



AX2500

Dual Channel, Forward/Reverse Digital Speed Controller

for Remote Controlled and
Computer Guided Robotic Vehicles

2 x 120Amps
SmartPower

Roboteq's AX2500 controller is designed to convert commands received from a R/C radio, wireless modem, or microcomputer into high voltage and high current output for driving one or two DC motors. Designed for maximal ease-of-use by professional and hobbyists alike, it is delivered with all necessary cables and hardware and is ready to use in minutes.

The controller's two channels can either be operated independently or mixed to set the direction and rotation of a vehicle by coordinating the motion on each side of the vehicle. The motors may be operated in open or closed loop speed mode. Using low-cost position sensors, they may also be set to operate as heavy-duty position servos.

The AX2500 can be reprogrammed in the field with the latest features by downloading new operating software from Roboteq's web site. Numerous safety features are incorporated into the controller to ensure reliable and safe operation in the most demanding mobile robotic vehicle applications.

Key Features	Benefits
Microcomputer-based digital design	Accurate, reliable, and fully programmable operation
R/C mode support	Connects directly to simple, low cost R/C radios
Serial mode support	Allows direct connection to microcomputers for autonomous operation or to wireless modem for two-way remote control
Built-in power drivers for two motors	Supports all common robot drive methods
Up to 120A output per channel	Gives robot strongest lifting or pushing power
Smart automatic current limitation	Protects motors, wiring and battery. High reliability
Open loop or closed loop speed control	Low cost or higher accuracy speed control
Closed loop position control	Create low cost, ultra-high torque jumbo servos
Extruded aluminum, heat sinking enclosure	Operates in the harshest shock and temperature environment
Field upgradable software	Never obsolete. Add features via the internet

give your robot muscle with brains

Roboteq's AX2500 controller is designed to fit a wide range of mobile robotic vehicle applications. Its compact size, high power drive capability, advanced safety features and multiple command modes make it the preferred choice for autonomous or remotely operated robots, such as:

- Automatic Guided Vehicles
- Law Enforcement Robots
- Hazardous Material Handling Robots
- Personal Transport Systems
- Underwater Remote Operated Vehicle
- Surveillance Robots
- Telepresence systems
- Bomb and Mine Removal robots
- Battlebots
- Remote Exploration Robots
- Animatronics
- Life-size model cars or boats
- ... and many others

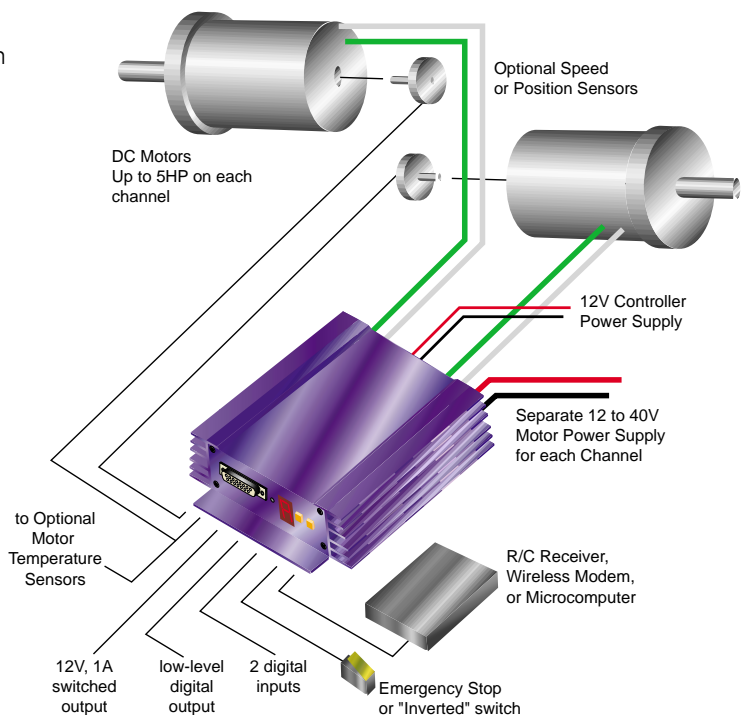


easy to install anywhere

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.

