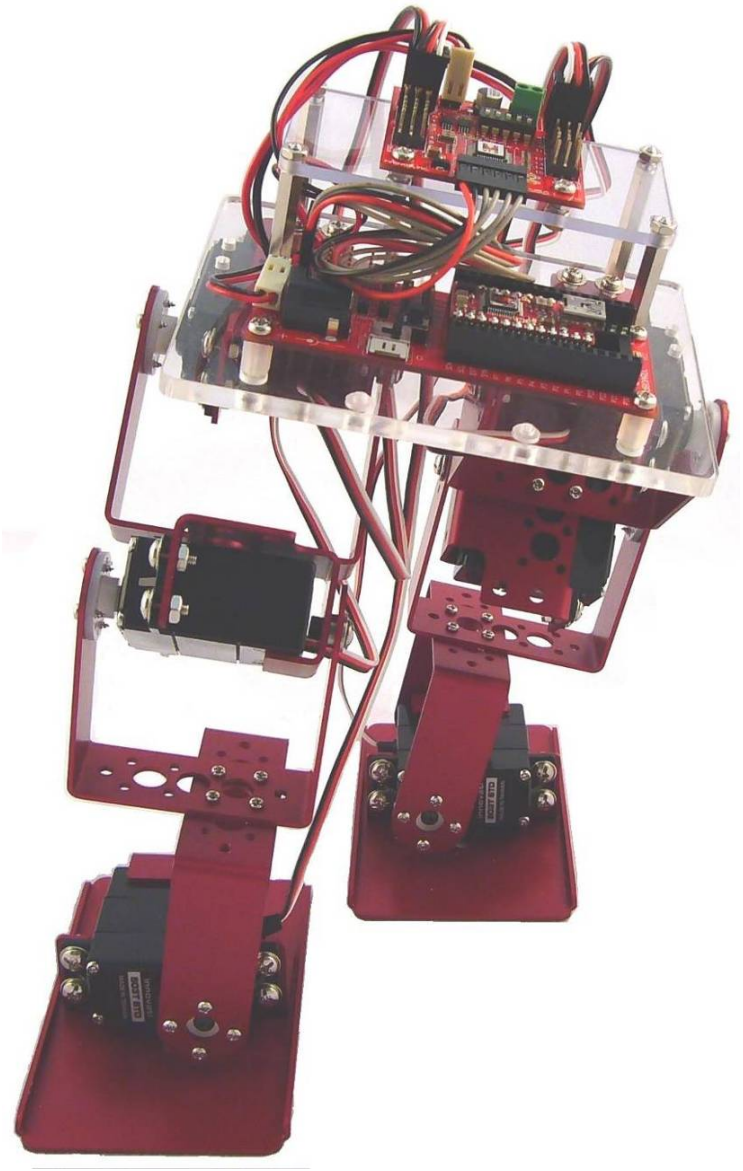
Bipedinno

6-DOF Waist-high Robot

Instruction Manual

Version 1.18



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Errata

We hope the users may regard this document as a lively and practical instruction manual. We have put tremendous efforts in making this instruction manual complete and correct; however, there may be unavoidable missing parts or errors. With a view to providing the user updated and complete information in the instruction manual, we keep improving and supplement the contents of this instruction manual. If you find any error in this manual, please contact us via the e-mail service@innovati.com.tw. Any related update information will be disclosed on our website. Please visit our website http://www.innovati.com.tw for more updated information.

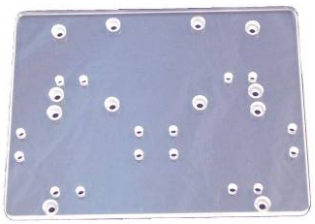
Precautions

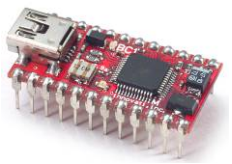
- This kit comprises 2 modules, BASIC Commander® and Servo Runner A, each with respective instructions for use and functions. Please refer to these for optimal effects.
- When installing BASIC Commander® to the Command Board, **make sure the input voltage is within the 6-12V range**, otherwise the module may burn.
- The input voltage to the Servo Runner A must correspond to the voltage rating of the servo. **Servos provided in this kit are rated 4.8-6V;** over or under voltage may cause unpredictable results, even burning of the motor. Make absolutely sure of the correct voltage before connecting the power supply.
- The kit provides a total of 6 servos. When operated simultaneously, they consume a large current; make sure the power supply or battery connecting to Servo Runner A is capable of providing **4A of current**, so as to properly operate the kit. Insufficient current may cause unexpected results and damage of the kit.
- When using a battery power supply to the module, the voltage may lower after some while of operation and cause abnormal actions of the kit. In such case, remove and fully charge the battery before using again. If prolonged testing and operation is required, we suggest you use a power supply unit to ensure uniform performance.

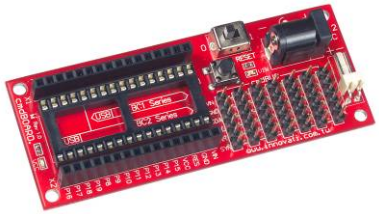
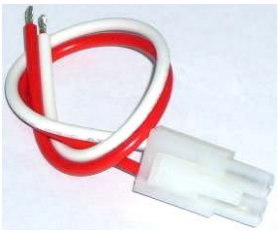
Prior to assembling the kit, install InnoBASIC™ Workshop as per the content of the CD; also make sure that the PC communicates with BASIC Commander® via a USB cable connection, so that the entire assembly can be accomplished.

Table of Contents

Part List

Item	Illustration	Qt'y	Specifications and instructions
Assembly Kit Parts			
Main Board for installing module		1	PC installation board for linking robot electronic modules with its leg parts; provides versatile layout of module or power supply accessories.
Top Board for installing module		1	PC board for installing electronic module of the robot and connecting with the main board; provides versatile layout of modules.
Aluminum Foot Bracket		2	For connecting with the Ankel Servo Bracket.
Aluminum Servo Bracket		6	For accommodating and fixing servo; lock holes are provided for connecting with another Servo Bracket or U-shape Bracket.
Aluminum U-shape Bracket, 47mm		6	Provides connection with the Servo Bracket and movement space of the Servo; it also provides connection with two U-shape Brackets for different applications.
Servo		6	Servo provides for 180° rotation moves capable of simulating articulation behaviors; connections with signal, power and ground are required for the operation. Pay attention to wire polarity. Avoid having the servo sustained to a same movement for a long period of time, to prevent wearing the motor. Dimensions (LxWxH): 39.5mmx20.0mmx39.5mm Weight: 46 g, Speed: 0.33 sec/60° Torque: 7.2 kg/cm

Screw A		24	ISOT 3 x 8 mm
Screw B		12	ISOP 3 x 6 mm
Screw C		18	ISOP 3 x 10 mm
Screw D		16	ISOP 2 x 5 mm
Screw E		24	TP1P 2 x 6 mm
Screw F		8	ISOF 3 x 6 mm
Screw G		8	ISOF 2 x 5 mm
Nut A		58	3 x 5 mm
Nut B		16	2 x 4 mm
Washer A		32	3 x 0.4 x 8 mm
Washer B		6	3 x 1 x 6 mm
Bearing		6	3 x 4 x 8 x 9.5 mm
Plastic Hex Post		4	3 x 8 mm
Hex post, copper		4	30 mm
Module Kits			
BC1		1	Innovati® BASIC Commander®, capable of storing programs and controlling operations of modules

Servo Runner A		1	Innovati® Servo Runner A, for controlling individual servos.
Command Board		1	This is used for installing BC1. It also provides a reserved cmdBUS™ for the user to connect directly.
Servo Power Line		1	Cable for connecting Servo Runner A with Power Supply Unit.
Command Board Power Line		1	Cable for connecting Command Board with Servo Runner A's Power Supply.
cmdBUS™		1	Signal cable for connecting Command Board with Servo Runner A.
Servo extension cable		2	Extends controlling signal cable of the servo, so that the user may perform servo control with a larger range or longer distance.
USB cable		1	Links BC1 with PC, allowing downloading of PC program to BC1, or performing communication in Debug Mode.
Cable Strap		2	Used for fixing wires, so that they do not tangle or affect motions unexpectedly during the operation of the Servo.

Wire Clamp		6	The wire clamp can be used to adjust the laying directions of various wires.

1. Tools

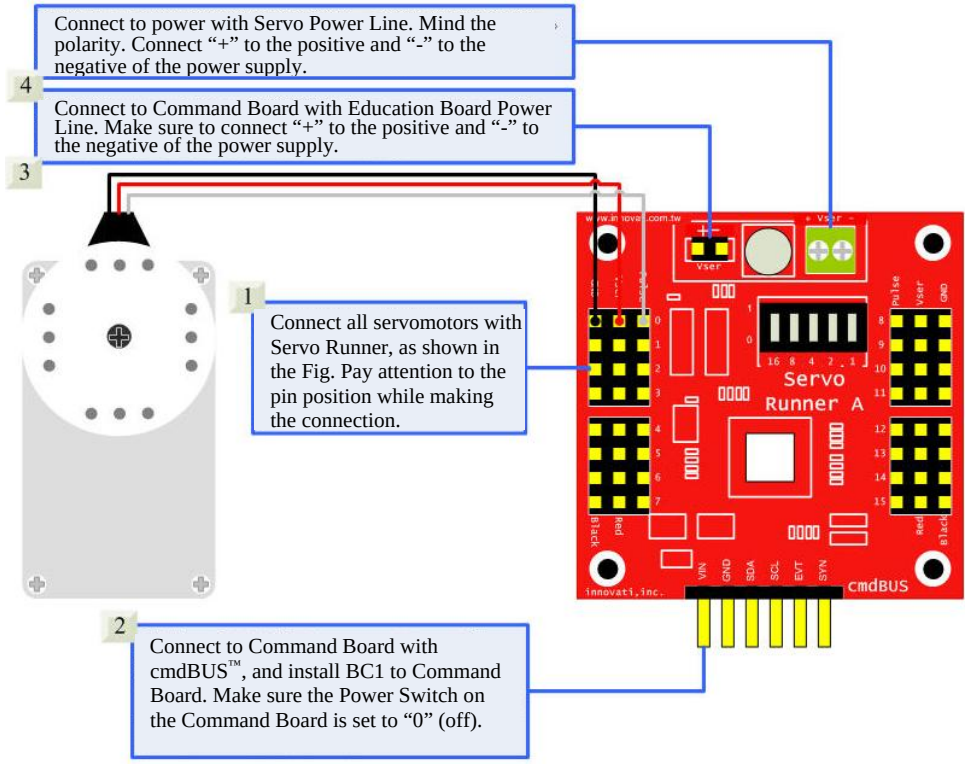
- Cross Screwdriver (2mm and 3 mm)
- Long Nose Pliers
- Screw Glue (selectively used between nut and bracket joints, to prevent the nut from loosening.)

2. Assembly Procedures

Calibrating Servos

Before starting installation, verify if the servo horn is at the correct position; if not, calibrate as follows:

- **Connect servo, Servo Runner A, Command Board, and power supply line in the sequence as illustrated below.**



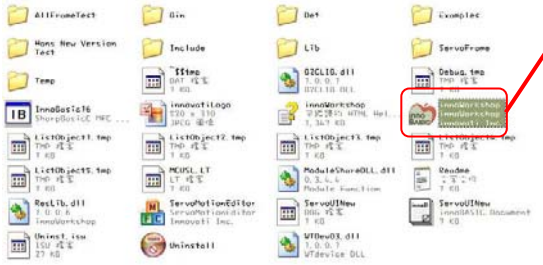
※ When the Command Board or Education Board shares the power supply with Servo Runner A, please notice that the voltage of this kit should be 6V (please refer to Notices). It is recommended to use a voltage regulator to ensure that the voltage is within the safe range.

i. **Connect the PC and BASIC Commander® with a USB cable.**

ii. **Make sure that the power switch on the Command Board is set at the 0 position (power off state). If it is not at the 0 position, please slide it to the 0 position.**

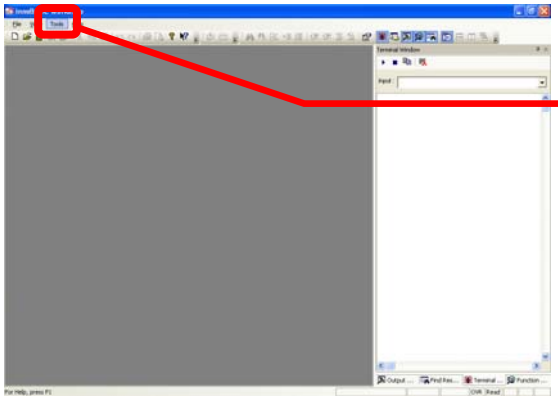
iii. **Connect the power line of the servo to the power supply. (Please make sure that the voltage and current from the power supply are within the ranges required by the servo. After the power line is connected, the servo may make a transient motion due to receiving a switch surge; this is normal. While connecting the power line, please pay attention not to place your hands within the space where the servo may move into to avoid being clamped.)**

iv. **Start the InnoBASIC™ Workshop.**



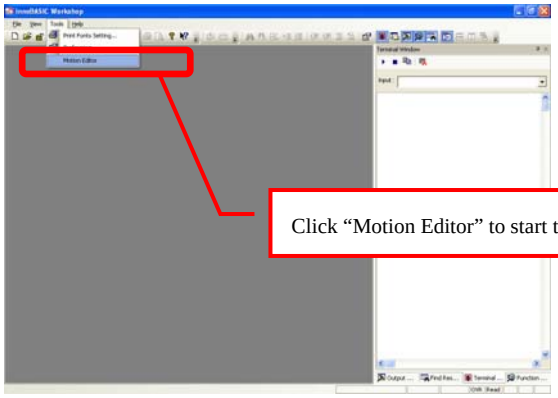
Click the application in the InnoBASIC™ Workshop folder to start the InnoBASIC™ Workshop.

v. **Click the "Tools" item in the menu bar on the top.**



After clicking each item, a pull-down menu with more function items will be displayed. Please click the "Tools" item now.

vi. **Click the "Motion Editor" in the pull-down menu (If a warning window appears, it means that the BASIC Commander® is not correctly connected. Please check if the USB cable is connected or unplug and then plug it again to ensure a correct connection. Exit the Motion Editor and then re-click this button.)**



Click "Motion Editor" to start the Motion Editor.

