
# robo-limb manual

touch bionics

Part number: MA01179: Issue No. 5, August 2016

robo-limb tm

This document provides instruction for the use and servicing of robo-limb and should be read in full prior to use.

This symbol signifies important information and is used throughout the manual.

# Table of Contents

# 1.0 robo-limb

## 1.1 Product Description

robo-limb is an externally powered, multi-articulating hand which offers a range of features beyond the functions of the traditional robotic hand. robo-limb allows users to test findings with robotic control and gives the user capability to control each of the 4 fingers and the motorized or manually rotatable thumb to suit their needs.

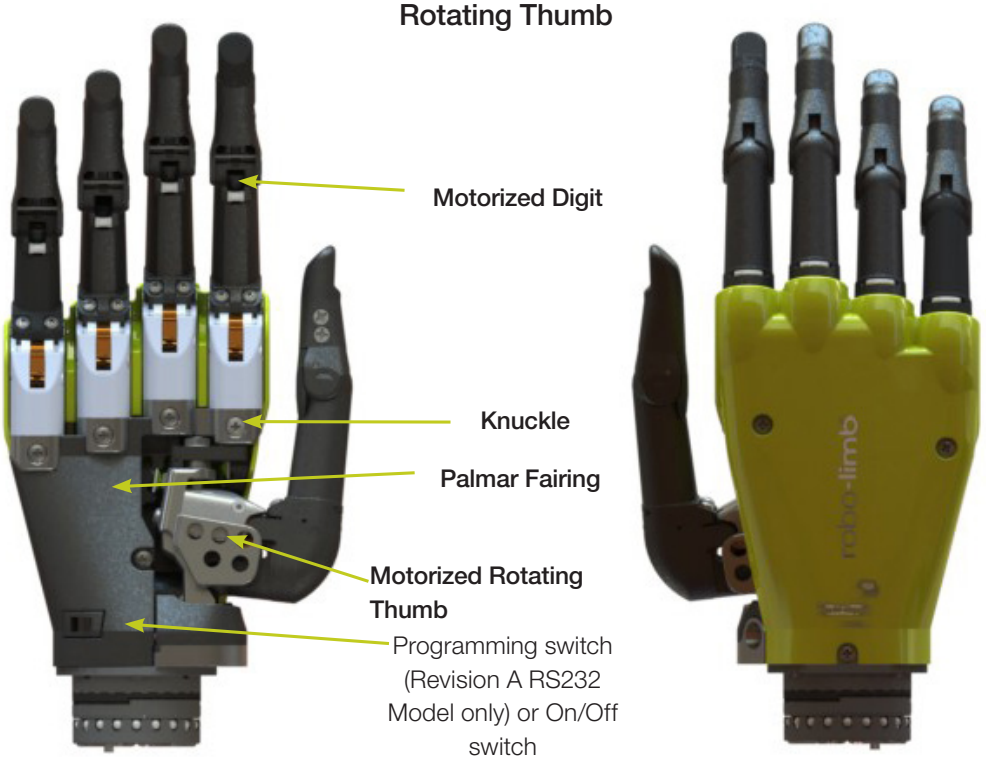

The control of the hand can be performed either via RS232 or CANbus. The most popular method is via CANbus (Controller Area Network bus)

## 1.2 robo-limb Overview

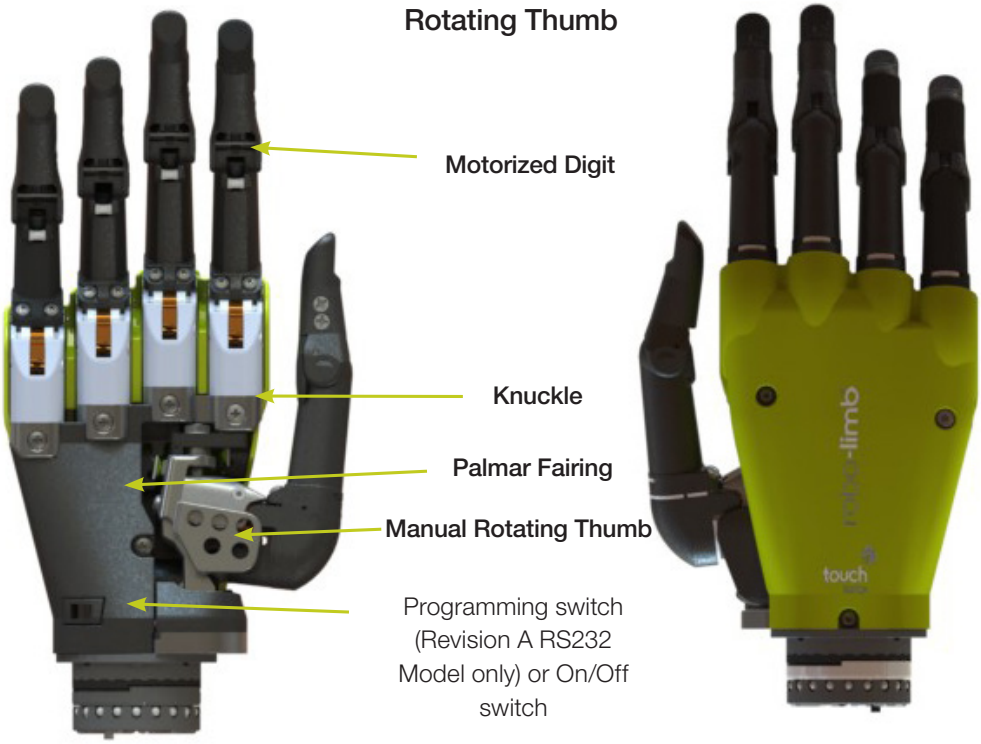
robo-limb is available in black with green dorsal cover. The hand serial number is positioned proximal to the base of the thumb on the connection plate. The serial numbers follow the pattern of CUxxxx for CANbus with a manual rotating thumb, CRxxxx (fig. 1) for CANbus with a powered rotating thumb, URxxxx for RS232 with powered rotating thumb, and UUxxxx for RS232 with manual rotating thumb.

**Figure. 1**

## robo-limb with Powered Rotating Thumb




## robo-limb with Manual Rotating Thumb



# 2.0 Power Supply and RS232 Wiring

## 2.1 Power Supply (V+):

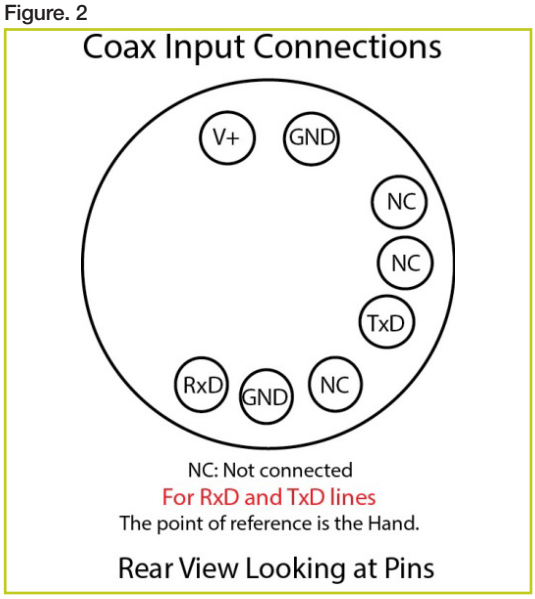
Power to the hand should be supplied by a 7.4V (7A peak) bench PSU or use the battery and charger supplied. 7.4V is the normal operating voltage for the hand (fig. 2)

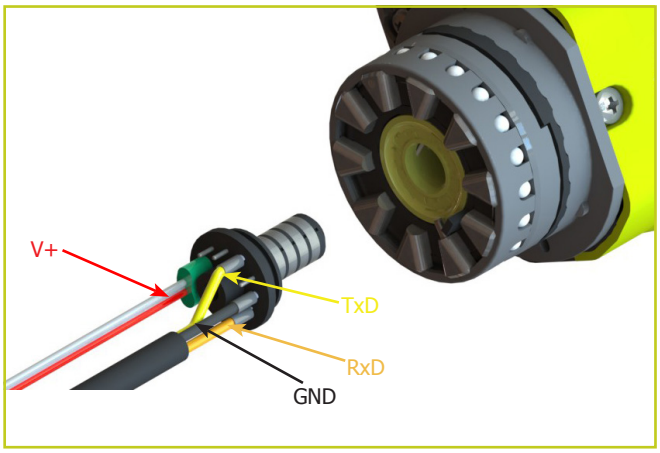
**Revision A only: to communicate with the hand, have the programming switch set to "ON". The "OFF" position allows connection with the APP.**

**DO NOT AT ANY TIME EXCEED VOLTAGES OF 8.3V AS THIS WILL CAUSE PERMANENT DAMAGE**

**Note:**
**RxD = Receive Data**
**TxD= Transmit Data**

Figure. 2



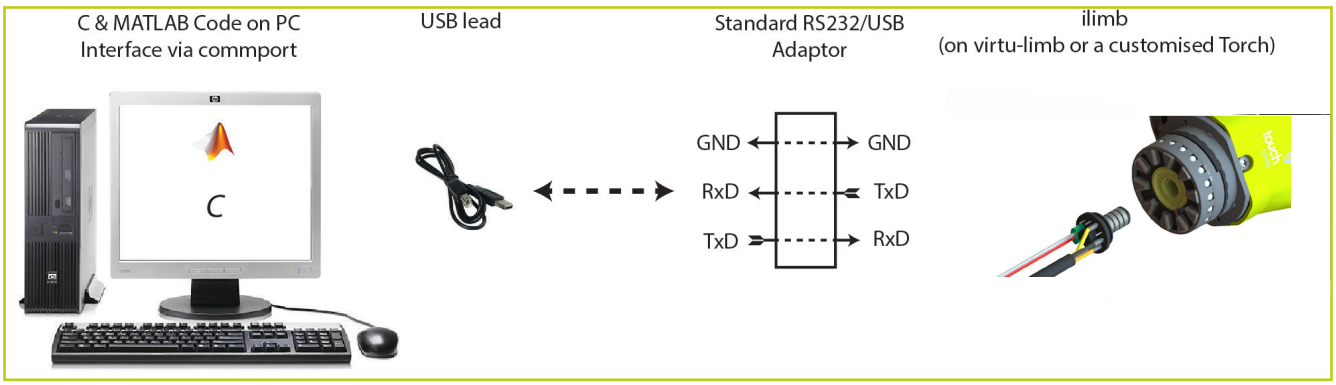



## 2.2 Connect to a PC

Simple and intuitive open-loop control of individual digits motion
at 7 discrete velocities.

