MODULE 13 - Lecture 48 - Experimental Set-up of closed loop control of temperature sensor

Electronic Modules for Industrial Applications using Op-Amps

Welcome to the module. So, now we will see

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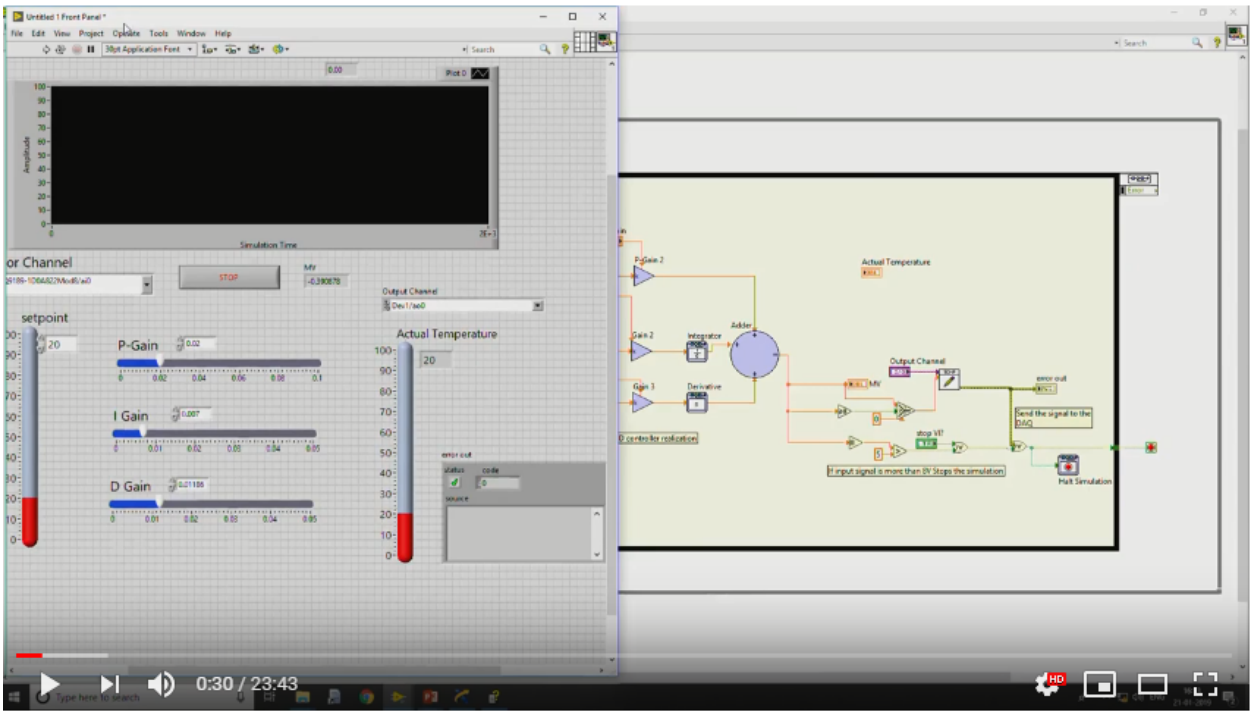

circuit board. So, this is our 2N3055 transistor, this is the temperature sensor, and this is 741 IC so, general purpose operational amplifier. Now, let me build, let me build a circuit what we have seen in the, in our circ, in our presentation. So, keeping on our presentation

