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## How to Use the SAMA5D2 Watchdog Under Linux®

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### Introduction

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This application note describes how to get started using the SAMA5D2 Watchdog under Linux.

The Watchdog timer can be used to detect and recover from system malfunctions. The basic principle is that once the Watchdog timer is kicked off, a periodic system reboot countdown begins, then the application needs to clear the Watchdog timer within a suitable time to avoid an immediate system reset by the Watchdog.

The device driver for the SAMA5D2 Watchdog has been released in the Microchip Linux BSP. It is easy to access this driver via the watchdog command in the Linux console simply by launching the Watchdog command in a suitable place (in the init.d scripts).

Refer to the section [Hands-On](#) to add new init.d scripts for Watchdog.

### Reference Documents

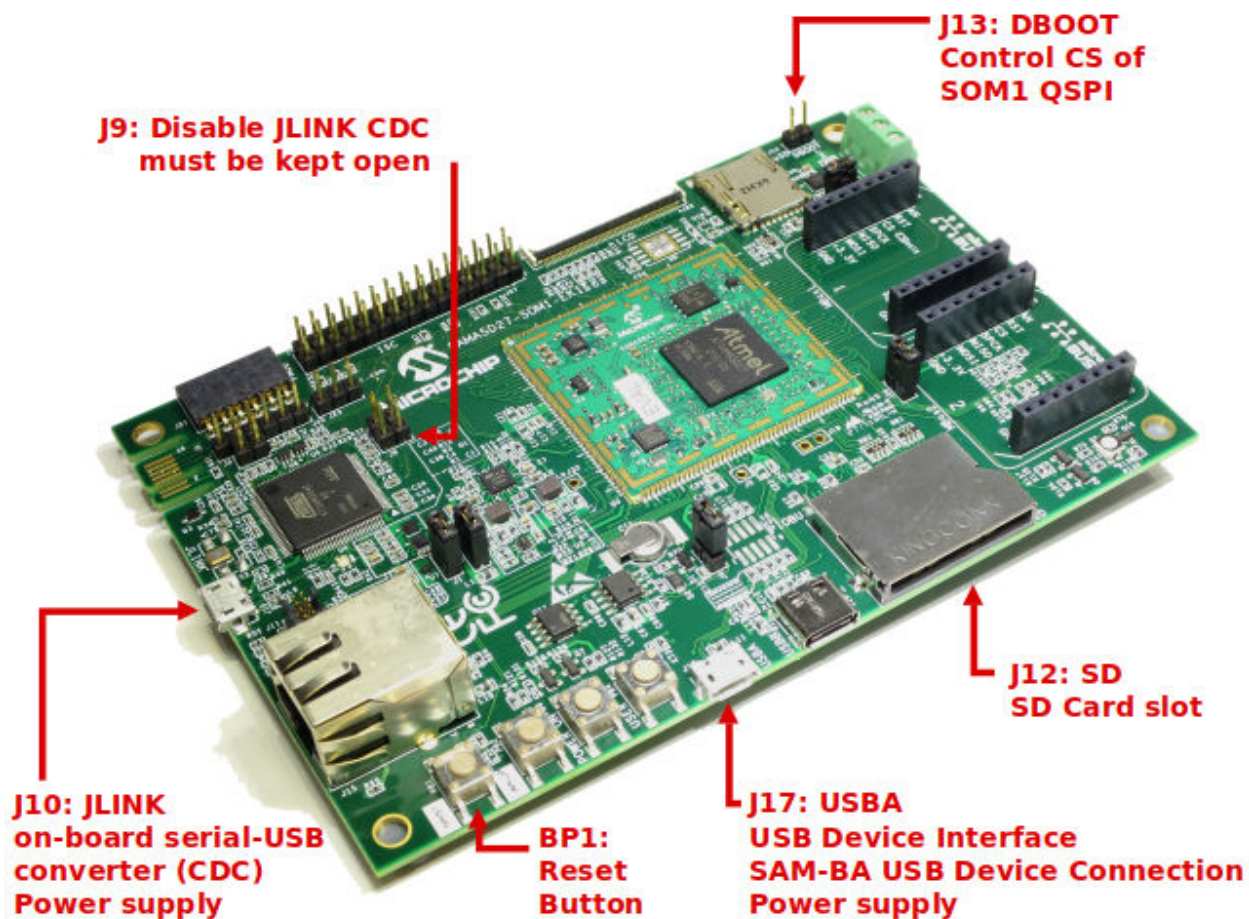
Title	Reference	Available
SAMA5D2 Series Datasheet	DS60001476	<a href="https://www.microchip.com/design-centers/32-bit-mpus">https://www.microchip.com/design-centers/32-bit-mpus</a>
SAMA5D27 SOM1 Kit1 User Guide	DS50002667	<a href="https://www.microchip.com/DevelopmentTools/ProductDetails/PartNO/ATSAMA5D27-SOM1-EK1">https://www.microchip.com/DevelopmentTools/ProductDetails/PartNO/ATSAMA5D27-SOM1-EK1</a>

