Incubator eletronics

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September 3, 2020

Abstract

Short introduction to subject of the paper . . .

1 Design

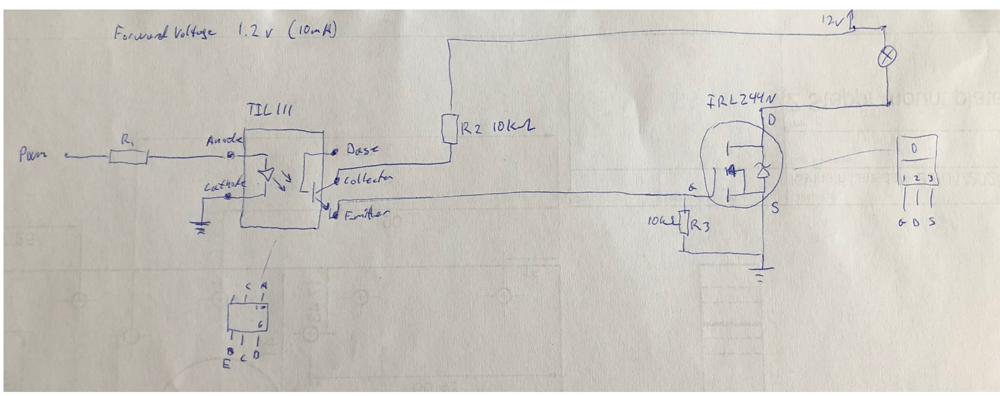


Figure 1: Overall design

1.1 Calculation of optocoupker resistor

Spec for TIL111

1. Forward Voltage 1.2v (10mA)

$$
\begin{aligned}
R &= \frac{V}{I} \\
R_1 &= \frac{3.3v - 1.2v}{0.010A} = 210\Omega
\end{aligned}
\tag{1}
$$

This means that the input resistor between the PI pin and the anote of the optocoupler must be at least 210 Ω so 220 Ω is a good candidate

1.2 MOSFET

Spec for IRLZ44N (N-channel mostfet:

1. $R_{DS_{ON}} = 0.022\Omega$ $V_{GS} = 10v$ $I_D = 25A$
2. $V_{GS} = 16V$ max gate voltage
3. 175 °C - max operation temp
4. $V_{CS(th)} = 1v$
5. $R_{BJ}A = 62$ °C/W

Heat disipation assuming a heated bed plate with this spec is powered:

1. $R = 1.65\Omega$ for 12v
2. $P = 87w$
3. $A = 7.25A$

Calculate watts for when powering the heated bed

$$\begin{aligned} P &= R * I^2 \\ &= 22mA * 7.25^2 = 1156mW = 1.156W \end{aligned} \tag{2}$$

Calculate watts the MOSFET can handle withtout cooling

$$\begin{aligned} P_D &= \frac{max(T_J) - T_A}{R_{øJA}} \\ &= \frac{175°C - 25°C}{62} = 2.4W \end{aligned} \tag{3}$$

So to use it without a heat sink we need $1.156W < 2.4W$ which it is so no heat sink required.

Calculating resistors between the optocoupker and mosfet. Two resistors are required. One to pull down the gate when not powered here a $10K\Omega$ or similar is fine the smaller the faster it turns off. The other resistor is required to make a voltage devider to protect the gate input voltage of the MOSFET which has a max input voltage of $V_{GS} = 16v$. This means if we power it by 12v then nothing is needed but for other reasons a resistor should be added, bla bla.. So we chose to design it to also allow for 24v and get both handled by the same design.

A Voltage desiver is defined as

$$V_{out} = \frac{V_s * R_2}{R_1 + R_2} \tag{4}$$

So lets find a resistor

$$
\begin{aligned}
V_{out} &= \frac{12v * 10K\Omega}{10K\Omega + 10K\Omega} = 6v \\
&= \frac{24v * 10K\Omega}{10K\Omega + 10K\Omega} = 12v
\end{aligned} \tag{5}
$$

So we see that both of these gives a voltage less than V_{gs} i.e. $12v < 16v$ so this resistor valye is fine. The value is also above $V_{CS(th)}$ so it is enough to turn it on

