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## How to Use the SAMA5D2 SPI Under Linux<sup>®</sup>

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### Introduction

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This application note describes how to get started using the SAMA5D2 SPI under Linux.

Since the SPI dev interface was introduced into the kernel, it is easy to access the SPI device in user space via the device node “/dev/spidev”. Refer to the section [Application](#) for SPI dev application demo code.

SPI devices have a limited user space API, supporting basic half-duplex read() and write() access to SPI slave devices. Also available are ioctl() requests, full duplex transfers and device I/O configuration.

### Reference Documents

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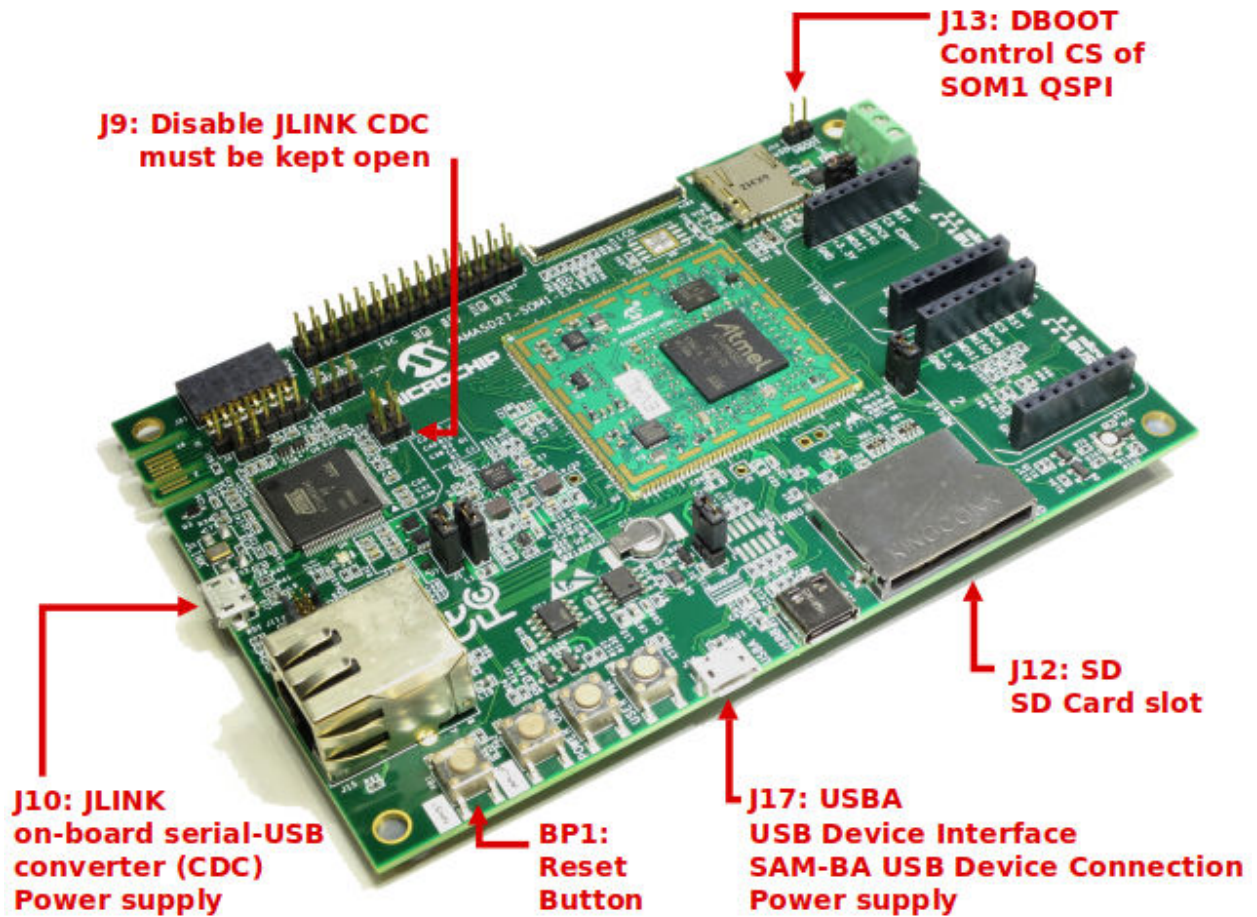
Title	Reference	Available
SAMA5D2 Series Datasheet	DS60001476	<a href="https://www.microchip.com/design-centers/32-bit-mpus">https://www.microchip.com/design-centers/32-bit-mpus</a>
SAMA5D27 SOM1 Kit1 User Guide	DS50002667	<a href="https://www.microchip.com/DevelopmentTools/ProductDetails/PartNO/ATSAMA5D27-SOM1-EK1">https://www.microchip.com/DevelopmentTools/ProductDetails/PartNO/ATSAMA5D27-SOM1-EK1</a>

### Prerequisites

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- Hardware
  - PC
  - SAMA5D27 SOM1 Evaluation Kit (Part Number: ATSAMA5D27-SOM1-EK1)
  - SDCard
- Software

This demo runs on the AT91 Linux platform built by Buildroot. The first step is to set up the AT91 Buildroot development environment. Refer to the web site: <http://www.at91.com/linux4sam/bin/view/Linux4SAM/BuildRoot>