### Prerequisites

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- Hardware
  - PC
  - SAMA5D27 SOM1 Evaluation Kit (Part Number: ATSAMA5D27-SOM1-EK1)
  - SDCard
- Software

This demo runs on the AT91 Linux platform built by Buildroot. The first step is to set up the AT91 Buildroot development environment. Refer to the web site: <http://www.at91.com/linux4sam/bin/view/Linux4SAM/BuildRoot>



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## Table of Contents

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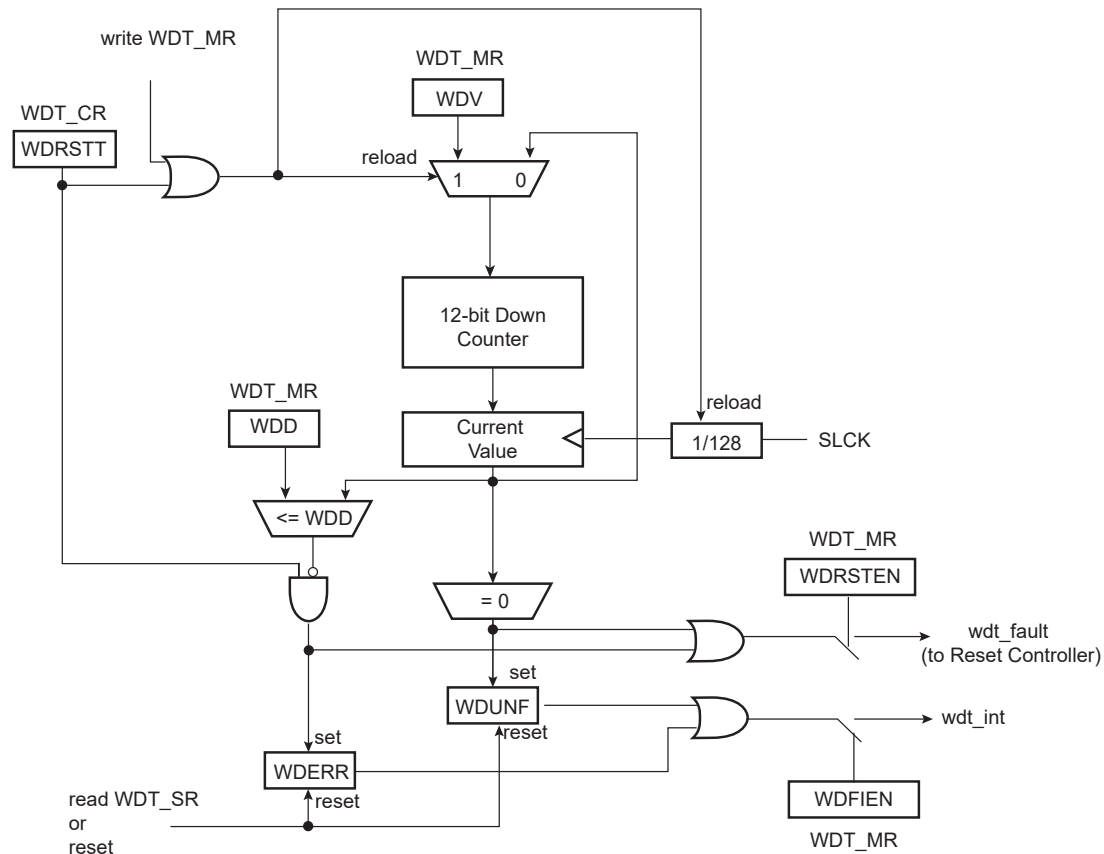
Introduction.....	1
Reference Documents.....	1
Prerequisites.....	1
1. Hardware Design.....	4
2. Software Design.....	5
2.1. Device Tree.....	5
2.2. Kernel.....	5
2.3. Rootfs.....	6
3. Hands-On.....	7
4. Revision History.....	9
4.1. Rev. A - 09/2019.....	9
The Microchip Website.....	10
Product Change Notification Service.....	10
Customer Support.....	10
Microchip Devices Code Protection Feature.....	10
Legal Notice.....	10
Trademarks.....	11
Quality Management System.....	11
Worldwide Sales and Service.....	12

