New Ideas in Motion...

Providing a Complete Motion Control Solution

DELTA Tau

- Semiconductor Manufacturing
- Aerospace
- Military
- Medical
- Positioning
- Robotics
- Packaging & Assembly
From the Simplest Application to the Most Complex and EVERYTHING in Between…

**Industries / Applications**

**Semiconductor Manufacturing**
Wafer Handling, Slicing, Stepping, Inspection, Die Bonding, Wire Bonding

**Aerospace**
Flight Simulations, Turbine Blades, Manufacturing, Machine Tool

**Military**
Autonomous Vehicle Control, Positioning Systems, Robotics

**Machine Tool**
Mills, Lathes, Grinders, Engravers, EDM, Water Jet Cutting, Turning Centers, Laser Cutting

**Robotics**
Pick-and-Place, Process Production, Scara, Delta Robots, Hexapods

**Packaging & Assembly**
Mixing, Cutting, Packaging, Sewing, Web Handling, Conveyor Belt Synchronization

**Positioning**
Telescope, Synchrotron, Inspection, Sub-Micron Operations, DNA Sampling

**Medical**

**Specialty**
Wind Power, Hexapod, Robotics, Remote Machinery Control, Printing on the Fly, Autonomous Vehicle Control

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From Machine Logic to High-Performance Motion Control
Delta Tau Provides a Complete Automation Solution

![Automation Solution Diagram](image-url)
Delta Tau’s Open Architecture platform provides complete flexibility to choose the best possible components for your application. Choose from the markets leading peripheral devices to create the ultimate control solution without limiting your options.

… for a totally integrated solution that fits all of your application needs.
Remaining focused on providing the highest performance machine control system, Delta Tau offers many motion and servo loop capabilities that differentiate us from the rest. All these features come standard in all our Machine Control products.

**MOTION CAPABILITIES**

**Dynamic Multi-Block Lookahead**
- Evaluates planned trajectory against motor limits
- Slows just enough to stay within position, velocity and acceleration limits without distorting the trajectory
- Executes fastest possible traversal within machine constraints

**Forward and Inverse Kinematics**
- Simplifies programming for non-Cartesian mechanisms
- User routines convert between tool tip and actuator mechanisms
- Permits direct specification of tool tip path

**S-curve Acceleration**
- Automatically limits rate of change of acceleration (jerk)
- Specified by jerk magnitude or S-curve time
- Provides smooth profiles with reduced high-frequency content

**Position Capture and Compare**
- Specialized circuitry tying encoder counts to digital outputs
- I/O on exact count (w/sub-count interpolation) at any speed
- For probing, registration, measurement trigger, laser firing

**Gantry Control with Skew Correction**
- Automatic removal of power-on skew in homing search sequence
- Follower motor automatically follows leader
- Optional cross-coupling servo correction

**Electronic Gearing and Cams**
- Powerful master/slave techniques
- Position following (gearing) requires no program for motion
- External time base (cam) keeps full trajectory flexibility

**Multiple Coordinate Systems**
- Axes acting together should be in same Coordinate System
- Axes acting independently should be in separate Coordinate Systems
- Separate Coordinate Systems act as independent machines

**Blended and Splined Moves**
- Automatic on-the-fly transition for multiple programmed moves
- Controlled, specified acceleration of transitions
- For single-axis profiles or multi-axis paths

**SERVO LOOP FEATURES**

**Adaptive Control**
Power PMAC servo loop's stiffness and damping factor may be adjusted automatically as the effective reflected load inertia changes without the need for special test inputs. This optional feature enables a form of Adaptive Control in the presence of load inertia changes of bounded nature (typically 1 to 5 times a normal value).

**Advanced Standard PID and High Order Filters**
Power PMAC's standard servo loop control algorithm includes both feedback and feedforward paths. In the feedback path, a position loop PID filter is combined with a velocity loop (dual-sensor) PI, acceleration feedback and a second-order low-pass filter. In addition, a 2-degree-of-freedom 7th order discrete time filter is implemented in cascade in the position loop. This 2-degree-of-freedom filter may be used for implementation of classical observers or frequency-based notch filters. These include up to 3 notch filters and a low pass filter. The feedforward path includes velocity and acceleration feedforward with a second-order low-pass filter independent of the feedback path. Low-pass filters are also available in the velocity feedback and feedforward loops.

