



# PLC system for producing perforated music

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## Abstract

In this application, a Mitsubishi FX3U PLC is used to collect data from a piece of music with a set sampling rate. The data is stored in the PLC data register sequentially and then used to control a punching system which perforates the notes on a plastic paper roll in the same sequence. The roll is used in musical instruments, automata, and mechanical music devices.

## Introduction

Making perforated music stayed the same for about the last 100 years until the introduction of MIDI and the modern PC. The MIDI enabled the arranger to be heard instantly instead of only the arranger knowing how it would sound in his head. Once the music is finished, perforating the master stencil is done by punching it manually. This process can be tedious and prone to mistakes. The need arises to Automate this task. Using a PLC has clear advantages. The PLC is versatile so we don't have to make any hardware changes every time a different tune needs to be recorded and perforated. Once the PLC is programmed, it works for any tune of any duration without having the need to reprogram.

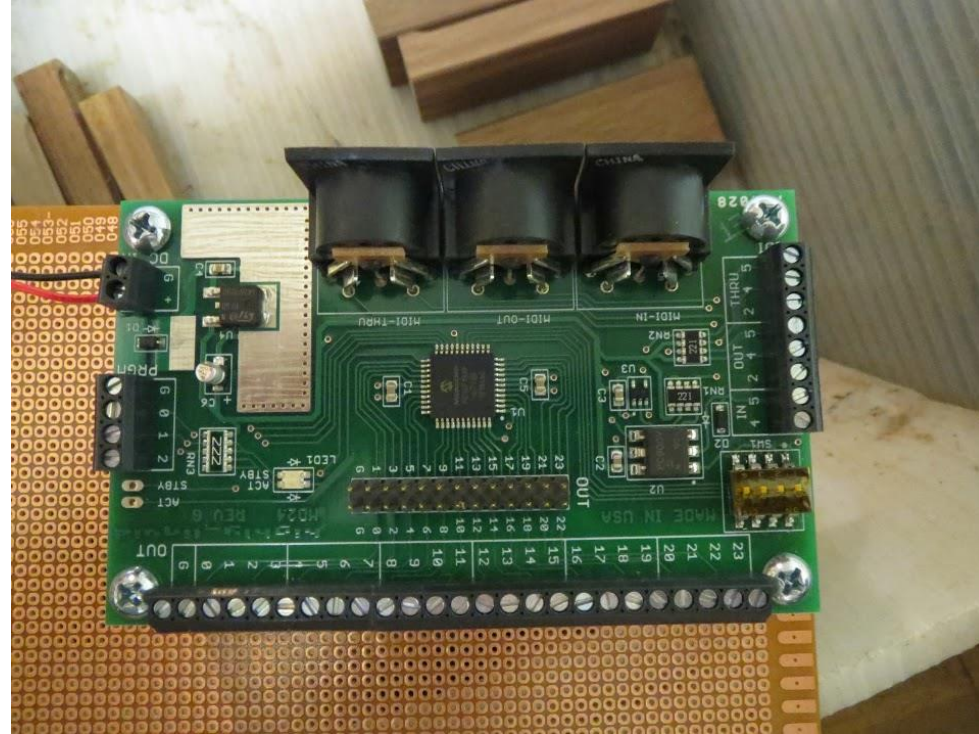


The MIDI output has 14 signals corresponding to the notes and the PLC acquires these as a word. Each sample is stored in a stack of word registers. For punching, each register is bitwise WAND with the previous register and the result is loaded to the output register which drives the punching solenoids. Once the stack ends the punching stops.

