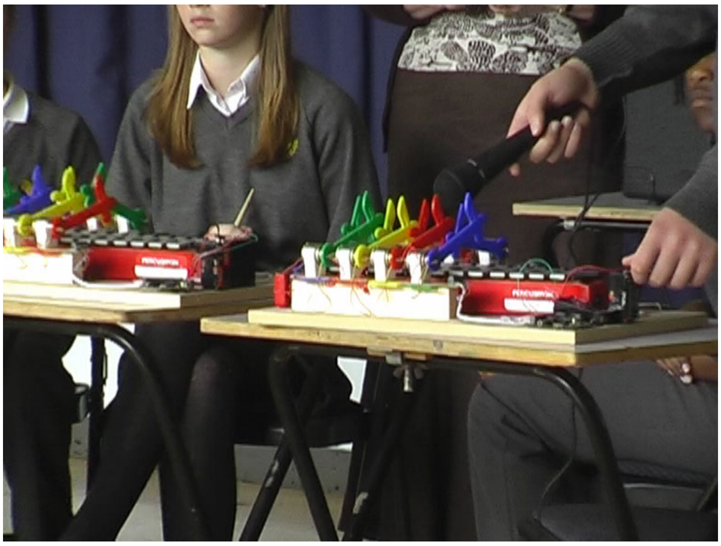
MOD028 Glockenspiel Techno-music-ology

MOD028 - Techno-music-ology Kit Contents

Motor Controller PCBs



14 220R (red red brown gold) resistors
2 330R (orange orange brown gold) resistors
16 1N4001 diodes
14 TIP31A transistors
14 220nF capacitors
4 100uF electrolytic capacitors
2 100nF capacitor
2 LED
2 4 way screw terminal block
4 8 core cable
1 10 way IDC header (grey)
1 10 way IDC header (black)
2 motor support PCB
14 motor
14 motor clip
14 laser cut hammers
14 elastic bands

Student Controller PCB

1 student controller PCB
1 10 way IDC header (grey)
1 10 way IDC header (black)
1 PICAXE-28X1 chip

Cables

1 ribbon cable assembly (grey connectors)
1 ribbon cable assembly (black connectors)

Also required (not included):

5V 2A power supply (part PWR006)
Glockenspiel (part MOD029)

Optional Extras (not included):

Additional Student Controller PCB (part AXE062)

This kit contains the electronic modules required to build the model. The MDF base etc. must be provided by the end user. These instructions are guidelines for basic assembly. Some experimentation with dimensions, elastic band tension etc. will be required, especially if using a different brand of glockenspiel.

The kit is designed for the Percussion Plus PP001 Soprano Diatonic Glockenspiel (available from Revolution as part MOD029). This is a high quality unit manufactured in the UK. We recommend this glockenspiel for best results.

Prior programming and knowledge of the PICAXE system is assumed.

Step 1 - Motor Support Boards Assembly (two required)

Assembly:

1. Solder the 7 of 220R (red red brown gold) resistors in positions R1-R7
2. Solder the 330R (orange orange brown gold) resistor in position R8.
3. Solder the 8 of 1N4001 diodes in positions D1-D8, ensuring correct polarity
4. Solder the 8 of transistors in positions Q1-Q7, ensuring correct polarity.
5. Solder the large 7 of 220nF capacitors in positions C1-C7
6. Solder the 2 of 100uF electrolytic capacitors in positions C8-C9, ensuring correct polarity.
7. Solder the 100nF capacitor in position C10.
8. Solder the LED is position L1, ensuring correct polarity.
9. Solder the 4 way screw terminal block in position CT2.
10. Solder the 10 way IDC header in position CT1. On one board use a grey colour connector, on the other use a black connector.