**Custom Servo/Phase Algorithms**
Power PMAC permits custom servo control algorithms to be implemented in C instead of using the standard algorithm. Power PMAC IDE software includes a C-cross compiler that provides an easy and quick tool for generation and implementation of custom servo algorithms for any number of motors. C-code can be automatically generated from tools such as MATLAB®/Simulink®.

**Cascaded Servo Loops**
With this technique, the output of one servo loop (one Power PMAC “motor”) is used as an input to another servo loop, permitting both servo loops to affect a single actuator. The outer loop does not directly drive an actuator; instead, it dynamically modifies the set point of the inner loop in an effort to drive its own error to zero. This technique has many possible uses; the most common is to be able to close an auxiliary loop around a standard position loop. The auxiliary loop controls some quantity affected by the position loop’s motion, such as torque or force applied, or distance from a surface. The coupling of the loops can be turned on or off, permitting easy switching between control modes. Common uses of this technique include: web tensioning, torque-limited screwdriving, metal bending, controlled-force part insertion and height control over an uneven surface (e.g. for auto-focus).

**Trajectory Prefilter**
A 4th-order Trajectory Prefilter is included as a standard feature of Power PMAC. The Trajectory Prefilter acts on the desired instantaneous trajectory of a motor in order to band-stop, or “notch out”, certain frequencies that may excite low frequency mechanical resonances. The Trajectory Prefilter operates as a discrete-time recursive filter with its own programmable sampling period.
Delta Tau offers a wide variety of Machine Control products. From highly integrated or embedded controllers to flexible and expandable Modular Rack systems, Delta Tau will provide a hardware solution that is right for your application.

…Put the power of Delta Tau to work for you with your next application.

### Embedded Controllers

Delta Tau’s embedded control products are designed to be cost-effective and highly integrated for high-volume, compact applications. All Delta Tau products can be used standalone or can communicate to the host PC via USB or Ethernet.

- Board level controllers with all the power of Delta Tau’s industry-leading motion control.
- Low cost, flexible, and expandable, offering a wide variety of output control signals and communication protocols.
- For controlling up to 256 axes with unparalleled built-in features for any motion application.
- Totally digital control provides both the highest possible throughput and accuracy as well as low maintenance cost.

### Modular Rack Systems

Referred to as UMAC systems (Universal Machine and Automation Controller), Delta Tau’s Modular Rack systems are flexible, scalable and expandable 3U-rack based systems. To configure, select from our vast list of CPUs and accessories and create a system specifically for your needs.

- User-selectable CPU or MACRO fiber optic interface, as well as Axis Interface boards, I/O, and communication interfaces (such as USB, Ethernet, RS-232, etc.).
- Standard and highly customized machine functions performed with a rich variety of available accessories.
- Racks are available in many sizes, providing a UL and CE-compliant, rugged and integrated system.
Delta Tau’s Intelligent Amplifiers combine the controller and amplifier in a single fully-integrated, enclosed package. The result is both powerful and versatile, allowing 1 to 8 channels of power amplification for driving a wide variety of motor types.

- Power Brick AC - 4/6/8-Axis (Cont/Peak)
  240 VAC, Single or 3-Phase Operation
  Axes 1-4 & 7-8: 5 A/10 A or 8 A/16 A (Cont/Peak)
  Axes 5-6: 15 A/30 A (Cont/Peak)
- Power Brick LV - 4/8-Axis
- Turbo Clipper Drive - 4 Axis
  60 VDC, 4-phase operation at .25 A/.75 A, 1 A/3 A and 5 A/15 A (Cont/Peak) Servo and Stepper Controller/Amplifier
- Additional axes can be added over MACRO
- Built-in analog and digital I/O

Delta Tau’s Intelligent Amplifiers complement the controller product lines and provide the power amplification to drive and support a wide variety of motors and power ranges.

- Amplifiers are available in embedded board level (PCB-level), enclosed panel mount, and UMAC rack mount formats.
- Virtually all interfaces are supported including +/- 10 VDC, Torque, Velocity, Direct PWM, Sinusoidal Phase Current, and Pulse and Direction (Stepper).
- 240 - 480 VAC, 1.5 A/4.5 A - 30 A/60 A (Cont/Peak)
Delta Tau provides all of the interface products necessary to easily and effectively implement communication and control, motion, and fieldbus networks.

