

From ESCC to Space-Graded and Off-the-shelf solutions for flexible heaters



ACCEDE | ESCCON

2025 Seville - Spain
25 to 27th March



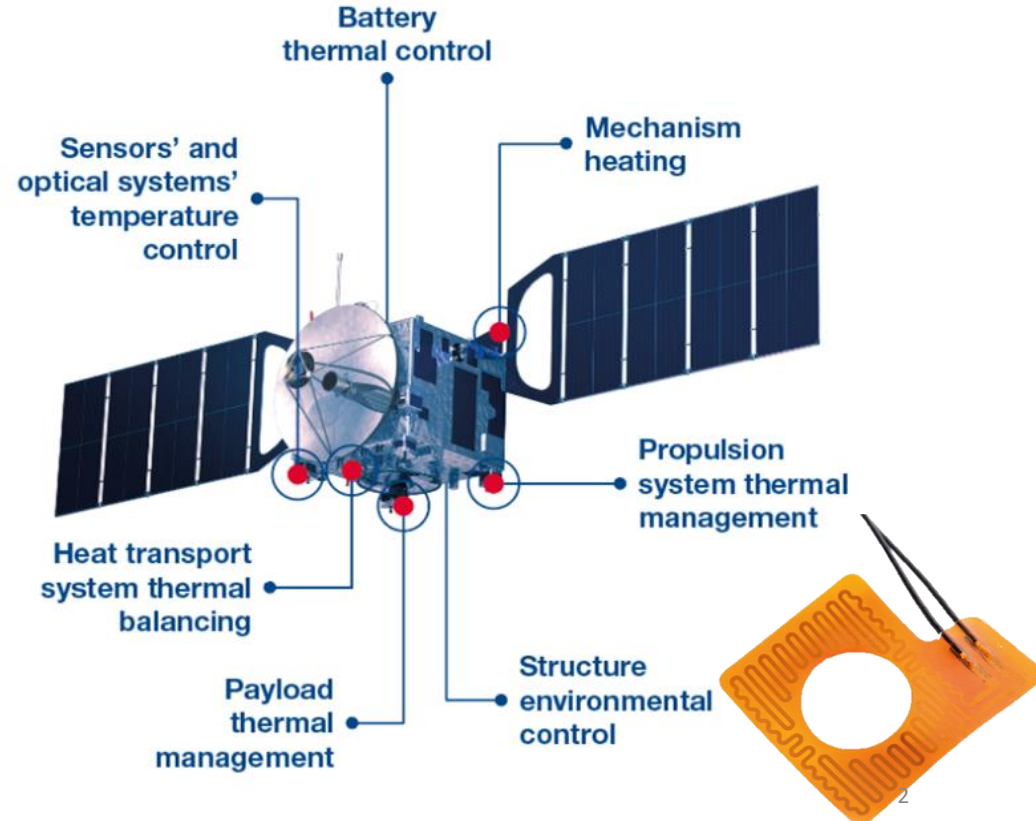
ALTER | 



FLEXIBLE HEATERS: DEFINITION

Flexible Heaters are crucial components for the **Thermal control**, thanks to their **versatility** and **efficiency** in the uniform distribution of heat at different power densities.

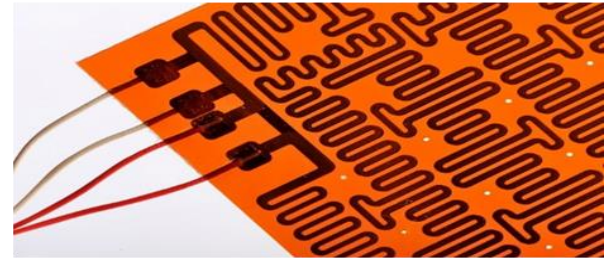
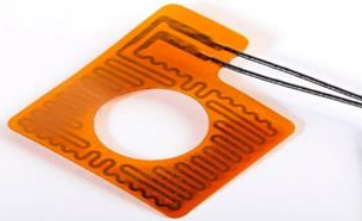
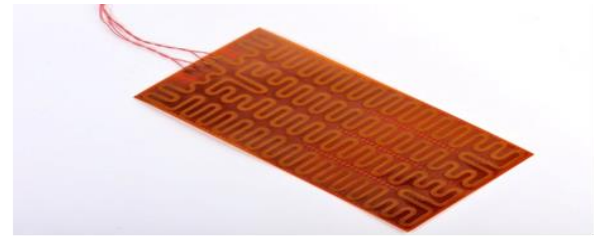
They are widely used in various parts of **satellites** or **habitable modules**, including propulsion elements, electronics, batteries, structures, optics, detectors and more.



