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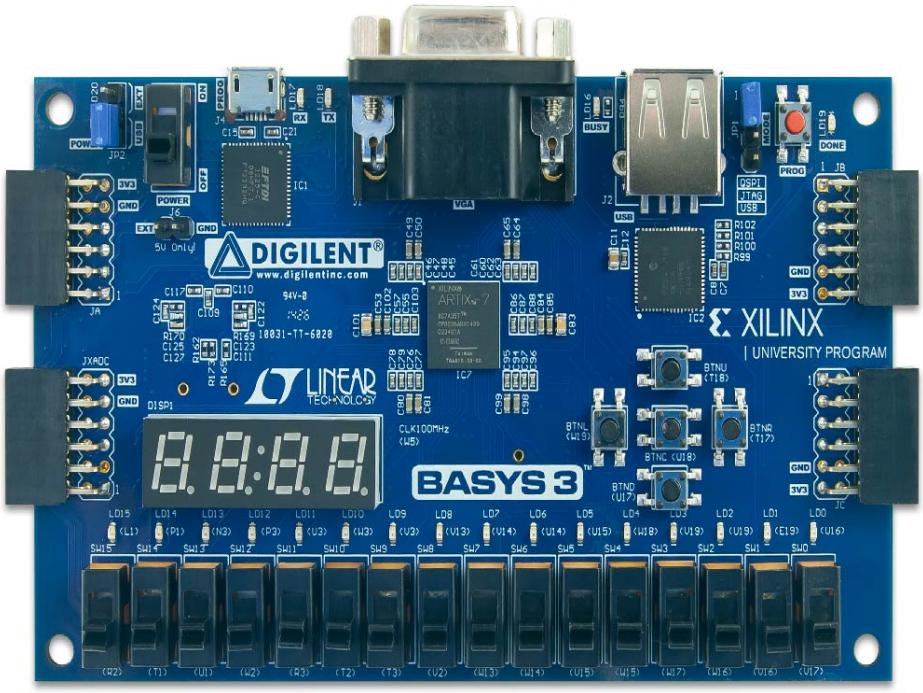
Elektronik und
Computer Engineering



MIC-1 *on XILINX Basys*3 *Board*

Team B

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V1.3

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1 General

The product is a MIC-1 processor implemented in SystemVerilog and executed on a FPGA board, with the ability to execute micro programs, swap programs and read and display the machine state and register values while running.

2 Security Aspects

User must be at least 10 years old. If the product gets damaged and individual parts become loose, there is a risk of ingestion. More safety aspects for the Basys 3 board can be found on the manufacturer's website. All safety precautions must be observed and followed. Not following safety precautions can lead to danger to life and health of individuals, environmental damage and/or property damage. In addition to the instructions in this manual, local accident prevention regulations and national occupational safety regulations apply. The operator of the machine/plant is responsible for the proper use of the machine/plant. For all damages arising from improper use, the operator alone is liable.

3 Technical Specification

3.1 Hardware

The implementation of the MIC-1 and the implementation for changing the program was designed for the Basys 3 Artix-7 FPGA Board (XC7A45T-ICPG236C). Therefore the bitstream should on be used on this board. For more information towards Hardware specification: https://digilent.com/reference/_media/reference/programmable-logic/basys-3/basys3_rm.pdf

3.1.1 Power Supplies

The Basys 3 board can receive power from the Digilent USB-JTAG port or from a 5V external power supply. Jumper JP3 (near the power switch) determines which source is used. All Basys 3 power supplies can be turned on and off by a single logic-level power switch (SW16). A power-good LED (LD20), driven by the "power good" output of the LTC3633 supply, indicates that the supplies are turned on and operating normally.

For more information look up the datasheet of the manufactor.

Supply	Circuits	Device	Current (max/typical)
3.3V	FPGA I/O, USB ports, Clocks, Flash, PMODs	IC10: LTC3633	2A/0.1 to 1.5A
1.0V	FPGA Core	IC10: LTC3633	2A/0.2 to 1.3A
1.8V	FPGA Auxiliary and Ram	IC10: LTC3621	300mA/0.05 to 0.15A

Table 3.1: Basys 3 power supplies.

3.2 Software

Xilinx Vivado 2022.2 is required to program the MIC-1. Older/Newer version are not supported by Vivado and can cause problems and errors. For interacting with the MIC-1 a Graphical user interface (GUI) is provided. The GUI enables to connect and disconnect the MIC-1 to the Computer/Laptop. As to do that a Micro-USB cable is required. The software communicates with the MIC-1 by a **baudrate** of 9600.

4 Description

4.1 Scope of application

The MIC-1 is the easiest form of a microcontroller. It is able to perform micro instructions and to execute microprogramms.

