The EECS 452 Flexible Peripheral eXpander

The purpose of the initial team report is to get the project teams to start thinking about what their projects really are and about how to proceed. This write-up is the management team's report. You are not expected to mimic what was done here but, then again, you might want to.

1 Introduction

The TI DSKs used in the EECS 452 lab are powerful DSP based systems They are extremely high in value as educational tools and greatly facilitate learning how to move digital signal processing concepts into working programs. However, they are somewhat lacking in terms of supporting user control inputs and the generation of displays in real-time.

The goal of this project is to develop a Flexible Peripheral eXpander unit, the FPX452, that will add user control inputs and a real-time display capability to the EECS 452 DSKs.

2 Team members

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3 Description of the project

The project will result in the enhancement of the EECS 452 DSKs by adding

- four rotatory knobs,
- a 16-key pad,
- two RS-232 ports,
- a 640x480 LCD graphic display
- an expansion port for use with other devices.

Figure 1 contains a diagram showing the major components making up the FPX452 system.

The key components of the FPX452 system are:

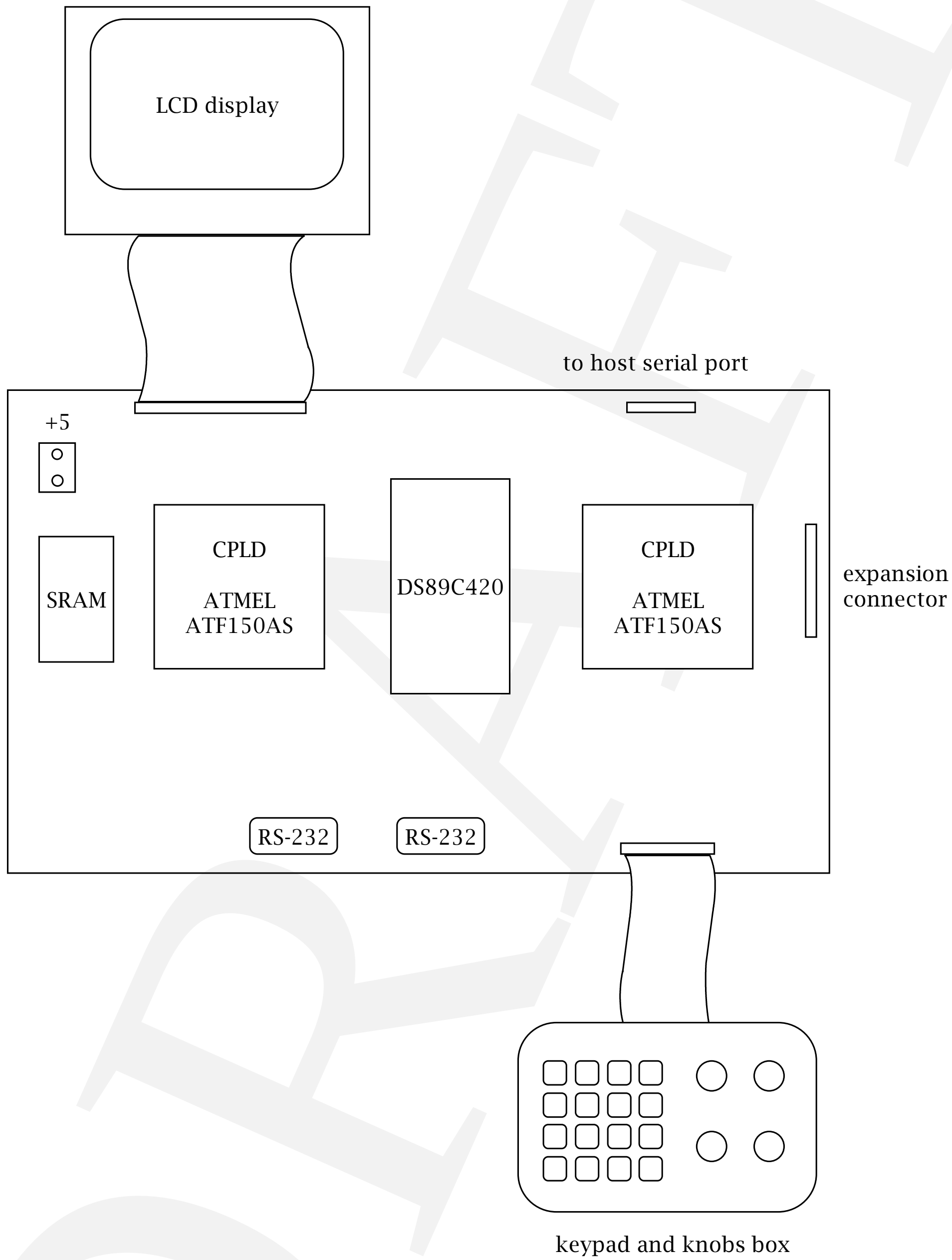

Figure 1: The FPX452.

