KM2-series: MPPT Converter for TEGs

TEconversion.com
THERMOELECTRIC CONVERSION SYSTEMS

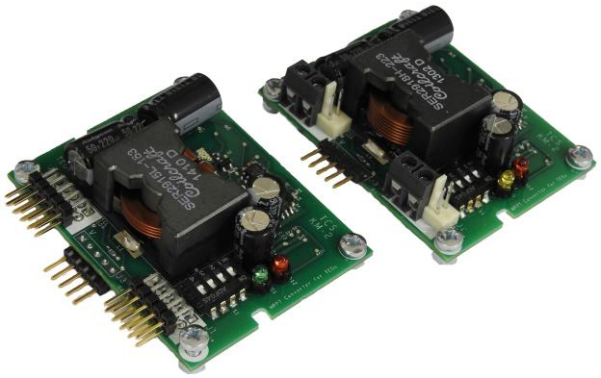
KM2 Series

Revised February 2016

Maximum Power Point Tracking Converter for Thermoelectric Generators

Features

- Interface to and charge of 12-V battery
- 99% MPPT Efficiency
- Up to 97% Electrical Efficiency
- I2C Communication Interface
- Input Voltage from 2V to 30V
- 50 W Rated Output Power with Natural Convection
- 75 W Rated Output Power with Forced Air Cooling (10 CFM)



Quick Description

The KM2 converters track the maximum power available from the thermoelectric generator(s) connected at its input. Maximum power is tracked every 500 ms with high accuracy. The KM2 converters store the electrical energy in a 12V lead-acid battery (not included). Battery charging management is an optional feature.

The KM2-30V converter interfaces TEGs whose voltage can be either lower or higher than the nominal 12V of the lead acid battery. The KM2-30V converter starts its voltage step-up operation with input voltages as low as 2V and continues harvesting electrical power provided that the TEG open-circuit voltage does not exceed 30V. The KM2-30V converter can operate in Boost or Buck-Boost mode. The KM2-30V converter can be set to optimise maximum power tracking either for typical energy harvesting applications or for constant temperature systems. Optional battery charging management provides state-of-charge regulation and prevents over-charging. The KM2 converters can communicate to other devices through I2C.

Absolute Maximum Ratings

	Value		
	Min	**Max**	**Unit**
Input Voltage (open-circuit)	-0.3	30	V
Output Voltage	10	20	V
Input power	0	50 (75*)	W
Input Current	0	8	A
Operating Temperature	-20	80	˚C

** With 10 CFM Forced Air Cooling*

Electrical Characteristics

Switching Frequency		78	kHz
MPPT Efficiency		2	Hz
Voc measurement Period		110	µsec
Electrical Efficiency in Boost mode	see Fig. 3	from 92 to 97	%
Electrical Efficiency in Buck-Boost mode	see Fig. 4	from 90 to 94	%
MPPT Efficiency in Steady-State		99.85	%
MPPT Efficiency in Transients	see Fig. 2	98.7	%
Maximum Input Power	with natural convection	50	W
	with 10 CFM forced air cooling	75	

Diagram of Connections

The TEG (input) and the battery (output) shall be connected as shown in Fig. 1. The output is not isolated from the input, *i.e.* TEG- is connected to BAT-

