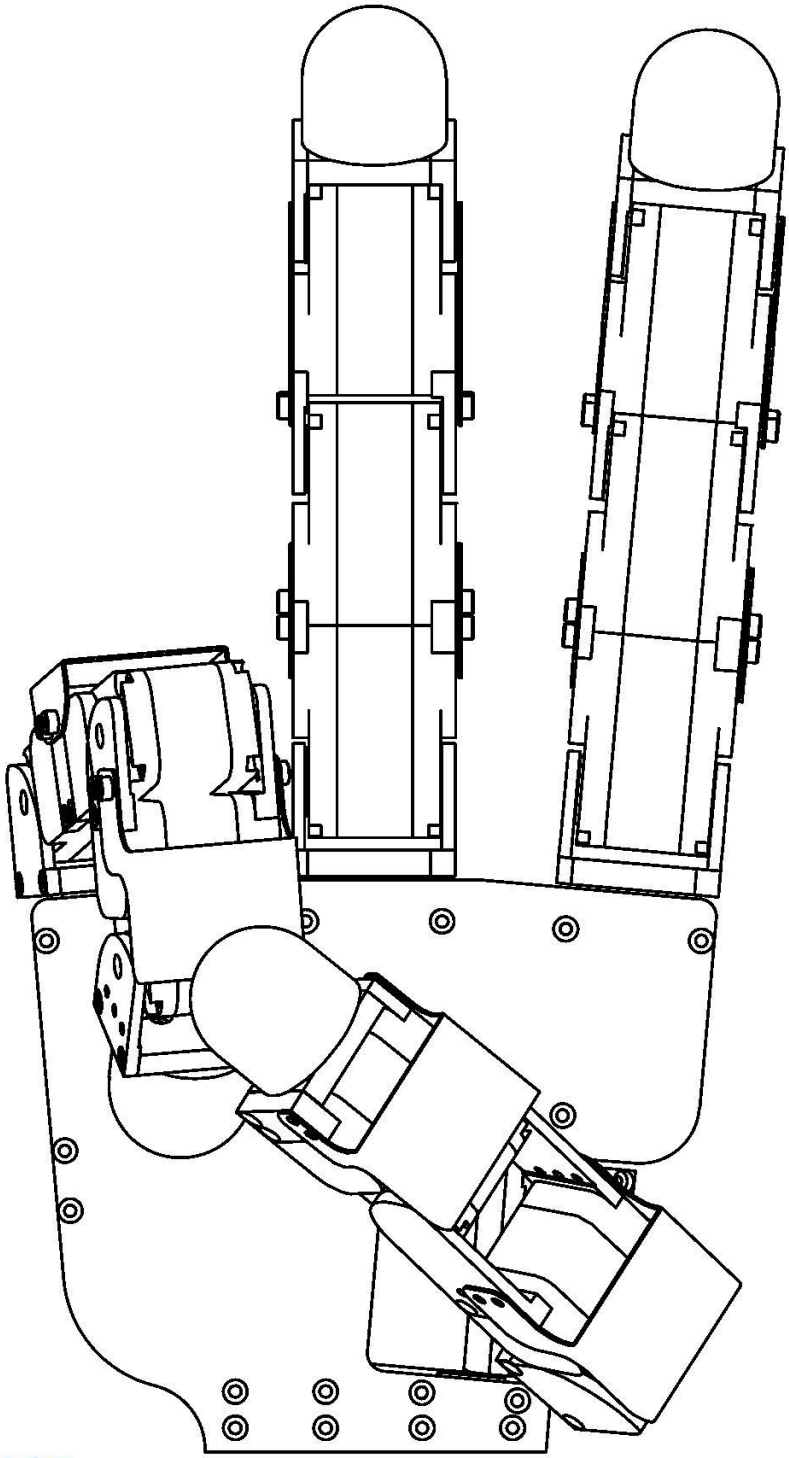
Allegro Hand

User's Manual



WONIK ROBOTICS

wiki.wonikrobotics.com/AllegroHandWiki

Allegro Hand User's Manual v4.0

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In The Box

Included are the software and hardware necessary to get you started.

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Power Supply

Power provided to the Allegro Hand must meet the following specifications:
A power supply meeting these requirements can be purchased along with the Allegro Hand

Voltage: 12V - 24V

Amperage: 120W

Wiki for Users

All information provided in this user's manual along with a forum and tutorials is available at **wiki.wonikrobotics.com/AllegroHandWiki**

Allegro Hand Overview

Allegro Hand is a low-cost and highly adaptive robotic hand.