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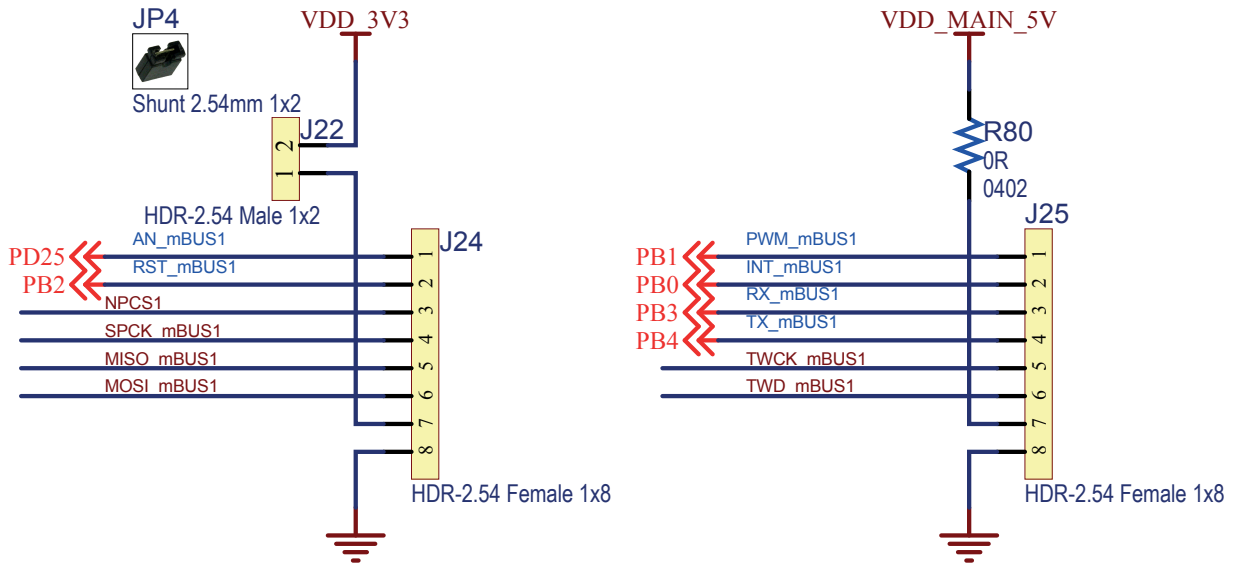
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## 1. Hardware Design

### 1.1 Interface



The mikroBUS1 connector is used for easy testing and monitoring.

To control the mikroBUS1 SPI on Linux, FLEXCOM4 (SPI mode) is connected to the SPI bus of the mikroBUS1 interface on the SAMA5D27-SOM1-EK as described below:

#### FLEXCOM4 SPI

- FLEXCOM4\_IO4 → PD0 → NPCS1
- FLEXCOM4\_IO2 → PC30 → SPCK\_mBUS1
- FLEXCOM4\_IO1 → PC29 → MISO\_mBUS1
- FLEXCOM4\_IO0 → PC28 → MOSI\_mBUS1

For more details about the pin multiplexing of the SAMA5D2, refer to the table “Pin Description (all packages)” in the SAMA5D2 data sheet.

#### FLEXCOM I/O Lines Description

Name	Description			Type
	USART/UART	SPI	TWI	
FLEXCOM_IO0	TXD	MOSI	TWD	I/O
FLEXCOM_IO1	RXD	MISO	TWCK	I/O
FLEXCOM_IO2	SCK	SPCK	–	I/O
FLEXCOM_IO3	CTS	NPCS0/NSS	–	I/O
FLEXCOM_IO4	RTS	NPCS1	–	O

## 2. Software Design

The Microchip Linux platform was built using Buildroot with the following configuration:

`atmel_sama5d27_som1_ek_mmc_dev_defconfig`

The SPI bus driver works under this default configuration.

There are two methods to access the SPI bus driver:

- In kernel space:
  - Register your own SPI driver via `spi_register_driver()` interface, then access the SPI bus driver via struct `spi_device` handle.
- In user space:
  - Enable the SPIDEV kernel feature, then access the SPI bus driver via the device node `"/dev/spidev"`.

SPIDEV is a good choice because all application code runs in user space, making development easier.

In the default configuration, SPIDEV is not enabled. The steps to enable it are described in the following sections.

### 2.1 Device Tree

- Action: need to change
  - Change 1:
    - Add descriptions for spidev device under FLEXCOM4 device node in device tree file.
- Location: `buildroot-at91/output/build/linux-linux4sam_6.0/arch/arm/boot/dts`
- Sources:
  - `sama5d2.dtsi`
  - `at91-sama5d27_som1_ek.dts`

#### Device tree for FLEXCOM4 in `sama5d2.dtsi`:

```
flx4: flexcom@fc018000 {
    compatible = "atmel,sama5d2-flexcom"; // specify which driver will be used for this
                                           // FLEXCOM device
    reg = <0xfc018000 0x200>; // FLEXCOM4 base address is 0xfc018000, size is 0x200
    clocks = <&flx4_clk>; // definition for uart4 clock source
    #address-cells = <1>;
    #size-cells = <1>;
    ranges = <0x0 0xfc018000 0x800>;
    status = "disabled"; // default disabled, and will be replaced with "okay"
};

flx4_clk: flx4_clk {
    #clock-cells = <0>;
    reg = <23>; // PID for FLEXCOM4 is 23, this definition of offset will be used to enable
               // FLEXCOM4 clock in PMC
    atmel,clk-output-range = <0 83000000>; // FLEXCOM4 input clock, max frequency is 83MHz
};
```

