

Customizing the Linux kernel and device tree

October 2020



SOM

System on Module

CB

Carrier Board

DK

Development Kit

Engineering

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Agenda

- ❑ Linux kernel recipe in meta-somlabs
- ❑ Modifying the kernel using devtool
- ❑ Customizing the device tree
- ❑ Using the SPI, UART and I2C in Linux

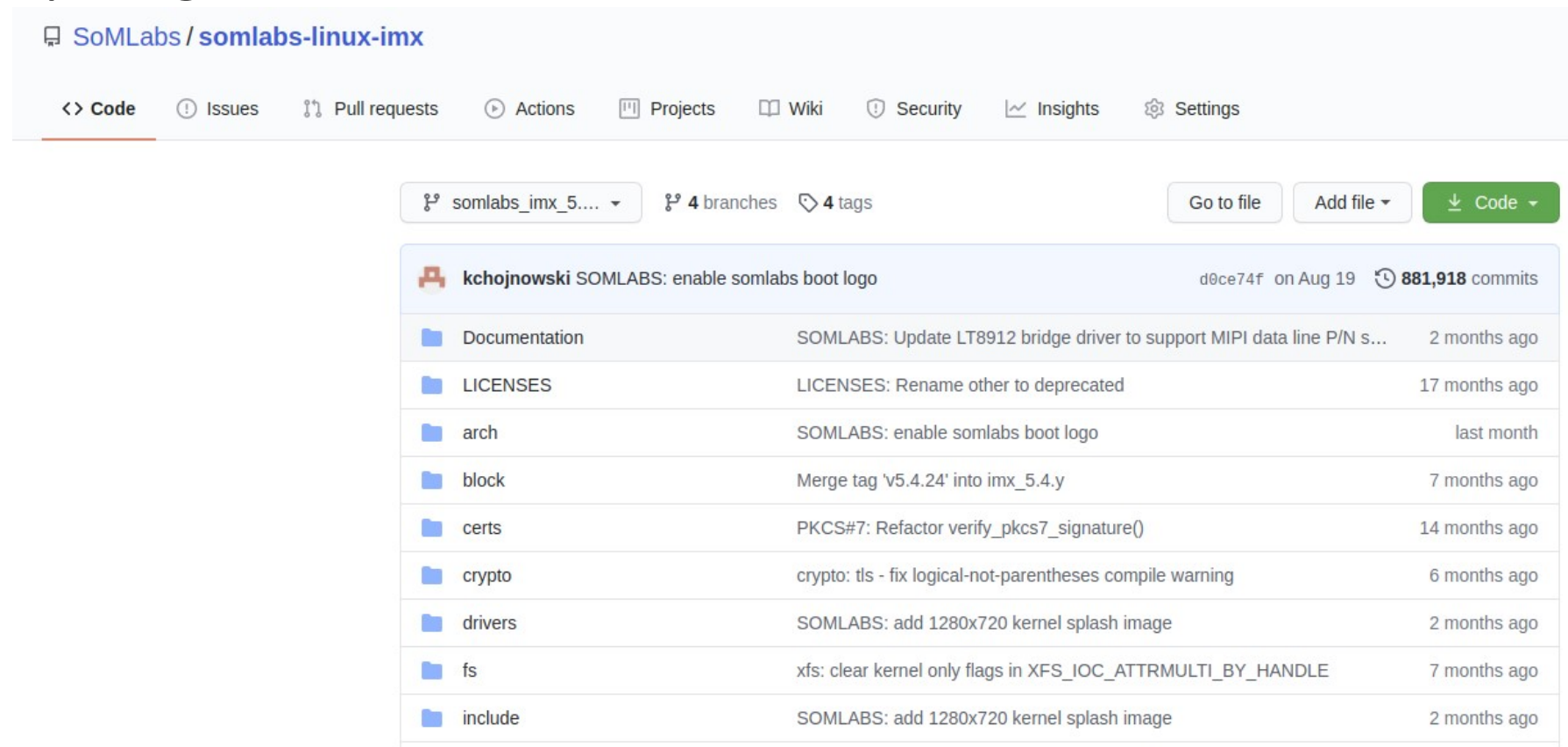
Exercises

- ❑ /home/dev/Excercises/Workshop2/
- ❑ Lab1 - Modifying the kernel configuration
- ❑ Lab2 - Modifying the device tree