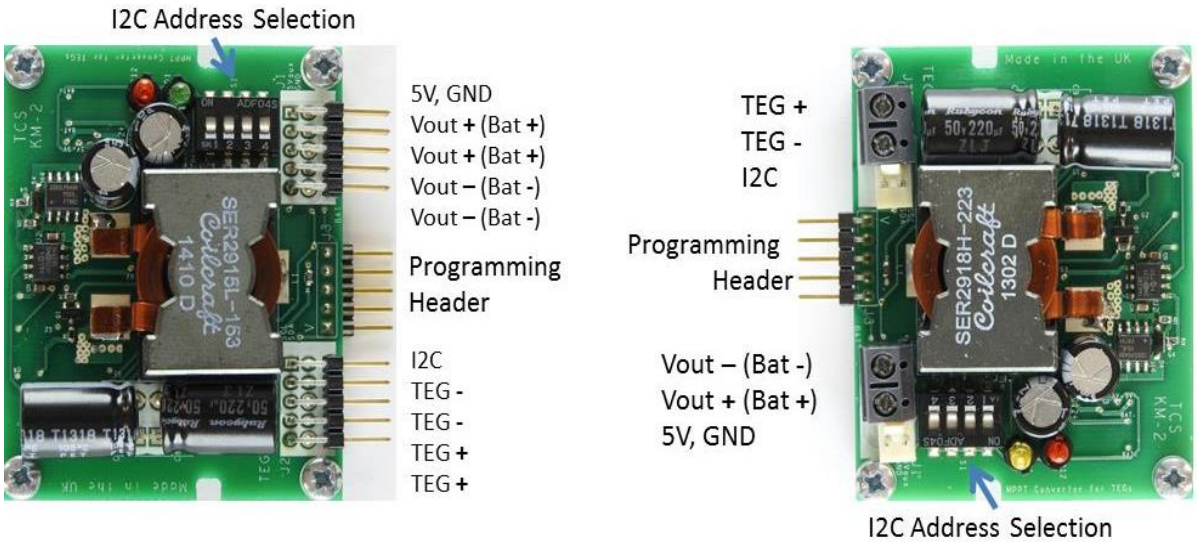


Fig. 1: Diagram of connections for the two versions of KM2 converters

Notes:

1. *The 5-pin programming header should not be used by customers and it is not populated.*
2. *Setting high Pin 1 of the I^2C Address Selection Switch activates battery charging management, while Pin 2 regulates the converter to 58% of the open-circuit voltage.*
3. *The KM2 does not require any information about the TEG devices to which it is connected,* i.e. *it automatically selects the optimum operating point.*

Typical Characteristics

MPPT Efficiency

The maximum power point tracking (MPPT) capability of the KM2 converters is assessed comparing the operating point set by the KM2 converter and the maximum power point obtained during a TEG electrical characterisation with the TEG test system sold by TCS.

In the following test, 3 TEG devices (product code: GM250-127-14-10; sold by: European Thermodynamics Ltd) are connected in series in the 4-fixtures test system under identical thermal conditions.

