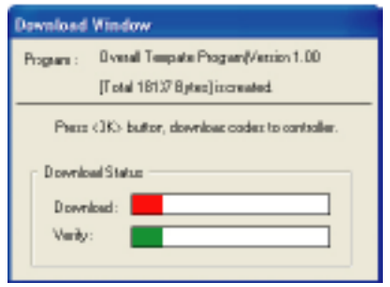




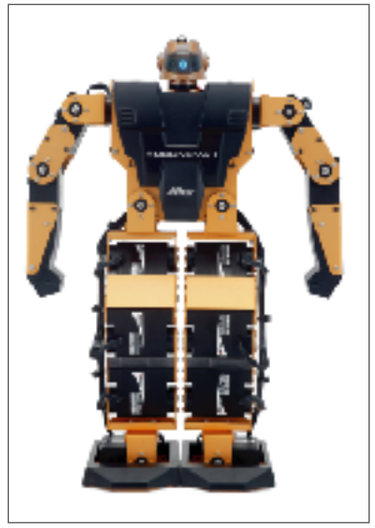
Click on "Run All" from the menu bar or the button in the tool bar.

"Run All" tool bar button

Once the program has been compiled, select ok on the Download window and the template program will upload into the controller.



Once the upload is complete, the robot will play music and move to the standard pose.



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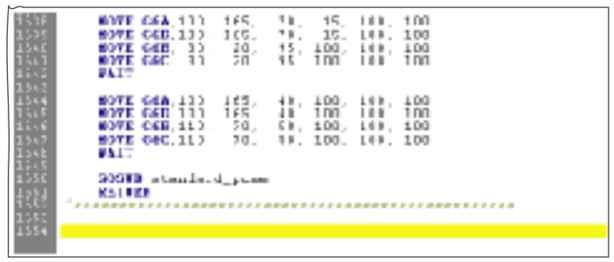
2. Adding Routines and Sensors

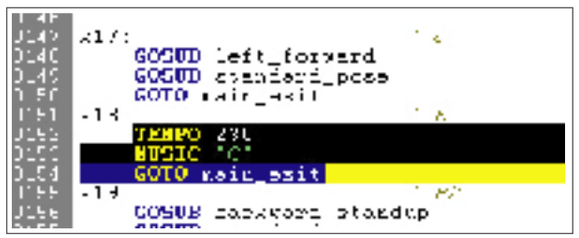
A. Create a Simple Routine

This section will show how easy it is to create new subroutines and add them to a remocon key.

Open the template program in RoboBASIC. Scroll to the last line in the program and create a new subroutine.

```
LED_toggle:
OUT 52,1
DELAY 1000
OUT 52,0
DELAY 1000
```

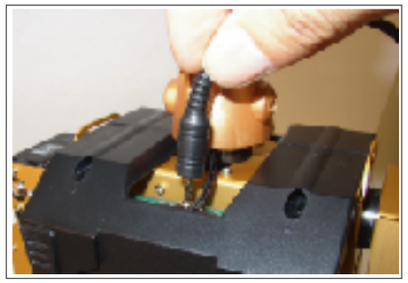


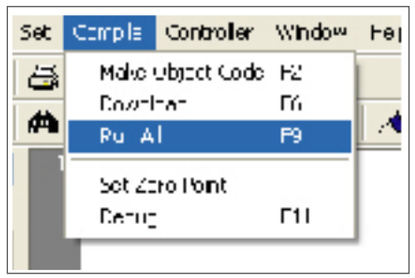


Add the new subroutine to Key 18 of the remocon. To do this, scroll to K18 in the template program and change it to:

K18:
GOSUB LED_toggle
GOTO main_exit

Connect the robot to the serial adapter and turn it on.





Either click the "RUN ALL" button on the tool bar or select it from the header "Compile" in the menu bar.

Run All tool bar button

After the program has been uploaded to the controller, pressing the "E" button (Key 18) of the remocon will cause the LED in the head to blink twice.

B. Adding a Gyro

Up to four gyros can be used at one time in the RoboNova-1 to increase stability. The gyros are plugged into two separate AD ports, one for input, and one for output. The RoboBASIC commands for the gyros are, GYRODIR (which direction the servos will turn), GYROSET (which servos respond to the specific gyro), and GYROSENSE (servo sensitivity to the gyro). The specifics of these commands will not be covered here but can be found in the RoboBASIC Command Instruction Manual found on the CD.

