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R8C Family

How to use Data Queue in place of Mailbox

Introduction

MR8C/4 is a LITE version of MR30/4. Its evolution resulted from the requirement of achieving small memory footprint suitable for implementation on R8C family devices. Therefore, few modules of MR30/4 are not included in MR8C/4. One such module is “Mailbox”.

This document aims to compare the differences between “Data Queue” and “Mailbox” modules, explains and demonstrates the process of using “Data Queue” to fulfill the functionality of “Mailbox”.

Target Device

Applicable MCU: R8C Family

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1. Guide in using this Document

Exclusion of “Mailbox” module in MR8C/4 might bring some amount of inconvenience to users who are versed in using it. This document aims to explain the workaround solution of using “Data Queue” module to replace “Mailbox” module.

Table 1 Explanation of Document Topics

Topic	Objective	Pre-requisite
Comparison between Data Queue and Mailbox	Perform a point by point comparison between Data Queue and Mailbox	MR8C/4 and MR30/4
Conversion Procedure	A step by step implementation of Data Queue in replacement of Mailbox	MR8C/4
Reference Documents	Listing of documents that equip users with knowledge in the pre-requisite requirements	None

2. Comparison between Data Queue and Mailbox

Data Queue and Mailbox are two almost similar methods in performing data communications between tasks. The differences between both modules are dependent on the type of RTOS. Based on MR30/4, functional behavior of Mailbox is explained in Figure 1. Figure 2 provide the functional description of Data Queue in MR8C/4.

2.1 Functionality Description of Mailbox

A Mailbox is an object used for synchronization and communication by sending or receiving a message placed in a shared memory. A Mailbox has an associated message queue for storing sent messages and a wait queue for receiving messages. A task sends a message and places it in the message queue identified by an ID number. A task receives a message from the Mailbox and removes it from the message queue. Tasks requesting for messages will be put in the Mailbox's wait queue if Mailbox is empty.

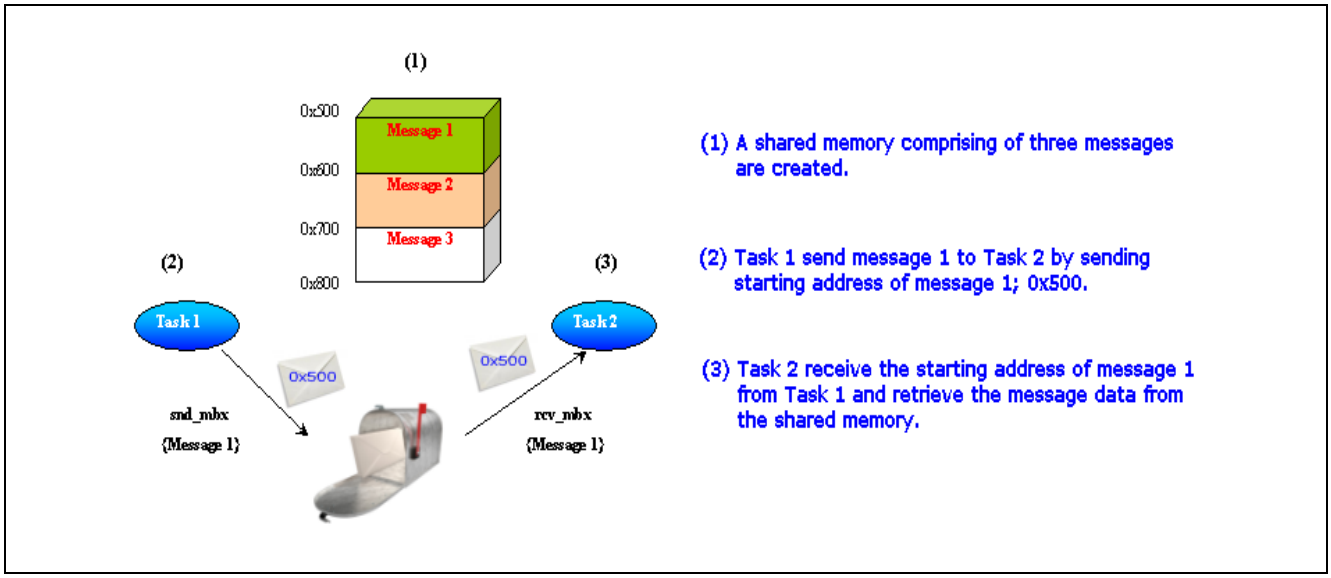


Figure 1 Functional Description of Mailbox Module in MR30/4

2.2 Functionality Description of Data Queue

A Data Queue is an object used for synchronization and communication by sending or receiving one word message; data element. A Data Queue has an associated Data Queue area for storing sent data elements. A task sends a data element by placing it in the Data Queue identified by a specified ID number. A task receives a data element and removes it from the Data Queue. If a Data Queue is full, tasks sending data element will be put in send wait queue. Conversely, if a there is not data element in the Data Queue, tasks requesting data element will be put in receive wait queue.

