**20401(05/07/10/13)**

*Thermoelectric power generator*

# *Thermagy™ power module (15W)*

## *Product Overview*

The 20401(05/07/10/13) Thermagy™ power module is a thermoelectric power generator that can convert heat of 700-1200°C into electricity and usable heat.

## *Features*

- For generation of electricity and heat
- Suitable for thermal radiating heat sources (700°C - 1200˚C)
- Suitable for convective concentrated heat sources (700°C - 1400°C)
- Suitable for operation with different coolants (water, oil) and a wide range of cooling temperatures
- Simple installation
- Operates under atmospheric conditions
- No mechanical pressure mount needed
- Maintenance free
- Robust thermal design
- Use of proven silicide materials

## *Performance overview*

Thermagy™ power module is available for the following heat flows: 100kW/$m^2$ – 65kW/$m^2$ – 50kW/$m^2$ – 35kW/$m^2$. These heat flows corresponds to different Thermagy models 20401(05/07/10/13). The performance of these power modules depends on the temperature of the heat sink and source. In the table below are 30°C and 60°C heat sinks displayed, this are typical sink temperatures depending on the available cooling system or to make use of the captured heat.

| Typical data | 2040105 (100kW) | | 2040107 (65kW) | | 2040110 (basic) (50kW) | | 2040113 (35kW) | |
|---|---|---|---|---|---|---|---|---|
| $T_{cooling}$ [°C] | 30 | 60 | 30 | 60 | 30 | 60 | 30 | 60 |
| Heat flow [kW/$m^2$] | 91 | 86 | 67 | 64 | 48 | 46 | 38 | 36 |
| Indicative $T_{source}$ no shield [°C] | 960 | 950 | 900 | 890 | 845 | 840 | 815 | 805 |
| Indicative $T_{source}$ with shield [°C]* | 1140 | 1125 | 1054 | 1045 | 980 | 965 | 925 | 915 |
| $P_{electric}$ [W] | 14,7 | 13,6 | 12,9 | 11,9 | 10,7 | 9,8 | 9,1 | 8,4 |

**A shield of 2mm steel under ideal circumstances*



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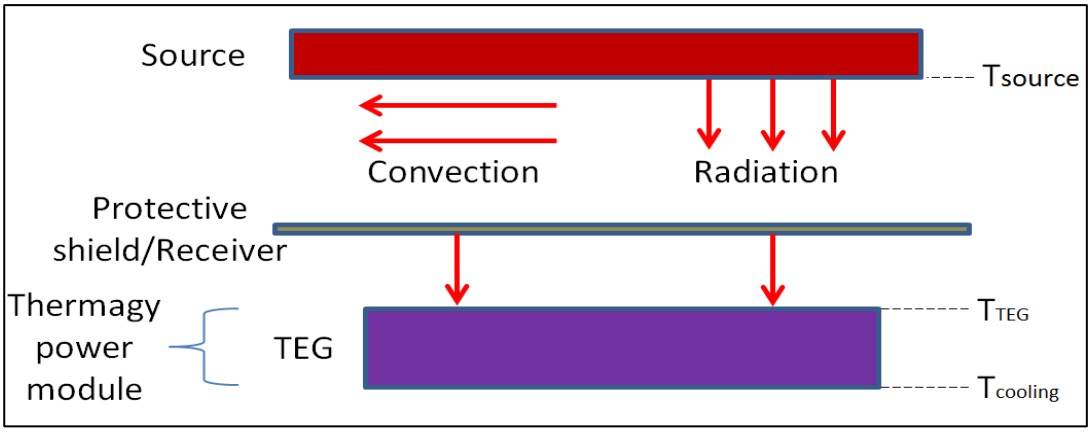


