Weeder Technologies

WTMCD-M

90-A Beal Pkwy NW, Fort Walton Beach, FL 32548 www.weedtech.com Voice/Fax 850-863-5723

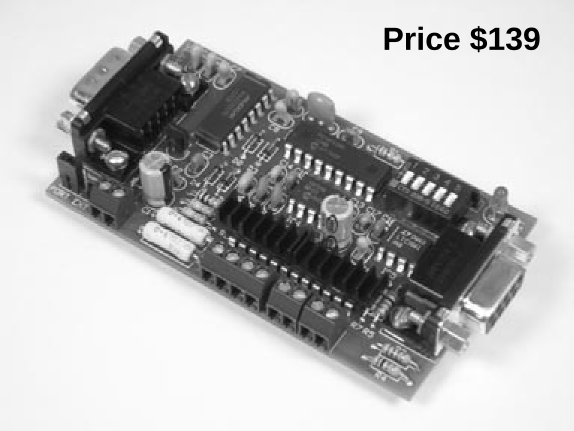
Microstep Chopper Driver

FEATURES

- Drives a two-phase bipolar stepper motor using constant-current chopper regulation.
- Plug units together for two or more axes.
- User programmable drive current and idle reduction current.
- Select up to 64 microsteps per step.
- Up to 10,000 pps step rate.
- S-curve acceleration and deceleration slope profiles provide smooth start/stop motion.
- Supports move-to-coordinate mode, move-to-limit-switch mode, and continuous-rotation mode.
- 24-bit absolute motor position counter.
- Two normally-open limit switch inputs.
- All user configuration settings stored in non-volatile memory.
- Automatic thermal shutdown protects motor driver Power MOSFETs from overheating.
- Industry standard RS-232 interface. Meets all EIA/TIA-232E and V.28 specifications.
- Screw-terminal connectors used on all inputs and outputs.

DESCRIPTION

Connects to the RS-232 serial port of a PC or laptop. Complete stepper motor driver/controller built into one. Simple coordinate commands sent from the host will advance motor to an exact position in the range of 0 to 16,777,215 using S-curve acceleration/deceleration slope profiles which reduce stall effects during ramping, and overrun effects during breaking. Host can also instruct the motor to accelerate to target velocity and continue to move until limit switch triggers deceleration curve, or rotate continuously while the host controls the velocity on the fly.



Price $139

SPECIFICATIONS

Drive Type	Dual, Full Bridge, Power MOSFETs
Drive Current	1.2A nominal 2.0A peak
Idle Current	Selectable in 10% increments of drive
Microsteps	2, 4, 8, 16, 32, or 64
Step Rate	Up to 10,000 pps
Limit Switches	Forward and Reverse, normally-open.
Processor	PIC16F628
Clock	20 Mhz
Communications	9600 Baud, N, 8, 1
Power Requirements	+8 to +30 VDC
Current Draw	20 mA, plus current drawn by motor
Operating Temperature	-20℃ to +80℃
Board Dimensions	3.5" x 2.0" x 0.7"
Weight	1.9 oz

TABLE 1: ADDRESS SETTING

HEADER CHARACTER **ASCII** (HEX)	**DIP SWITCH SETTING** **1=on, 0=off** 1 2 3 4 5
A (41)	**0 0 0 0 0**
B (42)	**0 0 0 0 1**
C (43)	**0 0 0 1 0**
D (44)	**0 0 0 1 1**
E (45)	**0 0 1 0 0**
F (46)	**0 0 1 0 1**
G (47)	**0 0 1 1 0**
H (48)	**0 0 1 1 1**
I (49)	**0 1 0 0 0**
J (4A)	**0 1 0 0 1**
K (4B)	**0 1 0 1 0**
L (4C)	**0 1 0 1 1**
M (4D)	**0 1 1 0 0**
N (4E)	**0 1 1 0 1**
O (4F)	**0 1 1 1 0**
P (50)	**0 1 1 1 1**
a (61)	**1 0 0 0 0**
b (62)	**1 0 0 0 1**
c (63)	**1 0 0 1 0**
d (64)	**1 0 0 1 1**
e (65)	**1 0 1 0 0**
f (66)	**1 0 1 0 1**
g (67)	**1 0 1 1 0**
h (68)	**1 0 1 1 1**
i (69)	**1 1 0 0 0**
j (6A)	**1 1 0 0 1**
k (6B)	**1 1 0 1 0**
l (6C)	**1 1 0 1 1**
m (6D)	**1 1 1 0 0**
n (6E)	**1 1 1 0 1**
o (6F)	**1 1 1 1 0**
p (70)	**1 1 1 1 1**