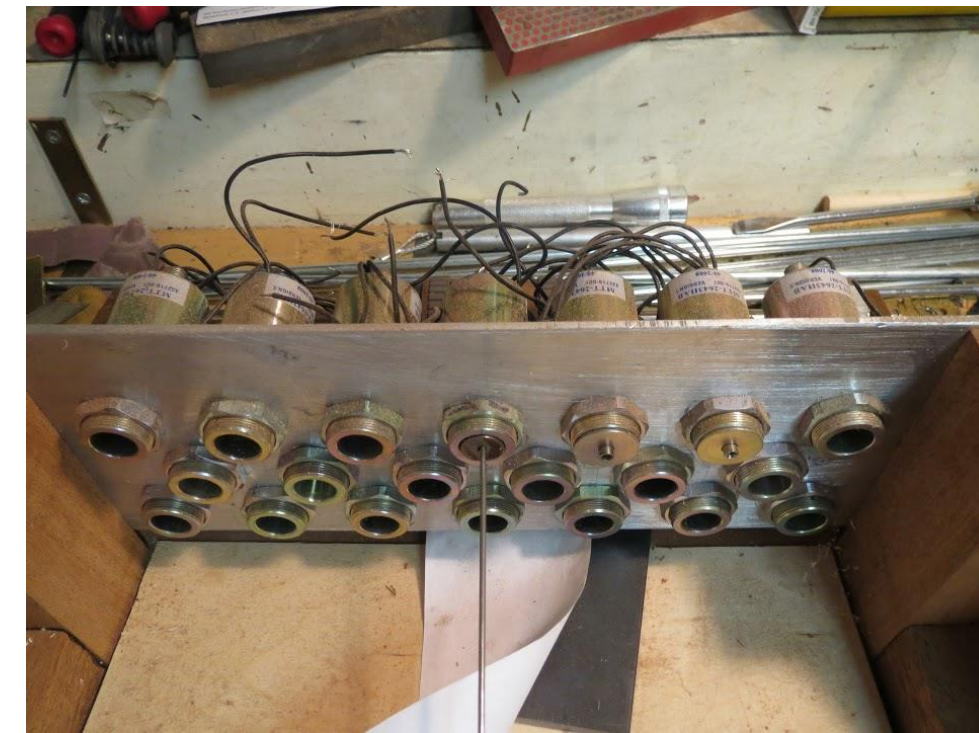
## System Components and operation

Mitsubishi FX3U PLC - The brains of the operation. Fully programmed, it will automate the entire operation.

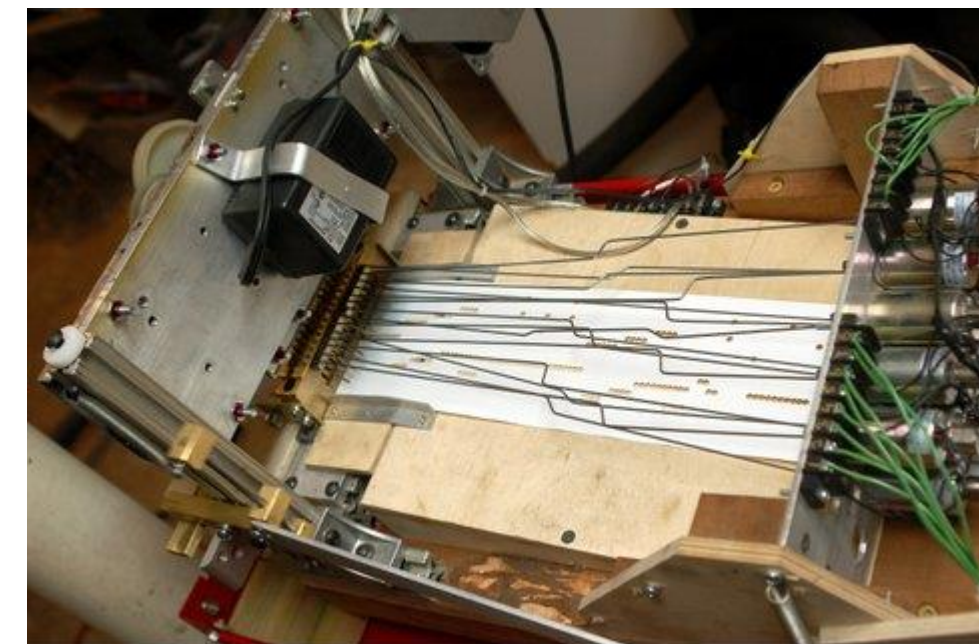
The MIDI module - Provides the signals to the PLC input module. There are 14 signals in total.



Solenoid module – Receives the outputs from the PLC and drives the punches. Each signal drives the corresponding punch.