**Figure 1 Schematic overview of the use of Power module**

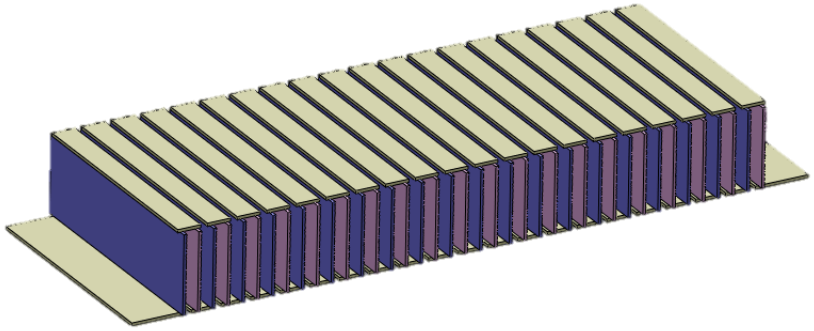

**Figure 2 Standard Thermagy power module**

The next specifications are the operating specifications for the complete range of Thermagy™ power modules.

| Cooling | 2040105 | 2040107 | 2040110 (basic) | 2040113 |
|---|---|---|---|---|
| **Minimum $T_{cooling}$** | 10°C | | | |
| **Maximum $T_{cooling}$** | 150 °C | | | |

| Thermal | 2040105 | 2040107 | 2040110 (basic) | 2040113 |
|---|---|---|---|---|
| **Maximum $T_{TEG}$** | 650 °C* | | | |

**The view factor and concentration of TEG to the heat source has a big influence at amount of captured heat flow and TEG temperature*

| Electrical | 2040105 | 2040107 | 2040110 (basic) | 2040113 |
|---|---|---|---|---|
| **Circuit** | DC (Direct Current) | | | |
| **Short circuit current** | 13,9 A | 11,8 A | 9,6 A | 8 A* |
| **Maximum power point** | ~300 mΩ | ~370 mΩ | ~460 mΩ | ~560 mΩ* |
| **Open circuit voltage** | 4,2 V | 4,4 V | 4,5 V | 4,5 V* |
| **Internal resistance** | ~300 mΩ | ~370 mΩ | ~460 mΩ | ~560 mΩ* |
| **Max power output** | 14 W | 12 W | 10 W | 9 W* |

**Depending upon heat flux through module*

| Interfaces | 2040105 | 2040107 | 2040110 (basic) | 2040113 |
|---|---|---|---|---|
| **Sink connection** | Self-completion, suggestion heat conductive epoxy (Duralco 133)* | | | |
| **Electrical connections** | Nickel strip | | | |

