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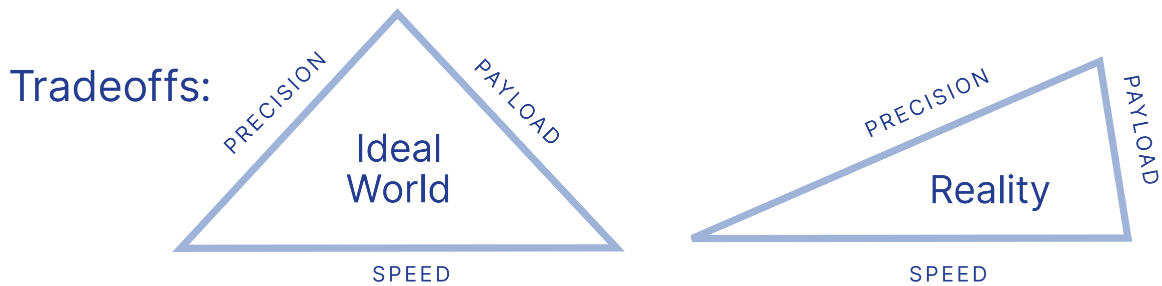
GYROPLUS Technology:

Taking Robot Performance to the Next Level

Performance = Speed + Payload + Precision

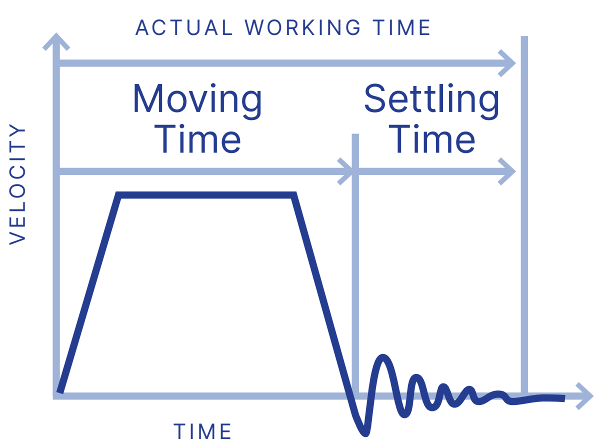
Innovations in robotic automation have allowed manufacturers in countless industries — including automotive, packaging, life sciences, and electronics — to achieve higher throughput, improved quality, and safer working environments.

But choosing a robot for an automation task often involves balancing tradeoffs between three key performance criteria: speed, payload, and precision. In other words, to achieve high precision, a user may have to sacrifice somewhat on the application's speed and payload. Alternatively, if the robot's payload is increased, the operating speed may need to be reduced.



The underlying cause of these performance tradeoffs is vibration of the robot arm. Take, for example, the objective of reducing cycle time — a priority for many manufacturers as they seek to increase throughput and reduce costs. The easiest, and in many cases, most effective way to reduce cycle time is to increase the robot's speed and acceleration.

But high speed and acceleration can lead to vibration in the robot arm. And higher vibration means longer settling time and reduced precision — so much of the cycle time improvement that was gained by increasing speed and acceleration is lost waiting for the vibration to settle, or dissipate, before the next process can be performed.



Manufacturing processes increasingly demand shorter cycle times for improved throughput, which in turn, requires higher speed and acceleration rates from the robot. But as speed and acceleration increase, so does vibration in the robot arm. As a result, the ratio of settling time to the overall cycle time increases, reducing throughput and precision.

Performance Tradeoffs and Workarounds

Robots estimate how the end of the arm is moving — and what control commands to issue to achieve the required position and velocity — based on position and speed information from the motor encoder. But a robot arm isn't perfectly rigid, so naturally, it experiences some amount of deflection. And the farther the end of the arm is from the motor, the higher the robot's speed, and the heavier its payload, the more deflection the arm will experience. This means the actual speed and position at the end of the robot arm often differs from the amount estimated based on the motor, and the vibration at the end of the arm goes undetected by the motor encoder. So the commands from the controller are based on inaccurate estimates of the behavior of the robot arm, compromising its ability to reach the intended position.

A common workaround to address vibration of the robot arm is to make the arm stiffer. But increasing the stiffness of the robot arm also requires increasing its weight. And a heavier robot means higher cost due to larger motors, gearboxes, and other drive components, higher energy consumption, and — typically — a larger footprint. So, even with these "workarounds" to address vibration, the user or machine builder is still faced with tradeoffs between performance and cost.

