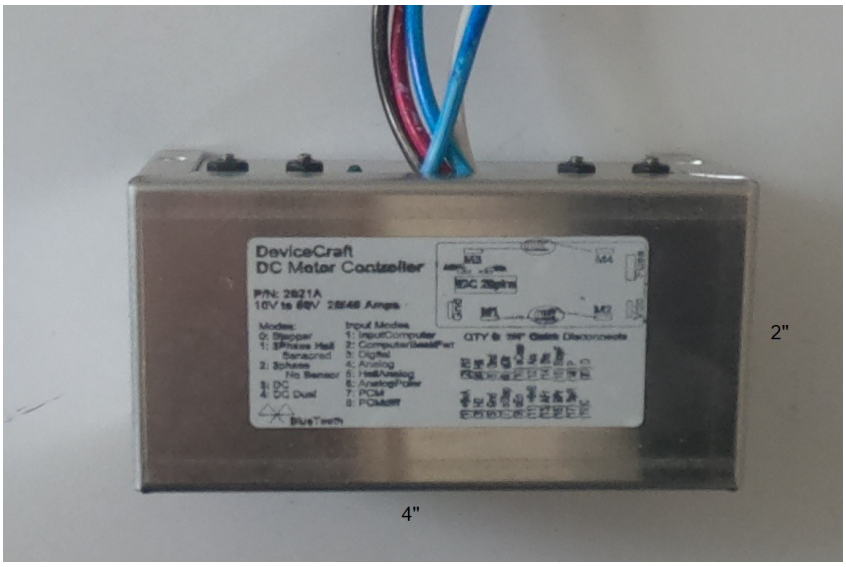
DeviceCraft

Revision #1 12/1/2020



DC Motor Driver / Speed Controller

P/N 2021A Dual 20/20Amps 9 to 60V

Single Stepper Motor (up to 14amps, adjustable microstepping to 32)

Brushless Three Phase (sensor and sensor-less)

Single DC motor (40amps)

Dual Dc motor (with select-able differential input)

Features:

- High power discrete MOSFET construction
- Optional customization for settings and quick connect and go installation
- Bluetooth control or setting parameters
- Bluetooth, serial, analog, analog bipolar, hall throttle, digital(stepper) , automatic internal operation.
- Connector popular 1/4” quick disconnects and 20-pin IDC
- Nonvolatile storage of parameters
- Remote and local over temperature protection.
- Select-able over current and maximum operation current(torque) control.
- On board regulator with a +5v regulated output for powering circuitry
- Forward Reverse ,forward stop, reverse stop, brake, and coast line pull down features.
- Hall sensor inputs for Three Phase brushless motors

- Under voltage protection
- On board blade fuse
- Enclosure 4.00" x 2.12" x 1.62" aluminum

Applications:

- Simple DC brush motor control
- Torque controller for valves
- Microscope axis movement
- Pump controllers
- Exercise equipment
- Machine automation
- Robots

Description

DC motor controller for stepper, sensor-ed and sensor-less three phase brush-less dc, dc motor, and dual dc motor. Enclosed box and quick disconnect connectors for reliable industrial and commercial applications. To-220 MOSFETs are bolted to enclosure for thermal head dissipation, performance and long life. Multiple inputs for forward/reverse stop, brake, and coast. Multiple input controls from computer Bluetooth, analog polar and bipolar, hall effect throttle, RC PCM(pulse code modulation), digital for stepper motors, and differential for dual dc motors. On board Blade fuse for protection. Current levels are available for setting and reading. Acceleration time, max duty cycle, max current(torque) are settable.

Bluetooth and serial inputs allow accessing parameters. Startup configuration parameters are stored in nonvolatile memory. Parameters can me assigned by user or setup during test. Volatile parameters can be read during operation. Power supply voltage, current level driving motors, and power supply current are readable. All input controls can be read including break, coast, forward reverse stop, forward reverse direction, duty cycle.

Internal custom modes are available. Automatic back and forth is included with unit. With stepper and 3phase motors motor travel to non volatile set point or stop is actuated the reverse to home. This motion will continue till disable or brake.

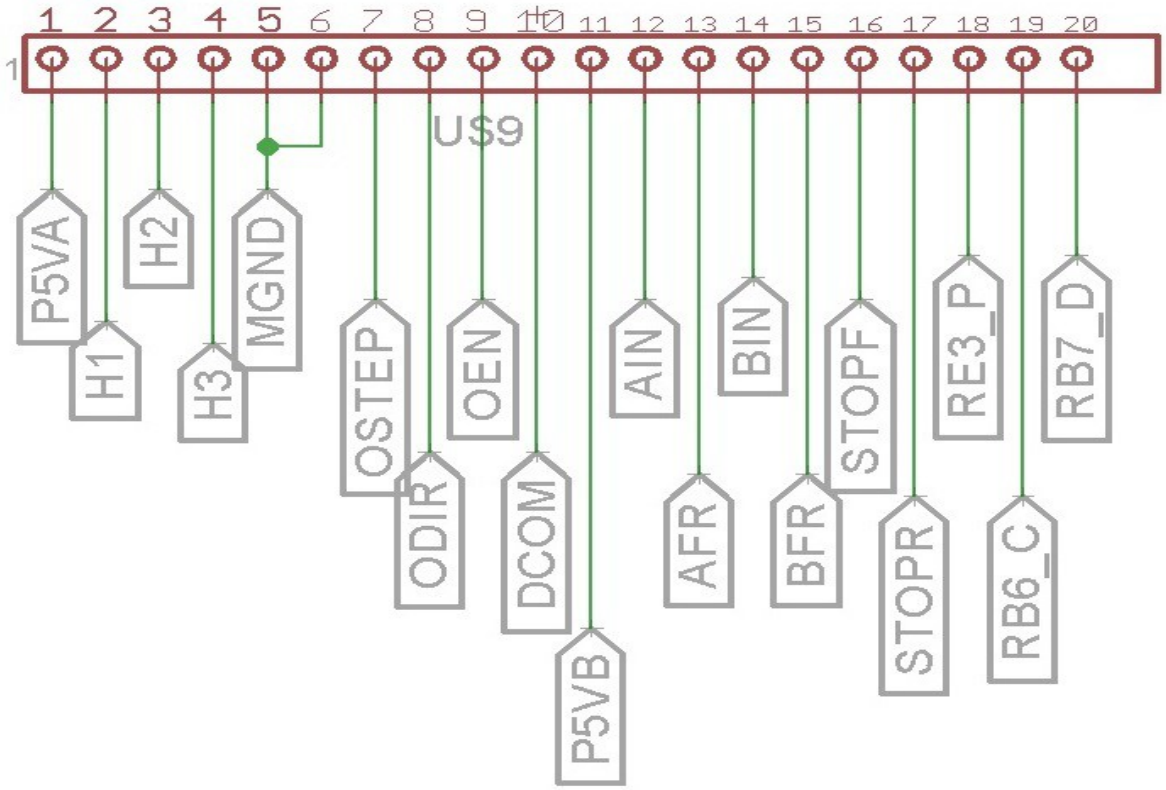
The maximum speed can be set with three phase motors, see PHMINTDUS parameter. Maximum duty cycle can be set for all motor types.

