DATASHEET

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- **ATT Powerfilm®**
- **ATT Powersense®**
- **ATT Powerlogic®**

- **Automotive**
- Aerospace
- Railway
- Defence
- Building Technology
- Industry

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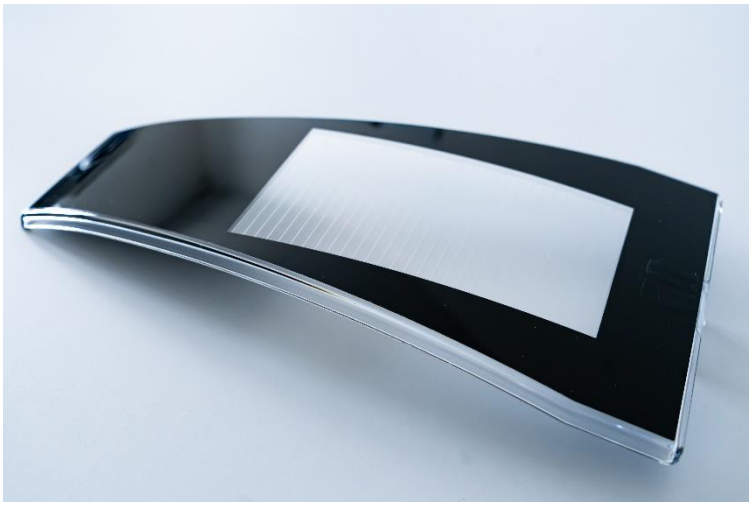

Fig. 001
ATT ADAS Sensor & Camera Heaters. The fastest and most efficient way of keeping RADAR and LiDAR sensor covers as well as camera covers free from snow, ice and a fogged up surface

ADAS SENSOR COVER HEATERS

Keeping Cameras, RADAR & LiDAR Sensors as well as camera covers free of snow & ice in the most efficient way with our moldable and transparent Heaters that enable back injection.

APPLICATION BACKGROUND

Since advanced driver-assistance systems (ADAS) and other cutting-edge self-driving innovations hit the automotive market, reliable LiDAR (Light Detection and Ranging) and RADAR (Radio Detection and Ranging) systems are crucial in the development of advanced self-driving vehicles. One significant challenge in this relation, is to guarantee clear visibility of those systems even in the harshest environmental conditions. For the sensor cover, especially the accretion of snow and ice as well as fogging is a significant issue that needs to be solved.

To ensure visibility during winter time, the RADAR and LiDAR sensor covers are currently equipped with wire based heating solutions. This state of the art solution is coming with some technological challenges during the manufacturing process, that is causing significant scrap rates. The homogeneity of the sensor cover temperature is often inadequate and overheating or even burning issues have been detected.

Since the required cooling air inlet of electrified vehicles is significantly smaller than that of a combustion engine car, large covers are used in the vehicle's frontend to mimic characteristic air inlet designs by incorporating a decorative, opaque foil into the otherwise transparent cover. These grills house all kind of sensors and cameras and thus, need to be heated to ensure a clear view of those devices, so a wire based heating system is added in addition to the decorative film.

VARIANTS OF SENSOR HEATERS

As an alternative to the technology currently on the market, ATT is offering two variants, both being screen printed onto (transparent) polycarbonate foils, saving process costs with respect to the currently available embedded wire technology.

VARIANT 1: Instead of using wire based heating systems, printed heating films based on silver are our go. This heating film is back moldable and transparent, and can be easily integrated in the back injection process, thus reducing the scrap rate significantly:

- Heating films are thermoformable, so even very complex geometries can be heated homogenously.
- Patented connector technology that comes together with the heating film – ready for further processing (e.g. Integration through back injection molding)
- The high power density of our heating solutions (up to 0.4 W/cm^2) leads to improved deicing times, a 2 mm ice layer can be melted in less than 180 seconds
- Thin (starting from 175 µm) and transparent in the wavelength relevant for RADAR and LiDAR.
    - RADAR: below -0.5 dB one-way attenuation (at 76 – 77 GHz)
    - LiDAR: > 90% transmittance of the electrode pattern
    - Visual range: > 90 % transmittance of the heating film
- Want to add an ice or humidity sensor so make sure the heating is only turned on when needed? This is possible as well using our capacitive sensor technology which can be directly integrated in the cover at defined positions

VARIANT 2: This is our flagship technology that features a PTC effect based on a combination of silver and carbon components, and thus enables on-demand heating of the sensor cover which we believe will be a future requirement in terms of efficiency and safety.

