

# Rockchip Developer Guide Linux FLEXBUS ADC and DAC Mode

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## **Preface**

## **Overview**

This document introduces how to use FLEXBUS ADC mode and DAC mode on Linux.

## **Product Version**

Chipset	Kernel Version
RK3576	6.1

## **Intended Audience**

This document (this guide) is mainly intended for:

Technical support engineers

Software development engineers

Revision History

Version	Author	Date	Change Description
V1.0.0	Wesley Yao	2024-06-11	Initial version

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# 1. FLEXBUS ADC mode

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## 1.1 Overview

FLEXBUS ADC mode is **FLEXBUS1 interfacing high-speed parallel ADC devices** such as TI ADS6144 (<http://www.ti.com/product/ADS6144>) and ADI LTC2207 (<https://www.analog.com/en/products/ltc2207.html>). **ADC devices with interface types such as SPI and I2C are not supported.**

- Clock frequency up to 100MHz
- Resolution up to 16-Bit

## 1.2 Configuration

### 1.2.1 Hardware configuration

- The LSB of the ADC device needs to be connected to FLEXBUS1\_D0, such as 10-Bit ADC to FLEXBUS1\_D[9:0], 16-Bit ADC to FLEXBUS1\_D[15:0]
- Slave mode indicates that the device provides CLK to FLEXBUS1, and master mode indicates that FLEXBUS1 provides CLK to the device

### 1.2.2 Kernel configuration

FLEXBUS ADC mode relies on the iio/adc framework.

Device Drivers -> Multifunction device drivers -> Rockchip Flexbus

Device Drivers -> Industrial I/O support -> Analog to digital converters -> Rockchip Flexbus ADC opmode driver

### 1.2.3 dtsti configuration

Take RK3576 platform and RK3576 TEST1 board, FLEXBUS1 for ADC as an example.

In rk3576.dtsi:

```
flexbus: flexbus@2a2f0000 {
    .....

    flexbus_adc: adc {
        compatible = "rockchip,flexbus-adc";
        #io-channel-cells = <0>;
        rockchip,slave-mode;    // Configuring this is the slave mode, not
        configuring this is the master mode
        rockchip,free-sclk; // Configuring this is clock keeps output, not
        configuring this is clock follows data
        rockchip,auto-pad;    // Default configuration
    };
};
```

```

        rockchip,cpol; // Configuring this is CPOL = 1, not configuring this is
0
        rockchip,cpha; // Configuring this is CPHA = 1, not configuring this is
0
        rockchip,dfs = <16>; // data frames
        status = "disabled";
    };

    flexbus_dac: dac {
        .....
    };
};

```

- rockchip,slave-mode: With configuring this is slave mode, the device provides CLK to FLEXBUS1; Without configuring this is master mode, FLEXBUS1 provides CLK to the device
- rockchip,free-sclk: With configuring this, clock keeps output; Without configuring this, clock follow data (this configuration is only valid in master mode)
- rockchip,cpol, rockchip,cpha: Same as SPI protocol definitions, configured according to the timing diagram in the device datasheet
- rockchip,dfs: data frames, only support configuration of 4, 8, 16; If the resolution of the device is not 4, 8 or 16, it needs to be rounded up; For example, when using ADC devices with 14-Bit resolution, rockchip,dfs needs to be configured to 16, and only 14bit data is obtained through software processing when receiving data

In arch/arm64/boot/dts/rockchip/rk3576-test1.dtsi:

```

&flexbus {
    rockchip,flexbus0-opmode = <ROCKCHIP_FLEXBUS0_OPMODE_XXX>;
    rockchip,flexbus1-opmode = <ROCKCHIP_FLEXBUS1_OPMODE_ADC>; // FLEXBUS1
selects ADC mode
    status = "okay"; // Enable FLEXBUS
};

&flexbus_adc {
    pinctrl-names = "default";
    pinctrl-0 = <&flexbus1m4_csn &flexbus1_clk
        &flexbus1_d0 &flexbus1_d1 &flexbus1_d2 &flexbus1_d3
        &flexbus1_d4 &flexbus1_d5 &flexbus1_d6 &flexbus1_d7
        &flexbus1_d8 &flexbus1_d9 &flexbus1_d10 &flexbus1_d11
        &flexbus1m1_d12 &flexbus1m1_d13 &flexbus1m1_d14 &flexbus1m1_d15>;
// Configure IOMUX for FLEXBUS1 ADC mode
    status = "okay"; // Enable ADC mode
};

