

**FEATURES**

- Wide voltage range:  
+24 to +190V
- 13A continuous, 26A peak
- 25 kHz pwm frequency
- Drives motors with 60° or 120° Halls.
- Fault protections:  
Output shorts  
Over/under voltage  
Over temperature
- 2.5kHz Bandwidth
- 0.2-40 mH load inductances
- +5,+15V Hall voltages
- Separate peak, peak-time, and continuous current limits
- Simplified compensation adjustments
- Surface mount technology

**Resolver option 513R**

- Replaces Hall sensors  
Tachometer emulation  
Encoder emulation
- Interface motors to microprocessor controls and PLC's.

**APPLICATIONS**

- X-Y stages
- Automated assembly machinery
- Robotics
- Component insertion machines

**THE OEM ADVANTAGE**

- Component header customizes amps for different motors
- Conservatively rated components for high MTBF

**±180 Volts at ±26A Peak, ±13A**

**Model 513**

**Model 513R**

**PRODUCT DESCRIPTION**

**Standard Amplifier (513)**

Model 513 is a complete pwm servoamplifier that operates from transformer-isolated single-voltage power supplies and provides six-step commutation of dc brushless servomotors.

Power output is four-quadrant for rapid acceleration and deceleration. Amplifier operates in torque ( current ) mode for use with microprocessor based control cards.

Analog ( brush ) tachometers can be used to make velocity loops. New servo preamplifier circuits give improved control over frequency response for faster setup and adjustment.

An internal header socket holds components that configure current limits and load-inductance compensation to set up the Model 513 for different loads and applications. Separate peak current, continuous current, and peak-time limits allow high acceleration without sacrificing protection against continuous motor overloads.

Over and under-voltage conditions will cause the unit to shutdown temporarily. Heatplate over-temperature and shorts from output to output, or output to ground will cause a latching disable that can be reset by grounding the Reset input, or by

powering off & on. Self-reset will occur if /Reset input is wired to ground. High quality components and conservative design insure long service life and high reliability in industrial installations.

Potentiometers may be replaced with fixed resistors for OEMs which require amplifiers that have no adjustments (contact factory).

DC brush motors also can be driven from the Model 513 by setting the DIP switch to 60°, leaving the Hall inputs open, and connecting the motor between the U and V outputs.