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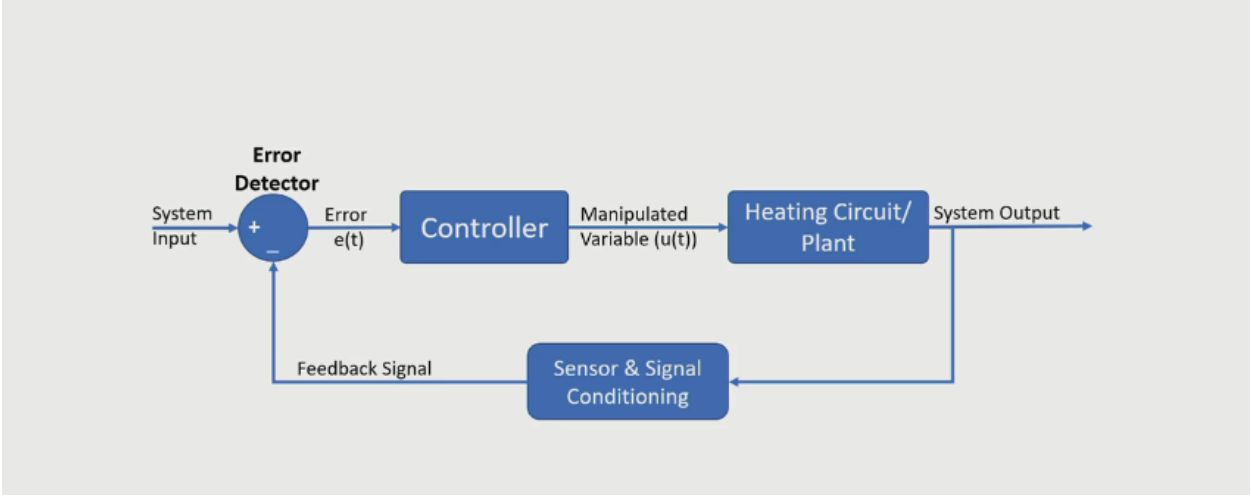

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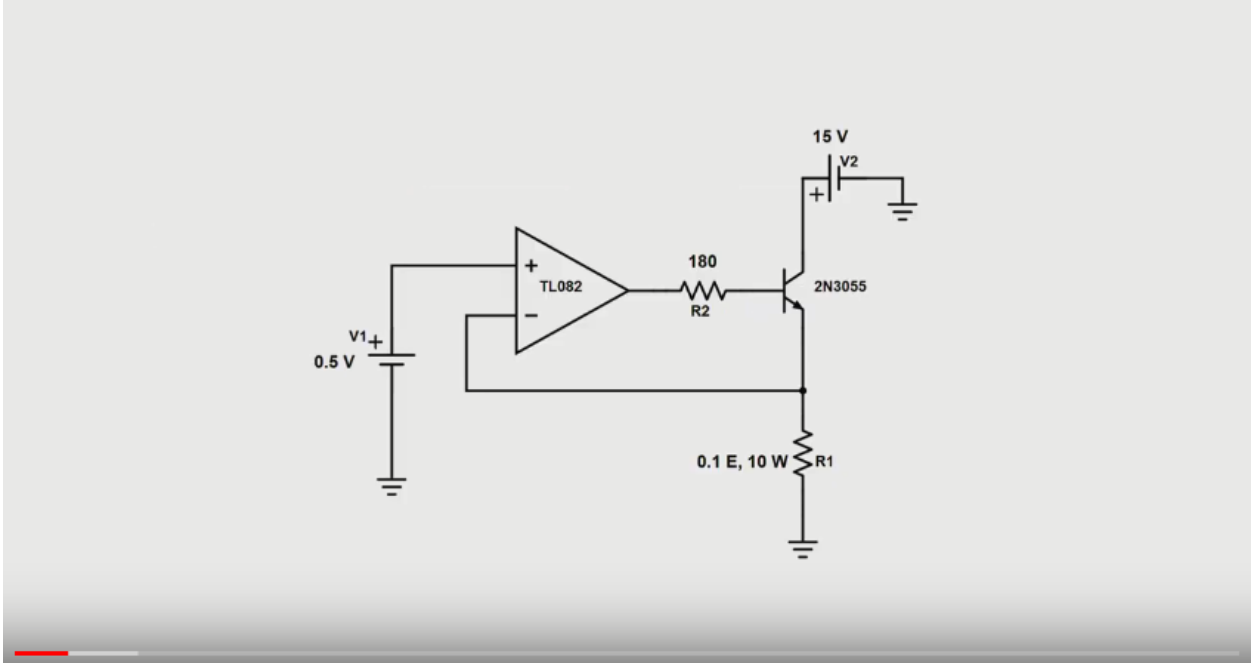

