Thermal 使用说明文档

1.0

2018.12.01

文档履历

版本号	日期	制/修订人	内容描述
1.0	2018.12.01	AWA1226	

目 录

1. 概述

1.1 编写目的

该使用文档介绍了 thermal 的温控策略配置方法，以及调试使用说明。

1.2 适用范围

本文档适用于 linux4.9 内核的所有平台。

1.3 相关人员

本文档适用于关心系统温度及温控策略的人员

2. 模块介绍

2.1 模块功能介绍

Thermal 俗称热控制系统，其功能是通过 temperature sensor 测量当前 CPU、GPU 等设备的温度值，然后根据此温度值，影响 CPU、GPU 等设备的调频策略，对 CPU、GPU 等设备的最大频率进行限制，最终实现对 CPU、GPU 等设备温度的闭环控制，避免 SOC 温度过高。

2.2 相关术语介绍

Temperature sensor：温度传感器。

Thermal：CPU 温度控制系统。

CPU：中央处理器。

GPU：图像处理器。

thermal zone：将提供温度及 trip 点相关信息给 themal core 子系统。

cooling device：themal core 子系统通过 cooling device 对 CPU、GPU 等设备最大频率进行限制。

2.3 模块配置介绍

进入内核源码目录，执行 make ARCH=arm(arm64) menuconfig 进入配置主界面，并按以下步骤操作：

首先，进入到 Device Drivers -->Generic Thermal sysfs driver，如下图所示：

图 1: figure11.png

配置项说明：

Default Thermal governor 选择，默认为step-wise

Thermal emulation mode support:支持thermal模拟温度功能

Thermal cooling 配置，进入到 Device Drivers -->Generic Thermal sysfs driver-->allwinner(SUNXI)thermal drivers-->allwinner(SUNXI)thermal cooling device drivers，如下图所示：

图 2: figure12.png

配置项说明：

进 入 到 Device Drivers -->Generic Thermal sysfs driver-->allwinner(SUNXI)thermal drivers-->allwinner(SUNXI)thermal sensor drivers，进行 thermal sensor 驱动配置，如下图所示：

图 3: figure13.png

配置项说明：

THermal sensor driver:支持thermal sensor驱动

THermal sensor drive for SUNXI platformr:支持sunxi thermal sensor驱动

2.4 源码结构介绍

linux4.9

|-- drivers/thermal/sunxi_thermal/sunxi_thermal_sensor //thermal sensor驱动代码

|-- drivers/thermal/sunxi_thermal/sunxi_cooling_device //thermal cooling代码

3. Dts 配置

3.1 of-thermal

在 thermal 模块开发中，只需要将 thermal zone、thermal Sensor、trip point、cooling Device 的关系在 DTS 文件内按照规定的格式描述，of-thermal 模块就会根据 DTS 将描述的内容自动注册，逻辑关系由 of-thermal 模块维护，使驱动代码量大大减少

```
thermal-zones{
        soc_thermal{

                polling-delay-passive = <500>;
                polling-delay = <2000>;
                thermal-sensors = <&combine0 0>;

                trips{
                    cpu_trip0:t0{
                        temperature = <65>;
                        type = "passive";
                        hysteresis = <0>;
                    };
                    cpu_trip1:t1{
                        temperature = <80>;
                        type = "passive";
                        hysteresis = <0>;
                    };
                    cpu_trip2:t2{
                        temperature = <90>;
                        type = "passive";
                        hysteresis = <0>;
                    };
                    cpu_trip3:t3{
                        temperature = <100>;
                        type = "passive";
                        hysteresis = <0>;
                    };
                    gpu_trip0:t4{
                        temperature = <85>;
                        type = "passive";
                        hysteresis = <0>;
                    };
                    gpu_trip1:t5{
                        temperature = <95>;
                        type = "passive";
```

```
                        hysteresis = <0>;
                };
            crt_trip:t6{
                temperature = <110>;
                type = "critical";
                hysteresis = <0>;
            };
        };

    cooling-maps{
        bind0{
            contribution = <0>;
            trip = <&cpu_trip0>;
//cpu温度高于cpu_trip0温度点(由上面配置知道是65度),cpucooling会把cpu状态调整为state1，由cpu_budget_cooling中的配置知道state1是1152M，4核
            cooling-device = <&cpu_budget_cooling 1 1>;
        };
        bind1{
            contribution = <0>;
            trip = <&cpu_trip1>;
            cooling-device = <&cpu_budget_cooling 2 2>;
        };
        bind2{
            contribution = <0>;
            trip = <&cpu_trip2>;
            cooling-device = <&cpu_budget_cooling 3 4>;
        };
        bind3{
            contribution = <0>;
            trip = <&cpu_trip3>;
            cooling-device = <&cpu_budget_cooling 5 6>;
        };
        bind4{
            contribution = <0>;
            trip = <&gpu_trip0>;
            cooling-device = <&gpu_cooling 1 1>;
        };
        bind5{
            contribution = <0>;
            trip = <&gpu_trip1>;
            cooling-device = <&gpu_cooling 2 2>;
        };
    };
    };
};
```

