RL78/G14 群

I2C Repeated START 信号

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要点

本应用说明将从 RL78 的 IICA 模块的主机和从机方面,介绍如何从代码生成器生成的 I2C 示例代码, 添加 Repeated START 状态的对应。

目标设备

RL78/G14

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1. I2C Repeated START 信号简介

在一个 I2C 传输中，经常需要先发送一个命令，然后读回一个答案。这是需要在没有被另一设备（多主机）中断操作风险下,完成整个工作。 I2C 协议定义了一个所谓的”Repeated START”状态。

RL78 族 IICA 模块能够支持 I2C Repeated START 条件, 如下:

ST	AD6 to AD0	R/$\overline{W}$	$\overline{ACK}$	D7 to D0	$\overline{ACK}$	ST	AD6 to AD0	R/$\overline{W}$	$\overline{ACK}$	D7 to D0	$\overline{ACK}$	SP

ST:	Start condition
AD6 to AD0:	Address
R/$\overline{W}$:	Transfer direction specification
$\overline{ACK}$:	Acknowledge
D7 to D0:	Data
SP:	Stop condition

然而，通过代码生成器生成的 I2C 示例代码并不支持及对应 I2C Repeated START 状态。但对应 Repeated START 状态可以通过修改示例程序来实现的。本应用笔记描述了如何修改由代码生成器生成，支持 I2C Repeated START（主从）的示例代码。

2. I2C 主模式示例程序修改

“总线忙”检查

在由代码生成器生成的 I2C 主控的示例程序，IICBSY 寄存器将发送 IIC 从地址之前进行检查。如果 IICBSY 为’1’，将返回错误值。

然而，如 Repeated START 状态下，总线状态为忙碌。该程序应忽略 IICBSY 检查。我们应该将下面的 R_IICA0_Master_Send（）和 R_IICA0_Master_Receive（）的部分代码, 移动到一个新的子程序 R_IICA0_Busy_Check（）。

```
MD_STATUS R_IICA0_Master_Send(uint8_t adr, uint8_t * const tx_buf, uint16_t tx_num, uint8_t wait)
{
    MD_STATUS status = MD_OK;

    IICAMK0 = 1U;      /* disable INTIICA0 interrupt */

    if (1U == IICBSY0)
    {
        /* Check bus busy */
        IICAMK0 = 0U;  /* enable INTIICA0 interrupt */
        status = MD_ERROR1;
    }
    else if ((1U == SPT0) || (1U == STT0))
    {
        /* Check trigger */
        IICAMK0 = 0U;  /* enable INTIICA0 interrupt */
        status = MD_ERROR2;
    }
    else
    {
        STT0 = 1U;     /* send IICA0 start condition */
        IICAMK0 = 0U;  /* enable INTIICA0 interrupt */

        /* Wait */
        while (wait--)
        {
            ;
        }
```

此部分代码移到 *R_IICA0_Busy_Check()*

以下代码是新创建的函数 *R_IICA0_Busy_Check().*

```
/***********************************************************************************************************************
* Function Name: R_IICA0_Busy_Check
* Description  : This function starts to check bus busy.
* Arguments    : -
* Return Value : status -
*                    MD_OK or MD_ERROR1 or MD_ERROR2 or MD_ERROR3
***********************************************************************************************************************/
MD_STATUS R_IICA0_Busy_Check(void)
{
    MD_STATUS status = MD_OK;

    IICAMK0 = 1U;      /* disable INTIICA0 interrupt */

    if (1U == IICBSY0)
    {
        /* Check bus busy */
        IICAMK0 = 0U;  /* enable INTIICA0 interrupt */
        status = MD_ERROR1;
    }
    else if ((1U == SPT0) || (1U == STT0))
    {
        /* Check trigger */
        IICAMK0 = 0U;  /* enable INTIICA0 interrupt */
        status = MD_ERROR2;
    }

    return status;
}
```

跳过'停止'状态

对于 Repeated START 状态，'停止'状态应 I2C 命令帧的结束送出去。在 r_iica0_callback_master_sendend（）和 r_iica0_callback_master_receiveend（）函数里的处理停止状态代码, 应该被移动到一个新的子程序 R_IICA0_StopCondition（）。

```
/***********************************************************************************************************************
* Function Name: r_iica0_callback_master_receiveend
* Description  : This function is a callback function when IICA0 finishes master reception.
* Arguments    : None
* Return Value : None
***********************************************************************************************************************/
static void r_iica0_callback_master_receiveend(void)
{
    SPT0 = 1U;
    /* Start user code. Do not edit comment generated here */
    IIC_flg_end = 1;
    /* End user code. Do not edit comment generated here */
}

/***********************************************************************************************************************
* Function Name: r_iica0_callback_master_sendend
* Description  : This function is a callback function when IICA0 finishes master transmission.
* Arguments    : None
* Return Value : None
***********************************************************************************************************************/
static void r_iica0_callback_master_sendend(void)
{
    SPT0 = 1U;
    /* Start user code. Do not edit comment generated here */
    IIC_flg_end = 1;
    /* End user code. Do not edit comment generated here */
}
```

此部分代码移到 *R_IICA0_StopCondition()*

以下代码是新创建的函数 *R_IICA0_StopCondition()*.