**Glue manual included*



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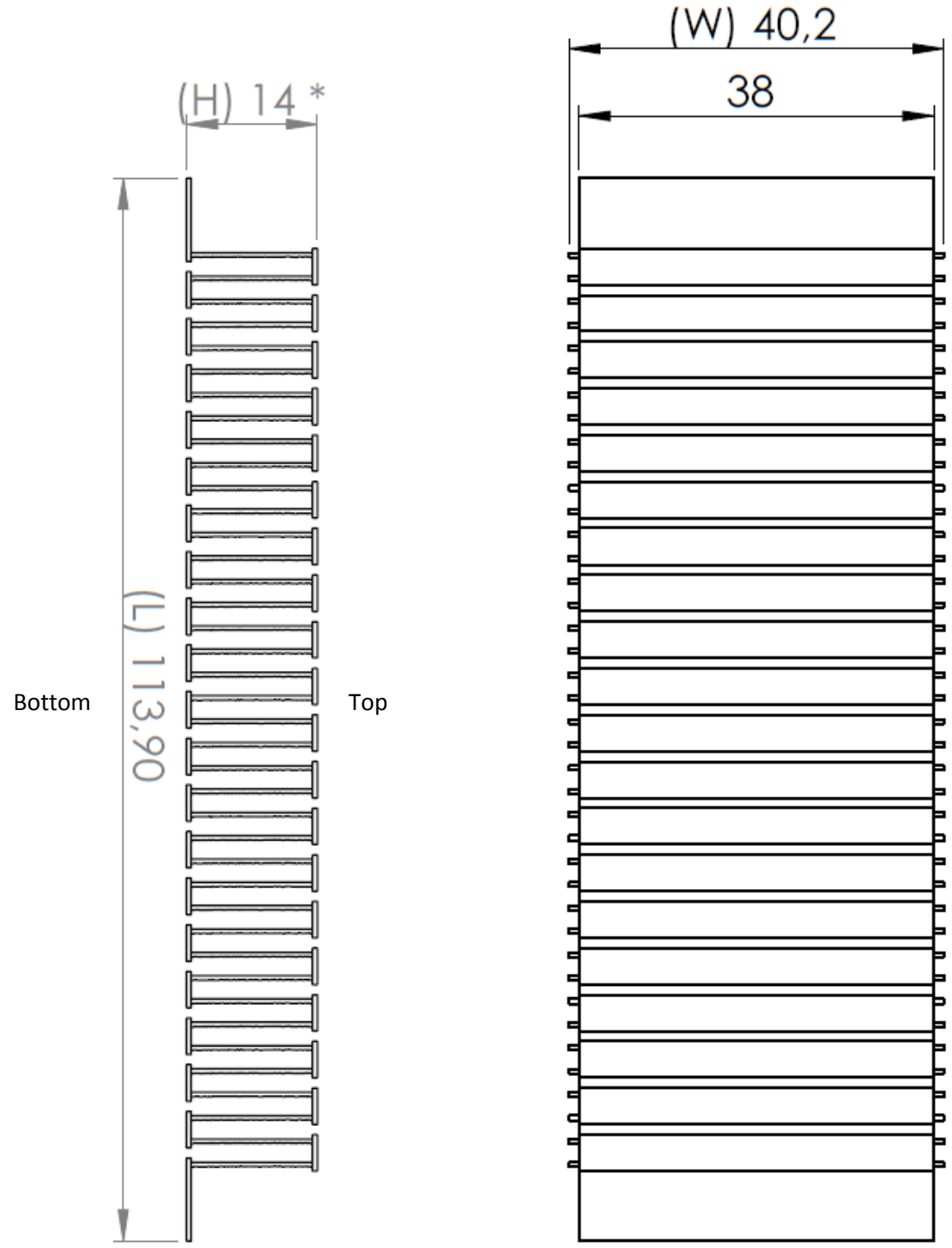
## Thermagy™ module dimensions (in mm)




**Height can vary to 6/8/11/14mm depending on model type.*



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***Power generation graphs for 30°C to 60°C cooling water***