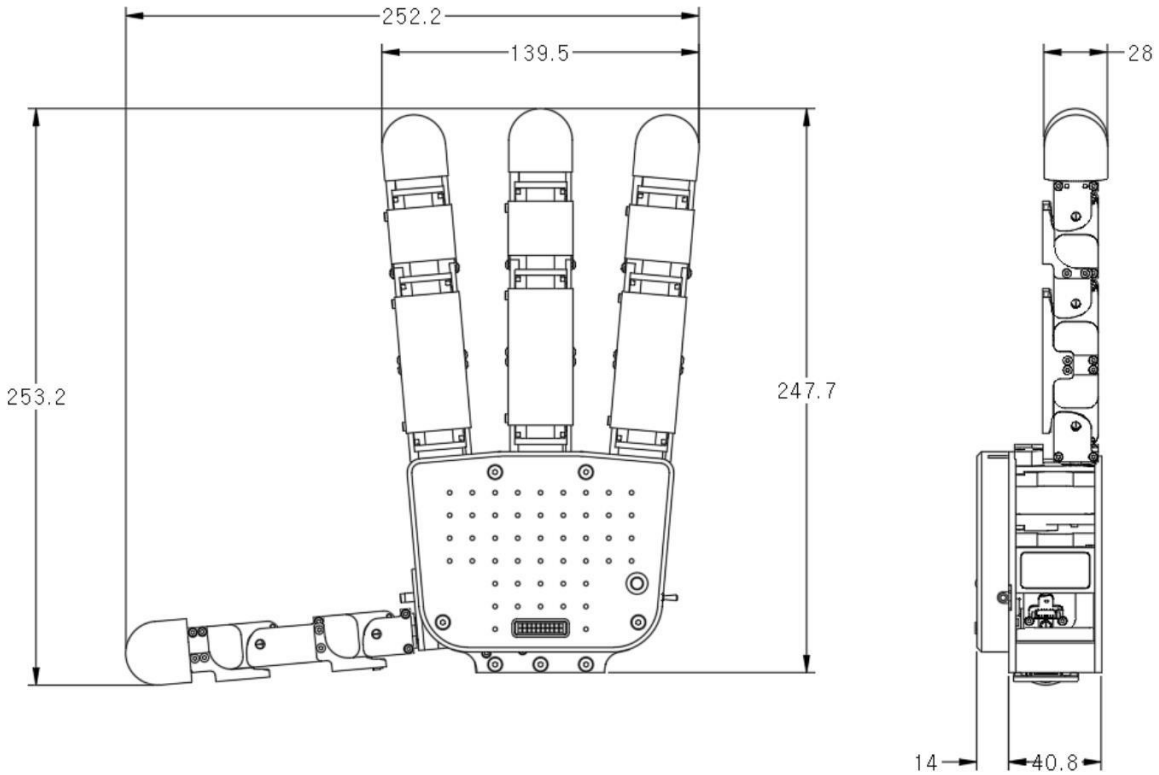
With four fingers and sixteen independent current-controlled joints,
it's the perfect platform for grasp and manipulation research.

Features

- Lightweight and portable anthropomorphic design
- Low-cost dexterous manipulation with applications in research and industry
- Multiple ready-to-use sensorless grasping algorithms capable of handling a variety of object geometries
- Capable of holding up to 1.5kg
- 16 independent current-controlled joints (4 fingers x 4 DOF ea.)
- Support for real-time control and online simulation

Technical Specifications

Number of Fingers	*Three (3) fingers and a thumb (1) = 4*	
Degrees of Freedom	*4 fingers x 4 = 16 (Active)*	
Actuation	*Type* *Gear Ratio* *Max. Torque* *Overdrive Torque*	*DC Motor* *1:369* *0.70 (Nm)* *0.90 (kg)*
Weight	*Finger* *Thumb* *Total*	*0.17 (kg)* *0.19 (kg)* *1.20 (kg)*
Joint Resolution	*Measurement* *Resolution (nominal)*	*Potentiometer* *0.002 (deg)*
Communication	*Type* *Frequency*	*CAN* *333 (Hz)*
Power Requirement	*12~24V, 120W*	



System Requirements

CPU	Intel® Core™2 Duo or higher
RAM	at least 2GB
HDD	at least 2GB
Graphics	OpenGL 3.0 H/W Acceleration enabled with at least 64Mb of video RAM
OS	MS Windows® XP, MS Windows® Vista,0.19 MS Windows® 7
Additional S/W	MS Visual Studio®
Communication	NI or PEAK CAN ***Note:*** *Any CAN interface can be user-configured for use with the Allegro Hand.*

