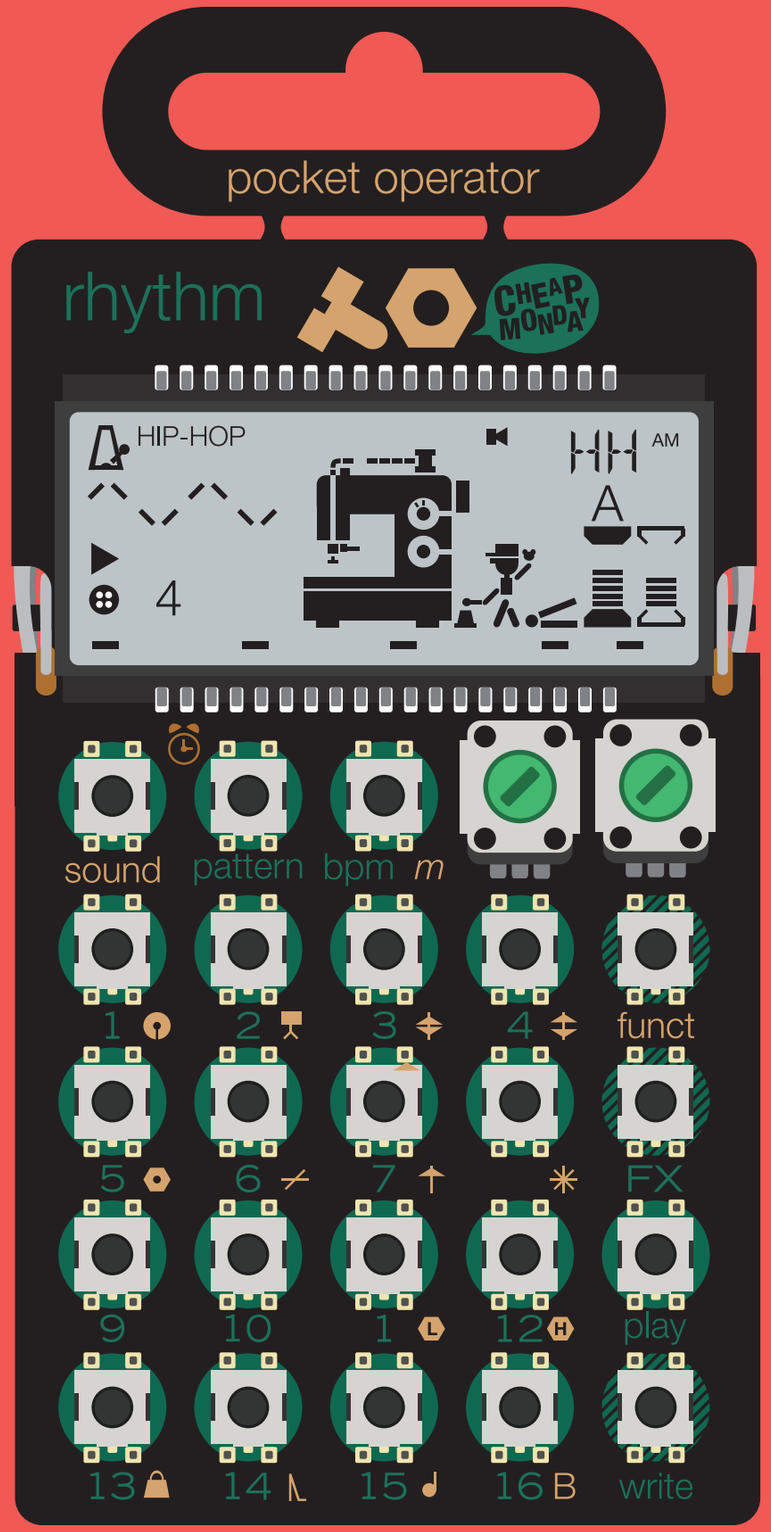

pocket operator
rhythm
CHEAP MONDAY
HIP-HOP
AM
A
4
sound
pattern
bpm
m
1
2
3
4
funct
5
6
7
FX
9
10
1
12
play
13
14
15
16
B
write

3 / Musical Instruments

The history of electronic musical instruments parallels the evolution of computers, sharing complexity and components. Initially large, complicated and costly, they gradually became smaller and more affordable through the late 20th century.

This chapter focuses on electrophones – instruments which produce sound solely through electricity – which are distinct from amplified instruments like electric guitars or electronically-controlled pipe organs. Some of these devices revolutionised music by offering new sounds and creative possibilities, while others were mass-produced for education or entertainment, and some were simply odd curiosities.

Elisha Gray, a telephone engineer, invented the first electric synthesiser in 1874 – the Electro-Harmonic Telegraph – which generated musical notes electronically using oscillators capable of playing two octaves. A major breakthrough came in 1906 with the invention of the audion, the first thermionic valve, which amplified audio signals and became essential for electronic instruments.

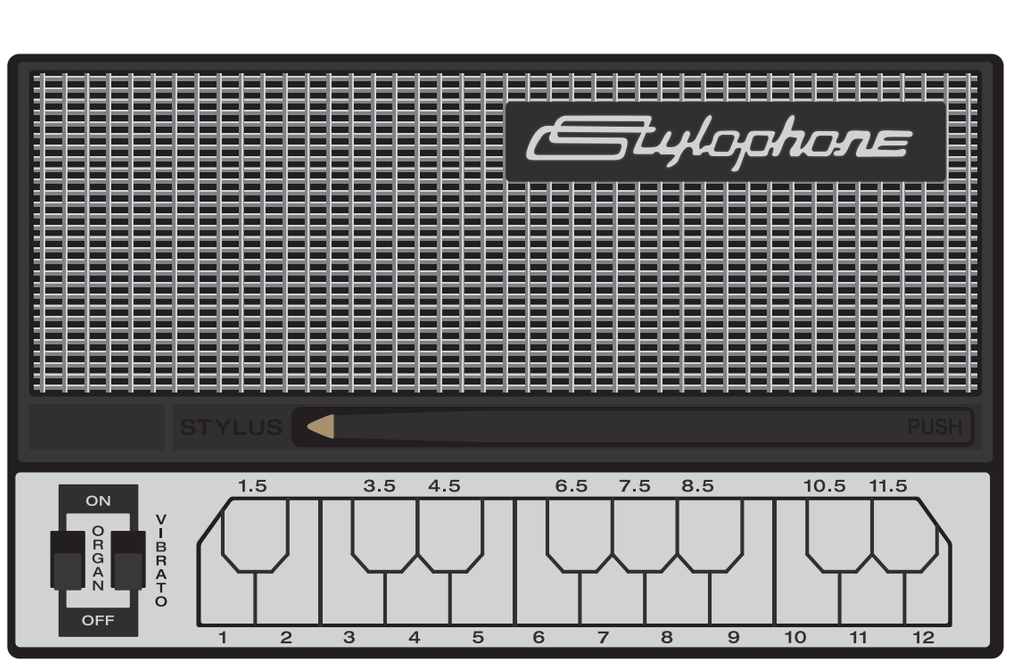
Following this, a variety of electronic instruments emerged, including the telharmonium, spharophon, trautonium, and theremin, the latter remaining a captivating and unique instrument. By the late 1930s, early synthesisers like the Hammond Novachord and Raymond Scott's Clavivox combined oscillators with circuits that modified sound, employing subtractive synthesis. This involved creating complex waveforms and then subtracting elements to shape distinctive tones, with envelope generators controlling note dynamics (attack, decay, sustain, release).

These principles formed the basis of modular synthesisers – large, complex systems allowing musicians to patch together sound components in countless configurations. Pioneers such as Don Buchla, Raymond Scott, Evgeny Murzin, and Robert Moog developed these instruments, which were adopted by iconic artists from The Beatles to The Doors, The Grateful Dead to Tangerine Dream. Modular synths shrank over time, becoming more reliable and accessible.

Subtractive synthesis dominated until the mid-1980s, when digital FM synthesis introduced new sonic possibilities. From the late 1980s onward, digital synthesisers, samplers, and workstations proliferated, while music production software enabled home musicians to emulate many physical instruments. The result of this was, almost inevitably, a reaction in the opposite direction. Musicians began to rediscover dusty old hardware and put it to use to create new sounds in incredibly creative ways. Despite the amazing selection of music production apps for Android and iPhones, the resurgence of modular synthesisers and the variety of manufacturers proves that musicians love creating new ideas out of old ones.

Teenage Engineering Pocket Operator PO-12 2015

01



02

01 **Theremin** 1920
Moog Etherwave Theremin: Introduced in the mid-1990s as a modern theremin model
Conceived by the Russian electrical engineer Leon Theremin, his eponymous device was an early synthesiser designed to be played by hand, but in a rather unexpected way.