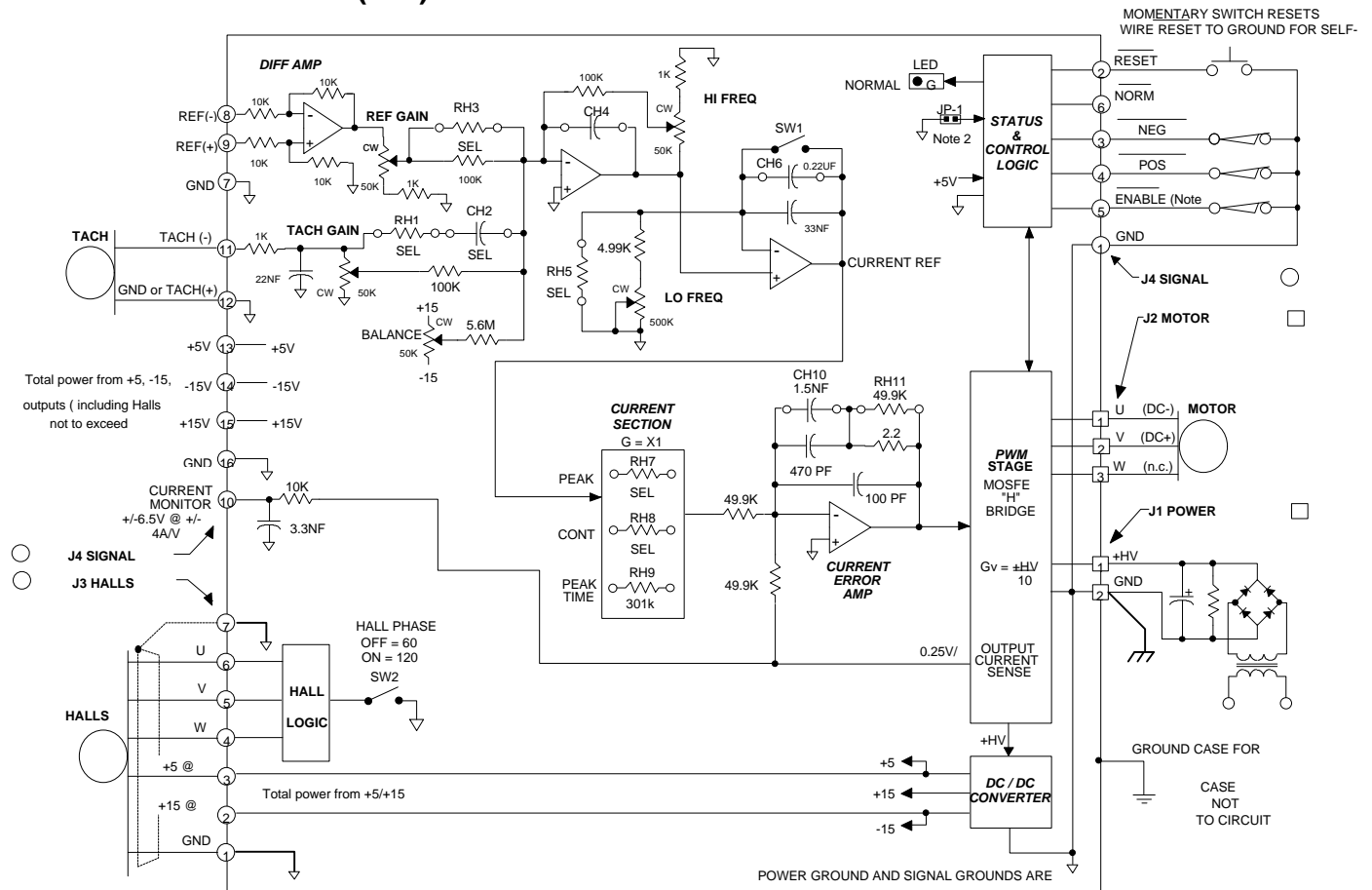
**Resolver Option (513R)**

Provides velocity-loop operation using resolver-derived analog tachometer signal. Encoder outputs give position feedback, emulate 1024 line quadrature encoder. Both permit use with programmable logic controls ( PLC's ) that require speed-loops for motion modules.

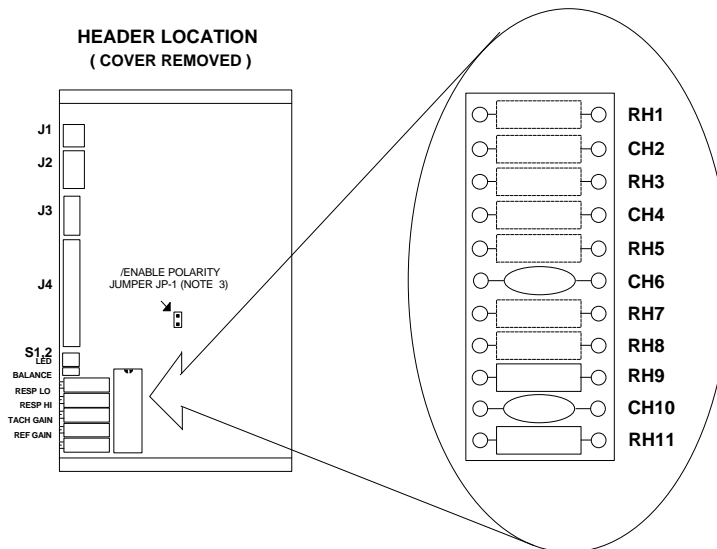
Option card installs inside drive case and interfaces with standard two-phase resolvers. A read-only memory chip converts resolver position data to Hall signals that control motor commutation for motors with 1-4 electrical cycles per revolution. Custom eproms available to interface with most motors ( contact factory ). Option eprom supports DC brush motors with resolvers.



