

Physics 335 – Analog to Digital Conversion Lab

Successive Approximation Register ADC

March 30, 2007

Notes

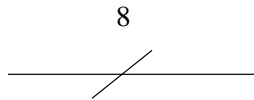
This lab will closely follow the first three section of Lab 17 in the manual. Reading the material in th manual on pages 406-409 and 411-416 prior to your lab section will be helpful.

Use only the +5 Volt fixed supplies for this lab. You should tie the negative side of the supply to the ground terminal on the supply if it is not already so. This will ensure that you have +5 Volts above ground throughout the lab. As usual, a $0.1 \mu F$ capacitor between +5 V and ground on the breadboard will help ensure you have a nice clean supply voltage

17-1 Following Section 17-1 There are no ribbon cables so use individual wires to connect the AD 558 inputs to +5 Volts or ground. Go through the “checkout” procedure. Measure the full scale output (all inputs connected to +5 Volts) and divide by 255 to determine the weight of the LSB (least significant bit).

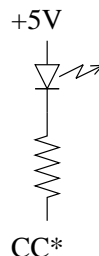
You may have a 74LS503 or a 74LS502 in your parts cabinet. You can use either, but note that it is necessary to ground pin 1 of the 74LS503 for it to operate correctly when used as we’re using it today. With Pin 1 grounded, the operation of the LS503 is identical to that of the LS502 in this lab exercise.

17-2 In Figure L17.4



means that 8 wires are represented by a single line in the diagram.

Skip connecting up the 8 LED’s at this time, but connect the CC* to a single LED. Put a 390 Ω resistor in series with the LED.



Since Convert Complete (CC*) goes LOW when the conversion is done, this will light the LED when the SAR is done with it’s conversion cycle. Remember that the flat side of the LED housing is the cathode (more negative) side, so this side will “face” CC*.

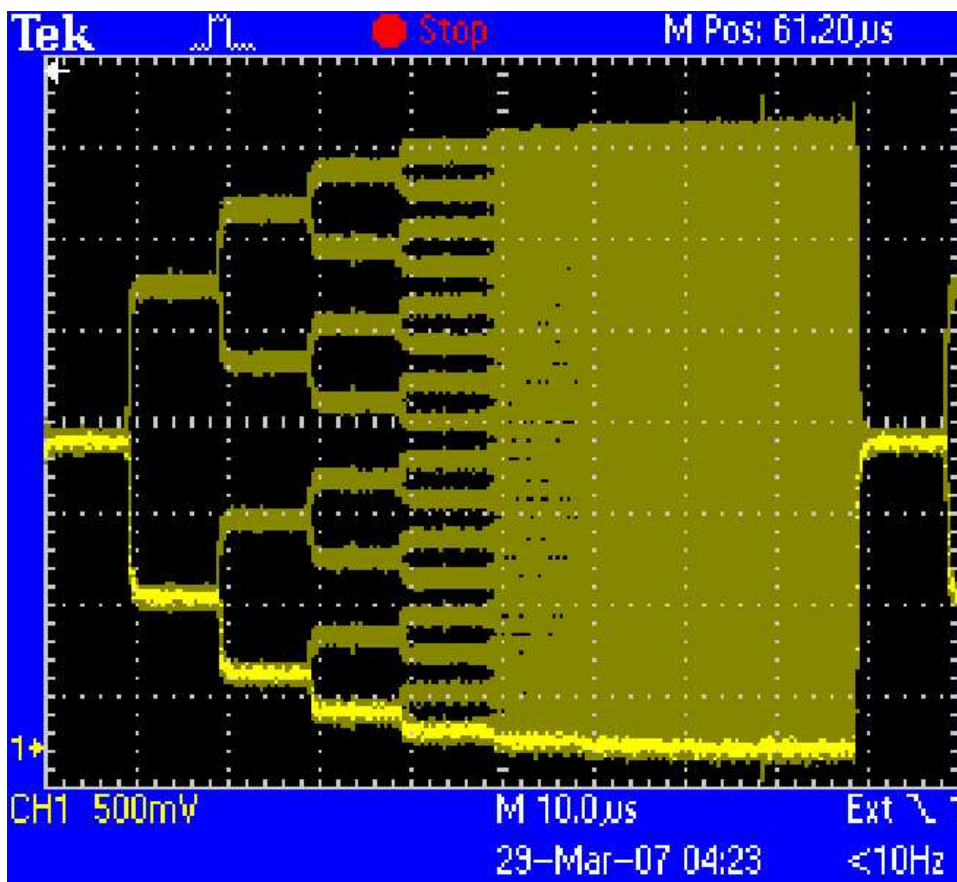
17-2.1 Use the prewired debounced switch in the parts cabinet for the CLOCK input to the 74LS502, or you can use the “Sync Out” output from the function generator. If you choose the latter, be sure you choose a “human-scaled” frequency (meaning < 1 Hertz) Use a regular SPDT toggle switch for the Start* to the LS502.

With the analog input input grounded, monitor the output of the 558 (pin 16) with a digital multimeter as you step through a conversion cycle. From how the 558 output changes between steps, can you tell with the output of the 502 is doing? Confirm your guess with the logic probe.