STACKABLE DATA MODULES

All modules in this series incorporate two EIA/TIA-232E serial ports which communicate at 9600 baud, no parity, 8 data bits and 1 stop bit. DB9 connectors are jumpered to satisfy hardware handshaking. The port labeled ''HOST'' is configured as a DCE device and should be connected to a PC's serial port. The port labeled ''SLAVE'' is a DTE device and can be left open, or connected to another module's host port. Up to 32 modules can be chained together in this fashion to form a network. Either plugged together end to end, or separated by a cable. Because a module contains two individual bi-directional ports which pass data through, it also acts as a repeater, extending the total allowable length of the RS-232 communications line.

A modem can serve as the host for remote operation, but since a modem uses a DCE port, a ''null modem'' adapter must be placed between the modem and the data module's host port. A gender changer may also be required. In addition, any hardware/software flow control must be disabled in the terminal program.

Each module in a network should be set to a different address using the on-board 32-position DIP switch. A module will only respond to data packets that begin with its' own unique header character, which is determined by this DIP switch setting. See Table 1. Data packets transmitted by a module will also begin with this header character. The host PC can use the header character to address each individual module in a network, and to identify a module which is talking.

COLLISION CONTENTION

The utilization of the communications line can be thought of more as a single, bi-directional, data bus, operated in a multi-drop mode rather then a standard RS-232 data link. A transmission from a data module travels in both directions, upstream to the host, and downstream to signal other modules that it has seized the line. Before transmitting, a module will listen to the communications line and wait for quiescence. After a silent period equal to the length of one byte, the waiting module will send its data packet using a Carrier Sense Multiple Access with Collision Detection communications protocol. See the application note (AN100) at the back of this manual for more details.

COMMAND SET

The host PC communicates with the Microstep Chopper Driver Module using a command set comprised of standard ASCII character strings as depicted in Table 2. Some commands are used to setup the operational parameters, while others are used to start a move sequence which will then execute independent of the host. A detailed description of each command follows.

MOVE - Moves the stepper motor to a specific coordinate within the range of the 24-bit motor position counter. After reception of this command, the direction of rotation will be determined by comparing the target position to the current motor position. The motor will then ramp up to the speed determined by VELOCITY using an S-curve acceleration profile and remain there until reaching the pre-calculated point of deceleration. An S-curve deceleration profile will then be used to bring the motor speed back to

TABLE 2: COMMAND SET

TITLE	COMMAND	DESCRIPTION
MOVE	M *pos*	Move stepper motor to a specific position (*pos*) at rate determined by VELOCITY using acceleration and deceleration curves. *pos* = 0 to 16,777,215. (Note 3)
HOME	H *dir runoff*	Move stepper motor in the specific direction (*dir*) at rate determined by VELOCITY using acceleration curve. Rotation will continue until limit switch activates runoff counter and deceleration curve. *dir* = + or - *runoff* = 0 to 255 If *runoff* omitted, uses default of 0. (Note 3)
DRIVE	D *dir*	Move stepper motor in a continuous rotation in specific direction (*dir*) at the rate determined by VELOCITY. While rotating, velocity can be modified on the fly. *dir* = + or - If *dir* omitted, rotation is halted. (Note 3)
STEP	S *dir*	Move stepper motor one step in a specific direction (*dir*). *dir* = + or -. (Note 3)
VELOCITY	V *value*	Sets the pulse-per-second rate used in the MOVE, HOME, or DRIVE functions. *value* = 1 to 200, multiplied by 50 pulses-per-second. Default = 10 (500 pps). (Note 3, 4)
RAMP-RATE	R *value*	Sets the ramp rate used in the acceleration and deceleration curves. *value* = 1 to 255. Default = 50. (Note 3, 4)
POSITION	P *value*	Modifies the motor position counter. *value* = 0 to 16,777,215. (Note 3) If *value* is omitted, reads current position. Returns 0 to 16,777,215.
EXCITE	E *value*	Sets the excitation mode which determines the number of microsteps per step. *value* = 1, 2, 4, 8, 16, 32, or 64. Default = 1. (Note 3, 4)
CURRENT	C *value*	Sets the drive current which is used at any time the motor is rotating. *value* = 1 to 20, multiplied by 0.1 amps. Default = 5 (0.5A). (Note 3, 4)
IDLE	I *value*	Sets the idle reduction current which is used at anytime the motor is at rest. *value* = 1 to 10, multiplied by 10 and listed as a percentage of full current set by the CURRENT command. Default = 2 (20%). (Note 3, 4)
ERROR	?	This character will be returned after an invalid command or variable.
RESET	!	This character will be returned after a power-on reset, or brown-out.

