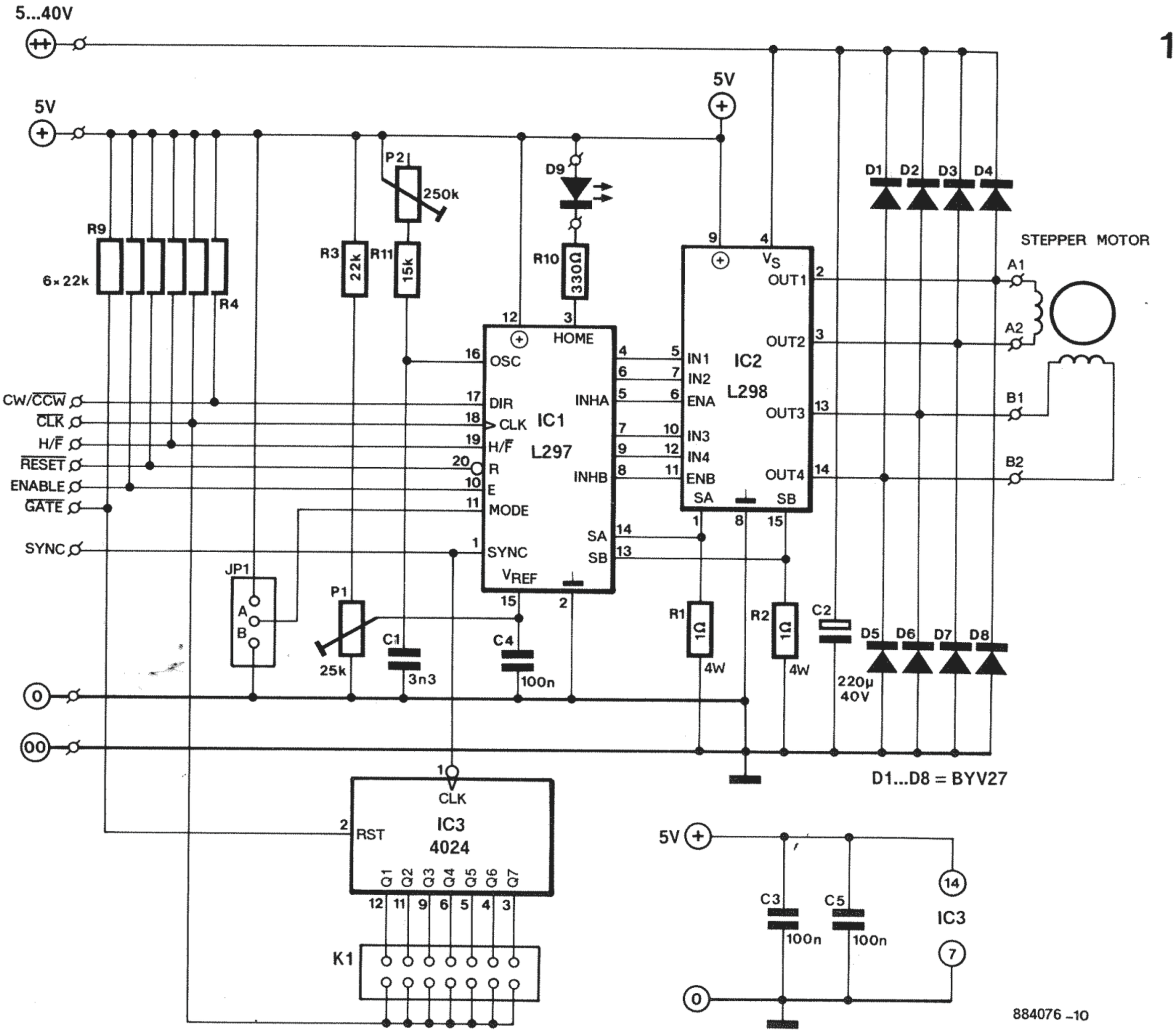
