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April 1st, 2010
Renesas Electronics Corporation

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M16C/28, 29 Group

Time Measurement Function of Timer S with Prescaler Function

1. Abstract

This application note describes the time measurement function of Timer S with the prescaler function, which measures a period from the beginning of the program to input of any edge.

2. Introduction

This application note is applied to the following microcomputers.

- MCU: M16C/28 Group
- M16C/29 Group

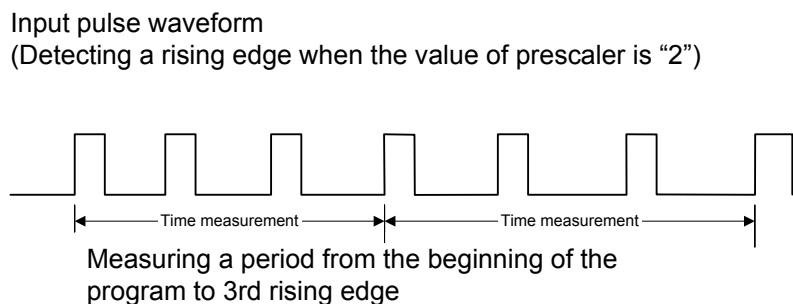
This program can also be used when operating other microcomputers within the M16C family, provided they have the same SFR (Special Function Registers) as the M16C/28, M16C/29 microcomputers. However, some functions may have been modified.

Refer to the Hardware Manual for details. Use functions covered in this Application Note only after careful evaluation.

3. Detailed Description

Timer S has one 16-bit base timer for free-run operation and eight 16-bit registers (channel 0 to 7) for the time measurement function and waveform generation function. Two channels (channel 6 and 7) out of eight have the prescaler function for the time measurement.

This example shows the process of the time measurement from the beginning of the program to input of any rising edge in the INPC1₆ with the prescaler function of the channel 6.



When using the prescaler function, the trigger input is counted, and the time measurement is executed every trigger input of the setting value in the G1TPR6 + 1.

(1) Time Measurement Function Setting

The channel 6 is used. In this example, the rising edge of the time measurement trigger is selected.

(2) Measurement Time Calculation

The time measurement interrupt of the channel 6 is used, and the value of the channel 6 in the time measurement register (G1TM6 register) is read during the interrupt routine.

The measurement time is the difference between the value that is measured last time and that of the channel 6.

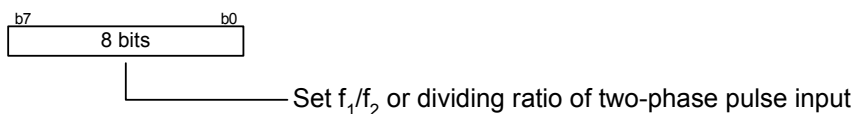
3.1 How to Set Up

This section shows the setting procedure and setting values to execute “3. Detailed Description”. Refer to the hardware manuals (M16C/28 Group or M16C/29 Group) for the details of each register.

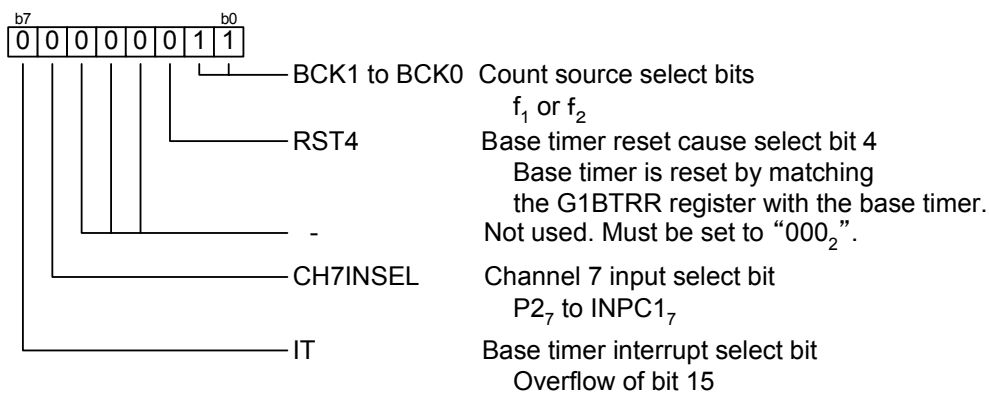
(1) Inhibiting an interrupt

Set I flag = “0”. Or set interrupt priority level = “000₂” in the interrupt control register that accepted interrupt requests issued by the timer S.

