

AD7280A IIO Lithium Ion Battery Monitoring System Linux Driver

Supported Devices

- [AD7280A](#)

Reference Circuits

- [CN0197](#)
- [CN0235](#)

Evaluation Boards

- [EVAL-AD7280AEDZ](#)

Description



This is a Linux industrial I/O ([IIO](#)) subsystem driver, targeting multi channel serial interface ADCs. The industrial I/O subsystem provides a unified framework for drivers for many different types of converters and sensors using a number of different physical interfaces (i2c, spi, etc). See [IIO](#) for more information.

The AD7280A contains all the functions required for general-purpose monitoring of stacked lithium ion batteries as used in hybrid electric vehicles, battery backup applications, and power tools. The part has multiplexed cell voltage and auxiliary ADC measurement channels for up to six cells of battery management. This driver supports the daisy-chain interface allowing up to eight parts to be stacked without the need for individual device isolation.

The driver automatically detects then number of devices present and creates the iio device files accordingly.

Source Code

Status

Source	Mainlined?
 git	 Yes

Files

Function	File
driver	 drivers/staging/iio/adc/ad7280a.c
include	 drivers/staging/iio/adc/ad7280a.h

Example platform device initialization

For compile time configuration, it's common Linux practice to keep board- and application-specific configuration out of the main driver file, instead putting it into the board support file.

For devices on custom boards, as typical of embedded and SoC-(system-on-chip) based hardware, Linux uses `platform_data` to point to board-specific structures describing devices and how they are connected to the SoC. This can include available ports, chip variants, preferred modes, default initialization, additional pin roles, and so on. This shrinks the board-support packages (BSPs) and minimizes board and application specific `#ifdefs` in drivers.

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Some device parameter may vary between applications and use cases. The `platform_data` for the device's "struct device" holds this information.

```
#define AD7280A_ACQ_TIME_400ns 0
#define AD7280A_ACQ_TIME_800ns 1
#define AD7280A_ACQ_TIME_1200ns 2
#define AD7280A_ACQ_TIME_1600ns 3

#define AD7280A_CONV_AVG_DIS 0
#define AD7280A_CONV_AVG_2 1
#define AD7280A_CONV_AVG_4 2
#define AD7280A_CONV_AVG_8 3

#define AD7280A_ALERT_REMOVE_VIN5 (1 << 2)
#define AD7280A_ALERT_REMOVE_VIN4_VIN5 (2 << 2)
#define AD7280A_ALERT_REMOVE_AUX5 (1 << 0)
```

```
#define AD7280A_ALERT_REMOVE_AUX4_AUX5 (2 << 0)

struct ad7280_platform_data {
    unsigned acquisition_time;
    unsigned conversion_averaging;
    unsigned chain_last_alert_ignore;
    bool thermistor_term_en;
}
```

In case platform_data is not present or set to NULL, the driver will use following defaults:

```
static const struct ad7280_platform_data ad7280_default_pdata = {
    .acquisition_time = AD7280A_ACQ_TIME_400ns,
    .conversion_averaging = AD7280A_CONV_AVG_DIS,
    .thermistor_term_en = true,
};
```

Declaring SPI slave devices

Unlike PCI or USB devices, SPI devices are not enumerated at the hardware level. Instead, the software must know which devices are connected on each SPI bus segment, and what slave selects these devices are using. For this reason, the kernel code must instantiate SPI devices explicitly. The most common method is to declare the SPI devices by bus number.

This method is appropriate when the SPI bus is a system bus, as in many embedded systems, wherein each SPI bus has a number which is known in advance. It is thus possible to pre-declare the SPI devices that inhabit this bus. This is done with an array of struct spi_board_info, which is registered by calling spi_register_board_info().

