P0612 Stepper driver module

The P0612 Stepper driver module provides a high performance current control mode micro-stepping driver for bi-polar and uni-polar stepper motors in a small low cost module. The module measures just 66 x 32 x 12mm and is capable of driving stepper motors at up to 30 Volts and 750mA per phase. The driver uses current mode control, recognized as producing the best performance from stepper motors and can operate in one of 4 modes, full step, half step, quarter step and eighth step. The module is capable of driving bi-polar and uni-polar stepper motors having 4, 6 or 8 wires.

The module interface is simple, there are 4 opto-isolated inputs for step, direction, reset and sleep and other control inputs for motor drive current, current decay mode selection and micro-stepping mode. The motor drive current can be set by just 1 resistor, or a control voltage of 1 .. 5 Volts if required. Motor drive current is selectable in 2 ranges of 50 .. 230mA and 150 .. 750mA per phase. The micro-stepping mode is selected by use of 2 inputs that are shorted to ground or VCC to select 1 of 4 modes.

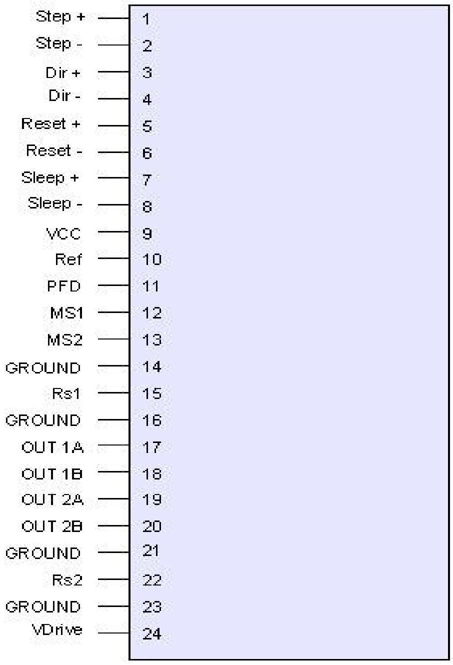
The module requires 2 power supplies, one supply for the motor in the range of 5 to 30 Volts and a second supply of +5 Volts for the logic and control interface. The module does not generate the +5 Volt logic supply on board because it would increase cost. A +5 Volt supply can be provided easily and where there is more than one module only a single supply is required. Our P0615 mini regulator is ideal for supplying up to 4 modules.

Specification

Parameter	***Condition***	***Signal***	***Min***	***Typ***	***Max***
Motor supply voltage	Normal	VDrive	5.0 V	-	30.0 V
Motor driver supply current	Normal	VDrive	-	-	5mA
	Reset	VDrive	-	-	200uA
	Sleep	VDrive	-	-	20uA
Logic supply voltage range	Normal	VCC	3.0 V	5.0	5.5 V
Logic supply current	Inputs off	VCC	-	-	20uA
	Inputs on	VCC	-	82mA	99mA
Step frequency	Normal	STEP+, STEP-	-	-	100KHz
Ref input voltage range	Normal	Ref	1.0 V	-	VCC
Thermal shutdown temperature	Normal		-	165º C	-
Thermal shutdown hysteresis	Normal		-	15º C	-
Step input voltage level	Active	Step +, Step -	3.5 V	5.0 V	8.0 V

Parameter	*Condition*	*Signal*	*Min*	*Typ*	*Max*
	Inactive	Step +, Step -	-0.6 V	-	0.8 V
Step input current	Active	Step +, Step -	6.8 mA	11mA	21mA
Dir input voltage level	Active	Dir +, Dir -	3.5 V	5.0 V	8.0 V
	Inactive	Dir +, Dir -	-0.6 V	-	0.8 V
Dir input current	Active	Dir +, Dir -	6.8 mA	11 mA	21 mA
Reset input voltage level	Active	Reset +, Reset -	3.5 V	5.0 V	8.0 V
	Inactive	Reset +, Reset -	-0.6 V	-	0.8 V
Reset input current	Active	Reset +, Reset -	4.7mA	8 mA	15mA
Sleep input voltage level	Active	Sleep +, Sleep -	3.5 V	5.0 V	8.0 V
	Inactive	Sleep +, Sleep -	-0.6 V	-	0.8 V
Sleep input current	Active	Sleep +, Sleep -	3.3 mA	5.5mA	10mA