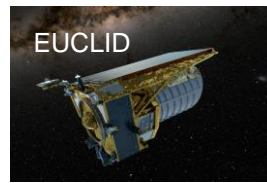
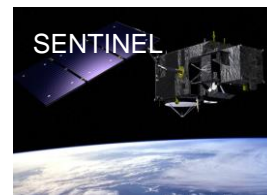
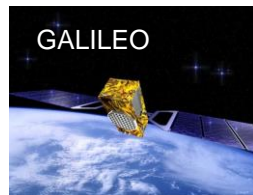
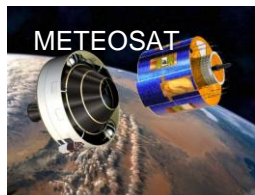
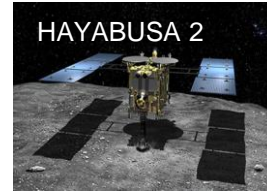
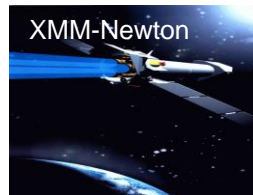
FLEX HEATERS FOR SPACECRAFTS

Since April 1992 Zoppas Industries (ZIHET / IRCA S.p.A.) is qualified by ESA ESCC 4009/002 & 4009/004 as Supplier of flexible heaters, single and double layer, for use in space projects.

Our flexible heaters have been used in more than 1000 satellites all over the world manufactured in different geographical areas such as: Europe, Japan, India, US, South America, Canada, South Korea.



SOME EXAMPLES OF OUR HERITAGE



“Stakeholders are asking for spacecraft that **perform better** at a **lower cost** and with **faster development times** [...]. We simply can't afford to custom-develop every component for every space mission.”

ESA COTS Guidelines

ECSS Q-ST-60 ECSS Q-ST-60-13

		<-----Informative area----->		<-----Normative area----->	
Mission references	Type		<u>"Low cost - experimental" mission,</u>	<u>"Robust" mission with high quality / reliability needs.</u>	<u>"Hi Rel certified" mission</u>
	Cost		Low	Low/medium	Medium/High
	Lifetime		few weeks/months up to 1 year	1 to 3 years	> 3 Year
	Reliability		low to medium	High	high
	Radiation	SEE	negligible due to lifetime	Relevant	relevant
	Example		ESEO, R&D payloads, serviceable systems?	SAT-AIS, Generic Constellation, Technology Demonstrators	MEX, GAIA, Bepi Colombo, Sentinel 1,2,3, METOP SG, EDRS, Electra, Galileo FOC, IOV...
Module, equipment or subsystem function	Radiation	TID	Minor (up to 5Krad)	Medium (up to 10-15 Krad)	Medium to High (higher than 10-15 Krad)
(Minimum) Equipment, Subsystem or System Criticality Category			Q ₂	Q ₁	Q ₀ According to ECSS-Q-ST-60-13C*, ECSS-Q-ST-60C ** extended to passives

“This standard¹ defines the requirements for selection, control, procurement and usage of EEE commercial components for space projects.

This standard is applicable to commercial parts from the following families:

- Ceramic capacitors chips
- Solid electrolyte tantalum capacitors chips
- Discrete parts (transistors, diodes, optocouplers)
- Fuses
- Magnetic parts
- Microcircuits
- Resistors chips
- Thermistors

In addition for families of EEE components not addressed by the present ECSS standard, it can be used as guideline on case by case basis.”

