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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（时钟同步串行 I/O 模式下的发送、多路时钟输出功能）

1. 要点
在时钟同步串行 I/O 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 在时钟同步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

<table>
<thead>
<tr>
<th>设定项目</th>
<th>设定内容</th>
<th>设定项目</th>
<th>设定内容</th>
</tr>
</thead>
</table>
| 分频前时钟选择 | O
fco-F     | 传送格式 | O
LSB 先     |
| 外围时钟     | O
f1SIO     | 发送中断请求产生条件 | 发送缓冲器空 |
| 传送时钟源   | O
内部时钟(f1SIO/f2SIO/f3SIO/f8SIO/f32SIO) | 输出传送时钟到多个引脚（注 1） | 不选择 |
| 外部时钟（CLKi 引脚） | O        |                      |          |
| CTS 功能     | CTS 功能允许 | 数据逻辑选择功能 | O
不反转        |
| CLK 极性     | O        | 在传送时钟的上升沿输出发送数据 | 反转 |
|             | O        | 在传送时钟的下降沿输出发送数据 |        |

注 1: 只能在 UART1 使用内部时钟时选择。

4. 串行 I/O 的操作

(1) 将发送允许位置为“1”，对 UARTi 发送缓冲寄存器中写入发送数据，进入数据发送状态就绪。

(2) 与传送时钟的第一个下降沿同步，UARTi 发送缓冲寄存器中发送数据被发送到 UARTi 发送寄存器中。此时，产生 UARTi 发送中断请求位变为“1”，发送数据的 bit0 也从 TxDi 引脚发送出去。然后，发送数据与下降沿同步按照从低到高的顺序逐位被发送出去。

(3) 当一个字节的数据发送结束时，发送寄存器空标志位变为“1”，表示发送结束，并且，发送时钟停止输出，并保持为“H”电平。此时，URATi 发送中断请求位变为“1”。

(4) 如果将 CLK/CLKS 选择位 1 和 CLK/CLKS 选择位 0 置“1”，则 CLKSi 引脚将变为时钟输出引脚。请在传送输入的状态更改此设置。

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使用 UARTi 在时钟同步 I/O 模式下发送数据的工作时序图如下所示:

图 1. 使用 UARTi 在时钟同步 I/O 模式下发送数据、输出多路时钟的工作时序图
5. 寄存器设置

为了能实现实义在“4. 串行 I/O 的操作”的功能，下列寄存器必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。

<table>
<thead>
<tr>
<th>设定UART时钟选择计数器</th>
<th>UART时钟选择寄存器 UCLKSEL0【地址 0252h】</th>
</tr>
</thead>
<tbody>
<tr>
<td>b7 b0</td>
<td>0 0 0 0</td>
</tr>
<tr>
<td>UART0~UART2分频前时钟选择位</td>
<td>0 : fi</td>
</tr>
<tr>
<td>UART5~UART7分频前时钟选择位</td>
<td>0 : fi</td>
</tr>
<tr>
<td>注：请在UART0<del>UART2、UART5</del>UART7发送/接收停止时设定OCOSEL0位和OCOSEL1位。</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>设定UART1发送/接收模式寄存器</th>
<th>UART1发送/接收模式寄存器 U1MR【地址 0258h】</th>
</tr>
</thead>
<tbody>
<tr>
<td>b7 b0</td>
<td>0 0 0 1</td>
</tr>
<tr>
<td>&lt;SMD2~SMD0&gt; 置为 “001”</td>
<td></td>
</tr>
<tr>
<td>&lt;CKDIR&gt; 内部/外部时钟选择位</td>
<td>0 : 内部时钟</td>
</tr>
<tr>
<td>&lt;STPS&gt;时钟同步I/O模式下无效</td>
<td></td>
</tr>
<tr>
<td>&lt;PRY&gt; 并行时钟同步I/O模式下无效</td>
<td></td>
</tr>
<tr>
<td>&lt;PRYE&gt; 串行时钟同步I/O模式下无效</td>
<td></td>
</tr>
<tr>
<td>&lt;IOPOL&gt; TxD、RxD输入/输出极性反转位</td>
<td>通常情况下设置为 “0”</td>
</tr>
</tbody>
</table>
串行 I/O 操作（时钟同步串行 I/O 模式下的发送、多路时钟输出功能）

### 设置UART1发送/接收控制寄存器0

UART1发送/接收控制寄存器 U1C0【地址 025Ch】

- **<CLK1, CLK0> U1BRG计数源选择位**
  - b7 b0
  - 0 0 : f1SIO或f2SIO（注1）
  - 0 1 : f3SIO
  - 1 0 : f32SIO
  - 1 1 : 不能设定

- **<CRS> CTS/RTS功能选择位**（在bit4 = “0”时有效）
  - 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> CTS/RTS禁止位**
  - 0 : 禁止CTS/RTS功能
  - 1 : 允许

- **<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）

- **<CKPOL> CLK极性选择位**
  - 0 : 在传送时钟的下降沿输出发送数据，在上升沿输入接收数据
  - 1 : 反之

- **<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 f1SIO。当PCLKR寄存器的PCLK0位为“0”时，选择时钟 f3SIO。

### 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】

- **<U1IRS> UART1发送中断源选择位**
  - 0 : 发送缓冲器空（TI = 1）

- **<CLKMD1> CLK/CLKS选择位0**
  - 0 : 时钟输出到CLK1
  - 1 : 时钟输出到CLKS1

- **<RCSP> UART1的CLK/CLKS选择位1**
  - 0 : 传送时钟输出多引脚选择位
  - 1 : 传送时钟输出多引脚选择位

### 设定UART1位速率寄存器

UART1位速率寄存器 U1BRG【地址 0259h】

- 00h~FFh范围内进行设定（注1）

### 注1：
在发送/接收停止时对U1BRG寄存器进行写操作。请使用MOV指令写U1BRG寄存器。在设定U1C0寄存器的CLK1和CLK0位后写U1BRG寄存器。
串行 I/O 操作（时钟同步串行 I/O 模式下的发送、多路时钟输出功能）

发送允许

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

写入发送数据

UART1发送缓冲寄存器 U1TB【地址 025Bh、025Ah】

设置发送数据

开始发送

查看UART1发送/接收控制寄存器的状态

UART1发送/接收控制寄存器 0 U1C0【地址 025Ch】

<TXEPT> 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

UART1发送缓冲寄存器 U1TB【地址 025Bh、025Ah】

设置发送数据

发送结束
6. 参考文献

数据手册
M16C/65 群硬件手册
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