PC Engines

apu1 series system board

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Federal Communications Commission Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio energy. If this equipment is not installed and used in accordance with the manufacturer's instructions, it may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.

- Increase the separation between the equipment and receiver.

- Connect the equipment to an outlet on a circuit different from that to which the receiver is connected.

- Consult the dealer or an experienced radio/TV technician for help.

This board is designed for installation in a shielded enclosure (metal or plastic with conductive coating). Shielded cables are required on LAN and serial ports to assure compliance with FCC regulations.

A copy of the test report will be provided on request.

Note: apu has been tested as a CPU board, installed in an enclosure, with the top cover removed. No further testing should be required if the board is used with other FCC tested modular components. Please see http://www.fcc.gov/oet/ for more details. The responsible party for FCC is the importer.

Recycling / disposal
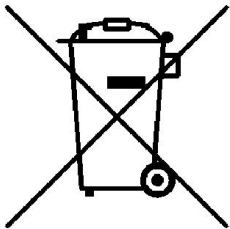
Do not discard electronic products in household trash!

All waste electronics equipment should be recycled according to local regulations.

Information for the recycler:

Please cut off Lithium battery, if present, for separate recycling.

PC Engines enclosures are made of aluminium.

CE declaration of conformity

Supplier's Name: PC Engines GmbH

Supplier's Address: Flughofstrasse 58, 8152 Glattbrugg, Switzerland

declares, that the product

Product name and model: apu1c, apu1c4, apu1d, apu1d4

conforms to the following Product Specifications and Regulations:

EMC:

      EN 55022 (2006) Class B

      EN 61000-6-2 (2006) for industrial environments (immunity)

      EN 61000-6-3 (2007) for residential environments (emissions)

RoHS:

      EN 50581:2012

The product herewith complies with the requirements of the EMC directive 2004/108/EC, the RoHS directive 2011/65/EU and carries the CE marking accordingly.

P. Dornier

Pascal Dornier

President

Glattbrugg, July 31, 2014

Note: Further compliance testing at the system level may be required for CE mark when other modules such as wireless cards are added.

Introduction / Features

PC Engines apu boards are small form factor system boards optimized for wireless routing and network security applications.

CPU	AMD G series T40N or T40E APU, 1 GHz dual core (Bobcat core) with 64 bit support, 32K data + 32K instruction + 512KB L2 cache per core
DRAM	2 or 4 GB DDR3-1066 DRAM
Storage	Boot from SD card (built-in adapter, connected through USB), USB or m-SATA SSD. 1 SATA data + power connector.
Power	12V DC, 2.5 mm center pin, center positive. About 6 to 12W depending on CPU load. Recommend 12V adapter rated for at least 1.5A to provide margin for peripherals.
Expansion	2 miniPCI express (one with SIM socket for 3G modem), LPC bus, GPIO header, I2C bus, COM2 (3.3V RXD/TXD).
Connectivity	3 Gigabit Ethernet (Realtek RTL8111E), 1 DB9 serial port (console).
Firmware	CoreBoot open source system BIOS with support for iPXE and USB boot.
Form factor	6"x6" (152.4 x 152.4 mm), fits in our case1d2*u enclosures.
Cooling	Conductive cooling from the CPU and south bridge to the enclosure.

Heat spreader assembly

The apu CPU and south bridge are passively cooled by heat conduction to the enclosure.

The apu board should not be powered up without cooling except for brief bench tests.

The included heat spreaders are designed for our enclosures. Third party enclosures should work if they are made from aluminium, and have a board standoff height of 5 mm. If in doubt, please contact us. Based on our measurements, at full load the CPU runs a few degrees cooler in the black (case1d2blku) or red (case1d2redu) enclosures, compared to the plain anodized enclosure (case1d2u).

Photos for this assembly procedure can be found at www.pcengines.ch/apucool.htm .

- Remove DB9 hex nuts. Using a small x-acto knife or similar, peel transparent backing foil from the small heat spreaders. Apply to CPU and south bridge. Then peel the blue cover foil from the heat spreaders.

- Place the alu heat spreader (blank side down) over CPU and south bridge. Make sure to avoid conflict with nearby through hole components. Peel the cover foil.

- "Bottoms up" - hold the enclosure base upside down, feed the board DB9 and LAN connectors through the openings. Lightly press board and enclosure base together to stick the heat spreader in place.

- Turn around and carefully press down around CPU and heat sink to get good contact between enclosure and heat spreader. Then insert screws and hex nuts.

Please do not disassemble the unit needlessly, the thermal conductive pads are easily damaged. Replacement pads are available from us on request.

Getting started…

- Please install heat spreader as described in the prior section.

- Insert a boot device (SD card, mSATA SSD, USB stick, or PXE through LAN).

