AN3325

How to Use the SAMA5D2 UART Under Linux®

Introduction

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

In the kernel, the UART driver is implemented based on the TTY (TeleTYpewriter) framework. Many types of terminal drivers are based on TTY, and the UART device is registered as a ttySx character device ('x' stands for the device number).

Besides the standard character device node interface (open(), read(), write()…), the TTY framework has its own set of interface functions for special features. For information about accessing a ttySx device, refer to the section Application.

Reference Documents

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

Prerequisites

- Hardware
  - PC
  - SAMA5D27 SOM1 Evaluation Kit (Part Number: ATSAMA5D27-SOM1-EK1)
  - SDCard
  - USB-to-serial cable (TTL level)
- 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

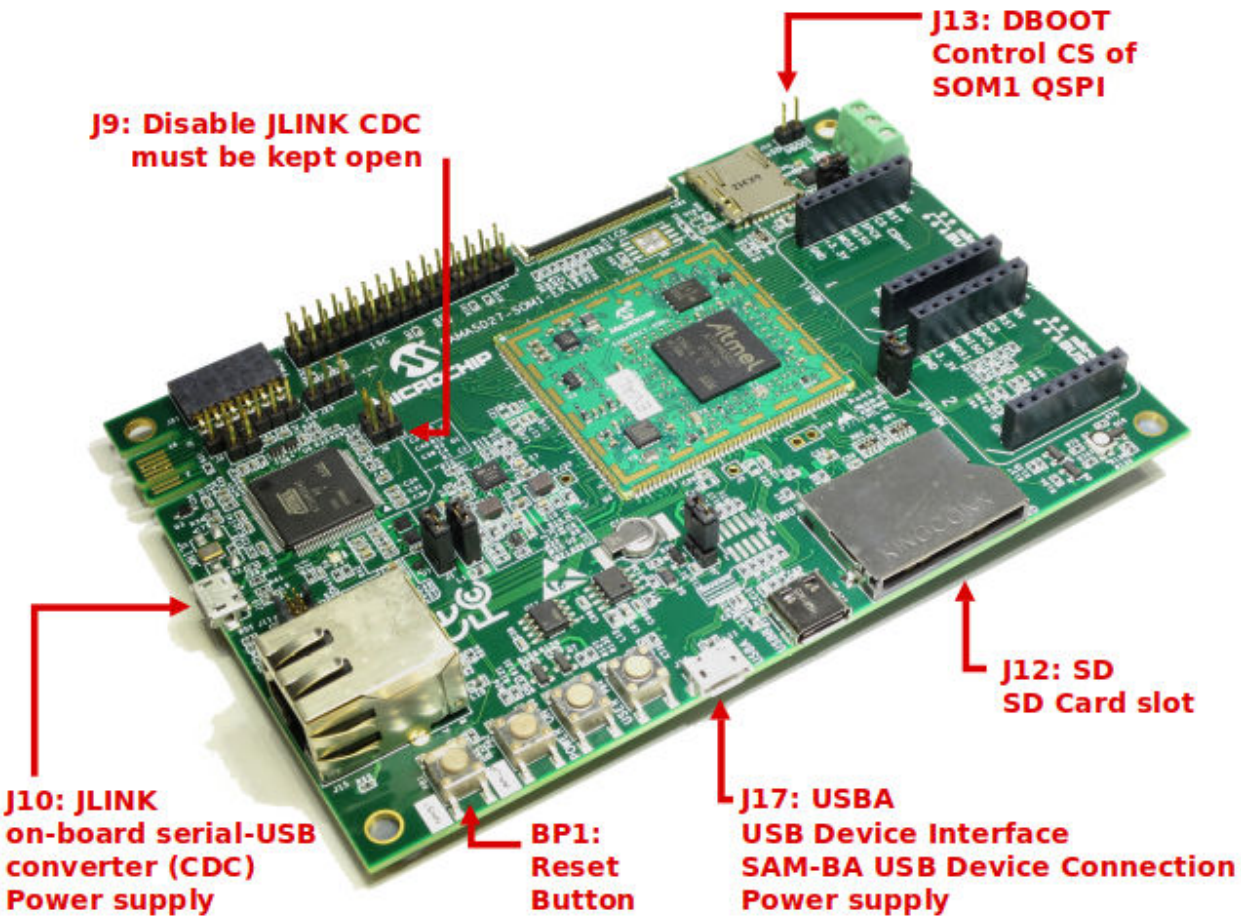
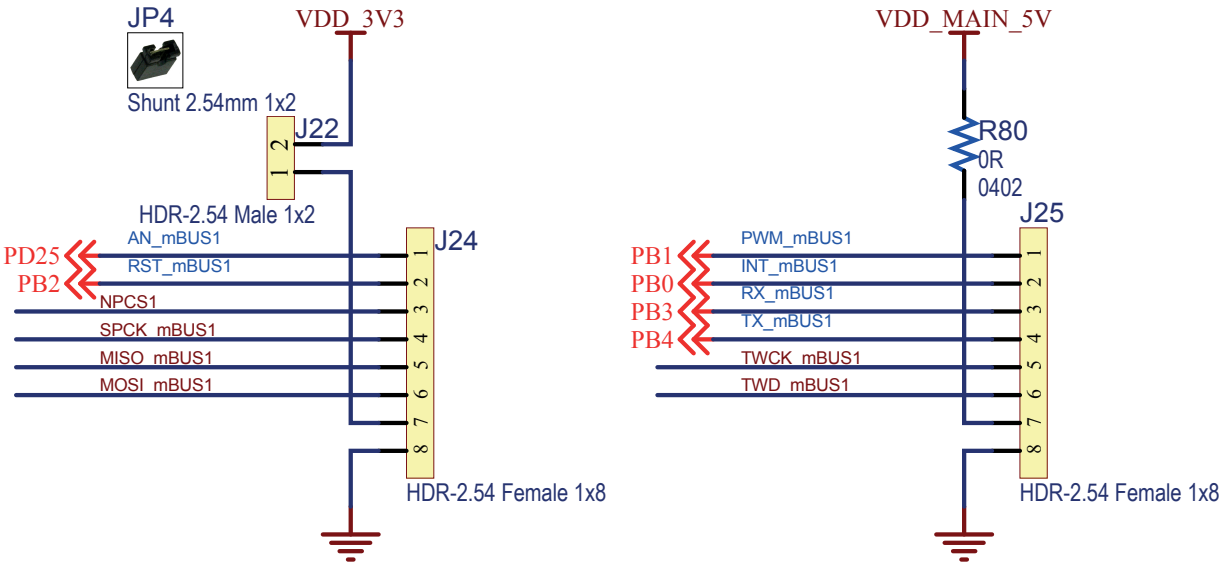

