DS54 Capacitor Discharge driver

The DS54 switch outputs have been designed to control modern solenoid switch machines which draw little current. I came across the problem of driving older "balky" switch machines which require a lot of current to operate and need a capacitor discharge unit to operate reliably. This is the reason why I designed this "Solenoid Switch Driver for DS54".

The schematic – (See attachment #1)

In the upper part of the schematic is shown one of the drivers. The Printed circuit Board has four drivers identical to this one (one for each of the DS54 output). In order to distinguish the drivers from each other, the second, third and fourth drivers have their parts referenced with an additional digit : "1" for the second one, "2" for the third one and '3' for the fourth one(ie : transistor Q4 will be referenced Q14 for the second driver, Q24 for the third one...).

Each driver is connected to the DS54 output by means of a 4-wire telephone cable (provided with the DS54) equipped with the same connector at each end. The driver output is connected to the switch using screw terminals. Each driver is capable of supplying a pulse of up to 2 Amps thus allowing to connect several switches in parallel (such as two switches for a crossover junction), which is not possible with the DS54, even for low current switch machines.

The drivers do not draw any current from the DS54. They are supplied by the Capacitor Discharge Unit.

The lower part of the schematic shows the Capacitor Discharge Unit (one per PCB) which supplies both the Vcc for the driver circuits and the Pulse to operate the switches. The Capacitor Discharge Unit is supplied by an external AC source. Several Boards can be supplied by the same AC source, as long as the this source is connected to the same terminals on each board (ie : pin 1 of TB1 of first board connected to pin 1 of TB1 on other boards and the same for pin 2).

The Capacitor Discharge Unit is designed so that the power input is disconnected when a switch is activated thus avoiding burning switch motors, in case the DS54 has not been properly programmed. Also, the Capacitor Discharge Unit is equipped with a constant current circuit for recharging the capacitors, allowing very fast recycle time (approx. 200 ms).

When recharging the capacitors, the Capacitor Discharge Unit draws about 600 mA from the AC source. This current can be decreased by increasing the value of resistor R9, but the recycle time will increase proportionally. When the same AC source is shared between several boards, the AC source must be sized to be able to power all boards at the same time.

When using DCS100 Command Station it is highly recommended to set the Option Switch OPSW#31 to "Closed" to meter switch commands (insert ½ s delay between switch commands) in order to allow the Capacitor Discharge Units to recycle between switch commands. For other Command Stations, check if the "meter switch command" option is available.

Bill of material

Reference	Part
Q1,Q2,Q11,Q12,Q21,Q22, Q31, Q32	2N3904
Q3,Q4,Q5,Q13,Q14,Q23,Q24, Q33,Q34	TIP120

Reference	Part
Q6	2N3906
D1,D2,D3,D8,D11,D12,D21, D22,D31,D32	1N4004
D4	BY255
D5	LED
D6,D7	1N4148
R1,R2,R3,R4,R8,R11,R12, R13,R14,R21,R22,R23,R24, R31,R32,R33,R34	10K - ¼ W
R5,R6,R15,R16,R25,R26, R35,R36	22K - ¼ W
R7,R9	2.2K - ¼ W
C3	470µF-50V
C4,C5	2200µF-63V
J1,J11,J21,J31	Tel socket 4-4
TB1	TB 2 terminals
TB2,TB12,TB22,TB32	TB 3 terminals

All the parts for one board, including the raw PCB should be available for less than 30$.

The Printed Circuit Board - (see attachment #2)

Shown in attachment #2 is the PCB for the "DS54 Capacitor Discharge Driver" (bottom view / solder side).

The PCB is a single sided board which can easily be made at home. This board has been designed for the components I had available and may need some modifications if different components are used (see Board Layout, below).

The Board Layout - (see attachment #3)

Shown in attachment #3 is the PCB layout for the "DS54 Capacitor Discharge Driver" (top view / component side).
The switch driver board have been designed so that the DS54 board can be piggybacked on top of it to save space. The outline of the DS54 board is shown on the layout.

Connection between the driver board and the DS54 is made of :

- 4 small telephone cables (2 to 3 inches long) equipped with 4wire-4contact plugs at each end (the same as the ones supplied with the DS54). Note that the telephone sockets on the driver board and on the DS54 are located right on top of each other.
- GND wire from DS54 (black wire located near the two screw terminals on the DS54) to solder to the GND pad on the driver board

Most parts have rather standard footprints. However, some specific parts may require to modify the layout and the PCB :