- MACRO is a powerful Ethernet-based open protocol offering a full line of controllers, drives, and I/O solutions.
- In addition, Delta Tau fully supports EtherCAT, EtherNet/IP, SSCNET Modbus, and a wide range of fieldbuses.

Industrial Networks

Software Tools

To aid customers in the integration and development process, Delta Tau offers several software tools. Delta Tau’s Integrated Development Environment (IDE) is unsurpassed in the industry and comes standard with every Power PMAC.

- Runs on Windows™ XP, Vista, or 7/8 with an advanced editor and built-in debugging features.
- Provides extensive project and resource management features, integrated GNU C cross-compiler, and an interactive “terminal mode” window.
- Many status and setup windows, along with tuning and graphical plotting screens simplifies the design, development, analysis, setup and implementation of your application.
- These IDE components can be directly incorporated in your application with MS Visual Studio™.
Controller Specifications

CPU HARDWARE SPECIFICATIONS

- Up to 1.2 GHz Single/Dual Core
- Full real-time Operating System (Linux OS w/ real-time kernel)
- Full file management system (programs, data, files, etc.)
- Dedicated controller runs in the RT Linux environment
- Full 32/64-bit architecture
- Hardware 64-bit double precision floating point math
- Support for very large memory
- 1 GB / 2 GB DDRAM active memory with error correction
- 64 MB NOR flash memory for standard firmware
- 512 MB built-in NAND flash for user memory (expandable)
- Built-in USB2.0 interface
- 2 ethernet 1 Gbps ports
- Optional direct video interface (DVI/HDMI)

MOTION SPECIFICATIONS

Number of Axes
Supports up to 256 motors simultaneously

Number of Coordinate systems
Up to 128 independent coordinate systems

Servo Loop Update Rate
- 1-axis: up to 60 kHz
- 4-axis: up to 40 kHz
- 8-axis: up to 20 kHz

Encoder Update Rate
- 10 MHz line rate and 40 MHz count rate for standard A/B Quad with Capture & Compare

Programmed Move Block Execution Rate
- Up to 10,000 Blocks/sec

Move Modes
- Blended linear and circular interpolation modes
- Rapid point-to-point, triggered, alterable PVT, and spline moves, and on-the-fly transition between blended and modern spline modes
- Dynamic Lookahead for velocity and acceleration limiting
- True jerk control

Commutation Features
- Sinusoidal commutation of AC servo motors
- Vector control of AC induction motors
- Digital current-loop closure with direct PWM output
- User can write a custom commutation algorithm in C if desired

Compensation Tables and Methods
- 1D, 2D, or 3D Compensation Tables with optional rollover
- 3rd-order interpolation between points every servo cycle
- Supports up to 256 Comp tables
- Torque compensation tables
- Backlash compensation
- Tool radius compensation: 2D & 3D

Number of I/O
- Supports thousands of I/O points

Servo Features
- Standard digital PID feedback filter
- Velocity, acceleration, and friction feedforward
- 7th-order polynomial filters
- Gains changeable at any time
- Programmable input, integrator, and output limits
- User-Written algorithms in C or MATLAB®/Simulink®
- Adaptive control
- Cross-coupled gantry control

Motion Program Features
- Automatic sequenced execution of moves
- Automatic coordination of multiple axes
- Ability to execute G-code programs
- Calculations and I/O can be synchronized to motion
- Axes can be programmed in user engineering units
- Commanded axis positions can be constants or expressions

Coordinate Systems and Master/Slave Features
- User-defined coordinate systems for automatic coordination of axes
- Separate coordinate systems for independent motion of axes
- Multi-motor axis support (e.g. gantries)
- Dynamic axis transformations (e.g. offsets, rotations, mirroring)
- User-written kinematic algorithms for non-Cartesian geometries
- Electronic gearing (no programming required)
- Electronic cams with programmable profiles

Safety Features
- Hardware and software overtravel limits
- Amplifier enable/fault handshaking
- Following error limits
- Integrated current limit
- Encoder loss detection
- Watchdog timer
- Error-correcting memory
- Collision avoidance algorithms can be implemented in inverse kinematic subroutines
The Motion Computer and Industrial Network Connectivity

Capable of communicating simultaneously to most real-time motion networks and fieldbuses.

… a universal CPU in a format that’s right for you.