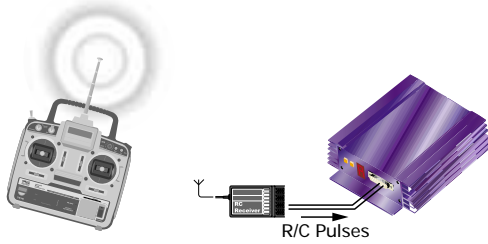
A convenient 15-pin connector is used for the following low voltage connections:

- 2 or 3* channel radio receiver inputs
- RS232 communication port
- Analog inputs for optional speed, position or motor temperature sensors
- Input for Emergency Stop switch or "inverted" switch for detecting when the robot is turned upside-down
- a 1A solid-state switched output for controlling a brake, weapon or other accessory.
- one low-current on-off output
- two digital input for user-defined sensors (RS232 mode)
- a regulated 5V supply output for powering the R/C radio (Battery Eliminator Circuit).



*3rd R/C channel is needed to activate accessory/weapon outputs in R/C mode

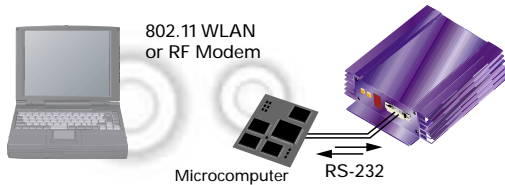
multiple input modes



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.

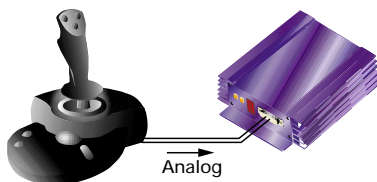
R/C Radio mode

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.

Visit www.roboteq.com for detailed applications examples and design tips.

programmable command corrections

When used in the R/C Radio command mode, the AX2500 can be configured to automatically correct and compute an adjusted motor command value.

Programmable deadband adjustment

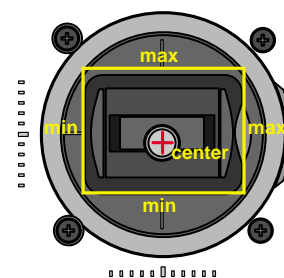
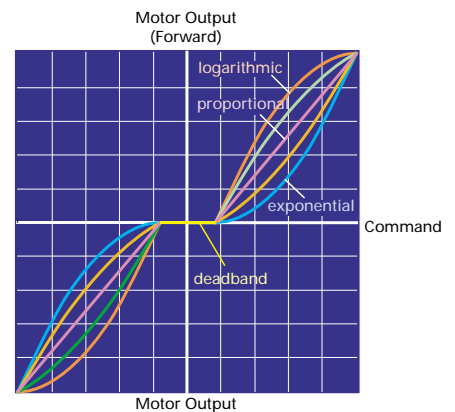
The controller allows a selectable amount of joystick motion from its center position before it begins applying power to the motors. This feature ensures a safe start and smooth operation for the robot.

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

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.

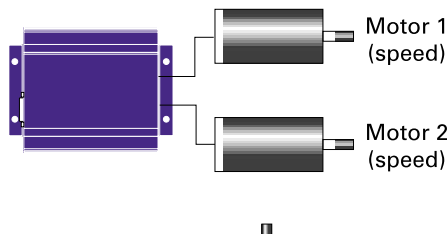


multiple command modes

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 commands

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.

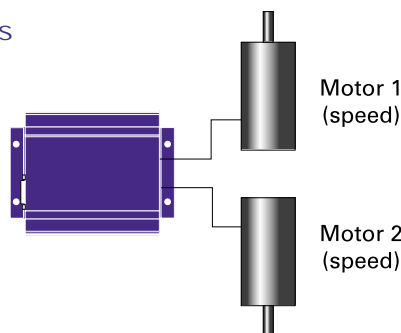


Commands Ch1	Ch2	Motors Mot1	Speed Mot2
100%	50%	Fast	Slow
0%	0%	Stop	Stop
50%	100%	Slow	Fast

Ch1 controls Motor 1's speed
Ch2 controls Motor 2's speed

Mixed Speed/Steering commands

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.

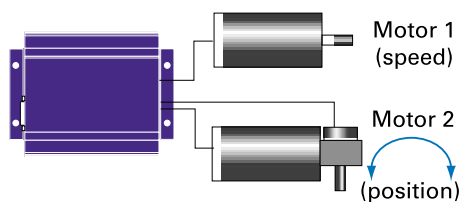


Commands Ch1	Ch2	Motors Mot1	Speed Mot2
100%	0%	Fast	Fast
0%	100%	Fast	Fast
0%	0%	Stop	Stop
0%	50%	Slow	Slow

Ch1 and Ch2 are mixed to control
Motors 1 & 2 in coordination

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.