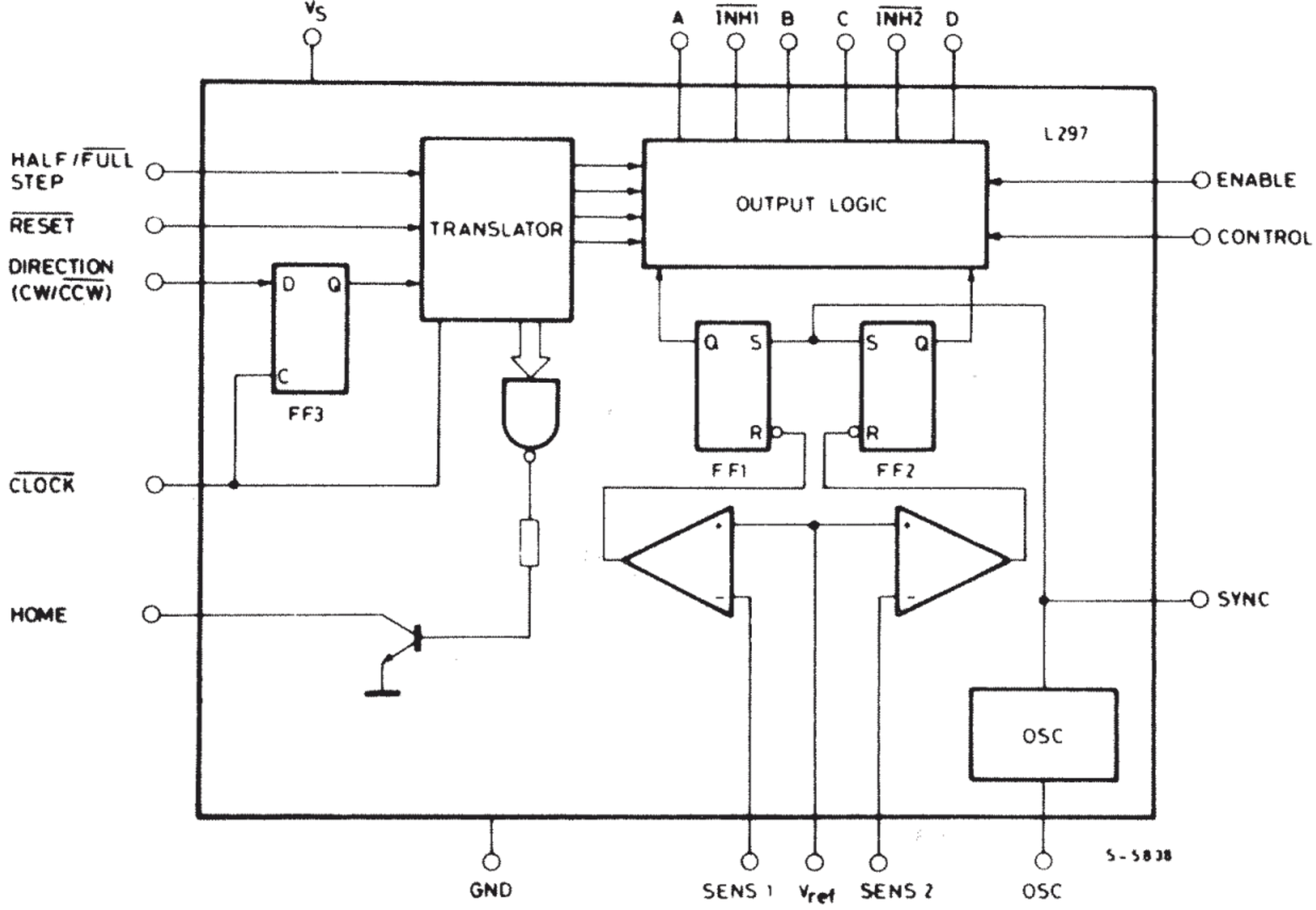
Stepper motor driver

