Homework 2: Due Thurs, Sept 17

Problem 1 - Instrumentation (Prob 3 from HW1)

A voltmeter on an ATE has 5 intrument ranges (0.1V, 1V, 2V, 5V, 10V). The Vref for the 8 bit instrument ADC is 1.2V.

(a) What is the role of ranging in an instrument?

(b) What is the quantization noise seen in the instrument ADC?

(c) I would like to use this instrument to measure the reference voltage on a DAC chip. This voltage can range between 2.75V and 2.85V. What instrument range should be used?

(d) Given your answer in part (c), find the PGA gain factor that will map the input appropriately to the instrument ADC. If the actual measurement was 2.842V,what value would come out of the PGA and go into the instrument ADC? Once the ADC adds the worst-case quantization noise and the computer scales the final value, find the worst case measurement that would be stored.

(e) If the instrument is placed in a high precision mode, the 2V DC offset can be removed from the measurement before going to the PGA. The instrument range will be automatically adjusted to the best range for the measurement without the 2V DC offset. What instrument range would be used?

(f) Given your answer in part (e), find the PGA gain factor that will map the input appropriately to the instrument ADC. What value would come out of the PGA and go into the instrument ADC? Once the ADC adds the quantization noise, and the computer scales the final value and adds the DC offset back in, find the worst case measurement that would be stored.

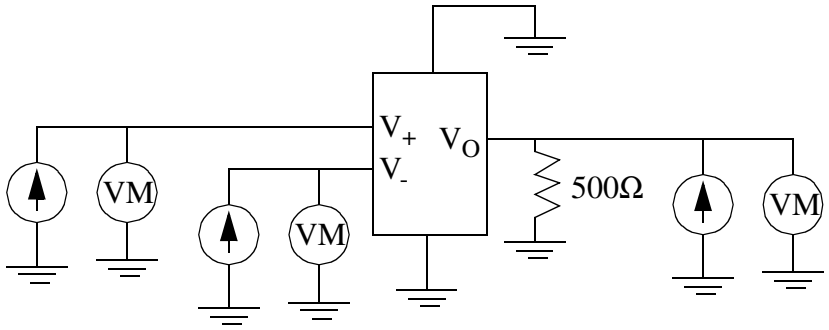
(g) What is the trade-off inherent in these two measurement techniques?

(h) (part d from Problem 2 HW1) Give 2 examples of how test time can be decreased without effecting accuracy.

Problem 2 - Continuity Test

(a) I wrote the standard continuity test for a circuit (sourcing 1mA into the pin). However, the V_O pin passed with no chip in it. Why is this bad?

(b) Upon closer inspection of the board, I found that a 500Ω load was connected to the output pin and not separated by a relay (see schematic). Why would this cause the problem?



(c) How could I write the test program (without changing the DIB, which is expensive) so that it fails open circuit and passes with a device?

(d) In lab, I stated that the continuity test failures are generally binned into a different hardware bin than the other test failures. Why?

For the following problems, use the MAX941 datasheet.

Problem 3 - Comparator Offset Voltage Test

In this problem, you will design a test for the input-referred trip points and the offset voltage.

(a) What is the difference between V_{TRIP} and V_{OS}?

(b) Draw a schematic that will test these specifications. Be sure to clearly label all voltage and/or current sources with variable names unless they are to be constant throughout the test. If they are constant, be sure to label the value of the current or voltage source. Also, be sure to clearly label any necessary measurement equipment (e.g. VM or IM) so that it is clear what type of resource would be necessary.

(c) What does the V_{CM} specification tell you about the test?

(d) If you were to perform a linear sweep to find the input-referred trip points, what input voltages should be used/swept for each operating condition listed? What resolution do you think would be best? Explain your answer.

(e) List the test procedure necessary to obtain V_{TRIP} and V_{OS} specification for $V_{CM}=V_{+}$.

(f) Describe any calculations necessary to obtain the specifications. Be sure to get the measured specifications in the datasheet units listed. What would your datasheet limits be?

(g) If you were to use the successive approximation approach with $V_{CM}=0V$, list the values of the input voltages that you would use to reach approximately a 0.25mV resolution. Present this as a binary tree.

Problem 4 - Input Bias Current Test

In this problem, you will design a test for the input bias current.

(a) How could you use the characterization curve for the input bias current as a function of common-mode voltage (see page 5) to determine which test conditions should be tested for this specification?

(b) Do you think you can measure the input bias current directly, or do you need to gain it up?

(c) Draw a schematic to test the input bias current. Be sure to label constant voltages with their values, changing values with variables, and show the instruments necessary for the test.

(d) Find value for Rb that would provide good production measurements. Valid QMS ranges include: 500mV, 1V, 5V, and 10V.

(e) If the resistor on the DIB has 5% tolerance, find the worst case resulting measurement. What voltage range should you use to perform the test?

(f) If the bias current was the typical value, would this be a good measurement or would it get lost in the quantization noise?

(g) List the steps necessary to perform this test.

(h) What calculations would be necessary to obtain the specifications in the units on the datasheet? Would you expect the current to be positive or negative? Explain your answer.