For more information see: [Documentation/spi/spi-summary](#)

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Depending on the converter IC used, you may need to set the modalias accordingly, matching your part name. It may also required to adjust max_speed_hz. Please consult the datasheet, for maximum spi clock supported by the device in question.

```
static struct spi_board_info board_spi_board_info[] __initdata = {
#if defined(CONFIG_AD7280A) || \
    defined(CONFIG_AD7280A_MODULE)
{
    .modalias = "ad7280a",
    .max_speed_hz = 1000000, /* max spi clock (SCK) speed
```

```

in HZ */
        .bus_num = 0,
        .chip_select = GPIO_PF10 + MAX_CTRL_CS, /* CS, change it
for your board */
        .mode = SPI_MODE_1,
        .irq = IRQ_PF6
    },
#endif
};

```

```

static int __init board_init(void)
{
    [--snip--]

    spi_register_board_info(board_spi_board_info, ARRAY_SIZE(
board_spi_board_info));

    [--snip--]

    return 0;
}
arch_initcall(board_init);

```

Adding Linux driver support

Configure kernel with “make menuconfig” (alternatively use “make xconfig” or “make qconfig”)



The AD7280A Driver depends on **CONFIG_SPI**

```

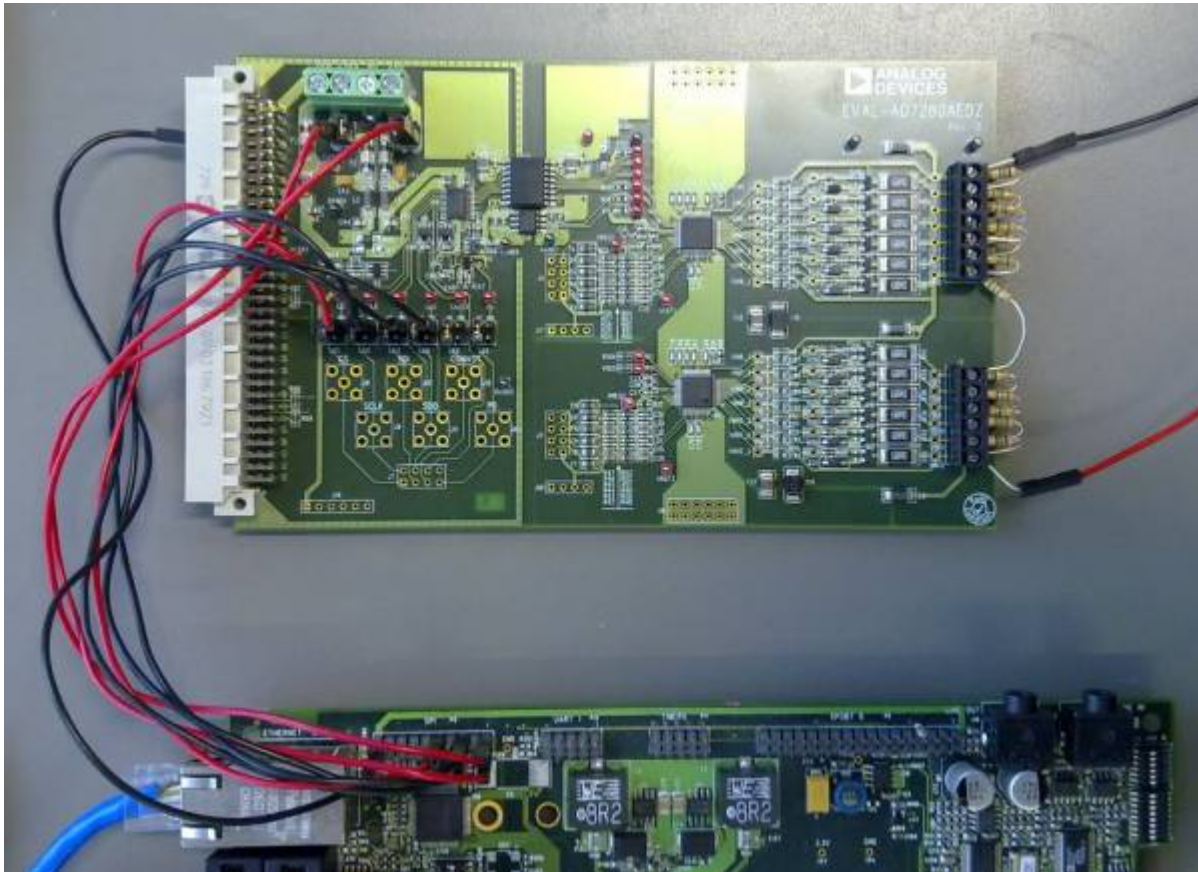
Linux Kernel Configuration
  Device Drivers  --->
    [*] Staging drivers  --->
      <*>      Industrial I/O support  --->
        --- Industrial I/O support
        *-   Enable ring buffer support within IIO
        *-   Industrial I/O lock free software ring
        *-   Enable triggered sampling support

            *** Analog to digital converters ***
        [--snip--]

      <*>      Analog Devices AD7280A Lithium Ion

