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2010年4月1日
瑞萨电子公司

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M16C/65 群

串行 I/O 操作（UART 模式下的发送）

1. 要点

在 UART 模式下发送数据，可以选择如表 1 中所列的各种功能。在表 1 中用符号“〇”表示本篇资料所选的项目，图 1 是串行 I/O 的工作时序图。本篇资料的参考例程是使用 UART0 在 UART 模式下发送数据的例子。

2. 说明

本篇资料，适用于 M16C/65 群单片机。

本篇应用说明也适用于 M16C 族中与上面所述的群具有相同 SFR（特殊功能寄存器）定义的产品。关于产品功能的改进，请参看手册中的相关信息。在使用本篇应用说明的程序前，需进行详细的评价。

3. 选定功能

表 1. 选定功能

设定项目	设定内容		设定项目	设定内容	
分频前时钟选择	O	f_1	发送中断请求产生条件		发送缓冲器空
		f_{OCO-F}		O	发送结束
外围时钟	O	f_{1SIO}	数据逻辑选择功能	O	不反转
		f_{2SIO}			反转
传送时钟源	O	内部时钟（f_{1SIO}/f_{2SIO}/f_{8SIO}/f_{32SIO}）	TxD、RxD 的 I/O 极性反转位	O	不反转
		外部时钟（CLKi 引脚）			反转
$\overline{CTS}$ 功能	O	$\overline{CTS}$ 功能允许	$\overline{CTS}$ /$\overline{RTS}$ 引脚独立（注 1）	O	复用引脚
		$\overline{CTS}$ 功能禁止			独立

注 1: $\overline{CTS0}$ /$\overline{RTS0}$ 独立功能是 $\overline{CTS0}$ 与 $\overline{RTS0}$ 引脚功能不复用，从 P6_0 引脚输出 $\overline{RTS0}$，从 P6_4 引脚输出 $\overline{CTS0}$ 的功能。当选择这个功能时，不能使用 UART1 的 $\overline{CTS}$ /$\overline{RTS}$ 功能，请将 $\overline{CTS}$ /$\overline{RTS}$ 禁止位设置为“1”。

4. 串行 I/O 的操作

(1) 将发送允许位置为“1”，将待发送数据写入 UARTi 发送缓冲寄存器中，进入数据发送状态。

(2) 当输入到 $\overline{CTSi}$ 引脚的电平变为“L”时，发送开始（$\overline{CTSi}$ 引脚必须由接收方控制）。

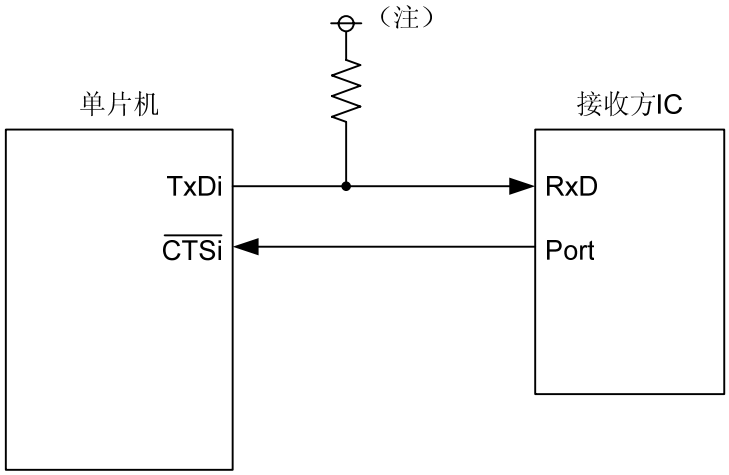
(3) 保存在 UARTi 发送缓冲寄存器的待发送数据被传送到 UARTi 发送寄存器中，同时，待发送数据的第一位（开始位）从 TxDi 引脚被发送出去。然后，数据将按照顺序一位一位的被发送出去：LSB、……、MSB、奇偶校验位和停止位。

