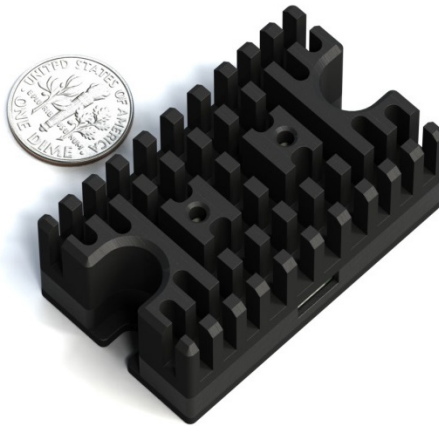


**Thermoelectric Generator
DX2625
MINI Solid State Energy
Harvester**

Quick Start Instruction



Edition June 2020

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Revision History

Changes from Revision 1.01. October 2020.

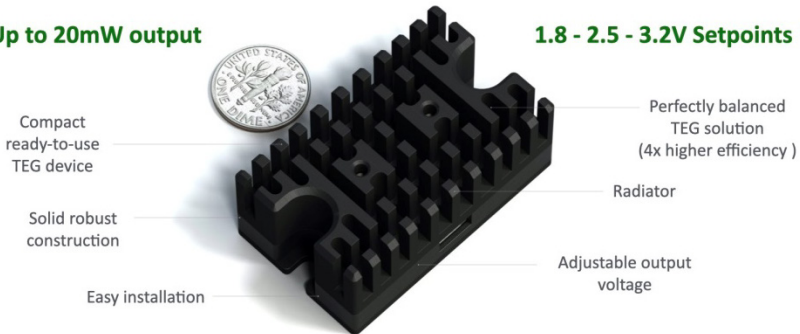
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Introduction

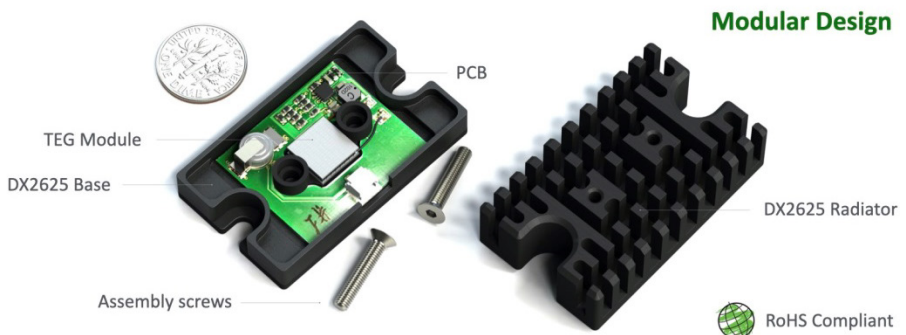
DX2625 is a high-efficient self-contained thermoelectric generator block. It harvests waste heat and converts it into usable output DC power. With its compact size and high-performance conversion ratio this device is perfect as a stand-alone maintenance-free power supply for wireless sensors and networks (WSN). Modular construction, easy to mount design and up to 20mW real power output in natural convection conditions make DX2625 perfect also for LED lighting and battery charging applications.

Up to 20mW output

1.8 - 2.5 - 3.2V Setpoints



Power from the harvester is generated by thermoelectric converting heat energy into electrical energy. The amount of generated electrical power depends on the temperature difference between heat source and ambient. In reality thermoelectric generator (TEG) is sensitive to ambient conditions. Optimal TEG construction requires a perfect matching of thermal resistances between TEG and heatsink.



The key advantage of DX2625 is in its optimized and well-balanced electrical and thermal design. TEG efficiency depends a lot also on the ratio between TEG electrical resistance and resistance of the attached electronics. Simple at first glance, TEG energy harvesting idea turns into a complex engineering task with detailed thermal analysis and design. DX2625 is the compact "ready-to-use" energy harvester, designed and already optimized by specialists in TEG applications. A visually simple solution is a combination of precise TEG estimations, accurate materials matching and a high-level engineering. The result is up to 20mW real output power in natural convection conditions, while the nearest analogs on the market have just a few milliwatts of actual output.

The output voltage of DX2625 can be changed on request: 1.8V, 2.5V or 3.2V.