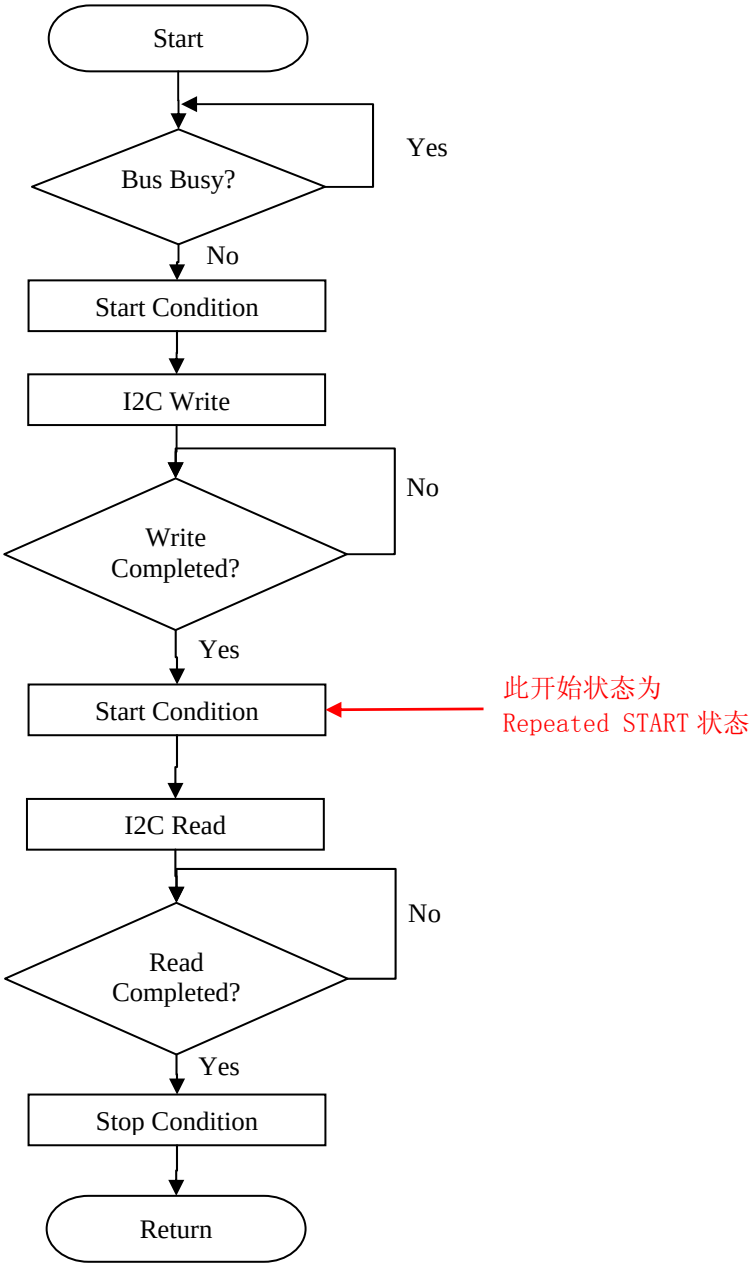
```
/***********************************************************************************************************************
* Function Name: R_IICA0_StopCondition
* Description  : This function sets IICA0 stop condition flag.
* Arguments    : None
* Return Value : None
***********************************************************************************************************************/
void R_IICA0_StopCondition(void)
{
    SPT0 = 1U;    /* set stop condition flag */
}
```

主程序的 I2C 发送命令与 Repeated START 状态

对于使用修改后的代码发送的 I2C，请参阅下面的代码示例。

```
if (R_IICA0_Busy_Check() == MD_OK)  //Check bus busy
{
        IIC_flg_end = 0;
        R_IICA0_Master_Send(0xA0, &IIC_data[0], 1, 0);    //Send data to slave

        while(IIC_flg_end == 0)         //Wait for transmit end
                NOP();
        IIC_flg_end = 0;

        IIC_data[0]= 0;
        R_IICA0_Master_Receive(0xA0, &IIC_data[0], 1, 0);   //Read data from slave
        timer = 0;
        while(IIC_flg_end == 0)         //Wait for recieved end
                NOP();
        IIC_flg_end = 0;

        R_IICA0_StopCondition();        //Send stop condition
}
```

