

## eTEG UPF40 Power Generator Evaluation Kit Application Notes

### Description and Features

The UPF40 eTEG evaluation kit is designed for simple, assembly-free evaluation of Nextreme's thermoelectric power generation technology. The kit provides a fully assembled unit containing a single UPF40 eTEG thermoelectric power generator, a thick film heater, a heat-sink/fan assembly and thermocouples. The kit is mounted to a pink-foam support to provide thermal insulation from the heater and to provide a stable mounting platform (Figure 1). In addition, a standard 12 VDC wall transformer is provided for powering the heat-sink fan.



*Figure 1: eTEG UPF40 Power Generator Evaluation Kit*

## Cautions and Operational Limits

- Heater voltage should not exceed 14V.
- Do not operate the kit without powering the heat-sink fan.
- Avoid operation of the kit in ambient air exceeding 30°C.
- Do not drive the eTEG with an external power source (i.e. do NOT attempt to use the eTEG in cooling mode).
- Keep areas around the fan and heat-sink clear for optimal air flow.
- Avoid excessive shock or vibration.
- Avoid exposure to water or high moisture environments.
- The eTEG UPF40 device is permanently mounted to the heat-sink and is not field serviceable or replaceable.
- If experiencing problems please contact Customer Service at (919) 597-7332

## Testing Overview

The eTEG Evaluation Kit comes complete with 5 pairs of electrical connections:

- eTEG power output and voltage sense: non-terminated red and black wires
- Thick-film heater power input: non-terminated orange wires
- Heat-sink fan power input: red and black wires terminated with a barrel jack
- Hot junction thermocouple, terminated with type-K miniature plug
- Cold junction thermocouple, terminated with type-K miniature plug

The minimum instrumentation required for testing is listed below. A schematic for testing is shown below in Figure 2.

- Variable power supply
  - For driving power to the thick film resistor (heat source)
  - Capable of a minimum of 20 VDC and 1 A current
  - Used in constant voltage mode with a minimum resolution of 0.1V
  - Connected to the orange wires shown in Figure 1
  - The heater connection is not polarized
- Meter(s) for reading two type K thermocouples
  - Provides temperature of the hot and cold junctions of the eTEG device
  - Note, a single meter could be used and the thermocouples could be alternately connected to determine  $T_{hot}$  and  $T_{cold}$
  - Capable of measuring 0.1°C minimum resolution
- A Volt Meter
  - For measuring the voltage output of the eTEG device
  - Capable of measuring 1mV minimum resolution
  - Connected to the red and black wires shown in Figure 1.
- A load resistor (provided)
  - For maximum power output, the load resistance should match the internal resistance of the UPF40 eTEG device as shown in the datasheet
  - The optimal load resistance changes with temperature but a close estimate is provided in the datasheet
  - The load resistor shall be connected across the ends of the black and red wires.
- DC power supply for the heat-sink fan (provided)
  - The heat-sink fan should be operated during testing.

The power output,  $P_{out}$ , from the eTEG is determined by measuring the voltage drop across the load resistor and can be calculated using equation 1. It should be noted that the eTEG internal resistance will change as a function of temperature so using a fixed load resistor provides only an estimate for maximum output power. The maximum output power for any value load resistor can be calculated using equation 2 where the open circuit voltage is also measured. The open circuit voltage of the eTEG can be measured directly by removing the load resistor and measuring the positive to negative lead voltage. It is important to note that the values,  $V_{oc}$  and  $V_L$ , in equation 2 while measured at separate times need to be at an identical  $\Delta T$ . Values measured at differing  $\Delta T$ s will give erroneous results.

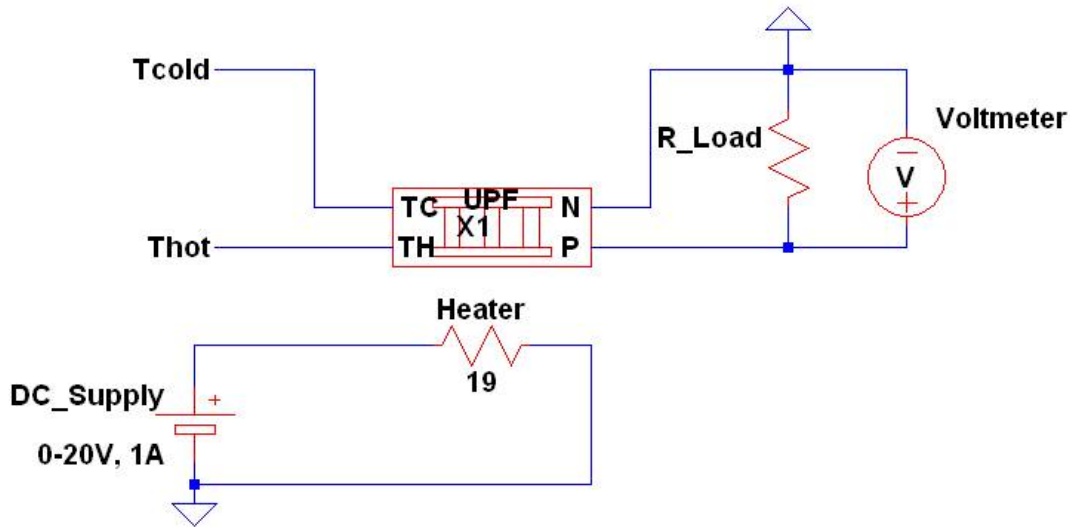


Figure 2: Electrical schematic of test set up.

## Equations

Equation 1 
$$P_{out} = \frac{V_L^2}{R_L}$$

Equation 2 
$$P_{max} = \frac{1}{4} \times \frac{V_{oc}^2}{R_L} \times \frac{V_L}{V_{oc} - V_L}$$

## Parameter Definitions

|            |  |
|------------|--|
| eTEG       | Thermoelectric Generator   |
| $\Delta T$ | Temperature difference measured between the hot and cold junctions of the eTEG module. |
| $T_{hot}$  | Temperature of the eTEG hot junction   |
| $T_{cold}$ | Temperature of the eTEG cold junction  |
| $R_L$      | Load resistor value, measured in ohms.   |
| $P_{out}$  | Output power generated by eTEG, measured in Watts.                                     |
| $P_{max}$  | Maximum Output power generated by eTEG, at matched load resistance, measured in Watts. |
| $V_{oc}$   | Open circuit voltage generated by eTEG, measured in Volts.                             |
| $V_L$      | Voltage across load resistor, measured in Volts.                                       |