Another great feature of DX2625 is its modular construction. The PCB inside has a reserved space for integrating customer electronics inside. Thus DX2625 from a pluggable TEG power supply unit can be transformed into a complete "all-in-one" solution based on customer requirements.

Technically DX2625 is a high-performance energy harvesting TEG chassis for various applications.

Key features

- ✓ Compact thermal energy harvester
- ✓ High energy converting efficiency
- ✓ Up to 20mW real output
- ✓ Suitable for vertical and horizontal surfaces
- ✓ Simple mounting
- ✓ Possible integrating of Customer electronics

Main applications

- ✓ Wireless Sensors and Transmitters
- ✓ Wireless Sensor Networks (WSN)
- ✓ LED Lighting
- ✓ Battery Charging
- ✓ Power Supply for IoT
- ✓ Alternative for replaceable cell batteries

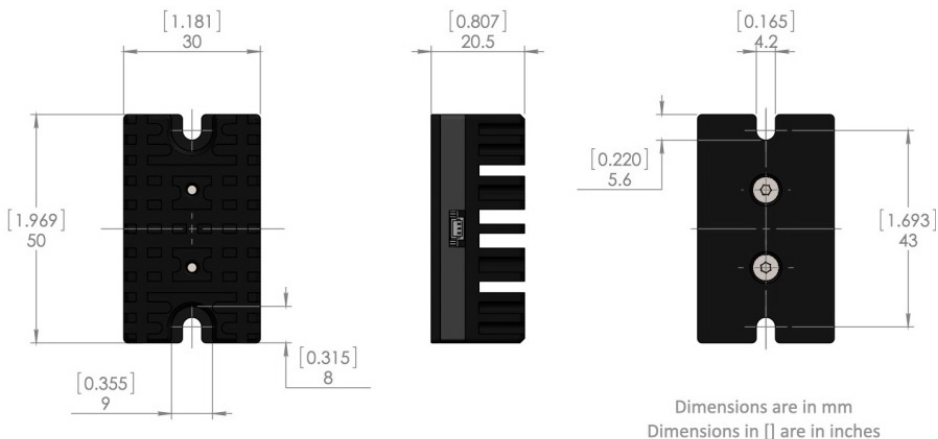
Specification

#	Parameter	Units	Min	Nom	Max	Note
1	Output Voltage	V	-	3.2	-	Default*
2	Temperature Difference**	°C	15*	-	70	$T_{hot} - T_{amb}$
3	Output Power	mW	0.5	-	20	
4	Operating Temperature	°C	-40	-	+85	
5	Dimensions	mm	30 x 50 x 20.5			W x L x H
2	Weight	g	25.0			

* - default value of output voltage is 3.2V (factory preset). Other output voltages are available in the range 1.8-3.2V by request. Only by factory preset.

** - at "cold-start" (see below "Cold start mode") it shortly needs $\Delta T_{min} \approx 30$ °C.

Dimensions



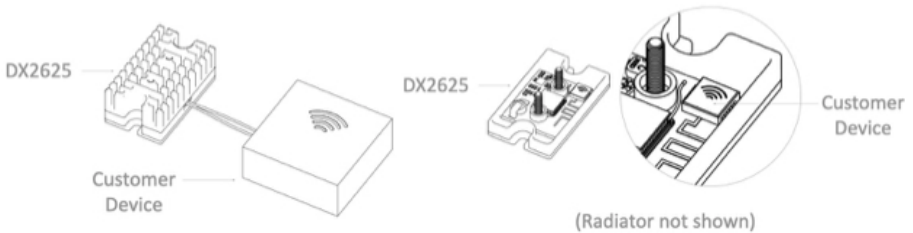
Delivery kit

#	Item	Q-ty	Note
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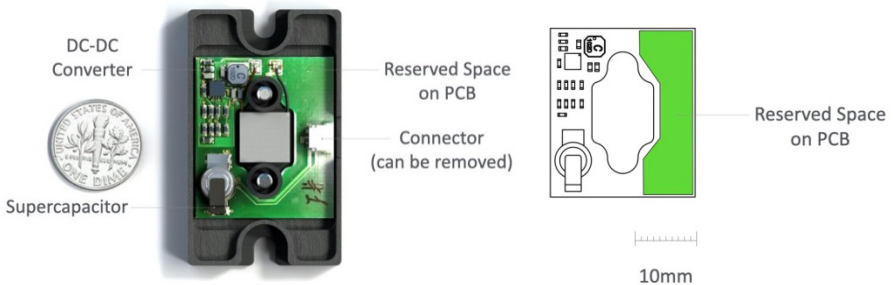
1	Thermoelectric Generator	1	
2	Connector with short cable	1	Type JST SHR-03V-S-B