- Capacitors C4 and C5 (2200µF - 63V) : I've used two capacitors in parallel, instead of one big 4700µF because they take less room. The Capacitors I've used are rather small as compared to other, so check what's available and modify the layout and board accordingly.
- Connectors J1, J11, J21 and J31 : These are sockets for small 4wire-4contact telephone handset plugs. Again, the footprint of these connectors vary from one manufacturer to another. In some case, the socket may even be flipped upside-down. Modify the PCB according to what is available.
- Terminal Boards TB1, TB2, TB12, TB22 and TB32 : These are screw terminals that I found here. You may found different ones and need to modify the PCB accordingly.
- Transistor Q5 : this transistor has to be equipped with a heat sink since it may dissipate some heat if the Capacitor Discharge Unit is used very frequently.
- Transistors Q3, Q4, Q5, Q13, Q14, Q23, Q24, Q33 and Q34 : the collector of these transistors are connected to both the middle pin (at the bottom of the transistor) and the metal tab (at the top of the transistor). The collector connection is made through the top metal tab, so the bottom middle pin is not used and cut short of the transistor case. The metal tab is connected to the PCB using brass screws/washers/nuts.
- Transistors Q3, Q4, Q13, Q14, Q23, Q24, Q33 and Q34 : these transistors are very closely spaced, so make sure, when mounting them, that the metal tabs do not touch each other.

I have been using 6 of these cards on my layout for many months without any problem and all my turnouts are operating very reliably, even for some crossovers where two switch motors are wired in parallel.
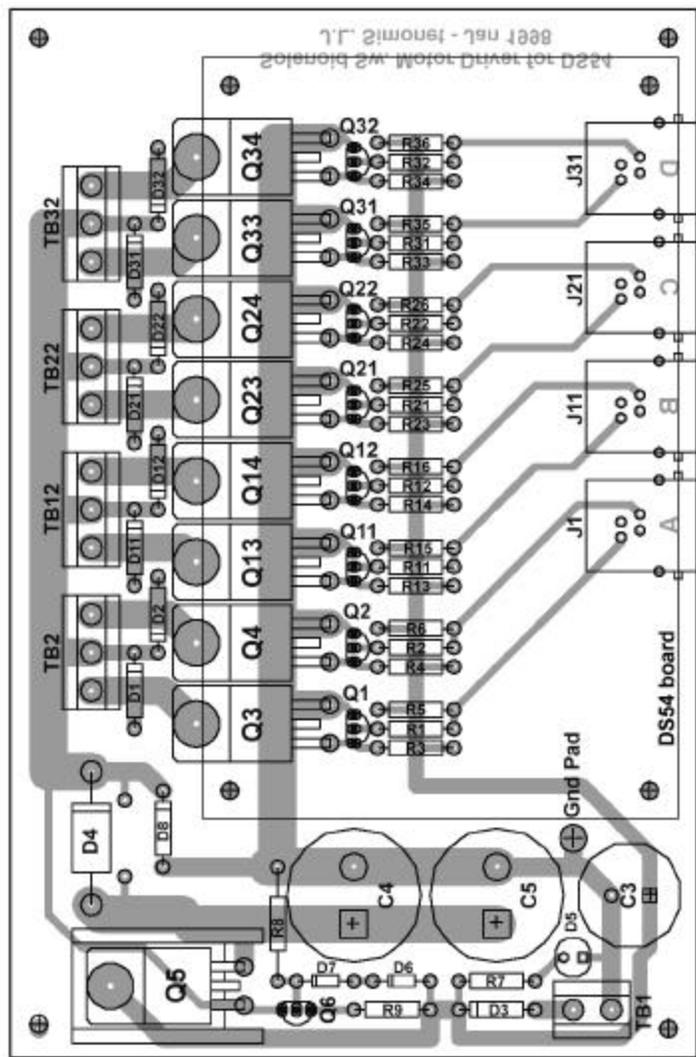
For any question or comment regarding this Solenoid Switch Driver for DS54, or any documentation request, don't hesitate to contact me (simonet@club-internet.fr)
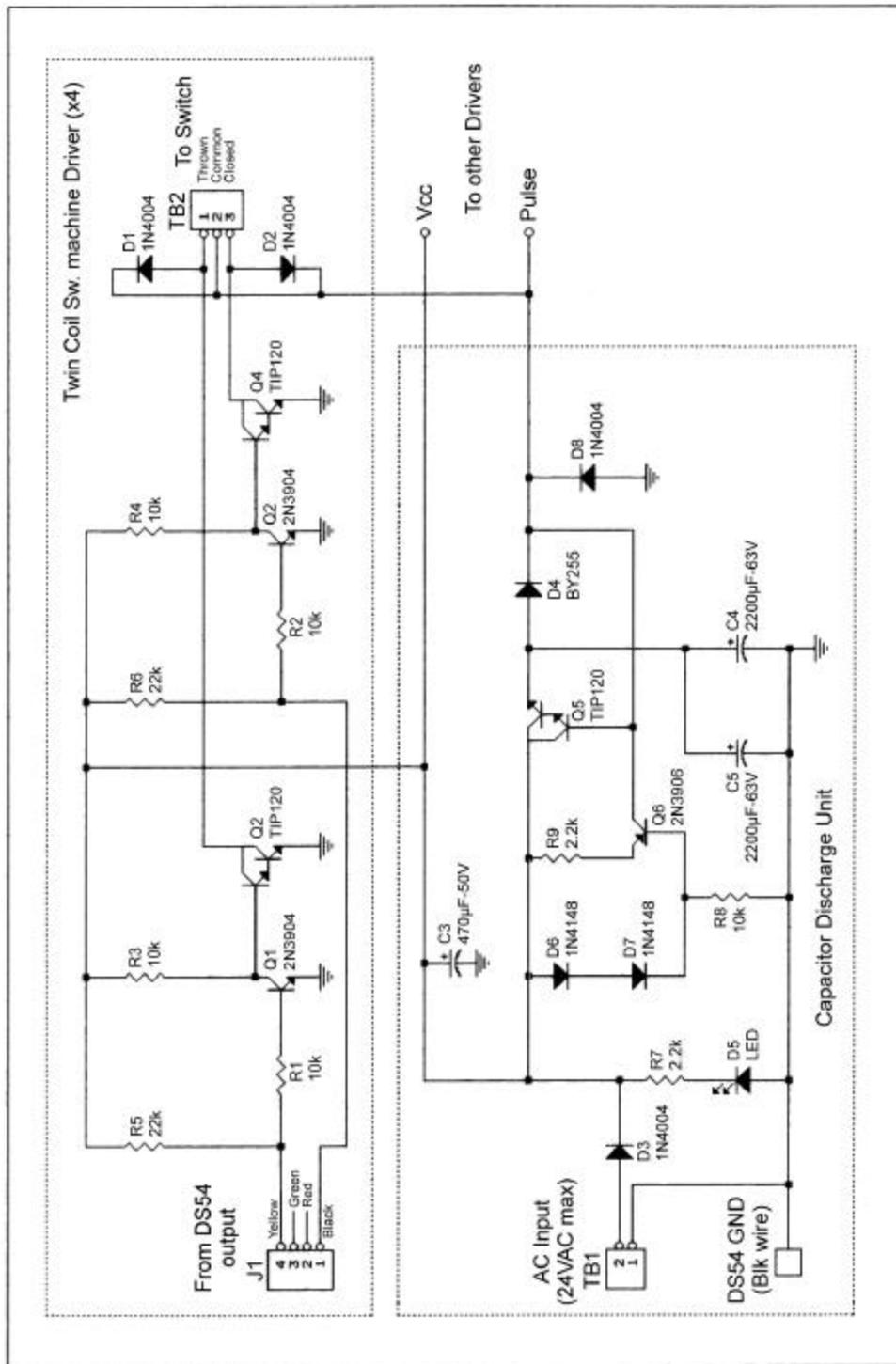
Attachment #1 : DS54-CDU Schematic

