Application Report
SLAA120 – December 2000

PWM DC Motor Control Using Timer_A of the MSP430

Brian Merritt and Murugavel Raju *Mixed Signal Products*

ABSTRACT

This application report and its associated software demonstrate the control of a DC motor using pulse width modulation (PWM). The Timer_A module, which independently generates a PWM output, is used to produce the control signal.

Introduction

Many of the MSP430 microcontrollers have either the Timer_A module or the Timer_A and Timer_B modules included in them. These modules contain a 16-bit counter that can be incremented from a number of clock sources. They can even count in low power modes. These timers also have a number of capture/compare registers that lend themselves to a variety of applications. One of these applications is the automatic generation of a PWM output to control a DC motor. This application note demonstrates one of the many potential motor control schemes that are possible using the Timer_A and/or Timer_B modules.

Theory of Operation

The example circuit (see Figure 1) operates by polling the two push button input pins and either incrementing or decrementing the Timer_A capture/compare register CCR1, when either of the inputs is at a logic low state. The software checks the value of the register to ensure that it does not exceed the minimum or maximum values the register will hold, and thereby prevents it from rolling over. Timer_A is configured in UP-mode with MCLK as timer clock source and output unit Out1 in output mode 7 to produce a PWM square wave output on P1.2/TA1. The CCR0 value is set to 255 to define Timer_A to count up to 256 counts (8 bits). Changing the value in CCR1 varies the duty cycle of the PWM signal produced by Timer_A. The PWM signal is used to switch a Darlington transistor. The transistor in turn powers the DC motor. As the PWM duty cycle varies, the average power to the motor also changes. This change in average power is what controls the speed of the motor. The motor speed is variable in 256 steps from 0 to maximum. The DCO is set to approximately 5MHz to achieve a PWM frequency around 20KHz thereby allowing the motor to run without producing any audible PWM noise.

Notice that there is no crystal connected to the MSP430 in the example circuit. The frequency of the digitally controlled oscillator (DCO) in the MSP430x11x(1) used here varies with temperature and voltage. As the PWM signal frequency is based on the DCO frequency, it also varies. Since the duty cycle of the PWM signal is a set ratio that is independent of whatever the frequency happens to be, the on and off times of the PWM signal varies proportionately. As a result the average power to the motor does not change even as the DCO frequency varies. If a constant PWM frequency is required, a crystal can be added to the circuit.

The TI TPS77133 shown in the example circuit provides both the regulated V_{CC} to the MSP430 and a power on reset signal to control the reset input of the MSP430. The TPS77233 can be used if the supply voltage supervisor (power good) function is required. Reference [3] is the datasheet for this device family.

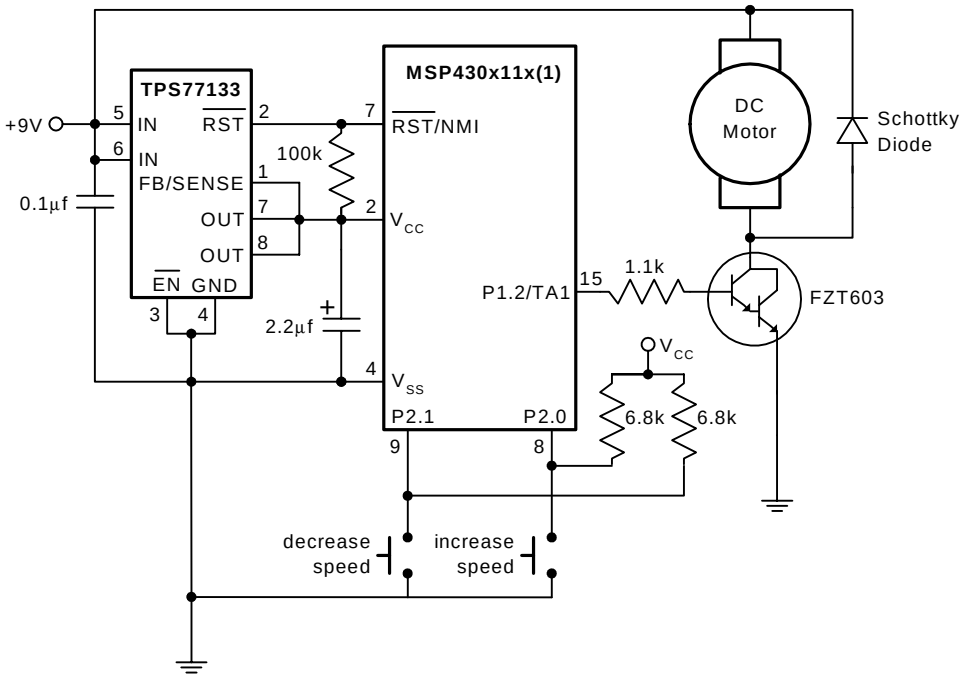

Figure 1. Schematic of PWM DC Motor Control Example Circuit

Example Code

The example code for this application is available from the MSP430 web site, http://www.ti.com/sc/msp430, as a zip file under this application note listing. The title of the program is dcmotor.*s43.* The code is written in assembly language using the IAR Kickstart integrated development environment.

References

1. MSP430x11x1 Datasheet (SLAS241)
2. MSP430x1xx User's Guide (SLAU049)
3. TPS77xxx Datasheet (SLVS225)

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third–party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265