J13: DBOOT
Control CS of
SOM1 QSPI
J9: Disable JLINK CDC
must be kept open
J12: SD
SD Card slot
J10: JLINK
on-board serial-USB
converter (CDC)
Power supply
BP1:
Reset
Button
J17: USBA
USB Device Interface
SAM-BA USB Device Connection
Power supply

Table of Contents

1. Hardware Design

1.1 Interface



The connector mikroBUS1 is used for easy testing and monitoring.

This application note describes how to control UART under Linux.

UART4 is connected to the UART bus in mikroBUS 1 on SAMA5D27-SOM-EK1:

- URXD4 → PB3 → RX_mBUS1
- UTXD4 → PB4 → TX_mBUS1

For more details about the pin multiplexing of the SAMA5D2, refer to the table “Pin Description (all packages)” in the SAMA5D2 data sheet.

1.2 Connection

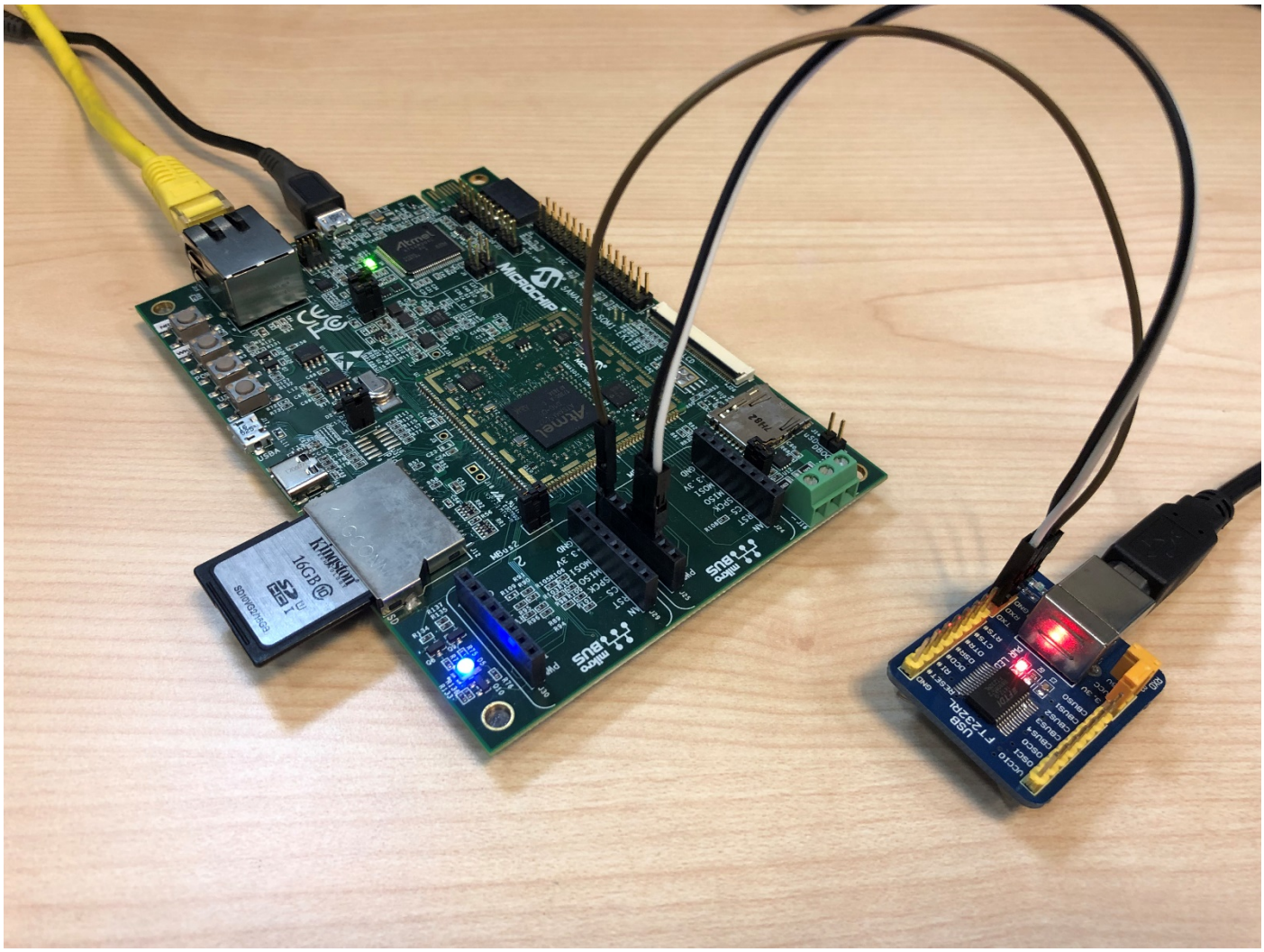
Connect UART4 of mikroBUS1 to the PC using the USB-to-serial cable (TTL level):

J25_3 RX_mBUS1 → TXD

J25_4 TX_mBUS1 → RXD

J25_8 GND → GND

Refer to the following picture.



2. Software Design

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

```
atmel_sama5d27_som1_ek_mmc_dev_defconfig
```

The UART device driver should work with this default configuration without any adjustment.

