Mondo-tronics' mini Dual H-bridge Circuit Kit - #3-301

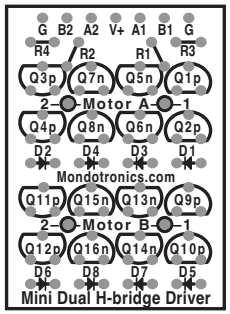
Section 1 - Introduction

Control two 3 volt DC motors, up to 300 milliamps continuous each. Independent control of motor speeds using Pulse Width Modulation in software for forward and reverse.

Input voltage: 5 Volts (6 Volts maximum)
Output voltage: 3 Volts each motor
Output current: 300 mA continuous (500 mA peak) each motor
Power: 500 mW total, each motor

Features standardized input connector - pin compatible with our MAXI Dual H-bridge kit. Run both motors via PC parallel port. Run both motors via any serial port by adding our Serial Motor Interface (#3-511). Awesome motor control for small DC motors!

Includes detailed instructions, schematic, application notes and sample control program in BASIC. Requires soldering, basic tools, cable parts and a PC with parallel port or other TTL or CMOS level control circuit.



Component Side Silkscreen Legend

Section 2 - Parts List

The kit includes the following:

Item	Quan	Location	Description
1.	4	R1-4	Resistor 1.3K Ω 1/4W 5% brn org red gld
2.	8	D1-8	Signal Diode, 1N4148
3.	8	Q1-4, Q9-12	Transistor PN2907A PNP general purpose
4.	8	Q5-8, Q13-16	Transistor PN2222A NPN general purpose
5.	1	J1	Header, Male 0.100" 1 x 7 Instructions,
6.	1	-	PCB Mini Dual H-Bridge, Rev B (PN 1-271)
7.	1	-	Instructions, Mini Dual H-Bridge, Rev B (these!)

Section 3 - Other Tools and Materials List

In addition, assembly and operation will require:

1. Soldering iron for electronics
2. Solder for electronics
3. Moist sponge to clean soldering iron tip
4. Wire stripper
5. Side cutter
6. PC computer with parallel port & QBASIC
7. Connectors & wire for cable to PC parallel port
8. DC motor(s), motor power supply and wiring

Section 4 - Build It

If you have not soldered or assembled electronics before, please consult a book on basic electronic assembly or get the assistance of an experienced board assembler.

Generally, assemble the Printed Circuit Board starting with components having the lowest height above the board, and work upwards - as per the order given in the Parts List above.

Note both the location of the part (don't put it in the wrong place), and its orientation - many parts, like diodes and integrated circuits, can be damaged or destroyed if powered "the wrong way".

Suggested order of assembly:

4.01) Four resistors at locations R1, R2, R3 and R4. (Bend them like the diodes as shown, but they can be installed in either direction.)

4.02) Eight diodes, D1 to D8 (note orientation - striped end goes to "bar" end on PCB)

NOTE: Before soldering any transistors in place, double check their type, location and their orientation. The PNP and NPN transistors are easy to confuse, but must be installed as shown.

4.03) Eight PN2907A PNP transistors, Q1 through Q4 and Q9 through Q12 (note locations, orientations as shown on the silkscreen on the board, and position of leads).

4.04) Eight PN2222A NPN transistors, Q5 through Q8 and Q13 throught Q16 (note locations, orientations as shown on the silkscreen on the board, and position of leads).

4.05) One header strip at J1 (short ends insert into component side of board).