Note 1: All command strings sent to the data module should be preceded with the header character (see Table 1), and terminated with a carriage return. All responses from the data module will also appear in this format.

Note 2: Any spaces shown above in the listing of the command strings are for clarity only. They should not be included in the actual transmission from the host, nor expected in a response from the data module.

Note 3: After successful execution, this command will be echoed back to the host in the same format as received.

Note 4: If *value* is omitted, reads the current setting which will be returned to the host in the same format as above.

TABLE 3: TERMINAL / CONNECTOR DESCRIPTION

NAME	TYPE	ELECTRICAL SPECS	COMMENTS:
HOST	DB9 (female)	EIA/TIA-232E Standard	RS-232 serial port configured as DCE. Connects to host PC. Hardware handshake jumpered.
SLAVE	DB9 (male)	EIA/TIA-232E Standard	RS-232 serial port configured as DTE. Can be connected to another data module's HOST port for networking.
Power Source	Jumper	N/A	Power source selection jumper. Selects either external, or port powered. (Note 1)
+	Screw Term	+8 to +30 VDC	External power supply input.
-	Screw Term	GND	External power supply ground.
A+, A-	Screw Term	Up to 30 VDC @ 2 A	Stepper Motor Phase A Output.
B+, B-	Screw Term	Up to 30 VDC @ 2 A	Stepper Motor Phase B Output.
FWD, REV	Screw Term	Protected to ±20V	Normally-open limit switch inputs.
Note 1: Selecting "port powered" will draw from the power supply source of an upstream data module. Caution, the COM port of a PC or laptop does not supply enough current to serve as the power supply source.			

zero as it approaches the target position. The motor position counter will be updated accordingly.

HOME - Moves the stepper motor in a specific direction until a limit switch is triggered. After reception of this command, the motor will ramp up to the speed determined by VELOCITY using an S-curve acceleration profile and remain there until detecting a trigger from the limit switch associated with the direction of movement. Following the trigger, the motor will continue to step until the value of the runoff counter expires, and then an S-curve deceleration profile will bring the motor speed back to zero. The motor position counter will be set to 0 if rotation was negative, or 16,777,215 if rotation was positive.

DRIVE - Moves the stepper motor in a continuous rotation in a specific direction at the rate determined by VELOCITY. While the motor is moving, the VELOCITY as well as the other operational parameters can be changed on the fly, but any of the other movement commands (MOVE, HOME, STEP) will be disabled. Note, before issuing this command, it is best to preset the VELOCITY to a slow speed to prevent the motor from stalling at initial take off.

STEP - Moves the stepper motor one step in a specific direction. The motor position counter will be updated accordingly and will roll-over from 16,777,215 to 0 or vice versa.

VELOCITY - Sets the pulse-per-second rate used in the MOVE, HOME or DRIVE functions, selectable between 50 and 10,000 pps in multiples of 50. Depending on the particular stepper motor and its load demand, setting the velocity too high will result in a stalled condition. This will cause a break down in motor rotation as well as corrupt the motor position counter.

RAMP-RATE - Sets the ramp rate used in the acceleration and deceleration curves, selectable between 1 and 255. 1 = slowest, 255 = fastest. If the ramp rate is too fast, a heavy load may cause a temporary stall during acceleration, and/or a mechanical overrun during deceleration. Either will result in a corrupted motor position counter.

