

Profiler

Construction kit for a general-purpose milling machine

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Have you always dreamed of having your own milling machine but found them just too expensive? If so, we have the perfect solution for you. Working in close collaboration with the Belgian manufacturer Colinbus, we have put together a construction kit for our readers that enables you to build a professional milling machine for a fraction of the cost of a ready-made model. This machine is suitable for a wide variety of jobs, ranging from making parts for models to milling circuit boards.

As an electronic hobbyist or professional, you have to work with more than just pure electronics, and you often have to deal with a lot of mechanical tasks. This includes jobs such as making printed circuit boards, routing wiring, and fashioning a suitable enclosure with a corresponding front panel. Some of these jobs require suitable tools if you want to achieve good results – at least if you want to do it all yourself.

Many hobbyists, as well as designers of prototypes and small development labs, would certainly be able to make good use of a small milling ma-

chine for this sort of work. Investing in such a machine may be affordable for commercial use, but the situation is a bit different for home use. A good, accurate milling machine can easily cost several thousand euros, and even then you only have a basic model without all the bells and whistles (such as vacuum swarf removal and a high-speed spindle motor).

We launched this project especially for all electronics hobbyists and professionals who regularly pursue their job and/or hobby at home. The idea for this construction project arose spontaneously during a conversation with Frank Jacobs of the Belgian

company Colinbus, which specialises in milling machines. When you talk with someone who not only sells milling machines but also designs them from the ground up, the conversation quickly turns to the fact that most electronics types have splendid ideas about all the nice things they could do with such a machine, but the price is an obstacle in most cases. Frank Jacobs understood this immediately (he has been an avid reader of *Elektor Electronics* for many years), and he suggested offering a construction kit at a special price for a limited time, exclusively for readers of *Elektor Electronics*.





'Profiler' technical specifications

Dimensions	453 (w) x 583 (d) x 468 (h) mm
Max. working area	300 (X) x 400 (Y) x 100 (Z) mm
Interface	Serial
Power	240 V, 50–60 Hz
X/Y/Z linear transport	MultiStab guideways
X/Y/Z drive	Stepper motors
Positioning speed	60 mm/s
Mechanical resolution	0.0075 mm
Software resolution	0.025 mm
Software	Colinbus User Interface Conversion program for Gerber and Excellon files

racy, and a generous working area of 30 x 40 cm — now that's something you can sink your teeth into! This machine is suitable for all sorts of jobs, such as dispensing, potting, camera inspection, boring holes in boxes, milling front panels, and even

Design

The 'Elektor Profiler', as we have christened the machine, is the smallest milling machine produced by Colinbus. Its construction is largely the same as the commercial CBR-40 model (see www.colinbus.com).

The machine is made from steel and aluminium parts. This combination of materials provides sufficient weight and stability to withstand the motion of the machine, while the accuracy of the guideways and the speed of travel are very high thanks to the use of aluminium extrusions.

The MultiStab system, which uses three rollers per edge travelling along precision steel rods pressed into aluminium extrusions, provides good mechanical guidance with minimum play. This design is used for all three axes. One roller of each set of three for each guideway assembly can be manually positioned to adjust the amount of play as necessary. Each of the three axes is driven by a spindle with a special zero-backlash nut.

The milling machine is controlled by a built-in processor board fitted with a Renesas H8/3003 and a driver board fitted with three ST L6208 ICs, which look after driving the three stepper motors. This approach makes the timing independent of the connected PC. The computer simply sends commands and coordinates to the processor board, which processes and executes the commands independently.

The processing power of the built-in microcontroller is not sufficient to drive all three stepper motors at the

3D

modelling (using separate software). You can also mill circuit boards with this machine, although the manufacturer explicitly wishes to state that this model is not designed primarily for this purpose, since it requires even higher accuracy. However, based on our experience it yields excellent results for average PCBs, and the necessary software is included.

