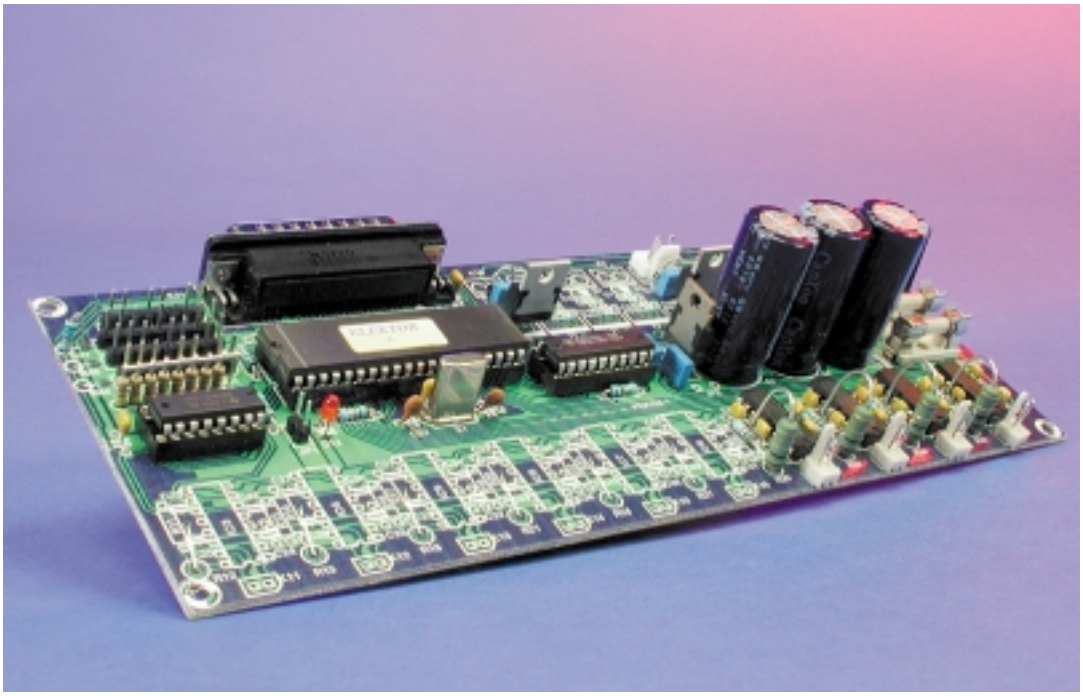
PCB Drilling Machine (3)

Part 3: PCB construction

Design by T. Müller (Radix GmbH)

www.radixgmbh.de

The controller board contains all the electronics for the plate motor and four drill arms. As a matter of course, the board population is in accordance with the actual number of drill arms you have in use.



All the components of the circuit can be built onto a single-sided printed circuit board. The PCB and component layout are shown in **Figure 1**. The power supply (as far as the transformers) is also built onto the circuit board: it provides a +30 V supply for the solenoids and stepper motor drivers, +15 V for the drill motors, and +5 V for the logic, regulated by IC1. The layout is very straightforward: along one long edge of the board we have the stepper motor drivers, each with a pair of terminal posts (K11-K20) for connection to the stepper motor windings. Since comparatively high currents flow through the ICs, they should be soldered directly to the board without sockets.

Along the other long edge we find the terminals for the jumpers and switches, the 25-way sub-D connector, the output stages for the solenoid drivers and drill motors (connected via the small PCB connectors K3-K10), and finally the power connectors K1 and K2. The microcontroller, the GAL and the shift register are in the middle of the board, and naturally good quality IC sockets should be used for them. One toroidal mains transformer with 2·12 V/ 80 VA secondary windings is used for each pair of drilling arms. If four arms are fitted, then the windings of the two transformers should be wired in parallel to connectors K1 and K2.

Fitting the components should present no difficulties. One point to note is that although all the ground connections are linked, the two marked heavy gauge wire links on the circuit board next to the fuses must be soldered in. This is to avoid long current paths over the circuit board and the interference problems this causes. The ground plane is split between the sub-D connector and the nearest corner of the circuit board: with the type of drilling motor used this gives the best EMC performance. With other types of motor it may be necessary to bridge the gap.

