How to enable SPI under BananaPi BPI-R4 v4.

1. Intro

All necessary files are located in my repo: https://github.com/drozdi70/bananapi_bpir4
Especially Adafruit_Blinka_SPI_Pack.tar used in point 5.

2. Image preparation.

Add in DTS file section related to enabling spi/spidev
(~/openwrt/target/linux/mediatek/files-6.6/arch/arm64/boot/dts/mediatek/mt7988a-bananapi-bpi-r4.dts):

```
&spi1 {
    #address-cells = <1>;
    #size-cells = <0>;
    pinctrl-names = "default";
    pinctrl-0 = <&spi1_pins>;
    status = "okay";

    spidev0: spidev@0 {
        compatible = "sitronix,st7789v";
        spi-max-frequency = <32000000>;
        #address-cells = <1>;
        #size-cells = <0>;
        reg = <0>;
        dc-gpios = <&pio 50 GPIO_ACTIVE_HIGH>;    //GPIO50/pin 15
        reset-gpios = <&pio 53 GPIO_ACTIVE_LOW>;  //pin 22 / GPIO53
        spi-cpol;
        spi-cpha;
        status = "okay";
    };
};
```

Install a patch for st7789v – 0004-spidev-lcd-6.6.patch in your directory where you compile openwrt:
cp 0004-spidev-lcd-6.6.patch ~/openwrt/target/linux/mediatek/patches-6.6/

In menuconfig → enable spi/spipdev to be sure all is installed as
kmod-spi-dev spi_tools spidev_test kmod-spi-gpio

Write image to SD and start router from SD card.
Make connection to internet working from your router.

apk update
apk upgrade

```
root@BPI-R4:~# ls -ltr /dev/spi*
crw-------    1 root     root    153,   0 Nov 23 20:27 /dev/spidev1.0
root@BPI-R4:~# lsmod | grep spi
crc_itu_t              12288  1 mmc_spi
crc7                   12288  1 mmc_spi
mmc_spi                16384  0
of_mmc_spi             12288  1 mmc_spi
spi_bitbang            12288  1 spi_gpio
spi_gpio               16384  0
spidev                 20480  0
root@BPI-R4:~#
```

3. SPI bus check

If nothing is connected to the bus:

root@BPI-R4:~# spidev_test -D /dev/spidev1.0 -v
spi mode: 0x0
bits per word: 8
max speed: 500000 Hz (500 kHz)
TX | FF FF FF FF FF FF 40 00 00 00 00 95 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
FF FF F0 0D |......@.........................|
RX | 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 |................................|

Next we short pin19 and pin21:

root@BPI-R4:~# spidev_test -D /dev/spidev1.0 -v
spi mode: 0x0
bits per word: 8
max speed: 500000 Hz (500 kHz)
TX | FF FF FF FF FF FF 40 00 00 00 00 95 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
FF FF F0 0D |......@.........................|
RX | FF FF FF FF FF FF 40 00 00 00 00 95 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
FF FF F0 0D |......@.........................|
root@BPI-R4:~#

root@BPI-R4:~# spi-config -d /dev/spidev1.0 -q
/dev/spidev1.0: mode=0, lsb=0, bits=8, speed=32000000, spiready=0

4. ST7899 LCD screen wiring to the board

BPI-R4 GPIO pinout:
https://docs.banana-pi.org/en/BPI-R4/GettingStarted_BPI-R4#_gpio_define

SPI - 1.69inch LCD Module 240x280 pixels, ST7789V2
SPI - 1.54inch LCD module 240x240 pixels, ST7789

```
VCC    -> 3.3V (pin 17)
GND    -> GND (pin 20)
SCL    -> SPI1_CLK (pin 23)        GPIO31
SDA    -> SPI1_MOSI (pin 19)       GPIO30
RST    -> pin 22 / GPIO53
DC     -> pin 15 / GPIO50
CS     -> pin26 / GPIO52
BL     -> +VCC or not connected

SPI1_CSB (24)        GPIO28 -- not connected!
SPI1_MISO (21)       GPIO29 -- not connected!
```