Right! So, when you look in to the circuit, so if you require the data sheet of 741 operational amplifier. So, the second pin is nothing but a negative terminal, whereas the posi, the third pin our 741 is non-inverting terminal, whereas the fourth pin is minus vcc and seventh pin is plus vcc, and the output is nothing but sixth pin. So, what I will be doing is, That! So, this is 180 ohm resistor, I will be connecting the output, which is nothing but sixth pin. So, four, five, six, the sixth pin with 180 ohm resistor with the base of transistor. So, this is 1 ohm, 5 watt resistor, this should be connected across the negative terminal and the ground. So, the negative terminal in this case is second pin and the ground here, somewhere here I will be taking it and I will be connecting it here. Similarly, even this, the negative terminal of an operational amplifier has to be connected with the emitter of transistor. So, when we look in to the connections of 2N3055, pinouts of 2N3055, the casing act as a collector, whereas this two terminals act as base as well as an emitter. So, in this case, the red wire. So, we have three wires here, the red wire indicates the collector. So, even here we can see is a collector, in this case the red wire act as a collector. So, the red color wire, this act as a collector, whereas this black color wire act as base, and the brown color wile, wire act as an emitter. So, what I will be doing is that I will be connecting this three terminals to this and in this case the black is base, so this will be connected to the base, Similarly the brown is emitter, emitter will be connected to the second terminal, which is negative and the first one is a collector, the collector will be connected to our power supply. Now, similarly the sensor require 5 volts. So, when you look into the data sheet of LM35, the red one indicates the plus 5 volts, the black one indicates the ground, and the brown indicates our output. So, I will be connecting with three male to male jumpers, red

one with yellow, output with green and black with output and outputs for this, I will be using USB DAQ. So, when we look in to our

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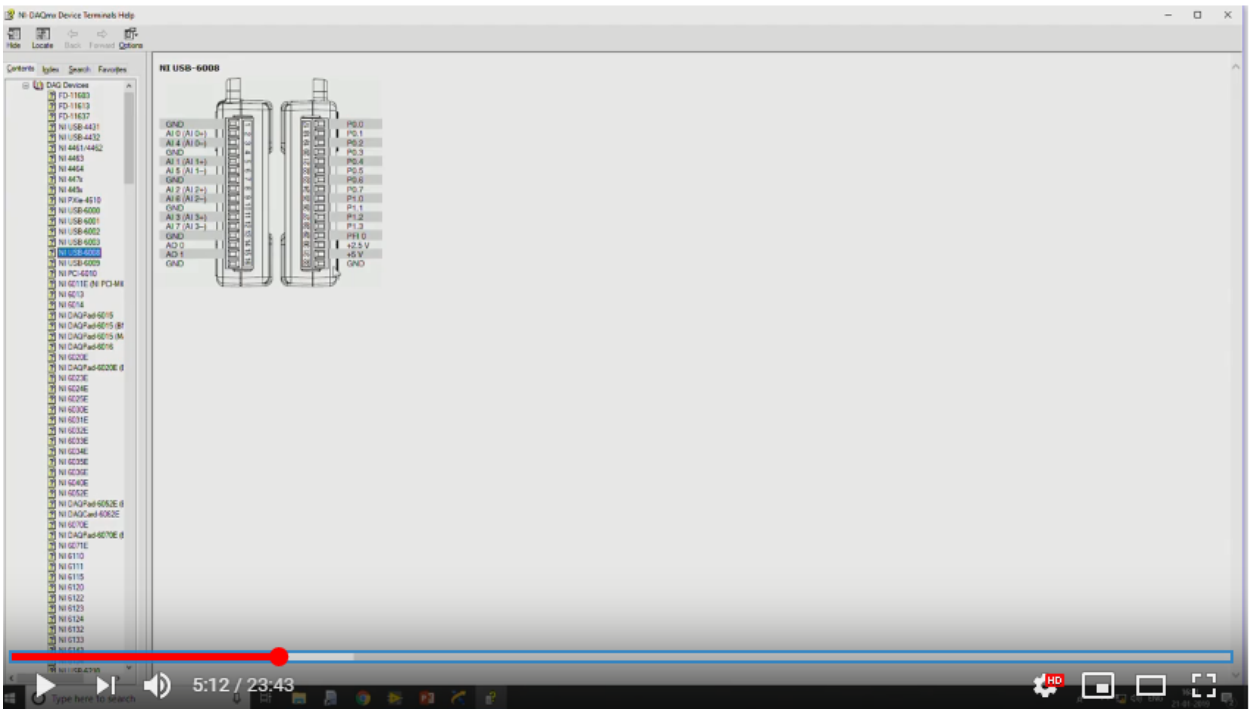

