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BEARING ENGINEERS, INC.

Advanced Vector Servo



STATE-OF-THE-ART SERVO CONTROL FOR THE PRICE OF A MICROSTEPPER!

- BRUSHLESS AC VECTOR SERVO — SUPERIOR TO EVEN SINEWAVE SERVOS
- COMPLETELY DIGITAL, DSP CONTROL — LOWER COST PER AXIS
- CLOSED-LOOP SPEED AND POSITION CONTROL WITH "STEP & DIRECTION" PULSES
- HIGH PERFORMANCE, DROP-IN REPLACEMENT FOR STEPPER SYSTEM; NO SOFTWARE CHANGES
- HIGHER SPEEDS AND ACCELERATIONS FOR GREATLY IMPROVED THROUGHPUT & FASTER SETTLING
- ULTRA SMOOTH MOTION, VIRTUALLY NO TORQUE OR VELOCITY RIPPLE; QUIET MOTION AT ALL SPEEDS
- WINDOWS®-BASED SETUP AND SERVO INTEGRATION SOFTWARE
- SIZE 17, 23, 34 MOTORS
- CE MARKED

AVS — Now you can get advanced servo control with the simplicity and low cost of a stepper

What is AVS?

AVS is a unique servo system applying an advanced vector servo technology that gives you high-speed, closed-loop position control using the same simple "step and direction" digital input as a stepper motor system. ***AVS*** not only outperforms other servo systems on the market, it costs no more than an open-loop microstepper! It is a high-performance, yet cost-effective, replacement for your stepper system.

If you already use servos, you can now get enhanced servo performance—higher bandwidth, faster settling time, increased stiffness, and other benefits (see box at right)—for a significantly lower cost per axis.

New Vector Torque Control

In contrast to simple analog current control even used on "digital" sinewave servo drives, ***AVS***'s proprietary vector controller does not use a separate servo loop for each phase. Instead, it "de-rotates" the measured phase currents—in other words, converts them into one vector value (amplitude and phase)—and calculates the actual magnetic field vector. This *vector*, which is *independent of motor speed and load*, is then digitally servo controlled to remain in precise alignment with the magnetic field of the rotor. Therefore, the true torque can be accurately produced. Consequently, the torque command from the higher-level servo calculations is executed quickly and accurately, producing excellent servo performance.

Custom DSP increases performance and cuts cost

A Digital Signal Processor (DSP) is a specialized type of Reduced Instruction Set Code (RISC) processor that is optimized for the real-time and non-linear computing needs of high-performance servo control. The core of ***AVS*** is a *DSP-modulated, brushless vector servo.* This proprietary servo controller contains embedded DSP software that, at the cost of a small piece of silicon, can execute such complex functions as input filtering, PIV and feed-forward algorithms, vector commutation, and output filtering. In addition, it also executes these functions with unsurpassed effectiveness. The result is a low-cost, state-of-the-art servo positioner.

Easy to use

AVS's simplicity goes much deeper than just step and direction control. It has easy-to-use features that even the most experienced servo user will appreciate: Fully digital operation means no DIP switches to set or pots to adjust—all features are accessed via RS-232 with a Windows®-based software utility called *ServoSet.* Custom ***AVS*** settings are automatically saved in non-volatile memory, and can also be saved to a PC for easy setup of other drives.

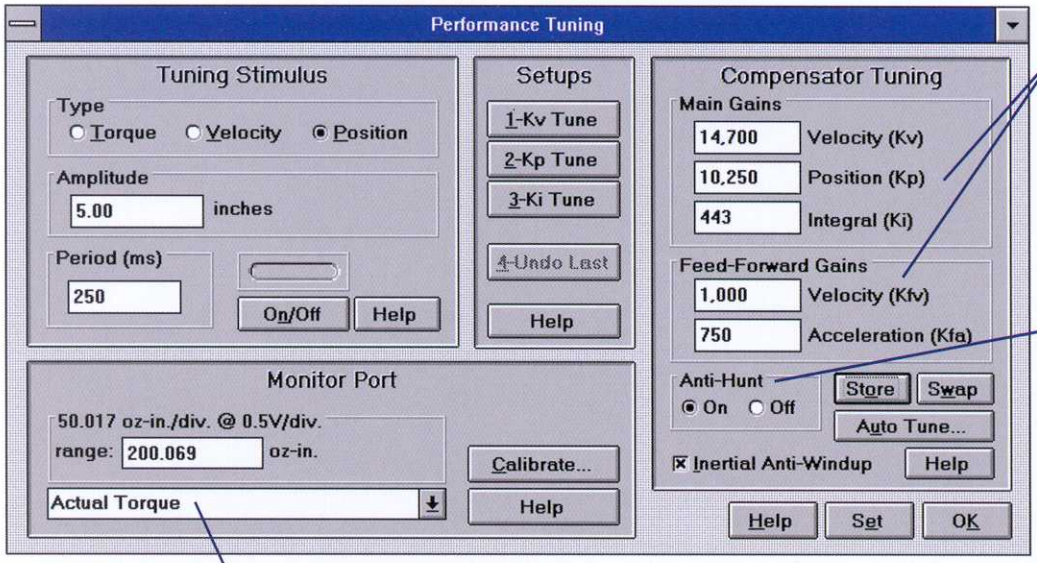
Additional user-friendly features include built-in stimulus-response instrumentation, user-definable units, extensive fault protection, and more. ***AVS*** is truly the easiest way to get high-performance servo control.