How to check which GPIO line is free and can be used?

root@BPI-R4:~# apk add gpiod-tools

root@BPI-R4:~# gpioinfo
gpiochip0 - 84 lines:
```
        line   0:      unnamed              output consumer=tx-disable
        line   1:      unnamed              input consumer=tx-fault
        line   2:      unnamed              input consumer=los
        line   3:      unnamed              input active-low consumer=rate-select0
        line   4:      unnamed              input
        line   5:      unnamed              output active-low consumer=reset
        line   6:      unnamed              input
        line   7:      unnamed              input
        line   8:      unnamed              input
        line   9:      unnamed              input consumer=kernel
        line  10:      unnamed              input consumer=kernel
        line  11:      unnamed              input
        line  12:      unnamed              input active-low consumer=cd
        line  13:      unnamed              input
        line  14:      unnamed              input active-low consumer=WPS
        line  15:      unnamed              input consumer=kernel
        line  16:      unnamed              input consumer=kernel
        line  17:      unnamed              input
        line  18:      unnamed              input
        line  19:      unnamed              input
        line  20:      unnamed              input consumer=kernel
        line  21:      unnamed              input active-low consumer=rate-select0
        line  22:      unnamed              input consumer=kernel
```

```
line  23:    unnamed          input consumer=kernel
line  24:    unnamed          input consumer=kernel
line  25:    unnamed          input consumer=kernel
line  26:    unnamed          input consumer=kernel
line  27:    unnamed          input consumer=kernel
line  28:    unnamed          input consumer=kernel
line  29:    unnamed          input consumer=kernel
line  30:    unnamed          input consumer=kernel
line  31:    unnamed          input consumer=kernel
line  32:    unnamed          input consumer=kernel
line  33:    unnamed          input consumer=kernel
line  34:    unnamed          input consumer=kernel
line  35:    unnamed          input consumer=kernel
line  36:    unnamed          input consumer=kernel
line  37:    unnamed          input consumer=kernel
line  38:    unnamed          input
line  39:    unnamed          input
line  40:    unnamed          input
line  41:    unnamed          input
line  42:    unnamed          input
line  43:    unnamed          input
line  44:    unnamed          input
line  45:    unnamed          input
line  46:    unnamed          input
line  47:    unnamed          input
line  48:    unnamed          input
line  49:    unnamed          input
line  50:    unnamed          input
line  51:    unnamed          input
line  52:    unnamed          input
line  53:    unnamed          input
line  54:    unnamed          input consumer=los
line  55:    unnamed          input consumer=kernel
line  56:    unnamed          input consumer=kernel
line  57:    unnamed          input consumer=kernel
line  58:    unnamed          input consumer=kernel
line  59:    unnamed          input consumer=kernel
line  60:    unnamed          input consumer=kernel
line  61:    unnamed          input consumer=kernel
line  62:    unnamed          input
line  63:    unnamed          output consumer=blue:wps
line  64:    unnamed          input consumer=kernel
line  65:    unnamed          input consumer=kernel
line  66:    unnamed          input consumer=kernel
line  67:    unnamed          input consumer=kernel
line  68:    unnamed          input
line  69:    unnamed          input consumer=tx-fault
line  70:    unnamed          output consumer=tx-disable
line  71:    unnamed          input consumer=kernel
line  72:    unnamed          input consumer=kernel
line  73:    unnamed          input
line  74:    unnamed          input consumer=kernel
```

line 75:	unnamed	input
line 76:	unnamed	input
line 77:	unnamed	input consumer=kernel
line 78:	unnamed	input consumer=kernel
line 79:	unnamed	output consumer=green:status
line 80:	unnamed	input consumer=kernel
line 81:	unnamed	input consumer=kernel
line 82:	unnamed	input active-low consumer=mod-def0
line 83:	unnamed	input active-low consumer=mod-def0