```

Hardware configuration



Driver testing

Each and every IIO device, typically a hardware chip, has a device folder under `/sys/bus/iio/devices/iio:deviceX`. Where X is the IIO index of the device. Under every of these directory folders reside a set of files, depending on the characteristics and features of the hardware device in question. These files are consistently generalized and documented in the IIO ABI documentation. In order to determine which IIO deviceX corresponds to which hardware device, the user can read the name file `/sys/bus/iio/devices/iio:deviceX/name`. In case the sequence in which the iio device drivers are loaded/registered is constant, the numbering is constant and may be known in advance.

02 Mar 2011 14:16 · [Michael Hennerich](#)

This specifies any shell prompt running on the target

```
root: /> cd /sys/bus/iio/devices/
root:/sys/bus/iio/devices> ls
device0          device0:event0
root:/sys/bus/iio/devices> cd device0

root:/sys/devices/platform/bfin-spi.0/spi0.18/device0> ls -l
drwxr-xr-x    3 root    root          0 Mar 14 11:16 device0:event0
-rw-r--r--    1 root    root        4096 Mar 14 11:16 in-in_scale
-r--r--r--    1 root    root        4096 Mar 14 11:16 in0-in12_raw
-rw-r--r--    1 root    root        4096 Mar 14 11:16
in0-in1_balance_switch_en
-rw-r--r--    1 root    root        4096 Mar 14 11:16
in0-in1_balance_timer
-r--r--r--    1 root    root        4096 Mar 14 11:16 in0-in1_raw
-rw-r--r--    1 root    root        4096 Mar 14 11:16
in1-in2_balance_switch_en
-rw-r--r--    1 root    root        4096 Mar 14 11:16
in1-in2_balance_timer
-r--r--r--    1 root    root        4096 Mar 14 11:16 in1-in2_raw
-rw-r--r--    1 root    root        4096 Mar 14 11:16
in10-in11_balance_switch_en
-rw-r--r--    1 root    root        4096 Mar 14 11:16
in10-in11_balance_timer
-r--r--r--    1 root    root        4096 Mar 14 11:16 in10-in11_raw
-rw-r--r--    1 root    root        4096 Mar 14 11:16
in11-in12_balance_switch_en
-rw-r--r--    1 root    root        4096 Mar 14 11:16
in11-in12_balance_timer
-r--r--r--    1 root    root        4096 Mar 14 11:16 in11-in12_raw
-rw-r--r--    1 root    root        4096 Mar 14 11:16
in2-in3_balance_switch_en
-rw-r--r--    1 root    root        4096 Mar 14 11:16
in2-in3_balance_timer
-r--r--r--    1 root    root        4096 Mar 14 11:16 in2-in3_raw
-rw-r--r--    1 root    root        4096 Mar 14 11:16
in3-in4_balance_switch_en
-rw-r--r--    1 root    root        4096 Mar 14 11:16
in3-in4_balance_timer
-r--r--r--    1 root    root        4096 Mar 14 11:16 in3-in4_raw
-rw-r--r--    1 root    root        4096 Mar 14 11:16
in4-in5_balance_switch_en
-rw-r--r--    1 root    root        4096 Mar 14 11:16
in4-in5_balance_timer
-r--r--r--    1 root    root        4096 Mar 14 11:16 in4-in5_raw
-rw-r--r--    1 root    root        4096 Mar 14 11:16
in5-in6_balance_switch_en
```

```

-rw-r--r--    1 root    root          4096 Mar 14 11:16
in5-in6_balance_timer
-r--r--r--    1 root    root          4096 Mar 14 11:16 in5-in6_raw
-rw-r--r--    1 root    root          4096 Mar 14 11:16
in6-in7_balance_switch_en
-rw-r--r--    1 root    root          4096 Mar 14 11:16
in6-in7_balance_timer
-r--r--r--    1 root    root          4096 Mar 14 11:16 in6-in7_raw
-rw-r--r--    1 root    root          4096 Mar 14 11:16
in7-in8_balance_switch_en
-rw-r--r--    1 root    root          4096 Mar 14 11:16
in7-in8_balance_timer
-r--r--r--    1 root    root          4096 Mar 14 11:16 in7-in8_raw
-rw-r--r--    1 root    root          4096 Mar 14 11:16
in8-in9_balance_switch_en
-rw-r--r--    1 root    root          4096 Mar 14 11:16
in8-in9_balance_timer
-r--r--r--    1 root    root          4096 Mar 14 11:16 in8-in9_raw
-rw-r--r--    1 root    root          4096 Mar 14 11:16
in9-in10_balance_switch_en
-rw-r--r--    1 root    root          4096 Mar 14 11:16
in9-in10_balance_timer
-r--r--r--    1 root    root          4096 Mar 14 11:16 in9-in10_raw
-r--r--r--    1 root    root          4096 Mar 14 11:16 name
drwxr-xr-x    2 root    root           0 Mar 14 11:16 power
lrwxrwxrwx    1 root    root           0 Mar 14 11:16 subsystem ->
../../../../../../../../bus/iio
-r--r--r--    1 root    root          4096 Mar 14 11:16 temp0_raw
-r--r--r--    1 root    root          4096 Mar 14 11:16 temp10_raw
-r--r--r--    1 root    root          4096 Mar 14 11:16 temp11_raw
-r--r--r--    1 root    root          4096 Mar 14 11:16 temp1_raw
-r--r--r--    1 root    root          4096 Mar 14 11:16 temp2_raw
-r--r--r--    1 root    root          4096 Mar 14 11:16 temp3_raw
-r--r--r--    1 root    root          4096 Mar 14 11:16 temp4_raw
-r--r--r--    1 root    root          4096 Mar 14 11:16 temp5_raw
-r--r--r--    1 root    root          4096 Mar 14 11:16 temp6_raw
-r--r--r--    1 root    root          4096 Mar 14 11:16 temp7_raw
-r--r--r--    1 root    root          4096 Mar 14 11:16 temp8_raw
-r--r--r--    1 root    root          4096 Mar 14 11:16 temp9_raw
-rw-r--r--    1 root    root          4096 Mar 14 11:16 temp_scale
-rw-r--r--    1 root    root          4096 Mar 14 11:16 uevent
root:/sys/devices/platform/bfin-spi.0/spi0.18/device0>

