Anexo 1

Reporte de visita a un clínica

El día 22 de marzo de 2016 se realizó una visita a la clínica VitaNova de rehabilitación física integral en el distrito de La Molina en la cual se pudo conversar con el doctor Cristiam Megue especialista en neuro-rehabilitación en adultos.

Se explicó la finalidad de la tesis y sus alcances, asimismo, el doctor recalcó que el proyecto también podría resultar beneficiosos para los pacientes que sufren de lesión cervical a partir del C4 hacia abajo; puesto que, en daños a la altura de vértebras superiores, el movimiento de la persona es extremadamente limitado como para moverse de forma independiente en una silla de ruedas. Este tipo de discapacidad impide al afecto cumplir las funciones motoras de su tronco y extremidades superiores e inferiores mientras que el movimiento de su cuello es mejor controlado. Estas personas requieren sillas neurológicas que les permita mantener una buena postura mediante topes y cojines, pero al ser costosas, los usuarios suelen adecuar sillas estándares para suplir funciones básicas de ergonomía.

Respecto a las características necesarias para una correcta silla de ruedas eléctrica, recomendó un diseño enfocado en practicidad y estabilidad dejando como secundario el tema de la velocidad ya que no es necesaria una gran rapidez de movimiento.

Como consideraciones adicionales para el sistema mecatrónico se tienen:

- Debe soportar un peso máximo de 80-90kg
- Ser capaz de subir pendientes

En conclusión, el proyecto se enfocará a un diseño de un acople mecatrónico para la silla de ruedas para personas capaces de controlar sus extremidades superiores y tórax, sin embargo, esto no excluye que pueda ser adaptado para usarse con un mando que responda ante movimientos de cabeza o faciales.

Anexo 2

Matriz morfológica

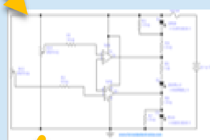
Dominio mecánico

FUNCIÓN	ALTERNATIVA 1	ALTERNATIVA 2	ALTERNATIVA 3	ALTERNATIVA 4	ALTERNATIVA 5
Acople a la silla	Pinza para tubos 	Bridas de fijación 	Pinza giratoria 	Abrazadera para tubos 	
Movimiento	Una rueda que avance y gire en x, y 	Dos ruedas paralelas adicionales 	Fricción entre ruedas 	Motor en la ruedas delanteras 	
Actuadores	Hub motor 	Motorreductor 	Servomotor 	Motor DC 	
Reducción	Engranajes 	Cadena 	Faja dentada 		

S1 S2 S3

Tabla 1: Matriz morfológica del dominio mecánico
Fuente: Propia

Dominio eléctrico-electrónico

FUNCIÓN	ALTERNATIVA 1	ALTERNATIVA 2	ALTERNATIVA 3	ALTERNATIVA 4	ALTERNATIVA 5
Transmisión de datos del mando al controlador	Cableada 	Inalámbrica 			
Mostrar estado de batería	Medidor de batería 	Circuito diseñado 			
Sensar si hay piso adelante	Sensor infrarrojo 	Sensor ultrasónico 			
Fuente de alimentación	Li-Po 	Ácido-Plomo 	Ni-Fe 		

S1 ● S2 ● S3 ●

Tabla 2: Matriz morfológica del dominio eléctrico-electrónico
Fuente: Propia

Dominio de control

FUNCIÓN	ALTERNATIVA 1	ALTERNATIVA 2	ALTERNATIVA 3	ALTERNATIVA 4	ALTERNATIVA 5
Controlador	Microcontrolador 	Arduino 	Raspberry Pi 		
Mando	Sensores del celular 	Señales neuronales (EEG) 	Voz 	Seguimiento ocular 	SmartBand 

S1 S2 S3

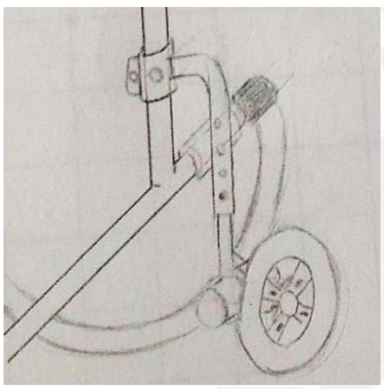
Tabla 3: Matriz morfológica del dominio
Fuente: Propia

ANEXO 3

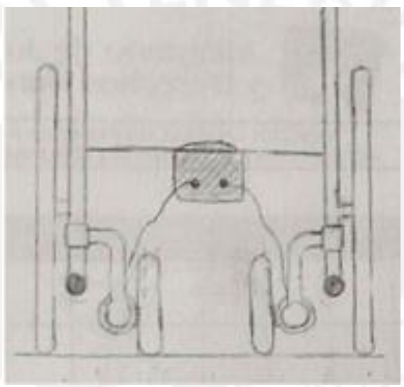
CONCEPTOS DE SOLUCIÓN

Concepto de solución 1

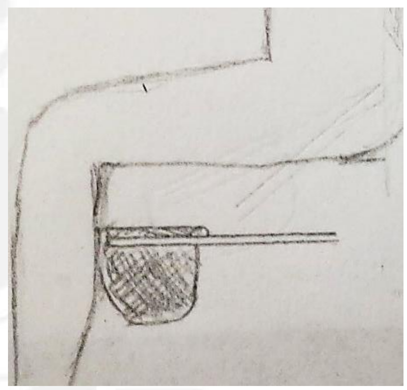
En este concepto de solución se usarán pinzas para tubos en la parte inferior de la silla de ruedas con el fin de sostener a las ruedas adicionales que se colocarán. La altura de éstas se regula mediante una barra telescópica. Estas ruedas estarán conectadas a motorreductores cada una la cuales se energizarán con una batería de ácido plomo sujetada a la parte anterior del asiento mediante una ranura presente en su carcasa. El mando será un smartphone con bluetooth colocado en una banda abdominal con bolsillo; el celular se conectará inalámbricamente al controlador Arduino el cual procesará la inclinación del celular respecto del eje gravitacional enviando así señales para el movimiento de los motores.



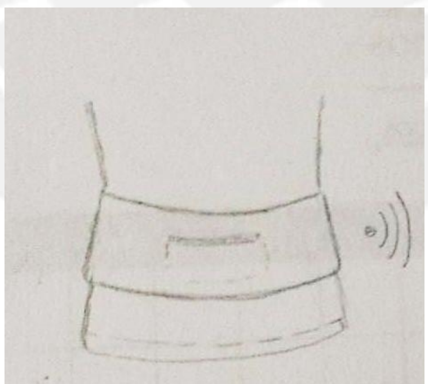
(a)



(b)



(c)

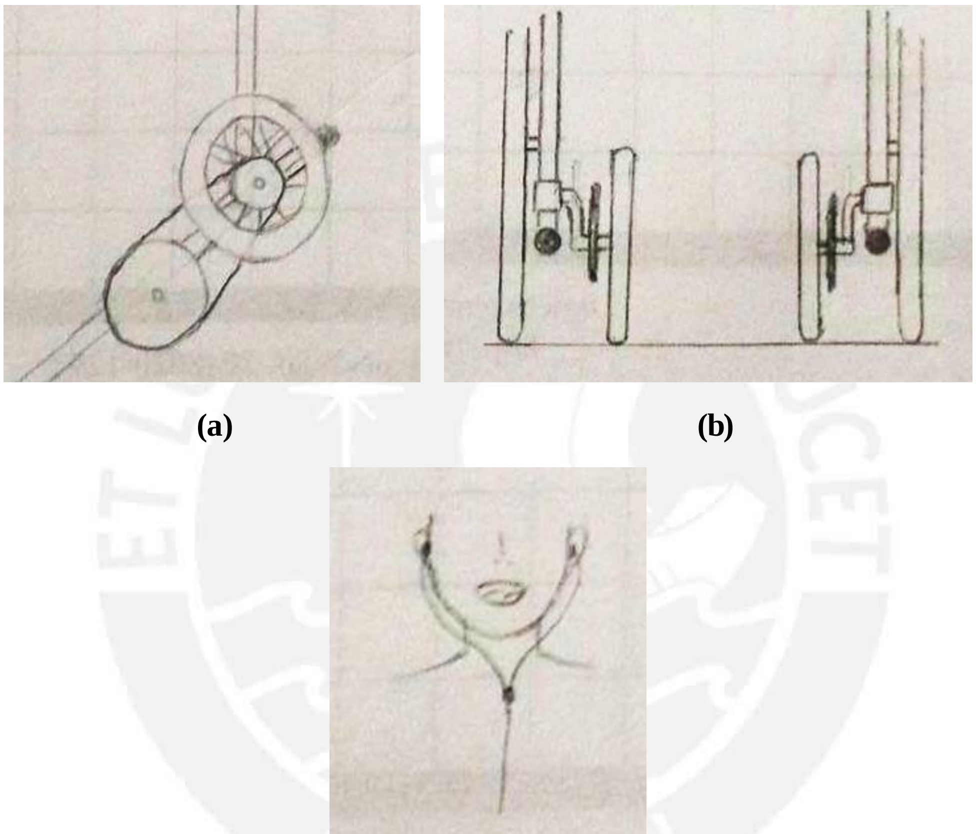


(d)

Figura 1: **(a)** Vista del acople de la rueda a la silla de ruedas **(b)** Vista posterior de la silla de ruedas, se aprecia la batería y acople **(c)** Vista lateral de la batería colocada en la parte anterior del asiento **(d)** Banda abdominal con bolsillo para celular
Fuente: Propia

Concepto de solución 2

En este concepto de solución se usará un motor dc con un mecanismo de reducción basado en una cadena y dos piñones a cada lado de la silla las cuales se sujetarán con pinzas giratorias. La batería de Ni-Fe se colocará de la misma forma que el concepto de solución 1: mediante una ranura en su carcasa. El modo de mando en este caso será mediante la voz con el uso de auriculares con micrófono incorporado u otro dispositivo similar con una conexión cableada la cual enviará los comandos de voz y se procesará con un Raspberry Pi.



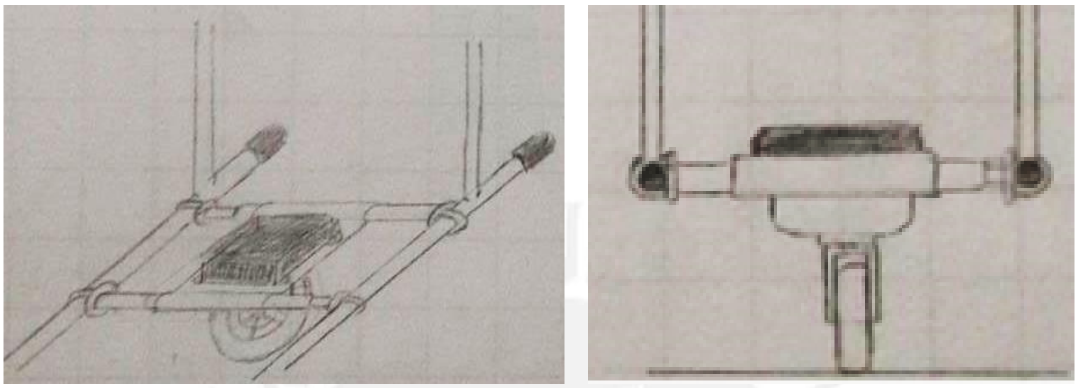
(a) **(b)** **(c)**

Figura 2: **(a)** Conexión de la cadena y piñones con la rueda y silla de ruedas **(b)** Vista posterior de la silla de ruedas con el acople de las ruedas **(c)** Persona con auriculares con micrófono dando órdenes sonoras al sistema

Fuente: Propia

Concepto de solución 3

En este concepto se usarán 2 barras telescópicas con el fin de acoplarlas paralelamente para sujetar todo el sistema mecatrónico. En la parte superior se encontrarán la batería de Li-Po y circuitos eléctrico-electrónicos, más abajo estará un servomotor conectado a una horquilla que direccionará el movimiento; la única rueda en el acople girará con un hub motor. En este caso, todo el sistema se encuentra agrupado al medio de la silla de ruedas. Como en el concepto anterior, el mando será un celular colocado en una banda abdominal.



(a) **(b)**

Figura 3: **(a)** Vista isométrica del acople mecatrónico con la silla de ruedas **(b)** Vista frontal del sistema, se puede observar la horquilla conectado a la carcasa del servomotor
Fuente: Propia

ANEXO 4

EVALUACIÓN TÉCNICA Y ECONÓMICA

Para la evaluación técnica y económica se asignarán puntajes (p) a cada concepto de solución con valores desde 0 a 4, siendo:

0: No satisface

1: Satisface a las justas

2: Suficiente

3: Bien

4: Muy bien

Asimismo, cada criterio técnico y económico tiene un grado de importancia (g. i) que varía entre los valores 1 y 4, siendo:

1: Importancia baja

2: Importancia media

3: Importante

4: Muy importante

Los grados de importancia y los puntajes asignados para cada concepto de solución con los criterios técnicos y económicos serán ponderados (g. p) y sumados. El valor resultante (puntaje total) de cada concepto de solución se dividirá entre el puntaje total máximo que se puede obtener en la parte técnica y económica, el valor que resulta de la división será el valor técnico o económico.

$$Puntaje\ total_{cs} = \sum p * g.i$$

$$Puntaje\ máximo = \sum 4 * g.i$$

$$Valor\ técnico/económico_{cs} = \frac{Puntaje\ total_{cs}}{Puntaje\ máximo}$$

Finalmente, para elegir el concepto de solución más adecuado, se elaborará una gráfica con puntos que representen a cada C. S cuyas coordenadas serán el valor técnico (x) y el valor económico (y) de cada una. Se trazará una recta con función y=x y aquel punto que esté más cercano a aquella línea será el concepto de solución óptimo para este proyecto.