Power generation graphs outside this temperature range available on request

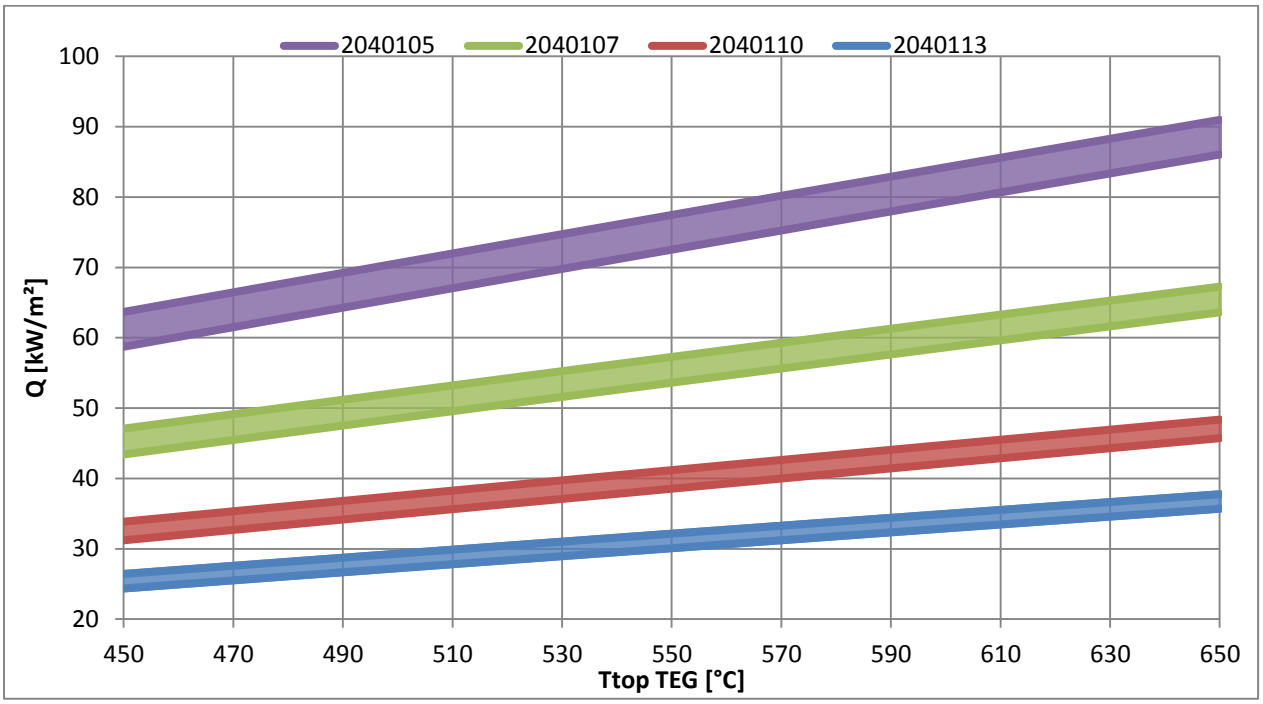


Figure 3 Heat flow vs Power module top temperature

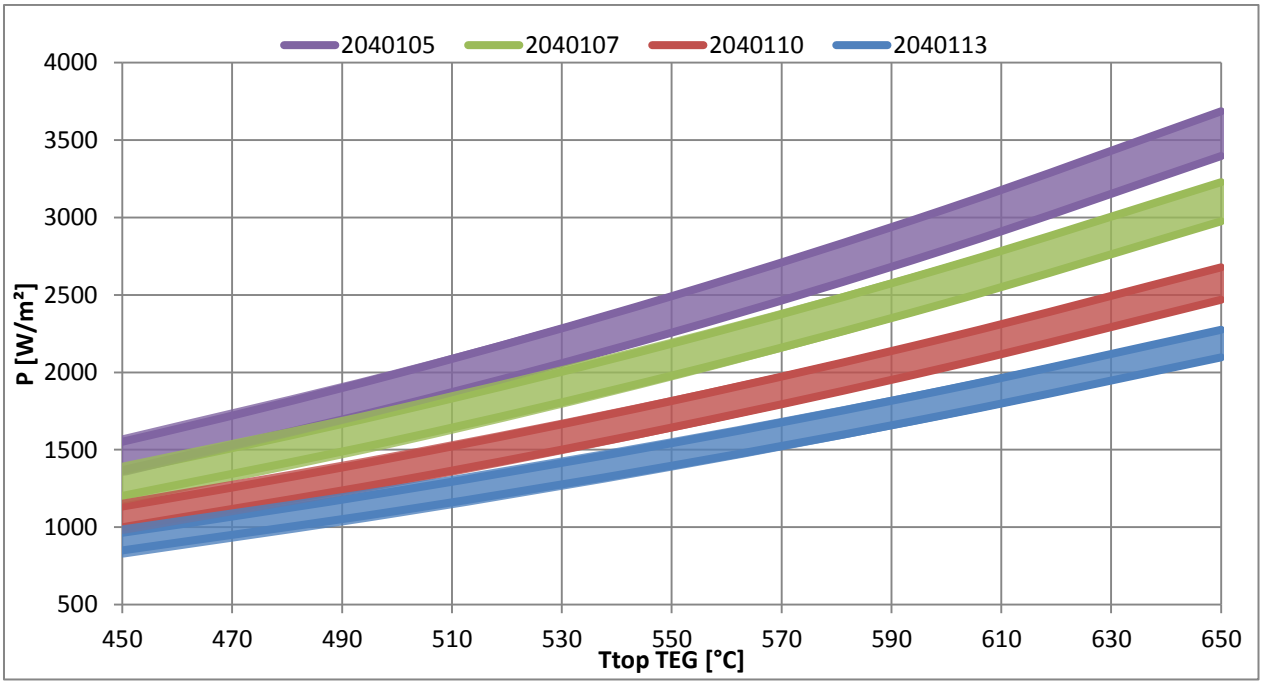


Figure 4 Power output vs Power module top temperature