POSITION - Modifies the motor position counter, selectable between 0 and 16,777,215. Can also be used to read current position of the motor.

EXCITE - Sets the driver excitation mode which determines the number of microsteps that each full step is divided by. Note, if changing from a large value to a smaller one, and the position of the motor is in-between the steps of the smaller value, the motor will jump to the nearest step.

CURRENT - Sets the motor drive current which is used at any time the motor is rotating. This value can be set as high as the "peak" rating shown in the specs if the motor is being rotated for short durations, or if a cooling fan is used.

IDLE - Sets the idle reduction current which is used at anytime the motor is at rest. This value is listed as a percentage of the full drive current and is selectable in 10% increments. 1 = 10%, 2 = 20%, 3 = 30%, etc. Note, If using a large drive current, a low idle current will allow the unit to cool down in-between move operations.

ERROR - Any data string sent from the host containing the correct header character but an invalid command or variable will be responded to with this error indicator.

RESET - Upon power-up or any other reset condition, this indicator is transmitted to the host. Note, all user configuration data is stored in non-volatile memory. Therefore, a reset or loss of power will not corrupt these settings.

OPERATION

In order to connect a stepper motor to the WTMCD module, you must first identify the wires coming out of the motor housing. And since there are no color code standards, you will have to consult the stepper motor manufacturer's documentation to identify each of the wires so that they can be attached to the appropriate terminal of the WTMCD. Shown in Figure 1 are various types of motors which can be wired up in a 2-phase bipolar mode which is necessary in order to be driven by the WTMCD module. 5-phase motors are not supported.

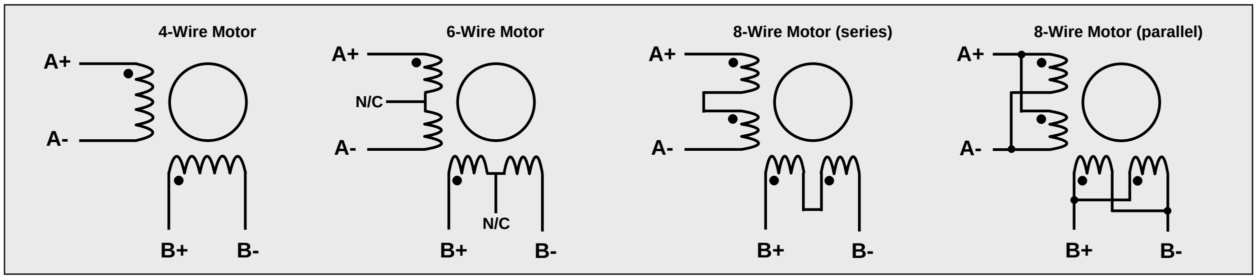
To hook the WTMCD to a host PC, use a standard RS-232 cable with male and female DB9 connectors on opposite ends. This cable should be wired straight through (pin to pin) with no crossover of the data lines. In other words, not a null modem cable. Connect a suitable DC power source to the **+** and **-** terminals of the WTMCD. This power source should be ample enough to supply the current necessary to drive the stepper motor. The power supply voltage rating is not that critical because the WTMCD module automatically controls the current through the motor coils regardless of input voltage. However, the higher the power supply voltage, the better the stepper motor's performance and the higher the speeds with which it can be run without stalling.

When the WTMCD is first powered up, the red LED will flash briefly. This indicates that the on-board microcontroller has booted up, successfully completed it's internal diagnostic test, and has transmitted the reset character to the host to signal that it is up and running. The red LED will also flash anytime the module receives or transmits any data packet, thus making it a valuable diagnostic tool when troubleshooting communications problems.

An easy-to-use Windows™ software package called "ModCom" is available and can be downloaded from Weeder Technologies' web site. This program will allow the user to quickly set up custom buttons which transmit commands, custom windows that poll for data, and a variety of other screen objects such as slider controls, event counters & timers, bar-graph level indicators, button selection arrays, and more. In addition, conditional statements can be set up to take action when specific events or conditions are met, sequences can be written and then called by other screen objects during run-time, and data can be logged to a file automatically at user-defined intervals.

