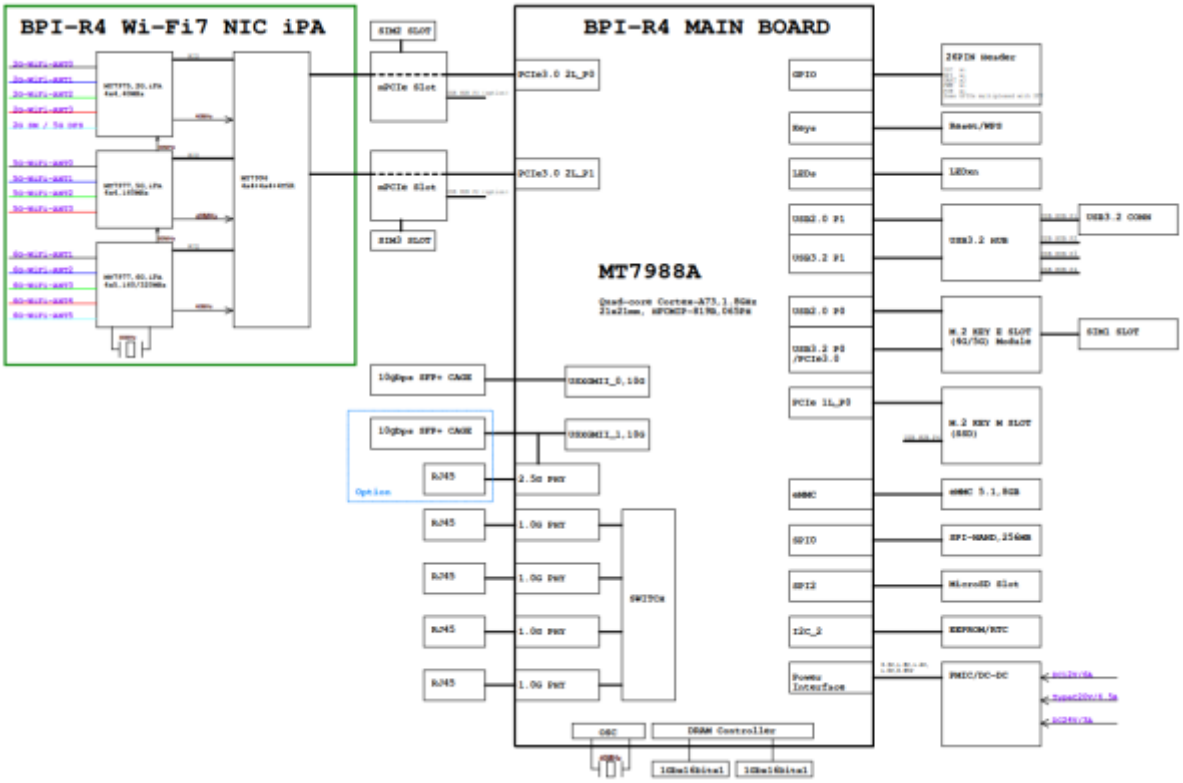
BananaPi R4

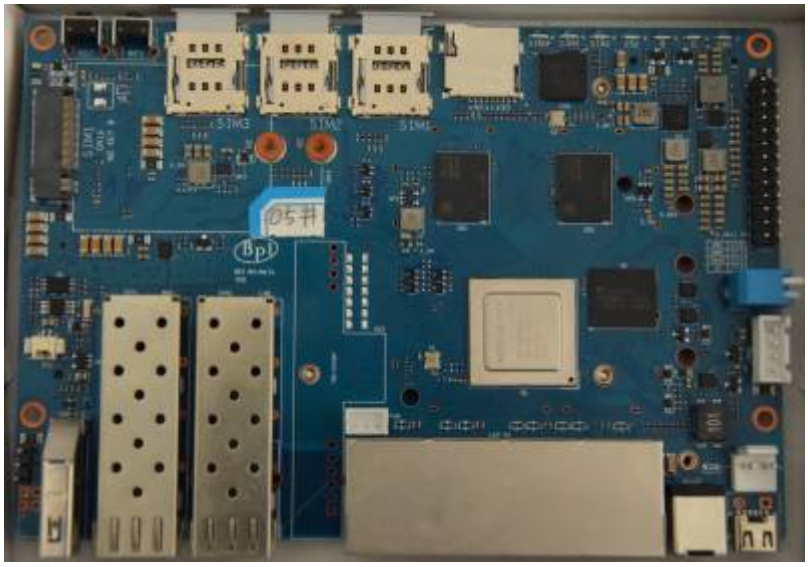
https://wiki.banana-pi.org/Banana_Pi_BPI-R4