Related Products

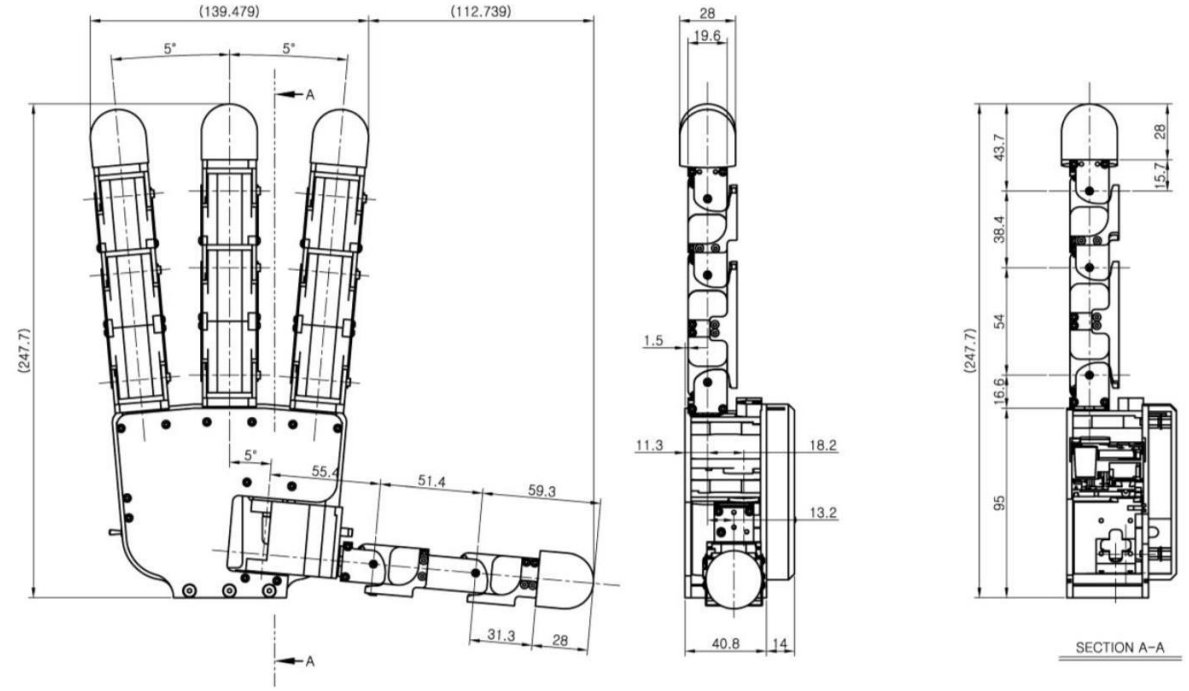
ROBOTICSLAB

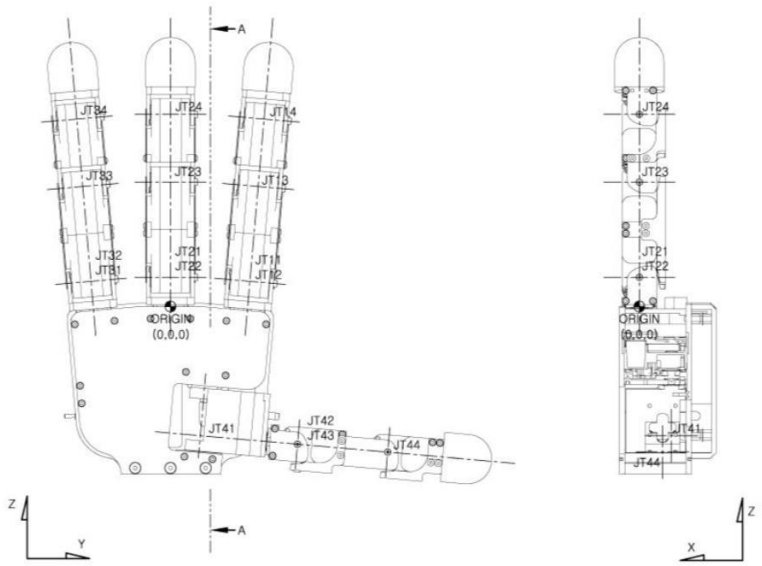
Paired with our RoboticsLab development environment, the user can take full advantage of robust dynamics and system control engines as well as out feature-rich controls SDK. RoboticsLab also enables users to easily model custom robots and test environments in 3D and add built-in and custom sensors, actuators and other devices. RoboticsLab provides the flexibility necessary to prototype and test control algorithms for any system.

For more information, please visit our RoboticsLab website:
www.wonikrobotics.com/RoboticsLab.htm

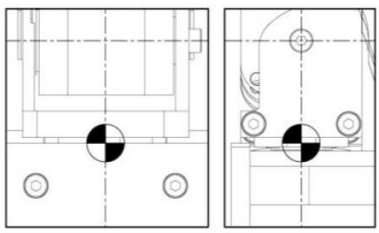
Joint Dimensions

All dimensions are displayed in millimeters (mm) and degrees.





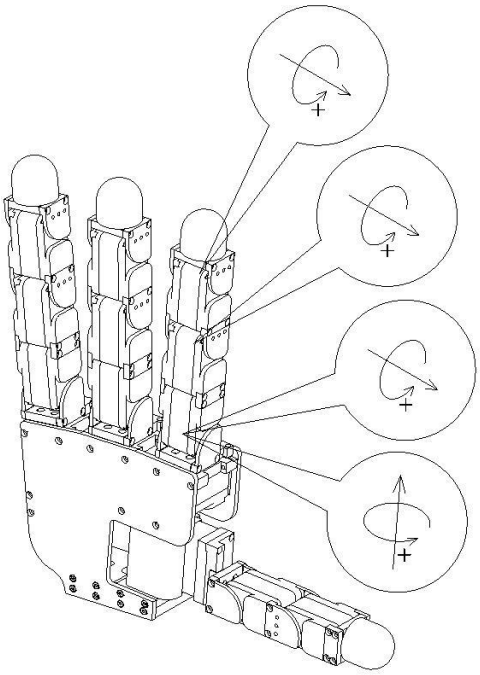
Joint	X / Y / Z
JT11	0 / 45.098 / 14.293
JT12	0 / 45.098 / 14.293
JT13	0 / 49.804 / 68.087
JT14	0 / 53.151 / 106.341
JT21	0 / 0 / 16.6
JT22	0 / 0 / 16.6
JT23	0 / 0 / 70.6
JT24	0 / 0 / 109
JT31	0 / -45.098 / 14.293
JT32	0 / -45.098 / 14.293
JT33	0 / -49.804 / 68.087
JT34	0 / -53.151 / 106.341
JT41	-18.2 / 16.958 / -73.288
JT42	-13.2 / 72.147 / -78.116
JT43	-13.2 / 72.147 / -78.116
JT44	-13.2 / 123.351 / -82.596

