TEC CONTROLLER EVALUATION KIT TTV2.1

The TEC controller module can be evaluated conveniently by using this evaluation kit TTV2.1 which comes with the evaluation board and a TEC controller module of TEC-A1 (there is no internal compensation network in this module). The main purpose of using the evaluation board is to tune the compensation network on the board to match the characteristics of users' thermal load. The objectives of the tuning are to minimize the response time of the thermal control loop and the dynamic temperature tracking errors, while keeping the control loop stable.

1. Connection

Figure 1 shows the layout of the evaluation board. After making the basic connections, the power supply, the TEC and the thermistor, to the board, you can see how controller works. Find a flat screw driver of right size, turn the temperature set-point switch **TEMPSP**, watch the LED: when it turns to green, the target temperature is locked to the set-point temperature within 0.1°C or less; when it turns to red, the target temperature is not locked to the set-point temperature.

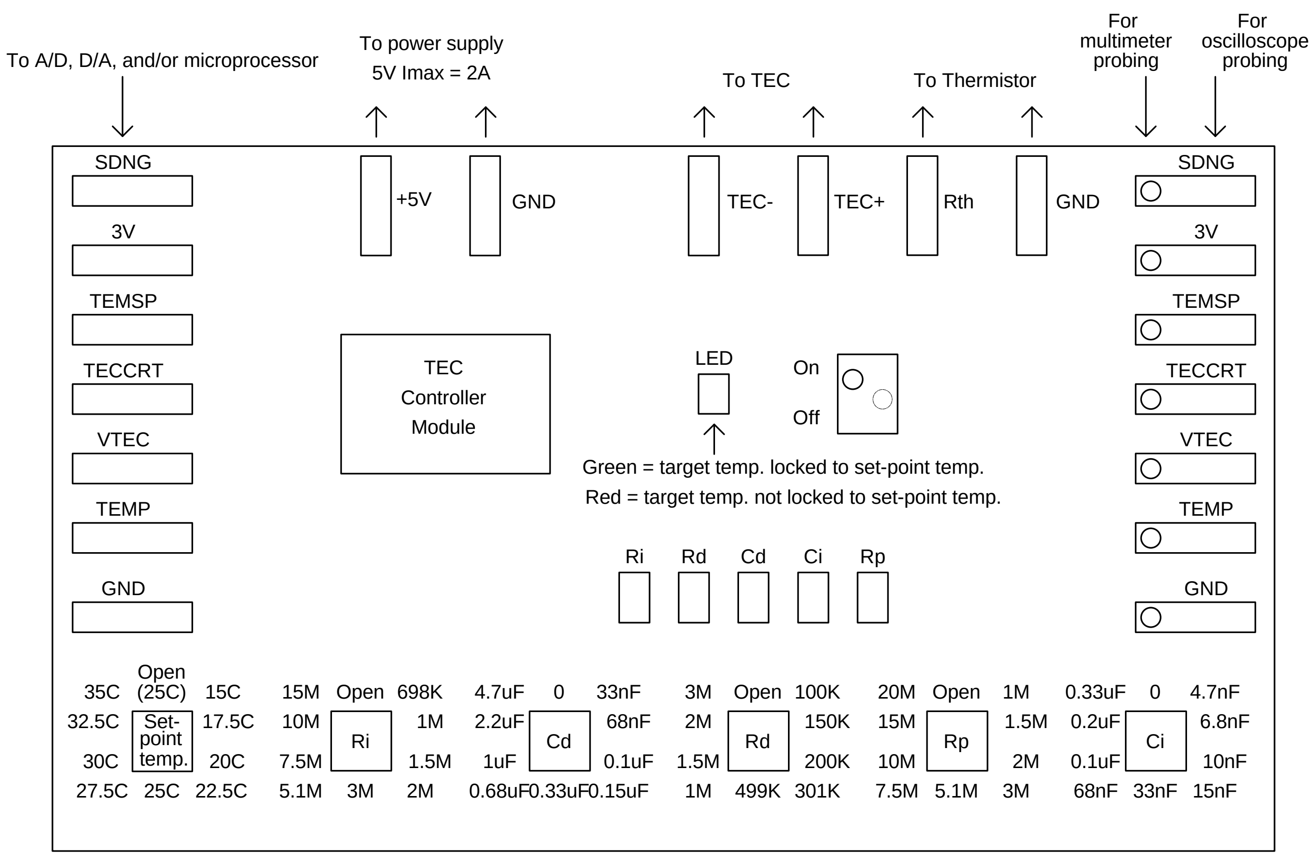

Figure 1 TEC Controller Evaluation Board TTV2

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2. Tuning

Adjust the switch **TEMPSP** (far left) to change the set-point temperature. At the same time, use an oscilloscope, set it to scrolling mode (0.2 Second/D or slower) and monitor the voltage of **VTEC** on the evaluation board (2V/D DC coupling) by one channel and **TEMP** (1V/D or less, DC) by the other channel.

In principle, these are the impacts of the components to the tuning results:

a. Rp/Ri determines the gain given to the proportional component of the feedback signal which is from the thermistor, Gp = Rp/Ri, in the control loop, the higher the gain, the smaller the short term error in the target temperature (which is of the cold side of the TEC) compared with the set-point temperature, but the higher the tendency of the loop's instability.

b. Rp/Rd determines the gain given to the differential component, Gd = Rp/Rd. The higher the gain, the shorter the rise time of the response, the more the overshoot and/or the undershoot, will be.

c. Cd*Ri determines the corner frequency when the differential component starts picking up (see Figure 2), Fd1, as the frequency goes up.

d. Cd*Rd determines the corner frequency when the differential component starts getting flat, Fd2. In time domain, it determines the cut-off frequency above which the TEC controller will give extra weight in response.

e. Ci*Rp determines the corner frequency when the integral component starts picking up, Fi, as the frequency goes down. In time domain, it determines the cut-off frequency below which the TEC controller will starting having a large open loop gain. The higher the open look gain, the smaller the tracking error will be.

