



DFSDM Linux driver



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1 Article purpose

The purpose of this article is to introduce the Linux[®] driver for the DFSDM internal peripheral:

- Which DFSDM features are supported by the driver
- How to configure, use and debug it
- What is the driver structure, where to find source code.



2 Short Description

The DFSDM Linux[®] driver (kernel space) is based on the IIO and ALSA frameworks. It offers various modes:

1. **IIO direct mode**: single capture on a channel
2. **IIO software buffer**: capture one or more channels
3. **IIO triggered buffer mode**: capture on one or more channels using triggers

It uses hardware triggers available in IIO. See [TIM Linux driver](#) and [LPTIM Linux driver](#).

It offers an extended API^[1] for audio usage which allows **PDM microphones capture** through a SPI interface.



3 Configuration

3.1 Kernel configuration

Activate the DFSDM Linux[®] driver in the kernel configuration by using the `menuconfig` tool.

3.1.1 IIO driver

Configuration flag: `CONFIG_STM32_DFSDM_ADC`

```
Device Drivers --->
  <*> Industrial I/O support --->
    Analog to digital converters --->
      <*> STMicroelectronics STM32 dfsdm adc
      <*> STMicroelectronics STM32 adc # DFSDM ADC IIO driver
```

When using the DFSDM ADC IIO driver (only), the user must also enable the driver for the external analog front-end (e.g. sigma delta modulator). The generic sigma delta modulators driver may be used for instance (`CONFIG_SD_ADC_MODULATOR`):

```
Device Drivers --->
  <*> Industrial I/O support --->
    Analog to digital converters --->
      <*> Generic sigma delta modulator # sigma delta
modulator driver
```

3.1.2 Audio driver

Configuration flag: `CONFIG_SND_SOC_STM32_DFSDM` (Note: This configuration depends on `CONFIG_STM32_DFSDM_ADC`)

```
Device Drivers --->
  <*> Sound card support --->
    <*> Advanced Linux Sound Architecture --->
      <*> ALSA for SoC audio support --->
        STMicroelectronics STM32 SOC audio support --->
          <*> SoC Audio support for STM32 DFSDM # DFSDM Audio driver
for digital microphone capture
```

3.2 Device tree

Refer to the [DFSDM device tree configuration](#) article when configuring the DFSDM Linux kernel driver.



4 How to use

4.1 IIO driver

In "**IIO direct mode**", the conversion result can be read directly from **sysfs**, see: [How to do a simple ADC conversion using the sysfs interface](#).

In "**IIO triggered buffer mode**", the configuration must be performed by using **sysfs** first. Then, **character device** (/dev/iio:deviceX) is used to read data, see [Convert one or more channels using triggered buffer mode](#).

For information on the standard IIO consumer interface, please refer to [How to use IIO kernel API](#) which gives an example of the IIO consumer kernel API.

4.2 Audio driver

The DFSDM Linux driver can be accessed from userland through an ALSA device. Refer to [ALSA overview](#) for information on how to list and use ALSA devices.



5 How to trace and debug

5.1 How to monitor

The DFSDM driver uses resources such as clocks and GPIOs.

- Refer to [Pinctrl_overview#How_to_monitor](#) to check DFSDM GPIOs.
- Refer to [Clock_overview#How_to_monitor_with_debugfs](#) to check DFSDM clocks.

5.1.1 How to monitor with debugfs

The DFSDM registers are accessed using REGMAP by *DFSDM Linux[®] driver*.

It comes with `debugfs` entries to dump registers:

```
$ cd /sys/kernel/debug/regmap/4400d000.dfsdm/
$ cat registers
000: 00000000
004: 00000000
008: 00000000
```

5.1.2 Other ways to monitor

- Man can check the DFSDM **interrupts** and/or the DFSDM **DMA** interrupts:

```
$ cat /proc/interrupts
          CPU0           CPU1
...
 99:             0             0   GIC-0 142 Level   4400d000.dfsdm:filter@0
100:            0             0   GIC-0 143 Level   4400d000.dfsdm:filter@1
101:            0             0   GIC-0 144 Level   4400d000.dfsdm:filter@2
...
```

5.2 How to trace

5.2.1 IIO driver

Refer to [How to trace with dynamic debug](#) for how to enable the debug logs in the driver and in the framework.

```
Board $> dmesg -n8
Board $> echo "file drivers/iio/adc/stm32-dfsdm* +p" > /sys/kernel/debug/dynamic_debug/control
```

To enable dynamic debug at boot time, append the following arguments on the kernel command line:

```
loglevel=8 dyndbg="file drivers/iio/adc/stm32-dfsdm* +p"
```

5.2.2 Audio driver

Refer to [ALSA_overview#How_to_trace](#) for details on trace tools.



5.3 How to debug

5.3.1 Audio driver

Refer to [ALSA_overview#How_to_debug](#) for details on debugging tools.



6 Source code location

It is composed of:

- `stm32-dfsdm-core.c` , core part of DFSDM Linux driver to handle common resources: registers, clock
- `stm32-dfsdm-adc.c` , ADC part of DFSDM Linux driver to handle **ADC** operations
- `stm32_adfsdm.c` , ASoC DAI part of DFSDM Linux driver to handle **audio** operations

See also sigma delta modulator driver:

- `sd_adc_modulator.c` , sigma delta modulator Linux driver to handle analog front-end



7 References

- `include/linux/iio/adc/stm32-dfsdm-adc.h` , DFSDM IIO custom API

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Digital Filter for Sigma-Delta Modulator

Industrial I/O Linux subsystem

Application programming interface

Serial Peripheral Interface

Analog-to-digital converter. The process of converting a sampled analog signal to a digital code that represents the amplitude of the original signal sample.

Secure digital

Advanced Linux sound architecture

System File System (See <https://en.wikipedia.org/wiki/Sysfs> for more details)

Debug File System (See <https://en.wikipedia.org/wiki/Debugfs> for more details)

Register map (Linux registers map abstraction API)

Direct Memory Access

Generic Interrupt Controller

ALSA System on Chip

Digital Audio Interface