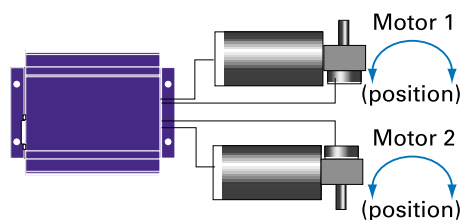


Commands Ch1	Ch2	Mot1 Speed	Mot2 Position
100%	50%	Fast	Right
0%	0%	Stop	Center
50%	100%	Slow	Left

Ch1 controls Motor 1's speed
Ch2 controls Motor 2's position

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, brakes, and steering of life-size vehicles or animate any large and heavy structure.

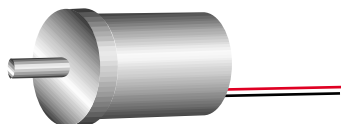


Commands Ch1	Ch2	Motors Mot1	Position Mot2
25%	0%	Right	Center
0%	25%	Center	Right
100%	25%	Left	Left

Ch1 controls Motor 1's position
Ch2 controls Motor 2's position

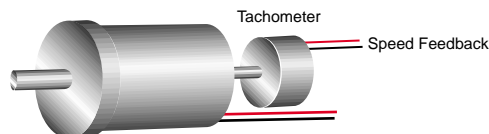
multiple motion modes

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



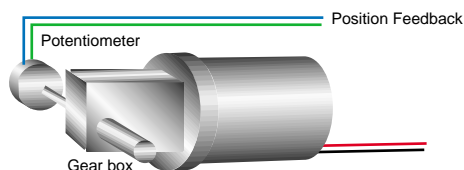
Open Loop Speed mode

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 ultra-high torque "jumbo servos" that can be used to drive steering columns, robotic arms, life-size models and other heavy loads.

efficient power output stages

The AX-2500 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

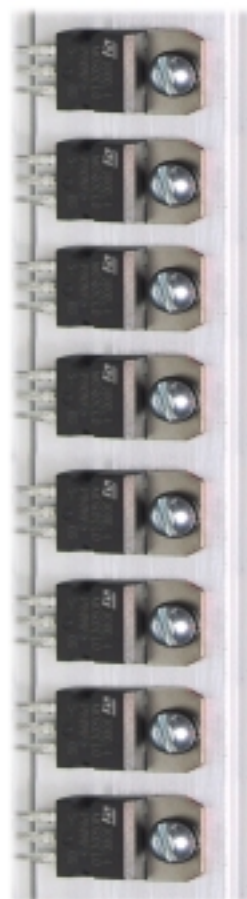
High efficiency MOSFET "H-Bridges" are used for full forward and reverse operation. The controller uses Pulse Width Modulation at 16kHz to generate smooth, variable output power in as little as 0.5% increments.

120Amps of SmartPower per Channel

The AX2500 features intelligent current sensing and control. After an initial surge allowed up to over 200A per motor, the controller will limit the power to 120A for the time typically required to accelerate or brake the robot. If the motor's current draw remains excessive after that time, as in the case of stalled motor or other unusual loading, the controller will gradually reduce the power to user-selected values. The MOSFET transistors are mounted directly against the heat-sinking extruded aluminum case for efficient cooling without the need of a fan in most applications.

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.



simple and fail-safe operation



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 non-volatile 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.

In case of short-circuits on the motor wires, a fast acting detection and disconnect circuit built into the controller provides added protection over fuses alone.

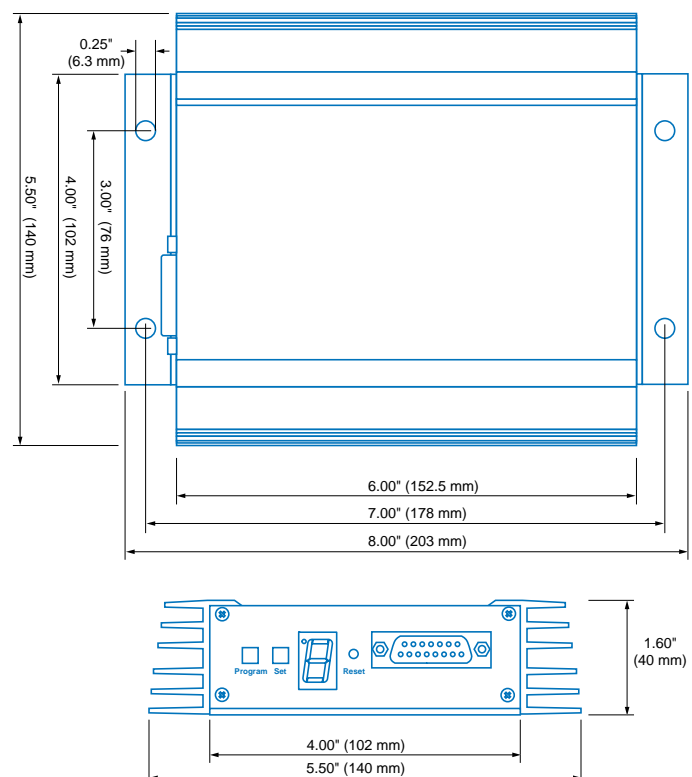
sturdy and lightweight construction

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 may be added for use in the most brutal environment.

