

## Customer story

# Korg synthesizers: Electronic music icon creates compelling sounds with powerful Raspberry Pi Compute Module

A simple setup with the fast and compact Raspberry Pi Compute Module 3 offers a cost-effective solution for Korg's highly regarded, high-spec instruments.

Raspberry Pi solution	Compute Module 3
Size of business	Large enterprise
Industry	Music technology

Iconic instrument maker Korg began life in Japan in the 1960s, bringing to market first drum machines, then Japan's first synthesizer and the world's first needle-type tuner. It came to international prominence with the rise of electronic music in the 1970s and 1980s. Demands for ever more capable synthesizers – as well as more affordable models – saw Korg expand its product lines into both home hobbyist and professional performer arenas. Keen to capitalise on the exciting possibilities of electronic music production, which was developing at a rapid pace alongside the exponential growth of home and office computing, Korg took an early interest in DSP-based synthesizers. A DSP, or digital signal processor, is a specialised chip for rapidly manipulating the digitised version of real-world analogue signals – audio input, for example.

In the 1990s, this meant using custom-built DSPs along with off-the-shelf parts from Motorola and Texas Instruments. In 2005, Korg started to use Linux running on Intel processors as the DSP for its high-end keyboards, starting with the Pentium-based OASYS, followed by the Atom-based Kronos. Most recently, Korg has launched a new line of more accessible digital synthesizers, including the wavestate, modwave, and opsix, which take advantage of Raspberry Pi Compute Module 3's processing abilities.

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## The challenge

Modern synthesizers need a lot of horsepower to deliver professional-quality audio, feature richness, and high polyphony (the number of voices that can be played simultaneously). Classic Korg instruments used multiple custom ASICs (Application Specific Integrated Circuits) for the task. The flexibility of these ASIC-based systems was necessarily limited, since the basic functionality was baked into the hardware design, and these bespoke systems also didn't come cheap: 1988's M1 keyboard listed for \$2,749, equivalent to about \$6,800 in 2022 dollars.

To break free from the constraints of ASIC designs, Korg's California-based Korg R&D team started to work on DSP-based synthesis. The idea was that the hardware would be generalised, with the bulk of the features dependent on software rather than hard-wired electronic circuitry. Such a system would be capable of running many different types of synthesis algorithms, such as physically modelled acoustic instruments, virtual analogue synths, sample playback, tonewheel organs, and so on.



Korg R&D decided on an array of Motorola DSPs for their 1999 OASYS PCI, a PCI-based synthesis and effects system for Macs and Windows computers, and they designed their 2005 OASYS "workstation" keyboard – a high-end instrument for professional users – around Linux running on an Intel Pentium processor. These instruments offered impressive flexibility, but they were expensive. "The Oasys was more than double the cost of our previous machine," notes Andy Leary. Still, "It made some incredible sounds that other things just couldn't do. It really was a flagship instrument, and a groundbreaking instrument."

Later products like the 2011 Kronos continued to build on the OASYS technology while achieving a more standard price point, and clearly struck the right note: the Kronos was a strong seller for ten years.

However, Korg R&D's goal was to hit lower price points while not compromising on features and fidelity, and they also found that technical issues remained with the platforms they were using. Korg chose TI's OMAP platform, which combined an ARM CPU with a DSP, for 2017's Grandstage and Vox Continental products, but despite having the CPU and DSP on the same die, it still had some of the same issues as the older OASYS PCI. "It still wasn't one chip that was doing all the work. We had to deal with this kind of interconnection issue between the DSP part, and the main CPU that was running the user interface," explains Andy.

## The solution

For their next product, Korg R&D's goal was to make products accessible to all musicians, by reaching the sub-\$1000 price point. Eventually they realised that solutions designed for traditional desktop and laptop computers "just cost a little too much". They switched to Raspberry Pi "and basically get all of what we needed, for a lot less. It's smaller, cheaper, faster, lighter, better, all that stuff. It was a clear path for us," says Dan Phillips.

Another compelling aspect was that with Raspberry Pi Compute Module everything was ready to go. Korg could focus on the custom aspects of their product, such as professional-quality audio hardware, the physical keyboard, and the extensive physical control surfaces, and then just plug in a single part to provide the CPU, RAM, and storage. "That part of the work is already done. It's like any other component; we don't have to lay out the board, build it, and test it."

## Why Raspberry Pi?

Korg was also persuaded by Raspberry Pi's commitment to a long-term roadmap producing and supporting its products – a key appeal for Korg, who had occasionally been forced to accommodate abrupt changes due to the discontinuation of DSPs, memory, and other components.

"It made sense to go with a company that was making something in huge volumes and was committed both to continued production and to pushing the technology forward into the next generation. That reassurance is exactly what a business needs," explains Dan.

It also helped that Korg didn't need to do that much to take advantage of it. In fact, they bought several Compute Module 3 units, tried them out and realised, "hey, we could make this work," says Andy.

## The results

In early 2020, Korg R&D announced the wavestate, a successor to its 30-year-old Wavestation and its first instrument to use Raspberry Pi Compute Module 3. The original Wavestation had legendary status, so news of a brand-new model was a big deal and expectations considerable.

The Wavestation used “Wave Sequencing” to crossfade between samples, combining them into new sounds. The Raspberry Pi-powered wavestate builds on this with “Wave Sequencing 2.0”, which introduces extensive real-time control, sophisticated pattern creation and manipulation inspired by 20th-century algorithmic composition, and controlled randomisation. It also has significantly higher audio quality and a much more powerful synthesis architecture than the original, while offering twice the polyphony.

The California-based Korg R&D team had been working together for many years before turning their hands to the wavestate and its first follow-up, the modwave wavetable synthesizer, which is also built around Raspberry Pi technology. The team uses software to prototype their instruments before implementing hardware designs. With the basic software platform already functional, developing the wavestate using Compute Module 3 took a fairly modest year from inception to its late 2020 launch. The setup has two circuit boards. The main panel board contains all of the user interface elements, including display, buttons, knobs, wheels, and other synth-specific controls, along with MCU microprocessors to support them and communicate with the CM3. The other circuit board has subsystems for audio, MIDI, the musical keyboard, and power, plus the socket for the CM3.

Andy describes the setup as “Very simple. Two boards. The philosophy that we’re going with is that, when we make new products, we can keep the same main board that has the processor, audio, and so on. The front panel board provides differentiation; it can be customised as required, and tailored to the precise needs of a specific instrument.”

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Dan told us that “not everyone understands that Raspberry Pi is actually making the sound – many people assume that it’s not... We use the CM3 because it’s very powerful, which makes it possible to create deep, compelling instruments.”

The wavestate has been very well received: “It’s been a really successful product for us and has got a lot of attention. People are very excited about how much the product can do for the price point. Somehow it seems like it was a great product to launch at the beginning of a pandemic.”

Asked to quantify just how successful the move to Raspberry Pi has been, the pair report that sales have far exceeded their expectations. “We can certainly say that these products have been very well received by the marketplace!”



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