Linux kernel recipe

Linux kernel recipe

❑ <https://github.com/SoMLabs/somlabs-linux-imx>



SoMLabs / somlabs-linux-imx

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somlabs_imx_5.... 4 branches 4 tags Go to file Add file Code

kchojnowski SOMLABS: enable somlabs boot logo d0ce74f on Aug 19 881,918 commits

Documentation	SOMLABS: Update LT8912 bridge driver to support MIPI data line P/N s...	2 months ago
LICENSES	LICENSES: Rename other to deprecated	17 months ago
arch	SOMLABS: enable somlabs boot logo	last month
block	Merge tag 'v5.4.24' into imx_5.4.y	7 months ago
certs	PKCS#7: Refactor verify_pkcs7_signature()	14 months ago
crypto	crypto: tls - fix logical-not-parentheses compile warning	6 months ago
drivers	SOMLABS: add 1280x720 kernel splash image	2 months ago
fs	xfs: clear kernel only flags in XFS_IOC_ATTRMULTI_BY_HANDLE	7 months ago
include	SOMLABS: add 1280x720 kernel splash image	2 months ago

Linux kernel recipe

❑ meta-somlabs/recipes-kernel/linux/linux-imx_5.4.bbappend

```
dev@somlabs:~/imx-yocto-bsp$ cat sources/meta-somlabs/recipes-kernel/linux/linux-imx_5.4.bbappend
FILESEXTRAPATHS_prepend := "${THISDIR}/${PN}:"

LOCALVERSION = "-lts-${KERNEL_BRANCH}"
KERNEL_SRC = "git://github.com/SoMLabs/somlabs-linux-imx.git;protocol=http"
SRC_URI = "${KERNEL_SRC};branch=${KERNEL_BRANCH} \
"

KERNEL_BRANCH = "somlabs_imx_5.4.24_2.1.0"
SRCREV = "d0ce74ff14da6634880b70698f17dd6efeb2816e"

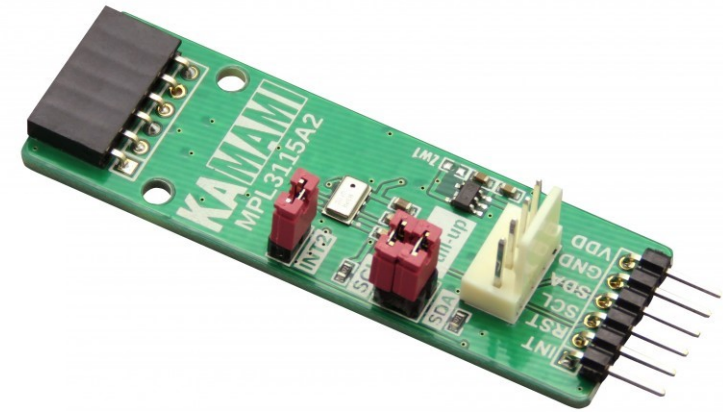
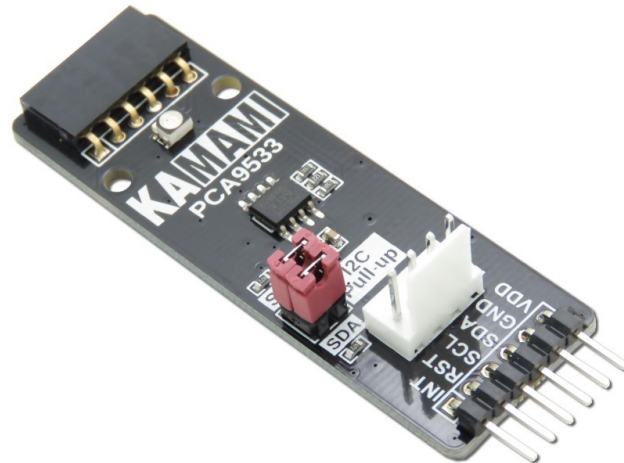
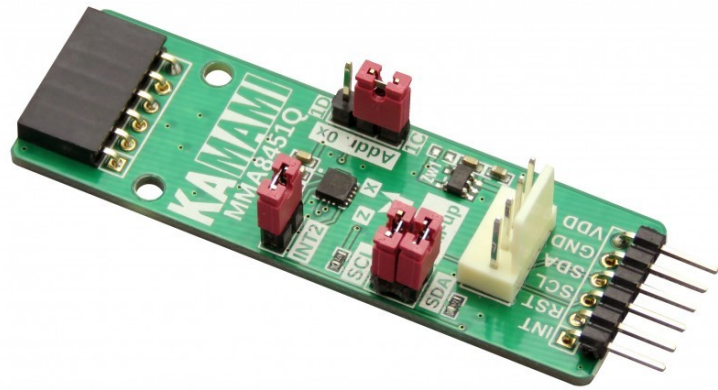
addtask copy_somlabs_defconfig after do_patch copy_defconfig before do_preconfigure
do_copy_somlabs_defconfig () {
}

do_copy_somlabs_defconfig_append_visionsom-8mm-cb () {
    cp ${S}/arch/arm64/configs/visionsom_8mm_defconfig ${B}/.config
    cp ${S}/arch/arm64/configs/visionsom_8mm_defconfig ${B}/../defconfig
}

do_copy_somlabs_defconfig_append_visioncb-6ull-std () {
    cp ${S}/arch/arm/configs/visionsom_6ull_defconfig ${B}/.config
    cp ${S}/arch/arm/configs/visionsom_6ull_defconfig ${B}/../defconfig
}
```

