

UART

- 8. UART

8. UART

8.1 UART

8.1.1 UART

UART Universal Asynchronous Receiver/Transmitter)

UART USART / / (Universal Synchronous/Asynchronous Receiver/Transmitte
UART 90 USART UART UART serial COI

8.1.2 UART

1) UART TTL

UARTx_TXD UARTx_RXD

UARTx_RXD UARTx_TXD

GND

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UART TTL TTL 1 0 TTL 2V 2.4V 3.4V (

TTL

2 TTL RS232

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TTL RS232 MAX232 SP:

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100ASK_IMX6ULL TTL USB

UART

UART	1	+8	+1	+1
------	---	----	----	----



ASCII 'A' ASCII 41 0100 0001 LSB MSB

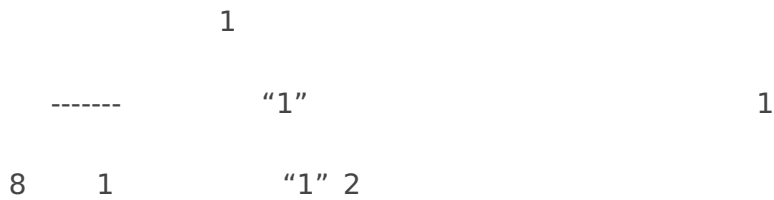
1

UART	UARTx_TXD	0
------	-----------	---

5 6 7 8 8

'A' 8	0100 0001	bit 0	1	bit 1	0	bit 7	0
-------	-----------	-------	---	-------	---	-------	---

4)



5)



8.2 IMX6ULL UART

UART:Universal Asynchronous Receiver/Transmitter

8.2.1 IMX6ULL UART

IMX6ULL 8 UART 8 UART

- TIA/EIA-232-F 5Mbit/s
- IR Ir-DA 115.2Kbit/s
- 9 RS-485
- 1 2
-
- 115.2Kbit/s
-
- SRST_B

Chapter 55 Universal Asynchronous Receiver/Transmitter(UART)

8.2.2 IMX6ULL UART

IMX6ULL 8 UART 17 IO

UART1



9

8.2.2.1 UART1_URXD



8.2.2.2 UART1_UTXD



8.2.2.3 UART1_UCR1

1

DMA

bit0



8.2.2.4 UART1_UCR2

2

RTS

5

UART



8.2.2.5 UART1_UCR3

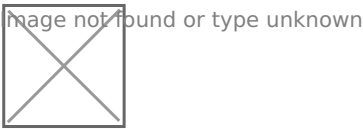
3

bit2



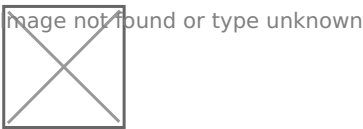
8.2.2.6 UART1_UFCR

FIFO fifo 32 RFDIV UART



8.2.2.7 UART1_USR2

TXDC ROR UART



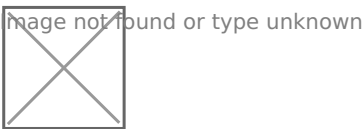
8.2.2.8 UART1_UBIR UART1_UBMR

UART

Chapter 55 Universal Asynchronous Receiver/Transmitter(I

8.3 IMX6ULL UART

8.3.1 UART



UART USB UART1 IMX6ULL Chapter 55 Universal Asynchronous Receiver/Tra

8.3.2 UART1

4 uart.c

8.3.2.1 1 UART1

UART1 Chapter 18: Clock Controller Module (CCM)

① UART CCM_CSCDR1

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CCM_CSCDR1 [UART_CLK_SEL] CCM_CSCDR1 [UART_CLK_PODF]

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CCM_CSCDR1

CCM_CSCDR1 [UART_CLK_SEL] 0 CCM_CSCDR1 [UART_CLK_PODF] 0

pll3_80m UART UART_CLK_PODF 1 UART 80MHz

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0

② UART CCM_CCGR5

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CCM_CCGR5 CCM_CCGR5[CG12] 11

