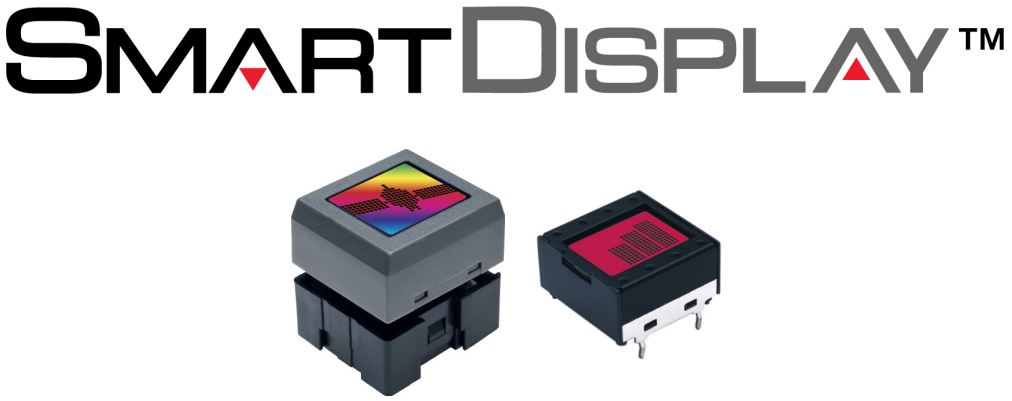
Application Notes for LCD 36x24 SmartDisplay

Revision B



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8. Refresh and LP Timing

The display must be refreshed continuously. The LP to LP timing has to be consistent. LP causes the internal LCD driver to use the data from the internal 40-bit shift register to energize the pixels of the corresponding row. If the LP to LP timing is not consistent the pixel rows that are energized for a longer time will be darker. If a row gets charged for too long it could damage the display.
When the LP to LP timing exceeds 1.2ms a flicker will be noticed on the displays. Lower LP to LP timing up to 0.7ms causes better contrast. However, LP to LP timing of below 0.7ms does not cause significant contrast improvement.

9. Timer Interrupt

A timer interrupt should be used for refreshing the display, backlighting, and switch scan. The timer interrupt interval should be equal to desired LP to LP timing. The timer interrupt should be set to low priority.
The following SmartDisplay related functions could be performed by timer interrupt routines:

a. Start of interrupt routine.
b. If it is the first line of the display set the FLM to high.
c. Shift the data for the corresponding row of the displays.
d. Toggle the LP.
e. Set the FLM to low.
f. Put LED data to effect.
g. Increment line number of the display. If equal to 25 set it to 1.
h. If the line number for the display is equal to 1 then scan the switches. This compensates for switch bouncing.
i. End of interrupt routine.

Manipulation of data and any other tasks can be done by the main program.

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10. Sample Schematics

Figure 3, Sample schematic for controlling 2 RGB SmartSwitches.