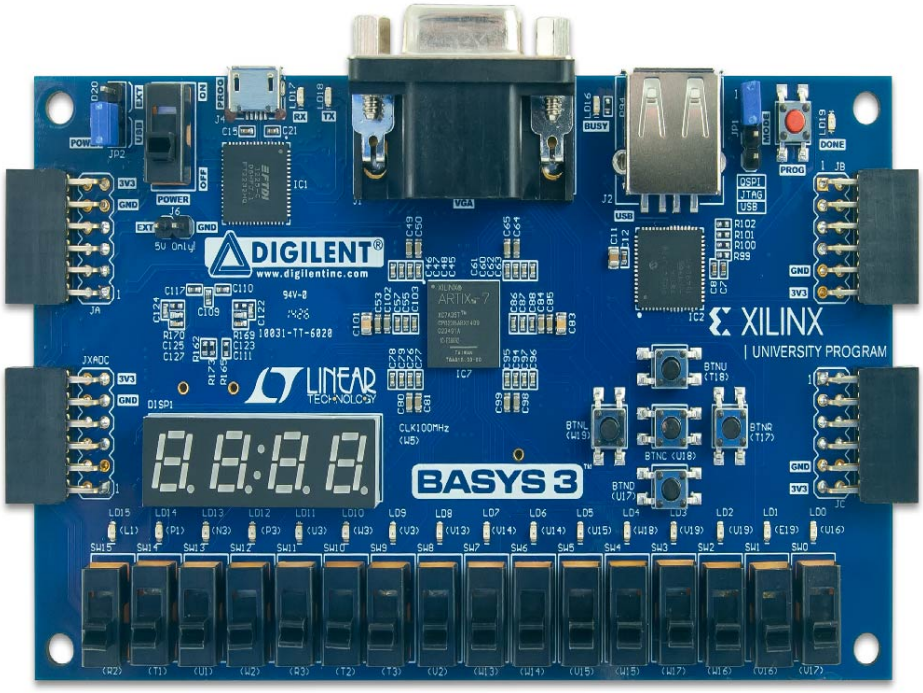

Figure 4.1: Digilent Basys3 Board

4.2 Short description

The MIC-1 microcontroller is a implementation based on the book 'Structured computer organization' by Andrew S. Tanenbaum and Todd Austin. Here you can see the necessary micro instruction format of the MIC-1.

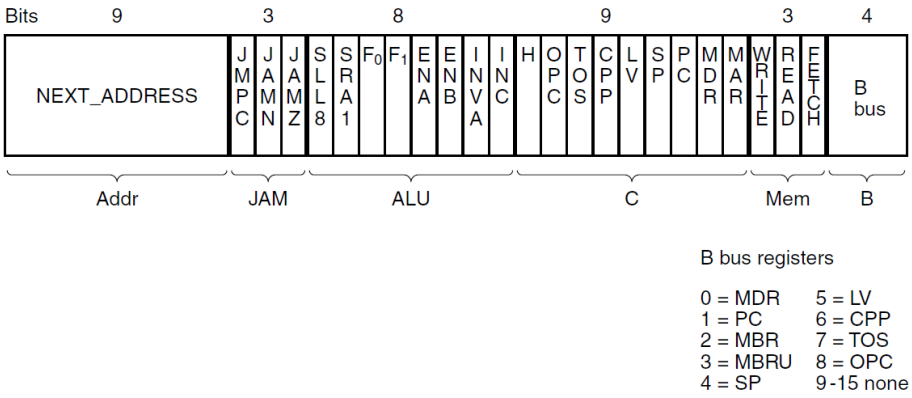

Figure 4.2: Format of the microinstructions of the MIC-1

The MIC-1 has a 512x36-Bit control storage and a Arithmetic Logic Unit to perform microinstructions.