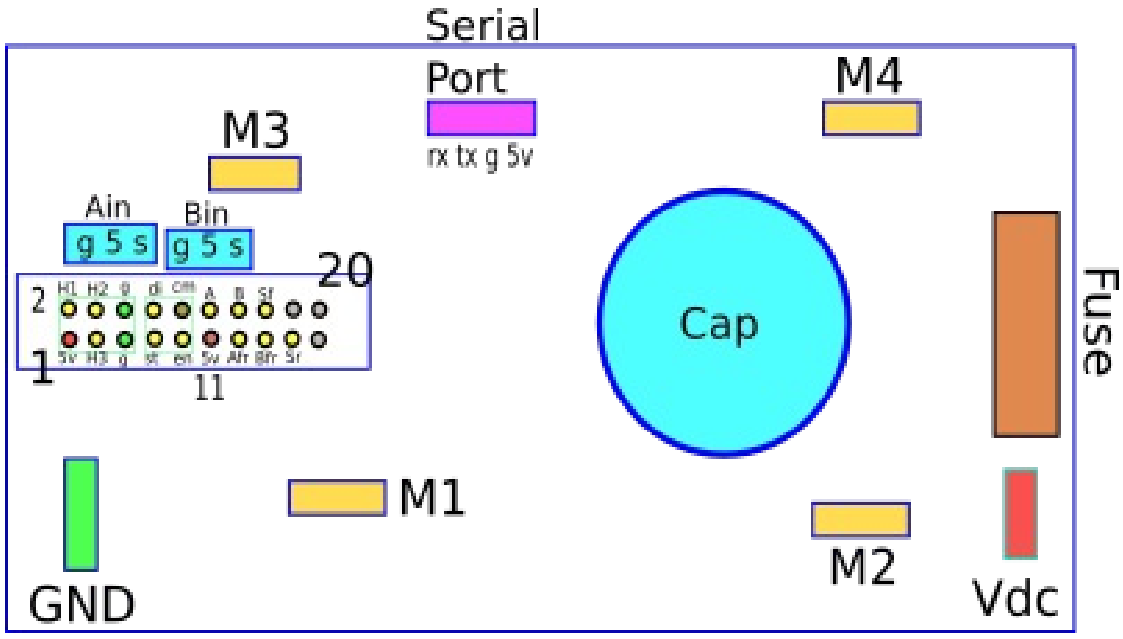
Specifications

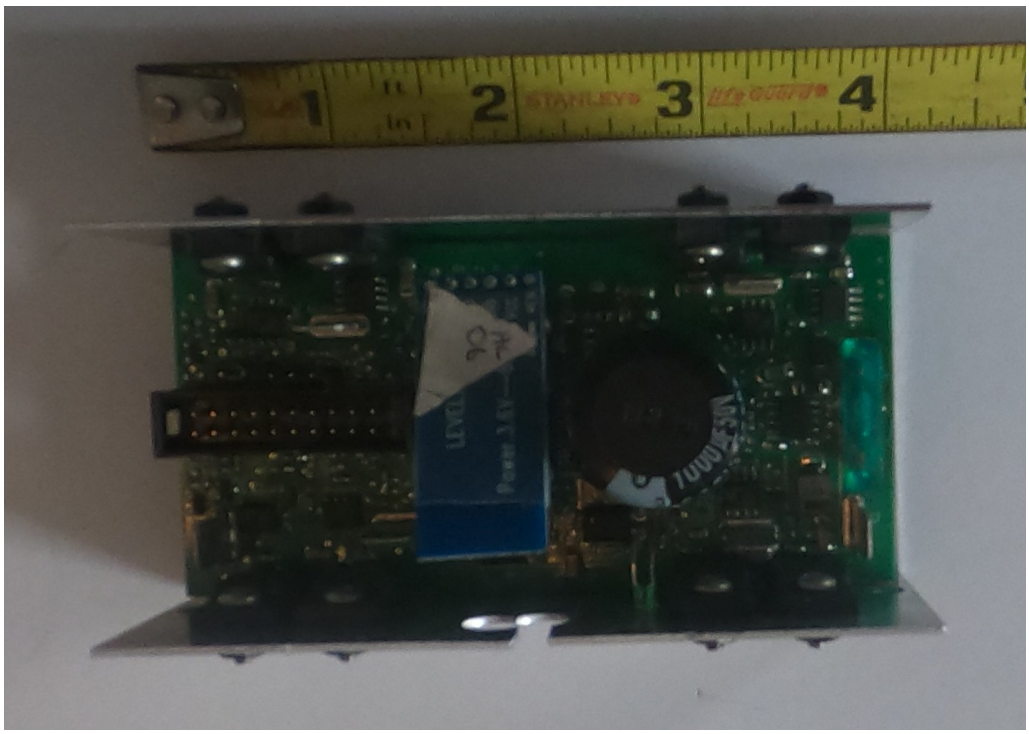
Operating Voltage	9V to 60V
Current Limit Setting	~20Amps each channel
Over trip Current Response Time	~6us
Over Temperature On	80C
Over Temperature Off	70C
Startup Time	~1Sec
Ramp Rate (stop to full speed)	~0ms to 10Sec
Duty Cycle	0 to ~99.9%
PWM switching rate	~30 Khz
Digital Input low	1.5v
Digital Input High	3v
Quiescent Current	80mA (due to step down DCDC number will vary)
MOSFET On resistance	Typical 4millphms each side

