

## Analog-to-Digital Conversion

1. The successive approximation Analog to digital converter circuit typically consists of four chief subcircuits. What is the name of the subcircuit that holds the digital number (DN)?
2. What is the name of the SAR register pair in the ATmega328P subsystem?
3. How many bits are required to hold the result of our ADC and how many bits is the ADCH:ADCL register pair?
4. An analog multiplexer allows the ADC subsystem of the ATmega328P to read more than one analog channel. How many single-ended inputs are supported by the Arduino and can these be read simultaneously?
5. List the Arduino and ATmega Port pin names of these 6 analog input pins.
6. What is the name of the Arduino IDE function used to convert an analog number into a digital value?
7. We have a 4-bit DAC with  $V_{ref} = 3.3v$  and an input voltage of  $V_s = 1.15v$ . Draw a diagram illustrating the conversion process of a successive approximation ADC. Label the x-axis conversion step and the y-axis Digital Number (DN).
8. For the previous problem, what digital number (DN) will be returned by the DAC? What percentage error does this represent?
9. Given a 10-bit DAC with  $V_{ref} = 3.3v$  and an input voltage of  $V_s = 1.15v$  applied to pin PC5 (ADC5/SCL/PCINT13), what digital number (DN) will be returned by the DAC? What percentage error does this represent? Hint: Use the equation  $ADC = V_{in} \times 1024 / V_{ref}$ .
10. What Arduino pin name corresponds to ATmega328P pin PC5 (ADC5/SCL/PCINT13)?
11. With respect to the Arduino schematic, configure the ADC Multiplexer Selection Register Control (ADMUX) to meet the following conditions :  $V_{ref} = 3.3v$ , the answer in ADCH:ADCL is right justified, and  $V_s$  is applied to Analog In 5.

Use the following code to answer the next question. The `analogReference` function is defined as:

```
void analogReference(uint8_t mode) {  
    analog_reference = mode;  
}
```

12. What data type is `mode` assigned?

Use the following code to answer the next three questions. The `analogRead` instruction begins:

```
int analogRead(uint8_t pin) {  
    uint8_t low, high;  
    ADMUX = (analog_reference << 6) | (pin & 0x0f);  
}
```

13. For conditions defined in problem 11, what value would be saved in variable `analog_reference`?
14. For conditions defined in problem 11, what value would be saved in variable `pin`?
15. This question is testing your understanding of the C++ instruction initializing the ADMUX register. With this in mind, assume `analog_reference = 0xFC` and `pin = 0xF5`, what value would be saved in variable (register) ADMUX?