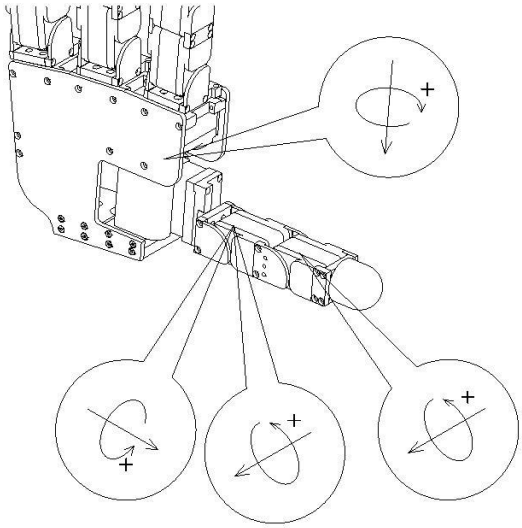


Origin Detail

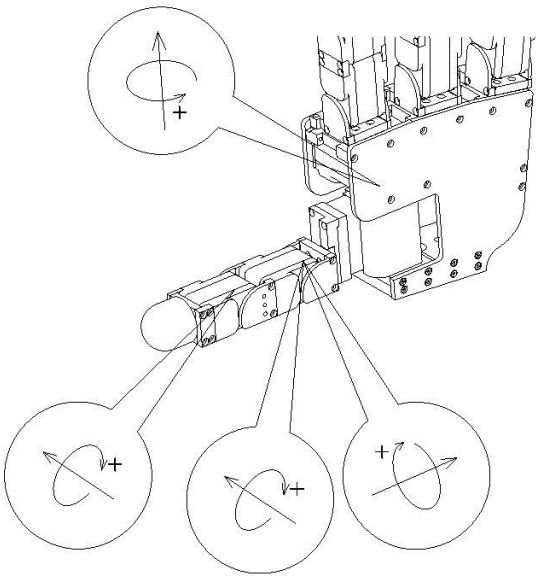
Joint Directions

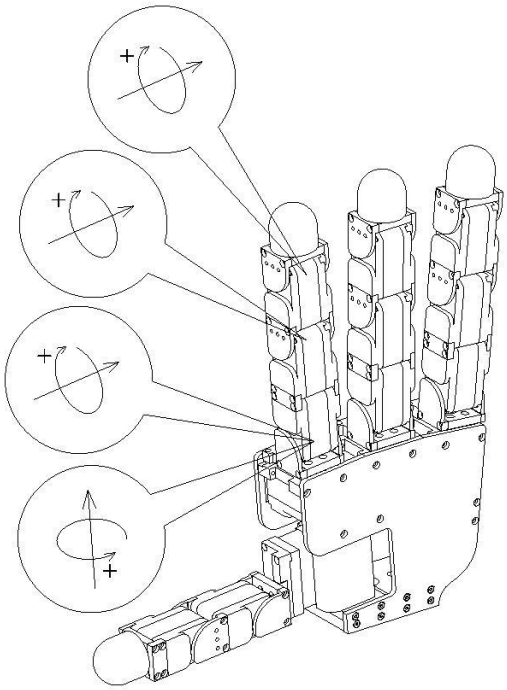
Right Hand





Left Hand



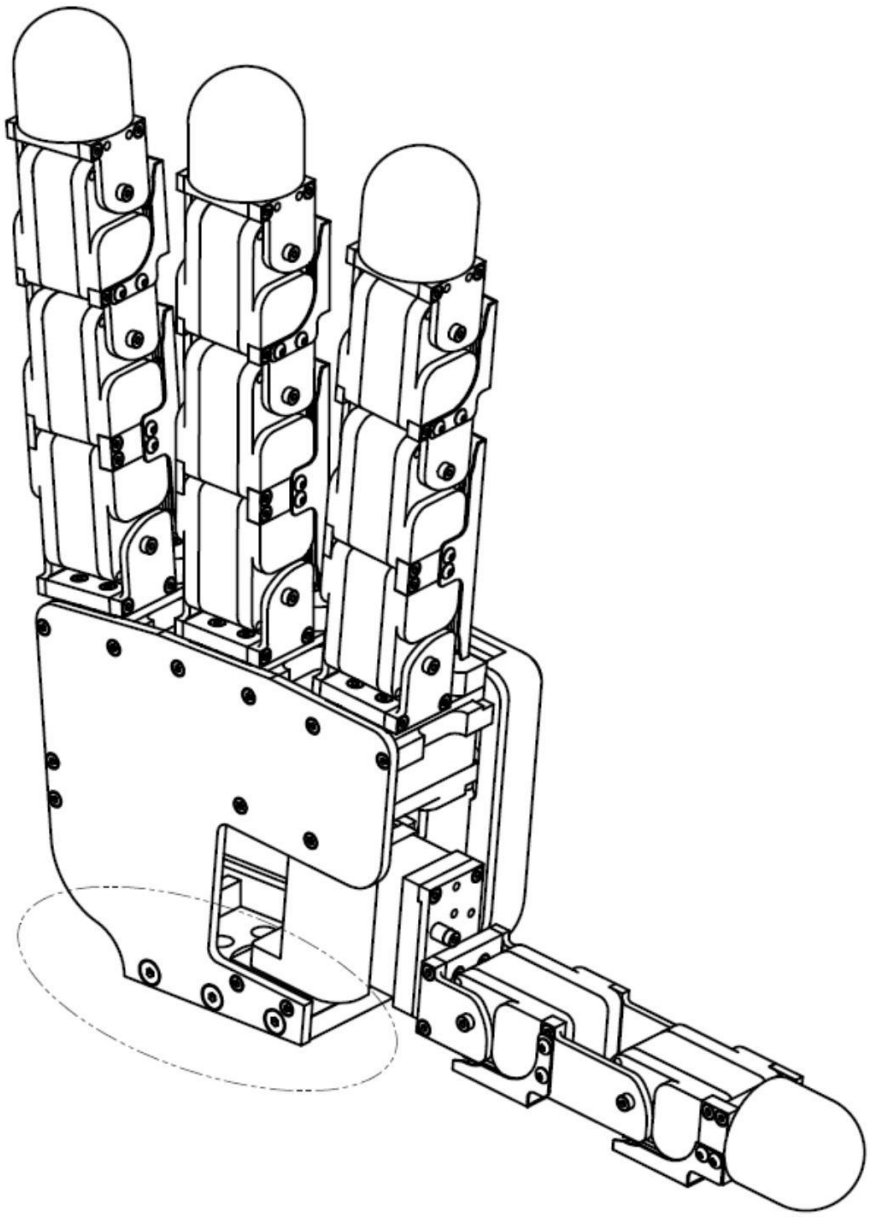


Mounting the Allegro Hand

All dimensions are displayed in millimeters (mm) and degrees.