Input/Output Pins:

Pin	Name	Function
1	5V	5vdc 50mA for powering external circuits or hall sensors in three phase brushless motors. Over current protected output
2	H1	Hall sensor input 1k pull up to 5v in controller
3	H2	Hall sensor input 1k pull up to 5v in controller
4	H3	Hall sensor input 1k pull up to 5v in controller
5	Gnd	Ground
6	Gnd	Ground
7	OStep	Optically isolated step input for stepper motor (ground common for use) Drive with 5v to activate or leave open.
8	Odir/brake	Optically isolated direction input for stepper motor or brake input for other motor types. Drive with 5v to activate or leave open. (ground common for use)
9	OEN/coast	Optically isolated disable input for stepper motor or coast input for other motor types. Drive with 5v to activate or leave open. (ground common for use)
10	COM	Common or ground for opto isolated inputs.
11	5V	5vdc 50mA for powering external circuits. Over current protected output
12	Ain	Analog input for motor A
13	Afr	Forward reverse for motor A , pull to ground to activate
14	Bin	Analog input for motor B
15	Bfr	Forward reverse for motor B , pull to ground to activate (remote temperature 10k thermistor input for single motor)
16	StopF	Stop forward motion pull to ground to activate
17	StopR	Stop reverse direction input pull to ground to activate.
18	P	Do not connect
19	C	Do not connect
20	D	Do not connect




Serial
Port
rx tx g 5v
M4
M3
Ain
g 5 s
Bin
g 5 s
20
2
1
11
Cap
Fuse
M1
M2
GND
Vdc



LED indicators:

1) Green LED

    A) 1 flash normal operation

    B) 5 flashes over current trip

Acceleration

Set the parameter ACCEL for acceleration from 10msec to 10sec.
The parameter is entered in milliseconds
10000 for 10sec ramp acceleration
From full reverse to full forward will be times two.

Temperature Measurement

Internal max temperature can be set and read. Default is 90C. 3C hysteresis.
A Remote thermistor can be attached to Bfr for remote over temperature.
The minimum voltage at thermistor can be set and is readable.

Input filtering

Ain, Bin, Forward, reverse, forward stop, reverse stop, are filtered. Pull Forward stop, reverse stop, Afr forward reverse, and Bfr forward reverse low to activate. Drive Ostep, OEN, and Odir with 5v to activate. Odir is brake in non stepper motors. OE is coast in all motor types.

Under Voltage

Under voltage level is settable and readable. This will prevent motor from operating with low battery or current limited power supplies.

Regeneration

Unit may regenerated when slowing down.

Blue Tooth

Power up unit. Find the Bluetooth device on the settings on your tablet, cell phone , or computer. Download your favorite serial terminal program. Connect to the blue tooth device. 9600 baud may be needed. Type in commands to the unit. Issure EE? Or STAT to check if unit is communicating. Some serial terminal programs allow storing of common commands. Echo is helpful on terminal programs.

If the power on the motor controller is cycled the terminal program may need to be reconnected. If the number of the motor controller Bluetooth ID is changed then the Bluetooth device may need to be re found. Some operating system notice the rename or continue connection with old name. Some operating systems see Bluetooth device as a COM port.

Current motor controller uses standard Bluetooth. BLE(blue tooth low energy) maybe custom ordered.

Motor types

The input mode is entered in non volatile memory with the MTYPE command.
Example : mtype 1;

MTYPE	Motor	Description
0	stepper	4 wire stepper. Adjustable micro-stepping from 4 to 32. Adjustable current from 1amp to 14amps.
1	Three phase brush-less with hall sensors	Maximum current torque, maximum speed, maximum duty are adjustable in non volatile memory. Power for hall position provided.
2	Three phase brushless	Features 5 select-able startup routines. Maximum current, maximum speed, maximum duty are adjustable in non volatile memory.
3	Single brushed DC	For brushed motors up to 40amps.
3	Dual brushed DC	For dual and differential brushed motors for up to 20amps.

Input Modes

The input mode is entered in non volatile memory with the INTYPE command.
Example : intype 4;

INTYPE	Input type	Description
0	None	For disabling motor
1	Computer	For Bluetooth or serial port the duty cycle is entered with CDUTYA and (CDUTYB for dual). With stepper motors (goto 1000) (gorel 2000) (zero) commands are entered.
2	Back and forth	For continuous back and forth movement. Stepper motor will travel till stops or position reached. Stop position is set in non volatile memory at GOA and GOB. The dwell at each step is applied.
3	Digital	Digital input for stepper motors. Step, direction, and OE lines are enabled. Noise reduction on feature step line.
4	Analog	Duty cycle is controlled with a analog input from Ain and (Bin dual). 0v is stop, 5v is full speed. The Zdead command is for buffing around the 0v end to ensure full stop. The Afr and (Bfr dual) control the direction. Will continue till stop lines are pulled low or disabled. Acceleration effects final value.
5	Analog Hall Effect throttle	Similar to to analog, range is .8v to 3.7v Below .8v is stopped 3.7v is full speed. Afr and (Bfr dual dc brushed) for reverse.
6	Analog BiPolar	Duty cycle is controlled with a analog input from Ain and (Bin dual). 0.0v full reverse, 2.5v is stop, 5v is full speed. The Zdead command is for buffing around the 0v end to ensure full stop. The Afr and (Bfr dual) reverse the direction. Will continue till stop lines are pulled low or disabled. Acceleration effects final value.
7	RC PCM	Pulse code modulation input on Ain and (Bin dual brushed dc). 1000Usec full reverse. 1500 useconds stop. 2000Usec full forward. (Afr and Bfr) reverse operation. Unit will ramp to stop if no input is received in 3sec or values are out of range.
8	Differential RC PCM	Same as (RC PCM) above. For dual brushed dc motors. Ain(speed) Bin(Direction). Normally used when motor sides control steering.

Illustration 1: 1/4" Insulated Quick Disconnect for motor and power supply

Insulated 1/4” quick disconnects are crimped or soldered to wires.