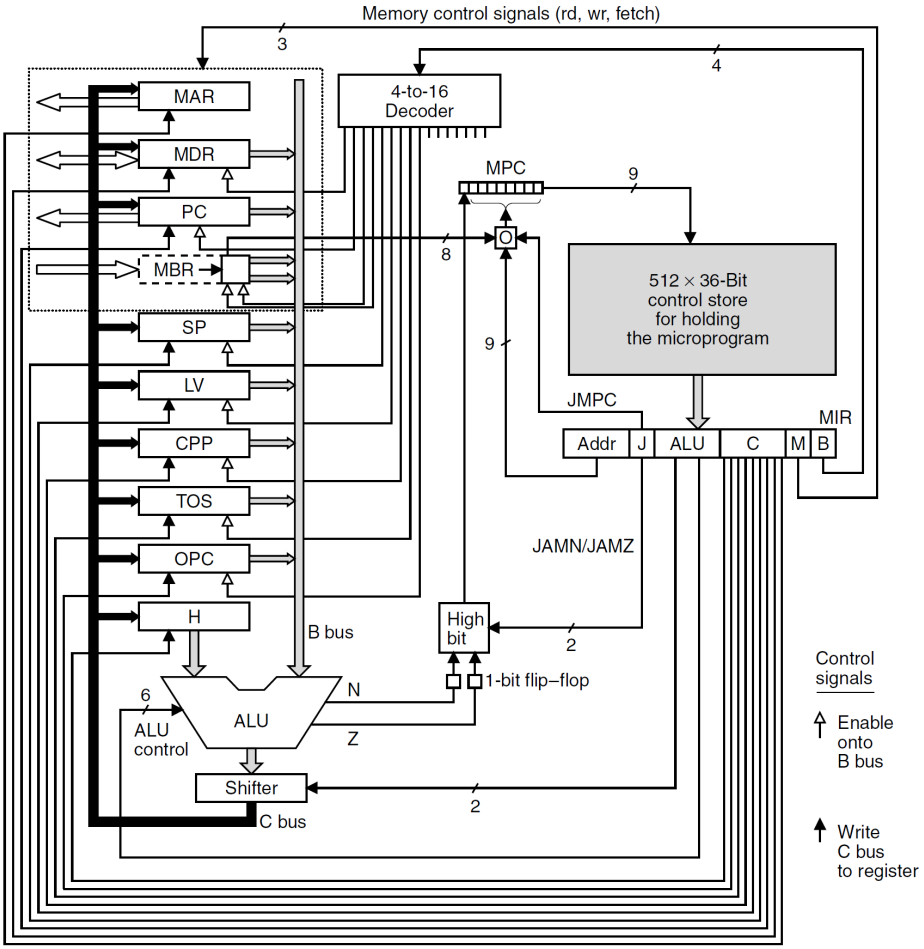

Figure 4.3: Block diagram of the complete microarchitecture of the MIC-1

In order to switch between different microprogramms the GUI can be used.

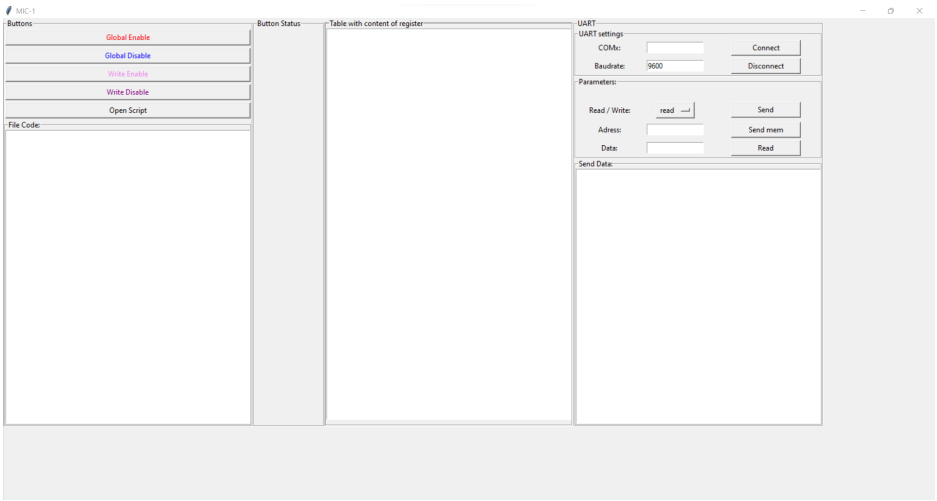

Figure 4.4: Graphical User Interface (GUI)

4.3 Delivery contents

The Delivery contents of this product are:

- Digilent Basys3 Artix-7 FPGA Board
- USB micro cable
- VGA cable
- Bitstream
- python file for the GUI

Figure 4.5: Hardware components included in the delivery (from left to right: Basys3 Board, Micro-USB-Cable, VGA-Cable

4.4 Ports

The Basys3 Board has several Ports which include a VGA connector, UART/JTAG USB port, External power connector, Pmod port(s) and Analog signal Pmod port(XADC). To power and communicate with the MIC-1 only the UART/JTAG USB port is needed. In order to display the memory on second monitor the VGA connector should be used.

4.5 Display and controls

Only the following components need to be used:

Callout	Component Description
1	Power Slider
2	VGA
3	Shared UART/ JTAG USB port
4	Switch MIC-1 / UART communication
5	Switch external / internal memory

Table 4.1: MIC-1 Control elements.