The reset input JP1 can be brought out and used as a kind of emergency switch. Using this switch will certainly confuse the system, however, since the controlling PC

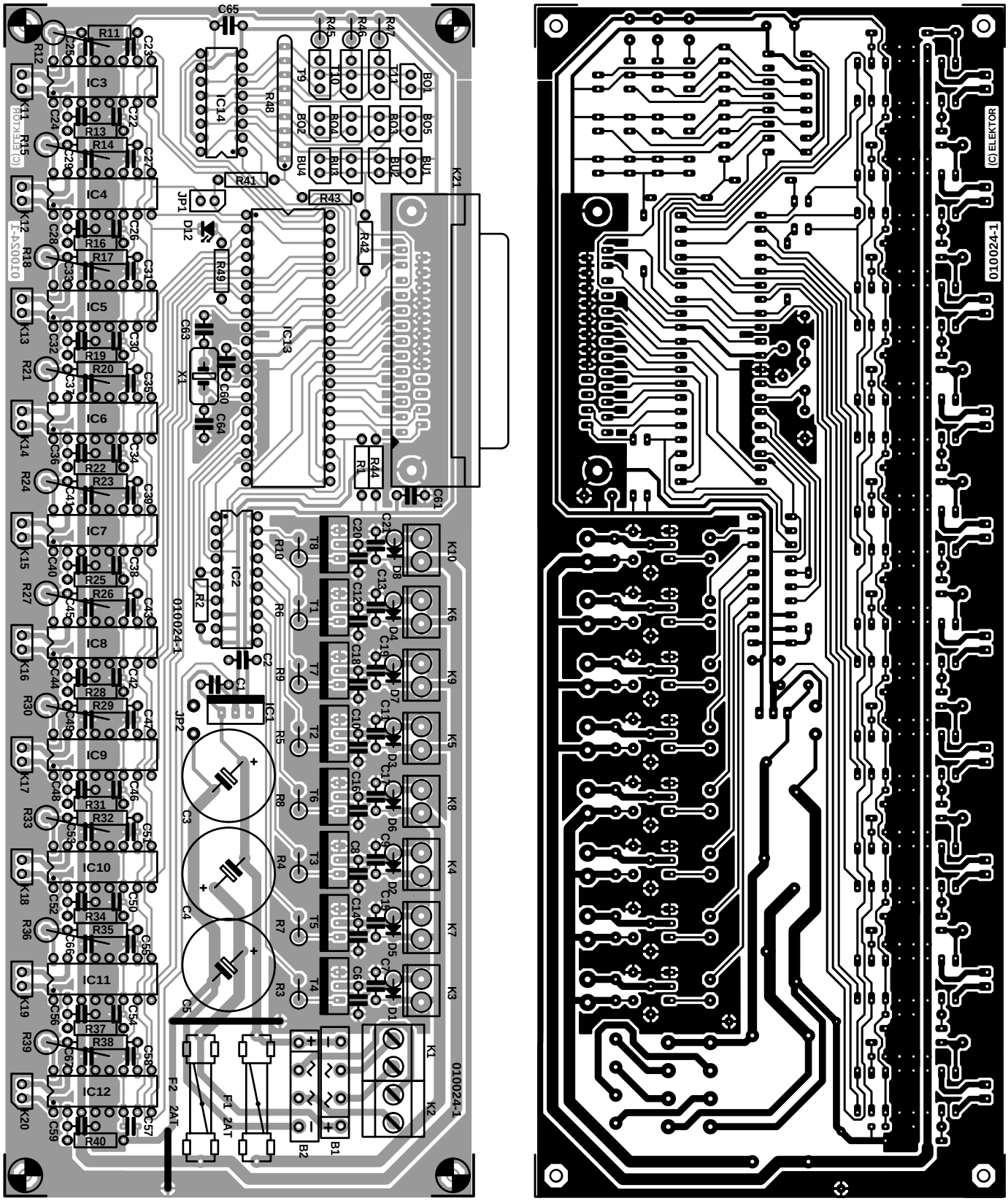


Figure 1. Track layout and component mounting plan of the controller board.

will not know when it has been operated; but in any case an emergency switch is not a bad idea.

(010024-3)

In the next instalment of this series we get down to the nuts and bolts of the project. The various parts of the PCB drilling machine will be brought together, with illustrations — and lots of glue and grease!

Compact PCB drilling machine

After discussions with several readers during the HobbyTronic Fair in Dortmund, Germany, and several e-mail enquiries and telephone calls, we have decided to describe briefly once more the operation of the PCB drilling machine, along with its advantages and capabilities.

Basic features of the PCB drilling machine

Our project is a CNC machine which carries out operating commands calculated with the help of a computer. Conventional CNC machines are constructed using linear components, such as worm drives, ball races, linear guides and many other — not inexpensive — specialist components. The construction of a linear machine appears very straightforward: simply select the required components in the appropriate sizes, fit them together, and set the computer going. But the devil is of course in the detail: all the parts must be precisely mounted, parallel, true, and free of play, or else things will grind and jam.

