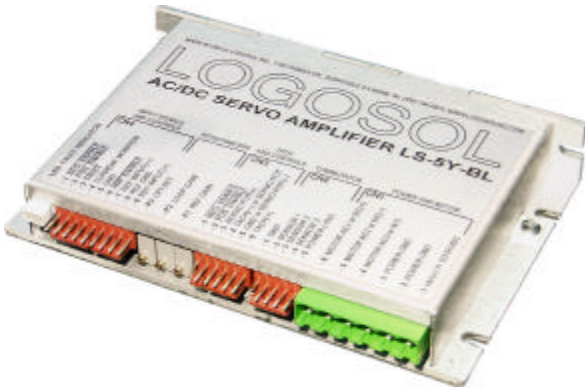
Logosol AC/DC Servo Amplifier LS-5Y-BL

Doc #713060001 / Rev. 1.5, 03/04/2002

Features

- **Motors supported:**
  - **Brushless 60°/120° commutated (AC)**
  - **Brush-commutated (DC)**
- **Motor type auto detection**
- **Single voltage supply 11÷91 VDC**
- **8A continuous, 12A peak output current**
- **Selectable modes of operation:**
  - **Current (Torque)**
  - **Velocity (Tach)**
  - **Analog position**
- **Individual continuous, peak and peak-time configurable current limits**
- **Comprehensive short-circuit protection:**
  - **Output to output**
  - **Output to ground**
  - **Output to power**
- **Over/under voltage shutdown**
- **Internal fast blowing fuse for maximum safety**
- **No integrator windup during power-up or amplifier disabled**
- **Four quadrant regenerative operation**
- **Small footprint, low cost, easy to use**
- **Conservative 100% through-hole design for high reliability**



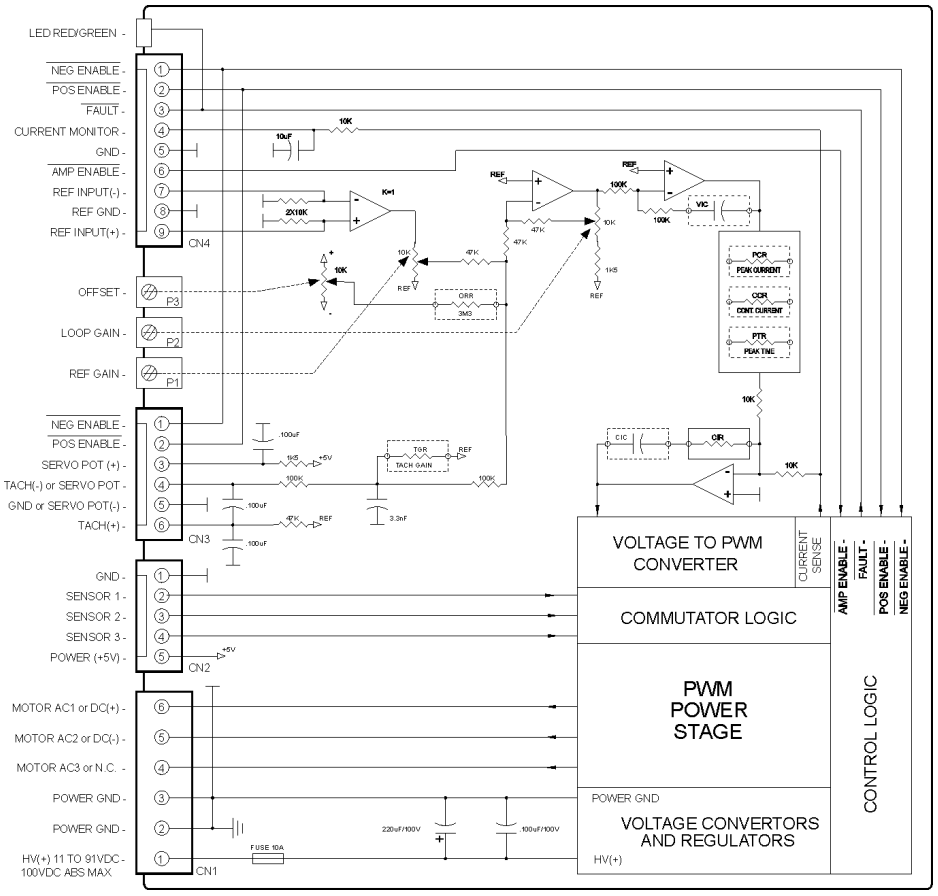
Description:

LS-5Y-BL servo amplifier is designed for applications using brushless or brush-commutated DC motors up to 3/4 HP. It provides a full set of features for motor control including remote inhibit/enable, directional enable inputs for connection to limit switches and all necessary protections for motor and amplifier. LS-5Y-BL can be used in conjunction with digital servo controllers or as a stand-alone drive.