Modifying kernel in Yocto with devtool

Customizing the kernel



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Customizing the kernel

❑ Copying the patch

```
cd ~/imx-yocto-bsp/sources/meta-somlabs/recipes-kernel/linux
```

```
cp ~/Exercices/Workshop2/Lab1/linux-imx_5.4.bbappend .
```

```
mkdir linux-imx
```

```
cp ~/Exercices/Workshop2/Lab1/0001-Added-sensors-to-kernel-  
defconfig.patch linux-imx
```

Customizing the kernel

❑ Creating own patch

```
cd ~/imx-yocto-bsp
```

```
DISTRO=fsl-imx-wayland MACHINE=visionsom-8mm-cb-std source  
imx-setup-release.sh -b build-visionsom-8mm-cb-std
```

```
devtool modify linux-imx
```

```
cd workspace/sources/linux-imx
```

Customizing the kernel

```
ARCH=arm64 make visionsom_8mm_defconfig
```

```
ARCH=arm64 make menuconfig
```

```
ARCH=arm64 make savedefconfig
```

```
cp defconfig arch/arm64/configs/visionsom_8mm_defconfig
```

Customizing the kernel

```
git add arch/arm64/configs/visionsom_8mm_defconfig
```

```
git commit
```

```
make mrproper
```

```
devtool update-recipe -a ../../../../../../sources/meta-somlabs/  
linux-imx
```

```
devtool reset linux-imx
```

Customizing the device tree

Customizing the device tree

- ❑ arch/arm64/boot/dts/freescale/
- ❑ visionsom-8mm.dtsi
- ❑ visionsom-8mm-cb.dtsi
- ❑ visionsom-8mm-cb-std.dts

Customizing the kernel

❑ Copying the patch

```
cd ~/imx-yocto-bsp/sources/meta-somlabs/recipes-kernel/linux
```

```
cp ~/Exercices/Workshop2/Lab2/linux-imx_5.4.bbappend .
```

```
cp ~/Exercices/Workshop2/Lab2/*.patch linux-imx
```

Customizing the kernel

❑ Copying the patch

```
linux
```

```
|— linux-imx
|   |— 0001-Added-sensors-to-kernel-defconfig.patch
|   |— 0002-Enabled-uart3-interface.patch
|   |— 0003-Enabled-spi1-interface.patch
|   |— 0004-Enabled-i2c1-interface.patch
|   |— 0005-Added-PCA9533-support.patch
|   |— 0006-Added-MMA8451-and-MPL3115-support.patch
|— linux-imx_5.4.bbappend
```


Customizing the device tree - UART

- ❑ visionsom-8mm-cb-std.dts
- ❑ arch/arm64/boot/dts/freescale/imx8mm-pinctrl.h
- ❑ Raspberry Pi Connector 8 (TXD), 10 (RXD)

```
&iomuxc {
    pinctrl-names = "default";
    visionsom-imx8mm-cb-std {
        pinctrl_uart3: uart3grp {
            fsl,pins = <
                MX8MM_IOMUXC_UART3_RXD_UART3_DCE_RX      0x140
                MX8MM_IOMUXC_UART3_TXD_UART3_DCE_TX      0x140
            >;
        };
    };
};
```