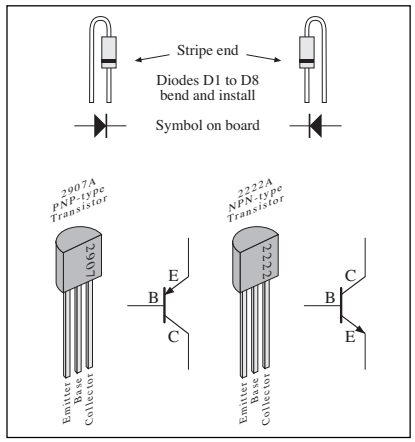


FIG 4.1 - Component Orientations

This completes the assembly of your mini Dual H-Bridge circuit. Double check all connections and solder points. Make sure all parts are in the correct locations and orientations, that the solder joints are bright and clean, that leads are trimmed, that there are no stray solder bridges or other connections to interfere with the circuit's operation.

Section 5 - Test It

5.1) Connect to Parallel Port

Build a cable for connecting the parallel port (D-25 connector) to the 7 pin, 0.100" spacing header J1 on the mini Dual board.

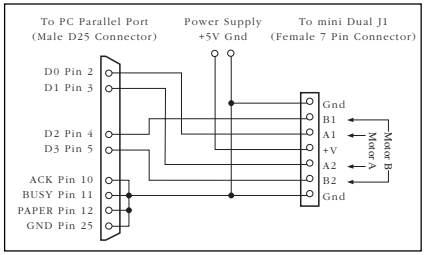


FIG 5.1 - Cable for PC Parallel Port to mini Dual H –>

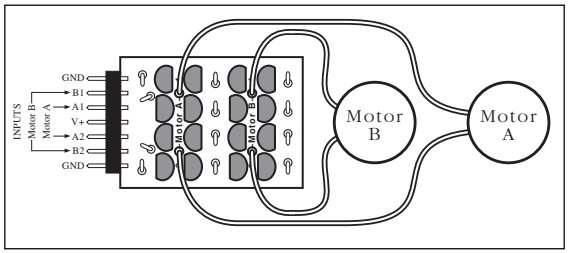


FIG 5.2 - Connecting DC Motors and Power

5.2) Connect Motors and Power

Connect an appropriate DC power supply and one or two 3-volt DC motors to the soldering point on the mini Dual H board.

WARNING: Be sure that the 5 Volt Power Supply is correctly connected at J1 (marked +V and GND) or damage may occur to the circuit, PC or motors.

5.3) Load the software

Boot up the PC, run QBASIC and load the program HBRIDGE.BAS (listed below). For more on QBASIC, see the Notes section below. You may carefully type the program in, or download it from our web site.

5.4) Turn On Power and Run (not away, just the software)

Turn on the power switch to the DC motors. Run the software. You should be able to control the speed and direction of each motor. Experiment with the mini Dual H, and use the software listing as a starting point to develop your own programs.