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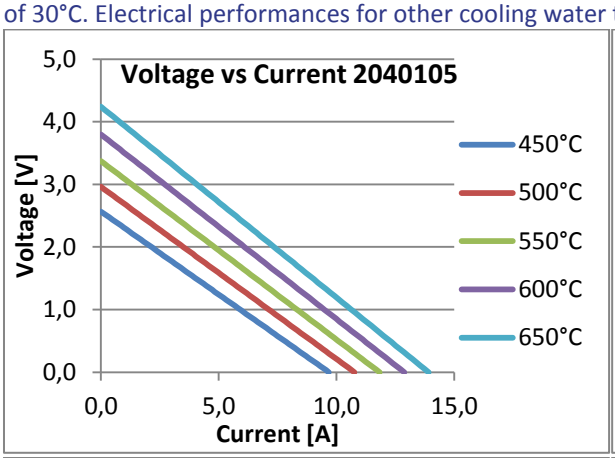
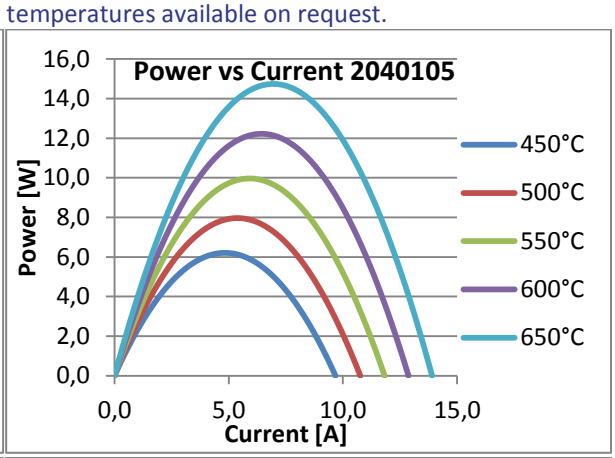
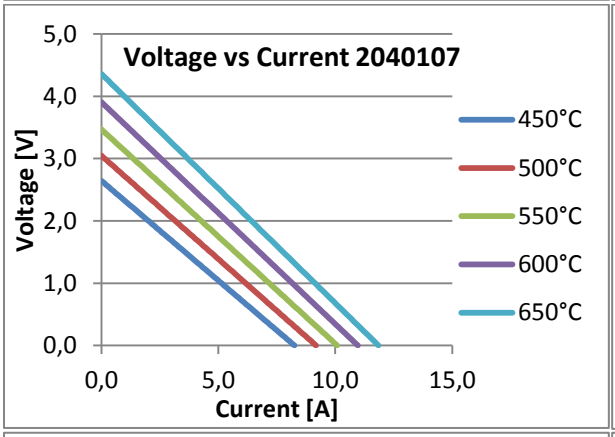
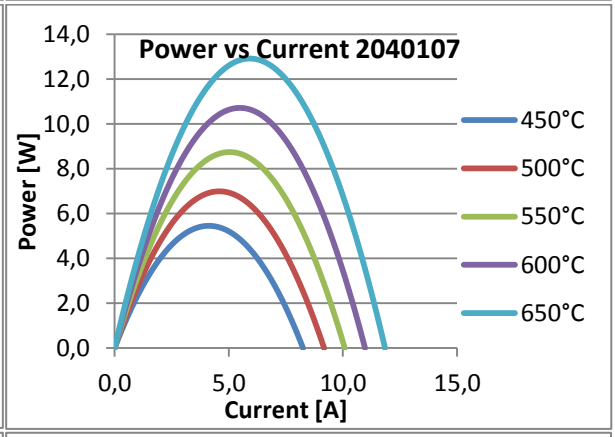
## *Electrical performance*