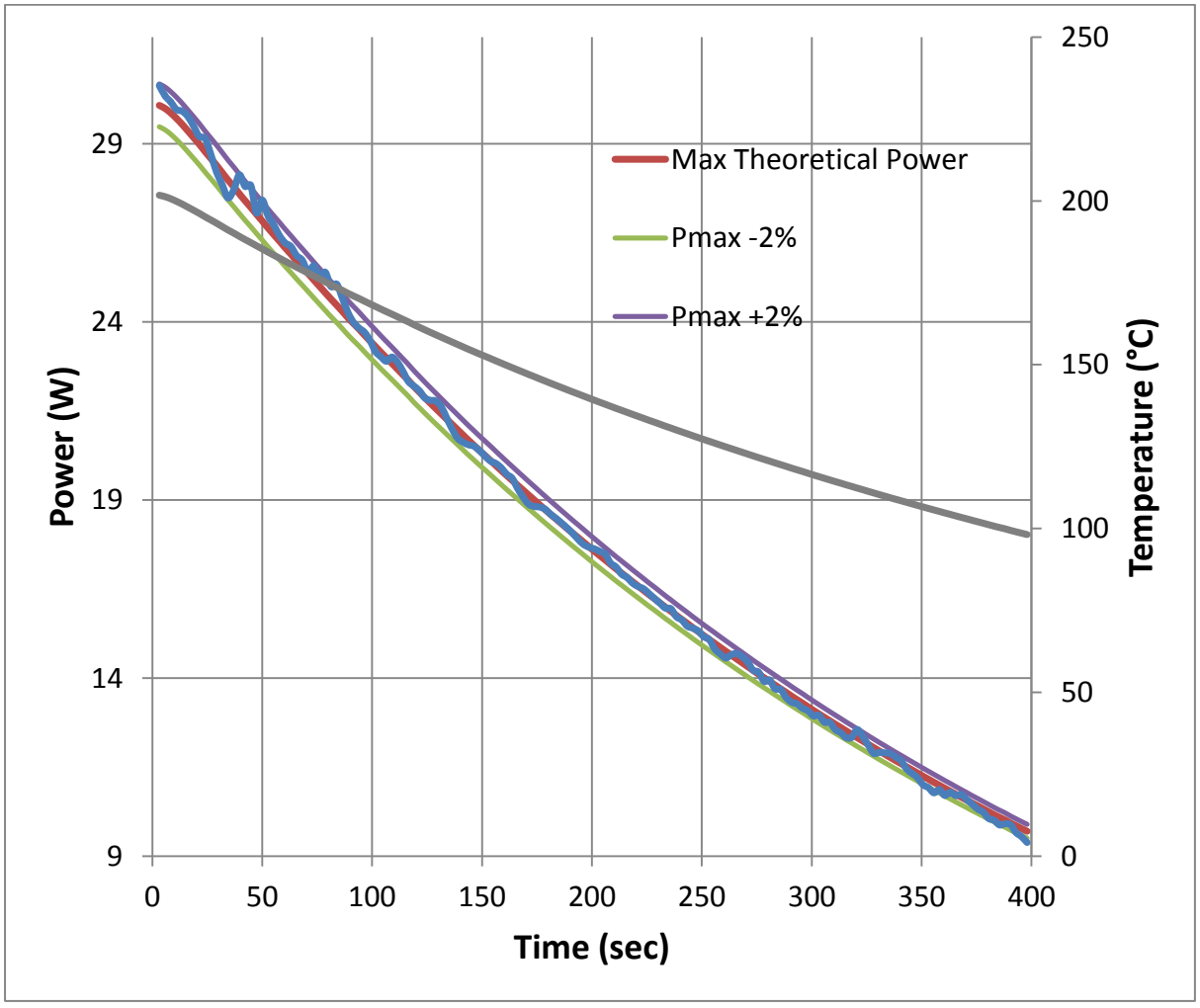


Fig. 2: Thermal transient from ΔT=200°C to ΔT=100°C across the three TEGs. Available and extracted output power on the left y-axis and temperature difference on the right y-axis. Time on the x-axis.

Electrical Efficiency

The electrical efficiency is measured with the KM2 converter powered by a power supply is series with a power resistor to emulate the electrical characteristic of a TEG. A 12 Ah 12 V lead-acid battery with variable load was connected to the output of the KM2 converter.

The input and output voltages are measured by high-precision multimeters. The input current measurement is provided by the power analyser and the output current is measured by a series connected multimeter.

Boost Mode

The voltage set on the power supply emulates the voltage generated by the TEG. The open-circuit voltage used is comprised between 12 V and 12.1 V.

A power resistor is connected in series between the positive terminal of the power supply and the positive input of the converter (to emulate the internal resistance of the TEG). The values used are 6.8Ω (low power around 5W), 3.3Ω (around 10W) and 1Ω (around 30W).