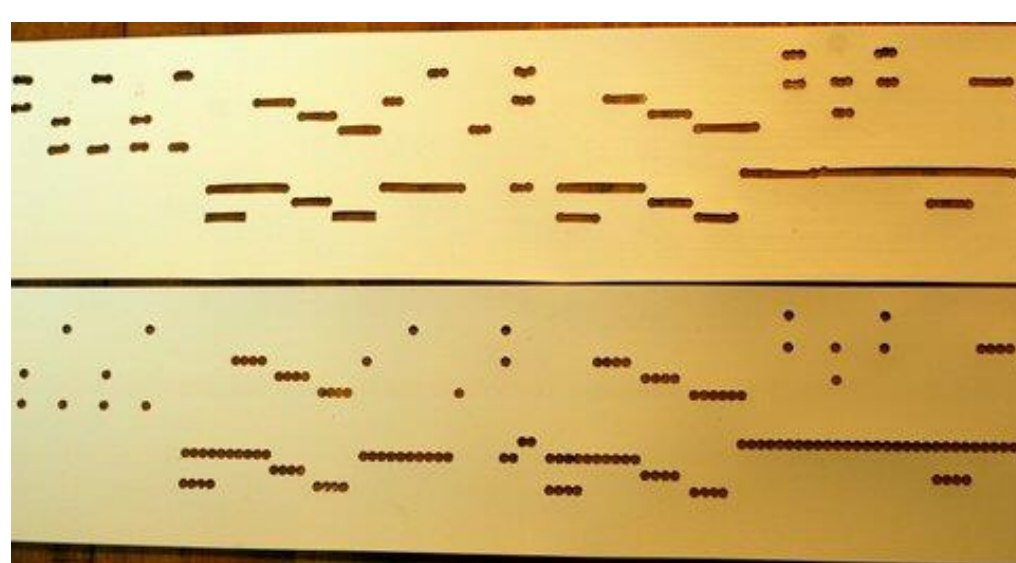


Assembly with punchers – Green wires from the PLC output drive the solenoids which punch the paper roll. A motor drives the paper forward for the next step of punching.



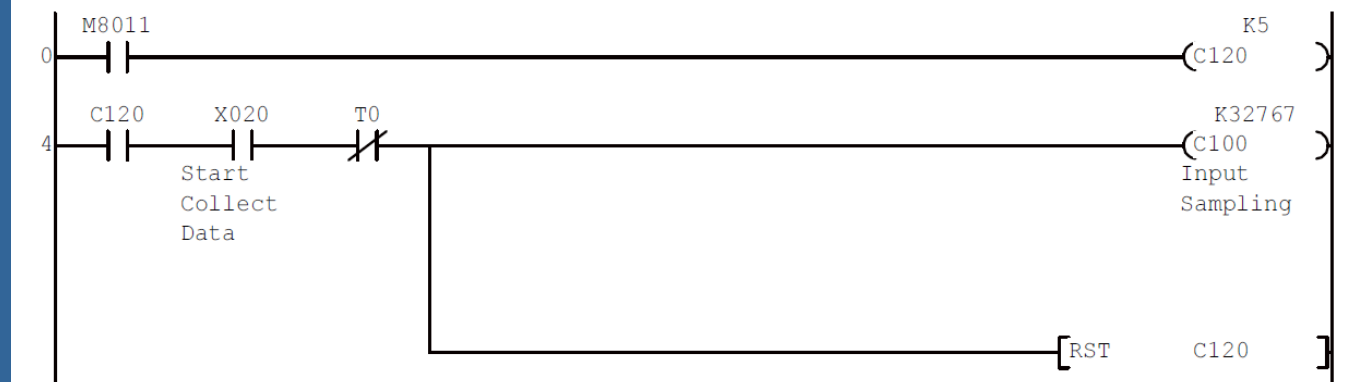
## Conclusion

The system is highly reliable and repeatable. The punching is compared below with a sample. The upper sample is produced by a professional firm and the bottom one is produced by the PLC. It can be seen clearly that the PLC is more accurate and precise in the punching as a result of the high sampling rate