(4) 当停止位发送完毕后，发送寄存器空标志位将被置为“1”，表明发送结束。同时，UARTi 发送中断请求位也被置为“1”，传送时钟停止并保持“H”电平。

(5) 当发送结束时，如果下一个数据的发送条件也满足，开始位又将紧随停止位发出，接着下一个数据将被发送。

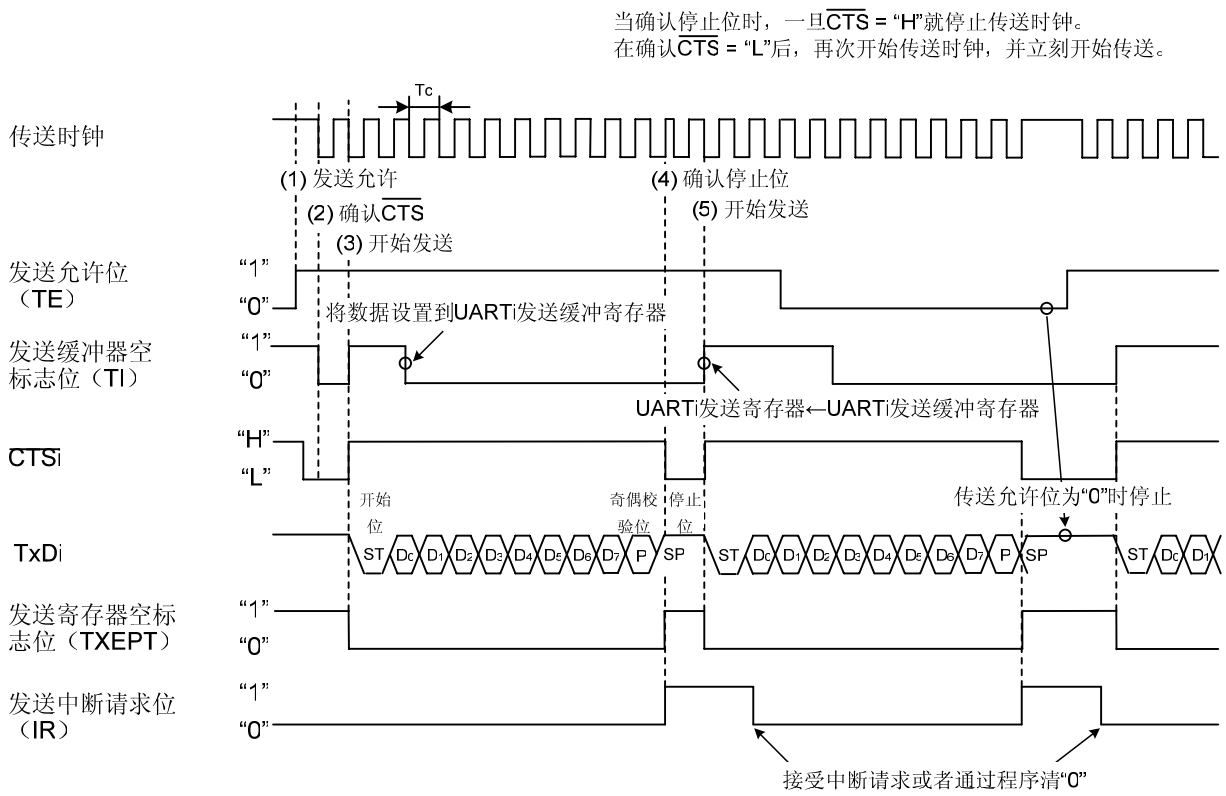
使用 UARTi 在 UART 模式下发送数据的工作时序图如下所示：

硬件连接示例



