

### Gimbal Glossary

<b>Acceleration</b>	The acceleration, often measured in degrees per second <sup>2</sup> or radians per second <sup>2</sup> is combined with the payload inertia in order to determine how much torque is required to increase or decrease the speed of the payload.
<b>Airborne</b>	Sagebrush Technology provides airborne systems for a variety of applications. None of Sagebrush's products are type-certified for commercial aircraft because the certification process is both aircraft and payload-dependent. The customer is responsible for obtaining the appropriate regulatory approval to fly a gimbal on the outside of an aircraft. When specifying airborne applications, the aircraft, airspeed, mounting location and operating altitude must be considered.
<b>Azimuth Travel Range</b>	The angular range the azimuth axis of the gimbal must travel for the application. A gimbal with a travel range of +/-180 degrees can sweep a full circle, but must then reverse direction. A gimbal with a continuous azimuth rotation can sweep continuously in one direction, but requires special hardware such as slip rings and rotary joints to prevent damage to the gimbal and payload wiring. Because of the expense associated with slip rings and rotary joints, continuous rotation systems should be specified only when absolutely necessary.
<b>Communication Format</b>	RS-232 is supported on all gimbals. RS-422 or RS-482 can be supported depending on the electronics used. At present, we do not support Ethernet interfaces.
<b>Continuous Rotation</b>	Continuous Rotation Azimuth drives have been developed for the Model 25 and Model 30 Worm Drive systems. The customer must describe the payload electrical and control requirements. This information is necessary for slip ring or rotary joint definition. Continuous Rotation systems require an export license under US Department of Commerce regulations. End-user data, including the payload, application, company or Government agency, and country of end use will be required prior to accepting a purchase order.
<b>Controller Description</b>	All of the gimbals can be controlled via the serial interface. Most gimbals also support joystick control. Depending on the model, the joystick is either connected directly to the gimbal, bypassing the need for a PC, or the joystick is connected to the PC and utilizes the serial interface.
<b>Drift</b>	Inertial sensors used to stabilize a gimbal can be influenced by the earth's motion, as well as the motion of the gimbal platform. The result can be a slow, cumulative error in pointing, commonly referred to as drift. The quality of the sensor is often directly related to the amount of drift. Automotive grade sensors often have significantly more drift than military sensors, but most military grade sensors cannot be shipped out of the United States without an export license. The drift in many inexpensive sensors is a function of temperature, so drift can be minimized using temperature-compensating software, or by maintaining the sensor at a constant temperature. All of Sagebrush's stabilized products have provisions for correcting for the sensor drift. The frequency at which the drift compensation has to be adjusted is a function of the sensor and the application.

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<b>Dust, Sand</b>	Most Sagebrush Technology products do not require lubrication and are well sealed against dust and sand. Please identify any exceptional conditions such as sandstorms or environments high in abrasive materials.
<b>Duty Cycle</b>	The duty cycle can be very important when combined with the operating environment. This is particularly true of systems that must operate continuously for many hours or days. For example, when a gimbal is moving back and forth scanning an area, every time the gimbal stops and changes direction, the energy used to decelerate the payload is converted to heat in the motors. Over time, the gimbal design must ensure that the heat does not continue to increase until the motors fail.
<b>Elevation Travel Range</b>	The angular range the elevation axis of the gimbal must travel for the application. In defining the elevation travel range, zero degrees typically represents horizontal. Note that for some gimbal configurations, such as the Model 30 or a Model 20 with an offset arm, the elevation range may be limited by interference between the payload and the gimbal.
<b>EMI/EMC</b>	Sagebrush Technology gimbals are FCC Class A devices. Some products also carry a CE mark. Where more stringent EMI/EMC requirements are applicable, please identify them.
<b>Gimbal Dimensions</b>	Please refer to gimbal data sheets and interface drawings for standard dimensions. If a custom gimbal is required, the space limitations for the gimbal and payload will be compared to the payload dimensions to confirm that there is sufficient space for the gimbal hardware.
<b>GUI</b>	Graphical User Interface. Sagebrush provides a sample GUI with all of its gimbal systems. The user interface is intended to demonstrate the capability of the gimbals. For Sagebrush-developed GUIs we also provide the source code to assist customers who are developing their own interface.
<b>Industrial Standards</b>	Sagebrush Technology products are designed to industrial standards, as opposed to military standards, for temperature, EMI/EMC, dust and sand. Please identify any applicable standards on the Specification Form.
<b>Inertia</b>	Inertia is an object's resistance to changing its speed or direction. Payload inertia is a critical factor in gimbal performance. Inertia is a function of an object's size, weight, and the location of the center of gravity relative to the axis of rotation.
<b>Input Voltage Available</b>	All Sagebrush gimbals are designed to operate at 24 VDC. The stepping motor version of the Model 20 can also work at 12 VDC. Larger systems, such as the Model 30 Worm Drive may have their best performance at higher voltages, such as 48 VDC.
<b>Maximum Power</b>	The maximum power required is a function of the performance requirements and the payload mass and inertia. The specification sheets for standard products list the power consumption required for typical payloads. Peak power requirements occur during acceleration/deceleration of the payload. Systems with high slew rates and high accelerations will have the highest peak power requirements.