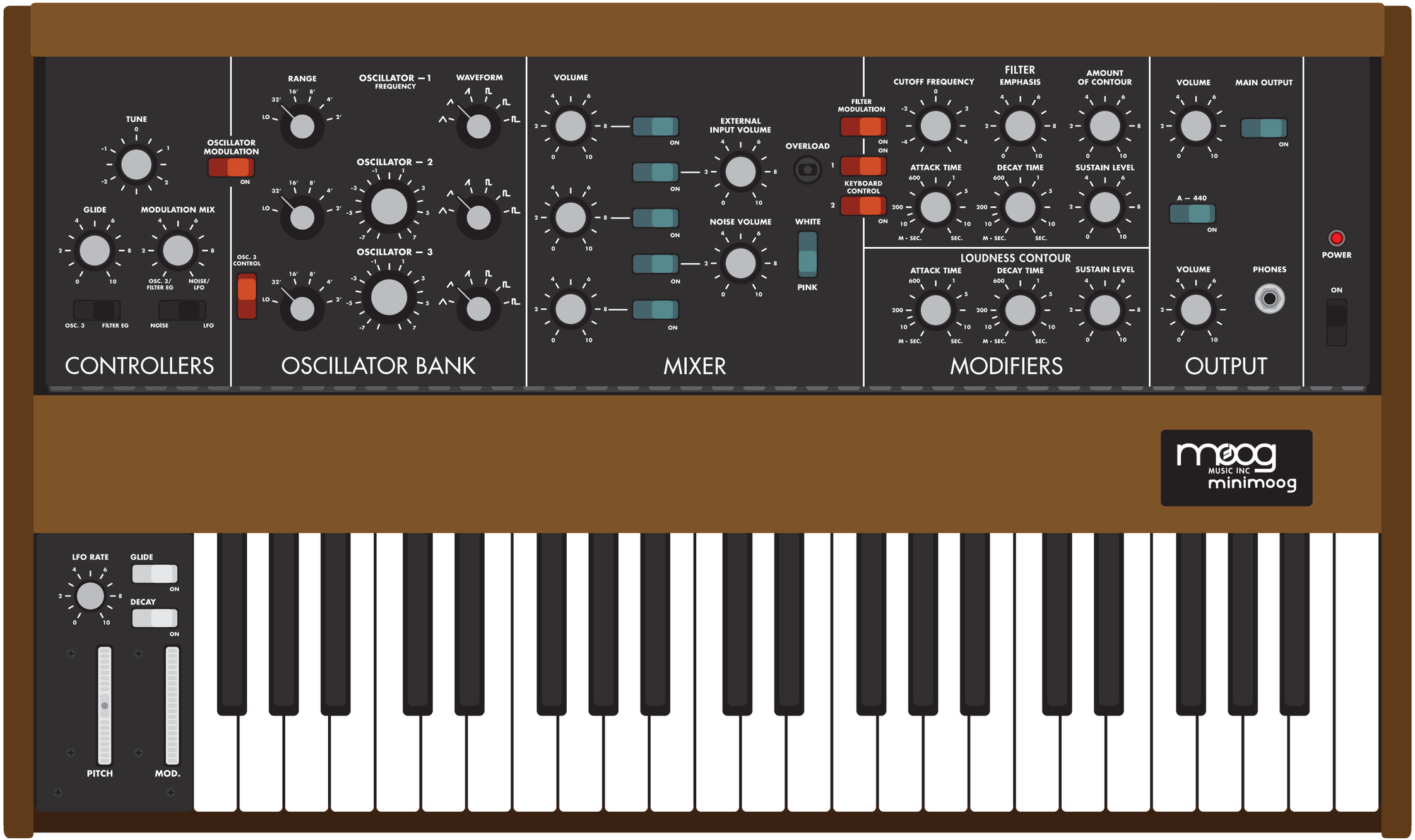
The theremin features a pair of antenna which are both sensitive to the theraminist's hand positions. One controls the frequency (pitch) and the other controls amplitude (volume). The musician moves their hands in the air to create a noise. It sounds like a gimmick, but the sound of the theremin is definitely unique and has a spooky, unearthly quality. It has been put to use by an impressively diverse collection of musicians, from experimental classical composers such as Christian Wolff and Percy Grainger to pop and rock artists from Jean-Michel Jarre to Led Zeppelin, the Rolling Stones, and the White Stripes. American alternative rock band Pixies used a theremin to great effect on 'Velouria' .It has also played an important role in movie soundtracks, adding its distinctive sound to mid 20th century sci-fi and horror flicks such as The Day the Earth Stood Still, and The Thing from Another Word, as well as more modern films like The Machinist, and First Man. Moog produce a number of theremins including this, the Etherwave.

02 **Dubreq Stylophone** 1968
Initially envisaged as a musical toy, the Stylophone was invented by the British sound engineer Brian Jarvis in 1967. It was a very basic analogue synthesiser which used a simple touch keyboard operated by a conducting stylus. The somewhat tinny sound it produced was no hindrance to its success — millions of Stylophones were sold, and it was re-released in 2007. It also appeared in many well-known tracks. David Bowie used one on 'Space Oddity', Kraftwerk on 'Pocket Calculator', and the White Stripes on 'Icky Thump'. Pulp were especially big fans, employing the Stylophone on many of their songs.

03 (*Overleaf*) **Moog MiniMoog** 1971
The enormous (and enormously expensive) modular analogue synthesisers of the 1960s had sparked a revolution in music, but they remained the preserve of an exclusive club — only the biggest bands and most well-funded studios could afford them. However, the synthesiser pioneer Robert Moog was to change all that. In fact, it was one of his engineers, Bill Hemsath, who had the idea of combining the core sound-generating modules of Moog's full size synthesiser with a compact keyboard in a single small cabinet. Moog himself was initially reluctant, viewing the prototype as a fun instrument but with questionable sales potential. By 1970 his company was struggling to shift their flagship modular systems in sufficient numbers, and so he took a chance on Hemsath's concept.

The Minimoog was released in 1971. It became hugely influential, with much of its appeal coming from the warm, rich sound it produced which derived in part from its imperfectly-synchronised oscillators — a technical issue that the engineers, fortuitously in retrospect, were unable to iron out before it went into production. It also featured a pitch wheel - a large dial which allowed the pitch of a note to be 'bent' up or down. This allowed musicians to add flourish to solos as a guitarist might. The compact size meant the Minimoog could be easily transported between studio and venue, and it was much more affordable than its modular predecessors.

The Minimoog became an instant classic, and a potent weapon in the arsenal of countless artists over the following decades. Early adopters included jazz trailblazers Herbie Hancock and Sun Ra, and Bernie Worrell of funk group Parliament, who used it to create the bass lines of 'Flash Light'. German electronic innovators Kraftwerk used it on many tracks, in turn inspiring future electro and techno artists. It was used for the bassline of Michael Jackson's 'Thriller', and hip hop producers Dr Dre and J Dilla both viewed the Minimoog (and its successor, the Moog Voyager) as an essential tool in their studios.


TUNE
OSCILLATOR MODULATION
ON
GLIDE
MODULATION MIX
OSC. 3/ FILTER EG
NOISE/ LFO
OSC. 3
FILTER EG
NOISE
LFO
CONTROLLERS
RANGE
OSCILLATOR — 1 FREQUENCY
WAVEFORM
OSCILLATOR — 2
OSCILLATOR — 3
OSC. 3 CONTROL
LO
OSCILLATOR BANK
VOLUME
EXTERNAL INPUT VOLUME
NOISE VOLUME
OVERLOAD
WHITE
PINK
MIXER
FILTER MODULATION
KEYBOARD CONTROL
CUTOFF FREQUENCY
FILTER EMPHASIS
AMOUNT OF CONTOUR
ATTACK TIME
DECAY TIME
SUSTAIN LEVEL
M - SEC.
SEC.
LOUDNESS CONTOUR
MODIFIERS
MAIN OUTPUT
A — 440
PHONES
POWER
OUTPUT
moog
MUSIC INC
minimoog
LFO RATE
GLIDE
DECAY
PITCH
MOD.