063 This stepper motor driver is simple without compromising versatility. It has a conventional computer interface, an optional on-board clock generator, and integrated motor control and driver stages. The board can drive dual-stator





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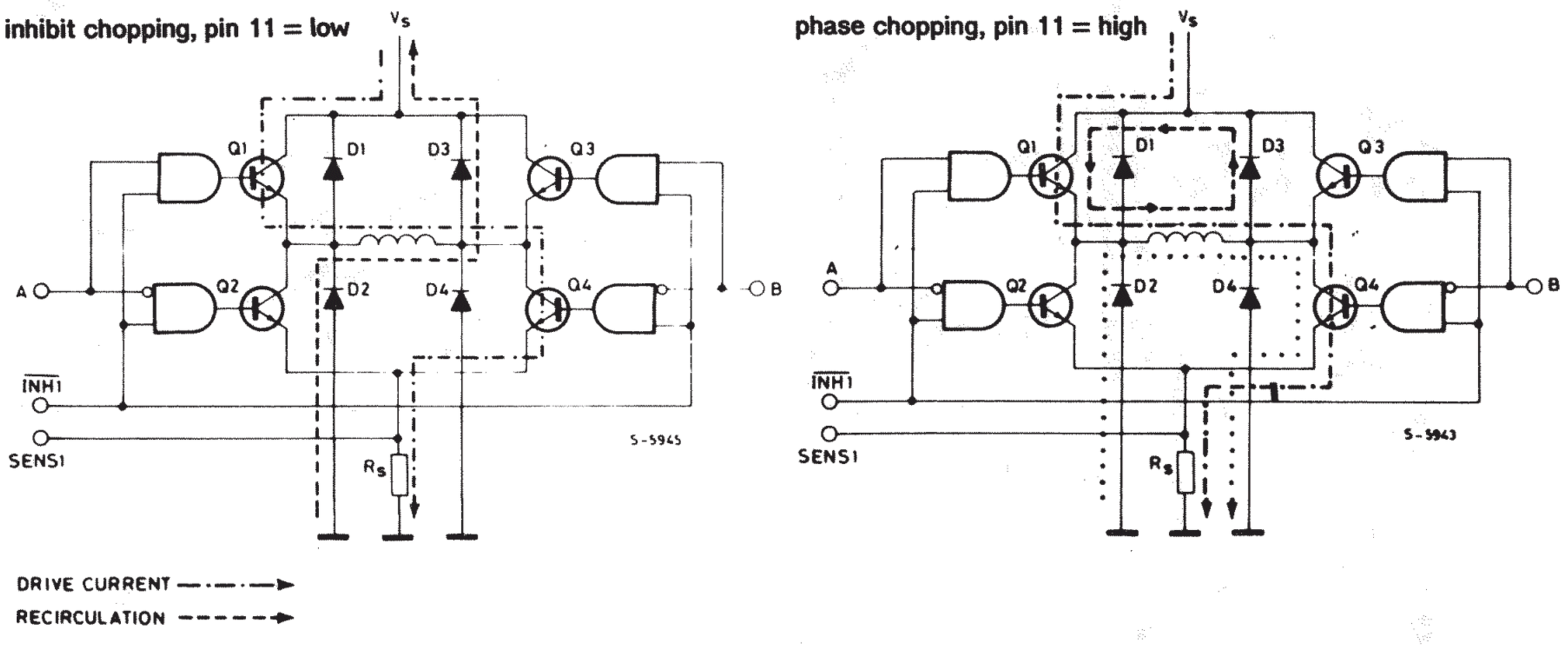
motors, i.e., motors with two bipolar, or four unipolar, phases. Maximum current per phase is 2A.

The circuit diagram of Fig. 2 shows that the circuit is designed around chip set L297-L298 from SGS.

The block diagram of the L297 is given in Fig. 1. This IC generates control signals for a dual-stator motor, and enables selecting direction of travel and full or half-step operation by appropriate programming of its TLL-compatible inputs. One full or half step is performed on the trailing edge of the signal applied to the clock input (CLK). When the enable input, E, is held logic low, the motor is not energized, so that the spindle can be rotated freely. Driving the reset input logic low causes the motor to remain halted in the home position (LED D_9 is quenched).