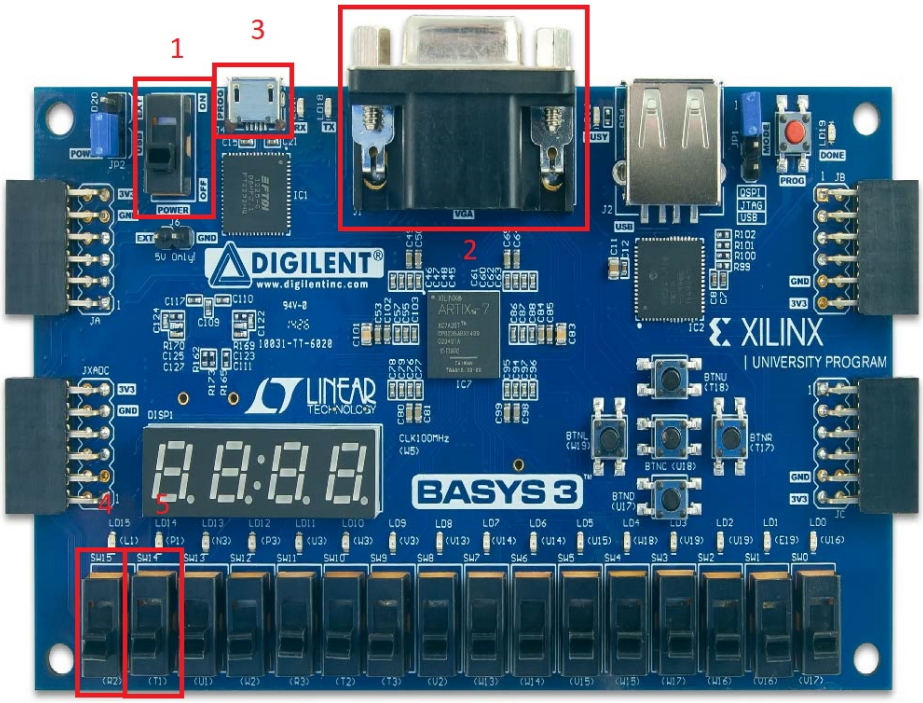

Figure 4.6: Control elements

4.6 Operating software

The operating software for the MIC-1 as well as the GUI can be downloaded at following website:
https://github.com/Electronic-and-Computer-Engineering/mic-1-hdl

5 Transport

The device shall be transported in its original packaging at all times. All connectors must be disconnected before transportation.

6 Storage

The product shall always be stored in the original packaging and the manual is advised to be kept closely and reachable at all times. The components shall be stored in a weather-protected area to avoid large temperature fluctuations and contamination. Keep small parts safe from damage and unauthorized removal by storing them in locked rooms.
storage temperatures: 0°C - 30°C.

7 Assembly

The product comes fully assembled and can be used right away. A connection to a Windows x86 machine (Windows 8 or later) has to be established via the provided Micro-USB-Cable. To visualize the output the VGA-Port has to be connected to a display with a resolution of min. 800x600 Pixels. It is recommended to only use the provided cables. The manufacturer takes no responsibility for damages if 3rd party connectors were used.

8 Startup

To startup the device it shall be connected as described in 7. After successfully connecting to a PC, open Vivado 2022.2, go to the section *PROGRAM AND DEBUG* (as shown in figure 8.1) and click on *Open Hardware Manager*. This will open a new drop-down menu, where *Open target* and further *Auto Connect* shall be selected.

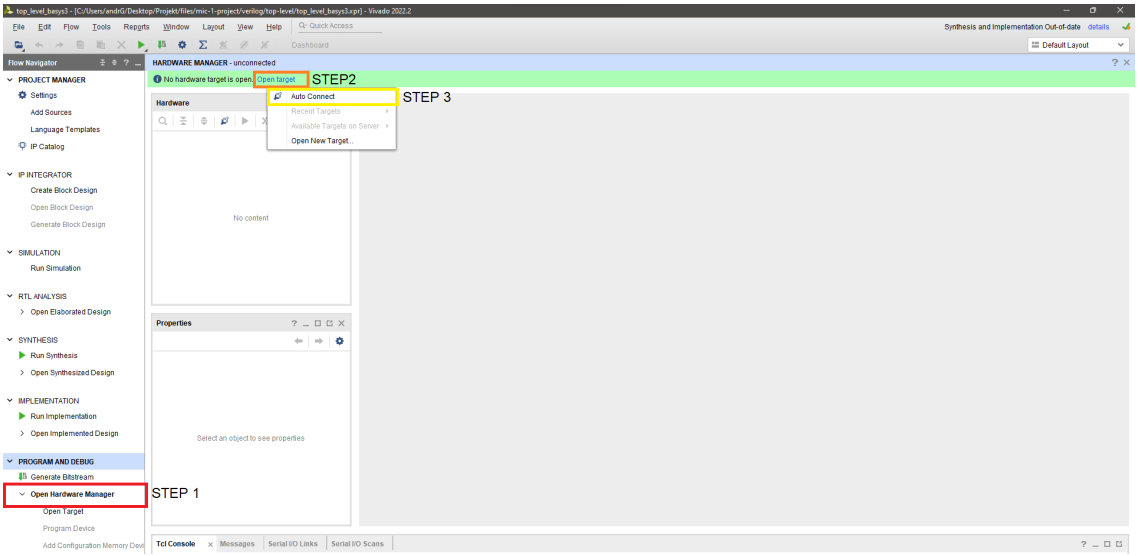

Figure 8.1: first steps to upload the Bitstream to the Basys3 Board

Now the before grayed out *Program Device* is available, which opens another drop-down menu with *xc7a35t_0* (as shown in figure 8.2).