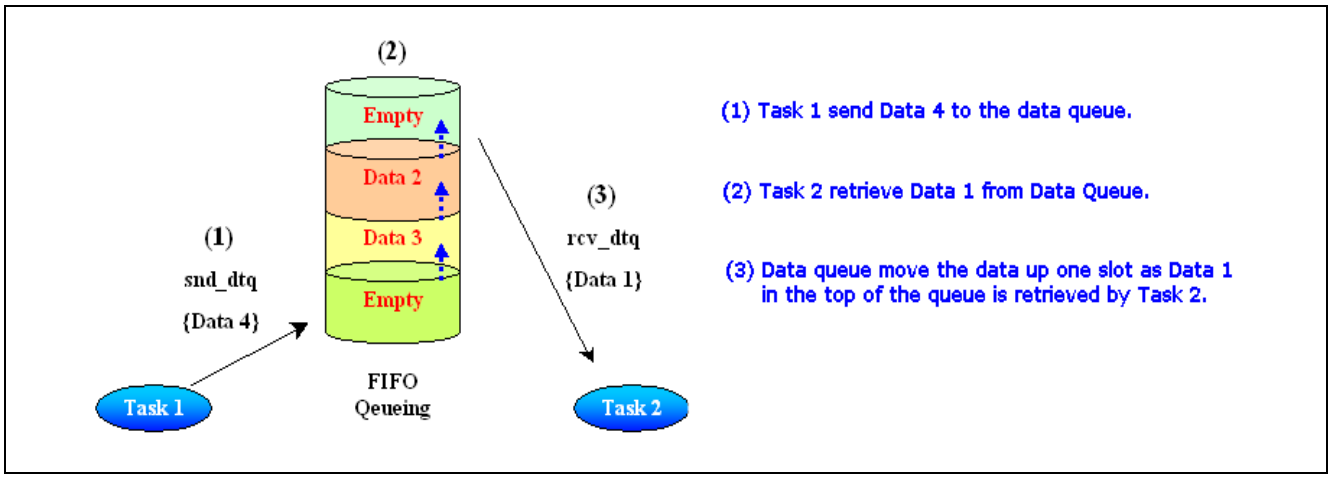


Figure 2 Functional Description of Data Queue Module in MR8C/4

2.3 Comparison between Mailbox and Data Queue

Figure 3 below describes the difference between Data Queue of MR8C/4 and Mailbox of MR30/4.

	MAILBOX	DATA QUEUE
Characteristics		
Function	Perform data communication between tasks	Perform data communication between tasks
Data Type	Starting address of a message	Actual data
Data Size Limit	No limit	Capacity limit of 65535 and Data size limit of 16 bits
Transfer Order	FIFO/ PRI	FIFO
Task Behaviour	Tasks will not be kept waiting for transmission	Tasks goes into wait state if data queue is full during transmission
Advantages	Small overhead because only the message storing address is transferred	Message size limit at 2 bytes (small overhead)
	No limitation on the message amount because the messages are managed by using a link list	No share memory required
	A large amount of message can be sent	
Disadvantages	Shared memory must be prepared	A large amount of message cannot be sent because the message size is fixed

Figure 3 Comparisons between Mailbox & Data Queue Modules

R8C family devices have lower on-chip memory capacity as compared to M16C/60 series devices. In additional, R8C Family devices are more suited for simpler application deployment as compared to M16C/60 series devices. As such, requirement of allocating a shared memory by Mailbox module will be inappropriate for implementation on R8C Family device. With inclusion of only Data Queue module in MR8C/4, it is more than sufficient to meet the requirements by R8C family devices.

3. Conversion of Mailbox Module to Data Queue Module

The main disparity between Mailbox and Data Queue modules are the information transmitted between two tasks. Mailbox transmits the starting address of the message in the shared memory whilst Data Queue transmits the actual data of the message. However, Data Queue can be configured to function as Mailbox by transmitting only the starting address of the message if proper synchronizations are enforced.