Illustration 2: 20pin IDC connector for control lines. .1" spacing ribbon .05" spacing

Ribbon cable can be connected to another board. Or cut pealed to connect to potentiometers and switches. Three phase sensor lines and opto isolators are group for low pin count idc connectors. Multicolored cables are also available from distributors.

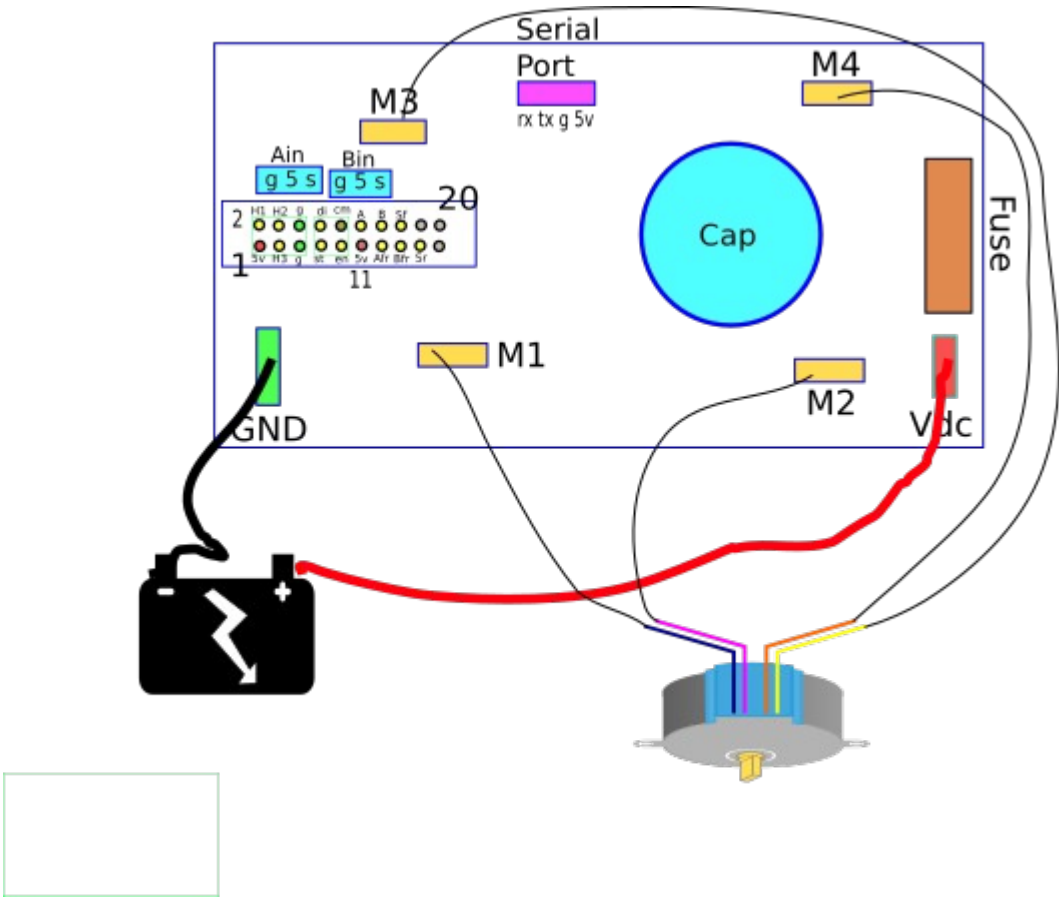


Illustration 3: Stepper Motor Hookup

MTYPE 0;
INTYPE 6;
STEPSIZE 10;

MMOTMAXIMA 5000;

Stepper motor controllable with all analog modes, digital, computer, PCM, back and forth.

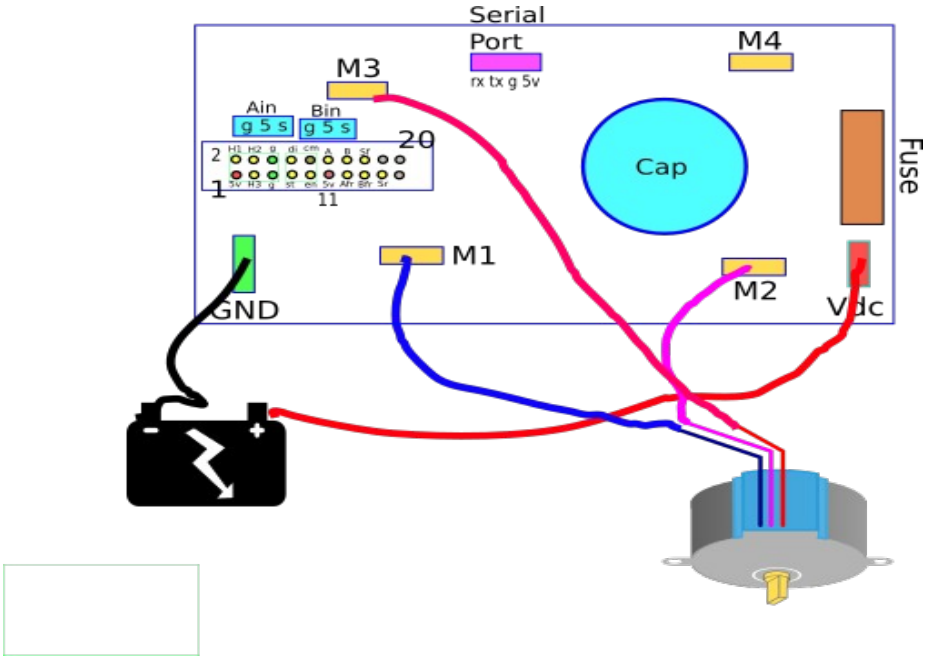


Illustration 4: Three Phase hookup

Three phase motor controllable with all analog modes, computer duty, PCM, back and forth. Digital does not apply. For sensor-ed three phase phases must match with digital sense lines.