Hardware

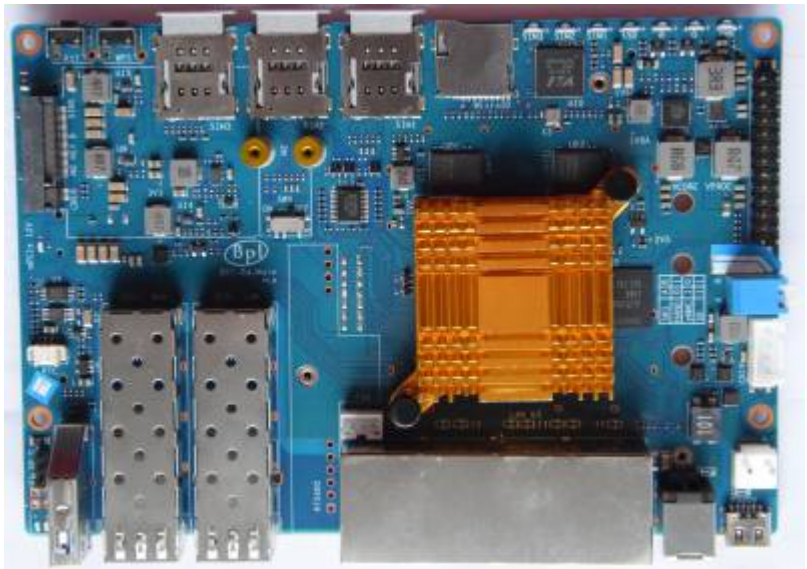
- MediaTek MT7988A (Filogic 880)
  - MT7530 switch builtin (1 cpu-port with 4GBit/s + 1Gbit/s user-ports)
- 4G RAM
- 8GB eMMC flash
- 128MB SPI-NAND Flash
- either 2x SFP+ (10GBit/s USXGMII) or 1SFP+ and 2g5 rj45 with PoE (link)
- Wifi7 with additional module connected to the 2 PCIe slots at bottom of board
  - BPI-R4-NIC-BE19 (no public sale): MT7996 + MT7975 (2.4G) + MT7977A (6G) + MT7977B (5G)
  - BPI-R4-NIC-BE14: MT7995AV + MT7976CN + MT7977IAN
- powersupply 12V/5A required when using wifi card,2A (like on other BPi Routers) is not enough



v00:

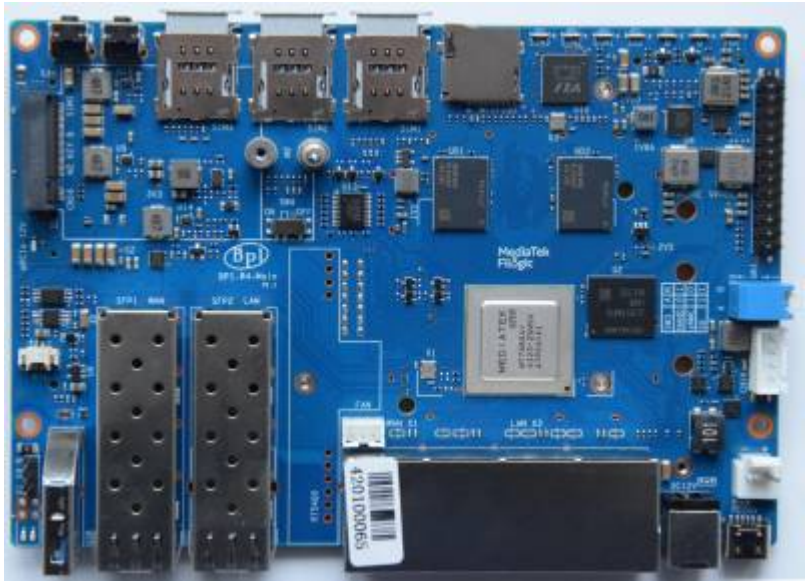


v1.0:



Changes between v0 and v1 (pm): https://forum.banana-pi.org/t/bpi-r4-linux-bootup/15926/59

v1.1:



Network

GMAC0 (4GBit/s) is connected internally to mt7530 switch variant where the 4 user-Ports are exposed as rj45 on board (1xWan,3xLan).

The SFP(+) cages are connected to SerDes lanes of GMAC1 and GMAC2, and those can be switched between SGMII/1000Base-X/2500Base-X mode for 10M/100M/1000M/2500M (via mtk-pcs-lynxi, just like on MT7622 and MT7986) and USXGMII/10GBase-KR for 5000M and 10000M. Hence it should be possible to support both, SFP modules with 1000M and 2500M, as well as SFP+ modules with 5000M and 10000M.

Sfp-connections

USB-A	SFP1-WAN	SFP2-LAN	4xRJ-45	12V	USB-C
	USXGMII0	USXGMII1	GSW		
	eth2	eth1	eth0		

pm: https://forum.banana-pi.org/t/bpi-r4-linux-bootup/15926/101 (changed interface-names because eth2 is wan-sfp)

full 10G will need RSS+LRO implemented in mtk ethernet driver and enabled (not yet working):

```
ethtool -K eth2 lro on # enable hw_lro
ethtool -k eth2 | grep large
large-receive-offload: on
iperf3 -bidir -c 192.168.90.10
```

RSS: https://git01.mediatek.com/plugins/gitiles/openwrt/feeds/mtk-openwrt-feeds/+/18f46a84d87308a4f56f9176ca166dc75c38bb20%5E%21/ LRO: https://git01.mediatek.com/plugins/gitiles/openwrt/feeds/mtk-openwrt-feeds/+/ddc366751fad05dade79b09932a999c5d5ae890c%5E%21/#F0

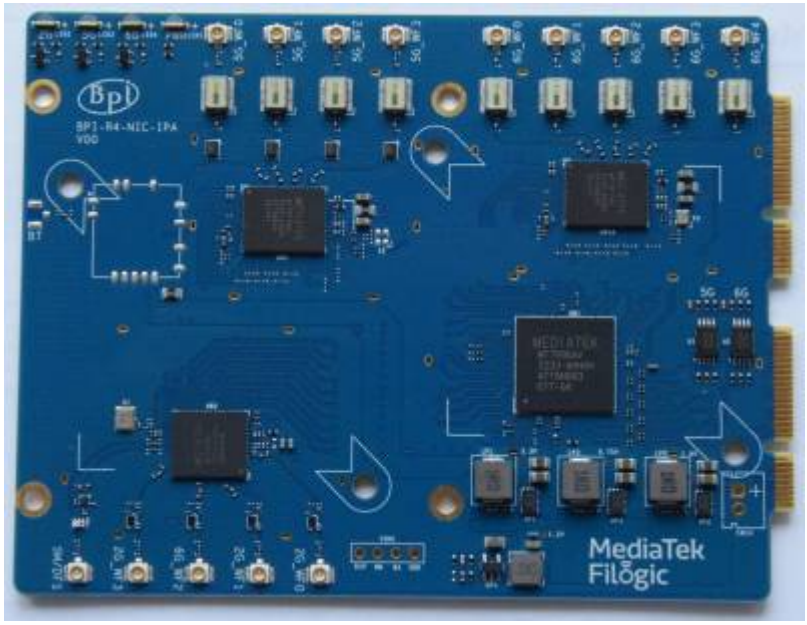
NETSYS: V2 for mt7986 (bpi-r3) V3 for mt7988 (bpi-r4)

Wifi

wifi is realized with daughter board (Network Interface Card) in the 2 mPCIe-Slots at bottom of the board.