Motor Connector Wires:

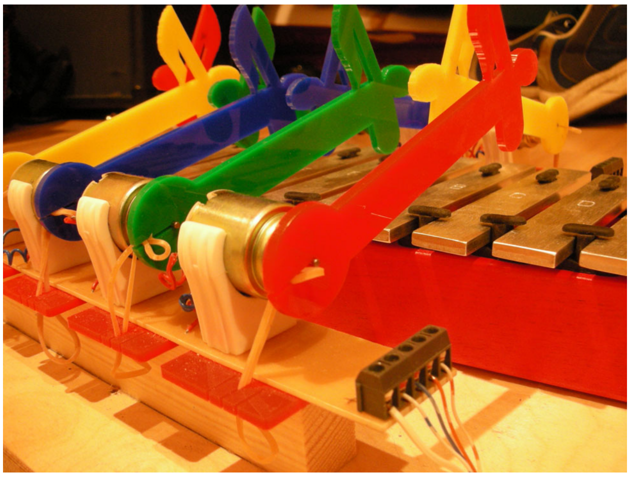
1. Using scissors carefully cut the 8 core ribbon cables into four 'pairs'. Solder one pair end to the motor positions on the motor support pcb (box beside the large capacitor).
2. At this point only solder to the PCB – not to the motor! Do not solder to the motor until the polarity (direction of rotation) of the motor contacts has been checked.

Elastic Bands:

1. The elastic bands need to be threaded down one hole and back up through the other – ensure you are doing it on the correct (outer edge) side of each board! Pass one end through the other loop and pull tight to secure on the board. The tension of the band is adjusted on the hammer connection. The tension of the bands will need periodic adjustment.
2. When correctly setup the hammer will lie horizontally about 10mm above the glockenspiel bar, and will move downwards with the slightest tap. The motor does not provide much torque, so the elastic band must be carefully adjusted for optimum performance.

Motors:

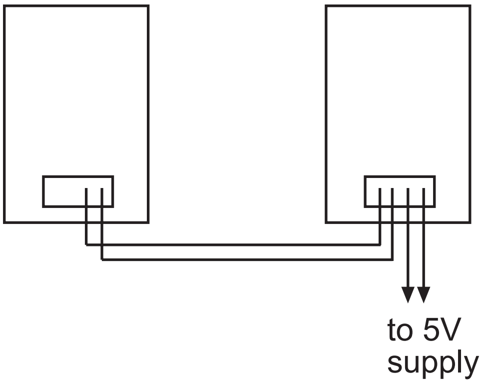
1. The motors snap into the pipe holders, which are first screwed into the bearers using woodscrews (not supplied). The screw passes through both the pipe clip and the pcb.
2. A small spacer (e.g. washers or thin strips of plywood) are required between the pcb and the bearer to allow clearance for the pcb solder joints.
3. Do not solder the wires to the motors until they are tested to ensure they rotate in the correct direction. If rotation is incorrect rotate the motor 180 degrees around to swap the motor contacts over.



Step 2 - Student Controller Assembly:

1. Carefully remove the protective layer from the rear of the board to expose the solder pads. Solder two 10 way IDC headers (one black, one grey) in the two 10 way positions (B0-B7 and C0-C7) marked on the board.
2. Using an off-cut resistor leg solder a jumper link across the jumper position J0.
3. Insert the 28X1 microcontroller into the socket, pin1 (dent) towards the download socket.

Step 3 - Power Connection to Motor Controller Boards



A 2A 5V DC supply is recommended (Revolution Education Ltd part PWR006).

1. The 5V DC power supply is connected to the screw terminal block on one of the motor boards. Power is then 'daisy chained' via wires to supply the second board. This means one pair of screw terminal joints on the second board is not used.
2. When the student controller is connected (via the colour coded cables supplied) to the motor boards the student controller takes power from the motor board and so no battery is required. In this situation the on/off switch has no effect. Power is indicated by the green LED on the student board. Note that the LEDs on the motor boards are controlled by programming output 7, they are NOT power indicators!
3. However if multiple student boards are used to download / test programs separately (ie not connected via the ribbon cables) each board will require a 4.5V (3xAA) battery pack, connected via the screw terminal block.

Additional student controllers are available as part AXE062.