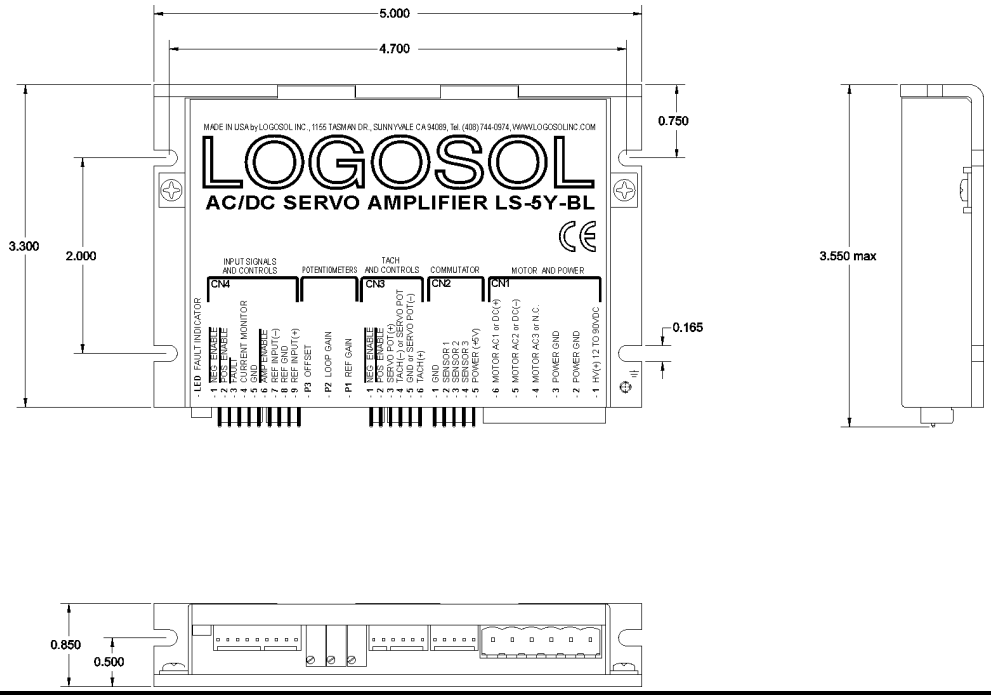
Loop gain, input gain and offset can be adjusted with multi-turn potentiometers. The offset potentiometer can also be used as on-board full range reference signal.

A configurable component carrier holding 6 resistors and 2 capacitors is used to select the operation mode and to customize the amplifier for specific motor parameters. Individual peak and continuous current limits allow high acceleration without sacrificing protection against continuous overloads. Peak current time can be adjusted from 3 to 0 sec.

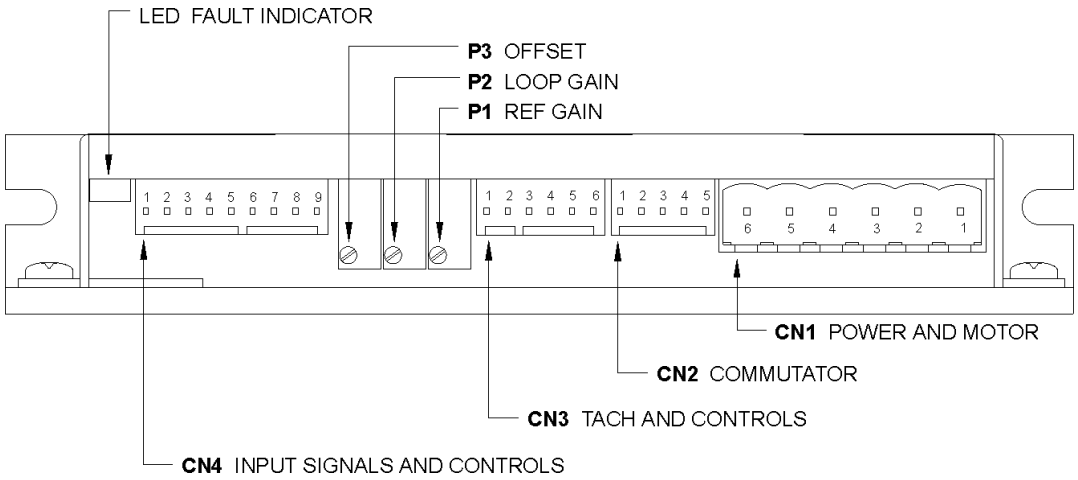
FUNCTIONAL DIAGRAM



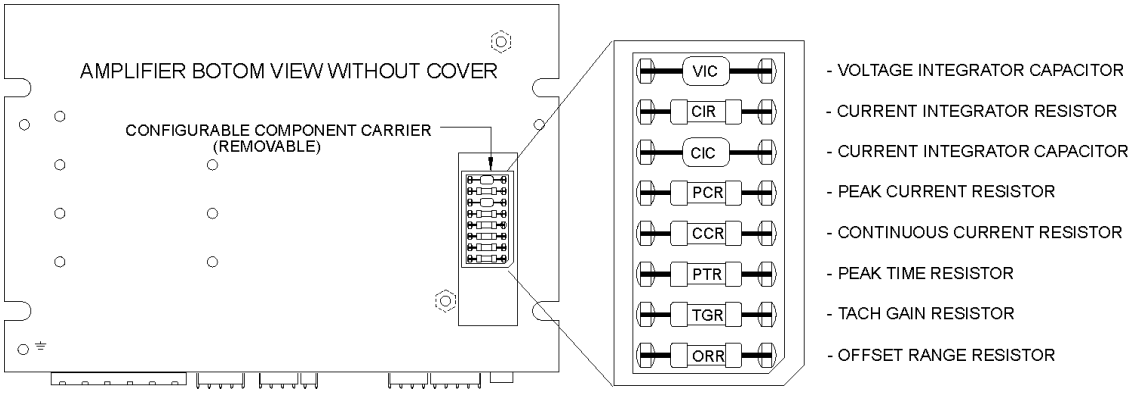
OUTLINE DIMENSIONS in inches



AMPLIFIER LAYOUT



CONFIGURABLE COMPONENT CARRIER



POTENTIOMETER FUNCTIONS

POT.	FUNCTION	DESCRIPTION
P1	REF GAIN	Adjusts the ratio between input signal and servo amplifier output
P2	LOOP GAIN	1. Adjusts voltage to current transfer ratio in current mode 2. Adjusts loop gain and bandwidth in velocity mode
P3	OFFSET	ORR = 3.0M – adjusts the imbalance in input signal or in servo amplifier (low range) ORR = 300K – works as an on board reference signal source driving servo amplifier output up to ±100% (max range)