Customizing the device tree - UART

- ❑ visionsom-8mm-cb-std.dts
- ❑ Documentation/devicetree/bindings/serial/fsl-imx-uart.txt

```
&uart3 {  
    pinctrl-names = "default";  
    pinctrl-0 = <&pinctrl_uart3>;  
    status = "okay";  
};
```

Customizing the device tree - UART

- ❑ /dev/ttymx1 - UART2
- ❑ /dev/ttymx2 - UART3
- ❑ /dev/ttymx3 - UART4 (console)

```
root@visionsom-8mm-cb-std:~# ls /dev/ttymx*  
/dev/ttymx1 /dev/ttymx2 /dev/ttymx3
```

Customizing the device tree - SPI

- ❑ visionsom-8mm-cb-std.dts
- ❑ arch/arm64/boot/dts/freescale/imx8mm-pinfunc.h
- ❑ Raspberry Pi Connector 19 (MOSI), 21 (MISO), 23 (CLK), 24 (CS)

```
&iomuxc {
    pinctrl-names = "default";
    visionsom-imx8mm-cb-std {
        pinctrl_ecspi1: ecspi1grp {
            fsl,pins = <
                MX8MM_IOMUXC_ECSPi1_SS0_GPIO5_IO9          0x19
                MX8MM_IOMUXC_ECSPi1_MISO_ECSPi1_MISO        0x19
                MX8MM_IOMUXC_ECSPi1_MOSI_ECSPi1_MOSI        0x19
                MX8MM_IOMUXC_ECSPi1_SCLK_ECSPi1_SCLK        0x19
            >;
        };
    };
};
```

Customizing the device tree - SPI

❑ visionsom-8mm-cb-std.dts

❑ Documentation/devicetree/bindings/spi/fsl-imx-cspi.txt

```
&ecspi1 {  
    pinctrl-names = "default";  
    pinctrl-0 = <&pinctrl_ecspi1>;  
    fsl,spi-num-chipselects = <1>;  
    cs-gpios = <&gpio5 9 GPIO_ACTIVE_LOW>;  
    status = "okay";  
    #address-cells = <1>;  
    #size-cells = <0>;  
  
    spidev@0 {  
        compatible = "spidev";  
        spi-max-frequency = <20000000>;  
        reg = <0>;  
    };  
};
```

Customizing the device tree - SPI

□ /dev/spidev0.0 - SPI1

```
root@visionsom-8mm-cb-std:~# ls /dev/spidev0.0  
/dev/spidev0.0
```

Customizing the device tree - I2C

- ❑ visionsom-8mm-cb.dtsi
- ❑ arch/arm64/boot/dts/freescale/imx8mm-pinctrl.h
- ❑ Raspberry Pi Connector 3 (SDA), 5 (SCL)

```
&iomuxc {  
    pinctrl-names = "default";  
    visionsom-imx8mm-cb-std {  
        pinctrl_i2c1: i2c1grp {  
            fsl,pins = <  
                MX8MM_IOMUXC_I2C1_SCL_I2C1_SCL        0x40000083  
                MX8MM_IOMUXC_I2C1_SDA_I2C1_SDA        0x40000083  
            >;  
        };  
    };  
};
```

Customizing the device tree - I2C

- ❑ visionsom-8mm-cb-std.dts
- ❑ arch/arm64/boot/dts/freescale/imx8mm-pinctrl.h

```
pinctrl_i2c1_gpio: i2c1grp-gpio {  
    fsl,pins = <  
        MX8MM_IOMUXC_I2C1_SCL_GPIO5_IO14        0x83  
        MX8MM_IOMUXC_I2C1_SDA_GPIO5_IO15        0x83  
    >;  
};
```


Customizing the device tree - I2C

- ❑ visionsom-8mm-cb-std.dts
- ❑ Documentation/devicetree/bindings/i2c/i2c-imx.txt

```
&i2c1 {  
    clock-frequency = <400000>;  
    pinctrl-names = "default";  
    pinctrl-0 = <&pinctrl_i2c1>;  
    pinctrl-1 = <&pinctrl_i2c1_gpio>;  
    scl-gpios = <&gpio5 14 GPIO_ACTIVE_HIGH>;  
    sda-gpios = <&gpio5 15 GPIO_ACTIVE_HIGH>;  
    status = "okay";  
};
```

