Clement Focuser

Automatic Heater Control for the Prevention of Dew

designed by Don Clement

Introduction

This is a description of a circuit for the automatic control of a heater element for telescope optics. The optics maybe a corrector, secondary mirror, eyepieces, or telrad finder. The circuit automatically maintains the temperature of the optics, at a preset amount above the ambient air temperature, so dew will not form on the optics. Many ATMers have tried this circuit and found it useful.

How the Circuit Works

The schematic at the top of page 3 is a circuit that I designed, built, and tested on the bench. The temperature is measured using LM335 precision temperature sensors that output 10mV/degree K. D1 measures the ambient temperature. D2 is mounted close to the heated optics for measuring the optics temperature. The output of U1 pin7 either pulls the gate of Q1 to close to the ground rail or allows R4 to pull the gate of Q1 up to the upper rail when there is a very small voltage difference on pins 2 and 3 of U1. When the gate of Q1 is pulled to the upper rail, current flows through the heater.

Positive feedback through resistors R5 and R6 cause the comparator (U1) to work as a schmitt trigger. This prevents U1 from oscillating with the slow changing inputs.

How to Perform One Time Calibration

One time calibration is accomplished by allowing the circuit to thermally stabilize at room temperature. The voltage from pin2 of D1 to pin2 of D2 is monitored with a voltmeter. Adjust R3 for a predetermined offset of 10mV/degree C. So if one wants the optics to be 2 degrees C above ambient, then adjust R3 so the voltmeter reads 20mV. The LM335 voltage output is directly proportional to absolute temperature in degrees K. This means that at room temperature the output of the LM335 is approximately 3V. R3 adjusts the slope of the voltage_out/deg K at one temperature. So if the offset voltage is set to 20mV (2 deg C) at room temperature, then when the system is in use at 0 deg C, the offset will be about 1.83 deg C. This is close enough to 2.0 degrees C offset at room temperature for the purpose of this circuit.

How to Determine the Resistance of the Heater
To determine the resistance of the heater the following equation is used: where **V**=battery voltage, **Rh**=resistance of heater, **Rds**=drain to source resistance of Q1, **P**= power dissipation of heater

Rh= ((V^2)/P - 2*Rds + ((2*Rds - (V^2)/P)^2 - 4*Rds)^1/2)/2

So lets assume one wants 12W heater and V=12V and Rds=0.5 ohm then Rh= 11 ohms The actual heater size will have to be determined by the size of the optics. I haven't gone beyond a bench test yet and will report back later with results of testing this circuit on my scope.

Where to Find Parts
The circuit is based on an idea from a Sky & Telescope August, 1978 p.161 entitled "*An Automatic Electronic Dewcap*" I made many improvements and implemented some suggestions from ATM List members. All parts are commercial and available from Digikey. Some parts, like the IRF510, are available from Radio Shack. Total cost should be under $10. Datasheets can be found at:

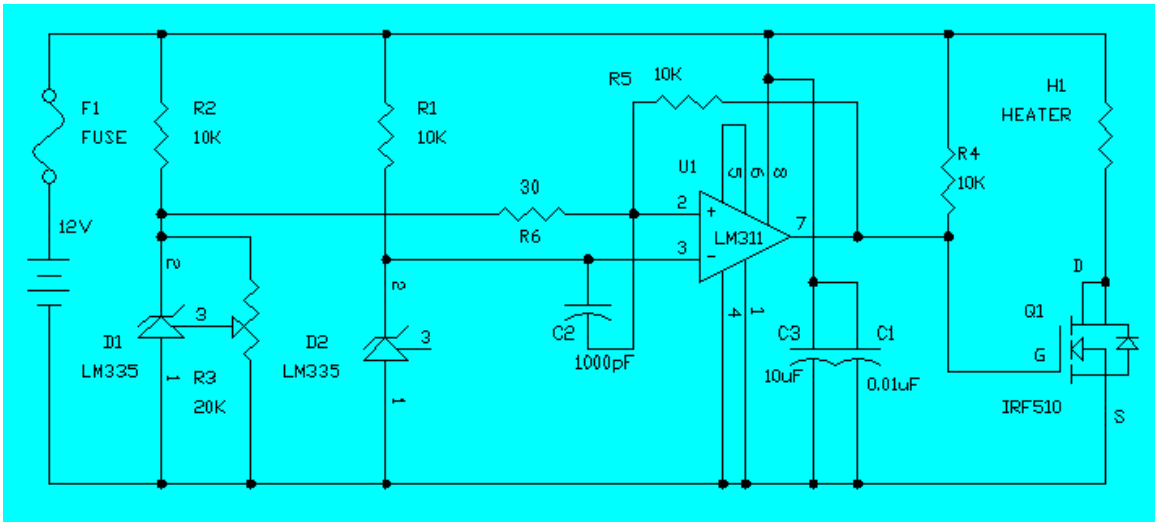
National Semiconductor Datasheet for LM335:
http://www.national.com/pf/LM/LM135.html
International Rectifier Datasheet for IRF510:
http://www.chipdocs.com/datasheets/datasheet-pdf/International-Rectifier/IRF510.html
National Semiconductor Datasheet for LM311:
http://www.national.com/pf/LM/General%20Description

I have built this circuit and it works on the bench. Q1 can switch 12W without a heat sink and 24W with an added heat sink. If you need to control a heater with more that 24W consider paralleling the IRF510.

Ken Lowther has a circuit board layout for this circuit available at:
http://www.atmsite.org/contrib/Clement/dewheater/pcb/index.html.

If you have comments or suggestions, email me at: clement.focuser@charter.net

See **Temperature Control Schematic** next page**.**



Temperature Control Schematic