Mounting Block Removal

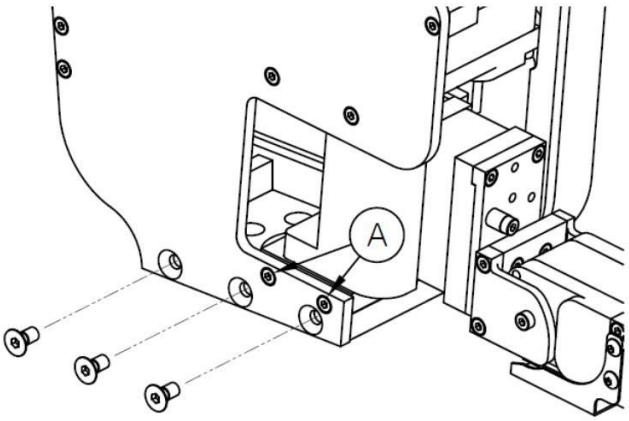
The mounting block is connected to the Allegro Hand using six (6) M3 flat-head screws (3 on each side).



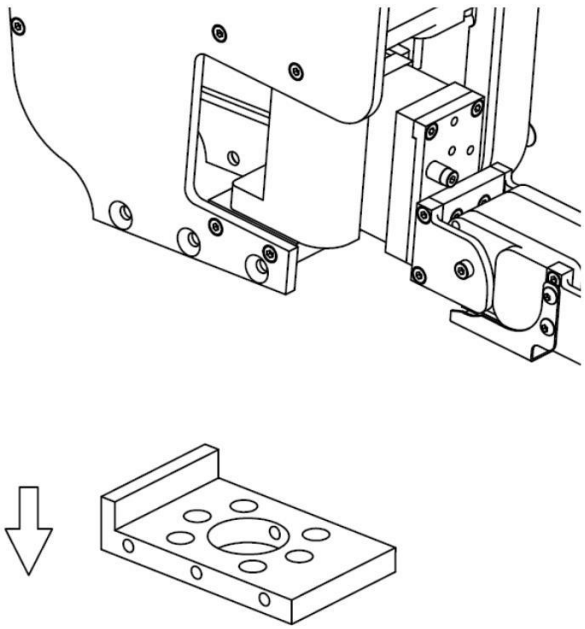
Remove three (3) screws on either side of the hand.

DO NOT remove the two (2) screws labeled A or the corresponding screws on the other side of the hand.

Note: *Secure the hand while unscrewing the mounting block to avoid dropping the hand once disconnected.*



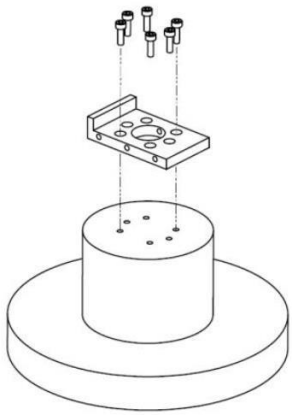
Once the six (6) screws have been removed, the mounting block can be removed from the bottom of the hand.



Mounting

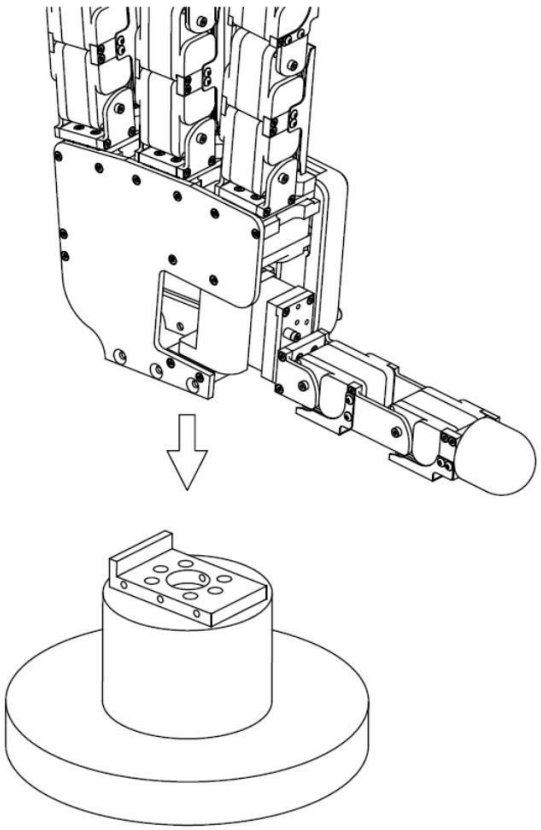
The block can be mounted to a surface using six (6) M3 socket-head cap screws.