All lines consumer=kernel cannot be used as already reserved.
We check lines (GPIO) 50,52,53

```
root@BPI-R4:~# gpioinfo |grep -e "50:"  -e "52:" -e "53:"
        line  50:        unnamed                     input
        line  52:        unnamed                     input
        line  53:        unnamed                     input
root@BPI-R4:~#
```

We also check base numer for gpiochip → in our case is 512 (needed for pin mapping).

```
root@BPI-R4:~# ls -ltr /sys/class/gpio/
--w-------    1 root     root          4096 Jan  1  1970 unexport
lrwxrwxrwx    1 root     root             0 Jan  1  1970 gpiochip512 -> ../../devices/platform/soc/1001f000.pinctrl/gpio/gpiochip512
--w-------    1 root     root          4096 Jan  1  1970 export
root@BPI-R4:~#
```

5. SPI configuration

SPI can work programmed in different ways, I decided to use Adafruit-Blinka package and adopt it a little bit as per now our board is not supported offcially there.
Please remember one fact that in the case of any possible upgrade of the package Adafruit_Blinka you need to repeat whole process as probably some files will be replaced by new ones from new release.

Adafruit-Blinka version: 8.50.0
Adafruit-platformdetect version: 3.75.0
Python 3.11

apk update
apk upgrade
apk add python3 curl git git-http
apk add python3-dev make
apk add python3-setuptools
apk add python3-pip sudo coreutils
apk add python3-pillow
apk add python3-gpiod

pip3 install Adafruit-Blinka

```
pip3 install adafruit-platformdetect
pip3 install --upgrade adafruit-python-shell click
pip3 install adafruit-circuitpython-st7789
pip install adafruit-circuitpython-display-text
pip install Adafruit-GPIO
```

Some Hocus-Pocus (based on https://github.com/Dangku/Adafruit_Python_PlatformDetect)

```
cd /usr/lib/python3.11/site-packages
mv adafruit_platformdetect adafruit_platformdetect.ORIG
copy  adafruit_platformdetect.tar here and extract
tar xvf  adafruit_platformdetect.tar
mv board.py board.py.ORIG
copy board.py here
copy bananapi.tar to /usr/lib/python3.11/site-packages/adafruit_blinka/board
mv bananapi bananapi.ORIG
tar xvf bananapi.tar
copy mt7988a.tar to /usr/lib/python3.11/site-packages/adafruit_blinka/microcontroller
tar xvf mt7988a.tar
in /usr/lib/python3.11/site-packages/
mv digitalio.py digitalio.py.ORIG
copy  digitalio.py here
in /usr/lib/python3.11/site-packages/
mv microcontroller microcontroller.ORIG
copy microcontroller.tar here and extract
tar xvf microcontroller.tar
```

==================================

Adafruit-Blinka version: 8.51.0
Adafruit-platformdetect version: 3.77.0
Python 3.13

For debian please use apt update/apt upgrade/apt install...

```
apk update
apk upgrade
apk add python3 curl git git-http
apk add python3-dev make
apk add python3-setuptools
apk add python3-pip sudo coreutils
apk add python3-pillow
apk add python3-gpiod (python3-libgpiod)
apk add python3.13-venv
```

Use option --*break*-system-packages for Adafruit packages or in python env:

```
root@bpi-r4:~# mkdir my-spi
root@bpi-r4:~# cd my-spi/
root@bpi-r4:~/my-spi# python3 -m venv –system-site-packages myenv
root@bpi-r4:~/my-spi# source myenv/bin/activate
```

