MPG-D655

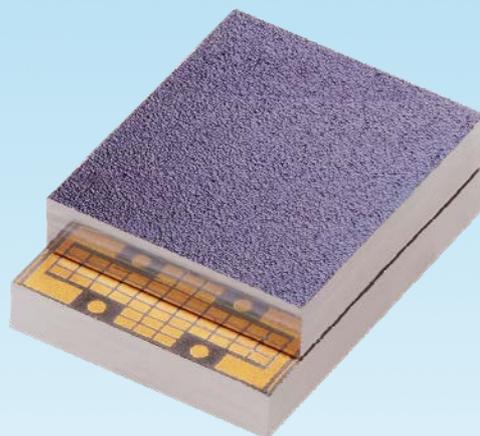## Thin Film Thermogenerator
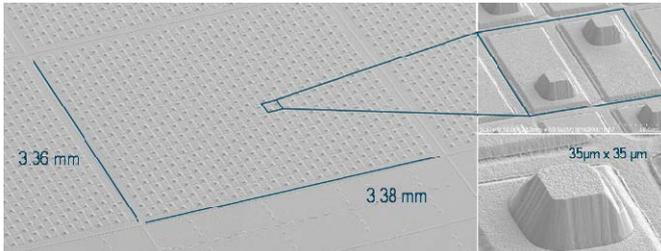
Preliminary Datasheet

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Power generation.

MPG-D655

Thin-film Thermogenerator Chip

1. Introduction

Thermoelectric power generation is based on the transfer of thermal energy through multiple couples of p-type and n-type thermoelectric legs.

Thermoelectric microstructure

The generated output voltage is proportional to the number of leg pairs and the temperature gradient ΔT across the thermogenerator.

$$U = N_{legpairs} \times \Delta T \times \alpha$$

U: Seebeck voltage
α: Seebeck coefficient in μV/K

1.1 General description

The MPG-D655 Micropelt thermogenerator chip converts heat energy (temperature difference) into electrical energy. The miniaturized dimensions of the MPG-D655 makes the thermogenerator chip ideal for ultra-compact equipment. Due to the 288 thermoelectric pairs, the MPG-D655 outputs an open circuit voltage of 80 mV/K, which enable extremely efficient voltage converter solutions (DC-Booster) and operation at very low temperature differences (e.g. 5 degrees Celsius)
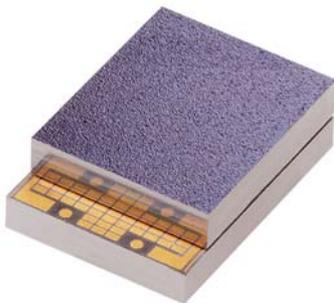
Micropelt thin-film thermoelectric chip

1.2 Features

- Micro integrated device with high power density

- Maintenance-free solid state operation

- Long life time

- Compatible with bonding assembly processes

- Low weight, low thermal mass

- High output voltage of 80 mV / K

- ROHS and WEEE compliant

Quick reference data

	min	typ	max
Characteristics			
R thermal	18 K/W	22 K/W	26 K/W
Seebeck voltage [U] output per degree Kelvin	70 mV/K	80 mV/K (T_{amb} = 25 °C)	90 mV/K
Number of leg pairs [Nlegpairs]	-	288	-
R electrical	180 Ω	210 Ω (T_{amb} = 25 °C)	240 Ω

1.3 Applications

Generic power supply utilizing waste heat to drive Milliwatt (wireless) applications, including:

- Wireless sensor networks (WSN)

- Condition monitoring

- Intelligent buildings and HVAC

- Automatic meter reading (AMR)

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1.4　Typical application diagram

By use of a DC Booster (refer Micropelt TE-CORE module datasheet), the output voltage of the micro generator can be up-converted to a stable output voltage of 1.9 V - 4.5 V (configurable).
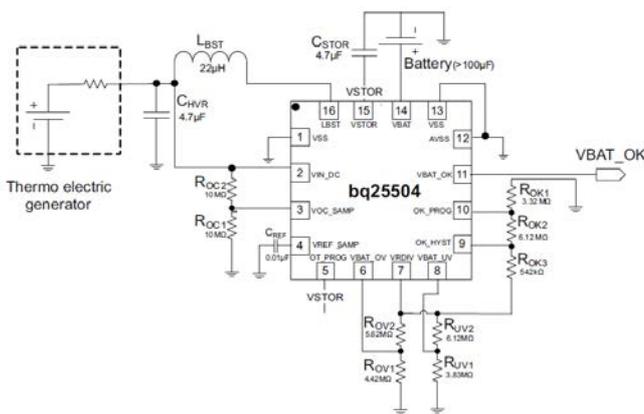http://www.micropelt.com/downloads/datasheet_te_core.pdf

The 1-chip DC-Booster solution bq255xx from Texas Instruments, offer additional features like battery management, warm start option and Maximum Power Point Tracking (MPPT).

