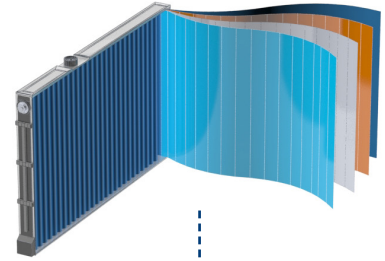




# High Definition Fiber Optic Sensing (HD-FOS) for Optimization of Battery Thermal Management

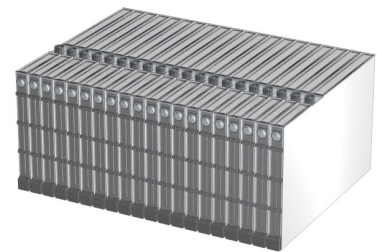
## At the Cell Level

Fiber optic sensing is a dielectric and immune to EMI/EMC. At only 155 microns in diameter fiber sensors can be inserted into the cell and provide a full field picture of the distribution of temperature. The battery cell is the fundamental building block of a battery system. A battery cell with an equal distribution of temperature will provide the best performance at the lowest cost.



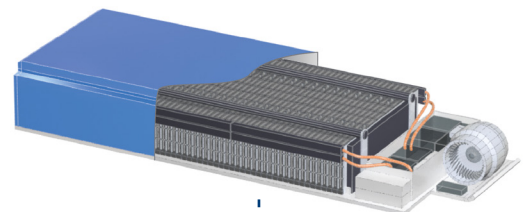
## At the Module Level

Sensors can be bonded across the module in multiple orientations and provide useful information on temperature distribution. An equal temperature distribution is an indication of cells sharing load equally which can reduce the number of cells required, and cost of the complete system.



## At the Battery Pack Level

In the complete assembly distributed fiber optic sensing can help optimize the balance between the number of cells required, the need for external cooling systems and thermally efficient packaging features. Distributed fiber optic sensing can help determine with certainty the change in magnitude and location of the peak temperature with different design configurations.



## At the Vehicle Level

Understanding the performance of the battery in its final operating environment under actual load conditions is critical. The vehicle represents a thermal network of conductive, convective and radiant heat transfer paths. High definition fiber optic sensing can help analyze the migration of heat generated in the battery to the ambient environment outside of the vehicle.