- Connect serial port to a PC through null modem cable (RXD / TXD crossed over). Set terminal emulator to 115200 8N1.

- Connect Ethernet as needed.

- Connect a 12V DC power supply to the DC jack. Power supply should be able to supply at least 18W for some margin. To avoid arcing, please plug in the DC jack first, then plug the adapter into mains.

The board should now power on. All three LEDs will light during BIOS POST, then the system will try to boot. You should see BIOS messages on the serial console. Press F12 for boot device selection:

```
Build date: Apr  1 2014
System memory size: 2017 MB

Press F12 for boot menu.

Select boot device:

1. USB MSC Drive   8.07
2. iPXE (PCI 00:00.0)
3. Payload [setup]
4. Payload [memtest]
```

Setup options

To set up the boot sequence and other options, press F12 for boot device selection, then select Payload [setup].

```
=============================================
Type lower case letter to move device to top
=============================================
boot devices

  a SD Card
  b USB 1
  c USB 2
  d mSATA
  e SATA 2
  f SATA 3
  g NETWORK / PXE


=============================================
Type upper case letter to invoke action
=============================================
  R Restore boot order defaults
  N Network/PXE boot - Currently Enabled
  S Serial console - Currently Enabled
  E Exit setup with save
  X Exit setup without save
```

The lower case letters will change the boot sequence, pull the selected device to the top of the list.

R   toggles serial console enable. Push the switch S1 during startup to get into setup when the serial console is disabled.
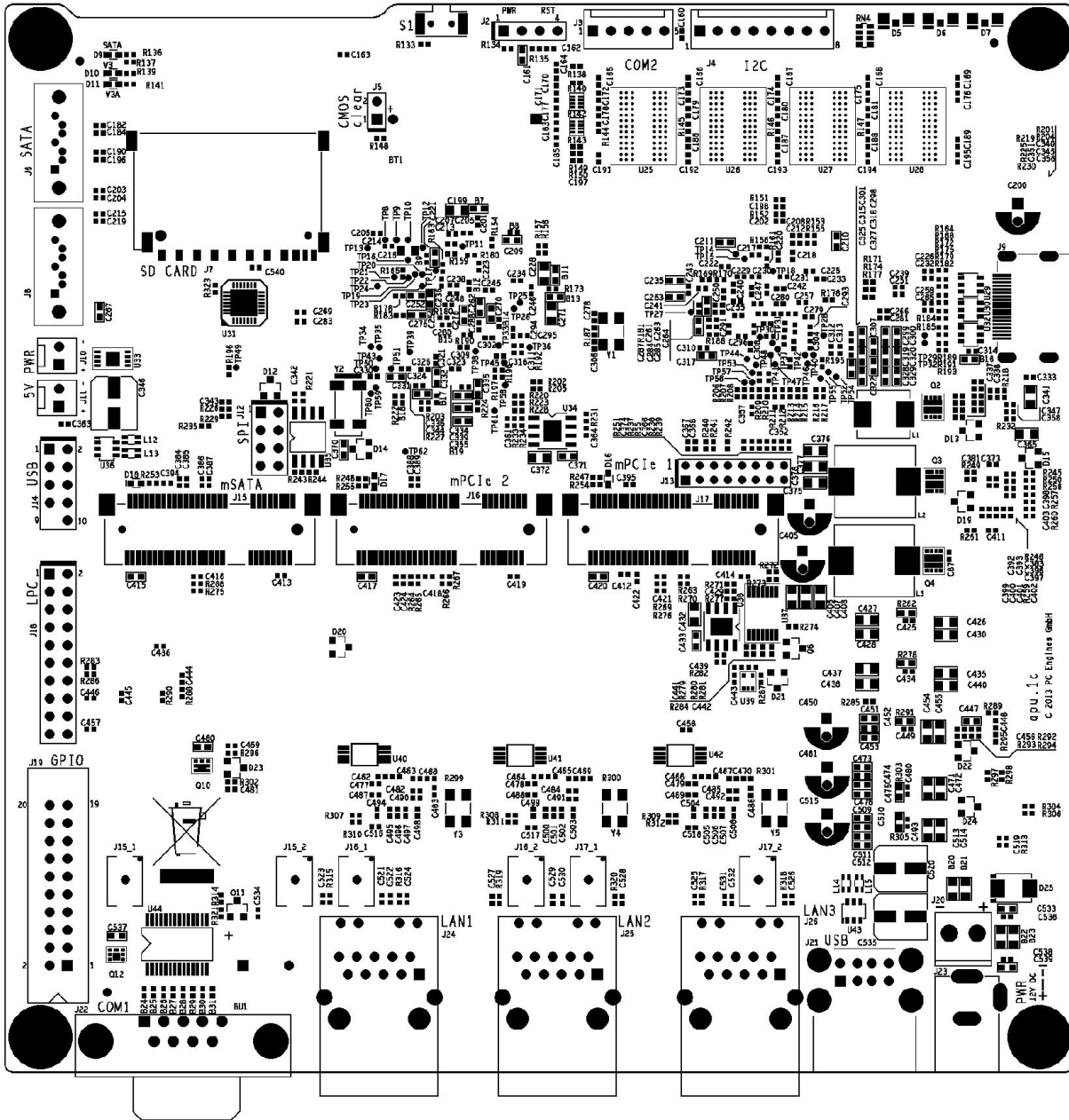
Memtest

To start, press F12 for boot device selection, then select Payload [memtest].

