



PicoPango

General MIDI synthesizer on a WaveBlaster daughterboard

User manual — firmware v0.9.3

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1. Meet PicoPango

PicoPango is a small General MIDI synthesizer on a classic WaveBlaster-pinout daughterboard. Plug it onto the WaveBlaster header of a sound card and your DOS games get proper wavetable music. Or leave the PC out of it altogether: connect it to any computer over USB and it is a General MIDI sound module, with its own stereo output on the board.

Inside is a Raspberry Pi RP2350 playing up to 48 notes at once, with four sound engines: the rich GU-Wave wavetable, the small and bright Pocket wavetable, and the FM sound of a 1990s Windows PC, dry or with reverb and chorus.

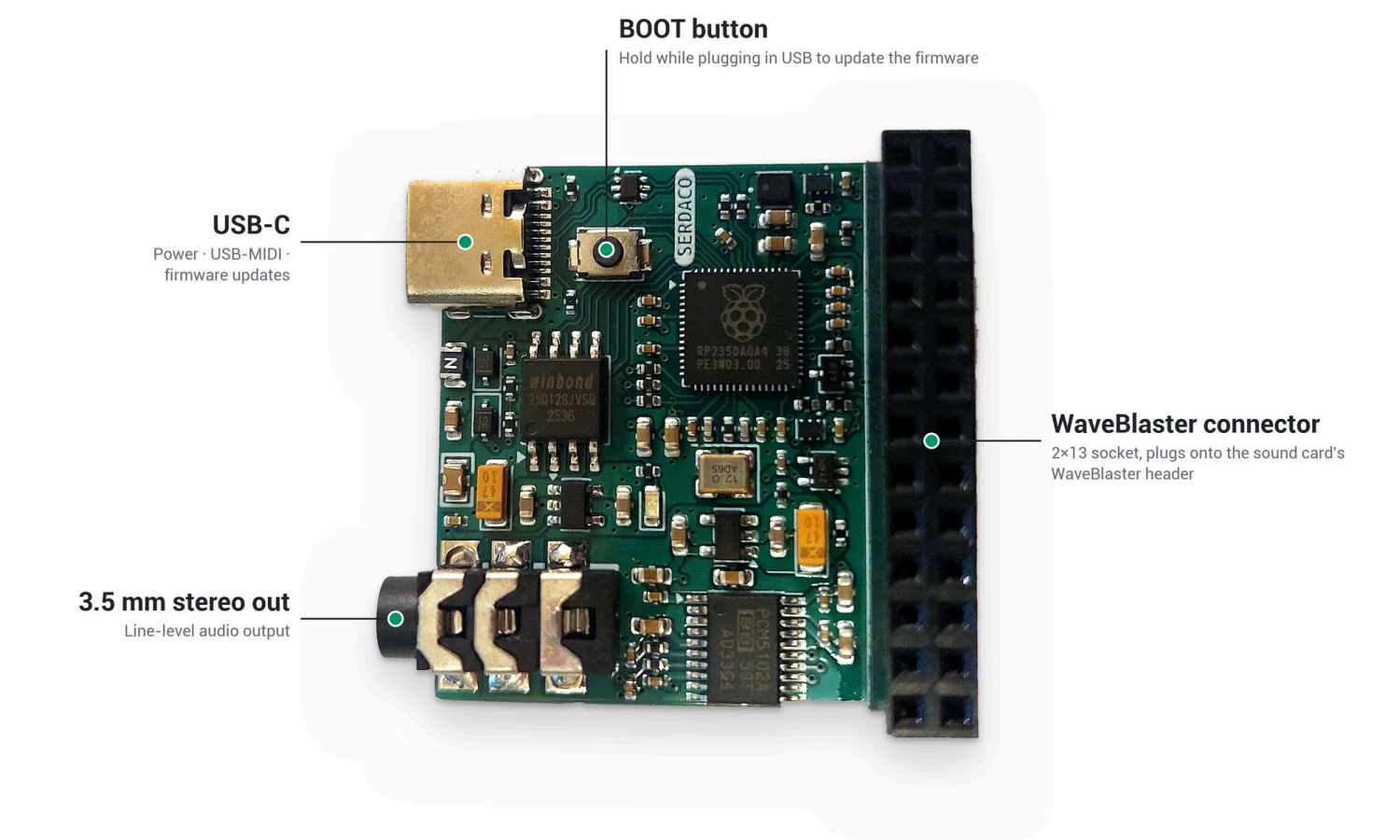
The vital statistics:

MCU	Raspberry Pi RP2350A @ 240 MHz
Sound engines	GU-Wave and Pocket (sample wavetable), FM-Classic and FM-Classic FX (Windows 9x FM)
Polyphony	48 voices, on every engine
Effects	Reverb and chorus (GU-Wave, Pocket, FM-Classic FX)
Audio	Stereo DAC, 44.1 kHz, 16 bit; to the sound card through the WaveBlaster connector, and to the 3.5 mm jack at the same time
MIDI in	WaveBlaster connector; USB MIDI (class compliant, no driver needed)
Connectors	USB-C, 2×13 WaveBlaster connector, 3.5 mm stereo jack
Power	5 V from the WaveBlaster connector or from USB
Board size	34 × 34 mm
Firmware	v0.9.3

PicoPango is available from the Serdaco shop at <https://serdashop.com/products/picopango>. The latest version of this manual, the settings MIDI files and the PANGOSET program for DOS (chapter 6), and firmware updates with the PicoPangoUpdate tool (chapter 7) can be downloaded from <https://serdaco.com/downloads/PICOPANGO/>.

The sound banks come from S. Christian Collins (GeneralUser GS), Sonivox (Pocket) and The Fat Man; their credits and all licences are in chapter 9.

2. The board



USB-C	Power, MIDI from your computer, and firmware updates. Any USB port will do.
BOOT button	A way into update mode by hand (chapter 7); PicoPangoUpdate does not need it. Leave it alone while PicoPango is playing.
WaveBlaster connector	The 2×13 socket that plugs onto a sound card's WaveBlaster header. It brings in power and MIDI from the card and sends PicoPango's audio back to the card's mixer. When the PC resets, so does PicoPango.
3.5 mm stereo out	The 3.5 mm jack: a line-level stereo output for powered speakers, a mixer or an amplifier. It is always live, in the PC or out of it.

A small LED on the board lights whenever PicoPango has power.

3. Getting started

On a sound card

1. Switch the PC off and unplug it.
2. Find the WaveBlaster header on the sound card: 26 pins in two rows, usually marked as the wavetable connector in the card's manual.
3. Fit PicoPango with its components facing the sound card and the pangolin facing up, lying over the card like any WaveBlaster daughterboard. Every pin must go into the socket, with none left over at either end. Press it down evenly.
4. Close the PC and switch it on. PicoPango starts in a couple of seconds.
5. In the game's or program's setup, choose **General MIDI** as the music device — it may also be called *Roland MPU-401* or *Sound Canvas* — on the sound card's MIDI port, usually 330.

PicoPango's sound joins the card's own output through its mixer. If the music is too quiet, look for a *Wavetable*, *MIDI* or *Line* level in the card's mixer program. The 3.5 mm jack on PicoPango plays at the same time, if you would rather listen there.

Always fit or remove PicoPango with the PC switched off.

On USB

Plug a USB-C cable into your computer. PicoPango appears as a MIDI device named **PicoPango GM Synth**; no driver is needed on Windows, macOS or Linux. Choose it as the MIDI output in your player or sequencer, and connect the 3.5 mm jack to your speakers.

Both inputs work at once: MIDI from the sound card and MIDI from USB play through the same engine. USB and the sound card can also both power the board at the same time without harm.

Whichever way it is connected, PicoPango plays on all 16 MIDI channels, with drums on channel 10 as usual, and comes back with the engine and volume you last chose.

4. The sound engines

Four engines: two sample wavetables and two kinds of FM. PicoPango starts on GU-Wave; chapter 6 shows how to switch, and PicoPango remembers the choice.

GU-Wave

A sample wavetable engine voiced with the GeneralUser GS bank, 261 instruments and 13 drum kits, with reverb and chorus effects and the full 48 voices. If you want your MIDI files to sound the way they were meant to, this is the complete General MIDI experience.