FUNCTIONAL DIAGRAM (513)



CONNECTOR & INTERNAL LAYOUT



Notes:

- Components shown in dotted lines are not installed at factory.
- Jumper JP-1 is delivered in non-shorting position, making /Enable input ground-active ( +5V or open inhibits ). To invert logic of /Enable input install jumper between pins. Now, +5V or open enables, ground inhibits. Note: the /Pos and /Neg enable inputs are not affected by this jumper, and remain ground-enable, +5V or open inhibits.

## DC BRUSHLESS SERVO AMPLIFIER (513) WITH RESOLVER OPTION (513R)

## TECHNICAL SPECIFICATIONS

Typical at 25°C, +HV = +190VDC. Load = 200μH. in series with 1 ohms.

## OUTPUT POWER

Peak power	±180V @ 20A, 3600W
2 Sec	±179V @ 26A, 4650W
500 mSec	±182V @ 13A, 2360W
Continuous power	

## OUTPUT VOLTAGE

$$V_{out} = 0.97 * HV - (0.2)(I_{out})$$

## MAXIMUM CONTINUOUS OUTPUT CURRENT

At 25°C. ambient, 190VDC, perpendicular to thermally conductive mounting surface	
Convection cooled, no heatsink	±9A
Fan cooled, 400 ft/min, no heatsink	±13A
At 190VDC, ±13A, fan-cooled with heatsink	50°C max. ambient

## LOAD INDUCTANCE

Selectable with components on header socket	0.2mH to 40mH (Consult factory for higher inductances)
---	--

## BANDWIDTH

Small signal	-3dB @ 2.5kHz with 200μH load
--------------	-------------------------------

## PWM SWITCHING FREQUENCY

25kHz

## INPUT CHARACTERISTICS

Reference	Differential, 20KΩ between inputs
Tachometer	Single-ended, 33KΩ minimum with no header components installed
Maximum tachometer voltage	±100V

## GAINS

Input differential amplifier	x1 to x.02 (Potentiometer adjustable)
Servo preamplifier	x1 to x52 (Potentiometer adjustable, with RH3, RH4 not installed)
Integrator	x1 (at f >> integrator break frequency)
PWM transconductance stage	4A/V

## POTENTIOMETERS

Reference gain, Tachometer gain, Balance  
Preamp gain, Preamp integrator break frequency

## LOGIC INPUTS

/Enable, /Forward Enable, /Reverse Enable, /Reset (Ground = enabled, +5V or open inhibits)  
Internal jumper inverts logic of /Enable only, so that +5V enables & ground inhibits

## LOGIC OUTPUTS

/Normal ( +Fault )	LO (current sinking) when unit operating normally. 2mA maximum, +5V maximum ratings <b>Note: Do not connect output to devices that operate at voltages &gt;+5V.</b>
--------------------	--

## MONITOR OUTPUT

Current monitor	±6.5V @ ±26A (4A/volt)
-----------------	------------------------

## AUXILIARY POWER OUTPUTS

+5VDC	30mA (Includes power for Hall sensors)
+15VDC	10mA
-15VDC	-10mA

Note: Total DC power from all auxiliary outputs and Hall outputs not to exceed 200mW

## PROTECTIVE FEATURES

Output shorts: output to output, output to ground	Latches unit OFF (Reset input resets, ground input for self-reset)
Heatplate overtemperature	Shutdown at 70°C (Latches unit OFF)
Power supply voltage too low (Undervoltage)	Shutdown at +HV <22VDC (Operation resumes when >22V)
Power supply voltage too high (Overvoltage)	Shutdown at +HV >196VDC (Operation resumes when <196V)

## POWER REQUIREMENTS

Model 513: 24-190VDC @ 26A peak , Model 513R: 60-190VDC @ 26A peak	
Minimum power consumption	2W
Maximum power consumption	61W @ 12.5A continuous, 232W @ 26A peak