4-1.3 CCM GPIO 11

8.3.2.2 2 GPIO UART1

GPIO UART1 Chapter 32: IOMUX Controller (IOMUXC)

3 GND GPIO UART1_TXD UART1_RXD

① UART1_TX

IOMUXC_SW_MUX_CTL_PAD_UART1_TX_DATA

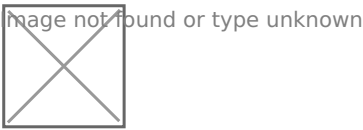
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IOMUXC_SW_MUX_CTL_PAD_UART1_TX_DATA[MUX_MODE] 0101 0 UART_TX

② UART1_RX

IOMUXC_SW_MUX_CTL_PAD_UART1_RX_DATA



IOMUXC_SW_MUX_CTL_PAD_UART1_RX_DATA[MUX_MODE] 0101 0 UART_RX

```
IOMUXC_SW_MUX_CTL_PAD_UART1_TX_DATA = (volatile unsigned int *) (0x20E0084);
IOMUXC_SW_MUX_CTL_PAD_UART1_RX_DATA = (volatile unsigned int *) (0x20E0088);

*IOMUXC_SW_MUX_CTL_PAD_UART1_RX_DATA = 0;
*IOMUXC_SW_MUX_CTL_PAD_UART1_TX_DATA = 0;
```

③ UART1_TX IOMUXC_SW_PAD_CTL_PAD_UART1_TX_DATA

4-1.3 IOMUXC (Mode) 0x10b0

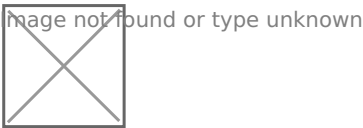
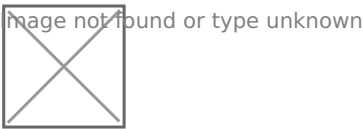
④ UART1_RX IOMUXC_SW_PAD_CTL_PAD_UART1_RX_DATA

4-1.3 IOMUXC (Mode) 0x10b0

8.3.2.3 3 UART1

UART1

① UART1_UCR2 0x2020084



UART1

```
UART1->UCR2 |= (1<<14) | (1<<5) | (1<<2) | (1<<1);
```

[14] 1 RTS

[8] : 0: 0

[6] : 0: 1 0

[5] : 1: 8

[2] : 1:

[1] : 1:

② UART1_UCR3 0x2020088

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[RXDMUXSEL] 1

[2] : 1:IM6ULL UART MUXED 1

```
UART1->UCR3 |= (1<<2);
```

③ UART1_UFCR 0x2020090

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UART1_UFCR[9-7] UART

101 5

```
UART1->UFCR = 5 << 7; /* Uart clk 80MHz */
```

④ UART1_UBIR 0x20200A4 , UART1_UBMR 0x20200A8

UART1_UBIR UART1_UBMR

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IMX6ULL

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a. 115200 BaudRate = 115200

b.UART1 80Mhz Ref Freq = 80000000

c.IMX6ULL $115200 = 80000000 / (16 * (UBMR + 1) / (UBIR + 1))$

d. UBMR UBIR

e. UART1_UBIR = 71 UART1_UBMR = 3124

```
UART1->UBIR = 71;
UART1->UBMR = 3124;
```

8.3.2.4 4 UART1

UART1 UART1_UCR1(0x2020080)

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UART1_UCR1[0] 1 UART 0 UART

```
Base->UCR1 |= (1 << 0); /*    */
```

8.3.3

8.3.3.1 1 UART1

UART1_USR2 UART1 [TXDC]

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UART1_USR2[3] : 0 1

uart.c

```
void PutChar(int c)
{
    while (!((UART1->USR2) & (1<<3))); /*
    UART1->UTXD = (unsigned char)c;
}
```

