Drivers for Embedded Thermoelectric Components Application Note

Nextreme's eTEC product portfolio includes modules that range in resistance from 50mΩ to 3Ω with corresponding I_{max} currents of 0.8A through 4A. The optimal drive current for these modules in an application is likely to be in the 0.2A to 1.5A range. Several off-the-shelf Thermoelectric Cooler Controllers or Temperature Controllers are available to drive and control Nextreme eTEC modules.

Table 1 lists controllers suitable for driving Nextreme eTECs in temperature controlled applications. These controllers utilize pulse width modulated H-bridge power drivers for maximum power efficiency and use current sensing to control the eTEC current. The devices rely on an external NTC thermistor to sense the load temperature and provide a control loop to adjust the eTEC current and maintain a desired load temperature.

Table 1. *Temperature controller ICs available recommended for driving Nextreme eTEC modules.*

Manufacturer & Part Number	Integrated Power Switches	Integrated Amps for Signal Conditioning & PID Control	Input Voltage V_{in} (V)	Maximum Output V_{out} (V)	Maximum Output I_{out} (A)	Package	Evaluation Kit	Application Notes
Maxim IC MAX1978	Yes	Yes	3 - 5.5	Vin-0.7	±3	48/THIN QFN	MAX1978-EVKIT	AN3318, AN3842, AN3264
Maxim IC MAX8520/ MAX8521	Yes	No	3 - 5.5	Vin-0.7	±1.5	20/THIN QFN, 32/UCSP	MAX8521-EVKIT	AN3318, AN3842, AN3264
Analog Devices ADN8831	No	Yes	3 - 5.5	Vin-0.05	Set by Ext. Switch	32/LFCSP	ADN8831-EVALZ	AN-695

Important Design Considerations:

- Select the TEC controller based on application requirements and follow design guidelines provided by the manufacturer.
- External inductor(s) and low ESR capacitors are required for power filtering.
- Additional passive components are required for the PID controller.
- The load temperature should be sensed using a NTC thermistor with the resistance value chosen based on desired operating temperature range (the evaluation kits target a typical value of 10kΩ at the desired operating point).
- Set appropriate output current and voltage limits for the TEC controller based on the chosen eTEC module.
- The circuit board should be designed to minimize interconnect resistances in the power stage and to the eTEC module to maximize efficiency. For example, 28 AWG, copper wire has a resistance of ~2.67mΩ/cm and a 122mil width PCB trace of $1oz/ft^2$ copper layer has a resistance of ~2mΩ/cm at 85C.

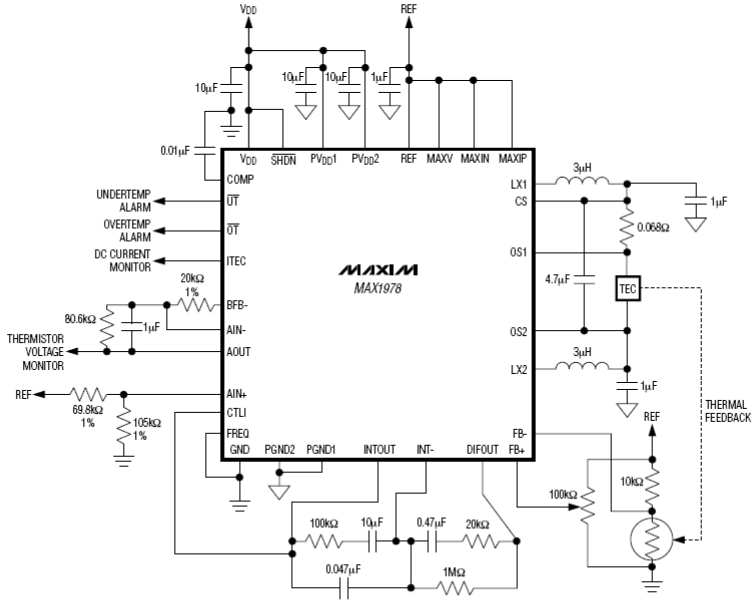

Figure 1. *MAX1978 typical application circuit.*

A typical application circuit is illustrated using the MAX1978 in Figure 1. The eTEC current is sensed using a 68mΩ resistor in this case. The estimated efficiencies of the MAX1978 and MAX8521 are shown in Figures 2 and 3. In the case of the ADN8831 the efficiency will depend on the external power MOSFET switches used.