Once ModCom is installed and running, go to the <Communicate> menu item at the top of the screen and click on <Send/Receive>. A dialog box will pop up which you can use to type in the commands from Table 2, transmit them directly to the WTMCD, and see the response coming back. Use this dialog box to familiarize yourself with the command set and to experiment with the various features supported by the module.

FIGURE 1: MOTOR WIRING DIAGRAM



The experience gained here is significant since these are the same command strings you will use when setting up the other objects in ModCom.

To control a stepper motor, start with the sample application "WTMCD.mod" which can be found in the ModCom subfolder called "Samples". After this file is opened, it will appear as shown in Figure 2. To start the main run-loop, click on the green toolbar button at the top of the screen. At this time, you can experiment with various pre-built functions such as adjusting the motor configuration, single-stepping the motor, moving the motor to a number of preset coordinates, or even sending the motor through a series of stop-and-go points automatically.

To understand how this application works, first halt the run-loop by clicking on the red toolbar button at the top of the screen, then right-click on any screen object to pull up it's properties dialog box. With the aid of the helps files which can be accessed by clicking on the <Help> menu item at the top of the screen, study the properties of each screen object to see how they operate. Also read through the chapter "How to control a stepper motor" in the help files.

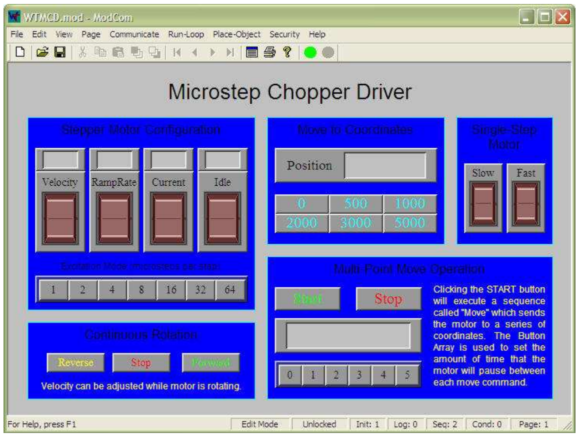
AUTOMATIC THERMAL SHUTDOWN

If using drive currents above the "nominal" current rating of the WTMCD, the motor driver MOSFETs will heat up considerably. Depending on the ratio of drive-time to idle-time, the unit may overheat and in turn, automatically shut off the current applied to the motor coils for a brief moment. This does not cause any harm to the module, however, if the motor is in the middle of a MOVE operation when this occurs, it will corrupt the motor position counter in the same way as a stall condition. To operate a stepper motor above the "nominal" current rating, use a low idle current setting and make sure there is adequate idle-time in-between each move operation so that the module can cool down. Good ventilation and the use of a cooling fan will improve the required drive-time to idle-time ratio.

LIMIT SWITCHES

Normally-open limit switches can be connected to the WTMCD module and used for braking or emergency stop. There are two independent switch inputs, one for each direction of rotation. During the execution of the HOME command, these switches will initiate a braking action when triggered, causing the stepper motor to begin its deceleration curve. During the execution of the MOVE command, these switches will initiate an emergency stop action, causing the motor to immediately stop. Note that the motor position value returned to the host (after executing a MOVE command which was interrupted by an emergency stop) will reflect the actual position of the motor, rather than the position used in the MOVE statement. At any time, if wishing to move the motor beyond any limit switch stopping point, use the STEP command.