Our PCB drilling machine is, as far as function and aims are concerned, exactly like an X/Y/Z-machine. It can handle circuit boards up to 200 mm by 300 mm with an accuracy of 0.03 mm, which is entirely adequate for our application. Because of its lightweight construction it can move extremely quickly, at almost 80 mm/s. In construction it is fundamentally different from linear machines. Everything is reduced down to two rotating, vertical axles. The only specialist components required are good-quality ball bearings to support these axles without play. In appearance, the machine resembles a record player: in the middle is a rotating table, on which the workpiece — the circuit board — is fixed. Instead of a cartridge we have a drill, which can be moved up and down. And in exactly the same way as the tone arm can reach any point on a record, the drill can get to any point where drilling is required on the circuit board.

As well as the rotating table, there is space for more tool arms, which can all operate practically simultaneously on the same circuit board. The advantages are that the job gets done quicker, and no tool changes are required.
The tool can be a drill, which can be used for drilling holes for the leads of components, or a milling tool, with which the conductors can be milled away. Drilling data is taken from one's preferred circuit board design program in Excellon format: all programs are capable of outputting this format. Milling data is sent to the machine in the HPGL plotter control language, allowing any desired cutting path to be followed. The machine can be connected directly to the printer port of an ordinary PC without extra hardware.

The machine is not designed for heavy-duty milling operations. If you want to produce milled aluminium front panels, you will have to look elsewhere. The key feature of the machine is its high speed, which can only be obtained with a lightweight construction. It is sturdy enough for working on printed circuit boards, but not sturdy enough to withstand the high sideways forces that arise when milling metals. The machine has to be small and light enough so that it finds a place not just in the workshop, but actually on the experimenter's bench

COMPONENTS LIST

Basic version, w/o tool arm

Resistors:
R1,R2,R41,R43,R44 = 10kΩ
R11,R14 = 1kΩ
R12,R15 = 1Ω, 1W
R13,R16 = 56kΩ
R42 = 220Ω
R45,R46,R47 = 560Ω
R48 = 8-way resistor array 47kΩ
R49 = 1kΩ5

Capacitors:
C1,C2,C60,C61,C65 = 100nF, 5mm lead pitch
C3,C4,C5 = 3300µF 50V radial
C22,C25,C26,C29 = 100nF, 2.5mm lead pitch
C23,C27 = 820pF, 2.5mm lead pitch
C24,C28 = 820pF, 5mm lead pitch
C63,C64 = 15pF

Semiconductors:
B1,B2 = GBU6B
D12 = LED, red, 3 mm dia.
IC1 = 7805
IC2 = GAL 16R8 (programmed, order code **010024-31**)
IC3,IC4 = PBL3717A
IC13 = PIC16C64-20P (programmed, order code **010024-41**)
IC14 = 74HC165

Miscellaneous:
K1,K2 = 2-way PCB terminal block, lead pitch 5mm
K11,K12 = 2-way pinheader, 0.1in. lead pitch
K21 = 25-way sub-D plug, angled pins, PCB mount
F1,F2 = fuse, 2A (T) time lag with PCB mount holder and cap
BU1-BU4,BO1-BO4,JP1 = 2-way SIL pinheader
JP2 = jumper
X1 = 20MHz quartz crystal
PCB, order code **010024-1**, see Readers Services or www.elektor-electronics.co.uk

COMPONENT LIST

(external components)

1 mains transformer for 2 drill arms: toroidal 2 x 12V 80VA
T9,T10,T11 = SFH309-F4 or LTR4206E
IR-LED: TSIP4400
Stepper motors type KH2JM2-851

COMPONENTS LIST

(for Tool Arm #1, replicate for other arms)

Resistors:
R8,R10 = 100Ω
R17,R20 = 1kΩ
R18,R21 = 1Ω, 1W
R19,R22 = 56kΩ

Capacitors:
C16,C20 = 100nF, 5mm lead pitch
C30,C33,C34,C37 = 100n, 2.5mm lead pitch
C17,C21 = 220nF, 5mm lead pitch
C31,C35 = 820pF, 2.5mm lead pitch
C32,C36 = 820pF, 5mm lead pitch

Semiconductors:
D6,D8 = BUV27-200
T6,T8 = BUZ11
IC5,IC6 = PBL3717A

Miscellaneous:
K8,K10 = 2-way pinheader, lead pitch 3.96mm
K13,K14 = 2-way pinheader, lead pitch 2.54mm