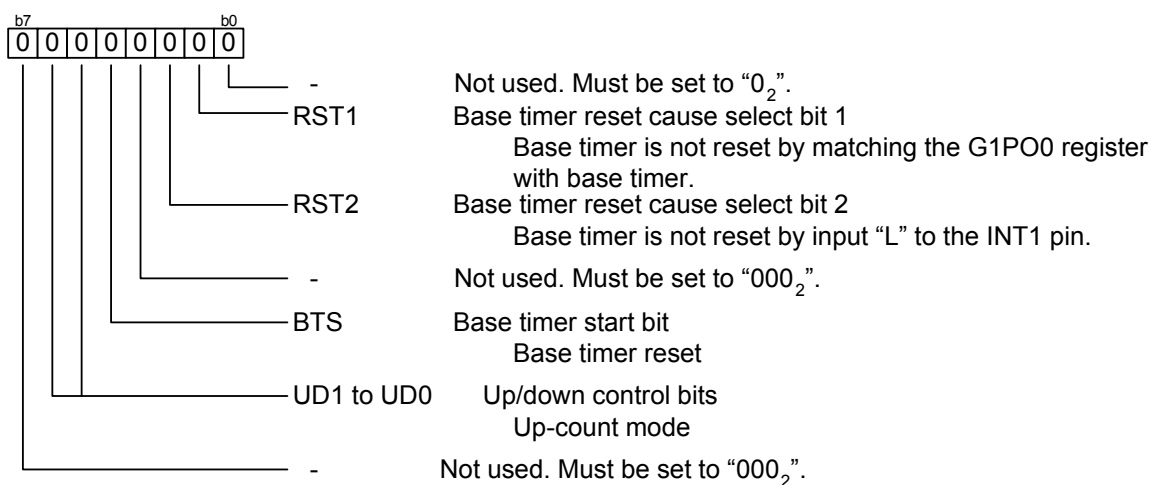
(2) G1DV register



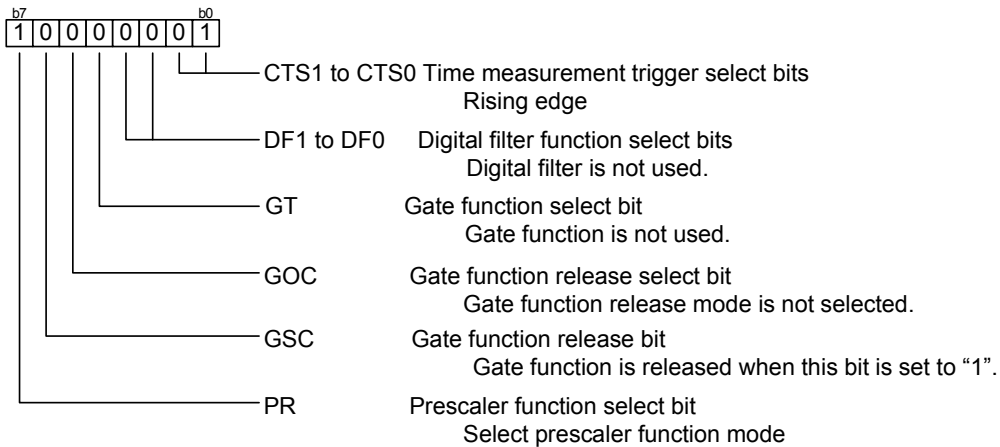
(3) G1BCR0 register



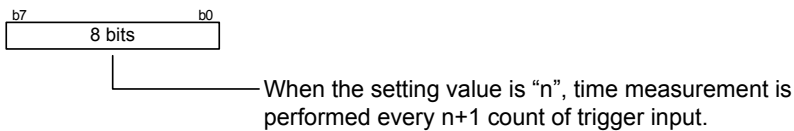
(4) G1BCR1 register



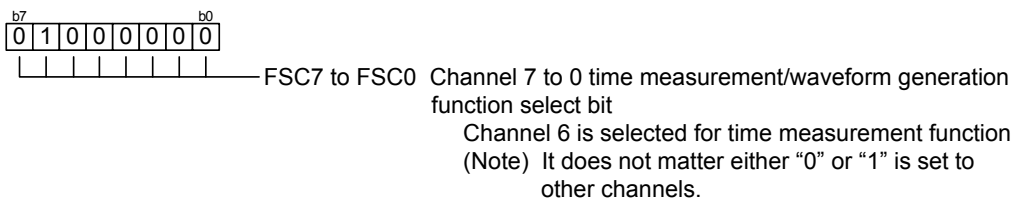
(5) G1TMCR6 register



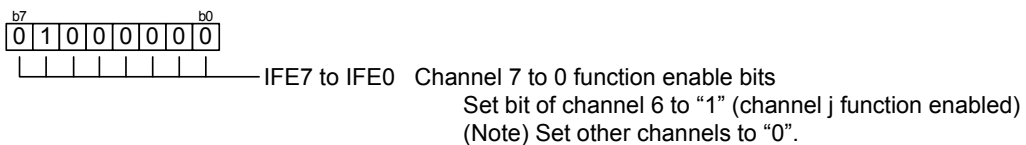
(6) G1TPR6 register



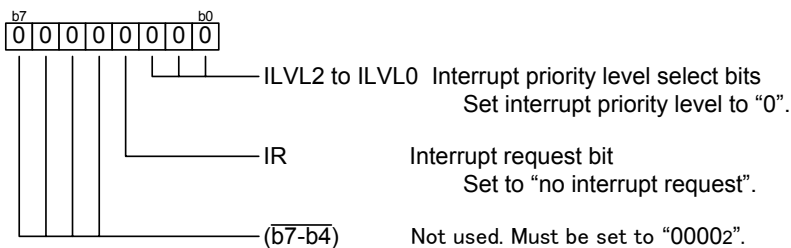
(7) G1FS register



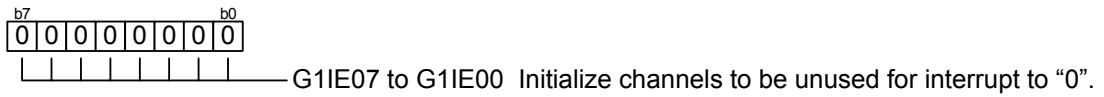
(8) G1FE register



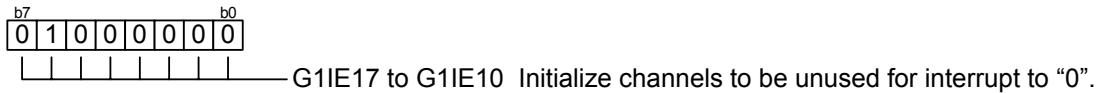
(9) ICOC0IC register (interrupt disabled setting /interrupt request bit clear)



(10) G1IE0 register (interrupt enabled register reset)