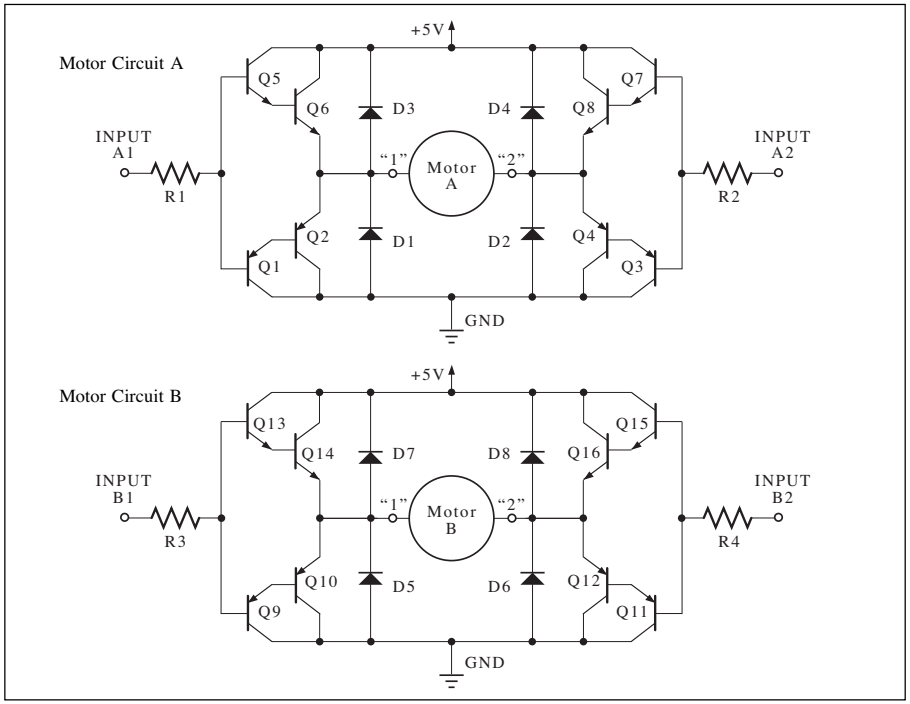
Section 6 - Technical Details

6.1) If it doesn't work...

a) Double check all connections
b) Double check all solder joints for
- wires in wrong locations
- bridged solder joints
- weak solder joints

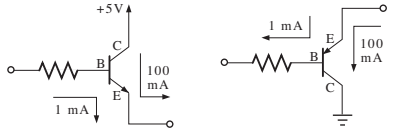
c) Double check the cable wiring with a continuity tester and make sure it matches the schematic.
d) Sufficient power? Power correctly connected (+ and -)?
e) Parallel port settings - correct port? - enabled?

6.2) Schematic



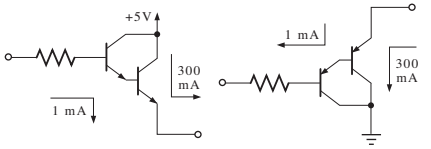
6.3) How It Works

Microprocessors and other logic-type integrated circuits typically deliver very little output current, from 1 to 30 milliamps (mA), depending on the family of chip. However, motors typically require 80 mA or more to run. The mini Dual H-Bridge circuit amplifies the small, low current signal to provide a higher current suitable for a small 3 Volt DC motor, and also provides forward and reverse control.



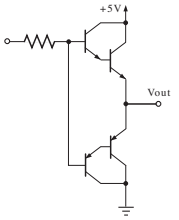
A single transistor permits the small current from a logic gate (such as an output of a microprocessor) to control a much higher current. A "Darlington pair" (two transistor connected as shown) can deliver an even higher output current.

This kit uses two discrete transistors to create a Darlington. However, they are also available with two transistors in one package.



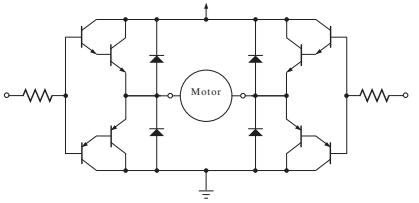
A "totem pole" of Darlington transistors will "source" (produce a positive voltage) or "sink" (accept a negative voltage) enough power to run a small motor. For current to flow through the top Darlington pair (made of NPN type transistors) the input voltage must be higher than Vout. For current to flow through the bottom Darlington pair (made of PNP type transistors) the input voltage must be lower than Vout.

This difference produces a "dead band" of input voltages where neither transistor pair will operate. This "break before make" (in old telephone relay terminology) prevents this circuit from short circuiting the power supply – a major problem with some other types of H-Bridge circuits.



Finally, an "H-Bridge" is constructed from two totem poles, and provides directional control of the motor with just a single supply voltage. This circuit uses two complete H-bridges, one for each motor.

A motor can produce a reverse voltage just after it is turned off or when it is spun by an external force (it becomes a generator!). The four diodes "snub" this inductive kick-back to protect the transistors. See Schematic above for more.



Input / Output Logic Table

Inputs		Rotation	Outputs	
1	2		1	2
L	L	None	L	L
L	H	Clockwise	L	H
H	L	Counter-Clockwise	H	L
H	H	None	H	H

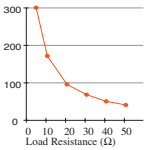
Attach the circuit to a 5 volt power source, a small motor and fire it up! Pins A1 and A2 control Motor A, pins B1 and B2 control Motor B as shown in the table.