Evaluación técnica

	Criterios técnicos	g. i	S1 p	S1 g. p	S2 p	S2 g. p	S3 p	S3 g. p
Objetivos	Precio	4	3	**12**	4	**16**	3	**12**
	Universalidad de acople	4	4	**16**	3	**12**	3	**12**
	Mando independiente del joystick	4	4	**16**	3	**12**	4	**16**
R. Mecánicos	Mínimas modificaciones a la silla de ruedas	3	3	**9**	2	**6**	4	**12**
	Peso máximo del usuario	3	3	**9**	4	**12**	2	**6**
	Capacidad de subir pendientes	3	3	**9**	4	**12**	2	**6**
	Ergonomía	2	3	**6**	2	**4**	3	**6**
	Velocidad de movimiento	1	4	**4**	3	**3**	3	**3**
	Poco volumen y peso	3	3	**9**	2	**6**	3	**9**
R. Eléctrico-Electrónicos	Autonomía	2	3	**6**	3	**6**	2	**4**
	Fácil entendimiento de uso del mando	3	4	**12**	2	**6**	4	**12**
	Detección de 'abismos'	3	4	**12**	3	**9**	3	**9**
R. Control	Capacidad de procesamiento	4	3	**12**	4	**16**	3	**12**
Adicional	Fabricación	3	4	**12**	2	**6**	2	**6**
	Facilidad de acople	3	4	**12**	3	**6**	3	**9**
	Facilidad de desacople	2	3	**6**	2	**2**	3	**6**
	Puntaje total			**162**		**134**		**140**
	Valor técnico			**0.86**		**0.71**		**0.74**

Tabla 4: Evaluación técnica de los conceptos de solución
Fuente: Propia

Puntaje máximo: 188

Evaluación económica

	Criterios económicos	g. i	S1 ● p	S1 ● g. p	S2 ● p	S2 ● g. p	S3 ● p	S3 ● g. p
Mecánica	Facilidad de adquisición	2	3	**6**	2	**4**	3	**6**
	Costo	4	3	**12**	3	**12**	3	**12**
	Costo de manufactura	3	3	**9**	3	**9**	2	**6**
Eléctrico-Electrónicos	Facilidad de adquisición	3	3	**12**	3	**9**	3	**9**
	Costo	4	4	**16**	4	**16**	3	**12**
	Costo de manufactura	2	4	**8**	4	**8**	3	**6**
Control	Facilidad de adquisición	2	4	**8**	4	**8**	4	**8**
	Costo	2	3	**6**	3	**6**	4	**8**
	Costo de manufactura	1	3	**3**	4	**4**	3	**3**
	Puntaje total			**80**		**76**		**70**
	Valor económico			**0.87**		**0.83**		**0.76**

Tabla 5: Evaluación técnica de los conceptos de solución
Fuente: Propia

Puntaje máximo: 92

Gráfica valor técnico vs. económico

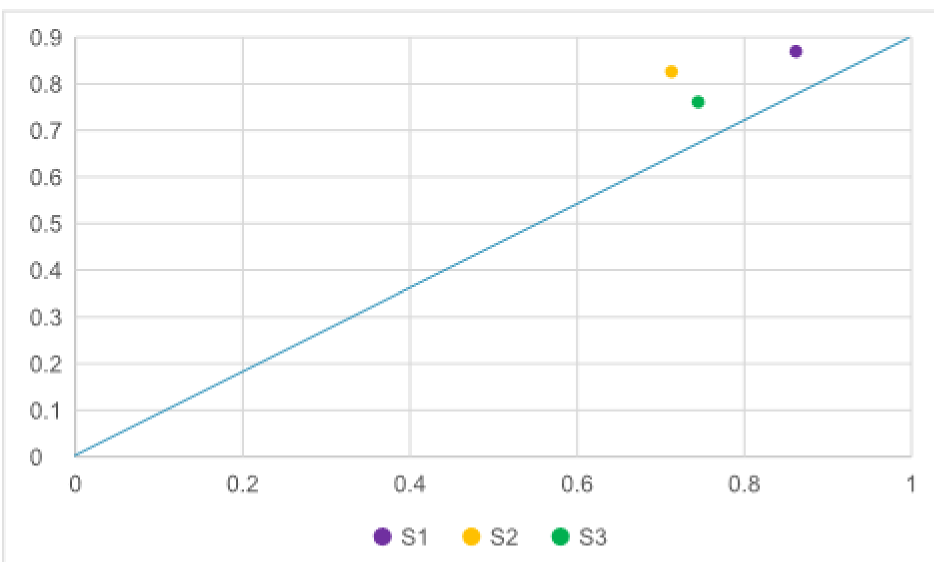


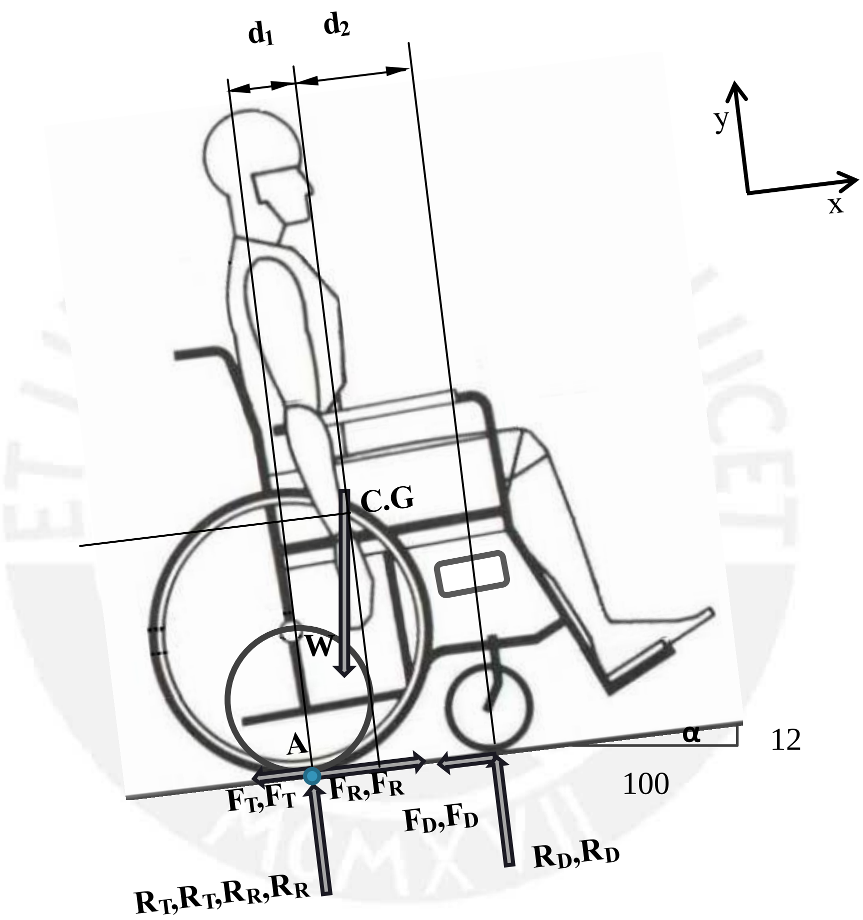
Figura 4: Valor técnico vs. económico

ANEXO 5

CÁLCULO DEL MOTOR Y RUEDAS

Se analizará el movimiento para la situación más crítica que ocurre cuando la silla de ruedas asciende con una pendiente de 12%

DCL del sistema silla de ruedas-usuario-acople



Siendo:

R_T: Reacción del piso en la rueda
F_T: Fuerza de rozamiento en la rueda
R_R: Reacción en el tornillo que une los acoples
F_R: Reacción en el tornillo que une los acoples
R_R: Reacción en el tornillo que une los acoples
F_R: Reacción en el tornillo que une los acoples

$$\sum \boldsymbol{F} = \boldsymbol{0}$$

- En x: $$2F_R = 2F_T + 2F_D + Wsen\alpha \quad \dots (1)$$
- En y: $$2R_R + 2R_T + 2R_D = Wcos\alpha \quad \dots (2)$$

$$\sum \boldsymbol{M} = \boldsymbol{0}$$

- En A: $$2R_D(d_1 + d_2) = W(d_1 cos\alpha - hsen\alpha) \quad \dots (3)$$

- Reacción normal y fuerza de fricción:

$$R_R \mu = F_R \quad \dots (4)$$
$$R_T \mu = F_T \quad \dots (5)$$
$$R_D \mu = F_D \quad \dots (6)$$

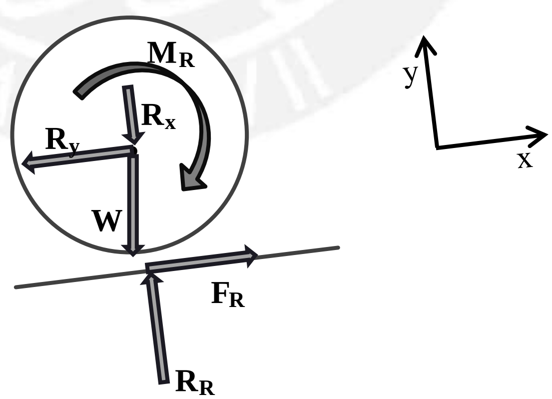
- (4), (5), (6) en (1)

$$2R_R\mu = 2R_T\mu + 2R_D\mu + Wsen\alpha$$
$$R_R - R_D - \frac{Wsen\alpha}{2\mu} = R_T \quad \dots (7)$$

- (7) en (2)

$$2R_R + 2\left(R_R - R_D - \frac{Wsen\alpha}{2\mu}\right) + 2R_D = Wcos\alpha$$
$$4R_R - \frac{Wsen\alpha}{\mu} = Wcos\alpha$$
$$R_R = \frac{W}{4}(cos\alpha + \frac{sen\alpha}{\mu}) \quad \dots (8)$$
$$F_R = R_R\mu = \frac{W}{4}(\mu cos\alpha + sen\alpha)$$

DCL de la rueda del acople



$$\sum M = 0$$

$$M_R = r_R F_R$$

Entonces el torque mínimo que necesitará motor es:

$$\boldsymbol{M_R = r_R(\frac{W}{4}(\mu cos\alpha + sen\alpha))}$$

Teniendo como datos las velocidades lineales del requerimiento del sistema, se halla la velocidad angular para el motor:

$$\omega_R\left(\frac{rad}{s}\right) = \frac{v_R(m/s)}{r_R(m)}$$

Para la elección del motor y ruedas, se realizará una tabla con diferentes medidas de diámetro de éstas últimas para encontrar un equilibrio entre momento y velocidad angular con el fin de elegir una opción más económica:

Diámetro de rueda (m)	Torque (N. m)	Velocidad angular (rad/s)	Potencia(W)
12”	15.979	12.871	205.671
10”	20.093	10.236	
8”	24.048	8.553	

Datos: tanα=12/100; μ=0.5; W=1029N (105kg); v_R= [0.6; 1.3] (m/s)

ANEXO 6

CÁLCULO PARA LA BATERÍA

La carga más exigente que se tendrá será la de los motores con una potencia de 205.671W cada uno. Dividiendo ese valor entre el voltaje de la batería (24V) se obtienen 8.57A; suponiendo que los motores representan un 80% del gasto de corriente total en paralelo con los componentes se obtendría como amperaje necesario para la batería de 21.42A (dos motores).

La autonomía mínima requerida es de 5km y la velocidad máxima de desplazamiento lineal es de 1.3m/s entonces:

$$Autonomía(km) = \frac{Capacidad(A.h)x\ velocidad(km/h)}{Corriente(A)}$$

Luego:

$$5km = \frac{Capacidad(A.h)\ x\ 4.68km/h}{21.42A}$$

Finalmente:

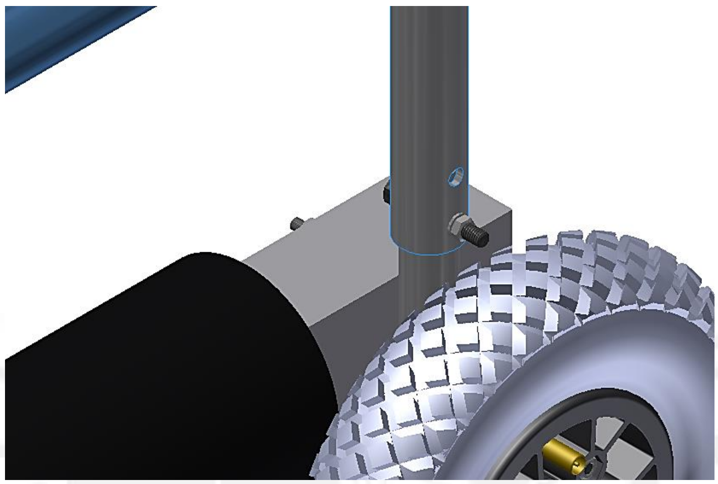
$$Capacidad = \ 22.88\mathrm{A.h}$$

ANEXO 7

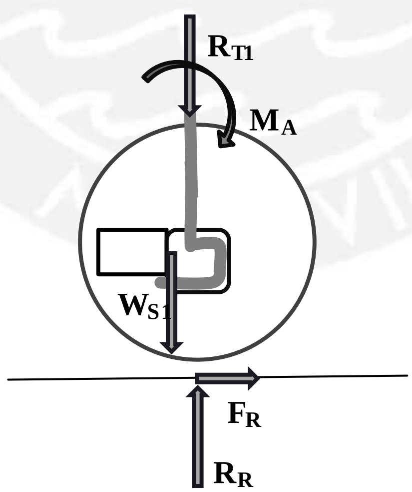
CÁLCULO DEL TORNILLO DE LA BARRA TELESCÓPICA

Este tornillo servirá para poder elevar o bajar las ruedas con el motor sin necesidad de desacoplar el sistema de la silla en caso no se requiera usar la silla de forma eléctrica. Como su función principal es la de limitar el movimiento vertical tubos concéntricos, estará sometido principalmente a esfuerzos de corte y en menor medida a aplastamiento.

La posición más crítica en este caso será cuando el piso no tenga ángulo de inclinación.