注：由于TxD2引脚为N沟道漏极开路，所以这个引脚需要上拉电阻。

运行示例



（）内标明的是位符号。

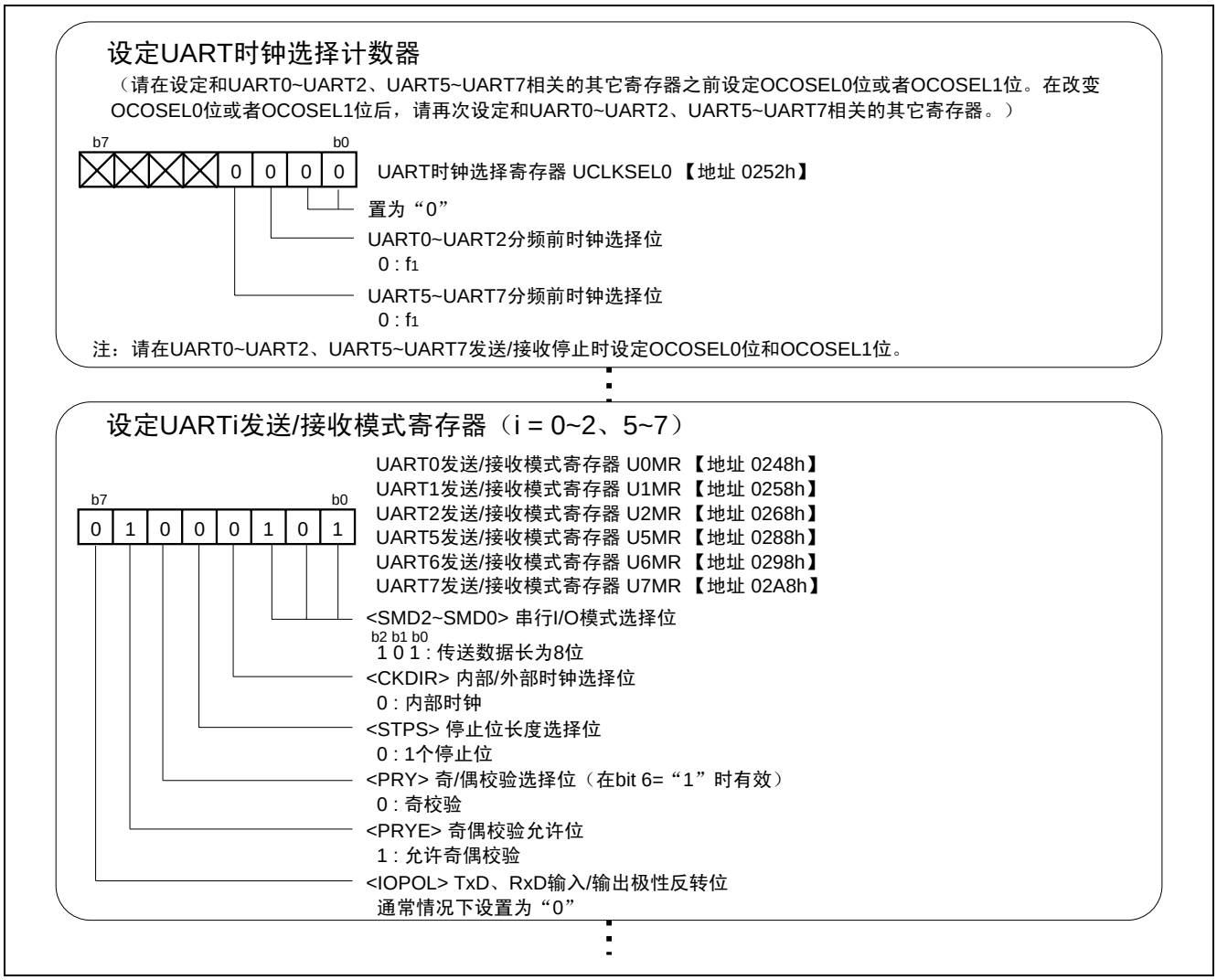
此图的设定条件为：
- 允许奇偶检验
- 1个停止位
- 选择CTS功能
- 发送中断源选择位 = “1”

Tc = 16 (n + 1) / fi 或者16 (n + 1) / fEXT
fi : BRGi计数源的频率（f1SIO、f2SIO、f8SIO、f32SIO）
n : BRGi寄存器的设定值