1.3 A first version of the schematics

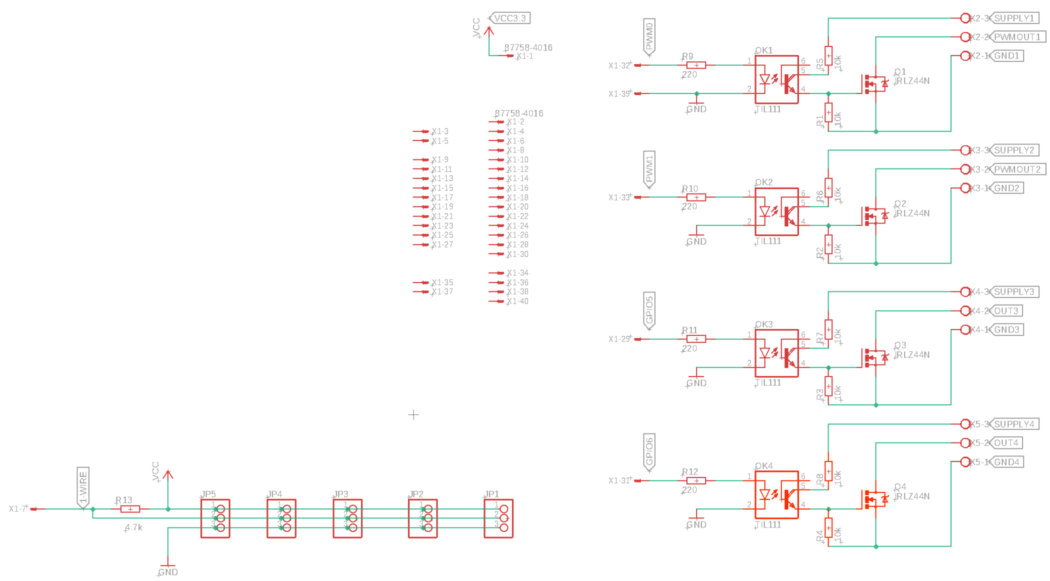


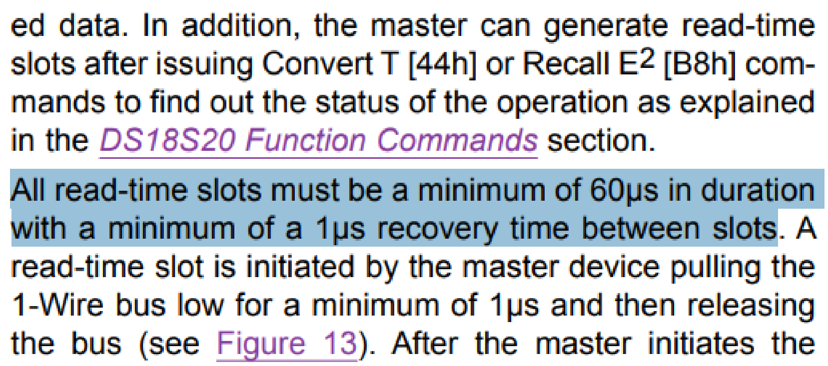
Figure 2: Schematics

2 Assumptions and Limits

Claudio: Hao, Kenneth, please add the calculations and assumptions here.

2.1 Reading Frequency of the sensors

From the sensor manual, The calculation of the frequency can be calculated as follows: Assume recovery time between read slots is 3 us, and the minimum time of reading a bit is 62us, we need to read 8 bits, so the approximate reading time is 62*8=496 about 500us. or maybe we need to read 16 bits, then the time



ed data. In addition, the master can generate read-time slots after issuing Convert T [44h] or Recall E^2 [B8h] commands to find out the status of the operation as explained in the *DS18S20 Function Commands* section.

All read-time slots must be a minimum of 60µs in duration with a minimum of a 1µs recovery time between slots. A read-time slot is initiated by the master device pulling the 1-Wire bus low for a minimum of 1µs and then releasing the bus (see Figure 13). After the master initiates the

Figure 3: Reading time slot

is approximate 1ms. If nothing is wrong I guess the frequency is larger than 10Hz.

Example code of reading and writing the sensors can be found at: Example code