Customizing the device tree - I2C

- ❑ /dev/i2c-0 - I2C1
- ❑ /dev/i2c-1 - I2C2 (Touchscreen)
- ❑ /dev/i2c-3 - I2C3 (PMIC)

```
root@visionsom-8mm-cb-std:~# ls /dev/i2c*  
/dev/i2c-0 /dev/i2c-1 /dev/i2c-3
```

```
root@visionsom-8mm-cb-std:~# i2cdetect -y 0  
    0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f  
00:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  
10:  --  --  --  --  --  --  --  --  --  --  --  1c  --  --  --  
20:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  
30:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  
40:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  
50:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  
60: 60  --  62  --  --  --  --  --  --  --  --  --  --  --  --  
70:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
```

Customizing the device tree - PCA9533

❑ visionsom-8mm-cb-std.dts

❑ Documentation/devicetree/bindings/leds/leds-pca9532.txt

```
#include <dt-bindings/leds/leds-pca9532.h>
```

```
leds: pca9533@62 {  
    compatible = "nxp,pca9533";  
    reg = <0x62>;  
    green {  
        label = "pca:green";  
        type = <PCA9532_TYPE_LED>;  
    };  
};
```

Customizing the device tree - PCA9533

- ❑ /sys/class/leds/pca:red
- ❑ /sys/class/leds/pca:green
- ❑ /sys/class/leds/pca:blue

```
root@visionsom-8mm-cb-std:~# i2cdetect -y 0
    0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f
00:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
10:  --  --  --  --  --  --  --  --  --  --  --  1c  --  --  --
20:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
30:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
40:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
50:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
60: 60  --  UU  --  --  --  --  --  --  --  --  --  --  --  --
70:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
```

```
root@visionsom-8mm-cb-std:/sys/class/leds# ls -l
total 0
lrwxrwxrwx 1 root root 0 Sep 20 21:16 LED-I0-04 -> ../../devices/platform/leds/leds/LED-I0-04
lrwxrwxrwx 1 root root 0 Sep 20 21:16 LED-I0-05 -> ../../devices/platform/leds/leds/LED-I0-05
lrwxrwxrwx 1 root root 0 Sep 20 21:16 LED-I0-06 -> ../../devices/platform/leds/leds/LED-I0-06
lrwxrwxrwx 1 root root 0 Sep 20 21:16 LED-I0-07 -> ../../devices/platform/leds/leds/LED-I0-07
lrwxrwxrwx 1 root root 0 Sep 20 21:16 mmc0:: -> ../../devices/platform/soc@0/soc@0:bus@30800000/30b40000.mmc/leds/mmc0::
lrwxrwxrwx 1 root root 0 Sep 20 21:16 mmc1:: -> ../../devices/platform/soc@0/soc@0:bus@30800000/30b50000.mmc/leds/mmc1::
lrwxrwxrwx 1 root root 0 Sep 20 21:16 mmc2:: -> ../../devices/platform/soc@0/soc@0:bus@30800000/30b60000.mmc/leds/mmc2::
lrwxrwxrwx 1 root root 0 Sep 20 21:16 pca:blue -> ../../devices/platform/soc@0/soc@0:bus@30800000/30a20000.i2c/i2c-0/0-0062/leds/pca:blue
lrwxrwxrwx 1 root root 0 Sep 20 21:16 pca:green -> ../../devices/platform/soc@0/soc@0:bus@30800000/30a20000.i2c/i2c-0/0-0062/leds/pca:green
lrwxrwxrwx 1 root root 0 Sep 20 21:16 pca:red -> ../../devices/platform/soc@0/soc@0:bus@30800000/30a20000.i2c/i2c-0/0-0062/leds/pca:red
lrwxrwxrwx 1 root root 0 Sep 20 21:16 status -> ../../devices/platform/leds/leds/status
```

Customizing the device tree - MMA8451

- ❑ visionsom-8mm-cb-std.dts
- ❑ Documentation/devicetree/bindings/iio/accel/mma8452.txt

```
accel: mma8451q@1c {  
    compatible = "fsl,mma8451";  
    reg = <0x1c>;  
};
```