Figure 4 provides a simple example of how Mailbox module of MR30/4 can be implemented. Two methods of utilizing Data Queue module to achieve the functional objective of the Mailbox module are illustrated as well in Figure 5 and Figure 6 respectively. The latter method is a workaround solution of overcoming the limitation in Data Queue module. Both methods discussed are feasible solutions and selection of either method to employ is highly dependent on users' requirements.

```
#include <itron.h>
#include <kernel.h>
#include "kernel_id.h"
#include <stdio.h>
#include "M3TMR30_RTOS.h"
#include "sfr_r825.h"
#include "typedefine.h"

typedef struct fifo_user_msg{
    T_MSG t_msg;
    unsigned short  data;
}FIFO_USER_MSG;

FIFO_USER_MSG g_fifousermsg[10];
ER ercd;

void Task1(VP_INT stacd)
{
    g_fifousermsg[0].data =  0x1234;
    ercd = snd_mbx(ID_Mbx1,(T_MSG *)&g_fifousermsg[0]);
    if (ercd == E_OK)
    {
        act_tsk(ID_Task2);
    }
}

void Task2(VP_INT stacd)
{
    T_RMBX pk_rmbx;
    ercd = ref_mbx(ID_Mbx1,&pk_rmbx);
    act_tsk(ID_Task3);
}

void Task3(VP_INT stacd)
{
    FIFO_USER_MSG * msgpt;
    ercd = rcv_mbx(ID_Mbx1,(T_MSG **)&msgpt);
    asm("NOP");
}
```

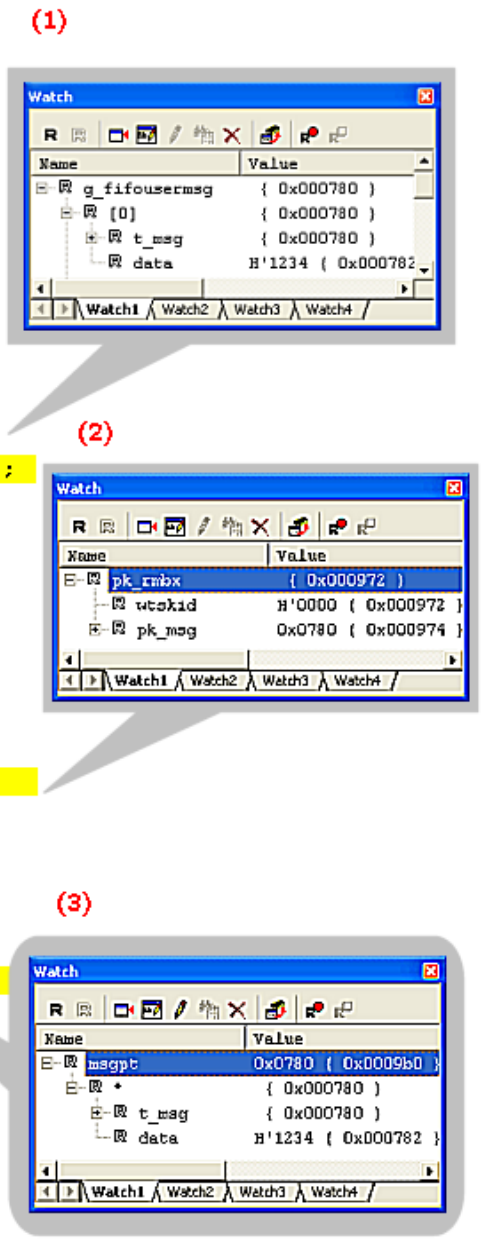


Figure 4 An Example of utilizing Mailbox Module of MR30/4

As shown in Figure 4 above, operation can be described as below:

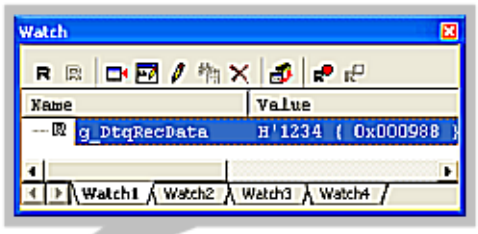
1) The message "*g_fifousermsg[0]*" was sent to the mailbox "*ID_Mbx1*" by Task1.
2) Pointer to the message packet shown that starting address (0x0780) of message "*g_fifousermsg[0]*" was sent to mailbox "*ID_Mbx1*".
3) Task3 receive starting address of message "*g_fifousermsg[0]*" and retrieve data "*0x1234*" from the shared memory location at "*0x0780*".

