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HEADS UP: BLAST GAUGE OFFERS IMPROVED WAY TO IDENTIFY SOLDIERS AT RISK FOR TRAUMATIC BRAIN INJURY

Traumatic brain injuries (TBIs)—often a problem for military personnel, due to their frequent exposure to blasts—have long stumped medical researchers, neurologists, and other clinicians.

Unlike other injuries, TBIs often have no immediate symptoms, so they can go undetected until it's too late for them to be treated effectively. But if medical personnel could better detect when soldiers have been subjected to potentially damaging shockwaves, they might be able to limit further exposure and decrease the soldiers' risk of developing TBIs.

Today, a wearable device created from a collaborative effort between Analog Devices, Inc. (ADI) and BlackBox Biometics is providing real-time data on blast effects. The device, Blast Gauge, measures exposures that could put soldiers (and others) at risk for a TBI long before its physical and cognitive symptoms surface.

Blast Gauge can quickly and accurately indicate when, and how severely, soldiers have been exposed to harmful shockwaves. That information helps medical personnel determine whether and when soldiers should return to the field—and helps reduce their risk for TBIs.

Better Detecting Wartime's 'Signature Wounds'

TBIs are often called the "signature wounds" for soldiers stationed in Iraq and Afghanistan because of the pervasive use of improvised explosive devices (IEDs) by enemy forces in those countries. According to the Defense Medical Military System, nearly 348,000 active U.S. military personnel suffered TBIs between 2000 and the first quarter of 2016. However, these numbers don't include the growing number of veterans diagnosed with TBIs years after their initial exposure to battlefield blasts.

Large explosions aren't the only threat, however; multiple smaller hits can also cause brain injuries. For example, "breachers"—soldiers who knock down doors and other obstacles, often using explosives—are routinely exposed to smaller blasts. "Recent research has shown that our service members are subjected to really significant repetitive blast exposures," explains BlackBox Biometrics founder and CTO David Borkholder. BlackBox Biometrics developed Blast Gauge with assistance from ADI, whose technology contributed significantly to the device's design and engineering.

Founded in 2011, BlackBox Biometrics focuses on developing wearable devices that measure blast "overpressure," the rapid pressure change and multiple shockwaves generated by IEDs, artillery, shoulder-fired rockets, and explosives.



▶ Sensors worn in three locations—helmet, shoulder, and chest—collect data that helps medical personnel monitor soldiers' exposure to blast levels that could lead to TBIs.



▶ A Blast Gauge sensor glows red,indicating exposure to potentially harmful blast shockwaves.

Blast Gauge began as a collaborative effort among Borkholder's team at the Rochester Institute of Technology, the Defense Advanced Research Projects Agency (DARPA), and ADI. Today, the device is used by more than 500,000 special-operations military forces from the United States, Canada, Australia, and the European Union, as well as by the FBI and police departments' special weapons and tactics, or SWAT, teams.

Blast Gauge consists of three ruggedized sensors that soldiers wear on their helmets, chests, and shoulders. Each includes an ultra-low-power microelectromechanical systems (MEMS) inertial sensor that captures blast magnitude and acceleration force. Blast Gauge uses the sensors' data to measure the blast impact, says Wayne Meyer, MEMS sensor strategic marketing manager at ADI, who has long collaborated with Borkholder on the Blast Gauge project.

In September 2016, BlackBox Biometrics rolled out its next-generation Blast Gauge. The new version includes a low-power accelerometer designed by ADI that dramatically increases the device's battery life.

It also allows medical personnel to wirelessly collect blast-impact data and make immediate decisions based on their findings. Previously, soldiers used USB ports to manually download Blast Gauge data to computers, delaying medics' access to critical information.

Long-Time Collaborators

ADI and Borkholder have been working together since 2009, when DARPA granted Borkholder $1 million to develop what eventually became Blast Gauge. With ADI's help, BlackBox Biometrics met an aggressive military deadline, deploying 1,000 units to soldiers in Afghanistan in just 11 months. BlackBox Biometrics needed an ultra-low-power high-G inertial sensor to use with military personnel. ADI's technology helps Blast Gauge devices capture data about the impact of a blast on individual soldiers—an impact that often measures between 60 and 120 times the force of gravity, ADI's Meyer explains. ADI was the ideal partner for providing that capability because of its expertise in MEMS sensor technologies, Bolkholder says, adding that ADI also achieved the first-time integration of three high-performance sensors in one low-power, wearable, ruggedized device.

ADI continues to be instrumental in helping BlackBox Biometrics develop additional generations of Blast Gauge, Borkholder says. "The battery life of the very first Blast Gauge prototype was only about one month. Now, thanks in large part to ADI's low-power technologies, batteries can last up to a year." That makes a big difference to soldiers in the field, Meyer notes: "When our system is deployed, they don't have to recharge it—which is really important."

Borkholder predicts that data from the use of increasingly sensitive devices will reveal the development of long-term neurological disorders from "repetitive sub-concussive hits," which are experienced not only by soldiers, but by athletes and industrial workers as well. ADI and BlackBox Biometrics have collaborated on Linx IAS, technology designed to help coaches, parents, and managers share crucial information with medical professionals to more accurately triage and treat head injuries.

Meanwhile, Meyer says, ADI and BlackBox Biometrics engineers regularly exchange ideas not only for new iterations of Blast Gauge, but for other products as well. That means that plenty of groundbreaking developments are likely just over the horizon.

To learn more about the collaborative work of Analog Devices, Inc. and BlackBox Biometrics, visit **analog.com** or **blastgauge.com/about.**