



# High-Power Density Drives Propel Soft Target for ADASs Testing

## Abstract

Advanced driver assistance systems (ADASs) such as anti-collision systems, lane-departure warning systems, and adaptive cruise control constitute a rapidly growing segment of the automotive market. To help developers test their systems without damaging the vehicles involved, AB Dynamics has developed the Guided Soft Target (GST). The GST consists of a disposable vehicle mockup (the Soft Car 360) mounted on an autonomous robotic platform. To be effective, the autonomous robot needs to propel the soft shell at highway speeds while preserving a low enough profile that a direct collision with the test car will not damage that vehicle's wheels or suspension. AB Dynamics achieved that combination of characteristics with the aid of high-speed motors powered by compact, high-power-density servo drives from Elmo Motion Control. "When we reached out to Elmo, we had some very specific requirements in terms of form factor, power density, and reliability," says Matthew Hubbard, chief operations officer at AB Dynamics. "They worked with us to deliver exactly what we needed."



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Elmo's values in this application

Making Smart Machines Smarter



Perfect Servo



Smallest & Lightest



Efficient Power Conversion



Highest Power Density



Ruggedness



Negligible EMI



Utmost Reliability



Easy & Simple to Operate



Precise & Efficient Networking



Utmost Safety

**GOLD DRUM  
HIGH VOLTAGE  
(HV)**  
(up to 65kW /  
900VDC)

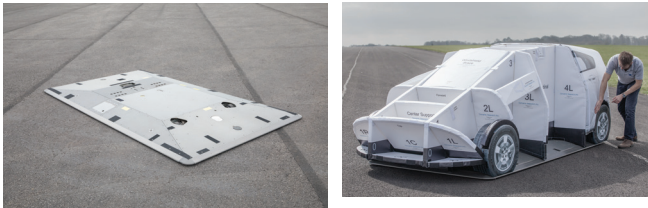


## Benefits

- + Ultra high voltage - help reach highway speeds
- + Low profile drive - fits in "flat" design
- + Reduces system complexity
- + Operating all day on a single charge
- + Ruggedized to handle extreme temperatures, shocks and vibrations.

## High speeds in a low form factor

The Soft Car 360 consists of a foam-core structure covered by a printed vinyl skin (see figure 1). The skin incorporates a metal mesh throughout. As a result, the Soft Car 360 presents visual and radar signatures mimicking those of an actual vehicle.



**Figure 1: The Guided Soft Target (GST) consists of a foam-core frame (left) covered by a vinyl skin (the Soft Car 360); an autonomous robotic platform (right) carries the mockup through test protocols at highway speeds and accelerations. (Courtesy of AB Dynamics)**

During testing, the GST platform carries the Soft Car 360 down the test track, following a preprogrammed sequence of movements. If the test vehicle collides with the GST, damage takes place only to the mockup, which can be rebuilt quickly and easily (see figure 2).



**Figure 2: When the test vehicle collides with the GST, the foam of the Soft Car 360 flies apart harmlessly, leaving the test vehicle undamaged. (Courtesy of AB Dynamics)**

Of course, it's not enough for the GST to look like a vehicle. The GST also needs to move like a vehicle, which brings us to the autonomous robotic platform. The platform must be capable of high speeds while providing precise, accurate steering that enables it to repeat test sequences exactly. To minimize cost, complexity, and part count, ABD went with a three-wheel design consisting of two passive steering wheels in the front and a single

active drive wheel in the back.

The 2.8 m x 1.5 m mobile platform is just 12.5 cm high, with slanted sides. The low profile benefits the application but added significantly to the challenge of motion-system design. The limited volume underneath the platform needed to accommodate wheels, motors, gearboxes, and, of course, drives. Every component needed to be as compact as possible. This presented a particular issue for the wheels and the drives.

## Boosting motor speeds

The drive-wheel assembly consists of a single DC servo motor operated by two Gold Drum High Voltage servo drives from Elmo Motion Control. Each Gold Drum drive delivers 100 A of output in a package that is just 75-millimeters tall, making the unit a good fit for the application both figuratively and literally.

The smaller the wheel diameter, the faster it needs to turn to achieve highway speeds. Elmo drives apply a technique known as phase advance to enable motors to safely operate at speeds several times faster than rated. Phase advance is frequently applied in drives for AC induction motors. Implementing it in servo drives is much less common, primarily because it is more challenging.

In a permanent-magnet servo motor, current in the stator windings generates a magnetic flux that interacts with the field of the rotor magnets, causing the rotor to turn. The windings are energized in sequence to maintain motion. There is a slight lag, or rise time, required for the field to achieve full strength. At almost the same time, the magnets moving through the field generate a back EMF that counters the force generated by the motor.