## THERMAL REQUIREMENTS

Storage temperature range	-30 to +85°C
Operating temperature range	0 to 70°C baseplate temperature

## MECHANICAL

Size	Amplifier: 4.4 x 7.32 x 1.29" (112 x 186 x 32.7mm), with heatsink: 4.4 x 7.32 x 2.6 (112 x 186 x 66mm)
Weight	1.32 lb (0.60 kg.) for 513, 1.48lb (0.67 kg.) for 513R, add 1.35 lb ( 0.61 kg ) for heatsink

## CONNECTORS

DC power (J1)	Phoenix: MSTB 2.5/3-ST-5.08;Curtis: PA256 10.16/2
Motor (J2)	Phoenix: MSTB 2.5/5-ST-5.08; Curtis: PA256 10.16/3
Halls (J3)	Housing: Molex 22-01-3077; Terminals (7): Molex 08-50-0114
Signal (J4)	Housing: Molex: 22-01-3167; Terminals (16) Molex 08-50-0114

Note: If using Phoenix, Weidmuller or equivalent connectors, some positions are no-connects. Observe J1 and J2 to see missing pins.  
Curtis connectors are delivered with unused contacts removed from connector housing.

## RESOLVER OPTION

*Note: when using this option the minimum supply voltage is +60VDC.*

### Installation

The resolver option card installs inside the case of the 513R. The cover has cutouts and silkscreens for the resolver card potentiometers, switches and connectors.

### Connections

Power for the option card is supplied by the DC/DC converter on the amplifier motherboard.

The Hall signals and tachometer emulator signals from the card connect to the amplifier via the card mounting connector. User-accessible connectors on the card connect to the resolver, and to the encoder inputs on an external controller.

Monitor signals are provided to measure the resolver Reference and Sine signals. A Sync function is provided which lets multiple amplifiers be jumpered together to synchronize the reference signals to eliminate interference between them.

### Resolver

Resolvers used must be of the type using two stators separated by 90° and a rotating winding that excites the stators. These typically have 2:1 ratios of primary ( Reference ) to secondary ( Sin & Cos ). The 1.8 to 4Vrms output range of the Reference output permits adjustment of the Sin/Cos signals to the 2.0Vrms requirement of the option card.

The 3-10kHz frequency range of the Reference signal drives a wide range of resolvers.

Phase adjust switches and a potentiometer provide adjustments to zero-out the phase difference between the reference and Sin signals.

A two section DIP switch sets the number of motor electrical cycles per resolver revolution from 1 to 4. (Consult factory for motors with other cycles/rev ratios).

### Reference Signal

This is the signal which excites the rotor of the resolver. It should be adjusted so that the Sin signal has an amplitude of 2.0Vrms (5.6V p-p) when the shaft is rotated to the point of maximum output. Typical resolvers have 2:1 ratios from Ref inputs to Sin or Cos outputs. Thus the reference signal from the option card will be in the 4Vrms range in most cases.

### Encoder Emulation

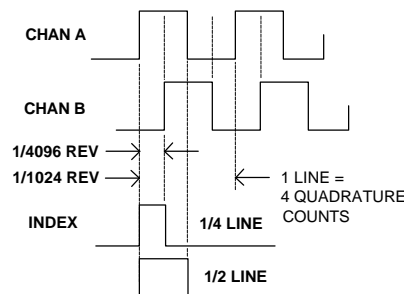
The position of the resolver is tracked by a position-feedback loop in the resolver integrated circuit. This position is then converted into a two-phase quadrature encoder signal which can be used by position controllers.

The electrical resolution of the position loop is 4096 parts per revolution. Each of these parts comprises a digital code, and four codes constitute an encoder 'line', giving the equivalent of a 1024 line quadrature encoder.

### Index Signal

A once-per-revolution index signal is part of the encoder emulation. The width of this signal may be set to 1/4 or 1/2 of an encoder cycle using the DIP switch S3.

#### ENCODER SIGNALS



### Commutation

An eeprom chip converts the binary output from the resolver converter into Hall signals for commutation. These connect to the amplifier Hall inputs internally to operate the motor in six-step ( trapezoidal ) mode.