Most single rate piezo gyros with gain adjustment can be used with the RoboNova-1.

Connection to the controller involves two AD ports. As an example, gyro #1 is connected to AD(0) and AD(4) ports of the controller. Connect the input from the controller to the gyro in AD(0) and the output from the gyro to controller in AD(4).

There are four gyro ports.
Gyro port #1: AD(0), AD(4)
Gyro port #2: AD(1), AD(5)
Gyro port #3: AD(2), AD(6)
Gyro port #4: AD(3), AD(7)

Here is an example of the code for a gyro:

```
GYROSET G6A, 0,1,1,1,0,0        'servos 2, 3,and 4 in motor group A are controlled by Gyro #1
GYROSET G6D, 0,1,1,1,0,0        'servos 2,3,and 4 in motor group D are controlled by Gyro #1

GYRODIR G6A, 0,0,0,0,0,0        'servos in motor group A will turn in their normal directions
GYRODIR G6D, 0,0,0,0,0,0        'servos in motor group D will turn in their normal directions

GYROSENSE G6A, 0,250,250,250,0,0,0   'servos 2, 3, and 4 in motor group A  are set to their highest sensitivity
GYROSENSE G6D, 0,250,250,250,0,0,0   'servos 2, 3, and 4 in motor group D  are set to their highest sensitivity
```

C. I2C

The MR-C3024 controller board has the ability to communicate via the I2C serial protocol with the SDA and SDL pins.

The following is an example of the code.

```
CONST SCL = 22
CONST SDA = 23

DIM A AS BYTE
DIM I AS BYTE
DIM CODE AS BYTE

'============================
I2C_SAMPLE:
'============================
A = IN(SDA)
S1: OUT SCL,0
 OUT SCL,1
'============================
S3: OUT SDA,0
 OUT SCL,0
 OUT SCL,1
'============================
OUT SDA, 1
OUT SCL, 0
OUT SCL, 1

OUT SDA, 0
OUT SCL, 0
OUT SCL, 1

OUT SDA, 0
OUT SCL, 0
OUT SCL, 1

OUT SDA, 1
OUT SCL, 0
OUT SCL, 1
'============================
CODE = 0
FOR I = 0 TO 7
OUT SCL, 0
OUT SCL, 1
A = IN(SDA)
A = A<<I
CODE = CODE OR A
NEXT I
'============================
RETURN
```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VIII. HMI Protocol

The HMI Protocol (Hitec Multi-protocol Interface) is a newly created interface for the HITEC programmable robot servos.
(For more detailed programming of the servos, an optional settings kit is required.)

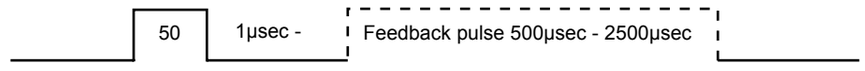
*The following information can be of use to high-end users as it concerns the pulse data. This pulse data is required for location (angle) feedback between HITEC robotic servos and a PC.

The servos will execute a specified movement when four kinds of pulses are inputted from an outside source.

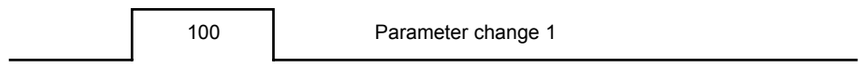
- 1) 50usec pulse width / Location (angle) value feedback
- 2) 100usec pulse width / Use servo parameter 1 value (default)
- 3) 150usec pulse width / Use servo parameter 2 value
- 4) 200usec pulse width / Use servo parameter 3 value

Note: To use the location (angle) feedback with an external circuit, the control signal terminal must have bidirectional functions. To read the feedback value, a pull-up process must be performed in the signal line.

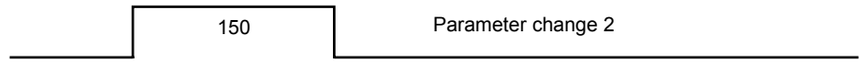
Control signal 50μsec



Control signal 100μsec



Control signal 150μsec



Control signal 200μsec

Note: Since this function is used in conjunction with the PWM control, there is a 10% error rate.

IX. Troubleshooting

1. Unable to connect to RoboBASIC:
If when connecting the robot via the serial cable to RoboBASIC and an error code 0 or 4 appears, check these items.
   1. The robot is turned on and the serial cable is connected to it and the serial port of the PC.
   2. That roboBASIC is set to the correct COM port. To do this, open the Windows Device Manager and locate the COM port settings.
   3. Make sure that the battery is fully charged.
   4. If an after markets USB to serial interface is being used, check with the manufacturer for proper installation.