#### Device tree for SPIDEV function in `at91-sama5d27_som1_ek.dts`:

```
flx4: flexcom@fc018000 {
    atmel,flexcom-mode = <ATMEL_FLEXCOM_MODE_SPI>; // specify SPI mode for this flexcom
    status = "okay"; // enable this device

    uart6: serial@200 {
        .....
    };

    spi3: spi@400 {
        compatible = "atmel,at91rm9200-spi"; // specify which driver will be used for this
                                           // SPI device
        reg = <0x400 0x200>; // register offset address is 0x400, size is 0x200
    };
};
```

```

interrupts = <23 IRQ_TYPE_LEVEL_HIGH 7>; // PID for FLEXCOM4 is 23, high level
// triggered, priority is 7
clocks = <&flx4_clk>; // definition for FLEXCOM4 clock source
clock-names = "spi_clk";
pinctrl-names = "default";
pinctrl-0 = <&pinctrl_mikrobus_spi &pinctrl_mikrobus1_spi_cs
&pinctrl_mikrobus2_spi_cs>;
atmel,fifo-size = <16>; // pin definition for FLEXCOM4 SPI function
status = "okay"; /* Conflict with uart6 and i2c3. */ // replace status property with
// "okay", enable SPI device

spidev@1 { // This is change 1
    compatible = "spidev"; // specify which driver will be used for this device
    reg = <1>; // this definition will be used as CS number of SPIDEV
    spi-max-frequency = <1000000>; // specify clock frequency for this SPIDEV
// Check buildroot-at91/output/build/linux-linux4sam_6.0/drivers/spi/spi.c of spi_parse_dt()
// for more options
};

};

i2c3: i2c@600 {
    .....
};

};

pinctrl_mikrobus1_spi_cs: mikrobus1_spi_cs {
    pinmux = <PIN_PD0_FLEXCOM4_IO4>; // the mux of PD0 will be switch to FLEXCOM4_IO4
    bias-disable;
};

pinctrl_mikrobus_spi: mikrobus_spi {
    pinmux = <PIN_PC28_FLEXCOM4_IO0>, // the mux of PC28 will be switch to FLEXCOM4_IO0
    <PIN_PC29_FLEXCOM4_IO1>, // the mux of PC29 will be switch to FLEXCOM4_IO1
    <PIN_PC30_FLEXCOM4_IO2>; // the mux of PC30 will be switch to FLEXCOM4_IO2
    bias-disable;
};
};

```

It is not recommended to use "spidev" as a device tree compatible name directly. It may work properly, but the following warning will display:

```

# dmesg | grep spidev
spidev spi1.1: buggy DT: spidev listed directly in DT
WARNING: CPU: 0 PID: 1 at drivers/spi/spidev.c:730 0xc045d630

```

Because "spidev" is part of the Linux implementation rather than a description of the hardware, it should never be referenced in the device tree without a specific name.

To avoid this warning, a compatible name other than "spidev" should be selected, for example:

```

spidev@1 {
    compatible = "atmel,at91rm9200-spidev";
    reg = <1>;
    spi-max-frequency = <1000000>;
};

```

Then edit the SPIDEV driver file `buildroot-at91/output/build/linux-linux4sam_6.0/drivers/spi/spidev.c`.

Add the new compatible name to the compatible table of the SPIDEV driver:

```

static const struct of_device_id spidev_dt_ids[] = {
    { .compatible = "rohm,dh228fv" },
    { .compatible = "lineartechnology,ltc2488" },
    { .compatible = "ge,achc" },
    { .compatible = "semtech,sx1301" },
    { .compatible = "atmel,at91rm9200-spidev" },
    {},
};

```

## 2.2 Kernel

- Action: need to change
- Location: `buildroot-at91/output/build/linux-linux4sam_6.0/`

- Defconfig: sama5\_defconfig
- Driver files:
  - drivers/spi/spi.c
  - drivers/spi/spi-atmel.c
  - drivers/spi/spidev.c

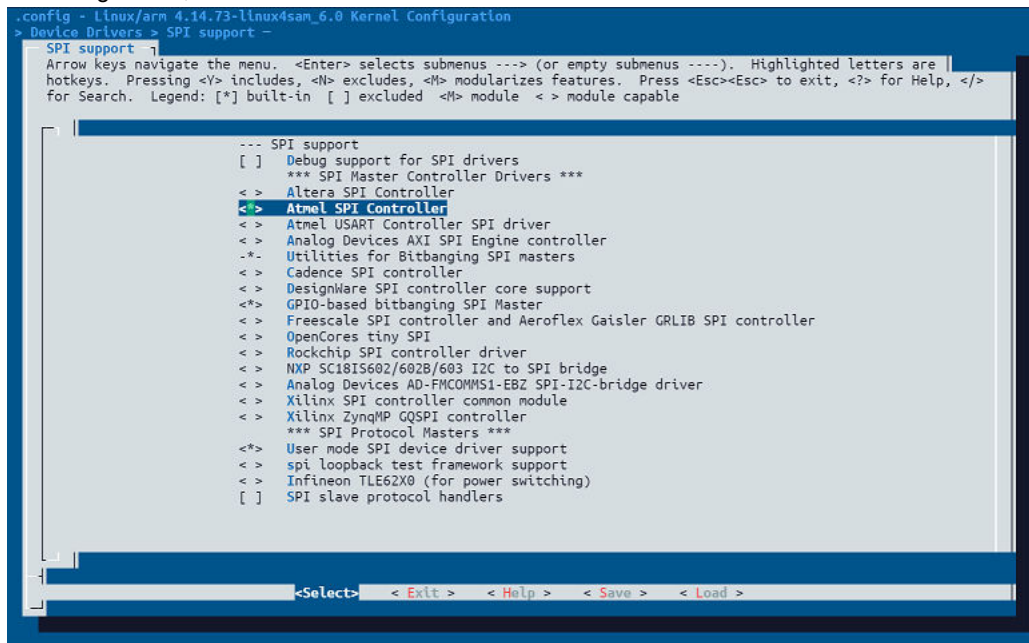
Add the kernel configuration for the SPIDEV function:

```
user@at91:~/buildroot-at91$ make linux-menuconfig
```