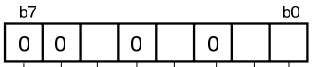
图 1. 使用 UARTi 在 UART 模式下发送数据的工作时序图

5. 寄存器设置

为了能实现定义在“4. 串行 I/O 的操作”的功能，下列寄存器必须按步骤顺序进行设置。对于每个寄存器的具体结构，请参考 M16C/65 群的硬件手册。



设置UARTi发送/接收控制寄存器（i = 0~2、5~7）



UART0发送/接收控制寄存器 U0C0【地址 024Ch】
UART1发送/接收控制寄存器 U1C0【地址 025Ch】
UART2发送/接收控制寄存器 U2C0【地址 026Ch】
UART5发送/接收控制寄存器 U5C0【地址 028Ch】
UART6发送/接收控制寄存器 U6C0【地址 029Ch】
UART7发送/接收控制寄存器 U7C0【地址 02ACh】

<CLK1~CLK0> UiBRG计数源选择位
b1 b0
0 0 : f_{1SIO}或f_{2SIO}
0 1 : f_{8SIO}
1 0 : f_{32SIO}
1 1 : 不能设定

<CRS> $\overline{CTS}$/$\overline{RTS}$功能选择位（在bit4=“0”时有效）
0 : 选择$\overline{CTS}$功能

<TXEPT> 发送寄存器空标志
0 : 发送寄存器中有数据（在发送中）
1 : 发送寄存器中无数据（发送结束）

<CRD> $\overline{CTS}$/$\overline{RTS}$禁止位
0 : 允许$\overline{CTS}$/$\overline{RTS}$功能

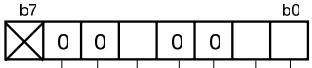
<NCH> 数据输出选择位
0 : TxDi/SDAi、SCLi引脚为CMOS输出
1 : TxDi/SDAi、SCLi引脚为N沟道漏极开路

<CKPOL> 在UART模式时清为“0”

<UFORM> 传送格式选择位
0 : LSB先

注1：当PCLKR寄存器的PCLK0位为“1”时，选择时钟 f_{1SIO}，当PCLKR寄存器的PCLK0位为“0”时，选择时钟 f_{2SIO}。
注2：请将对应引脚的端口方向位清“0”（输入模式）。

设定UART发送/接收控制寄存器2



UART发送/接收控制寄存器2 UCON【地址 0250h】

<U0IRS> UART0发送中断源选择位
1 : 发送结束（TXEPT=1）

<U1IRS> UART1发送中断源选择位
1 : 发送结束（TXEPT=1）

<U0RRM> 在UART模式时清为“0”

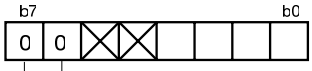
<U1RRM> 在UART模式时清为“0”

<CLKMD0> 在UART模式时无效

<CLKMD1> 在UART模式时清为“0”

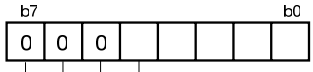
<RCSP> UART0 $\overline{CTS}$/$\overline{RTS}$独立位
0 : $\overline{CTS}$/$\overline{RTS}$复用引脚

设定UARTi发送/接收控制寄存器1（i = 0~2、5~7）



UART0发送/接收控制寄存器1 U0C1 【地址 024Dh】
UART1发送/接收控制寄存器1 U1C1 【地址 025Dh】

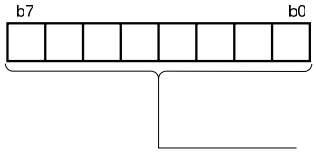
<UiLCH> 数据逻辑选择位
0：无反转
<UiERE> 错误信号输出允许位
0：禁止输出



UART2发送/接收控制寄存器1 U2C1 【地址 026Dh】
UART5发送/接收控制寄存器1 U5C1 【地址 028Dh】
UART6发送/接收控制寄存器1 U6C1 【地址 029Dh】
UART7发送/接收控制寄存器1 U7C1 【地址 02ADh】