3. I2C 主模式与 Repeated START 状态流程



4. I2C 从模式示例程序修改

添加检查 Repeated START 状态

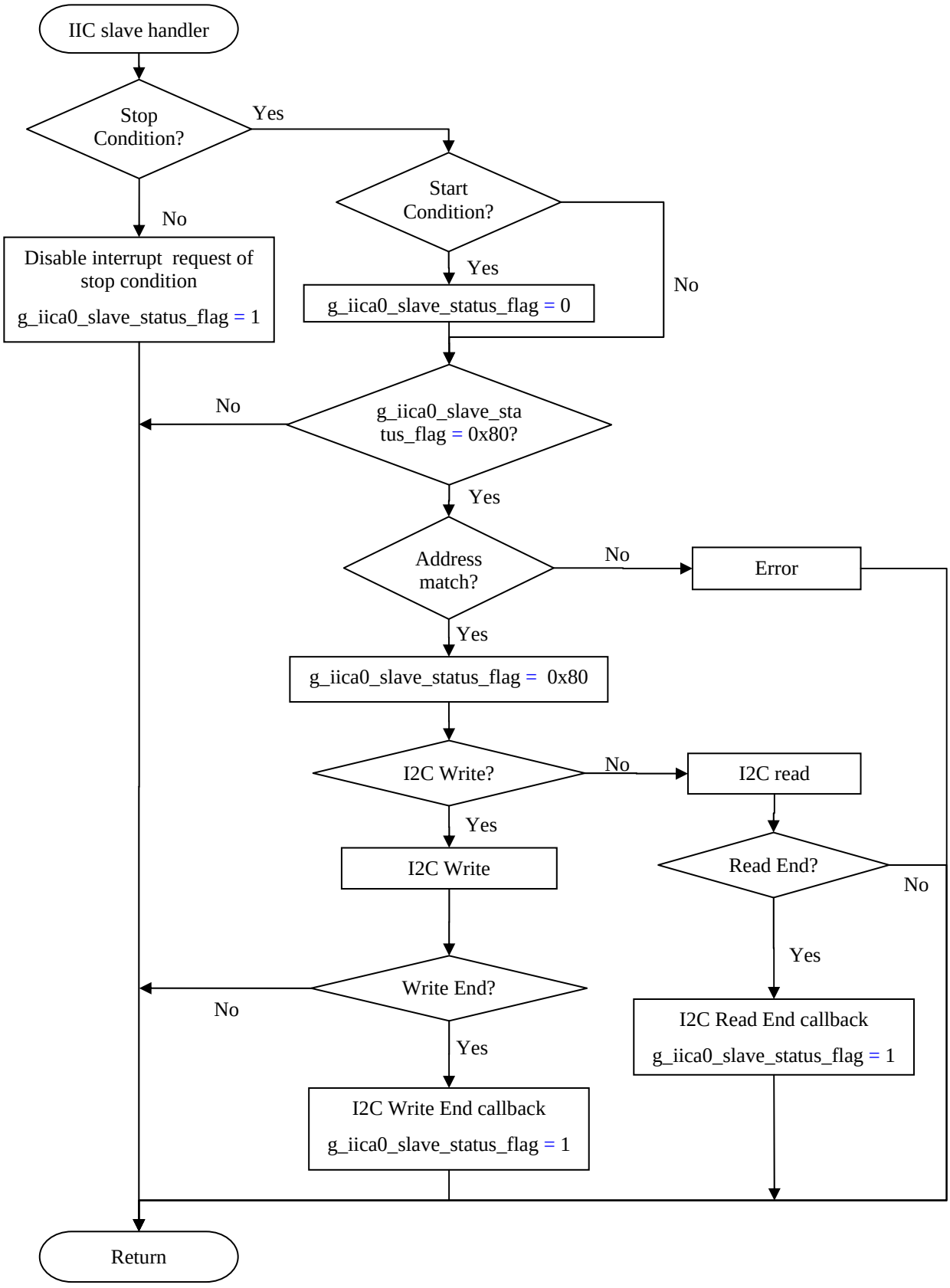
在由代码生成器生成的 I2C 从示例程序，并没有检查 START 状态。当接收到 I2C 主设备 START 或 Repeated START 状态是, I2C 的从状态机将无法复位，并在 Repeated START 状态引起问题。

为了支持 Repeated START 状态，我们可以添加程序检查 Repeated START 状态以及状态机复位手段。修改代码如下所示。

```
/***********************************************************************************************************************
* Function Name: iica0_slave_handler
* Description  : This function is IICA0 slave handler.
* Arguments    : None
* Return Value : None
***********************************************************************************************************************/
static void iica0_slave_handler(void)
{
    /* Control for stop condition */
    if (1U == SPD0)
    {
        /* Get stop condition */
        SPIE0 = 0U;
        g_iica0_slave_status_flag = 1U;
    }
    else
    {
        if(1U == STD0)/* start or restart condition*/
            g_iica0_slave_status_flag = 0U;  //Reset slave status flag

        if ((g_iica0_slave_status_flag & _80_IICA_ADDRESS_COMPLETE) == 0U)
        {
            if (1U == COI0)
            {
                SPIE0 = 1U;
                g_iica0_slave_status_flag |= _80_IICA_ADDRESS_COMPLETE;

                if (1U == TRC0)
                {
                    WTIM0 = 1U;

                    if (g_iica0_tx_cnt > 0U)
                    {
                        IICA0 = *gp_iica0_tx_address;
                        gp_iica0_tx_address++;
                        g_iica0_tx_cnt--;
                    }
                    else
                    {
                        r_iica0_callback_slave_sendend();
                        WREL0 = 1U;
                    }
                }
```