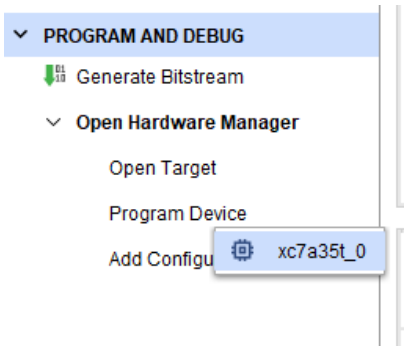

Figure 8.2: additional steps to upload the bitstream to the Basys3 Board

Eventually a window opens (as shown in figure 8.3). With right-click on *Program* the bitstream will be uploaded to the board. After the *Run Button* (BTNL W19) was pressed the Board's LEDs should illuminate as shown in figure 8.4.

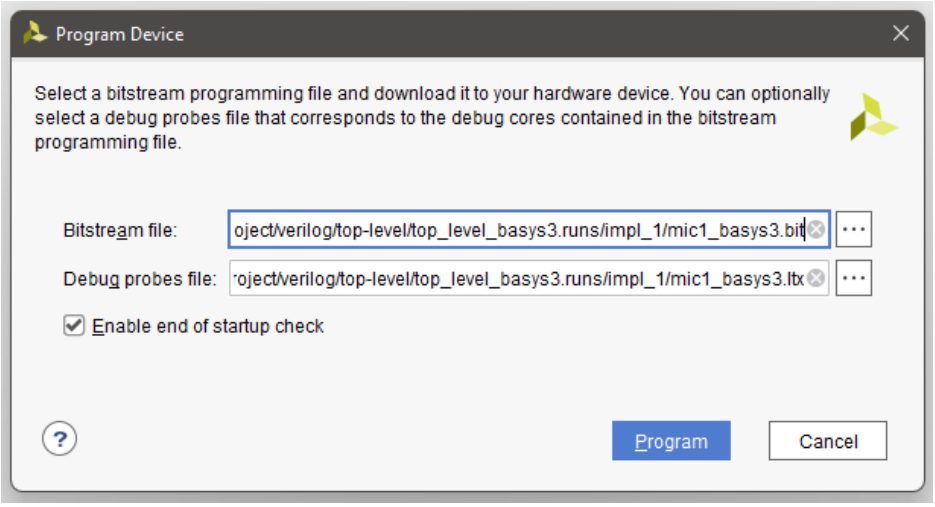

Figure 8.3: final steps to upload the bitstream to the Basys3 Board

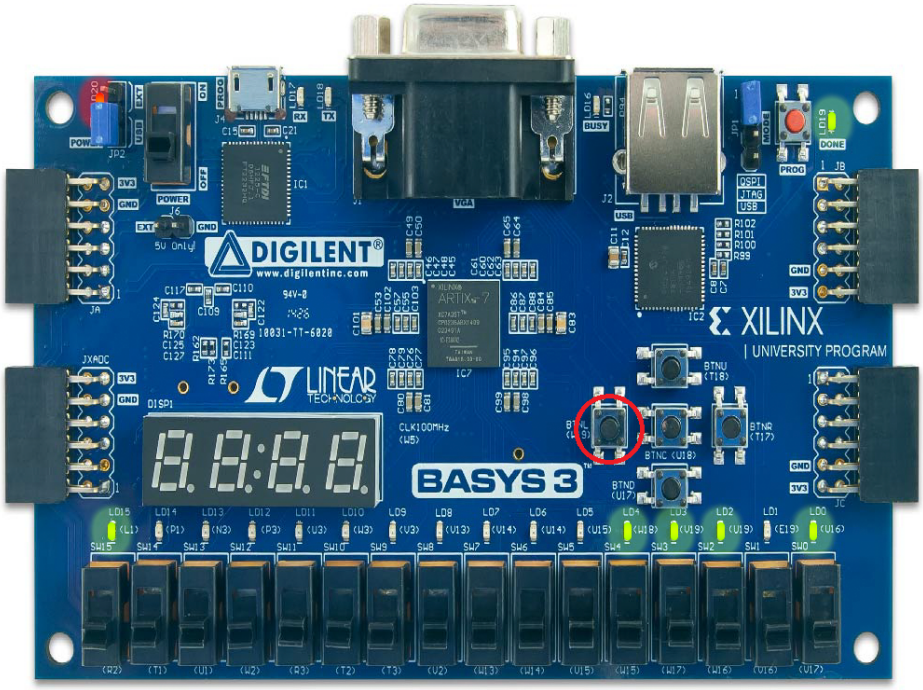

Figure 8.4: LEDs illuminated once programmed correctly

9 Operation

To operate the device, first must be distinguished, whether a communication with the Processor's Input UART Interface or the Memory's UART Interface is desired. The processor input UART Interface handles hex-values for calculations while the memory UART interface writes data to the memory, which manipulates the entire program run on the board.

