

Design Issues

Stepper-motor control using an MSP430

Michigan State University – ECE 480 – Design Team 6

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Introduction

Design Team 6 has spent the semester redesigning the DRV88xxEVM. The DRV88xxEVM is an evaluation module (EVM) that is used as a developmental tool for putting the DRV88xx series motor drivers into different solutions using Texas Instruments MSP430F1612 microcontroller. This EVM comes with a Windows GUI that allows the user to pick the speed of the motor and how fast the user would like to accelerate it. This is useful because all stepper motors are different and they require different acceleration rates to get to certain speeds, the Windows GUI makes it so the user can find what acceleration rates they must program the microcontroller to control the DRV88xx. After that all the code has been provided for the MSP430 and the user can cut and paste the sections they need for their project. The problem with this is that only the MSP430F1612 can be used with the EVM and this is not optimal because customers would like to control the DRV88xx with different microcontroller families.

Team 6 solution to this is to insert a Dual Inline Memory Module (DIMM) onto the EVM this allows for different microcontrollers on ControlCards to be inserted into the EVM. Team 6 integrated the MSP430F1612 onto a ControlCard as to keep the same abilities as the original DRV88xxEVM. Team 6 then took a Stellaris ControlCard and integrated it with the new DRV88xxEVM which involved creating all of the code to work with the Windows GUI and also an alternative web browser GUI that uses the Ethernet capabilities of the Stellaris.

Product Lifecycle Management

The process of handling all aspects of a project, from its initial design and concept, through its manufacturing from raw materials and utilization by the customer, ending at its ultimate disposal of the product simply describes Product Lifecycle Management, PLM. PLM is an important part of industry as it can offer several benefits such as insight into improved product quality, reduced cost, and reduced waste. There are several key events in the process that take place.

The first of these processes is the conception and the design of the product of service. While in the design phase of the project several factors were taken into consideration, research was done on the industry standards for DIMM card pin outs. Texas Instruments implements multiple ControlCards and while there are similarities in the pin outputs of the cards, such as ports designated for communication or analog signals, there was no standard set. While designing the MSP430 ControlCard and the DRV88xxEVM these similarities were taken into consideration, however the lack of a standard provided leeway. The modular design of the DRV88xxEVM requires that it work with these various ControlCards. Cost was also taken into consideration. With a relatively low budget of \$500 multiple manufacturing companies had to be taken into account to stay as close to budget as possible.

The production process of PLM plays a large part for this project. Once the hardware design of the project was complete ample time was necessary for the product to be manufactured, assembled, and shipped. These sequential elements generally take between 2-4 weeks for a small production which is large percentage of the total timeline. These time constraints were taken into consideration early in the design phase. Milestones were created for when the design was to be ready for production. While these deadlines were not strictly followed they allowed time in case the design was delayed. The quality of the product was also taken into consideration. Both the ControlCard and the DRV88xxEVM needed to be professionally manufactured to allow for the modularity designed into the project. The production of the two boards can be broken down into several different items. Fabrication of the printed circuit board for the DRV88xxEVM is estimated at \$25 per board for large quantities. Parts for each board would be estimated at \$20 also when ordered in bulk. The final part of the production for the hardware is the assembly which is estimated at about \$25 per board. As with anything, the cost associated with each board manufactured decreases as the number of boards increases.

After the EVM and the ControlCard are produced they are ready for distribution. Texas Instruments as a vast website containing all of their solutions to motor control. These solutions can be ordered off of the website or over the phone with a sales representative. The DRV88xxEVM would be priced comparably to the other evaluation modules at \$100 per board. Various shipping options are available for the customers, allowing their order to be shipped at the appropriate rate. TI also has multiple warehouses located in several locations which will allow for the product to be produced in large quantities and stored until the customer places an order.

The consumption phase of the PLM process covers the user and customer end of the product life. The product's purpose is to evaluate different solutions for motor control. TI currently has several training videos provided online that walk through the user of typical motor control. Also, there are multiple application notes provided with the EVM boards that give typical application that use the board. The modular design of the DRV88xxEVM has the ability to work with multiple ControlCards. Say over the life of the board the customer wants to change the method of controlling the motor. They would only need to use a different ControlCard that has a different microcontroller on the card. This modularity allow for a prolonged life of the product. The DRV88xxEVM printed circuit board also has the ability to be upgraded to use a different DRV motor controller chip. All that is needed is to replace the chip currently on the board and switch 2 resistors.

While the product is meant to be modular in a fashion that would allow it to be used for a long period of time over multiple applications, it will eventually become obsolete as newer technologies become available. The board may be recycled and raw materials sold for use with other products. There are various electronics recycle centers the board can be taken to for recycling. This reuse will help with the environmental issues by not requiring new materials to be used.

Environmental issues

Environmental issues include impact on the ecosystem, such as disposal of waste and energy usage. Design Team 6 project includes creating a product that is in turn very environmentally safe. The best thing about evaluation modules is there extremely long lifecycle. Since this product is being used to create new designs and be placed in various other

applications, the evaluation module will continued to be used for a longer period of time. And now with the DIMM extension added it is much more modular and will extend the period of use even longer since the user can used the same motor driver with different microcontrollers. The DRV88xxEVM has also another unique feature to it based of the fact that all DRV88xx motor driver modules have the same pins that are inputs. So this means that the user can switch the chip on the evaluation module with any chip from the DRV88xx family as long as it's meant to control a bipolar load.

Protection of intellectual property

Intellectual properties are intangible products of the mind, such as inventions publications, and computer programs. Texas Instruments releases all the source code and design files for every developmental board they sell. If team 6 newest revision of the DRV88xxEVM is decided to be released all information including code and design files will be released on the web as to help the customers better understand how to control a motor. Texas Instruments hides the design of the motor controller but releases all information on developmental boards so customers can easily transfer the designs into their current projects, which in turns makes Texas Instruments more profit.

Standards

Standards can be specific to many products or a select few; it really depends on what the product is. If the product is a Bluetooth keyboard then it must follow the IEEE standard 802.15.1, or if a new road is being built then it must follow government regulations. Standards can also define the amount of energy that is allows to be consumed.

Team 6 project involves standards in two major ways. Firstly team 6 is setting standards for other DIMM modules to have pins that are inputs and outputs at certain ports. Team 6 is also trying to define a more established DIMM pinout standard that relates to all Texas Instruments ControlCards, a unified standard between all families of microcontrollers would allow for all future projects to be better compatible. Secondly the DRV88xxEVM is used by other people to meet other standards, since this is used to design products it's an accurate base model of how there end solution will work and how much power it will consume. It's for these reasons that companies and individuals buy these evaluation modules.

Product Liability

Product liability is when manufacturers, distributors, retailers, and others who make products available to the public are held responsible for injuries caused. Team 6 evaluation module is an application of Texas Instruments parts, and all code provided by team 6 is given out “AS IS” with a disclaimer to state no responsibility is held on team 6. The evaluation module meets the analog specifications of the DRV8824, all the correct capacitors and resistors are being used according to the DRV8824 datasheet. If anything happened to the chip on the evaluation module it would make Texas Instruments at liability for a faulty part and not have any argument against team 6 and their design.