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 UART4 in sama5d2.dtsi:

```
uart4: serial@fc00c000 {
compatible = “atmel,at91sam9260-usart”;

 // specify which driver will be used for this UART device


reg = <0xfc00c000 0x100>;

 // uart4 base address is 0xfc00c000, size is 0x100


dmas = <&dma0

 // two dma channel will be used for tx and rx


(AT91_XDMAC_DT_MEM_IF(0) | AT91_XDMAC_DT_PER_IF(1) |
AT91_XDMAC_DT_PERID(43))>,
<&dma0
(AT91_XDMAC_DT_MEM_IF(0) | AT91_XDMAC_DT_PER_IF(1) |
AT91_XDMAC_DT_PERID(44))>;
dma-names = “tx”, “rx”;
interrupts = <28 IRQ_TYPE_LEVEL_HIGH 7>;

 // PID of UART4 is 28, high level triggered, priority is 7


 // used to configure UART4 interrupt in AIC


clocks = <&uart4_clk>;

 // definition for uart4 clock source


clock-names = “usart”;
status = “disabled”;

 // default disabled, and will be replaced with “okay”


};
uart4_clk: uart4_clk {
#clock-cells = <0>;
reg = <28>;

 // PID of UART4 is 28, this definition of offset will be used to enable uart4 clock in PMC
```

```
atmel,clk-output-range = <0 83000000>;
 // uart4 input clock, max frequency is 83MHz


};
```

Device tree for UART4 in at91-sama5d27_som1_ek.dts:

```
aliases {
serial0 = &uart1; /* DBGU */
serial1 = &uart4; /* mikro BUS 1 */
 // the aliases of uart4 is serial1, then uart4 will be registered as ttyS1


serial2 = &uart2; /* mikro BUS 2 */
i2c1 = &i2c1;
i2c2 = &i2c2;
uart4: serial@fc00c000 {
atmel,use-dma-rx;
 // With this definition DMA feature will be enabled for rx


atmel,use-dma-tx;
 // With this definition DMA feature will be enabled for tx


pinctrl-names = “default”;
pinctrl-0 = <&pinctrl_mikrobus1_uart>;
 // pin definition for uart4


status = “okay”;
 // replace status’s property with “okay”, enable uart4 device


};
pinctrl_mikrobus1_uart: mikrobus1_uart {
pinmux = <PIN_PB3__URXD4>,
 // the mux of PB3 will be switched to URXD4


<PIN_PB4__UTXD4>;
 // the mux of PB4 will be switched to UTXD4


bias-disable;
 // pull up/down feature disabled


};
```

2.2 Kernel

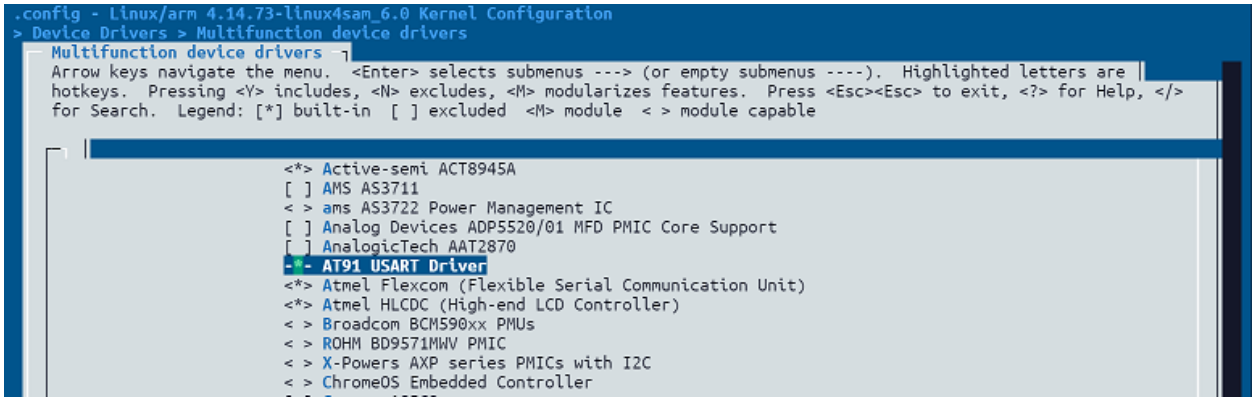
- Action: no need to change
- Location: buildroot-at91/output/build/linux-linux4sam_6.0/
- Defconfig: sama5_defconfig
- Driver files: drivers/tty/serial/atmel_serial.c

