# Converting MIDI files to electrical outputs to control a xylophone

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## Aim of the Project

The aim of this is to improve the music playing capabilities of a pneumatically controlled xylophone.

## MIDI Files

| Note | -1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 0 | 12 | 24 | 36 | 48 | 60 | 72 | 84 | 96 | 108 | 120 |
| C# | 1 | 13 | 25 | 37 | 49 | 61 | 73 | 85 | 97 | 109 | 121 |
| D | 2 | 14 | 26 | 38 | 50 | 62 | 74 | 86 | 98 | 110 | 122 |
| D# | 3 | 15 | 27 | 39 | 51 | 63 | 75 | 87 | 99 | 111 | 123 |
| E | 4 | 16 | 28 | 40 | 52 | 64 | 76 | 88 | 100 | 112 | 124 |
| F | 5 | 17 | 29 | 41 | 53 | 65 | 77 | 89 | 101 | 113 | 125 |
| F# | 6 | 18 | 30 | 42 | 54 | 66 | 78 | 90 | 102 | 114 | 126 |
| G | 7 | 19 | 31 | 43 | 55 | 67 | 79 | 91 | 103 | 115 | 127 |
| G# | 8 | 20 | 32 | 44 | 56 | 68 | 80 | 92 | 104 | 116 | |
| A | 9 | 21 | 33 | 45 | 57 | 69 | 81 | 93 | 105 | 117 | |
| A# | 10 | 22 | 34 | 46 | 58 | 70 | 82 | 94 | 106 | 118 | |
| B | 11 | 23 | 35 | 47 | 59 | 71 | 83 | 95 | 107 | 119 | |

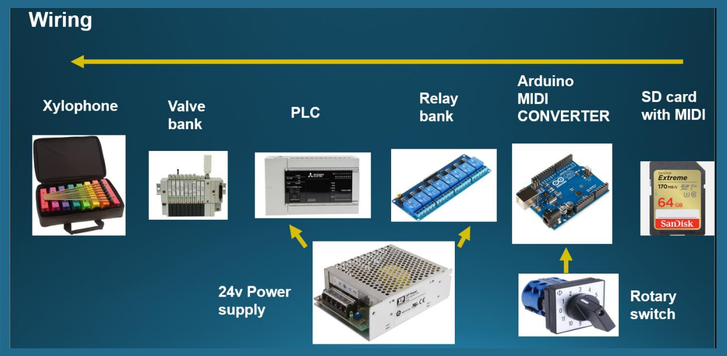
MIDI is a music standard language. It is used for instruments to communicate with each other. MIDI files consist of numbers, each number represents a different note

## Arduino & Code

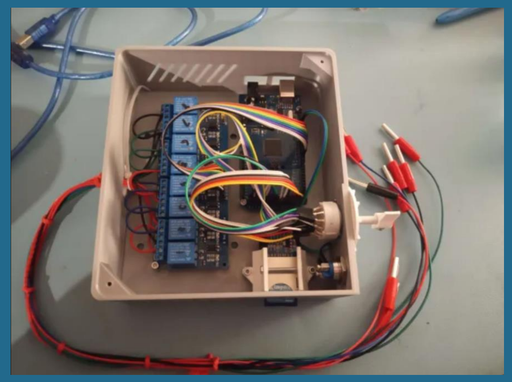
```
//MIDI pitch values for each "note"
int Aa [ ] = {0, 1, 12, 13, 24, 25, 36, 37, 48, 49, 60, 61, 72, 73, 84, 85, 96, 97, 108, 109, 120, 121}; //22 items in list
int Bb [ ] = {2, 2, 14, 14, 26, 26, 38, 38, 50, 50, 62, 62, 74, 74, 86, 86, 98, 98, 110, 110, 122, 122};
int Cc [ ] = {3, 4, 15, 16, 27, 28, 39, 40, 51, 52, 63, 64, 75, 76, 87, 88, 99, 100, 111, 112, 123, 124};
int Dd [ ] = {5, 6, 17, 18, 29, 30, 41, 42, 53, 54, 65, 66, 77, 78, 89, 90, 101, 102, 113, 114, 125, 126};
int Ee [ ] = {7, 7, 19, 19, 31, 31, 43, 43, 55, 55, 67, 67, 79, 79, 91, 91, 103, 103, 115, 115, 127, 127};
int Ff [ ] = {8,  9, 20, 21, 32, 33, 44, 45, 56, 57, 68, 69, 80, 81, 92, 93, 104, 105, 116, 117, 128, 129};
int Gg [ ] = {10, 11, 22, 23, 34, 35, 46, 47, 58, 59, 70, 71, 82, 83, 94, 95, 106, 107, 118, 119, 130, 131};

const char* songsList [ ] = {"firstmid.mid","second.mid"}; //songlist on SD card
int songNums = 1; //number of songs on SD card

//create all motor outputs (relay signals (HIGH/LOW))
const int NoteA = 2;
const int NoteB = 3;
const int NoteC = 4;
const int NoteD = 5;
const int NoteE = 6;
const int NoteF = 7;
const int NoteG = 8;
int statusLed = LED_BUILTIN;   // select the pin for the LED

int action=2; //0 =note off ; 1=note on ; 2= nada
```