3.1 Method 1: Data Queue Module Implementation without Share Memory

This method illustrates the employment of using Data Queue module to send the actual data from one task to another without the usage of a share memory. In this method, user is imposed with the limitation of Data Queue module in terms of capacity and data size.

```
#include <itron.h>
#include <kernel.h>
#include "kernel_id.h"
#include "sfr_r825.h"
#include "typedefine.h"

ER ercd;

void Task1(VP_INT stacd)
{
    VP_INT g_DtqSendData;
    g_DtqSendData = 0x1234;
    ercd = snd_dtq(ID_Dtq1,g_DtqSendData);
    if (ercd == E_OK)
    {
        sta_tsk(ID_Task2);
    }
}

void Task2(VP_INT stacd)
{
    VP_INT g_DtqRecData;
    ercd = rcv_dtq(ID_Dtq1,&g_DtqRecData);
    asm("NOP");
}
```

(1)



(2)

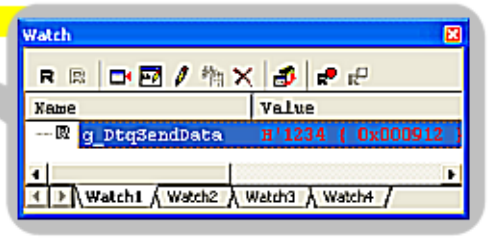


Figure 5 Data Queue Module Implementation without Share Memory in MR8C/4

As shown in Figure 5 above, operations can be described as below:

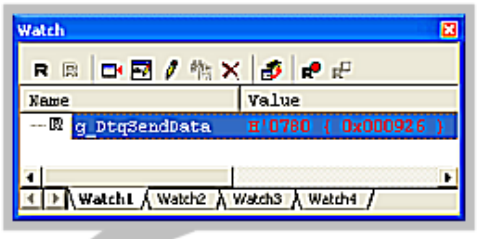
1) The message *"g_DtqSendData"* carrying the actual data value of (H'1234) was sent to the Data Queue *"ID_Dtq1"* by Task1.
2) Task2 receive message data (H'1234).

3.2 Method 2: Data Queue Module Implementation with Share Memory

This method illustrates the attempt of using Data Queue to emulate the functional operation of Mailbox. In this example, share memory is created to store the data. Data Queue module is being used to send the starting address of the data location in the share memory. Using this method, limitation on capacity and data size can be overcome.

```
#include <itron.h>
#include <kernel.h>
#include "kernel_id.h"
#include "sfr_r825.h"
#include "typedefine.h"


typedef struct user_data{
    unsigned short  data;
}USER_DATA;

USER_DATA g_Data[10];
ER ercd;

void Task1(VP_INT stacd)
{
    VP_INT g_DtqSendData;

    g_Data[0].data = 0x1234;
    g_DtqSendData = (VP_INT)&g_Data[0];
    ercd = snd_dtq(ID_Dtq1,g_DtqSendData);
    if (ercd == E_OK)
    {
        sta_tsk(ID_Task2);
    }
}

void Task2(VP_INT stacd)
{
    VP_INT g_DtqRecData;
    VP_INT *g_Task2Data;

    ercd = rcv_dtq(ID_Dtq1,&g_DtqRecData);
    g_Task2Data = (VP_INT*) g_DtqRecData;
    asm("NOP");
}
```

(1)



(2)

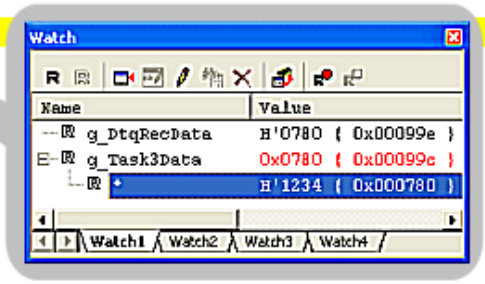


Figure 6 Data Queue Module Implementation with Share Memory in MR8C/4

As shown in Figure 6 above, operations can be described as below:

1) The message "*g_DtqSendData*" carrying the starting address of the data structure "g_Data[0]" was sent to the Data Queue "*ID_Dtq1*" by Task1.
2) Task2 receive message data (H'0780) and retrieve the data (H'1234) be referencing to the starting address of (H'0780).

4. Reference Documents

User's Manual

- MR8C/4 V1.00 User's Manual

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