Integrating methods

DX2625 is the complete power supply unit with all electronics on-board. It's a full set, you just need to plug it in and power your device. If required it's possible to integrate customer electronic components right onto DX2625 PCB. It requires a customization, but in this case the device will be turned into a complete stand-alone sealed autonomous system, that can work for decades without any maintenance.



DX2625 Mini TEG is the example of high-end engineering approach in thermoelectric generating and green energy harvesting. Behind visually simple construction there is a full round of precise analysis, estimations, mechanical and thermal optimizations. The resulting efficiency of TEG harvester is at 5-8 times better than available analogs on the market.

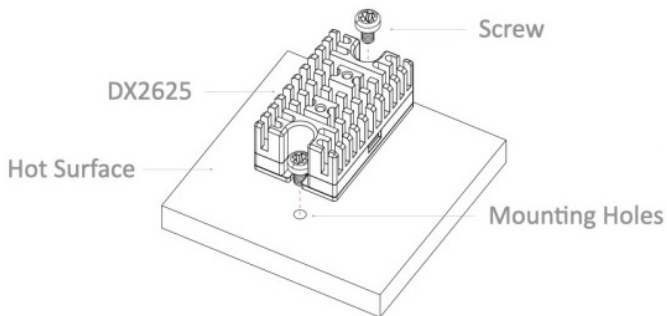


DX2625 is the perfect solution for Wireless Sensor Networks (WSN) - a fast-growing market that brings new possibilities with autonomous maintenance-free network systems. It brings new perspectives in automatic monitoring of power lines, forest fires, avalanches, hurricanes, failure of countrywide utility equipment, traffic, hospitals and much more. TEC Microsystems provides a full service with development and integrating of high-efficient compact thermoelectric generating solutions for WSN and similar applications.

Mounting methods

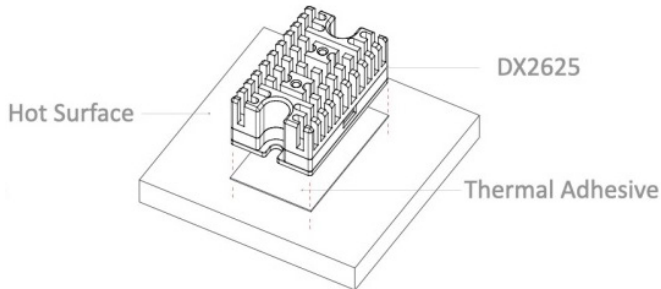
Two mounting methods of DX2625 Thermoelectric Generator onto heat source are recommended and possible.

Mounting using screws



1. Select flat surface on heat source - size at least not less than dimensions of DX2625 Generator unit bottom.
2. Prepare the screw threaded holes (for instance, type M2-3).
3. Clear bottom surface of Generator.
4. Place thin film of thermoconductive grease or thin sheet.
5. Attach generator bottom to the prepared surface of the heat source.
6. Apply screws.

Mounting with thermoconductive adhesive tape



1. Select flat surface on heat source - size at least not less than dimensions of the DX2625 Generator unit bottom.
2. Prepare thermoconductive two sides adhesive tape with size equal to dimensions of the device bottom – 30x50 mm².
3. Clear bottom surface of the Generator.
4. Place tape to the Generator bottom.
5. Attach the Generator bottom to the prepared surface of the heat source.