- An 8-bit, 33 MHz microcomputer. This provides intelligence and adaptability. The two serial ports are used to provide the serial RS-232 channels. The Dallas Semiconductor DS89C420 has been chosen based on the past experience of one of the team members. Development tools and support code are available.

- Two CPLDs are included as amorphous logic. One CPLD will interface the DSK to the DS89C420, the knob box, and and the keypad. The second CPLD is dedicated to being the interface between the SRAM used for the display memory, the LCD device and the DS89C420.

- A block of memory provided by static RAM. This is used to hold the pixels used to create the displays. Multiple display pages will be supported. This memory appears in the DS89C420's memory space and be used as general purpose memory.

- A keypad/knob box. EECS 452 presently has two complete and one partial (knobs only) units. These were built to plug directly on the the Motorola DSP56303 EVMs used in previous semesters. The knobs use quadrature phase rotary shaft encoders. The keypad uses a crosspoint switch organization with columns being scanned and row outputs being tested for switch closures.

- LCD display. The feeling is the more pixels the better. A monochrome display will be used in the initial system. These are easier to work with in terms of accessing pixels and will serve as a learning experience on which to base decisions about any possible follow on designs. A 640x480 pixel monochrome LCD display will be used.

At the DSK end the FPX452 will look like a peripheral device. The first cut interface will mimic the SPI interface used with the AIC23 codec. The plan is to use the AIC23 DSP Paradigm example code but to move it the McBSP channel 0 and to make it bi-directional.

It presently planned to make use of the Tektronix 4010 display terminal protocol for controlling the display from the DSK.

We are thinking about obtaining and adding an RS-232 serial port interface to a DSK so that we can use a PC based T4010 terminal emulator for testing the modified lab applications while the FPX452 is being developed. This allows work to proceed in parallel.

If there is a second generation version of the FPX452 it might be desirable to provide a parallel interface that will allow ready movement of images captured using a digital camera.

4 The DSP aspects

The FPX452 is intended to provide user control inputs and real-time display generation to any micro-computer/processor system possessing a serial port. As such it can augment and enhance wide range of DSP applications.

Our application of DSP in this project will be to use the FPX452 to make the transfer function program and/or the real time FFT program as found in the lab exercises into a complete measurement system. Provision will be made to allow user interaction with the real time results being displayed on the LCD display.

5 Commercialization

An obvious market is the set of university and commercial training courses that make use of computers possessing a McBSP like serial port. In particular, EECS 452 and like courses. The device being developed should work on any current TI DSK that adheres to TI's daughter board interface specification as well as the evaluation modules from other DSP manufacturers.

A secondary market results from the incorporation of the FPX452 or a successor into stand alone DSP based devices. Examples of which consist of:

- Transfer measurement unit.
- Real time spectrum monitoring.
- LRC measurement system.
- Musical instrument tuner.
- Dynamic sound controlled artwork.
- Fish finding sonar.

Because of the programmable nature of computers it may be commercially advantageous to combine applications. For example it would be very easy and useful to develop a product targeted at audiophiles that would

- allow inspection of time waveforms
- allow displaying waveforms in the frequency domain
- measure room impulse response
- measure speaker transfer functions

6 End of semester demonstration

The end of semester show-and-tell demonstration will be of one of the lab DSP applications either the transfer function program or the real-time spectrum program (or both) using the FPX452 to provide interactive operator input and to generate a real time display.

7 Initial time line estimate

An important aspect of creating a schedule is determining what tasks are to be done. The following task list is somewhat ordered in terms of start times and many tasks will overlap.

- Mount components on the FPX452.
- Design and have constructed a small interface board to be used on the DSK to talk to the FPX452. A couple of other projects have a similar need so maybe we can group these together.
- Develop a suite of test programs for verifying operation of the FPX452. This will include CPLD “programs”.
- Acquire an LCD display and design a connector adapter to go between it and the FPX452.
- Write display generation self-test programs for the DS89C420.
- Design the control logic to be implemented in the display CPLD.
- Using the self programs bring the display on-line. This involves setting a balance between CPLD logic implementation and code in the DS98C420.
- Design the programming interface to be implemented between the DSK and the FPX452.
- Design and implement the logic to be implemented in the interface CPLD.
- Design and implement the interface support software needed by the DS89C420.
- Modify one or both of the TF and RTSpectrum programs for operation with the FPX452.
- Test the modified DSK programs with the FPX and bring to operational status.
- Document the design.
- Generate the final project presentation.
- Give the final presentation.
- Issue collective sighs of relief.

Much of the testing will be greatly facilitated by having a microcomputer built into the FPX452 that can be used in stand alone mode.

Figure 2 contains our first attempt at establishing project time lines.