CONNECTORS AND PINOUTS

CN1 – POWER AND MOTOR CONNECTOR

PIN	SIGNAL	DESCRIPTION
1	+HV	DC Power Supply Input 11 to 91VDC (100V Abs Max)
2 and 3	POW GND*	Power Supply Return and Amplifier GROUND
4	MOTOR AC3 or NC	1. Amplifier Output to Motor phase 3 for brushless motors 2. Not connected for brush motors
5	MOTOR AC2 or DC(-)	1. Amplifier Output to Motor phase 2 for brushless motors 2. Amplifier Output to Motor (-) terminal for brush motors
6	MOTOR AC1 or DC(+)	1. Amplifier Output to Motor phase 1 for brushless motors 2. Amplifier Output to Motor (+) terminal for brush motors

CN2 – COMMUTATOR CONNECTOR

PIN	SIGNAL	DESCRIPTION
1	GND	Signal and power GND for motor commutator
2	SENSOR 1	1. Amplifier input for brushless commutation SENSOR 1 2. NC for DC brush motors
3	SENSOR 2	1. Amplifier input for brushless commutation SENSOR 2 2. NC for DC brush motors
4	SENSOR 3	1. Amplifier input for brushless commutation SENSOR 3 2. NC for DC brush motors
5	POWER (+5V)	Power source output for motor commutator 5V/100mA

CN3 – TACH AND CONTROL CONNECTOR

PIN	SIGNAL	DESCRIPTION
1	$\overline{\text{NEG ENABLE}}$	Negative direction enable input LO (GND) if direction is enabled HI (OPEN) if direction is disabled Internally wired to CN4-PIN1
2	$\overline{\text{POS ENABLE}}$	Positive direction enable input LO (GND) if direction is enabled HI (OPEN) if direction is disabled Internally wired to CN4-PIN2
3	SERVO POT (+)	+5V REF voltage with 1K5 resistor in series. Used as potentiometer +REF in analog position mode
4	TACH (–) or SERVO POT	1. Tachometer input in velocity mode 2. Potentiometer feedback pin in analog position mode
5	GND* or SERVO POT (–)	1. Signal GROUND. Tachometer cable shield in velocity mode 2. Potentiometer (-REF) in analog position mode
6	TACH (+)	Tachometer positive input

CN4 – INPUT SIGNAL AND CONTROL CONNECTOR

PIN	SIGNAL	DESCRIPTION
1	$\overline{\text{NEG ENABLE}}$	This pin is wired to CN3-PIN1 and transfers $\overline{\text{NEG ENABLE}}$ to the control system LO (GND) if direction is enabled HI (OPEN) if direction is disabled
2	$\overline{\text{POS ENABLE}}$	This pin is wired to CN3-PIN2 and transfers $\overline{\text{POS ENABLE}}$ to the control system LO (GND) if direction is enabled HI (OPEN) if direction is disabled
3	$\overline{\text{FAULT}}$	TTL output LO if output is shorted, amplifier is disabled or power supply is out of voltage range
4	CURRENT MONITOR	Current monitor output ± 1V = ±5A
5	GND*	Signal GROUND
6	$\overline{\text{AMP ENABLE}}$	Amplifier enable input LO (GND) enables amplifier HI (OPEN) disables amplifier
7	REF INPUT (–)	Negative reference input. Connect to signal GROUND at reference voltage source
8	REF GND*	Reference cable shield
9	REF INPUT (+)	Reference input ±10V

* POW GND, GND and REF GND are electrically connected. Amplifier case is isolated from the amplifier circuitry and can be grounded externally.

PHASING A BRUSHLESS MOTOR

CN2 Signal	Motor manufacturer signal names			
SENSOR 1	R	U	A	S1
SENSOR 2	S	V	B	S2
SENSOR 3	T	W	C	S3

Phasing procedure:

- Replace configurable components **CIC** and **VIC** with wire jumpers (SHORT). Replace **ORR** with 1.0M resistor. Connect the motor commutation sensors to **CN2** using the table with the most popular manufacturers signal names. Connect the commutator power leads to **GND** and **+5V**.

Connect the three motor leads to **AC1**, **AC2**, and **AC3** to **CN1** using the same order as commutation sensor signals. Power and enable the amplifier. Rotate amplifier **OFFSET** potentiometer CW and CCW. If the motor is phased properly it will rotate smoothly in both directions. If motor runs slower in one direction needs help to start or vibrates the phasing is incorrect. There are five more ways to connect the three motor wires. The best way is to try all six combinations the right one should be quite obvious. If the motor is phased properly the rotation direction can be reversed interchanging **SENSOR 1**/**SENSOR 3** and **AC1**/**AC2**.

CONFIGURABLE COMPONENTS SETTING

CIC is the current integrator capacitor.
CIR is the current integrator resistor.

The values of these components are related to the amplifier bandwidth and have to be configured depending on the motor inductance and power supply voltage.