8.3.3.2 2 main

main.c

```
#include "uart.h"

int main()
{
    unsigned char cTestData = 'A'; /*
    Uart_Init();

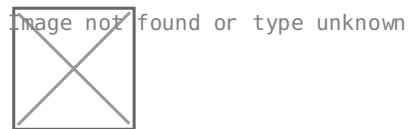
    while(1)
    {
        PutChar(cTestData);
    }

    return 0;
}
```

** ** Git NoosProgramProject/(8_UART /001_uart_txd_char)

8.3.3.3 3 4-1.4

8.3.3.4 4 3-1.4



‘A’

8.3.4

8.3.4.1 1 UART1

UART1

UART1_USR2

[ROR]



UART1_USR2[0] : 0 1

uart.c

```
unsigned char GetChar(void) [ ]
{
    [ ]
    [ ]while (!(UART1->USR2 & (1<<0))); /* */
    [ ]return (unsigned char)UART1->URXD;
}
```

8.3.4.2 2 main

main

main.c

```
#include "uart.h"

int main()
{
    [ ]unsigned char cTestData ; /* */
    [ ]Uart_Init() [ ] ;

    [ ]while(1)
```

```

{
    cTestData = GetChar() ; // */
    PutChar( cTestData)    ; // */
}

return 0;
}

```

4.4.4 3.4

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100ask.6ull

** ** Git NoosProgramProject/(8_UART /002_uart_txd_char)

8.3.5

main

main.c

```

while(1)
{
    cTestData = GetChar() ; // */

    if ( cTestData == ' \r' ) // */ \n\r */
    {
        PutChar(' \n' );
    }

    if ( cTestData == ' \n' )
    {
        PutChar(' \r' );
    }

    PutChar( cTestData)    ; // */ */
}

```

'\r' '\n'

8.3.6

8.3.6.1 1

** **

my_printf.c

```
void PutStr(const char *s) {}  
{  
    while (*s)  
    {  
        PutChar(*s);  
        s++;  
    }  
}
```

8.3.6.2 2 main

main

main.c

```
PutStr("Hello, world! \n\r"); /* */
```

8.3.6.3 3 4-1.4

8.3.6.4 4 3-1.4

Hello world

```
Hello, world!
```

8.4 printf

8.4.1 1.3

① uart.c raise

uart.c

```
119 int raise(int signum) /* raise      */
120 {
121     return 0;
122 }
```

② Makefile

my_printf.c libgcc.a libgcc.a Makefile

 "-L" "-l" -lgcc "libgcc.a"

Makefile

a. \$(CC) -nostdlib -g -c -o my_printf.o my_printf.c

b. \$(LD) -T imx6ull.lds -g start.o uart.o main.o my_printf.o -o my_printf.elf

-lgcc -L<libgcc.a >

\$(LD) -T imx6ull.lds -g start.o uart.o main.o my_printf.o -o my_printf.elf **gcc**

-L/home/book/100ask_imx6ull-sdk/ToolChain/gcc-linaro-6.2.1*-2016.11-x86_64_arm-linux-gnueabi/lib/gcc/arm-linux-gnueabi/6.2.1

8.4.2

format ...

vc6.0 stdarg.h

```
typedef char * va_list;

#define _INTSIZEOF(n)   ( (sizeof(n) + sizeof(int) - 1) & ~(sizeof(int) - 1) )
#define va_start(ap, v) ( ap = (va_list)&v + _INTSIZEOF(v) )
#define va_arg(ap, t)   ( *(t *)((ap += _INTSIZEOF(t)) - _INTSIZEOF(t)) )
#define va_end(ap)      ( ap = (va_list)0 )
```

1 _INTSIZEOF(n)

2 va_start(ap,v) ap

3 va_arg(ap,t)

4 va_end(ap) NULL

printf

int printf(const char *format, ...) my_printf

my_printf.c

```
int printf(const char *fmt, ...)
{
    va_list ap;

    va_start(ap, fmt);
    my_vprintf(fmt, ap);
    va_end(ap);
    return 0;
}
```

