Real Time and Embedded Systems: Project 6

Voltage Level Indicator

David Ruan
dxr2863@g.rit.edu

Harshdeep Singh Chawla
hxc3427@g.rit.edu

Abstract

The objective of this project is to design and implement an embedded system, which converts analog voltage to a digital signal using ADC on the Athena boards, and indicate the voltage level using servomotors controlled by Freescale Microcontrollers.

Areas of Focus:

- David worked on code and logic of the project.
- Harshdeep also helped with the coding by providing regular inputs. Report was done by Harshdeep.

Analysis/Design

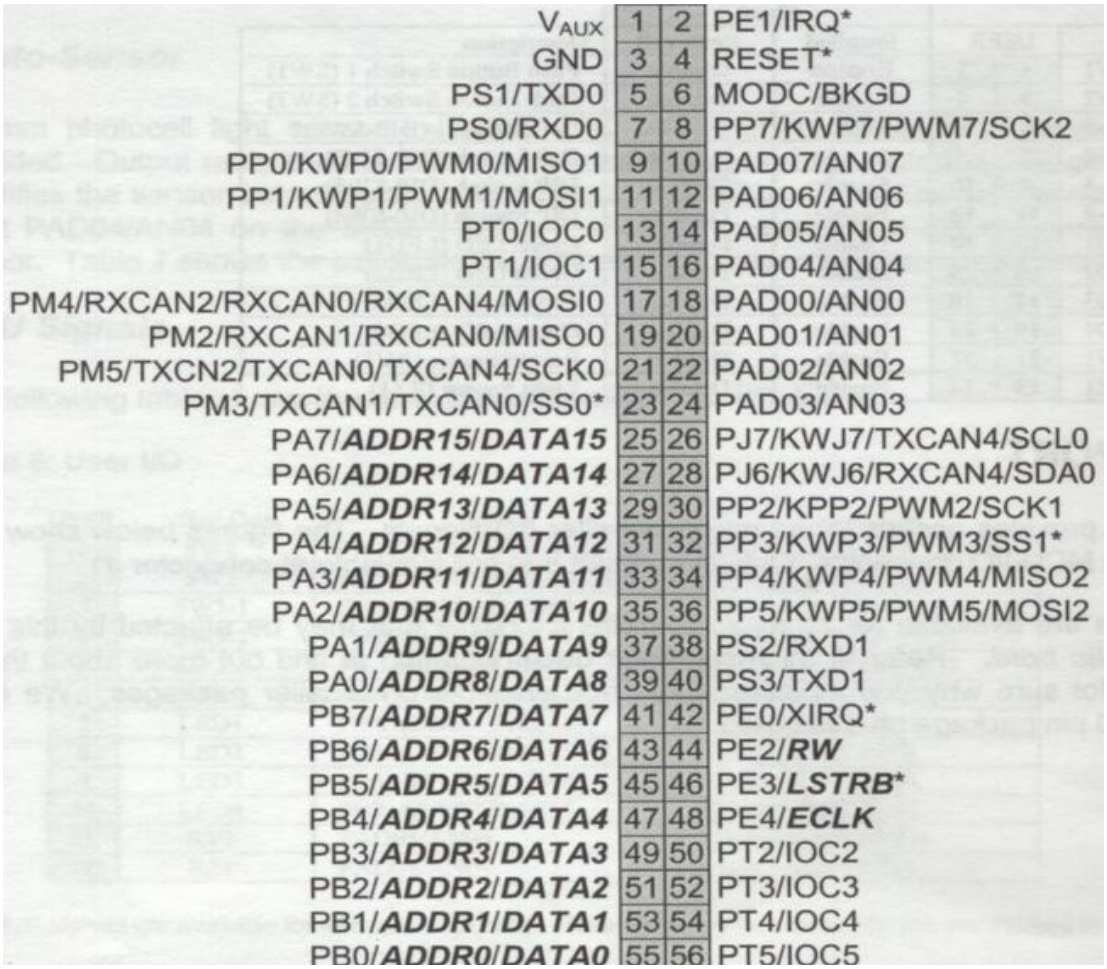
Approach: The approach used in the completion of this project is as follows:

- Understand the components and functionality of the ADC.
- Determine the calculations required for ADC conversion.
- Determine a way to use Freescale board in cooperation with purple box.
- Write and debug program.