The bq255xx can directly be connected to Micropelt TE-CORE module. More information and datasheet is available here http://www.micropelt.com/te_core.php

DC booster concept, bq25504 from Texas Instruments

1.6　Absolute Maximum Ratings

Stress beyond the limits of the absolute maximum ratings may cause permanent damage to the device.

|	min	max	conditions
ESD sensitivity		9000 V	
Latch-up			Unlike CMOS devices, immune to latch-up
Assembly / Curing temperature		150 ºC	Heat conductive epoxy; max. 60 min
Operating temp	0	+ 70 ºC	
Storage temp	20 ºC	30 ºC	

2.   Electrical parameters

The matched output power and open circuit output voltage of the MPG-D655 depends on the temperature difference across the device.

Both the hot and cold side of the MPG-D655 component are fixed to a defined temperature.

For performance numbers under practical conditions in combination of the MPG-D655 with a heatsink, please refer to the datasheet of the TGP generator package in combination with different heats sinks:

http://www.micropelt.com/downloads/ datasheet_thermogenerator_package.pdf

MPG-D655 open circuit output voltage
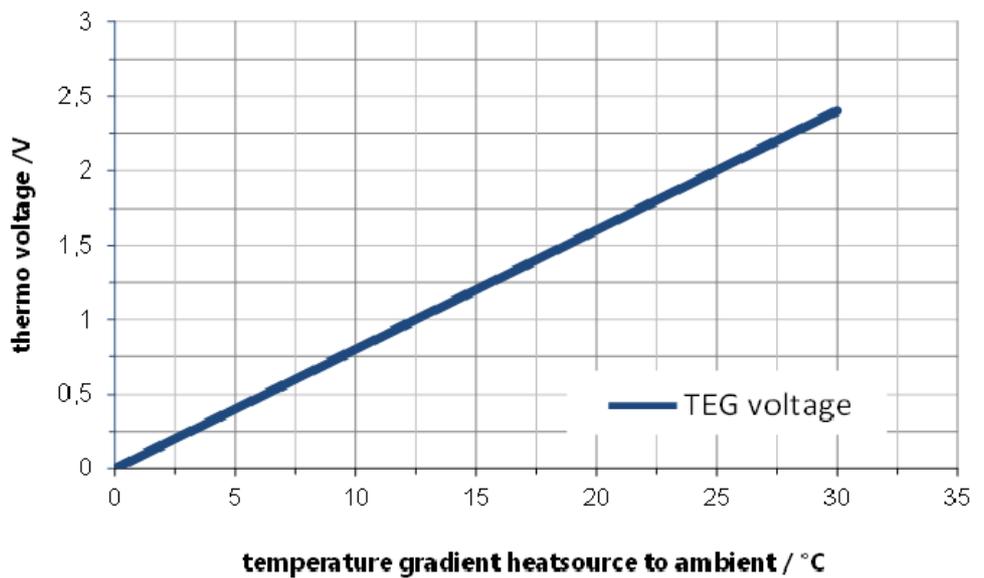
MPG-D655 matched output power
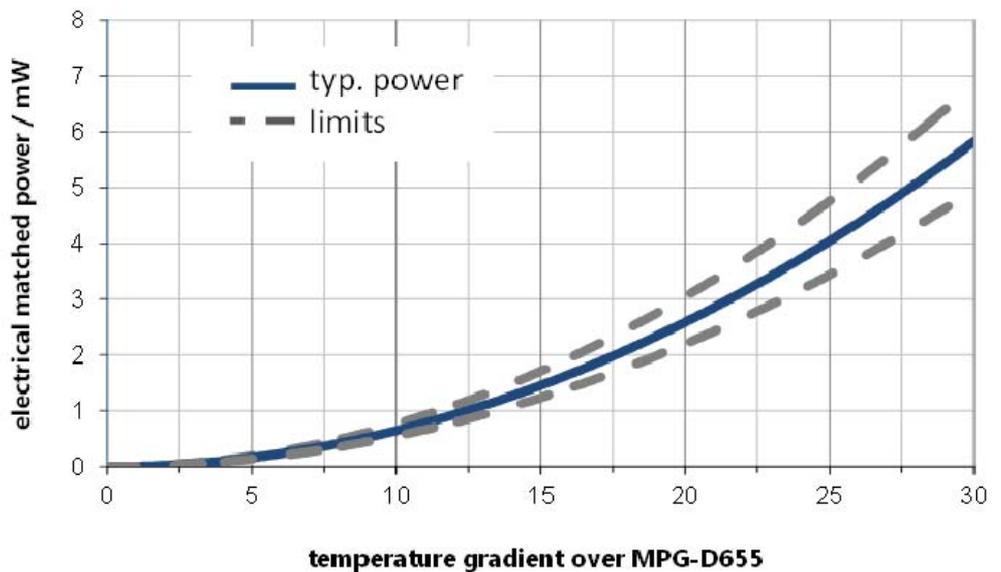
MPG-D655