Does not react to keystrokes, but basic test should still be useful.

CoreBoot source code

The CoreBoot firmware is licensed under the GPL. To obtain the source code and a Voyage Linux image with the tool chain needed to compile it, please contact support@pcengines.ch .

Connectors

J1 SIM	(bottom side) – SIM socket for 3G modem installed in miniPCIe J16.
J2 power / reset	Pins 1 – 2 = power button; pins 3 – 4 = system reset
J3 COM2	3.3V serial port (RXD / TXD only).
(J4 I2C / LED)	(optional expansion, see schematic for pinout)
J5 CMOS reset	Short these pins while power is off to clear RTC / CMOS RAM. Don't leave jumper permanently as this would drain the battery.

(J6 SATA)	Not populated as future AMD Kabini based boards will only support 2 SATA devices (m-SATA + SATA).
J7 SD card	SD card interface, connected through USB.
J8 SATA	For SATA devices.
(J9 HDMI)	(Not populated, and not supported by our BIOS)
(J10 SATA power)	(5V power for SATA devices, not populated)
J11 SATA power	5V power for SATA devices.
J12 SPI	SPI header for debricking using Dediprog or similar SPI flash programmer.
J13 JTAG	Debug only, not populated.
J14 USB	Internal USB (2 x USB 2.0)
J15 m-SATA	For m-SATA SSD only, not for miniPCI express devices.
J16 miniPCI express	For miniPCIe cards, including 3G modems (SIM socket J1 on bottom side)
J17 miniPCI express	For miniPCIe cards.
J18 LPC	LPC header for debricking and expansion.
J19 GPIO	General purpose I/O pins + extra serial ports.
J20 internal power	Optional power header
J21 USB	External USB (2 x USB 2.0)
J22 COM1	Serial port. Full handshake signals this time…
J23 Power	DC jack (2.5 mm center pin, center positive).
J24 LAN1	GigE port. Left LED (green) indicates activity, right LED (amber) is turned on when the connection is Gigabit.
J25 LAN2	GigE port
J26 LAN3	GigE port

Schematics

Can be found on our web site.

Hardware limitations

This board does not support power over Ethernet.

GPIO

The following signals are driven by the AMD A50M FCH south bridge:

Pushbutton switch S1 = G187

LED1 = G189, LED 2 = G190, LED 3 = G191

GPIO pins on header J19 are driven by the Nuvoton NCT5104D I/O controller. Data sheet and sample code available on request.

Operating system compatibility

Please keep in mind that apu boards do not include a keyboard controller. Some boot loaders may hang and need to be modified.

FreeBSD

Please do a BIOS upgrade to build date April 1 2014 or later.

FreeDOS

Tested ok, booting from SD card or USB stick.

FreeDOS serial console is broken as usual, backspace does not behave the way it should, use ^H instead.

CoreBoot is limited to two active USB storage devices, and does not react to kindly to hot plug events.

Linux

Please contact support@pcengines.ch for support if necessary. We provide sample images for tinyCore Linux at www.pcengines.ch/tinycore.htm. To access the thermal sensor under Voyage Linux:

```
# apt-get install lm-sensors
# sensors-detect
…
        AMD Family 12h and 14h thermal sensors...              Success!
    (driver `k10temp')
…
# sensors
k10temp-pci-00c3
Adapter: PCI adapter
temp1:        +57.4 C  (high = +70.0 C)
                       (crit = +100.0 C, hyst = +97.0 C)
```

NetBSD

NetBSD 6.x works.

OpenBSD

Please do a BIOS upgrade to build date April 1 2014 or later.

pfSense® software

Wle200nx is supported by pfSense software version 2.2 and later.

Simplified install instructions:

Prepare a USB stick with TinyCore Linux (see above).

Copy the pfSense software image (amd64 nanobsd with serial console) to the FAT partition of the TinyCore USB stick

Boot the apu board with the TinyCore USB stick

Write the image to the mSATA or SD card:

```
gzip -dc pfSense-2.X-RELEASE-Xg-amd64-nanobsd.img.gz | pv | dd of=/dev/sda bs=10M
```

Remove USB stick and reboot, the system should now start.