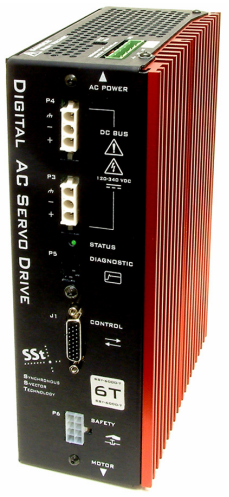
SSt-6000-T

DSP Brushless Servo Amplifier



The SSt-6000-T is a high-bandwidth, fully digital, DSP vector brushless (or brush) torque amplifier that accepts ±10V analog torque commands. Upgrading a conventional current loop "torque" amplifier to an SSt-6000-T will improve tracking, smoothness and settling time.

These performance improvements are possible because conventional torque amplifiers (six-step/trapezoidal or sinewave type) all share a little-known flaw. They servo control current, not torque. Systems that use these amplifiers actually run *open-loop* with respect to torque!

Servo controlling torque requires synchronized control of all motor phases with respect to the magnetic field of the motor's rotor. Conventional torque amps control each motor phase with a separate, dissociated current loop servo. This scheme ignores the fact that the motor phases are tied together and thus interdependent. Furthermore, small errors in each phase can combine to create a large vector (torque) error.

With the conventional method of control, where the torque runs open-loop, torque errors are corrected by the slower velocity and position loops. Errors in motor torque cause velocity and position to deviate from the target, and it is only after these deviations occur that the servo controller can see and react to the error. The controller compensates for the torque error in the only way it can—by adjusting the torque command. *Iteratively*, the controller eventually converges on a torque command that resolves the error, *if* there are no further disturbances or trajectory changes. But trajectories do change (acceleration changes to deceleration, etc.) and disturbances occur (imperfect mechanics, other axes moving, etc.), so torque dithering occurs frequently during a move, impairing tracking accuracy, settling time and smoothness. As applications become more demanding, the impairment becomes more and more pronounced.

The SSt-6000-T employs a proprietary torque control method: *sinewave, vector feed-forward with DQ decoupling*. This method constantly measures all the variables required to accurately calculate the true torque output (and the out-of-phase currents which only heat the motor) and continuously works to servo the torque to the commanded value and the out-of-phase currents to zero. So in the SSt, the torque is truly under closed-loop control. The controller no longer needs to dither the torque command to compensate for torque errors—these errors are *preemptively eliminated*. Removing the dithering process smoothes axis motion. Additionally, eliminating most of the error in the delivered torque improves axis tracking and settling. So, as a drop-in replacement for a conventional torque amp, the closed-loop SSt-6000-T improves motion quality on all axes, especially demanding ones.

ROBUST PERFORMANCE

Outstanding Large-Signal Bandwidth

Most amplifier vendors specify bandwidth—small-signal bandwidth. However, in the real world, to effectively fight disturbances, accurately track aggressive commands, and settle loads quickly, amps must respond rapidly to *large-signal* inputs. This is where the SSt-6000-T's torque control method has a clear advantage. For example, at the moment a motor begins to change from acceleration to deceleration, it requires a large-signal change in torque. At 75% of rated motor speed, the torque response time disparity between an SSt and a conventional digital, sinewave amp is striking: 0.1ms vs. 10ms![1] This difference has a significant impact on smoothness, tracking and settling time.

Anti-Resonance Torque Loops

The digital torque loop can be tuned to control unwanted resonances. This provides optimal performance with axes that suffer from in-band resonances.

FLEXIBLE, LOW EFFORT INTEGRATION

Drop-in Controller Compatibility

SSt drives have an open control interface, accepting the standard ±10V analog torque command.

Universal Motor Interface

The SSt controls rotary and linear servomotors, brush motors, galvos, voice coils, etc. from any manufacturer with virtually no motor restrictions (such as minimum inductance value).

Ease of Development/Assembly Features

- The robust, proprietary torque compensator provides perfect tuning repeatability via a simple file download.
- The SSt-6000-T provides intuitive diagnostics to qualify production machines and troubleshoot systems rapidly.
- QuietDesign™ EMI reduction system eliminates shield clamps, ferrite slugs, etc. required to meet CE.
- Built-in monitoring detects faulty cables and sensors.
- OEM friendly cabling is robust, mass producible and easily testable. And with Teknic's cable CAD drawings available at no charge, the cabling is economical to build.