Power driver Type L298 supports constant current drive of the stator windings. Current drive gives good results because it allows stepper motors to be connected to a voltage that is higher than specified for voltage drive. Current drive considerably improves the motor's dynamic characteristics (start frequency and maximum step-rate). An internal oscillator sets a bistable at the start of each period, when the stator windings are connected to the supply voltage. Due to the stator inductance, output current will initially rise linearly, resulting in a linear voltage on current sensing resistors R_1 and R_2. When the measured voltage reaches a certain user-defined peak value, V_{ref}, two internal comparators reset the bistables, and the stator current is interrupted. Free-wheeling diodes then reduce the induced stator field. From the above it is clear that current drive works by peak detection. The resultant avarage current depends on V_{ref} (adjustable with P_1), the oscillator frequency (adjustable with P_2) and the values of the sensing resistors. Ripple amplitude on the stator current depends on stator self-inductance and the logic level at the MODE input. When this is high, the outputs of IC_2 are switched to high impedance during the free-wheeling period. The stator field is reduced fairly rapidly via the free-wheeling diodes which conduct because the instantaneous voltage on the stator winding is slightly higher than the supply voltage. When MODE is held logic low, one transistor in the bridge circuit internal to the L298 remains on during the free-wheeling period. This causes the free-wheeling voltage on the stator winding to remain relatively low, resulting in slower reduction of the stator field strength and, therefore, reduced ripple (*phase chopping*, see Fig. 3). This option is offered to enable efficient current control of motors with a relatively low stator self-inductance.

Synchronization of the oscillators in the L297s is required when multiple drivers and motors are used in a single system. This is simple to accomplish by fitting parts P_2, R_{11} and C_1 on one driver board only, and feeding the signal available at the SYNC output to the SYNC



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terminal on the other boards.

An on-board divider, IC_3, is provided to supply the clock signal when the relevant computer output line cannot be programmed to toggle at the required step-rate. The divider is clocked with the SYNC signal of the L297, and jumper block K_1 allows selecting 1 of 7 available clock frequencies (step-rates). On-board clocking via IC_3 can be disabled by driving input GATE logic low. The CLOCK input then functions as an output, enabling the computer to keep track of the number of steps performed. When external clock pulses are applied to the board, IC_3 is simply omitted.

The 5 – 40 V supply rail need not be regulated — smoothing is adequate here. The maximum attainable step-rate increase with supply voltage, but 40 V should not be exceeded.

The chopper frequency (refer to Fig. 3), and hence the step-rate in stand-alone applications, is set with P_2. Stator current is set with P_1. Lisping sounds produced by the motor point to instability of the current drive. This effect can be remedied by either re-adjusting the chopper frequency, or by selecting the other logic level at the MODE input of IC_1. When this still fails to stabilize the current drive, the supply voltage must be reduced until the motor operates with voltage instead of current drive.

Stand-alone use of the driver is simple to accomplish by connnecting three external switches as shown in Fig. 5. Figure 6 shows how to connect the driver board to a unipolar motor. The oscillator inside IC_1 is used only for generating the clock signal required in stand-alone applications of the driver. When it is used, the step-rate can be set by fitting a jumper in the appropriate position on K_1, and adjusting P_2.

Finally, IC_2 is purposely located at the edge of the printed circuit board to enable it to be bolted on a metal surface for cooling.

