How to swap a microcontroller on a PCB
Specifically: C2000 to MSP430 on a control card

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Abstract:

Swapping out a microcontroller can be tedious and long process, but there are several things that are common of most microcontrollers. If this is realized between the micro on the board and the micro its being swapped with it can be much easier. In the case of swapping out a C2000 micro with a MSP430 micro this is an important step.

Key Words:

C2000, MSP430, Microcontroller(micro), PWM, ADC, DIMM, IC, UART

Overview:

There are several steps to follow when swapping the C2000 for a MSP430. If followed, it allows an easier design method for the board.

Steps

1. Break down the essential functions of the IC's on the PCB
2. Understand why the functions are wanted/needed on the board e.g. power, communication
3. Convert the circuitry to provide the same functions with the new micro
4. Make sure any essential pins on the new micro are handled e.g. set/reset, Vcore, proper filtering

Breaking down the essential functions of the C2000 control card:

The control card on a basic level has several functions that it must provide. First, it must power on and execute code stored on the flash memory on the C2000. Second, it must be able to be programmed through USB with code defined by the user. Lastly, it must interface with a DRV8412 motor driver board to control a motor.

Understanding the need/want for the essential functions of the C2000 control card:

How the control card interfaces with DRV8412:

This card is designed to interface with Texas Instruments DRV8412 motor driver board through a 100 pin DIMM card slot. This means that there must be a way to communicate PWM signals and sense current from the DRV8412 with the MSP430. This can only be done with specific pins of the MSP430. These connections are also filtered to protect the chip.

How the control card is powered:

The control card and most of the ICs are powered by 3.3V regulated, except for the regulator itself, and the USB connector which is powered by 5 V that is coming into the card.

How the control card is programed:

The control card is programmed through USB through a FT2232D IC. This IC converts USB to UART. This UART signal is then passed through digital isolators and fed into the C2000.

Converting circuitry for the MSP430:

There are several main similarities and differences that need to be accounted for between the C2000 and MSP430. On the control card, the specific C2000 micro used is tms320f28035. The MSP430 chosen to replace it is a MSP430f5435. This was for several reasons. First, this MSP430 has 80 pins which is the same as the C2000 used and it is the same physical size. Second, it has an adequate amount of ADC, flash memory and PWM capable pins.

Similarities between tms320f28035 and MSP430f5435:

- 80 pins
- Programmed through the same protocol (UART)
- Powered by the same voltage
- Both have software programmable output on all pins
- Same physical size

Differences between C2000F28035 and MSP430f5435:

- Different number of ADC
- Different powering scheme
- MSP430f5435 has a Vcore pin that is used to control power consumption

Solution to the conversion:

Due to both micros having the same number of pins and the same size, it was easy to place the MSP430 into the PCB redesign. Both chips having the same power requirements and programming protocol allows the circuitry for these functions to be left untouched. By having software programmable output on all pins deciding were the pins are routed to, is relatively easy. The only design constraints are the way power is connected and number of ADC pins.

The C2000 has six power in pins: one ADC power, two digital I/O, and three power pins. The ADC power and digital I/O power are wired through filters for cleaner power. Where as the generic power pins are wired to ground. The MSP430 has only four power pins that all need to be wired to 3.3V. One of these power pins, the ADC power this is wired the same way as the C2000 ADC power. The other pins are then wired directly to 3.3V. This will allow full functionality of the microcontroller.

The number of ADC pins on the MSP430 is 12 where as the C2000 has 16. These ADC pins are wired directly to the DIMM slot for interfacing with the DRV8412. Map the MSP430 pins in the same pattern as the C2000 to provide the same functionality with the driver board.

This will cover the functionality of the driver board, but if the control card is used for other applications it might not suffice to use the MSP430 version.

Making sure the essential pins on MSP430 are handled:

Vcore

Vcore is how the MSP430 controls it's power consumption. It must be tied to ground through a 470nF capacitor. This can be found in the MSP430 datasheet. This is an essential pin that does not have an equivalent on the C2000 and can be easily missed in redesigning the control card.

Conclusion:

If done correctly, this should provide a working control card with the same functionality of the C2000 control card with the MSP430 as the microcontroller.