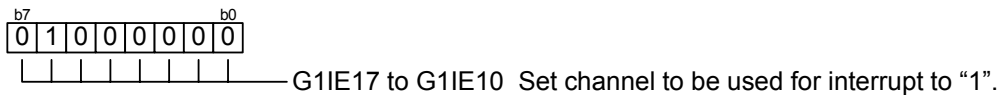
(11) G1IE1 register



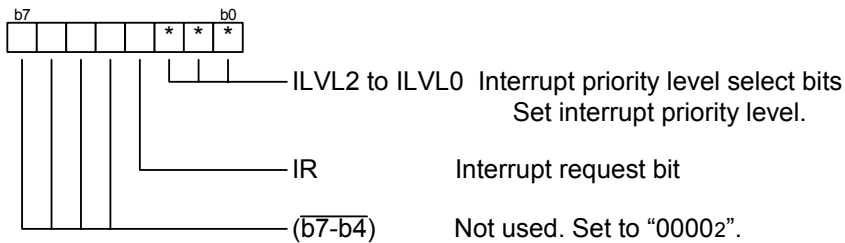
(12) G1IR register



(13) G1IE1 register

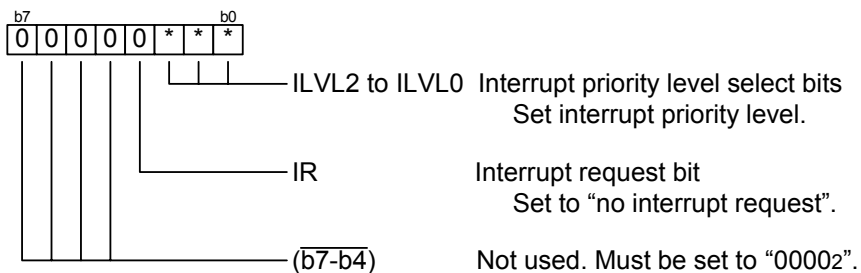


(14) ICOC1IC register (interrupt priority level setting^(*))



(*) Use "OR" instruction so that interrupt request bit is not changed when setting the interrupt priority level.

(15) BTIC register



3.2 Precaution on Interrupt

In the process of Timer S interrupt, the description varies depending on the interrupt routine by the base timer or by each channel.

In the case of the base timer interrupt, interrupt request bit is “0” when the request is accepted. (It is not necessary to set to “0” by the program.)