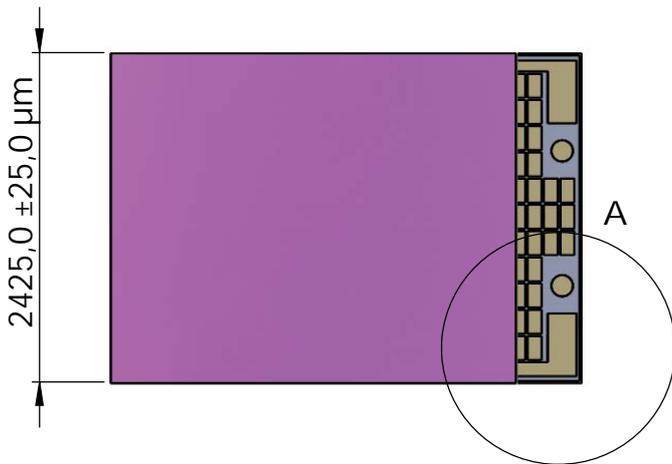# Thin-film Thermogenerator Chip

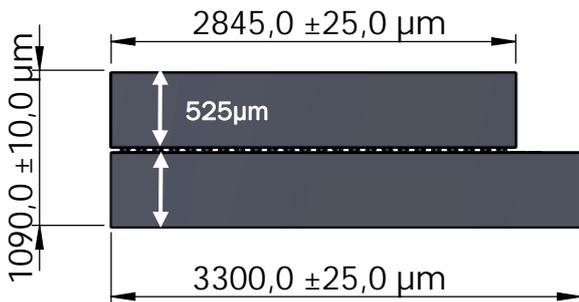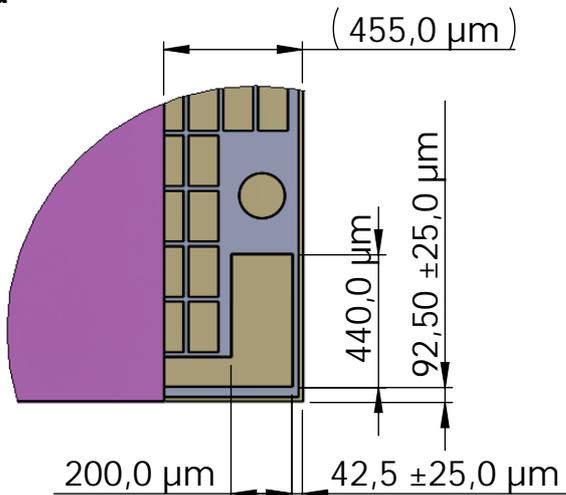## 3. Product information

3.1 Chip dimensions

All dimensions are given in millimeters.

Drawings are not to scale.

Side view and top view

2845,0 ±25,0 µm

525µm

1090,0 ±10,0 µm

3300,0 ±25,0 µm

2425,0 ±25,0 µm

A

Bondpad

(455,0 µm)

440,0 µm

92,50 ±25,0 µm

200,0 µm

42,5 ±25,0 µm

	min	TYP	max	UNIT
Parameter				
Length bottom side	3275	3300	3325	µm
Length top side	2820	2845	2870	µm
Width	2400	2425	2450	µm
Thickness	1080	1090	1100	µm

