DSP SYSTEM

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1. DSP System:-

Digital signal processing (DSP) is concerned with the representation of the signals by a sequence of numbers or symbols and the processing of these signals. Digital signal processing and analog signal processing are subfields of signal processing. A digital signal controller (DSC) can be thought of as a hybrid of microcontrollers and DSP processors. Like microcontrollers, DSCs have fast interrupt responses, offer control-oriented peripherals like PWMs and watchdog timers, and are usually programmed using the C programming language. DSCs are used in a wide range of applications, but the majority goes into motor control, power conversion, and sensor processing applications. Currently DSCs are being marketed as "green" technologies for their potential to reduce power consumption in electric motors and power. A Digital Signal Processor is a special-purpose CPU (Central Processing Unit) that provides ultra-fast instruction sequences, such as shift and add, and multiply and add, which are commonly used in math-intensive signal processing applications. Microprocessors are typically general purpose devices that run large blocks of software. They are not often called upon for real-time computation and they work at a slower pace, choosing a course of action, then waiting to finish the present job before responding to the next user command. A DSP, on the other hand, is often used as a type of embedded controller or processor that is built into another piece of equipment and is dedicated to a single group of tasks. In this environment, the DSP assists the general purpose host microprocessor. Digital Signal Processing is a technique that converts signals from real world sources (usually in analog form) into digital data that can then be analyzed. Analysis is performed in digital form because once a signal has been reduced to numbers, its components can be isolated, analyzed and rearranged more easily than in analog form. Eventually, when the DSP has finished its work, the digital data can be turned back into an analog signal, with improved quality. For example, a DSP can filter noise from a signal, remove interference, amplify frequencies and suppress others, encrypt information, or analyze a complex wave form into its spectral components. The introduction of the microprocessor in the late 1970's and early 1980's made it possible for DSP techniques to be used in a much wider range of applications. However, general-purpose microprocessors such as the Intel x86 family are not ideally suited to the numerically-intensive requirements of DSP, and during the 1980's the increasing importance of DSP led several major electronics manufacturers (such as Texas Instruments, Analog Devices and Motorola) to develop Digital Signal Processor chips specialized microprocessors with architectures designed specifically for the types of operations required in digital signal processing. (Note that the acronym DSP can variously mean Digital Signal Processing, the term used for a wide range of techniques for processing signals digitally, or Digital Signal Processor, a specialized type of microprocessor chip). Like a general purpose microprocessor, a DSP is a programmable device, with its own native instruction code. DSP chips are capable of carrying out millions of floating point operations per second, and like their better-known general-purpose cousins, faster and more powerful versions are continually being introduced. DSPs can also be embedded within complex "system-on-chip" devices, often containing both analog and digital circuitry.

1.1 Control :-

Traditionally, motor control systems consist of a mix of analog components managed by an MCU[14]. Typical implementations were open loop, with a developer trying to evaluate positioning information quickly enough with the less than ideal mathematical capabilities of a low-cost MCU. Changing any aspect of the design usually requires a redesign of the control loop as well. Digital signal controllers are a combination of DSP and MCU technologies to provide a device with a real time responsiveness of DSP to perform a complex control algorithm in real time and peripherals and interrupt capabilities of an MCU. By running sophisticated algorithms, efficiency of control can be managed dynamically. Instead of directing a motor to move to a position, typical of an analog open loop implementation, a digital signal controller can determine where the motor actually is using a close loop or field oriented control algorithm.

By moving control to the digital domain developers can achieve application efficiencies on many different levels. With the high performance of a DSP, developers can implement complex algorithms such as field oriented control that increase motor efficiency, enabling use of smaller, less noisy and lower power motors to achieve greater horse power than possible with an analog implementation. Moving from analog to digital also enables new efficiencies through integrations. Today's digital signal controllers offer a wide range of peripherals optimized for the various controls applications. Additionally by moving formally analog components in to software, developers able to scale designs design without having to completely redesign the base architecture. Digital control enables other operating efficiencies as well. For example, developers can implement torque at zero rpm. In other words, the system can have torque before the motor has begum to spin. This is only possible with sophisticated algorithms not feasible to implement using analog components. Developers can also correct any deficiencies in power with PFC (power fact correction), another algorithmically intensive function.

Digital signal controller also brings additional processing capability to motor control. Instead of simply driving the motor, a digital signal controller can monitor complex feedback and incorporate in motor's operation. For example feedback from a wiper blade system can be used to determine how much water is present on the wind shield. The torque of the blade can then be adjusted to result in better feasibility for the driver. Analyzing feedback in more detail can result in new features that never exist in analog system.

1.2 MCU functionality with DSP Performance: The C2000 Digital Signal Controller advantage:

The raw performance of C2000 digital signal controllers enables innovation and product differentiation simply not possible with traditional analog and MCU-based designs [8]. Digital signal controllers are built for speed, enabling developers to close the control loop more quickly. FIFO serving communication peripherals substantially reduce the burden of interrupt servicing by the CPU, and ultra fast ADCs with dual sample and hold enable controllers to capture data efficiently with low peripheral overhead.

TI's digital signal controllers have also been architected to accelerate control loop processing common to most control applications, enabling controllers to do more each loop iteration while consuming fewer cycles. Multiuse pipeline architecture enables the controller to read and write multiple data values in a single cycle, compared to traditional MCUs which can only work with a single data value at a time. True single-cycle math operations provide a significant advantage over the multiple cycles multiplies typical of MCUs. Additionally, pipelined flash further improves performance. One key point of resistance to the initial use of DSPs motor control applications was matching interrupt and user interface (UI) capabilities of microcontrollers. Developers wanted the raw processing power of DSPs but didn't want to give up the control and ease of programming they had come to expect from MCUs. To meet this need, C2000 devices offer an RMW (read/ write/modify) atomic structure unique among DSPs, as well as important MCU peripherals and a C-efficient architecture backed with a complete development environment and optimizing compiler.

