APPLICATION NOTE

M16C/5M Group
D/A Converter
Using the D/A Converter

R01AN0153EJ0100
Rev.1.00
Mar 15, 2011

1. Abstract

This document describes the setting procedure to use the D/A converter in the M16C/5M Group.

2. Introduction

The application example described in this document applies to the following microcomputer (MCU):

- MCU: M16C/5M Group

This application note can be used with other M16C Family MCUs which have the same special function registers (SFRs) as the above group. Check the manual for any modifications to functions. Careful evaluation is recommended before using the program described in this application note.

3.   D/A Converter Operation

The D/A converter outputs analog voltage which is D/A converted from an analog output pin.

Output analog voltage (V) is determined by a value set in the DA0 register (n) (n is decimal number).

$$V = \frac{VREF \times n}{256}$$ n = 0 to 255; VREF: Reference voltage

The following describes the setting procedure to use the D/A converter.

  (1) D/A conversion starts by writing a value to the DA0 register.

  (2) When setting the DA0E bit in the DACON register to 1, an analog value is output from the DA0 pin.

  (3) When setting the DA0E bit in the DACON register to 0, the state of the DA0 pin becomes high impedance, and an analog value is not output.

  • When using the DA0 pin, set the PD9_3 bit in the PD9 register to 0 (input mode).

3.1   Calculating the Setting Value in the DA0 Register

The following formula is used to calculate a setting value in the DA0 register:

$$n = \frac{V \times 256}{VREF}$$ n: Setting value in the DA0 register
V: D/A output voltage (V)
VREF: Reference voltage (V)

Example 1. To get D/A output voltage of 2.5 V when VREF is 5.0 V.

$$n = \frac{2.5 \times 256}{5.0}$$

n = 128 (setting value in the DA0 register)

Example 2. To get D/A output voltage of 2.5 V when VREF is 3.0 V.

$$n = \frac{2.5 \times 256}{3.0}$$

n = 213.33... ≈ 213 (setting value in the DA0 register)

4. Settings

Figure 4.1 shows the D/A Output Operation Procedure.
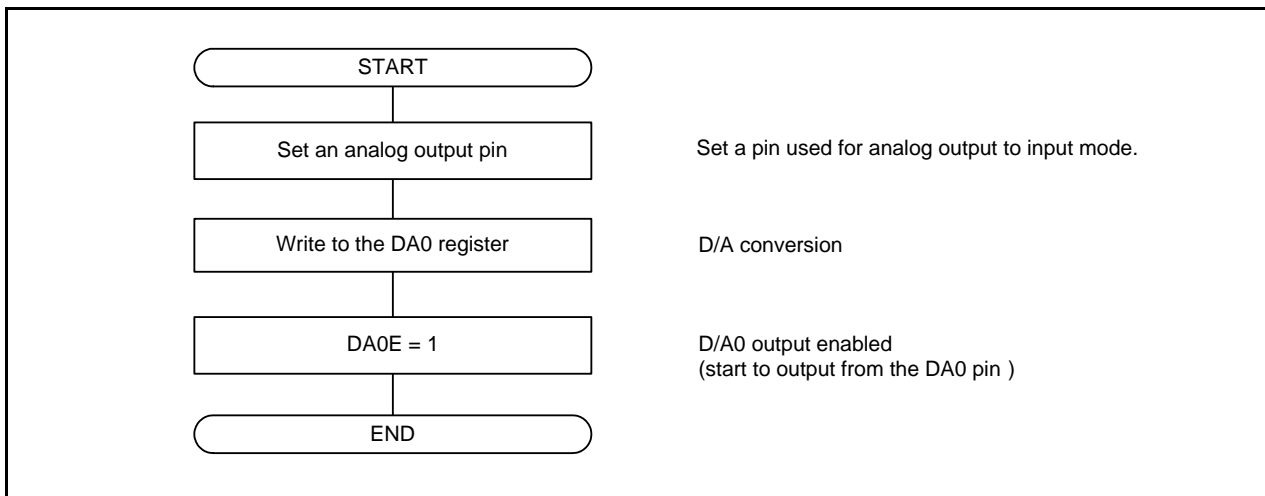Refer to the User's Manual: Hardware for details on registers.

```
                    ┌─────────────────────┐
                    │        START        │
                    └─────────────────────┘

              ┌─────────────────────────────┐
              │   Set an analog output pin   │      Set a pin used for analog output to input mode.
              └─────────────────────────────┘

              ┌─────────────────────────────┐
              │   Write to the DA0 register  │      D/A conversion
              └─────────────────────────────┘

              ┌─────────────────────────────┐
              │          DA0E = 1            │      D/A0 output enabled
              └─────────────────────────────┘      (start to output from the DA0 pin )

                    ┌─────────────────────┐
                    │         END         │
                    └─────────────────────┘
```

