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Design of a Microcontroller board for VR Surgery

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Description of Microcontroller hardware for VR surgery.

The original design of the data acquisition system for the VR Surgery simulator involved a Pentium based PC and a number of ISA bus cards with quadrature encoder ICs.[1] The PC was running Linux based software to read the encoder data and send it via TCP/IP to a graphics workstation.

This was perceived as being somewhat inefficient, and it was desired that a more updated version be designed to enable use of USB for the data acquisition purposes. This required redesigning a system that acquired quadrature encoded data and sent it via USB to the hosting graphical workstation.

In order to use as much of the previous design as possible, a microcontroller board was designed that would mimic a PC's ISA bus and allow use of the existing ISA quadrature encoder cards.

The microcontroller chosen is a Dallas Semiconductor 8051 derivative (DSC89430) that can run at up 33MHz and is available with up to 64kb of Flash memory.[2] This device was chosen for its common development environment and simple programming requirements. In addition, the 8051 based I/O signaling is very similar to the RD/WR bus signaling as used by the ISA bus.

To perform the USB data communications, an FTDI245 based transceiver module was chosen. This device appears to the host computer as a virtual RS-232 serial port and provides an 8-bit FIFO data bus to the host microcontroller.[3] A pre-built 24 pin DIP module from DLP was chosen for this purpose since the the FTDI device is surface mount and speed of development was desirable. The module has the USB socket built in.[4]

Most 8051 based microcontrollers have four full 8-bit data buses (P0 – P3) that can be configured in various combinations of data, address and address/data. The chosen configuration for this application uses P0 to mimic the ISA data bus, P1 to communicate with the USB FIFO bus and P2 to mimic the ISA address bus. P3 is configured as a general purpose I/O port and used for strobing the USB FIFO bus RD/WR lines and reading the buffer full flags.

A normal ISA address bus is 16 bits wide and so a 74HC573 data latch IC is used to latch the upper 8 bits of addressing so the full 16 bits can appear on an 8 bit port. The 8051 device fully supports this configuration.

The microcontroller is programmed from a standard RS-232 serial port via a MAX232 level conversion device.[5] A 74HC125 tri-state buffer IC is used to co-ordinate reset and programmig states as per the DSC89430 datasheet.

The schematic on the following page shows the circuit used.

The microcontroller was programmed using the Small Device C Compiler (sdcc) in a Linux environment, with details available in the Maxim Application Notes.[6][7] The details of setting up the ports and programming the device can be found in the Microcontroller's User's Guide.[8]
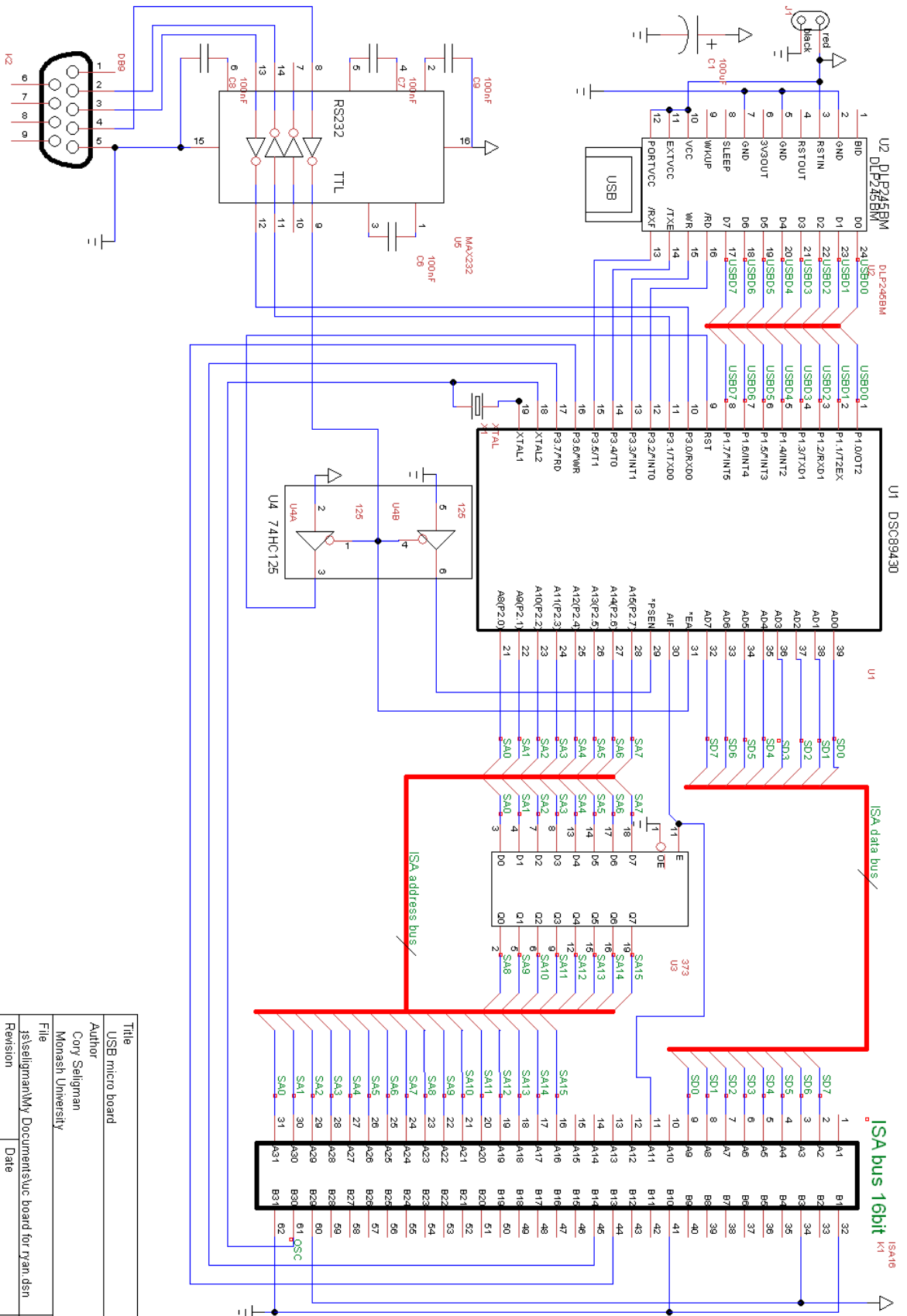
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