Hardware

Signal Generator: A signal generator is used to produce a waveform with a low frequency and limited amplitude (-5V to +5V).Multiple waveforms are possible, including a sine wave, a square wave, and a triangle wave.

Voltage Indicator:The voltage indicator provides a rough (non-calibrated) indication of the input voltage.The indicator movement reflects the voltage changes of the signal generator. One servomotor is used where the center represents zero volts. The upper half and lower half of the position represent 0 to +5V and 0 to -5V respectively.



V_{AUX}	1	2	PE1/IRQ*
GND	3	4	RESET*
PS1/TXD0	5	6	MODC/BKGD
PS0/RXD0	7	8	PP7/KWP7/PWM7/SCK2
PP0/KWP0/PWM0/MISO1	9	10	PAD07/AN07
PP1/KWP1/PWM1/MOSI1	11	12	PAD06/AN06
PT0/IOC0	13	14	PAD05/AN05
PT1/IOC1	15	16	PAD04/AN04
PM4/RXCAN2/RXCAN0/RXCAN4/MOSI0	17	18	PAD00/AN00
PM2/RXCAN1/RXCAN0/MISO0	19	20	PAD01/AN01
PM5/TXCN2/TXCAN0/TXCAN4/SCK0	21	22	PAD02/AN02
PM3/TXCAN1/TXCAN0/SS0*	23	24	PAD03/AN03
PA7/***ADDR15/DATA15***	25	26	PJ7/KWJ7/TXCAN4/SCL0
PA6/***ADDR14/DATA14***	27	28	PJ6/KWJ6/RXCAN4/SDA0
PA5/***ADDR13/DATA13***	29	30	PP2/KPP2/PWM2/SCK1
PA4/***ADDR12/DATA12***	31	32	PP3/KWP3/PWM3/SS1*
PA3/***ADDR11/DATA11***	33	34	PP4/KWP4/PWM4/MISO2
PA2/***ADDR10/DATA10***	35	36	PP5/KWP5/PWM5/MOSI2
PA1/***ADDR9/DATA9***	37	38	PS2/RXD1
PA0/***ADDR8/DATA8***	39	40	PS3/TXD1
PB7/***ADDR7/DATA7***	41	42	PE0/XIRQ*
PB6/***ADDR6/DATA6***	43	44	PE2/***RW***
PB5/***ADDR5/DATA5***	45	46	PE3/***LSTRB****
PB4/***ADDR4/DATA4***	47	48	PE4/***ECLK***
PB3/***ADDR3/DATA3***	49	50	PT2/IOC2
PB2/***ADDR2/DATA2***	51	52	PT3/IOC3
PB1/***ADDR1/DATA1***	53	54	PT4/IOC4
PB0/***ADDR0/DATA0***	55	56	PT5/IOC5

Figure: Pin-out of Freescale board

- To start the system an input from the push button is given, this input is received by pin 51. (here, Port B was used as an input port).
- Pins 33,35,37,39 are used to receive the encoded output from the purple box (here, Port A was used as an input port).
- Whenever input to the QNX is higher than 5V or lower than -5V a led starts glowing. The led is connected to pin 49 (here, Port B was made an output port).
- The PWM signal which was given to the motor was from pin 9. while the +5V and GND was given to the motor through pin 1 and pin 3.