Text-based commands run on for example standard C, MATLAB platforms or terminal emulator software (fig. 3).

Figure. 3




## 2.3 RS232 Protocol Specifications

USB/RS232 Configurations via COM port (fig. 4):

- Baud Rate: 115200
- Data bits: 8 bits
- Parity: No
- Stop Bit: 1
- Flow control: None

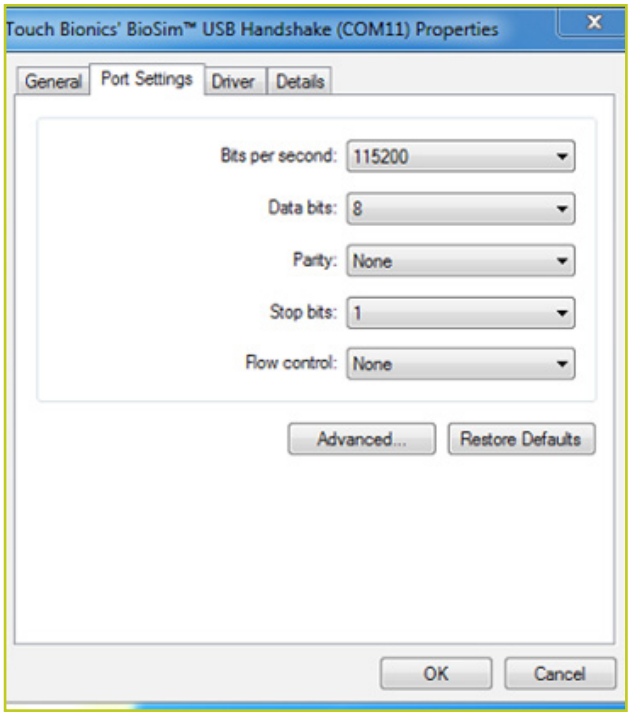
**Once the hardware is connected to USB adaptor, please wait for a couple of seconds for initialisation. Afterwards, you can start programming/running the hand.**

**When programming in C or MATLAB you should send a carriage return (CR) as the Terminator. e.g. in MATLAB use:**

- **LINK = serial('COM11');**
- **set(LINK,'Terminator','CR');**

**The choice of COM port is arbitrary. "11" is just an example.**

Figure. 4



# 3.0 Text Based Commands

## 3.1 Control Commands

robo-limb can be controlled by computer with set of simple text based commands of format:

- $d_1\,\mathrm{X}_1\,d_2\,\mathrm{X}_2\,d_3\,\mathrm{X}_3\,d_4\,\mathrm{X}_4\,d_5\,\mathrm{X}_5\,d_6\mathrm{X}_6$ where $d_i$ denotes direction of thumb $i$ and $\mathrm{X}_i$ represents the velocity of motor $i$
- $\mathrm{d}\in\{+,-\}$ and $F\in\{0,1,2,\cdots 7\}$

Motor Order: Thumb-Index-Middle-Ring-Little-Rotating Thumb

For manual rotating thumb last command should be +0 or -0

A few examples are:

- To OPEN all fingers at FASTEST velocity use: fprintf(LINK,'+7+7+7+7+7+0');
- To OPEN all fingers at SLOWEST velocity use: fprintf(LINK,'+1+1+1+1+1+0');

- To CLOSE all fingers at FASTEST velocity use: fprintf(LINK,'-7-7-7-7-7-0');
- To CLOSE all fingers at SLOWEST velocity use: fprintf(LINK,'-1-1-1-1-1-0');

- To OPEN Thumb only at velocity 5 without moving any other finger use: fprintf(LINK,'+5+0+0+0+0+0');

**When you want to change the movement direction of a finger, you should stop the finger first with sending "+0+0+0+0+0+0" and then the command for reversing the direction**

Assume the scenario that you would like change the movement direction of thumb and index fingers (with velocity -6) that are currently opening at speed e.g. +3. You have sent fprintf(LINK,'+3+3+3+3+3+0') less that 1.2 s ago (the time it takes for the hand to fully flex).

You should first send fprintf(LINK,'+0+0+3+3+3+0') to stop those fingers and then after 10 ms, you should send fprintf(LINK,'-6-6+3+3+3+0').

Finer speed control can be achieved by setting the PWM level to each motor.

- To CLOSE all fingers at FASTEST velocity use:
- fprintf(LINK,'P-297-297-29
- 7-297-297-297');
- To OPEN all fingers at FASTEST velocity use:
- fprintf(LINK,'P+297+297+297+297+297+297');
- Valid values are 0 to 297

Feedback from motors:

Default streaming is enabled when powered on.

- Send DI?(D & I must be capitalized) to poll the current motors feedback
- Send DI0 to disable streaming of feedback messages
- Send DI1 to enable streaming of feedback messages

Feedback is sent approx every 20 milliseconds

- Value is 12 bit, left justified
- Divide by 21825 to convert to Amps

Sent out as "I" followed by "Feedback of thumb, Feedback of index, Feedback of middle, Feedback of ring, Feedback of little, Feedback of rotator"

To get the information about the hand

- Use fprintf(LINK,'HI?)  H & I must be capitalized

You will get the response that indicates about Build Rev, (either 'A' or 'B') Powered Thumb (1 if Powered Thumb. 0 if not), Handedness (1 if right hand, 0 if left), Size (0 if medium, 1 if small) and firmware version as FW followed by firmware version.

To get the hand ID, send following command

- Use fprintf(LINK,'ID?) I & D must be capitalized

## 3.2 Status Commands

The response to a digit status command takes the form of one status number per digit in the same order as outlined in the control section. Each number is followed by a comma for separation and easy pairing by the user. The numbers are defined below:

Digit/s status:

- 0 is idle
- 1 is closing
- 2 is opening
- 3 is stalled closed
- 4 is stalled open

For Digit/s Status query:
Use: fprintf(LINK,'DS?'); D & S must be capitalized

There is also an additional number sent that indicates whether the thumb is rotated fully palmar or fully lateral as identified by the detection switch being made as shown in the table:

- 0 thumb not fully palmar or lateral
- 1 thumb is fully palmar or lateral

Note: "1 thumb is fully palmar or lateral" is always this state in a manual thumb system and should be ignored in that case.

**Operating the digits at low speeds may result in a delay of up to 4 seconds before the correct digit status is reported**.

## 3.3 RS232 To Activate Pulsing

Pulsing can be achieved in robo-limb by the following steps:

1. Issue a close digit/s full power command
2. Poll robo-limb by sending the digit/s query state command
3. If digit/s are closed stalled, Issue a stop digit/s command
4. Wait for 16ms and then issue close digit/s full power command
5. Wait for 14ms and then issue stop digit/s command
6. Repeat steps 4 and 5 seven times and then wait for 100ms
7. Repeat steps 4, 5 and 6 four times

Note: Steps 4, 5, 6 and 7 can be repeated more than once to achieve pulsing multiple times. However to avoid lockup of the gearbox and heating of the motors, steps 4, 5, 6 and 7 MUST NOT BE REPEATED MORE THAN THREE TIMES

Note: to achieve highest grip force, pulsing should be applied at maximum speed setting.

| Force | Without Pulsing | With Pulsing |
|---|---|---|
| Power grip force | 10.2kg (100N) | 13.9Kg (136N) |
| Lateral pinch force | 2.1kg | 3.5kg |

## 3.4 Quick Grips Commands

Quick grips can be invoked in robo-limb by use of the following commands:

| Command | Grip | Description |
|---|---|---|
| QG00 | Normal | Normal hand grip |
| QG01 | Standard precision pinch closed | Middle, ring and little fingers remain fully opened and switch off. Both index and thumb will move to provide grip |
| QG02 | Standard 3 Jaw chuck (tripod) closed | Ring and little fingers automatically opened and switch off. Thumb, Index and middle fingers will move to provide grip |
| QG03 | Thumb park continuous | All four fingers remain fully open and switch off. Only thumb will move |
| QG04 | Reserved | |
| QG05 | Lateral grip | All four fingers fully close and switch off. Only thumb will move |
| QG06 | Index point | Thumb, middle, ring and little fingers fully close and switch off. Only index finger will move |
| QG07 | Standard precision pinch opened | Middle, ring and little fingers automatically close and switch off. Both index and thumb will move to provide grip |
| QG08 | Reserved | |
| QG09 | Thumb precision pinch closed | Middle, ring and little fingers automatically closed and switch off. Thumb automatically moves to a partially closed position. Only index will move to provide grip against fixed thumb |
| QG10 | Thumb precision pinch opened | Middle, ring and little fingers remain fully opened and switch off. Thumb automatically moves to a partially closed position. Only index will move to provide grip against fixed thumb |
| QG11 | Thumb 3 Jaw chuck (tripod) closed | Ring and little fingers automatically closed and switch off. Thumb automatically moves to partially closed position. Only Index and middle fingers will move to provide grip against fixed thumb |
| QG12 | Reserved | |
| QG13 | Standard 3 Jaw chuck (tripod) opened | Ring and little fingers remain fully opened and switch off. Thumb, Index and middle fingers will move to provide grip |
| QG14 | Thumb 3 Jaw chuck (tripod) opened | Ring and little fingers remain fully opened and switch off. Thumb automatically moves to partially closed position. Only Index and middle fingers will move to provide grip against fixed thumb |
| QG15- QG23 | Reserved | |
| QG24 | Donning or doffing cover | Hand forms the proper shape for donning or doffing a cover |

For example, commanding the hand to thumb precision pinch closed grip would require sending the following RS232 message: QG09

Sending the same command again will return the hand to normal grip.

