

# Coil body prototype in 3D printing technology

Instructions for the laboratory exercise

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## 1. Aim of the exercise

The aim of the exercise is to become familiar with 3D printing technology prototype construction elements. In the exercise, the coil body is designed using a CAD program. The designed element is made on 3D printer.

## 2. Introduction

Coils of chokes and transformers are made of wound copper wires on properly shaped bodies also called carcasses. The body is made of electrical insulating material [1]. In mass production, the bodies are made of plastic by forming molten material in dedicated forms.

Making such forms is uneconomical for prototype constructions. favorable is the use of 3D printers.

The exercise uses a Bits from Bytes printer type BFB-3000 3D Touch - fig. 2.

Fig. 1. View of the BFB-3000 3D Touch printer

The BFB-3000 3D Touch printer is a device using the FDM ( *Fused Deposition Modeling* ). This is the method of melting in the printheads material supplied by feeders and deposition of material in subsequent layers on work table. The head moves in the X and Y axes while the work table in the Z axis. The principle of operation of the device is shown in Fig. 2.

Fig. 2. The principle of 3D printer operation in the FDM technique

The thickness of the applied plastic layers is 0.025 mm. As a model material

You can use durable ABS plastic or biodegradable plastic

PLA. PLA material can also be used as a support material. Head temperature

for PLA it is 195 ° C while for ABS it is 260 ° C. **In the exercise, the model will be made of PLA.**

However, using support material requires a time-consuming application process,

e.g. PLA support material is removed by placing the model in water at a temperature 80 ° C for 48 hours. Therefore, it was assumed that in the exercise the **model is to be**

**designed like this**

**not to use support material.**

## 3. Coil body design

Any CAD program can be used to design the coil body,

which allows you to prepare spatial models and export the project in a format STL

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, e.g. commercial Autodesk Inventor, or free Google SketchUp, Free CAD or Autodesk 123D Design.

The exercise uses a free program available on the Internet - Autodesk

123D Design [2]. The advantage of this program is simple and intuitive operation and possibility

exporting the model to a file in STL format.

An example of a designed carcass is shown in Fig. 3.

† STL - common graphic format for three-dimensional models ( *STereoLithography* )

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5 m

m

40 m

m

1 mm

10 m

m

20 mm

Fig. 3. View of the designed coil body

Before starting to draw the body, you should anticipate the later way making an element on a 3D printer. According to the assumption, the prototype is to be made without the use of support material, therefore the body will be designed and made of two parts.

The first element drawn is the cylinder forming the base of the body. Solid - the roller is available under: PRIMITIVES → CYLINDER (fig. 4).

Fig. 4. Choosing a solid - a cylinder

A roller will appear on the screen, whose parameters can be set in the bottom window - fig. 5. The height should be set to 1 mm and the width to 40 mm. Mouse movement changes cylinder position.

Fig. 5. Setting the cylinder dimensions

When placing the roller, pay attention to the printing area, it is best to arrange element in the center of the visible window.

The operation should be repeated for the second part of the body. After correct execution operations, both rollers should look like the one in figure 6.

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Fig. 6. Bases of the bottom and top of the body

To change the direction of looking at the model, you can use the perspective tool located on the legal upper side of the screen - Fig. 7.

Fig. 7. The perspective tool for changing the direction of looking at the model

The next step is to place the roller on the base of the lower part of the carcass. This roller it will constitute the central part of the carcass - Fig. 7.

Fig. 7. Lower part of the body

The center of the cylinder must be removed so that the core column fits within it. choosing circle under SKETCH → CIRCLE (Fig. 8) you can mark the surface that next will be removed - Fig. 9.

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Fig. 8. Choosing a circle

Fig. 9. Drawing a circle

Then select the circle and select the function for extruding the figure under CONSTRUCT → EXTRUDE - fig. 10.

Fig. 10. Selecting the EXTRUDE function

Another option to activate the EXTRUDE function is to double-click on the area of the circle and

entering the negative length of the middle cylinder in the settings - fig. 11 and fig. 12.

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Fig. 11. Removing material from the center of the cylinder of the lower part of the coil body

Fig. 12. Removing material from the center of the cylinder of the upper part of the coil body

Both parts of the body are to be pressed together. The diameters should be chosen correctly rolls.

The result of the work is shown in Fig. 13.

Fig. 13. Ready models of coil body components

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The prepared project should be exported in STL format from the 123Design menu → Export STL. This file allows the later import of the model to AXON, which will process the file so that the printer can print the developed pattern.

#### **4. Preparation of the printer service file**

The 3D printer accepts as input data a file with the BFB extension. The BFB file is generated in the AXON 2 program dedicated to the BFB-3000 3D Touch printer. IN the AXON program sets the model orientation and determines the type of material and accuracy and method of performance.

Import the STL file to the AXON program from the STL File → OPEN menu. After after importing the file, the model view should appear - Fig. 14.

Fig. 14. Body model imported in AXON

Then enter the printer settings available in the menu: SETTINGS

BUILD → Printer Configuration - fig. 15

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Fig. 15. Editing printer settings

The BUILD command starts the process of compiling the model and creating the resulting file BFB - fig. 16.

Fig. 16. The process of compiling the model into a BFB file

After the model build is completed, additional elements will appear in the body view.

Additional thin layers are added to ensure stable positioning of elements on the table working area - fig. 17.

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Fig. 17. The process of compiling the model into a BFB file

#### **5. Body design on the BFB-3000 3D Touch printer**

The file with the BFB extension prepared in AXON should be lost to memory USB. Connect the memory to the printer - Fig. 18.

Fig. 18. Transferring the BFB file to the printer via a USB stick  
The printer is operated using a button and a touch control panel - fig 19.

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Fig. 19. 3D printer control panel

On the printer panel, select PRINT on the screen (Fig. 20a) and select the file name with the project (Fig. 20b) and)

b)

Fig. 20. Control panel: a) print command, b) model file selection

After selecting the file, the printer automatically starts the printing process. For example model, printing takes about 60 minutes.

The view of the finished body model is shown in Fig. 21 and Fig. 22.

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Fig. 21. Finished coil body

Fig. 22. Copper winding wound on the coil body

### **6. Exercise program**

1. Draw the coil body model. The dimensions of the model should be selected according to the core indicated by the teacher.

2. Prepare the BFB file for the printer.

3. Print the body.

### **7. Literature**

1. Konopiński T., Pac R. : *Transformers and chokes for electronic power devices* . WNT, Warsaw 1979.

2. Autodesk 123D Design *website* : [www.123dapp.com/design](http://www.123dapp.com/design)

3. Bits from Bytes *website* : [www.bitsfrombytes.com/](http://www.bitsfrombytes.com/)

4. MAGNETICS *website*: [www.mag-inc.com](http://www.mag-inc.com)

5. MAGNETICS: *Ferrite cores* . 2012 Catalog.

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### **8. Annex - data on MAGNETICS cup ferrite cores**