Optimization procedure:

Set the amplifier in current mode by putting jumper wire instead of **VIC**. Replace **CIC** with a wire jumper (SHORT). Set **P1** and **P2** fully CCW. Connect the motor and power supply to the amplifier. Apply a square wave signal ±1V/20 ÷ 50Hz to amplifier **REF INPUT**. Use an oscilloscope to measure the signal at current monitor (**CN4**-Pin4). Output signal is approximately 200mV/A. Enable the amplifier **AMP ENABLE**=LOW. Rotate **P1** CW to set ±100mV square wave signal at the oscilloscope screen. Select **CIR** for best transient response (lowest risetime with minimum overshoot). After **CIR** has been set choose the lowest value of **CIC** that does not result in additional overshoot or degradation of the pulse response.

The table below shows some approximate values of the current integrator resistor and capacitor depending of motor inductance.

	LOAD INDUCTANCE	CIC	CIR
	0.2 ÷ 0.6mH	4.7nF	100K
*	0.7 ÷ 1.9mH	10nF	100K
	2 ÷ 6mH	22nF	100K
	7 ÷ 20mH	47nF	100K

Note: ***** indicates factory standard setting. Values in table are for 24VDC power supply voltage. For higher voltages **CIR** should be decreased and **CIC** increased.

PCR is the adjusting resistor for peak current limit
CCR is the adjusting resistor for continues current limit.

The table below shows component values for the most used continuous and peak current combinations.

	I peak	I cont	PCR	CCR	I peak	I cont	PCR	CCR
*	12A	8A	SHORT	SHORT	6A	3A	22K	30K
	12A	6A	SHORT	10K	5A	2.5A	30K	39K
	10A	6A	4.7K	6.2K	4A	2A	43K	47K
	10A	5A	4.7K	13K	3A	1.5A	62K	68K
	8A	4	11K	22K	2A	1A	100K	120K
	7A	3.5A	16K	24K	1A	0.5A	220K	220K

Note: ***** indicates factory standard setting. Contact Logosol customer support for specific settings.

PTR is adjusting resistor for the **PEAK TIME**.

The table below shows some basic settings.

	PEAK TIME	PTR	PEAK TIME	PTR
*	3 sec	OPEN	0.5 sec	68K
	2 sec	510K	0.25 sec	33K
	1.5 sec	330K	0.1 sec	15K
	1 sec	150K	0.05 sec	SHORT

Note: ***** indicates factory standard setting. Contact Logosol customer support for specific settings.

VIC is the voltage integrator capacitor.

For current mode this capacitor is replaced by a wire jumper or 0 Ohm resistor. Change of the wire jumper with a capacitor sets the amplifier in velocity mode. This mode is applicable only for motors with brush tachometers.

Optimization procedure:

- Proceed with **CIR** and **CIC** optimization as described above. Set the amplifier in velocity mode putting **VIC** = 10nF. Set **P1** fully CCW. Connect motor and tachometer. Power and enable the amplifier. Rotate motors shaft slightly. If the tachometer, polarity is wrong motor will "Run away". If this happens, reverse tachometer wires **(+)** and **(-)**. With correct tachometer polarity motor will resist the manual rotation of its shaft. Apply square wave signal ± 1V/5 ÷ 20 Hz to amplifier **REF INPUT**. Move the oscilloscope probe to **TACH(-)** signal (**CN3** - Pin4). DC offset at this pin is approximately 2.15V. For easy measurement the oscilloscope can be used in AC Input Mode. Rotate **P1** CW to set ± 1V square wave signal at the oscilloscope screen. Find the best response (lowest rise time with minimum overshoots) by changing **VIC** and adjusting **P2 LOOP GAIN**

TGR is an adjustment resistor affecting amplifier in velocity (tachometer) and analog position modes.

For analog position mode the value of this resistor supposed to be 33K (as delivered). The value of this resistor changes amplifier tachometer input sensitivity between ZERO (**TGR=0**) and MAX (**TGR=**OPEN). Choose the value of **TGR** depending on your tachometer parameters and V_{tach}/V_{ref} ratio requirements.

ORR is the offset range resistor.

Its value changes the range of regulation with the **OFFSET** potentiometer. For 100% regulation set the **ORR** = 300K. To reduce the regulation range increase the resistor. Factory setting **ORR** = 3.0M gives enough range for input imbalance adjustment. All values between 300K and ∞ can be used.