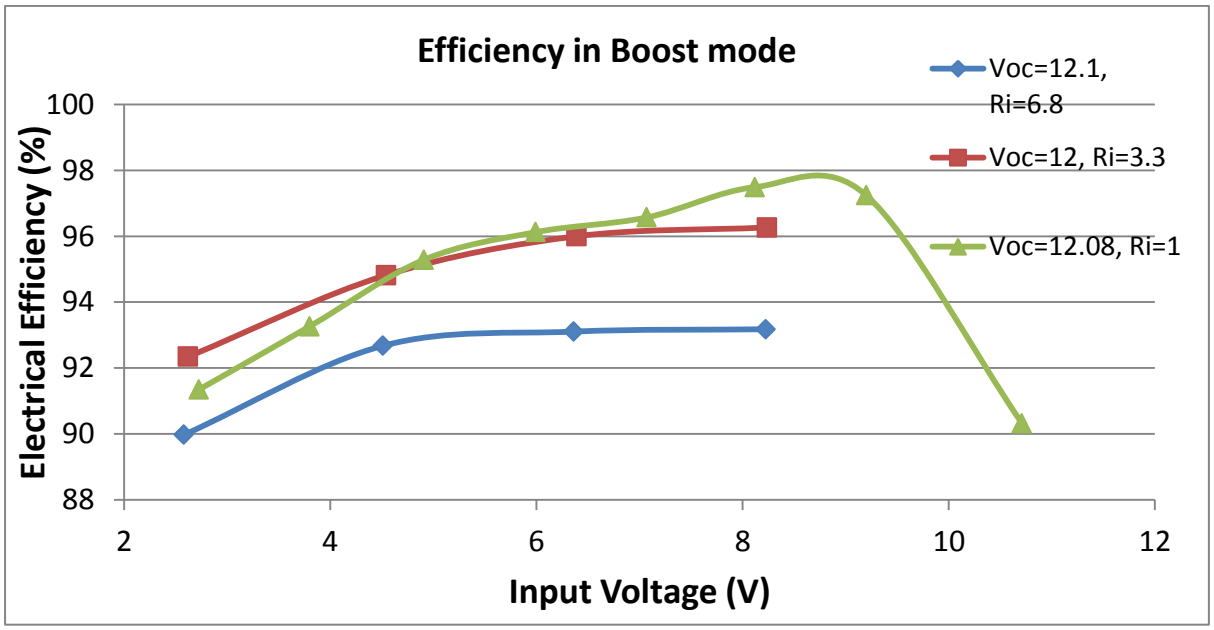


Fig. 3: Electrical efficiency of the KM2-30V converter in Boost mode.

Buck-Boost Mode

The voltage set on the power supply emulates the voltage generated by the TEG. The open-circuit voltage used is comprised between 16 V and 27 V.

A power resistor is connected in series between the positive terminal of the power supply and the positive input of the converter (to emulate the internal resistance of the TEG). The values used are 6.8Ω (low power around 5W), 3.3Ω (around 10W) and 1Ω (around 30W).