### Device Drivers > SPI support > Atmel SPI Controller

This is the driver for the Atmel SPI controller.

In the default configuration, this item is selected.



### Device Drivers > SPI support > User mode SPI device driver support

This is the driver for SPIDEV. Select it to enable the SPIDEV function.

```
.config - Linux/arm 4.14.73-linux4sam_6.0 Kernel Configuration
> Device Drivers > SPI support -
SPI support
Arrow keys navigate the menu. <Enter> selects submenus ---> (or empty submenu ---). Highlighted letters are
hotkeys. Pressing <Y> includes, <N> excludes, <M> modularizes features. Press <Esc><Esc> to exit, <?> for Help, </>
for Search. Legend: [*] built-in [ ] excluded <M> module <> module capable

--- SPI support
[ ] Debug support for SPI drivers
*** SPI Master Controller Drivers ***
<> Altera SPI Controller
<*> Atmel SPI Controller
<> Atmel USART Controller SPI driver
<> Analog Devices AXI SPI Engine controller
-* Utilities for Bitbanging SPI masters
<> Cadence SPI controller
<> DesignWare SPI controller core support
<*> GPIO-based bitbanging SPI Master
<> Freescale SPI controller and Aeroflex Gaisler GRLIB SPI controller
<> OpenCores tiny SPI
<> Rockchip SPI controller driver
<> NXP SC18IS602/602B/603 I2C to SPI bridge
<> Analog Devices AD-FMCOMMS1-EBZ SPI-I2C-bridge driver
<> Xilinx SPI controller common module
<> Xilinx ZynqMP QOSPI controller
*** SPI Protocol Masters ***
<*> User mode SPI device driver support
<> spi loopback test framework support
<> Infineon TLE62X0 (for power switching)
[ ] SPI slave protocol handlers

<Select> < Exit > < Help > < Save > < Load >
```

## 2.3 Rootfs

- Action: no need to change
- Location: buildroot-at91/output/images/rootfs.tar

There is no definition for the SPI bus number in the device tree files, and the bus number of the SPI controller is allocated automatically when registering.

For example, the first registered SPI controller is assigned the bus number 0, the second is assigned the bus number 1 and so on.

The device node below is used to access the SPI bus driver. The first 1 indicates bus number 1, the second 1 indicates the CS number:

- /dev/spidev1.1

## 2.4 Application

This section provides a C language demo to access the SPI bus driver via the device node "/dev/spidev1.1":

### How to Compile

```
user@at91:~$ buildroot-at91/output/host/bin/arm-buildroot-linux-uclibcgnueabi-hf-gcc spi_dev.c
-o spi_test
```

### Source Code

```
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <fcntl.h>
#include <sys/ioctl.h>
#include <linux/spi/spidev.h>

#define DEV_SPI "/dev/spidev1.1"

int main(int argc, char *argv[])
{
    int fd;
```



```
int ret;
unsigned int mode, speed;
char tx_buf[1];
char rx_buf[1];
struct spi_ioc_transfer xfer[2] = {0};

// open device node
fd = open(DEV_SPI, O_RDWR);
if (fd < 0) {
    printf("ERROR open %s ret=%d\n", DEV_SPI, fd);
    return -1;
}

// set spi mode
mode = SPI_MODE_0;
if (ioctl(fd, SPI_IOC_WR_MODE32, &mode) < 0) {
    printf("ERROR ioctl() set mode\n");
    return -1;
}
if (ioctl(fd, SPI_IOC_RD_MODE32, &ret) < 0) {
    printf("ERROR ioctl() get mode\n");
    return -1;
} else
    printf("mode set to %d\n", (unsigned int)ret);

// set spi speed
speed = 1*1000*1000;
if (ioctl(fd, SPI_IOC_WR_MAX_SPEED_HZ, &speed) < 0) {
    printf("ERROR ioctl() set speed\n");
    return -1;
}
if (ioctl(fd, SPI_IOC_RD_MAX_SPEED_HZ, &ret) < 0) {
    printf("ERROR ioctl() get speed\n");
    return -1;
} else
    printf("speed set to %d\n", ret);

// transfer data
tx_buf[0] = 0xa5;
xfer[0].tx_buf = (unsigned long)tx_buf;
xfer[0].len = 1;
xfer[1].rx_buf = (unsigned long)rx_buf;
xfer[1].len = 1;

do {
    if (ioctl(fd, SPI_IOC_MESSAGE(2), xfer) < 0)
        perror("SPI_IOC_MESSAGE");
    usleep(100*1000);
} while (1);

// close device node
close(fd);

return 0;
}
```

Another SPIDEV application is provided in Buildroot:

```
user@at91:~/buildroot-at91$ make menuconfig
```

with code located here: buildroot-at91/output/build/spidev\_test-v4.10/spidev\_test.c