The requirements for “commercial” **heaters** are not specified, but the standard ECSS-Q-ST-60-13C can be used as a **guideline**

ECSS-Q-ST-60-13C defines some acceptable derogations to ECSS-Q-ST-60 → ESCC requested tests:



ECSS-Q-ST-60-13C Rev.1
12 May 2022

8.2 Applicable Procurement test tables		
8.2a	The Test Tables Table 8-1, Table 8-2, Table 8-3, Table 8-4, Table 8-5, Table 8-6, Table 8-7, Table 8-8 shall be used for evaluation, screening and LAT of commercial parts.	New
8.2b	Based on the review of representative data, as per 8.2f, the supplier may propose an adaptation and a minimization of these evaluation tests, to be submitted to customer for approval through the JD's approval process. NOTE This permission is referenced in the Procurement Test Tables as "Note (a)".	New
8.2c	Based on representative data, as per 8.2f, collected in evaluation tests and in the JD, the supplier may propose an adaptation and a minimization of these screening tests to be submitted to customer for approval through the JD's approval process. NOTE This permission is referenced in the Procurement Test Tables as "Note (b)".	New
8.2d	The supplier may propose an adaptation and a minimization of these LAT tests, to be submitted to customer for approval through the JD's approval process, based on representative data, as per 8.2f, on parts not older than 2 years. NOTE This permission is referenced in the Procurement Test Tables as "Note (c)".	New

...provided that the parts comply with representativity criteria: "same serie; same range of voltage, resistance and packages; same manufacturing plant"

In addition to ESCC qualified flexible heaters, ZIHET also offers levels of **more commercial qualifications, such as QM (Qualification Model) and PFM (Proto-Flight Model)**, which ensure compliance for in-flight use, while allowing **faster response times and market competitiveness.**

→ **Same product, same process, same manufacturing lines**

→ **Reduced set of testing**

Qualification level	Description
Qualification Heater (QM)	These heaters are provided in full compliance with the applicable ESCC specification's prescribed materials and manufacturing; a minimal set of verification steps (i.e. Functional visual inspection, Production Control tests and #ESCC-compliant Final Room Temperature Electrical Measurements) is performed, to ensure its suitability for functional and environmental qualification testing.
Protoflight Heater (PFM)	These heaters are provided in full compliance with the applicable ESCC specification's prescribed materials and manufacturing; the verification campaign is performed on a statistical basis w.r.t ESCC requirements, according to UNI ISO 2859-1 type G, AQL 0,40 (Burn-in, final visual inspection, electrical measurements).
ESA qualified Heater (ESCC)	Fully ESA-qualified Space Heater, covering all the inspections, controls and tests foreseen by the applicable ESCC specification.

Beyond customized products, ZIHET provides also a wide range of **standard flexible heaters**, available in our warehouse in different sizes and ohmic values, as immediate solutions for commercial missions and test equipment.

- The standard heaters are available for **immediate delivery**.
- They are offered in both versions **ESCC (FM)** and **QM**

P/N QM heaters	P/N FM heaters	Size (Y)	Size (X)	Size (Y)	Size (X)	Lead exit size	Net heating area		Resistance (@22°C, wire included)	Wire	Wire length	Typical power
		[mm]	[mm]	[inch]	[inch]		[mm x mm]	[cm ²]				
SC012037Q	SC012037F	12,5	37,5	0,49	1,47	10x11	2,63	0,40	313,6	26	500	2.5 W at 28 V
SC012075Q	SC012075F	12,5	75	0,49	2,95	10x11	6,56	1,01	247,2	26	500	3.2 W at 28 V
SC012125Q	SC012125F	12,5	125	0,49	4,92	10x11	11,81	1,83	139,4	26	500	5.6 W at 28 V
SC025025Q	SC025025F	25	25	0,98	0,98	10x14	3,61	0,55	392	26	500	2 W at 28 V
SC025037Q	SC025037F	25	37,5	0,98	1,47	10x14	6,49	1,00	239,1	26	500	3.3 W at 28 V
SC025050Q	SC025050F	25	50	0,98	1,96	10x14	9,36	1,45	172	26	500	4.6 W at 28 V
SC025075Q	SC025075F	25	75	0,98	2,95	10x14	15,29	2,36	110,2	26	500	7.1 W at 28 V
SC025100Q	SC025100F	25	100	0,98	3,93	10x14	20,97	3,25	81,1	26	500	9.7 W at 28 V
SC037037Q	SC037037F	37,5	37,5	1,47	1,47	10x14	11,18	1,73	150,1	26	500	5.2 W at 28 V
SC037050Q	SC037050F	37,5	50	1,47	1,96	10x14	15,44	2,39	109,4	26	500	7.2 W at 28 V
SC037100Q	SC037100F	37,5	100	1,47	3,93	10x14	33,27	5,15	52,5	26	500	14.9 W at 28 V
SC050050Q	SC050050F	50	50	1,96	1,96	10x14	21,36	3,31	80,2	26	500	9.8 W at 28 V
SC050075Q	SC050075F	50	75	1,96	2,95	10x14	33,36	5,17	52,3	26	500	15 W at 28 V