The standard eeprom will drive motors having 1,2,3, or 4 Hall cycles per mechanical revolution of the motor

( 2, 4, 6, or 8 pole motors ) To accommodate other motors, contact factory for custom eeproms.

### Synchronization

When using multiple resolvers in a motion control system, coupling between cables can introduce noise due to the slightly differing frequencies between oscillators on different resolver cards. In such a case, the oscillators can be wired together via a Sync connector so that all will operate at the same frequency. Connecting these inputs via a 'daisy-chain' cable will cause all resolvers to oscillate at the same frequency.

### Tachometer Emulation

A tach signal provided by the resolver card makes it possible to configure the drive as a velocity-loop. This is particularly useful with PLC's with motion control modules which output position error signals. Velocity loop operation frequently improves the performance of microprocessor controls which derive velocity information from the encoder signal.

Scaling potentiometers on both the resolver card and amplifier permit the user to set the RPM/volt factor over a wide range.

### Cabling

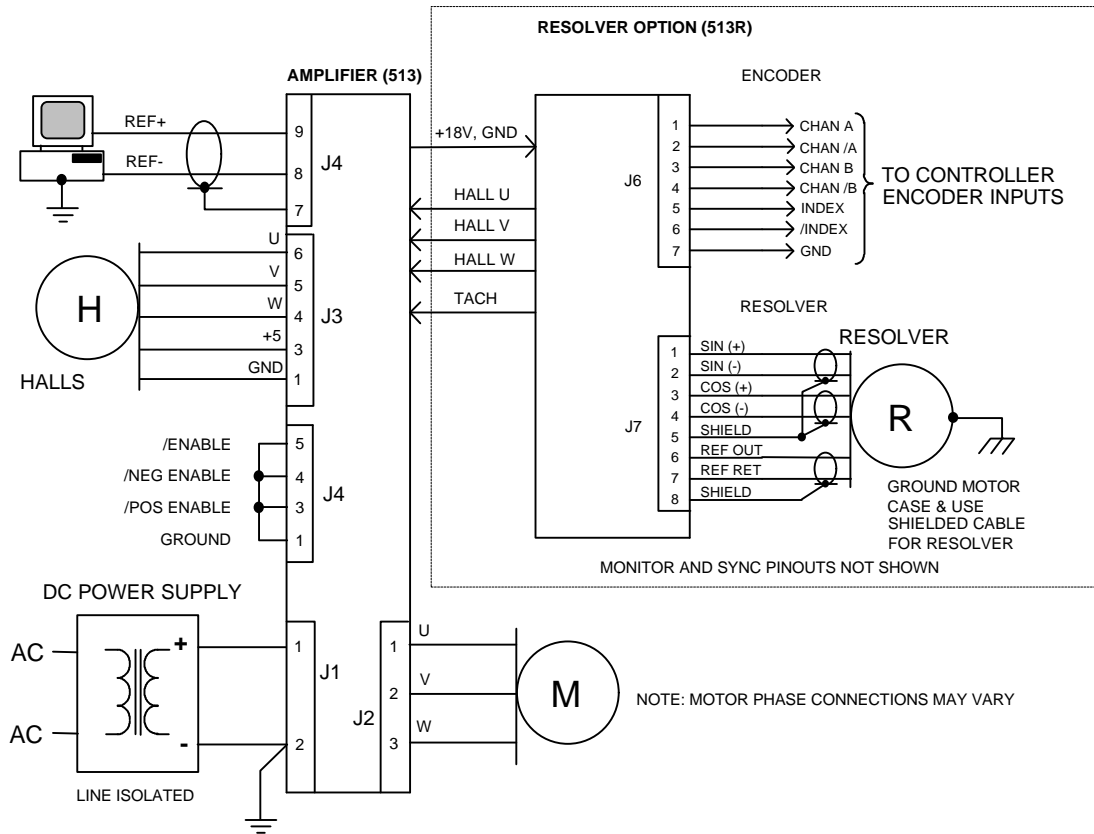
Shielded cable should be used for connection to the resolver, and grounded at the amplifier. The motor case should also be grounded. This will minimize coupling between the motor windings and the resolver.