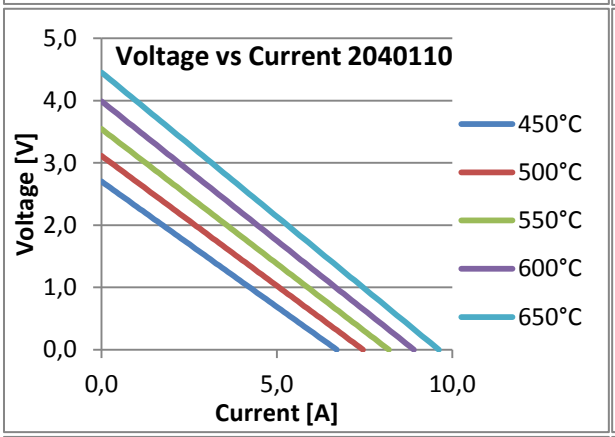
The following graphs show the voltage and power output for different TEG temperatures and a water temperature of 30°C. Electrical performances for other cooling water temperatures available on request.

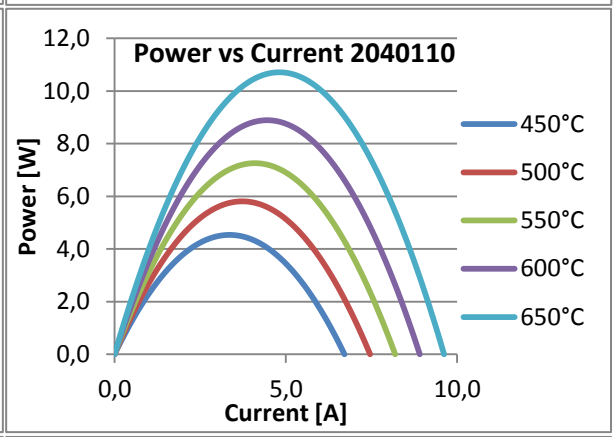


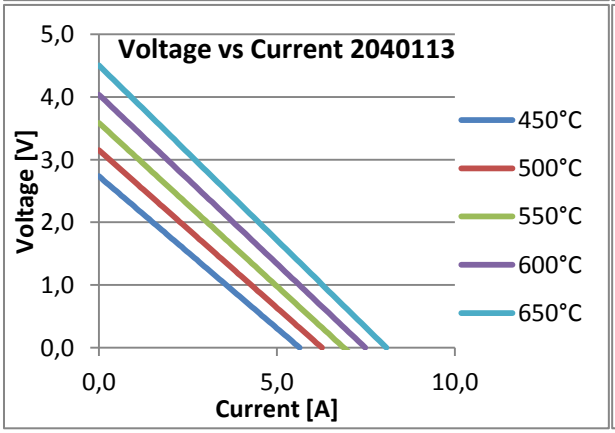



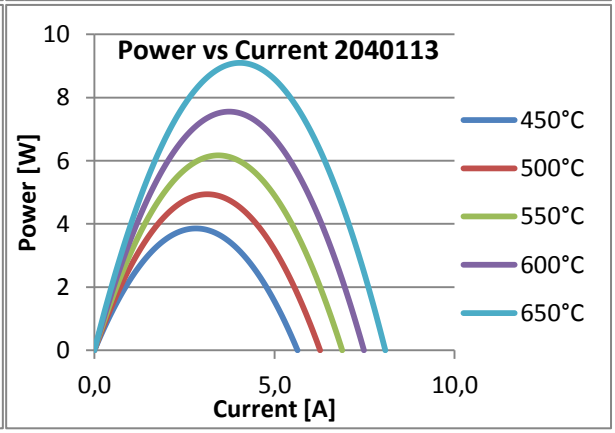



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### System application design guidelines

Depending on the desired purpose for the captured heat at the heat sink, it is necessary to choose a model that fits these expectations. The graph shows a window of the Thermagy™ power module work field.