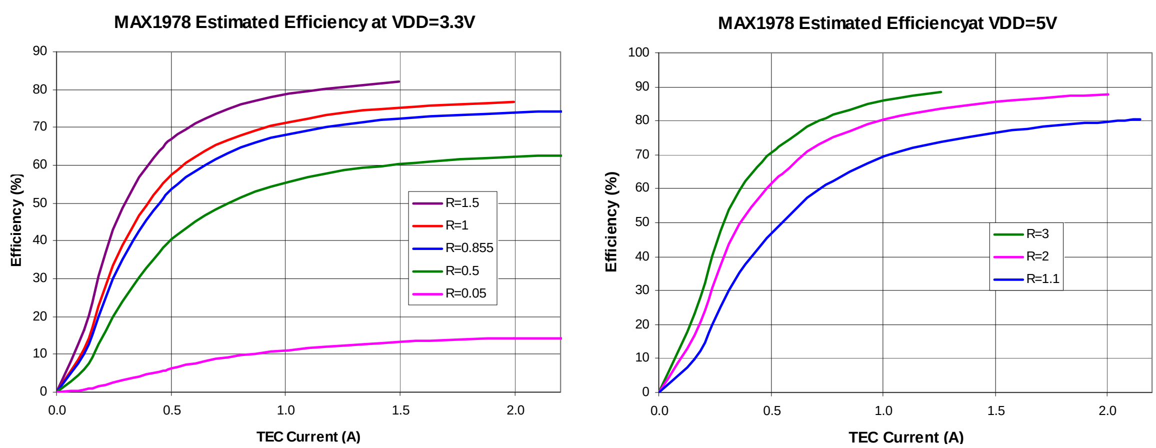

Figure 2. *Efficiency of MAX1978 for various load conditions estimated from datasheet.*

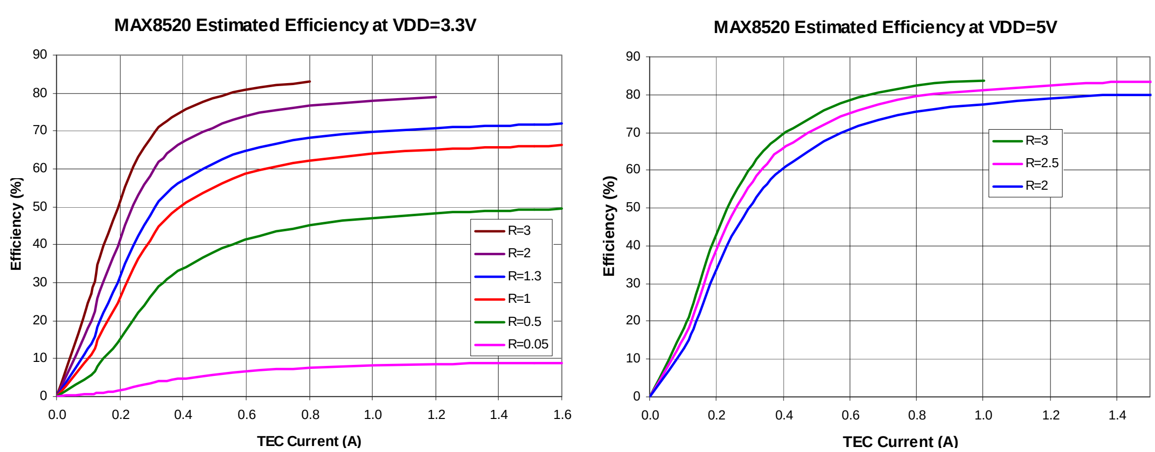

Figure 3. *Efficiency of MAX8520 estimated from datasheet for various load conditions.*