Assembly of the machine is quite straightforward, and the clearly written instructions practically exclude any problems. The accompanying circuit boards with the drive electronics are fully assembled and tested, so all you have to do is install and connect them.

Naturally, we must admit that the kit is not exactly inexpensive at £ 1099 or € 1599 plus shipping costs, but this still represents a savings of nearly £ 1400 relative to a comparable ready-assembled model. That's an attractive reward for a day or so of assembly work.

Of course, several small milling machines are also commercially available at a lower cost, but they are all quite small and have limited features. If you look at the photos in this article, you can see that we're talking about a completely different category here. Robust construction, high accu-



Figure 1. The mechanical parts of the construction kit.

You can order the construction kit for the Profiler milling machine by filling in the Order Form on the Elektor Electronics website at www.elektor.com (click 'Milling Machine' under 'Quick Service'). The price is 1099 pounds (1599 euros) including VAT, plus shipping charges. The shipping charges depend on the country and are stated on the website Order Form.

The kit is supplied and invoiced directly and exclusively by the manufacturer, i.e. not by Elektor. There are also several optional extras available for the machine. Consult the Colinbus website for information about these options.

same time (this trick is reserved for the larger and more expensive Colinbus models), so it can only drive two at the same time. The machine can thus execute smooth motions in a two-dimensional plane. For 3D motions, it switches rapidly back and forth between two axes, which

makes it appear that all three motors move simultaneously. This has little noticeable effect in practice, since the steps resulting from the interpolation are very small. The control board in the milling machine has a serial interface, but a standard USB to RS232 adapter can

be used without any problems to operate the machine via the USB port of the PC.

The spindle motor supplied with the milling machine is a fairly basic model from Ferm, which allows you to start using the machine right away. Naturally, you can also fit other types of motors, but we should remark here that a true professional-quality spindle motor can easily cost more than the entire construction kit.

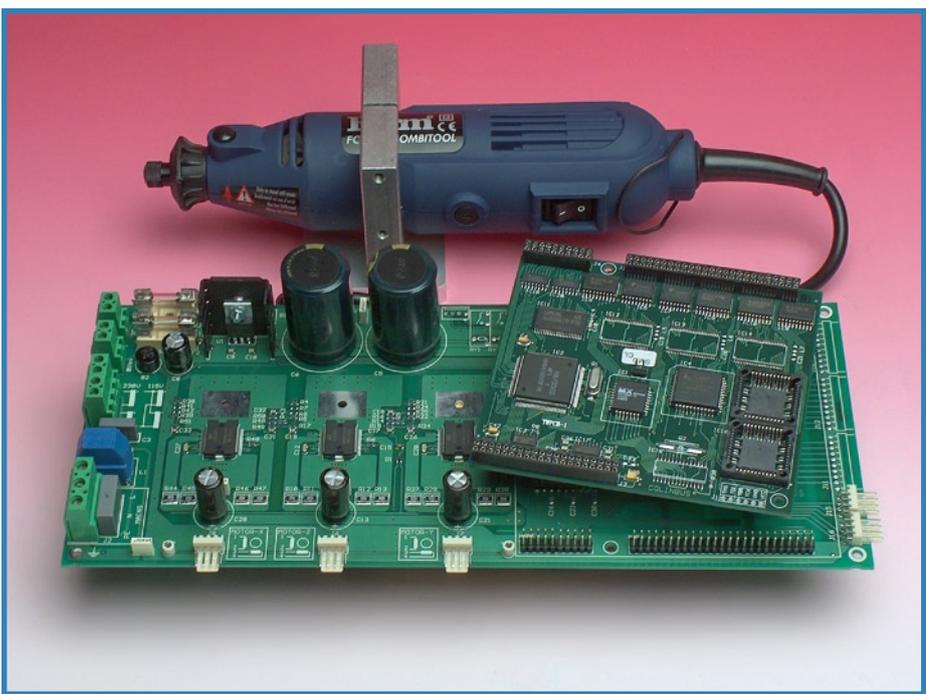


Figure 2. The assembled circuit boards and the spindle motor and bracket.