Alternatively, commanding the hand to normal grip will give the same result. This would require sending the following RS232 command: QG00

To get the current grip number, send following command

- Use fprintf(LINK,'QG?) Q & G must be capitalized

## 3.5 Configuration Settings

The hand can be configured to move differently when changing grip as desired for the application. Options are set via bit-fields within the configuration parameter word as described below. These settings are retained through a power cycle.

Use: fprintf(LINK,'SCxx'); S & C must be capitalized

• Send characters x1 and x2 with the relevant characters '1' or '0' to enable/disable the configuration options.

x1 - to rotate thumb on exit from a quick grip (i.e. enter normal grip). If this is ('1'), then whenever the grip changes to normal the thumb will rotate to the palmar position. If this is ('0') then the thumb rotator will not move and the thumb will stay in its current position.

x2 - to open digits on exit from a quick grip (i.e. enter normal grip). If this is ('1'), then whenever the grip changes to normal the digits will move to the open position. If this is ('0') then the digits will remain in their current position until instructed to move, either open or close.

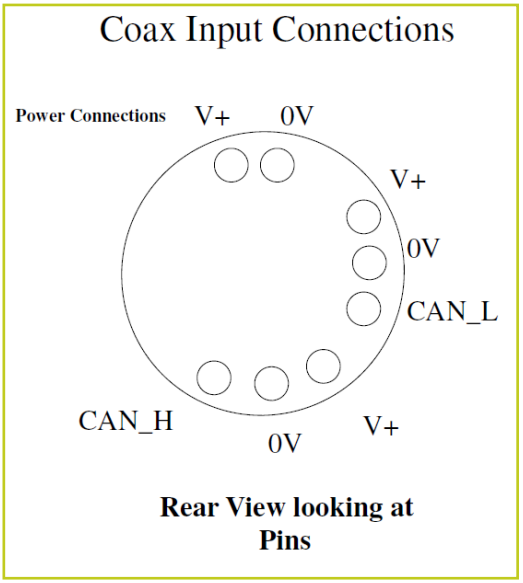
To read configuration settings: Use: fprintf(LINK,'GC?'); G & C must be capitalized

# 4.0 Power Supply and CAN bus Protocol

## 4.1 Power Supply (V+):

Power to the hand should be supplied by a 7.4V (7A Peak) bench PSU or use the battery and charger supplied. 7.4V is the normal operating voltage for the hand

**Do not at any time exceed voltages of 8.3V as this will cause permanent damage**




## 4.2 Connect to PC: Termination

A high-speed CAN bus ISO 11898-2 must be terminated on both ends with 120 Ohms. Otherwise there will be interfering signal reflections and the transceivers of the connected CAN nodes will not work.

The CAN connection is supplied un-terminated and requires to be connected to suitably terminated CAN bus.

A simple CAN Connection is shown in Fig. 5. In this example the Hand is connected to the interface by a cable that is terminated at both ends.

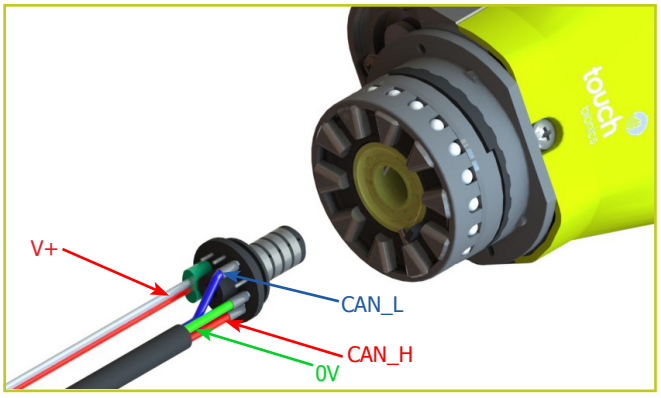
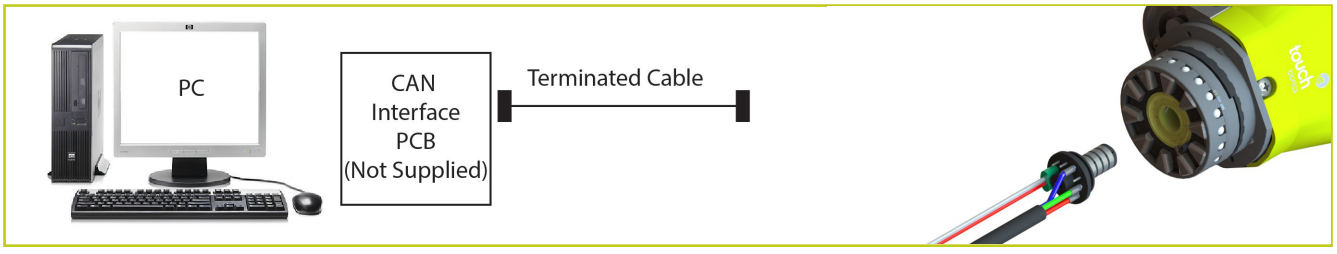



Figure. 5



## 4.3 CANbus Configuration

- Standard CAN Mode has been implemented.
- Baud rate is set to 1 Mbit/sec
- Bit Time = 10, TSEG1 = 6, TSEG2 = 1, Sampling Point = 80%
- Each message has a 4 byte payload

## 4.4 CANbus Communication Protocol

To get the connected hand serial number:

- Send CAN message from ID 0x402 with no relevant data (i.e. 4 bytes all 0) (fig. 6).

Figure. 6

| 0x402 | 0x00 | 0x00 | 0x00 | 0x00 |
|---|---|---|---|---|
| I.D | Byte 0 | Byte 1 | Byte 2 | Byte 3 |

- The hand will respond with 0x403 and 4 bytes of data being the hand type “CU” or “CR” and the serial number of the hand as a UINT16, e.g. CR1234 would return “CR” (0x43, 0x52) and 1234 (0x04D2) or 0x435204D2 (fig. 7).

Figure. 7

| 0x403 | 0x43 | 0x52 | 0x04 | 0xD2 |
|---|---|---|---|---|
| I.D | Byte 0 | Byte 1 | Byte 2 | Byte 3 |

To drive the individual motors:

- Each digit has a unique mailbox ID, 0x101,0x102, …, 0x106 (thumb, index, middle, ring, little, rotator).
- Message payload is set to 2 words, that is 2x16 bits.
- High Word contains the direction of finger or thumb
  - 0 for STOP
  - 1 for CLOSE
  - 2 for OPEN

**When you want to change the movement direction of a finger, you should stop the finger first and then the CAN message for reversing the direction**

- Low WORD contains PWM level to apply to motor to adjust speed.
  - valid values are 0 to 297

For example, commanding ring finger to close with maximum speed (297) would require sending the following 4 byte message to mailbox 0x104 (fig 8)

Figure. 8

| 0x104 | 0x00 | 0x01 | 0x01 | 0x29 |
|---|---|---|---|---|
| I.D | Not Used | Closed | PWM Value | |

**Note: 297= 0x129**

**Feedback from motors:**

Default streaming is enabled when powered on.

- To disable streaming of feedback from motors, send:
  0x40B 0x00 0x00 0x00 0x00
  I.D Byte 0 Byte 1 Byte 2 Byte 3
- To poll feedback from motors, send
  0x40C 0x00 0x00 0x00 0x00
  I.D Byte 0 Byte 1 Byte 2 Byte 3
- To enable streaming of feedback from motors, send
  0x40B 0x00 0x00 0x00 0x01
  I.D Byte 0 Byte 1 Byte 2 Byte 3

When streaming is enabled, feedback is sent every 20 milliseconds

- One mailbox used per digit with ID of 0x201,0x202 ... 0x206
- Message payload of 2 WORDS ( 2x16 bits)
  - High byte of High WORD contains thumb rotator switch status
    - 0 is thumb not fully palmar or lateral
    - 1 is thumb is fully palmar or lateral
  - Low byte of High WORD contains digit status:
    - 0 is stop
    - 1 is closing
    - 2 is opening
    - 3 is stalled closed
    - 4 is stalled open
  - Low WORD contains raw A/D value (12bit) of measured motor current draw.
    - Value is 12 bit, left justified
    - Divide by 21825 to convert to Amps

**To get information about the hand:**

0x407 0x00 0x00 0x00 0x00
I.D Byte 0 Byte 1 Byte 2 Byte 3

You will receive a response that indicates Build Rev, Powered Thumb, Handedness, Size and firmware version from ID 0x408 as:

"0x408 Build revision Powered thumb Handedness Size I.D Byte 0 Byte 1 Byte 2 Byte 3 Build revision will be 'A', 'B' etc., 1 if Powered Thumb 0 if not, 1 if right hand 0 if left, 0 if medium, 1 if small"

To get firmware version use:

0x409 0x00 0x00 0x00 0x00
I.D Byte 0 Byte 1 Byte 2 Byte 3

You will get response from ID 0x40A, e.g. for firmware version 2.4.0.34:

0x40A 0x02 0x04 0x00 0x12
I.D Byte 0 Byte 1 Byte 2 Byte 3

**Operating the digits at low speeds may result in a delay of up to 4 seconds before the correct digit status is reported**

**For example a 4 byte response from Ring Finger indicating that it was closing with a measured current draw of 87.2 mA (1904 / 21825) would look like (fig. 9)**

Figure. 9

| 0x204 | 0x00 | 0x01 | 0x07 | 0x70 |
|---|---|---|---|---|
| I.D | Not Used | Closed | Value | |

## CANbus communication messages (PWM value = 277)

| ID | Data (Byte) | Comment | Digit Mapping |
|---|---|---|---|
| 0x101 | 0 0 1 15 | Idle Thumb | Thumb |
| 0x101 | 0 1 1 15 | Close Thumb | |
| 0x101 | 0 2 1 15 | Open Thumb | |
| 0x102 | 0 0 1 15 | Idle Index | Index |
| 0x102 | 0 1 1 15 | Close Index | |
| 0x102 | 0 2 1 15 | Open Index | |
| 0x103 | 0 0 1 15 | Idle Middle | Middle |
| 0x103 | 0 1 1 15 | Close Middle | |
| 0x103 | 0 2 1 15 | Open Middle | |
| 0x104 | 0 0 1 15 | Idle Ring | Ring |
| 0x104 | 0 1 1 15 | Close Ring | |
| 0x104 | 0 2 1 15 | Open Ring | |
| 0x105 | 0 0 1 15 | Idle Little | Little |
| 0x105 | 0 1 1 15 | Close Little | |
| 0x105 | 0 2 1 15 | Open Little | |
| 0x106 | 0 0 1 15 | Idle Rotator | Rotator |
| 0x106 | 0 1 1 15 | Close Rotator | |
| 0x106 | 0 2 1 15 | Open Rotator | |

## 4.5 CANbus To Activate Pulsing

Pulsing can be achieved in robo-limb(CAN) by the following steps:

1. Issue a close digit message with maximum PWM of 297
2. Observe the digit status message until the digit status in the high word becomes 3 i-e, digit is closed stalled. Once this value is seen, issue a stop digit message
3. Wait for 16ms and then issue close digit message with PWM of 297
4. Wait for 14ms and then issue stop digit message
5. Repeat steps 3 and 4 seven times and then wait for 100ms
6. Repeat steps 3, 4 and 5 four time

**Note**: Steps 3, 4, 5 and 6 can be repeated more than once to achieve pulsing multiple times. However to avoid lockup of the gearbox and heating of the motors, steps 3, 4, 5 and 6 **MUST NOT BE REPEATED MORE THAN THREE TIMES**

**Note:** to achieve highest grip force, pulsing should be applied at maximum speed setting.

## 4.6 Quick Grip Messages

Quick grips can be invoked in robo-limb by:

- Message sent to mailbox ID 0x301
- Message payload is set to 2 WORDS, that is 2x16 bits:
  - Low byte of low word contains the desired grip
  - Each grip has a unique byte value
  - Normal grip is used to bring the hand to normal grip

| Force | Without Pulsing | With Pulsing |
|---|---|---|
| Power grip force | 10.2kg (100N) | 13.9Kg (136N) |
| Lateral pinch force | 2.1kg | 3.5kg |

| Byte Value | Grip | Description |
|---|---|---|
| 0x00 | Normal | Normal hand grip |
| 0x01 | Standard precision pinch closed | Middle, ring and little fingers remain fully opened and switch off. Both index and thumb will move to provide grip |
| 0x02 | Standard 3 Jaw chuck (tri-pod) closed | Ring and little fingers automatically opened and switch off. Thumb, Index and middle fingers will move to provide grip |
| 0x03 | Thumb park continuous | All four fingers remain fully open and switch off. Only thumb will move |
| 0x04 | Reserved | |
| 0x05 | Lateral grip | All four fingers fully close and switch off. Only thumb will move |
| 0x06 | Index point | Thumb, middle, ring and little fingers fully close and switch off. Only index finger will move |
| 0X07 | Standard precision pinch opened | Middle, ring and little fingers automatically close and switch off. Both index and thumb will move to provide grip |
| 0x08 | Reserved | |
| 0x09 | Thumb precision pinch closed | Middle, ring and little fingers automatically closed and switch off. Thumb automatically moves to a partially closed position. Only index will move to provide grip against fixed thumb |
| 0x0A | Thumb precision pinch opened | Middle, ring and little fingers remain fully opened and switch off. Thumb automatically moves to a partially closed position. Only index will move to provide grip against fixed thumb |
| 0x0B | Thumb 3 Jaw chuck (tripod) closed | Ring and little fingers automatically closed and switch off. Thumb automatically moves to partially closed position. Only Index and middle fingers will move to provide grip against fixed thumb |
| 0x0C | Reserved | |
| 0x0D | Standard 3 Jaw chuck (tri-pod) opened | Ring and little fingers remain fully opened and switch off. Thumb, Index and middle fingers will move to provide grip |
| 0x0E | Thumb 3 Jaw chuck (tripod) opened | Ring and little fingers remain fully opened and switch off. Thumb automatically moves to partially closed position. Only Index and middle fingers will move to provide grip against fixed thumb |
| 0x0F-0x17 | Reserved | |
| 0x18 | Donning or doffing cover | Hand forms the proper shape for donning or doffing a cover |

For example, commanding the hand to thumb precision pinch closed grip would require sending the following 4 byte message to mailbox 0x301 (fig 10).

Figure. 10

| | | | |
|---|---|---|---|
| 0x00 | 0x00 | 0x00 | 0x09 |

Sending the same message again will return the hand to normal grip

Alternatively, commanding the hand to normal grip will give the same result. It would require sending the following 4 byte message to mailbox 0x301(fig. 11)

Figure. 11

| | | | |
|---|---|---|---|
| 0x00 | 0x00 | 0x00 | 0x00 |

To get the current grip number:

- Send CAN message with ID 0x302 with no relevant data (i.e. 4 bytes all 0) (fig.12).

Figure. 12

| | | | | |
|---|---|---|---|---|
| 0x302 | 0x00 | 0x00 | 0x00 | 0x00 |
| I.D | Byte 0 | Byte 1 | Byte 2 | Byte 3 |

- The hand will respond with 0x303 and data as per command 0x301 set grip (fig. 13).

Figure. 13

| | | | | |
|---|---|---|---|---|
| 0x303 | 0x00 | 0x00 | 0x00 | Grip no |
| I.D | Byte 0 | Byte 1 | Byte 2 | Byte 3 |

## 4.7 Configuration Settings

The hand can be configured to move differently when changing grip as desired for the application. Options are set via bit-fields within the configuration parameter word as described below. These settings are retained through a power cycle.

Bit 0 - to rotate thumb on exit from a quick grip (i.e. enter normal grip). If this bit is set (1), then whenever the grip changes to normal the thumb will rotate to the palmar position. If this bit is cleared (0) then the thumb rotator will not move and the thumb will stay in its current position.

Bit 1 - to open digits on exit from a quick grip (i.e. enter normal grip). If this bit is set (1), then whenever the grip changes to normal the digits will move to the open position. If this bit is cleared (0) then the digits will remain in their current position until instructed to move, either open or close.

To write configuration settings:

- Send CAN message ID 0x404 with the relevant bits set/ cleared to enable/disable the configuration options (fig. 14).

Figure. 14

| | | | | |
|---|---|---|---|---|
| 0x404 | 0x00 | 0x00 | 0x00 | Options |
| I.D | Byte 0 | Byte 1 | Byte 2 | Byte 3 |

To read configuration settings:

- Send CAN message ID 0x405 with no relevant data (i.e. 4 bytes all 0) (fig. 15).

Figure. 15

| 0x405 | 0x00 | 0x00 | 0x00 | 0x00 |
|---|---|---|---|---|
| I.D | Byte 0 | Byte 1 | Byte 2 | Byte 3 |

- The hand responds with message 0x406 and the options as currently set (fig. 16).

Figure. 16

| 0x406 | 0x00 | 0x00 | 0x00 | Options |
|---|---|---|---|---|
| I.D | Byte 0 | Byte 1 | Byte 2 | Byte 3 |

For example, to enable rotate thumb on exit and disable open digits on exit from a quick grip, would require sending message ID 0x404 with bit 0 set and bit 1 cleared (fig. 17).

Figure. 17

| 0x404 | 0x00 | 0x00 | 0x00 | 0x01 |
|---|---|---|---|---|
| I.D | Byte 0 | Byte 1 | Byte 2 | Byte 3 |

## 4.8 Analogue & CAN Control

On Power up, hand will by default be in analogue mode. When the user sends any relevant CAN message, the hand will switch to CAN mode.

# 5.0 robo-limb Battery Specifications

## 5.1 robo-limb Battery Specifications

| | | robo-limb 1,300 mAh Battery |
|---|---|---|
| Capacity | | 1,300 mAh |
| Battery Dimensions | Length | 70mm (2.76”) |
| | Width | 35mm (1.39”) |
| | Height | 6mm (0.24”) |
| Dummy Battery Dimensions | Length | 69mm (2.77”) |
| | Width | 35mm (1.39”) |
| | Height | 10mm (0.39”) Single cell<br>16mm (0.63”) Dual cell |

**Only Touch Bionics batteries are approved for use with robo-limb. Use of alternative batteries will invalidate the warranty and may compromise device safety.**

**Cutting or modifying the battery wires in any way will invalidate the warranty and may compromise device safety.**

**Do not bend or shape the battery in any way.**

**Ensure the battery is not subject to continued pressure.**

## 5.2 Battery Charger

**Only use supplied Touch Bionics charger to charge battery. Depending on your location, you will receive one of the below chargers (fig. 18, or fig. 19)**

robo-limb should only be charged using the Touch Bionics charger supplied.