Target Packages > Debugging, profiling and benchmark > spidev\_test

```
/home/user/prj/bus_demo/bulldroot/bulldroot-at91/.config - Buildroot 2018.02 Configuration
> Target packages > Debugging, profiling and benchmark
Debugging, profiling and benchmark
Arrow keys navigate the menu. <Enter> selects submenus --- (or empty submenus ---). Highlighted letters are
hotkeys. Pressing <Y> selects a feature, while <N> excludes a feature. Press <Esc><Esc> to exit, <?> for Help, </>
for Search. Legend: [*] feature is selected [ ] feature is excluded

[*] ltrace
[ ] lttng-babeltrace
[ ] lttng-modules
[ ] lttng-tools
[ ] memstat
[ ] netperf
*** netsniff-ng needs a glibc or musl toolchain w/ threads, headers >= 3.0 ***
*** nmon needs a glibc toolchain ***
[ ] oprofile
[ ] pax-utils
[ ] pv
[ ] ranspeed/smp
[ ] ranspeed
[ ] rt-tests
[*] spidev_test
[ ] strace
[ ] stress
*** stress-ng needs a glibc toolchain w/ dynamic library, headers >= 3.3 ***
[ ] sysdig
[ ] tcf-agent
[ ] tinymembench
[ ] trace-cmd
[ ] trinity
[ ] uclibc-ng-test
[ ] valgrind
[ ] whetstone

<Select> <Exit> <Help> <Save> <Load>
```

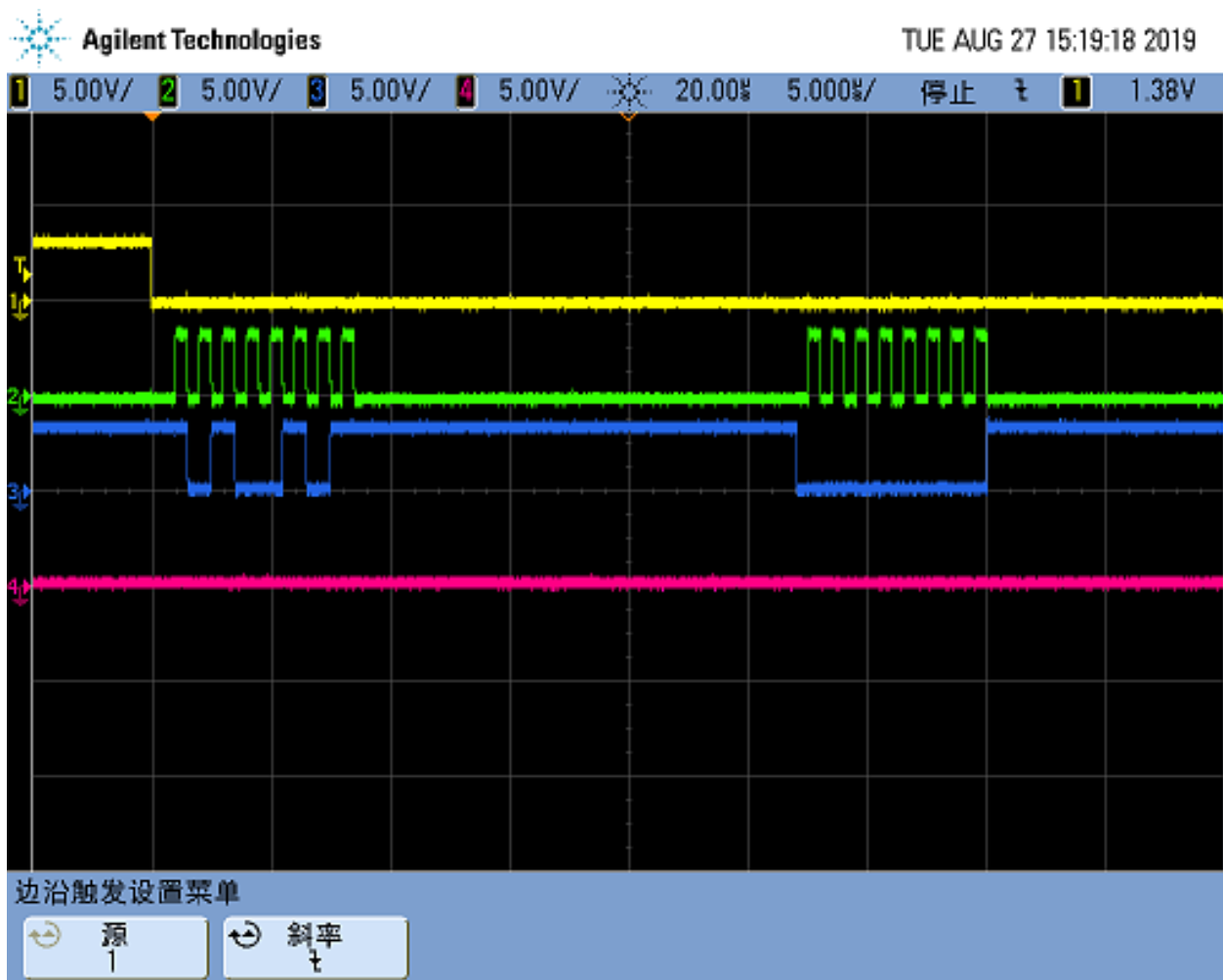
### 3. Hands-On

Copy the spi\_test application to the target and execute it, then the SPI waveform is monitored on the mikroBUS1 SPI bus.

```
# chmod +x spi_test
# ./spi_test
```