## 1. Hardware Design

The SAMA5D2 MPU integrates a Watchdog with the characteristics listed below:

- 12-bit Key-protected Programmable Counter
- Watchdog Clock is Independent from Processor Clock
- Provides Reset or Interrupt Signals to the System
- Counter May Be Stopped while the Processor is in Debug State or in Idle Mode

**Figure 1-1. Watchdog Timer Block Diagram**



## 2. Software Design

The Microchip Linux platform was built using Buildroot with the following configuration:

```
atmel_sama5d27_som1_ek_mmc_dev_defconfig
```

All necessary functions for the Watchdog have been selected in this configuration, but with the default setting, the watchdog is not enabled. We can launch and feed it with the BusyBox Watchdog command.

### 2.1 Device Tree

- Action: no need to change
- Location: buildroot-at91/output/build/linux-linux4sam\_6.0/arch/arm/boot/dts
- Sources:
  - sama5d2.dtsi
  - at91-sama5d27\_som1\_ek.dts

**Device tree for Watchdog in sama5d2.dtsi:**

```
watchdog@f8048040 {
    compatible = "atmel,sama5d4-wdt"; // specify which driver will be used for this watchdog
                                   //device
    reg = <0xf8048040 0x10>; // watchdog base address is 0xf8048040, size of register block
                                   //is 0x10
    interrupts = <4 IRQ_TYPE_LEVEL_HIGH 7>; // PID of watchdog is 4, high level triggered,
                                   //priority is 7
    clocks = <&clk32k>; // definition for watchdog clock source
    status = "disabled"; // default disabled, and will be replaced with "okay"
};

clk32k: sckc@f8048050 {
    compatible = "atmel,sama5d4-sckc"; // specify which driver will be used for this slow
                                   //clock device
    reg = <0xf8048050 0x4>; // slow clock controller base address is 0xf8048050, size of
                                   //register block is 0x4

    clocks = <&slow_xtal>; // two clock sources for slow clock controller, external 32.768KHz
                                   //crystal or internal 64KHz RC
                                   // here we use the external 32.768 kHz crystal oscillator.
    #clock-cells = <0>;
};
```

**Device tree for Watchdog in at91-sama5d27\_som1\_ek.dts:**

```
watchdog@f8048040 {
    //atmel,watchdog-type = "software"; // with this property, a watchdog interrupt will be
                                   //asserted instead of reset chip, then system could
                                   //be reset in interrupt service routine
    synchronization
        //atmel,idle-halt; // with this property, the watchdog stops when the system is in
                                   //idle state
        //atmel,dbg-halt; // with this property, the watchdog stops when the processor is in
                                   //debug state
    status = "okay"; // here we set status of watchdog to "okay", enable watchdog device
};
```

### 2.2 Kernel

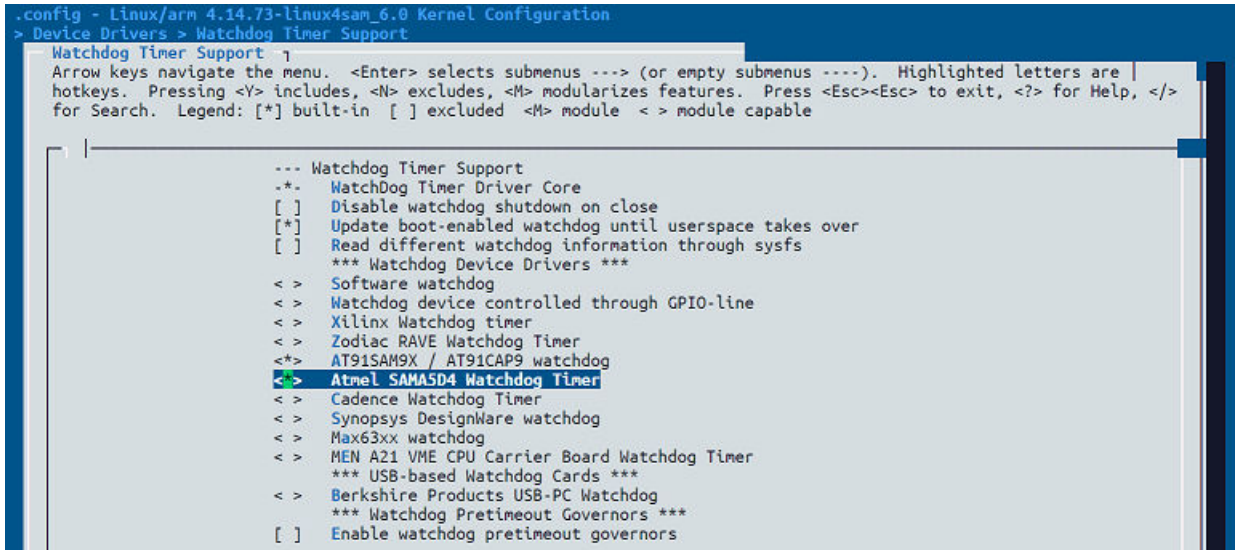
- Action: no need to change
- Location: buildroot-at91/output/build/linux-linux4sam\_6.0/
- Defconfig: sama5\_defconfig
- Driver files: drivers/watchdog/sama5d4\_wdt.c