Caso 1: DCL del tubo inferior, motor y rueda cuando la rueda está en contacto con el piso:



Siendo:

R_{T1}: Reacción en el tornillo que une los acoples
M_A: Momento que se genera entre los acoples (superior e inferior)

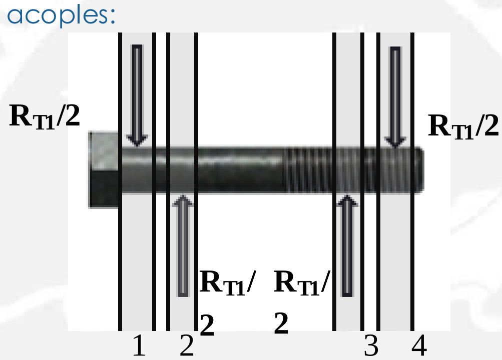
W_{S1}: Peso del sistema conformado por el acople inferior (AI), motor (M), rueda (R) y hub de acople motor-rueda (H)
F_R: Fuerza de fricción
R_R: Reacción normal

$$\sum \boldsymbol{F} = \boldsymbol{0}$$
$$R_{T1} + W_{S1} = R_R$$
$$R_{T1} = R_R - W_{S1} \qquad \dots (1)$$
$$W_{S1} = W_M + W_R + W_H + W_{AI}$$

- Usando la fórmula (8) del anexo 3: $$R_R = \frac{W}{4}(cos\alpha + \frac{sen\alpha}{\mu})$$
- Entonces: $$R_{T1} = 213.5N$$

Datos: α=0°; μ=0.5; W=1029N (105kg); W_M=34.3N (3.5kg); W_R =5N (0.51kg); W_H = 0.4N (0.042kg); W_{AI} = 4N (0.411kg)

DCL del tornillo entre los dos acoples:



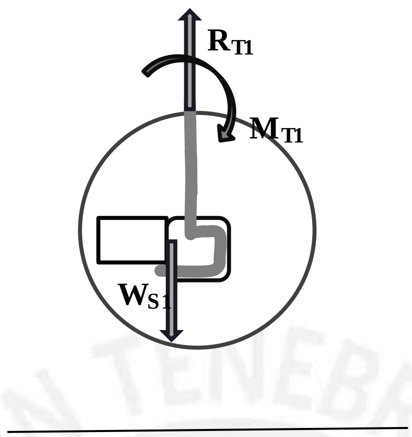
- Asumiendo que para 1, 2, 3, 4: $\tau_t \approx 0$; $\sigma_n \approx 0$; $\sigma_f << \tau_c$
$$\sigma_{eq} < \frac{\sigma_{Lim}}{FS}$$
- Según Von Mises:
$$\sqrt{(\sigma_f + \sigma_n)^2 + 3({\tau_t}^2 + {\tau_c}^2)} < \frac{\sigma_{Lim}}{FS}$$
$$\frac{\sqrt{3}\, x\, \frac{R_{T1}}{2}}{A_{T1}} < \frac{\sigma_{Lim}}{FS}$$

Datos: F.S = 2.5; σ_{Lim}=240N/mm^2(Tornillo 4.6); R_{T1}=213.5N; A_{T1}=$\pi d^2/4$

- Entonces:

d>1.566mm

Caso 2: DCL del tubo inferior, motor y rueda cuando la rueda no se encuentra en contacto con el piso:



$$\sum F = 0$$

$$R_{T1} = W_{S1} \qquad \ldots (1)$$

$$W_{S1} = W_M + W_R + W_H + W_{F1}$$

- Entonces: $R_{T1} = 43.7N$

Datos: α=0°; μ=0.5; W=1029N (105kg); W_M=34.3N (3.5kg); W_R =5N (0.51kg); W_H = 0.4N (0.042kg); W_{F1} = 4N (0.411kg)

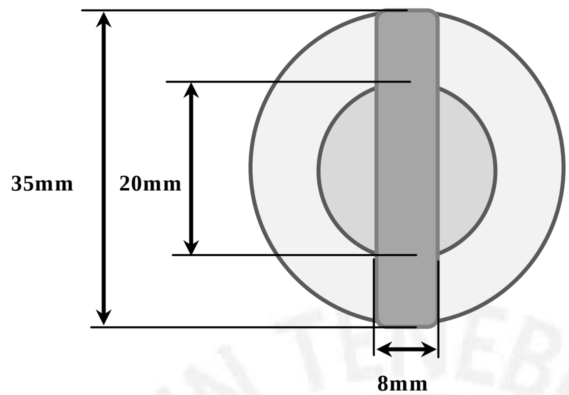
Al soportar una reacción menor comparada al primer caso (213.5N >43.7N), no se efectuará el análisis para esa situación.

En resumen:

Debido a que el largo del tornillo debe ser suficiente para pasar a través del tubo de diámetro exterior de 26.67mm adicionando el espesor de la tuerca y arandela, el tornillo normalizado que cumple inmediatamente con esa condición y la que desprende del análisis en el caso 1 es de M5.

Anexo 9

Comprobación del diámetro de la clavija entre el acople rueda-motor y el eje del motor



Para la clavija se cumple:

$$F_c = \frac{M}{D_e}$$

$$\tau_c = \frac{4xF_c}{\pi x d^2}$$

$$\tau_c \leq \tau_{c\ Adm}$$

Siendo:

F_c: Fuerza de corte en la clavija

M: Momento

D_e: Diámetro del eje

d: diámetro de la clavija

T_c: Esfuerzo cortante para la clavija

$T_{c\ Adm}$: Esfuerzo cortante admisible para la clavija

Entonces:

$$\tau_c = 23.87 N/mm^2$$

Datos: M=24N.m; D_e= 20mm; d= 8mm; $T_{c\ Adm}$=50N/mm^2 (St37)

Como:

$$\tau_c < \tau_{c\ Adm}$$

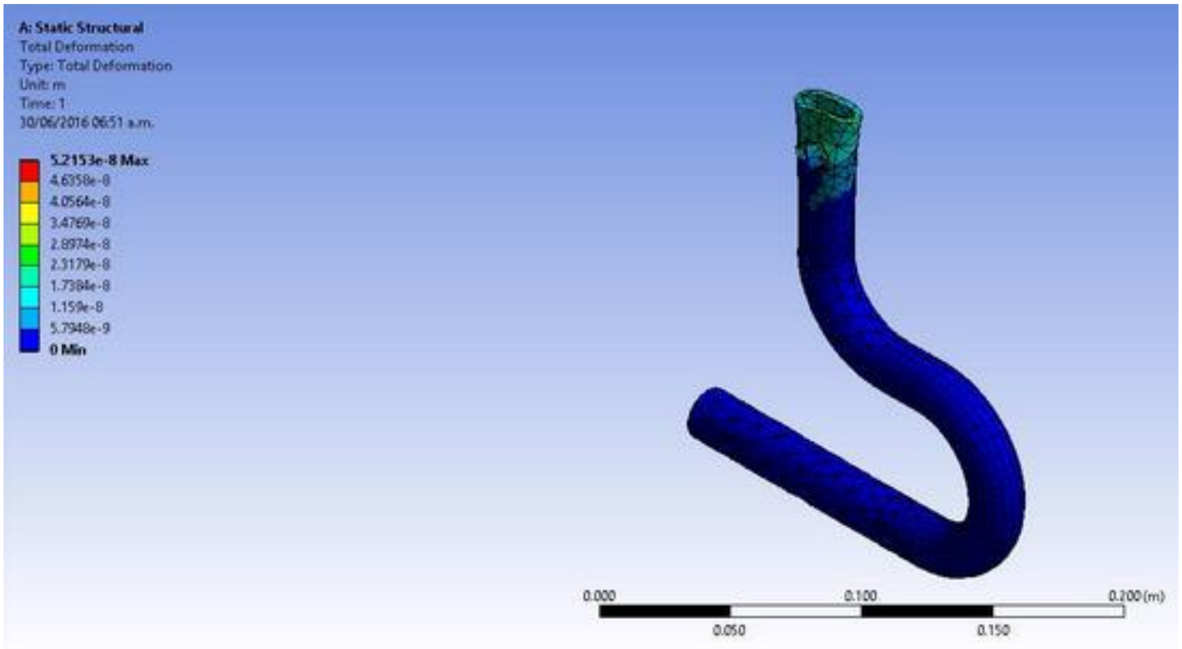
Para el diámetro del pin se cumple la condición a corte.

ANEXO 10

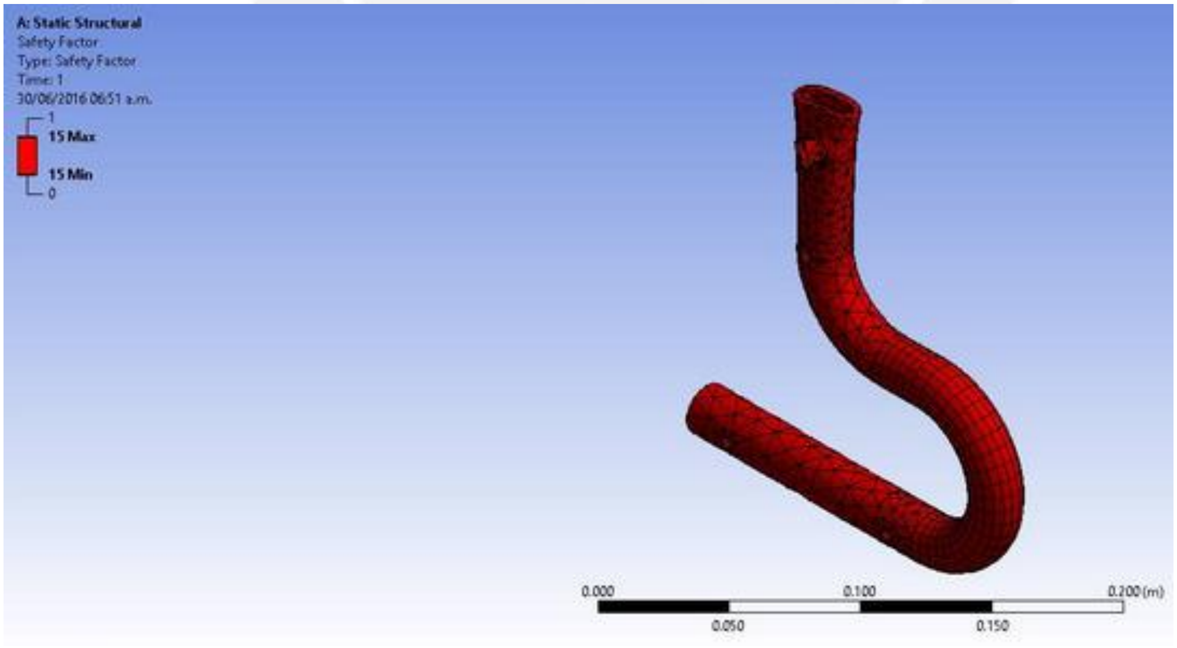
SIMULACIONES

Estructura inferior

Deformación total:

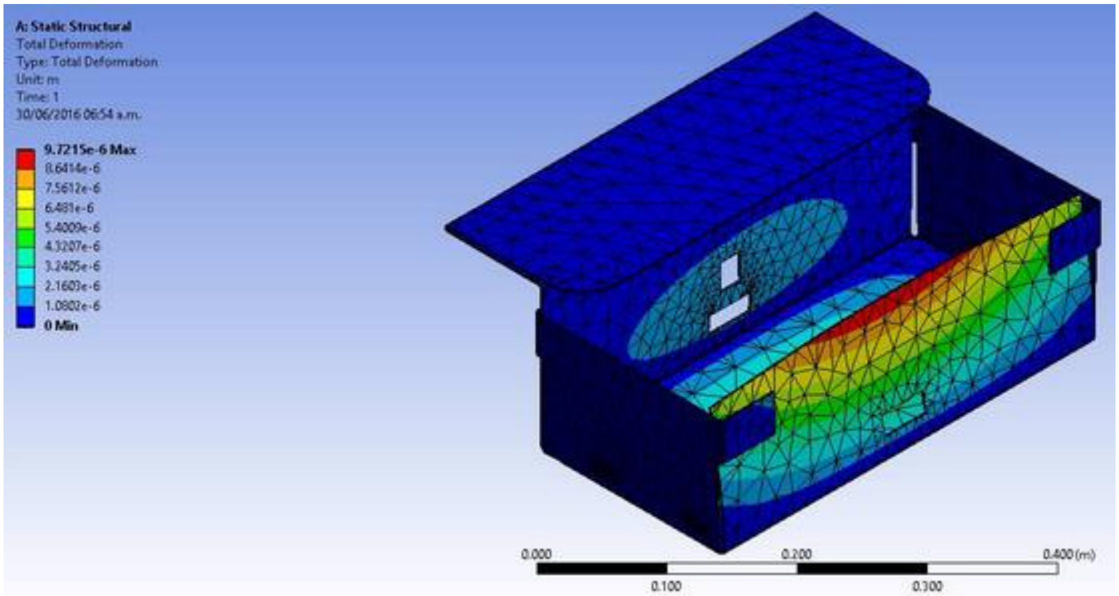


Factor de seguridad

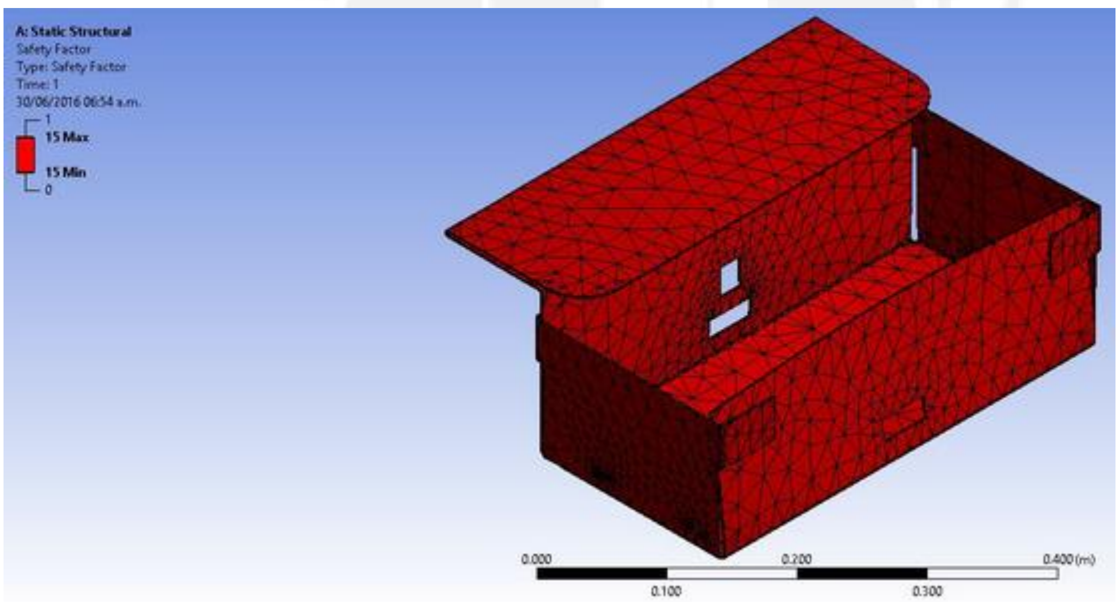


Ensamble soporte electrónico

Deformación total:



Factor de seguridad



ANEXO 11

COTIZACIONES

ZOLID

Cotización de Servicio

Código#: CT133

Fecha: 29/06/2016

Nombre: Kiara Jesenia Campos

Vendedor: Melissa Velarde Polar

Servicio	Descripción	Cantidad	Precio unitario sin. IGV	Precio total Inc. IGV
Impresión 3D	Acople mando 1	1	S/. 18	S/. 21.24
Impresión 3D	Acople mando 2	1	S/. 18	S/. 21.24
Impresión 3D	Mando d	1	S/. 22.50	S/. 26.55
Impresión 3D	Mando u	1	S/. 13.50	S/. 15.93
Impresión 3D	Soporte ultra	1	S/. 3	S/. 3.54
			Total	S/. 88.50

Validez: 15 días

Fecha de entrega: 2 días luego de recibida la orden de compra, si estuviera antes se comunicará a la brevedad posible.