#### Legend

- Yellow line: NPCS1
- Green line: SPCK\_mBUS1
- Blue line: MOSI\_mBUS1
- Red line: MISO\_mBUS1



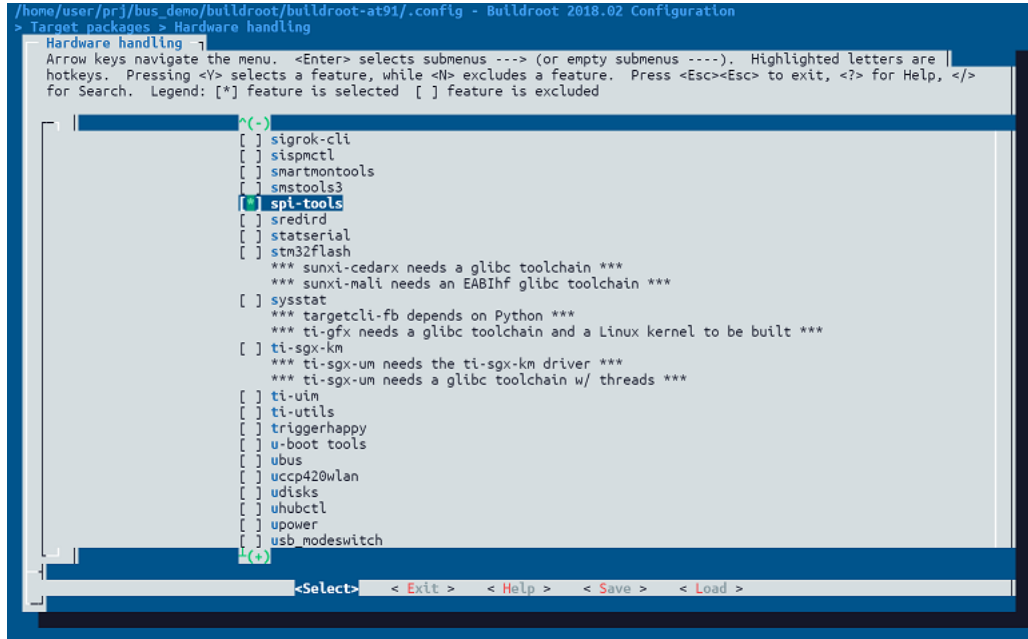
## 4. Tools and Utilities

Spi-tools is a tool for SPI bus testing included in Buildroot.

With the default Buildroot configuration, this tool is selected.

```
user@at91:~/buildroot-at91$ make menuconfig
```

### Target packages > Hardware handling > spi-tools



There are two commands in spi-tools:

```
# spi-config -h
usage: spi-config options...
options:
  -d --device=<dev>   use the given spi-dev character device.
  -q --query           print the current configuration.
  -m --mode=[0-3]     use the selected spi mode:
                     0: low iddle level, sample on leading edge,
                     1: low iddle level, sample on trailing edge,
                     2: high iddle level, sample on leading edge,
                     3: high iddle level, sample on trailing edge.
  -l --lsb={0,1}     LSB first (1) or MSB first (0).
  -b --bits=[7...]   bits per word.
  -s --speed=<int>   set the speed in Hz.
  -h --help           this screen.
  -v --version        display the version number.
# spi-config -d /dev/spidev1.1 -q
/dev/spidev1.1: mode=0, lsb=0, bits=8, speed=1000000
# spi-pipe -h
usage: spi-pipe options...
options:
  -d --device=<dev>   use the given spi-dev character device.
  -b --blocksize=<int> transfer block size in byte.
  -n --number=<int>   number of blocks to transfer (-1 = infinite).
  -h --help           this screen.
  -v --version        display the version number.
# spi-pipe -d /dev/spidev1.1 -b 6 -n 1
111111
```

Input six '1' and press the Enter key. The waves are captured from an oscilloscope accordingly.