Check the kernel configuration for the Watchdog function:

```
user@at91:~/buildroot-at91$ make linux-menuconfig
```

### Device Drivers > Watchdog Timer Support > Atmel SAMA5D4 Watchdog Timer

With the default setting, the Atmel Watchdog driver is selected.



```
.config - Linux/arm 4.14.73-linux4sam_6.0 Kernel Configuration
> Device Drivers > Watchdog Timer Support
  Watchdog Timer Support
  Arrow keys navigate the menu. <Enter> selects submenus ---> (or empty submenus ----). Highlighted letters are |
  hotkeys. Pressing <Y> includes, <N> excludes, <M> modularizes features. Press <Esc><Esc> to exit, <?> for Help, </>
  for Search. Legend: [*] built-in [ ] excluded <M> module < > module capable

  --- Watchdog Timer Support
  -* Watchdog Timer Driver Core
  [ ] Disable watchdog shutdown on close
  [*] Update boot-enabled watchdog until userspace takes over
  [ ] Read different watchdog information through sysfs
  *** Watchdog Device Drivers ***
  < > Software watchdog
  < > Watchdog device controlled through GPIO-line
  < > Xilinx Watchdog timer
  < > Zodiac RAVE Watchdog Timer
  <*> AT91SAM9X / AT91CAP9 watchdog
  <*> Atmel SAMA5D4 Watchdog Timer
  < > Cadence Watchdog Timer
  < > Synopsys DesignWare watchdog
  < > Max63xx watchdog
  < > MEN A21 VME CPU Carrier Board Watchdog Timer
  *** USB-based Watchdog Cards ***
  < > Berkshire Products USB-PC Watchdog
  *** Watchdog Pretimeout Governors ***
  [ ] Enable watchdog pretimeout governors
```

## 2.3 Rootfs

- Action: no need to change
- Location: buildroot-at91/output/images/rootfs.tar

The following device node is used to access the Watchdog driver in userspace:

- /dev/watchdog

### 3. Hands-On

Once all the Watchdog functions have been selected in the configuration as described in the previous sections, then the Watchdog can be launched and fed with the BusyBox Watchdog command.

#### Usage of the Watchdog command:

```
# watchdog
BusyBox v1.27.2 (2019-04-26 11:28:56 CST) multi-call binary.

Usage: watchdog [-t N[ms]] [-T N[ms]] [-F] DEV

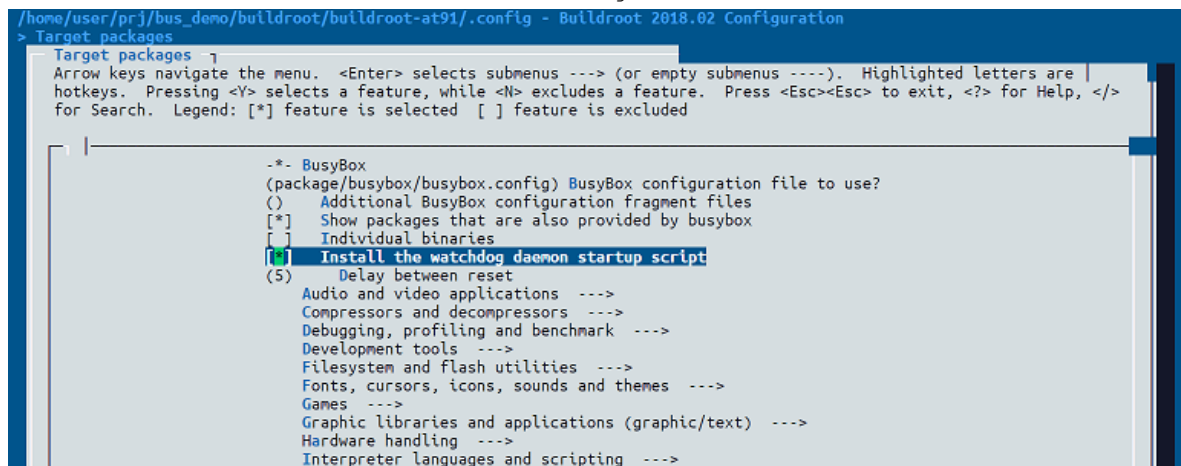
Periodically write to watchdog device DEV

    -T N    Reboot after N seconds if not reset (default 60)
    -t N    Reset every N seconds (default 30)
    -F      Run in foreground

Use 500ms to specify period in milliseconds
```