Construction kit

What do you get for the price of £1099 or €1599? The photos in **Figure 1** and **Figure 2** show almost all the parts included in the kit. They include all the mechanical parts, screws and bolts, guideway rollers, spindles, bearings, stepper motors, cables and so on, plus the drive electronics on the two pre-assembled circuit boards. The previously mentioned Ferm spindle motor (and associated bracket) is also included in the kit. A MDF panel (also included in the kit) serves as the base plate.

The companion software for the milling machine consists of two programs: a user-friendly interface for configuring and operating the machine and a conversion program for PCB layouts (see below). The kit includes assembly instruc-

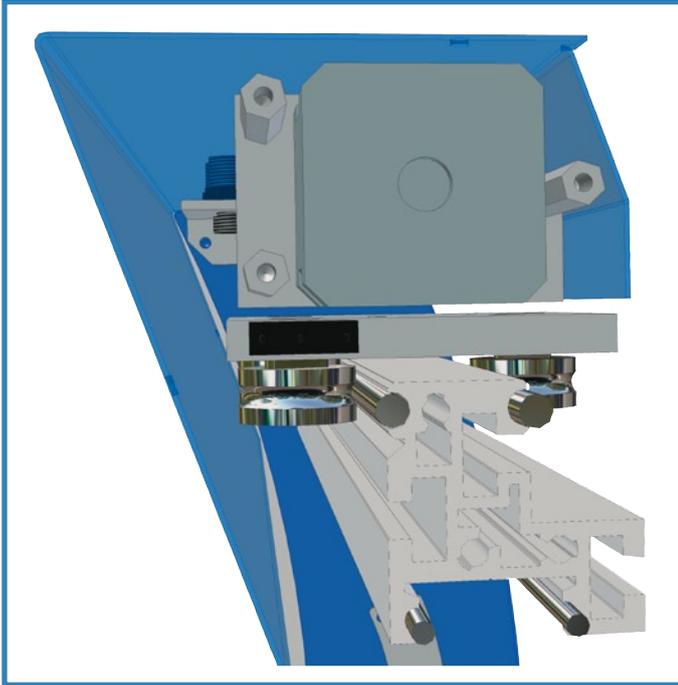


Figure 3. Cross-section drawing of the boring head mount on the bridge.

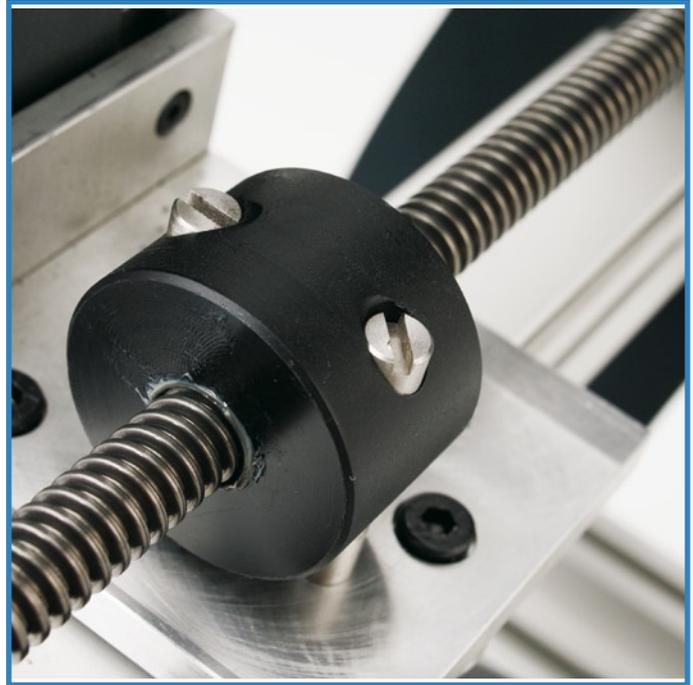


Figure 4. Detail of the plastic nut with the transverse pins, which provide a zero-play coupling.

tions that provide a step-by-step description of how to put the machine together.