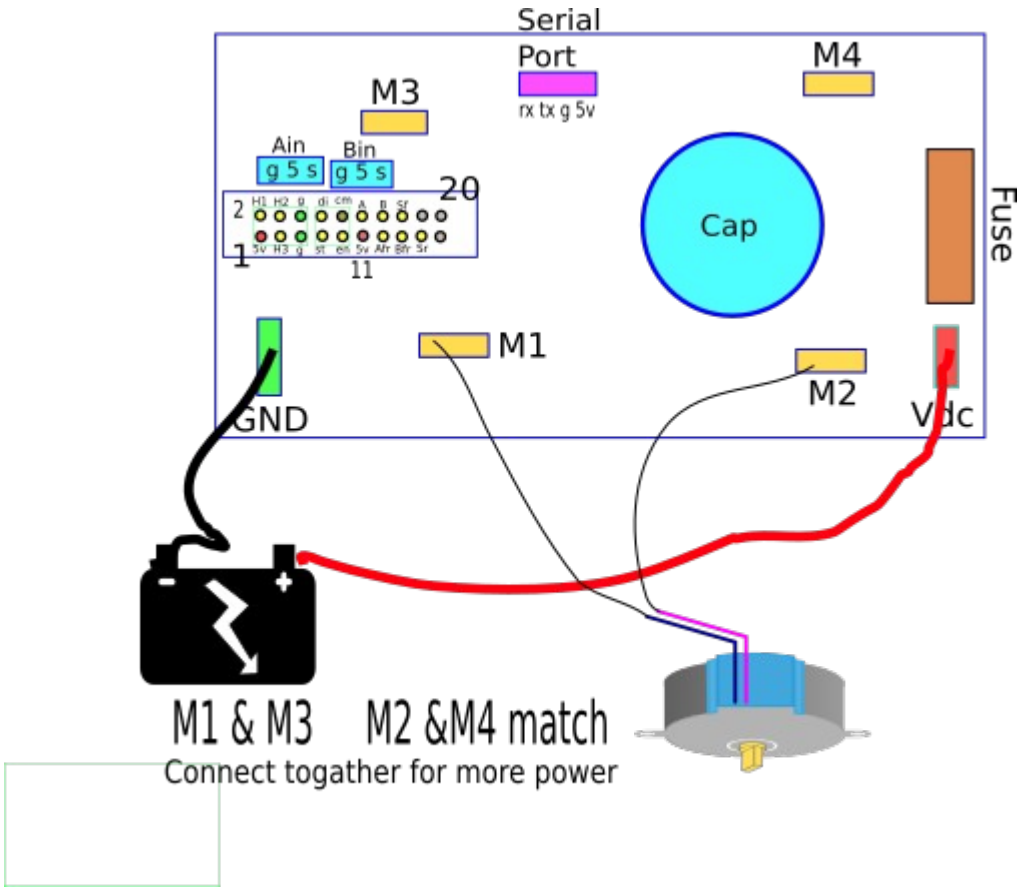


Illustration 5: Single DC motor

Dc motor controllable with all analog modes, computer duty, RC PCM. Bank and forth and digital are not available.

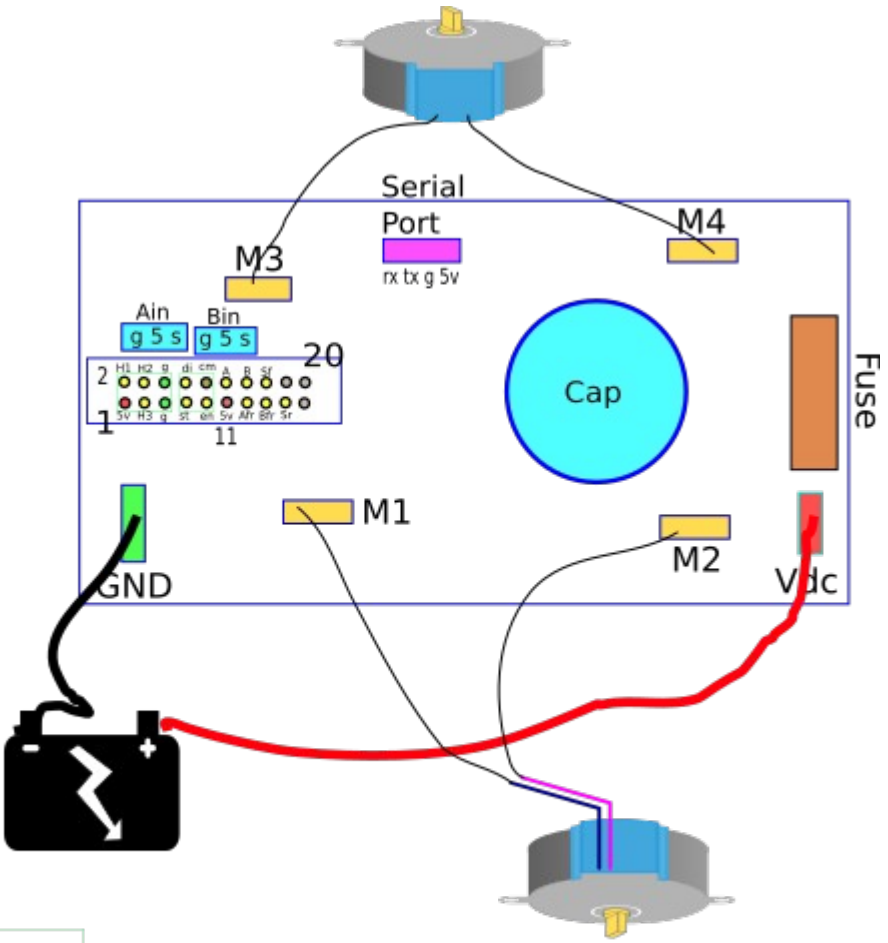


Illustration 6: Dual DC motor hookup

Wire Resistance Table

AWG	Diameter	Resistance per foot
24	20 mils (thousands of inches)	26 milliohms
22	25 mils	16 milliohms
20	32 mils	10 milliohms
18	40 mils	6.2 milliohms
16	50 mils	4 milliohms
14	64 mills	2.5 milliohms
12	80 mils	1.6 milliohms

Nonvolatile Parameters:

Nonvolatile parameters are stored in motor controller. Parameters do not change with power is cycled.
Commands are not case sensitive.
Spaces are ignored.
Carriage return, line feed, and semicolon triggers command execution