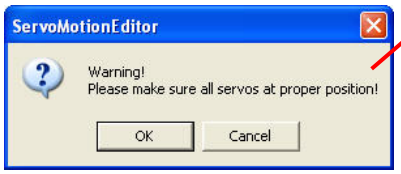
If this message appears, it means that the USB cable is not connected correctly.

vii. **If the connection is correct, the message "Downloading servo manager..." will be displayed on the PC screen meaning that the program is being downloaded. Please slide the power switch on the Command Board to the 1 position and wait a moment.**

The message means that the program is being downloaded. Please do not remove the USB cable.

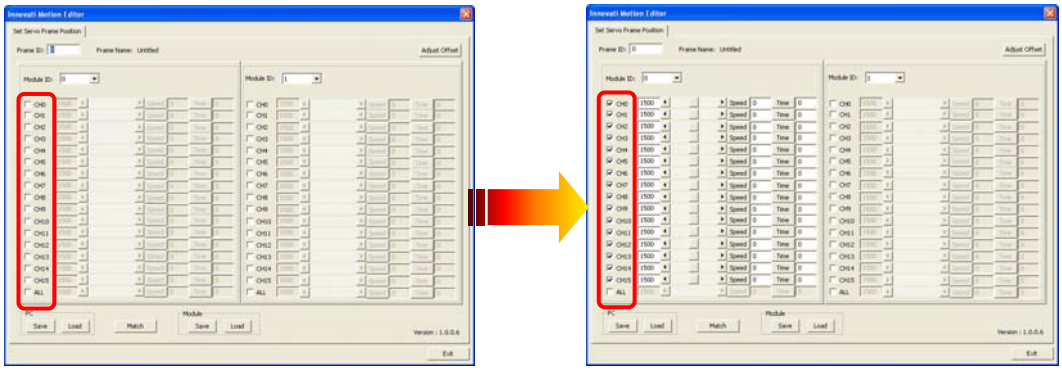
viii. **After the downloading is complete, a notification window will appear. Please**

make sure that each servo has been connected correctly. After confirming all the connections, please click “OK”. (If “Cancel” is clicked, the Motion Editor will be closed. If there is any component is incorrectly connected at this moment, please click “Cancel” to terminate the program.)

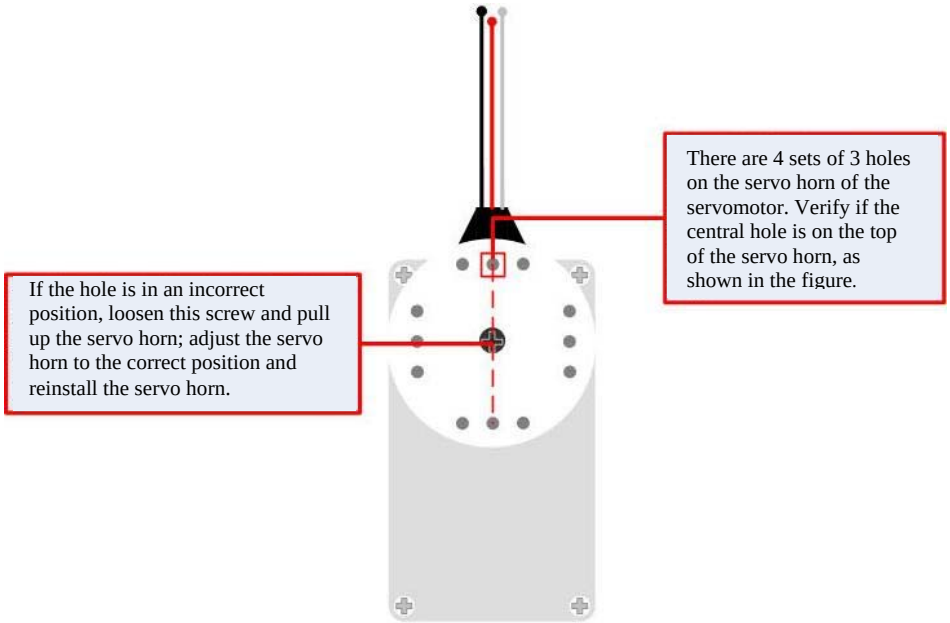


The message appears for notifying the download is complete. Please make sure that each component has been connected correctly.

ix. **Please pay attention not to place your hands within the space where the servos may move into so as to avoid being clamped. Then check the "All" checkbox at the lower left corner to allow all the servos to move to their central points.**



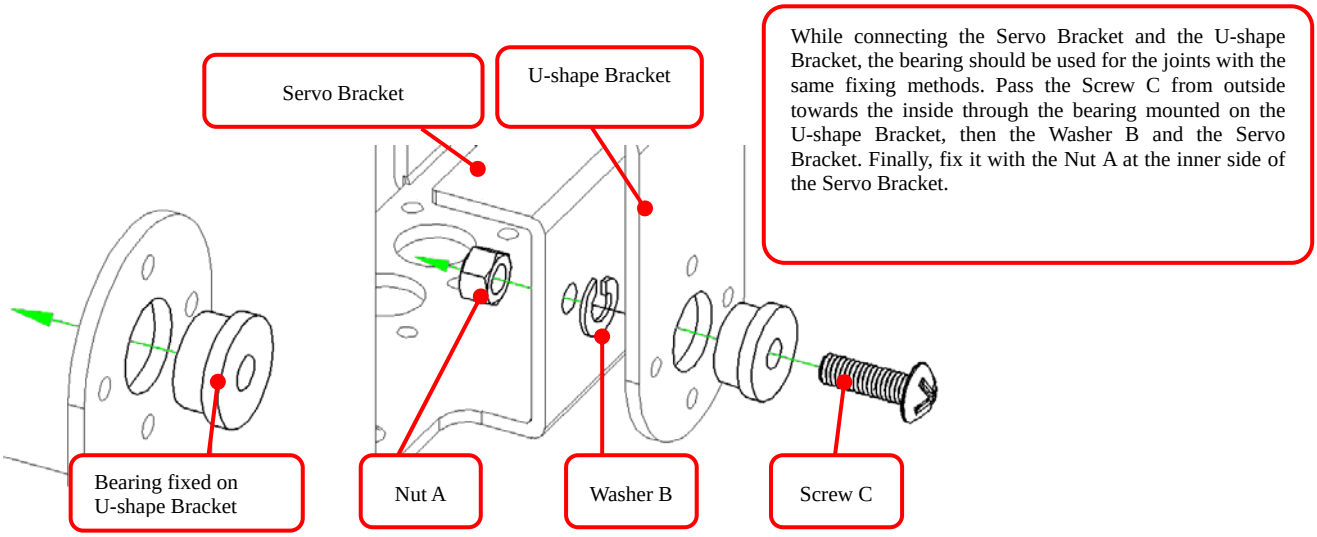
- **Check if the all the servo horns are at correct position; in case of any deviation, remove the central screw and pull off the servo horn, adjust it to the correct angle and re-lock.**



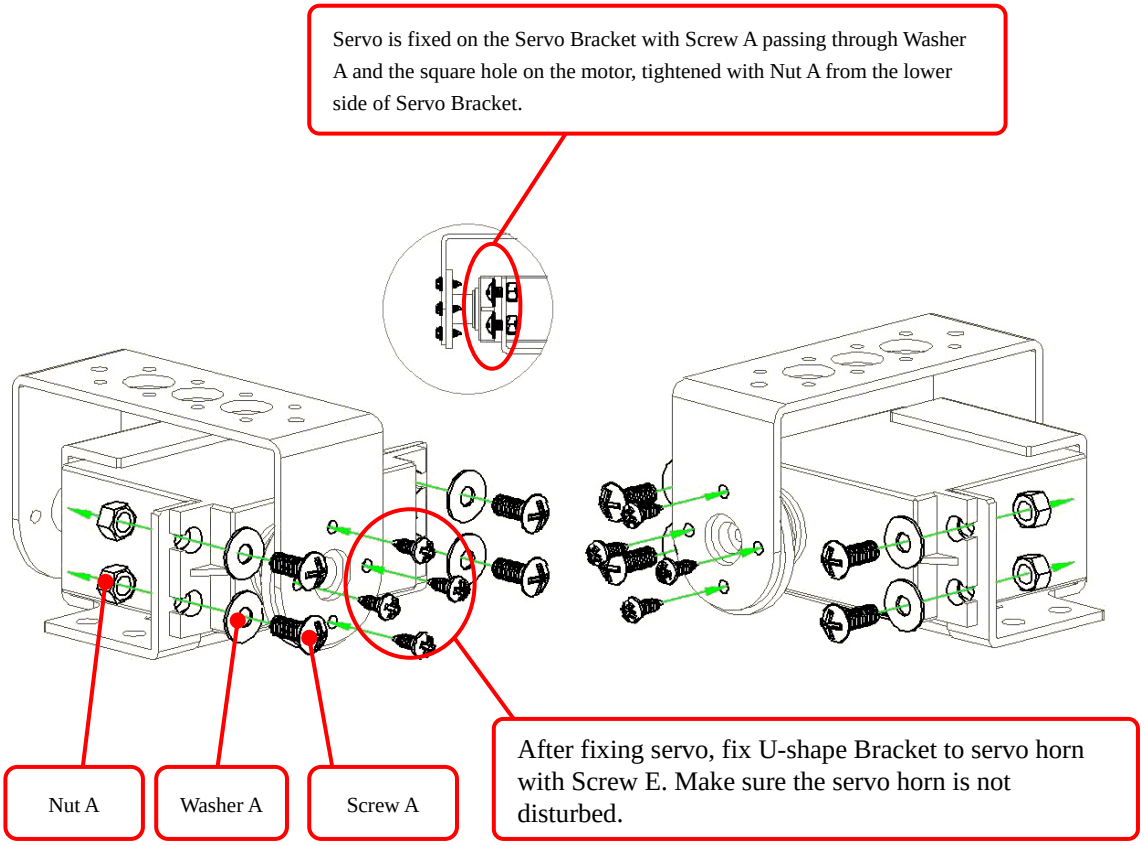
- **While making the assembly, before fixing the servo horn, make sure the servo horn is maintained at the correct angle. In case the servo horn is moved, follow this procedure to adjust it, to prevent from any unexpected movement or damage of the parts.**

Installing the bearing (For reference only. Please do not

assemble it first.)