There's not much that can go wrong during assembly. The various parts fit together very accurately thanks to the combination of precision holes in the steel panels and the steel rods in the aluminium extrusions, so no further alignment is necessary. You have to provide the necessary wiring for the two circuit boards for the control and drive electronics, and the connectors and transformer must be soldered in place.

All the assembly steps are clearly described in the instructions. However, we would like to clarify a few details here.

Once the machine is partially assembled, the guideways must be adjusted. The accuracy of the entire milling machine depends entirely on this adjustment. The guideways for the bridge (on the sides) have of three rollers, of which one can be adjusted using an adjustment plate. It must be adjusted so there is very little play, but it should not be made too tight, since otherwise the rollers will jam. A similar construction is also located at the top of the bridge and in the motor column, but the latter part must be partially disassembled to access the rollers.

The drives use spindles with trap-

ezoidal threads that run in special plastic nuts (see **Figure 4**). These nuts are fitted with transverse pins that provide the coupling to the bridge or the boring column. The X and Y spindles must also be carefully aligned to achieve the specified accuracy and linearity. Note that the

special plastic nuts on these spindles must be lubricated using only the special grease included with the kit. Do not use normal grease! The rest of the assembly process is adequately described by the instructions included with the kit.



Figure 5. The boring column and the guideway in the bridge.

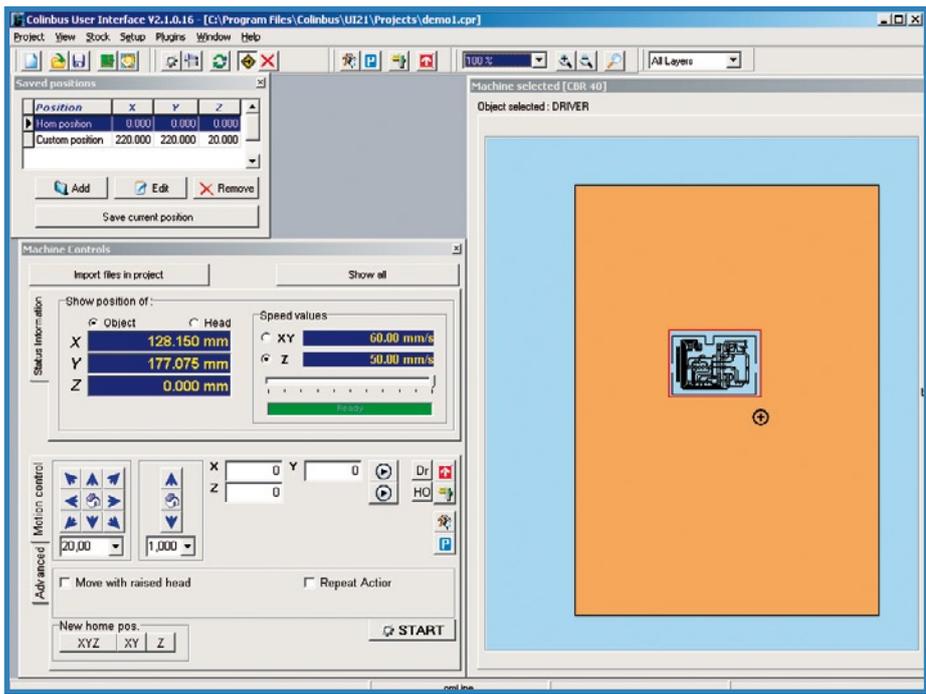


Figure 6. The user interface. The working surface of the machine is shown at the upper right.

Software

The user interface specially written for the Colinbus milling machine provides the operator interface for the machine (Figure 6). This program is designed such that even inexperienced users can work with it easily.