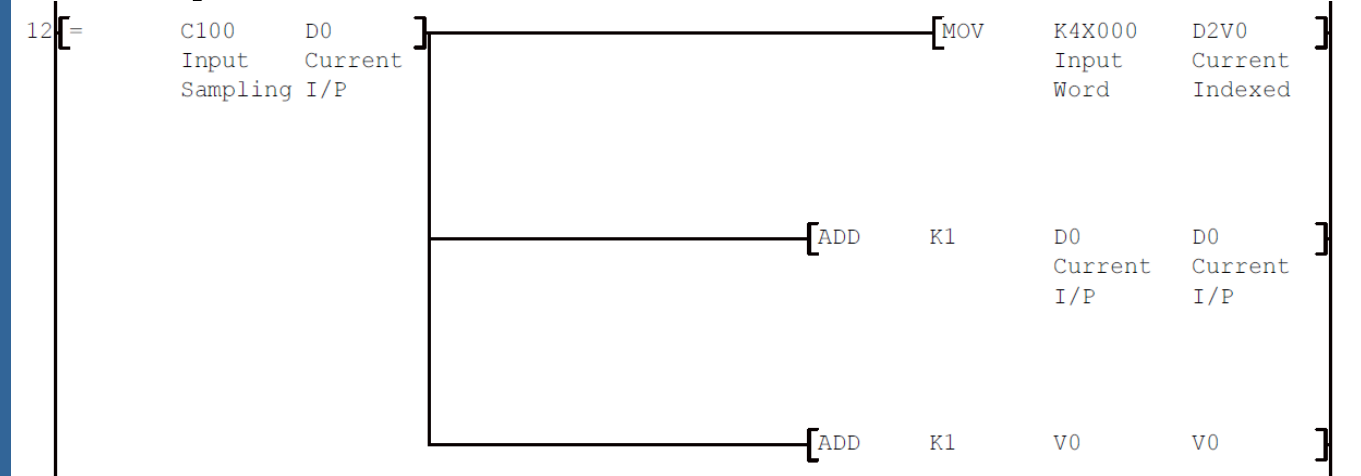


## Programming

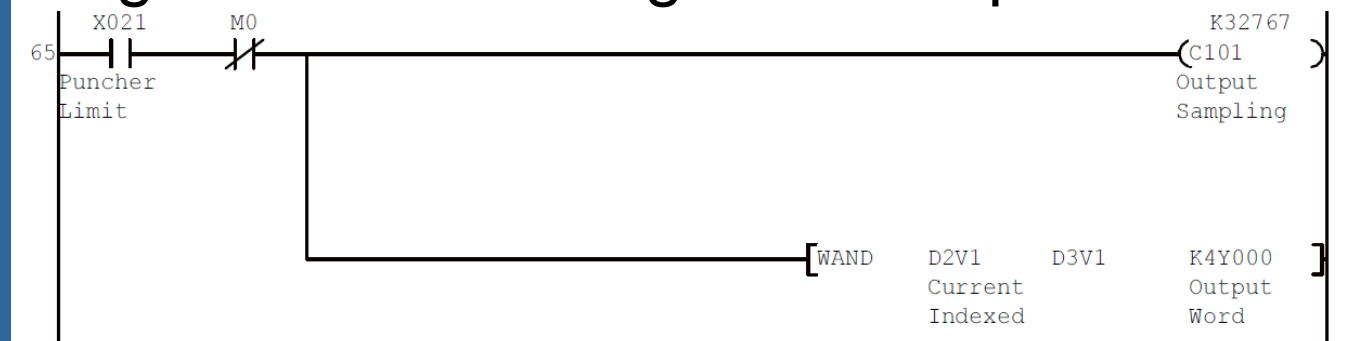
The sampling is done every 50ms, generated by a 10ms pulse counted 5 times. Data acquisition is activated by the input X020.



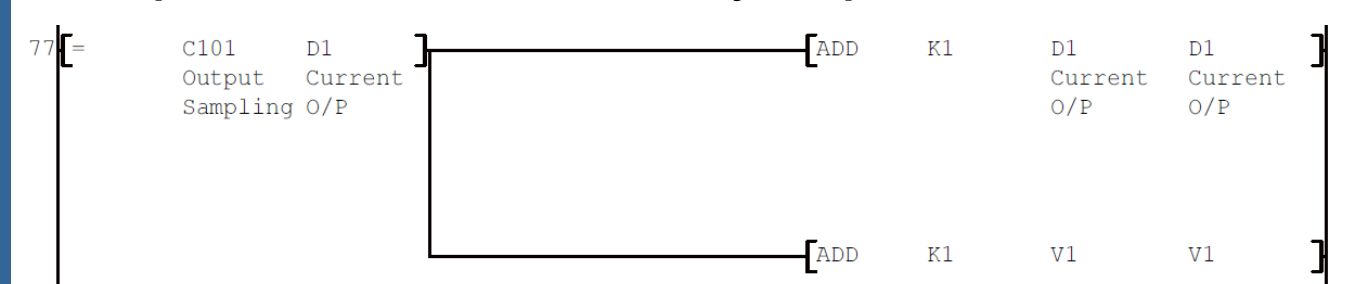
The data is stored in word registers Sequentially, using a stack pointed by D0. The stack pointer is incremented every 50ms.