STOCK FLEXIBLE HEATER FOR SPACE MARKET
(SATELLITE - VEHICLE - LAUNCHER
AND GROUND SEGMENT)



COTS APPROACH TO ESA MISSION

			ESA COTS Guidelines		ECSS Q-ST-60 ECSS Q-ST-60-13
			<-----Informative area----->		<-----Normative area----->
Mission references	Type		"Low cost - experimental" mission.	"Robust" mission with high quality / reliability needs.	"Hi Rel certified" mission
	Cost		Low	Low/medium	Medium/High
	Lifetime		few weeks/months up to 1 year	1 to 3 years	> 3 Year
	Reliability		low to medium	High	high
	Radiation	SEE	negligible due to lifetime	Relevant	relevant
	Example		ESEO, R&D payloads, serviceable systems?	SAT-AIS, Generic Constellation Technology Demonstrators	MEX, GAIA, Bepi Colombo, Sentinel 1,2,3, METOP SG, EDRS, Electra, Galileo FOC, IOV...
Module, equipment or subsystem function	Radiation	TID	Minor (up to 5Krad)	Medium (up to 10-15 Krad)	Medium to High (higher than 10-15 Krad)
(Minimum) Equipment, Subsystem or System Criticality Category			Q ₂	Q ₁	Q ₀ According to ECSS-Q-ST-60-13C*, ECSS-Q-ST-60C ** extended to passives

Until we get into the EPPL-2:

All our space heaters are here (Q₀)

Indeed, our heaters satisfy the «green requirements»:

<-----Normative area----->			
Mission references	Type		"Hi Rel certified" mission
	Cost		Medium/High
	Lifetime		> 3 Year
	Reliability		high
	Radiation	SEE	relevant
	Example		MEX, GAIA, Bepi Colombo, Sentinel 1,2,3, METOP SG, EDRS, Electra, Galileo FOC, IOV...
Module, equipment or subsystem function	Radiation	TID	Medium to High (higher than 10-15 Krad)
(Minimum) Equipment, Subsystem or System Criticality Category			Q ₀ According to ECSS-Q-ST-60-13C*, ECSS-Q-ST-60C ** extended to passives

- Lifetime: > 10 years
- Reliability: from prev. slide
- Radiation: tested at 1Mrad



IRCA S.p.A. is currently candidate to become one of the first “**Enhanced Grade**” - **EPPL 2 (*)** entries, with our QM / PFM / Stock heaters.

→ We are now in the **technology flow qualification** process.

- (*) **EPPL: European Preferred Parts List**
 - EPPL-1: ESCC-qualified parts
 - EPPL-2: Enhanced-grade parts

And concerning innovation...

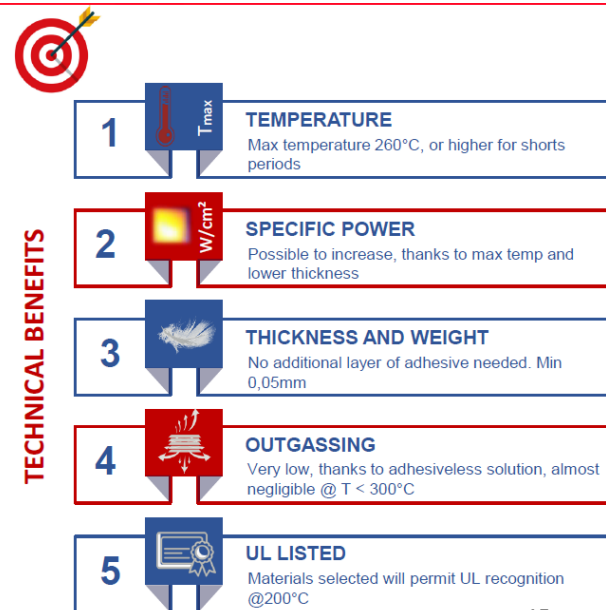
The heaters are ESCC qualified to operate in a temperature range that can vary from -65°C to $+200^{\circ}\text{C}$.