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<b>Mil Standards</b>	Sagebrush Technology does not typically design or certify its products to military standards. Where military standards or qualifications are required, they must be identified on the Specifications Form.
<b>Payload Description</b>	What is the device that is mounted to the gimbal? A camera, antenna, mirror, telescope, rangefinder, etc. In addition, providing a brief summary of the intended application is always helpful. This information allows Sagebrush Technology to draw on its experience with other customers and projects to identify which gimbals may be suitable for a given payload and application.
<b>Payload Dimensions</b>	In addition to being a component of the payload inertia, the dimensions of the payload can be limiting factors in the range of motion because of the potential for interference between the payload and the gimbal structure. When combined with the range of motion, the dimensions produce a swept volume; the area in three dimensions that any portion of the payload might pass through. Swept volumes are used to identify areas of interference with the gimbal structures, supporting equipment, wiring, and other nearby objects.
<b>Payload Weight</b>	Payload weight is an important component of the payload inertia. When combined with the requirements for pointing accuracy, acceleration, and slew rate, the weight and resulting inertia are major factors in the gimbals' performance.
<b>Pointing Accuracy</b>	Pointing accuracy is a measure of the absolute error between where the gimbal actually points a payload, and where the gimbal was expected to point the payload. An appropriate pointing accuracy is generally a function of both the payload and the application. For example, when pointing an antenna whose beam width is 3 degrees, a pointing accuracy of 0.25 degrees may be more than adequate. However, when pointing a camera and zoom lens with a field of view of 0.5 degrees at 2000 meters, that same pointing accuracy may result in missing the target at least half the time. Pointing accuracy is a function of the gimbal structure, drive train, position instruments, control software, and payload.
<b>Positional Resolution</b>	For gimbals with position measuring instruments, such as encoders or resolvers, the positional resolution is the smallest increment of a degree of angular motion that has to be measured by the instrument. In many instances, it is not specified directly, but is inferred from the requirements for pointing accuracy. Positional resolution of standard products is identified in the product specifications.
<b>Power Limitations</b>	Many Sagebrush products can be operated from portable power sources, such as batteries or solar cells. The factors involved in sizing these power sources are the payload inertial, gimbal type, duty cycle, maximum acceleration, and slew rate. Please describe any limitations or special power considerations on the Specifications Form.

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<b>Protocol</b>	The format of messages exchanged over the communications interface. For Servomotor systems, Sagebrush Technology supports TASS (Tactical Automated Security System) protocol. For the stepping motor systems the protocol is different, but we provide the customer with all of the necessary formats and documentation. If a customer-specific protocol is required, please provide information on the protocol format and we will quote the price of protocol emulation.
<b>Repeatability</b>	Repeatability is the gimbal's ability to point to exactly the same point in space when commanded to go to a specific position. Note that a gimbal with perfect repeatability will always go to the same point in space when given the same coordinates, but the point it goes to may still be off-target by the value of the pointing accuracy.
<b>Settling Time</b>	The settling time is a measure of how long it takes for the gimbal and payload to come to rest after moving from one point to another. It is a function of the mechanical stiffness of the gimbal and payload structures, the control software, and the structure the gimbal is mounted on. As a general rule, weight equals stiffness. Lightweight gimbals with heavy payloads will have higher settling times than heavy gimbals with the same payload.
<b>Slew Rate</b>	The slew rate, typically measured in degrees per second or radians per second is the angular velocity of the gimbal and payload. When combined with the payload weight and inertia, the maximum slew rate often determines what gimbal is required. There are two important considerations with respect to the minimum slew rate. First, low values of a minimum slew rate, such as those required for long-range cameras, often determine the desired drive ratio and/or whether servo or stepping motors are required. Second, the ratio of the maximum and minimum slew rates is an indicator of the variation in required speeds. Very high ratios (greater than 1000:1) may be difficult to achieve.
<b>Space Limits</b>	Where the choice of gimbal may be limited by space considerations, provide a description of the available space and any potential interference.
<b>Stabilization</b>	A stabilized gimbal automatically compensates for motion of the Gimbal's mounting platform in order to maintain the payload's alignment in space. Stabilization error is typically defined as line-of-sight stability, the amount of error allowed in any direction from the line of sight. Stability is a function of the payload, application, and environment. Please note that in 3-dimensional space, a two-axis gimbal will always have at least one axis of spatial rotation that cannot be compensated for by the gimbal. If stabilization is required, please identify the type of vehicle, aircraft, or ship, and the operating environment. Also provide information on allowable stabilization error.
<b>Temperature</b>	Please refer to gimbal data sheets and interface drawings for standard operating temperatures. Where gimbals are exposed to low or high temperatures for sustained periods of time, special consideration may be given to lubrication, heating, and/or cooling.
<b>Vibration and Shock</b>	Shock and vibration environments, such as moving vehicles, can result in reduced payload capacity or gimbal performance. Under some circumstances different mounting options or gyro-stabilization may be appropriate.

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<b>Weather (indoor/outdoor)</b>	A white powder coat finish is standard on all Sagebrush products, and is recommended for gimbals that will be used outdoors. Where snow or ice loads are expected, the additional weight may limit payload capacity or performance.
<b>Weight Requirements</b>	Please refer to gimbal data sheets for typical gimbal weights. Where the gimbal weight is limited, please provide information on the weight limit and the reason for the limitation. Note that in most cases it will be both difficult and expensive to customize a gimbal and reduce its weight.