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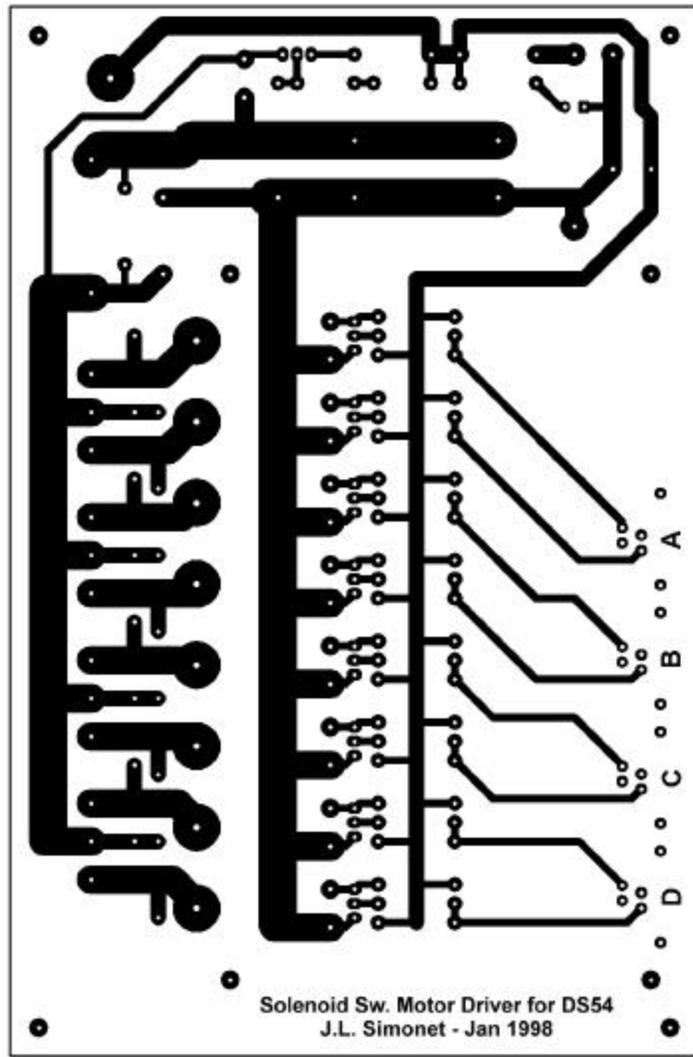
Attachment #2 : DS54-CDU Printed circuit board (bottom view)

Attachment #3 : DS54-CDU Layout (top view)