In the case of interrupt by each channel, interrupt requests for each channel are set in the interrupt request register (G1IR Register). When an interrupt request in the channel *i* occurs, the bit *i* in the G1IR Register is set to “1”.

If the bit *i* in the interrupt enable register 0 (G1IE0 Register) is “1”, the interrupt request bit in the IC/OC0 interrupt control register (ICOC0IC Register) is set to “1”.

If the bit *i* in the G1IE1 register is “1”, the interrupt request bit in the IC/OC1 interrupt control register (ICOC1IC Register) is set to “1”.

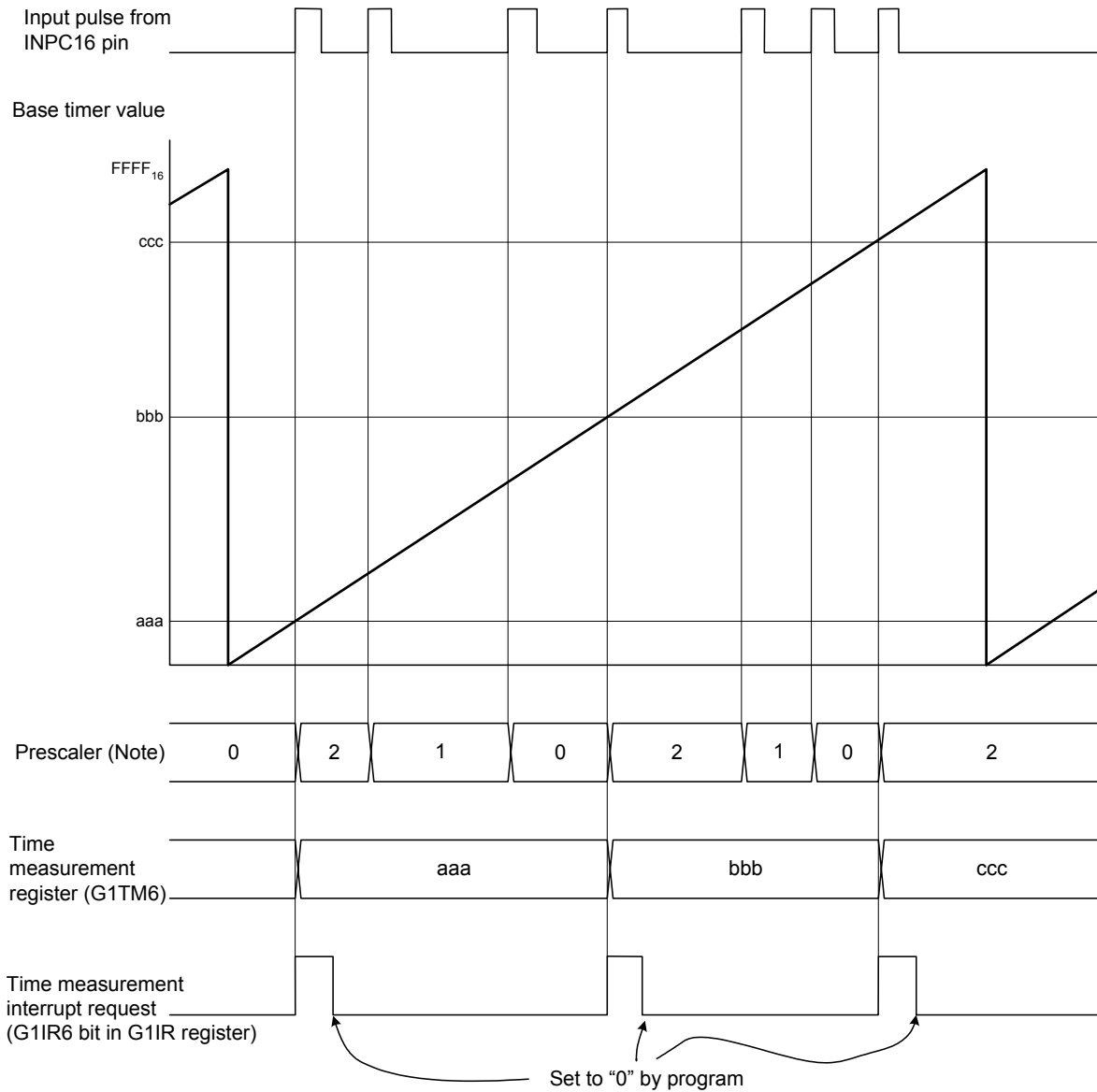
Interrupt request bits in the IC/OC0 and IC/OC1 interrupt control register are set to “0” automatically when they receive the interrupt request. However the interrupt request bits of each channel in the G1IR register are not set to “0” automatically, so set to “0” (no interrupt request) by the program.