Forma de pago: contra entrega

ZOLID DESIGN SAC
Dirección: Av. Angamos Este 1551, Block 2,
2do piso Tienda 41 L-34 Perú
Tel: 241-2024 / 241-2025
Cel: 987961283
Email: melissa@zolid.pe

ANEXO 12

HOJAS DE DATOS

JOYSTICK MODULE

Description

Lots of robotic projects need a joystick. This module offers an affordable solution to that. The Joystick module is similar to analog joysticks found in gamepads. It is made by mounting two potentiometers at a 90 degrees angle. The potentiometers are connected to a short stick centered by springs.

This module produces an output of around 2.5V from X and Y when it is in resting position. Moving the joystick will cause the output to vary from 0v to 5V depending on its direction. If you connect this module to a microcontroller, you can expect to read a value of around 512 in its resting position (expect small variations due to tiny imprecisions of the springs and mechanism) When you move the joystick you should see the values change from 0 to 1023 depending on its position.

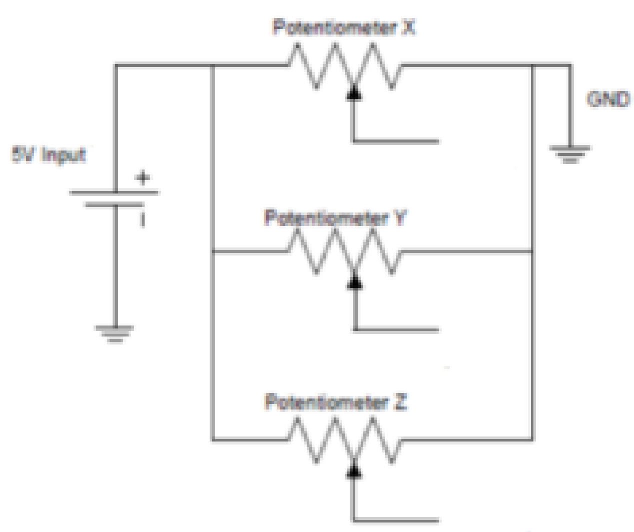
Specifications

- Directional movements are simply two potentiometers - one for each axis
- Compatible with Arduino interface
- The biaxial XY Joystick Module KY-023 applies ARDUINO
- Dimensions: 1.57 in x 1.02 in x 1.26 in (4.0 cm x 2.6 cm x 3.2 cm)
- 5 Pin
- Color: Black

Pin Configuration

1. GND: ground
2. +5V: 5V DC
3. VRx: voltage proportional to x position
4. VRy: voltage proportional to y position
5. SW: switch pushbutton

Schematic Diagram



How to test

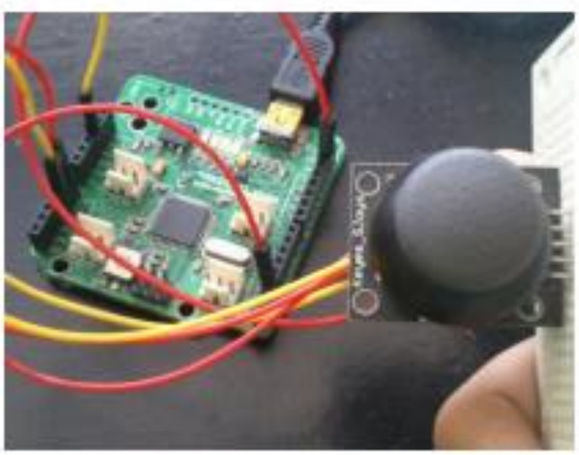
The components to be used are:

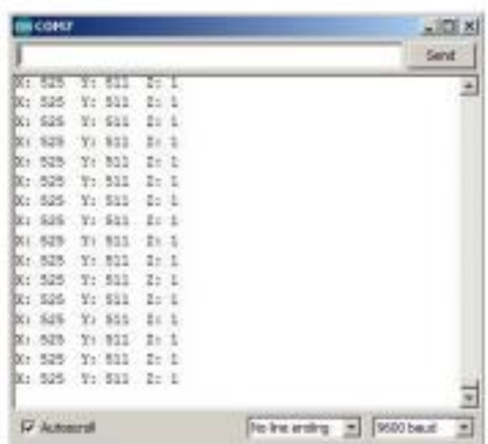
- Microcontroller (any compatible arduino)
- Joystick module
- 1 Pin M-M connectors
- Breadboard
- USB cable

1. Connect the components based on the figure shown in the wiring diagram using a M-M pin connector. +5V pin is connected to the 5V power supply, GND pin is connected to the GND, the VRx and VRy pins are connected to the analog input pins and the SW pin is connected to the digital I/O pin. Pin number will be based on the actual program code.
2. After hardware connection, insert the sample sketch into the Arduino IDE.
3. Using a USB cable, connect the ports from the microcontroller to the computer.
4. Upload the program.
5. See the results in the serial monitor.

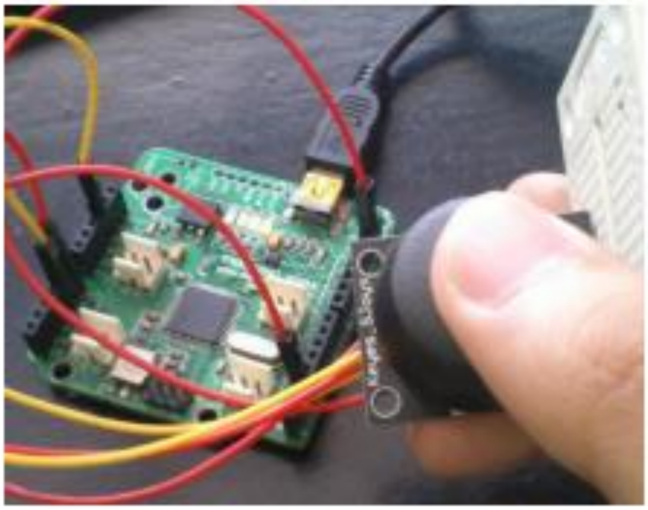
Testing results

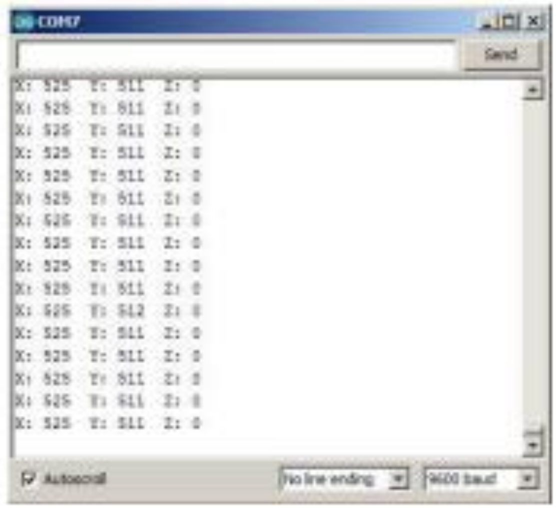
The serial monitor displays the X, Y and Z positions based on the position of the stick.



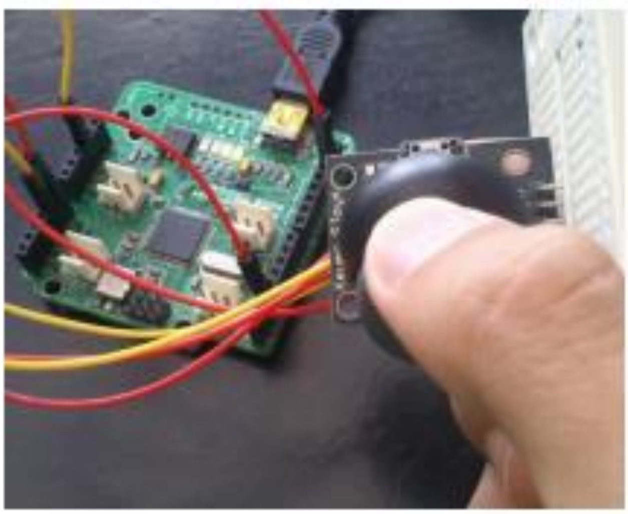


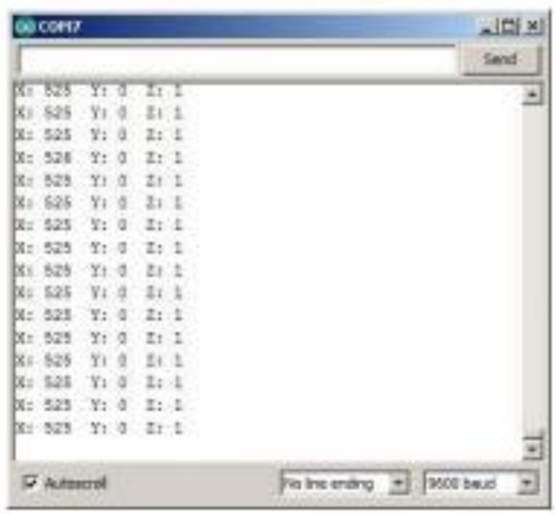
When the middle button was pressed:



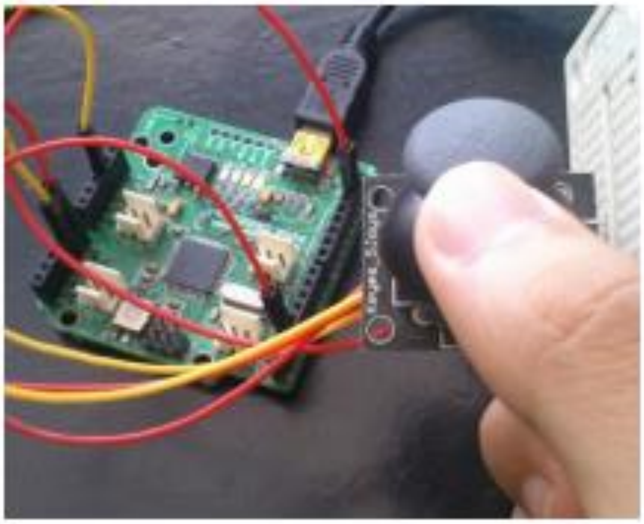


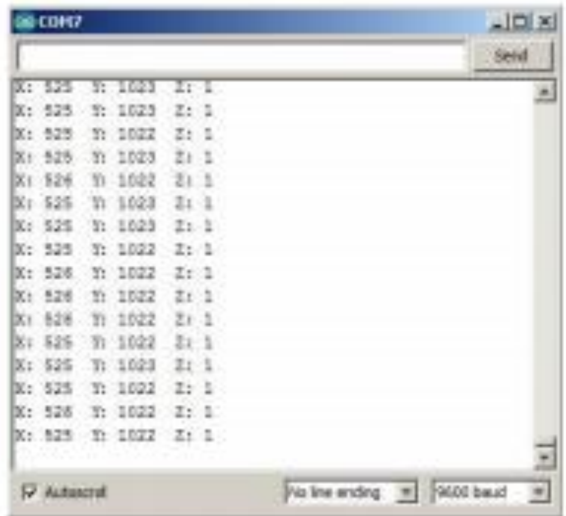
When the stick was moved downward:



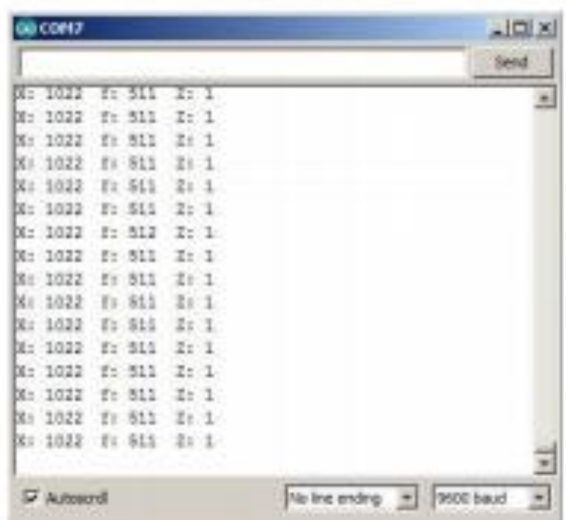


When the stick was moved upward:

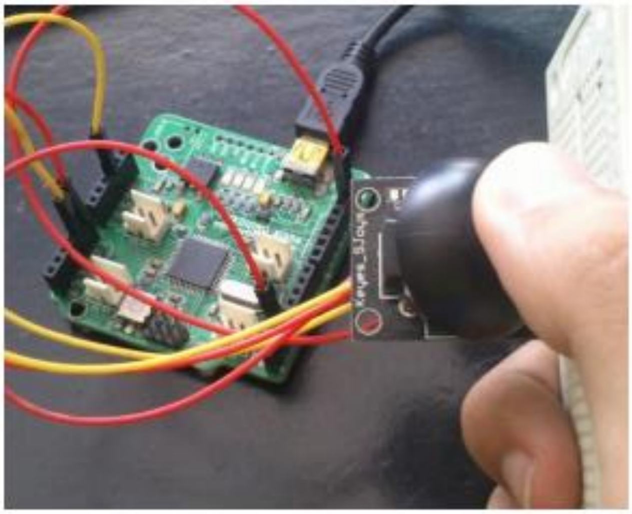


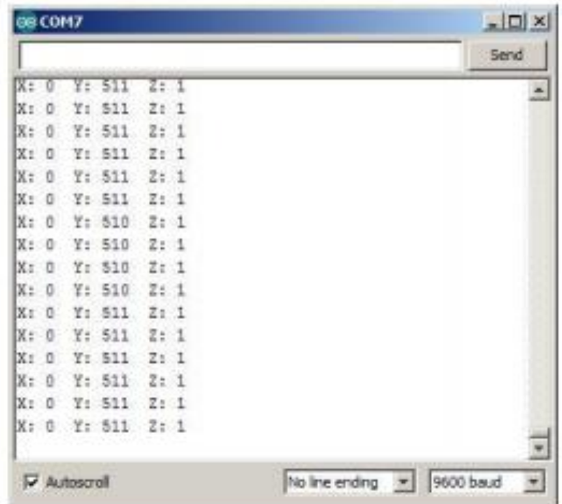


When the stick was moved to the left:



When the stick was moved to the right:





Tech Support: services@elecfreaks.com

Ultrasonic Ranging Module HC - SR04

Product features:

Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit. The basic principle of work:
(1) Using IO trigger for at least 10us high level signal,
(2) The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.
(3) IF the signal back, through high level , time of high output IO duration is the time from sending ultrasonic to returning.
Test distance = (high level time×velocity of sound (340M/S) / 2,

Wire connecting direct as following:

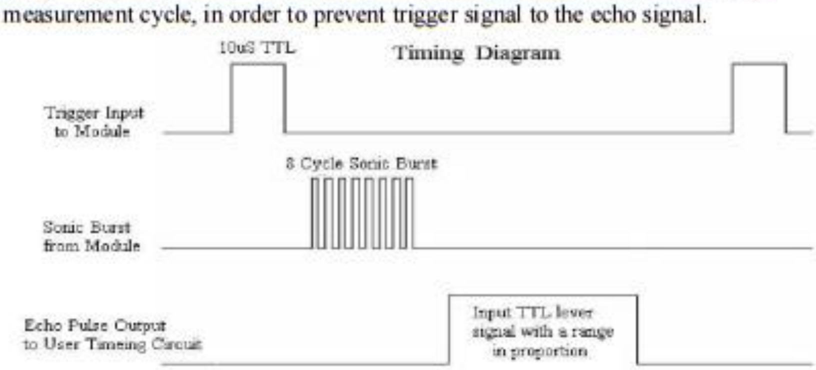
- 5V Supply
- Trigger Pulse Input
- Echo Pulse Output
- 0V Ground

Electric Parameter

Working Voltage	**DC 5 V**
Working Current	**15mA**
Working Frequency	**40Hz**
Max Range	**4m**
Min Range	**2cm**
MeasuringAngle	**15 degree**
Trigger Input Signal	**10uS TTL pulse**
Echo Output Signal	**Input TTL lever signal and the range in proportion**
Dimension	**45*20*15mm**

Timing diagram

The Timing diagram is shown below. You only need to supply a short 10uS pulse to the trigger input to start the ranging, and then the module will send out an 8 cycle burst of ultrasound at 40 kHz and raise its echo. The Echo is a distance object that is pulse width and the range in proportion .You can calculate the range through the time interval between sending trigger signal and receiving echo signal. Formula: uS / 58 = centimeters or uS / 148 =inch; or: the range = high level time * velocity (340M/S) / 2; we suggest to use over 60ms measurement cycle, in order to prevent trigger signal to the echo signal.



Attention:

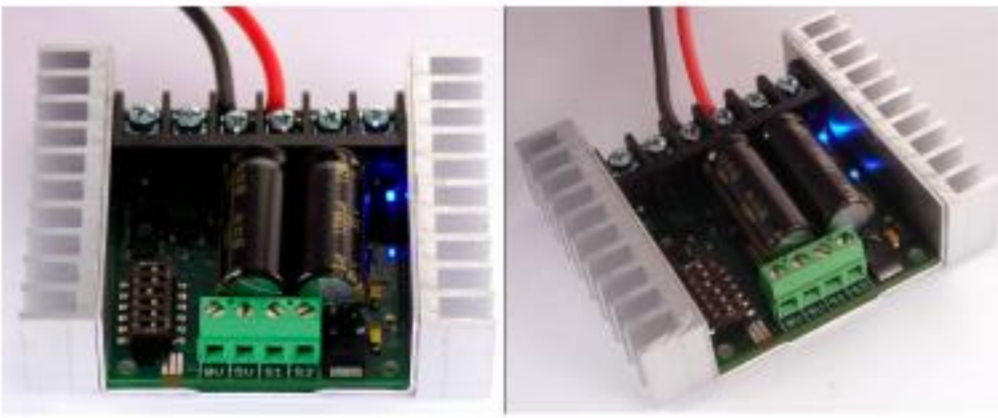
- The module is not suggested to connect directly to electric, if connected electric, the GND terminal should be connected the module first, otherwise, it will affect the normal work of the module.
- When tested objects, the range of area is not less than 0.5 square meters and the plane requests as smooth as possible, otherwise ,it will affect the results of measuring.

www.Elecfreaks.com

DimensionEngineering

Sabertooth 2x25 User's Guide

July 2007



nput voltage: 6-24V nominal, 30V absolute max.

)utput Current: Up to 25A continuous per channel. Peak loads may be up to 50A per hannel for a few seconds.

Recommended power sources are:

- 5 to 18 cells high capacity NiMH or NiCd
- 2s to 6s lithium ion or lithium polymer. Sabertooth motor drivers have a lithium battery mode to prevent cell damage due to over-discharge of lithium battery packs.
- 6v to 24v high capacity lead acid
- 6v to 24v power supply (when in parallel with a suitable battery).

ll batteries must be capable of maintaining a steady voltage when supplying 20+ amps AA or 9V batteries aren't going to cut it! An 18Ah lead-acid battery is a good starting point)

)imensions:

Size: 2.6" x 3.2" x .8"	65 x 80 x 20mm
Weight: 3.5oz / 96g	

Features

Mixed and independent options:
Sabertooth features mixed modes designed especially for differential drive robots, where two motors provide both steering and propulsion. It also has independent options in all operating modes. This is useful for if you have two motors to control, but they aren't necessarily being used to drive a differential drive robot. The motors do not need to be matched or even similar, as long as they both are within Sabertooth's operating limits.

Synchronous regenerative drive:
Going one step farther than just regenerative braking, a Sabertooth motor driver will return power to the battery any time a deceleration or motor reversal is commanded. This can lead to dramatic improvements in run time for systems that stop or reverse often, like a placement robot or a vehicle driving on hilly terrain. This drive scheme also saves power by returning the inductive energy stored in the motor windings to the battery each switching cycle, instead of burning it as heat in the motor windings. This makes part-throttle operation very efficient.

Ultra-sonic switching frequency:
Sabertooth 2x25 features a PWM frequency of 32kHz, which is well above the maximum frequency of human hearing. Unlike some other motor drivers, there is no annoying whine when the motor is on, even at low power levels.

Thermal and overcurrent protection:
Sabertooth features dual temperature sensors and overcurrent sensing. It will protect itself from failure due to overheating, overloading and short circuits.

Easy mounting and setup:
Sabertooth has screw terminals for all inputs and outputs. There are four mounting holes, which accept 4-40 screws. Mounting hardware is included. All operating modes and options are set with DIP switches – there are no jumpers to struggle with or lose. No soldering is required.

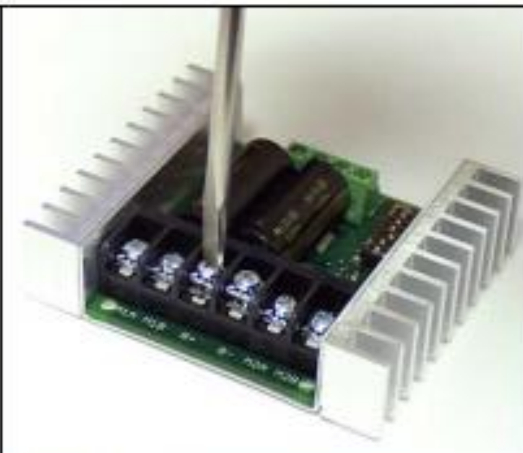
Compact Size:
Sabertooth utilizes surface mount construction to provide the most power from a compact package. Its small size and light weight mean you have more space for cargo, batteries, or can make your robot smaller and more nimble than the competition.

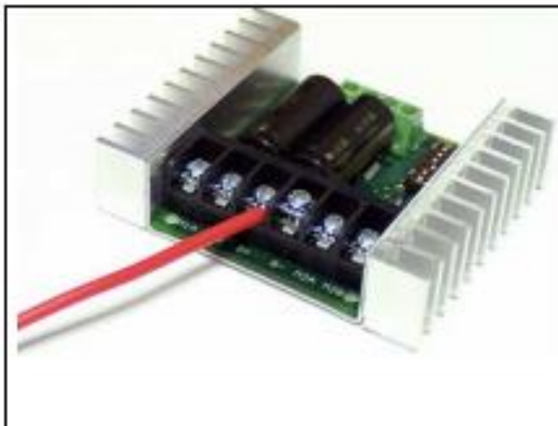
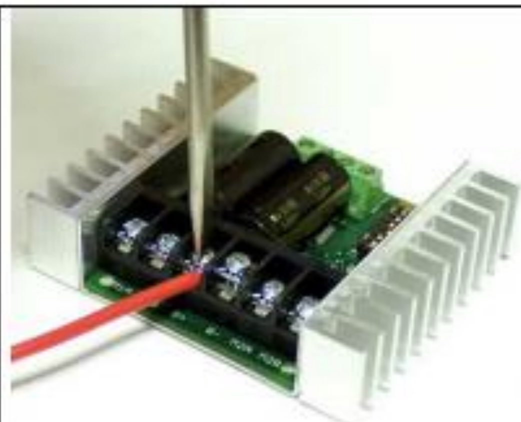
Carefree reversing:
Unlike some other motor drivers, there is no need for the Sabertooth to stop before being commanded to reverse. You can go from full forward immediately to full reverse or vice versa. Braking and acceleration are proportional to the amount of reversal commanded, so gentle or rapid reversing is possible.

Many operating modes:
With analog, R/C and serial input modes, as well as dozens of operating options, the Sabertooth has the flexibility to be used over and over, even as your projects grow more sophisticated. Yet it is simple enough to use for your first robot project.

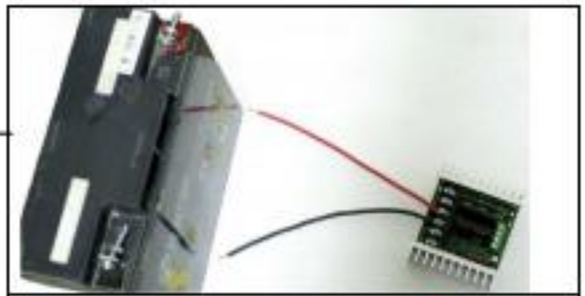
Hooking up the Sabertooth motor driver

All connections to the Sabertooth are done with screw terminals. This makes it easy to set up and reconfigure your project. If you've never used screw terminal connections before, here is a quick overview.

	
Step 1: Strip the wire which you are using approximately ¼" The wires may be 12 gauge to 30 gauge. Use thicker wire for high current applications.	**Step 2:** With a large screwdriver, turn the top screw counter-clockwise until it stops gently.

	
Step 3: Insert the stripped portion of the wire into the opening in the screw terminal	**Step 4:** Turn the top screw clockwise until you encounter resistance, then tighten the screw firmly. Pull on the wire gently to ensure that it is secured.

Battery Terminals
B+ and B-



The battery connects to terminals B+ and B-

The battery or power supply is connected to terminals B- and B+. B- connects to the negative side of the battery (usually black.) B+ connects to the positive side of the battery (usually red or yellow.) It is usually best to connect the battery through a connector instead of directly to the motor driver. This makes it easy to unplug the battery for charging, and prevents plugging in the battery backwards.

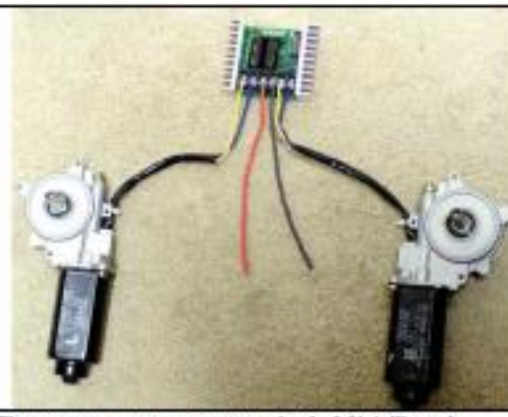
Using a battery connector to connect/disconnect power to Sabertooth

Warning! Be very careful to wire and plug in the battery and connector correctly. Connecting the battery backwards will destroy the Sabertooth and will void the warranty.

Motor Terminals

Motor 1 is connected to terminals M1A and M1B as shown below. If the motor runs in the opposite way that you want, you may reverse the motor wires to reverse rotation.

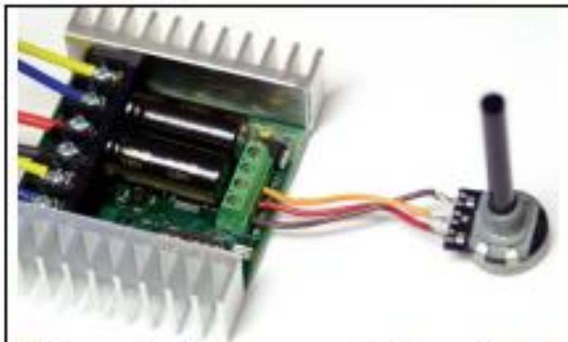
Motor 2 is connected to terminals M2A and M2B



The motors connect to terminals M1A/B and M2A/B

Signal Input Terminals S1 and S2

The input signals that control the Sabertooth are connected to terminals S1 and S2. If you are running in analog mode, it is important to have both the signal connected before applying power to the device. Otherwise, the motors may start unexpectedly.



The input signals connect to terminal S1 and/or S2

Power terminals 0V and 5V

The 5V terminal can be used to power small loads, like a potentiometer or a radio receiver. The 0V signal must be connected to the ground of the device generating the input signal.