Check the kernel configuration for the UART function:

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

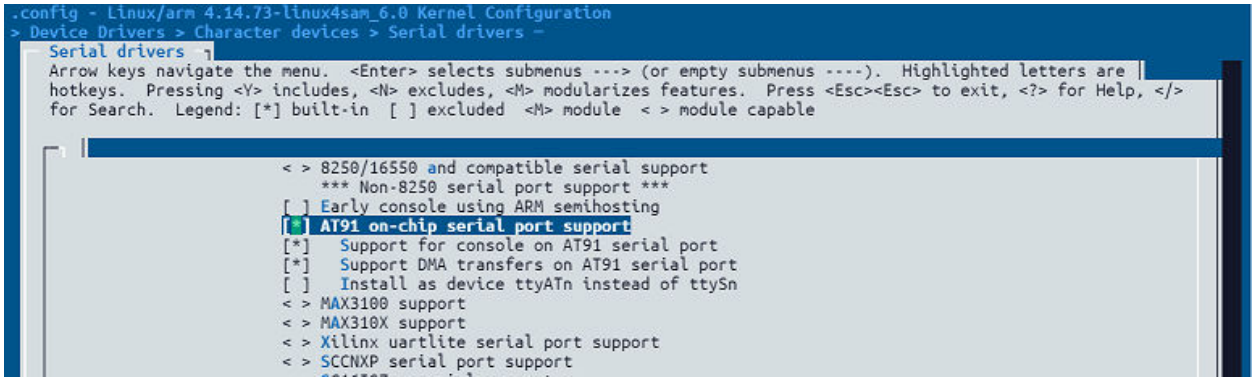
Device Drivers > Multifunction device drivers > AT91 USART Driver

Some Microchip USART controllers are compatible with the SPI function, but the UART module does not support this feature. With the default setting, a UART device is added via this mfd driver.



Device Drivers > Character devices > Serial drivers > AT91 on-chip serial port support

Driver for the AT91 UART port.



2.3 Rootfs

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

As mentioned in 2.1 Device tree, UART4 will be registered as ttyS1.

Use the following device node to access the UART4 port driver:

- */dev/ttyS1*

2.4 Application

This section provides a C language demo used to access the UART port driver.

How to Compile

```
user@at91:~$ buildroot-at91/output/host/bin/arm-buildroot-linux-uclibcgnueabihf-gcc uart.c -o
uart_test
```

Source Code

```
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <fcntl.h>
```

```
#include <termios.h>
#include <string.h>
```

```
#define DEV_TTY "/dev/ttyS1"
#define BUF_SIZE 256
```

```
int main(int argc, char *argv[])
{
    int fd;
    int ret;
    char tx_buf[] = "Hello World!\n\r";
    char rx_buf[BUF_SIZE] = "";
    struct termios options;
```

```
    /* open uart */
    fd = open(DEV_TTY, O_RDWR|O_NOCTTY);
    if (fd < 0) {
        printf("ERROR open %s ret=%d\n\r", DEV_TTY, fd);
        return -1;
    }
    /* configure uart */
    tcgetattr(fd, &options);
    options.c_cflag &= ~PARENB;
    options.c_cflag &= ~CSTOPB;
    options.c_cflag &= ~CSIZE;
    options.c_cflag |= CS8;
    options.c_cc[VTIME] = 10; // read timeout 10*100ms
    options.c_cc[VMIN]  = 0;
    options.c_lflag &= ~(ICANON | ECHO | ECHOE | ISIG);
    options.c_oflag &= ~OPOST;
    options.c_iflag &= ~(ICRNL | IXON);
    cfsetispeed(&options, B115200);
    cfsetospeed(&options, B115200);
    options.c_cflag |= (CLOCAL | CREAD);
    tcflush(fd, TCIFLUSH);
    tcsetattr(fd, TCSANOW, &options);
```

```
    while (1) {
        /* read uart */
        while ((ret = read(fd, rx_buf, BUF_SIZE-1)) > 0) {
            puts(rx_buf);
            memset(rx_buf, 0, ret);
        }
        /* write uart */
        ret = write(fd, tx_buf, sizeof(tx_buf));
        if (ret != sizeof(tx_buf))
            printf("ERROR write ret=%d\n", ret);
    }
```

```
    /* close uart */
    close(fd);
```