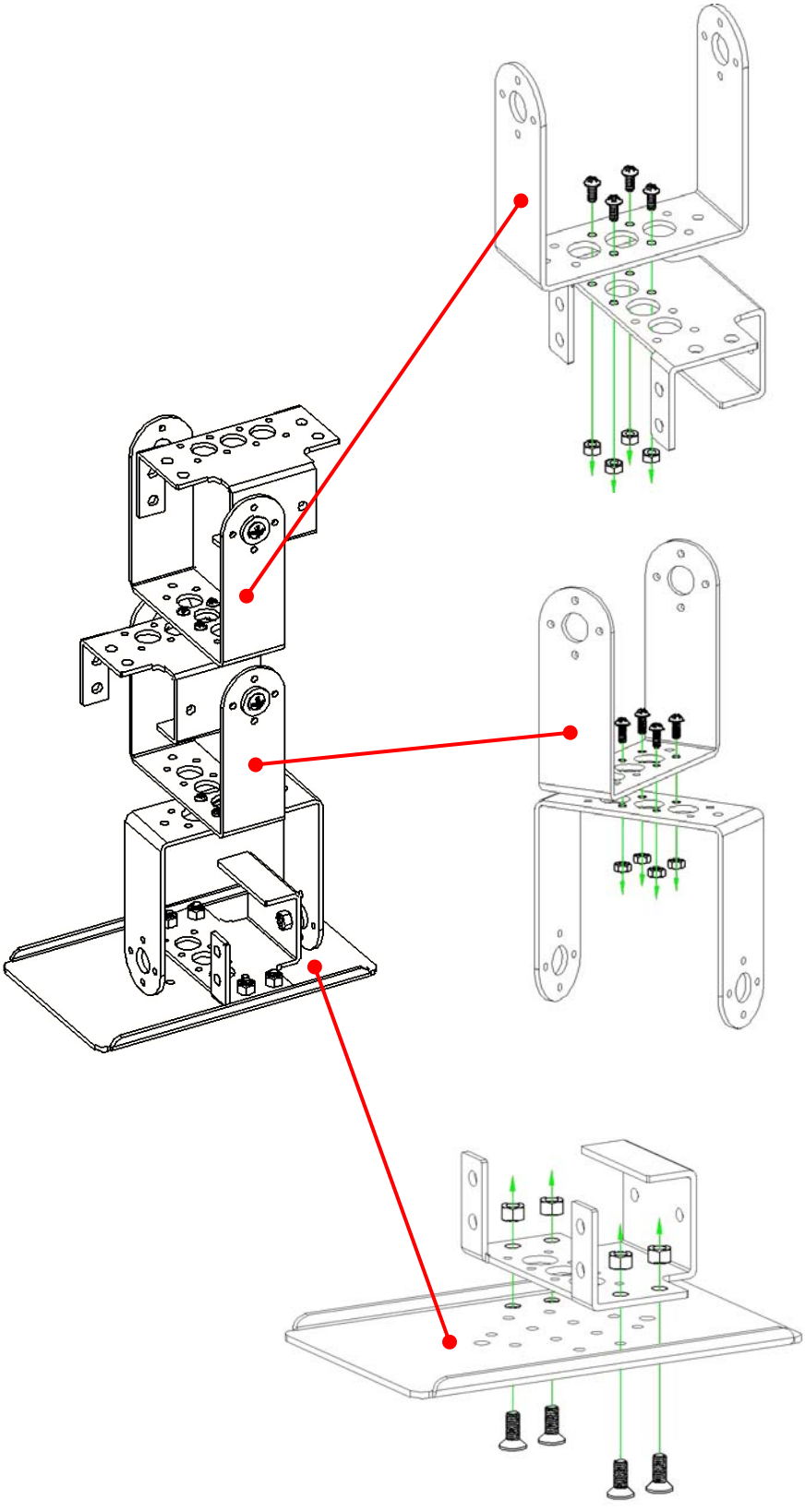


- **Fixing the servo (For reference only, please do not assemble it first.)**



A. Assemble the leg frames

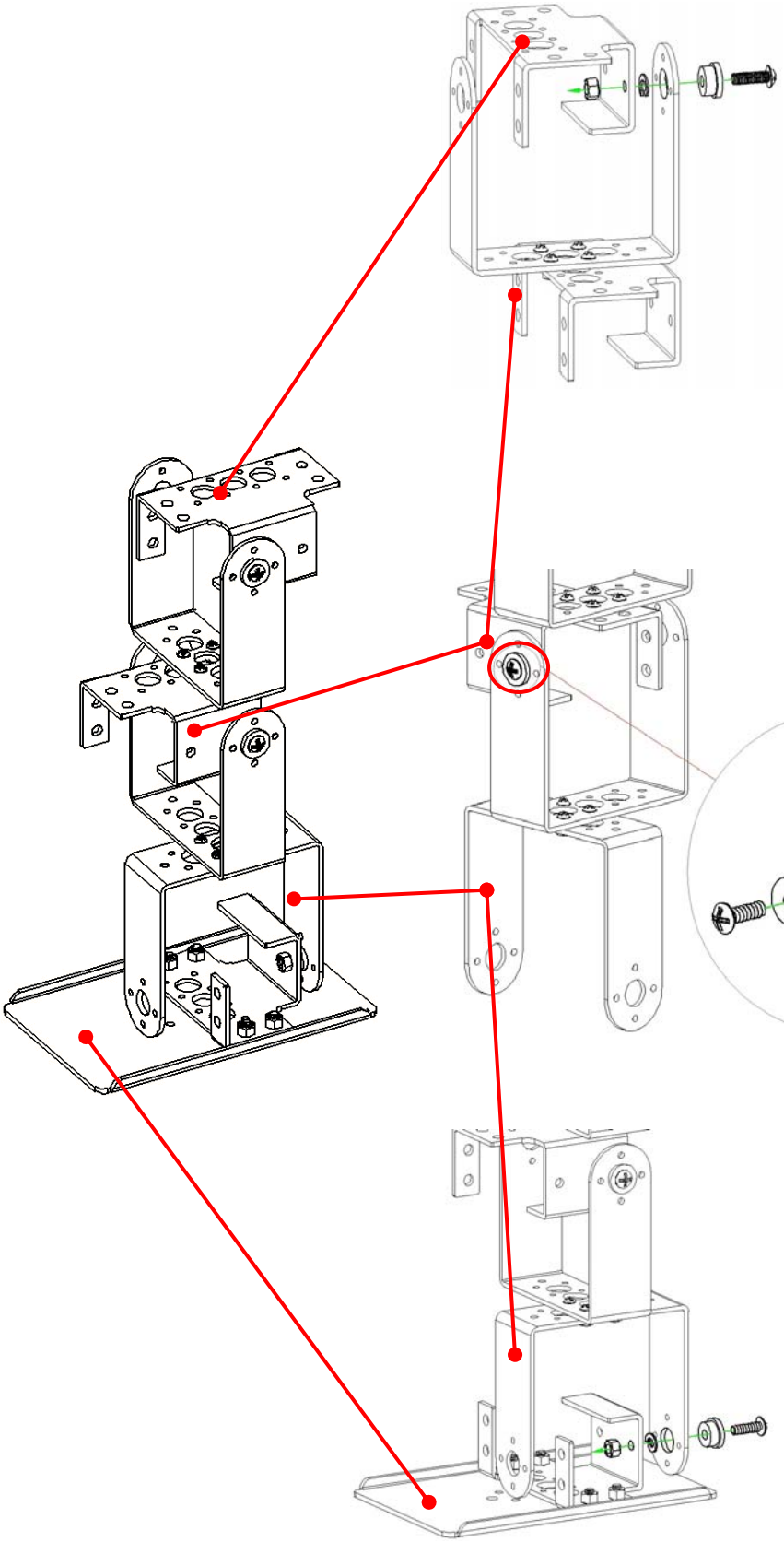
i. Assemble the Right Leg Frame



Part A: Connect the U-shape Bracket and Servo Bracket together and then fix them with Screw D and Nut B as shown in the figure. Please notice the positions of the corresponding holes.

Part B: Connect the two U-shape Brackets together and then fix them with Screw D and Nut B as shown in the figure. Please notice the positions of the corresponding holes.

Part C: Place the Servo Bracket on the Foot Bracket and then fix the two Brackets with Screw G and Nut A as shown in the figure. Please notice the positions of the corresponding holes. The Screw G should pass the brackets from the bottom of the leg board and then fasten with a nut at the top to avoid a protrusion at the bottom.



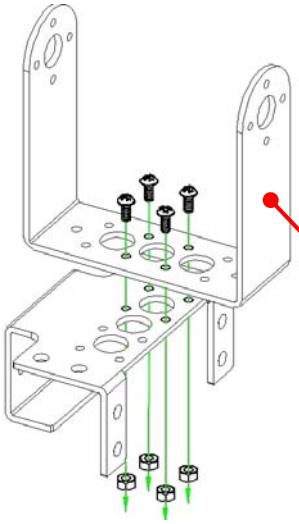
Fix the upper part of Part A with a bearing and then attach the Servo Bracket (please refer to the assembly instructions for the bearing). During the installation, please make sure the position for installing the bearing. It is necessary to confirm the orientation of the Servo Bracket carefully.

Connect the part assembled in the previous step to Part B by using the bottom Servo Bracket and the bearing. Please make sure that the Servo Bracket is connected to Part B at the hole position marked as a red circle in the figure.

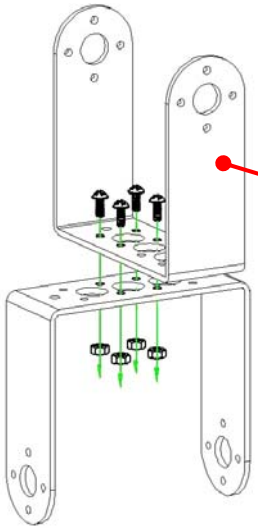
Fix the Foot Bracket on the bottom most Servo Bracket by using a bearing to complete the installation of the left leg frame. Please re-check whether the assembled left leg frame has the same structure as shown in the figure.

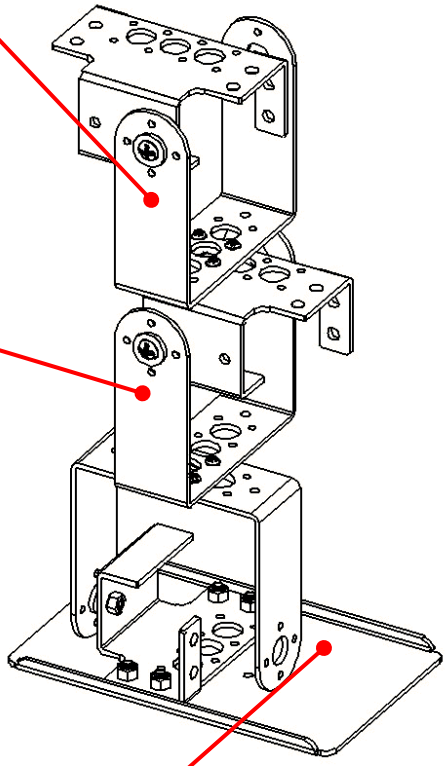
ii. Assemble Left Leg Frame

Part A: Connect two Servo Brackets together and then fix them with Screw D and Nut B as shown in the figure.

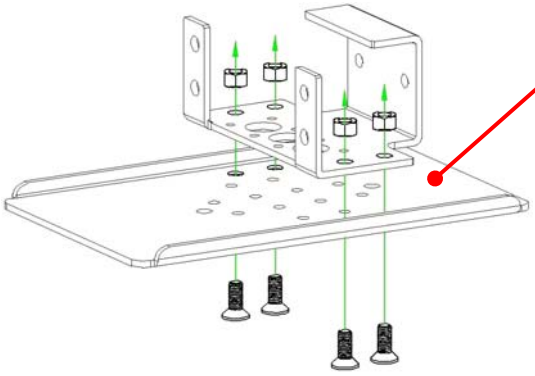


Part B: Connect two U-shape Brackets together and then fix them with Screw D and Nut B as shown in the figure. Please notice the positions of the corresponding holes.



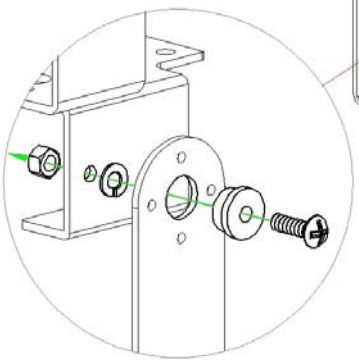


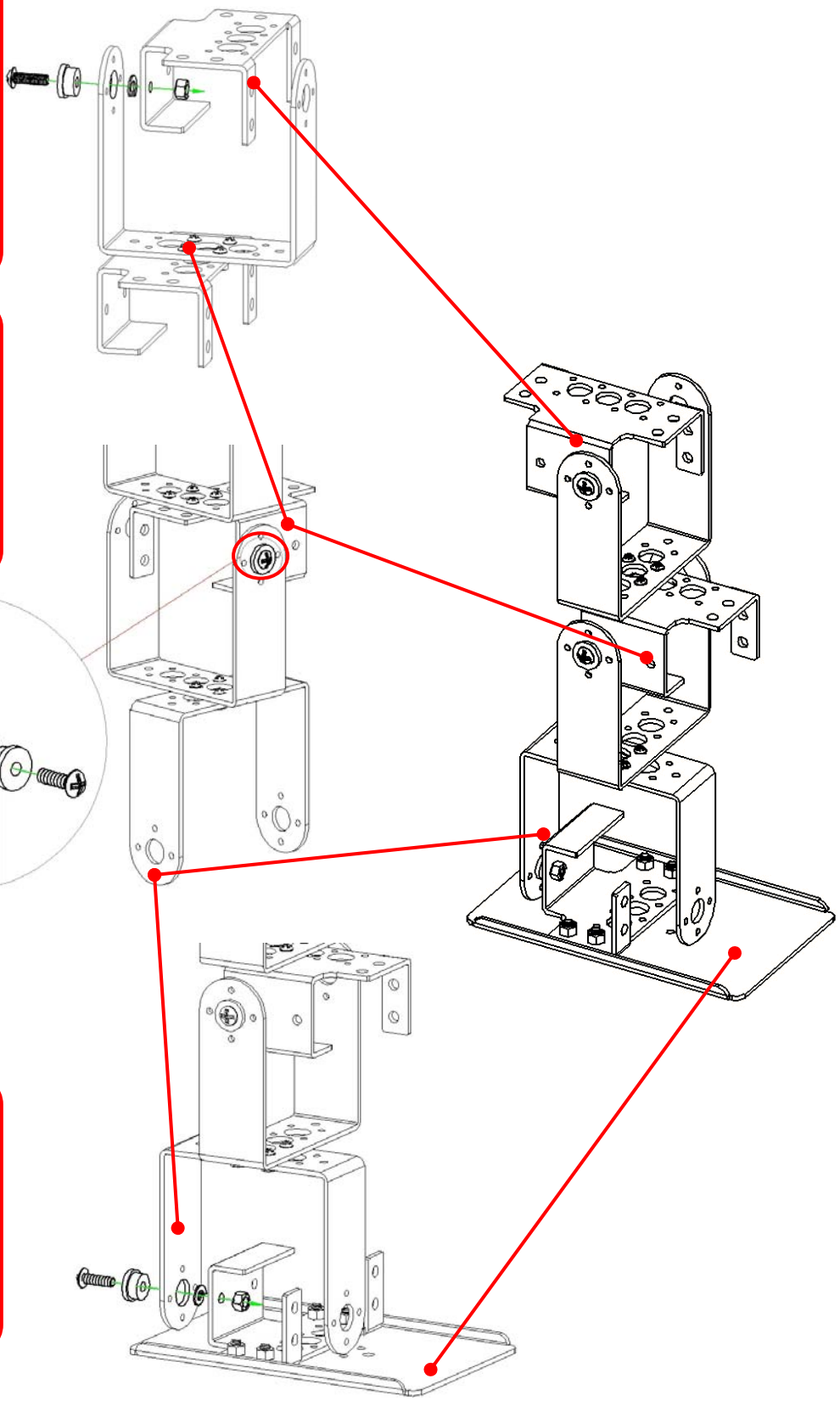
Part C: Place the Servo Bracket on the Leg Bracket and then fix the two brackets with Screw G and Nut A as shown in the figure. Please notice the positions of the corresponding holes. The Screw G should pass the brackets from the bottom of the leg board and then fasten with a nut at the top to avoid a protrusion at the bottom.