USB DAQ, pinouts. So, thirty first is 5 volts, and thirty two is ground. So, what I will be doing is, red I will be connecting it to thirty first and the black I will be connecting it to ground, sensor. Now, so after connecting the power supply, required power supply to this, the output of this particular terminal has to be connected to n log input channels, in this case is y0. So, what I will be doing is that the output side, which is nothing but green, I'll be connecting it to this. So, to the input, we have to provide n log output, Okay. Then, let me connect this power supply. So, we also have to provide plus 15 to operational amplifier and minus 15 as well, along with this we require plus 15 to be provided to the collector of this. So, what I will do is it, I will from channel 1 the maximum voltage, I will set to 12 volts and the current, the maximum current I will set it to 2.5 amps, so that more than 2.5 amps the, the su, the power supply will switches off. In sim, similarly, in case of channel 2, channel 2, 12 volts I am setting, the current is 1.5 amps and the press output, so both channels and supply the same amount of output, yeah! So, this is our channel 1, whereas this is our channel 2. So, what I will be doing is that so the 15 volts should be connected to the seventh terminal, Okay. And, whereas this is our minus 15 terminal. So, the plus 15, I am replacing with this wire, connecting it to plus fifth, the vcc terminal of operational amplifier, whereas this is our ground, this ground I will be connected it to this. So, everything should have the same common ground, and similarly even minus 15, so this is the positive terminal of that terminal. So, so in this case it act as a

ground, where since we have to provide minus, I will be connecting it. So, everything is having a common ground right now. Similarly, we also require to connect the output, which is nothing but the thirty three pin, thirty second pin to be connected to the same ground. So, I will what I will be taking is, I'll take another wire, so in order to make everything as common ground I'll be connecting with this here, let me make the connections. So, this is minus vcc, this I'll connect it to the fourth pin. Similarly, we have to power LM35. So, in this case this it is required 5 volts I will be connecting the yellow wires which is 5 volts in this case to this device, and ground should be grounded here same common ground, and output which is ground in this case has to be acquired using this particular pin. So, now the connections to the sensor is done. So now if you see the connections so what we have made, so we have realized our circuit what ever we have seen which is with operational amplifier as well as our 2N3055 on this bread board such that the base of the transistor is connected to the output of operational amplifier using this particular resistance 180 ohms. Now when you see that under the terminal which is emitter in this case. So, the emitter when you see the emitter, the emitter is connected to the second terminal which is negative terminal along with this the, the resister 0.1, 1 ohm 5 watt resistor is also connected across the negative terminal and the ground, and all grounds are connected shorted and as well as the output, the analog output from the which is generating from USB DAQ is connected to the positive terminal of the operational amplifier which is nothing but the terminal. Similarly, the power the required power to the operational amplifier as providing using this particular power supply. So, this is channel 1, and this channel 2 as if know I have not switched on the output so that when one switch on the power when I switch on it provides 12 volts as well as minus 12 volts, and the power to the transistor is connected to LM35 which requires 5 volts in order to operate has been provided by using USB DAQ at the terminal at pins of 31 and 32. And similarly the input voltage which is been acquired by the operational amplifier sorry the sensor output voltage will be acquired using NI9207 C DAQ so which is connected at this particular point. So now all connections are made so let me switch on so this right now the current flowing through is channel 1 is 24 milli amps, now I have not still provided the output yet suppose if I collector so this drawing 1.8 and this started heating. Okay? So, when we look into the PC