DIO A0	1	2	DIO A1
DIO A2	3	4	DIO A3
DIO A4	5	6	DIO A5
DIO A6	7	8	DIO A7
DIO B0	9	10	DIO B1
DIO B2	11	12	DIO B3
DIO B4	13	14	DIO B5
DIO B6	15	16	DIO B7
DIO C0	17	18	DIO C1
DIO C2	19	20	DIO C3
DIO C4/GATE0	21	22	DIO C5/GATE1
DIO C6/CLK1	23	24	DIO C7/OUT0
EXTTRIG	25	26	TOUT1
+5V out	27	28	DGND
VOUT0	29	30	VOUT1
VOUT2	31	32	VOUT3
AGND(Vout)	33	34	AGND(Vin)
VIN0	35	36	VIN8
VIN1	37	38	VIN9
VIN2	39	40	VIN10
VIN3	41	42	VIN11
VIN4	43	44	VIN12
VIN5	45	46	VIN13
VIN6	47	48	VIN14
VIN7	49	50	VIN15

figure: Pin-out of purple box

- Pin 34 was used as an Analog GND and Pin 43 as the analog I/P pin. The analog I/P was taken from signal generator.
- Pin 1,2,3,4 provided the digital O/P which were connected to the freescale board.
- Pin 28 was connected to Pin 3 of freescale board for common GND.