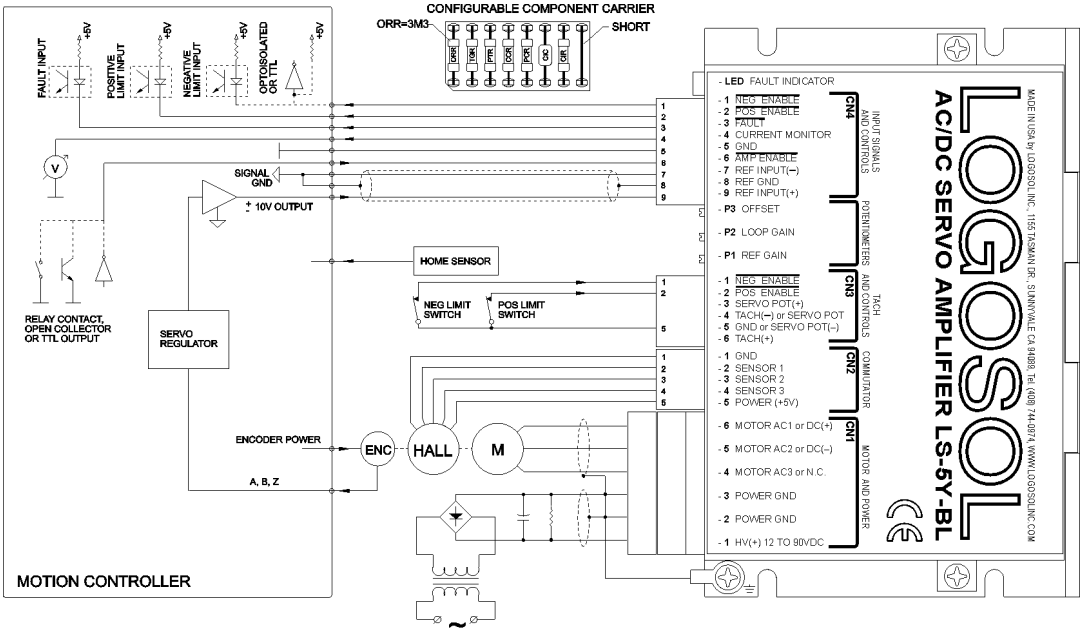
ORDERING GUIDE

PART NUMBER	MODEL	DESCRIPTION
923060001	LS-5Y-BL	AC/DC Servo Amplifier
230601001	LS-5Y-BL-CN	Mating Connector Kit

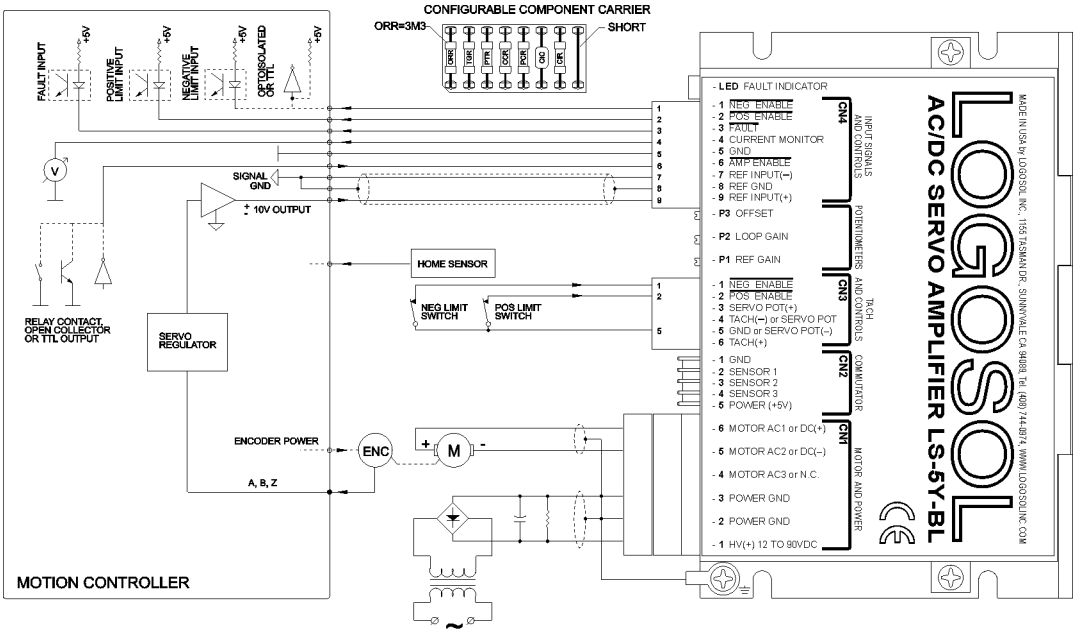
TECHNICAL SPECIFICATIONS rated at 25°C ambient, +HV=80VDC, Load=250µH motor

DC SUPPLY VOLTAGE	11 to 91VDC (100VDC Abs. Max)
OUTPUT POWER	
Peak power	±12A at 80V
Continuous power	±8A at 80V
OUTPUT CONTINUOUS CURRENT	
Convection cooled, no conductive cooling	±4A at 35°C max, ambient
With forced air cooling or heatsink maintaining 60°C max	±8A at 60°C max
OUTPUT VOLTAGE	V_{out}= 0.96(HV) – 0.21(I_{out})
MINIMUM LOAD INDUCTANCE	200µH
SMALL SIGNAL BANDWIDTH Note: actual bandwidth will depend on supply voltage, load inductance and configurable components	2.5Hz with 250µH load
PWM SWITCHING FREQUENCY	25KHz
ANALOG INPUT CHARACTERISTICS	Differential, ±10V (±20V max), 20K between inputs
GAINS - Current mode	1A/V as delivered. Adjustable 0 to 10A/V
POTENTIOMETERS	
REF GAIN	Attenuates REFINPUT from x 1 to Zero
LOOP GAIN	1. Increases A/V gain in current mode 2. Controls bandwidth in velocity mode
OFFSET	1. ORR = 3M – adjusts the imbalance in the input signal or in the servo amplifier 2. ORR = 300K – can be used as on board reference signal driving servo amplifier output up to ±100%
COMMUTATION	60/120 degree with automatic detection
COMMUTATOR INPUTS	HI: ≥ 2.6V, LO: ≤ 1.6V (–0.5VDC to + 5.5VDC Abs. Max) Histeresis TYP. = 1.0V, Pull up to +5V = 5.1K
TACHOMETER INPUT	±3V to ±50VDC (±60V Abs.Max)
LOGIC INPUTS	HI: ≥ 2.5V, LO: ≤ 1.0V (–0.5VDC to + 5.5VDC Abs. Max)
AMP ENABLE	LO enables amplifier
POS ENABLE	LO enables positive direction rotation, HI inhibits
NEG ENABLE	LO enables negative direction rotation, HI inhibits
POWER UP DELAY	100msec
FAULT OUTPUT	
TTL level HI = 3V min at 10mA, LO = 0.5V max at 10mA	HI when operating normally LO if output is shorted, amplifier is disabled or power supply (+HV) is out of tolerance
INDICATOR (LED)	GREEN when operating normally RED if output is shorted, amplifier is disabled or power supply (+HV) is out of tolerance
CURRENT MONITOR	
10K, 10nF RC filter	± 2.4V at ±12A (5A/V)
PROTECTION	
Output short (output to output, output to ground, output to +HV)	Shutdown when output is shorted with self resume
Power supply voltage too low (undervoltage)	Shutdown at +HV < 11VDC with self resume
Power supply voltage too high (overvoltage)	Shutdown at +HV > 91VDC with self resume
Overtemperature	Shutdown at 75°C internal temperature with self resume
FIRE SAFETY – internal fuse	10A Quick blow
POWER DESSIPATION	
Minimum power consumption at 0A output, 12V supply	1W
Power dissipation at 5A output, 80VDC supply	15W
Power dissipation at 10A output, 80VDC supply	31W
THERMAL REQUIREMENTS	
Storage temperature range	–30 to +85°C
Operating temperature range	0 to 75°C
MECHANICAL	
Size	5.00 x 3.30 x 0.85 in. (127 x 84 x 22 mm)
Weight	0.5 lb. (0.23 kg)
CONNECTORS	
Power & motor	Magnum EM2565-06-VL or Phoenix: MSTB 2.5/6-ST-5.08
Signal and control	Molex: 22-01-3097 housing with 08-50-0114 pins (9pcs)
Tach. and direction limits	Molex: 22-01-3067 housing with 08-50-0114 pins (6pcs)
Commutator	Molex: 22-01-3057 housing with 08-50-0114 pins (5pcs)