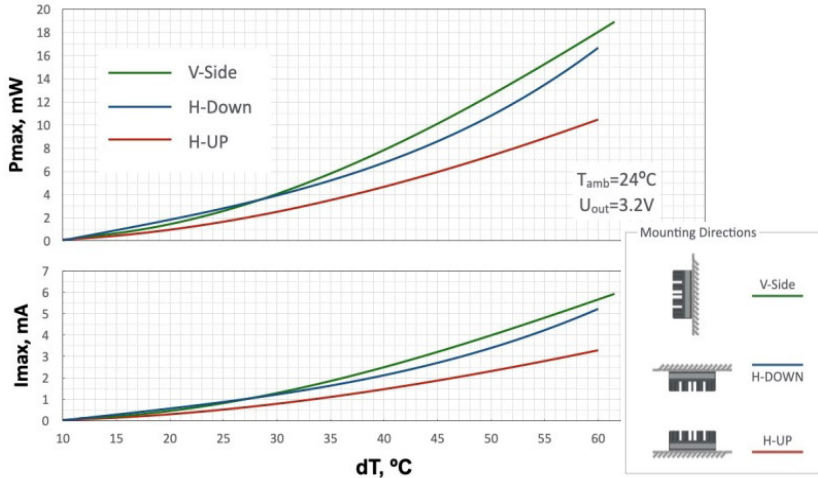
Important! Ensure good contact of DX2625 generator to surface of heat source. Performance of the generator depends strongly on the thermal contact.



Note. As a rule mechanical mounting by screw provides better thermal contact rather than adhesive tape. But sometimes preparing of screw threaded holes for this is not available, so adhesive tape looks as simpler.

Operating performance on orientation

Operating performance of DX2625 thermoelectric generator depends on orientation of the device in ambient because of physics of heat dissipation by natural convection.



Preferable for better performance is to mount of DX2625 by side (V-Side) or facedown (H-Down).



Important! Ensure proper heat dissipation from a hot side of your TEC by using proper heatsink and good thermal contact between TEC hot side and a heatsink.

PIN description

The thermoelectric generator DX2625 has standard on-board connector JST SM03B-SRSS-TB (JST) with three pins which is situated at the side of the DX2625 unit housing.



Note: For connecting, please use the mating part of the connector (JST SHR-03V-S-B) which with short wires is included in the package (“Delivery kit”)



Mating cable connector SHR-03V-S-B pinout and color code

SN1 Connector pinout configuration

#	PIN Name	Supply	Description
1	Vout+	+ U _{OUT}	Output voltage + (plus)
2	Vout-	- U _{OUT}	Common – (minus)
3	BAT-OK	0...U _{OUT}	Battery status: 0 - not ready; U _{out} - ready for work.

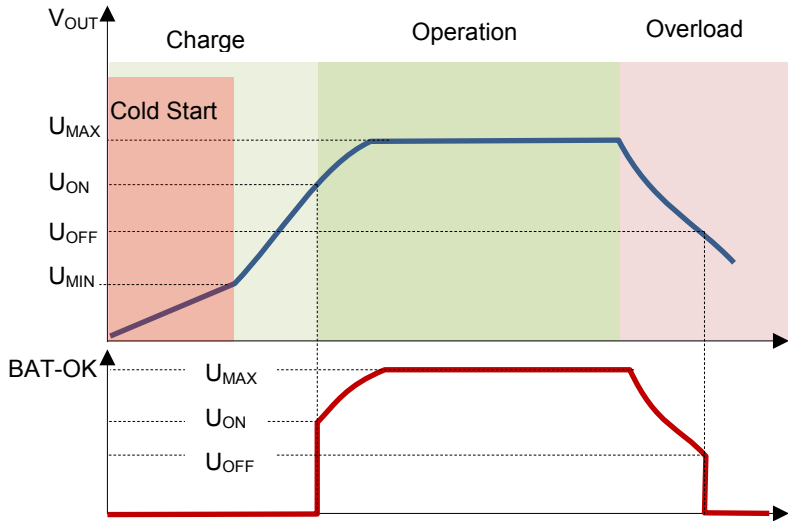
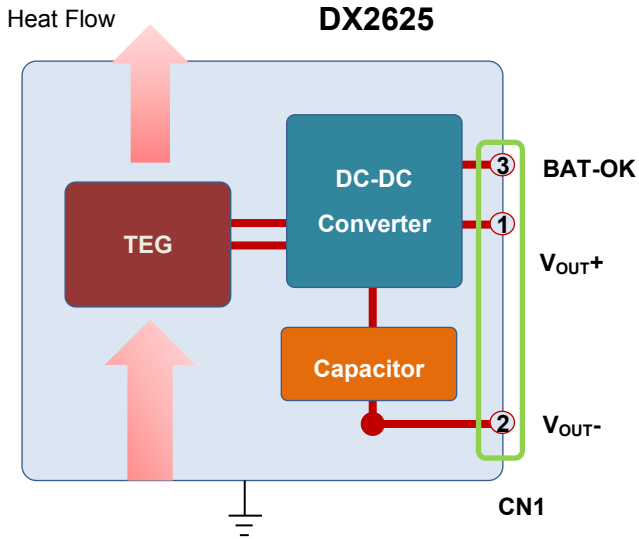


