CIRCUIT CELLAR™

AVR Design Contest 2004

Multi Saw Edger Controller

Project Number A3630

Multi-Saw Edger Controller

The Multi-saw Edger Controller is used to accurately position circular saws for cutting timber in widths varying from 50 mm to 350 mm or more. Figure 1 is a block diagram of the control system We have three saws on a shaft, with Saw 1 being fixed to the shaft and Saws 2 and 3 sliding along the shaft with bi-directional hydraulic actuators.

The moving saws are also coupled to magnets that move close to a Balluff position transducer. Saw 2 is coupled to an electromagnet and Saw 3 is coupled to a permanent magnet. If the electromagnet is energised then the transducer output will be a voltage proportional to the displacement between Saw 1 and Saw 2. If the magnet is de-energised, the output will be a voltage proportinal to the displacement between saw 1 and Saw 3.

The transducer output is conneceted to an analog input of the Controller. An ADC converts this and the microcontroller program compares this to a Set Size. The hydraulic actuators are operated to move the selected saw till the error is less than 1 mm.

A conveyor belt (not shown on the diagram) follows the movable saws so that it picks up the cut timber and allows waste to fall off. This is operated by a similar position control system whereby the belt transducer signal is compared to the saw transducer signal. Some Edgers are fitted witha movable "fence" against which the timber is rested prior to being pushed through the saws. This allows for a thin useable piece to be cut to the left of the fixed saw. This also uses a similar control system.

The block diagram of the Controller is shown in Figure 2 and the schematic in Figures 3 and 4. An Atmel Mega161 or 162 microcontroller is used. The analog inputs are measured by a Maxim MAX1270 12 bit ADC. A 74C923 chip scans the keyboard and generates an interrupt on each key press.

All power switching is done by zero-crossing triac switches and heavy duty relays.

Up to 48 standard sizes may be stored arranged as four banks of 12. One key cycles through the four memory banks and 12 keys select pre-programmed size. The Set Size, Memory Bank number, Actual Size and Output belt position are displayed on an LCD module.

A safety interlock input detects when timber is passing through saws and inhibits any saw movement.

Setting up of standard sizes and system calibration is all done from the keyboard. The switch functions are re-defined when in the Setup Mode.

Sawmills are unforgiving places so the whole unit is built in a rugged polycarbonate case with heavy duty switches used for the keyboard. All connection to the outside world is via large circular connectors.

Control Loop

The control loop firmware is in fact a very small part of the total code, the bulk being taken up by the setup and calibration functions. The set size is compared with the ADC measured size. Because of the noisy environment, we take 8 readings from the ADC and average them. Depending on the polarity of the error, one side or the other of a double acting hydraulic cylinder is actuated.

There is also a flow control. If the distance to set point is more than 40 mm, we switch in another cylinder that increases oil flow. This speeds up saw movement by about a factor of ten. It also means that there is considerable overshoot once the fast cylinder is turned off, of the order of 10 mm. So the last 30 mm of the movement takes place slowly. When the error is 1 mm, we turn off the hydraulics.

The slight overshoot brings the saws very close to the set point. This can be finely tuned by adjusting the oil flow.

Whilst the saws are moving we flash the backlight of the LCD module with a 1:1 duty cycle and a period of one second. The outfeed conveyor belt control loop is then brought into operation. This has only one speed of operation, and as its mass is a couple of orders of magnitude greater than the saws, it has a lot more overshoot. Here, we turn off the hydraulics within 5 mm of the set point. Accuracy of the belt following the saw is not critical, and a 5 mm error is tolerable. During outfeed setting, the LCD backlight is flashed at double rate.

Once all movement is finished, the LCD backlight is steady and this is an indication that the plank may pushed through the saws.