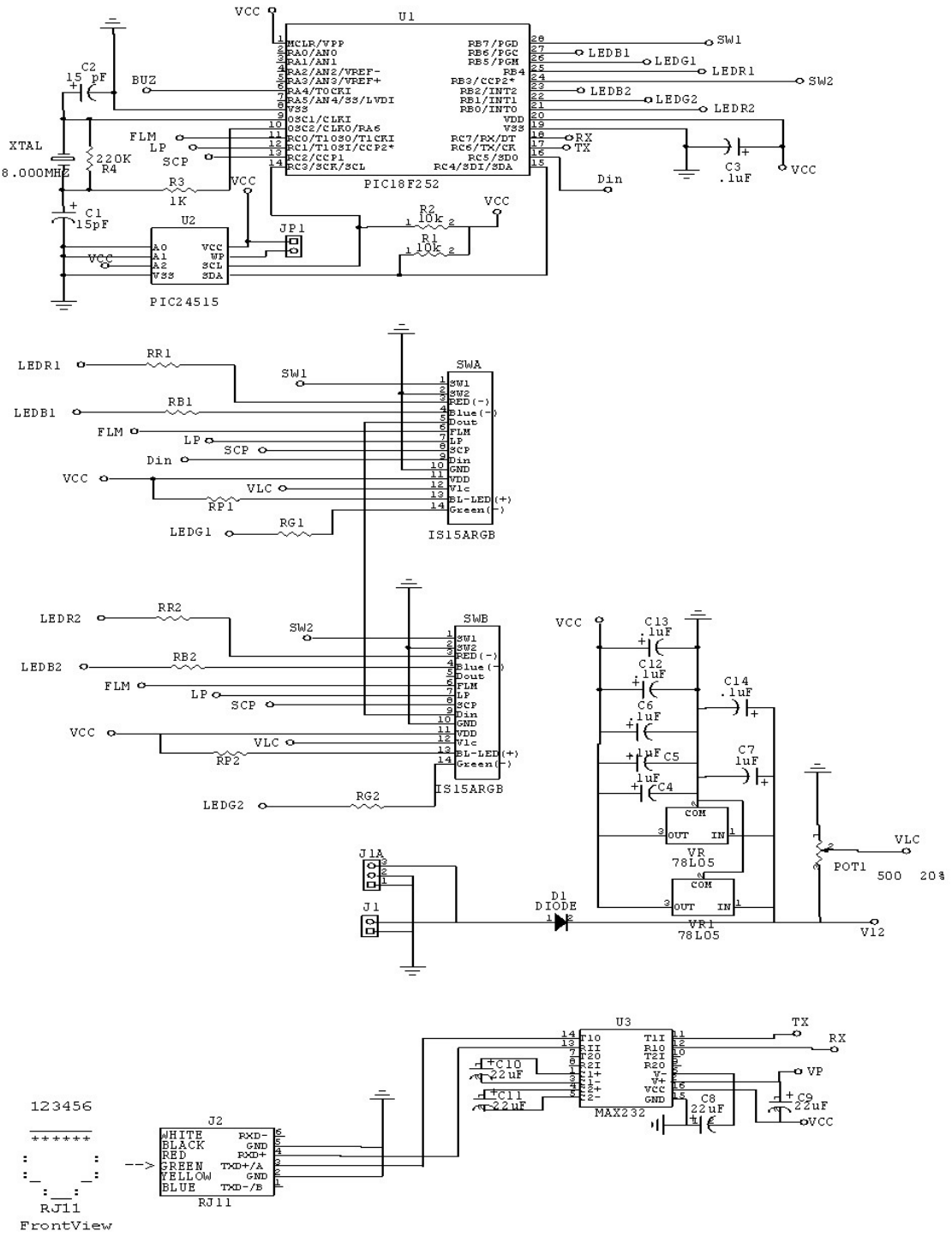

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Figure 3, Sample schematic for controlling 3 RGB SmartSwitches.