Fix the upper part of Part A with a bearing and then attach the Servo Bracket (please refer to the assembly instructions for the bearing). During the installation, please make sure the position for installing the bearing. It is necessary to confirm the orientation of the Servo Bracket carefully.

Connect the part assembled in the previous step to Part B by using the bottom Servo Bracket and the bearing. Please make sure that the Servo Bracket is connected to Part B at the hole position marked as a red circle in the figure.



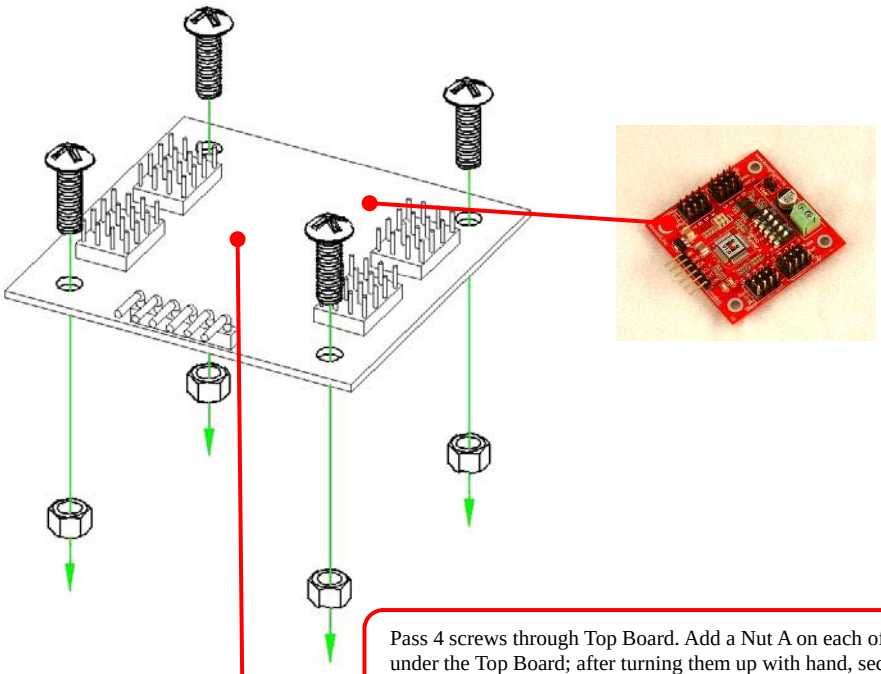


Fix the Leg Bracket on the bottom most Servo Bracket by using a bearing to complete the installation of the left leg frame. Please re-check whether the assembled left leg frame has the same structure as shown in the figure.

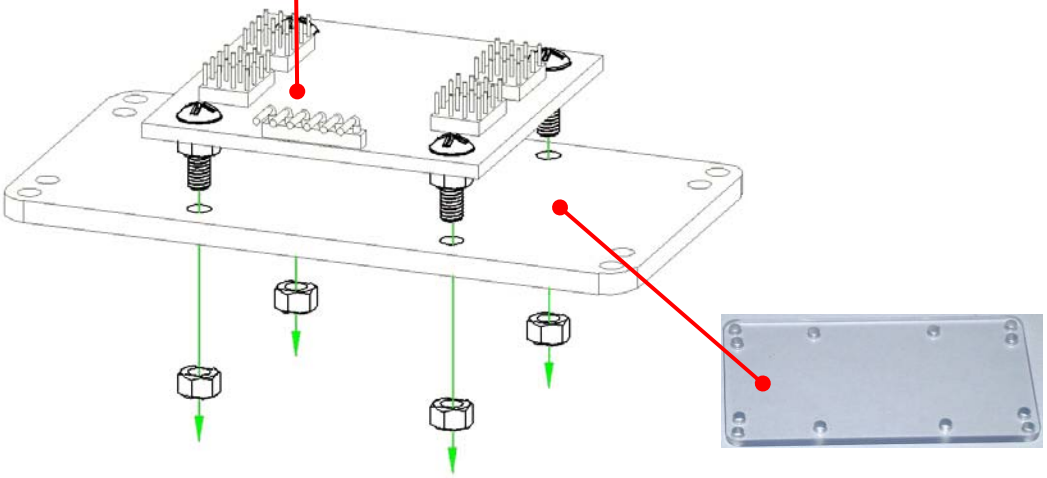
B. Connecting Top Board with Module

i. Assemble Top Board with Servo Runner A

Insert Screw C into 4 holes of Servo Runner A and fix them with Nut A from below as illustrated.



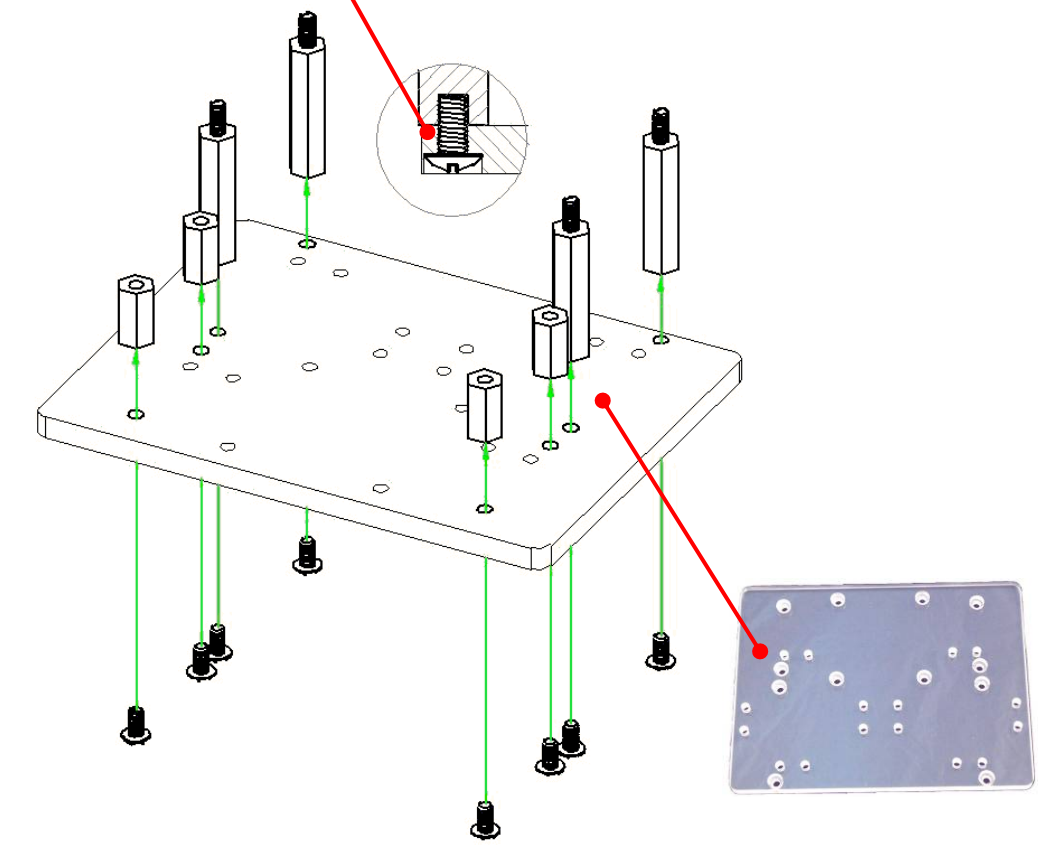
Pass 4 screws through Top Board. Add a Nut A on each of the protruding screws under the Top Board; after turning them up with hand, secure them with long nose pliers.



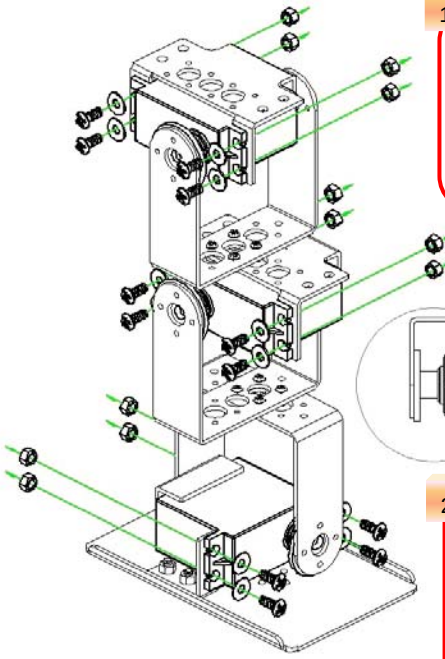
ii. Assembly of the Main Board and Hex Posts

Fix the 4 plastic hex posts on the main board for module installation with Screw B. Please notice that the screw head should be buried in the sink-hole while fixing the screw so as not to influence the installation of other components. In addition, the copper hex posts should be fixed with Screw B in the same way as fixing the plastic posts.

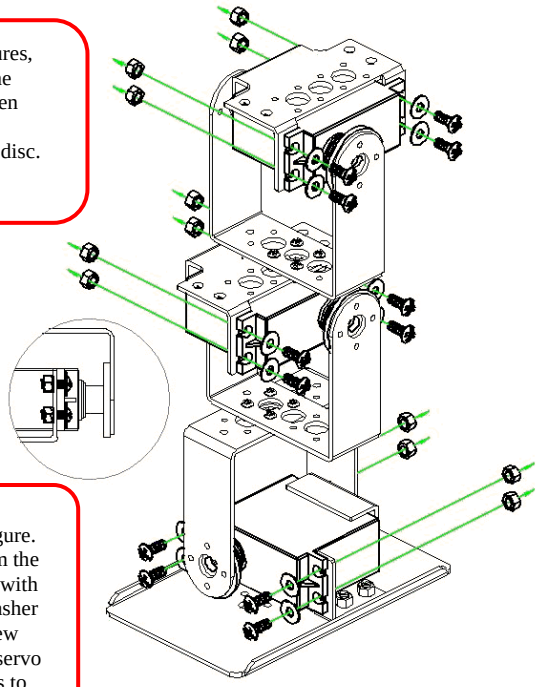
After being fixed correctly, the screw head will hide inside the Main Board.



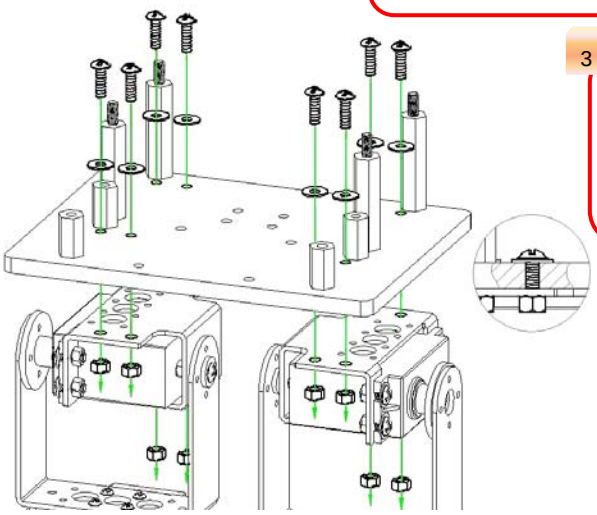
iii. Install Servos and Connect the Main Board



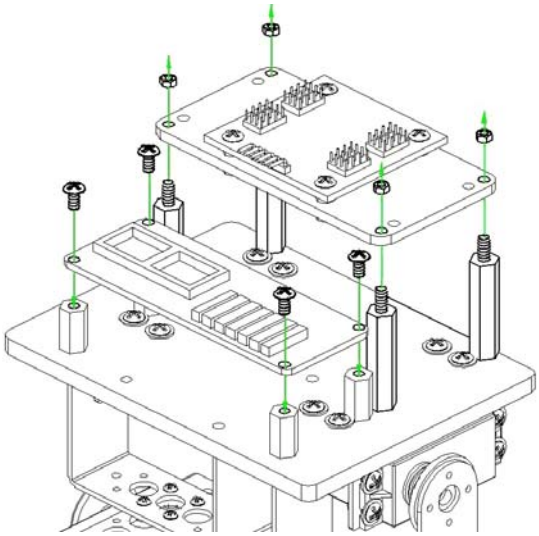
1 As shown in the left and right figures, please install the six servos into the Servo Bracket. If the servo has been calibrated in advance, please pay attention not to rotate the rotation disc.



