For a general overview of the REMI wave-table synth design, please refer to the author's website: www.mjbauer.biz

Here is a link to the schematic of the main circuit board, which can also be downloaded from the REMI synth web page, or perhaps wherever you found this document.

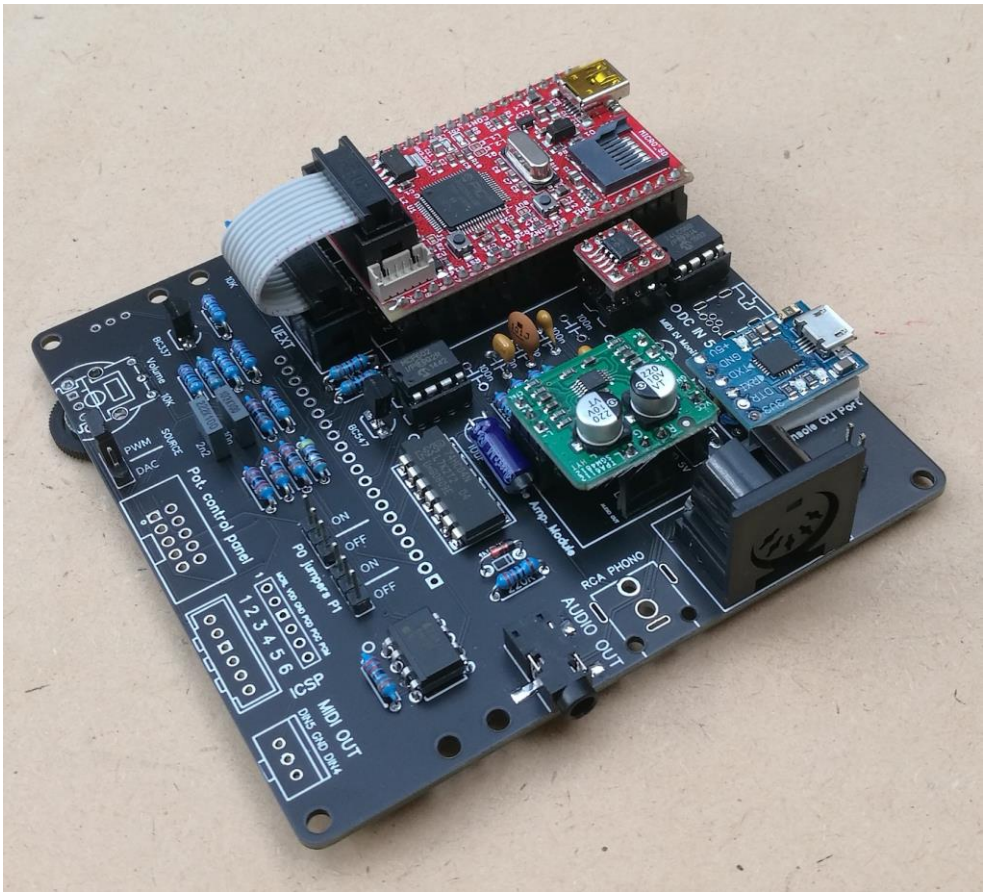
Main board (MAM)

Construction of the REMI synth (mk3) is based on the PIC32-PINGUINO-MICRO module (PIC32MX440 MCU) from Olimex, priced at €9.95 (AU$17 approx). This module is available from major suppliers, e.g. Digikey, Mouser, and from Olimex directly.

The Olimex MCU module is mounted on a base-board (PCB) named "MIDI Audio Module" (MAM), designed by a project collaborator, Jean-Pierre Meyer (in France). The MAM board has provision for MIDI IN and MIDI OUT interface circuits, audio output circuits (PWM or SPI DAC), IIC EEPROM, etc.

The board accepts connectors to interface various on-board or external sub-assemblies, including USB/UART adapter (console CLI port), headphone amplifier, graphics LCD module (128 x 64 pixels) and a control panel with 6 potentiometers for setting patch parameters.

The board is powered by a 5V USB plug-pack (e.g. phone charger). It can also be powered via the USB/UART adapter module.



Synth MAM base board with PIC32 MICRO module and essential components fitted

'UEXT' connector

Some of the PIC32 I/O signals required to be routed to the main board are accessed via the 'UEXT' header (DIL-10) on the Olimex MCU module. The MAM board provides two alternative ways to connect the UEXT header, as follows…

The first option is to modify the Olimex module. This gives a more elegant result, but there is a risk of damage to the module. The existing UEXT connector (DIL-10 box header) must be removed from the module. This is best done by de-soldering each pin, heating and pulling them out one at a time. Then, a DIL-10 pin header must be soldered on the underside of the module, so that it can plug into a female DIL-10 (2 x 5) socket on the MAM board, in the same way as the SIL side connector strips (CON1, CON2) plug in.