If you want the technical details...

- All servo loops (torque, velocity and position) are closed by a single DSP in the motor drive and perfectly synchronized. This inherently provides better performance than designs using a torque/velocity amp and a separate servo position controller.
- Servo type is "Proportional-integral with embedded velocity loop." PIV control is superior to common PID servos—it's easier to tune and more effective. Velocity and acceleration feed-forward is also included for close tracking of commanded moves.
- Proprietary Inertia Matching Technology™ gives higher stiffness with no overshoot on higher inertial loads (resulting in faster settling times).
- Anti-hunt™ allows higher gains without servo jitter and "hunting."
- All servo loops, including the auto-calibrating torque loop, are under DSP control and completely digital. The resultant wide servo bandwidth provides responsiveness, accuracy and stiffness.
- Sinewave vector commutation is derived from encoder feedback giving ultra-smooth motion even at very low speeds (no "cogging" even with linear motors).
- Indirect, "dq" dynamic phase angle adjustment gives improved efficiency at medium and high speed—get more power and use smaller, less expensive motors.
- Easy configuration allows use of any 3-phase brushless servo motor, linear motor or DC brush motor.

ServoSet—Servo Toolbox

Windows®–based Setup and Servo Integration System Software: Easily monitor torque, speed, and other variables with your oscilloscope.



Advanced PIV Servo

Performs better than PID algorithms and is easier to tune. Feed-forward terms allow fine tuning for optimum tracking accuracy and settling time performance.

Proprietary Anti-Hunt™ Technology

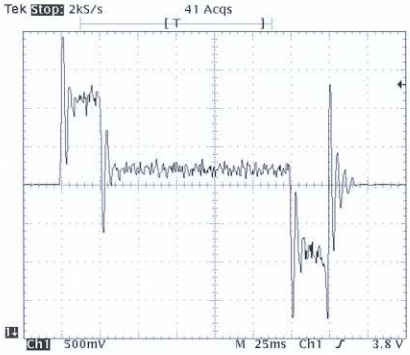
Allows very high gain settings for fast response and impressive stiffness without the typical servo jitter and "hunting."

See True Performance with the Monitor Port

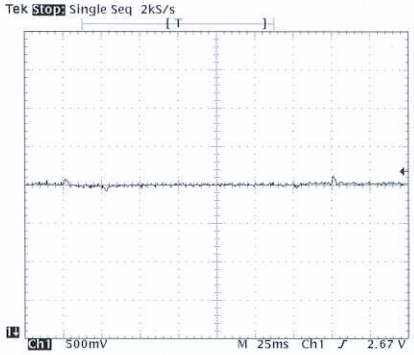
The Monitor Port allows quantitative, real-time analysis of all aspects of your system. Parameters such as velocity profiles, tracking accuracy, and instantaneous torque can be accurately determined. This capability has many invaluable uses: assisting in and optimizing tuning, evaluating mechanics, troubleshooting, characterizing and verifying proper performance, and many more.

Monitor Port's display of a commanded velocity profile for a ten inch "trapezoidal" move. The profile was produced by an off-the-shelf PC-based indexer. Maximum velocity attained by the leadscrew-driven load during this move is 67 in/sec. The acceleration is almost 6.5g's!

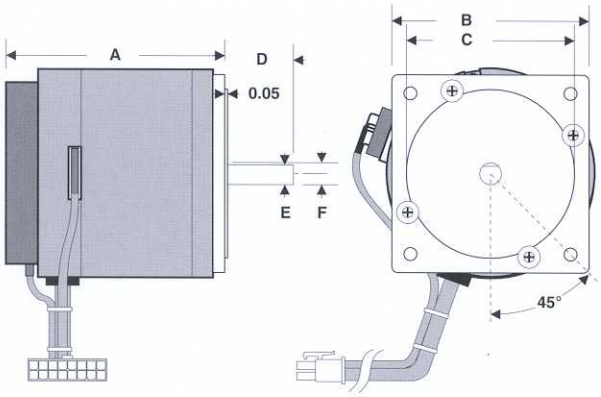




Monitor Port's display of the actual torque used during above move. Scaling shown is 40 oz-in/div. What's interesting to notice are the rapid fluctuations in the torque magnitude and direction necessary to achieve minimal tracking error (see figure at the bottom right). This is only achievable with high servo bandwidth.