Connect the Inputs as shown ("H" is "high" or +5 Volts, and "L" is "low" or Ground or zero Volts) and observe the motors for proper spin direction.

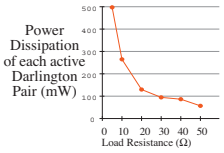
If a motor runs opposite from the direction desired, simply reverse the two wires at the motor.

Performance Ratings

Input: 5 Volts (6 V Max.)
Output: 3 Volts each motor
Current: 300 mA (500 peak) per motor
Power: 500 mW per motor



Test conditions
Power: V+ = 4.8 Volts.
Input signals provided by a 74HCT00 chip (under 1 mA input signal)



Section 7 - Sample BASIC Stamp 2 Program for MAXI Dual 2

This program operates the Mini Dual 2 circuit using a BASIC Stamp 2 microcomputer when connected as shown in Figure 7.1 below. Though simple, it provides a good start and permits full, independent control of both motors. You can adapt the circuit and this program to run with other BASIC Stamps, other 24 pin microcomputers, or use it to develop your own programs in other languages. This program is available as a .PDF file via our website, so get it and avoid typing in this program!

```
'Maxi2tst.BS2 - Maxi Dual H-Bridge Cct Demo Program for BASIC Stamp 2 - RG 0408.05 / 0409.02
'Demonstrate control of two DC motors via a Stamp 2 with variable speed and direction
'
'Demo Sequence:
'Motor A - Forward slow to full speed, pause, decrease to stop, pause
'Motor A - Reverse slow to full speed, pause, decrease to stop, pause
'Motor B - Forward slow to full speed, pause, decrease to stop, pause
'Motor B - Reverse slow to full speed, pause, decrease to stop, pause

output 0                    'motor B, pin 1
output 1                    'motor A, pin 1
output 2                    'motor A, pin 2
output 3                    'motor B, pin 2
Rate    var     word        'rate for Motor (0 to 255)
Motor   var     byte        'Motor A = 1, Motor B = 3
i       var     word        'counter

main:                       'begin main program loop
       Motor = 1                    'start with Motor A
       low 0  'motor B, pin 1              'startup settings - all motors off
       low 1  'motor A, pin 1
       low 2  'motor A, pin 2
       low 3  'motor B, pin 2

submain:
       For Rate = 0 to 4950 step 50         'motor forward ramp up
              pulsout Motor,Rate            'wiggle pin 1 or 3
              pause (5001-Rate)/100
       Next                                 'Rate

Rate = 5000
       For i = 0 to 4950 step 50            'motor hold forward at max
              pulsout Motor,Rate            'wiggle pin 1 or 3
              pause (5001-Rate)/100
       Next                                 'i

       For Rate = 5000 to 50 step 50        'motor forward ramp down
              pulsout Motor,Rate            'wiggle pin 1 or 3
              pause (5001-Rate)/100
       Next                                 'Rate

pause 500                       'pause for stopped motor

'reverse motor direction
       toggle 0       'motor B, pin 1
       toggle 1       'motor A, pin 1
       toggle 2       'motor A, pin 2
       toggle 3       'motor B, pin 2

       For Rate = 0 to 4950 step 50         'motor reverse ramp up
              pulsout Motor,Rate            'wiggle pin 1 or 3
              pause (5001-Rate)/100
       Next                                 'Rate
```



```
Rate = 5000                     'motor hold reverse at max
       For i = 0 to 4950 step 50
              pulsout Motor,Rate            'wiggle pin 1 or 3
              pause (5001-Rate)/100
       Next                                 'i

       For Rate = 5000 to 50 step 50        'motor reverse ramp down
              pulsout Motor,Rate            'wiggle pin 1 or 3
              pause (5001-Rate)/100
       Next                                 'Rate

pause 500                   'motor hold at stop

If Motor = 3 then main              'if Motor B then go to Motor A
       Motor = 3                    'otherwise switch to Motor B

goto submain                'repeat cycle for Motor B

'end
```