Insert the charger (fig. 18 or fig. 19) into the power outlet. The charger will need to be inserted into the power outlet prior to connecting to the charge port. To charge, insert the charger lead connector into the charge port. A “click” should be heard on connection. If the green light is on when you first plug in the device, ensure the switch block is off.

The light display for fig. 18 is:

- Solid Red – charging
- Solid Green – fully charged or idle
- Continuous flashing red – fault condition
- Rapid flashing amber – Threshold state between charging and fully charged ( should only last for 1-2 seconds)
- Continuous flashing red or green – Connection Error. Remove charger lead connector from the charge port. Ensure charger is plugged in and switched on at the mains. Re-insert the charger lead connector into the charge port.

The light display for fig. 19 is:

- Solid Amber – on standby
- Slow flashing amber – pre-charge mode
- Rapid flashing amber – Error
- Slow flashing green – maintenance charge
- Rapid flashing green – rapid charge
- Solid green – fully charged

Insert the charger lead connector into the charge port (fig.20). A “click” should be heard on connection.

Insert the charger into the power outlet.

Figure. 18

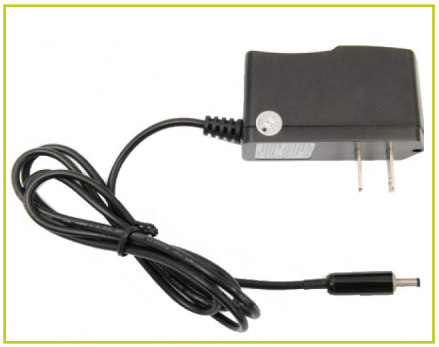
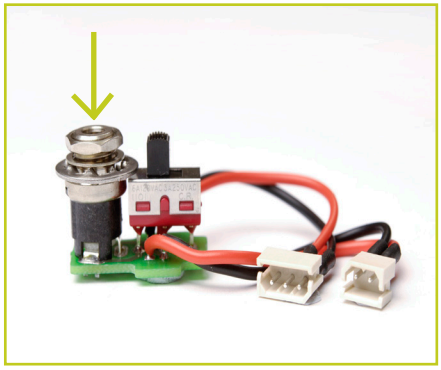


Figure. 19

Figure. 20

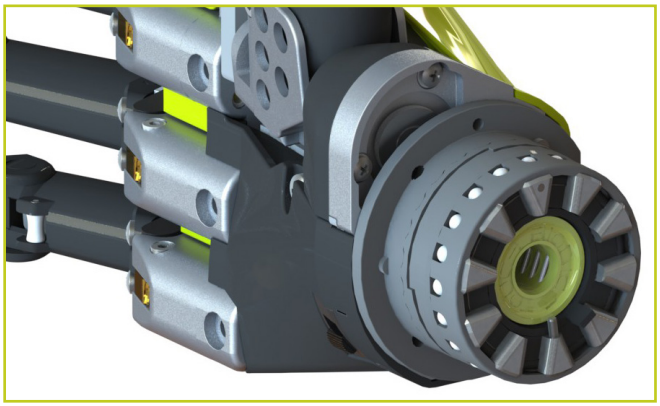


# 6.0 Connecting robo-limb

## 6.1 Wrist Connection

The Quick Wrist Disconnect (QWD) wrist option is supplied with robo-limb (fig. 21).

Figure. 21



**Note:** Please contact Touch Bionics if you require a QWD female connector (fig 22). This connection is normally laminated into a structural support and is used to lock/unlock the hand into position. The CANbus or RS232 cable can then be connected as an electrical interface.

Figure. 22(not supplied)

## 6.2 Quick Wrist Disconnect (QWD)

The QWD is supplied by Touch Bionics. Connection or disconnection of robo-limb fitted with a QWD from the socket is completed as follows:

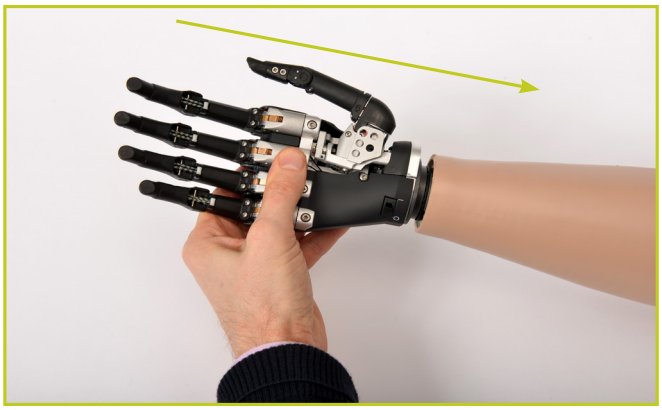
### Connecting robo-limb using the QWD

1 Ensure the robo-limb is switched off (only applies to CANbus version).

2 Align the QWD connection of robo-limb with the connection.

3 Engage the coupling.

4 Test the connection is fully engaged with a slight rotation.

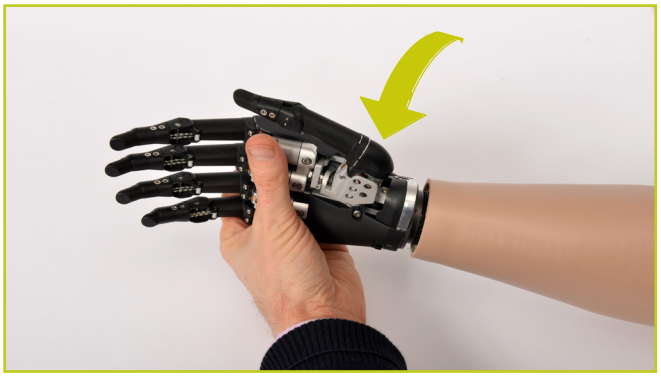


## Disconnecting robo-limb using the QWD

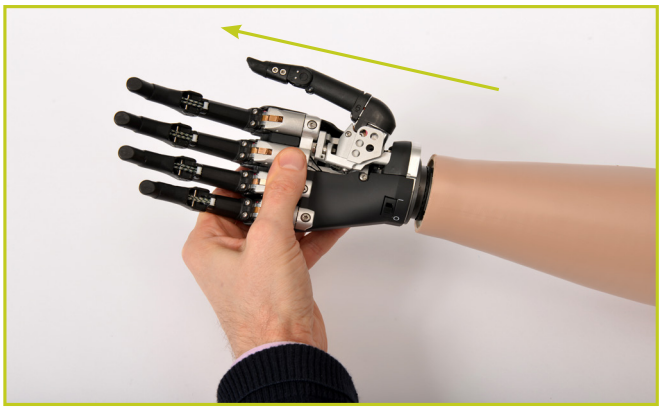
1 Ensure robo-limb is switched off.

2 Support robo-limb in the palm of the hand.

3 Rotate the robo-limb through 360° in either direction until a click is heard



4 The robo-limb will now disengage from the socket. Support the hand and withdraw away from the socket



# 7.0 Adjustments

## 7.1 robo-limb Digit Reference Guide

Individual digits for robo-limb are manufactured as sizes 2, 3, and 5. Sizes 2 and 3 contain a small motor, while size 5 contains a larger motor. The standard digit configuration of robo-limb is outlined in the table.

| robo-limb digit guide | |
|---|---|
| Digit | Size number |
| Thumb | 5 |
| Index | 5 |
| Middle | 5 |
| Ring | 3 |
| Little | 2 |

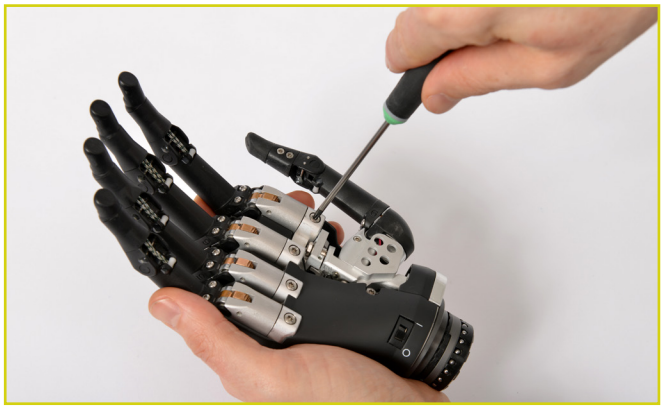
## 7.2 Digit Maintenance

robo-limb is only compatible with Touch Bionics robo-limb digits. To install a digit, ensure that the correct digit size is selected. Remove the digit by the following steps:

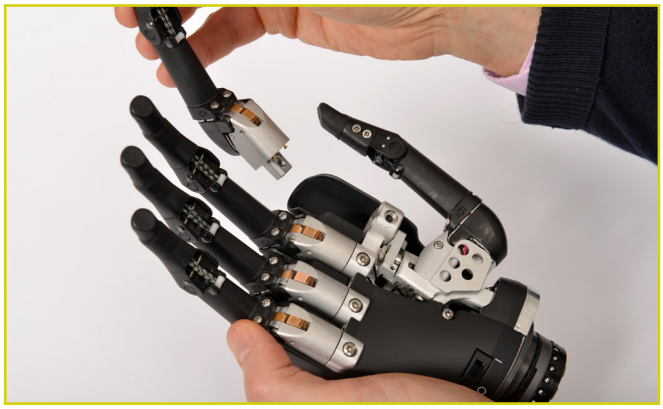
Instruments required: T10 Screwdriver (not included). Contact Customer Support for ordering information

1. Ensure robo-limb is switched off.

2. Support robo-limb in the palm of the hand with the digits in the fully open position. Insert the T10 Screwdriver in the screw of the Knuckle block.