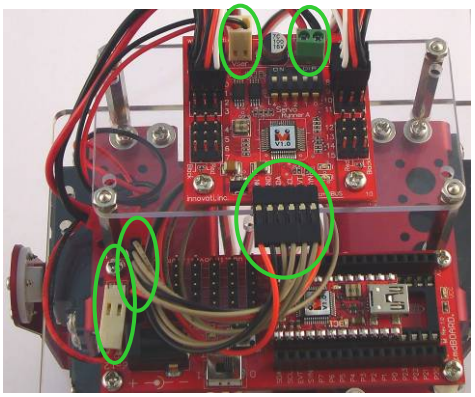
2 Fix each servo as shown in the figure. Insert Screw A and Washer A from the left to the right and then fix them with Nut A at the opposite end. The washer should be placed between the screw head and the plastic board of the servo to distribute the force evenly so as to prevent the plastic board from being damaged due to excessive forces.



3 Connect the Main Board for module installation with the two legs. Please pass Screw C though Washer A, insert it into the Main Board from the top, and then fix it on the Servo Bracket with Nut A from the bottom side. Please refer to the fixing position of each component shown in the left figure.



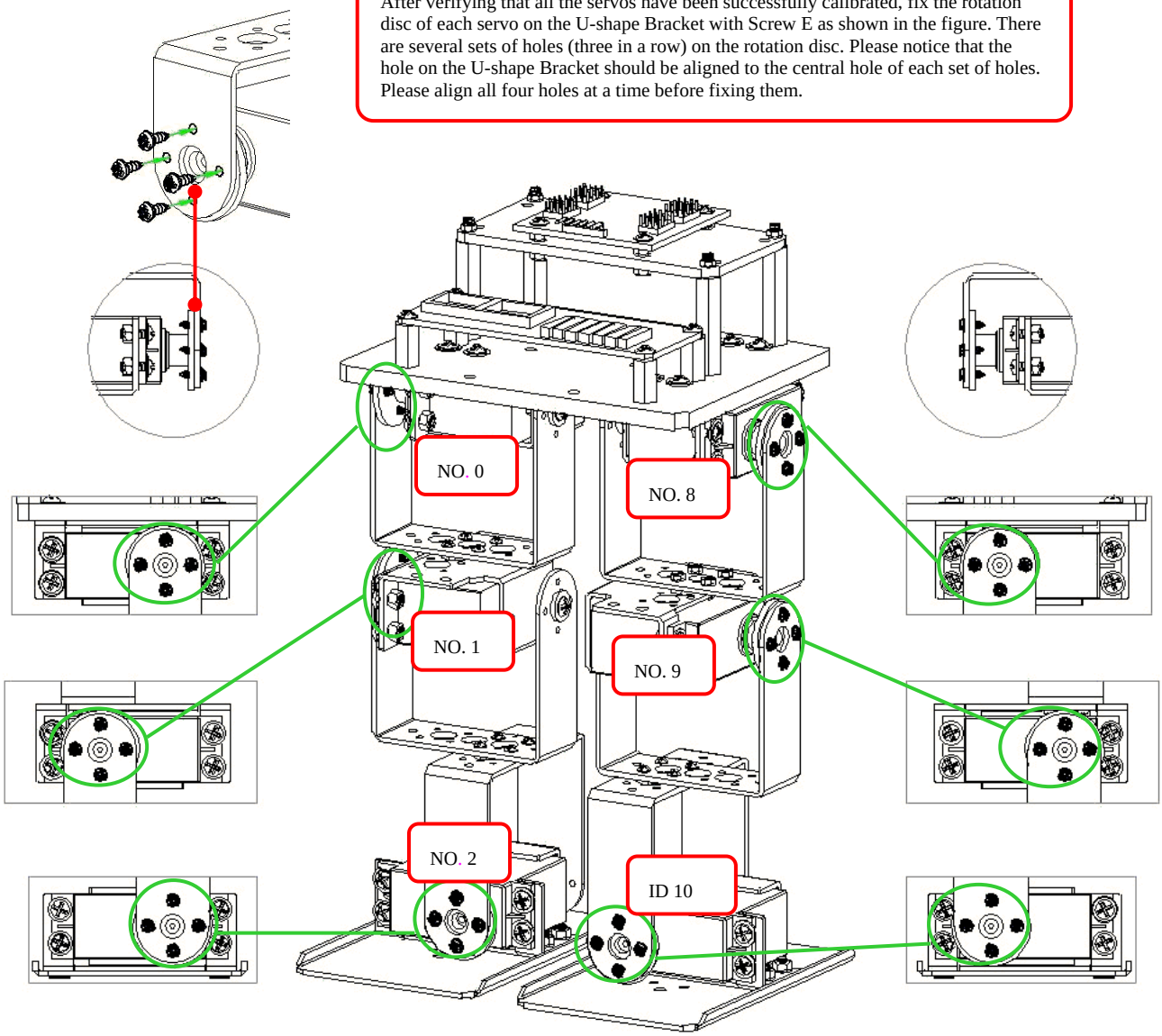
4 Fix the Command Board to the plastic hex posts on the Main Board with Screw B and then fix the top bracket on the copper hex posts with Nut A.



5 Choose a suitable power line and fix it to Servo Runner A. Then connect Command Board to Servo Runner A with a power line and link the Command Bus. While connecting these three lines, please notice the polarity of the electricity. Incorrect connection will damage the module.

1

After verifying that all the servos have been successfully calibrated, fix the rotation disc of each servo on the U-shape Bracket with Screw E as shown in the figure. There are several sets of holes (three in a row) on the rotation disc. Please notice that the hole on the U-shape Bracket should be aligned to the central hole of each set of holes. Please align all four holes at a time before fixing them.



2

Connect the control cable of each servo to the corresponding pins on the Servo Module according to the ID number marked in the above figure. While connecting the servo at the foot, the user can connect with the extension cable of the servo to increase the operable range. While connecting the cables, please notice the ID number of each servo. Incorrect connection may result in unexpected motions. If it is required to adjust the ID number of the servo, please also change the settings in the demonstrative program so as to avoid damage to the servos due to incorrect settings.

※ A Servo number is provided beside each Servo Module. Note that the white wire is signal, red the power and black the Ground. Connect them as indicated on the module, to avoid any damage of the module.

3. Fine-tuning initial value of servo

There might be some positioning errors in each servo that are possibly caused by installation or mechanical errors. Therefore, before assembling and installing, it is necessary to perform a two-step adjustment so as to allow the follow-up operations to be positioned correctly.

A. Structure fine-tuning:

- **Prior to the final step of installation, all the servo horns are not yet fixed to the structure. You may unscrew the central black screw and adjust position of the servo horn now.**
- **Connect all servos to the Servo Module and connect to the power supply. Referring to servo calibration procedures, let all servos move to their center point respectively.**
- **Check if all screw holes align with holes on the servo horn. If not, unscrew the central screw and pull up the servo horn, align servo horn holes to holes on the structure and lower the servo horn.**

※Both the PC and aluminum are flexible to a certain extent. In case hole positions on the PC board misalign with the hole positions of servos, just slightly pull PC board up and adjust the servo horn, by lifting it up, to a desired angle and replace it.

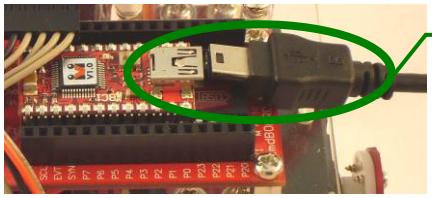
- **Align holes of all 6 servos one by one, and then proceed with final fixing of the installation.**

B. Software fine-tuning:

- **After completing structure fine-tuning and fixing servo horns (the final step of installation), proceed with software fine-tune program.**
- **Enter fine-tune value of each servo respectively and adjust all motors to their desired positions. In case satisfactory result cannot be achieved within the limit range (127~-128), go back to structure fine-tune and readjust the structure.**

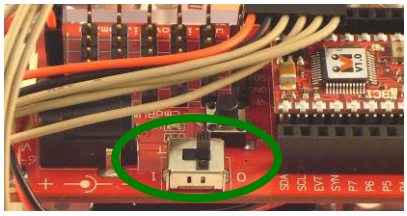
※ ***Make sure all servo horn screws are tightened and all servos are within the tolerance range while performing software fine-tuning.***

B_1. Connect the PC and the BASIC Commander® on the robot with the USB cable.

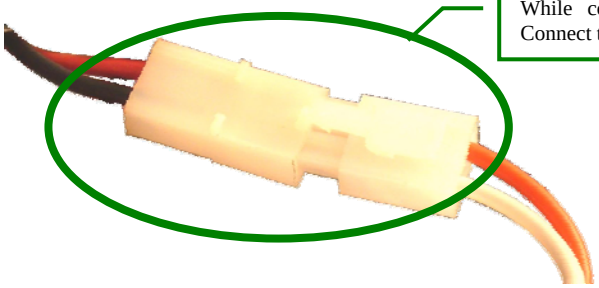


The connectors at the two ends of the USB cable are of different sizes, so please connect the smaller one to the BASIC Commander.

B_2. **Make sure the power switch on the Command Board is at the 0 position. If not, please slide it to the 0 position.**

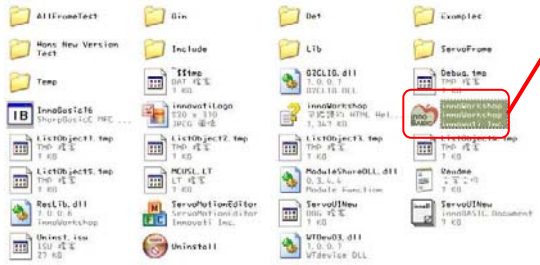


B_3. **Connect the power line of the servo to the power supply (Please make sure that the voltage and current from the power supply are within the range required by the servo. After connecting the power line, the servo will make a transient motion due to receiving the switch surge, which is normal. While connecting the power line, please pay attention not to place your hands within the space where the servo will move into to avoid being clamped.)**



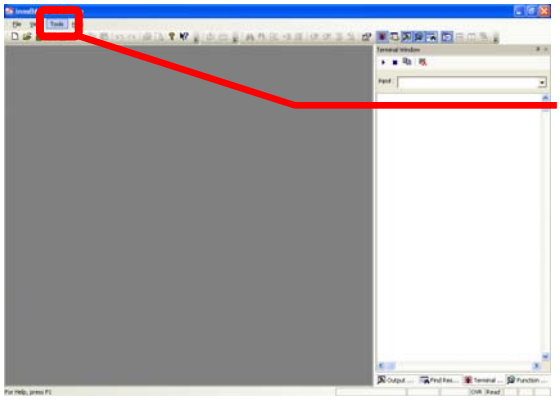
While connecting the power line, please notice the polarity. Connect the two red wires together.

B_4. **Start InnoBASIC™ Workshop.**



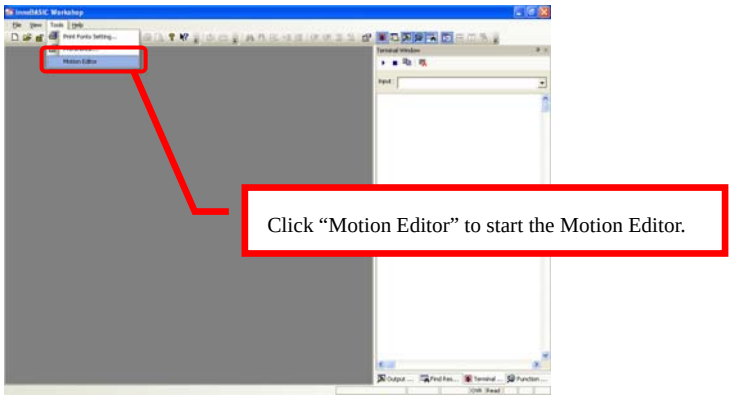
Click the application under the InnoBASIC™ Workshop folder to start the InnoBASIC™ Workshop.

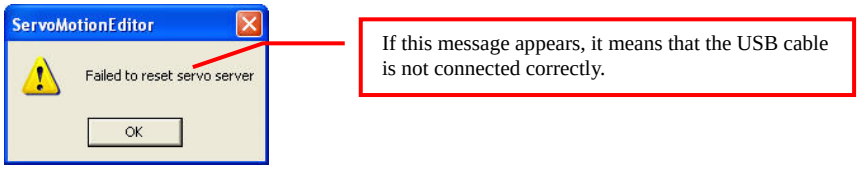
B_5. **Click “Tools” in the menu bar on the top.**



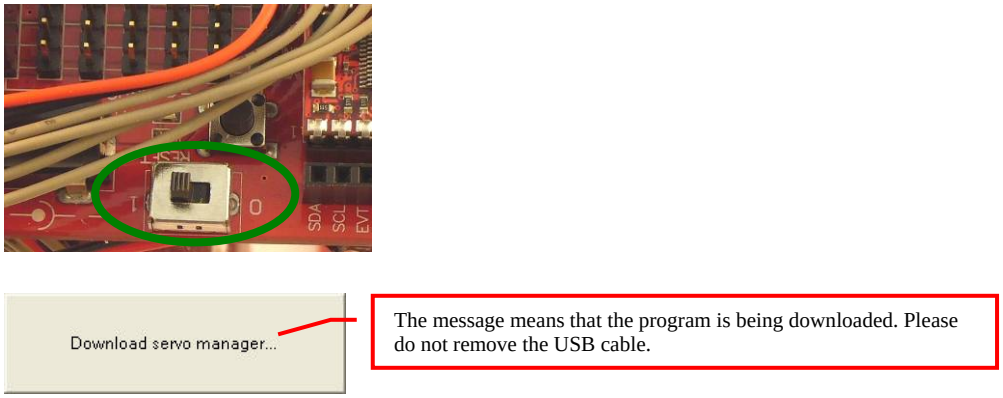
After clicking each item, a pull-down menu with more function items will be displayed. Please click the “Tools" item now.