```

## 1.2.4 Driver file

The driver file is drivers/iio/adc/rockchip-flexbus-adc.c.

rockchip\_flexbus\_adc\_read\_block() is a function of reading ADC device data. The main operations are as follows:

1. rockchip\_flexbus\_writel(rkfb, FLEXBUS\_RX\_NUM, num\_of\_dfs);  
Configure the number of RX in dfs (rockchip,dfs in dtsi)
2. rockchip\_flexbus\_writel(rkfb, FLEXBUS\_DMA\_DST\_ADDR0, (ulong)dst\_phys >> 2);

Configure physical address of dst buffer

3. rockchip\_flexbus\_writel(rkfb, FLEXBUS\_DMA\_DST\_LEN0, dst\_len);

Configure length of dst buffer

4. rockchip\_flexbus\_writel(rkfb, FLEXBUS\_ENR, FLEXBUS\_RX\_ENR);

Enable RX transfer

5. wait\_for\_completion\_timeout(&rkfb\_adc->completion, FLEXBUS\_ADC\_TIMEOUT)

Wait for the RX transfer to complete and generate an interrupt (the interrupt handler is rockchip\_flexbus\_adc\_isr())

6. rockchip\_flexbus\_writel(rkfb, FLEXBUS\_ENR, FLEXBUS\_RX\_DIS);

Disable RX transfer

## 1.3 Common interface

### 1.3.1 Check the device corresponding to FLEXBUS ADC

For example:

```
root@rk3576-buildroot:/# cat /sys/bus/iio/devices/iio\:device0/name
2a2f0000.flexbus:adc
```

FLEXBUS ADC corresponds to iio:device0.

### 1.3.2 Get ADC value

```
root@rk3576-buildroot:/# cd /sys/bus/iio/devices/iio\:device0
root@rk3576-buildroot:/sys/bus/iio/devices/iio:device0# cat in_voltage_raw
33004
```

### 1.3.3 Get and change clock frequency

Get clock frequency:

```
root@rk3576-buildroot:/# cd /sys/bus/iio/devices/iio\:device0
root@rk3576-buildroot:/sys/bus/iio/devices/iio:device0# cat
in_voltage_sampling_frequency
99000000
```

The current clock frequency is 99MHz.

Change clock frequency:

```
root@rk3576-buildroot:/sys/bus/iio/devices/iio:device0# echo 25000000 >
in_voltage_sampling_frequency
```

The clock frequency is changed to 25MHz.

Note:

- Only master mode supports getting and changing clock frequency. The CLK of slave mode comes from the ADC device
- Clock frequency up to 100MHz

## 2. FLEXBUS DAC mode

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### 2.1 Overview

FLEXBUS DAC mode is **FLEXBUS0 interfacing high-speed parallel DAC devices** such as ADI max5885 (<https://www.analog.com/en/products/max5885.html>) and ADI AD9744 (<https://www.analog.com/en/products/ad9744.html>). **DAC devices with interface types such as SPI and I2C are not supported.**

- Clock frequency up to 100MHz
- Resolution up to 16-Bit

### 2.2 Configuration

#### 2.2.1 Hardware configuration

- The LSB of the DAC device needs to be connected to FLEXBUS0\_D0, such as 10-Bit DAC to FLEXBUS0\_D[9:0], 16-Bit DAC to FLEXBUS0\_D[15:0]

#### 2.2.2 Kernel configuration

FLEXBUS DAC mode relies on the iio/dac framework.

Device Drivers -> Multifunction device drivers -> Rockchip Flexbus

Device Drivers -> Industrial I/O support -> Digital to analog converters -> Rockchip Flexbus DAC opmode driver

#### 2.2.3 dtsti configuration

Take RK3576 platform and RK3576 TEST1 board, FLEXBUS0 for DAC as an example.