添加代码以检查 START 和 Repeated START 状态。如果发现 START 和 Repeated START 的状态，复位状态标志。

5. I2C 从模式与 Repeated START 状态程序流程



6. I2C 主机参考例程

```
/***********************************************************************
* File Name    : r_main.c
* Version      : CodeGenerator for RL78/I1A V2.00.00.04 [21 Feb 2013]
* Device(s)    : R5F107AE
* Tool-Chain   : CA78K0R
* Description  : This file implements main function.
* Creation Date: 13/9/2013
***********************************************************************/

/***********************************************************************
Pragma directive
***********************************************************************/

/***********************************************************************
Includes
***********************************************************************/
#include "r_cg_macrodriver.h"
#include "r_cg_cgc.h"
#include "r_cg_serial.h"
#include "r_cg_userdefine.h"

/***********************************************************************
Global variables and functions
***********************************************************************/
uint8_t IIC_data[250], timer,i;
uint16_t l;
uint8_t IIC_flg_end = 0;


/***********************************************************************
* Function Name: main
* Description  : This function implements main function.
* Arguments    : None
* Return Value : None
***********************************************************************/
void main(void)
{
    for(i=0; i<250; i++)
       IIC_data[i]=0;

    timer = 0;

    while (1U)
    {
          for(l=0; l<55000; l++)
             NOP();

          if (R_IICA0_Busy_Check() == MD_OK)  //Check bus busy
          {
             timer = 0;
             IIC_flg_end = 0;
             //Send data to slave
             R_IICA0_Master_Send(0xA0, &IIC_data[0], 1, 0);
             //Wait for transmit end
             while(IIC_flg_end == 0)
```

```
                NOP();
            IIC_flg_end = 0;

            IIC_data[0]= 0;
            //Read data from slave
            R_IICA0_Master_Receive(0xA0, &IIC_data[0], 1, 0);
            timer = 0;
            //Wait for recieved end
            while(IIC_flg_end == 0)
                NOP();
            IIC_flg_end = 0;

            R_IICA0_StopCondition();   //Send stop condition
        }
    }
}
```

```
/***********************************************************************
* File Name    : r_cg_serial.c
* Version      : CodeGenerator for RL78/I1A V2.00.00.04 [21 Feb 2013]
* Device(s)    : R5F107AE
* Tool-Chain   : CA78K0R
* Description  : This file implements device driver for Serial module.
* Creation Date: 13/9/2013
***********************************************************************/

/***********************************************************************
Pragma directive
***********************************************************************/

/***********************************************************************
Includes
***********************************************************************/
#include "r_cg_macrodriver.h"
#include "r_cg_serial.h"
/* Start user code for include. Do not edit comment generated here */
/* End user code. Do not edit comment generated here */
#include "r_cg_userdefine.h"

/***********************************************************************
Global variables and functions
***********************************************************************/
volatile uint8_t   g_iica0_master_status_flag; /* iica0 master flag */
volatile uint8_t   g_iica0_slave_status_flag;  /* iica0 slave flag */
volatile uint8_t * gp_iica0_rx_address;        /* iica0 receive buffer address */
volatile uint16_t  g_iica0_rx_len;             /* iica0 receive data length */
volatile uint16_t  g_iica0_rx_cnt;             /* iica0 receive data count */
volatile uint8_t * gp_iica0_tx_address;        /* iica0 send buffer address */
volatile uint16_t  g_iica0_tx_cnt;             /* iica0 send data count */
/* Start user code for global. Do not edit comment generated here */
/* End user code. Do not edit comment generated here */

/***********************************************************************
* Function Name: R_IICA0_Create
* Description  : This function initializes the IICA0 module.
* Arguments    : None
* Return Value : None
***********************************************************************/
void R_IICA0_Create(void)
{
    IICA0EN = 1U;  /* supply IICA0 clock */
    IICE0 = 0U;    /* disable IICA0 operation */
    IICAMK0 = 1U;  /* disable INTIICA0 interrupt */
    IICAIF0 = 0U;  /* clear INTIICA0 interrupt flag */
    /* Set INTIICA0 high priority */
    IICAPR10 = 0U;
    IICAPR00 = 0U;
    /* Set SCLA0, SDAA0 pin */
    P1 &= 0xFCU;
    PM1 &= 0xFCU;
    SMC0 = 1U;
    IICWL0 = _15_IICA0_IICWL_VALUE;
    IICWH0 = _14_IICA0_IICWH_VALUE;
    DFC0 = 0U;     /* digital filter off */
    IICCTL01 |= _01_IICA_fCLK_HALF;
```

```
    SVA0 = _10_IICA0_MASTERADDRESS;
    STCEN0 = 1U;
    IICRSV0 = 1U;
    SPIE0 = 0U;
    WTIM0 = 1U;
    ACKE0 = 1U;
    IICAMK0 = 0U;
    IICE0 = 1U;
    LREL0 = 1U;
    /* Set SCLA0, SDAA0 pin */
    PM1 &= 0xFCU;
}

/***********************************************************************
* Function Name: R_IICA0_Stop