Use the following instructions when writing “0” to each bit in the G1IR register.

AND, BCLR

3.3 Timing Diagram

The following shows a timing diagram according to the section “3.1” and “3.2”.



Note: This applies to the second period that the G1TPR6 register decrements after setting the PR bit in the G1TMCR6 register to “1” (prescaler used).

4. Sample Program

```

/*****
*
* FILE NAME :
* Version : 1.10
* Function : 16-bit Time measurement mode with prescaler
*
* Copyright (C)2004, Renesas Technology Corp.
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*
*****/
/*****
* include file
*****/
#include "sfr28.h"

/*****
* Function Definition
*****/
void bt_int(void);
#pragma INTERRUPT bt_int

void icoc1_int(void);
#pragma INTERRUPT icoc1_int

void port_init(void);
void icoc_init(void);
/*****
* Global variable
*****/

static unsigned short pluse;
static unsigned short new_tr;
static unsigned short old_tr;

/*****
* main
*****/
void main(void) {

    port_init();
    icoc_init();

    pluse = 0;
    new_tr = 0;
    old_tr = 0;

    bts_glbcr1 = 1; /* Base Timer Start */
    asm (" fset I");
    while (1) {
    }
}

void port_init() {
    p0 = 0;
    p1 = 0;
    p2 = 0;
    p3 = 0;

    p7 = 0;
    p8 = 0;
    p9 = 0;
    p10 = 0;

    pd0 = 0xff;
    pd1 = 0xff;
    pd2 = 0x00;