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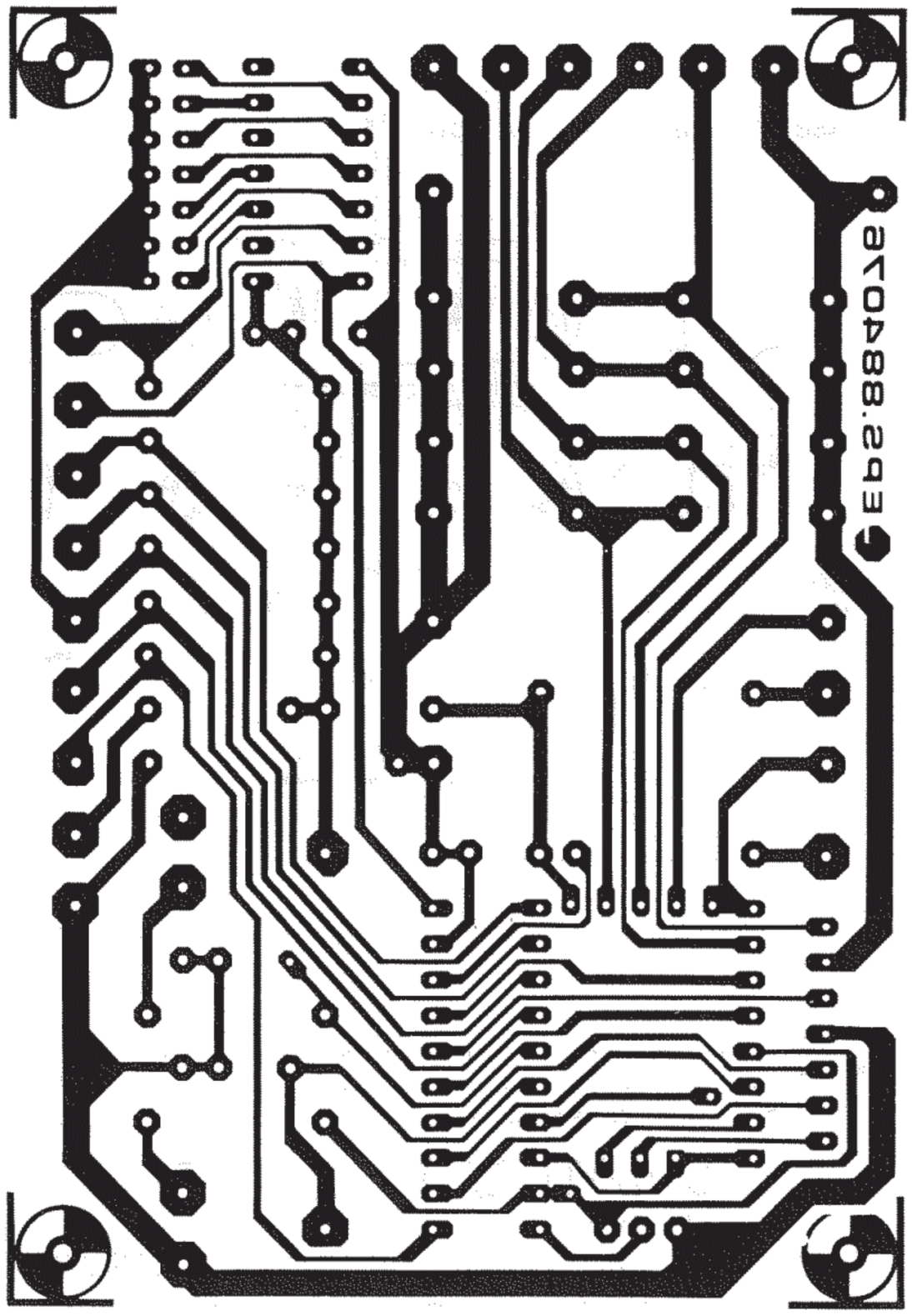