Wifi-Module needs 12V...v1 uses sw4 in on-position, v0 used devicetree-overlay which enables the WIFI_PWR_EN regulator. Be careful with this setting when using different card in mPCIe slots!

kernel-module: mt7996e.ko



Newer wifi card with reduced antenna-count (6 instead of 14):

https://forum.banana-pi.org/t/banana-pi-bpi-r4-bpi-be14-wi-fi7-nic-module/17182

newer card currently has timeout on 3rd wifi interface (6.8-netnext), i guess we need another firmware file for the mt7977ia frontend

PCIE

2x1Lane (M.2 slots) and 2x2lane. the 2x2lane is for wifi (mPCIe slots).

USB

Bootswitch

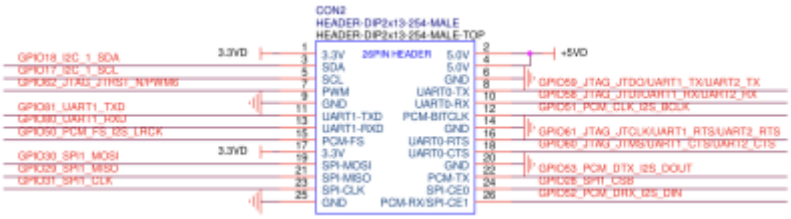
	A	**B**
nand	0	1
eMMC	1	0
SD	1	1

switch down is “1”, so both down booting from sdcard (v0 had both up to boot from sdcard)

v0:

1. both switches up ⇒ sdcard
2. down (1),up (0) seems to be nand as this have mtd command
3. up(0),down(1) also boots into bpis bootmenu, but i have no mtd command, so i guess this is the emmc
4. both down failed

GPIO



uboot/ATF

currently use these:

- uboot: https://github.com/frank-w/u-boot/tree/2023-10-bpi
- ATF: https://github.com/frank-w/u-boot/tree/mtk-atf

and bootup "my" kernel like this:

```
MT7988> setenv fit 6.5.0-rc1-mt7988.itb
MT7988> setenv kaddr 0x48000000
MT7988> fatload mmc 0:5 ${kaddr} ${fit}
4970220 bytes read in 417 ms (11.4 MiB/s)
MT7988> bootm ${kaddr}
```

kaddr 0x46000000 works too, if uncompressed kernelimage is smaller than 32M (fit size of 14M was too large)

in newer u-boot i have set kaddr to 0x46000000 (fit loadaddr 0x44000000, rdaddr 0x48000000)

swiotlb errors (in ethernet-driver) can be fixed with limiting ram in uboot/cmdline to 3G (32bit border)

uboot

tftp

```
BPI-R4> setenv bootfile 6.5.0-rc1-mt7988-r4.itb
BPI-R4> run bootnetfit
```

openwrt image

using bin/targets/mediatek/filogic/openwrt-mediatek-filogic-bananapi_bpi-r4-initramfs-recovery.itb

```
BPI-R4> usb start
BPI-R4> ls usb 0:1 r4
            ./
```

```
            ../
  7929856   openwrt-mediatek-filogic-bananapi_bpi-r4-initramfs-recovery.itb

1 file(s), 2 dir(s)

BPI-R4> fatload usb 0:1 0x50000000 r4/openwrt-mediatek-filogic-bananapi_bpi-
r4-initramfs-recovery.itb
7929856 bytes read in 672 ms (11.3 MiB/s)
BPI-R4> bootm 0x50000000#config-mt7988a-bananapi-bpi-r4#mt7988a-bananapi-
bpi-r4-sd
```

to get the bootconfigs (after #) we can use dumpimage from uboot-tools, see https://www.gibbard.me/linux_fit_images/