03

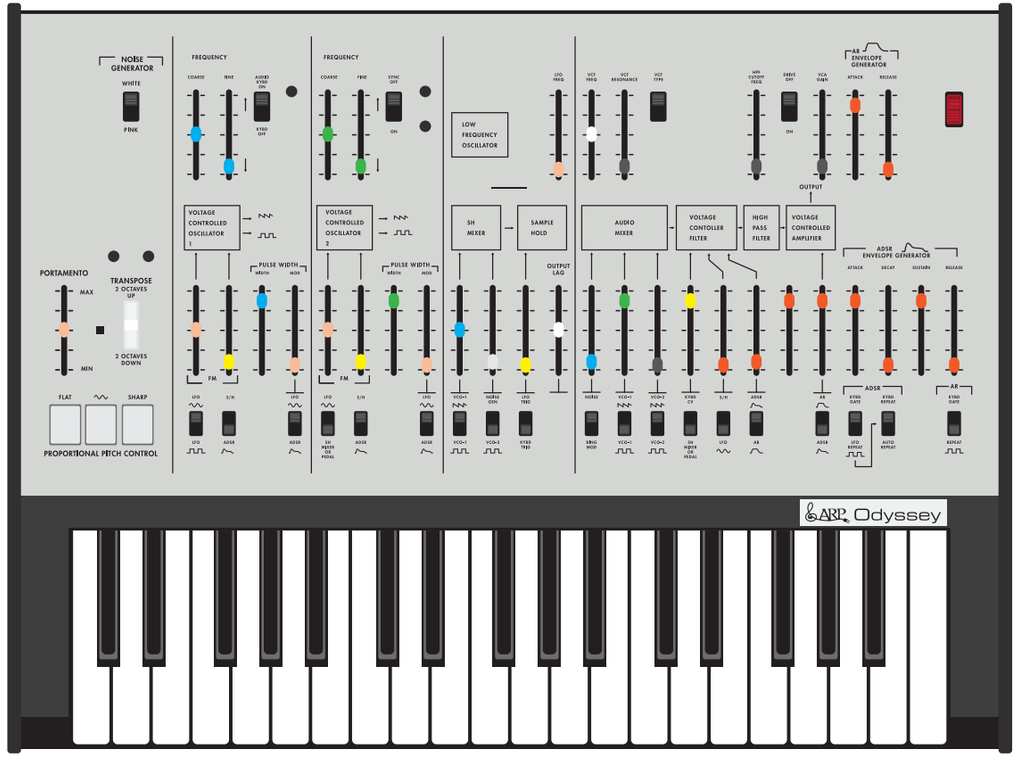
04 **ARP Odyssey** 1972
Like Moog, Alan Pearlman's company ARP initially produced very large and expensive modular synthesizers but, noticing the huge success of the Minimoog, they decided to release their own compact and lower-priced model which they named the Odyssey. It was powerful and well-featured, with sound modifying functions including ring modulation and a sample and hold mixer. The Odyssey appeared on tracks such as Elton John's 'Rocket Man', Deep Purple's 'Space Truckin' and 'Vienna" by Ultravox. It has a starring role in both Herbie Hancock's 'Chameleon", and 'The Hand That Feeds' by Nine Inch Nails. It also provided part of the sound for the 1980 rearrangement of the 'Dr Who' theme music. ARP declared bankruptcy in 1981, but the Odyssey was relaunched by Korg in 2015 with a number of updates including MIDI and USB connectivity.

05 **Boss DS1** 1978
Electric guitarists had been using various techniques to change the sound of their instruments since guitar amplifiers emerged in the 1930s. Initially this involved tweaking the amplifier controls or even modifying the speaker cone inside. Later, separate pre-amplifiers were developed to allow guitarists to create particular sound effects. These evolved into guitar pedals — effects boxes that could be turned on and off onstage by pressing the pedal with your foot whilst playing. In the late 1960s and early 1970s, hard rock bands like Black Sabbath and Led Zeppelin experimented with distortion effects, and in 1978, Roland released the DS-1 under their guitar effect brand Boss. The DS-1 has been used by Stevie Vai, Prince, John Frusciante, PJ Harvey and Dave Navarro. Perhaps most famously, it was used on almost every track of Nirvana's breakthrough album 'Nevermind".

06 **Electro Harmonix Mini-Synthesizer** 1980
British engineer David Cockerell had been producing synthesiser technology for EMS (Electronic Music Studios) and its enigmatic founder Peter Zinovieff in the latter's Putney garden studio since the late 1960s. EMS equipment was popular with some of the leading classical modernist composers of the time, including Karlheinz Stockhausen, Harrison Birtwistle, and Hans Werner Henze. Cockerell left the struggling EMS in 1972 and joined New York-based Electro-Harmonix, who produced electronic effects devices for guitarists. His technical expertise led to the development of some novel new devices, including the Super Replay— an early digital sampler — and the Mini-Synthesizer. The latter was a compact analogue synth featuring a touch-sensitive membrane keyboard and some distinctive, deep bass sounds. It was certainly quirky, and not the easiest instrument to play, especially live. Perhaps because of Electro-Harmonix's reputation with rock guitar effects, it was put to good use by Van Halen, playing a starring role on their 1981 track 'Sunday Afternoon in the Park'. It was also used by French electronic populariser Jean-Michel Jarre.

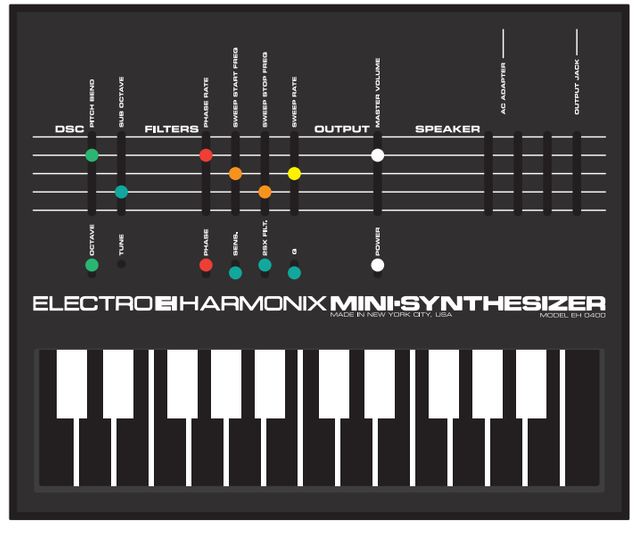
07 (*Overleaf*) **Sequential Prophet 5** 1978
The Prophet 5 was an innovative synthesiser in many ways. It was polyphonic, which meant it could play simultaneous combinations of notes or chords, rather than just single notes (like the Minimoog) or pairs of notes (like the Odyssey). It was also the first instrument to have a microprocessor within its circuitry. It used various components designed by E-mu Systems, who would go on to become leaders in sampling technology. The list of Prophet 5 users is like a who's who, and includes Tangerine Dream, Michael Jackson, Madonna, Peter Gabriel, Phil Collins, Radiohead, Dr Dre, Too Short and Talking Heads. New Order used the Prophet 5 for their hit Blue Monday, and Brad Fiedel used one for the iconic theme tune to The Terminator.

08 **Faemi Mini** 1972
Mostly unknown to European and American musicians, synthesisers of varying degrees of sophistication were being designed and produced within the USSR during this period. One of the more compact devices was FAEMI's Mini. Styled around an accordion-sized keyboard, the Mini had a bank of control switches that could modify timbre, vibrato and register, and the quality of sound it produced was certainly characterful. In fact, the Mini has gone on to become something of a cult classic, at least amongst analogue synth collectors.