Be sure to read what the book notes the “Odd” behavior of S*. Specifically, note that this means that to start a conversion cycle, you need at least 1 clock with S* Low (where CC* goes High) and enough subsequent conversion clocks to set all 8 bits to their proper value.

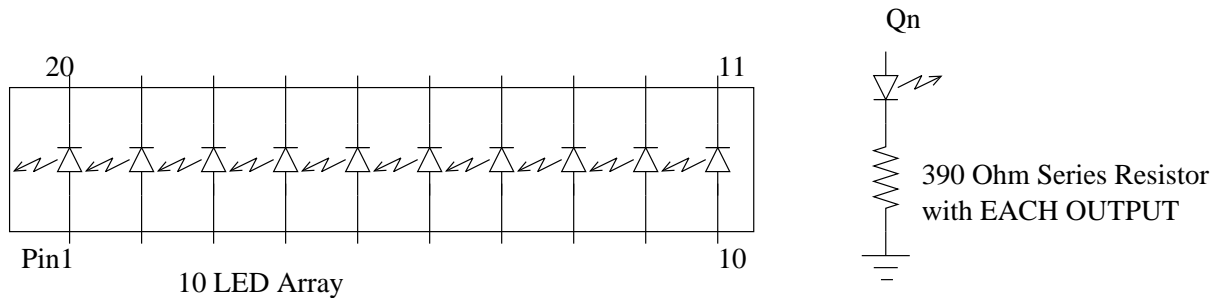
17.2.2 Leave the LED connected to CC*. Use a 2k (or so) pot for the variable voltage source. Trigger the scope on CC* (Watch the output of the 558 as you vary the potentiometer over its entire range.

17-2.3 Use one of the extra function generators in the lab to provide the 0-4 volt input signals. Check this signal out on the scope before connecting it to the input of your A \rightarrow D circuit. If the input signal doesn't cover the entire range of the 558 output, what will the search tree look like? Confirm your hunch by varying the amplitude of the input signal. The “quaking aspen” effect alluded to in the manual is most easily seen with an analog scope. Our digital scopes have some advantages and disadvantages in this regard. Open the “Display” menu and play with the “Persistence” (Persist) setting. You may be able to see a similar effect. To see the entire search tree, it may be helpful to turn the persist to ∞ (or at least some value other than “None”). You'll probably see something similar to this:

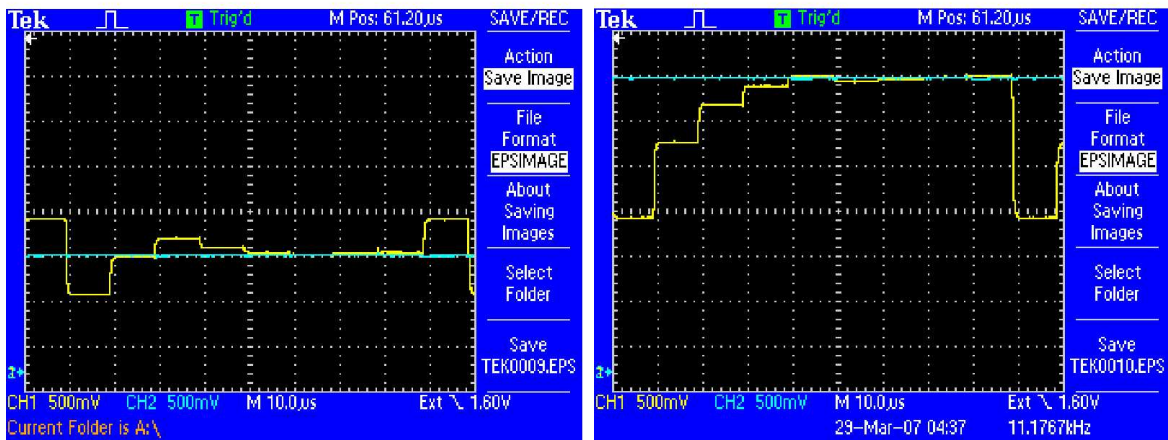


17-2.4 Highly optional

17-3 This is a nice, but optional, wrap-up to this lab. The LED's are on the 10 LED chip, a pinout of which is shown below. Each LED can be driven by an output (Q_n) of the 74 HCT 574. Use a 390 Ω resistor in series with EACH LED. Reconnect the input of the A \rightarrow D circuit to the center tap of the potentiometer. With some fine tuning of the pot, one can see the digital output change by one or two bits at a time.



Again, as the SAR circuit hones in on it's final value, you'll see the 558's analog output voltage bounce back and forth on either side of the "true" input voltage. The following traces show how we get closer and closer to the input value for a relatively low and high voltage. The input voltage is shown in BLUE, the Analog output from the 558 is shown in YELLOW.



To make a trace like these, how would you decide on an appropriate time base for your scope?

That's it!

Please disassemble your circuit, gently prying out any chips from underneath with a pair of angled forceps, and return all parts to the SAR LAB parts bin at your lab stations so they're there for the next people!