* Description  : This function stops IICA0 module operation.
* Arguments    : None
* Return Value : None
***********************************************************************/
void R_IICA0_Stop(void)
{
    IICE0 = 0U;    /* disable IICA0 operation */
}

/***********************************************************************
* Function Name: R_IICA0_StopCondition
* Description  : This function sets IICA0 stop condition flag.
* Arguments    : None
* Return Value : None
***********************************************************************/
void R_IICA0_StopCondition(void)
{
    SPT0 = 1U;    /* set stop condition flag */
}

/***********************************************************************
* Function Name: R_IICA0_Busy_Check
* Description  : This function starts to check bus busy.
* Arguments    : -
* Return Value : status -
*                    MD_OK or MD_ERROR1 or MD_ERROR2 or MD_ERROR3
***********************************************************************/
MD_STATUS R_IICA0_Busy_Check(void)
{
    MD_STATUS status = MD_OK;

    IICAMK0 = 1U;      /* disable INTIICA0 interrupt */

    if (1U == IICBSY0)
    {
        /* Check bus busy */
        IICAMK0 = 0U;  /* enable INTIICA0 interrupt */
        status = MD_ERROR1;
    }
    else if ((1U == SPT0) || (1U == STT0))
    {
        /* Check trigger */
        IICAMK0 = 0U;  /* enable INTIICA0 interrupt */
```

```
        status = MD_ERROR2;
    }

    return status;
}


/***********************************************************************
* Function Name: R_IICA0_Master_Send
* Description  : This function starts to send data as master mode.
* Arguments    : tx_buf -
*                    transfer buffer pointer
*                tx_num -
*                    buffer size
*                wait -
*                    wait for start condition
* Return Value : status -
*                    MD_OK or MD_ERROR1 or MD_ERROR2 or MD_ERROR3
***********************************************************************/
MD_STATUS R_IICA0_Master_Send(uint8_t adr, uint8_t * const tx_buf, uint16_t tx_num,
uint8_t wait)
{
    MD_STATUS status = MD_OK;

    IICAMK0 = 1U;      /* disable INTIICA0 interrupt */
    STT0 = 1U;     /* send IICA0 start condition */
    IICAMK0 = 0U;  /* enable INTIICA0 interrupt */

    /* Wait */
    while (wait--)
    {
       ;
    }

    if(0U == STD0)
    {
        status = MD_ERROR3;
    }

    /* Set parameter */
    g_iica0_tx_cnt = tx_num;
    gp_iica0_tx_address = tx_buf;
    g_iica0_master_status_flag = _00_IICA_MASTER_FLAG_CLEAR;
    adr &= (uint8_t)~0x01U; /* set send mode */
    IICA0 = adr;           /* send address */

    return (status);
}
```

```
/***********************************************************************
* Function Name: R_IICA0_Master_Receive
* Description  : This function starts to receive IICA0 data as master mode.
* Arguments    : rx_buf -
*                    receive buffer pointer
*                rx_num -
*                    buffer size
*                wait -
*                    wait for start condition
* Return Value : status -
*                    MD_OK or MD_ERROR1 or MD_ERROR2 or MD_ERROR3
***********************************************************************/
MD_STATUS R_IICA0_Master_Receive(uint8_t adr, uint8_t * const rx_buf, uint16_t rx_num,
uint8_t wait)
{
    MD_STATUS status = MD_OK;

    IICAMK0 = 1U;  /* disable INTIIA0 interrupt */

    {
        STT0 = 1U;     /* set IICA0 start condition */
        IICAMK0 = 0U;  /* enable INTIIA0 interrupt */

        /* Wait */
        while (wait--)
        {
            ;
        }

        if(0U == STD0)
        {
            status = MD_ERROR3;
        }

        /* Set parameter */
        g_iica0_rx_len = rx_num;
        g_iica0_rx_cnt = 0U;
        gp_iica0_rx_address = rx_buf;
        g_iica0_master_status_flag = _00_IICA_MASTER_FLAG_CLEAR;
        adr |= 0x01U;    /* set receive mode */
        IICA0 = adr;    /* receive address */
    }

    return (status);
}
```

```
/***********************************************************************
* File Name    : r_cg_serial_user.c
* Version      : CodeGenerator for RL78/I1A V2.00.00.04 [21 Feb 2013]
* Device(s)    : R5F107AE
* Tool-Chain   : CA78K0R
* Description  : This file implements device driver for Serial module.
* Creation Date: 13/9/2013
***********************************************************************/

/***********************************************************************
Pragma directive
***********************************************************************/
#pragma interrupt INTIICA0 r_iica0_interrupt

/***********************************************************************
Includes
***********************************************************************/
#include "r_cg_macrodriver.h"
#include "r_cg_serial.h"
/* Start user code for include. Do not edit comment generated here */
/* End user code. Do not edit comment generated here */
#include "r_cg_userdefine.h"

/***********************************************************************
Global variables and functions
***********************************************************************/
extern volatile uint8_t   g_iica0_master_status_flag;  /* iica0 master flag */
extern volatile uint8_t   g_iica0_slave_status_flag;   /* iica0 slave flag */