FIGURE 2: MODCOM APPLICATION



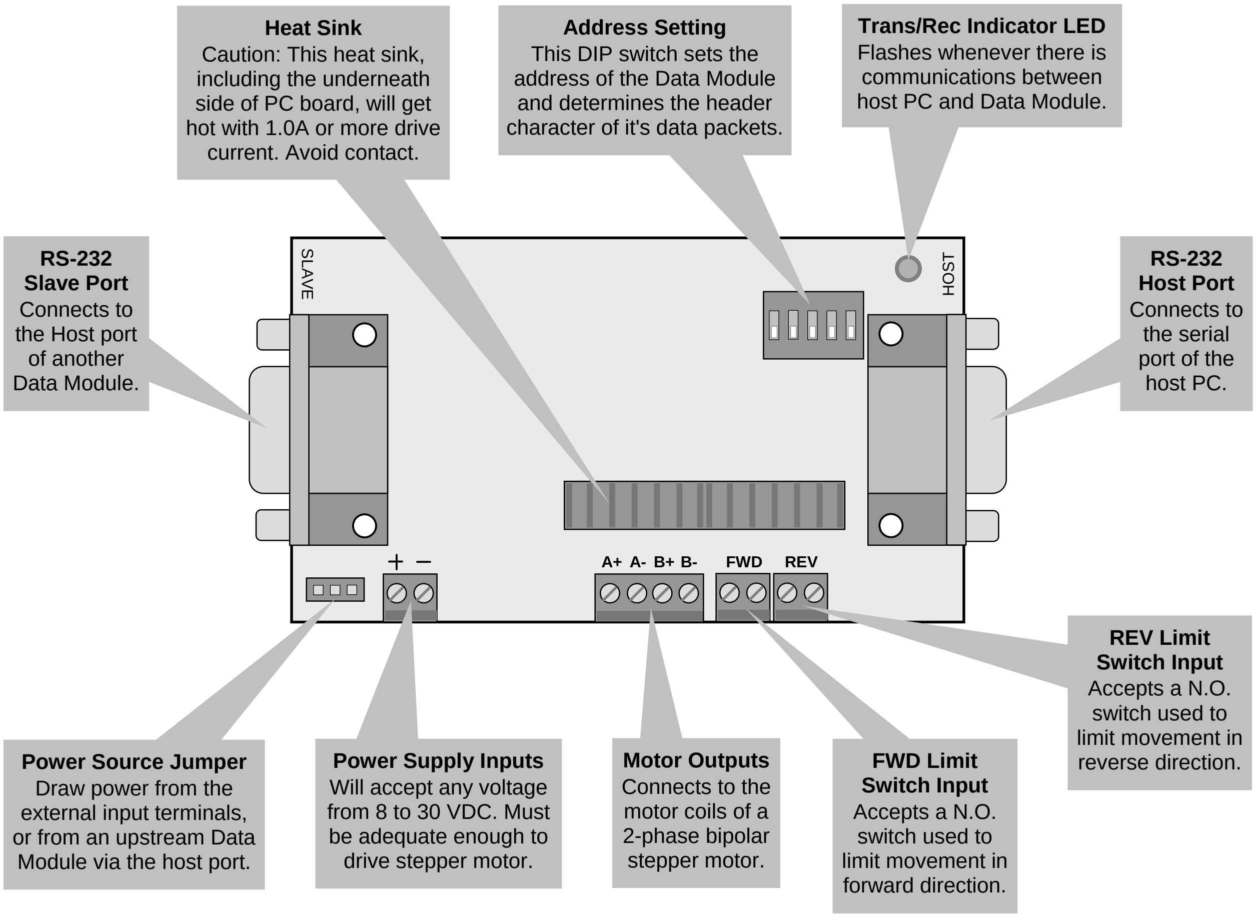
Velocity can be adjusted while motor is rotating.

Clicking the START button will execute a sequence called "Move" which sends the motor to a series of coordinates. The Button Array is used to set the amount of time that the motor will pause between each move command.

MOTOR REFERENCE POINT

Most applications require the stepper motor to be moved to an exact zero position which can then be used as a reference point for all other move operations. The HOME command with it's runoff counter is provided for this very purpose. Since the VELOCITY and RAMP-RATE will effect the distance moved after a limit switch triggers a breaking action during a HOME operation, these parameters should be adjusted appropriately prior to calculating a runoff value.

To setup a motor reference point which can be used for a zero starting position, a limit switch should be installed on the apparatus at a location which will activate the break and bring the motor to rest just short of the desired stopping point. Use the HOME command to send the motor to this position and then use the STEP command and count the number of extra steps necessary to trim the motor position to the true reference. The number of extra steps should then be used as the runoff value in the HOME command which will cause the stepper motor to stop at this exact position every time.



Heat Sink
Caution: This heat sink, including the underneath side of PC board, will get hot with 1.0A or more drive current. Avoid contact.

Address Setting
This DIP switch sets the address of the Data Module and determines the header character of it's data packets.