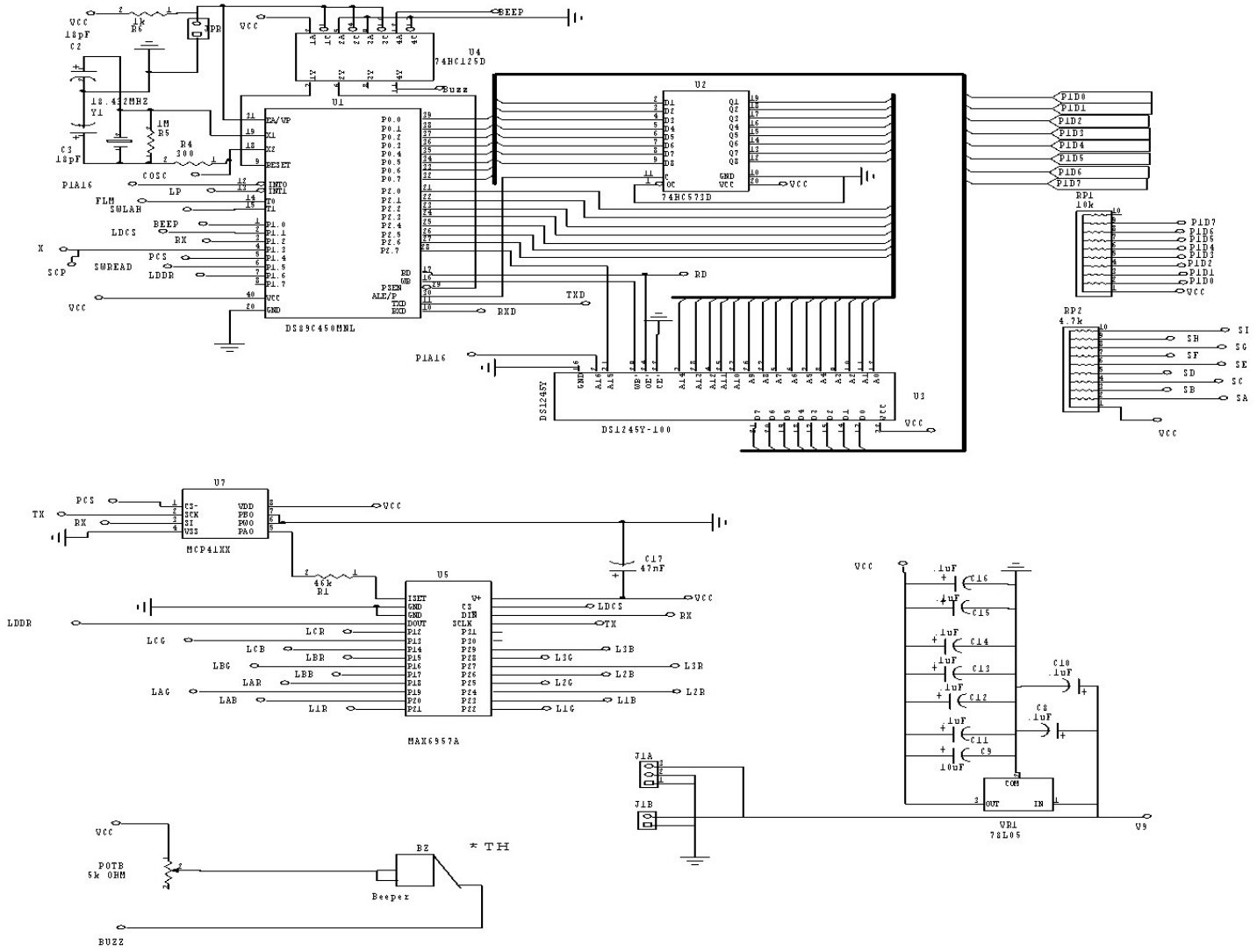

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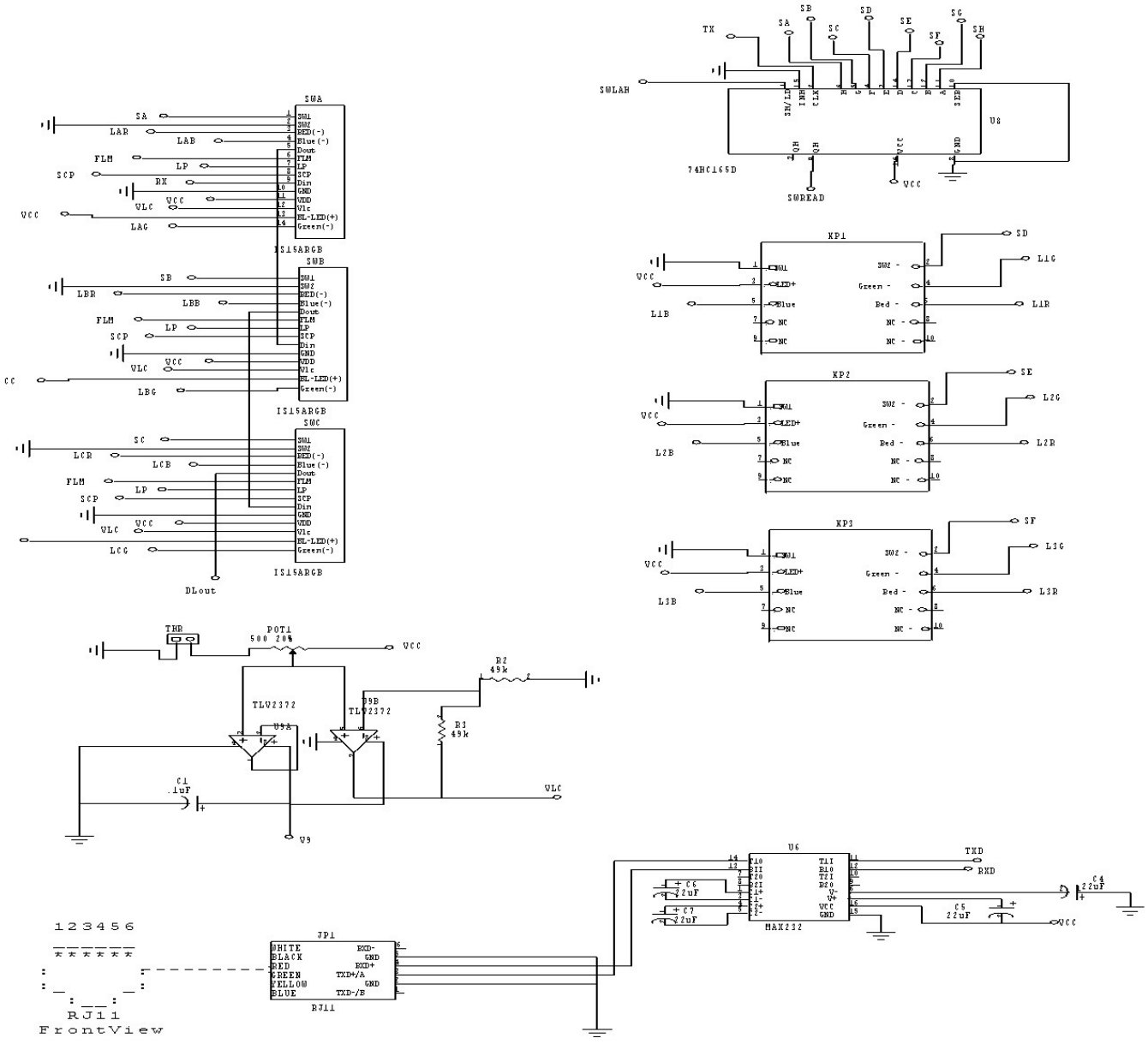
Figure 3, Sample schematic for controlling 3 RGB SmartSwitches (continued).