B_6. **Click the “Motion Editor” in the pull-down menu (If a warning window appears, it means that the BASIC Commander® is not correctly connected. Please check if the USB cable is connected or unplug and then plug it again to ensure a correct connection. Exit the Motion Editor and then re-click this button.)**

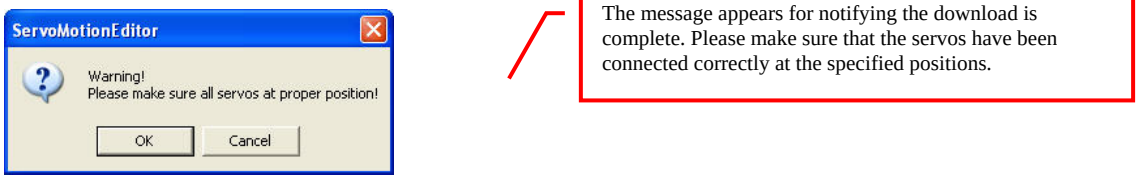




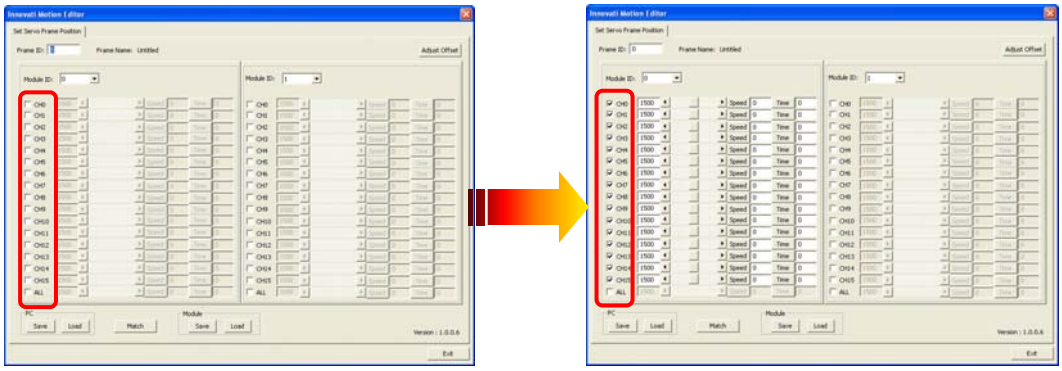
B_7. **If the connection is correct, the message “Downloading Editor Program...” will be displayed on the PC screen meaning that the program is being downloaded. Please slide the power switch on the Command Board to the 1 position and wait a moment.**



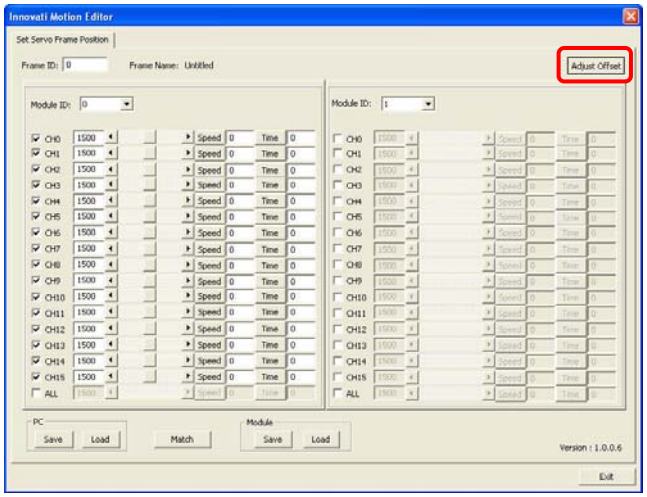
B_8. **After the downloading is complete, a notification window will appear. Please make sure that each servo has been connected correctly. After confirming all the connections, please click “OK”. (If “Cancel” is clicked, the Motion Editor will be closed. If there is any component is incorrectly connected at this moment, please click “Cancel” to terminate the program.)**



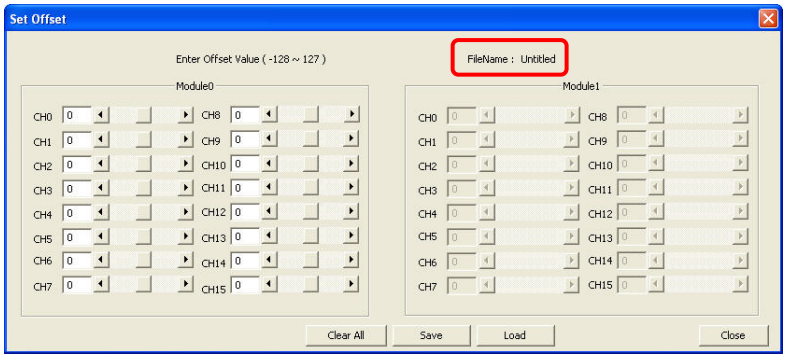
B_9. **Please pay attention not to place your hands within the space where the servos may move into to avoid being clamped. Please check the checkbox for activating the servos on the left side to move all the servos to their central points. Please note that the number next to it should be 1500. If it is not 1500, please click the number directly, enter the number 1500 and then click “Enter”.**



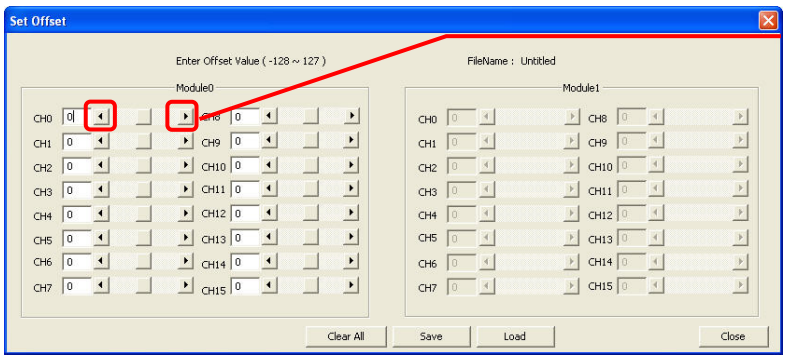
B_10. **Click the “Adjust Offset” button at the upper right corner.**



B_11. **If the fine tune values are not yet stored, the Filename will be “Untitled”. The user can specify a preferred name while storing the file.**

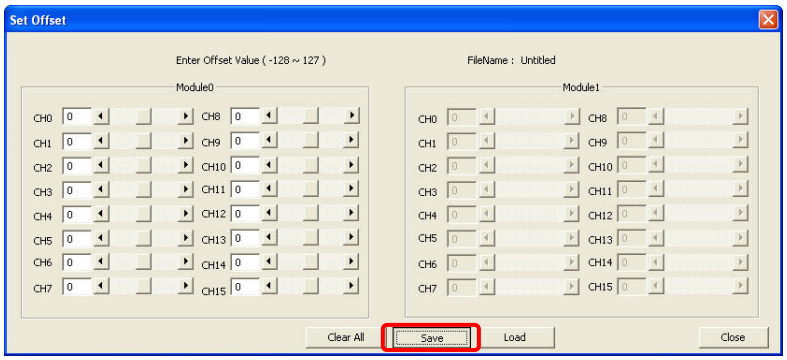


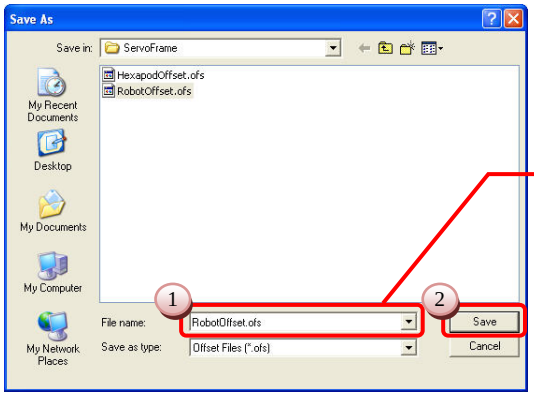
B_12. **Observe the servo that requires the fine tune and click the corresponding arrow buttons. The servo will rotate in the selected direction. Please make sure that the rotation is in the correct direction. If the reverse rotation is required, click the opposite arrow button. Adjust each servo to its central point one by one.**



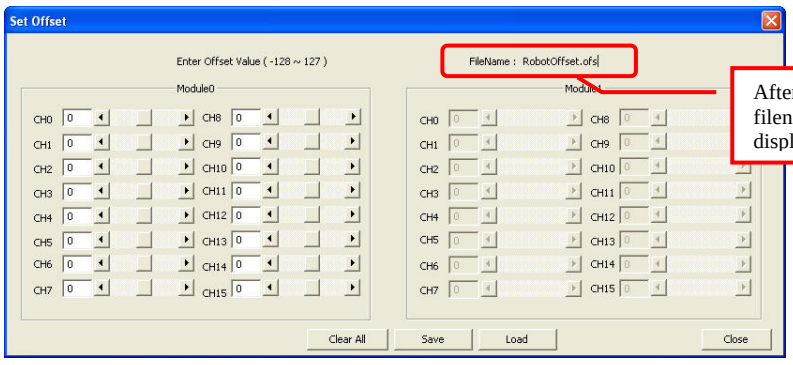
The left/right arrow buttons can be used to rotate the servo clockwise or counterclockwise. Please observe the rotation of the servo to the required central position. Then adjust the next servo.

B_13. **Please note the values after fine tune. Click "Save", select the location for storing the file, enter a preferred filename, and then click OK to save the values in the PC. If it is required to query or download the values, click "Load" to read out the values.**



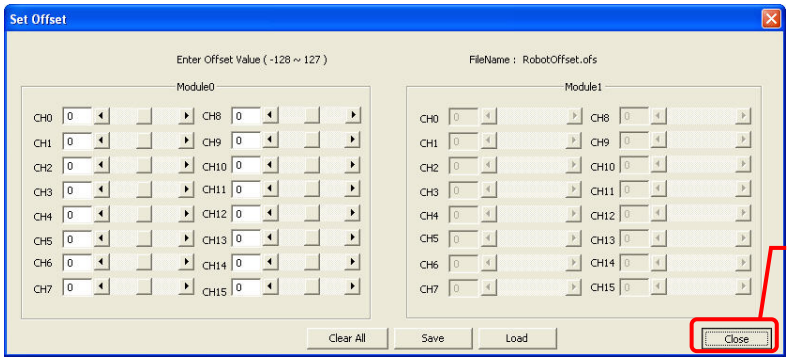


Please enter a preferred name in the "filename" and then click "Save".



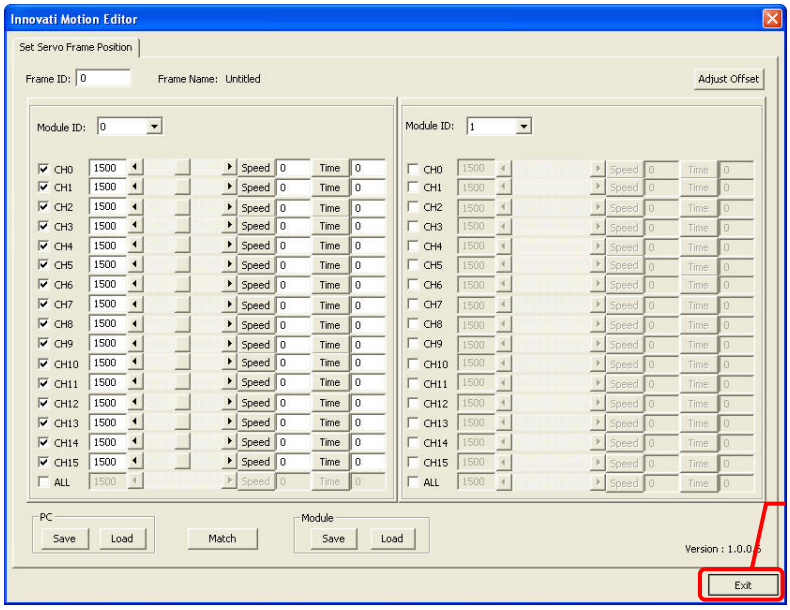
After the file is successfully stored, the filename of the last stored file will be displayed in the "Filename".

B_14. **Click the "Close" button at the lower right corner to close the window.**



Click the “Close” button to close the window.