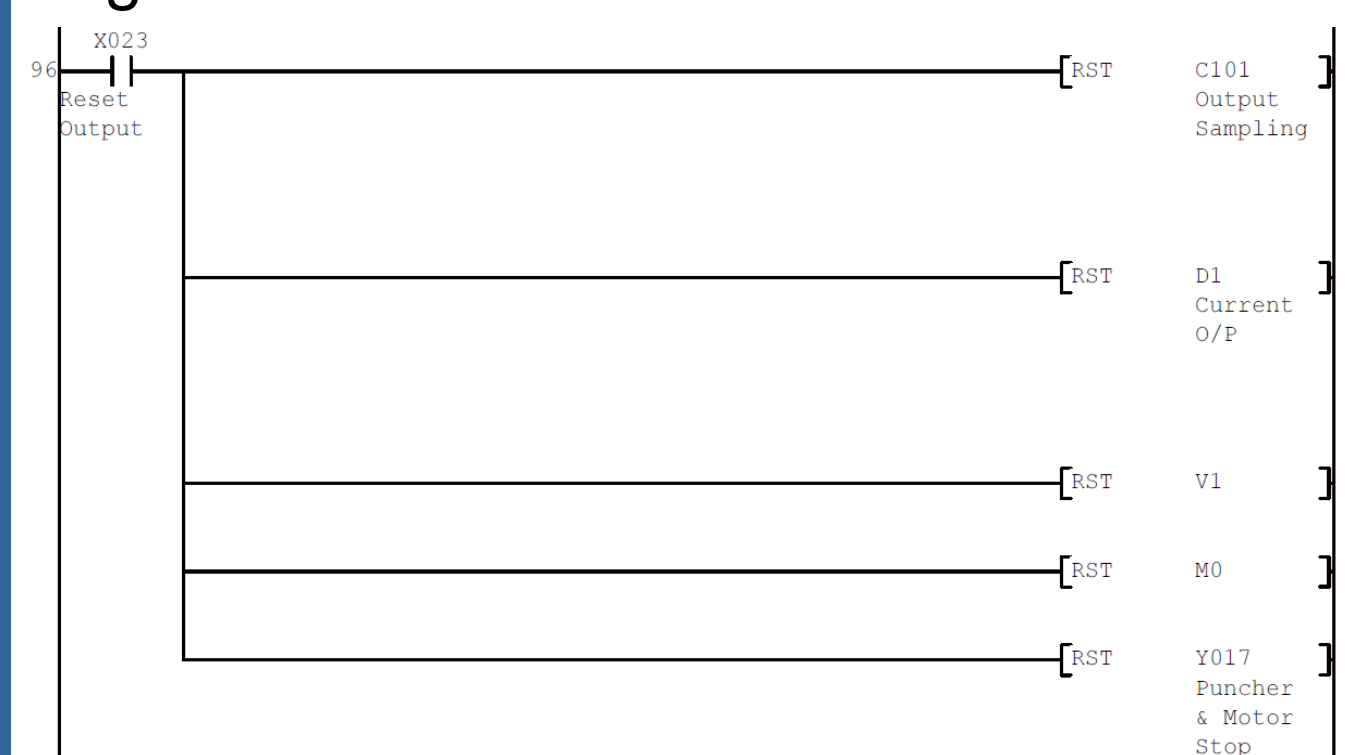
Once the data is stored inside the PLC, the perforation of the paper can be done by activating the limit switch of the punching machine. The outputs are driven by word AND two consecutive registers and storing in the output word.



After every word AND operation, the sequence is tracked by a pointer D1.



The sequence finishes and the punching and motor are stopped using the reset signal from X023.



## References

- Programming manual for Mitsubishi PLC Anatoly Zaya-Ruzo Street Organ <http://www.zayaruzostreetorgan.com/> Automata by Anatoly Zaya-Ruzo <http://www.automatadolls.com/inside.htm> Teanola Mechanical Music <http://www.teanola.com/> Melvyn Wright Mechanical Music <http://www.melright.com/music>