The second option requires no modification to the Olimex PIC32 module. The photo on page 1 shows this option implemented. A short length (45mm) of 10-core ribbon cable is fitted with a DIL-10 IDC plug at each end. One end plugs into the MCU module UEXT header; the other end plugs into a DIL-10 box header on the MAM board. (Note: If access to the UEXT signals is required for a custom user application (other than the REMI synth) then a UEXT "breakout adapter" of some sort will need to be made.)

LCD and button boards (GUI)

The complete synth build incorporates a front-panel user interface (GUI) consisting of a low-cost monochrome graphic LCD module and 6 push-buttons. The MAM base board is designed so that the LCD module and push-buttons can be mounted on piggy-back PCB's which plug into connectors on the back (underside) of the main board. The component side of the MAM board thus faces opposite the LCD and button panel.

Alternatively, the LCD module may be wired to the main board using hook-up wires. This option offers flexibility in location of the LCD panel and button board in the enclosure. It is probably quicker to do and will save some money, but maybe not as elegant. Note: If the LCD screen faces the same way as the component side of the MAM board, then the LCD connector pin orientation will be reversed.

NB: Provision of a front-panel user interface (LCD module and push-buttons) is optional. The synth can be operated completely with the CLI alone. The firmware adapts itself automatically if the front-panel is absent. Likewise, the "Pot Control Panel" is optional. (Details below.)

A suitable LCD panel is available from Sparkfun. Compatible modules are available at lower cost from online suppliers, e.g. Ali-Express. This particular type of LCD module has smaller overall dimensions (~75mm wide) and smaller dot pitch (~0.4mm) compared to other types available. The recommended LCD module uses a controller chip type KS0108. Other LCD modules use the ST7920 chip. Synth firmware variants can be built to support either of these controller types.

Breakout modules

Likewise, the USB/UART adapter and headphone amplifier module can be sourced online. If you want to minimize cost, and you're not in a hurry to get the parts, try Ali-Express.

Depending on your choice of enclosure for the synth, it may be inconvenient to fit the MIDI IN socket, audio jacks and/or volume potentiometer on the main board. Panel-mount types can be substituted for these parts so that they can be located anywhere in the enclosure and wired to pads on the PCB.

An IC socket (DIL-8) should be provided for the I2C EEPROM (24LC08) in case a future revision of the synth (or other application) requires a higher capacity device, e.g. 24LC64.

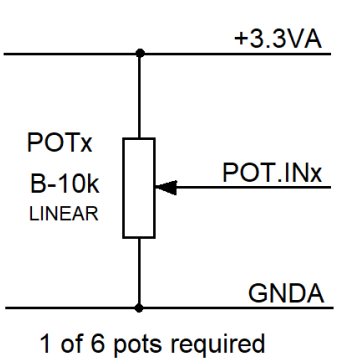
Preferably, find a USB/UART adapter module which has a footprint and pin-out compatible with the MAM board; also using 3.3V logic on the I/O pins, and having a 5V output pin.

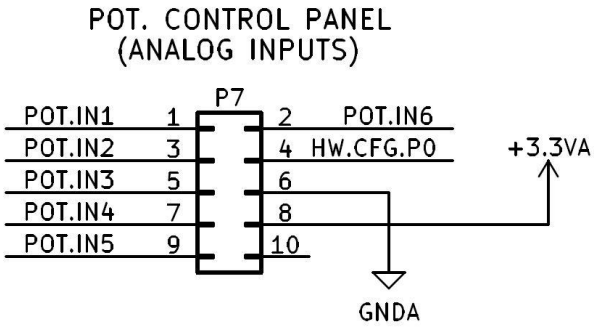
You can use a USB/UART module which has 5V I/O signals, provided that its TXD voltage level is reduced to 3V. A resistive voltage divider does the trick. Suitable resistor values are 2.2k (to TXD pin) in series with 3.3k (to GND). The divider output (junction of R1 and R2) is wired to the RX input on the MAM board. In this case, the USB/UART module cannot be fitted in the space provided on the PCB. You will need to make some other arrangement to mount the module in the enclosure, ensuring that the USB connector is accessible externally.

Pot Control Panel

The synth GUI supports a hardware "Control Panel" comprising 6 potentiometers connected to micro-controller analog inputs. Provision of a "Pot Module" is optional, but it is recommended for synth users who want to experiment with new sound patches.

