IRONKERNEL EMBEDDED

Product Brief
Revision 11-10-2026

IronKernel 64

A SID music machine on a Digilent Nexys Video: two MicroBlaze V cores, an open-source SID chip in the FPGA, a C64-style shell on HDMI and UART, and a drive that serves tunes from a network share or from the image.

IronKernel 64 plays SID music the way a C64 does, on an Artix-7 FPGA board. Type `LOAD"$",9`, `LIST`, `LOAD"CANON*",9` and `RUN` on a USB keyboard or a UART terminal. Core 0 runs the screen editor and command shell, a 6502 interpreter and a PSID player, and sends every SID register write with its clock cycle to the reDIP-SID core in the fabric. Core 1 emulates a 1541-style disk drive: device 8 reads an SMB network share, device 9 is a read-only tune bank held in DDR3. The picture is 720p60 HDMI with a now-playing screen, and the sound leaves through the board's ADAU1761 codec. The firmware is C, and the gateware and firmware are open source apart from the network core.

Highlights

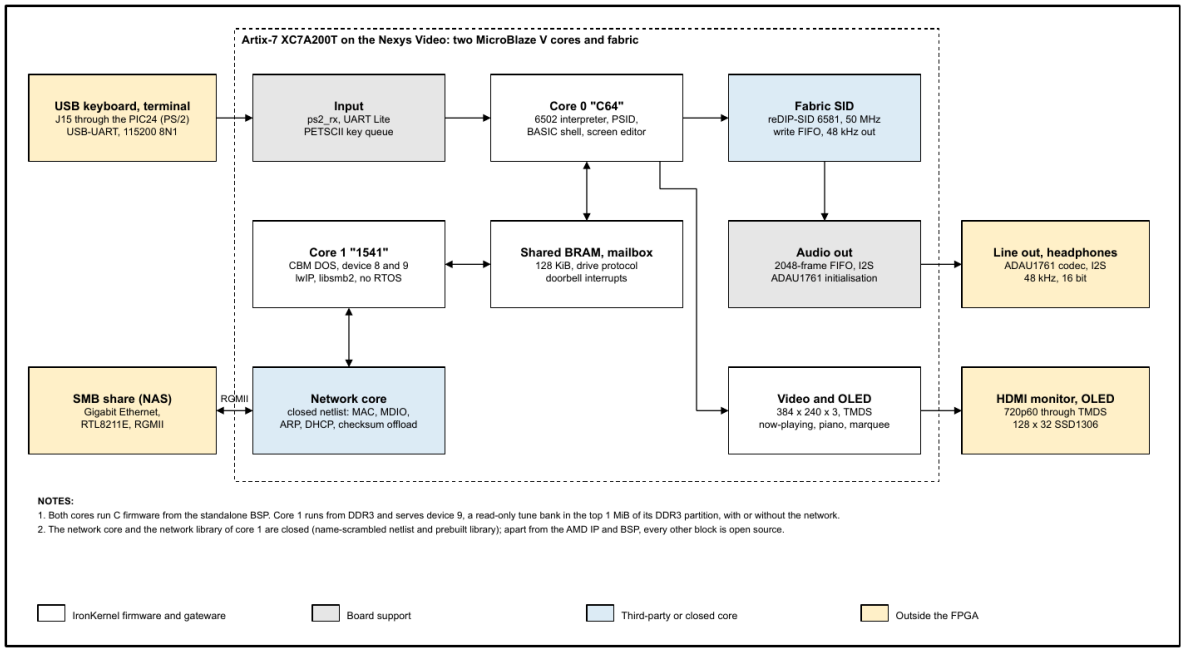
- SID in gateware: reDIP-SID, one 6581, fed at its own 985,248 Hz clock with cycle-exact register writes
- Two MicroBlaze V cores: a "C64" core with the shell and the 6502, a "1541" core with CBM DOS and the network
- C64-style commands: LOAD, LIST, RUN, NEW, the @ wedge, wildcards, cursor-edit of directory lines
- Two drives: device 8 is an SMB share over Gigabit Ethernet, device 9 is a built-in bank that works without a network
- Now-playing screen with song select, voice level bars and two piano keyboards; 128 x 32 OLED marquee
- PSID v1 to v4, vertical-blank and CIA-timer tunes, PAL and NTSC
- UART mirrors the screen; Ctrl-B opens an engineering command line
- Public tune bank of 9 arrangements of public-domain pieces
- Stand-alone boot from one QSPI flash image: bitstream, both firmware images and the tune bank, `READY.` about 4 s after power-up