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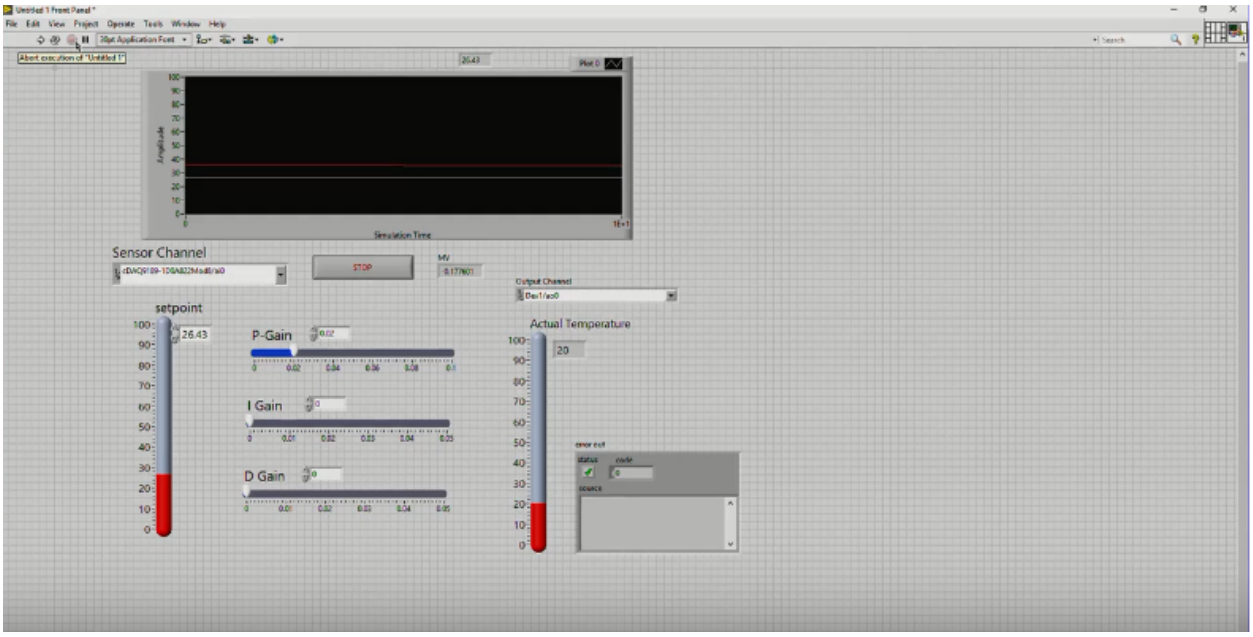

So here we can see right now the set point is 26.43, so just make it as 25. Okay? So, when I start running the system the actual temperature right now it is showing as 20 degree, so this has been not connected yet, so this is our actual temperature so when I run the program. Right? So the actual temperature on top of the transistor is 30.81 were as the set point is 25, so that's why the manipulated variable output is of minus volts, so when we provide a minus voltage to the driver circuit which makes the, the you know the system to be off. So, when you look into the power supply the current drawn will be as similar to the previous step which is, which is nothing but right now the system is in off condition. Now when I make the set point to 50 say now, we can see the manipulated variable has been increased to somewhere around 0.33.