<UiIRS> UARTi发送中断源选择位
1：发送结束（TXEPT=1）
<UiRRM> 在UART模式时通常置为“0”
<UiLCH> 数据逻辑选择位
0：无反转
<UiERE> 错误信号输出允许位
0：禁止输出

设定UARTi位速率寄存器（i = 0~2、5~7）

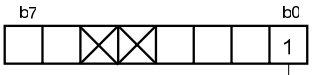


UART0位速率寄存器 U0BRG 【地址 0249h】
UART1位速率寄存器 U1BRG 【地址 0259h】
UART2位速率寄存器 U2BRG 【地址 0269h】
UART5位速率寄存器 U5BRG 【地址 0289h】
UART6位速率寄存器 U6BRG 【地址 0299h】
UART7位速率寄存器 U7BRG 【地址 02A9h】

在00h~FFh范围内进行设定（注1）

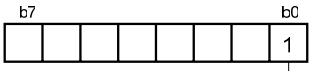
注1：请在发送/接收停止时对UiBRG寄存器进行写操作。请使用MOV指令写UiBRG寄存器。请在设定UiC0寄存器的CLK1和CLK0位后写UiBRG寄存器。

发送允许



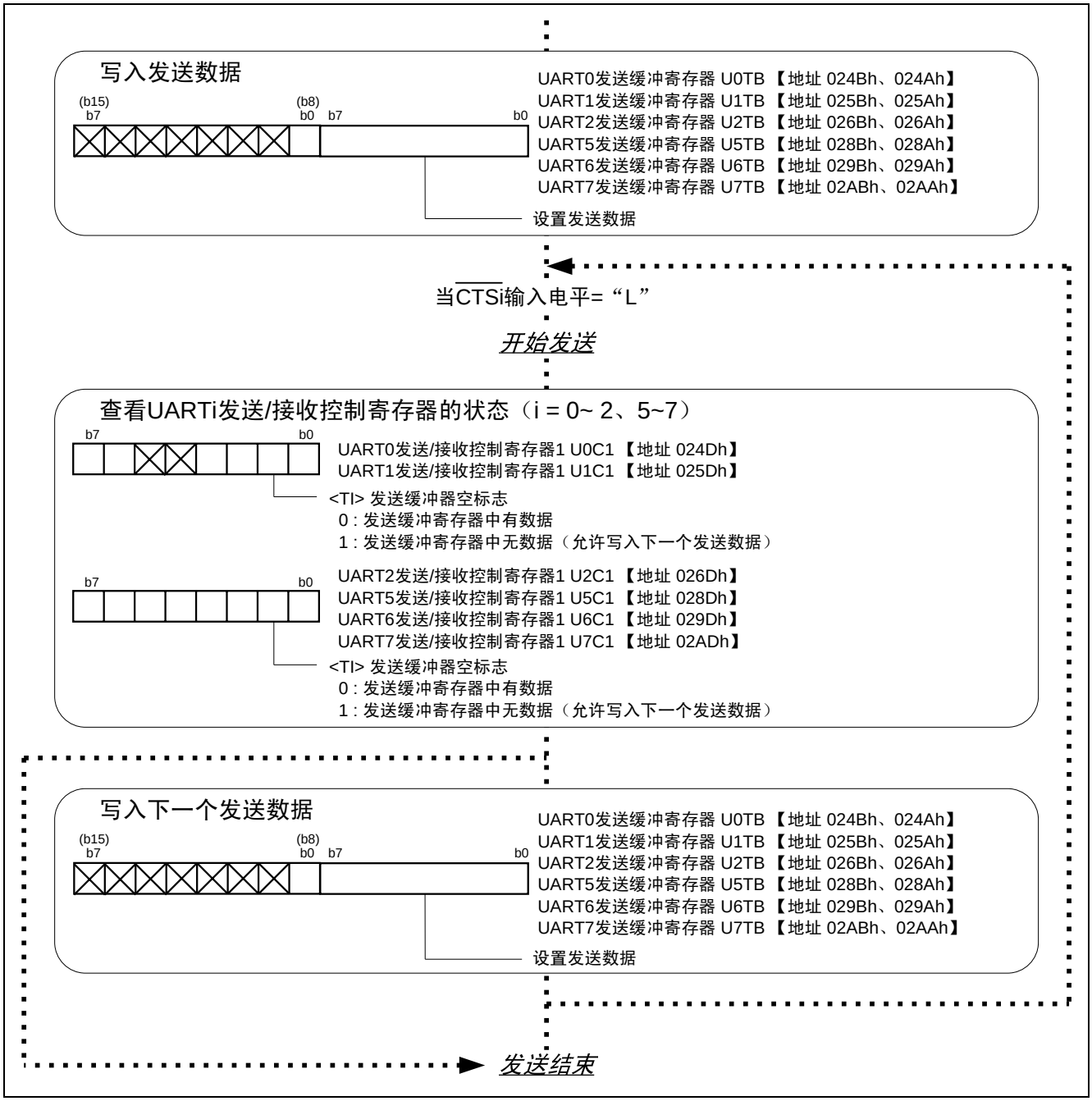
UART0发送/接收控制寄存器1 U0C1 【地址 024Dh】
UART1发送/接收控制寄存器1 U1C1 【地址 025Dh】