linux

https://www.kernel.org/doc/html/v6.1/admin-guide/kernel-parameters.html

3GB Ram limit not needed anymore as ethernet driver now uses 36bit addressing

Currently we need to limit ram to 3G because of swiotlb buffer full issues in ethernet driver

```
mem=3G
```

in cmdline (bootopts in my uboot uEnv.txt)

kernel

https://github.com/frank-w/BPI-Router-Linux/tree/6.6-dango

debug

```
# mount -t debugfs none /sys/kernel/debug/
# cat /sys/kernel/debug/gpio
# cat /sys/kernel/debug/pinctrl/pinctrl-handles
# cat /sys/kernel/debug/regulator/regulator_summary
# cat /sys/kernel/debug/clk/clk_summary

#enable debug for driver probe
# echo 'file dd.c +p'>/sys/kernel/debug/dynamic_debug/control
# echo 'file core.c +p'>/sys/kernel/debug/dynamic_debug/control

# echo '11230000.mmc' > /sys/bus/platform/drivers/mtk-msdc/unbind
# echo '11230000.mmc' > /sys/bus/platform/drivers/mtk-msdc/bind
```

interface config

```
ip link set lan0 up
ip a a 192.168.0.19/24 dev lan0
ip r a default via 192.168.0.10
date -s "2023-08-23 19:37 CEST"
#stats
ip -s link show dev eth2
ethtool -S eth2
```

DNS needs to be set in /etc/resolv.conf or in systemd like this:

```
mkdir -p /etc/systemd/resolved.conf.d/
cp /etc/systemd/resolved.conf /etc/systemd/resolved.conf.d/TEST.conf
echo "DNS = 192.168.0.10" >> /etc/systemd/resolved.conf.d/TEST.conf
systemctl restart systemd-resolved.service
```

modules in initrd:

```
mount /dev/mmcblk0p6 /mnt
mkdir /lib/modules
mkdir /lib/firmware
mount -o bind /mnt/lib/modules /lib/modules
mount -o bind /mnt/lib/firmware /lib/firmware
modprobe mt7996e
```

openwrt

- clone openwrt master
- add this to feeds.conf.default: “src-git mtksdk https://git01.mediatek.com/openwrt/feeds/mtk-openwrt-feeds”
- scripts/feeds update -f mtksdk
- make menuconfig:
  - Target System (MediaTek Ralink ARM)
  - Subtarget (Filogic 8×0 (MT798x))
  - Target Profile (MediaTek MT7988a nand rfb) #here i see no sd-variant

adding additional options:

```
CONFIG_PACKAGE_f2fs-tools=y
CONFIG_PACKAGE_e2fsprogs=y
CONFIG_PACKAGE_dosfstools=y
CONFIG_PACKAGE_resize2fs=y
CONFIG_PACKAGE_nano=y
CONFIG_PACKAGE_iperf3=y
#CONFIG_PACKAGE_netcat
CONFIG_PACKAGE_tcpdump=y
CONFIG_BUSYBOX_CUSTOM=y
```

```
CONFIG_BUSYBOX_CONFIG_TELNET=y
```

> *-initramfs-kernel.bin is not the production image we're using. We only use it for testing purpose since it contains rootfs and won't read the flash.
> *-sysupgrade.bin is the actual production image. It's a tar ball for nand/emmc/sd boards. It contains separate kernel and rootfs that will be written to ubi volume for nand, or the partitions defined for sd/emmc.

```
tar -xf bin/targets/mediatek/filogic/openwrt-mediatek-filogic-
mediatek_mt7988a-rfb-nand-squashfs-sysupgrade.bin sysupgrade-
mediatek_mt7988a-rfb-nand/kernel
dumpimage -l sysupgrade-mediatek_mt7988a-rfb-nand/kernel
```

Known Issues

* Card in M.2 slot causes i2c issues (sfp not detected):
https://forum.banana-pi.org/t/bpi-r4-nvme-i2c/17152/2

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