extern volatile uint8_t * gp_iica0_rx_address;         /* iica0 receive buffer
address */
extern volatile uint16_t  g_iica0_rx_cnt;              /* iica0 receive data
length */
extern volatile uint16_t  g_iica0_rx_len;              /* iica0 receive data
count */
extern volatile uint8_t * gp_iica0_tx_address;         /* iica0 send buffer
address */
extern volatile uint16_t  g_iica0_tx_cnt;              /* iica0 send data
count */
extern uint8_t IIC_flg_end;

/***********************************************************************
* Function Name: r_iica0_interrupt
* Description  : This function is INTIICA0 interrupt service routine.
* Arguments    : None
* Return Value : None
***********************************************************************/
__interrupt static void r_iica0_interrupt(void)
{
      P20 = 0xff;
    if ((IICS0 & _80_IICA_STATUS_MASTER) == 0x80U)
    {
        iica0_master_handler();
    }
        P20 = 0x00;
}
```

```
/***********************************************************************
* Function Name: iica0_master_handler
* Description  : This function is IICA0 master handler.
* Arguments    : None
* Return Value : None
***********************************************************************/
static void iica0_master_handler(void)
{
    /* Control for communication */
    if ((0U == IICBSY0) && (g_iica0_tx_cnt != 0U))
    {
        r_iica0_callback_master_error(MD_SPT);
    }
    /* Control for sended address */
    else
    {
        if ((g_iica0_master_status_flag & _80_IICA_ADDRESS_COMPLETE) == 0U)
        {
            if (1U == ACKD0)
            {
                g_iica0_master_status_flag |= _80_IICA_ADDRESS_COMPLETE;
                if (1U == TRC0)
                {
                    WTIM0 = 1U;
                    if (g_iica0_tx_cnt > 0U)
                    {
                        IICA0 = *gp_iica0_tx_address;
                        gp_iica0_tx_address++;
                        g_iica0_tx_cnt--;
                    }
                    else
                    {
                        r_iica0_callback_master_sendend();
                    }
                }
                else
                {
                    ACKE0 = 1U;
                    WTIM0 = 0U;
                    WREL0 = 1U;
                }
            }
            else
            {
                r_iica0_callback_master_error(MD_NACK);
            }
        }
        else
        {
            /* Master send control */
            if (1U == TRC0)
            {
                if ((0U == ACKD0) && (g_iica0_tx_cnt != 0U))
                {
                    r_iica0_callback_master_error(MD_NACK);
                }
                else
                {
```

```
                    if (g_iica0_tx_cnt > 0U)
                    {
                        IICA0 = *gp_iica0_tx_address;
                        gp_iica0_tx_address++;
                        g_iica0_tx_cnt--;
                    }
                    else
                    {
                        r_iica0_callback_master_sendend();
                    }
                }
            }
            /* Master receive control */
            else
            {
                if (g_iica0_rx_cnt < g_iica0_rx_len)
                {
                    *gp_iica0_rx_address = IICA0;
                    gp_iica0_rx_address++;
                    g_iica0_rx_cnt++;

                    if (g_iica0_rx_cnt == g_iica0_rx_len)
                    {
                        ACKE0 = 0U;
                        WREL0 = 1U;
                        WTIM0 = 1U;
                    }
                    else
                    {
                        WREL0 = 1U;
                    }
                }
                else
                {
                    r_iica0_callback_master_receiveend();
                }
            }
        }
    }
}

/***********************************************************************
* Function Name: r_iica0_callback_master_error
* Description  : This function is a callback function when IICA0 master error
occurs.
* Arguments    : flag -
*                    status flag
* Return Value : None
***********************************************************************/
static void r_iica0_callback_master_error(MD_STATUS flag)
{
    /* Start user code. Do not edit comment generated here */
    /* End user code. Do not edit comment generated here */
}
```

```
/***********************************************************************
* Function Name: r_iica0_callback_master_receiveend
* Description  : This function is a callback function when IICA0 finishes
master reception.
* Arguments    : None
* Return Value : None
***********************************************************************/
static void r_iica0_callback_master_receiveend(void)
{
    IIC_flg_end = 1;
}

/***********************************************************************
* Function Name: r_iica0_callback_master_sendend
* Description  : This function is a callback function when IICA0 finishes
master transmission.
* Arguments    : None
* Return Value : None
***********************************************************************/
static void r_iica0_callback_master_sendend(void)
{
    IIC_flg_end = 1;
}
```

