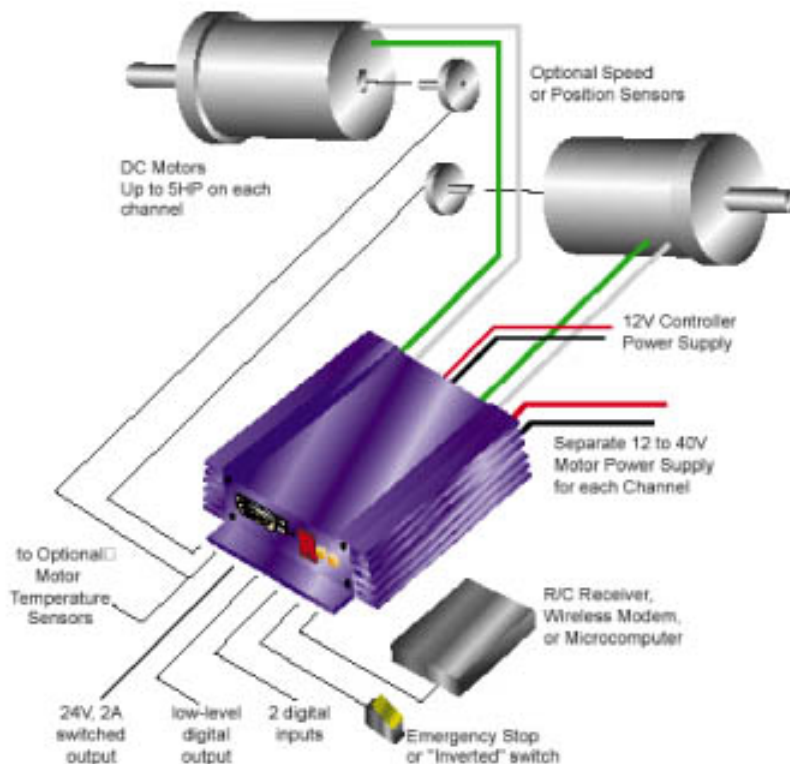## Simple and Fail-safe Operation

Roboteq's AX2500 is a high performance, microcontroller-based motor controller, loaded with numerous features and operating modes. Yet, for all its sophistication, the AX2500 is very simple to install and operate. Its many configuration options are programmed using only two switches and a LED display on the controller front panel. The controller may also be connected to a PC for setting configuration parameters using a convenient Graphical User Interface. Once programmed, the configuration data are stored permanently in the controller's nonvolatile memory, eliminating the need for cumbersome and unreliable jumpers. During normal operation, the LED display provides running and alarm indication.

The AX2500 is fitted with many safety features ensuring a secure power-on start, automatic stop in case of command loss, overcurrent protection on both channels, and overheat protection. A temperature sensor will shut down the power stage and protect the controller in case of overheating. Connections are provided for external thermal sensor to monitor motor temperature.

Easy to Install in any Robot

The AX2500 is designed for simple installation in a variety of robotic vehicles. The controller is fitted with heavy gauge cables for direct connection to high amperage batteries and motors.

Optional Speed
or Position Sensors

DC Motors
Up to 5HP on each
channel

12V Controller
Power Supply

Separate 12 to 40V
Motor Power Supply
for each Channel

to Optional
Motor
Temperature
Sensors

R/C Receiver,
Wireless Modem,
or Microcomputer

24V, 2A
switched
output

low-level
digital
output

2 digital
inputs

Emergency Stop
or "Inverted" switch

A convenient 15-pin connector is used for the following low voltage connections:

- the radio receiver or microcomputer,
- optional speed, position or temperature sensors
- an input for an Emergency Stop switch
- an "inverted" switch input for detecting when the robot is turned upside-down, correcting the controls accordingly,
- a 2A solid-state switched output for controlling a brake, clutch, weapon or other device.
- a regulated 5V supply output for powering the R/C radio (Battery Eliminator Circuit).
- When operating in RS232 mode, additional low voltage inputs (up to 2) for connecting switches or sensors.

Multiple Input Modes

The AX2500's multiple command input modes - R/C Radio Pulse Width, Serial Port or Analog - make it uniquely interfaceable to all types of microcontrollers, remote control radios, or other command devices.

R/C Radio mode

R/C Radio is the most popular, simplest and least expensive method to build and operate a remote controlled robot. In this mode, the controller supports many configurable options, including joystick calibration of min, max and center positions and deadband adjustment.

Serial Port (RS232) mode

Using the serial mode, the controller may be interfaced to a microcomputer for autonomous operation. Using a wireless modem or wireless network adapter (802.11), more advanced remote control operations are possible, including remote control via the Internet.
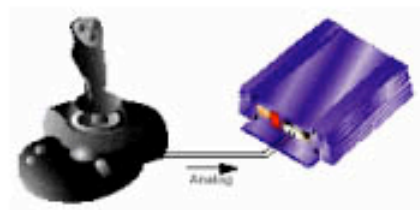
Analog mode

A simple 0-5V analog control mode is also provided for direct connection to potentiometers or analog joysticks.