### Example: How to apply the graphs for system design

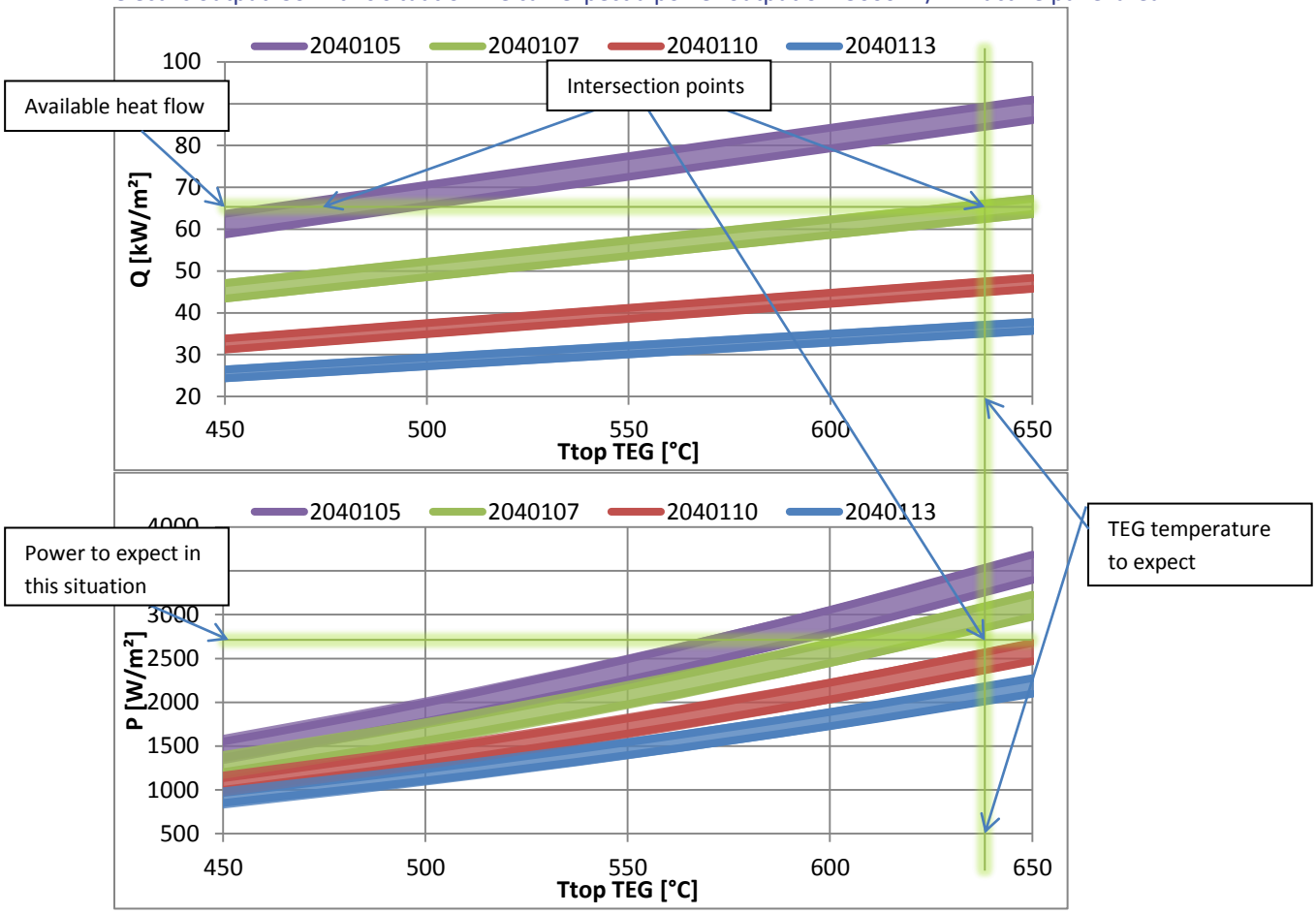
1) Check/measure/calculate the available heat flow from your system through the Thermagy™ power module surface dependent of the Thermagy™ power module top temperature;
2) Draw a horizontal line from the available heat flow through the graph;
3) Check if there is an intersection with one or more of the model lines, choose the one with the highest temperature on the X-axis (the Thermagy™ power modules work the most efficient at high temperature);
4) Draw from this intersection a vertical line through both graphs;
5) Check in the other graph the intersection with the line of the same model;
6) Draw from this intersection a horizontal line to determine the electrical power generation.