Currently, ZIHET has completed the internal qualification of a new product, capable of reaching even higher temperatures ($+260^{\circ}\text{C}$).



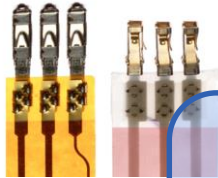
Ongoing:

- ESCC qualification of the new heater «PPH PurePolyimide»



ZIHET recently qualified with **IPC 610/620** and **ECSS-Q-ST-70-26C** certifications to supply assembled heaters with connectors, to:

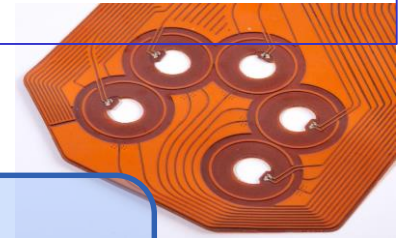
- Facilitate the integration of the electrical interface with the power subsystem
- Simplify the Supply Chain
- Reduce supply times thanks to standardization of connections



Ongoing:
ESCC Qualification of the assembly «connectorized heater»

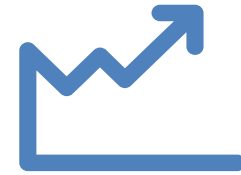


When the thermal environment to be regulated is distributed in small dimensions, and the TRP is located close to the heater, a product that integrates a heating element and an ESCC-qualified temperature sensor (**PT100/PT1000/NTC**) can help optimize the integration. An integrated sensor can also help in the ECSS-derating rules' correct application.



Ongoing:
ESCC qualification of the assembly «sensorized heater»

Growing Together !



zoppasindustries.com




space@zoppas.com
alessandra.marcer@zoppas.com




Backup slides

OUR QUALIFICATION LEVELS - TEST DETAILS



Test Category	Test Description	FM	PFM	QM
In-process External Visual Inspection (according to ESCC 2054009)	External Visual Inspection after etching	OK Complete lot	OK Complete lot	OK Complete lot
	External Visual Inspection after 2° Lamination	OK Complete lot	OK Complete lot	OK Complete lot
	External Visual Inspection after Cable Sealing (only cable sealing area)	OK Complete lot	OK Complete lot	OK Complete lot
In-process Electrical tests	Room Temperature Electrical Measurements (ESCC 4009 – 8.1.3)	OK Complete lot	OK Complete lot	OK Complete lot
Production Control (CHART F2 - ESCC 4009)	Robustness of termination (ESCC 4009 – 5.2.1)	OK Complete lot	OK Complete lot	OK Lot start and end
	Dimension check	OK (ESCC 4009 – 5.2.2) (3 pieces per lot)	OK (ESCC 4009 – 5.2.2) (3 pieces per lot)	OK (5 pieces per lot)
	Weight (ESCC 4009 – 5.2.3)	OK	OK	OK



Screening Tests (CHART F3 - ESCC 4009)	Room Temperature Electrical Measurements (ESCC 4009 – 8.1.3)	OK Complete lot	OK Statistical Control according to UNI ISO 2859-1 type G, AQL 040	N/A
	Rapid Change of Temperature (ESCC 4009 – 8.2)	OK Complete lot	OK Statistical Control according to UNI ISO 2859-1 type G, AQL 040	N/A
	Overload (ESCC 4009 – 8.3)	OK (5 pieces per lot)	OK (5 pieces per lot)	N/A
	Burn-in (ESCC 4009 – 8.4)	OK Complete lot	OK Statistical Control according to UNI ISO 2859-1 type G, AQL 040	N/A
	High and Low Temperature Electrical Measurement (ESCC 4009 – 8.1.2)	OK (3 pieces per lot)	OK (3 pieces per lot)	N/A
	Final Room Temperature Electrical Measurements (ESCC 4009 – 8.1.3)	OK Complete lot	OK Statistical Control according to UNI ISO 2859-1 type G, AQL 040	OK 5 pieces per lot
	Check for Lot Failure (ESCC 4009 – 6.4)	OK Complete lot	OK Statistical Control according to UNI ISO 2859-1 type G, AQL 040	N/A
	External Visual Inspection (according to ESCC 2054009)	OK Complete lot	OK Statistical Control according to UNI ISO 2859-1 type G, AQL 040	N/A