1. Execute the following command to launch the Watchdog manually. Set the reboot time as 10 seconds and the reset time as 5 seconds. The Watchdog command feeds the Watchdog device automatically.  
# watchdog -T 10 -t 5 /dev/watchdog
2. An alternative is to add an init script for the Watchdog: the Watchdog is then launched and fed automatically after system boot-up.  
Configure Buildroot and select the feature Install the watchdog daemon startup script:

```
user@at91:~/buildroot-at91$ make menuconfig
```



3. Rebuild Buildroot with the following command:

```
user@at91:~/buildroot-at91$ make
```

A new init script of the Watchdog is generated as S15watchdog in /etc/init.d:

```
user@at91:~/buildroot-at91$ cat output/target/etc/init.d/S15watchdog
#!/bin/sh
#
# Start watchdog
#
case "$1" in
start)
    echo "Starting watchdog..."
    watchdog -t 5 /dev/watchdog
    ;;
stop)
    ;;
restart|reload)
    ;;
*)
    ;;
esac
```

```

        echo "Usage: $0 {start|stop|restart}"
        exit 1
    esac
    exit $?

```

### How to Verify the Watchdog Reboot Function

1. With the default setting, the BusyBox Watchdog command runs in the background. Do not try to kill it to verify the Watchdog reboot function. With the following source code, the Watchdog is disabled before the task exits: *buildroot-at91/output/build/busybox-1.27.2/miscutils/watchdog.c*

We can use the `-F` option to make the BusyBox Watchdog command run in the foreground, and use `Ctrl + z` to suspend to the system. In this case, the Watchdog device is enabled but is no longer fed. After a few seconds (max 16s), the chip is reset by the Watchdog device.

- 1.1. Use *killall* to kill the Watchdog command which is running in background; and then execute it in foreground:

```

# killall watchdog
# watchdog -t 5 /dev/watchdog -F
watchdog: WDIOC_SETTIMEOUT: Invalid argument
^Z[1]+  Stopped                  watchdog -t 5 /dev/watchdog -F

```

- 1.2. Input `Ctrl + Z` from the Linux command line.

```

# RomBOOT

AT91Bootstrap 3.8.11 (Fri Apr 26 11:49:16 CST 2019)

SD/MMC: Image: Read file u-boot.bin to 0x23f00000
MMC: ADMA supported
SD: Card Capacity: High or Extended
SD: Specification Version 3.0X
SD/MMC: Done to load image

```

2. Another option is to put the system into Sleep mode. The system reboots within seconds of entering Sleep mode.

**Note:** If the property "atmel,idle-halt" of the Watchdog is enabled in the device tree, the system does not reboot after entering Sleep mode. With the default settings, this property is not enabled.

```

# echo mem > /sys/power/state
PM: suspend entry (deep)
PM: Syncing filesystems ... done.
Freezing user space processes ... (elapsed 0.000 seconds) done.
OOM killer disabled.
Freezing remaining freezable tasks ... (elapsed 0.001 seconds) done.
Suspending console(s) (use no_console_suspend to debug)
RomBOOT

AT91Bootstrap 3.8.11 (Fri Apr 26 11:49:16 CST 2019)

SD/MMC: Image: Read file u-boot.bin to 0x23f00000
MMC: ADMA supported
SD: Card Capacity: High or Extended
SD: Specification Version 3.0X
SD/MMC: Done to load image

```



## **4. Revision History**

### **4.1 Rev. A - 09/2019**

First issue.

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