DC BRUSHLESS SERVO AMPLIFIER (513) WITH RESOLVER OPTION (513R)

RESOLVER OPTION SPECIFICATIONS

REFERENCE OUTPUT	Frequency Amplitude	3 to 10kHz 1.8 to 4.0 VRMS, 50mA RMS max
ENCODER EMULATION	Outputs Accuracy Resolution Bandwidth Max. speed Index output	Ch. A,B, and Index, differential line driver (+5V CMOS, 24mA source/sink) ±10.6 arc mins. ±1 lsb (±1/2 encoder cycle ±1 lsb) 1024 lines/rev (4096 quadrature counts), non-adjustable 700 Hz. min. 375 resolver cycles/sec max (1.5M quadrature counts/sec) Index width settable to 1/4, or 1/2 encoder cycle (1/1024 rev)
TACHOMETER OUTPUT	Connects to amplifier tachometer input internally. Tach voltage can be monitored at amplifier J4-11. Output voltage range ±4V. Tach Gain pots on option card and amplifier interact. Adjust so that tach voltage does not exceed the ±4V range, or clipping may occur.	
POTENTIOMETERS	Reference frequency, reference amplitude, sin-ref phase adjust, tach gain	
DIP SWITCHES	Sin/reference phase adjust (2 switches), motor electrical cycles (2 switches), index width (1 switch)	
CONNECTORS	Sync (J5): Housing: Molex 22-01-2027, Terminals (2) Molex 08-50-0114 Encoder (J6): Housing: Molex 22-01-2077, Terminals (7): Molex 08-50-0114 Resolver (J7): Housing: Molex 22-01-2087; Terminals (8): Molex 08-50-0114 Monitor (J8): Housing Molex 22-01-2037, Terminals (3) Molex 08-50-0114	
HALL OUTPUTS	U,V,W commutation signals, 120° phasing, internally connected to amplifier	
MONITOR OUTPUTS	Ref & Sin signals. Used to measure amplitude, and to adjust phasing between Sin and Ref signals	
SYNCHRONIZATION	Jumper resolver cards together to synchronize excitation oscillators Oscillators will sync to lowest frequency when adjusted within ±1%.	
DIP SWITCHES	S1, S2 Sin/ref phase adjust. Range will vary with frequency. Adjust so that pot can set Sin/Ref phase difference to zero°. S3 Index pulse width; sets index pulse to 1/4096 or 1/2048 revolution (1/4 or 1/2 encoder line) S4, S5 Motor electrical cycles per revolution setting. Standard choices are 1, 2, 3, or 4 cycles per revolution. Other options possible, consult factory.	