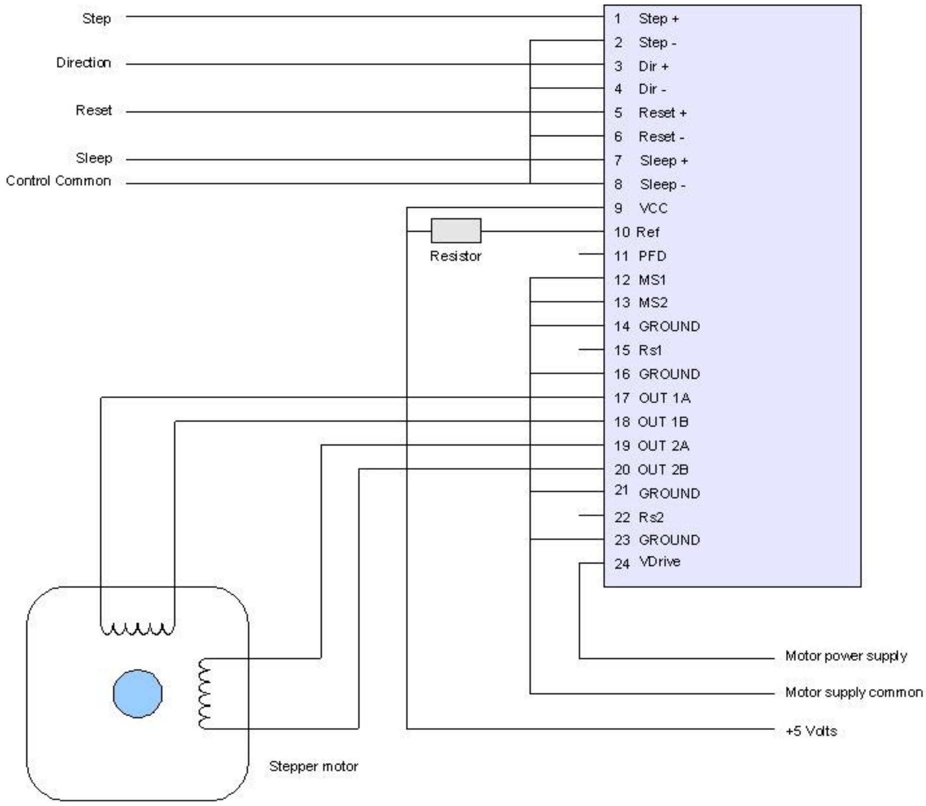
Layout and pin description



Pin	Name	Function
1, 2	Step +, Step -	Opto-isolated inputs for the Step signal.
3, 4	Dir +, Dir -	Opto-isolated inputs for the Direction signal.
5, 6	Reset +, Reset -	Opto-isolated inputs for the Reset signal.
7, 8	Sleep +, Sleep -	Opto-isolated inputs for the Sleep signal.
9	VCC	The power supply input for the control logic.
10	Ref	The motor drive current setting input.
11	PFD	The current decay mode setting input.
12, 13	MS1, MS2	The inputs for setting the micro-stepping mode.
15, 22	Rs1, Rs2	The Motor drive current range selection inputs.
17, 18	OUT 1A, OUT 1B	The drive outputs for the motor phase 1.
19, 20	OUT 2A, OUT 2B	The drive outputs for the motor phase 2.
24	VDrive	Motor drive power supply input.
14, 16, 21, 23	GROUND	Module common supply GROUND connection.