TI's digital signal controllers also integrates the key MCU peripherals necessary for control applications like watchdog timers, multiple GPIO ,PWM ,large RAM blocks, secure on chip flash memory and various communication interfaces and peripherals. Independent PWM channels, captures and quadrature encore interfaces allow designers to optimally allocate resources. Such integration not only reduces chip count, making boards smaller and easier to manufacture. Flash is a critical peripheral of control applications that need to store persistent data such as calibration tables event logs and code updates event when the power is turned off.

Additionally, Flash eliminates the need for ROM masks. ROM masks have high NREs and lock application code. With Flash, there are no NREs and devices can be programmed in system during assembly as well as reprogrammed in the field. Digital motor drive control for white goods such as washing machines eliminates speed/current sensors and mechanical gearing, enabling the use of smaller DC link capacitors through ripple compression and reduces EMC filter size through power factor correction to result in overall higher spin speeds, larger baskets in the same size enclosure and less noise and vibration.

1.3 TMS320C2000TM Digital Signal Controllers:-

Providing the control peripheral integration and ease of use of an MCU with the processing power and efficiency of TI's leading DSP technology, ideal for embedded industrial applications such as digital motor control, digital power supplies and intelligent sensor applications[19]. Combine control peripheral integration and ease of use of a microcontroller with the processing power and C efficient of TI's leading DSP technology. All C28xTM controllers are 100 % software compatible.

1.3.1 TMS320F283xx Floating Point Controllers:-

The industry's first floating point digital signal controllers operate at up to 150 MHz and offer up to 300 MFLOPS and 521KB of on chip flash memory. 32 bit floating point C28x TM DSC core up to 150 MHz operation with 300 MFLOPS six channel DMA powerful and flexible control specific interfaces.

1.3.2 TMS320F281x Controllers:-

Fixed point 32 bit controllers with up to 256KB flash memory and performance of 150 MIPS. Pin compatible ROM and RAM only versions also available. 32 bit, fixed point C28xTM DSP core. Easy to use software and development tools speed time to market.

Key Features of the eZdspTM F2812

The eZdspTM F2812 has the following features [7]:

• TMS320F2812 Digital Signal Processor.

• 150 MIPS operating speed.

• 18K words on-chip RAM.

• 128K words on-chip Flash memory.

• 64K words off-chip SRAM memory.

• 30 MHz clock.

• 2 Expansion Connectors (analog, I/O).

• Onboard IEEE 1149.1 JTAG Controller.

• 5-volt only operation with supplied AC adapter.

• TI F28xx Code Composer Studio tools driver.

• On board IEEE 1149.1 JTAG emulation connector.

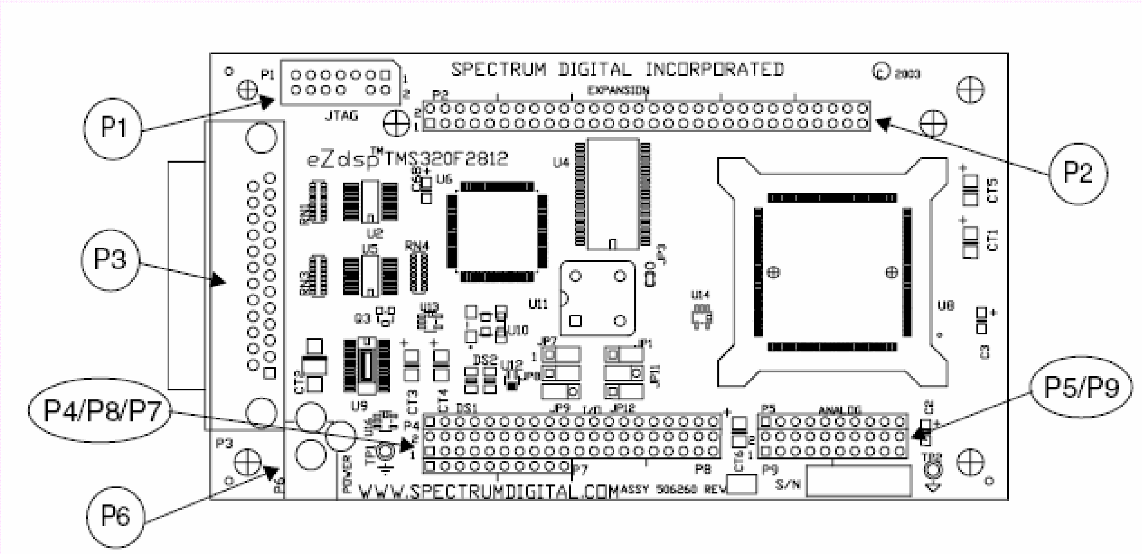

Fig 3.3.2 eZdspTM F2812

1.3.3 TMS320F280xx Controllers:-

Fixed point 32 bit controllers with up 256KB flash memory and performance up to 100MIPS in 100 pin packages. There are 12 members of the F280xx series and all of them are pin to pin compatible, 32 bit, fixed point C28xTM DSP core. Easy to use software and development tools speed time to market.

1.3.4 TMS320LF240x Controllers:-

Older16 bit architecture offers 40 MIPS of performance with highly integrated Flash memory, control and communication peripherals. Pin compatible ROM version also available. Up to 40 MIPS operation. Three power down modes, code compatible, control optimized DSPs. JTAG scan based emulation.