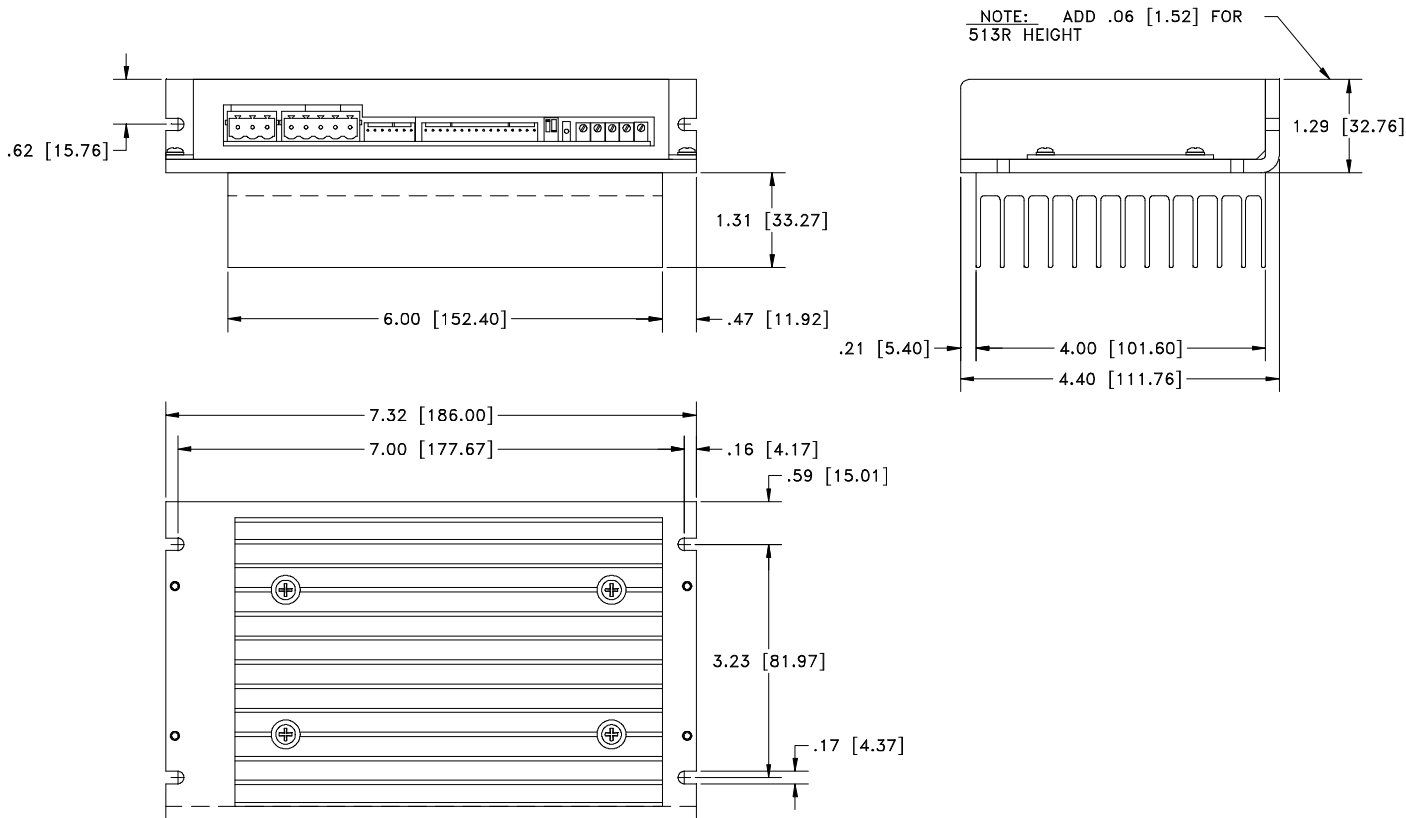
TYPICAL CONNECTIONS



**MODEL 513, 513R**  
**DC BRUSHLESS SERVO AMPLIFIER (513) WITH RESOLVER OPTION (513R)**

**OUTLINE DIMENSIONS**

Dimensions in inches (mm.)



**ORDERING GUIDE**

Model 513	13A Continuous, 26A Peak DC Brushless Servo Amplifier
Model 513R	Model 513 with Resolver option

Notes:

1. For custom configurations such as potentiometer replacement with fixed resistors, non-standard component header parts, etc. please consult factory.
2. For heatsink add "H" to part number.

**OTHER BRUSHLESS AMPLIFIERS**

- Model 503** Torque mode brushless amplifier. 5A continuous, 10A peak, 18-55VDC operation.
- Model 505** **NEW!** Same power output as 503. Adds Hall / Encoder tachometer for velocity loop operation.
- 5001 Series** **NEW!** Six models covering +24 to +225VDC operation, 5-15A continuous, 10-30A peak. With optional Hall / Encoder tachometer, and brushless tachometer features.



Corporate Office, USA  
 20 Dan Road  
 Canton, MA 02021  
 Tel: 781-828-8090  
 Fax: 781-828-6547  
 Visit us on the web @ [www.copleycontrols.com](http://www.copleycontrols.com)