Trips 为触发点的信息，包括 CPU、GPU。crt_trip 为 thermal 的关机触发点。

cooling-maps 描述了触发点与 cooling device 的绑定关系。

3.2 Thermal zone

```
sunxi_thermal_sensor:thermal_sensor{
        compatible = "allwinner,thermal_sensor";
        reg = <0x0 0x01c25000 0x0 0x400>;
        interrupts = <GIC_SPI 31 IRQ_TYPE_NONE>;
        clocks = <&clk_hosc>,<&clk_ths>;
        sensor_num = <3>;
        shut_temp= <120>;
        status = "okay";

        combine0:combine0{
            #thermal-sensor-cells = <1>;
            combine_cnt = <3>;
            combine_type = "max";
            combine_chn = <0 1 2>;
        };
    };
```

sensor_num：表示支持的 sensor 个数。

3.3 Cooling device

```
cpu_budget_cooling:cpu_budget_cool{
        compatible = "allwinner,budget_cooling";
        #cooling-cells = <2>;
        status = "okay";
        state_cnt = <7>;
        cluster_num = <1>;
        state0 = <1152000 4>;
        state1 = <1104000 4>;
        state2 = <1008000 4>;
        state3 = <816000 4>;
        state4 = <648000 4>;
        state5 = <648000 2>;
        state6 = <648000 1>;
    };

    gpu_cooling:gpu_cooling{
        compatible = "allwinner,gpu_cooling";
        reg = <0x0 0x0 0x0 0x0>;
```

```
            #cooling-cells = <2>;
            status = "okay";
            state_cnt = <4>;
            state0 = <0>;
            state1 = <456>;
            state2 = <360>;
            state3 = <144>;
    };
```

此配置，表明了 CPU/GPU 各个状态的最大频率，及最大核数值。在 trips 与 cooling device 的绑定关系里，会指明此触发点对应的状态。请参考 3.1 节的配置。

4. 使用说明

4.1 查看 sensor 温度

不同平台温度 sensor 的个数及温度监控区域 thermal_zone 是不一样的。多个温度监控区域在/sys/class/thermal 目录下就会有多个 thermal_zone。查看 thermal_zone 的温度，下面以 thermal_zone0 为例：

```
查看thermal_zone的类型
#cat sys/class/thermal/thermal_zone0/type
cpu_thermal_zone
```

```
查看thermal_zone温度
#cat sys/class/thermal/thermal_zone0/temp
36
```

4.2 模拟温度

thermal 有温度模拟功能，可以通过模拟温度校验温度策略是否符合预期。

```
设置thermal_zone0的模拟温度
#echo 80 > /sys/class/thermal/thermal_zone0/emul_temp
```

```
关闭thermal_zone0的模拟温度功能
#echo 0 > /sys/class/thermal/thermal_zone0/emul_temp
```

5. Declaration

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