This is an extract of the Bascom code that is used for the control function:

```
' ************************************ CONTROL LOOPS ******************************
'
' Saw and Outfeed control done here.

 Position_saw2:

   Saw_number = 2
   Locate 1 , 5                                          ' Cursor on Line 1, pos 5
   Lcd Saw_number                                        ' Write to LCD module
   Set saw_2_relays                                      ' turn on saw 2 relays
   Flash_rate = 1                                        ' flash backlight rate = 1 Hz
   Gosub Adc_saw_2                                       ' get reading for Saw 2
   Gosub Saw_error_2                                     ' and correction
   Seek_size = Set_size * 5                              ' Convert to 0.2 mm increments

Saw_2_loop:
   If Update_flag = 1 Then Gosub Update_display          ' update size on screen
   If Clear_flag = 1 Then Goto Exit_ps2                  ' Exit if clear button pressed
   Reset Watchdog
   Gosub Read_adc0                                       ' Get raw reading
    Saw_size = Adc_channel_0
     Saw_size = Saw_size + Saw_error                     ' + Saw_error
      If Seek_size = Saw_size Then Goto Exit_ps2
      If Size_reached = 1 Then Goto Exit_ps2             ' finished setting size
         If Seek_size > Saw_size Then Gosub Move_right
      If Seek_size < Saw_size Then Gosub Move_left
   Goto Saw_2_loop                                       ' and loop till equal

Exit_ps2:
   Clear_flag = 0
   Reset Fast_solenoid                                   ' reset TRIAC drivers
      Reset Left_solenoid
   Reset Right_solenoid
   Size_reached = 0                                      ' and reset flag
   Waitms 100
   Reset saw_2_relays                                       ' and turn off relays
   Gosub Position_belt                                   ' Now move belt to follow
   Flash_rate = 0                                        ' diplay backlight not flashing

   Return


' Returns integer Saw_error with offset needed to be added to raw reading

Saw_error_2:
   Readeeprom Low_byte , 98                              ' Get low byte of offset
   Readeeprom High_byte , 99                             ' and high byte
   Saw_error = High_byte * 256
   Saw_error = Saw_error + Low_byte                      ' this is offset
                                                         ' that has to be added on
   Return



' Read ADC for displacement value in Temp_1

  Adc_saw_2:
      Set Porte.0                                        ' Turn on magnet 1
```

```
        Waitms 40                                           ' Pause to stabilise magnet
       Gosub Read_adc0
   Temp_1 = Adc_channel_0                                   ' store here
   Return


Move_right:
   Error = Seek_size - Saw_size
      Error = Abs(error)                                    ' absolute value
         If Error =< 5 Then Set Size_reached                ' set flag as within
                                                            ' 1 mm (5 * 0.2mm)
      If Error =< 5 Then Return
         If Error => 200 Then Set fast_solenoid Else Reset fast_solenoid
                                                            ' Fast solenoid on outside 40 mm
         If Saw_direction = 0 Then Set left_solenoid Else Set right_solenoid
    Return
```