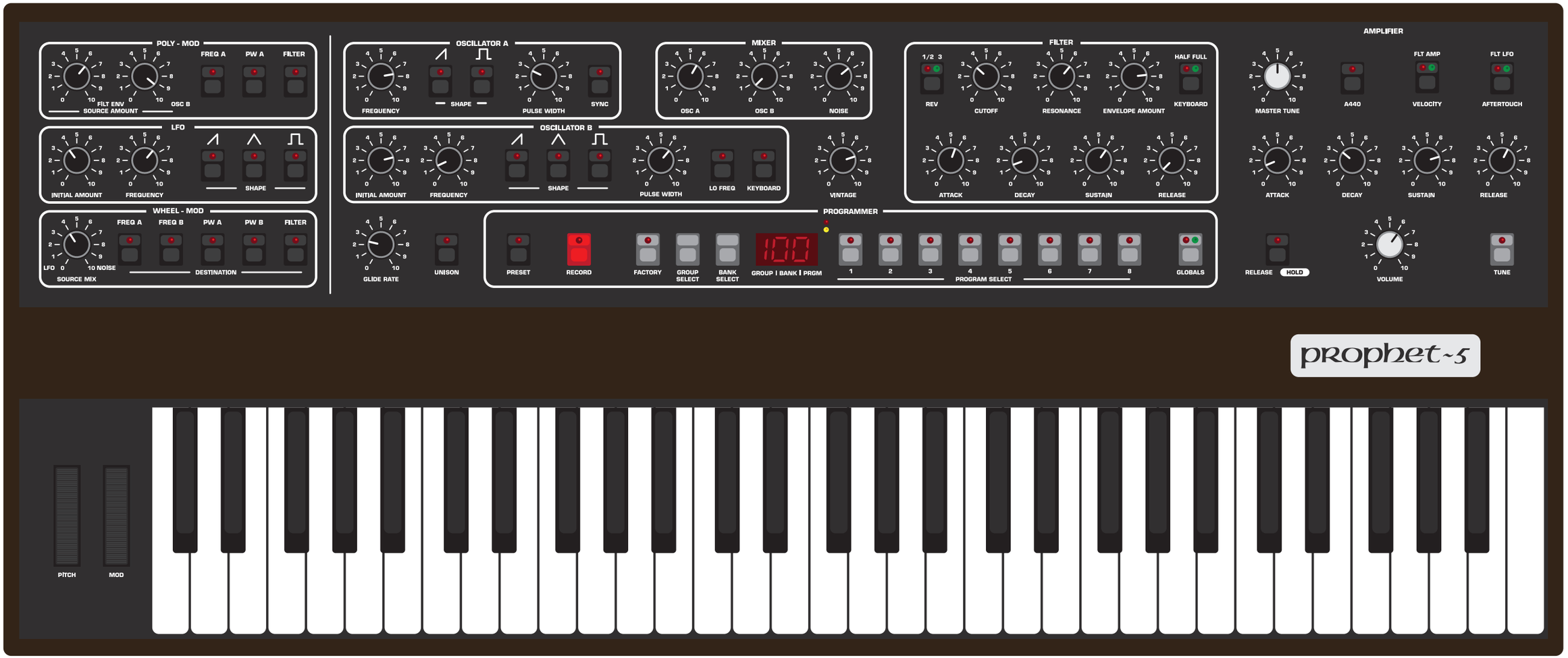


04

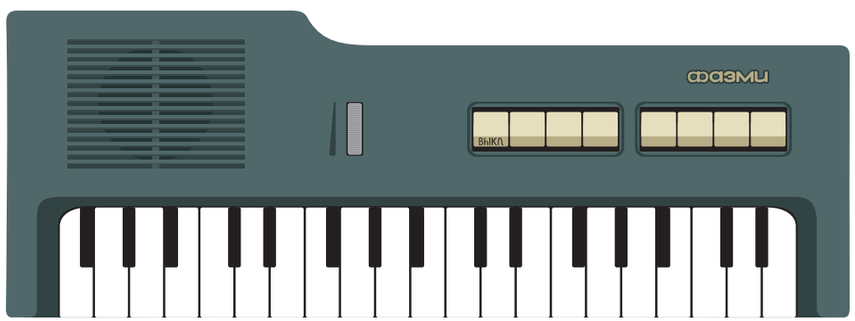
05



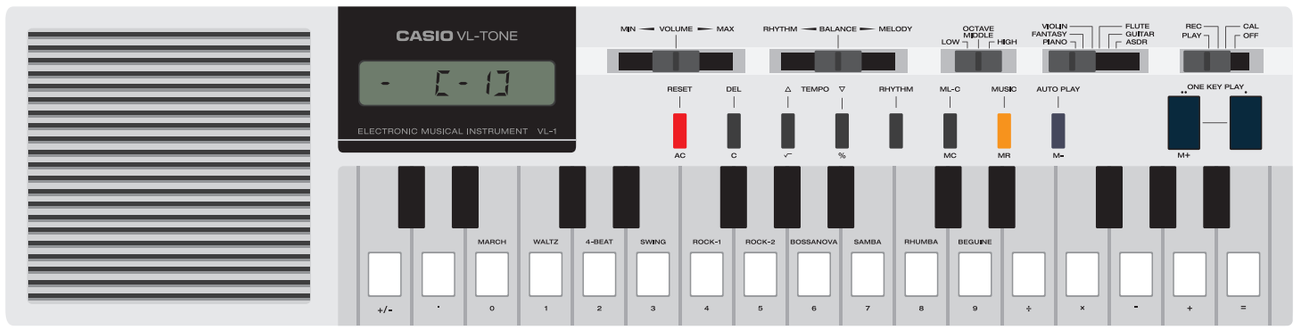
06


POLY - MOD
FREQ A
PW A
FILTER
FILT ENV
SOURCE AMOUNT
OSC B
LFO
INITIAL AMOUNT
FREQUENCY
SHAPE
WHEEL - MOD
FREQ A
FREQ B
PW A
PW B
FILTER
LFO
NOISE
SOURCE MIX
DESTINATION
OSCILLATOR A
FREQUENCY
SHAPE
PULSE WIDTH
SYNC
OSCILLATOR B
INITIAL AMOUNT
FREQUENCY
SHAPE
PULSE WIDTH
LO FREQ
KEYBOARD
GLIDE RATE
UNISON
MIXER
OSC A
OSC B
NOISE
VINTAGE
FILTER
1/2 3
REV
CUTOFF
RESONANCE
ENVELOPE AMOUNT
HALF FULL
KEYBOARD
ATTACK
DECAY
SUSTAIN
RELEASE
PROGRAMMER
PRESET
RECORD
FACTORY
GROUP SELECT
BANK SELECT
GROUP I BANK I PRGM
1
2
3
4
5
6
7
8
PROGRAM SELECT
GLOBALS
AMPLIFIER
MASTER TUNE
A440
FLT AMP
FLT LFO
VELOCITY
AFTERTOUCH
ATTACK
DECAY
SUSTAIN
RELEASE
RELEASE
HOLD
VOLUME
TUNE
prophet-5
PITCH
MOD

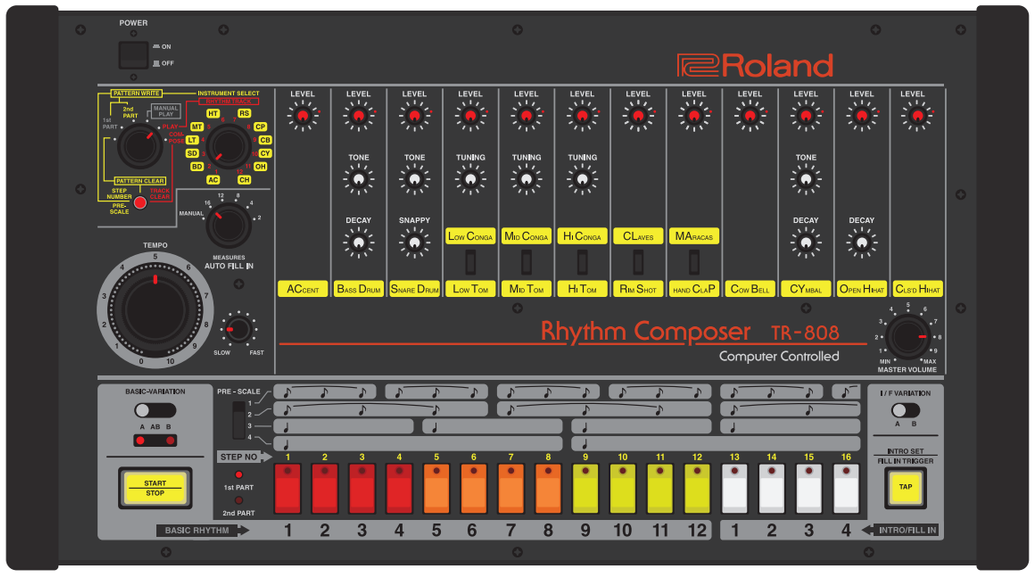
07


ФАЗМИ
ВКЛ

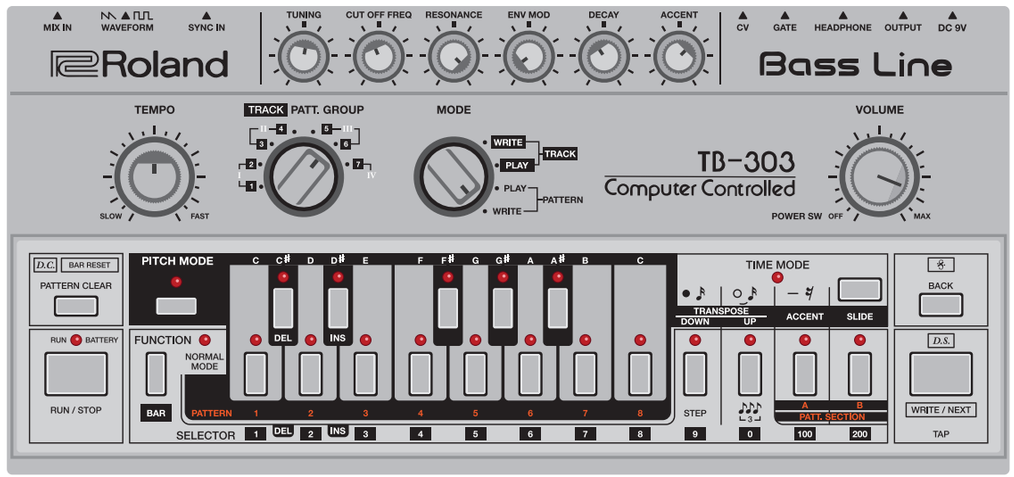
08


CASIO VL-TONE
- C-10
ELECTRONIC MUSICAL INSTRUMENT VL-1
MIN VOLUME MAX
RHYTHM BALANCE MELODY
OCTAVE
LOW MIDDLE HIGH
VIOLIN
FANTASY
PIANO
FLUTE
GUITAR
ASDR
REC
PLAY
CAL
OFF
RESET
DEL
TEMPO
RHYTHM
MU-C
MUSIC
AUTO PLAY
ONE KEY PLAY
AC
C
%
MC
MR
M-
M+
MARCH
WALTZ
4-BEAT
SWING
ROCK-1
ROCK-2
BOSSANOVA
SAMBA
RHUMBA
BEGUINE
+/-
.
0
1
2
3
4
5
6
7
8
9
÷
×
-
+
=

09



10



11

09 (*Previous page*) **Casio VL1** 1979

The next great electronic music revolution would come from Japan. Electronics company Casio was, up until this point, predominantly a manufacturer of calculators. This would all change in 1979. Discovering that they could combine electronic calculator circuitry with a module capable of the newly-invented digital sound synthesis technology, Casio did so. They first produced a calculator that could play sounds – the Melody 80. Then they produced a proper digital synthesiser with controllable modulation and sequencer – the first production digital synth no less – which could also be used as a calculator – the VL-1.