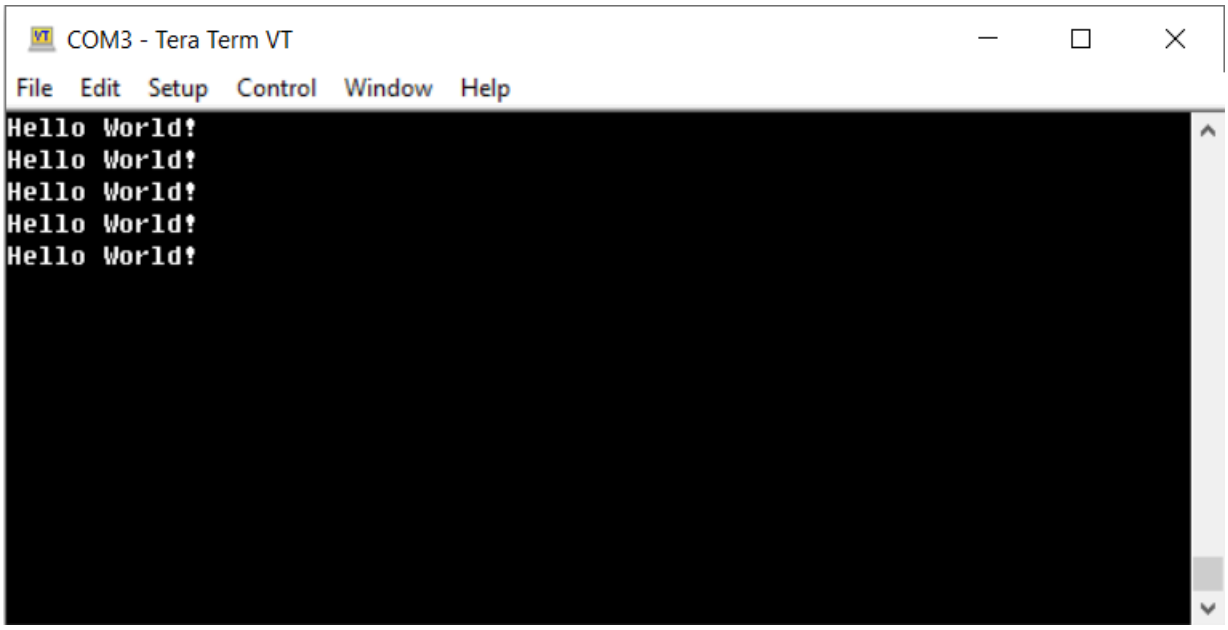
```
    return 0;
}
```

3. Hands-On

Copy the uart_test application and execute it, then the UART waveform is monitored on the mBUS1 UART port.

```
# chmod +x uart_test
# ./uart_test
```

Open the COM port of the USB-to-serial cable. The following displays:



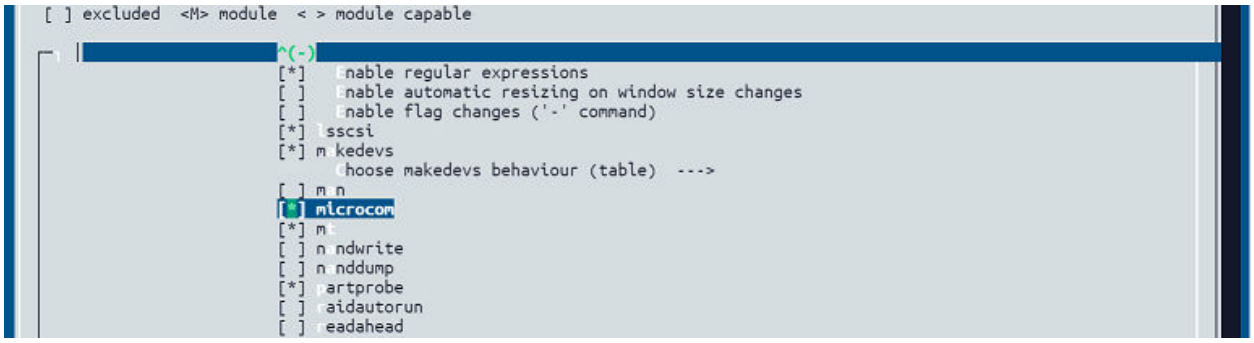
4. Tools and Utilities

microcom is a tool for UART port testing included in Buildroot.

With the default Buildroot configuration, this tool is selected.

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

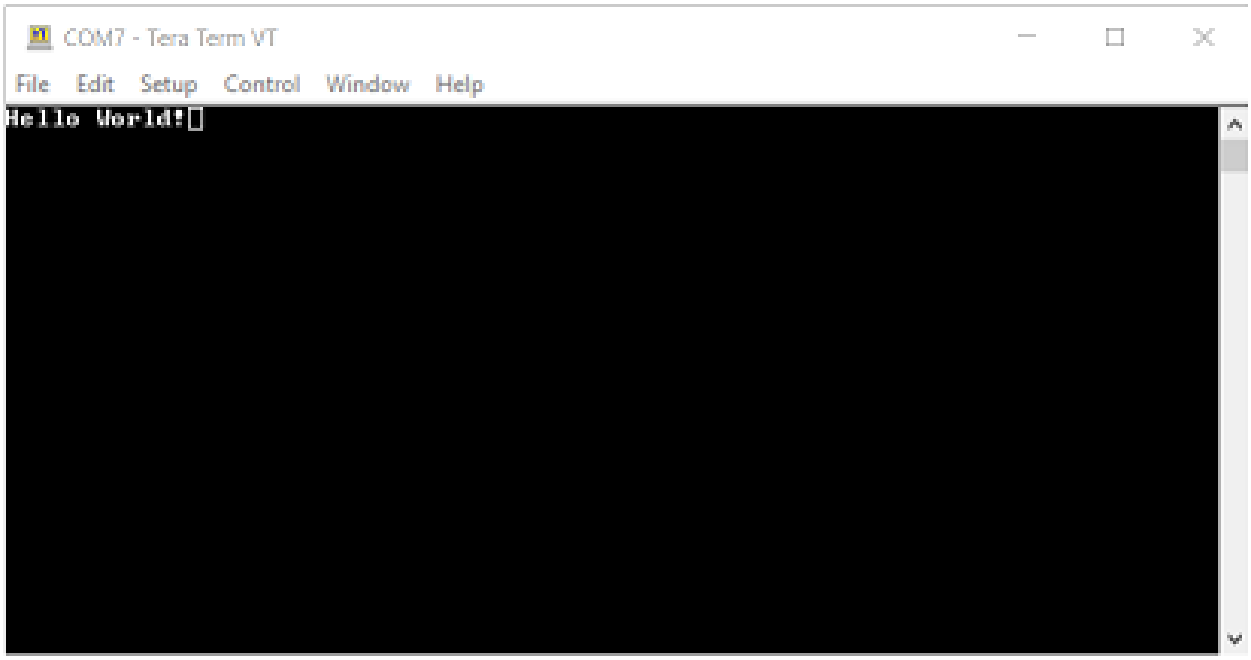
Miscellaneous Utilities > microcom



Execute the following command on the target board (Ctrl + X to exit), then type any string.

```
# microcom -s 115200 /dev/ttyS1
Type "Hello World!"
```

If uart4 is connected to the PC COM port, the following displays:



5. Revision History

5.1 Rev. A - 11/2019

First issue.

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