Multiple Command Modes

The AX2500 may be connected to two motors which will react to commands received on two input channels. Using these two channel inputs, the motors can be commanded independently or in a combined fashion to accommodate the most common drive and steering methods in robotic vehicles.
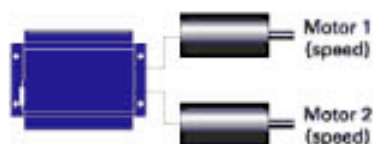
Independent Speed command

In this mode, each of the two motors is commanded independently of the other. This operating mode is best suited for generic motor control applications.
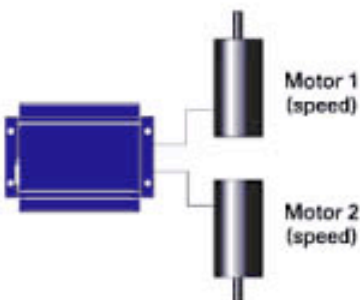
Mixed Speed/Steering command

In this mode, the motors work in combination to move and turn a vehicle by combining the forward/reverse command information and the left/right steering information. This mode of operation provides a cost effective method for moving and steering tank-style robots and underwater vehicles.
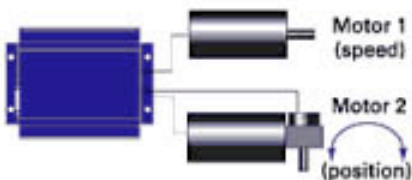
Speed and Position commands

In this mode, one channel is used to control the forward/ reverse motion of the vehicle. The other channel is used to make the motor work like a position servo which can be then connected to a steering column. This mode is the most energy efficient as no power is lost to friction due to skidding.
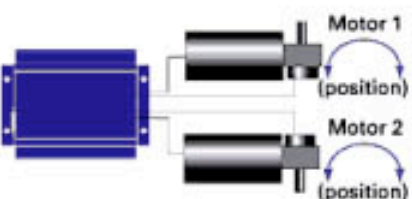
Dual Position Commands

In this mode, each channel independently controls the angular position of one motor. The heavy duty servos built in this way can be used to control throttle, breaks, and steering of life-size vehicles or animate any large and heavy structure.

Programmable Command Corrections

The AX2500 can be configured to automatically correct and compute an adjusted motor command value.
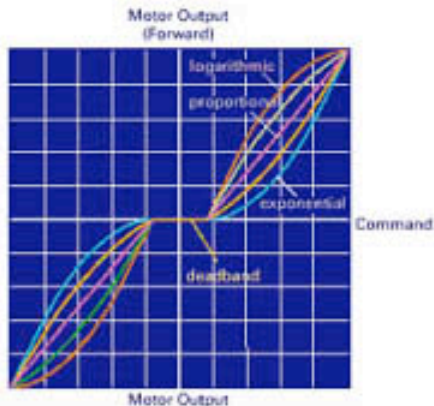
Programmable deadband adjustment (R/C mode only)
The controller allows a selectable amount of joystick motion from its center position before it begins applying power to the motors. This feature ensures a safe start and smooth operation for the robot.

Exponentiation adjustment
After the joystick moves past the deadband position, the AX2500 can be set to add an increasing (exponential) or decreasing (logarithmic) amount of power to the motor. This allows the operator to set the robot's best driving characteristic for a particular use.
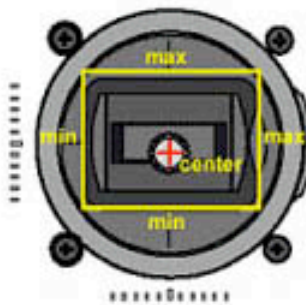
Joystick calibration (R/C mode only)
With the push of a button, the min, max and center positions of the R/C joysticks can be captured and stored in the controller. Because of this feature, the AX2500 will deliver on the full joystick travel position and will always start at a safe idle position.
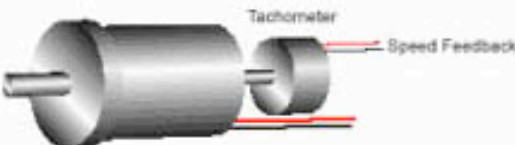
Multiple Motion Modes

For each channel, the AX2500 supports multiple motion control modes:

Open Loop Speed mode
In this mode, the controller delivers an amount of power proportional to the command information. The actual motor speed is not measured. This mode is adequate for most applications where the operator maintains a visual contact with the robot.