(myenv) root@bpi-r4:~/my-spi#

pip3 install Adafruit-Blinka
pip3 install adafruit-platformdetect
pip3 install --upgrade adafruit-platformdetect
pip3 install --upgrade adafruit-python-shell click
pip3 install adafruit-circuitpython-st7789
pip install adafruit-circuitpython-display-text
pip install Adafruit-GPIO

cd /usr/local/lib/python3.13/dist-packages
cd ./root/my-spi/myenv/lib/python3.13/site-packages/ (or if you create env)

mv adafruit_platformdetect adafruit_platformdetect.ORIG
copy adafruit_platformdetect.tar here and extract
tar xvf adafruit_platformdetect.tar
!!!
cd /usr/local/lib/python3.13/dist-packages/adafruit_platformdetect
vi board.py
in line 913 please replace the line
if board_value and "Bananapi BPI-R4" in board_value:
with
if board_value and "BPI-R4" in board_value:

cd /usr/local/lib/python3.13/dist-packages/
mv board.py board.py.ORIG
copy board.py here
copy bananapi.tar to /usr/local/lib/python3.13/dist-packages/adafruit_blinka/board
mv bananapi bananapi.ORIG
tar xvf bananapi.tar
copy mt7988a.tar to /usr/local/lib/python3.13/dist-packages/adafruit_blinka/microcontroller
tar xvf mt7988a.tar
in /usr/local/lib/python3.13/dist-packages
mv digitalio.py digitalio.py.ORIG
copy digitalio.py here
in /usr/local/lib/python3.13/dist-packages
mv microcontroller microcontroller.ORIG
copy microcontroller.tar here and extract
tar xvf microcontroller.tar

Tests:

root@BPI-R4:~# python3 detect.py
Board Detection Test

Check that the Chip and Board IDs match your board and that this it is

correctly detecting whether or not it is a Linux board.

Board deteted:

Chip id: MT7988A
Board id: BANANA_PI_BPI_R4

Linux Detection

Is this an embedded Linux system? True

Raspberry Pi Boards

Is this a Pi 3B+? False
Is this a Pi 4B? False
Is this a 40-pin Raspberry Pi? False
Is this a Raspberry Pi Compute Module? False

Other Boards

Is this a Siemens Simatic IOT2000 Gateway? False
Is this a BananaPi board? True
Is this a 96boards board? False
Is this a BeagleBone board? False
Is this a Giant board? False
Is this a Coral Dev board? False
Is this a MaaXBoard? False
Is this a SiFive board? False
Is this a PYNQ board? False
Is this a Rock Pi board? False
Is this a NanoPi board? False
Is this a Khadas VIM3 board? False
Is this a Clockwork Pi board? False
Is this a Seeed Board? False
Is this a UDOO board? False
Is this an ASUS Tinker board? False
Is this an STM32MP1 board? False
Is this a MilkV board? False
Is this a Luckfox Pico board? False
Is this a generic Linux PC? False
Is this an OS environment variable special case? False

BananaPi board detected.

```
root@BPI-R4:~# python3 blinktest.py
Hello, blinka!
Digital IO ok!
I2C ok!
SPI ok!
done!
root@BPI-R4:~#
```

6. Examples for LCD ST7899

git clone https://github.com/adafruit/Adafruit_CircuitPython_ST7789

cd Adafruit_CircuitPython_ST7789/examples/

edit a file and adjust SPI lines parameteres as below:

```
spi = busio.SPI(board.D23, MOSI=board.D19)
tft_cs = board.D26
tft_dc = board.D15
tft_backlight = None
```

or

```
tft_dc = board.D15
tft_cs = board.D26
spi_clk = board.D23
spi_mosi = board.D19
tft_rst = board.D22
backlight = None
spi = busio.SPI(spi_clk, spi_mosi)
```

or

```
spi = board.SPI()
tft_cs = board.D26
tft_dc = board.D15
```

```
display_bus = FourWire(spi, command=tft_dc, chip_select=tft_cs, reset=board.D22)
```

or

```
spi = board.SPI()
tft_cs = None
tft_dc = board.D15
```

display_bus = FourWire(spi, command=tft_dc, chip_select=tft_cs)

The CS line of ST7899V2 attached to D24!!!