Step 4 - Physical assembly

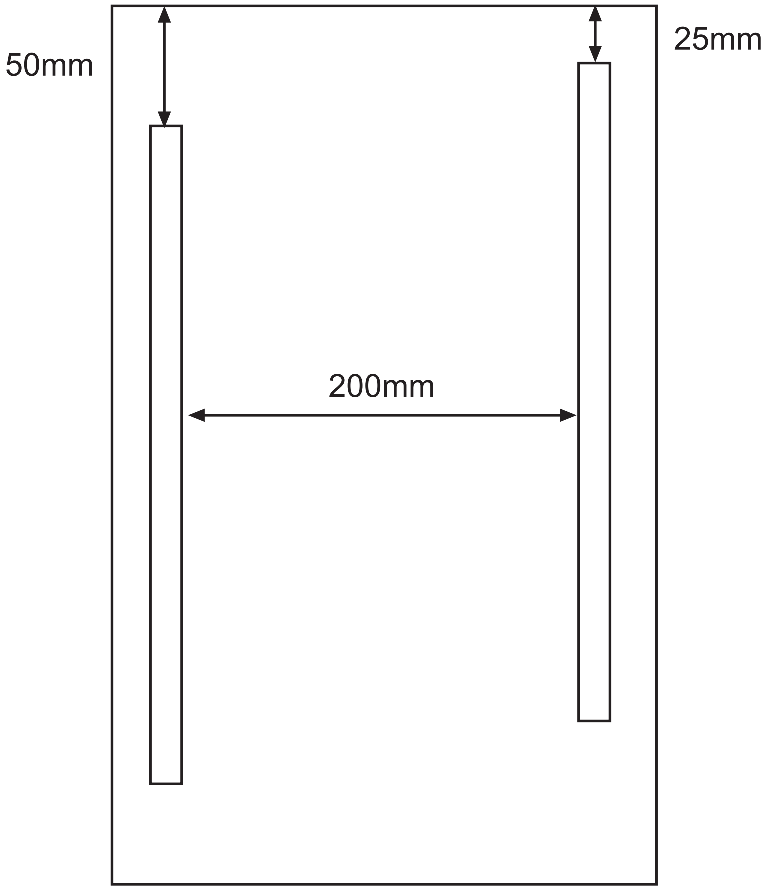
These instructions assume use of the Glockenspiel part MOD029 as supplied by Revolution Education Ltd.

Also required (not supplied):

- MDF base board, 12 or 15mm thick, approx 500 x 250 mm
- Two softwood bearers (44mm* tall x 21mm wide (2" x1") x 400mm long).
- Plywood offcuts or washers
- Wood screws
- Glue

* Note the height of the softwood bearer is dependant upon the glockenspiel used. The height should be adjusted so that the hammer, when fitted on the motor, lays horizontal about 10-15mm above the glockenspiel bars.

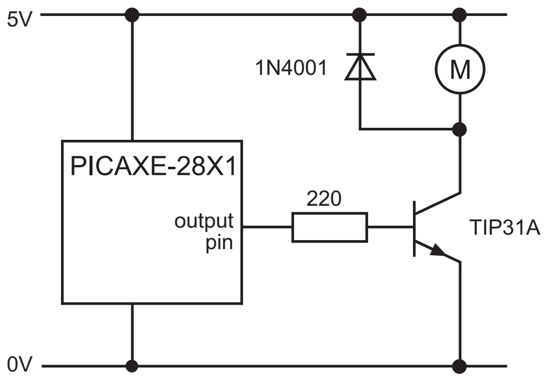
The two software bearers are mounted parallel on the base, 100mm from the centre line (ie 200mm between bearers). One bearer is offset by 25mm, ie the right bearer should be mounted 25mm from the rear edge and the left bearer 50mm from the rear edge.



Step 5 - Testing the Motors

To test the motors download the following program into the PICAXE-28X1 chip. This program will pulse all 16 outputs on every two seconds. This will enable testing of the motors:

Motor driver circuit - repeated on each output




```
init:
      lets dirsc = 255        ' make all outputs

main:
      let pins = 255          ' all portb on
      let pinsc = 255         ' all portc on
      pause 150               ' wait 150 ms
      let pins = 0            ' all portb off
      let pinsc = 0           ' all portc off
      pause 2000              ' wait 2 seconds

      goto main
```

Once correct operation of each motor is assured, solder the wires to the motor terminals.

Step 6 - Programming

Each motor is controlled by high/low commands. The motors connected to outputs on port B are controlled as follows:

```
high 0
pause 150
low 0
```

The motors connected to outputs on port C are controlled as follows:

```
high portc 0
pause 150
low  portc 0
```

Note the command line 'let dirsc = 255' MUST be included at the start of every program. This changes the port C to outputs (default power up status of port C is as inputs).

There are 7 motors (outputs 0 to 6) on each side. The last output, output 7, controls the LED on each motor board. This can be a useful indicator, if, for instance, a student is playing a flute alongside the glockenspiel. In this situation the LED can be programmed to indicate when the glockenspiel is about to start playing.