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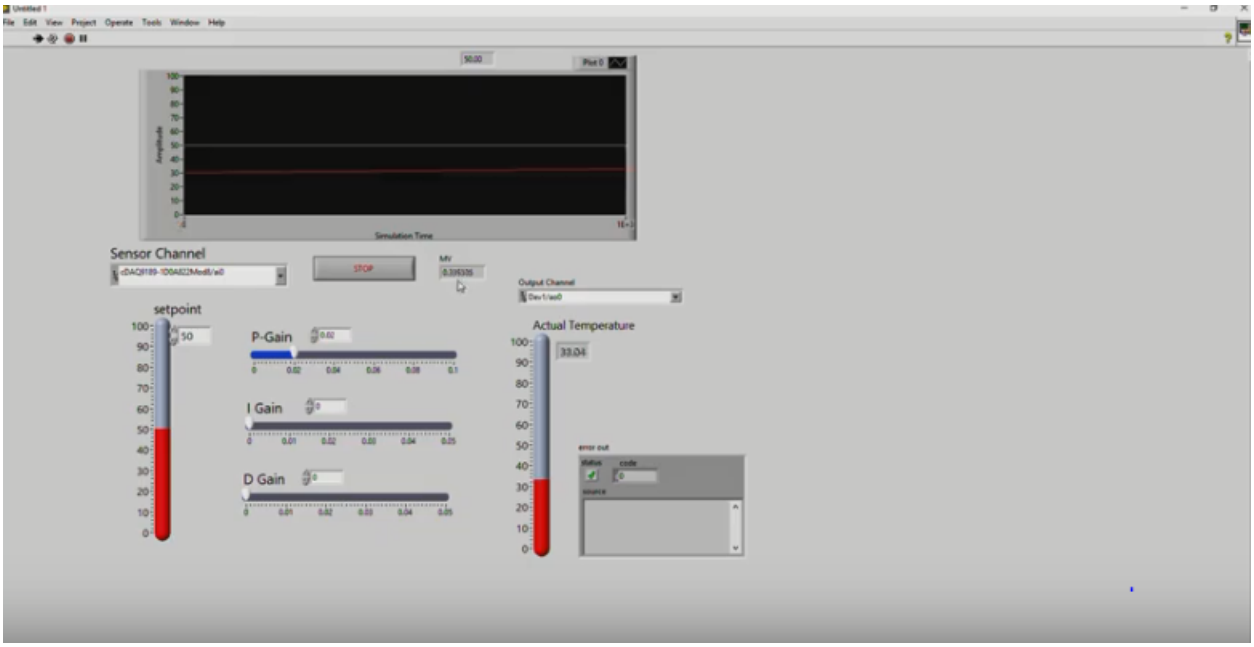

So, when you see the current drawn by the system is increased 24 milli amps to somewhere around approximately 0.8 to 1 amps keep on increasing.

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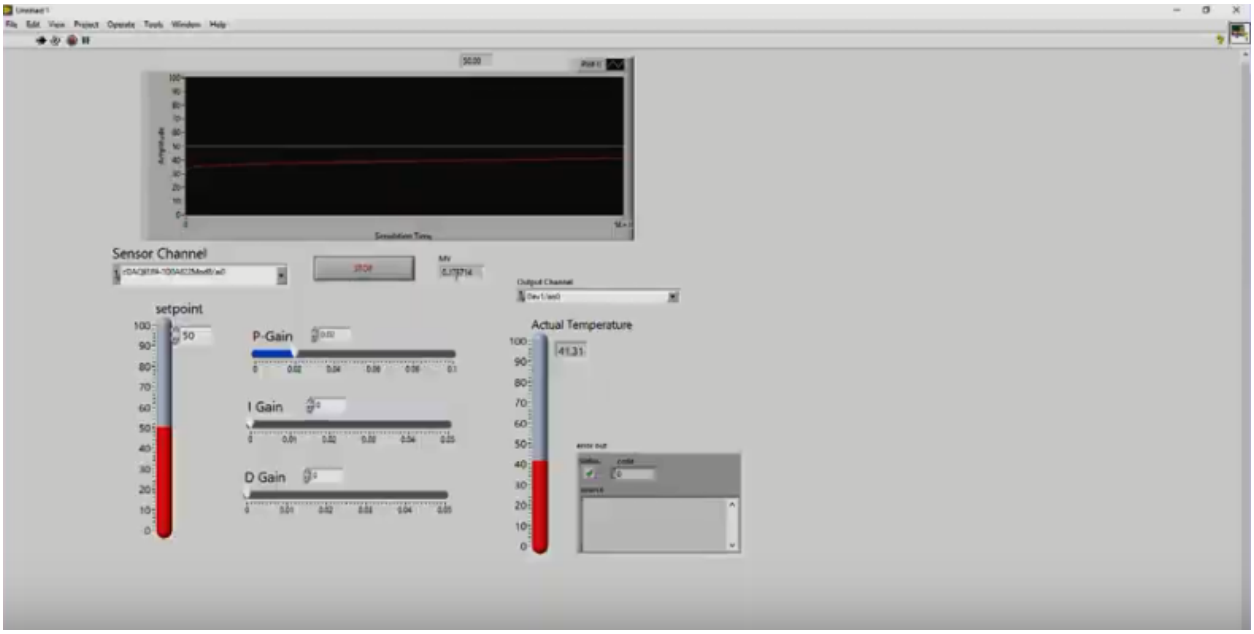