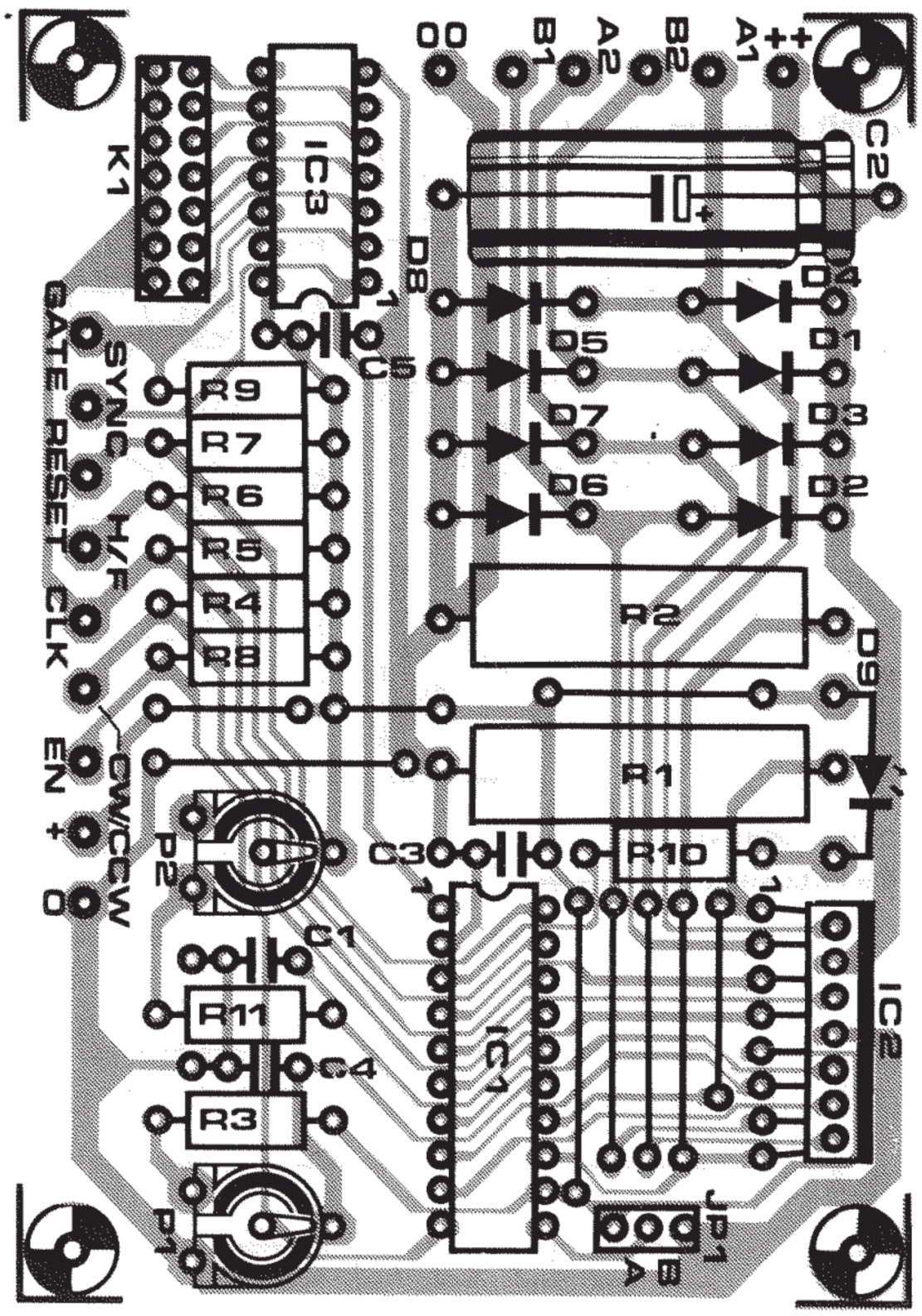

Parts list

Resistors (±5%):
R_1;R_2 = 1R0; 4 W
R_3 . . . R_9 incl. = 22K
R_{10} = 330R
R_{11} = 15K
P_1 = 25K or 22K preset H
P_2 = 250K or 220K preset H

Capacitors:
C_1 = 3n3
C_2 = 220μ; 40 V
C_3;C_4;C_5 = 100n

Semiconductors:
D_1 . . . D_8 incl. = BYV27 (Philips Components)
D_9 = LED
IC_1 = L297 (SGS)
IC_2 = L298 (SGS)
IC_3 = 4024

Miscellaneous:
JP_1 = 3-way terminal strip (pitch: 0.1 in.); 1 jumper.
K_1 = 2 off 7-pin terminal strips (pitch: 0.1 in.); 1 jumper.
14 off solder pins dia. 1.3 mm.
PCB Type 884076