3. Loosen the Knuckle block screw while supporting the digit, remove the digit.



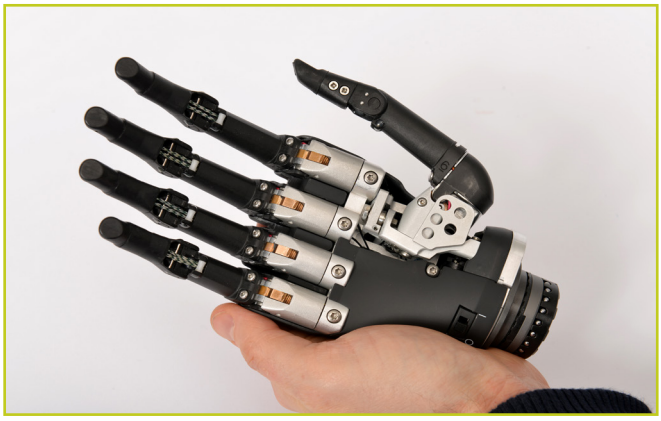
4. Select the appropriate sized replacement digit and follow the steps in reverse order to replace.

**It is recommended that you discard the used screws as the anti-vibration pad on the screw shaft will be deformed during use. Digit screws should be replaced using the new screws provided.**

**Do not over tighten screws.**

**If there is resistance while tightening the screw check for cross threading by removing and re-inserting the screw.**

## 7.3 Thumb Maintenance

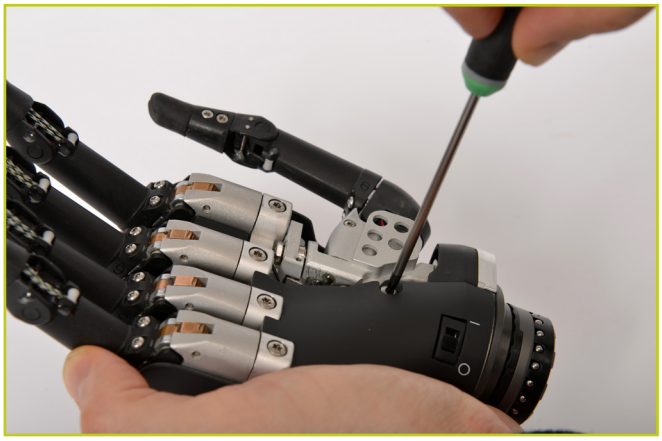


robo-limb is only compatible with a Touch Bionics' robo-limb thumb. To exchange a thumb ensure the correct size has been selected.

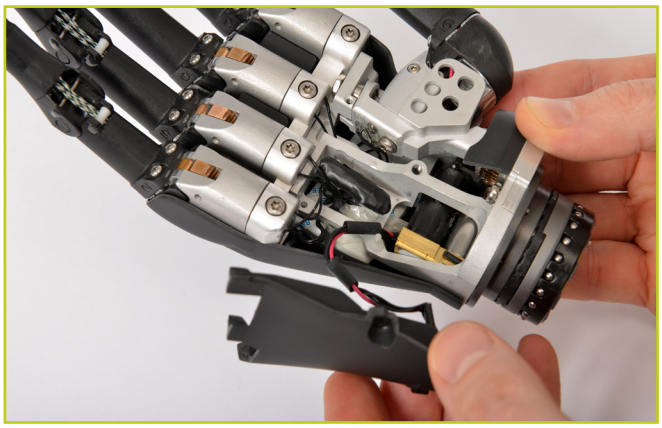
Instruments required: T10 Screwdriver (not included). Contact Customer Support for ordering information.

1. Fully abduct the rotating thumb.

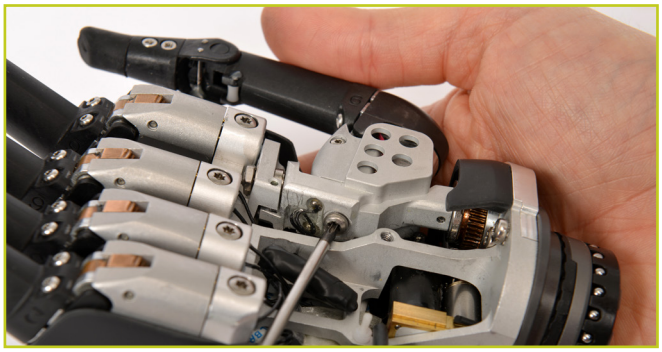
2. Disconnect the palmar fairing using the T10 screwdriver to loosen the palmar T10 screw.



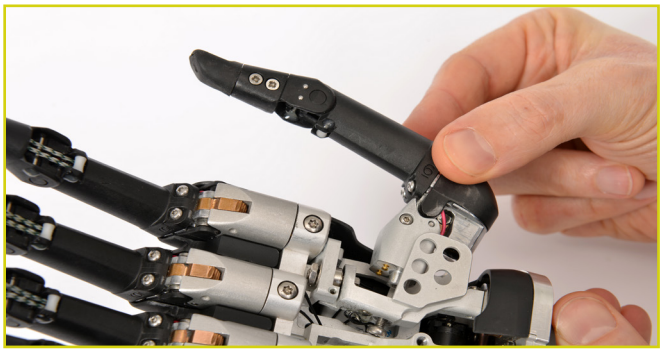
3. Gently move the palmar fairing to the ulnar side to allow access to the exposed T10 screw at the base of the thumb.



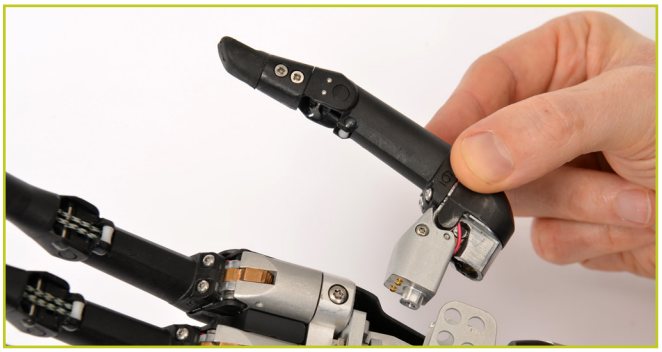
4. Using the T10 Screwdriver access the screw from the medial to lateral direction to loosen.



5. The thumb is now easily removed from the knuckle block.



6. Position the replacement thumb in the knuckle block and follow the above steps in the reverse order to reconstruct the hand. When replacing the palmar fairing, ensure wires are not pinched between the palmar fairing and the chassis.



**It is recommended that you discard the used screws as the anti-vibration pad on the screw shaft will be deformed during use. Digit screws should be replaced using the new screws provided.**

**Do not over tighten screws.**

**If there is resistance while tightening the screw check for cross threading by removing and re-inserting the screw.**

**Touch Bionics recommends T10 Screwdriver for use with all T10 screws in robo-limb. T10 Screwdriver is available for order from Touch Bionics. Contact Customer Support for ordering information.**

# 8.0 i-limb skin active covers

## 8.1 i-limb skin active cover

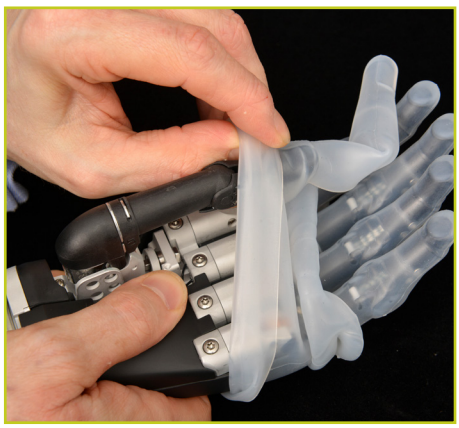
The i-limb skin active cover is designed for the robo-limb and will fully cover the hand. The palm and inner surface of the cover provide some frictional properties for slip resistance when gripping.

**The cover of robo-limb is very important. robo-limb should not be used without an approved cover that is well maintained.**

## 8.2 Donning the i-limb skin active cover

1. To don the active cover you will need to manually position your robo-limb. The 4 fingers should be fully open and the thumb closed with a 15mm space between thumb and index finger. The hand should then be switched off to ensure this position is maintained.

2. Align the i-limb skin active cover with the digits and pull the cover down over the digits. Gently pull up and over the thumb, taking care not to cause any undue downward pressure on the thumb.



3. Pull the i-limb skin active cover over the hand to the wrist.

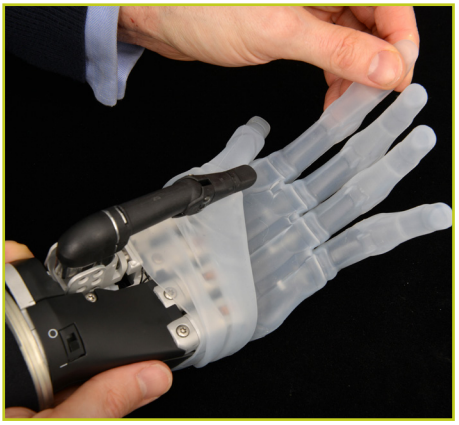
4. Individually maneuver the fingers of the i-limb skin active cover over the digits until they are fully aligned.

## 8.3 Doffing the i-limb skin active cover

1. To doff the active cover you will need to manually position robo-limb. The 4 fingers should be fully open and the thumb closed with a 15mm space between thumb and index finger. The hand should then be switched off to ensure this position is maintained.

   Gently maneuver the i-limb skin active cover from the wrist up and over the base of the thumb taking care not to cause any undue downward pressure on the thumb.

2. Pull the fingertips of the cover upwards on each finger in turn to loosen the cover. Once loosened the cover can be gently pulled up and off robo-limb to remove.