[1] Test conditions: 8 pole motor; Kt=11.1 oz-in/A; R=0.76Ω; L=1.25mH; Torque Command = ± 18A square wave; 20 oz-in² load; SSt-1500-T vs. digital sinewave amp with equivalent power ratings.

THE FINER POINTS

Closed-loop torque control, excellent large signal bandwidth and anti-resonance torque loops combine to deliver superb amplifier performance. But SSt drives have many niceties that make them more than just class-leading performers…

Burn-Out Protection

A real-time algorithm constantly tracks actual motor torque and compares that to the motor's continuous capacity to eliminate motor burn-out.

High Motor Efficiency

Teknic's proprietary closed-loop torque control delivers precise, accurate torque while working to eliminate extraneous motor heating. While all motors will run cooler, in some cases OEMs can downsize motors to reduce cost.

SmartSaturation™

This dynamic algorithm maintains elegant motor control in the event of voltage and/or current saturation.

Multiple Power Inputs

Dual input power connectors allow for daisy chain simplicity.

Auto-Calibrating Sensors

The current sensors are continuously monitored and re-calibrated to ensure precise and repeatable performance as power usage and temperatures fluctuate.

Exceptional Noise immunity

The SSt-6000-T fully isolates logic and power, making it highly noise immune. This allows OEMs to avoid the hassle and cost of single point grounding, star power wiring, inductive control, etc. typically required in ±10V systems.

Simplified Safety Compliance

When power and logic are not isolated, safety standards dictate the entire control system (PC, controller, keypad, etc.) is to be considered a shock hazard. The SSt isolates power from logic, which removes the control electronics from shock-hazard categorization. This reduces safety compliance effort and ongoing compliance cost.

SPECIFICATIONS

GENERAL	Dimensions, in (mm):	8.93 (227) x 5.56 (141) x 3.15 (80).
	Weight, oz (g):	71.8 (2035).
ENVIRONMENTAL	Temperature:	0-40 Degrees C.
	Humidity:	0-95%, non-condensing.
COMPLIANCE	Electrical safety:	EN 61010, UL508C.
	EMI:	EN 50081-2, EN 50082-2.
	Machine safety:	EN 954-1, with proper power control.
OUTPUT POWER	Current:	23 Amps Peak (3 seconds). 9 Amps RMS vertical on metal surface. 12 Amps RMS with mounted fan cooling.
	PWM ripple frequency:	*28KHz*, center balance vector type.
COMPENSATOR	Torque control:	Synchronous vector torque control with dq decoupling, and automatic current sensor calibration, tunable response for resonance control, ongoing vector refinement.
ENCODER	Interface:	TTL or differential, user selectable.
	Max count rate:	15MHz.
	Features:	Bad sequence detection, user selectable digital filtering.
MOTOR COMPATIBILITY	Requirements:	3-phase motor with encoder in any electrical configuration, such as linear, rotary, galvo, voice coil, etc. or DC brush motors.
± 10V ANALOG INPUT	Format:	Differential input, ±10V range.
	Impedance:	*greater than 10k.*
	Range:	10% per volt.
LIMIT INPUTS	Interface:	TTL with 2K pull-up, digitally filtered.
HALL SENSOR INPUTS	Specifications:	*Optically isolated; 475 ohm pull-up to +5V.*
	Features:	Digitally filtered; used for setting torque vector upon initialization; drive can run in hall-less mode.
DEDICATED INTERFACE INPUTS/OUTPUTS	Outputs:	Drive ready; encoder and limits pass-through, +5V.
	Inputs:	Enable power stage; Analog torque; encoder; limits.
REAL-TIME MONITOR PORT	Format:	0.5V-4.5V analog signal (0=2.5V).
	Features:	Configurable filtering, sync pulse at move start, wide scaling with high zoom, non-volatile configuration.
	Output variables:	Commanded torque, actual torque, actual velocity, max phase voltage.
PROTECTION & SAFETY FUNCTIONS	SSt--6000 protection:	Short circuit (phases-to-phase, phase-to-ground), over temp, over voltage, over current, protected for open windings, fuse.
	Motor protection:	True RMS torque limiting, automatic speed limit, motor jam detection, over temp.
	Mechanical safeguards:	Limit switch servoing, adjustable torque limit and adjustable speed limit, encoder bad sequence detection, encoder run-away protection.
INPUT SUPPLY	Input voltage:	90-240 VAC (50-60Hz) or 128-340 VDC.
COUNTRY OF ORIGIN	Manufactured in:	USA.