If these steps do not solve the problem, contact Hitec Robotics for assistance.

2. Servos are not moving in the right direction.
If one or more servos are moving in the wrong direction, double check the splined horn alignment and that the correct servo is installed in the corresponding joint. The servo placement chart will assist in this.

3. Servo is overheating.
If excess heat is felt from one servo, turn the robot off immediately.

Check the splined horn alignment. If it is incorrect, adjust it so it matches the correct position according to the assembly instructions. Also check that the joint is moving freely and not straining against a bracket or wiring.

If the problem persists, contact Hitec Robotics for assistance.

4. Head LED is constantly blinking.
Reload the overall_template_program.bas with the line GOSUB robot_voltage remarked out.

In order to use this subroutine, a special circuit must be installed in the robot. A previous section shows the circuit and installation.

5. The remocon does not communicate with the robot.
The remocon and the RoboNova have the ability to be programmed with four different IDs. Make sure the ID of the remocon matches the one programmed into the RoboNova. If the robot is being used under bright lights, the lighting will interfere with the IR receiver.

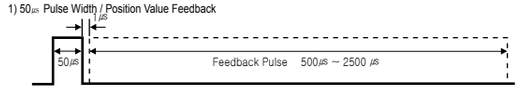
6. How do I connect a sensor.
There are many after market sensors available online. The RoboBASIC command manual should be the first place to look when installing and using different sensors.

Another valuable resource is the online community. The Hitec Robotics forum is a place where individuals can post their questions and share their knowledge. As well as our forum, many private forums deal with the RoboNova-1.

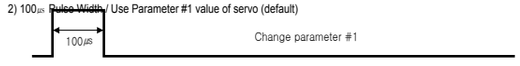
HMI (Hitec Multi-protocol Interface) provides you with an interface to program the HITEC Robot Servos.
This information is only available for HITEC Robot Servos with firmware versions 1.10 or above.
(To program all the features of the Robot Servos, an optional kit is required.)

1. HMI Protocol Pulse
In this section, the structure of the HMI Protocol Pulse is described for advanced users wishing to know the exact positions of HITEC Robot Servos connected to a PC.
Users can get the Feedback Data from servos using a Micom that is programmed to output 4 types of pulses to the servo and to receive a feedback pulses from the servo through the signal wire of the servos.

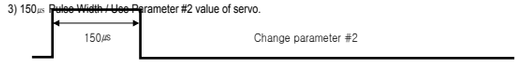
1) 50㎲ Pulse Width / Position Value Feedback



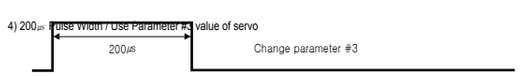
2) 100㎲ Pulse Width / Use Parameter #1 value of servo (default)



3) 150㎲ Pulse Width / Use Parameter #2 value of servo.



4) 200㎲ Pulse Width / Use Parameter #3 value of servo



■ Parameter #1: Default
■ Parameter #2 and #3: Reserved Parameter. It is possible to setup parameter #2 and #3 with the HMI Servo Programmer Kit (optional item). To set the servos operating characteristics during operation, a user will have to create a custom program using the open source code found at http://www.hitecrobotics.com.

Note1: To get position feedback using an external circuit, the communication port of the controller must be bi-directional, and the signal terminal should be setup in a Pull-Up state.
Note2: Because the positional feedback mentioned in note 1 operates in conjunction with the PWM control function, there is a chance that a communication error will occur 10% of the time.

2. Parameters that can be set using the HMI Servo Programmer kit

■ D-gain Parameter
■ Dead Zone Parameter
■ P-gain Parameter

3. PC to Servo Serial Interface

■ Through the serial port of a PC, HMI can control up to 127 HITEC Robot Servos (which are programmable with HMI) directly without any interconnection devices.

■ The number of servos that can be controlled through the serial port is dependent on the PC environment and interface (especially on the signal level of the serial port).

■ In the case of Voltage/Current Feedback, the value is presented as an integer (0~256), so users will have to convert the integer to make sense of it as a physical value.