Bondpad **+** is the V_{TEG} connection that outputs a positive voltage, when the heat flow is in the direction from the smaller, top side to the larger, bottom part of the MPG-D655.
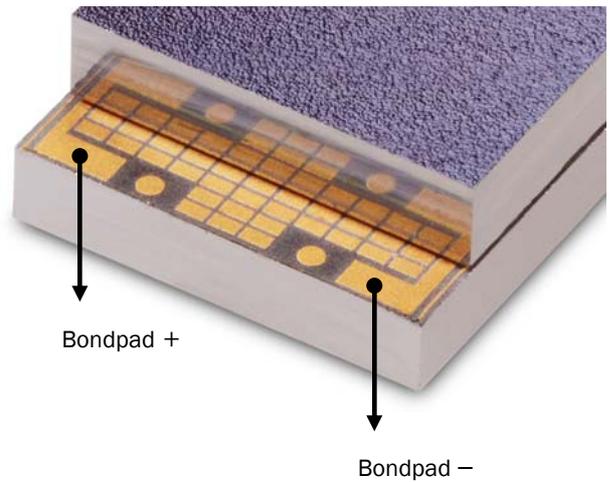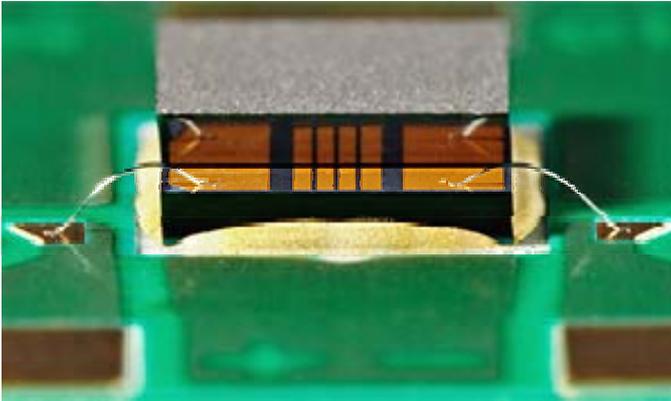
Bondpad **+**

Bondpad **–**

3.2 Material information

The backside material of the MPG-D655 chip is SiO_2. The MPG-D655 has Au bond pads, with a thickness of 2 µm.

The used thermoelectric material bismuth-telluride has a thickness of 40 µm.

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3.4   Assembly

The MPG-D655 chip will have to be mounted between two metal plates, one being the hot and the other the cold side. To protect the chip from excessive mechanical stress, an isolator with a thickness of 1.00 mm is put as spacer between the hot and cold metal sides.

To mount the MPG-D655 chip, use a heat-conductive glue such as silver-filled epoxy. Recommended epoxy is Heraeus PC3201. A curing procedure of the epoxy material with a maximum ramp of 10 K/minute must used (Do not use a pre-heated oven).

Recommended is to use on the other side a thermal gap filler material Sarcon of the company Fujipoly, with a thickness of either 300 um or 500 um.
Alternative is to use the Sarcon material at both sides of the MPG-D655 chip.

Ensure that the wire bonding process maintain a coplanar orientation of the mating surface. No bonding pressure should be applied closer than 2 µm to the adjacent of the bond pads. The maximum wire bonding force should be limited to 5N.

Both Ball Wedge and Wedge Wedge bonding processes can be used. Important is to avoid physical contact between the silicon outer side of the chip and the bonding equipment during bonding.
Au or Al wires (25 µm or 40 µm) can be used.

3.3   Handling

The single chips should not be handled by tweezers. The chip surface should not be cleaned by any material prior to assembly.

3.5   Environmental compliance

Micropelt MPG-D655 are compliant to the Restriction
of Hazardous Substances Directive of RoHS.

3.6   Ordering information

MPG-D655-M11   packed in Gel tray or
                               Membrane box

3.7   Packaged thermogenerator

Micropelt's microgenerators are also available as pack-
aged components, TGP—**T**hermo**g**enerator in **P**ackage:
More info > http://www.micropelt.com/tgp.php

4.   List of Document Changes

Ver. 2.0 (2013-02.01)   First published version of MPG-D655 datasheet

Ver. 2.1 (2014-09.25)   Changes in 1.6 Max. Ratings and in 3.2 Material Information concerning humidity.

Ver. 3.0 (2015-09.07)   Changes in 3.0 product information, polarity of chip changed,
                                         Changes in 4. Important Notices

4. Important Notices – Please read carefully prior to use

4.1   Reconfiguration of Products

The Thin-film Thermogenerator Chip PRODUCT is designed for reliable operation. Micropelt recommends that users do not change parameters. Micropelt does not accept any warranty claims for PRODUCTS that have been altered or reprogrammed.

4.2   Preliminary datasheet

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Limiting values

Stress above one or more limiting values (as defined in the Absolute Maximum Ratings and the handling and storage instructions) may cause permanent damage to the PRODUCT.

User Feedback

Micropelt welcomes user feedback on the results of any tests and evaluations of the PROTOTYPES and PRODUCTS. In particular, we appreciate experience information on use cases with indications of strengths and weaknesses of the PROTOTYPES and PRODUCTS, their robustness in operation and their long-term durability. Please, contact our Micropelt Application Engineering colleagues by email at info@micropelt.com.

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