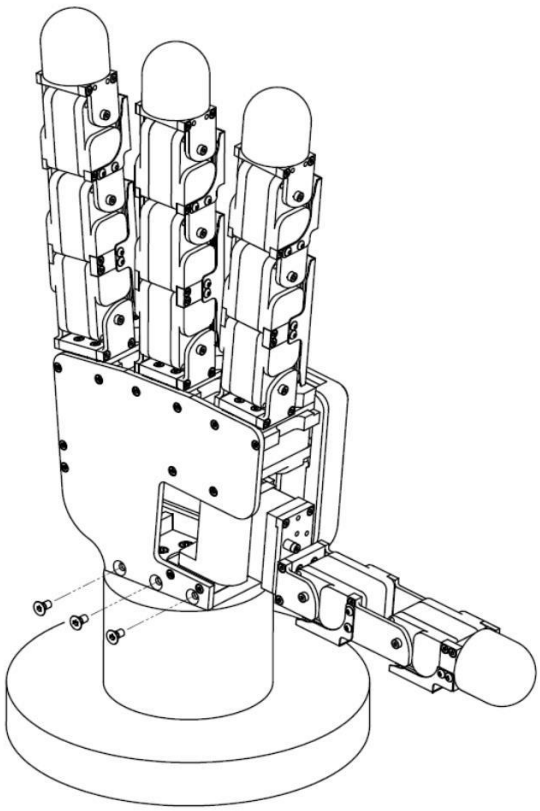
Note: *The hand should be mounted to a raised area so as to avoid thumb-mount interference during hand movement.*



Reassembly

Place the hand onto the mounting block and replace the six (6) M3 flat-head screws (3 on each side).

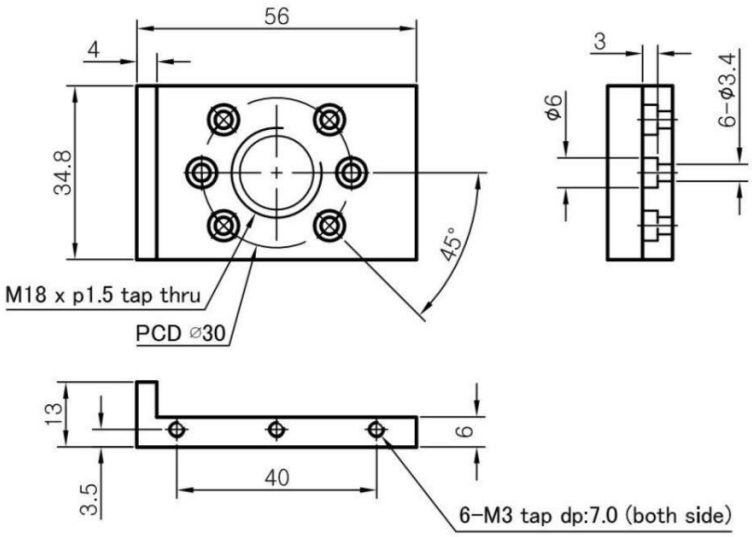




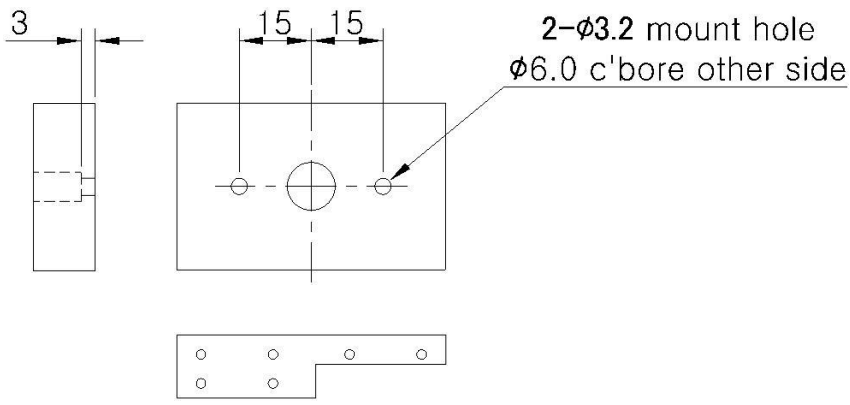
Mount Block Dimensions

The relevant dimensions of the mounting block are presented in millimeters (mm).

4.x, 3.x:



2.x:



Allegro Hand Wiring

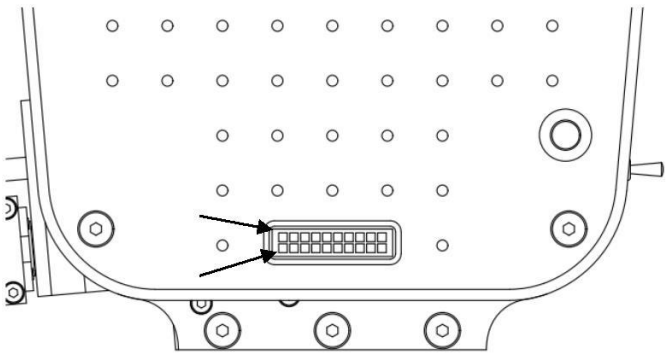
Wiring

On the back of the Allegro Hand, you will see a connector. This connector is used to supply power to hand. It also has external interfaces. Connector used is JST PHD series 20 position part

	Part Name	Note
PCB Header	JST B20B-PHDSS	
Plug Housing	JST PHDR-20VS	Crimp : SPHD-001T-P0.5

Connector Pinout

No.	I/O	Description	No.	I/O	Description
1	PWR	Power In. +12~24V	2	PWR	Power In. +12~24V
3	PWR	Power In. 0V	4	PWR	Power In. 0V
5	I/O	CAN H	6	I/O	CAN L
7	I/O	RS-485 A	8	I/O	RS-485 B
9	O	DC 3.3V/100mA	10	O	GND
11	I	F1	12	I	F2
13	I	F3	14	I	F4
15	I	F5	16	I	F6
17	I	F7	18	I	F8
19	I	F9	20	I	F10



Power

The Allegro Hand must be powered by DC +12~24V, 120W power supply. If a capacity of power supply is not sufficient, It will not work properly.