```

Show device name

This specifies any shell prompt running on the target

```
root:/sys/devices/platform/bfin-spi.0/spi0.18/device0> cat name  
ad7280a
```

Show cell channel scale

Description:

scale to be applied to inX-inY_raw in order to obtain the measured voltage in millivolts.

This specifies any shell prompt running on the target

```
root:/sys/devices/platform/bfin-spi.0/spi0.18/device0> cat in-in_scale  
0.976000
```

Show channel 0-1 measurement

Description:

Raw unscaled voltage measurement on cell channel in0-in1_raw

This specifies any shell prompt running on the target

```
root:/sys/devices/platform/bfin-spi.0/spi0.18/device0> cat in0-in1_raw  
2254
```


$$U = in0-in1_raw * in-in_scale + offset = 2254 * 0.976000 + 1000 = \mathbf{3199.904\ mV}$$

Show voltage across all cells measurement

Description:

Raw unscaled voltage measurement on all cell channel in0-inX_raw

This specifies any shell prompt running on the target

```
root:/sys/devices/platform/bfin-spi.0/spi0.18/device0> cat in0-in12_raw  
27048
```

$$U = in0-in1_raw * in-in_scale + (cell_num * offset) = 27048 * 0.976000 + (12 * 1000) = \mathbf{38398.848\ mV}$$

Show auxiliary/temperature channel scale

Description:

scale to be applied to tempX_raw in order to obtain the measured voltage in millivolts.

This specifies any shell prompt running on the target

```
root:/sys/devices/platform/bfin-spi.0/spi0.18/device0> cat temp_scale  
1.220000
```

Show auxiliary/temperature channel measurement

Description:

Shows high accuracy band gap temperature sensor temperature in milli degrees Celsius.