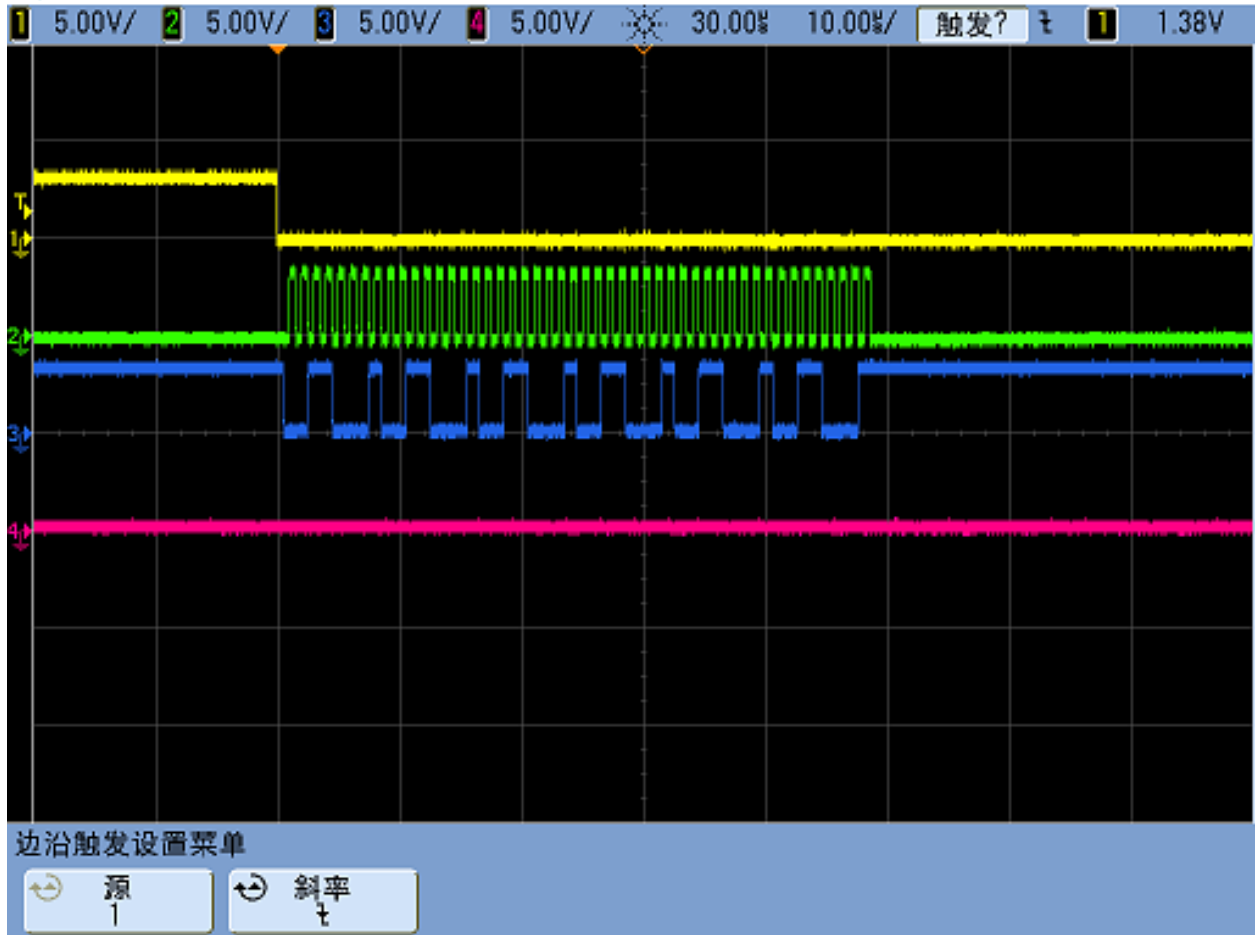
Legend

- Yellow line: NPCS1
- Green line: SPCK\_mBUS1
- Blue line: MOSI\_mBUS1
- Red line: MISO\_mBUS1



Agilent Technologies

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## 5. Microchip Peripheral I/O Python® (MPIO)

The Microchip Peripheral I/O (MPIO) Python package provides easy access to various hardware peripherals found on Microchip MPU processors and evaluation boards running Linux. The API is clean, consistent, flexible, documented, and well tested. It makes navigating and exercising even the most complex hardware peripherals a trivial task.

For more information, see <https://github.com/linux4sam/mpio>. Code examples showing how to work with the MPIO interface modules are provided in the folder `mpio/examples`.

### 5.1 MPIO in Buildroot

In order to benefit from MPIO in your Buildroot configuration, follow the steps below:

#### 1. Enable Python

```
user@at91:~/buildroot-at91$ make menuconfig
```

Select “**python**” to enable python support:

- Target packages > Interpreter languages and scripting > [\*] **python**

Then enter “**python module format to install**” and select “**.py sources and .pyc compiled**”.

- Target packages > Interpreter languages and scripting > python > python module format to install > **.py sources and .pyc compiled**

```

/home/user/tmp/mpio/test/buildroot-at91/.config - Buildroot 2018.02 Configuration
* Target packages > Interpreter languages and scripting - core python modules
Interpreter languages and scripting
Arrow keys navigate the menu. <Enter> selects submenus ---> (or empty submenus ----). Highlighted letters are hotkeys. Pressing <Y> selects a feature, while <N> excludes a feature. Press <Esc><Esc> to exit, <?> for Help, </> for Search. Legend: [*] feature is selected [ ] feature is excluded

[ ] 4th
[ ] anscript
[ ] arlang
[ ] execline
[ ] fcl
[ ] gauche
[ ] gulle
[ ] haserl
[ ] janvn
[ ] jintcl
[ ] lua
[ ] luajit
[ ] micropython
[ ] noarvn
[ ] mono
[ ] nodejs
[ ] perl
[ ] php
[*] python
    python module format to install (.py sources and .pyc compiled) --->
    core python modules --->
    External python modules --->
[ ] ruby
[ ] tcl

```

Some additional python modules must be selected. Enter “**core python modules**” and select “**curses module**”, “**readline**” and “**hashlib module**”.

- Target packages > Interpreter languages and scripting > core python modules > [\*] **curses module**
- Target packages > Interpreter languages and scripting > core python modules > [\*] **readline**

- Target packages > Interpreter languages and scripting > core python modules > [\*] hashlib module

```

/home/user/tmp/mpio/test/buildroot-at91/.config - Buildroot 2018.02 Configuration
> Target packages > Interpreter languages and scripting > core python modules
core python modules
Arrow keys navigate the menu. <Enter> selects submenus ---> (or empty submenu ----). Highlighted letters are hotkeys. Pressing <Y> selects a
feature, while <N> excludes a feature. Press <Esc><Esc> to exit, <?> for Help, </> for Search. Legend: [*] feature is selected [ ] feature is
excluded

*** The following modules are unusual or require extra libraries ***
[ ] bzip2 module (NEW)
[ ] bsddb module (NEW)
[ ] codescjk module (NEW)
[*] curses module
[ ] ossaudiodev module (NEW)
[*] readline
[ ] ssl (NEW)
[ ] unicodedata module
[ ] sqlite module
[ ] xml module (NEW)
[ ] zlib module (NEW)
[*] hashlib module

```

Enter “External python modules” and select “python-setuptools”.