Monitor Port's display of the tracking accuracy. Scaling shown is 0.014 in/div. Even at the extreme acceleration of this move, the tracking error is barely discernable. Actually, the small error seen here is due to "jerk"—the rate of acceleration change—inherent in this trapezoidal move. No error is attributable to the constant acceleration part of the move.



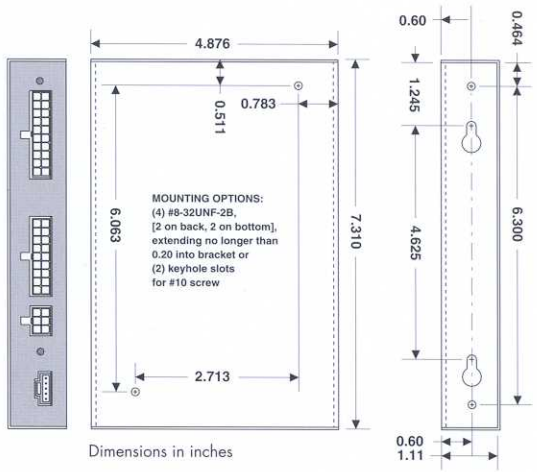
Size	A	B	C	D	E	F
M172	2.08	1.65***	.865	.940	.250	.250
M233	3.32*	2.25	1.50	.800	.223	.250
M234	5.07*	2.25	1.50	.800	.223	.250
M343	3.75**	3.375	2.875	1.175	.335	.375
M345	5.00**	3.375	2.875	1.175	.335	.375

*Subtract 0.45 inches if the NEMA flange is removed.
**Subtract 0.20 inches if the NEMA flange is removed.
***A 0.225 inch projection on the encoder cover is not shown

Dimensions in inches

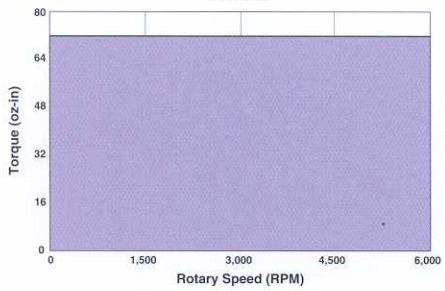
AVS Specifications

Operating Voltage	24 to 75 volts
Output Current	9 Amps Continuous, 23 Amps Peak
Step & Direction Input	TTL with 470 ohm Pull-Up Resistor — Maximum Input Rate is 1.25MHz (2.0 MHz with filtering disabled)
Analog Monitor Output	± 2V Output Range — Actual Velocity, Velocity Error, Position Error, Actual Torque
Protection	True RMS Torque Limiting, Tracking Error Limit, Foldback Overspeed Limit, Over-Voltage, Motor Short Circuit (phase to phase, phase to ground), Thermal Overload, Fuse
Environmental	Operating Temperature: 0-40° C, Humidity: 0-90%

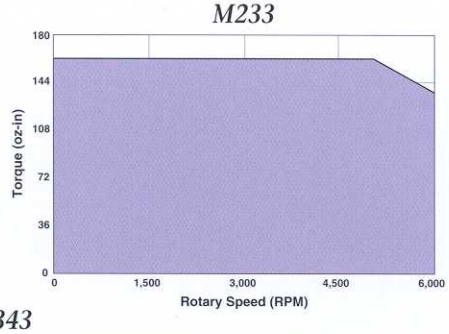


Dimensions in inches

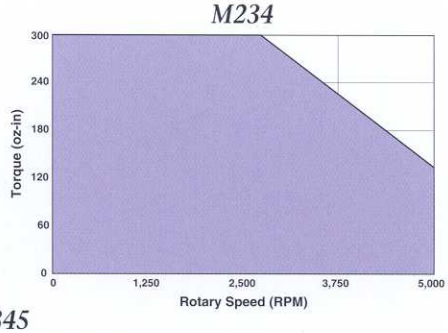
M172



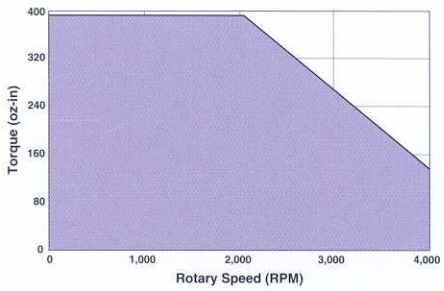
M233



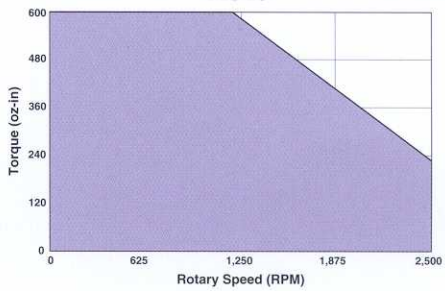
M234



M343



M345



Sustained continuous torque values are approximately 33% of the peak torque values shown. Peak torque is capable for a 3 second duration.

BEARING ENGINEERS, INC.

Motion Group

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