FM-Classic

The sound of a Windows 9x PC. Two-operator FM with The Fat Man's classic GM patches, and it behaves like the old Windows FM driver too: the same volume curve, the same tuning, even the same slightly coarse pitch bends. No effects, plain left/centre/right panning. Its FM modulates as deep as the real OPL3 chip does, so it is dry and bright, just as you remember it.

FM-Classic FX

The same FM-Classic with the reverb and chorus a song asks for (CC91/CC93, a little reverb when the song sets none), which the real chip never had: the Windows 9x sound in a room.

Pocket

The General MIDI set of the Sonivox EAS synthesizer, the one that has played MIDI files and ringtones on Android phones since the very first. All of General MIDI in under a quarter of a megabyte: 8-bit samples at 22 kHz, played as they are. Bright, small and a little lo-fi, with reverb and chorus. It has one instrument per program and one drum kit, so a song that asks for a GS variation or another kit gets the capital instrument and the standard kit.

5. MIDI implementation

- 16 channels, percussion on channel 10 (and via bank select MSB 127/120 on any channel).
- Controllers: modulation (1), volume (7), pan (10), expression (11), sustain (64), reverb send (91), chorus send (93), all sound off (120), reset controllers (121), all notes off (123). The effect sends apply to GU-Wave, Pocket and FM-Classic FX. Reset controllers keeps the pitch bend range; notes held by the sustain pedal keep sounding through all notes off until the pedal is released.
- Pitch bend, default ± 2 semitones; range adjustable via RPN 0 on every engine, up to 24 semitones. NRPN messages are accepted and ignored, and never change the bend range.
- Switching engines in the middle of a song keeps what the music set up on each channel: instrument, volume, pan, expression, modulation, effect sends, pitch bend and its range.
- Bank select with GS variation semantics (CC0) and XG-style fallbacks; unknown variations fall back to the capital patch.
- GM, GS and XG reset SysEx are honoured.
- PicoPango's two settings can be changed with a SysEx message of its own — chapter 6.

6. Changing settings over MIDI

PicoPango has no front panel: its two settings, the engine and the volume, are set from the other end of the MIDI cable. That works just as well from a DOS batch file as from a sequencer — switch to FM-Classic before a game starts and put GU-Wave back when it finishes, without opening the case.

The messages are SysEx, seven bytes each:

```
F0 7D 50 52 <setting> <value> F7
```

7D is the MIDI identifier set aside for private messages, and 50 52 is PicoPango's signature. PicoPango ignores anything that does not carry it, so it will not change its settings because some other device on the bus talks in private messages too.

Setting	What it changes	Values
01	Engine	0 GU-Wave, 1 FM-Classic, 2 FM-Classic FX, 3 Pocket
02	Volume	0 to 127 (100 when new)

The values are sent as hexadecimal bytes, like the rest of the message. Ready to copy:

Message	Does
F0 7D 50 52 01 00 F7	GU-Wave
F0 7D 50 52 01 01 F7	FM-Classic
F0 7D 50 52 01 02 F7	FM-Classic FX
F0 7D 50 52 01 03 F7	Pocket
F0 7D 50 52 02 64 F7	Volume 100
F0 7D 50 52 02 7F F7	Volume 127 (full)

A value outside its range is ignored rather than clamped, and so is a setting number PicoPango does not know. Changes are written to memory a few seconds after the synth next falls quiet, and they survive a power cut.

Ready-made files

The same messages also come as small MIDI files, one setting per file and nothing else in it, so anything that can play a .MID can change a setting — a DOS MIDI player, a sequencer, a media player. They are in the PicoPango settings download at <https://serdaco.com/downloads/PICOPANGO/>, together with PANGOSET.

Files	What they set
ENG0 - ENG3	GU-Wave, FM-Classic, FM-Classic FX, Pocket
VOL000 - VOL127	Volume 0, 32, 64, 100 and 127

The names are the old eight-character DOS kind on purpose, so they survive a trip through DOS unchanged.

PANGOSET for DOS

On a PC with PicoPango on its sound card, the small DOS program **PANGOSET** from the same download does it in one command. It sends the settings through the sound card's MIDI port (MPU-401), the same way a game's music reaches PicoPango, so no MIDI player is needed.