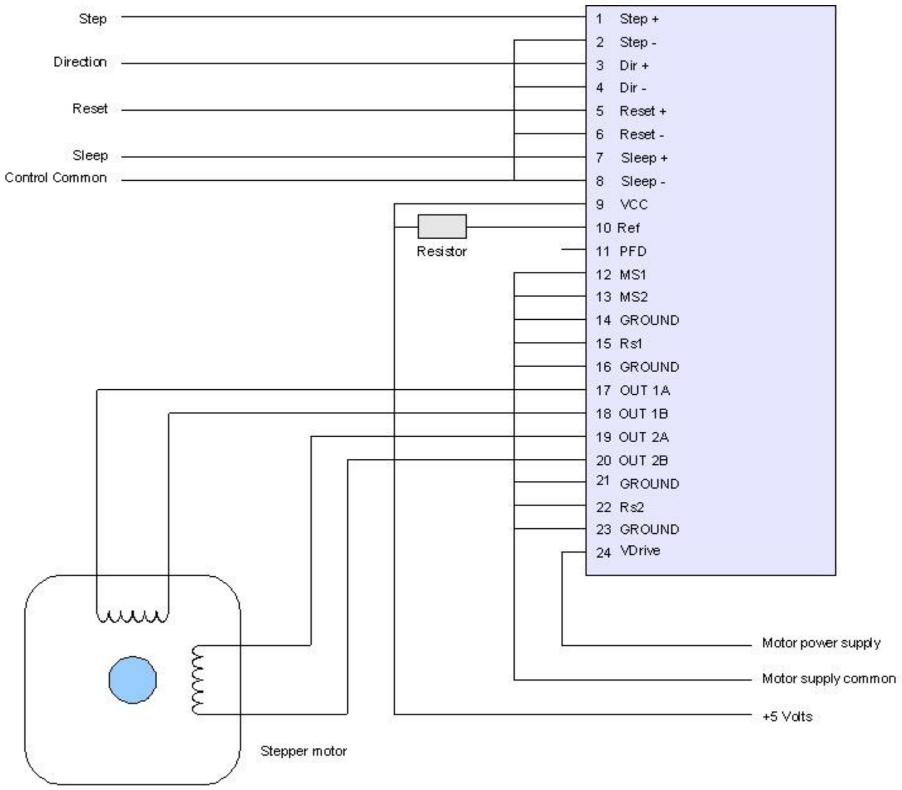
Stepper driver wiring

The diagram below shows the basic stepper driver configuration.



Basic motor driver connection for LOW current range.

The motor driver basic requirements are +5 Volts to the VCC supply input, a motor supply voltage of 5 to 30V to the VDrive supply input and all 4 ground inputs connected to the common for VCC and VDrive. MS1 and MS2 must be connected to either VCC or GROUND. A resistor is used to set the motor drive current; in the example above the low current range is being used, Rs1 and Rs2 are not connected. For the motor drive HIGH current range short Rs1 and Rs2 both to GROUND as below -



Basic motor driver connection for HIGH current range.

It is important that Rs1 and Rs2 are both connected to GROUND or both left disconnected. Do not connect one to GROUND and leave the other disconnected.

The Micro-stepping control inputs are both shown connected to GROUND, this connection will set FULL-STEP mode, the table below shows how to connect MS1 and MS2 for all 4 micro-stepping modes.

MS1	***MS2***	***Mode***
GROUND	GROUND	Full step
VCC	GROUND	Half step
GROUND	VCC	Quarter step
VCC	VCC	Eighth step

In both examples above the PFD input has been left disconnected. The PFD input sets the current decay mode and speed for when a pulse on the Step input causes the current in a phase to be reduced; this decay rate affects the smoothness and quietness of the motor. Generally the PFD input can be left disconnected and internal resistors on the module fix the PFD at 0.5 x VCC. Refer to the data sheet for the A3967 driver chip for more information on the PFD signal.

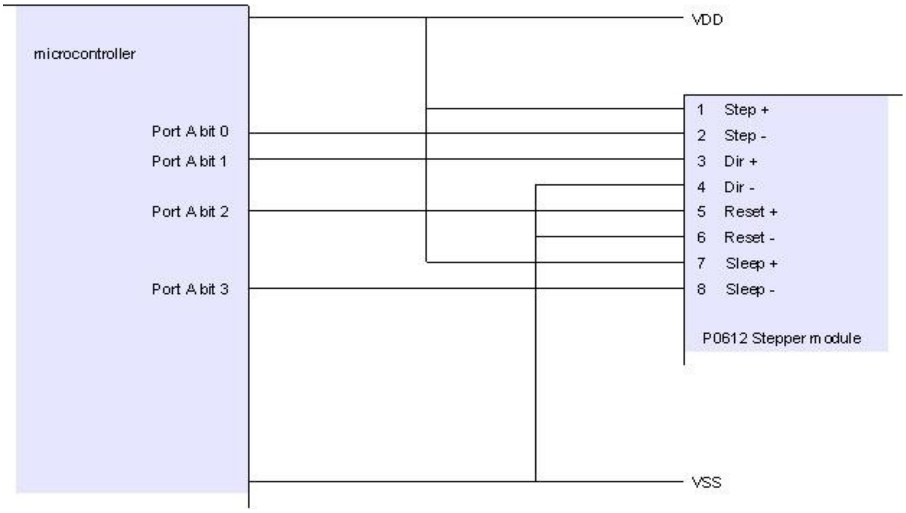
Setting motor drive current

The motor drive current is set by use of a single resistor or control voltage and by linking Rs1, Rs2 to GROUND or leaving them open-circuit. The most simple means of controlling motor drive current is to use a resistor between Ref and VCC. Internal resistors set the Ref input to 1.0 Volts (the minimum), so the external resistor is used to set a higher voltage. The table below provides a guide but generally some experimentation is required to achieve the maximum performance from a stepper motor.