- Target packages > Interpreter languages and scripting > External python modules > [\*] python-setuptools

```

/home/user/tmp/mpio/test/buildroot-at91/.config - Buildroot 2018.02 Configuration
> Target packages > Interpreter languages and scripting > External python modules
External python modules
Arrow keys navigate the menu. <Enter> selects submenus ---> (or empty submenu ----). Highlighted letters are hotkeys. Pressing <Y> selects a
feature, while <N> excludes a feature. Press <Esc><Esc> to exit, <?> for Help, </> for Search. Legend: [*] feature is selected [ ] feature is
excluded

^(-)-
[ ] python-pyudev (NEW)
[ ] python-pyusb (NEW)
[ ] python-pyxb (NEW)
[ ] python-pyaml (NEW)
[ ] python-pyzmq (NEW)
[ ] python-raven (NEW)
[ ] python-remi (NEW)
[ ] python-requests (NEW)
[ ] python-requests-oauthlib (NEW)
[ ] python-requests-toolbelt (NEW)
[ ] python-rpi-gpio (NEW)
[ ] python-rtstlib-fb (NEW)
[ ] python-scandir (NEW)
[ ] python-schedule (NEW)
[ ] python-sdnottyfy (NEW)
[ ] python-secretstorage (NEW)
[ ] python-see (NEW)
[ ] python-serial (NEW)
[ ] python-service-identity (NEW)
[ ] python-setorocitle (NEW)
[*] python-setuptools
[ ] python-sh (NEW)
[ ] python-shutilwhich (NEW)

```

## 2. Enable the MPIO Module

Enter “External options” and select “python-mpio”.

- External options > [\*] python-mpio

```

/home/user/tmp/mpio/test/buildroot-at91/.config - Buildroot 2018.02 Configuration
> External options
External options
Arrow keys navigate the menu. <Enter> selects submenus ---> (or empty submenu ----). Highlighted letters are hotkeys. Pressing <Y> selects a
feature, while <N> excludes a feature. Press <Esc><Esc> to exit, <?> for Help, </> for Search. Legend: [*] feature is selected [ ] feature is
excluded

*** MCHP (in /home/user/tmp/mpio/test/buildroot-external-microchip) ***
[ ] g1-decoder
*** gst1-at91 needs a toolchain w/ glibc ***
*** libplanes depends on libdrm, cairo, lua, and cJSON ***
[ ] ptc_examples
*** python-iocontrol depends on pyqt5 and mpio ***
[*] python-mpio
[ ] dt-overlay-at91
Init configuration (none) ----

```

## 3. Finish the Buildroot Configuration and Build

Enter “Filesystem images” and set the exact size of rootfs to 120MB.

- Filesystem images > (120M) exact size

```

/home/user/tmp/mpio/test/buildroot-at91/.config - Buildroot 2018.02 Configuration
Filesystem Images
Filesystem Images
Arrow keys navigate the menu. <Enter> selects submenus ---> (or empty submenus ----). Highlighted letters are hotkeys. Pressing <Y> selects a
feature, while <N> excludes a feature. Press <Esc><Esc> to exit, <?> for Help, </> for Search. Legend: [*] feature is selected [ ] feature is
excluded

[ ] axfs root filesystem
[ ] cloop root filesystem for the target device
[ ] cpio the root filesystem (for use as an initial RAM filesystem)
[ ] cramfs root filesystem
[*] ext2/3/4 root filesystem
   ext2/3/4 variant (ext4) --->
   ( ) filesystem label
   (120M) exact size
   (0) exact number of inodes (leave at 0 for auto calculation)
   (5) reserved blocks percentage
   (-O ^64bit) additional mke2fs options
   Compression method (no compression) --->

```

After saving, the following new settings are added to the configuration file of Buildroot:

```

.....
BR2_PACKAGE_PYTHON=y
BR2_PACKAGE_PYTHON_PY_PYC=y
BR2_PACKAGE_PYTHON_CURSES=y
BR2_PACKAGE_PYTHON_READLINE=y
BR2_PACKAGE_PYTHON_HASHLIB=y
BR2_PACKAGE_PYTHON_SETUPTOOLS=y
BR2_PACKAGE_PYTHON_MPIO=y
BR2_TARGET_ROOTFS_EXT2_SIZE="120M"
.....

```

Then re-configure and build Buildroot:

```

user@at91:~/buildroot-at91$ make atmel_sama5d27_som1_ek_mmc_dev_defconfig
user@at91:~/buildroot-at91$ make

```

## 5.2 Examples

After building successfully, burn your SD card with `buildroot-at91/output/images/sdcard.img`.

Execute the python codes on the target board, for example:

```

# ./adc2.py DEVICE
# ./gpio1.py PIN
# ./pwm_led.py DEVICE CHANNEL
.....

```

**Note:** The python example code can be found in <https://github.com/linux4sam/mpio/examples>



**6. Revision History**

**6.1 Rev. A - 09/2019**

First issue.

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