Competing Performance Criteria	Improving This Specification →	Worsens This Specification	Impact On Performance
Speed vs. Precision	Speed	Vibration	Settling Time is Increased
Cycle Time vs. Vibration Damping	Cycle Time	Settling Time	Tact Time is Increased
Vibration Damping vs. Cost	Arm Rigidity	Robot Size and Weight	Robot Cost is Increased
Vibration Damping vs. Cost	Arm Rigidity	Robot Size and Weight	Energy Consumption is Increased
Vibration Damping vs. Ease of Install	Arm Rigidity	Robot Size and Weight	Robot Footprint is Increased

Robot performance has traditionally involved tradeoffs between precision, speed, and payload. And the common workarounds to these problems, such as increasing the rigidity of the robot arm, result in different performance tradeoffs.

GYROPLUS Technology:

A new way to address the speed-payload-precision dilemma

For decades, these performance tradeoffs have been accepted as an inevitable part of robot selection and operation — the laws of physics haven't changed. But thanks to GYROPLUS Technology from Epson, the compromises between a robot's speed, payload, and precision are finally being addressed.

Using our extensive experience in quartz-based sensor production, Epson has developed a patented gyro sensor that can be used to measure movements at the end of the robot arm. Gyro sensors are used extensively in applications such as vehicle navigation, but their size has — historically — made their use in robotics difficult.

Epson remedied this problem by developing a gyro sensor with a volume 1/100 that of conventional designs, making it possible to integrate the gyro sensor directly into the end of the robot arm without affecting the robot's weight, size, or inertia.

Quartz-Based

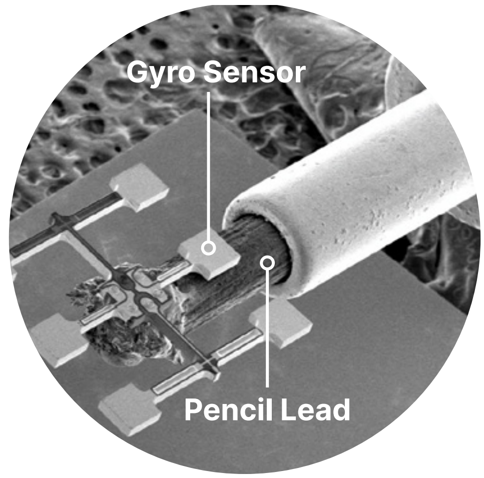
Precision Movement

Compact Size

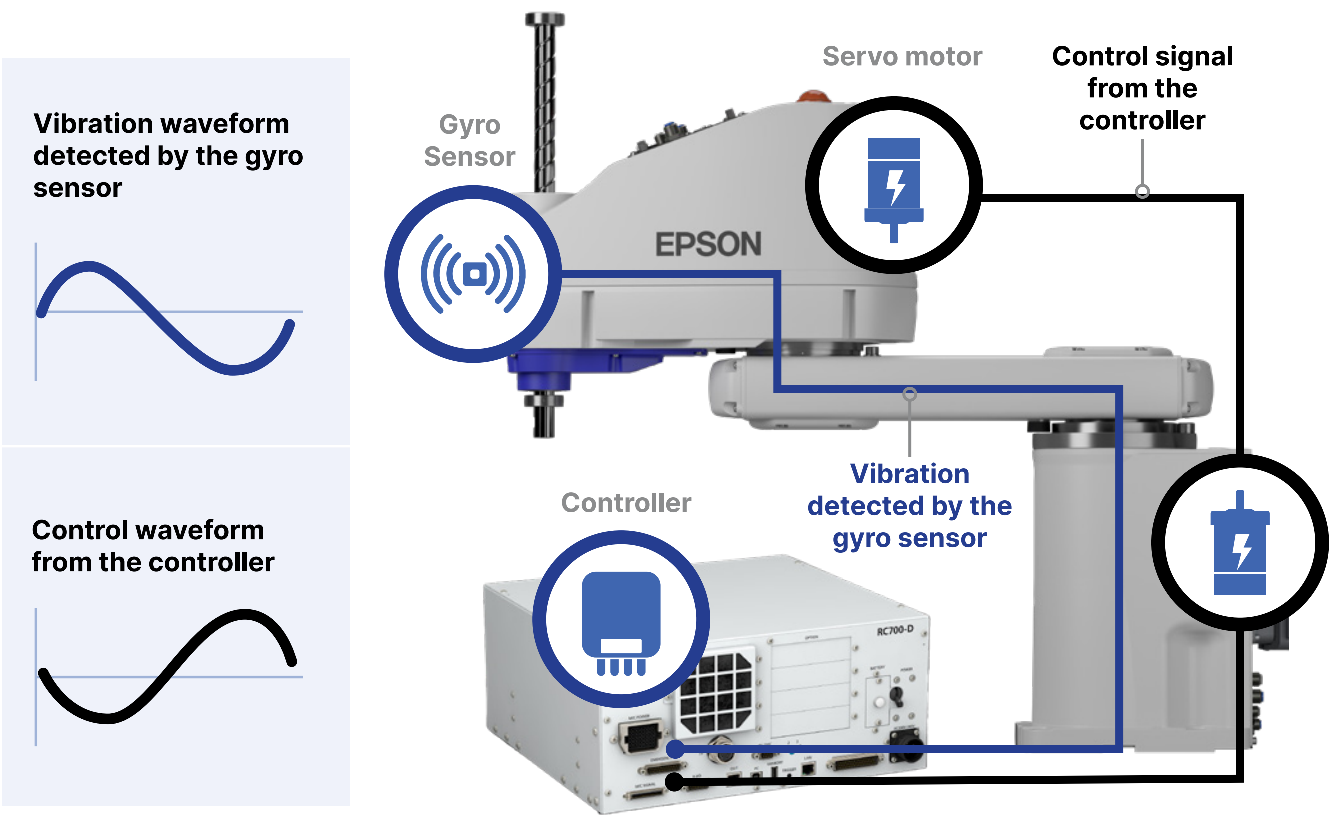
GYROPLUS Technology: extremely compact, high-performance, quartz-based gyro sensors