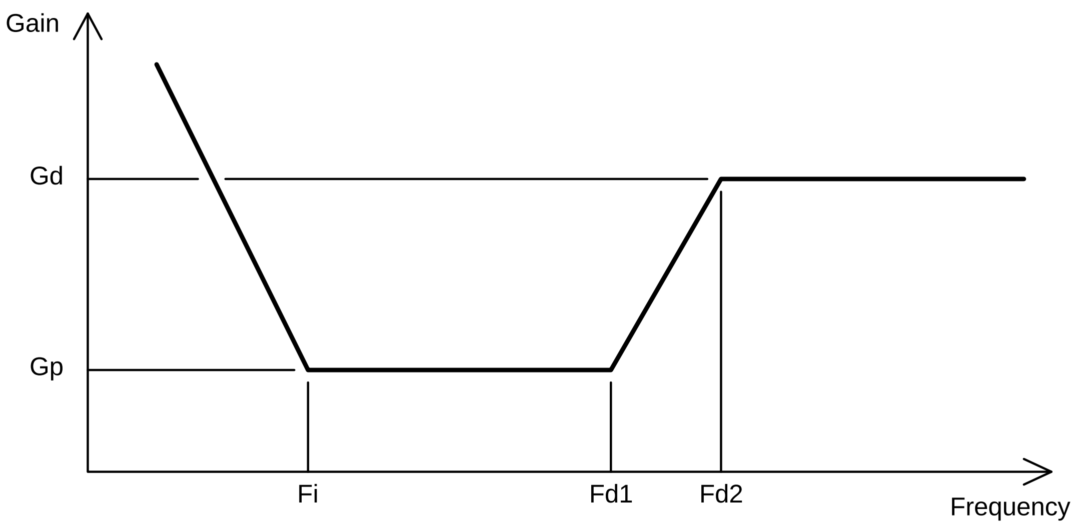

Figure 2 Control Loop Frequency Response

To start the tuning, turn off the differential circuit by setting Rd all way up (the "Open" position) and Cd all way down (0). Toggle the set-point temperature around 25°C, i.e. set it to 25°C, 22.5°C, 25°C…, back and forth, 5 seconds per change. Set Ci all way up (0.33uF), set Ri to 3M, and increase the ratio of Rp/Ri as much as possible, as long as the loop is stable (no oscillation seen in **VTEC**). Then, minimize Ci as much as possible, as long as the loop is stable. The next step is to minimize Rd and maximize Cd while maintaining about 5% overshoot found in **VTEC**. Optimum result can be obtained after intelligent and patient tuning. It is fun and important.

You do not have to turn on the laser diode while tuning the TEC controller. To simulate the active thermal load given by the laser diode, setting the set-point temperature low and/or keeping the body temperature of the laser head (i.e. the hot side of the TEC) high (by using a hot plate) is enough.

For a typical laser head used in EDFA's or laser transmitters (found in DWDM applications, for instance), Ri = 3MW, Rp = 3MW, Ci = 0.22mF, Cd = 0.33mF, and Rd = 1MW. These values may vary, depending on the characteristics of a particular thermal load.

To be conservative in stability, use larger Ci and larger Ri; To have quicker response, use smaller Rd and larger Cd.

The closer to the TEC the thermistor is mounted, the easier to have the loop stabilized, the shorter the rise time and the settling time of the response will be.

3. More testing and control

a. To know the difference between the set-point temperature and the target temperature, use a multimeter, set it to a voltage meter, measure the voltage difference between **TEMPSP** and **TEMP** pins (insert the probes into the sockets), the reading scale is: 6.67°C/V.

b. To know the set-point temperature, use the voltage meter to measure the voltage between the **TEMPSP** and the **GND** pins, the reading result is: target temperature = 15°C + (**TEMPSP** voltage (V))*6.67°C for approximation.

c. To know the actual target temperature, use the voltage meter to measure the voltage between the **TEMP** and the **GND** pins, the reading result is: target temperature = 15°C + (**TEMP** voltage (V))*6.67°C for approximation (see the curve in the TEC controller data sheet).

d. To know how hard the TEC is working, measure the voltage **VTEC** by a voltage meter or an ADC, TEC voltage = 2.5V – VTEC (V). When the TEC voltage (from the calculation) is positive, it is in cooling mode; when the TEC voltage is negative, it is in heating mode.

e. To try other values not provided by the evaluation board for the components in the compensation network, turn the switches for the components you want to try to the top point (the "0" points for capacitors and the "Open" points for resistors), connect the component to the corresponding soldering pads located below the LED (See Figure 1).

To shut down the TEC controller, turn the switch located on the right side of the LEC down (See Figure 1).

f. To control the set-point temperature directly by using a DAC, set the set-point temperature switch to the top point (25°C), connect **TEMPSP** pin to the output of the DAC and use this formula for approximation when the input voltage is between 0V and 3V:
set-point temperature (°C) = 15°C + (**TEMP** voltage (V))*6.67°C. The maximum voltage allowed is Vps (power supply). See the curve in the TEC controller data sheet.

g. To control the TEC voltage directly by using a DAC, connect **TECCRT** to the output of the DAC and use this formula: TEC voltage = 2.5V – TECCRT (V).

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h. To shut down the TEC controller by using a microprocessor, connect **SDNG** to one of its digital outputs. When pulling low, the TEC controller is shut off. When pulling high or leaving **SDNG** open, the TEC controller is turned on.

Using the TEC controller for more applications not described here, such as **wave-locker controllers**, please consult with us.

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