Figure 4.1   D/A Output Operation Procedure

5. Sample Code

A sample code can be downloaded from the Renesas Electronics website.
To download, click "Application Notes" in the left-hand side menu of the M16C Family page.

5.1 Sample Code Operation

The sample code operation is as follows; set the CPU clock as the main clock with no division by executing functions for CPU initialization, and transition from 125 kHz on-chip oscillator mode to high-speed mode, then execute the D/A output setting function. The D/A output setting function sets the output voltage from the DA0 pin to 1/2VREF(V). Refer to 5.2 Function Tables for details on functions.

5.2 Function Tables

Function Tables for This Document

Declaration	void da0_output(void)
Outline	D/A output setting
Argument	None
Variable	None
Returned value	None
Function	Set a value to output 1/2VREF(V) from the DA0 pin to the DA0 register. Set the DA0E bit to output enabled, and start D/A output from the DA0 pin.

Function Tables for the Sample Code

Declaration	void mcu_init(void)
Outline	CPU initialization
Argument	None
Variable	None
Returned value	None
Function	Set to single-chip mode. Switch the CPU clock from 125 kHz on-chip oscillator mode divided-by-8 to 125 kHz on-chip oscillator mode divided-by-1.

Declaration	void highspeed_from_foco125k(void)
Outline	Transition from 125 kHz on-chip oscillator mode to high-speed mode
Argument	None
Variable	None
Returned value	None
Function	Switch the CPU clock from 125 kHz on-chip oscillator mode (fOCO-S divided by 1) to high-speed mode.

6.   Reference Documents

M16C/5M Group User's Manual: Hardware Rev.1.01
The latest version can be downloaded from the Renesas Electronics website.

Technical Update/Technical News
The latest information can be downloaded from the Renesas Electronics website.

M16C Series/R8C Family C Compiler Package V.5.45 C Compiler User's Manual Rev.3.00
The latest version can be downloaded from the Renesas Electronics website.

Website and Support

Renesas Electronics website
http://www.renesas.com/

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http://www.renesas.com/inquiry

Revision History	M16C/5M Group Using the D/A Converter		

Rev.	Date	Description	
		Page	Summary
1.00	2011.03.15	—	First edition issued

General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this manual, refer to the relevant sections of the manual. If the descriptions under General Precautions in the Handling of MPU/MCU Products and in the body of the manual differ from each other, the description in the body of the manual takes precedence.

1. Handling of Unused Pins

   Handle unused pins in accord with the directions given under Handling of Unused Pins in the manual.

   — The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

   The state of the product is undefined at the moment when power is supplied.

   — The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.

   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.

   In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

   Access to reserved addresses is prohibited.

   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals

   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.

   — When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.

5. Differences between Products

   Before changing from one product to another, i.e. to one with a different part number, confirm that the change will not lead to problems.

   — The characteristics of MPU/MCU in the same group but having different part numbers may differ because of the differences in internal memory capacity and layout pattern. When changing to products of different part numbers, implement a system-evaluation test for each of the products.

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