Epson's GYROPLUS Technology was born out of the company's experience as a leading manufacturer of high-quality quartz crystal materials. We've applied this quartz crystal technology — along with proprietary MEMS (microelectromechanical systems) processing technology — to sensing devices, producing an extremely compact, high-performance, quartz-based gyro sensor.

The gyro sensor is configured as a "double-T" type crystal oscillator, which provides a very high signal-to-noise ratio, excellent resistance to vibration and shock, and high temperature stability. Combined with proprietary control algorithms, the gyro sensor is incorporated into Epson robots to detect and dampen both rotational and vertical vibrations, without adding mass to the robot or increasing its size.



Gyro sensors are used in devices such as automobile navigation systems, and typical sizes are relatively large — about the size of a thumb. But Epson's GYROPLUS Technology uses a gyro sensor small enough to balance on the end of a pencil lead.



Mitigating Tradeoffs in Robot Performance

The addition of a gyro sensor at the end of the robot arm, providing continuous feedback to the robot controller, is a first in the industrial robot industry. **But what does this mean for machine builders and end users?**

Traditional robot controls use angular velocity feedback located on the robot's motor. But the true angular velocity at the end of the robot arm often differs from the motor's angular velocity, due to mechanical tolerances, friction, and the influence of the attached load and peripherals such as end effectors and wiring. Now, with Epson's GYROPLUS Technology mounted at the end of the robot arm, the robot controller receives information about the behavior directly at the end of the arm, so it can deliver motion commands to address the exact movement and position of the arm, rather than an estimate based on the motor's angle and velocity. This means more precise control of positioning, along with significant vibration reduction.

GYROPLUS Technology also means that smaller, lighter-weight robot arms can now execute faster moves, handle heavier payloads, and provide better precision than traditional robots without this technology. In other words, machine builders and end users can get higher throughput and precision from their robotic automation solutions. And with Epson's GYROPLUS Technology, SCARA and 6-Axis robots can now be used in applications that were previously inaccessible to these devices, due to precision, payload, and cycle time requirements that were just beyond the robots' capabilities.

For example, in applications where machine builders and end users were once forced to use complex Cartesian and gantry robots for high-speed, high-precision applications, they can now use SCARA and 6-Axis robots to achieve the same or better performance, but with a much smaller footprint, less mass, simpler integration, and less complex programming.

To learn more about Epson's GYROPLUS technology and how it can help you address tradeoffs between speed, precision, and payload in your application, visit epson.com/GXSeries

The Epson Robots Applications team can help provide insight and answers to your automation questions. Let us help you find the right solution for your project or application by calling 562-290-5997 or visit epson.com/robots today.

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