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M16C/60, M16C/Tiny, M32C/80

Frequency Modulated Waveform Generation Using DMA Using IAR C-Compiler

Introduction

This application note explains how to create a periodical waveform using M32C or M16C family DMA channels (Direct Memory Access). Typical applications could be sound generation or carrier signal generation (for modems as example).

The application generates a frequency modulation of a sinus periodic curve. The periodic curve is 8bit resolution and 64 samples per period. The sinus is modulated with 3 frequency steps which are 10KHZ, 20KHZ and 30KHZ.

The M16C62P and M32C devices have 2 digital to analog converters (DA0 and DA1) that can directly output analog signals. DA0 is selected to output the sinus wave. On devices not having a digital to analog peripheral, one timer in PWM mode can realize similar features but requires additional external filtering.

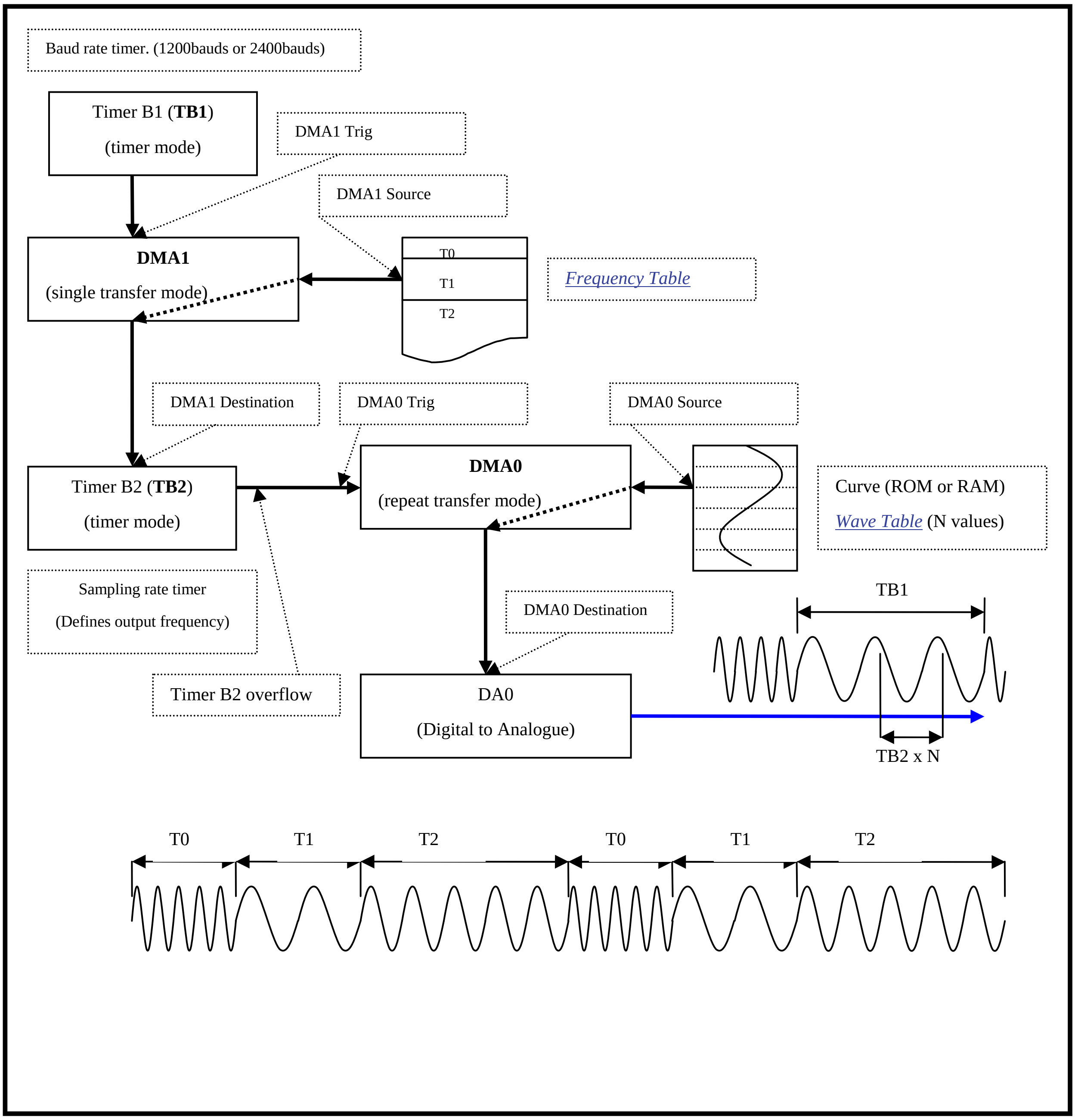
Contents

Peripheral usage and settings.

