

ADI's breakthrough 3-axis, $\pm 200 g$ MEMS accelerometer improves INDYCAR driver impact safety program



Few sports test the limits of safety equipment design like Indy car racing. Widely regarded as one of the most intense—and most thrilling—forms of competitive motorsports, INDYCAR® premier IZOD IndyCar Series cars routinely reach speeds of 200+ mph, leaving little margin for error for the world's most skilled drivers. Consequently, INDYCAR's team of safety experts takes tremendous care when designing and evaluating car and driver safety standards, applying the most sophisticated technology available to ensure the best possible protection.

This spirit of safety innovation is exemplified by the recent streamlined redesign of the earpieces worn by all IZOD IndyCar Series and Firestone Indy Lights drivers. In addition to enabling communication between drivers and their pit crews, each earpiece is equipped with Analog Devices MEMS sensor technology designed to measure and record the g -force and driver impact of every bump or collision. The earpiece sensors complement the accident data recorder which measures g -forces on the car chassis. These two data sources are then used in combination to create accurate sled tests for safety improvements to helmets, shoulder harnesses, driver position, and padding, utilizing INDYCAR's THOR (Test Device for Human Occupant Restraint) crash test dummy. Many of the safety enhancements applied to the new IZOD IndyCar Series car introduced in 2012 were developed through downloaded data from these systems.



The previous earpiece design incorporated three separate Analog Devices single-axis, high g accelerometers to measure vertical, lateral, and longitudinal force. Each accelerometer was only 5 mm \times 5 mm \times 2 mm, but taking into account placement and alignment requirements, the design was complex and size was an issue. INDYCAR's engineering team found the ideal solution in Analog Devices' breakthrough [ADXL377](#) 3-axis, $\pm 200 g$ analog MEMS accelerometer. Just 3 mm \times 3 mm \times 1.45 mm—slightly smaller than each individual accelerometer used in the previous earpiece design—the ADXL377 MEMS accelerometer reduces board space demands for designs that incorporate multiple, single-axis accelerometers. Each individual ADI MEMS sensor is able to collect the same amount of data previously obtained using three single-axis MEMS sensors, greatly improving data capture efficiency and eliminating the need for orthogonal alignment of multiple sensors.

“Moving from three individual accelerometers to one 3-axis accelerometer simplified our design and manufacturing significantly,” said INDYCAR director of engineering, Jeff Horton. “The new design allows the sensor to be positioned further into the ear canal for more precise measurements, and the earpiece is more compact and comfortable for the driver.”

Available in a small, low profile 16-lead LFCSP, ADI's ADXL377 3-axis MEMS accelerometer enabled INDYCAR's engineering team to minimize design complexity, achieve significant gains in manufacturing efficiency, and gather precise measurement data for safety enhancements, while improving the comfort of the customized ear molds produced for each driver.

“Analog Devices' ADXL377 MEMS accelerometer is a great addition to our driver safety program.”
Jeff Horton, Director of Engineering, INDYCAR