Nonvolatile parameters

Command	**Range**	**Description**
EE?		See all parameter settings
BLUEID	0 to 10000	Bluetooth changeable ID to identify motor controller on computer. Syntax: BLUEID 321
MTYPE	0 to 4	Motor type 0 None 1 Stepper Motor 2 Three phase brushless with hall sensors 3 Three phase brushless without sensors 4 Dual DC motor Syntax: MTYPE 1
INTYPE	0 to 8	Type of input to control motor. 0 None 1 Computer 2 ComputerBackFwr 3 InputDigital 4 Analog 5 HallAnalog 6 AnalogPolar

		7 PCM for RC 8 PCMdiff for RC
LWPWRDIV	1 to 10	For low powering stepper motor when idle for an extended period. This number will divide down the source current. Set to 1 for no low power down.
STEPSIZE	4 to 32	Step size for stepper motor default size is 10 for 2000 step/rev for 1.8 degree stepper motors.
MMOTMAXIMA	100 to 20000	Maximum current draw for motor. Set to 4000 for 4Amps. This is equivalent to torque control.
PSMAXIMA	1000 to 40000	Maximum power supply current in mA. The motor will decelerate if value reach.
RATE	200 to 50000	Rate for internal stepper motor movement
ACCELMS	0 to 20000	Acceleration time in milliseconds
GOA	0 to 13Million	Goto position A for automatic back and forth
DWAMS	0 to 30k	Dwell time at position A for automatic back and forth
GOB	0 to 13Million	Goto position B for automatic back and forth
DWBMS	0 to 30k	Dwell time at position B for automatic back and forth
MAXDUTY	0 to 1000	Maximum duty cycle
PHMINTDUS	0 to 10000	Min cycle time for 3phase motor for max speed control Typical number 500
ZDEAD	0 to 100	Dead area in potentiometers to ensure off near zero. 5miliVolt per bit.
TRIOPT	0 to 5	Various startup parameters for 3 phase sensorless. 0 for bigger motors 5 for small motors.
UVMV	9000 to 900000	Under voltage input in mV. Motor will no long accelerate.
ROTMV	0 to 5000	Remote temperature under voltage in mv. 10K thermistor from FRB to ground Typical value to 500 for 10k thermistor to trigger at 90C.

Volatile Multiuse commands

Command	Range	Description
zero		Zero absolute position (invalid for DC motors)
Stop		Stop movement
Goto		Goto a position example GOTO 1000; (invalid for DC motors)
GOREL		Goto a position relative to current position (invalid for DC motors)
SETDFT		Set defaults for novolatile parameters
STAT		Replies with the status of stop bits, coast, over temperature
ATAB		Stepper acceleration parameters
RST		Reset the motor controller. Similar to reboot.

Volatile Parameters:

Volatile parameters and measurement readings are cleared when power is cycled.
Commands are not case sensitive.
Spaces are ignored.
Carriage return, line feed, and semicolon triggers command execution

Query by adding a ?
Example:
IVSMA?

Volatile **signed 32bit** parameters

Command	Range	Description
volw?		Read all 32bit volatile parameters
LGO		Last go to position sent to motor controller
APOS		Absolute position
DELTAPOS		Difference between current position and goto position
STARTPOS		Start position
ABSDELTA		Absolute delta position
RAMPDWPT		The point from ends where motor will begin ramping down
ACELK		Acceleration calculated value, inverse square root of position and constant.
DWELLCLK		Dwell clock count down count for back and forth set.
SREV		Software revision of motor controller
IVSMA		Power supply current reading in mili amps. Range is 40amps.
RPM		Revolutions per minute for 3phase motors with 48 poles. Divid or multiply for other motor with other pole counts.

These parameters are normally only read.

Volatile **signed 16bit** parameters

Command	Range	Description
voli?		Read all 16bit volatile parameters
CDUTYA	(-1000 to 1000)	Computer set of duty cycle. Set this value to set duty cycle.
RDDUTYA?	(-1000 to 1000)	The desired duty cycle after scaling and dead band offset.
SETDUTYA?	(-1000 to 1000)	The duty cycle sent to the output stage. Derived from rdduty . Affected by acceleration, over current, over speed, temperature.
MAXDUTYA?	0 to 1000	Maximum positive duty cycle, derived from nonvolatile parameters
NMAXDUTYA?	-1000 to 0	Maximum negative duty cycle, derived from nonvolatile parameters
CDUTYB	(-1000 to 1000)	Computer set of duty cycle. Set this value to set duty cycle.
RDDUTYB?	(-1000 to 1000)	The desired duty cycle after scaling and dead band offset.
SETDUTYB?	(-1000 to 1000)	The duty cycle sent to the output stage. Derived from rdduty . Affected by acceleration, over current, over speed, temperature.
MAXDUTYB?	0 to 1000	Maximum positive duty cycle, derived from nonvolatile parameters
NMAXDUTYB?	-1000 to 0	Maximum negative duty cycle, derived from nonvolatile parameters
TEMP?	-55 to 125	Current temperature of motor controller. If over 90c the set duty cycle with decelerate.

Other than CDUTY write, parameters are normally read.

Volatile **unsigned 16bit** parameters

Command	Range	Description
volw?		Read all 16bit volatile parameters
STAT		One number word for reading the status of motor controller.
CLKPDW		Power count down clock for stepper motors.
CLKOVI		Over maximum current trip clock.
RCACLK		Last RC PCM count down clock. To ensure valid RC signal.
RCBCLK		Last RC PCM count down clock. To ensure valid RC signal.
PHBF	0 to 5	Used for back forward custom movement. Shows the state whether moving or dwelling phase.
DACA	0 to 1024	Internal DAC set value
DACB	0 to 1024	Internal DAC set value
PCMAS	0 to 65535	Used for PCM RC calculation
PCMAF	0 to 65535	Used for PCM RC calculation
PCMAD	0 to 65535	Used for PCM RC calculation
PCMBS	0 to 65535	Used for PCM RC calculation
PCMBF	0 to 65535	Used for PCM RC calculation
PWMA	0 to 1024	PWM pulse width modulator A value
PWMB	0 to 1024	PWM pulse width modulator B value
WAITUS	0 to 65535	Wait time calculations
ATD	0 to 65535	Stepper Ramp delay till next step u Seconds
PKPHCNT	0 to 65535	Countdown clock counter to check sensor-less 3 phase operating correctly.
PHMINUS	0 to 65535	Min phase time. From non volatile. To set 3 phase max speed
PHTUS	0 to 65535	Actual measure 3 phase brush-less phase time in u Seconds
PHSCLK	0 to 65535	Count down clock in 10msec to count phases in 3phase
PHPTSEC	0 to 65535	Final total number of phases pasted. Used to find RPM
CNTPH	0 to 65535	Counter for number 3phase phases. To count rpm
PSMXIB	0 to 1024	Max power supply current bits(converted from nonvolatile)
MMXIBITS	0 to 1024	Max current bits for motor(converted from nonvolatile)
MVI	0 to 65535	16bit version of min power supply voltage.