The block diagram below shows the different peripherals in use and their settings.

The DA0 (Digital to Analog output 0) contents are loaded by DMA0 (Direct Memory Access channel 0) transferred from a memory table containing the sinus 64 values. Timer B2 (TB2) defines the curve sampling period. The output signal period is the product of TB2 period by the number of samples (ie TB2 runs 64 times faster than sinus curve period).

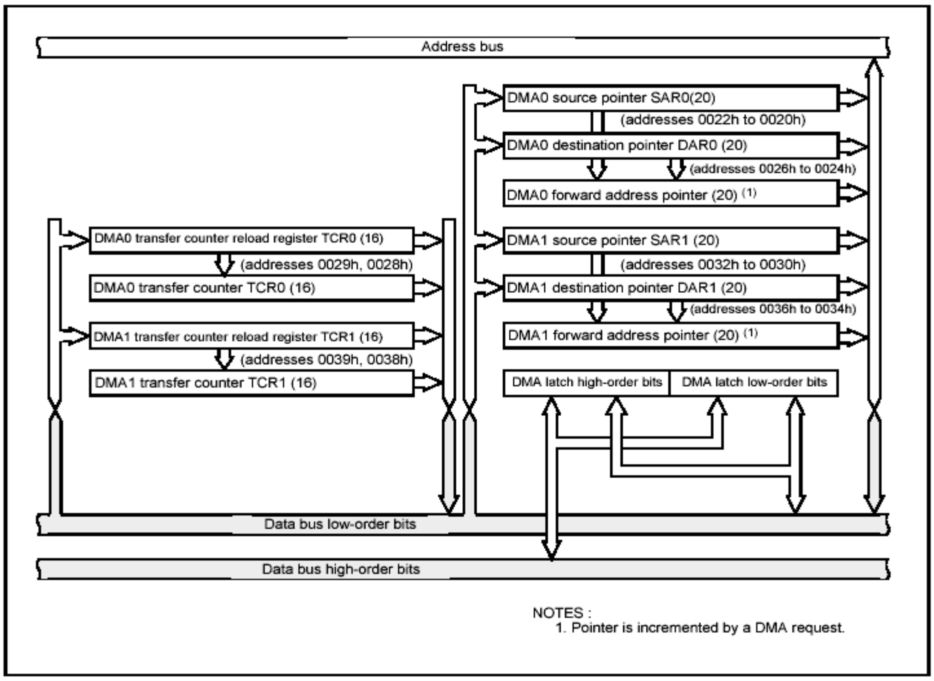
Timer B2 (TB2) value is set by DMA transfer from the Frequency Table each time Timer B1 (TB1) overflows. This means the duration at a defined frequency is defined by TB1 re-load value.



M16C DMA operation.

All M16C devices have at least two DMA channels (DMA0 and DMA1). DMA's role is to transfer a certain amount of data (defined by software) from a source to a destination trigged by some event. To achieve this each DMA channel has its own source register (20bit address), destination register (also 20bits) and count register (16bits) along with configuration registers.

The DMA source and/or destination can be any location inside the M16C, it could be either RAM or Flash or SFR register. DMA block diagram is bellow.



The DMA channel only accepts source <u>or</u> destination increment (not both at same time).

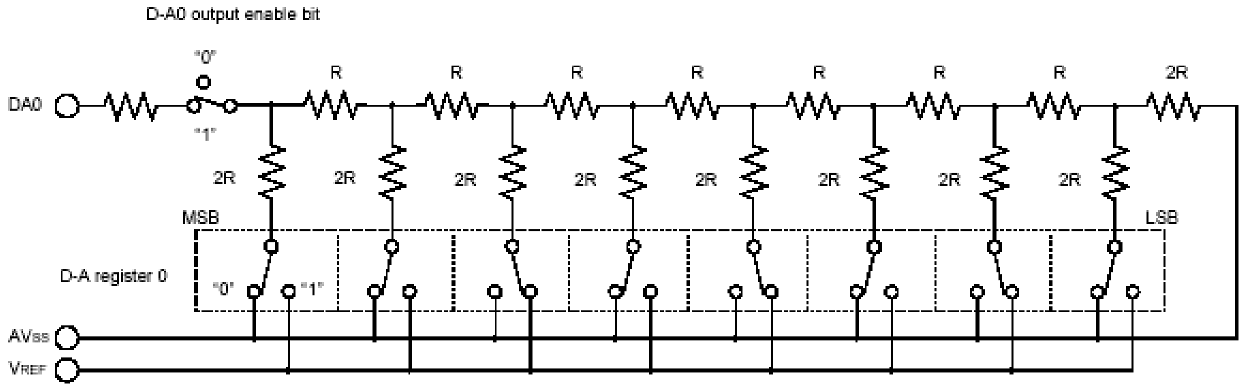
DMA's are used in repeat mode with fixed destination and forward source which means that the source pointer is incremented after each DMA transfer. When the transfer counter (TCRi) reaches zero the source pointer and the transfer counter are automatically reloaded with their SFR reload register values and process continues.