In rk3576.dtsi:

```
flexbus: flexbus@2a2f0000 {
    .....

    flexbus_adc: adc {
        .....
    };

    flexbus_dac: dac {
```



```

compatible = "rockchip,flexbus-dac";
#io-channel-cells = <0>;
rockchip,free-sclk; // Configuring this is clock keeps output, not
configuring this is clock follows data
rockchip,cpol; // Configuring this is CPOL = 1, not configuring this is
0
rockchip,cpha; // Configuring this is CPHA = 1, not configuring this is
0
rockchip,dfs = <16>; // data frames
status = "disabled";

};
};

```

- rockchip,free-sclk: With configuring this, clock keeps output; Without configuring this, clock follow data
- rockchip,cpol, rockchip,cpha: Same as SPI protocol definitions, configured according to the timing diagram in the device datasheet
- rockchip,dfs: data frames, only support configuration of 4, 8, 16; If the resolution of the device is not 4, 8 or 16, it needs to be rounded up; For example, when using DAC devices with 14-Bit resolution, rockchip,dfs needs to be configured to 16, and bit15 and bit14 of the sent data are replaced by 0.

In arch/arm64/boot/dts/rockchip/rk3576-test1.dtsi:

```

&flexbus {
    rockchip,flexbus0-opmode = <ROCKCHIP_FLEXBUS0_OPMODE_DAC>; // FLEXBUS0
selects DAC mode
    rockchip,flexbus1-opmode = <ROCKCHIP_FLEXBUS1_OPMODE_XXX>;
    status = "okay"; // Enable FLEXBUS
};

&flexbus_dac {
    pinctrl-names = "default";
    pinctrl-0 = <&flexbus0m4_csn &flexbus0_clk
                &flexbus0_d0 &flexbus0_d1 &flexbus0_d2 &flexbus0_d3
                &flexbus0_d4 &flexbus0_d5 &flexbus0_d6 &flexbus0_d7
                &flexbus0_d8 &flexbus0_d9 &flexbus0_d10 &flexbus0_d11
                &flexbus0_d12 &flexbus0m0_d13 &flexbus0m0_d14 &flexbus0m0_d15>;
// Configure IOMUX for FLEXBUS0 DAC mode
    status = "okay"; // Enable DAC mode
};

```

## 2.2.4 Driver file

The driver file is drivers/iio/dac/rockchip-flexbus-dac.c.

rockchip\_flexbus\_dac\_write\_block() is a function of sending data to DAC device. The main operations are as follows:

1. rockchip\_flexbus\_writel(rkfb, FLEXBUS\_TX\_NUM, num\_of\_dfs);  
Configure the number of TX in dfs (rockchip,dfs in dtsi)
2. rockchip\_flexbus\_writel(rkfb, FLEXBUS\_TXWAT\_START, val);  
Configure waterline
3. rockchip\_flexbus\_writel(rkfb, FLEXBUS\_DMA\_SRC\_ADDR0, (ulong)src\_phys >> 2);  
Configure physical address of src buffer

4. `rockchip_flexbus_writel(rkfb, FLEXBUS_DMA_SRC_LEN0, src_len);`  
Configure length of src buffer
5. `rockchip_flexbus_writel(rkfb, FLEXBUS_ENR, FLEXBUS_TX_ENR);`  
Enable TX transfer
6. `wait_for_completion_timeout(&rkfb_dac->completion, FLEXBUS_DAC_TIMEOUT)`  
Wait for the TX transfer to complete and generate an interrupt (the interrupt handler is `rockchip_flexbus_dac_isr()`)
7. `rockchip_flexbus_writel(rkfb, FLEXBUS_ENR, FLEXBUS_TX_DIS);`  
Disable TX transfer

## 2.3 Common interface

### 2.3.1 Check the device corresponding to FLEXBUS DAC

For example:

```
root@rk3576-buildroot:/# cat /sys/bus/iio/devices/iio\:device2/name
2a2f0000.flexbus:dac
```

FLEXBUS DAC corresponds to `iio:device1`.

### 2.3.2 Send data to DAC

```
root@rk3576-buildroot:/# cd /sys/bus/iio/devices/iio\:device0
root@rk3576-buildroot:/sys/bus/iio/devices/iio:device2# echo 16383 >
out_voltage_raw
```

### 2.3.3 Get and change clock frequency

Get clock frequency:

```
root@rk3576-buildroot:/# cd /sys/bus/iio/devices/iio\:device2
root@rk3576-buildroot:/sys/bus/iio/devices/iio:device2# cat
out_voltage_sampling_frequency
99000000
```

The current clock frequency is 99MHz.

Change clock frequency:

```
root@rk3576-buildroot:/sys/bus/iio/devices/iio:device2# echo 25000000 >
out_voltage_sampling_frequency
```

The clock frequency is changed to 25MHz.

Note:

- Clock frequency up to 100MHz