Figures:

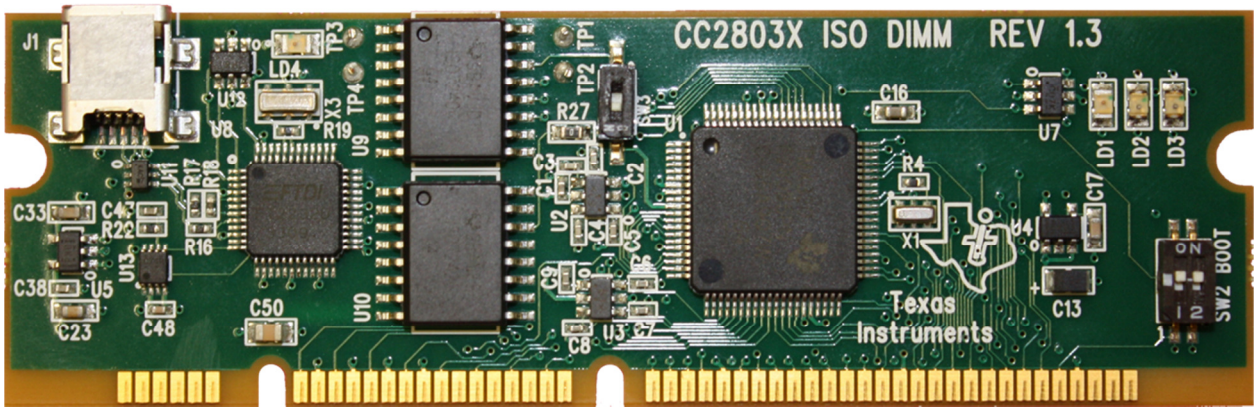

Figure 1: C2000 Control Card

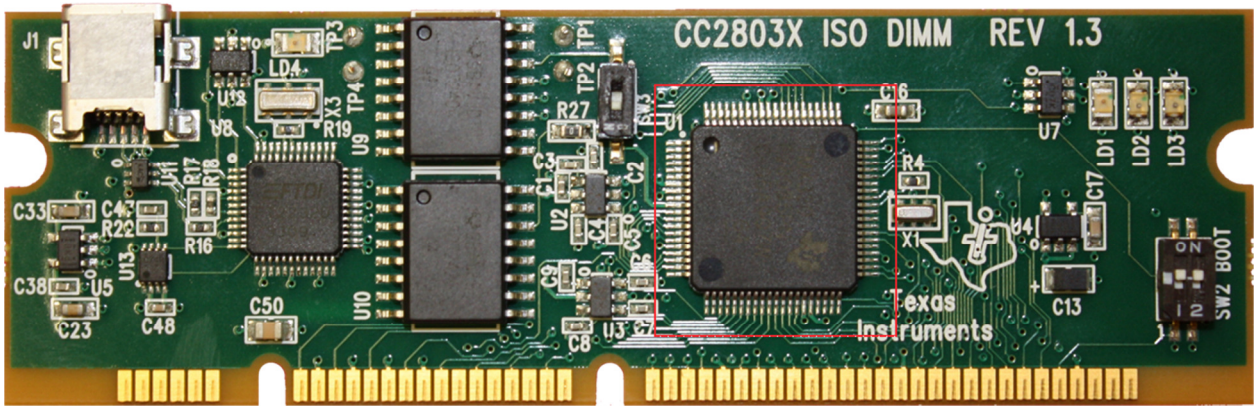

Figure 2: Control Card with tms320f28035 outlined

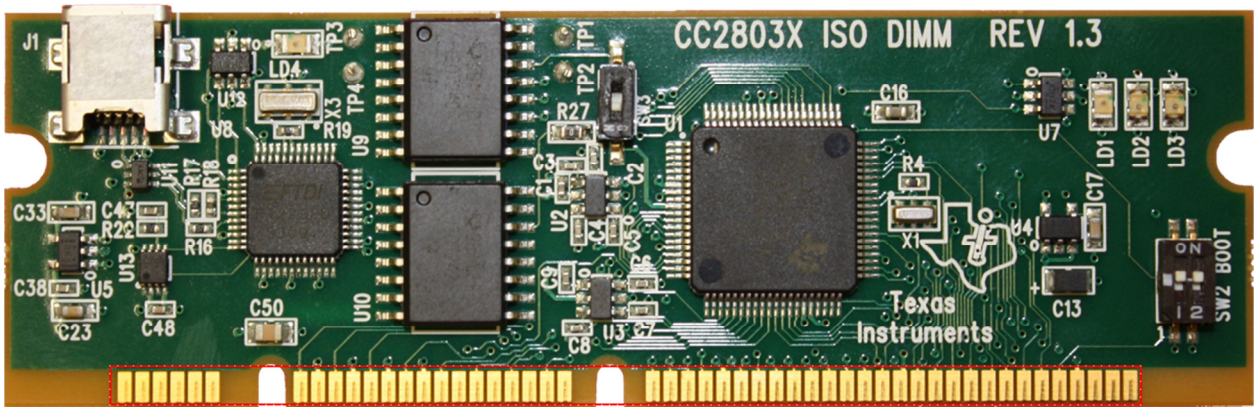

Figure 3: Control Card with DIMM pins outlined

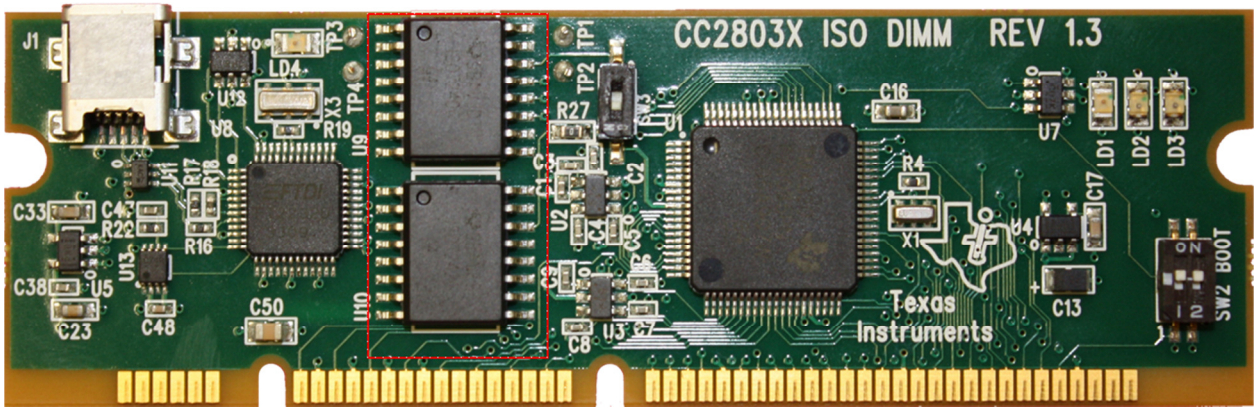

Figure 4**:** Control Card with Isolator IC outlined

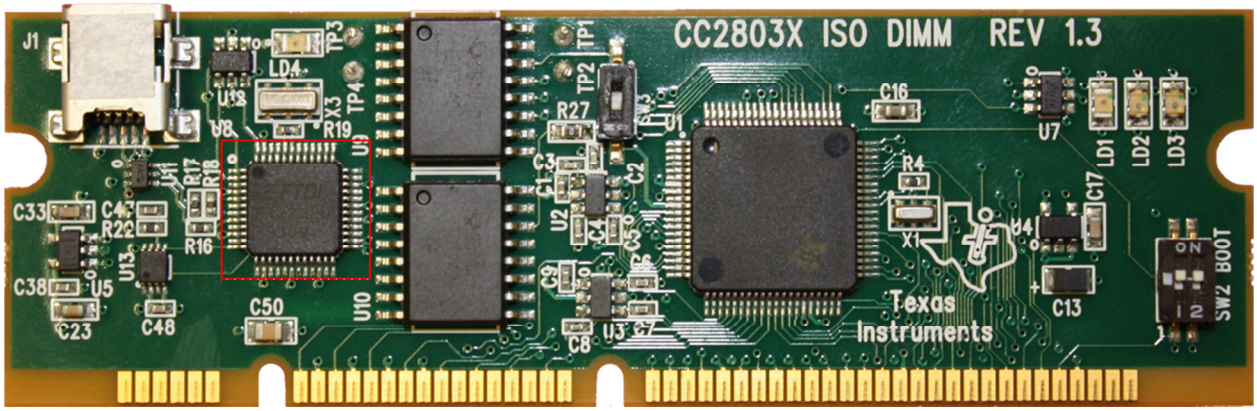

Figure 5: Control Card with FT2232D outlined

References

- C2000 tms320f28035 Data sheet - http://focus.ti.com/docs/prod/folders/print/tms320f28035.html
- MSP430f5435 Datasheet - http://focus.ti.com/docs/prod/folders/print/msp430f5435.html
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- F28035 Piccolo control card dev pack - http://focus.ti.com/docs/toolsw/folders/print/tmdxcncd28035.html