7. I2C 从机参考例程

```
/***********************************************************************
* File Name    : r_main.c
* Version      : CodeGenerator for RL78/I1A V2.00.00.04 [21 Feb 2013]
* Device(s)    : R5F107AE
* Tool-Chain   : CA78K0R
* Description  : This file implements main function.
* Creation Date: 13/9/2013
***********************************************************************/

/***********************************************************************
Pragma directive
***********************************************************************/

/***********************************************************************
Includes
***********************************************************************/#
include "r_cg_macrodriver.h"
#include "r_cg_cgc.h"
#include "r_cg_serial.h"
#include "r_cg_userdefine.h"

/***********************************************************************
Global variables and functions
***********************************************************************/
extern unsigned char rx_end;
extern unsigned char tx_end;
uint8_t  g_read_value[250]; //buffer I2C read
uint8_t  g_write_value[250];//buffer I2C write

/***********************************************************************
* Function Name: main
* Description  : This function implements main function.
* Arguments    : None
* Return Value : None
***********************************************************************/
void main(void)
{
     R_IICA0_Slave_Receive(&g_read_value[0], 1);

     g_write_value[0] = 0x55;
    R_IICA0_Slave_Send(&g_write_value[0], 1);
    while (1U)
    {
       if (rx_end == 1)    //1 byte IIC data recieved?
       {
           rx_end = 0;     //clr recieve flag
           //set recieve another IIC data
           R_IICA0_Slave_Receive(&g_read_value[0], 1);    }

           if (tx_end == 1)    //1 byte IIC data transmit?
           {
               tx_end = 0;
               g_write_value[0] = 0x55;
               //set recieve another 250 IIC data
```

```
            R_IICA0_Slave_Send(&g_write_value[0], 1);  }
    }
}
```

```
/***********************************************************************
* File Name    : r_cg_serial.c
* Version      : CodeGenerator for RL78/I1A V2.00.00.04 [21 Feb 2013]
* Device(s)    : R5F107AE
* Tool-Chain   : CA78K0R
* Description  : This file implements device driver for Serial module.
* Creation Date: 13/9/2013
***********************************************************************/

/***********************************************************************
Pragma directive
***********************************************************************/

/***********************************************************************
Includes
***********************************************************************/
#include "r_cg_macrodriver.h"
#include "r_cg_serial.h"
/* Start user code for include. Do not edit comment generated here */
/* End user code. Do not edit comment generated here */
#include "r_cg_userdefine.h"

/***********************************************************************
Global variables and functions
***********************************************************************/
volatile uint8_t   g_iica0_master_status_flag; /* iica0 master flag */
volatile uint8_t   g_iica0_slave_status_flag;  /* iica0 slave flag */
volatile uint8_t * gp_iica0_rx_address;        /* iica0 receive buffer address */
volatile uint16_t  g_iica0_rx_len;             /* iica0 receive data length */
volatile uint16_t  g_iica0_rx_cnt;             /* iica0 receive data count */
volatile uint8_t * gp_iica0_tx_address;        /* iica0 send buffer address */
volatile uint16_t  g_iica0_tx_cnt;             /* iica0 send data count */
/* Start user code for global. Do not edit comment generated here */
/* End user code. Do not edit comment generated here */

/***********************************************************************
* Function Name: R_IICA0_Create
* Description  : This function initializes the IICA0 module.
* Arguments    : None
* Return Value : None
***********************************************************************/
void R_IICA0_Create(void)
{
    IICA0EN = 1U; /* supply IICA0 clock */
    IICE0 = 0U; /* disable IICA0 operation */
    IICAMK0 = 1U; /* disable INTIICA0 interrupt */
    IICAIF0 = 0U; /* clear INTIICA0 interrupt flag */
    /* Set INTIICA0 high priority */
    IICAPR10 = 0U;
    IICAPR00 = 0U;
    /* Set SCLA0, SDAA0 pin */
    P6 &= 0xFCU;
    P6 |= 0x03;
    PM6 |= 0x03U;
    SMC0 = 1U;
    IICWL0 = _15_IICA0_IICWL_VALUE;
    IICWH0 = _14_IICA0_IICWH_VALUE;
    DFC0 = 0U; /* digital filter off */
```

```
    IICCTL01 |= _01_IICA_fCLK_HALF;
    SVA0 = 10_IICA0_SLAVEADDRESS;
    STCEN0 = 1U;
    IICRSV0 = 1U;
    SPIE0 = 0U;
    WTIM0 = 1U;
    ACKE0 = 1U;
    IICAMK0 = 0U;
    IICE0 = 1U;
     LREL0 = 1U;
     /* Set SCLA0, SDAA0 pin */
    PM1 &= 0xFCU;
}

/***********************************************************************
* Function Name: R_IICA0_Stop
* Description  : This function stops IICA0 module operation.
* Arguments    : None
* Return Value : None
***********************************************************************/
void R_IICA0_Stop(void)
{
    IICE0 = 0U;    /* disable IICA0 operation */
}

/***********************************************************************
* Function Name: R_IICA0_Slave_Send
* Description  : This function sends data as slave mode.
* Arguments    : tx_buf -
*                    transfer buffer pointer
*                tx_num -
*                    buffer size
* Return Value : None
***********************************************************************/
void R_IICA0_Slave_Send(uint8_t * const tx_buf, uint16_t tx_num)
{
    g_iica0_tx_cnt = tx_num;
    gp_iica0_tx_address = tx_buf;
    g_iica0_slave_status_flag = 0U;
}

/***********************************************************************
* Function Name: R_IICA0_Slave_Receive
* Description  : This function receives data as slave mode.
* Arguments    : rx_buf -
*                    receive buffer pointer
*                rx_num -
*                    buffer size
* Return Value : None
***********************************************************************/
void R_IICA0_Slave_Receive(uint8_t * const rx_buf, uint16_t rx_num)
{
    g_iica0_rx_len = rx_num;
    g_iica0_rx_cnt = 0U;
    gp_iica0_rx_address = rx_buf;
    g_iica0_slave_status_flag  = 0U;
}
```

```
/***********************************************************************
* File Name    : r_cg_serial_user.c
* Version      : CodeGenerator for RL78/I1A V2.00.00.04 [21 Feb 2013]
* Device(s)    : R5F107AE
* Tool-Chain   : CA78K0R
* Description  : This file implements device driver for Serial module.
* Creation Date: 13/9/2013
***********************************************************************/

/***********************************************************************
Pragma directive