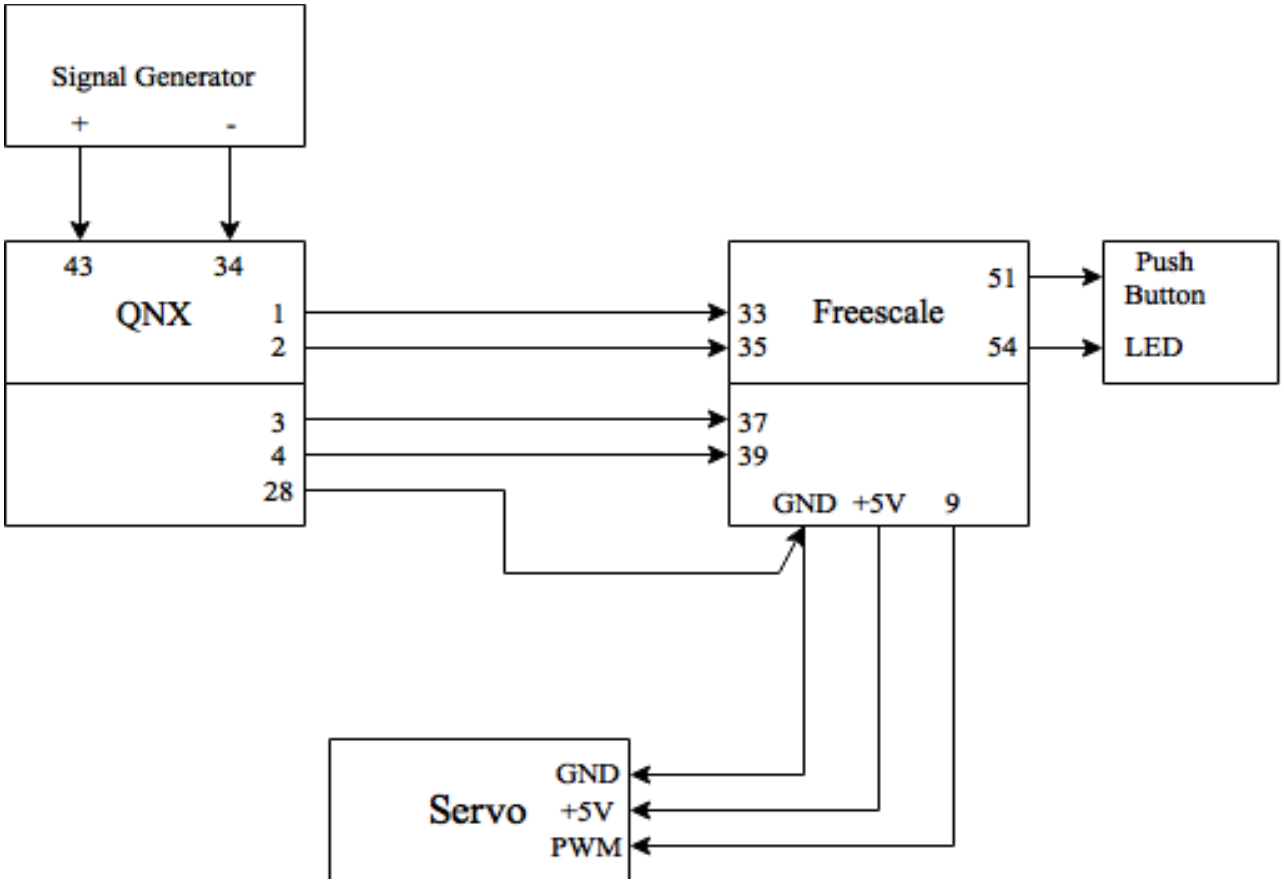


Figure: Block Diagram of the system

The above figure shows the connections between all hardware components of the systems. The main components consist of the signal generator, the QNX purplebox, the Freescale board and the servomotors.

Software

QNX:

The QNX program initiates the Analog to Digital Converter and periodically read the voltage produced by the signal generator. The ADC is set to received value from -10V to +10V in order to detect voltages outside the range of -5V to +5V as indicated in the project constraints. After the conversion, the voltage value is encoded to a value from 0 to 15, where there are 14 intervals each representing a small range of voltage. Four connections are made from the QNX box to the Freescale board solely for communicating the encoded value. This allows for 2^4 or 16 values.

Freescale:

The Freescale board is switched on by the push button. Then, it receives the input from the QNX and compare it with the assigned values. The duty cycle of the PWM is varied according to the values from QNX. The PWM is then fed to the servo which serves as a control signal.

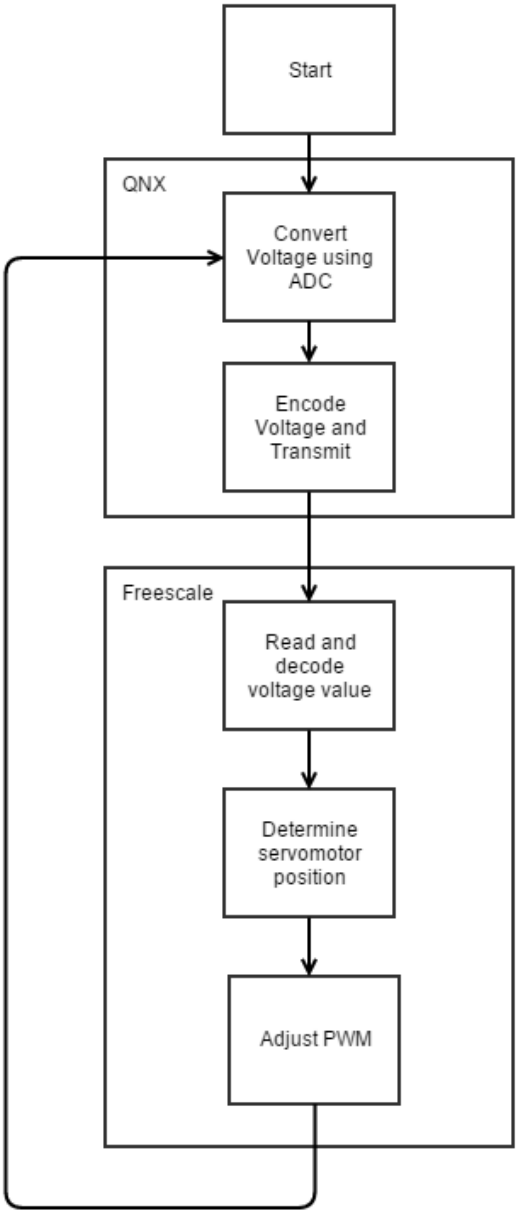


Figure: Block Diagram of the software

The figure above shows the flow of operation in the software used by the QNX and the Freescale hardware. QNX is set with the task of converting and encoding the voltages from signal generator. The Freescale is used to decode the values, determine position and generate PWM signals to control the servomotors

Test Plan

Signal Generator:
Before using the signal generator as an input to the QNX, the signal to be used was checked with the help of oscilloscope. Voltage, frequency of the signal was measured to ensure the range of -5V to +5V.