The DMA0 channel source points to the Wave Table that contains the data to be set for each curve sampling cycle, the destination is the DA0 register and the number of transfers is defined by the curve number of samples (64 in this example).

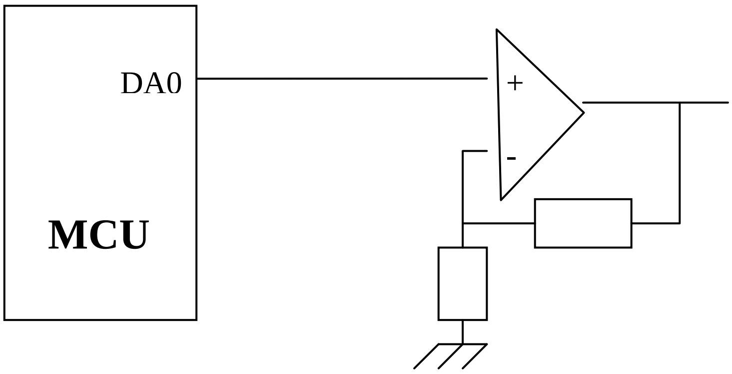
DMA1 source points to the Frequency table that contains the duration at each frequency step; the destination is the Timer B2 reload register.

Digital to Analog operation.

The DA converter is made of R/2R resistor network with 8bit resolution. As the DA output is not bufferised it is mandatory to check external impedance in order to get a correct signal levels.



External operational amplifier should be added external before sending the signal to low impedance devices as shown below.



Conclusion.

This software allows generating frequency modulated analog signals.

The CPU usage is limited to peripheral initialisation, the CPU is left free for customer application.

Appendix

Code listing

```
// ---------------------------------------------------------------------------
// Calculates the sinus curve and sets the frequency table
// ---------------------------------------------------------------------------
// Input Parameters :     None
// ---------------------------------------------------------------------------
// Returned Parameters :  None
// ---------------------------------------------------------------------------
// Modified globales:     Wave_Table and Frequencies_Table contents
// ---------------------------------------------------------------------------
void Calculate_Tables(void)
{
char i;
for(i=0;i!= NB_STEPS_MAIN;i++)
  Wave[i] = 128.0 + 127.0*sin((2.0*__PI*i)/NB_STEPS_MAIN);
  Frequency[0] = T0;
  Frequency[1] = T1;
  Frequency[2] = T2;}
// ---------------------------------------------------------------------------
// Initialises M16C62P peripherals and loops in a dummy loop.
// ---------------------------------------------------------------------------
// Input Parameters :     None
// ---------------------------------------------------------------------------
// Returned Parameters :  None
// ---------------------------------------------------------------------------
// Modified globales:     None
// ---------------------------------------------------------------------------
void main (void)
{

  init();
  Calculate_Tables();// Just an example how to create a sinus table (if re-calculation)
  timer_b1_init_timer_mode();  // Timer used for Baud rate setting
  timer_b1_set(30);            // Define speed for Frequency scan
  dma1_repeat_mode((char __far*)Frequency,(char __far*)&TB2,sizeof(Frequency)/2);
  dma0_repeat_mode((char __far*)Wave,(char __far*)&DA0,sizeof(Wave));
  timer_b2_init_timer_mode();   // Wave table sampling timer
  timer_b2_set(Frequency[0]);
  timer_b2_start();          // Start Timer B2 (trig source for Timer A3)
  timer_b1_start();          // Start Timer A3 (One shot timer)
  dma0_start();              // Allow DMA
  dma1_start();
  dac_0_start();
  for(;;) ;        // Never ending loop
}
```

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