Important! Vout- (output “minus”) does not combined with device housing “ground”.

How does it work

Internal design

The DX2625 thermoelectric generator consists of thermoelectric mini-generator module (TEG), electronic DC-DC converted, supercapacitor and three-pin connector (CN1). All of the items are integrated into aluminum anodized housing which plays a role of heat collector (bottom side) and heat sink (top side) for heat dissipation.



Operation

Operation phase in general can be divided into three different regimes (Charge, Operation, Overload) and Cold start mode into Charge regime.

Key parameters are shown into the table

#	Voltage	Value (default), V	Notes
1	U_{MIN}	1.8	The values are given for default 3.2V operation Output Voltage (Specification). For other Operation Voltages available by factory pre-set the values to be differ.
2	U_{ON}	3.0	
3	U_{MAX}^*	3.2	
4	U_{OFF}	2.1	

* - is equal to Output Voltage (Specification)

Charge regime

In a case of very first start or when internal supercapacitor is discharged ($V_{OUT} < U_{ON}$) then before normal use of DX2625 it needs a time to charge the internal supercapacitor to nominal value (0.2 F). Normal time – about 6...10 minutes at $\Delta T \approx 60^\circ C$.

When the charge is enough ($V_{OUT} > U_{ON}$) then the BAT-OK output switches from 0 to V_{OUT} . And keep the voltage during Operation mode (BAT-OK = V_{OUT}).

Cold start mode

Note very important so-could “cold-start” issue caused by internal DC-DC converter operation behavior.

If the internal capacitor is charged less than U_{ON} (1.8 V), then initiation of DC-DC converter operation and change of supercapacitor is possible only if the input voltage from internal thermoelectric generator module (TEG) is about two times more than in case of normal operation. It means that in the cold-start case minimal ΔT_{min} must be about 2 times more than specified minimal value for normal operation (“Specification”). This is a feature of electronic DC-DC converter circuit.

Operation regime

After supercapacitor is charged enough the normal operation mode is available with output power performance according to the above diagram (“Operating performance”).

The BAT-OK output indicates beginning of working regime. The BAT-OK jumps from “0” (low value) to value of working voltage V_{OUT} , and keeps the value during operation regime. Other words – if BAT-OK stays high, then operation mode is available.

During Operation mode BAT-OK stays high (BAT-OK= V_{OUT}).

Default operation voltage is 3.2 V. Other factory pre-sets are available in the limited range by request. In the case internal supercapacitor will be correspondingly replaced for other working voltage nominal.

Overload regime

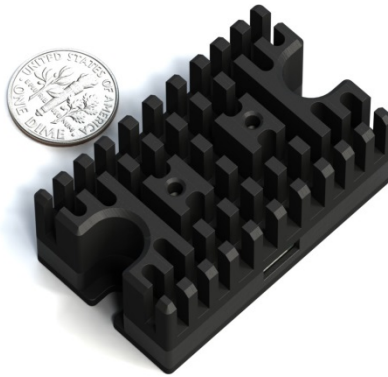
If output electrical load to DX2625 becomes higher than available - the internal TEG cannot provide more power than specified - then the internal capacitor starts to discharge and output voltage V_{OUT} drops down.

When V_{OUT} becomes less than U_{OFF} (2.1 V, default value) then BAT-OK switch to zero, giving a signal that DX2625 generator is out of use.

To come back – it is necessary to reduce power load to DX2625 generator.



Important! Do not discharge capacitor to voltage less than 1.8 V. Otherwise “Cold start” issue will realize – need minimal ΔT to return working of DC-DC converter.



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