Ref Voltage	***Resistor value***	***Motor drive current***	
		Low range Rs1, Rs2 open	High range Rs1, Rs2 grounded
1.0	OPEN	46mA	151mA
1.5	58K	69mA	226mA
2.0	24.4K	93mA	301mA
2.5	13.4K	116mA	377mA
3.0	8K	139mA	452mA
3.5	4.8K	162mA	527mA
4.0	2.7K	185mA	602mA
4.5	1.1K	208mA	678mA
5.0	0	231mA	753mA

Control signals

Each of the 4 control signals has a + and – input, in the above examples all – control signal inputs have been connected together and would normally be connected to the negative or common supply of the device controlling the module, however each control signal can be connected as desired. The example below shows a typical connection to a micro-controller.



Example connection to a microcontroller

In the above example, Reset – and Dir – are connected to VSS (negative supply), so port A bit 1 and port A bit 2 each need to go HIGH to activate their respective signals. Step + and Sleep + are connected to VDD (positive supply), so port A bit 0 and port A bit 3 each need to go LOW to activate their respective signals. The connections depend on the output polarities available for the signals. Some stepper controllers have fixed polarities and some firmware available for microcontrollers is also not too flexible.

Stepper motor configurations

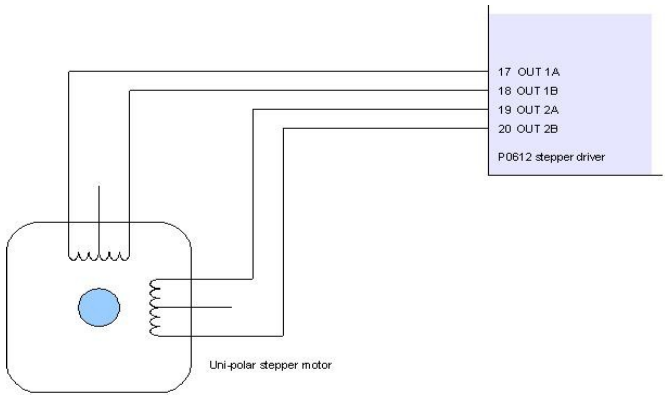
The P0612 stepper module can drive most bi-polar and uni-polar stepper motors having 4, 6 or 8 wires.

4 wire bi-polar stepper motors

The examples above, *'Basic motor driver connection'* show how to connect to a bi-polar stepper motor with 4 wires. Phase 1 connects to pins *Out 1A* and *Out 1B* and phase 2 connects to pins *Out 2A* and *Out 2B*.

6 wire uni-polar stepper motors

These motors have a common, a + connection and a – connection per phase. When driving these motors do not use the common, leave it disconnected.

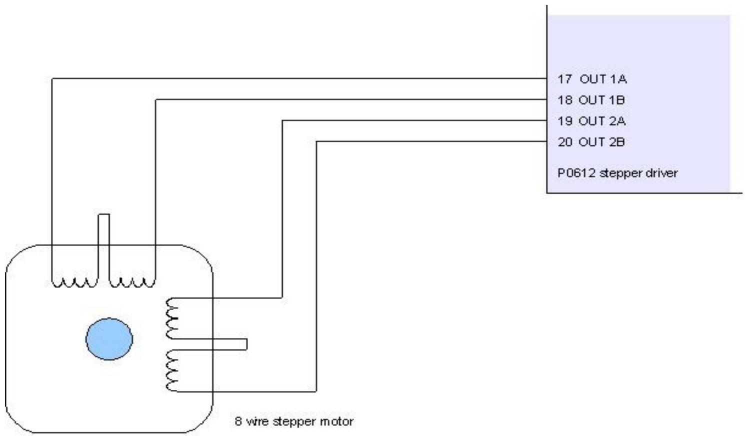


Driving uni-polar stepper motors

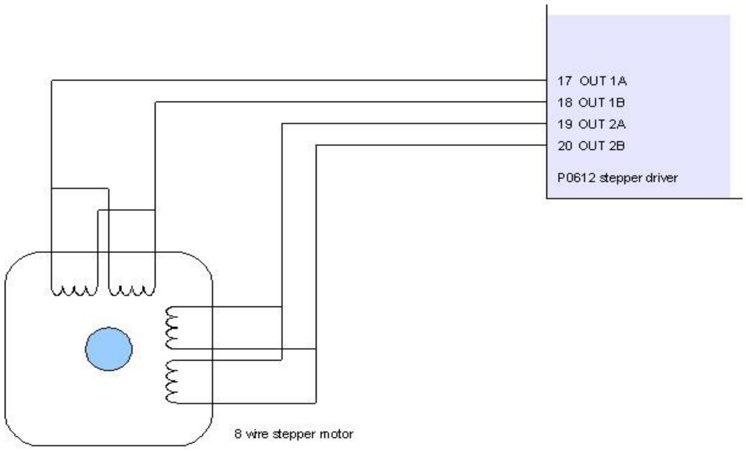
The manufacturer's datasheet will indicate which connections to use but if this is not available then measure the resistance of the wires for each phase. Phase + or - to common will be half the resistance of phase + to phase -.