Once the power is supplied at the rated values, the power switch on the back of the Allegro Hand can be switched on (upward towards the fingers) to provide power to the hand.

CAN Driver Installation

Your CAN interface, USB (NI, PEAK), should be installed or plugged in to you computer before installing the proper drivers.

CAN Hardware drivers, if not included with the hardware, can be downloaded from the respective manufacturer's website. For the two CAN interfaces available through WONIK ROBOTICS, product drivers and documentation are available at the following websites.

Note: *After installation, check in Start Menu > Control Panel > Device Manager to make sure that a driver has installed successfully.*

NI USB-8473s CAN

Product Page: *sine.ni.com/nips/cds/view/p/lang/en/nid/203385*

Driver Page: *joule.ni.com/nidu/cds/view/p/id/3152/lang/en*

PEAK PCAN-USB (Drivers available for Windows and Linux)

Product Page: *http://www.peak-system.com/PCAN-USB.199.0.html?&L=1*

Driver Page: *http://www.peak-system.com/forum/viewtopic.php?f=119&t=66*

Note: *You may be required to reboot after your CAN driver installation.*

Any of the CAN interface devices mentioned about can be purchased through WONIK ROBOTICS.

CAN Protocol

The Allegro Hand designed with CAN specification 2.0

Baud-Rate

The CAN communication baud-rate is 1Mbps.

Non-Periodic Communication

Messages can be sent to initialize or stop CAN communication.

Remote frame can be used to request data. If host sends remote frame, the Allegro Hand responds with it regardless periodic communication status.

Periodic Communication

The Allegro Hand control software attempts to communicate with the real or simulated hand at a regular control interval. Every 3 milliseconds, the joint torques are calculated and the joint angles are updated.

CAN Frames

Arbitration Identifier

The Allegro Hand uses 11 bit standard arbitration identifier. It is composed with two part.

MSB	9	8	7	6	5	4	3	2	1	LSB
Message ID									Device ID	

Message ID

Message	Message ID	RTR	Description
Servo ON	0x040		Engage joint motor driver
Servo OFF	0x041		Disable joint motor driver
Set Torque Finger 1	0x060		Set torque of finger #1
Set Torque Finger 2	0x061		Set torque of finger #2
Set Torque Finger 3	0x062		Set torque of finger #3
Set Torque Finger 4	0x063		Set torque of finger #4
Set Position Finger 1	0x0E0		Set position of finger #1
Set Position Finger 2	0x0E1		Set position of finger #2
Set Position Finger 3	0x0E2		Set position of finger #3
Set Position Finger 4	0x0E3		Set position of finger #4
Set Periodic Read	0x081		Set periodic read interval for position, IMU, temperature, status
Config	0x068		Set Device ID, Baud-rate for RS-485
Information	0x080	R	Product information and status
Serial	0x088	R	Product serial number
Position Finger 1	0x020	R	Current angle position of finger #1
Position Finger 2	0x021	R	Current angle position of finger #2
Position Finger 3	0x022	R	Current angle position of finger #3
Position Finger 4	0x023	R	Current angle position of finger #4
IMU	0x030	R	Current IMU quaternion
Temperature Finger 1	0x038	R	Current temperature of finger #1
Temperature Finger 2	0x039	R	Current temperature of finger #2
Temperature Finger 3	0x03A	R	Current temperature of finger #3
Temperature Finger 4	0x03B	R	Current temperature of finger #4
Status	0x010	R	Current Status

Messages marked with RTR can be sent by host in remote frame, and the Allegro Hand will respond it.

Device ID

Multiple Allegro Hand can be used in the same CAN bus. In such case, Device ID field is used to distinguish each device.

Default device ID is 0, and it can be configured using **Config** message. Changed Device ID is stored in internal non-volatile memory and will be retained for power cycle.

Data Structure

Each message has different data filed format. All multi-byte data structures in data filed uses little endian.

Servo ON
Data Length = 0

This message does not have data field.

Servo OFF
Data Length = 0

This message does not have data field.

Set Torque Finger #
Data Length = 8

Each finger has 4 joints. This message sets joint torque set-point. Torque set-point is 2 byte signed digit. Data field is composed as below.

Torque Data[0:7]							
0	1	2	3	4	5	6	7
Joint 1		Joint 2		Joint 3		Joint 4	

Set Position Finger #
Data Length = 8

Each finger has 4 joints. This message sets position set-point. Position set-point is 2 byte signed digit. Data field is composed as below.

This message is not implemented yet.

Position Data[0:7]							
0	1	2	3	4	5	6	7
Joint 1		Joint 2		Joint 3		Joint 4	

Set Periodic Read
Data Length = 8

This message sets periodic report interval. Period is configured in milli-second. If period is set to 0, that message will not be reported periodically.

Period Data [0:7]							
0	1	2	3	4	5	6	7
Position		IMU		Temperature		Status	

Config
Data Length = 6

This message sets Device ID and RS-485 baud-rate. If **SET** field bit is marked, corresponding data will be stored in internal non-volatile memory.

Config Data [0:5]					
0	1	2	3	4	5
SET	Dev.ID	RS-485 baud-rate			

SET field is structured as below.

SET field bit flag							
MSB	6	5	4	3	2	1	LSB
x	x	x	x	x	x	Baud-rate	Dev. ID

Dev.ID field is structured as below.

Dev.ID field bit							
MSB	6	5	4	3	2	1	LSB
x	x	x	x	x	x	Device ID	

Baud-rate field is structured as below.