For enabling the connection to the memory's UART Interface put the sliders *R2* and *T1* in following positions:

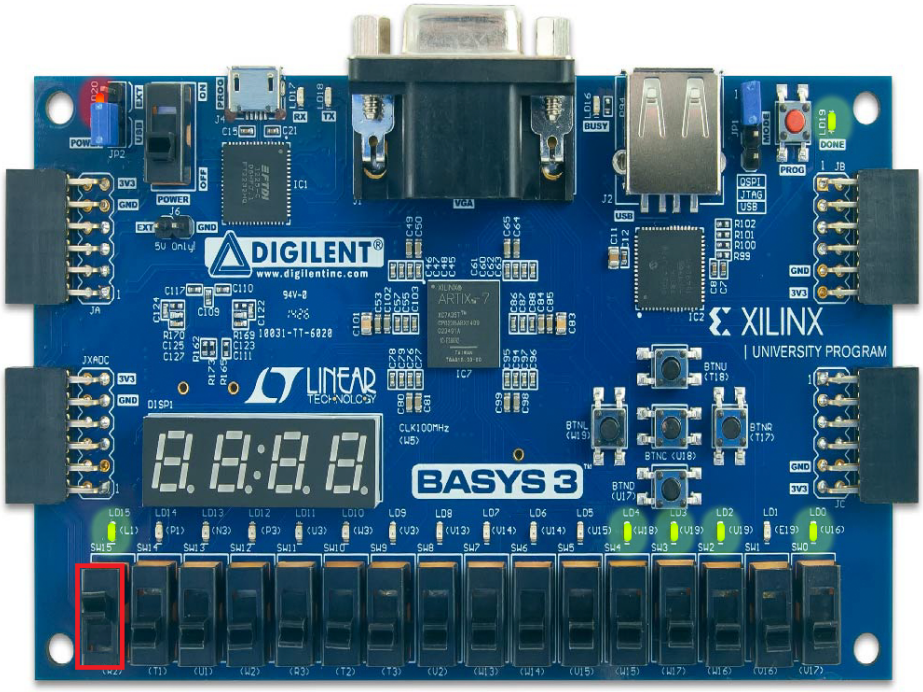

Figure 9.1: Slider R2 = HIGH, Slider T1 = LOW.

To enable the communication to the MIC processor:

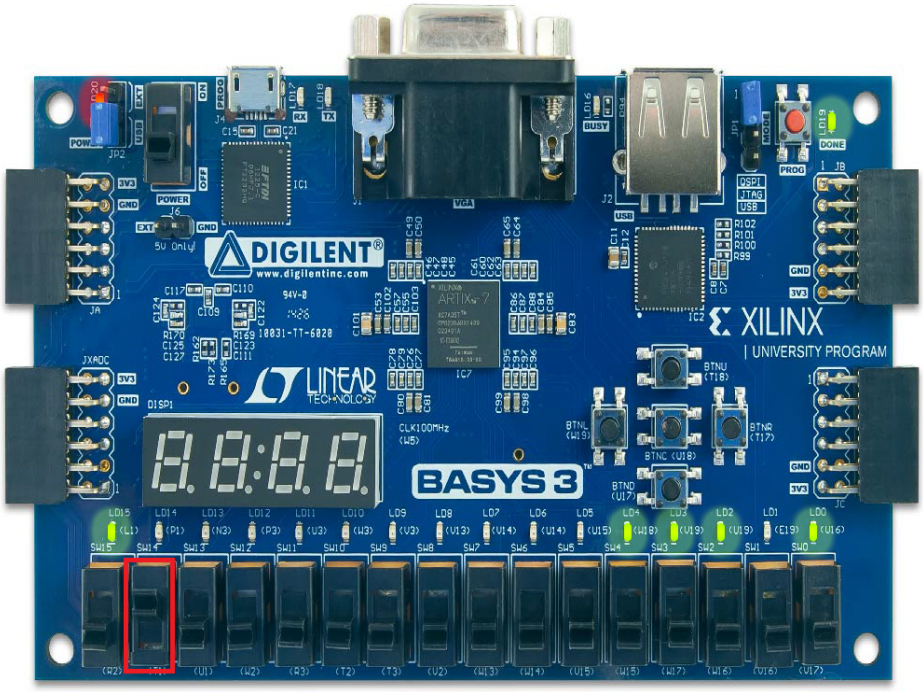

Figure 9.2: Slider R2 = LOW, Slider T1 = HIGH.

In order to swap the program of the MIC-1,a new program has to be uploaded. To open the MEM-file (which contains the program) press the button "Open Script".