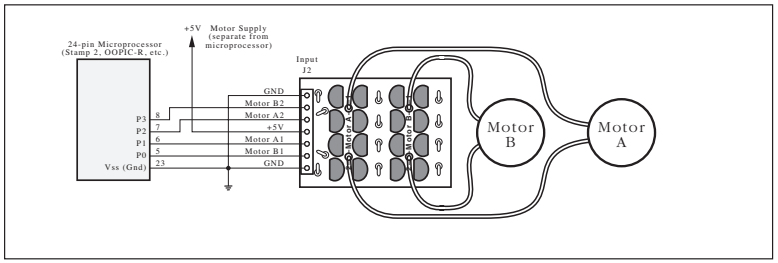


Figure 7.1 - Testing or operating the board with a 24-pin Microprocessor like the BASIC Stamp 2 or OOPIC-C

Note that the Motor Supply can be 6 Volts. To protect the microprocessor from electrical noise that may be generated by the DC motors, the motor power supply should be separated or isolated from the power supply that runs the microprocessor. This can be as simple as running the processor from a 9 Volt battery, and the motors from a separate 6 Volt battery pack. If a single supply must be used, it may be helpful to add appropriate noise reducing capacitors to the power wiring.

Section 8 - Notes

8.1) Running QBASIC on Your PC

In Windows 95, 98 or NT, look under the Start Menu, choose MS DOS Command Prompt. Then, from the DOS window, type QBASIC.

If you don't have QBASIC installed, follow these steps:

1. Start Windows
2. Put the Windows CD-ROM into your CD-ROM drive.
3. Double-click on My Computer on the Desktop.
4. Right-click on your CD-ROM drive and click on Open.
5. Double-click on Other and then on Oldmsdos.
6. Click on Qbasic.
7. While holding down Shift, use the right cursor (arrow) key to select Qbasic.exe and Qbasic.hlp.
8. Click on Edit and then on Copy.
9. Close all My Computer windows.

10. Double-click on My Computer on the Desktop again.
11. This time, double-click on your hard drive icon.
12. Click on File, drag the cursor to New and then click on Folder.
13. A folder with the name New Folder appears. Type in QBASIC and then press Enter.
14. Double-click on Qbasic, the folder that you just created.
15. Click on Edit and then Paste. Two new items, Qbasic.exe and Qbasic.hlp were created under that folder.
16. Close all My Computer windows.
17. To create an icon for QBASIC, click on the Start button, and then drag the mouse cursor to Settings, next click on Taskbar...
18. Click on the Start Menu Programs tab and then Add...
19. For the Command line:, type in: C:\QBASIC\QBASIC.EXE, click on Next.
20. Click on New Folder..., type in QBASIC, and press Enter.
21. Click on Finish and then click on OK in the Taskbar Properties window.
22. To access QBASIC, click on Start, move the cursor over Programs, then move it over QBASIC, finally, click on Microsoft Quick BASIC.

For more on QBASIC visit:

http://www.geocities.com/SiliconValley/Park/4504/index.html

8.2) Using this board with the Serial Motor Interface board

Using this motor driver with Mondo-tronics' Serial Motor Interface (SMI) board permits full control of both motors via a single RS-232 serial data line. Plus, multiple SMIs can be chained together on the same serial line to control multiple motors - up to 254 of 'em!