B_15. **After returning the “Edit Servo Motion” window, click the “Exit” button at the lower right corner to close the fine tune operation.**

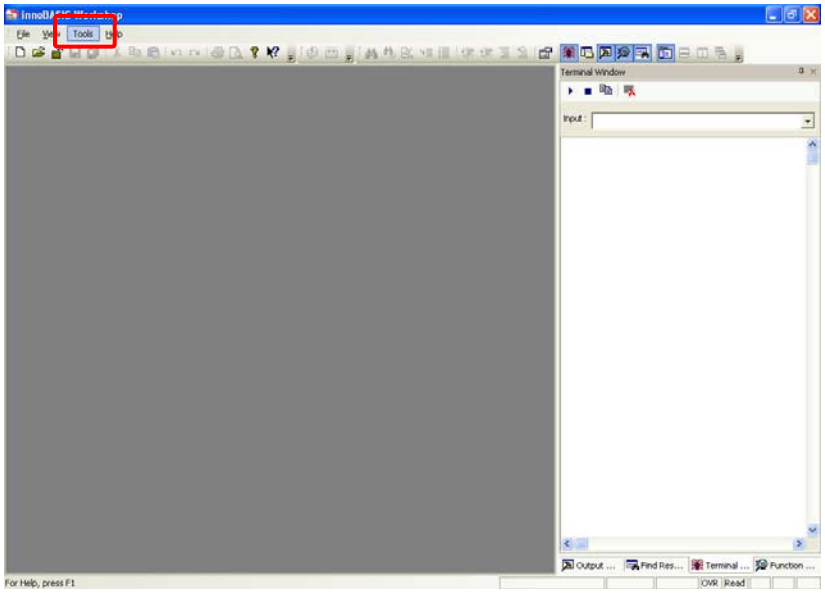


Click the “Exit” button to close the Motion Editor.

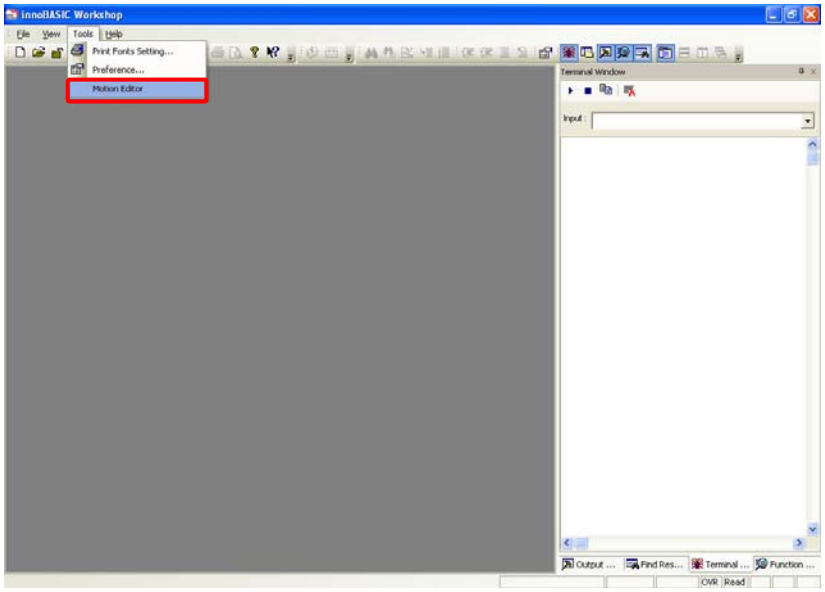
4. Perform Demonstrative Motions

4_1. **Please copy the folder “6-DOF Waist-high Robot Documents” to the PC.**

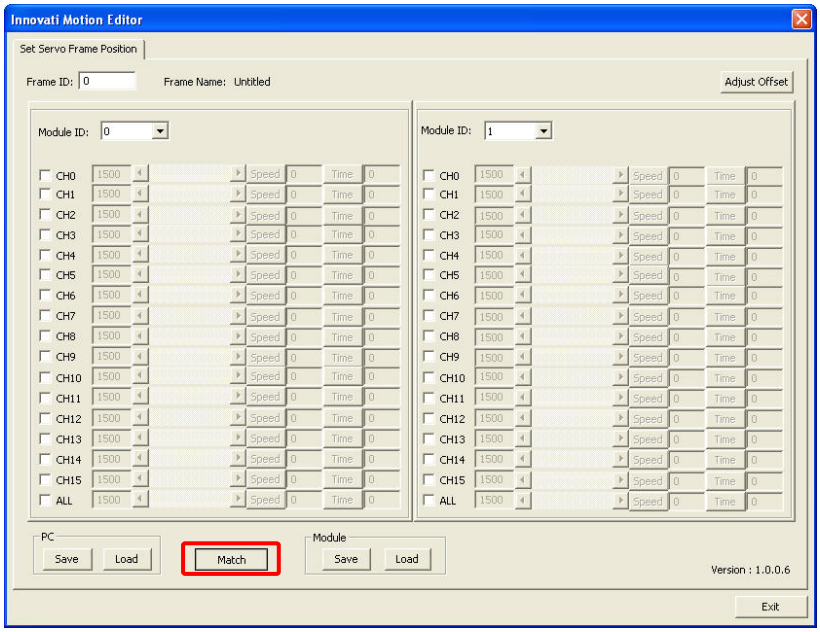
4_2. **In the InnoBASIC™ Workshop, click “Tools” in the menu bar on the top.**



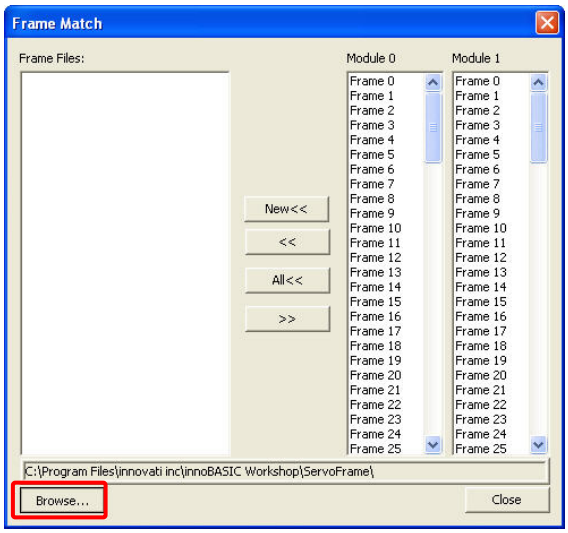
4_3. **Click “Motion Editor” in the pull-down menu.**



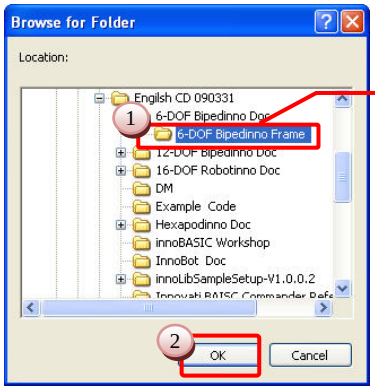
4_4. **Click the button “Match” at the bottom of the Motion Editor.**



4_5. **Click the “Browse” button at the lower left corner.**

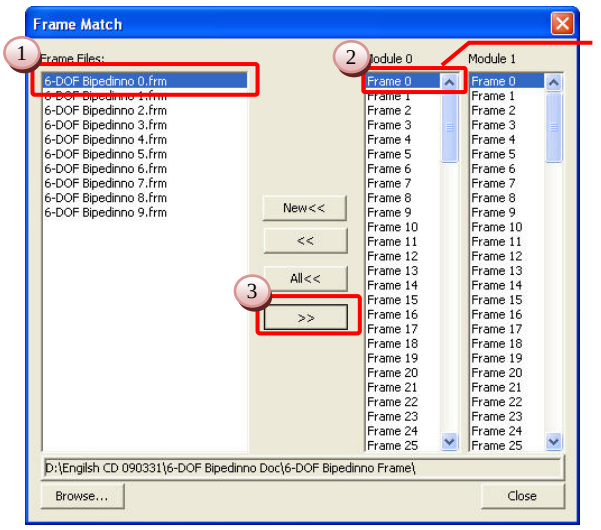


4_6. **Set the “Browse for Folder” location to the “6-DOF Bipedinno Frame” folder under the “6-DOF Bipedinno Doc” folder and then click the “OK” button.**



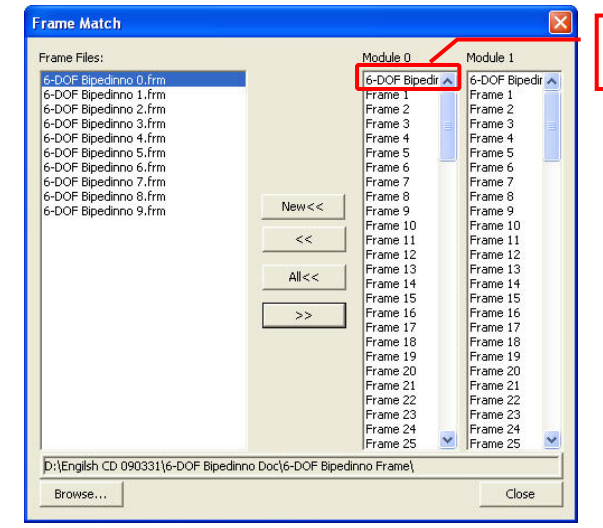
The selected folder will be highlighted. Please make sure that the selected folder is “6-DOF Bipedinno Frame”.

4_7. **Please click the “6-DOF Bipedinno 0.frm” below the frame files on the left side, click the “Frame 0” under the “Module 0”and then click the “>>” button.**



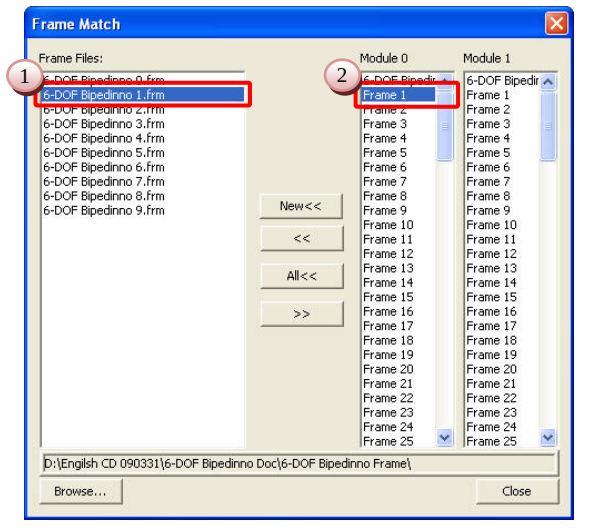
Before clicking the “>>” button to download the motion file into the module, please make sure that the “Frame 0” under the Module 0 has been selected and highlighted.

4_8. **Before clicking the “>>” button to download the motion file into the module, please make sure that the “Frame 0” under the Module 0 has been selected and highlighted.**



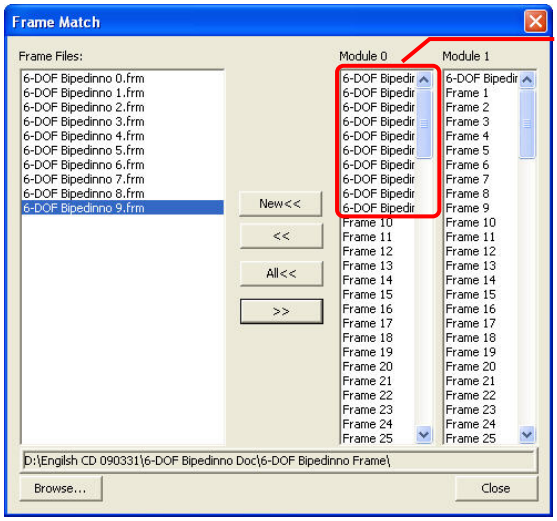
After the download is complete, the original text “Frame 0” will turn into “6-DOF Bipedinno 0”.

4_9. **Now click the “6-DOF Bipedinno 1” below the “Frame Files” and “Frame 1” below the “Module 0” as the two steps describe above. Repeat the operation for all the motions till Frames 0-9 have been downloaded to the corresponding frames.**



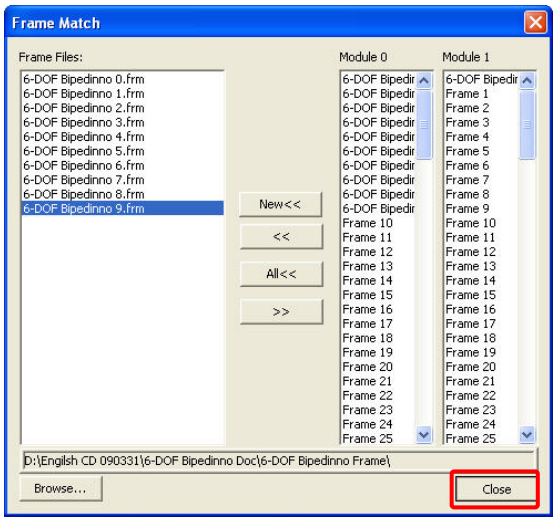
4_10. **After all the download operations are complete, it is clear that all the motions**

above Motion 10 and below the "Module 0" have been changed to the corresponding motions.