The screen is composed of several windows. The effective working surface of the machine is shown in the right-hand window. After loading a file, you can use the mouse to place the object to be machined in the desired location on this surface. The ma-

chine will then start working at exactly this position. You can also specify the values of all the settings and preferences for the machine. In addition, you can operate all machine axes manually using this program. Everything you can think of can be configured here, such as reading memory points, relative zero points and so on with micrometre accuracy.

The user interface includes a PCB contouring program (Figure 7), which you can use to edit and merge the Gerber and Excellon files generated by commonly used PCB programs and then convert the coordinates in these files into the contours used by the milling machine. You can manually specify the reference points to be used on the circuit board and then use them to ensure that the data in the Gerber and Excellon files are registered exactly with each other (the Gerber file contains the data for the PCB tracks, while the Excellon file contains the hole data). The file generated by the program can then be imported into the user interface program so you can see the PCB layout, which you can drag to a specific location on the working surface.

If you want to process 3D files (such as DXF files), you will need the separate RAMS3D program, which is not included in the construction kit due to the special price.

Finally, there's something for diehard DIYers: the entire command set for controlling the milling machine is freely available, so you can also write your own code.

1001 jobs

This robust, versatile milling machine opens up a world of opportunities for handy hobbyists and professionals who aren't afraid to roll up their sleeves. With it, making rectangular openings in a box is a piece of cake and a machining a slot in a front panel for a slider is no sooner said than done. What's more, this milling machine is a handy tool for things that have nothing to do with electronics. For instance, you can use it to make your own parts for a model airplane or toys for your kids (and donate your jigsaw to local charity!).

In short, there are more than enough things you can do with this machine. Once you've used it, you won't want to do without it.

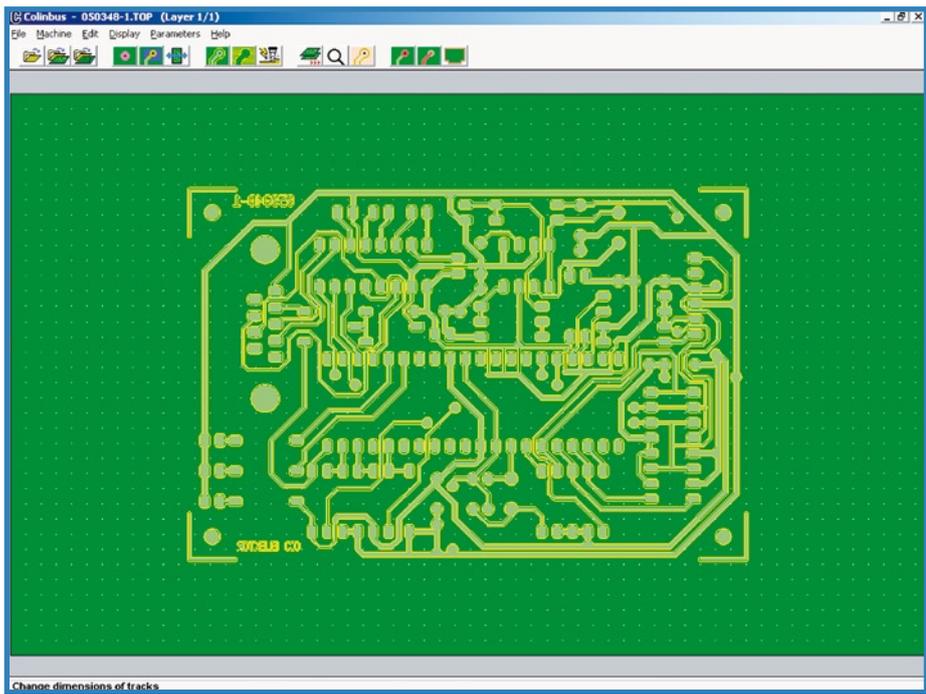


Figure 7. Gerber and Excellon files can be read in with the PCB contouring program and converted into contour data for the milling machine.

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