To describe the VL-1 as 'proper' is a somewhat generous though, because its preset sounds bear very little resemblance to the guitar, violin and piano they were intended to represent. Nevertheless, the $70 VL-1 became a massive hit. Over subsequent decades, its sounds and rhythms have been used with varying degrees of irony by a diverse spectrum of musicians. Most irritating of these is undoubted German group Trio's 'Da Da Da', who used the preset 'rock' rhythm and 'piano' voice straight out of the box. Not close behind, Vengaboys deployed the 'drum' rhythm on their mysteriously popular 'Boom, Boom, Boom, Boom!!'. Other users have included Thomas Dolby, The Human League, The Fall, Beastie Boys, Stevie Wonder, Fergie, Dee-Lite and Lady Gaga.

10 **Roland TR-808 Rhythm Composer** 1980

In the early 1980s, the Roland Corporation created a series of iconic electronic music devices which would go on to shape the future of a whole raft of genres and styles. One of the most appealing aspects of this legacy is the fact that virtually none of the instruments which Roland developed during this period would actually end up being used for the purpose for which they were designed.

The Roland TR-808 Rhythm Composer was envisaged as a programmable drum machine that might enable the rapid creation of the drum track on a musical demo. In order to keep the cost down, Roland used analogue synthesis to achieve the sounds, rather than emerging digital technology in the form of actual sampled percussion instruments. Like the TB-303 which followed, the 808 was a commercial failure because it didn't really sound like the instruments it was intended to emulate. The kick drum in particular was very keep and powerful, and could be extended using the decay control. Marvin Gaye's track 'Sexual Healing' was the first hit single to feature an 808. Gaye programmed the sparse, futuristic 808 backing track himself. The instruments has since become perhaps the best-known electronic instrument in history. Hip hop artists like Run-DMC, Public Enemy and the Beastie Boys picked it up in the 1980s. It was used by Hugh pop acts such as Whitney Houston, Phil Collins and Madonna. Kanye West based his album '808s & Heartache' around the instrument, using it for every track. In 2015 the British filmmaker Alexander Dunn released a documentary film about it, simply named '808'.

11 **Roland TB-303 Bass Line** 1981

Roland designer Tadao Kikumoto designed the TB-303 Bass Line in 1981 with the aim of producing an electronic programmable bass guitar that could act as an accompaniment for a solo guitarist. However, the sound produced by the unit sounded nothing like a stringed bass, and it was a commercial disaster. Roland discontinued the 303 in 1984. Over the following years, just like with the 808, electronic music producers would pick up 303s at rockbottom prices and start experimenting with them. The combination of various sound modifying circuits and the method the device used to produce its square waveform allowed the 303 to produce some fairly unique sounds, which included the distinctive squelchy bass that became the signature of acid house. Phuture's 1987 single 'Acid Tracks' exemplified this sound, which was also used on 'Higher State of Consciousness' by Josh Wink, and Hardfloor's 'Acuperience'. It was also used by A Guy Called Gerald, Daft Punk, New Order and Tame Impala. Fatboy Slim (aka Norman Cook) even name checked it on his track 'Everybody Needs a 303'.

(12) **Roland SH-101** 1982
In 1982 Roland released their SH-101 compact monophonic analogue synthesiser. Far less well-known than the 808 or the 303, the 101 was originally conceived as a 'keytar' device — a keyboard to be played standing (or leaping around) by a pop artist, together with a plug-in guitar neck-styled 'modulation grip' which allowed pitch bending. But pop performers, voting with their feet, eschewed the 101 in favour of Yamaha's new digital DX-7 keyboard. One group of musicians took advantage of the flood of cheap 101s floating around — early Detroit techno pioneers such as Derrick May, Juan Atkins and Kevin Saunderson. The bass sounds they created with the 101 became a Detroit signature, and influenced other musicians around the world. In the UK, A Guy Called Gerald's early house hit 'Voodoo Ray' was in many ways an advert extolling the versatility and depth of the 101s abilities.

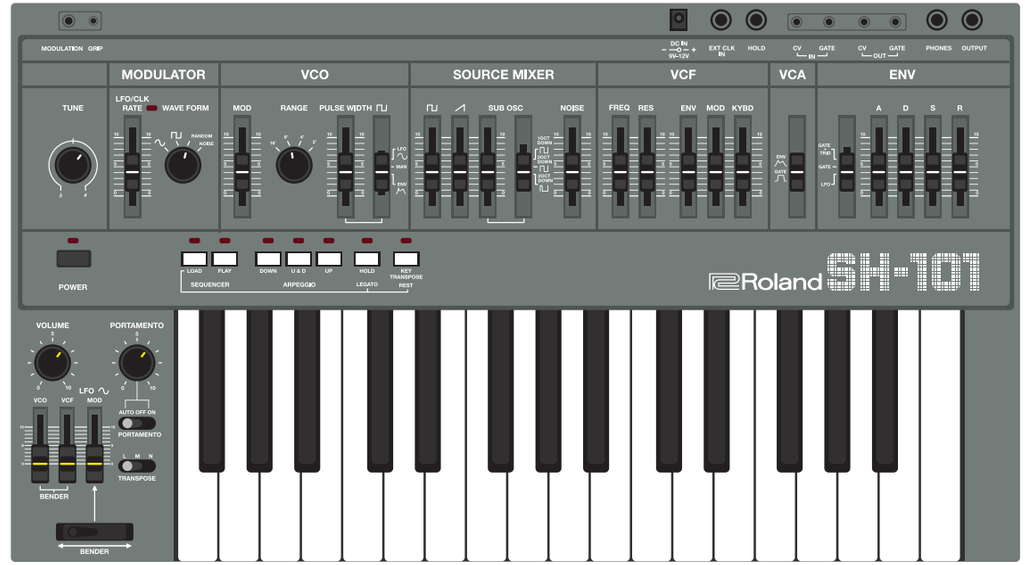
By the early 1990s every dance music producer worth their salt had an SH-101. It has been used on tracks by Aphex Twin, Boards of Canada, 808 State, Portishead, Orbital, The Prodigy, Josh Wink, the Chemical Brothers, Future Sound of London, Squarepusher, the Crystal Method, and Les Rhythmes Digitales.

With the rise of software synthesis in the late 1990s and early 2000s, it's unsurprising that the sounds of the SH-101 became popular with bedroom producers, whose eagerness to recreate its unique tones was typically not matched by their equipment budget. Indeed, as is the case with Roland's 1980s line-up in general, the SH-101 is now a very expensive collectors item. In 2017 the company released the SH-01A — an updated "virtual analogue"recreation of the original 101 — as part of its Boutique line, which also includes recreations of the 808, 303 and 909.

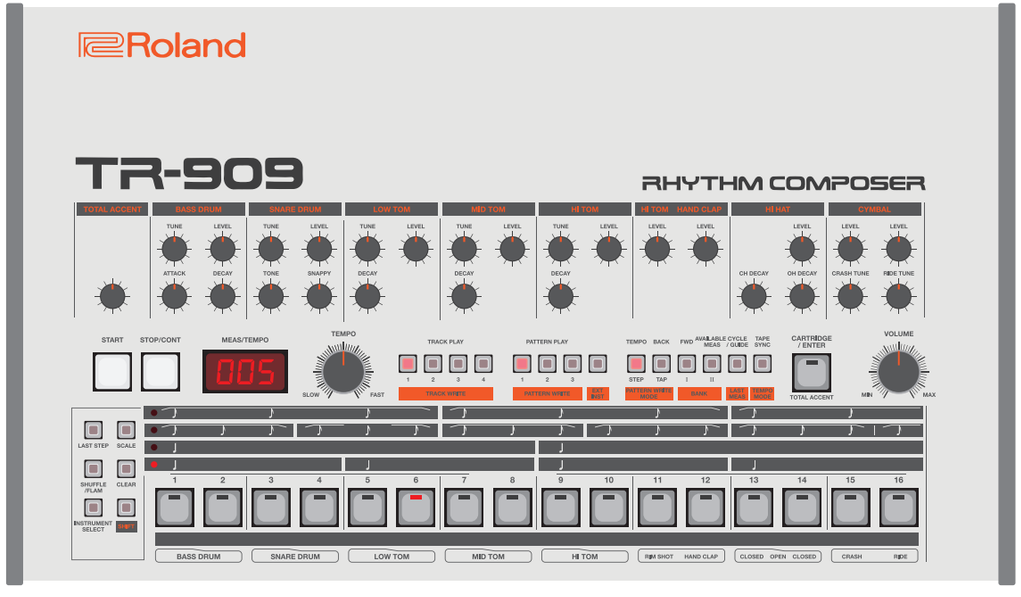
(13) **Roland TR-909 Rhythm Composer** 1983
The Roland TR-909 Rhythm Composer was a successor to the 808, and employed more advanced technology. Some sounds were still produced by analogue synthesis, but others were digital samples. It also was equipped with the newly-developed MIDI, which allowed it to communicate with and be triggered by other electronic devices using this standard. Like its brothers, the 909's idiosyncratic sound was not popular with its target market, and Roland only produced 10,000 909s before they cancelled production. By the mid 1980s a handful of hip hop artists were using the 909, including Ultramagnetic MCs, Mantronix, and Public Enemy. However, it really took off when it found its place in the studios of electronic music producers. The 909 became an essential in the studios of techno pioneers like Derrick May, Juan Atkins and Jeff Mills. It was also important in the development of Chicago house where it was used by artists like Frankie Knuckles and Joe Smooth. Since then it has appeared in Daft Punk's 'Revolution 909', Bjork's 'Hunter', Technotronic's 'Pump Up the Jam', and countless tracks by Orbital and Aphex Twin.