TYPICAL CURRENT (TORQUE) MODE APPLICATION FOR BRUSHLESS MOTOR

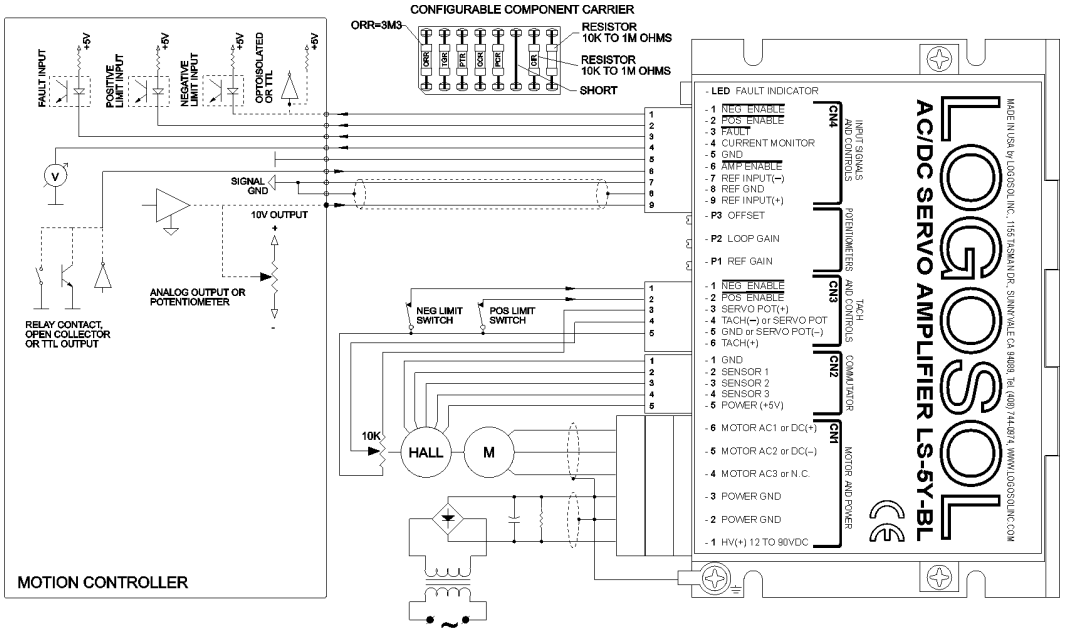


TYPICAL CURRENT (TORQUE) MODE APPLICATION FOR BRUSH MOTOR

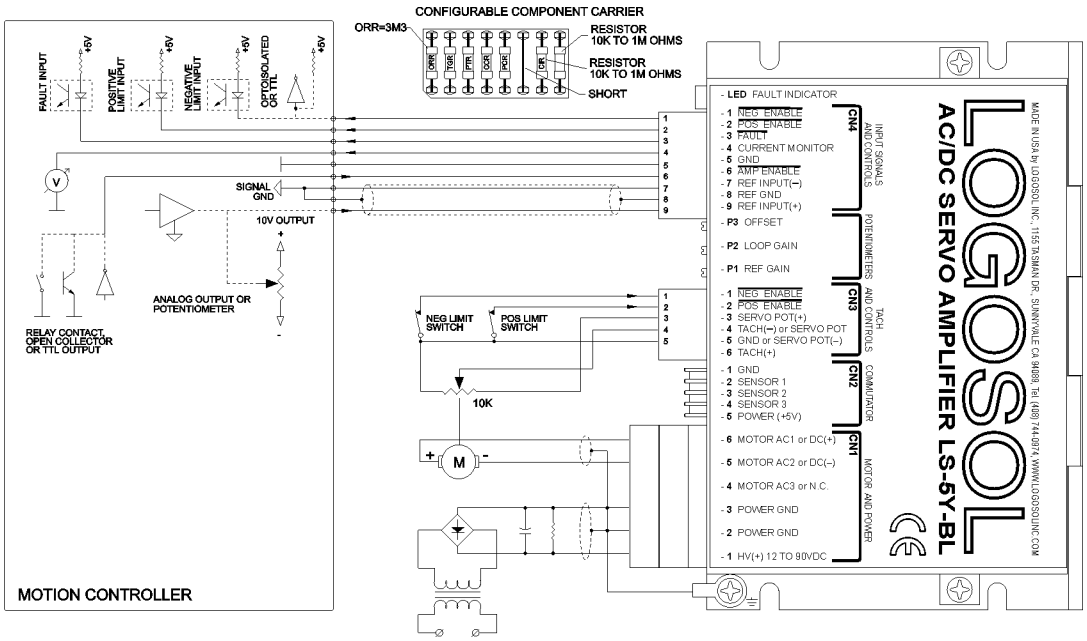


In current mode the amplifier produces motor current proportional to the voltage applied to the **REF INPUT**. DC motor shaft torque is proportional to the motor current. Current mode gives best results (motor stiffness) if the servo amplifier is used with a digital position controller. **P1** REF GAIN and **P2** LOOP GAIN adjust the ratio between the input signal and amplifier output current. Set **P1** REF GAIN fully CW and **P2** LOOP GAIN fully CCW. To increase the gain turn **P2** CW. To decrease it turn **P1** CCW. In this mode, only CIC and CIR must be optimized.
CAUTION! Without controller this mode can produce motor “RUN AWAY”.