So as a result when it comes very close to the set point the current drawn by the system will also decrease, so here we can see from the graph so the, the white one indicates the set point, whereas the red one indicates the actual output on top of the transistor. So the temperature of the transistor slowly, slowly increasing so right now the temperature is 44 degree and the time it is required to take in order to reach to the set point entirely depends up on external environmental factors as well as what is the gain we are set

to the system, so right now I-controller gain as well as D-controller gain in this case is 0 which means that the controller right now which is influencing the plant is a P-controller so it's a P it is working based up on the P controller. So, let me try to increase the gain to 0.025, Excuse me! So, it's started increasing, increasing so 50 right, so here we clearly see that it is now it is trying to maintain the temperature on the plant is equivalent to the temperature of the set point. Right? It will not go beyond that within the range of plus or minus 2 percent up to 5 percent of tolerances error band within that range it is trying to maintain the temperature on the plant B of constant. Suppose for further increase 270 degree now here we can see the temperature increase to 71 degree, so the manipulated variable also changed. So, by drawing really high amount of current so approximately 2 amps of current.

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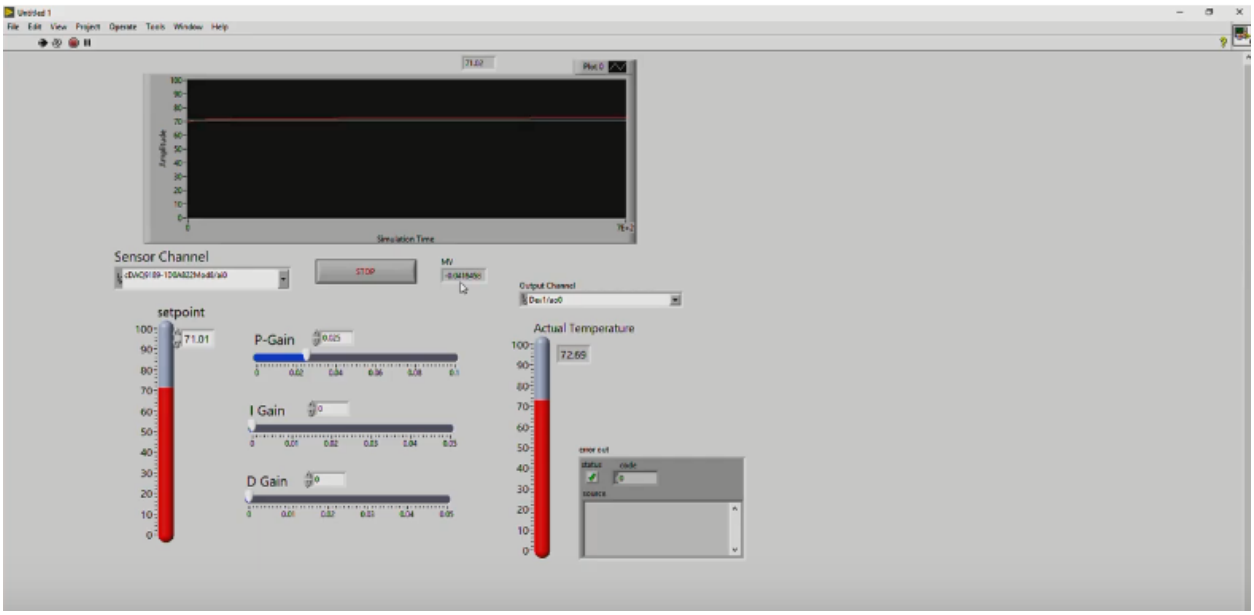

The sensor also the plant also heated to very high temperatures. So, we can see from power supply, so it is drawing power and keep on varying.