# 9.0 robo-limb app

## 9.1 robo-limb app overview

robo-limb is fitted with a Bluetooth® transceiver enabling it to work with the robo-limb mobile app.

For users to operate the robo-limb mobile app, you will need to download the robo-limb App (downloadable from the Apple® App Store) to one of the following compatible Apple® devices: iPhone® (4s or newer), iPad® (4th generation or newer), iPad® mini, iPod (5 or newer).

The robo-limb app provides access to grip patterns, hand health check mode, and firmware updates.

Occasionally updates to the robo-limb app will be provided. An automated notification will advise you when this is needed. Follow the steps as advised in the notification.

## 9.2 Getting started

**Revision A RS232 only: To connect to the APP, first disconnect the lead from the PC, switch the programming switch to '0', recycle power. You're now able to connect to the App. For connecting via RS232 the programming switch is set to '1'.**

**To connect to the APP using CAN based systems, first disconnect the lead from the PC and recycle power. You're now able to connect to the App.**

For general instructions on using your Apple device, read your device's respective user manual provided by Apple. The first time you use your device, you will need to be connected to the Internet via cellular or Wi-Fi connection. You can connect to a Wi-Fi network by tapping on the "Settings" icon on the first screen.

Next, go to the App Store via the icon. Tap on it to start the app. To search for the robo-limb app, type "Touch Bionics" or "robo-limb" in the search tab and download the app to your Apple device. Note: an Apple ID will be required to download the app. If you do not have one, please create an account by logging on to the Apple website.

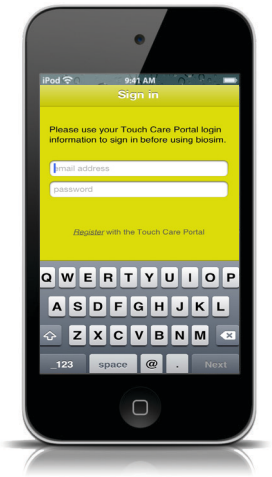
Upon downloading the robo-limb app, an icon will appear on your mobile device's screen. Tap on it to start the app.

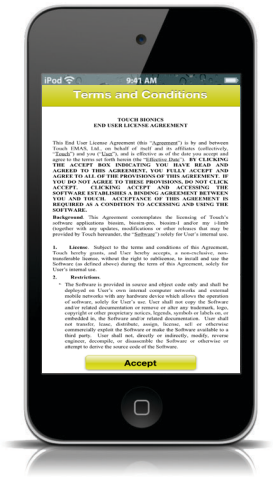
**Note**: Touch Bionics recommends using the latest iOS for best performance. If you are using an older version of iOS, you may receive a one-time notice. Tap continue to acknowledge.

## 9.3 Activation

The first time you connect to the robo-limb app, you will see the “Sign in” screen. Here you will need to enter the email address and password that you use when you log-in on the Touch Care Portal on Touch Bionics’ web site. If you need to create an account, you may also do so by selecting “Register” on the screen below.

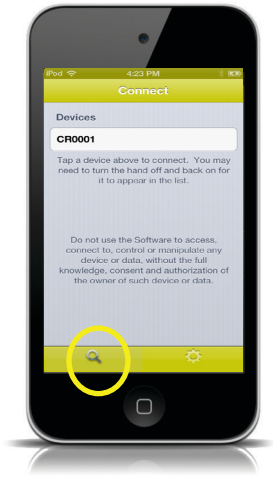
Upon registering, when the application is opened for the first time you will see our Terms and Conditions disclaimer. Tap "Accept“ to continue to access the app.



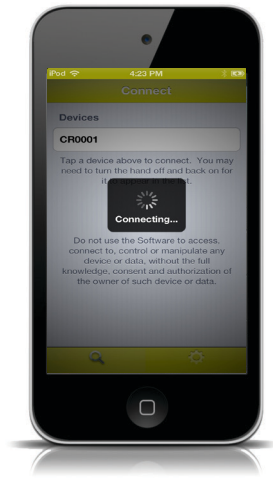

## 9.4 Connection

After signing in, you will be brought to the connection screen where you will tap your device to connect



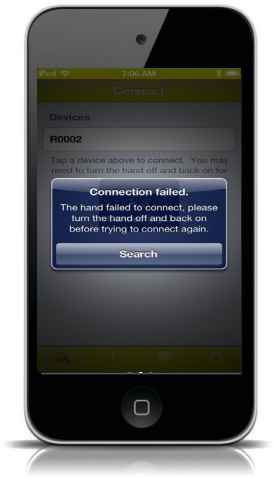

If you need to connect to a different device, simply tap the magnifying glass in the bottom left corner of the app and it will search for any devices in the area.

**Note:** Should someone try to access robo-limb using different Touch Care Portal log-in credentials, they will see the “Authorized use only” screen. This feature will protect your device from unauthorized users accessing it. The 4 digit code to access robo-limb will be your devices serial number located proximal to the base of the thumb on the connection plate. You only have to enter this once as your mobile device will remember the code.

## 9.5 Connection failed

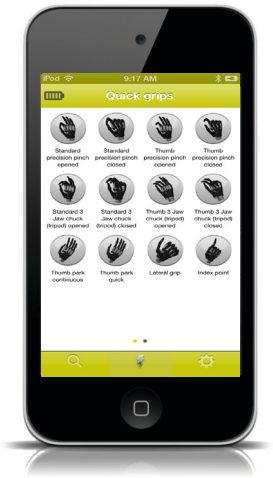
If robo-limb fails to connect to the app due to loss of power, proximity with the Apple device, or other reasons, the "Connection Failed" screen will appear:




In this instance, turn the device off for 4 seconds, then turn back on.  Press the “Search“ button to reconnect.

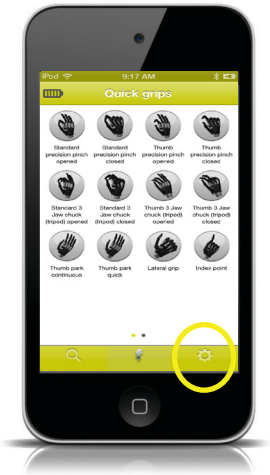
## 9.6 Quick Grips screen

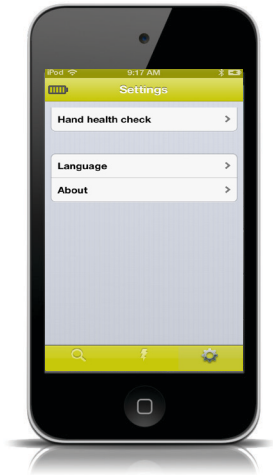
After connecting, you will see the Quick Grips screen. Here you get instant access to grip patterns with a single tap. Tapping a grip icon immediately puts the device into that mode.




## 9.7 Settings

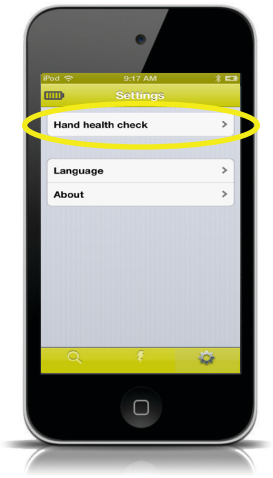
To access the Settings page, tap the gear on the bottom right of the Quick Grips page.



## 9.8 Hand health check

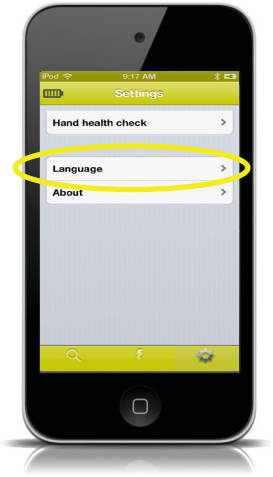
Selecting “Hand health check” from the Settings menu brings up the option to run a test on your robo-limb to ensure that everything is running as it should. Tapping “Run health check” will run through a series of checks and will alert us to contact you if anything requires attention.





## 9.9 Languages

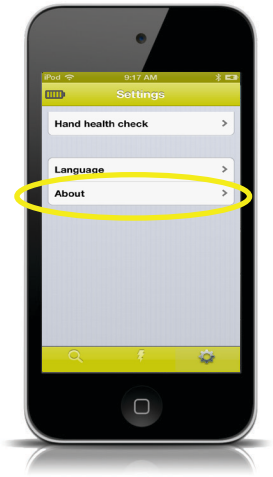
The default language setting is English. Select “Language” to change the settings to another language.



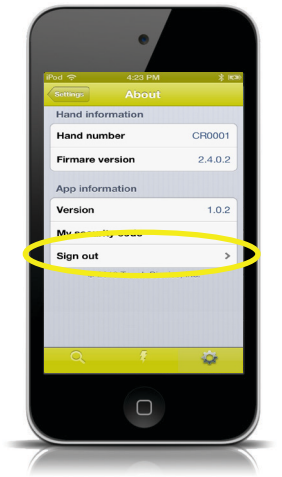


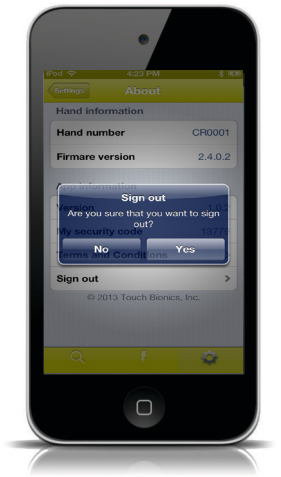
## 9.10 About

The final option on the settings page is the “About” option. Tapping this brings up a screen displaying information about robo-limb and the application.




Tapping “Sign out“ will end the session and require you to sign in again for your next session.