(14) (*Overleaf*) **Yamaha DX7** 1983
Yamaha Corporation had a distinguished history in the manufacture of pianos and organs, and their music division has been experimenting with various forms of synthesis since the release of their GX-1 synth organ in 1975.

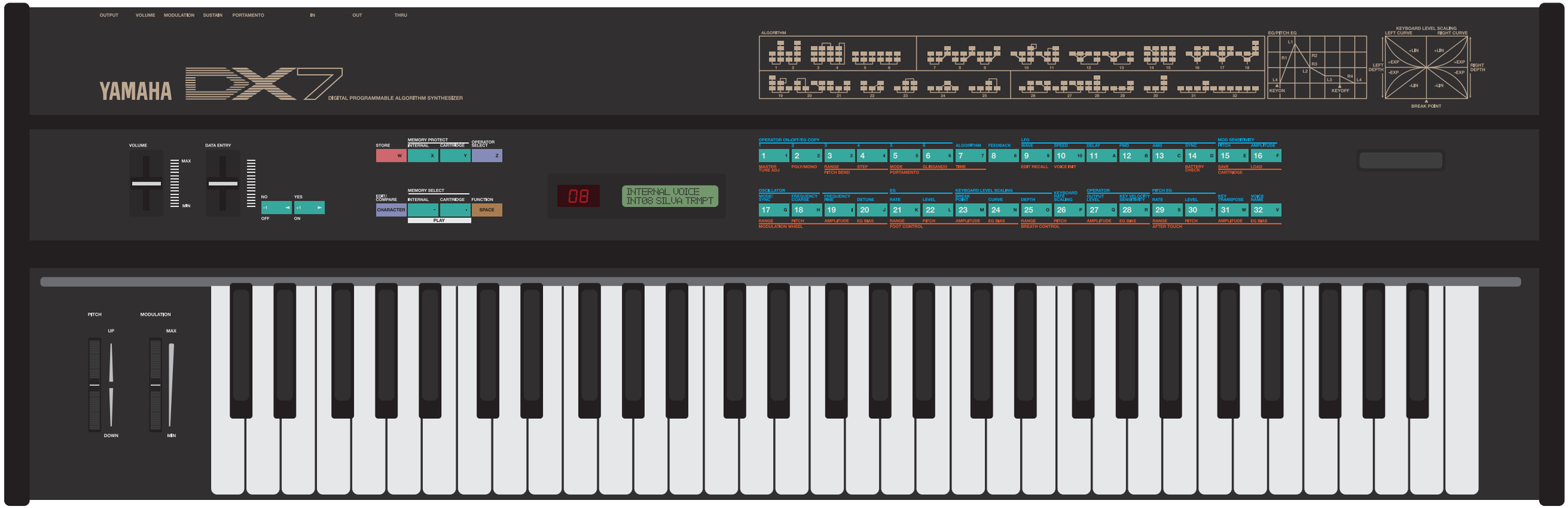
They went on to design and develop the DX7, which was the first mass-produced digital synthesiser. It used a technique developed by Yamaha, known as frequency modulation synthesis to produce its sounds. These sounds were very different to those produced by analogue synthesisers, being much brighter and glassier compared to the latter's fuzzy warm tones. The distinctive new sound it produced rapidly became the big new thing, and the DX7 sold in huge numbers. It could be programmed to generate new sounds — this was perhaps best demonstrated by the synthesiser maestro Brian Eno on his album 'Apollo: Atmospheres and Soundtracks'. However, because of the lack of control knobs, the tricky-to-use membrane buttons and small screen, most artists didn't both attempting this and instead used the standard set of sounds. The DX7 appeared in many of the 1980s best-known pop tracks, including Phil Collins' 'One More Night', A-Ha's 'Take On Me', Kenny Loggins' 'Danger Zone' and Europe's 'The Final Countdown'. The success of the DX7 would become its undoing though. The sounds that had initially sounded so appealing and futuristic became outdated and even cliched in the years that followed.

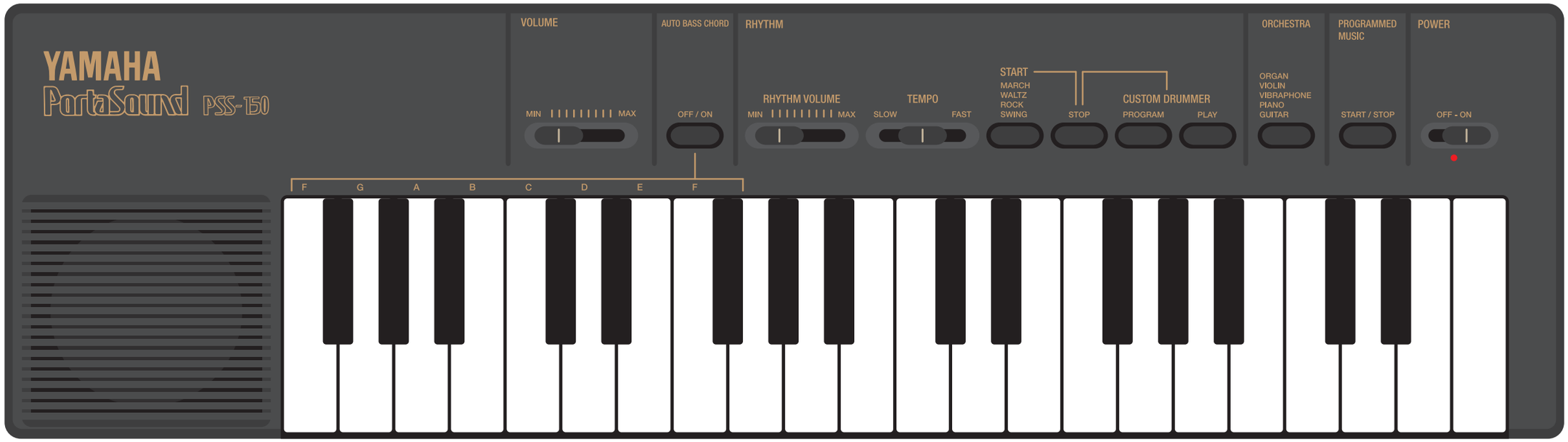


12



13


OUTPUT
VOLUME
MODULATION
SUSTAIN
PORTAMENTO
IN
OUT
THRU
YAMAHA
DX7
DIGITAL PROGRAMMABLE ALGORITHM SYNTHESIZER
ALGORITHM
EG/PITCH EG
KEYBOARD LEVEL SCALING
LEFT CURVE
RIGHT CURVE
LEFT DEPTH
RIGHT DEPTH
BREAK POINT
KEYON
KEYOFF
VOLUME
DATA ENTRY
MAX
MIN
NO
YES
OFF
ON
STORE
MEMORY PROTECT
INTERNAL
CARTRIDGE
OPERATOR SELECT
EDIT/ COMPARE
MEMORY SELECT
CHARACTER
PLAY
SPACE
08
INTERNAL VOICE
INT08 SILVA TRMPT
OPERATOR ON-OFF/EG COPY
MASTER TUNE ADJ
POLY/MONO
RANGE
PITCH BEND
STEP
MODE
PORTAMENTO
GLISSANDO
TIME
ALGORITHM
FEEDBACK
LFO
WAVE
SPEED
DELAY
PMD
AMD
SYNC
MOD SENSITIVITY
PITCH
AMPLITUDE
EDIT RECALL
VOICE INIT
BATTERY CHECK
SAVE CARTRIDGE
LOAD
OSCILLATOR
MODE/ SYNC
FREQUENCY COARSE
FREQUENCY FINE
DETUNE
EG
RATE
LEVEL
KEYBOARD LEVEL SCALING
BREAK POINT
CURVE
DEPTH
KEYBOARD RATE SCALING
OPERATOR
OUTPUT LEVEL
KEY VELOCITY SENSITIVITY
PITCH EG
KEY TRANSPOSE
VOICE NAME
MODULATION WHEEL
AMPLITUDE
EG BIAS
FOOT CONTROL
BREATH CONTROL
AFTER TOUCH
PITCH
MODULATION
UP
DOWN
MAX
MIN


