# Method for a resistor/diode network for thermal control

Disclosed is a method for resistor/diode network for thermal control. Benefits include improved functionality, improved thermal performance, improved performance, improved power performance, improved reliability, and improved cost effectiveness.

## Background

The conventional thermal control solution includes more than one thermoelectric cooler (TEC) to divide the voltage in the thermal control unit (TCU) to draw less current for heating/cooling. As a result, wasted heating/cooling is achieved, more material is required to house the TECs, and thermal response is slow.

The conventional solution for thermal control includes TECs that match the electrical requirements for a power supply and a bridge that limits the heating/cooling effect of the overall system. The TECs are connected directly to the power supply and bridge by a closed looped system and determine the direction or polarity of current. By changing the direction of current, the TECs cool or heat (see Figure 1).

The switching effect creates a voltage divider so the current (I) is limited to saturation limits and sets the heating/cooling condition. The voltage divider limits the life of a TEC due to coefficient of thermal expansion (CTE) mismatch of the materials making up the TECs. The on/off effect also produces an overshoot or undershoot for thermal control. Water or air cooling removes the excess heat from the hot side of the TEC, adding to the inefficiency of the design.

## General description

The disclosed method is a resistor/diode (R/D) network for thermal control. The key elements of the disclosed method include:

- Thermoelectric cooler
- Voltage drop/regulator
- One set of resistors to limit the current used by the TEC for heating or cooling
- One set of resistors to tune the current used by the TEC for heating or cooling
- One set of diodes to limit the direction of current used by the TEC for heating or cooling

The network is optimized for heating or cooling as required by the application. A set of resistors limits the current draw of the TEC to prevent overpowering the power supply. The next sets of diodes are arranged in parallel to enable the reduced current to pass through and prevent current from flowing in the opposite direction. The second sets of resistors are used to tune the current to prevent spiking and maintain quick response.

## Advantages

The disclosed method provides advantages, including:

- Improved functionality due to providing an R/D network for thermal control
- Improved functionality due to providing a small, compact design
- Improved functionality due to providing higher capability
- Improved functionality due to optimizing/tuning the TCU design to match a thermal controller or application
- Improved thermal performance due to providing optimized heating or cooling
- Improved performance due to preventing response delays from spiking
- Improved performance due to providing fast ramping rates without using an external power source
- Improved power performance due to eliminating the requirement for an external power source
- Improved reliability due to increasing the life of the TEC by limiting the CTE mismatch
- Improved cost effectiveness due to reducing the requirement for multiple TECs

## Detailed description

The disclosed method is resistor/diode (R/D) network for thermal control. An R/D network is inline with the TECS to enhance thermal control performance for high-power devices under test (see Figure 2).

The voltage drop/regulator adjusts the load impedance to match the power level (*V*I*) of the power supply. This feature enables the TCU to work with any controller and power supply. The unit can be any resistive device or a voltage and current regulator.

The tuning network balances the heating and cooling ratio of the TCU based on the user requirement. This feature uses two sets of diode-resistor circuits. The diodes control current direction while the resistive devices (R2 and R3) tune the current. R2 and R3 can be any resistive device or a voltage/current regulator.

Resistors and diodes are attached directly to the heat exchanger. This configuration enables the circuit to handle high current/power. The heat exchanger optimizes the size of the R/D network.

The disclosed method can be implemented using the following steps:

1. Determine the voltage drop resistor value.
2. Determine the TEC voltage and current specification.
3. Determine the thermal controller power-supply specification.
4. Calculate the value of the resistive device required to match the power supply voltage.
5. Determine the heating and cooling time ratio that will satisfy the thermal response required for the appropriate device under test.
6. Adjust the resistive device values (R2 and R3) to achieve the target ratio between heating and cooling.

The disclosed method can be verified using simulation. Results indicate the method eliminates temperature spikes and overshoots.

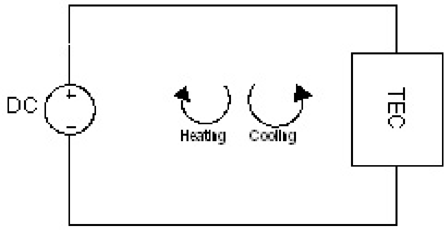


Fig. 1

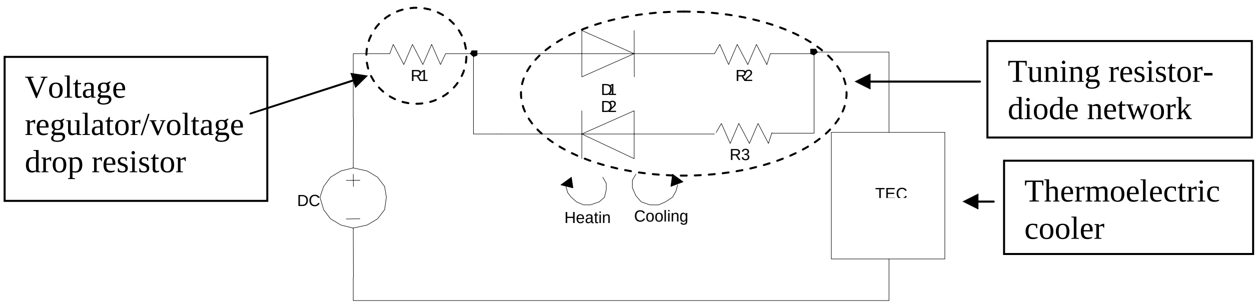


Fig. 2

**Disclosed anonymously**
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