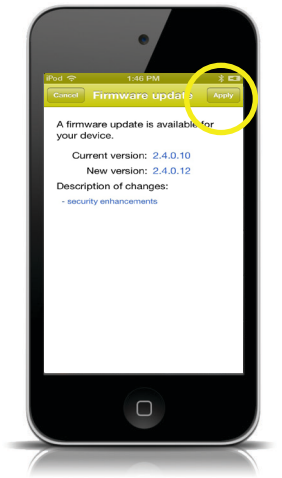



## 9.11 Firmware Updates

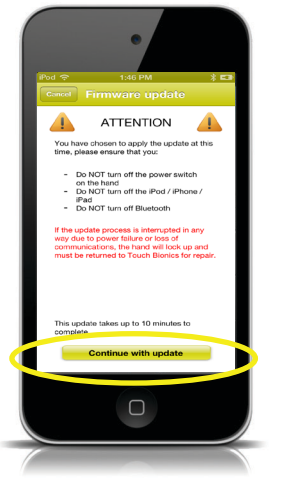
Touch Bionics‘ always recommends that you download the latest firmware for your device. If a firmware update is available, you will be prompted with the following screen upon connection to robo-limb.

Tap "apply“ to initiate the update. Tapping "cancel“ will dismiss this screen.



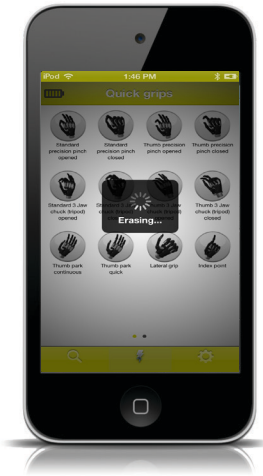

Tapping "Apply“ will bring you to the app update warning screen. Ensure you review the warnings listed. Tap "Continue with update" to proceed.

Note: Ensure that you are able to perform the update without interruption. Loss of power or hand communication could result in your device locking, which will require service by Touch Bionics. Total update time may take up to 10 minutes.



After tapping "Continue with update" you will arrive at a final confirmation screen.  Tap "yes" to continue.

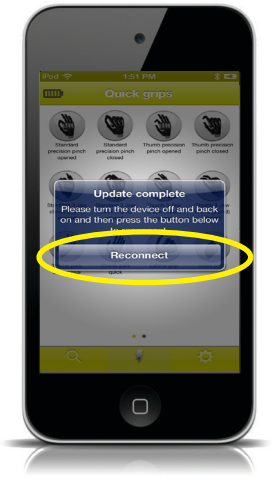

After tapping "yes" the update will begin.  You will see a variety of screens as the update progresses.





At the conclusion of the update you will be prompted to turn your device off and back on again to complete the update.

After powering off and on, tap "Reconnect" to continue to the robo-limb app.



# 10.0 Maintenance

## 10.1 Storage and Maintenance

Always turn off the hand when not in use.

Aim to charge the battery each day after use.

Replace the battery every 12 months.

Ensure robo-limb is serviced every 12 months

## 10.2 Troubleshooting

If you experience any issues with robo-limb please contact Touch Bionics to troubleshoot.

## 10.3 Warnings and Precautions

### robo-limb

Do not use without an approved cover.

Do not use under water.

Do not expose to excessive moisture, liquid, dust, vibration or shock.

Do not expose to high temperatures.

Do not expose to flames.

Do not use or expose to explosive atmospheres.

Do not disassemble componentry or modify in any way.

Maintenance, repairs and upgrades may only be performed by qualified Touch Bionics technicians and technical partners.

Only approved Touch Bionics accessories and tooling may be used with robo-limb.

Failure to comply with the above guidelines will invalidate the warranty.

### Batteries

Do not bend or exert excessive pressure on the battery.

Do not pierce the battery.

Do not disassemble.

Do not expose to high temperatures.

Do not incinerate batteries.

Do not alter battery terminal wires.

Do not short circuit the battery.

Do not store batteries inside a vehicle.

Dispose of batteries in accordance with US, European or local regulations.

Only use the appropriate Touch Bionics charger to charge Touch Bionics batteries.

If the battery has visibly ballooned or swelled:

- discontinue the charging process immediately
- disconnect the battery
- remove to a safe area
- leave and observe for 15 minutes
- replace the battery
- do not re-use
- dispose of any leaking batteries in an appropriate manner

Failure to comply with the above guidelines will invalidate the warranty.

If you experience technical problems with robo-limb contact Touch Bionics

**North American Customers (Canada, Mexico & US)**
Tel:+1 855 MYiLIMB (694 5462)
**UK & Non-North American Customers**
Tel: +44 1506 438 556

# 11.0 Appendix

## 11.1 Technical Information

| Technical Information | Description |
|---|---|
| Voltage | 7.4V (nominal) |
| Max. current | 7A |
| Battery capacity | Rechargeable lithium polymer; 7.4V (nominal); 1300mAh capacity |
| Max hand load limit (static limit) | 90kg/198lb |
| Finger carry load limit | 32kg/71lb |
| Time from open position to full power grip | 1.2 seconds |
| Device weight | Manual Thumb 469g,  Powered Thumb 507g |

| Force | Without Pulsing | With Pulsing |
|---|---|---|
| Power grip force | 10.2kg (100N) | 13.9Kg (136N) |
| Lateral pinch force | 2.1kg | 3.5kg |

## 11.2 robo-limb Information

| Hazardous Area Classification | |
|---|---|
| The robo-limb  device is not intended for use outside the boundaries of the environments listed below. The customer or user of the robo-limb device should assure that it it not used in such environments | |
| Condition | Level |
| Maximum temperature | +70˚c |
| Minimum temperature | -40˚c |
| Hazardous Area Classification | Non Hazardous |

## 11.3 Component Compatibility

### General Safety

11.3.1 robo-limb is an electrical device, which under certain circumstances could present an electrical shock hazard to the user. Please read this user manual thoroughly and follow directions stated in this manual to assure maximum safety during charging and operation.

11.3.2 EMI/EMC

- 11.3.2.1 Compliance against standard BS EN 61326-1:2013

11.3.3 Radio Spectrum Matters (ERM)/Bluetooth

- 11.3.3.1 Compliance against standard EN 301 489-1 V1.8.1

11.3.4 Radiation emissions, Enclosure

- 11.3.4.1 EN 301-489-1 Clause 8.2 - Pass (30MHz to 6,000MHz)

11.3.5 Zones of Use

- 11.3.5.1 Not recommended in zones 0, 1, 2

**Note.** See www.touchbionics.com for further information on EMC testing carried out on products within this manual.

| | |
|---|---|
| CE | European Conformity |
|  | Refer to operating instructions |
|  | Class II equipment – provides double Isolation to protect against electric shock |
| IP40 | Degree of protection – IP40<br><br>Protection against penetration by solid particles with diameters larger than 1 mm. No special protection against penetration by water |
| SN | Serial Number |
|  | WEEE Compliance |
| REF | Catalogue number |
|  | Manufacturer/ Date of Manufacture |

Customer Service/Contact Information:

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Mansfield MA 02048, USA

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# 11.4 Warranty

## Limited Warranty for robo-limb

Touch Bionics warrants that robo-limb will conform to its specifications and be free of defects in material and/or workmanship for twelve (12) months from the date of Touch Bionics invoice for robo-limb. This Limited Warranty applies only to robo-limb provided by Touch Bionics or an affiliate authorized by Touch Bionics to provide robo-limb. This Limited Warranty applies to all components including but not limited to fixtures, motors, bearings, and electronics. This Limited Warranty is governed by UK law and is not transferrable.

## Warranty:

Touch Bionics reserves the right to credit, repair or replace an “in-warranty” robo-limb as its option. If required, replacements will be new products. The user shall report any defect claim to Touch Bionics directly or to the facility that provided robo-limb immediately upon discovering the defect, and, in any event, within the warranty period. The defective robo-limb must be returned to Touch Bionics or any other Touch Bionics authorized representative. To find the nearest location, visit www.touchbionics.com or call +1-855-MY-iLIMB (US & Canada), or +44 (0) 1506 438 556 (International). The unit must be in assembled condition and include an approved covering when returned. The warranty is void if robo-limb is subjected to abuse, neglect, alteration, modification, improper repair and/or maintenance performed by anyone other than Touch Bionics or a Touch Bionics’ affiliate. Damage as the result of normal wear and tear including the result of fatigue is not covered during the warranty period. Damage resulting from installation of parts and accessories not compatible with robo-limb by anyone other than Touch Bionics or an affiliate is not covered, including use of non-Touch Bionics batteries. The warranty is void if damaged covers are not replaced or repaired in a timely manner by a Touch Bionics cosmesis facility or another facility authorized by Touch Bionics, or if an approved covering is not donned at all times when the robo-limb is being used.

This is the exclusive remedy under this warranty, any and all other remedies that may otherwise be applicable are excluded, including, but not limited to, incidental or consequential damage or punitive damage to the maximum extent permitted by law. This is the only warranty made by Touch Bionics on robo-limb and components, and there are no warranties which extend beyond the description herein. Any warranties that may otherwise be implied by law including, but not limited to, any implied warranty of merchantability or fitness for a particular purpose are extended.

This Limited Warranty gives the consumer specific legal rights. The consumer may also have other legal rights which vary from country to country, from state to state in the U.S, from province to province in Canada and from state to state in Mexico. Some countries and states may not allow the exclusion or limitation of incidental or consequential damages or warranties, so the above limitations or exclusions may not apply to you. If it is determined by a court of competent jurisdiction that a certain provision of this limited warranty does not apply, such determination shall not affect any other provision of this limited warranty and all other provisions shall remain in effect.

touch bionics

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please visit www.touchbionics.com



**Issue No. 5, August 2016** **Part number: MA01179**