Customizing the device tree - MMA8451

□ /sys/class/input/input0

```
root@visionsom-8mm-cb-std:/sys/class/input/input0# cat name
mma845x
```

```
root@visionsom-8mm-cb-std:~# i2cdetect -y 0
    0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f
00:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
10:  --  --  --  --  --  --  --  --  --  --  --  --  UU  --  --
20:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
30:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
40:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
50:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
60: UU  --  UU  --  --  --  --  --  --  --  --  --  --  --  --
70:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
```

```
root@visionsom-8mm-cb-std:/sys/class/input/input0# echo 1 > enable
root@visionsom-8mm-cb-std:/sys/class/input/input0# evtest /dev/input/event0
Input driver version is 1.0.1
Input device ID: bus 0x18 vendor 0x0 product 0x0 version 0x0
Input device name: "mma845x"
Supported events:
Event type 0 (EV_SYN)
Event type 3 (EV_ABS)
  Event code 0 (ABS_X)
    Value   -576
    Min    -8192
    Max     8191
    Fuzz     32
    Flat     32
  Event code 1 (ABS_Y)
    Value   -376
    Min    -8192
    Max     8191
    Fuzz     32
    Flat     32
  Event code 2 (ABS_Z)
    Value  16448
    Min    -8192
    Max     8191
    Fuzz     32
    Flat     32
Properties:
Testing ... (interrupt to exit)
Event: time 1600636906.280399, type 3 (EV_ABS), code 0 (ABS_X), value -576
Event: time 1600636906.280399, type 3 (EV_ABS), code 1 (ABS_Y), value -376
Event: time 1600636906.280399, type 3 (EV_ABS), code 2 (ABS_Z), value 16448
```

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Customizing the device tree - MPL3115

- ❑ visionsom-8mm-cb-std.dts
- ❑ Documentation/devicetree/bindings/trivial-devices.yaml

```
pressure: mpl3115a2@60 {  
    compatible = "fsl,mpl3115";  
    reg = <0x60>;  
};
```

Customizing the device tree - MPL3115

□ /sys/bus/iio/devices/iio:device0

```
root@visionsom-8mm-cb-std:/sys/bus/iio/devices/iio:device0# cat name
mpl3115
```

```
root@visionsom-8mm-cb-std:~# i2cdetect -y 0
    0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f
00:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
10:  --  --  --  --  --  --  --  --  --  --  --  --  UU  --  --
20:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
30:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
40:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
50:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
60: UU  --  UU  --  --  --  --  --  --  --  --  --  --  --  --
70:  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
```

```
root@visionsom-8mm-cb-std:/sys/bus/iio/devices/iio:device0# ls -l
total 0
drwxr-xr-x 2 root root  0 Sep 20 21:24 buffer
-r--r--r-- 1 root root 4096 Sep 20 21:24 consumers
-rw-r--r-- 1 root root 4096 Sep 20 21:24 current_timestamp_clock
-r--r--r-- 1 root root 4096 Sep 20 21:24 dev
-rw-r--r-- 1 root root 4096 Sep 20 21:24 in_pressure_raw
-rw-r--r-- 1 root root 4096 Sep 20 21:24 in_pressure_scale
-rw-r--r-- 1 root root 4096 Sep 20 21:24 in_temp_raw
-rw-r--r-- 1 root root 4096 Sep 20 21:24 in_temp_scale
-r--r--r-- 1 root root 4096 Sep 20 21:23 name
lrwxrwxrwx 1 root root  0 Sep 20 21:24 of_node -> ../../../../../../../../../../firmware/de
drwxr-xr-x 2 root root  0 Sep 20 21:24 power
drwxr-xr-x 2 root root  0 Sep 20 21:24 scan_elements
lrwxrwxrwx 1 root root  0 Sep 20 21:16 subsystem -> ../../../../../../../../../../bus/iio
-r--r--r-- 1 root root 4096 Sep 20 21:24 suppliers
drwxr-xr-x 2 root root  0 Sep 20 21:24 trigger
-rw-r--r-- 1 root root 4096 Sep 20 21:16 uevent
root@visionsom-8mm-cb-std:/sys/bus/iio/devices/iio:device0# cat in_temp_raw
329
root@visionsom-8mm-cb-std:/sys/bus/iio/devices/iio:device0# cat in_temp_scale
0.062500
```


Customizing the device tree - I2C

❑ Connecting modules

Module pin	Raspberry Pi connector pin
VDD	1
GND	6
SDA	3
SCL	5



- Connecting the Future
- Customer Centric