- Due to the Positive-Temperature-Coefficient (PTC) effect of our solution, the heating film comes with intelligence. The PTC effect describes the phenomena that the electric resistance increases with the temperature. Due to this effect, heat is only applied to areas of the cover that show ice or snow accretion as well as fogging.
- The PTC effect enables significantly increased power densities, resulting in faster de-icing rates (ready to use scenario) than any other solution currently available on the market.
- On-demand heating reduces the heating power significantly which leads to an efficient and range improving operation.
- Overheating or even burning issues can be eliminated because of the self-regulating effect of the heating film. Even without temperature sensors, the maximum specified temperature cannot be exceeded.
- Transparency in relevant wavelength regimes
    - RADAR: below -0.5 dB one-way attenuation (at 76 – 77 GHz)
    - LiDAR: > 90% transmittance of the electrode pattern
    - Visual range: > 90% transmittance of the electrode pattern
- Heating films are thermoformable, so even very complex geometries can be heated homogenously.
- The high power density of our heating solutions (up to 1,5 W/cm^2) leads to improved deicing times (a 2 mm ice layer can be melted in less than 60 seconds).
- Want to add an ice or humidity sensor so make sure the heating is only turned on when needed? This is possible as well using our capacitive sensor technology which can be directly integrated in the cover at defined positions

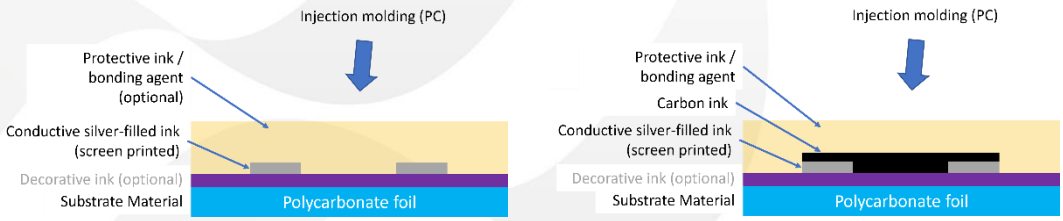

Fig. 002
ATT ADAS Sensor & Camera Heaters schematic: Variant 1 (left) and Variant 2 – PTC (right)

TECHNICAL PARAMETER

PARAMETER	VALUE	COMMENT
Dimensions	up to 1m x 1.4m	Geometry and actual size depending on the component to be heated. 3D shapes possible as well.
Weight	ca. 210 g/m²	Actual weight depends on the selected layer structure and base film thickness
Thickness	ca. 0,2 mm	Actual weight depends on the selected layer structure and base film thickness
Operating voltage range	12 V - 48 V	Other voltages on request
Heating power density at -20 °C	up to 1,5 W/cm²	Depending on the chosen technology
Heating film temperature	ca. 90 °C	Is controlled via the ECU, depending on requirements and materials used, deviating target temperature on request
Surface temperature (Anti-Icing)	> 5 °C	up to -20 °C ambient temperature and 130 km/h vehicle speed
De-Icing rate	bis 2 mm in 60 s	at -40 °C ambient temperature and vehicle at standstill (PTC - variant)
Transparency (visual range and near infrared)	> 90 %	Wavelength range relevant for cameras, optical assistance systems and common LiDAR sensors
Haze	< 2 %	Depending on the chosen substrate
One-way attenuation (76-77 GHz):	max. -0.5 dB	Frequency range of common mid- and long-range radar sensors
Certification		According to customer specific norms
IP protection category	IP67	Depending on the selected connector and installation position of the heating film in the component

Fig. 003
ATT ADAS Sensor & Camera Heaters

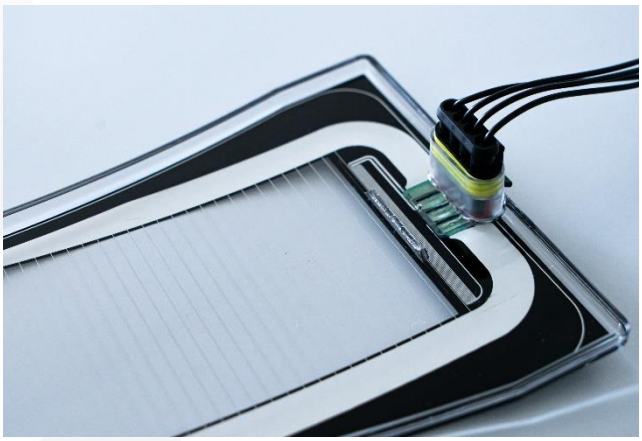

Fig. 004
ATT ADAS Sensor & Camera Heaters

SCOPE OF SUPPLY

- Heating element including connector
- Stackable ABS plastic trays for protected transport of heating elements
- Small load carrier or other containers according to customer specification

TRANSPORT AND STORAGE CONDITIONS

- Passive temperature range: -40°C up to +90°C
- Relative humidity: not relevant

SAFETY INSTRUCTIONS

- Folds, cracks or cuts in the product can lead to failure and must therefore be avoided during storage as well as during assembly.

DISPOSAL

- According to directive 2000/53 / EC on end-of-life vehicles

CERTIFICATION

- According to customer requirements

KEY ADVANTAGES OF THE ATT ADAS SENSOR COVER HEATING

01 Extremely **short defrosting times** due to very high heating power densities.

02 **Optimized process cost -** Combination of decorative and functional screen printing

03 **On-demand heating** to optimize functionality and energy efficiency