There is a PCB design available for the Pot Control Panel, thanks to Jean-Pierre Meyer who also designed the main "MAM" PCB. However, you don't need a PCB – the 6 pots can be mounted directly on the enclosure front panel and connected to the main board via a DIL-10 IDC plug. Wiring of the pots is shown in the diagram below.





Be sure to link pins 4 and 6 on the DIL-10 plug. This is how the micro-controller can tell if a pot control panel is connected or not. If you prefer, the control panel can be built as a separate, detachable plug-in module, allowing the synth itself to be built in a smaller box.

Firmware

A PIC programming tool, Microchip PICkit-3, is required to install the synth firmware.

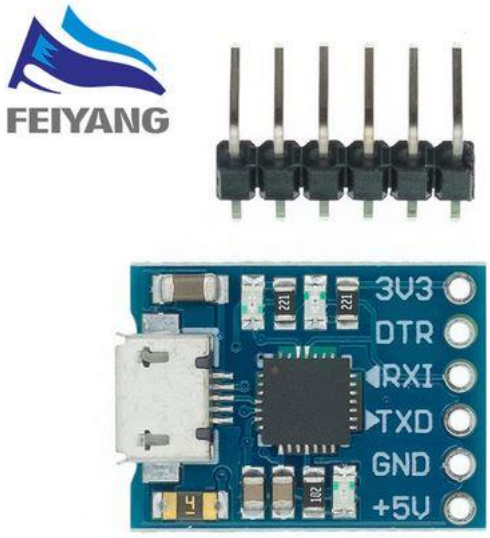
Low-cost (< €10) PICkit-3 clones are available from online suppliers via AliExpress, eBay, etc.

A special "mini ICSP" cable is required to connect the PICkit-3 to the Olimex MCU module. Be sure to include this cable in your order with the Olimex PIC32 module. (Price: €1.50)

The MAM board has provision to fit two 6-pin SIL headers (2.54mm pitch). To reduce stress on the tiny ICSP connector on the PIC32 micro module, it is recommended to modify the Olimex mini ICSP cable (i.e. cut the plug off one end) and wire it to the ICSP "breakout" header on the MAM board.

REMI firmware is built using Microchip PIC development tools - MPLAB.X IDE with XC32 compiler, free to download from Microchip's website. If you intend to modify or extend the firmware, you will need these tools. Otherwise, you just need to install the PIC programmer application ("IPE", included with MPLAB.X download) on your computer.

Module Descriptions and Data



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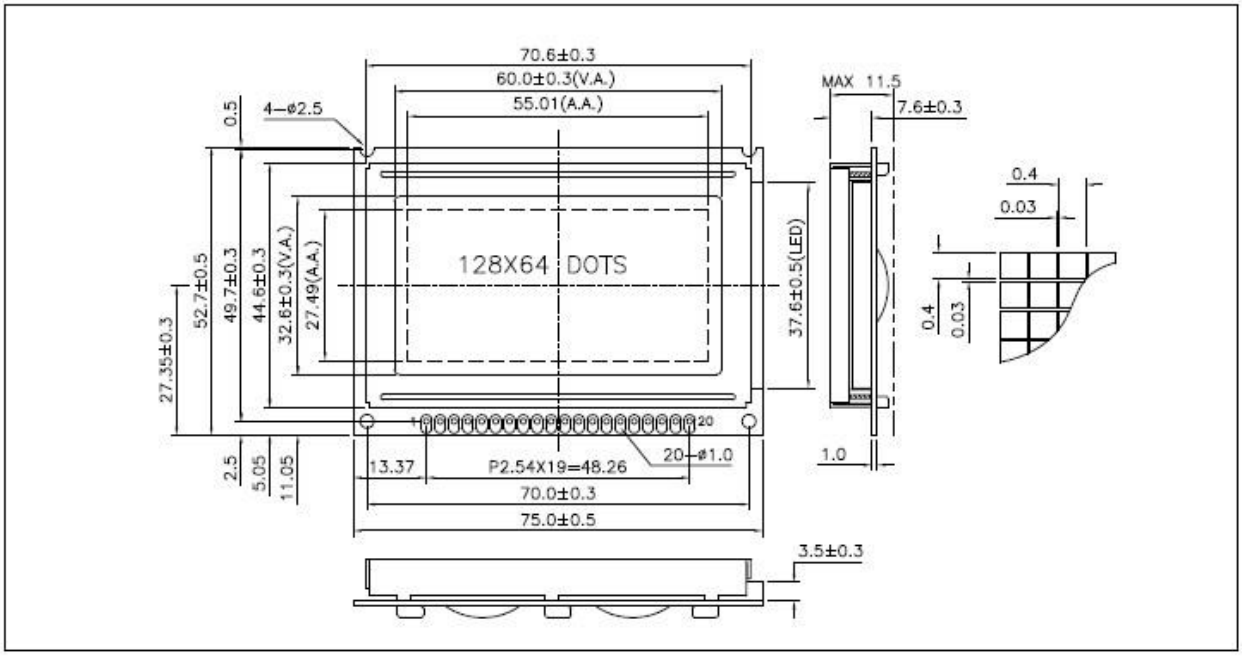


ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Min.	Max.	Unit
Supply Voltage(Logic)	V_{DD}- V_{SS}	-0.3	7.0	V
Supply Voltage(LCD)	V_{DD}- V_O	-0.3	19.0	V
Input Voltage	V_I	-0.3	V_{DD}+ 0.3	V
Operating Temp.	T_{opr}	-20	70	°C
Storage Temp.	T_{stg}	-30	80	°C

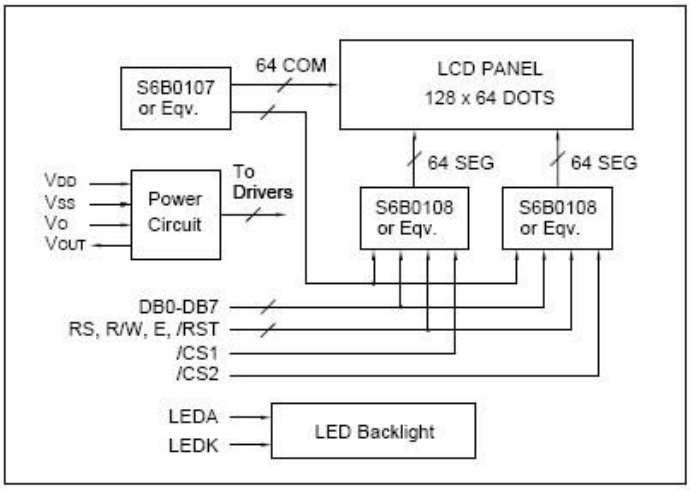
MECHANICAL DATA

Item	Nominal Dimensions	Unit
Module Size (W x H x T)	75.0 x 52.7 x 11.5	mm
Viewing Area (W x H)	60.0 x 32.6	mm
Dot Pitch (W x H)	0.43 x 0.43	mm
Dot Size (W x H)	0.40 x 0.40	mm
Weight	Approx. 45	g

ELECTRICAL CHARACTERISTICS (V_{DD}=5V± 0.25V)

Item	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Input High Voltage	V_{IH}	--	2.0	--	V_{DD}	V
Input Low Voltage	V_{IL}	--	- 0.3	--	0.8	V
Output High Voltage	V_{OH}	I_{OH} = - 0.2mA	2.4	--	V_{DD}	V
Output Low Voltage	V_{OL}	I_{OL} = 1.6mA	0	--	0.4	V
Supply Current	I_{DD}	V_{DD} = 5.0V	--	6.0	8.0	mA
LCD Driving Voltage	V_{DD} - V_O	Ta=25°C	--	11.2	--	V

BLOCK DIAGRAM



PIN CONNECTIONS

Pin	Symbol	Level	Function
1	V_{DD}	+5V	Power supply for logic
2	V_{SS}	0V	GND
3	V_O	--	Operating voltage for LCD
4	DB0	H/L	Data bus
5	DB1	H/L	
6	DB2	H/L	
7	DB3	H/L	
8	DB4	H/L	
9	DB5	H/L	
10	DB6	H/L	
11	DB7	H/L	
12	/CS1	L	Chip selection for IC1. Active "L".
13	/CS2	L	Chip selection for IC2. Active "L".
14	/RST	L	Reset signal. Active "L".
15	R/W	H/L	H : Read L : Write
16	RS	H/L	H : Data L : Instruction code
17	E	H,H→L	Enable signal
18	V_{OUT}	-10V	Output voltage for LCD driving
19	LEDA	+5V	Power supply for LED backlight
20	LEDK	0V	

LED BACKLIGHT SPECIFICATIONS (Ta=25°C)

Item	Symbol	Typ.	Max.	Unit
Forward Voltage	Vf	3.1	3.3	V
Forward Current	If	45	--	mA
LED Color	White			