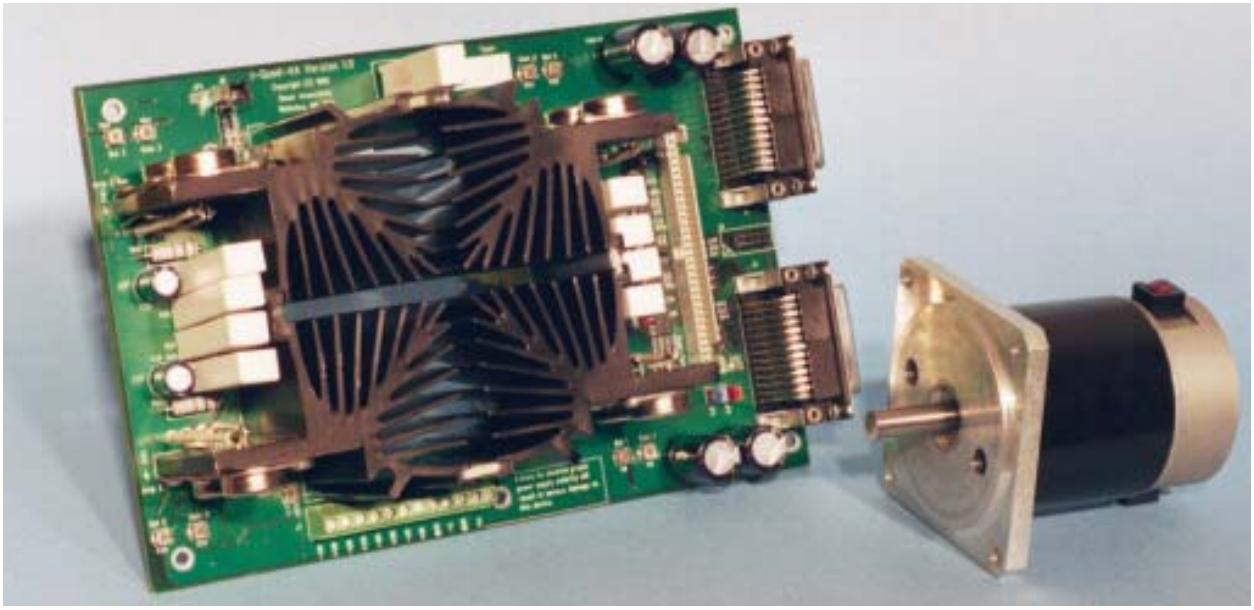

Specification Sheet
The Bauer I-QUAD-4A Four Channel True Current Mode Servo Amplifier

Specifications:

Note: specifications are based on operation with +/- 19V power supply; exact behavior varies with choice of power supply voltages over the range of +/- 12V to +/- 25V. For operation outside those limits, contact Bauer for additional information. Specifications refer to each of the four amplifier sections.

package size (including fan)	6.00 inches (width) 9.25 inches (length) 3.85 inches (height)
maximum current output at +16V:	10 amps
maximum current output at 0V:	4 amps
maximum current output at -16V (worst case motor deceleration):	2 amps
short circuit duration to ground:	indefinite
short circuit duration to either supply rail:	indefinite
current injection tolerance (output voltage beyond supply rails):	4 amps
maximum heat sink temperature:	100 °C, +/-10 °C
thermal shutdown:	automatic

Note: When operated with its cooling fan, with free air flow in an environment < 40 °C, the system will not overheat under any conditions of operation. Thermal shutdown protects the system against excessive temperature rise under conditions of restricted air flow, high ambient temperatures, or when the amplifier is used without its cooling fan.