If your text is mirrored please use option polarity 0/1 in function FourWires to correctly display text!
display_bus = FourWire(spi, command=tft_dc, chip_select=tft_cs, polarity=1,baudrate=24000000)
(https://docs.circuitpython.org/en/stable/shared-bindings/fourwire/index.html)

7. XPT2046 touchscreen wiring to the board

```
| TFT   | Board     | GPIO   | Pin # |
| ----- | --------- | ------ | ----- |
| T_CLK | SPI1_CLK  | GPIO31 | 23    |
| T_CS  |           | GPIO52 | 26    |
| T_DIN | SPI1_MOSI | GPIO30 | 19    |
| T_DO  | SPI1_MISO | GPIO29 | 21    |
| T_IRQ |           | GPIO50 | 15    |
| T_RST |           | GPIO53 | 22    |
```

VCC   -> 5V (pin 2 or pin 4)
GND   -> GND (pin 20)

Installation:

```
# pip3 install xpt2046-circuitpython
# pip3 install adafruit-circuitpython-rgb-display
```

8. Examples for touchscreen XPT2046

```
git clone https://github.com/humeman/xpt2046-circuitpython
```

cd xpt2046-circuitpython/sample

Setting proper values for GPIO lines as:

from board import D23, D19, D21, D26, D15

```
# Pin config
T_CS_PIN = D26
T_IRQ_PIN = D15
MOSI = D19
SCK = D23
MISO = D21
```

In my case touchscreen is not returning correct value ;)

```
root@BPI-R4:~/xpt2046-circuitpython/samples# python3 read.py
(0, 0)
(0, 0)
(0, 0)
(0, 0)
(0, 0)
(0, 0)
(0, 0)
(0, 0)
(0, 0)
(0, 0)
(0, 0)
(0, 0)
(0, 0)
(0, 0)
(0, 0)
(0, 0)
(0, 0)
(0, 0)
```

9. Referrences/Docs

https://docs.circuitpython.org/projects/st7789/en/stable/examples.html
https://github.com/russhughes/st7789_mpy/tree/master
https://forum.banana-pi.org/t/banana-pi-bpi-r64-spi-touch-panel-test-with-openwrt/10009/2
https://www.coderdojotc.org/micropython/displays/graph/14-lcd-st7789V/
https://github.com/rm-hull/luma.examples
https://forum.banana-pi.org/t/bpi-r2-r3-and-ssd1306-oled-screen/11917/47
https://github.com/abhra0897/stm32f1_st7789_spi
https://git.datalabrotterdam.nl/customer/projects/Micropython-examples/-/tree/main/SPI
%20ST7789%20Display?ref_type=heads
https://github.com/solinnovay/Python_ST7789
https://github.com/sonocotta/st7789-orangepi-python
https://techatronic.com/st7789-display-pi-pico/#google_vignette
https://forum.banana-pi.org/t/spi-touchscreen-ads7846-xpt2046-on-ubuntu-images-bpi-r2/4781/29
https://blog.embeddedexpert.io/?p=1215
https://github.com/pimoroni/st7789-python
https://techatronic.com/st7789-raspberry-pi/
https://github.com/pimoroni/st7789-python
https://github.com/devbis/st7789_mpy
https://forums.pimoroni.com/t/adafruit-st7789-1-54-python-code/14238
https://git.datalabrotterdam.nl/customer/projects/Micropython-examples/-/tree/main/SPI
%20ST7789%20Display
https://github.com/russhughes/ttgo-hershey-fonts
https://github.com/solinnovay/Python_ST7789
https://raspberrypi.stackexchange.com/questions/104846/how-to-connect-st7789-lcd-to-spi-bus-1-
as-2nd-screen
http://helloraspberrypi.blogspot.com/2021/02/raspberry-pi-picomicropython-st7789-spi.html
https://python.scitoys.com/st7789
https://www.programcreek.com/python/example/101401/machine.SPI

https://pypi.org/project/xpt2046-circuitpython/