The code uses an Arduino to read MIDI notes form an SD card and converts MIDI notes into electrical signals that activate relays.

## Prototyping

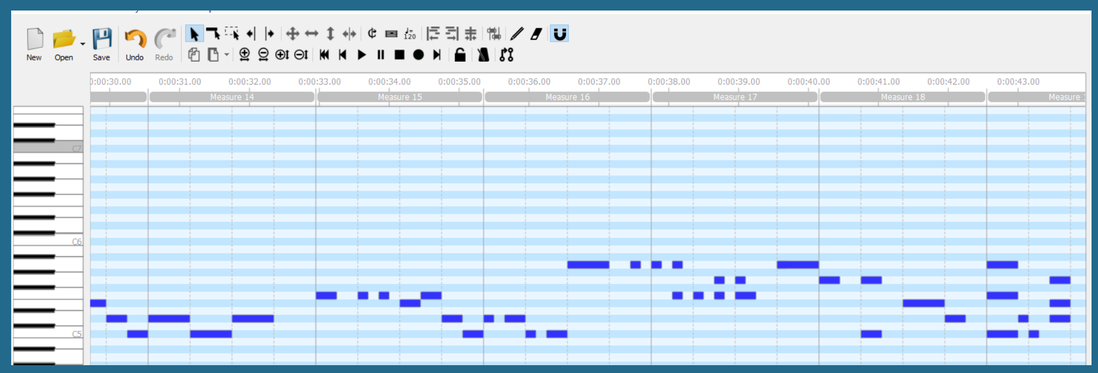



The MIDI files will be on an SD card. This will be converted to output signals that will trigger a relay. The relay signal will be read by a PLC and sent on to a valve bank. The valve bank controls air cylinders that actuate beaters that play the xylophone



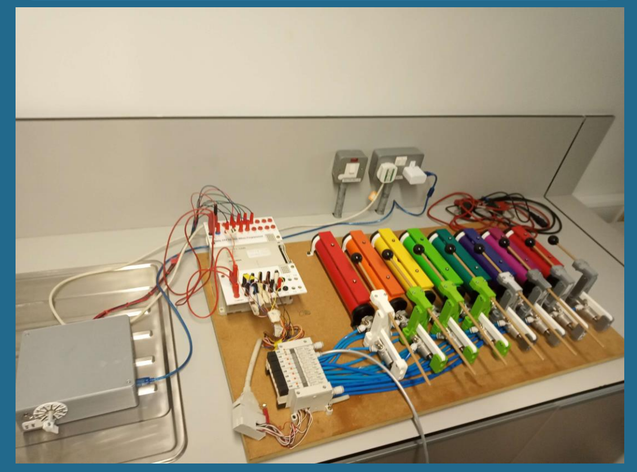

The components are plugged and soldered together. Banana connectors are attached to each relay to be able to plug into a PLC. A start/ stop button is added, and a rotary switch allows switching between 12 songs. The components are mounted to a 3D printed box

## Converting MIDI files




User made MIDI files can be found online. The file is opened using a music editing software called MIDI Editor. The instruments that correspond to the melody of the song are left and the other instruments are deleted. The spacing and tempo of the song are changed to be easier to play. Using a website called MIDI Note Restrictor the notes are compressed into the 8 note range of the xylophone. The final MIDI file is named 1-12 and uploaded to an SD card. The file is named 1-12 for the code to detect the file

## Testing



The assembled control box is plugged into the PLC of the pneumatic xylophone. First simple songs were played at 90 beats per minute (BPM). Further tests were conducted with more complex songs and the BPM was increased to 130 BPM. Different songs were uploaded and played. This was done to find what are the best sounding songs to fill up the 12-song playlist.

## Conclusions

- The best sounding songs are songs with the melody comprised of a piano or guitar.
- The max BPM is 120
- The best sounding notes are when the beater sticks stop half a cm before the note.
- The return valve on each cylinder is screwed in ¾ of the way to slow down cylinder, the xylophone is less jerky and smooth from this.