8 Resources required

The following pretty much constitute what is going to be required:

- printed circuit board
- components including
  - printed circuit board

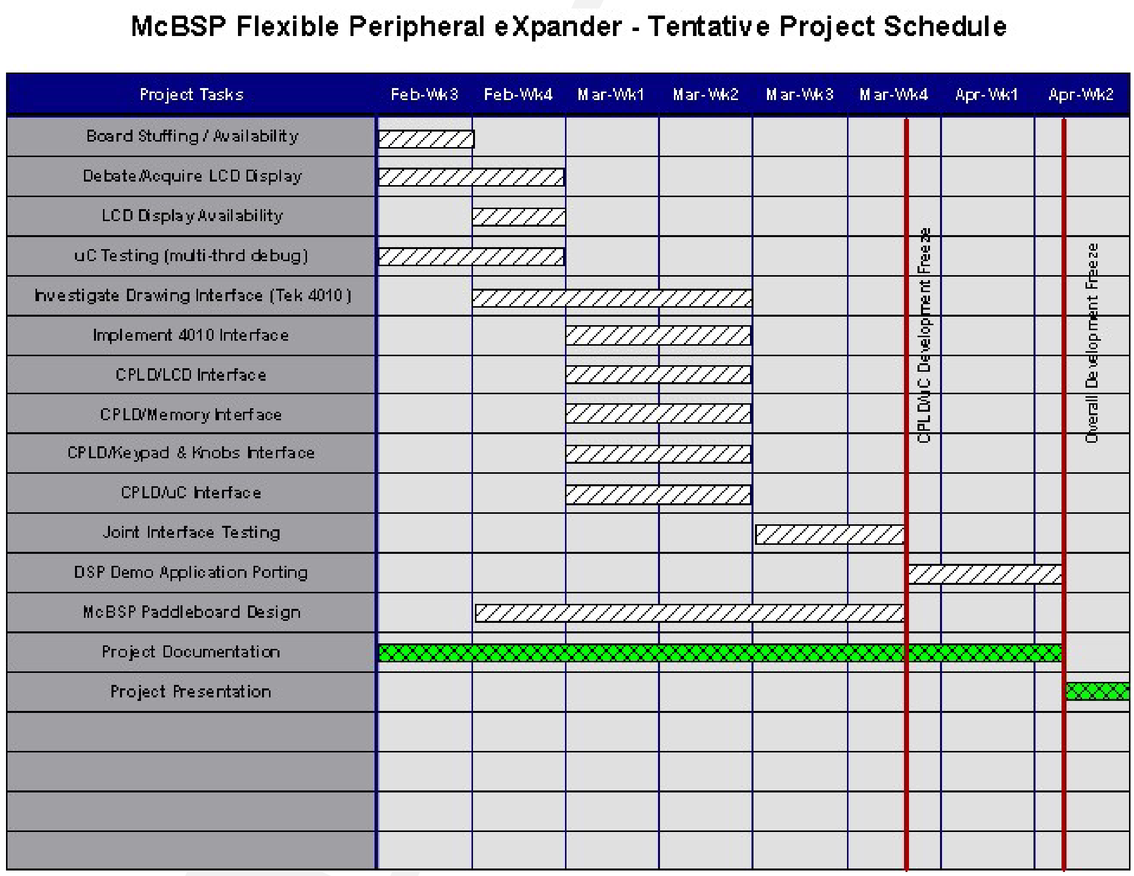

Figure 2: First cut schedule timelines.

  - CPLDs
  - microcomputer: Dallas Semiconductor DS89C420
  - RAM chips
  - daughter board for use on the DSK
  - keypad/knob box
  - LCD display unit
  - programmer for the DS89C420
  - programmer for the ATMEL CPLDs
- C compiler and assembler for the microcomputer
- operating software for the microcomputer
- DSK

Most of these resources are presently on-hand.

A printed circuit board is available that was designed and fabricated last summer for this application. Many of the parts were also obtained at this time as well. The only major item remaining to be obtained is the LCD display and the inverter needed to power the back-light.

The FPX452 printed circuit board was designed with a number of possible display devices in mind. Ideally a color display having 640x480 pixels would be used. However, to keep the cost of the prototype system in hand, a monochrome unit will be used on the initial prototype. This will allow us to learn what lessons we need learn at minimal cost. A color display can always added later if warranted.

We are presently considering the use of a Hantronics 640x480 black and white LCD display. The cost is on the order of $200 including the back light power inverter. This is available from Mousser (assuming they have stock).

One of the knob boxes available in the lab will be modified to connect to the FPX452. This consists of replacing the cable previously used with the Motorola DSP56303 EVMs with a slightly different cable. A “knob” box mounts a 16-key keypad and four rotary controls (the knobs).

Programmers are available for both the DS89C420 and the ATMEL CPLDs. A C/assembler is also available for the DS89420. It is anticipated that WinCUPL (available free from ATMEL) will be used used in programming the CPLDs.

One of the project members is making available for the FPX452’s microcomputer a small real-time monitor that he wrote in assembler several years ago. This monitor provides preemptive round-robin scheduling of tasks, support for serial ports, console support via a RS-232 channel, numeric conversion routines and a thread dedicated to interactive debug support. The use of this code should provide a good foundation on which to build.

The DSK that we will be targeting is the TI C5510 DSK used in lab.