***********************************************************************/
#pragma interrupt INTIICA0 r_iica0_interrupt

/***********************************************************************
Includes
***********************************************************************/
#include "r_cg_macrodriver.h"
#include "r_cg_serial.h"
/* Start user code for include. Do not edit comment generated here */
/* End user code. Do not edit comment generated here */
#include "r_cg_userdefine.h"

/***********************************************************************
Global variables and functions
***********************************************************************/
extern volatile uint8_t   g_iica0_master_status_flag;  /* iica0 master flag */
extern volatile uint8_t   g_iica0_slave_status_flag;   /* iica0 slave flag */
extern volatile uint8_t * gp_iica0_rx_address;         /* iica0 receive buffer address
*/
extern volatile uint16_t  g_iica0_rx_cnt;              /* iica0 receive data length */
extern volatile uint16_t  g_iica0_rx_len;              /* iica0 receive data count */
extern volatile uint8_t * gp_iica0_tx_address;         /* iica0 send buffer address */
extern volatile uint16_t  g_iica0_tx_cnt;              /* iica0 send data count */
uint8_t rx_end = 0;                                      //rx end flag
uint8_t char tx_end = 0;                                    //tx end flag
extern uint8_t  g_read_value[250];                     //buffer for data read
extern uint8_t  g_write_value[250];                    //buffer for data write

/***********************************************************************
* Function Name: r_iica0_interrupt
* Description  : This function is INTIICA0 interrupt service routine.
* Arguments    : None
* Return Value : None
***********************************************************************/
__interrupt static void r_iica0_interrupt(void)
{
    P3 = 0x08;
    if ((IICS0 & _80_IICA_STATUS_MASTER) == 0U)
    {
        iica0_slave_handler();
    }
     P3 = 0x00;
}
```

```
/***********************************************************************
* Function Name: iica0_slave_handler
* Description  : This function is IICA0 slave handler.
* Arguments    : None
* Return Value : None
***********************************************************************/
static void iica0_slave_handler(void)
{
    /* Control for stop condition */
    if (1U == SPD0)
    {
        /* Get stop condition */
        SPIE0 = 0U;
        g_iica0_slave_status_flag = 1U;
    }
    else
    {
  if(1U == STD0)/* start or restart condition*/
   g_iica0_slave_status_flag = 0U;  //Reset slave status flag

        if ((g_iica0_slave_status_flag & _80_IICA_ADDRESS_COMPLETE) == 0U)
        {
            if (1U == COI0)
            {
                SPIE0 = 1U;
                g_iica0_slave_status_flag |= _80_IICA_ADDRESS_COMPLETE;

                if (1U == TRC0)
                {
                    WTIM0 = 1U;

                    if (g_iica0_tx_cnt > 0U)
                    {
                        IICA0 = *gp_iica0_tx_address;
                        gp_iica0_tx_address++;
                        g_iica0_tx_cnt--;
                    }
                    else
                    {
                        r_iica0_callback_slave_sendend();
                        WREL0 = 1U;
                    }
                }
                else
                {
                    ACKE0 = 1U;
                    WTIM0 = 0U;
                    WREL0 = 1U;
                }
            }
            else
            {
                r_iica0_callback_slave_error(MD_ERROR);
            }
        }
        else
        {
```

```
            if (1U == TRC0)
            {
                if ((0U == ACKD0) && (g_iica0_tx_cnt != 0U))
                {
                    r_iica0_callback_slave_error(MD_NACK);
                }
                else
                {
                    if (g_iica0_tx_cnt > 0U)
                    {
                        IICA0 = *gp_iica0_tx_address;
                        gp_iica0_tx_address++;
                        g_iica0_tx_cnt--;
                    }
                    else
                    {
                        r_iica0_callback_slave_sendend();
                        WREL0 = 1U;
                    }
                }
            }
            else
            {
                if (g_iica0_rx_cnt < g_iica0_rx_len)
                {
                    *gp_iica0_rx_address = IICA0;
                    gp_iica0_rx_address++;
                    g_iica0_rx_cnt++;

                    if (g_iica0_rx_cnt == g_iica0_rx_len)
                    {
                        ACKE0 = 0U;
                        WTIM0 = 1U;
                        WREL0 = 1U;
                        r_iica0_callback_slave_receiveend();
                    }
                    else
                    {
                        WREL0 = 1U;
                    }
                }
                else
                {
                    WREL0 = 1U;
                }
            }
        }
    }
}
```

```
/***********************************************************************
Function Name: r_iica0_callback_slave_error
* Description  : This function is a callback function when IICA0 slave error occurs.
* Arguments    : None
* Return Value : None
***********************************************************************/
static void r_iica0_callback_slave_error(MD_STATUS flag)
{
    /* Start user code. Do not edit comment generated here */
    /* End user code. Do not edit comment generated here */
}

/***********************************************************************
Function Name: r_iica0_callback_slave_receiveend
* Description  : This function is a callback function when IICA0 finishes slave
reception.
* Arguments    : None
* Return Value : None
***********************************************************************/
static void r_iica0_callback_slave_receiveend(void)
{
    rx_end = 1;
}

/***********************************************************************
Function Name: r_iica0_callback_slave_sendend
* Description  : This function is a callback function when IICA0 finishes slave
transmission.
* Arguments    : None
* Return Value : None
***********************************************************************/
static void r_iica0_callback_slave_sendend(void)
{
    tx_end = 1;
}
```

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修订记录	RL78/G14 群 应用说明

Rev	发行日	修订内容	
		页	修订处
1.00	Jan 10, 2014	—	初版发行

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9. 不可将瑞萨电子产品和技术用于或者嵌入日本国内或海外相应的法律法规所禁止生产、使用及销售的任何产品或系统中。也不可将本文档中记载的瑞萨电子产品或技术用于与军事应用或者军事用途有关的任何目的（如大规模杀伤性武器的开发等）。在将本文档中记载的瑞萨电子产品或技术进行出口时，应当遵守相应的出口管制法律法规，并按照上述法律法规所规定的程序进行。
10. 向第三方分销或处分产品或者以其他方式将产品置于第三方控制之下的瑞萨电子产品买方或分销商，有责任事先向上述第三方通知本文档规定的内容和条件；对于用户或第三方因非法使用瑞萨电子产品而遭受的任何损失，瑞萨电子不承担任何责任。
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(注1) 瑞萨电子：在本文档中指瑞萨电子株式会社及其控股子公司。
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