MIA	0 to 512	Scaled current sense motor coil A
MIB	0 to 512	Scaled current sense motor coil B
MINV	0 to 512	Scaled current power supply
OTBITS	0 to 512	Over temperature bits (converted from nonvolatile)

Volatile **unsigned 16bit ADC** measurements parameters

4.9 millivolt per bit

Command	Range	Description
adc?		Read all 16bit analog measurementvolatile parameters
AIN?	0 to 1023	Read the analog Ain input, for potentiometer input. 2.5volts will read 512. 5 volts will read 1023.
PSV	0 to 1023	Power supply voltage. Power supply divided by 20. 100milli volts per bit. 10volts will read 100. 100volts will read 1000.
BIN	0 to 1023	Read the analog Bin input, for potentiometer input
ISV	0 to 1023	Power supply current 12 bits per amp
ISA	0 to 1023	Phase A current 37 bits per amp
ISB	0 to 1023	Phase B current 37 bits per amp
FRB	0 to 1023	Forward reverse B. Used also for remote temperature reading.
VREF	0 to 1023	Read internal voltage ref. 2.048 volt dc.
ATMP	0 to 1023	Read the internal temperature voltage. Later converted to Celsius. See TEMP? Signed 16bit integer.

Example Terminal Output:

ee?

BLUEID,67, MTYPE,2, INTYPE,6, LWPWRDIV,3, STEPSIZE,10, MMOTMAXIMA,12000, PSMAXIMA,15000, RATE,1000, ACCELMS,500, GOA,0, DWAMS,200, GOB,1500, DWBMS,200, MAXDUTY,950, PHMINTDUS,60, ZDEAD,20, TRIOPT,1, UVMV,10000, ROTMV,1000, EEC,0,

voll?

LGO,0, APOS,-215557, DELTAPOS,0, ABSDELTA,0, STARTPOS,0, RAMPDWPT,0, ACELK,0, DWELLCLK,0, SREV,22021, IVSMA,576, RPM,1850,

volw?

STAT,32, CLKPDW,0, CLKOVI,0, RCACLK,0, RCBCLK,0, PHBF,0, DACA,511, DACB,511, DACE,896, PCMAS,0, PCMAF,0, PCMAD,1500, PCMBS,0, PCMBF,0, PCMBD,1500, PWMA,950, PWMB,0, WAITUS,65535, ATD,125, PKPHCNT,112, PHMINUS,60, PHTUS,582, PHSCLK,6,

PHPTSEC,148, CNTPH,60, PSMXIB,211, MMXIBITS,444, MVI,6, MIA,30, MIB,105, MINV,100, OTBITS,200,

voli?

CDUTYA,0, RDDUTYA,-1000, SETDUTYA,-950, MAXDUTYA,950, NMAXDUTYA,-950, CDUTYB,0, RDDUTYB,0, SETDUTYB,0, MAXDUTYB,950, NMAXDUTYB,-950, TEMP,23,

adc?

AIN,0, PSV,197, BIN,0, ISV,519, ISA,539, ISB,619, FRB,1023, VREF,427, ATMP,467,

volb?

STEPZ,10, STEPZFULL,40, SARRAYE,39, PHASEOPT,1, ZDEAD,20, STBYTE,2, MTYPE,6, MINPUT,1, HA,1, HB,0, HC,0, CLC,0, CMA,0, CMB,0, CMC,0, CMD,0, CME,0, CMF,0, PORTA,16, PORTB,231, PORTC,104, PORTD,3, PORTE,96,