<TE> 发送允许位
1：允许发送



UART2发送/接收控制寄存器1 U2C1 【地址 026Dh】
UART5发送/接收控制寄存器1 U5C1 【地址 028Dh】
UART6发送/接收控制寄存器1 U6C1 【地址 029Dh】
UART7发送/接收控制寄存器1 U7C1 【地址 02ADh】

<TE> 发送允许位
1：允许发送


写入发送数据
(b15)
b7
(b8)
b0
b7
b0
UART0发送缓冲寄存器 U0TB【地址 024Bh、024Ah】
UART1发送缓冲寄存器 U1TB【地址 025Bh、025Ah】
UART2发送缓冲寄存器 U2TB【地址 026Bh、026Ah】
UART5发送缓冲寄存器 U5TB【地址 028Bh、028Ah】
UART6发送缓冲寄存器 U6TB【地址 029Bh、029Ah】
UART7发送缓冲寄存器 U7TB【地址 02ABh、02AAh】
设置发送数据
当CTSi输入电平=“L”
开始发送
查看UARTi发送/接收控制寄存器的状态（i = 0~ 2、5~7）
b7
b0
UART0发送/接收控制寄存器1 U0C1【地址 024Dh】
UART1发送/接收控制寄存器1 U1C1【地址 025Dh】
<TI> 发送缓冲器空标志
0：发送缓冲寄存器中有数据
1：发送缓冲寄存器中无数据（允许写入下一个发送数据）
UART2发送/接收控制寄存器1 U2C1【地址 026Dh】
UART5发送/接收控制寄存器1 U5C1【地址 028Dh】
UART6发送/接收控制寄存器1 U6C1【地址 029Dh】
UART7发送/接收控制寄存器1 U7C1【地址 02ADh】
<TI> 发送缓冲器空标志
0：发送缓冲寄存器中有数据
1：发送缓冲寄存器中无数据（允许写入下一个发送数据）
写入下一个发送数据
(b15)
b7
(b8)
b0
b7
b0
UART0发送缓冲寄存器 U0TB【地址 024Bh、024Ah】
UART1发送缓冲寄存器 U1TB【地址 025Bh、025Ah】
UART2发送缓冲寄存器 U2TB【地址 026Bh、026Ah】
UART5发送缓冲寄存器 U5TB【地址 028Bh、028Ah】
UART6发送缓冲寄存器 U6TB【地址 029Bh、029Ah】
UART7发送缓冲寄存器 U7TB【地址 02ABh、02AAh】
设置发送数据
发送结束

6. 参考文献

数据手册

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