The 0V and 5V connections are used to power and interface to low-power control circuits.

The 5V connection is a 5v power **output**. This is useful for supplying power to low-current devices, such as a potentiometer or a radio receiver. The 5v terminal is capable of supplying 100 milliamps if the source battery is 12.6v or less. If the source battery is greater than 12.6 volts, the 5v terminal is capable of supplying 10 milliamps. If more power is needed, we recommend using a SportBEC or DESW050 to supply the needed 5V power to the rest of the robot.

The 0V connection is the signal ground for the Sabertooth. In order to receive input signals correctly, it must be connected to the ground of the device sending the signals.

Using the 0V and 5v connections to power a radio receiver in R/C mode and potentiometer in analog mode is shown in Figures 2.1 and 2.2. If you are using multiple Sabertooths running from the same radio receiver, only one should have the 5v line connected.

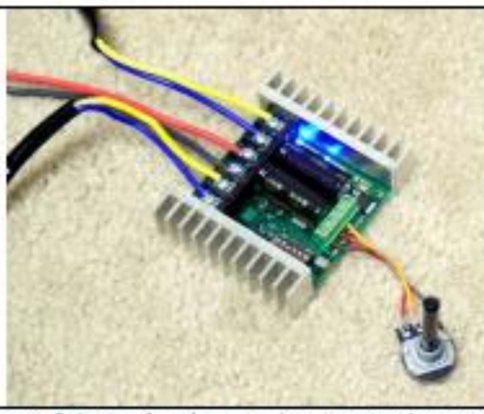


Figure 2.1: Analog input using a potentiometer powered from terminal 5V

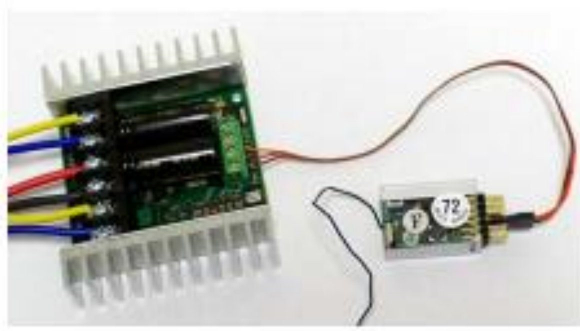


Figure 2.2: R/C input using a receiver powered from terminal 5V

Status and Error LEDs

All Status LEDs on

Sabertooth 2x25 has three indicator LEDs.

The blue LED marked Status1 is used to communicate various information about the current state. In most cases Status1 acts as a power indicator. In R/C mode, it glows dimly if there is no RC link present and brightly if there is an RC link.

The blue LED marked Status2 is only used in lithium mode. It blinks to indicate the number of lithium cells detected.

The red Error LED illuminates if the Sabertooth has detected a problem. It will light if the driver has shut down due to a depleted battery or due to overheating, overcurrent or overvoltage. If you are using a NiCd or NiMH battery, and commanding an acceleration causes the motor to jerk and the Error LED to flash on and off, the battery is depleted.

Mounting your Sabertooth 2x25

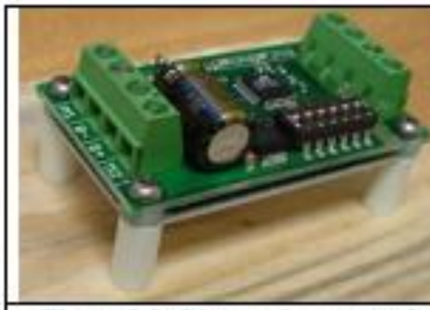


Figure 2.3: Mounted to a wood frame using standoffs

The Sabertooth is supplied with four mounting holes. These can be used to attach it to your robot. The centers of the mounting holes form a 1.75" x 2.25" rectangle. The holes are .125 inches in diameter. The proper size screw is a 4-40 round head machine or wood screw. Four 5/8" long machine screws and nuts are included.

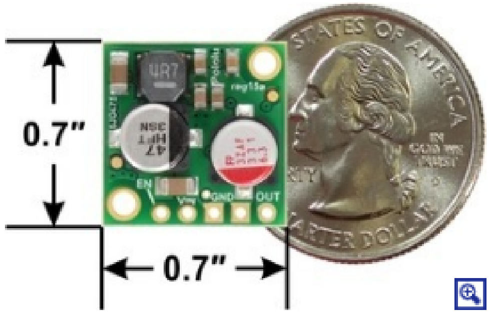
If your robot or device is constructed from insulating materials such as wood or plastic, it may be necessary to mount the Sabertooth on standoffs to allow air to circulate. An example is shown in Figure 2.3

Figure 2.4: Mounted directly to a metal frame

If your robot or device is constructed from metal, it is usually better to attach the bottom heat spreader of the Sabertooth directly to the frame, without standoffs. This will allow your frame to act as a heat sink and will cause the Sabertooth to run cooler. This is shown in Figure 2.4

Pololu 7.5V 2.5A Step Down

Overview



The D24V25Fx family of step-down voltage regulators generates lower output voltages from input voltages as high as 38 V. They are switching regulators (also called switched-mode power supplies (SMPS) or DC-to-DC converters) with typical efficiencies between 85% and 95%, which is much more efficient than linear voltage regulators, especially when the difference between the input and output voltage is large. The available output current is a function of the input voltage and efficiency (see the *Typical efficiency and output current* section below), but the output current can typically be as high as 2.5 A.

At light loads, the switching frequency automatically changes to maintain high efficiencies. These regulators have a typical quiescent (no load) current draw of less than 1 mA, and the ENABLE pin can be used to put the boards in a low-power state that reduces the quiescent current to approximately 10 μA to 20 μA per volt on VIN.

The modules have built-in reverse-voltage protection, short-circuit protection, a thermal shutdown feature that helps prevent damage from overheating, and a soft-start feature that reduces inrush current.

Features

- Input voltage:
  - 4.5 V to 38 V for the version that outputs 3.3 V
  - [*output voltage* + *dropout voltage*] to 38 V for output voltages of 5 V and higher (see below for more information on dropout voltage)
- Fixed 3.3 V, 5 V, 6 V, 7.5 V, or 9 V output (depending on regulator version) with 4% accuracy
- Typical maximum continuous output current: 2.5 A
- Integrated reverse-voltage protection, over-current protection, over-temperature shutoff, and soft-start
- Typical efficiency of 85% to 95%, depending on input voltage and load; the switching frequency automatically changes at light loads to maintain high efficiencies
- Typical no-load quiescent current under 1 mA; can be reduced to 10 μA to 20 μA per volt on VIN by disabling the board
- Compact size: 0.7″ × 0.7″ × 0.35″ (17.8 mm × 17.8 mm × 9 mm)
- Two 0.086″ mounting holes for #2 or M2 screws

Using the regulator

Connections

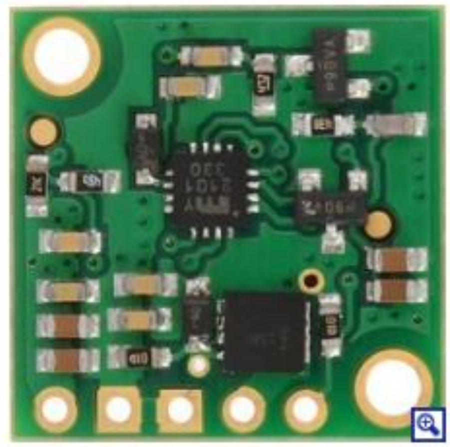
This buck regulator has five connection points for four different connections: enable (EN), input voltage (VIN), 2x ground (GND), and output voltage (VOUT).

The input voltage, **VIN**, powers the regulator. Voltages between 4.5 V and 38 V can be applied to VIN, but for versions of the regulator that have an output voltage higher than 4.5 V, the effective lower limit of VIN is VOUT plus the regulator's dropout voltage, which varies approximately linearly with the load (see below for graphs of dropout voltages as a function of the load).

The output voltage, **VOUT**, is fixed and depends on the regulator version: the D24V25F3 version outputs 3.3 V, the D24V25F5 version outputs 5 V, the D24V25F6 version outputs 6 V, the D24V25F7 version outputs 7.5 V, and the D24V5F9 version outputs 9 V.

The regulator is enabled by default: a 100 kΩ pull-up resistor on the board connects the **ENABLE** pin to reverse-protected VIN. The ENABLE pin can be driven low (under 0.6 V) to put the board into a low-power state. The quiescent current draw in this sleep mode is dominated by the current in the pull-up resistor from ENABLE to VIN and by the reverse-voltage protection circuit, which will draw between 10 µA and 20 µA per volt on VIN when ENABLE is held low. If you do not need this feature, you should leave the ENABLE pin disconnected.

Pololu 2.5A Step-Down Voltage Regulator D24V25Fx with included hardware.



Pololu 2.5A Step-Down Voltage Regulator D24V25Fx, bottom view.

The five connection points are labeled on the top of the PCB and are arranged with a 0.1″ spacing for compatibility with solderless breadboards, connectors, and other prototyping arrangements that use a 0.1″ grid. Either the included 5×1 straight male header strip or the 5×1 right angle male header strip can be soldered into these holes. For the most compact installation, you can solder wires directly to the board.

Pololu 2.5A Step-Down Voltage Regulator D24V25Fx, side view.

The board has two 0.086″ mounting holes intended for #2 or M2 screws. The mounting holes are at opposite corners of the board and are separated by 0.53″ both horizontally and vertically.

Typical efficiency and output current

The efficiency of a voltage regulator, defined as (Power out)/(Power in), is an important measure of its performance, especially when battery life or heat are concerns. This family of switching regulators typically has an efficiency of 85% to 95%, though the actual efficiency in a given system depends on input voltage, output voltage, and output current. See the efficiency graph near the bottom of this page for more information.

The maximum achievable output current is typically around 2.5 A, but this depends on many factors, including the ambient temperature, air flow, heat sinking, and the input and output voltage.

Typical dropout voltage

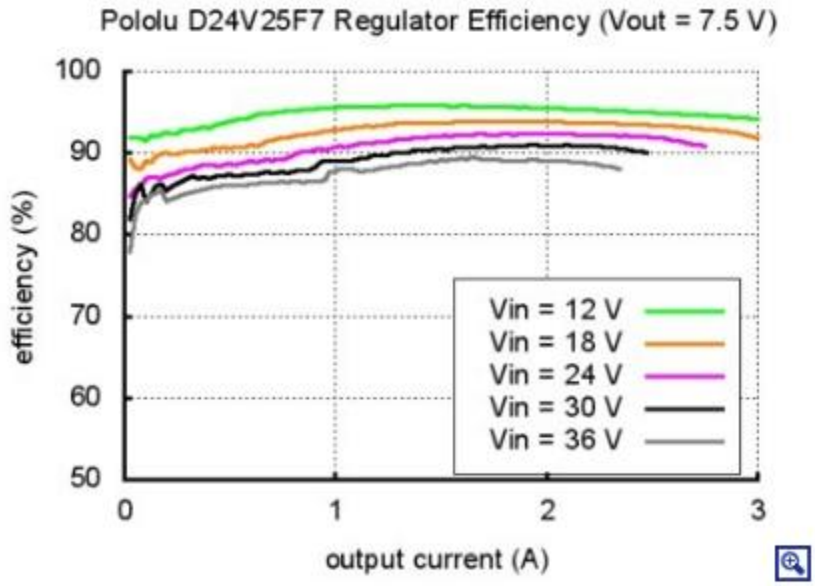
The dropout voltage of a step-down regulator is the minimum amount by which the input voltage must exceed the regulator's target output voltage in order to ensure the target output can be achieved. For example, if a 5 V regulator has a 1 V dropout voltage, the input must be at least 6 V to ensure the output is the full 5 V. Generally speaking, the dropout voltage increases as the output current increases. See the "Details" section below for more information on the dropout voltage for this specific regulator version.

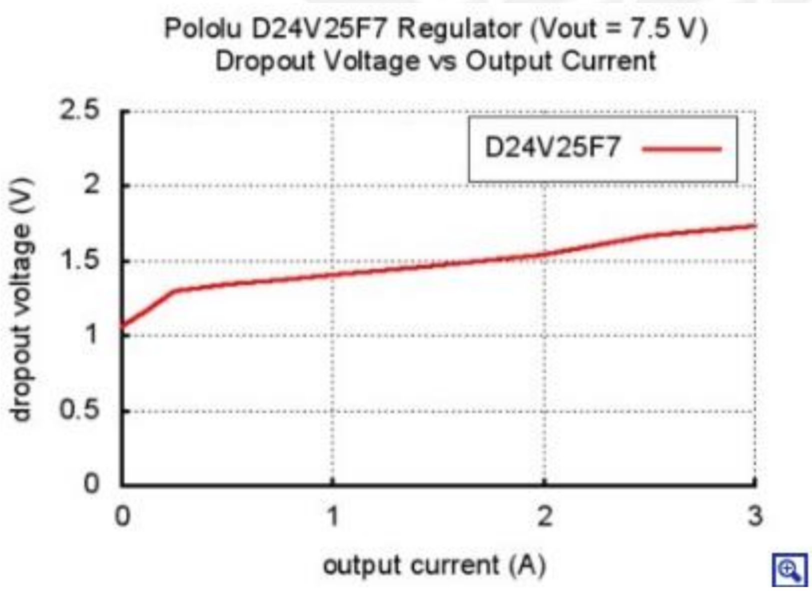
Switching frequency and behavior under light loads