Section 9 - Program

The sample program below operates a MAXI or mini Dual H-bridge driver circuit via a PC parallel port, and permits full, independent control of both motors. You can adapt the circuit and this program to run with BASIC Stamps, or use it to develop your own programs in other languages. These instructions are available as a .PDF file via our website: http://www.Mondotronics.com. Get it and avoid re-typing this text!

```
'HBridge.BAS - Demo program for MAXI and mini Dual H-Bridge Ccts 9701.28 / 0107.20
'Gives direction and 20 step speed control for two DC motors.
'Active Braking "Brake Mode" available on MAXI Dual circuit only
'no harm in using it on mini Dual - behaves same as non-brake mode

OPEN "lpt1:" FOR OUTPUT AS #1
WIDTH #1, 255

Restart:
A1 = Ø: A2 = Ø: B1 = Ø: B2 = Ø: DcntA = 1Ø: DcntB = 1Ø
ModeA$ = "Stop A": ModeB$ = "Stop B":
GOSUB Display

BIGLOOP:                                                'Main motor control loop
Bit1 = A1: Bit2 = A2: Bit3 = B1: Bit4 = B2
FOR I = Ø TO 19
Main:
A$ = INKEY$
IF A$ <> "" THEN GOSUB Incoming
IF I >= 2Ø - DcntA THEN Bit1 = Ø: Bit2 = Ø
IF I >= 2Ø - DcntB THEN Bit3 = Ø: Bit4 = Ø
PRINT #1, CHR$(Bit1 + (Bit2 * 2) + (Bit3 * 4) + (Bit4 * 8));
NEXT I
GOTO BIGLOOP

Incoming:                                               'Upper Case - Motor A
IF A$ = "J" THEN SpeedA$ = "SlowerA": DcntA = DcntA + 1: IF DcntA > 2Ø THEN DcntA = 2Ø
IF A$ = "L" THEN SpeedA$ = "FasterA": DcntA = DcntA - 1: IF DcntA < 1 THEN DcntA = 1
IF A$ = "I" THEN ModeA$ = "CW A  ": A1 = Ø: A2 = 1
IF A$ = "M" THEN ModeA$ = "CCW A ": A1 = 1: A2 = Ø
IF A$ = "K" THEN ModeA$ = "Stop A": A1 = Ø: A2 = Ø
IF A$ = "B" THEN ModeA$ = "BrakeA": A1 = 1: A2 = 1              'Brake mode - MAXI Dual only
```



```
                                                        'Lower Case - Motor B
IF A$ = "j" THEN SpeedB$ = "SlowerB": DcntB = DcntB + 1: IF DcntB > 2Ø THEN DcntB = 2Ø
IF A$ = "l" THEN SpeedB$ = "FasterB": DcntB = DcntB - 1: IF DcntB < 1 THEN DcntB = 1
IF A$ = "i" THEN ModeB$ = "CW B  ": B1 = Ø: B2 = 1
IF A$ = "m" THEN ModeB$ = "CCW B ": B1 = 1: B2 = Ø
IF A$ = "k" THEN ModeB$ = "Stop B": B1 = Ø: B2 = Ø
IF A$ = "b" THEN ModeB$ = "BrakeB": B1 = 1: B2 = 1              'brake mode - MAXI Dual only

IF A$ = "Q" OR A$ = "q" THEN PRINT "Done": PRINT #1, CHR$(15); : END
IF A$ = "R" OR A$ = "r" THEN GOTO Restart
GOSUB Display
RETURN

Display:
CLS
PRINT "Mondo-tronics' H-Bridge Motor Driver Demo         V1.2"
PRINT
PRINT "                   Clockwise"
PRINT "                      I"
PRINT "            Slower  J  +  L  Faster"
PRINT "                      M"
PRINT "                Counterclockwise"
PRINT ""
PRINT "      CAPS - Motor A   lowercase - Motor B"
PRINT ""
PRINT "K/k for Stop   B/b for Brake   R for Reset   Q to Quit"
PRINT ""
PRINT "   MODE A: "; ModeA$; "    DELAY A: "; DcntA
PRINT "   MODE B: "; ModeB$; "    DELAY B: "; DcntB
RETURN
```

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