stat

STEPLOWPWR,
ENABLED,NOBRAKE,FWREN,REVEN,NO OVERI,NO OVERTEMP,NO UNDERVOLT,ROTEN,

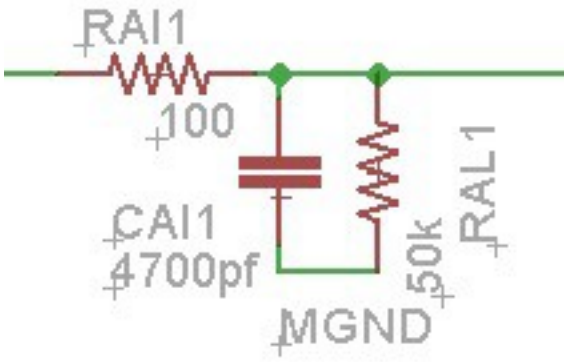


Illustration 7: Analog Inputs

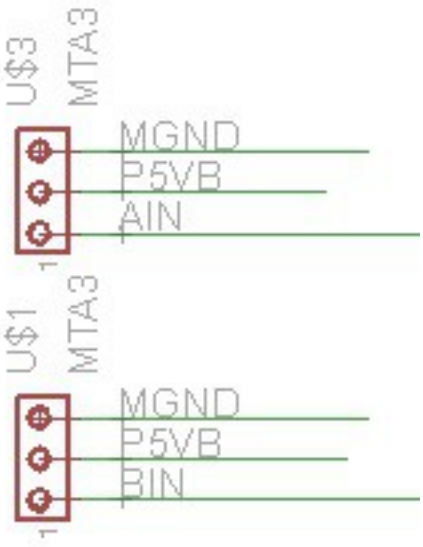


Illustration 8: Optional RC input headers

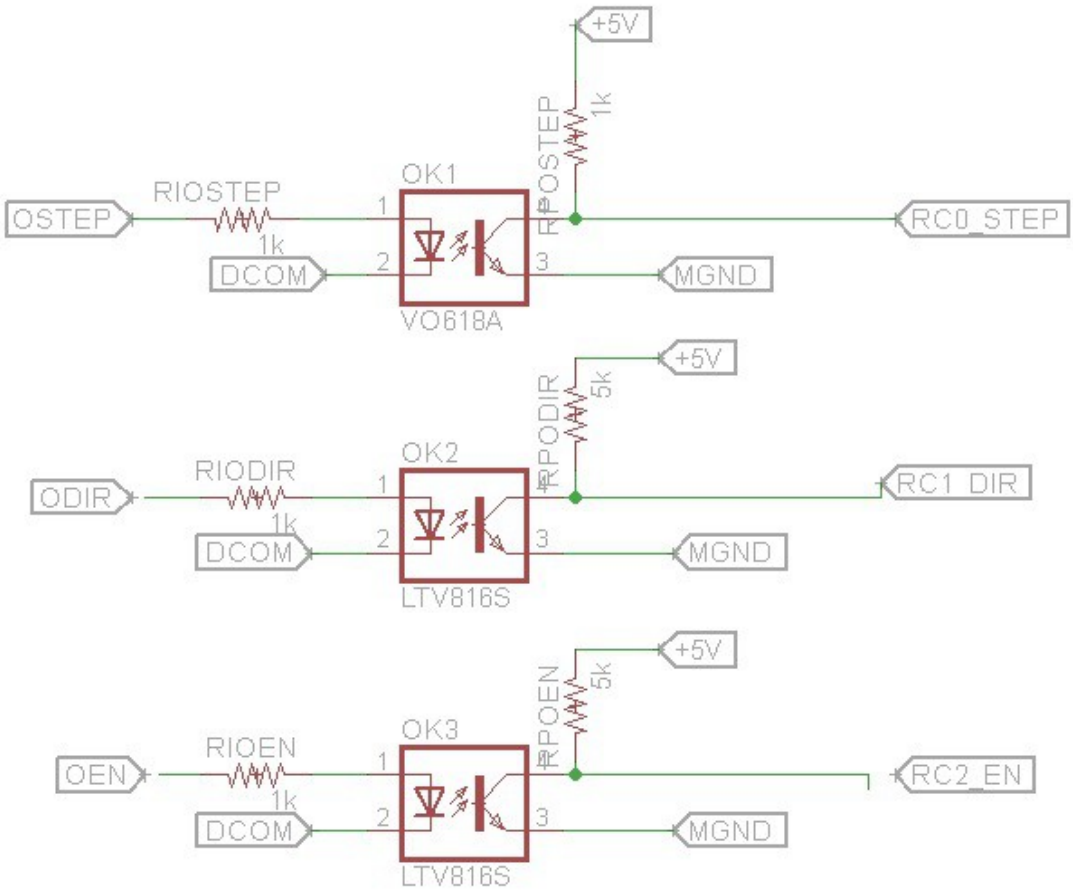
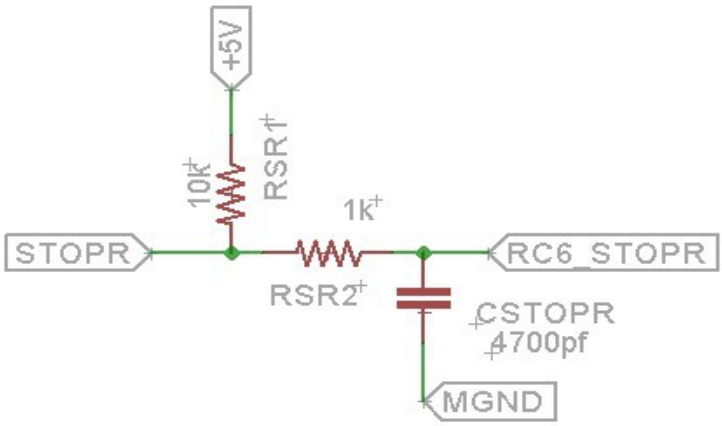


Illustration 9: Optoisolator inputs

Illustration 10: Stop forward reverse inputs



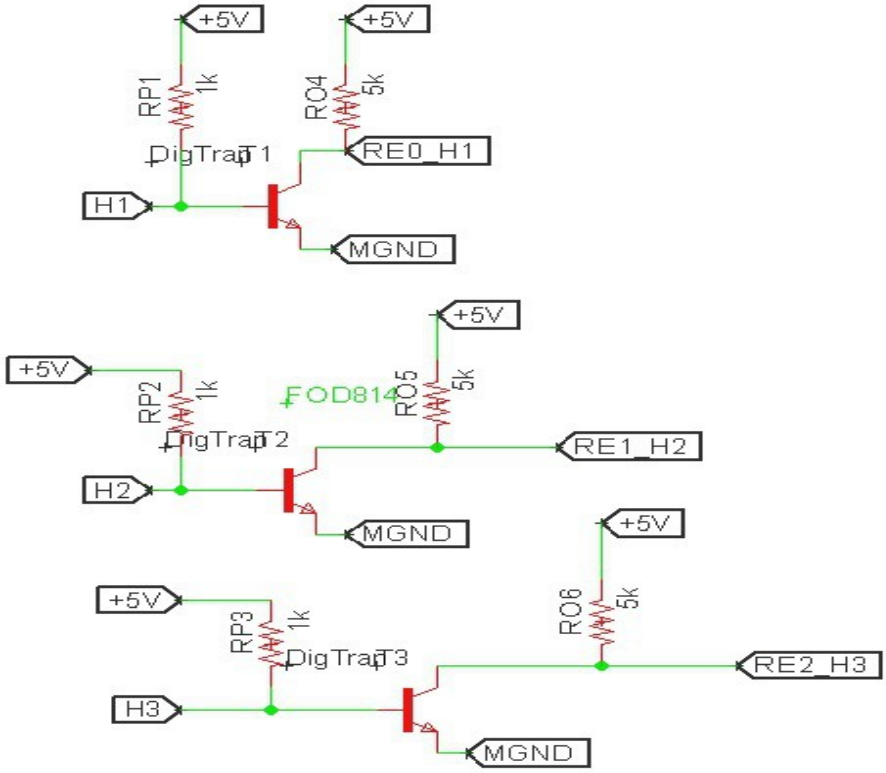


Illustration 11: Three phase hall position inputs