YAMAHA
PortaSound PSS-150
VOLUME
MIN MAX
AUTO BASS CHORD
OFF / ON
RHYTHM
RHYTHM VOLUME
MIN MAX
TEMPO
SLOW FAST
START
MARCH
WALTZ
ROCK
SWING
STOP
CUSTOM DRUMMER
PROGRAM
PLAY
ORCHESTRA
ORGAN
VIOLIN
VIBRAPHONE
PIANO
GUITAR
PROGRAMMED MUSIC
START / STOP
POWER
OFF - ON
F G A B C D E F

15


YAMAHA
SHS-10
FM DIGITAL KEYBOARD WITH MIDI
50
DEMO
MODE
PARAMETER CHANGE
CHORD SEQUENCER
VOICE / STYLE SELECT
RHYTHM CONTROL
EFFECT
POWER
OFF ON
VOLUME
MIN MAX

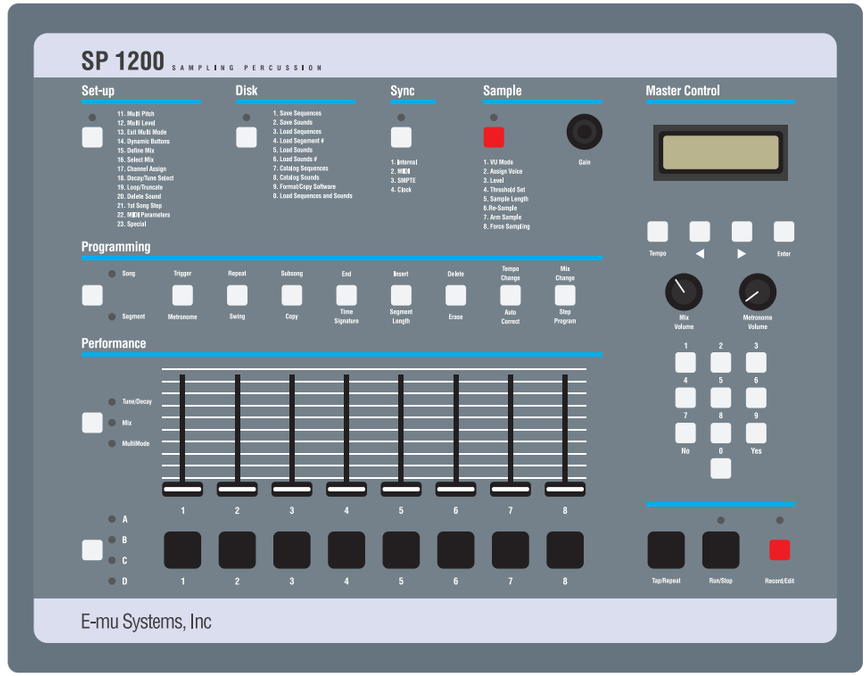
16

(15) (*Previous page*) **Yamaha PSS-150** 1985
The success of the Casio's VL-1 prompted Yamaha to work fast on their own range of cheap, portable digital keyboards. They launched the first of their PortaSound series— the PS-1 — in 1980, and many other models followed with production continuing until the late 1990s. The PSS-150 came out in 1985 and, though only furnished with five voices and four preset beats, came with a programmable percussion sequencer — the 'custom drummer' — which allowed the creatively-minded to do a lot with seemingly little.

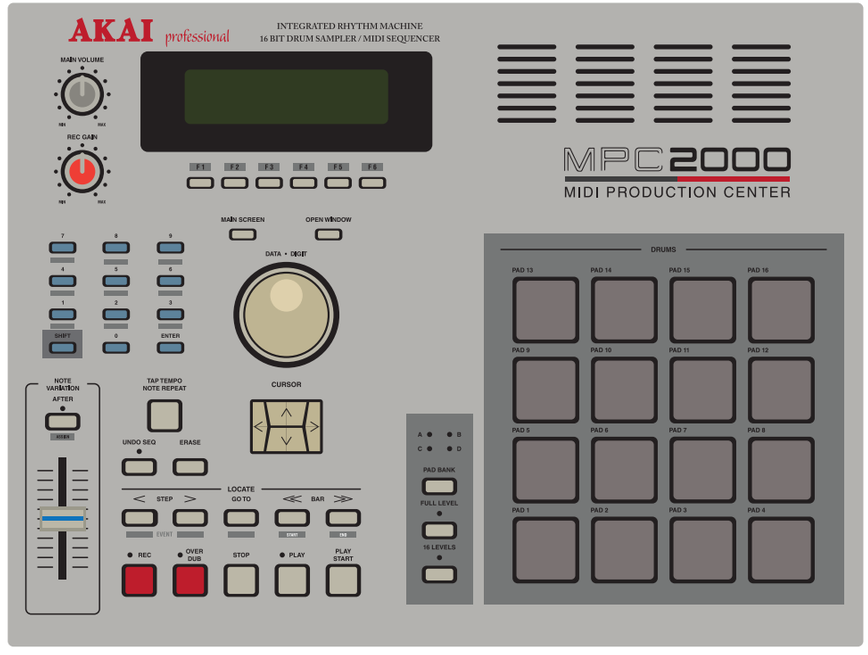
(16) **Yamaha SHS-10** 1987
The Yamaha SHS-10 is one of the most well-known iterations of the keytar — a keyboard-based instrument design to be carried like a guitar with a strap. It had a small keyboard with 32 keys, and various sound controls accessible on the neck, including a pitch bend wheel. The sounds it produced were fairly unexceptional and though it did appear in some music videos it's fairly clear that the actual music was created on something far more sophisticated.

(17) **Emu SP-1200** 1987
E-mu Systems had originally been launched to produce a range of modular synthesizers, and their early work also involved producing components for other manufacturers, including Sequential's Prophet 5. They began working on the emerging technology of digital sampling, releasing the Emulator in 1981. This was followed by the SP-12 and then the more advanced SP-1200 in 1987. These devices were originally intended to sample short drum sounds, which could then be combined using the sequencer to create complex drum beat arrangements. The SP-12 could be modified to extend the sampling time to 5 seconds, and the SP-1200 could manage 10 seconds. The result was the ability to sample drum loops and other extended samples from other tracks, and combine and play these using the large touch pads and sequencer. For the first time, music producers could rapidly create complete arrangements using a single machine and a sound source, such as a turntable. Also, because of the sample compression and the internal filter, the sounds produced by the SP-1200 had a distinctive crunchy, punchy, dirty characteristic. Hip hop producers realised they could create amazing new beat arrangements using the SP-1200. Rick Rubin used it to add a distinctive punch to the Led Zeppelin drum samples used in the opening of the Beastie Boys' 'Rhymin & Stealin'. J Dilla used it on the A Tribe Called Quest track 'Get A Hold', and Pete Rock did the same on his and CL Smooth's 'They Reminisce Over You (T.R.O.Y.)'. It's also been used by The Wu Tang Clan, Gang Starr, Slick Rick, Cypress Hill, and MF Doom.

(18) **Akai MPC (2000)** 1998
The Akai MPC was designed by Roger Linn, who had previously developed a series of digital drum machines under his own Linn brand. The idea was to create a single machine that could be used to create entire tracks from samples in an intuitive way. The initial MPC60, launched in 1988, did everything the E-mu SP-1200 could do, but it could handle longer samples recorded at a higher quality, and the tools for editing and applying effects to the samples were much more advanced. The MPC2000 was released in 1997 and had a number of updates including the ability to quantise beats — automatically arrange individual sample beats into a rhythm — as well as various controls and greater memory which made it easier to play the device live as well as in the studio. The MPC series has remained in production and has been progressively updated ever since. It has become a stalwart tool in the hip hop production arsenal with many producers using it as their main production tool. These include Outkast's Big Boi, Mark Ronson, Dr Dre and Erykah Badu. DJ Shadow produced his entire sample-led album Endtroducing using an MPC, and Kanye West has used his on stage for the opening of his track Runaway. The late J Dilla's MPC is now on display at the Smithsonian.



17



18

(19) **Korg Kaossilator Pro** 2010
Korg developed a radical audio effects unit in the late 1990s which they names the Kaoss Pad. It enabled sound effects such as pitch-pending, delay and distortion which were nothing special on their own, but what was different was the controls - it used a touch-sensitive screen which you wiped your finger around and across to control the effect. It proved extremely popular. At a later point, Korg realised that, rather than using the Pad to modify other sound sources like voice or guitar, they could add a synthesiser to create a complete instrument that could be controlled in a similar way, and they named it the Kaossilator. As well as producing some really interesting sounds, it allowed looping and complete tracks could be recorded and stored on its inbuilt memory.