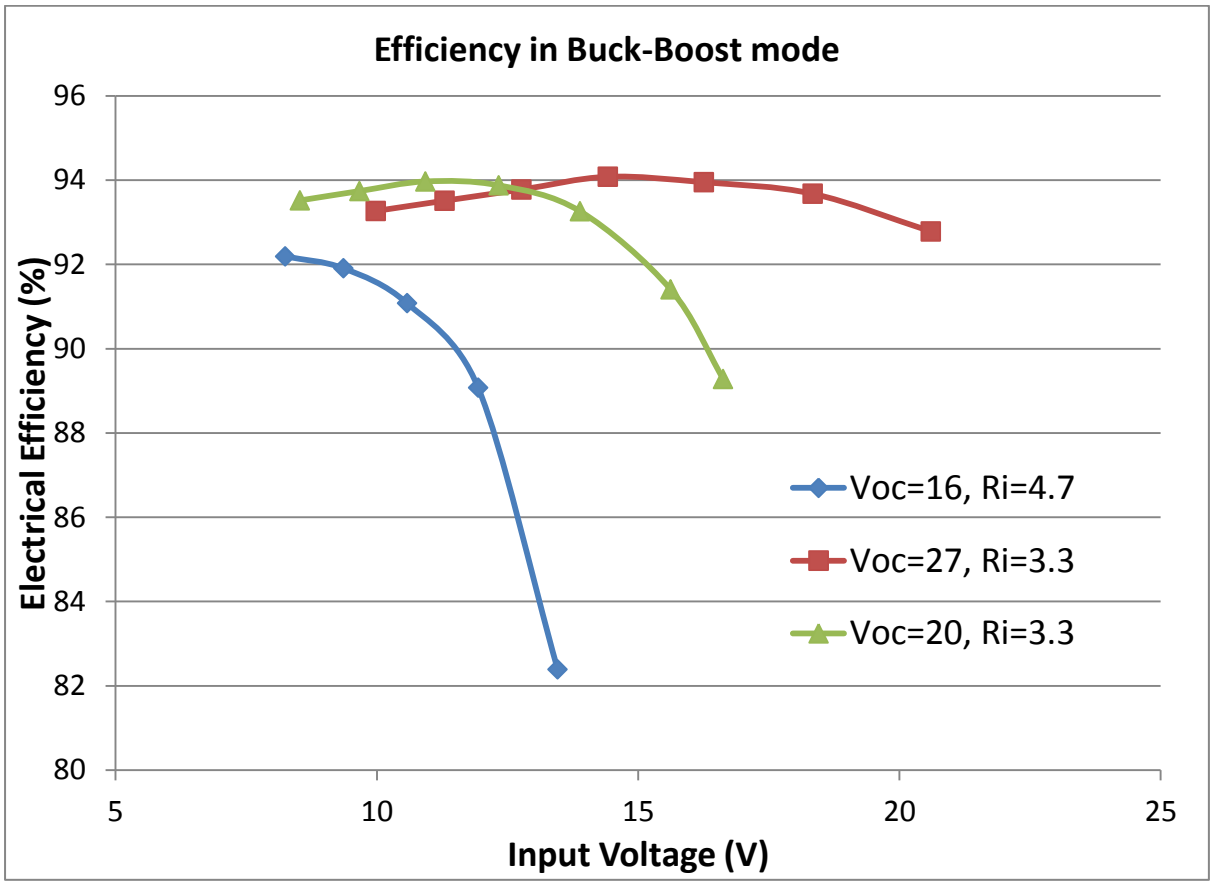


Fig. 4: Electrical efficiency of the KM2-30V converter in Buck-Boost mode.

Thermal Considerations

In order to ensure safe operation of the KM2 in the end-use equipment, the temperature of the components listed in the table below must not be exceeded. Temperature should be monitored using thermocouples placed on the hottest part of the component (out of direct air flow).

Temperature Measurements (At maximum ambient)	
Component	**Maximum Temperature (˚C)**
Inductor	100
Electrolytic Capacitors	100
SOIC-8 Ics	120
Other components	80

Service Life

The estimated service life of the KM2 is determined by the cooling arrangements and load conditions experienced in the end application. Due to the uncertain nature of the end application this estimated service life is based on the actual measured temperature of components within in the product when installed in the end application.

Product Drawings

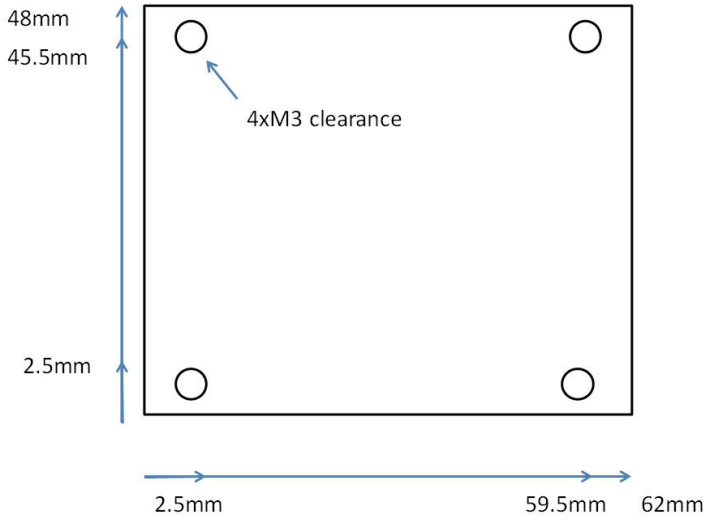


Fig. 5: Mechanical Drawing