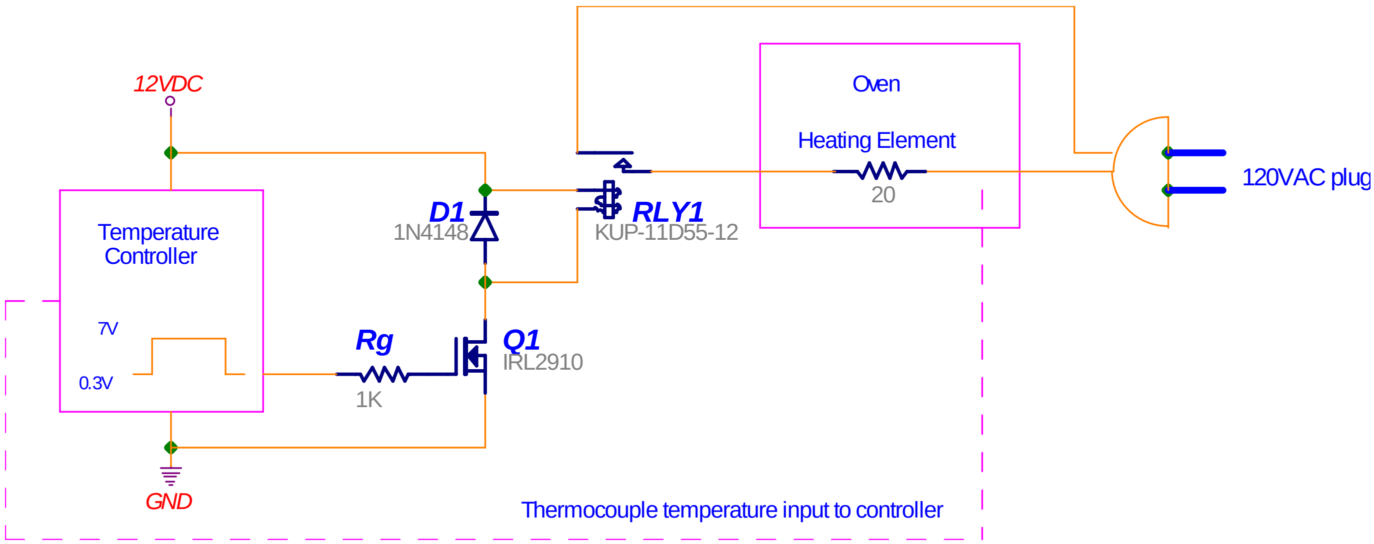
HWK #2 Solution FET Relay Driver

The circuit is the same except that a FET has replaced the BJT transistor.



The relay is the same Tyco **KUP-11D55-12** with the following specs:.
Contacts 10A@240VAC, coil 12VDC@100mA.

The FET must handle at least 12V@200mA and be fully turned on with a gate drive of 7V. Note: By fully turned on I mean that the majority of the voltage is dropped across the load and not the FET. Ex: If with V_{GS} = 7V and I_D = 100mA what would V_{DS} be? It should be much smaller than the voltage being switched (12V in this case).

Lets try the FET we've been using in class.
The **IRL2910** from irf.com has the following specs: $\mathbf{V_{DS} = 100V}$, **ID = 55A, Rds = 0.026Ω**.

This looks promising but you need to check that the FET will be ON with a gate drive of 7V. Looking at the graph (from page three of the datasheet) we see that there are curves for a V_{GS} of 6V & 8V. Both curves appear to overlap so we can assume that with a V_{GS} of 7V we would be operating at the bottom of the thick black curve.

This FET can handle lots of current so the graph stops at 1A and 0.1V. But with V_{GS} = 7V we can see that with a drain current of 5A V_{DS} is only 0.1V. Since we're operating with a drain current of 100mA (50 times less current) the voltage drop across the FET would be about 50 times less (~5mV).

If the FET is fully ON we can also use Rds to calculate V_{DS}. The published Rds would

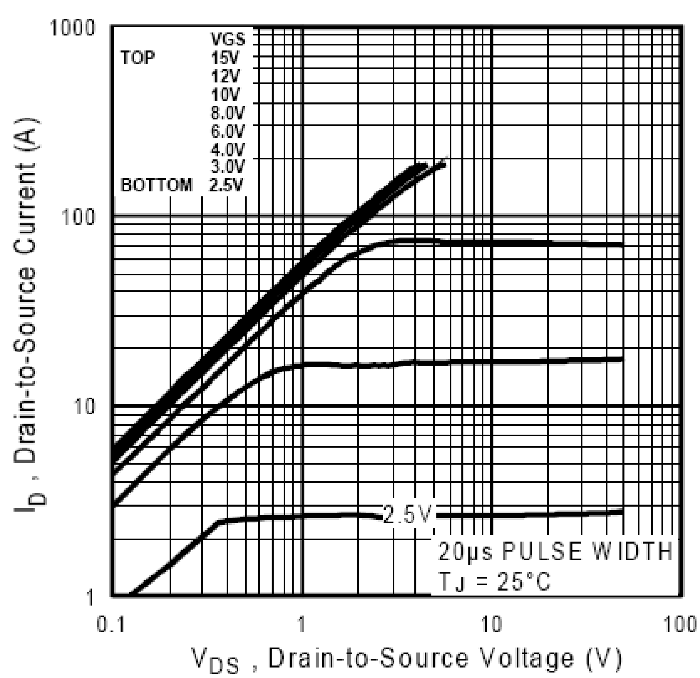


Fig 1. Typical Output Characteristics

correspond the top line with V_{GS} = 15V. It's almost the same as with V_{GS} = 7V. Ex: 100mA times an Rds of 0.026Ω = 2.6mV. This is close to the 5mV we calculated above.

One could also compare the on resistance of the FET to the load (in this case the 120Ω relay coil). If with V_{GS} = 7V Rds << 120Ω the FET will work well as a switch. As a rule of thumb at least 95% of the voltage should be dropped across the load and 5% or less of the voltage should be dropped across the switch (i.e. the FET).

Note: The gate resistor isn't really needed. It's there to limit the inrush current into the gate when the temperature controller output switches. Once the FET has switched (i.e. the gate capacitance is fully charged or discharged) the gate doesn't draw any current. Increasing the gate resistor would increase the time it takes to charge the gate capacitance and therefore slow down the switching speed. Another words, the gate resistor can be adjusted to control the switching time of the FET.

Besides N & P channel FETs there are also enhancement mode or depletion mode FETs. Enhancement mode FETs enhance the conductivity (i.e. turn on) with a positive V_{GS}. Depletion mode FET's have a conducting channel without any gate voltage applied and deplete the channel (i.e. switch off) when a negative V_{GS} is applied. We've been using enhancement mode FETs in class.