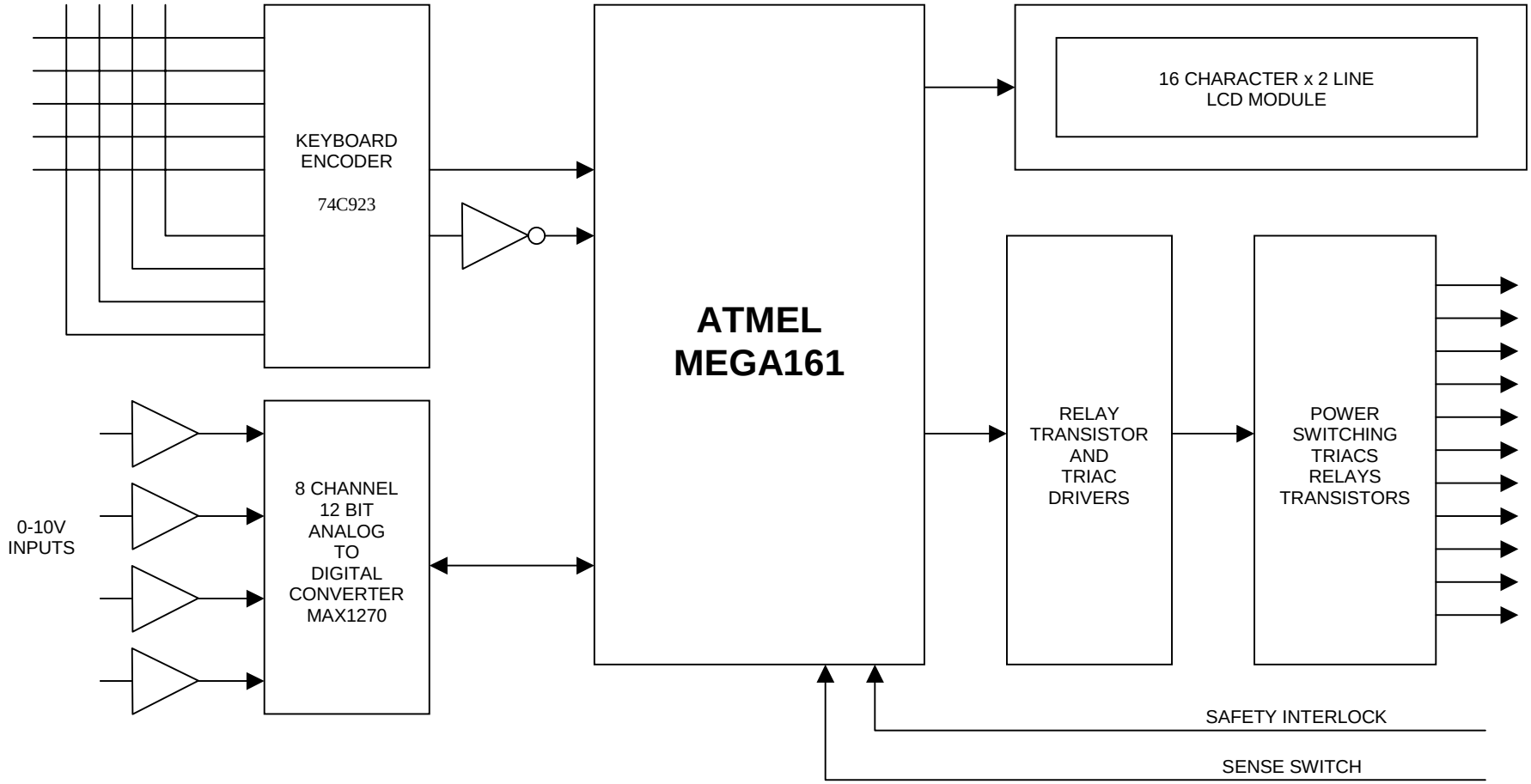


Fig. 2 CONTROLLER BLOCK DIAGRAM

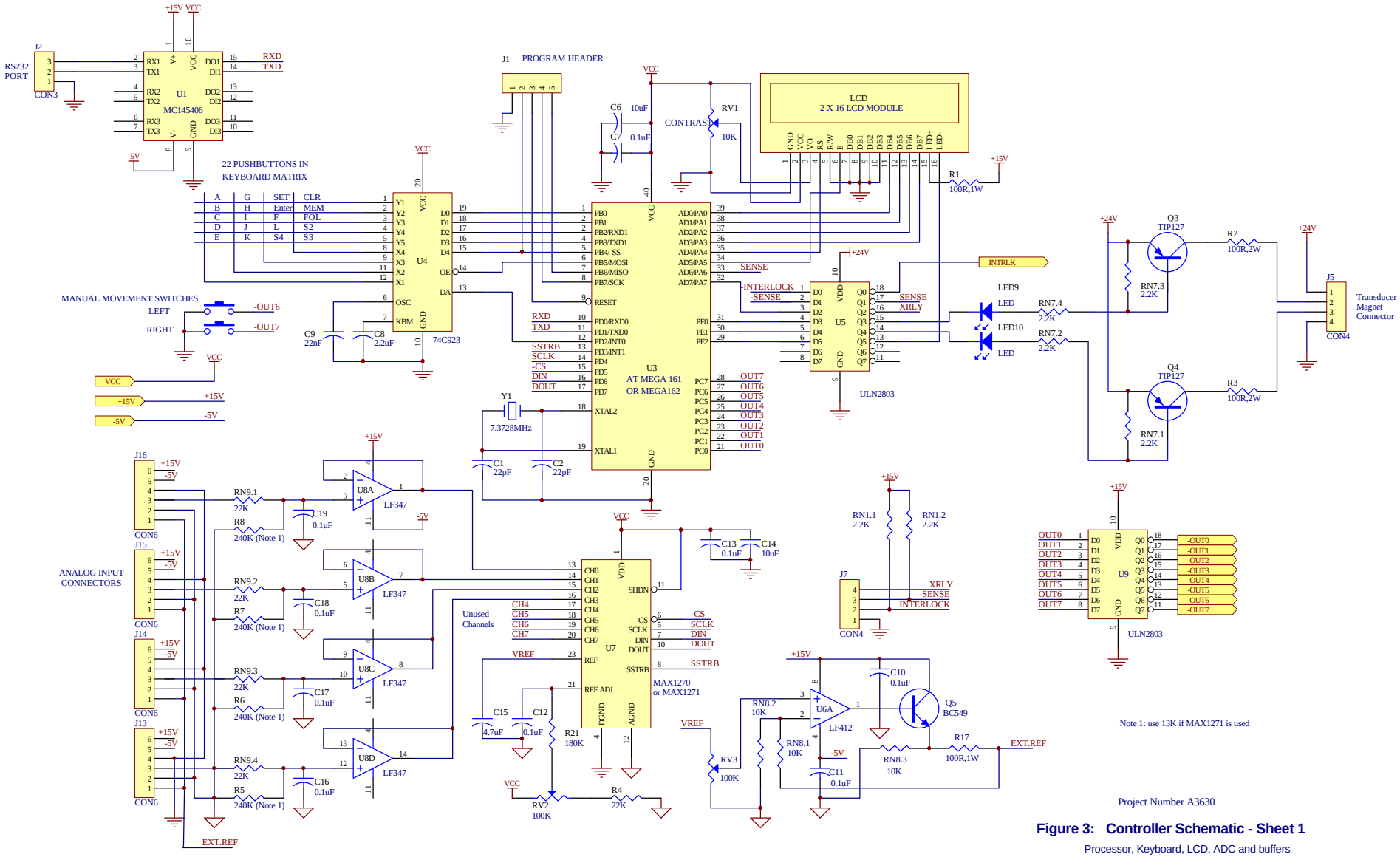
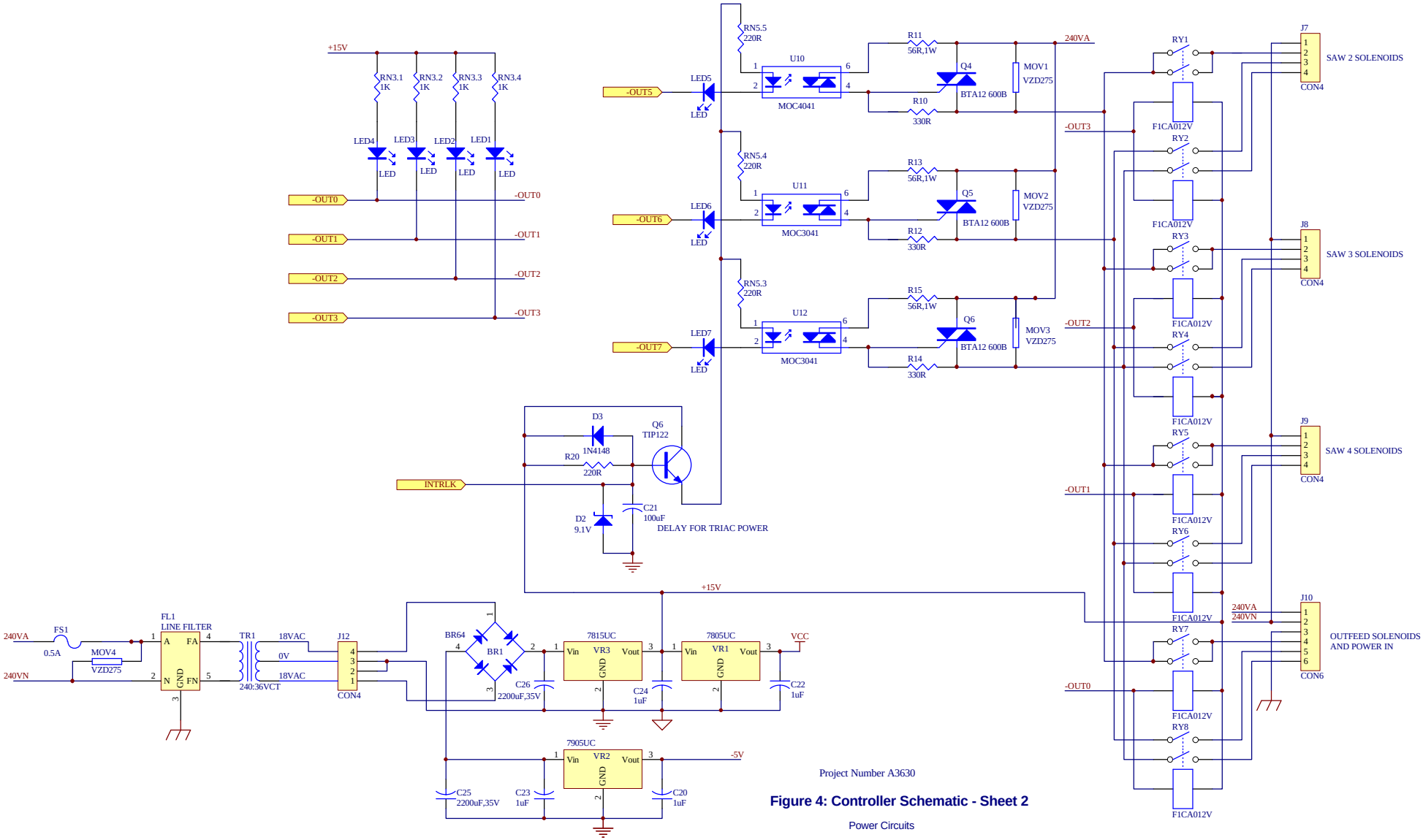


Figure 3: Controller Schematic - Sheet 1

Processor, Keyboard, LCD, ADC and buffers



Project Number A3630

Figure 4: Controller Schematic - Sheet 2

Power Circuits