### Example

A radiating source of ~975°C with an emissivity coefficient of 0,75 to Thermagy power module of ~640°C and an emissivity coefficient of 0,95 and no need of a protective plate with a view factor of 0,95. The heat flow in this situation can be calculated with:

"$Q= S*\beta*\varepsilon*(T_{source}^4-T_{receiver}^4)$" = 0,95* 5,670373·$10^{-8}$*(0,95*0,75)*($975^4$-$640^4$)=66 kW/$m^2$

In this example we have an heat flow of 66 kW/$m^2$ to our availability, which has two intersection points (2040105 and 2040107). We choose the intersection with the green line of the 2040107 model because this one is working on a higher top temperature. In the power graph we see the vertical line crosses the 2040107 line at 3000 W/$m^2$ electric output. So in this situation we can expect a power output of ~3000 W/$m^2$ "active panel area".



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### *Module Assembly Options (on request)*

RGS development BV is flexible and likes to think along with your ideas for thermoelectric applications. The following shows a few assemblies that could be supplied on request.

**Dimensions**

The standard power module fits by the dimensions length (L) ~100mm and width (W) ~40mm. The height (H) depends on the chosen model that fits with the available heat flow.

Alternative dimensions:

| | | | |
|---|---|---|---|
| L [mm] | 50; | W [mm] | 40 |
| L [mm] | 300; | W [mm] | 40 |

**Heat sink**

To generate electric power with the Thermagy power module a temperature difference over the TEG is necessary, a heat sink at the cold side is one of the solutions to do this. RGS development BV can supply an aluminum water cooled heat sink. In this case the power module will already be glued to this heat sink at delivery.

Aluminum heat sink, 2 x G1/4 thread for water connections, 4 x M5 thread for mounting.

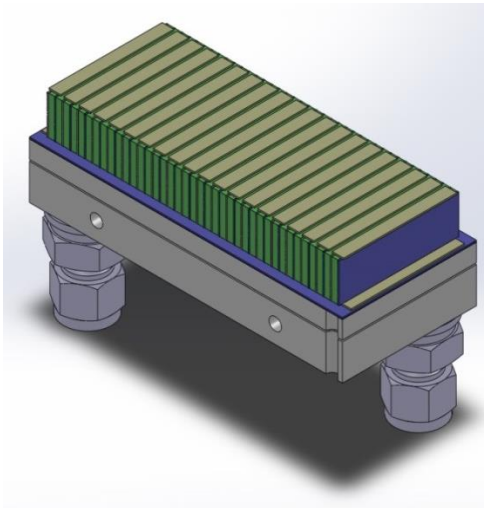

Figure 5 Standard Thermagy power module glued to a heat sink

**Mounting plate**

To simplify the assembly an already applied mounting plate can be ordered. The dimensions for this plate can be determined in consultation.

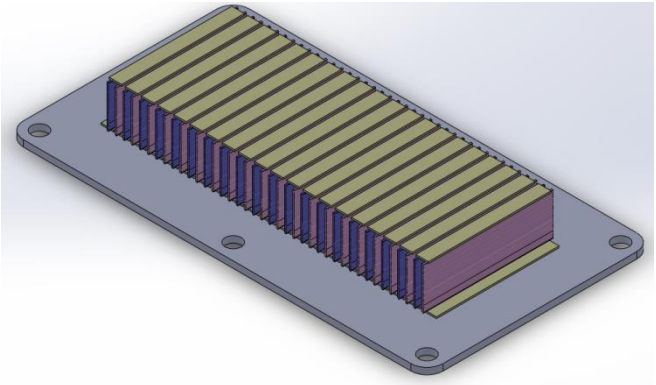

Figure 6 Example of a mounting plate



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