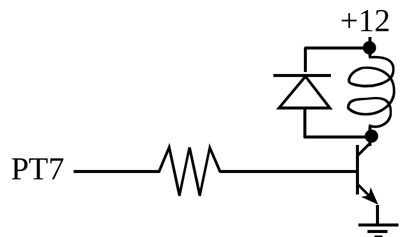
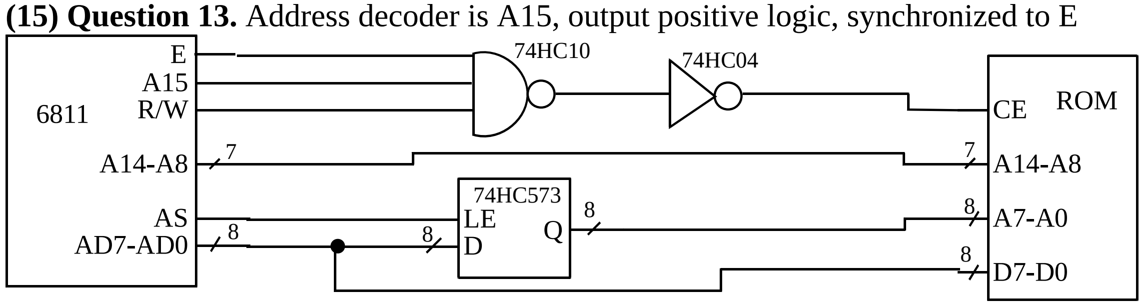
**(4) Question 1.** To make it allocated in permanent RAM, **C)** **`static`**
**(4) Question 2.** Because of all the calculations, use **B) Binary fixed-point**
**(4) Question 3**. To increase $V_{OH}$ **C) No, add a resistor to +5V** (it will effect $I_{OL}$)
**(4) Question 4.** ADC range is 2V, Precision is 2V/0.001V, which is 2000 alternatives. Use an **11-bit ADC**, which has a precision of 2048 alternatives.
**(4) Question 5.** Need NPN to sink current, need resistor to set LED current **(C)**
**(4) Question 6.** Slowing down the 9S12 will B) make the batteries last longer
**(4) Question 7.** Because the Fifo is empty, the software is not putting much data into it
**A)** The system is CPU bound
**(4) Question 8.** Because the Fifo is empty, the input rate is slow
**C)** The system is I/O bound
**(4) Question 9.** *Functional debugging* means we are interested in the input/output data. *minimally intrusive* means the debugging instrument needs to execute fast as compared to the time between interrupt calls. The dump is the fastest way to collect data

D)
```
asm sei
if(n<100){BufX[n]=x; BufY[n]=y; n++;}
asm cli
```

**(4) Question 10.** Start with coworkers (you probably measured something wrong), then go to your boss, then go to the safety officer at the company. As a last resort, contact federal safety commissions.
**(5) Question 11.** Clock is normally high (CPOL=1), 9S12 needs to latch on the falling edge (other edge from the input device) (CPHA=0). See book figure 7.40
**(10) Question 12.** Use +12V supply because it is a 12V motor. Use a NPN, because it is simpler to interface a current sink to the 9S12 (they share common ground, but do share a common supply). Need 12V/10Ω = 1.2A, so use a TIP120, which has a maximum ICE of 3A. The hFE=1000 of the TIP120 means the IIH of the 9S12 will only be 1.2mA. The resistor can be added to limit the base current to a maximum of 1.2mA. The snubber diode (1N914) prevents back EMF.

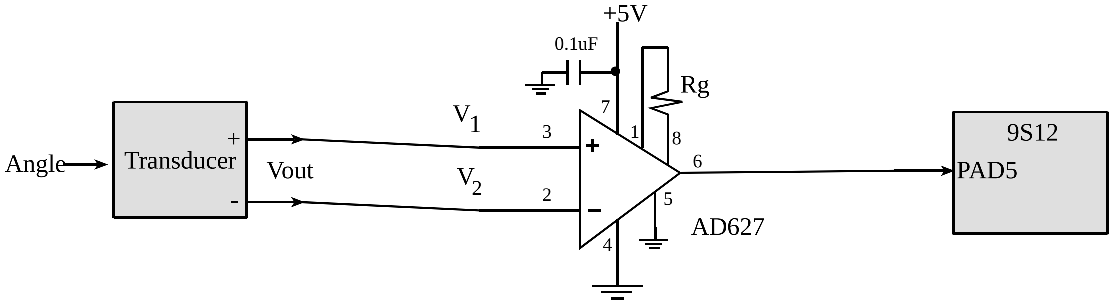



**(15) Question 13.** Address decoder is A15, output positive logic, synchronized to E




Part b) The delays on first start of the interval are maximums, and at the end we use minimums. **Read Data Available** = [250+15+15+60,500+5+5+10] = [340,520]

**(15) Question 14.** A data acquisition system to measure angle.
Part a) Good CMRR and differential means use instrumentation amp. Need gain = 5 (no Rf is needed, leave pins 1,8 open)




Part b) It is unsigned, and the integer will be 16 bits. Since 360/1024 is 0.35, I would choose 0.1 º for the resolution
Part c) Scale 0 to 1023 into 0 to 3600.

```
unsigned short Convert(unsigned short rawData){
unsigned long answer;
  answer = 3600*rawData;
  return answer/1023;
}
unsigned short Convert(unsigned short rawData){
  return 3600*rawData /1023;  // some compilers will do this correctly
}
unsigned short Convert(unsigned short rawData){
  return 225*rawData /64;  // some compilers will do this correctly
}
```

**(15) Question 15.** TDRE will be 1 at the time of each IC interrupt

```
unsigned char Count; // 0,1,2,3,4 used to find every fifth edge
void main(void){
  TIOS &= ~0x01;  // PT0 input capture
  DDRT &= ~0x01;  // PT0 is input
  TSCR1 = 0x80;   // enable TCNT
  TCTL4 = (TCTL4&0xFC)|0x01; // rising
  TFLG1 = 0x01;   // Clear C0F
  TIE |= 0x01;    // Arm IC0
  Count = 5;
  SCIBD=13;       // br=MCLK/(16*baudRate)
  SCICR1 = 0;     // 1 start, 8 data, 1 stop, no parity
  SCICR2 = 0x0C;  // TE, enable transmit, RE, enable receive(optional)
  asm cli
  while(1){};
}
interrupt 8 void TC0handler(void){ unsigned char dummy;
  TFLG1 = 0x01;  // ack by clearing C0F
  Count--;
  if(Count == 0){
    Count = 5;      // fifth rising edge
    dummy = SCISR1; // read status with TDRE set
    SCIDRL = 0x56;  // output ‘V’
  }
}
```