TYPICAL ANALOG POSITION MODE APPLICATION FOR BRUSHLESS MOTOR

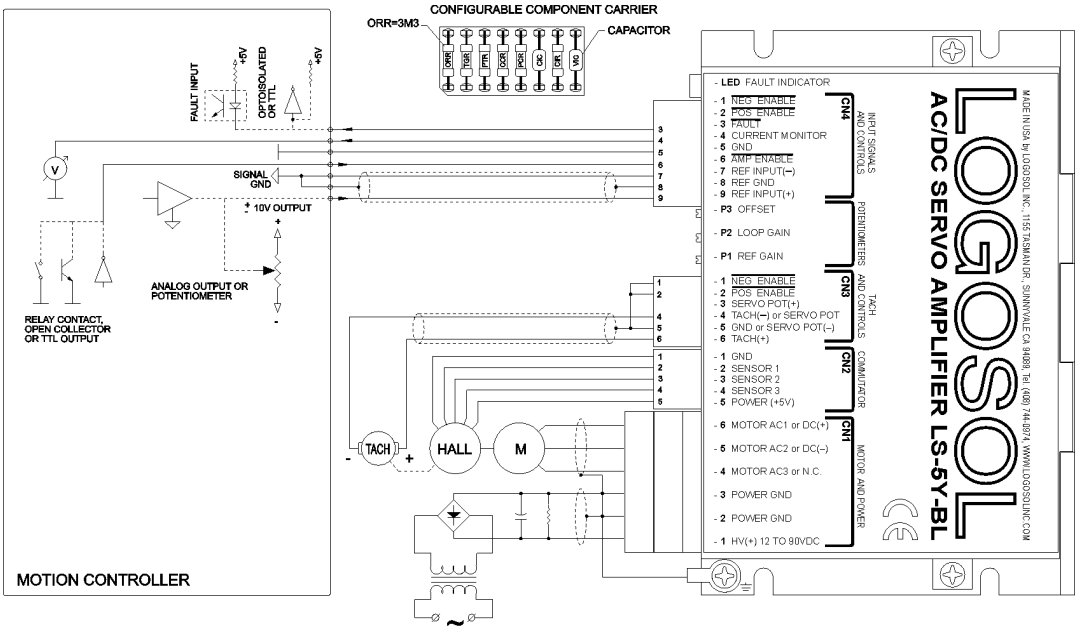


TYPICAL ANALOG POSITION MODE APPLICATION FOR BRUSH MOTOR

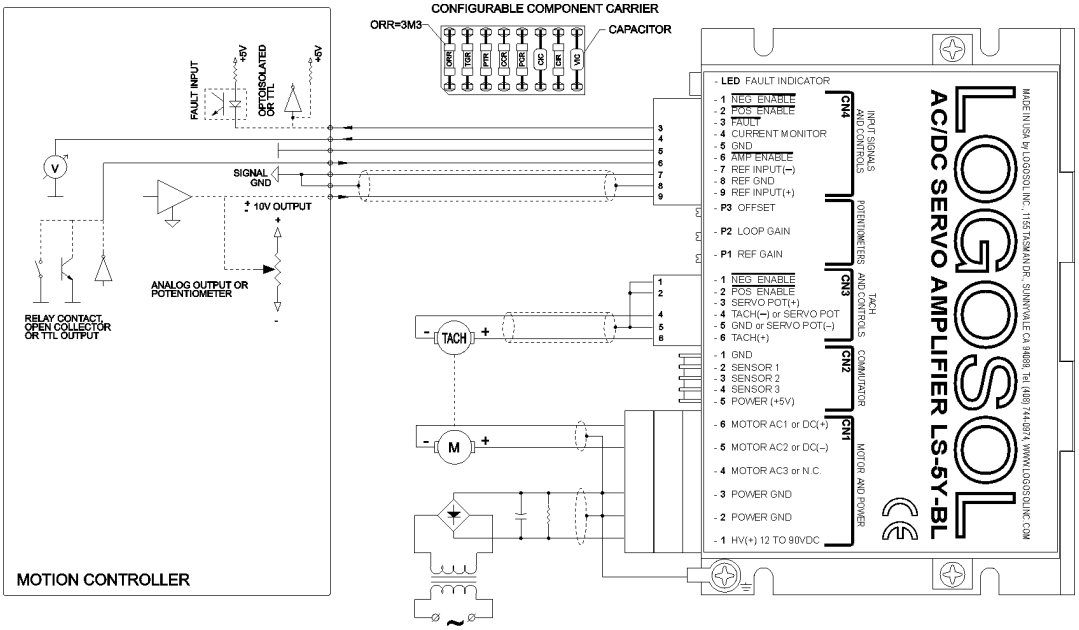


In analog position mode, an analog 10K potentiometer is mechanically coupled to the positioned object. The potentiometer supplies voltage proportional to its position. This voltage is used as a feedback signal, which drives the motor keeping the potentiometer position proportional to the reference input voltage.

TYPICAL VELOCITY (TACH) MODE APPLICATION FOR BRUSHLESS MOTOR

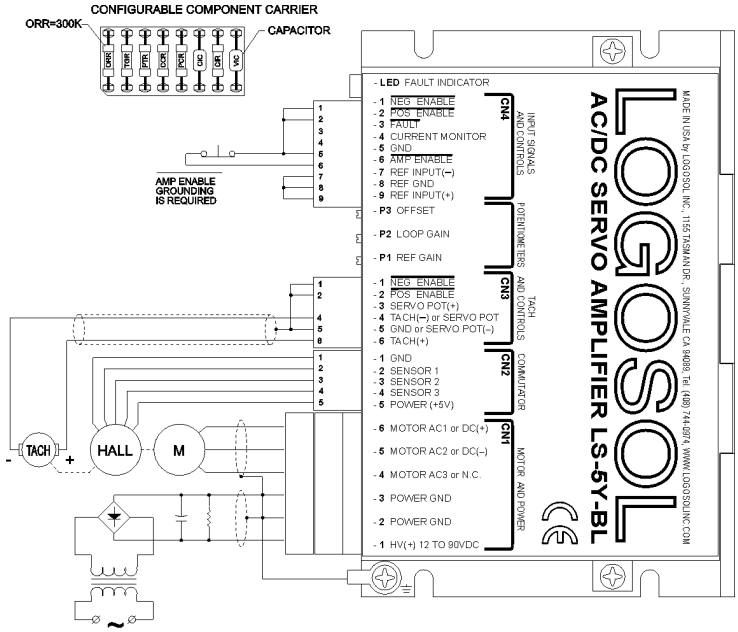


TYPICAL VELOCITY (TACH) MODE APPLICATION FOR BRUSH MOTOR

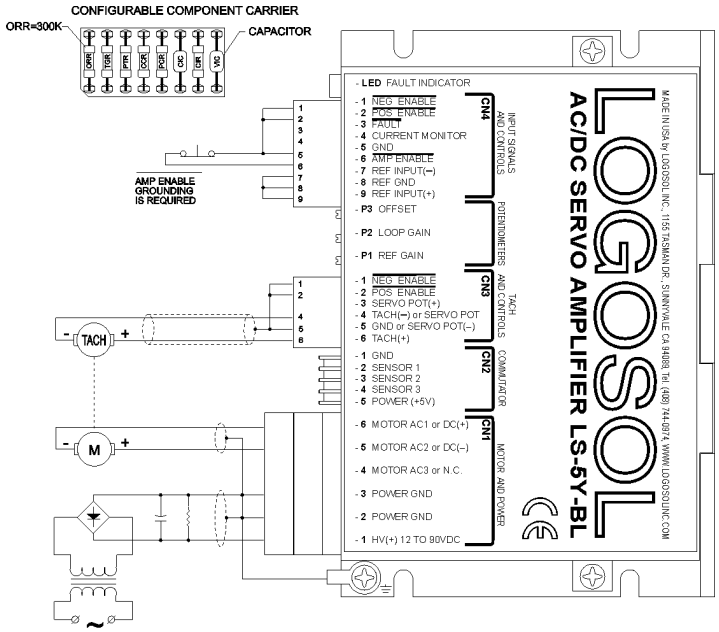


Velocity mode is only applicable for motors with tachometers. A tachometer produces a voltage proportional to the motor shaft speed. By using this voltage as a feedback, the amplifier keeps motor shaft speed proportional to the reference voltage applied to the **REF INPUT**. Set **P1** REF GAIN fully CCW and P2 LOOP GAIN fully CW. Power and enable the amplifier. Spin the motor shaft manually. If the motor “runs away” reverse tachometer or motor polarity. In this mode the configurable components **CIC**, **CIR**, **VIC** and **TGR** must be optimized. **P1** REF GAIN adjusts the ratio between **REF INPUT** voltage and motor rotation speed. P2 LOOP GAIN adjusts amplifier loop gain and bandwidth (system stability).

STAND ALONE VELOCITY (TACH) MODE APPLICATION FOR BRUSHLESS MOTOR



STAND ALONE VELOCITY (TACH) MODE APPLICATION FOR BRUSH MOTOR



In this configuration the amplifier drives a motor-tachometer pair keeping constant speed. Motor speed is adjustable with **P3** OFFSET. **P1** REF GAIN has no effect if **REF INPUT (+)** and **REF INPUT (-)** are grounded, otherwise set P1 REF GAIN fully CCW. All remaining settings are the same as described for typical velocity mode application.