1) B_Version : Verifying ID and Version <- Feedback the ID and Version of the Servo

B_Version	80	E7	0	0	version	ID

>> Packet Command

HEADER□	Command□	Data1□	Data2□	CHKSUM□	Receive[0x00]□	Receive[0x00]
□1byte□	1byte□	1byte□	1byte□	1byte□	1byte□	1byte

- header = 0x80 (packet start)
- command = 0xE7
- data1 = 0x00
- data2 = 0x00
- check = header + command + data1 + data2
- NULL = 0x00
- NULL = 0x00

>> Packet Receive

Recieve[Data1]□	Receive[Data2]
1byte□	1byte

- data1 = version <-version feedback
- data2 = ID <-ID feedback

B_Version	80	E8	0	0	current	voltage

2) B_Battery : Verifying Voltage and Current.

>> Packet Command

HEADER□	Command□	Data1□	Data2□	CHKSUM□	Receive[0x00]□	Receive[0x00]
□1byte□	1byte□	1byte□	1byte□	1byte□	1byte□	1byte

- header = 0x80(packet start)
- command = 0xE8
- data1 = 0x00
- data2 = 0x00
- check = header + command + data1 + data2
- NULL = 0x00
- NULL = 0x00

>> Packet Receive

Recieve[Data1]□	Receive[Data2]
1byte□	1byte

- data1 = current <-Current feedback
- data2 = voltage <-Voltage feedback

3) B_ID_R_POS_PC : Setting up motor speed and verifying position

B_ID_R_POS_PC	80	E9	00-7F(ID)	speed	pos_H	pos_L	ID

>>Packet Command

HEADER□	Command□	Data1□	Data2□	CHKSUM□	Receive[0x00]□	Receive[0x00]
□1byte□	1byte□	1byte□	1byte□	1byte□	1byte□	1byte

- header = 0x80 (Packet Start)
- command = 0xE9
- data1 = 00-7F(ID)
- data2 = speed <- Setting up speed
- check = header + command + data1 + data2
- NULL = 0x00
- NULL = 0x00

>> Packet Receive

Recieve[Data1]□	Receive[Data2]
1byte□	1byte

- data1 = pos_H <- High byte of position feedback value
- data2 = pos_L <- Low byte of position feedback value

4) B_ID_W_MOV_MAX : Setting up motor position

B_ID_W_MOV_MAX	80	E9	00-7F(ID)	pos_H	pos_L	-	-	ID

>> Packet Command

HEADER□	Command□	Data1□	Data2□	CHKSUM□	Receive[0x00]□	Receive[0x00]
□1byte□	1byte□	1byte□	1byte□	1byte□	1byte□	1byte

- header = 0x80(Packet Start)
- command = 0x00-7F(ID)
- data1 = pos_H <- Writing high byte of position command\
- data2 = pos_L <- Writing low byte of position command
- check = header + command + data1 + data2
- NULL = 0x00
- NULL = 0x00

>> Packet Receive

Recieve[Data1]□	Receive[Data2]
1byte□	1byte

- data1 = 0x00 <- High byte of current position value feedback
- data2 = 0x00 <- Low byte of current position value feedback

5) B_motor_go_stop : Motor operation setup

B_motor_go_stop	80	EB	0	0/1	03	03	0:stop 1:go

>> Packet Command

HEADER□	Command□	Data1□	Data2□	CHKSUM□	Receive[0x00]□	Receive[0x00]
□1byte□	1byte□	1byte□	1byte□	1byte□	1byte□	1byte

- header = 0x80(Packet Start)
- command = EB
- data1 = 0
- data2 = 0x00 / 0x01 (0- stop / 1- go)
- check = header + command + data1 + data2
- NULL = 0x00
- NULL = 0x00

>> Packet Receive

Recieve[Data1]□	Receive[Data2]
1byte□	1byte

- data1 = 0x03
- data2 = 0x03

You can find more detailed information at the HITEC Robotics Home Page (http://www.hitecrobotics.com) and download all articles of interest.

4. Overload Protection
The HITEC Robot Servos have an Overload Protection Function, which is intended to protect motor, amplifier, and Robot.

■ If overload occurs, the overload protection is activated and the power to the servo is turned off within 10 seconds.
■ Overload protection is removed when the power is cycled to the servo.
■ For safety, the overload protection function is not user-programmable.

5. After the power to the servo has cycled, it will move slowly to neutral. Thereafter, it will operate normally. This is not a malfunction.

6. Robot Servos usually have high torque, so users need to be very careful handling the robot while it is operating. Carelessly touching a joint or servo may cause injury.

7. HITEC Robot Servos are developed for Robot Control only. Use of them for the other applications (RC, etc) is prohibited.