Fieldbus Connectivity:
- EtherNet/IP Adapter (Server)
- DeviceNet (Master/Slave)
- PROFIBUS (Master/Slave)
- CANopen (Master/Slave)
- CC-Link (Slave)
- Modbus

Real-Time motion Networks:
MACRO or EtherCAT

1GB Ethernet

The Power PMAC can provide an embedded operator interface, eliminating the need for a separate PC.
- Most reliable Motion Network built on 100-Base Ethernet
- Reduced Hardware Cost with Increased Performance
- 125 Megabits/second Data Rate
- Available with Optical Fiber for Complete Noise Immunity (up to 1 mile) or RJ-45 Cat-5 Cable for Low Cost (up to 100 feet)
- 1 to 16 Masters, 16 to 256 Slaves
- Supports 128 Motion and 128 I/O Nodes
- Centralized Software, Distributed Hardware

**Interface to EtherCAT Amplifiers:**
Supports CoE, FoE, EoE and specifically the DS402 spec. for CoE drives in Cyclic Position, Velocity or Torque modes.

**Interface to EtherCAT Peripherals:**
Any EtherCAT I/O Device, Bridge module, etc…
Programming Languages
Delta Tau controllers can be programmed in several different types of languages simultaneously. Choose your preference for motion and PLCs.

The PMAC Script Language
PMAC Script Language is a “Basic-like” programming language used to write Motion, PLC and sub-routines. The Power PMAC offers an enhanced version with even more flexibility and user friendliness.

“C” Language
For advanced programmers who prefer to program in C, the Power PMAC gives you the ability to write Servo, Phase, and Kinematic algorithms in C, as well as PLCs and general-purpose applications.

Other Programming/Software methods available

G-Code
Power PMAC can accept standard RS-274 “G-code” part programs, as generated by CAD/CAM programs. Codes are implemented with customizable subroutines.

MATLAB®/Simulink®
C-code automatically generated from the MATLAB®/Simulink® graphical environment can easily be run on controllers for servo, commutation, or other tasks.

LabVIEW™
The communication library and IDE components integrate seamlessly into the NI LabVIEW™ graphical programming environment.

EPICS & Tango
The open-source collaborative EPICS scientific experiment management software can be run directly on all controllers, eliminating the need for a separate embedded computer.
Power PMAC Integrated Development Environment (IDE)

Includes all the necessary tools for setting up, developing, managing, and diagnosing your Power PMAC application:

- Microsoft Windows™ 32/64-bit operating systems for XP, Vista or 7/8.
- Advanced editor with built-in debugging features
- Extensive project and resource-management features
- Integrated GNU C cross-compiler
- Interactive terminal window
- Many status and setup windows
- Tuning and plotting graphics screens
- Intellisense and Syntax Checking
- Structured Programming
- CAM Generator

System Setup
- Hardware Auto-identify
- Easy-to-use Diagnostics
- Step-by-step Motor Setup
- Step-by-step Network Setup
- Expandable & Portable Motor & Amplifier Setup Database

Powerful Tuning Tools
- Basic Auto-Tune
- Advanced Auto-Tuning
- Servo Analyzer with Interactive Tuning Tool
- Trajectory Pre-Filter
- Advanced Feedback/Feedforward Filter Calculator
- Single and Double Notch Filter
- Single and Double Notch Filter + Low Pass Filter
- Low Pass Filter
- Velocity Loop Filter
- Custom Servo and Phase algorithm selection GUI

The IDE was designed using Microsoft Visual Studio™, comprised of several .Net components, which can also be used with your custom application software.

Program editor with color code, syntax checking and structured programming.
Display windows for Position, Following Error, Velocity, etc…
Intellisense and Auto-completion of programming commands.
Error and status monitors and parameter watch table.
Project Management provides an organized tree structure for each function or structure within the project.
With over 30 years of motion control experience, Delta Tau is the leader for innovative, high-performance, machine-control solutions. Controlling over a million axes of motion, Delta Tau is dedicated to providing solutions for the simplest to the most complex applications in the world.

From the beginning, our main focus has been meeting customer requirements with both the highest reliability and ROI. Operating out of a modern 120,000 square-foot building, Delta Tau takes pride in its manufacturing process, the very latest in SMT manufacturing, and automated inspection and testing. The result is delivering the highest quality products with the fastest lead time.

By developing tomorrow’s technology today, and delivering easy-to-use and cost-effective products, Delta Tau can provide solutions that solve your tough automation problems and keep you a step ahead of your competition.
Other Motion Tech Products

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