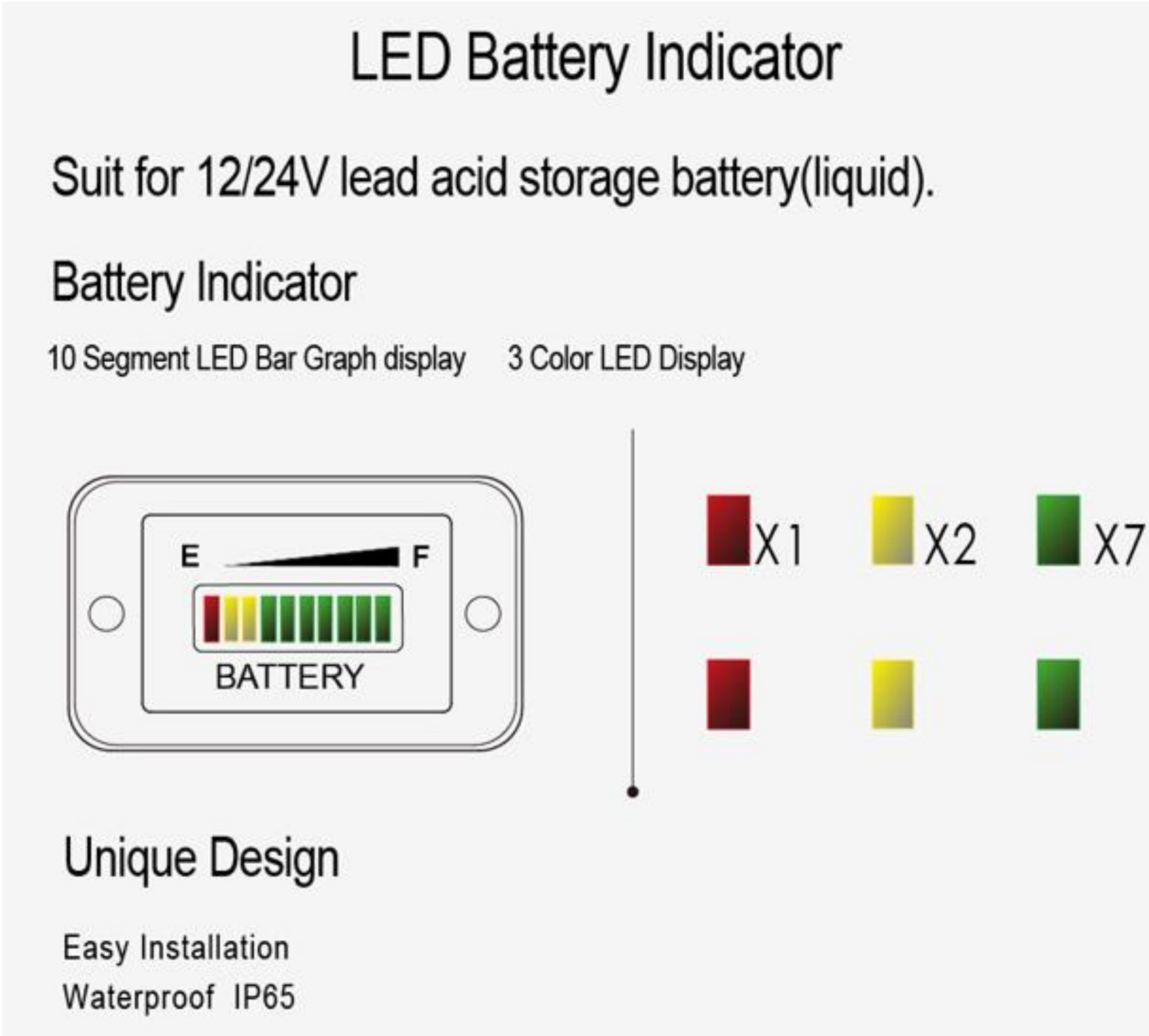
The regulator generally operates at a switching frequency of around 600 kHz, but the frequency drops when encountering a light load to improve efficiency. This could make it harder to filter out noise on the output caused by switching.

Details for item #2853

The graphs below show the typical efficiency and dropout voltage of the 7.5 V D24V25F7 regulator as a function of the output current:






LED Battery Indicator
Suit for 12/24V lead acid storage battery(liquid).
Battery Indicator
10 Segment LED Bar Graph display
3 Color LED Display
E
F
BATTERY
X1
X2
X7
Unique Design
Easy Installation
Waterproof IP65

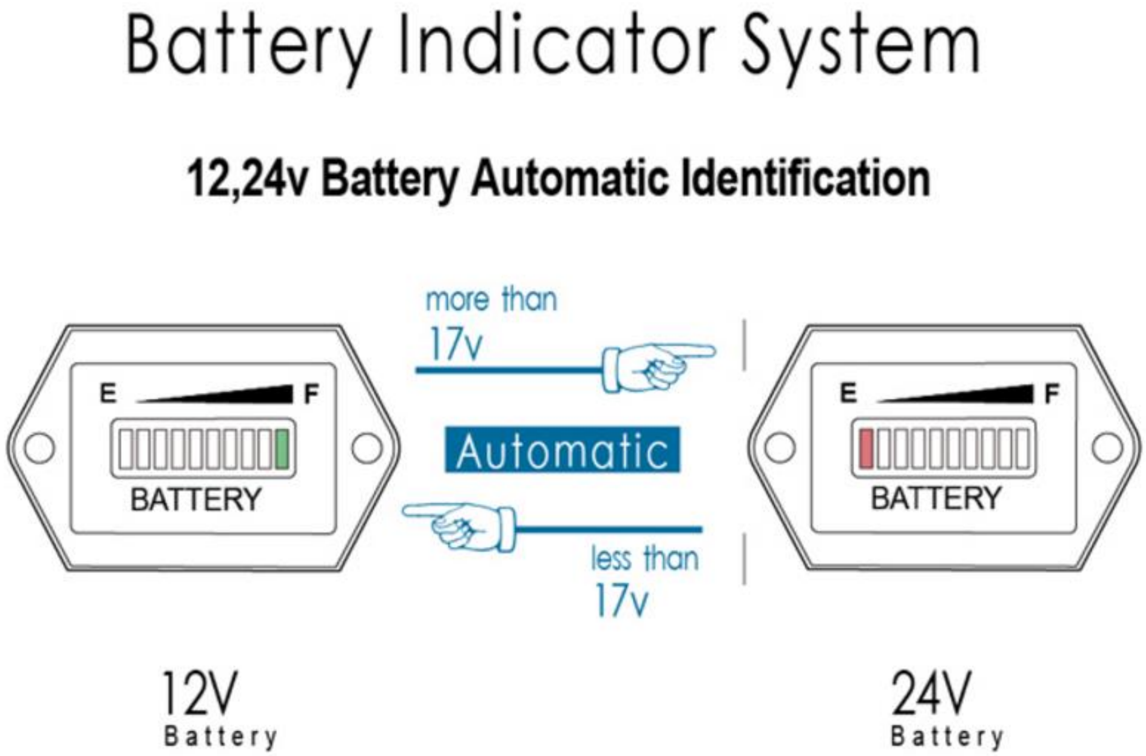
Working voltage of every bar

Battery charge voltage

12V battery indicator use the voltage higher than 13.6V

24V battery indicator use the voltage higher than 24.6V

Voltage	≤1	2	3	4	5	6	7	8	9	10
12V	10.38	10.59	10.8	11.01	11.22	11.43	11.64	11.85	12.3	≥12.3
24V	20.76	21.18	21.6	22.02	22.44	22.86	23.28	23.7	24.6	≥24.6
Display Mode	1#—2# flash Alternately (frequency :1Hz)	Only 2# flash (frequency :1Hz)	Only 3# lit	Only 4# lit	Only 5# lit	Only 6# lit	Only 7# lit	Only 8# lit	Only 9# lit	Only 10# lit
Display colors of LED	Red	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green


Battery Indicator System
12,24v Battery Automatic Identification
more than
17v
E
F
BATTERY
Automatic
less than
17v
12V
Battery
24V
Battery

Specification

Product Name	Battery Indicator
Item Number	RL-BI003
Product Size	53mm×32mm×24mm
Display Screen	10 Segment LED Bar Graph
Operation Current	20mA
Pin Material	Copper
Pin Type	+, -, C
Storage Temperature	-40°C - +85°C
Display Panel Material	Transparent ABS
Package	White Box
Package Size	190mm*113mm*25mm
N.W.	45g
Waterproof Rate	IP65
Operation Temperature	-30℃—85℃

HC Serial Bluetooth Products

User Instructional Manual

1 Introduction

HC serial Bluetooth products consist of Bluetooth serial interface module and Bluetooth adapter, such as:

(1) Bluetooth serial interface module:

Industrial level: HC-03, HC-04(HC-04-M, HC-04-S)

Civil level: HC-05, HC-06(HC-06-M, HC-06-S)

HC-05-D, HC-06-D (with baseboard, for test and evaluation)

(2) Bluetooth adapter:

HC-M4

HC-M6

This document mainly introduces Bluetooth serial module. Bluetooth serial module is used for converting serial port to Bluetooth. These modules have two modes: master and slaver device. The device named after even number is defined to be master or slaver when out of factory and can't be changed to the other mode. But for the device named after odd number, users can set the work mode (master or slaver) of the device by AT commands.

HC-04 specifically includes:

Master device: HC-04-M, M=master

Slave device: HC-04-S, S=slaver

The default situation of HC-04 is slave mode. If you need master mode, please state it clearly or place an order for HC-O4-M directly.The naming rule of HC-06 is same.

When HC-03 and HC-05 are out of factory, one part of parameters are set for activating the device. The work mode is not set, since user can set the mode of HC-03, HC-05 as they want.

The main function of Bluetooth serial module is replacing the serial port line, such as:

1. There are two MCUs want to communicate with each other. One connects to Bluetooth master device while the other one connects to slave device. Their connection can be built once the pair is made. This Bluetooth connection is equivalently liked to a serial port line connection including RXD, TXD

signals. And they can use the Bluetooth serial module to communicate with each other.

2. When MCU has Bluetooth salve module, it can communicate with Bluetooth adapter of computers and smart phones. Then there is a virtual communicable serial port line between MCU and computer or smart phone.

3. The Bluetooth devices in the market mostly are salve devices, such as Bluetooth printer, Bluetooth GPS. So, we can use master module to make pair and communicate with them.

Bluetooth Serial module's operation doesn't need drive, and can communicate with the other Bluetooth device who has the serial. But communication between two Bluetooth modules requires at least two conditions:

(1) The communication must be between master and slave.

(2) The password must be correct.

However, the two conditions are not sufficient conditions. There are also some other conditions basing on different device model. Detailed information is provided in the following chapters.

In the following chapters, we will repeatedly refer to Linvor's (Formerly known as Guangzhou HC Information Technology Co., Ltd.) material and photos.

2 Selection of the Module

The Bluetooth serial module named even number is compatible with each other; The salve module is also compatible with each other. In other word, the function of HC-04 and HC-06, HC-03 and HC-05 are mutually compatible with each other. HC-04 and HC-06 are former version that user can't reset the work mode (master or slave). And only a few AT commands and functions can be used, like reset the name of Bluetooth (only the slaver), reset the password, reset the baud rate and check the version number. The command set of HC-03 and HC-05 are more flexible than HC-04 and HC-06's. Generally, the Bluetooth of HC-03/HC-05 is recommended for the user.

Here are the main factory parameters of HC-05 and HC-06. Pay attention to the differences:

HC-05	HC-06
Master and slave mode can be switched	Master and slave mode can't be switched
Bluetooth name: HC-05	Bluetooth name: linvor
Password: 1234	Password: 1234

Master role: have no function to remember the last paired salve device. It can be made paired to any slave device. In other words, just set AT+CMODE=1 when out of factory. If you want HC-05 to remember the last paired slave device address like HC-06, you can set AT+CMODE=0 after paired with the other device. Please refer the command set of HC-05 for the details.	Master role: have paired memory to remember last slave device and only make pair with that device unless KEY (PIN26) is triggered by high level. The default connected PIN26 is low level.
Pairing: The master device can not only make pair with the specified Bluetooth address, like cell-phone, computer adapter, slave device, but also can search and make pair with the slave device automatically. Typical method: On some specific conditions, master device and slave device can make pair with each other automatically. (This is the default method.)	Pairing: Master device search and make pair with the slave device automatically. Typical method: On some specific conditions, master and slave device can make pair with each other automatically.
Multi-device communication: There is only point to point communication for modules, but the adapter can communicate with multi-modules.	Multi-device communication: There is only point to point communication for modules, but the adapter can communicate with multi-modules.
AT Mode 1: After power on, it can enter the AT mode by triggering PIN34 with high level. Then the baud rate for setting AT command is equal to the baud rate in communication, for example: 9600. AT mode 2: First set the PIN34 as high level, or while on powering the module set the PIN34 to be high level, the Baud rate used here is 38400 bps. Notice: All AT commands can be operated only	AT Mode: Before paired, it is at the AT mode. After paired it's at transparent communication.

when the PIN34 is at high level. Only part of the AT commands can be used if PIN34 doesn't keep the high level after entering to the AT mode. Through this kind of designing, set permissions for the module is left to the user's external control circuit, that makes the application of HC-05 is very flexible.	
During the process of communication, the module can enter to AT mode by setting PIN34 to be high level. By releasing PIN34, the module can go back to communication mode in which user can inquire some information dynamically. For example, to inquire the pairing is finished or not.	During the communication mode, the module can't enter to the AT mode.
Default communication baud rate: 9600, 4800-1.3M are settable.	Default communication baud rate: 9600, 1200-1.3M are settable.
KEY: PIN34, for entering to the AT mode.	KEY: PIN26, for master abandons memory.
LED1: PIN31, indicator of Bluetooth mode. Slow flicker (1Hz) represents entering to the AT mode2, while fast flicker(2Hz) represents entering to the AT mode1 or during the communication pairing. Double flicker per second represents pairing is finished, the module is communicable. LED2: PIN32, before pairing is at low level, after the pairing is at high level. The using method of master and slaver's indicator is the same. Notice: The PIN of LED1 and LED2 are connected with LED+.	LED: The flicker frequency of slave device is 102ms. If master device already has the memory of slave device, the flicker frequency during the pairing is 110ms/s. If not, or master has emptied the memory, then the flicker frequency is 750m/s. After pairing, no matter it's a master or slave device, the LED PIN is at high level. Notice: The LED PIN connects to LED+ PIN.
Consumption: During the pairing, the current is	Consumption: During the pairing, the current is

fluctuant in the range of 30-40mA. The mean current is about 25mA. After paring, no matter processing communication or not, the current is 8mA. There is no sleep mode. This parameter is same for all the Bluetooth modules.	fluctuant in the range of 30-40 m. The mean current is about 25mA. After paring, no matter processing communication or not, the current is 8mA. There is no sleep mode. This parameter is same for all the Bluetooth modules.
Reset: PIN11, active if it's input low level. It can be suspended in using.	Reset: PIN11, active if it's input low level. It can be suspended in using.
Level: Civil	Level: Civil

The table above that includes main parameters of two serial modules is a reference for user selection.