Trans/Rec Indicator LED
Flashes whenever there is communications between host PC and Data Module.

RS-232 Slave Port
Connects to the Host port of another Data Module.

RS-232 Host Port
Connects to the serial port of the host PC.

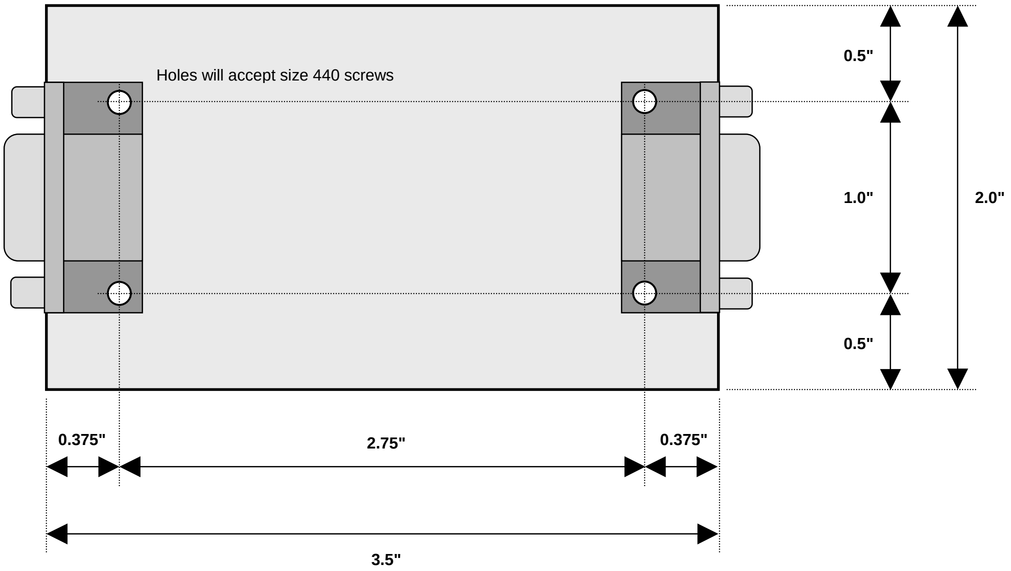
REV Limit Switch Input
Accepts a N.O. switch used to limit movement in reverse direction.

Power Source Jumper
Draw power from the external input terminals, or from an upstream Data Module via the host port.