Baud-rate filed [31:0]				
MSB	30	…	1	LSB
Baud rate in bps				

Information
Data Length = 7

Information message is composed with hardware version, firmware version, palm temperature, status flag. The Allegro Hand sends this message when the host request by remote frame.

Information Data [0:6]						
0	1	2	3	4	5	6
Hardware Ver.		Firmware Ver.		L/R	Temp	Stat

Hardware Ver. And **Firmware Ver.** Is 2 byte number.

L/R field shows which side hand is. If this field is 0, it means the Hand is right hand.

Temp. field shows palm temperature. Represented in signed Celsius degree.

Stat field represents current status. The same data can be retrieved using **Status** message.

Stat. field bit flag							
MSB	6	5	4	3	2	1	LSB
x	x	x	F4	F3	F2	F1	S

- S : Servo status. 0 means servo OFF.
- F1 : One or more of joints is in high temperature fault state.
- F2 : One or more of joints is in high temperature throttling state.
- F3 : One or more of joints is in communication timeout state.
- F4 : Palm is in high temperature fault state.

Serial
Data Length = 8

Serial number can be retrieved using CAN interface. It is stored in ASCII characters. The Allegro Hand sends this message when the host request by remote frame.

Position Finger #
Data Length = 8

Joint position is reported through this message format. The Allegro Hand sends this message when the host request by remote frame or report period comes. All values are represented as signed 2 byte integer.

Position Data[0:7]							
0	1	2	3	4	5	6	7
Joint 1		Joint 2		Joint 3		Joint 4	

Joint angle can be calculated by this equation

$$\text{angle[rad]} = \frac{(\text{position data}) * 2 * \pi}{32767 * 330}$$

IMU
Data Length = 8

The pose of device is measured by IMU and reported through this message format. The Allegro Hand sends this message when the host request by remote frame or report period comes. All values are represented as signed 2 byte integer.

Quaternion Data[0:7]							
0	1	2	3	4	5	6	7
Quaternion W		Quaternion X		Quaternion Y		Quaternion Z	

Temperature Finger #
Data Length = 4

The temperature of joint is reported through this message format. The Allegro Hand sends this message when the host request by remote frame or report period comes. All values are represented as signed 1 byte integer.

Temperature is represented as Celsius degree.

Temperature Data[0:3]			
0	1	2	3
Joint 1	Joint 2	Joint 3	Joint 4

Status
Data Length = 1

Hand Status can be retrieved by this message. The Allegro Hand sends this message when the host request by remote frame or report period comes.

Status bit field is same with **Stat** field in **Information** message.

Using Allegro Hand Sample Program

Download Sample Program

The Allegro Hand sample program is available to download from git repository. There are windows and linux programs so you can test it on both environments.

windows : https//github.com/simlabrobotics/allegro_hand_windows_v4.git

linux : https//github.com/simlabrobotics/allegro_hand_linux_v4.git

BHand Library
BHand Library provides several grasping algorithms that users can integrate with their robot research such as robot arms. You might start with the sample program which is mentioned above to experience this library. Please check commands below before executing.

Home
Press “H” button on a keyboard. The position assumed by the Allegro Hand is a starting position that ensures that all joints are oriented properly for executing a grasp.

Ready
Press “R” button on a keyboard to prepare for each type of grasping motion.

Note: *For the virtual hand, you will notice the finger joints sagging if left in ready mode too long. As the finger tip locations are controlled, all joint angles do not necessarily matter. Due to the lack of friction found in the actual system, the ready position does not remain constant. In this case, simply push Home then Ready again to prepare for a grasp.*

Grasp 3
Press “H” and “R” button on a keyboard to prepare the hand for a grasp.

Now press “G” button. This grasping algorithm is a torque-controlled, three-fingered grip. This grasp can be used for pick-and-place style object grasping as the object is held between the tips of the thumb, index and middle fingers.

Grasp 4
Press “H” and “R” button on a keyboard to prepare the hand for a grasp.

Press “K” button. This grasping algorithm is a torque-controlled, four-fingered grip. This grasp can be used for pick-and-place style object grasping as the object is held between the tips of the thumb and three fingers.

Pinching with index finger
Press “H” and “R” button on a keyboard to prepare the hand for a grasp.

Press “P” button. This grasping algorithm is a torque-controlled, two-fingered pinch. This grasp can be used for pick-and-place style object grasping and more dexterous manipulation as the object is held between the tips of the thumb and the index finger.

Pinching with middle finger
Press “H” and “R” button on a keyboard to prepare the hand for a grasp.

Press “M” button. This grasping algorithm is a torque-controlled, two-fingered pinch. This grasp can be used for pick-and-place style object grasping and more dexterous manipulation as the object is held between the tips of the thumb and the middle finger.

Envelop
Press “H” and “R” button on a keyboard to prepare the hand for a grasp.

Press “E” button. This grasping algorithm can be used to fully envelop an object within the hand's four fingers. This algorithm can handle a variety of object geometries.

Power Off
Press “O” button to stop sending PWM signal. In this mode, you can still get encoder values.

Technical Support

The newest versions of all documents found in this manual can be found in the Allegro Hand wiki at

wiki.wonikrobotics.com/AllegroHandWiki

A forum is also available on the wiki where users can share problems and solutions with each other and with WONIK ROBOTICS. Upon request, you may be granted editing access to the wiki to host your tutorials and samples of your work. In fact, we would love to collaborate.

For any further questions please contact us.

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Please enjoy your Allegro Hand,
and feel free to share your success stories and videos!