This specifies any shell prompt running on the target

```
root:/sys/devices/platform/bfin-spi.0/spi0.18/device0> cat temp0_raw
2096
```

$$U = temp0_raw * temp_scale = 2096 * 1.220000 = 2557.12 \text{ mV}$$

Enable cell balance output switch on channel 4-5

The AD7280A has cell balancing interface outputs designed to control external FET transistors to allow discharging of individual cells.

Description:

Writing 1 enables the cell balance output switch corresponding to input Y. Writing 0 disables it. If the inY-inZ_balance_timer is set to a none zero value, the corresponding switch will enable for the programmed amount of time, before it automatically disables.

This specifies any shell prompt running on the target

```
root:/sys/devices/platform/bfin-spi.0/spi0.18/device0> echo 1 >
in4-in5_balance_switch_en
root:/sys/devices/platform/bfin-spi.0/spi0.18/device0> cat
in4-in5_balance_switch_en
1
```

```
root:/sys/devices/platform/bfin-spi.0/spi0.18/device0> echo 0 >
in4-in5_balance_switch_en
root:/sys/devices/platform/bfin-spi.0/spi0.18/device0> cat
in4-in5_balance_switch_en
0
root:/sys/devices/platform/bfin-spi.0/spi0.18/device0>
```

Enable cell balance timer on channel 4-5

Description:

The inY-inZ_balance_timer file allows the user to program individual times for each cell balance output. The AD7280A allows the user to set the timer to a value from 0 minutes to 36.9 minutes. The resolution of the timer is 71.5 sec.

The value written is the on-time in milliseconds. When the timer value is set 0, the timer is disabled. The cell balance outputs are controlled only by inY-inZ_balance_switch_en.

This specifies any shell prompt running on the target

```
root:/sys/devices/platform/bfin-spi.0/spi0.18/device0> echo 150000 >
in4-in5_balance_timer
root:/sys/devices/platform/bfin-spi.0/spi0.18/device0> cat
in4-in5_balance_timer
143000
root:/sys/devices/platform/bfin-spi.0/spi0.18/device0>
```

Enabling cell and auxiliary/temperature channel threshold events

This specifies any shell prompt running on the target

```

root: /> cd /sys/bus/iio/devices/
root:/sys/bus/iio/devices> ls
device0          device0:event0
root:/sys/bus/iio/devices> cd device0:event0

root:/sys/devices/platform/bfin-spi.0/spi0.18/device0/device0:event0> ls
-l
-r--r--r--    1 root    root          4096 Mar 14 13:37 dev
-rw-r--r--    1 root    root          4096 Mar 14 13:37
in-in_thresh_high_value
-rw-r--r--    1 root    root          4096 Mar 14 13:37
in-in_thresh_low_value
drwxr-xr-x    2 root    root           0 Mar 14 13:37 power
lrwxrwxrwx    1 root    root           0 Mar 14 13:37 subsystem ->
../../../../../../../../bus/iio
-rw-r--r--    1 root    root          4096 Mar 14 13:37
temp_thresh_high_value
-rw-r--r--    1 root    root          4096 Mar 14 13:37
temp_thresh_low_value
-rw-r--r--    1 root    root          4096 Mar 14 13:37 uevent
root:/sys/devices/platform/bfin-spi.0/spi0.18/device0/device0:event0>

```

The AD7280A includes a dynamic alert function that can detect whether the cell voltages or auxiliary ADC inputs exceed an upper or lower limit defined by the user.

Description:

Specifies the value of threshold (`_high|_low`) that the device is comparing against.

This specifies any shell prompt running on the target

```

root:/sys/devices/platform/bfin-spi.0/spi0.18/device0/device0:event0>
echo 2300 > in-in_thresh_low_value
root:/sys/devices/platform/bfin-spi.0/spi0.18/device0/device0:event0>
cat in-in_thresh_low_value
2285

root:/sys/devices/platform/bfin-spi.0/spi0.18/device0/device0:event0>
echo 4000 > in-in_thresh_high_value
root:/sys/devices/platform/bfin-spi.0/spi0.18/device0/device0:event0>
cat in-in_thresh_high_value
3994

```

More Information

- IIO mailing list: linux-iio@vger.kernel.org
- [IIO Documentation](#)
- [IIO Utils Main Page](#)
- [IIO test and visualization demo application](#)
- [IIO Command Server](#)
- [Pointers and good books](#)

Need Help?

- [Analog Devices Linux Device Drivers Help Forum](#)
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