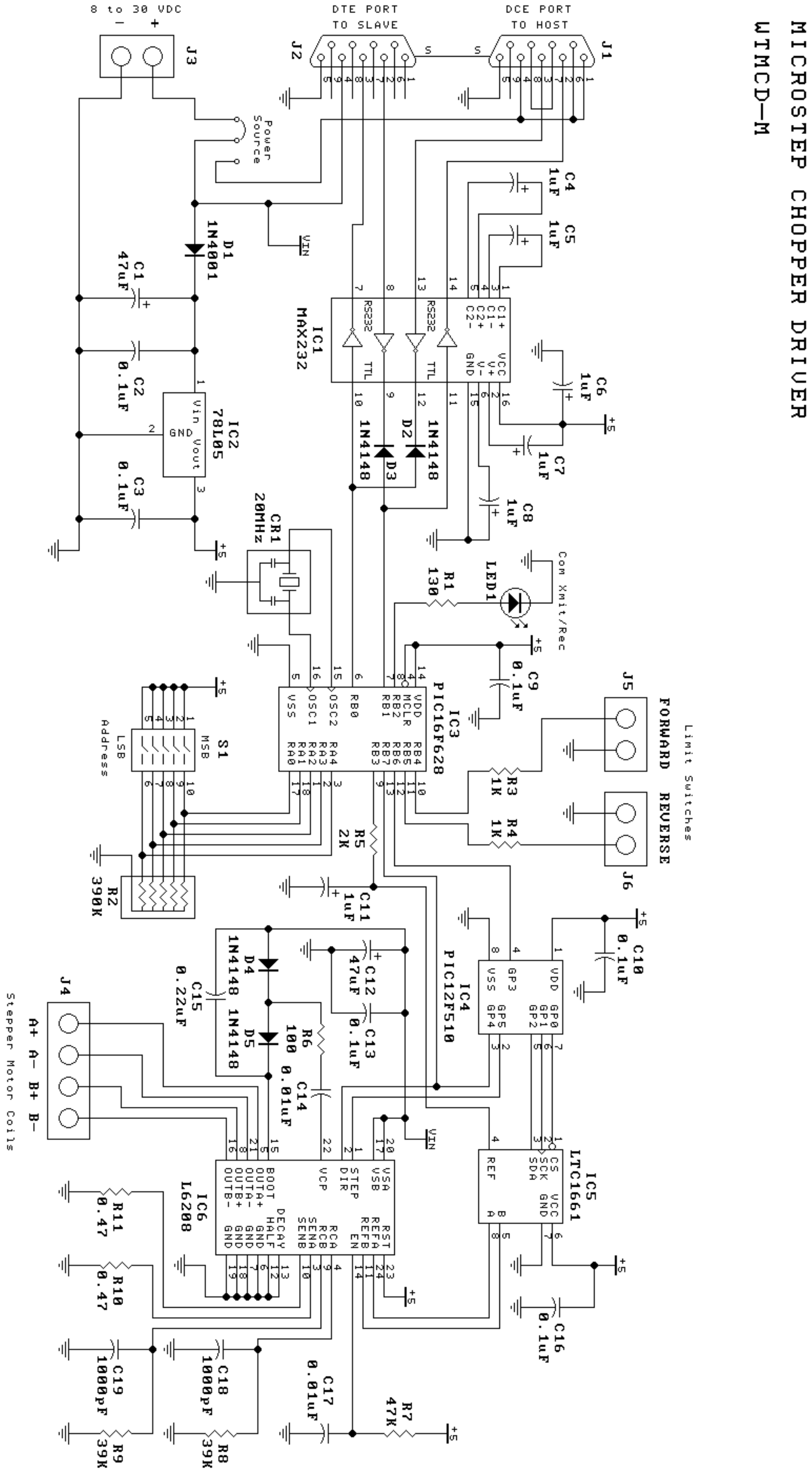
Power Supply Inputs
Will accept any voltage from 8 to 30 VDC. Must be adequate enough to drive stepper motor.

Motor Outputs
Connects to the motor coils of a 2-phase bipolar stepper motor.

FWD Limit Switch Input
Accepts a N.O. switch used to limit movement in forward direction.



Holes will accept size 440 screws


MICROSTEP CHOPPER DRIVER
WTMCD-M
8 to 30 VDC
- +
J3
DTE PORT TO SLAVE
J2
DCE PORT TO HOST
J1
Power Source
VIN
D1 1N4001
C1 47uF
C2 0.1uF
C3 0.1uF
IC2 78L05
Vin Vout GND
C4 1uF
C5 1uF
C6 1uF
C7 1uF
C8 1uF
IC1 MAX232
C1+ C1- C2+ C2- VCC V+ V- GND
RS232 TTL
D2 1N4148
D3 1N4148
CR1 20MHz
R1 130
LED1
Com Xmit/Rec
C9 0.1uF
IC3 PIC16F628
VDD MCLR RB2 RB1 RB0 OSC2 OSC1 VSS RB4 RB5 RB6 RB7 RB3 RA4 RA3 RA2 RA1 RA0
S1
MSB LSB Address
R2 390K
J5 FORWARD
J6 REVERSE
Limit Switches
R3 1K
R4 1K
R5 2K
C11 1uF
C10 0.1uF
IC4 PIC12F510
VDD GP0 GP1 GP2 GP3 VSS GP5 GP4
IC5 LTC1661
CS SCK SDA VCC GND REF B A
C16 0.1uF
C12 47uF
C13 0.1uF
D4 1N4148
D5 1N4148
C15 0.22uF
R6 100
C14 0.01uF
IC6 L6208
VSA VSB STEP DIR VCP BOOT OUTA+ OUTA- OUTB+ OUTB- RST REFA REFB EN RCA RCB SENA SENB DECAY HALF GND
J4
A+ A- B+ B-
Stepper Motor Coils
R11 0.47
R10 0.47
C19 1000pF
C18 1000pF
C17 0.01uF
R9 39K
R8 39K
R7 47K
+5