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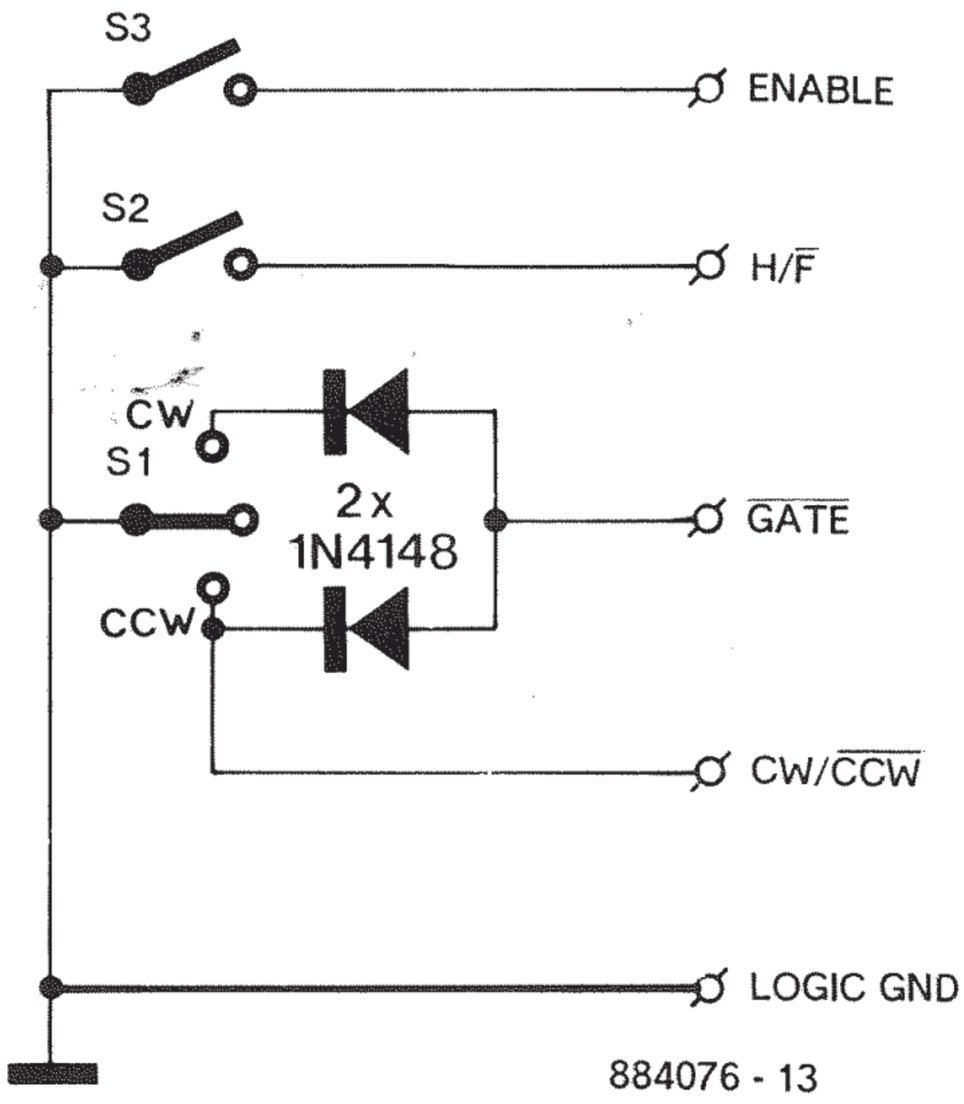

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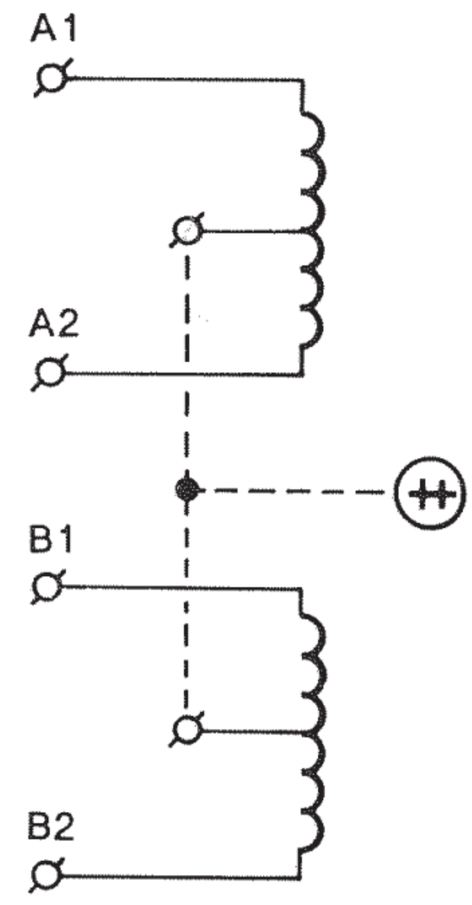

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