Stepper motors with 8 wires

These motors are designed to be used as either bi-polar or uni-polar motors and in bi-polar operation can be wired with the coils in series or parallel depending on the motor and available supply current/voltage. When using this type of motor with the P0612 module, the coils are wired either in series or parallel and care must be taken to ensure that the coil pairs for each phase are not mixed or reversed. There are two possible connection configurations depending on the motor type, series or parallel. The series connection is higher voltage and lower current whereas the parallel connection is lower voltage and higher current.



8 wire stepper motor series connection



8 wire stepper motor parallel connection

Using the P0612 stepper driver

This section contains a range of hints and tips on using the stepper driver module.

Power supply and board layout

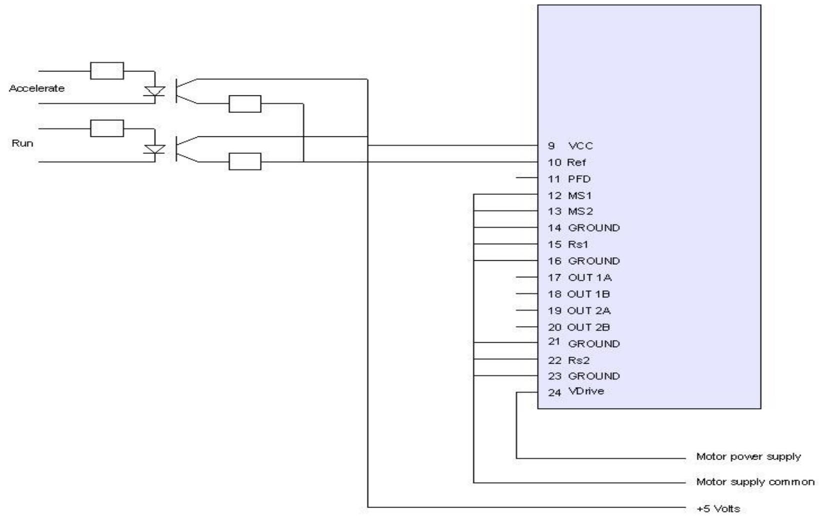
The P0612 includes all necessary decoupling capacitors so there is no requirement for any additional components on the power supplies. The logic supply VCC requires a fairly clean supply of +5 Volts +/- 10% with ripple and noise below 100mV; a Linear regulator could be used and we recommend a simple L-C filter on its input, mainly to protect the regulator from spikes and switching noise that may be present on the motor supply. A good ground connection is essential for reliable operation; the P0612 has 4 ground pins and all 4 should be used and connected to a ground plane if possible.

If the P0612 is to be used in high power mode (Rs1 and Rs2 connected to ground) then these pins should be connected directly to the ground pins either side of Rs1 and Rs2 preferably directly to the ground plane if there is one. It is essential that a low resistance path exists between these pins and the module ground pins, hence the reason for a ground pin either side of these pins.

Designing for efficiency

The P0612 use of switching techniques and current mode control provides a very efficient means of driving stepper motors, however efficiency can be increased further by use of a number of techniques.

In many cases the power to a stepper motor can be removed after a move, it depends on the application and also means that the home or index position must be found each time a move is performed. If power can not be removed each time then the motor drive current can be reduced when not moving, also the drive current can be adjusted depending on the operation, e.g. When the motor is accelerating it may require higher current to accelerate at the desired rate. The circuit example below allows the current to be altered as required.



Controlling motor current dynamically

The above example shows 2 opto-isolators being used to provide up to 4 motor drive current ranges. With both opto-isolators off the motor drive current is at the module's minimum setting, this could be used to maintain position after a move. Some experimentation may be required to ensure that drive current can be adjusted without any mis-positioning occurring.

The sleep and Reset inputs can be used to increase efficiency by switching off power to the motor when not required. The Sleep input uses low current and is therefore quite slow to respond; at least 20uS should be allowed after powering the Sleep input before driving the Step input.

The Step input has a relatively high current requirement to enable fast switching and a high step rate. If efficiency is important then keep the step pulses short; a Step pulse width of 3.0uS is sufficient to drive the opto-isolator and generate reliable steps.

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