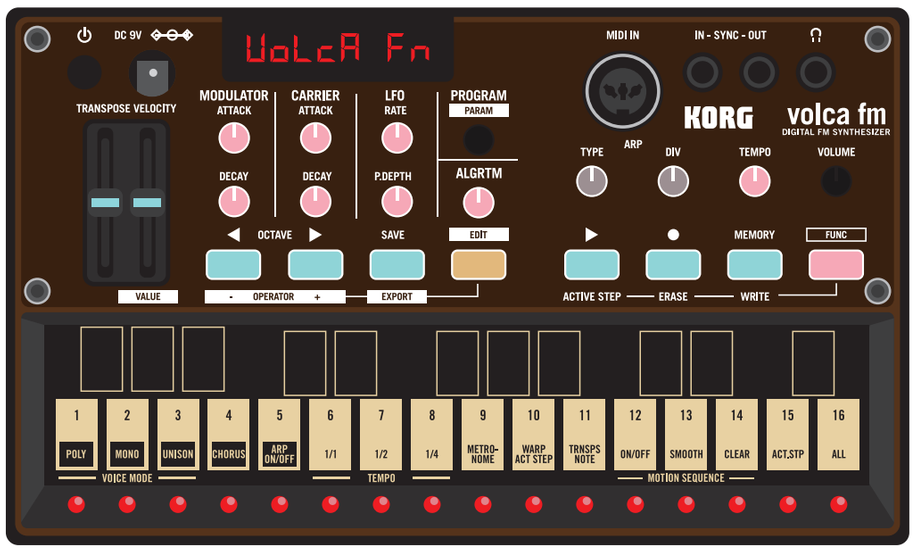
(20) (*Overleaf*) **Ableton Push** 2013
From the mid 1990s onwards, personal computers became powerful enough to run software capable of assembling musical compositions, either by sequencing MIDI connected instruments or, increasingly, by using the computer's own processor to generate sound via software synthesizers. This spawned a generation of producers who could make music without the expense of purchasing multiple hardware synths, drum machines and samplers. Ableton Live was one of these DAWs (digital audio workstation) which was designed both for conventional music production and also for live performance. It could also be used by DJs to mix music. Various controllers were developed to provide musicians with a more tactile alternative to a laptop keyboard. In 2013, Ableton finally realised their own controller. Built for Ableton by Akai, it had a monochrome screen and a variety of buttons and knobs which could be programmed to control a huge variety of musical effects. It also featured a main bank of pressure-sensitive pads which, like those on the E-mu Sp-1200 or MPC, could be used to play samples or drum beats, or to trigger tracks or loops. Strikingly, the pad grid changes color based on musical scales and functions, making harmony visible. The Push 2 was launched in 2015, adding a much larger, multicolour display and more functions. The Ableton Push has been used extensively by artists and producers including DeLaurentis, Stro Elliot, Sonøren, Afrikan Sciences, and Nosaj Thing.

(21) **Korg Volca FM** 2016
The rise of software DAWs and synths would trigger an opposite reaction. Many musicians started rejecting this new technology, and sought out physical instruments which they could play and make music without using a computer at all. Analogue and modular synthesizers had been undergoing a renaissance for sometime, and in 2013 Kong released their Volca line. The Volca concept was simple, fun, low-priced hardware synths which could be connected up to create fully sequenced tracks. The initial series included a drum machine, baseline and an analogue synth. In 2016 Korg introduced the FM, which used FM synthetics to provide DX7 type sounds for a new generation.

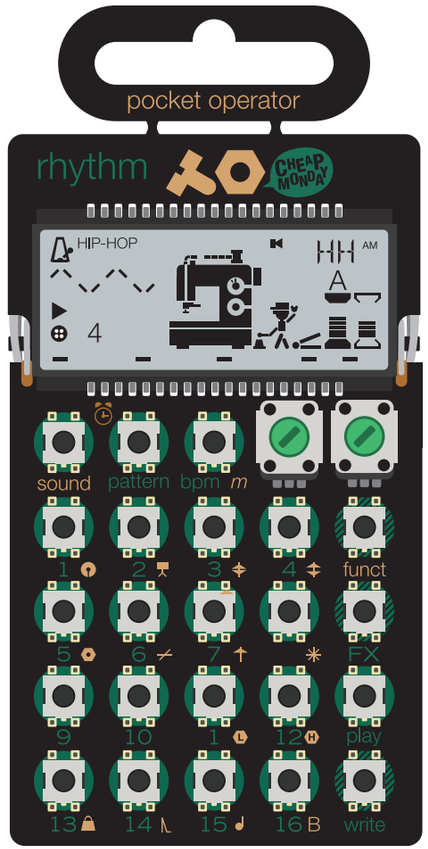
19


Tap Tempo
Metronome
Setup
User
Delete
Undo
FILTER TYPE
Lowpass
Drums
FREQUENCY
11.3 kHz
FM Synth
RESONANCE
44 %
Bassline
FILTER CIRCUIT
PRD
Synths
DRIVE
1.41 dB
Synths
LFO AMOUNT
0.0
Sound FX
LFO SYNC
Free
Long Delay
LFO FREQUENCY
0.11 Hz
Reverb
Add Device
Device
Mix
Add Track
Browse
Clip
Mute
Solo
Stop Clip
Master
Convert
Double Loop
Quantize
Duplicate
New
Fixed Length
Automate
1/32t
1/32
1/16t
1/16
1/8t
1/8
1/4t
1/4
Repeat
Accent
Layout
Session
Octave
Page
Page
Octave
Shift
Select

20


DC 9V
VoLcA Fn
MIDI IN
IN - SYNC - OUT
TRANSPOSE VELOCITY
MODULATOR ATTACK
CARRIER ATTACK
LFO RATE
PROGRAM
PARAM
KORG
volca fm
DIGITAL FM SYNTHESIZER
DECAY
DECAY
P.DEPTH
ALGRTM
ARP
TYPE
DIV
TEMPO
VOLUME
OCTAVE
SAVE
EDIT
MEMORY
FUNC
VALUE
- OPERATOR +
EXPORT
ACTIVE STEP
ERASE
WRITE
1 POLY
2 MONO
3 UNISON
4 CHORUS
5 ARP ON/OFF
6 1/1
7 1/2
8 1/4
9 METRO-NOME
10 WARP ACT STEP
11 TRNSPS NOTE
12 ON/OFF
13 SMOOTH
14 CLEAR
15 ACT.STP
16 ALL
VOICE MODE
TEMPO
MOTION SEQUENCE

21


pocket operator
rhythm
CHEAP MONDAY
HIP-HOP
AM
A
4
sound
pattern
bpm
m
1
2
3
4
funct
5
6
7
FX
9
10
11
12
play
13
14
15
16 B
write

22


Beads
texture synthesizer
FREEZE
SEED
DENSITY
TIME
PITCH
SIZE
SHAPE
DENSITY
IN L
IN R
FREEZE
SEED
L
R
Mutable Instruments

23

(22) (*Previous page*) **Teenage Engineering Pocket Operator PO-12** 2015
The Swedish electronics company Teenage Engineering had launched their first synthesiser in 2010. The OP1 was a fun-to-play and innovative instrument that had a fresh design not dissimilar from the Casio VL-1. In 2015 they released the first instruments in their Pocket Operator series. The ideas was not a million miles away from Korg's Volca concept, but more stripped back. Powered by AA batteries, the devices looked like calculators with the body removed to expose the printed circuit board underneath. The LCD screens and their graphics were heavily influenced by Nintendo's Game & Watch series. A diverse variety of modules were added to the series in the years that followed, including bass synths, vocal samplers, and rhythm units. Like the Volca series, they could be connected up together to produce complex arrangements. The PO-12 Rhythm is a 16 sound drum machine and sequencer, featuring both synthesised and sampled drum sounds as well as an array of effects.

(23) **Mutable Instruments Beads** 2020
The renaissance in modular synthesiser equipment in the early 2000s saw the development of a new system of standardisation. The German company Doepfer had pioneered a format for synthesiser modules called Eurorack. As more module manufactures adopted it, it allowed enthusiasts to mix and match modules in their own unique combinations. Mutable Instruments is a French modular brand who have created some of the most interesting and unusual modules in recent years. Beads is a texture synthesiser, the attraction of which is the ability to take an audio signal, which it then stores internally, before applying various effects to. One of these is known as granular synthesis. The sample is chopped up into little sections, called grains, which can then be outputted to create sonic textures, either stretched out and overlapping, or short and plucky.

(24) **Teenage Engineering PO-80 Record Factory** 2022
Another iconic Teenage Engineering device, the PO-80 Record Factory is a compact, DIY vinyl cutter that lets users create and play back 5-inch discs with a warm, lo-fi sound quality. Released in 2022, it was developed in collaboration with Japanese designer Yuri Suzuki and inspired by his earlier EZ Record Maker. The device is portable, USB-powered, and includes built-in speakers, enabling users to cut records via a 3.5mm audio input and play them back instantly.

(25) **Telepathic Instruments Orchid** 2025
The brainchild of Kevin Parker, the creative force behind Tame Impala, alongside product designer Ignacio Germade, Telepathic Instruments' Orchid is a groundbreaking "idea machine" for musicians, blending advanced chord generation with a 16-voice digital polysynth. Inspired by Parker's decade-old vision, the Orchid integrates three distinct synth engines (virtual analog, FM, and reed piano), onboard effects, and performance modes like Strum and Arpeggiator to foster creativity. Portable with built-in speakers and a rechargeable battery, it aims to revolutionise songwriting by encouraging experimentation and breaking creative boundaries

(24)

(25)