Please note the microcontroller is capable of driving up to 48 SmartSwitches.

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11. Frequently Asked Questions

Does the display have to be refreshed?
Yes. The displays have to be refreshed. The drawback for the switches that have a refreshing circuit in the switch cap is that the controller can not detect when the refreshing circuit freezes due to an ESD charge.

Why is one of the display rows darker than the rest?
The timing between the latch pulse of that row and the next row is longer than the timing between the rest of latch pulses.

What happens if the display is not refreshed?
If the VLC is present, one row of display gets charged for a long time, which can damage the display. If the micro-controller has to go to sleep mode, it must disable the VLC.

Does the micro-controller have to have external memory?
For a large number of switches the memory is needed to keep the pictures. For a small number of switches the pictures can be made on the fly using ASCII code and look up table without using external memory.

Is the display visible without the backlighting?
Yes. The LCD in the switch is transflective so it can be seen with sufficient ambient lighting. The negative LCD option requires backlighting.

Is the display sun light readable?
Since the LCD is transflective, it is sun light readable. However, the reflection from the lens may cause problem.

How many switches can be driven by a micro-controller?
The number of Modules that a Micro-controller can control depends on the instruction execution time, other tasks performed, hardware design, and software design.

- Example

  Given: A micro-controller with an average instruction execution time of 1 MicroSecond and with 34% of the time performing other tasks. The LP to LP timing is 1 ms.
  Calculate: The number of Modules that can be controlled by the Micro-controller.
  Solution: Time to refresh one line = (1ms)* (.66) = .66 ms = 660 instructions

  The data has to be addressed, retrieved, and shifted. The time for each of these tasks depends on hardware and software design. The fastest addressing scheme is to have the Buffer of the picture data on the RAM as shown on Figure 2.

  This scheme has the higher byte of the DATA POINTER holding the Module line number and the lower byte of the DATA POINTER points to the last byte of the last Module (same number for all the lines). Once the DATA POINTER is loaded a byte of the data is retrieved and shifted, and the lower byte of the DATA POINTER decrements, a byte of the data is retrieved and shifted…and so forth until the lower byte of the DATA POINTER is equal zero.

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Shifting the data with Micro-controller pins for many Modules is very time consuming. In this example we assume the data is written via the micro-controller parallel bus to a device such as the 3-shift register method described above or via serial port (8-bit mode). The shift speed of data must be such that the Micro-controller does not wait to write the shift data.
This method takes 3 Instruction per byte of data (Load the byte, Write the byte to the shift register and decrement the data pointer). If the Interrupt overhead takes 15 Instruction. This Micro-controller can control 43 Modules.

(660 Instr./line – 15 Instr./overhead)/ ((5 byte/Module)*(3 Instr./byte)) = 43 Modules. However due to driver fan-out and noise the actual number should be less.
WE have controlled 16 to 24 using 74HC4050 driver without any problem.

Can the switches be controlled with the low voltage?
The specification does not support it but we have tested the switches at 3.0V VDD and signals without any problem.

I only need to display a small picture. Do I need to refresh the whole display?
The FLM signal indicates the first line. If you do not need the display for all the 24 row of pixels, you can use FLM after as many lines as you need.
If you need to center your display, you can toggle the LP to insert a line.

Is it possible to have an image with shades of gray?
Yes, it is possible. Multiple pictures must be refreshed consecutively. The pixels that are ON for all the pictures will be the darkest, the pixels that are OFF for only one picture will be the second darkest and so on.
The number of shade of gray depends on how fast the controller can refresh the LCD.

How many backlight colors can be achieved?
Infinite. It depends on how many levels of control are present for each discrete color.
For example with a RGB SmartDisplay and 16 levels of control for each color the total number of colors is 16x16x16 = 4096 different color.

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