QNX:
O/P from ADC was displayed and compared with the values displayed on the oscilloscope.

Freescale:
The O/P from the PWM channel was checked with the help of oscilloscope.

System test:

- All connections were tested.
- All the values were tested using oscilloscope.
- Servo was also tested to ensure functionality.

Lessons Learned

- This was the first time we were using multiple boards, setting up whole system and synchronizing various required things like signal conversion, transmitting signal and displaying the value by the use of motors.
- Use of ADC was again a new topic that we came across in this project. The knowledge which we gained during the semester helped to complete this project.

Final Output

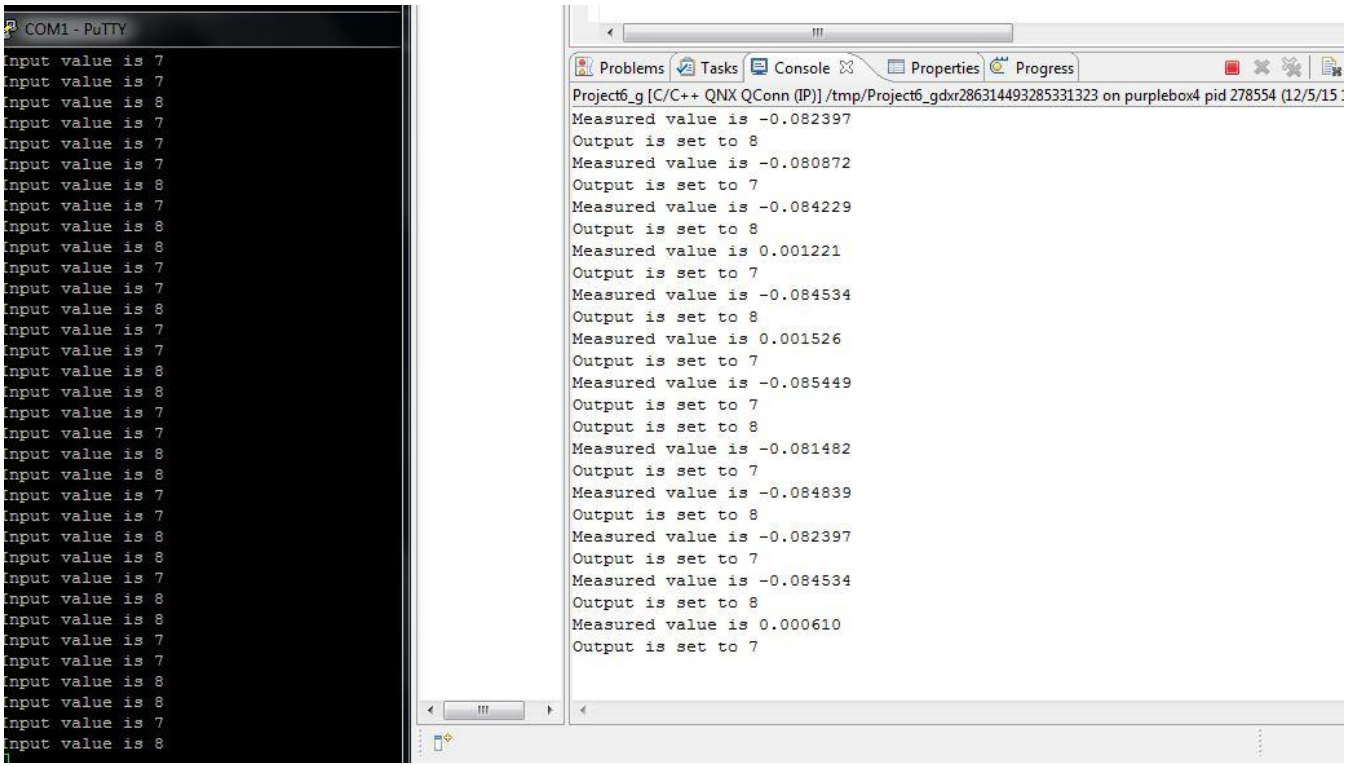


Figure: Output