Command	Does
PANGOSET GU	Sound engine GU-Wave
PANGOSET FM	Sound engine FM-Classic
PANGOSET FX	Sound engine FM-Classic FX
PANGOSET POCKET	Sound engine Pocket
PANGOSET VOL 100	Volume, 0 to 127
PANGOSET FM VOL 90	Several settings at once
PANGOSET /P:300 GU	Another MPU-401 port (hex)

PANGOSET takes the port from the `P` value of the `BLASTER` variable when there is one, and uses `330` otherwise; `PANGOSET /?` shows the help.

If PANGOSET reports that no MPU-401 answered, check the MIDI port in the sound card's setup program and give it with `/P`. PANGOSET checks the whole line before it sends anything, and ends with errorlevel 0 when the settings were sent, 1 for a mistake on the command line and 2 when no MPU-401 answered. It runs on any PC from an 8086 up.

7. Updating the firmware

New PicoPango firmware is a file whose name ends in `.uf2`. The firmware download at <https://serdaco.com/downloads/PICOPANGO/> holds the firmware together with **PicoPangoUpdate**, which installs it over USB.

With PicoPangoUpdate (Windows)

1. Connect PicoPango to the computer with a USB cable. It can stay on the sound card.
2. Close any program that uses PicoPango's MIDI port, such as a MIDI player or a sequencer.
3. Drag the firmware file onto `PicoPangoUpdate.exe`.
4. PicoPangoUpdate switches PicoPango to update mode, copies the firmware and waits for PicoPango to come back. This takes a minute or two; leave the cable in until it says *Done*.

If an update is interrupted — the cable comes out, or the computer goes to sleep — PicoPango stays in update mode. Run PicoPangoUpdate again with the same file: it finds PicoPango waiting and offers to finish the job.

PicoPangoUpdate only writes to the PicoPango it switched to update mode itself — it checks the serial number — and it stops if another board is already in update mode or more than one PicoPango is connected.

Without Windows

1. Send PicoPango this message from any program that can send SysEx: `F0 7D 50 52 7F 42 F7` . It switches to update mode. (Holding the **BOOT** button while plugging in the USB cable does the same.)
2. A drive named **RP2350** appears, as if you had plugged in a memory stick. Copy the firmware file onto it.
3. The drive disappears by itself when the copy is done, and PicoPango restarts on the new firmware.

8. If something is not right

What happens	What to try
No sound from the 3.5 mm jack	It is a line output: it needs powered speakers or an amplifier. Check that the volume has not been set low (chapter 6).
A game plays no music on the sound card	Choose General MIDI / MPU-401 on port <code>330</code> in the game's setup, and check that the card's MIDI port is enabled in its own setup program. Raise the card's wavetable or MIDI level.
PicoPango does not appear over USB	Try another cable: some USB-C cables carry power only. If the RP2350 drive appears instead, PicoPango is in update mode: finish the update (chapter 7), or unplug it and plug it in again.
PicoPangoUpdate says the MIDI port is in use	Close the program that has PicoPango open — a MIDI player, a sequencer — and run it again. If nothing has it open, unplug PicoPango, plug it in again and retry: Windows sometimes keeps a stale MIDI port after a board has been reconnected.

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Sonivox

The Pocket sample bank is the 22 kHz General MIDI wavetable of the Sonivox EAS synthesizer, converted by Serdaco for PicoPango's sample engine. The Apache License 2.0 it is used under is reproduced in full at the end of this chapter.

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The Fat Man OPL tone library

The FM-Classic patch bank, for FM-Classic and FM-Classic FX alike, is The Fat Man's 2-operator General MIDI tone set, the one the Windows 9x FM driver shipped with.

Tone libraries for OPL2 and OPL3 chips produced by The Fat Man.

Developed by K. Weston Phelan and George Alistair Sanger

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Raspberry Pi Pico SDK

The runtime, the hardware drivers and the boot code.

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TinyUSB

The USB stack behind USB-MIDI.

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Tiny printf

The text formatting behind the panel and the console, part of the Pico SDK.

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