When operating in phase-advance mode, the drive energizes each winding sooner than normal. This advances stator field, placing it in phase with the back EMF. The change mitigates the drag of the back EMF. As a result, Elmo drives can boost motor RPM by a factor of two or three over the rated amount. In the case of the GST, the increased RPMs helped the AB Dynamics team achieve the high-speed operation they needed. The trade-off for phase-advance mode is a slight drop in efficiency. Given that the drives are already 99.6% efficient, however, this does not markedly impact the application.



## GOLD TROMBONE

Compact, Direct to Mains,  
Network-based Servo Drive  
(Up to 16 A/800 V and up to 22  
A/400 V).  
Up to 10 kW of Qualitative  
Power.



## Benefits

- + Gold Line core motion control technology
- + Ultra-compact, highest power density
- + Highly efficient, high bandwidth performance
- + Multiple communication options: EtherCAT, CANopen, USB, Ethernet
- + Supports a wide variety of feedback sensors
- + Advanced filtering and gain scheduling options for enhanced dynamic performance
- + Vector control sinusoidal commutation

## High power density

Although the Soft Car 360 is very lightweight, its large cross-section makes air resistance a factor. Countering the resistance requires high torque from the motor. That, in turn, requires a higher voltage drive – which generally means a bigger drive. The latter wasn't an option for the AB Dynamics team. "Drive size is an issue, as the components we use determine how small we can make the platform," says Hubbard. Elmo drives deliver higher power densities, enabling the drives to fit in the limited envelope available underneath the platform while providing the required voltage. The combination worked well for the AB Dynamics team. "We are continually looking for ways to improve the GST's acceleration and top speed to better simulate driving scenarios," says Hubbard. "Elmo is the only company that can offer sufficient power density to deliver the speeds we require."

High torque was also a requirement for the steered wheels. Those wheels must be capable of rapidly and accurately changing angle when the vehicle is at a stop and friction is at its most extreme. Once again, the AB Dynamics design team found themselves searching for a servo drive with the highest possible power density. Once again, they found the solution with Elmo Motion Control.

The steering wheels are positioned by a single DC servo motor coupled to the wheels by a rack and pinion assembly. A single Elmo Gold Trombone servo drive is used to power the steering motor. The drive generates up to 10 kW of qualitative power with 99% efficiency. It delivers from 16 A/800 V up to 22 A/400.

## Systems that last

Time at test tracks is at a premium. Organizations want to make the most of each session. As a result, they will run test after test in quick succession. The GST needs to operate reliably every time. The GST runs off of a 240 VDC bus, powered by lithium ion phosphate batteries. The high-efficiency Elmo servo drives enable the target vehicle to be operated for all day on a single charge.

To ensure reliability, vehicle testing needs to replicate the conditions of use. This means outdoor testing at high duty cycles and in a variety of weather conditions. As a result, the GST robotic platform is routinely exposed to extreme temperatures, high shock and vibration, and contamination.

The latter includes not only moisture and dust but corrosive materials such as salt and snow melt. Elmo servo drives are rated to operate at temperatures ranging from 0°C to 40°C. They are built to withstand 15 G shock and 5G of vibration. In extensive testing, the Elmo drives survived prolonged exposure to track conditions without any issues.

"We have adopted Elmo motor drives across our track testing products and they have proved to be extremely reliable, which is important given that 98% of our sales are to overseas customers," says Hubbard. The company is working on a new version of the GST that provides even better performance. To achieve their goals and better serve their customers, AB Dynamics is partnering once again with Elmo Motion Control. "We're currently working on a new product that is only feasible due to the availability of Elmo's Twitter drive, which has unparalleled power density," he adds.

By better serving customers, AB Dynamics is supporting the development of Advanced Driver Assistance System (ADAS) designed to make the roads ever more safe. By assisting AB Dynamics with constantly improving versions of the GST, Elmo Motion Control is doing its part to help put safer cars on the road.

Find out what Elmo Motion Control high-power-density servo drives can do for your next project. Contact our sales and support team at

## About Elmo Motion Control

Elmo Motion Control (Elmo) designs, produces and implements comprehensive, field-proven motion control solutions that make clients' data-driven, smart machines smarter. The company's R&D department combines intelligent motion control technologies, real-time programming and control algorithms with advanced digital hardware to enable leaner, more flexible machines. Controlled by the Elmo application studio (EAS)—a software environment that cuts integration time and maintenance costs—Elmo's servo drives and multi-axes motion controllers minimize a machine's footprint and cabling, improve throughput, and give original equipment manufacturers (OEMs) a competitive edge. Founded in 1988, the company is headquartered in Israel, employs more than 300 staff worldwide, and has a dedicated presence in the United States, China, Germany, Italy, Korea, Poland and the United Kingdom. For more information, visit [www.elmomc.com](http://www.elmomc.com).