Closed Loop Speed mode
In this mode, an analog tachometer measures the actual motor speed. If the speed changes because of changes in load, the controller automatically compensates the power output. This mode is preferred in precision motor control and autonomous robotic applications.
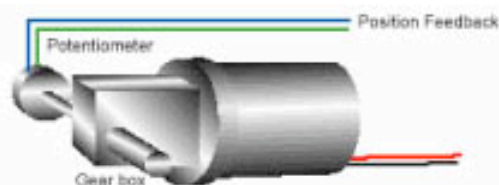
Closed Loop Position mode
In this mode, the axle of a geared down motor is coupled to a potentiometer that is used to compare the angular position of the axle versus a desired position. This unique feature makes it possible to build ultrahigh torque "jumbo servos" that can be used to drive steering columns, robotic arms, animatronics, life-size models and other heavy loads.

Efficient Power Output Stages

The AX2500 includes two high-efficiency Power Output stages which can operate from 12 to 40VDC (independently set for each motor). Each of these stages supports the following advanced features:

Precise, Smooth, Forward/Reverse Control

High efficiency MOSFET "H-Bridges" are used for full forward and reverse operation. The controller uses Pulse Width Modulation at 16kHz to generate smooth, variable output power in as little as 0.5% increments. Ultra-low "On" resistance of 3 miliohms and synchronous rectification ensures operation up to 120A (250A peak) per channel with very little heat generated by the controller. The MOSFET transistors are mounted directly against the heat-sinking extruded aluminum case for efficient cooling without the need of a fan.

Current Limiting and Programmable Acceleration

A sensor measures the actual current delivered to the motors and automatically reduces the power if the current goes over the preset limits during extended periods of time. This feature eliminates the need for oversizing the controller and allows the AX2500 to perform as better than competing controllers without current limitation.

Controlled Motor Acceleration

The AX2500 can also be configured to automatically "smooth" command changes (from stop to full speed, for example) to avoid sudden overloads on the controller, the batteries and/or the robot's mechanical components. The controller's programmable acceleration feature will automatically limit abrupt speed changes to preset user values.

PC-Based Configuration and Monitoring Utility

The AX2500 is delivered with a PC utility and connection cable that will allow you to perform the following functions:

- Read and set the programmable parameters with a user-friendly graphical interface
- Obtain the controller's software revision and date
- Send precise commands to the motors
- Read and chart real-time current consumption value, motor temperature and/or battery voltage

Using the PC and an internet connection, it is also possible to download and install software updates to the controller in order to improve existing features or enable new ones as they become available. This unique capability keeps the AX2500 from ever becoming obsolete.

Upon request, Roboteq can also perform custom modifications to the embedded software to meet specific user's requirements.
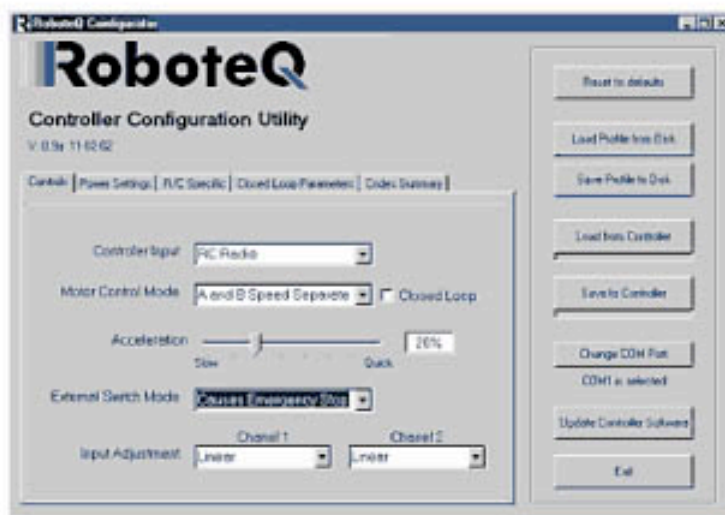
Screen shot of Parameters Configuration and Software Updating Utility

Updating the AX2500 with the latest software is a very simple and quick point-and-click procedure requiring no special computer or electronics skill. Upon request, Roboteq can also perform custom modifications to the embedded software to meet specific user's requirements.

Sturdy and Lightweight Construction

The AX2500 is built into a extruded aluminum case which also serves as a heat sink for its electronics. The large fin area ensures sufficient heat dissipation for operation without a fan in most applications. Mounting brackets on each end are provided for durable assembly of the controller onto any robot chassis. Optional shock mount absorbers are available for use in the most brutal environment.

Click here to view a **mechanical drawing** of the AX2500 enclosure.

The 15-pin connector includes mounting nuts to secure a permanent connection with the radio receiver or microcomputer and the various external sensors. At 2lbs (900g), the AX2500 is one of the most compact and
lightweight motor controller in its class.