```

```

pd3 = 0xff;

pd7 = 0xff;
pd8 = 0xff;
prcr = 4;
pd9 = 0xff;
pd10 = 0xff;
}

void icoc_init() {

    gldv = 2-1;           /* fBT is 10MHz */
    glbcr0 = 0x03;
    glbcr1 = 0x00;       /* The base timer is reset by matching the G1P00 register */

    gltmcr6 = 0x81;     /* ch-6 Time Measurement set */

    gltpr6 = 2;

    glfs = 0x40;        /* ch-0 to ch-5, ch-7 Waveform generation function select */
                        /* ch-6 Time Measurement function select */

    glfe = 0x40;        /* ch-6 function enable */

    ifsr2a = 0;

    icoclic = 0x00;     /* IC/OC 1 Interrupt control register set to 0 */

    glie0 = 0x00;       /* Interrupt enable register 0 set to 0 */
    glie1 = 0x00;       /* Interrupt enable register 1 set to 0 */

    glir = 0;           /* Interrupt request register initialize */

    glie1 = 0x40;       /* Interrupt enable register 1 set */

    icoclic |= 0x04;    /* IC/OC 1 Interrupt control register set */

    btic = 0x04;        /* Base timer Interrupt control register set */
}

void bt_int() {

    p10_7 = 1;         /* for Base timer over flow detection */
}

void icoc1_int() {

    p10_4 = 1;
    glir6 = 0;
    old_tr = new_tr;
    new_tr = (unsigned short)gltm6;
    if ( p10_7 == 1) {
        pluse = 0xFFFF -old_tr;
        pluse = pluse + new_tr;
        p10_7 = 0;
    } else {
        pluse = new_tr - old_tr;
    }
    p10_4 = 0;
}

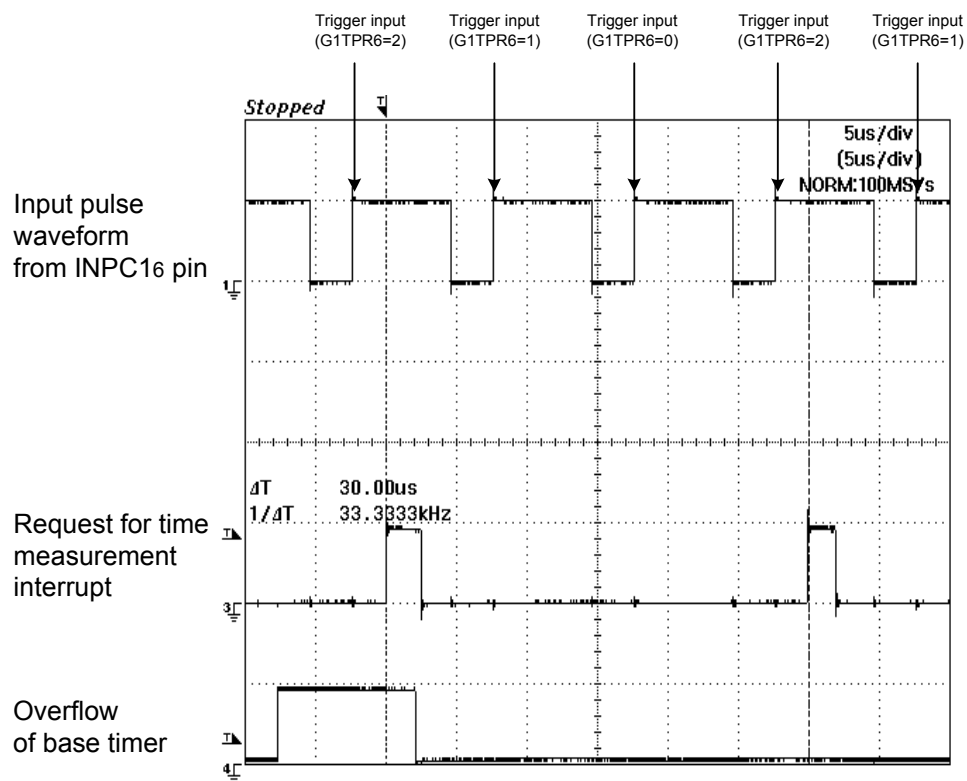
```

5. Example

The following shows an example of the input signal pulse width from INPC1₆ pin of Timer S.

Conditions: Supply voltage = 5V
 Main clock (X_{IN}) = 20MHz
 Base timer operation clock (f_{BT1}) = 10MHz
 Input pulse = 100kHz
 Prescaler value = 2

Result: 300
 ($300 / 10\text{MHz} = 30.00\mu\text{s}$)



6. Reference

Hardware Manual

M16C/28 Group Hardware Manual

M16C/29 Group Hardware Manual

(The latest version is available on the website: <http://www.renesas.com>)

7. Website and Contact for Support

Renesas Website

<http://www.renesas.com/>

For technical information related to M16C family

E-mail: support_apl@renesas.com

REVISION HISTORY

Rev.	Date	Description	
		Page	Summary
1.10	2004.10.15	-	First edition issued

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