At a glance

Item	Value
Board	Digilent Nexys Video, XC7A200T, 512 MiB DDR3
Processors	2 x MicroBlaze V RV32IMC, 100 MHz
SID	reDIP-SID 6581 at 50 MHz, 48 kHz out
Video	720p60 HDMI, 384 x 240 drawn 3x
Audio	ADAU1761, 16 bit, 48 kHz
Input	USB keyboard (J15), USB-UART 115200
FPGA use	LUT 29.3 %, BRAM 78.5 %, DSP 1.6 %
Core 0 image	89,686 B text, 96.0 % of 256 KiB LMB

How it works

Figure 1. IronKernel 64 and what it connects to (product-brief, sheet 1)



A key typed on the keyboard or the UART reaches core 0. `LOAD` becomes a request in a shared 128 KiB BRAM, and a mailbox doorbell wakes core 1, which reads the file from the share or from the bank and answers. `RUN` parses the PSID header and runs the tune's init and play routines on the 6502 interpreter; each SID write is queued with its cycle and replayed by the fabric SID, whose 48 kHz output reaches the codec without CPU time. Video, the OLED and the keyboard are fabric blocks on core 0's register window.

Area	Features
Shell	40 x 25 screen editor, RETURN reads the logical line, C64 error messages, boot banner with the probed RAM size
Commands	`LOAD"name",8` or `,9`, `LOAD"$"`, `LIST`, `RUN`, `NEW`, `@`, `@$pattern`, CBM wildcards
Keys	cursor, Home, Insert, Delete, function keys, colours, Caps Lock as SHIFT LOCK; X or RUN/STOP breaks a tune; `+`, `-`, `1` to `9` pick songs
Player	PSID v1 to v4, VBI and CIA speed, PAL and NTSC, 6502 with documented and stable illegal opcodes
SID	reDIP-SID 6581 in fabric, 512-entry timestamped write FIFO, OSC3 and ENV3 read-back
Video	720p60 CEA-861, 3x pixel scaling, Colodore palette, MEGA65 Open ROMs font
Drive	CBM DOS channels, byte-exact directory program, status codes, device 8 SMB 2/3 client, device 9 bank
Network	Gigabit RGMII, DHCP in the closed network core, lwIP and libsmb2 without an RTOS
Tools	host tests, RTL regression with negative controls, bank packer, siddump-style SID dump over the UART

Verification

Evidence	Result
RTL regression (reset-policy scan, 16 benches each with a forced-failure control)	33 passed, 0 failed
Timing of the release build, 0 failing endpoints	WNS 0.083 ns, WHS 0.012 ns
Host tests: drive bank, CBM DOS, CLI, piano, OLED, PSID, SID, screen (`ik64_host_tests.sh`)	12 of 12 PASS
Public bank: 9 tunes through the real PSID loader, 6502 and memory map	all PASS; worst play call 3,266 of 20,000 cycles
Board: boot, DDR3, codec, Gigabit link, SMB 3.1.1, `LOAD` and `RUN` from the share	demonstrated 11-09-2026 over the UART
Board: boot from QSPI flash, owner and public release images, device 9 bank, share, `VERSION`	demonstrated 11-10-2026
Board: listening check against sidplayfp, 30-minute soak	to verify

Offerings

Offering	Content
Source	firmware, tools and scripts under GPL-3.0-or-later; gateware under GPL-3.0-or-later or CERN-OHL-S-2.0
Network core	closed netlist and library, with an interface document; licence exception for use with IronKernel 64 (README)
Images	flash image `ik64_qspi.mcs` and bitstream `c64_qspi.bit` with SHA-256 sums; no share configured
Services	by agreement with the owner

Hardware needed

A Digilent Nexys Video, a USB keyboard on J15, an HDMI monitor, a line input or headphones on the audio jacks, a USB cable for the UART, and for device 8 an SMB share on the Ethernet LAN. Device 9 needs no network. Not included: any C64 ROM image, HVSC tunes, microSD support.

Open-source components

The full list with commits, licences and file locations is in chapter 14 of the specification and in `docs/THIRD_PARTY_NOTICES.md`.

Component	Licence	Used for
reDIP-SID (Dag Lem)	CERN-OHL-S-2.0	SID chip in fabric
reSID tables (Dag Lem)	GPL-2.0-or-later	waveform and filter tables
libsmb2 (Ronnie Sahlberg)	LGPL-2.1-or-later	SMB client of device 8
lwIP 2.2.0	BSD-3-Clause	TCP/IP
MEGA65 Open ROMs font	LGPL-3.0-or-later	character set
Dormann 6502 tests	GPL-3.0	CPU self test
Digilent board files, master XDC	MIT	pins and DDR3 settings
AMD IP and BSP	AMD licence	MicroBlaze V, DDR3, AXI blocks
IronKernel network core	closed	Ethernet MAC and protocols

Commodore 64 is a trademark of its owner. IronKernel 64 is an unaffiliated hobby project and contains no Commodore ROMs.