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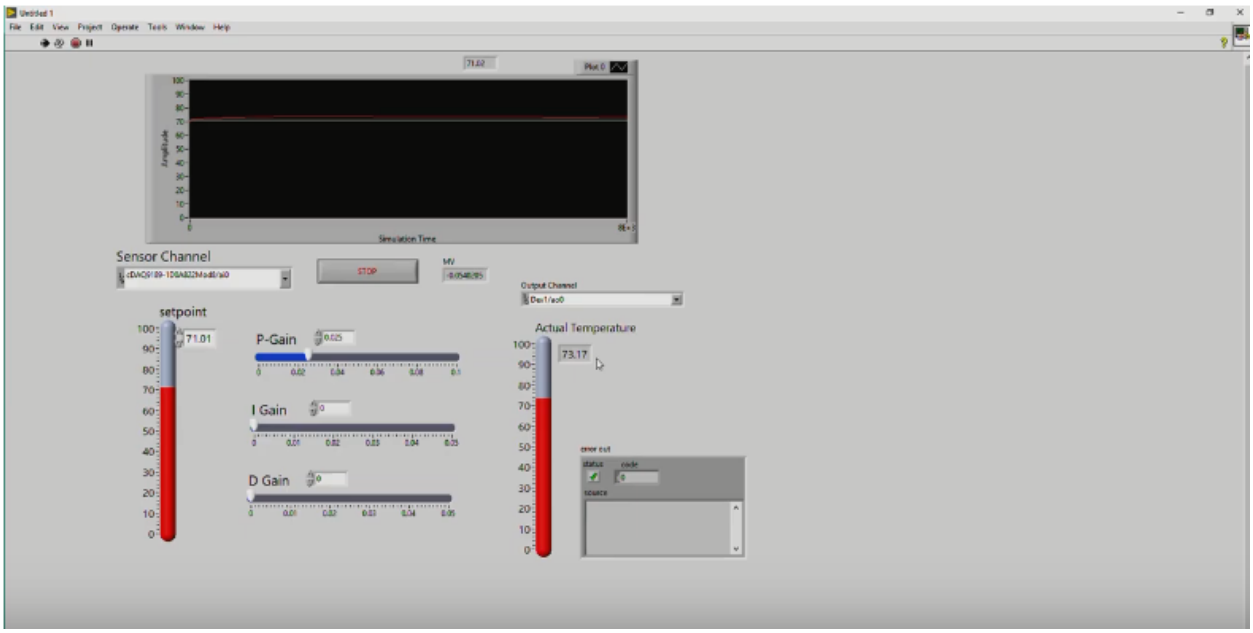

So, since the temperature actual temperature is higher than the set point temperature the manipulated variable is of 0 right now. So minus voltage which is nothing but zero, which means using external environment it has to cool. So, let me decrease 240. So, the temperature the actual temperature right now is 57 degree but the set temperature is 30 I will make it as 30 degree, so by matchers since we do not have any forced convention so, by using natural convection heat has to be dissipated to the environment, so it will start cooling it. So as a result, once decrease to 30 degrees it will again try to maintain the same temperature. As long as it is the actual temperature is higher than the set point temperature the manipulated variable will be in negative which means the system is in off condition right now, it is not providing any power to pass through the transistor. As a result, the system that means it is 0 volts which means that it will not heat the transistor.

So, we can see that it is slowly decreasing, you can observe the response. Let me change the set point to 35 degree so that it will not take much of time, just to understand now if you observe that when the set actual temperature is slowly reaching towards the set point, so just I will make it as 40 now the temperature is 37 degree. So, since the difference is little higher, it also pushes little energy and started heating so here we can clearly see it started heating and now again after reaching to the actual temperature value it is trying to maintain at 40 degree centigrade, you can see what is the actual temperature here, so now the both the temperature, the plant as well as the set point, you can see the plant temperature it as at 40 degree, whereas the required temperature is also 40 degree, both with almost approximately the same value even at output side. So, with this we can understand the working, the working of a P-controller as well as implementation of the P- controller using the data acquisition device as well as the labview. So, this particular process is called software in-loop. So, this is be, this is called as

software in-loop because the software is acting as a controller whereas a plant is externally connected to, externally connected and these two things are interfaced using data acquisition. So, that why this is called software in-loop, the software, which is written in labview programming will be, will be in-loop with the plant, so were the plant is sitting outside. Right? So, the similar way we can even implement the PI controller as well as the PID controller it is not necessary that the same PI controller and PID controller to be implement for all the times in order to control even we can develop our own algorithm say similar to that of fuzzy logic as well as neural networks interfaced to the real world signal in order to understand the working of any system or any algorithm using functionality of any system, so with this we will stop.

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