Additionally the start switch on the student controller (input 0) can be programmed to control the start of playback ie the glockenspiel does not play until the switch is pushed.

History of Techno-Music-Ology

By Clive Seager, Technical Director of Revolution Education Ltd

One of the joys of working so closely with education partners is seeing the wide range and ingenuity of different projects that use our PICAXE microcontrollers.

The PICAXE-08M chip introduced the concept of playing musical ring tones within student projects several years ago, and this functionality is now also available on 14, 20 and 28 pin PICAXE chips. However Allen Bower, D&T Advisor for Staffordshire, UK took the music concept one step further with his 3-day 'Techno-Music-Ology' workshops, where students programmed a PICAXE chip to play a real-life glockenspiel with their own composition!

The project arose after funding was made available for some special 'Gifted and Talented' student workshops. Whilst meeting the local Music Adviser, Allen discussed his ideas for integrating the Technology and Music subjects, with a PIC controlling a musical instrument - based on his interest in bells and Campanology. When Allen expressed his frustration at not being able to afford bells or expensive solenoids to 'play' the bells, she simply sighed – "why not use a glockenspiel!"

Creating the Prototypes

Cutting a long story short, several prototypes when made, with great assistance from colleagues from Hope Valley College, Derbyshire and their laser cutter! The main design issue was getting the 'hammers' to return correctly, and several methods of reversing motors were attempted.

But as with all great designs, the solution is often very simple. A rubber band simply pulls the hammer back up when the motor is de-energised! So a laser cut hammer is attached directly to the motor spindle, and when energised provides enough torque to move the hammer down. When the motor is switched off the elastic band then takes over and returns the hammer to the default position. This ingenious mechanism has several advantages:

- DC motors are much, much cheaper than servos, steppers or solenoids.
- As the motor never completely spins, the mechanism is almost completely silent.
- The mechanism is extremely reliable.
- The elastic band can easily be adjusted to increase/reduce movement.
- Student programming is simply on / off type commands, so the technicalities of reversing motors do not arise.

The Techno-Music-Ology Unit

As can be seen from the photos the original prototype used a PICAXE-18 project board giving 8 output lines to control the actuators. So to get the system to play music you simply program each motor in turn to switch on and off in an appropriate sequence. However as a soprano diatonic glockenspiel typically has 13 notes, the production kits now use a PICAXE-28X1 instead of the PICAXE-18, so all 13 notes can be used.

The motors are held in pipe clips that are fastened to a baseboard through a printed circuit board carrying up to 8 outputs either side. Each motor is simply driven from the PICAXE output pin via a TIP31 transistor. Programs can be generated in BASIC using the free Programming Editor software or in flowcharts in software products such as PIC-Logicator, Flowol or Yenka PICs.

Sample BASIC code for beginning of Doh a Deer, a Female Deer. (Sound of Music)

```
main:
      high 7               'output 7 goes high and hammer strikes
      pause 150            'optimum time period for motor to remain energised
      low 7                'output 7 now goes low and hammer returned with elastic

      pause 800            'varying off period to give timing between notes
      high 6               'next note to be played i.e. output 6 goes high
      pause 150
      low 6

      pause 150
      high 5
      pause 150
      low 5

      pause 500
      high 7
      pause 150
      low 7

      etc…
```

The Event

The activity was set in D&T week in June 2007 over a 3-day period. Part of the aim of project was for the Senior school to integrate with their feederPrimary schools through a unique event. The schools came into the Kingston Centre in Stafford – the morning was spent manufacturing the units and the afternoon was spent in programming.

In his naivety Allen initially thought that it would have been sufficient for the young participants to program tunes such as happy birthday and jingle bells – not so when you work with a Music Adviser! She set the schools the task of developing a 3-part composition in which the glockenspiel unit may possibly play the role of a soloist or be an integral part of an ensemble.

A little later a celebration event was held at a Staffordshire school, some of the groups arrived with whole band equipment! It was unbelievable to witness the creativity. one school spent a day in their music lab putting a backing track together and created an anthem called 'Techno-music-ology'.

We hope you have as much fun with your Techno-music-ology kit!

With many thanks to Allen Bower and the teachers and students involved.