bandwidth:	0 Hz to 1 kHz; second order Bessel rolloff above 1 kHz.
transconductance:	maximum of 1 amp per volt
input:	full differential (balanced), may be connected for single-ended
input impedance:	200,000 ohms
input common mode rejection:	> 100:1
nonlinearity:	1% maximum
input / output connector:	matches the 60-pin dual row header connector used by Delta Tau for their PMAC series of motor controller cards
output connectors:	screw terminals for very high current operation
	25 pin 'D' connectors (sockets) for most applications
signals passed through from the PMAC input / output connector to the 'D' output connectors:	
	differential quadrature encoders
	limit switches
	home switches
	power and ground for encoders, limit switches
additional signals on the PMAC input / output connector:	
	over-temperature "fault" for each amplifier
	amplifier "enable" input for each amplifier
additional board connectors:	
	+, -, ground power input (screw terminals)
	+5V input for external switches and encoders
	24V regulated "fan" output
	over-temperature LED output
controls:	gain (1 A/V to 0 A/V), offset -- twenty-turn screwdriver adjust
jumpers:	low-voltage operation (for use with supplies less than +/- 17V)
	ground selection for interface
	"fault" signal polarity
	"enable" signal polarity

Detailed design features:

Each amplifier is built around two independent current output sections -- a current sourcing section, and a current sinking section. The "current sense" for each section comes from the emitters of each output transistor, once again, independently for both the current sourcing and current sinking sections of the circuit. The actual output comes from the collectors of each transistor. This completely isolates the output from any feedback circuitry, and makes the current output independent (up to the point of voltage clipping) of the load. The inherent output impedance of the circuit closely approaches that of a theoretical "current source," and is on the order of millions of ohms.

The "true current mode" topology, by isolating the load from any feedback circuitry, not only avoids the possibility of EMI-related overload, but also makes it possible to parallel as many

sections as wanted in order to achieve higher current output capabilities. Considerations such as "feedback interaction" or "current hogging" that occur with amplifiers that use output-derived feedback are not simply reduced, but are entirely eliminated by this topology. Thus, if 4 amps into a short circuit load (a starting motor) does not suffice for a particular application, additional amplifier sections may be parallel-connected to achieve whatever current output is necessary. All four amplifiers dedicated to a single motor would provide 16 amps, and, if necessary, still more amplifiers may be safely paralleled to achieve higher currents.
Reliability is assured by the use of independent "safe operating area" protection circuits for each output transistor, and by the use of an oversized, massive heat sink designed specifically for efficient forced-air cooling. The output transistors are not restricted duty cycle 'audio' power modules, but individual 200 watt, 30 amp, 120 volt, independent complementary transistors in high-reliability hermetic cases. Secondary protection against overheating caused by restricted air flow under extreme operating conditions is provided by thermal sensors. The thermal sensors only interrupt amplifier behavior so long as an overheat condition exists (the heat sinks at the temperature of boiling water), and automatically reset to normal operation once the temperature of the heat sinks goes down by approximately 10 °C.
Because DC servo motors typically exhibit a significant amount of winding inductance that can produce stability-reducing 'flyback pulses', the amplifier includes a 'snubber' network across its output, consisting of a 100 ohm resistor in series with a 33 microfarad capacitor. The values of this 'snubber' network were determined according to the evaluation of a wide range of 'typical' servo motors, and were chosen to minimize the possibility of 'peaking' in the transfer function -- something that often limits the possible amount of negative feedback that can be successfully applied.

The amplifier also includes a 12 dB/octave bandwidth limit of 1 kHz, to minimize the possibility of high frequency oscillation due to cable routing, and to operate as an 'anti-aliasing' filter when used with digital control loop systems. Unusual servo applications (e.g., those using very low inductance, low time-constant motors driving low-inertia loads at high accelerations) may benefit from an analysis leading to some modifications to the standard snubber and bandwidth-limiting component values. In those special applications, the full power bandwidth of the amplifier could extend to 50 kHz. Contact Bauer for more information.

The "true current mode" topology allows the indefinite paralleling of multiple output stages to achieve increased current capability. However, that topology prohibits the connecting of amplifiers in "H-Bridge" configurations to achieve higher voltage capability. In most cases, the careful selection of standard DC servo motors makes that restriction irrelevant. In some cases, though, higher voltage outputs are necessary. The design of this amplifier makes it practical to supply higher output voltage configurations with only minor component value changes, up to +/- 50V, on special order. Contact Bauer for more information.