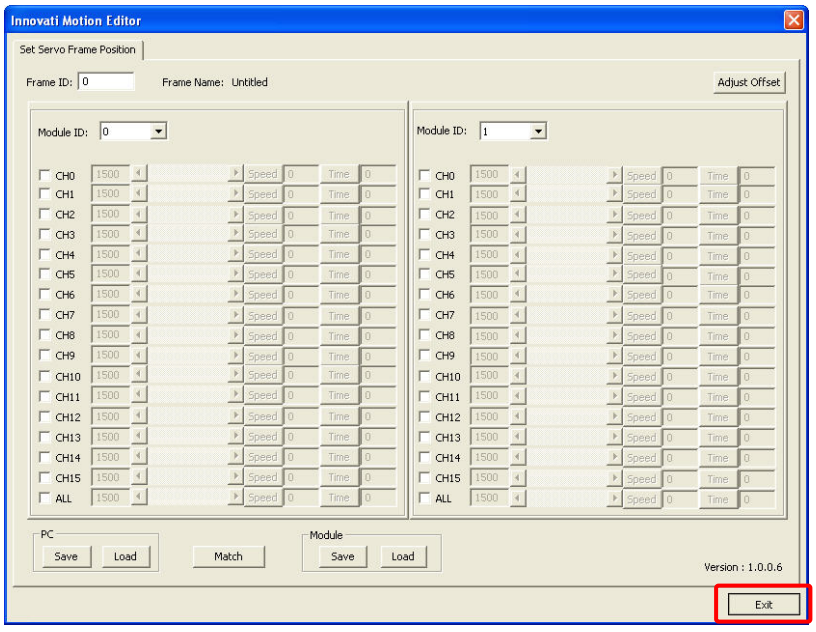


Please make sure that first 10 Frames have been successfully downloaded.

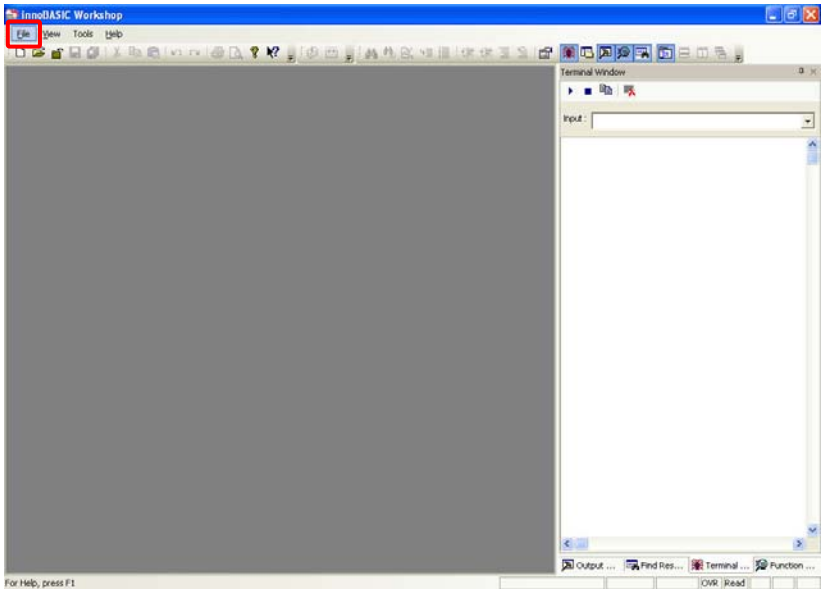
4_11. **After the verifying the operations, click the "Close" button at the lower right corner to close the window for setting the corresponding motions.**

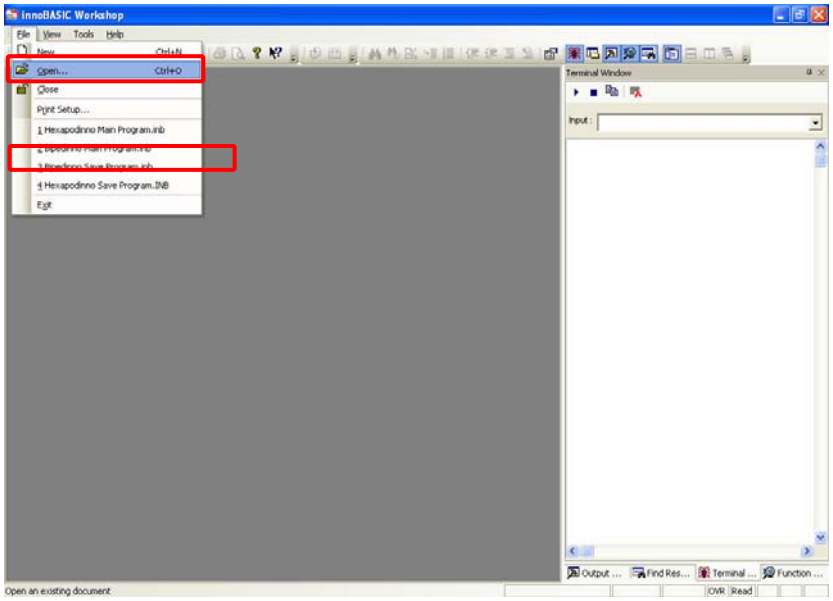


4_12. **In the Edit Servo Motions window, click the "Exit" button at the lower right corner to close the Motion Editor.**

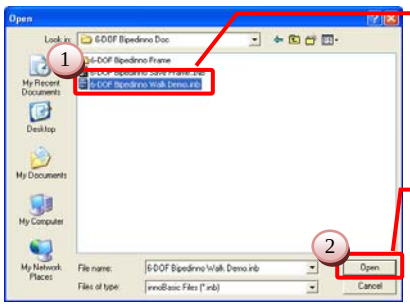


4_13. **Click “File” in the menu bar and click “Open”.**





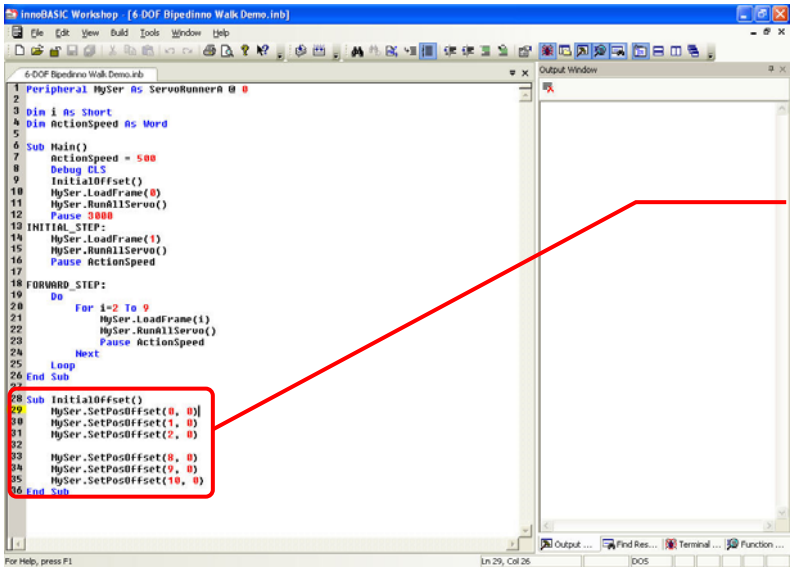
4_14. **Please select the “6-DOF Bipedinno Walk Demo” in the folder and click “Open”.**



The selected folder will be highlighted. Please make sure that the selected folder is “6-DOF Bipedinno Walk Demo”.

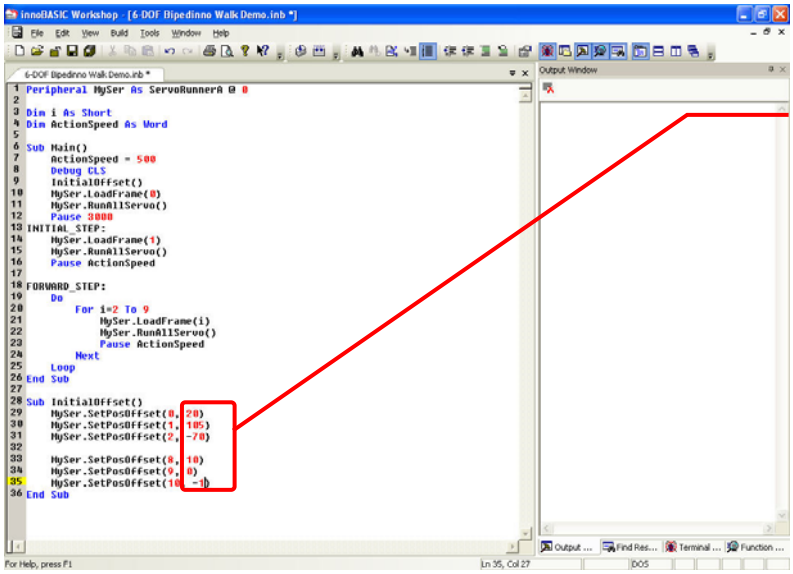
Click the “Open” button to download the program into the innoBASIC Workshop for editing or creating motions.

4_15. **Move to the 29th line of the program to see the Initial Function. (To move within the program, the user can also click the mouse button at any position in the program and then rotate the mouse wheel to scroll the program page.)**



The number on the left side represents the line number of the program. The Function starts at "Sub" and ends at "End Sub" within which the operations are defined to store the fine tune values into the module. At the beginning of each program, it is necessary to set the fine tune values.

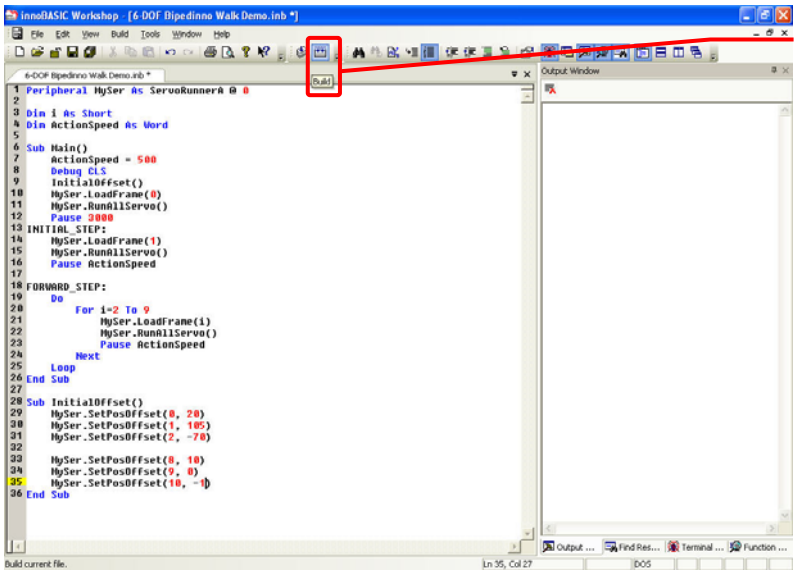
4_16. **Update the fine tune values, which are recorded during the software fine tune, into the Initial Function to replace the original values of "0".**



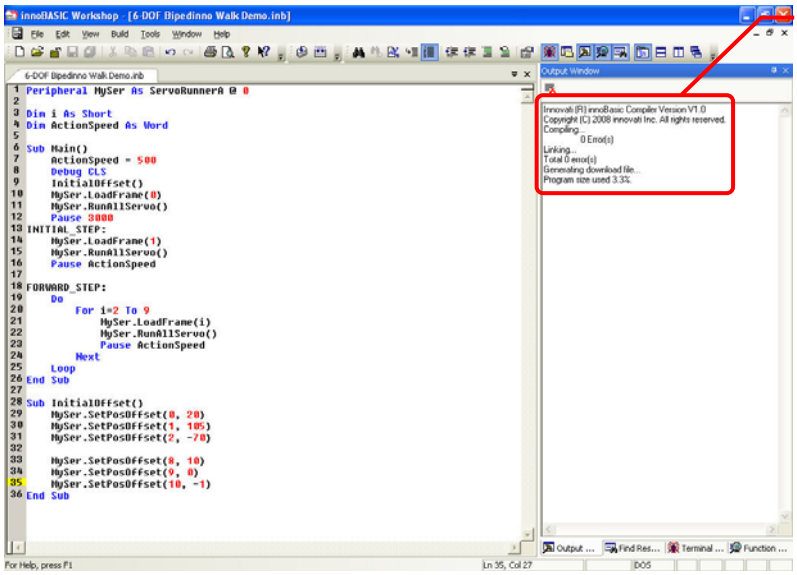
The SetPosOffset command has two parameters: one is the Servo ID and the other is the fine tune value. Please enter the fine tune value according to the value recorded for each servo ID. The number in the figure is arbitrarily defined, Please do not enter the same number as shown in the figure.

4_17. **Slide the power switch from the 1 position to the 0 position to prevent the robot from starting the motion directly after the program is successfully created.**

4_18. **Press the "Build" button and wait until the download is complete.**



If the user is not sure about the function of each button, the user can move the mouse pointer over the image. After a while, the English name will automatically appear. After click the "Build" button, the program will be downloaded into the BASIC Commander® and stored automatically.
According to the layout, the "Build" button may appear at different position.



After the download is complete, the output window will display the used memory space. If there is any error, it will be displayed in the output window. Please make sure that no error is displayed in the output window.

4_19. **Remove the USB cable that has been connected to the robot and place the robot at a location prepared for performing the motion operations.**

4_20. **Slide the power switch from the 0 position to the 1 position. The robot will perform a forward movement according to the demonstrative program.**