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 the most compact and lightweight motor controller in its class.



always up-to-date software

Most of the AX2500's features are made possible by its embedded microcomputer and its Flash ROM-based program. Using a PC and an internet connection, it is possible to download and install updated software to improve existing features or enable new ones as they become available. This unique capability keeps the AX2500 from ever becoming obsolete.

The AX2500 controller is delivered with a cable for connection to a PC allowing configuration setting and software update installations. 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.



ready to work right out of the box



The AX2500 controller is delivered complete with the hardware, cables, and software necessary for its operation. The controller's factory default settings will satisfy the most common robot designs so that it can be installed and operated within minutes of unpacking. The controller is supported by a detailed and illustrated User's Manual, including a 10-page Quick Start section and over 100 pages of Reference Information.

Package Content

- AX2500 controller fitted with power cables
- R/C radio adapter cable
- Serial Communication cable
- CD containing PC Configuration Software
- User's Manual

Ordering References

AX2500

Dual Channel Forward/Reverse Speed controller up to 40V and 120A SmartPower per channel

Partial references listing only. Order on-line at www.roboteq.com or from your local distributor

technical specifications

Fully Digital, Microcomputer-based Design

- Multiple operating modes
- Fully programmable using either built-in switches and 7 segment LED display or through connection to a PC
- Non-volatile storage of user configurable settings. No jumpers needed
- Simple operation
- Software upgradable with new features

Multiple Command Modes

- Radio-Control Pulse-Width input
- Serial port (RS-232) input
- Analog Voltage input

Multiple Advanced Motor Control modes

- Independent channel operation
- Mixed control (sum and difference) for tank-like steering
- Open Loop or Closed Loop Speed mode
- Position control mode for building high power position servos
- Modes can be set independently for each channel

Automatic Joystick Command Corrections

- Joystick min, max and center calibration
- Selectable deadband width
- Selectable exponentiation factors for each joystick
- 3rd R/C channel input for weapon and accessory output activation

Special Function Inputs/Outputs

- 2 Analog inputs. Used as
 - ▲ Tachometer inputs for closed loop speed control
 - ▲ Potentiometer input for position (servo mode)
 - ▲ Motor temperature sensor inputs
 - ▲ User defined purpose (RS232 mode only)
- One Switch input configurable as
 - ▲ Emergency stop command
 - ▲ Reversing commands when running vehicle inverted
- Up to 2 general purpose outputs for accessories or weapon
 - ▲ One 12V, 1A output
 - ▲ One low-level digital output
- Up to 2 digital input signals

Low Power Consumption

- 12V at 150mA controller power supply
- No consumption by output stage when motors stopped
- Regulated 5V output for powering R/C radio. Eliminates the need for separate R/C battery.

High Efficiency Motor Power Outputs

- Two independent power output stages
- Dual H bridge for full forward/reverse operation
- Ultra-efficient 3 mOhm ON resistance MOSFETs
- 12 to 40 V operation (independently set for each motor)
- SmartPower Automatic current limitation
 - ▲ 120A up to 5 seconds (per channel)
 - ▲ 100A up to 30 seconds
 - ▲ 80A continuous
- High current 8 AWG cable sets for each power stages
- 250A peak Amps per channel
- 16 kHz Pulse Width Modulation (PWM) output
- Heat sink extruded case

Advanced Safety Features

- Safe power on mode
- Optical isolation on R/C control inputs
- Automatic Power stage off in case of electrically or software induced program failure
- Watchdog for automatic motor shutdown in case of command loss (R/C and RS232 modes)
- Large and bright run/failure diagnostics on 7 segment LED display
- Programmable motors acceleration
- Built-in controller overheat sensor
- Motor temperature sensing and protection
- Emergency Stop input signal and button
- Built-in, fast-acting short-circuit protection*

Sturdy and Compact Mechanical Design

- All-in-one design. Built from aluminum heat sink extrusion with mounting brackets
- Efficient heat sinking. Operates without a fan in most applications.
- 7" (178mm) L, 5.5" W (140mm), 1.8" (40mm) H
- -20° to +70° C operating environment
- 2 lbs (900g)

* Short-circuit protection provided for extra protection only. Warranty does not cover damage due to short-circuits or other abuse