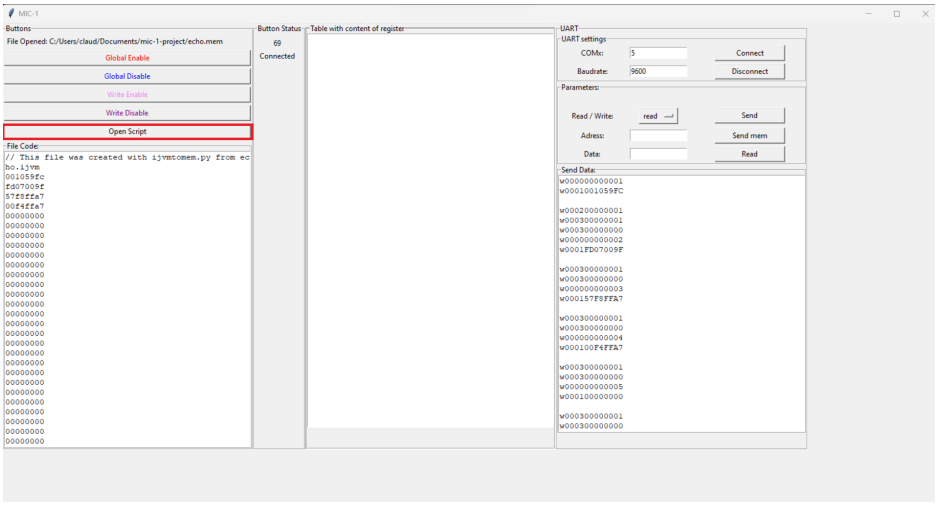

Figure 9.3: open a MEM-file

After that, a window pops up in which a file can be selected.

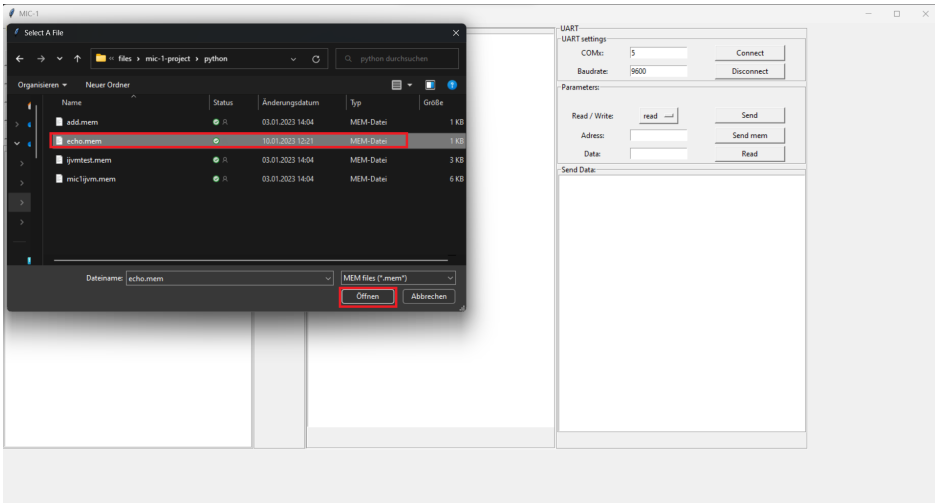

Figure 9.4: choose a MEM-file

The File path is displayed in the upper left corner of the GUI.The number of lines in the file is shown in the Button Status Table. In addition, the content of the file is displayed in the "File Code" Window.

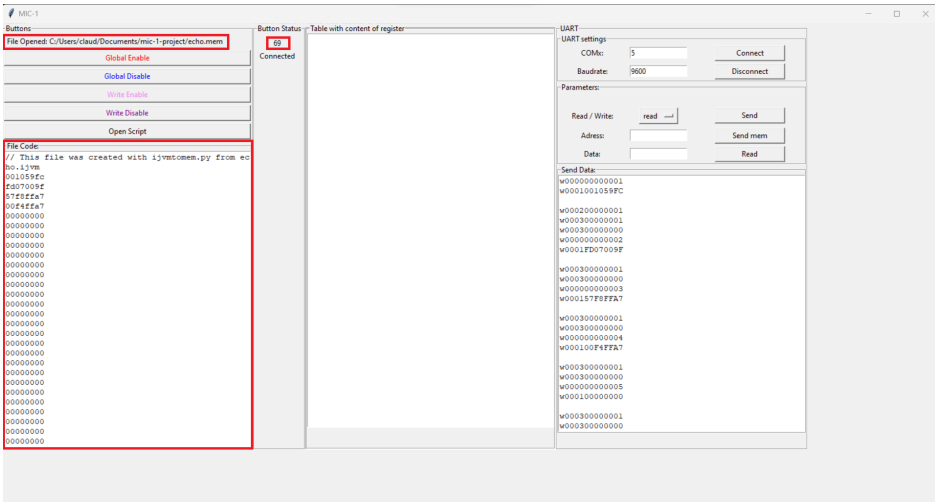

Figure 9.5: open file

Before sending the file, the MIC-1 should be connected via UART. To do that enter the COM-Port (can be found in the Device Manager) and click Connect. When the MIC-1 is successfully connected, the word Connect is displayed in the button table.