8.4.3 my_vprintf(fmt, ap)

int vprintf(const char *format, va_list ap) my_vprintf

my_printf.c

```
static int my_vprintf(const char *fmt, va_list ap)
{
    char lead=' ';
    int maxwidth=0;

    for(; *fmt != '\0'; fmt++)
    {
        if (*fmt != '%') {
            putchar(*fmt);
            continue;
        }
    }
```



```

    lead=' ';
    maxwidth=0;

    //format : %08d, %8d, %d, %u, %x, %f, %c, %s
    fmt++;
    if(*fmt == '0'){
        lead = '0';
        fmt++;
    }

    while(*fmt >= '0' && *fmt <= '9'){
        maxwidth *=10;
        maxwidth += (*fmt - '0');
        fmt++;
    }

    switch (*fmt) {
    case 'd': out_num(va_arg(ap, int), 10, lead, maxwidth); break;
        case 'o': out_num(va_arg(ap, unsigned int), 8, lead, maxwidth); break;
    case 'u': out_num(va_arg(ap, unsigned int), 10, lead, maxwidth); break;
    case 'x': out_num(va_arg(ap, unsigned int), 16, lead, maxwidth); break;
    case 'c': outc(va_arg(ap, int )); break;
        case 's': outs(va_arg(ap, char *)); break;

    default:
        outc(*fmt);
        break;
    }

    return 0;
}

```

8.4.4 out_c outs out_num

void PutChar(int c) out_c outs out_num outc %c

my_printf.c

```
static int outc(int c)
{
    _PutChar(c);
    _return 0;
}
```

outs %s

my_printf.c

```
static int outs (const char *s)
{
    while (*s != '\0')
        _PutChar(*s++);
    _return 0;
}
```

out_num %d %o %u %x

my_printf.c

```
static int out_num(long n, int base, char lead, int maxwidth)
{
    unsigned long m=0;
    char buf[ MAX_NUMBER_BYTES], *s = buf + sizeof(buf);
    int count=0, i=0;

    *--s = '\0';

    if (n < 0){
        m = -n;
    }
    else{
        m = n;
    }

    do{
        *--s = hex_tab[m%base];
        count++;
    }
```

```

}while ((m /= base) != 0);

if( maxwidth && count < maxwidth){
    for (i=maxwidth - count; i; i--){
        *--s = lead;
    }

    if (n < 0)
        *--s = '-';

    return outs(s);
}

```

8.4.5 my_printf_test

my_printf.c

```

int my_printf_test(void)
{
    printf("This is www.100ask.org   my_printf test\n\r") ;
    printf("test char           =%C,%c\n\r", 'A','a') ;
    printf("test decimal number =%d\n\r",    123456) ;
    printf("test decimal number =%d\n\r",    -123456) ;
    printf("test hex      number =0x%x\n\r",  0x55aa55aa) ;
    printf("test string      =%s\n\r",      "www.100ask.org") ;
    printf("num=%08d\n\r",    12345);
    printf("num=%8d\n\r",     12345);
    printf("num=0x%08x\n\r",  0x12345);
    printf("num=0x%8x\n\r",   0x12345);
    printf("num=0x%02x\n\r",  0x1);
    printf("num=0x%2x\n\r",   0x1);

    printf("num=%05d\n\r",  0x1);
    printf("num=%5d\n\r",   0x1);

    return 0;
}

```

8.4.6 main

main 8.3.5 my_printf_test

main.c

```
#include "my_printf.h"
#include "uart.h"
int main()
{
    Uart_Init();
    my_printf_test();
    return 0;
}
```

Git NoosProgramProject/(8_UART /005_myprintf_test)

8.4.6.1 1 4-1.4

8.4.6.2 2 3-1.4

```
This is www.100ask.org    my_printf test
test char                =A, a
test decimal number =123456
test decimal number =-123456
test hex        number =0x55aa55aa
test string               =www.100ask.org
num=00012345
num=    12345
num=0x00012345
num=0x    12345
num=0x01
num=0x 1
num=00001
num=    1
```

** **

Git NoosProgramProject/(8_UART /005_printf_test