HC-03/HC-05 serial product is recommended.

3. Information of Package

The PIN definitions of HC-03, HC-04, HC-05 and HC-06 are kind of different, but the package size is the same: 28mm * 15mm * 2.35mm.

The following figure 1 is a picture of HC-06 and its main PINs. Figure 2 is a picture of HC-05 and its main PINs. Figure 3 is a comparative picture with one coin. Figure 4 is their package size information. When user designs the circuit, you can visit the website of Guangzhou HC Information Technology Co., Ltd. (www.wavesen.com) to download the package library of protle version.

Figure 1 HC-06

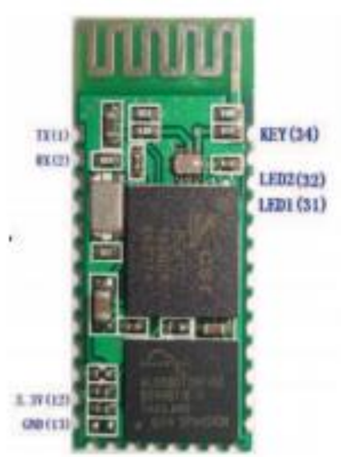
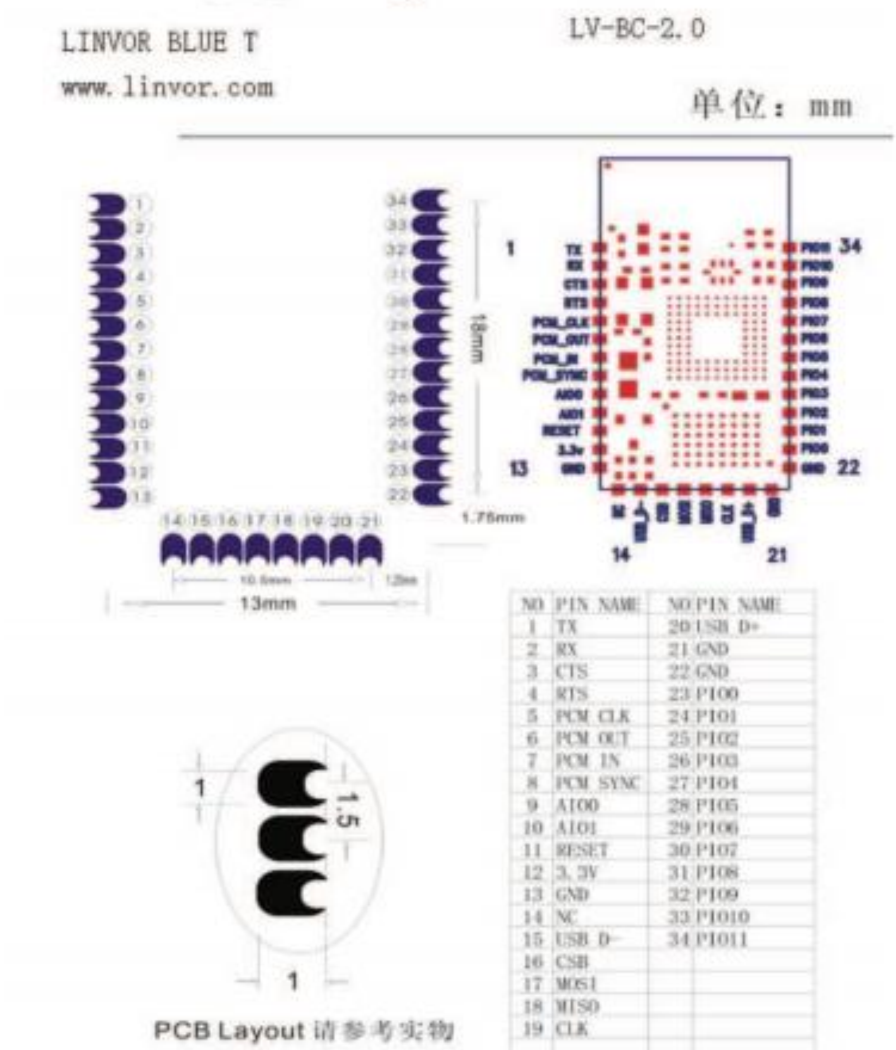


Figure 2 HC-05

Figure 3 Comparative picture with one coin



NO	PIN NAME	NO	PIN NAME
1	TX	20	USB D+
2	RX	21	GND
3	CTS	22	GND
4	RTS	23	PIO0
5	PCM CLK	24	PIO1
6	PCM OUT	25	PIO2
7	PCM IN	26	PIO3
8	PCM SYNC	27	PIO4
9	AIO0	28	PIO5
10	AIO1	29	PIO6
11	RESET	30	PIO7
12	3.3V	31	PIO8
13	GND	32	PIO9
14	NC	33	PIO10
15	USB D-	34	PIO11
16	CSB		
17	MOSI		
18	MISO		
19	CLK		

Figure 4 Package size information

4. The Using and Testing Method of HC-06 for the First Time

This chapter will introduce the using method of HC-06 in detail. User can test the module according to this chapter when he or she uses the module at the first time.

PINs description:

PIN1	UART_TXD , TTL/CMOS level, UART Data output
PIN2	UART_RXD, TTL/COMS level, s UART Data input
PIN11	RESET, the reset PIN of module, inputting low level can reset the module, when the module is in using, this PIN can connect to air.
PIN12	VCC, voltage supply for logic, the standard voltage is 3.3V, and can work at 3.0-4.2V
PIN13	GND
PIN22	GND
PIN24	LED, working mode indicator Slave device: Before paired, this PIN outputs the period of 102ms square wave. After paired, this PIN outputs high level. Master device: On the condition of having no memory of pairing with a slave device, this PIN outputs the period of 110ms square wave. On the condition of having the memory of pairing with a slave device, this PIN outputs the period of 750ms square wave. After paired, this PIN outputs high level.
PIN26	For master device, this PIN is used for emptying information about pairing. After emptying, master device will search slaver randomly, then remember the address of the new got slave device. In the next power on, master device will only search this address.

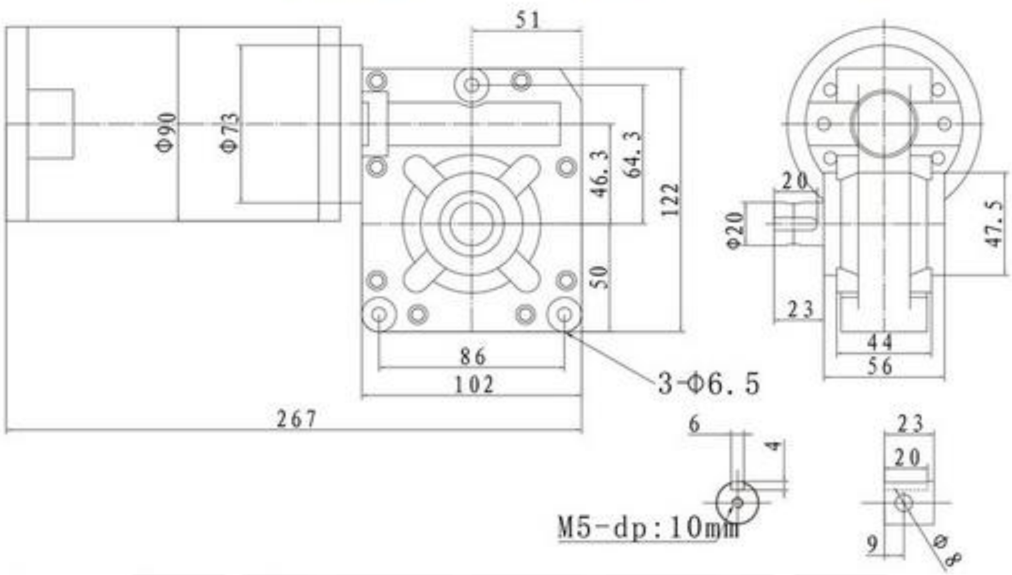
PMDC Worm Gear Motor

90W/ZYJ08
(200W~350W)

Wheel Chair Special Worm Gear Motor

Permissible Load Rang:10N.m~40 N.m

● Dimensions



●Worm motor Torque/Speed

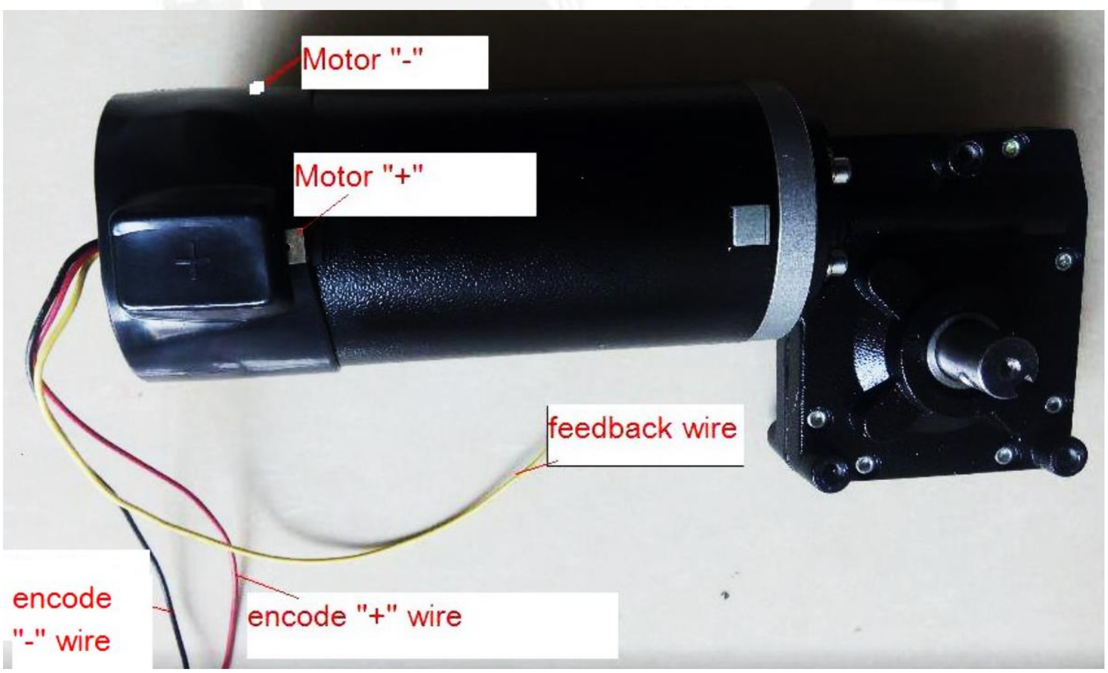
	Reduction ratio	25:1	30:1	50:1
12V, 200W	Rated torque Kg-cm	150	180	300
	Rated speed rpm	120	100	60
24V, 250W	Rated torque Kg-cm	185	225	375
	Rated speed rpm	120	100	60
90V, 250W	Rated torque Kg-cm	185	225	375
	Rated speed rpm	120	100	60

	Reduction ratio	25:1	30:1	50:1
12V, 300W	Rated torque Kg-cm	200	250	400
	Rated speed rpm	120	100	60
24V, 350W	Rated torque Kg-cm	240	280	450
	Rated speed rpm	120	100	60
90V, 400W	Rated torque Kg-cm	250	300	500
	Rated speed rpm	120	100	60

● Motor Technical Data

MODEL	Rated Volt	Rated torque	Rated speed	Rated current	No load speed	No load Current	Rated Output	Weight
	V	Kg-cm	rpm	A	rpm	A	W	KG
RS-90ZY-12-3600	12	8	3000	30	3600	4.5	250	3.5
RS-90ZY-24-3600	24	11	3000	20	3600	3	350	3.5
RS-90ZY-90-3600	90	12.7	3000	7	3600	2	400	3.5

●Shaft size , voltage,output speed, rated torque can customize


Motor "-"
Motor "+"
feedback wire
encode
"-" wire
encode "+" wire

YUASA 52515

Marca	Yuasa
Modelo	52515
Voltios	12
Arranque(A)	130
Amperios (Ah)	25
Salida de gases	Derecha
Referencia	52515
Polaridad	Positivo derecha
Peso (kg)	8,4
Tecnologia	Plomo Abierto Con Mantenimiento
Largo (mm)	186
Ancho (mm)	130
Alto (mm)	171
Medida(mm)	186x130x171
Garantia (Meses)	6

Arduino Mega 2560

Technical specs

Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	54 (of which 15 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz
Length	101.52 mm
Width	53.3 mm
Weight	37 g

Power

The Mega 2560 can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the GND and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may become unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

- Vin. The input voltage to the board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- 5V. This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board. We don't advise it.
- 3V3. A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- GND. Ground pins.
- IOREF. This pin on the board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs for working with the 5V or 3.3V.

Input and Output

See the mapping between Arduino pins and Atmega2560 ports:

PIN MAPPING
Atmega2560

Each of the 54 digital pins on the Mega can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive 20 mA as recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50 k ohm. A maximum of 40mA is the value that must not be exceeded to avoid permanent damage to the microcontroller.

In addition, some pins have specialized functions:

- Serial: 0 (RX) and 1 (TX); Serial 1: 19 (RX) and 18 (TX); Serial 2: 17 (RX) and 16 (TX); Serial 3: 15 (RX) and 14 (TX). Used to receive (RX) and transmit (TX) TTL serial data. Pins 0 and 1 are also connected to the corresponding pins of the ATmega16U2 USB-to-TTL Serial chip.
- External Interrupts: 2 (interrupt 0), 3 (interrupt 1), 18 (interrupt 5), 19 (interrupt 4), 20 (interrupt 3), and 21 (interrupt 2). These pins can be configured to trigger an interrupt on a low level, a rising or falling edge, or a change in level. See the attachInterrupt() function for details.
- PWM: 2 to 13 and 44 to 46. Provide 8-bit PWM output with the analogWrite() function.
- SPI: 50 (MISO), 51 (MOSI), 52 (SCK), 53 (SS). These pins support SPI communication using the SPI library. The SPI pins are also broken out on the ICSP header, which is physically compatible with the Arduino /Genuino Uno and the old Duemilanove and Diecimila Arduino boards.
- LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.
- TWI: 20 (SDA) and 21 (SCL). Support TWI communication using the Wire library. Note that these pins are not in the same location as the TWI pins on the old Duemilanove or Diecimila Arduino boards.