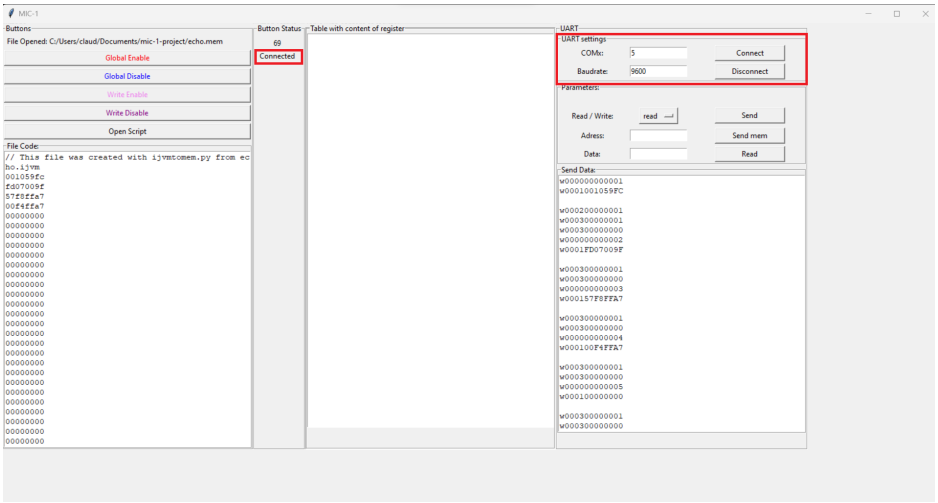

Figure 9.6: UART Setup

Now the program can be uploaded on the MIC-1. To do this, put the sliders *R2* and *T1* in the right position as shown in figure 9.1 and press the "Send mem" button. After the programming is completed, the sent commands are displayed in the "Send Data" Window.

The other buttons are irrelevant for the user.

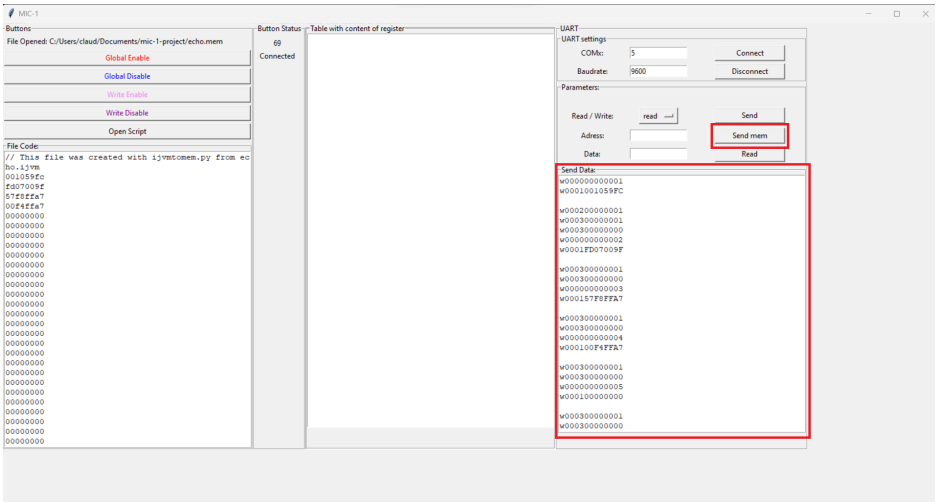

Figure 9.7: steps to send the file to the MIC-1

10 Maintenance

There is no maintenance required. The product is designed to run on Vivado 2022.2. Any updates could lead to malfunction of the device. It is strictly required to stay on named version, to guarantee its functionality.

11 Repair

The device shall be repaired by a professional only. Do not try to repair the device yourself, otherwise all claims for warranty expire.

12 Failures

If the devices is not reacting, check if the devices is connected to the PC properly.

13 Decommissioning

To decommission the product, the device has to be disconnected from the PC and all other connectors must be removed, before storing it in the original packaging.

14 Disassembly

The device itself does not need to be disassembled for storing.

15 Recycle

Do not dispose this device in a general waste bin. This device contains electrical component, which might harm the environment. Therefore follow the instructions of your local waste disposal.

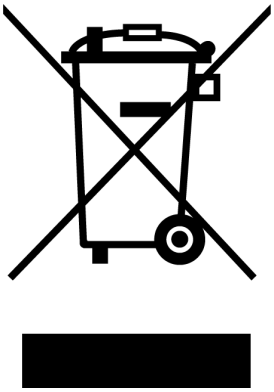

Figure 15.1: Do not dispose into general waste!

16 Revision history

Version	Task	Date
V1.0	Creating basic Structure of template, Adding description for Handling of Graphics and Coding and for the Cover Page	10.11.2022
V1.1	Adding Hyperlink function to the template, added information for Guidelines, Target Audience and short descriptions of all headings	11.11.2022
V1.2	Adding chapter "Structure of TD", added description for enumerations, lists and Teams	05.12.2022
V1.3	Adding detailed information for chapters Teams, Lifecycles and Lists	15.01.2023

Table 16.1: Overview of changes made to the document.

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