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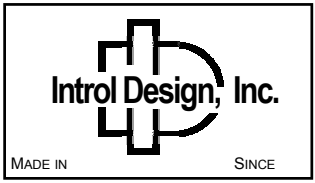
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SERVOLOC 3 SERIES
MODELS SL3-08-230, SL3-15-230, SL3-24-DC

DIGITAL BRUSHLESS SERVO CONTROLLER

OPERATION MANUAL



MAY 1999

INTROL DESIGN, INC.

48 NORTH STREET

LOCKPORT, NY 14094

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IMPORTANT

This control has been designed as a component intended to be implemented in a control system. Introl Design, Inc. has no control over the numerous control schemes, therefore it is the responsibility of the user to install this device in a system with the safeguards in place to prevent personal injury or equipment damage. The user should comply with the National Electrical Code as well as any local or other applicable codes. Although every effort has been made to assure the accuracy of the information contained in this manual, Introl Design, Inc. accepts no liability whatsoever with respect to the information provided herein. There are no implied warranties of merchantability or fitness for a particular purpose that apply to the control described in this manual.

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REVISIONS LOG

Revision Number	Date	Description
01	10-00	Added Connection Diagrams, pages 9-11.
02	11-00	Correction of Connection Diagram on page 11.
03	12-00	Correction of Connection Diag. on page 9 (sin/cos).
04	10-06	Added options and included DC Servo Motor drawings.
05	5-08	Added Connection Diagram, page 16.

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ServoLoc 3

Digital Brushless Servo Controller

The Introl ServoLoc 3 is a digital controller designed to control the speed and torque of a motor in a fast responsive servo loop. The ServoLoc 3 is capable of controlling DC/AC brushless servo motors, as well as DC brush motors with DC tach or encoder or resolver feedback. This drive accepts DC or AC power input.

The ServoLoc series of controls offer a variety of selectable/ programmable options through the furnished PC software. Even though the drive is designed for servo control type applications, it also offers a unique acceleration/deceleration with coast or ramp to stop option which could be used for spindle drive applications. All drive parameters can be changed while in operation (on the fly) through the RS485 serial communication port, which lends itself to a multi-axis control environment.

The drive can be configured for velocity or torque mode operation with a programmable current limit in the velocity mode, or programmable current output at full input analog command input.

Please take a few minutes to read through this manual and familiarize yourself with the drive. Also, please copy the drive model number and serial number below. You will need these numbers any time you call for questions or service.

Drive Serial Number _____

Drive Model Number _____

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SPECIFICATIONS

Power Input Requirements	**SL3-08-230, SL3-15-230** - 85 VAC to 240 VAC rms line to line. Three phase/ single phase at 15 Amps. - Single phase power can be used for motor rms currents under 7 Amps. - DC power source can also be used, 100 to 350 VDC at 20 Amp max. **SL3-24-DC** - 20 to 40 VDC at 20 Amp max.
Output Power	- For brushless servo motors, 3 phase sinusoidal current, 0 to input line voltage rms, up to 15 Amps continuous and 30 Amps peak for one second. - For DC brush motors, 0 to 1.4 times the input line voltage rms, up to 15 Amps continuous and 30 Amps peak for one second.
Discrete Inputs	- Three optically isolated inputs, 5 to 24 VDC at 5 to 25 mA. Drive Enable Not Used Motor Thermal Switch
Discrete Outputs	1 – Fault relay contact output, normally open held closed, rated at 24 VDC at 0.5 Amp. 2 – Open collector transistor output, capable of sinking to drive common 50 mA at 24 VDC, to indicate current limit (overload) condition. 3 – Three open collector transistor output, to simulate encoder channels A, B, and reference in quadrature format when resolver is used as the drive feedback, optional line driver output.
Feedback Devices	- Two pole (single speed) resolver feedback - Single ended (optional differential) dual channel encoder of selectable resolutions. Encoder input is used as feedback or master input. - Analog DC Tach feedback for brush type DC Servo mode with 3 to 50 VDC/1000 RPM. The tach voltage not to exceed 150 volt at drive terminals.

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SPECIFICATIONS (cont.)

Analog Inputs	- One 0 to +/-10VDC input as velocity command. - One 0 to 10 VDC input as selectable external current limit/torque limit. - One differential DC Tach feedback in DC brush type Servo mode.
Analog Outputs	- One 0 to 20ma output proportional to current command/output current. - Optional - One 0 to +/- 10VDC output proportional to velocity (with resolver feedback only) - Optional - One 0 to 10VDC output proportional to current.
Drive Faults	- Based on the following conditions, the drive will automatically shut OFF the output power to the motor, the Fault LED on the face of the drive will illuminate, and the fault relay contact output will close. 1 – Motor/motor wiring/output power transistor short, or overcurrent condition. 2 – Low DC bus voltage. 3 – High DC bus voltage. 4 – AC power interrupt. 5 – Motor over temperature.
Environment	- The drive is designed to operate safely in a non-corrosive atmosphere of 0 to 60°C ambient temperature, with the heatsink temperature not to exceed 85°C.
Serial Comm.	- RS485/RS232 with PC software for set-up provided. Up to 32 drives can be linked, each with a unique programmed address.
Physical Dimensions	- Footprint 10.2" H x 3.4" W - Size 10.2" H x 3.4" W x 6.0" Deep, including mating connector.

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INSTALLATION AND SET-UP

The installation of this equipment should be performed by qualified electrical personnel and should conform to all applicable local and national electric codes.

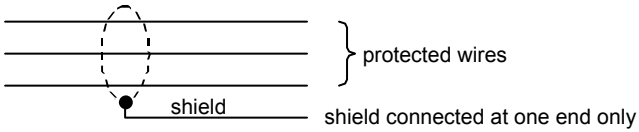
Warning: Use extreme caution during installation and start-up. Hazardous potentials exist on some drive terminals. Familiarize yourself with the drive terminals before installation. STOP and read the manual fully and study the appropriate connection diagram. Have all your questions answered before installation. After unpacking, check for any type of physical damage. DO NOT install a damaged drive; return for repair or replacement.

Disconnect power and safety lock-out at the power source before installation, and any time service is needed.

1 – Select an appropriate location. A good location is a dust-free, non-corrosive atmosphere with an ambient temperature within 0 to 60° C, non-condensing (no moisture). Use the dimensions provided at the end of this manual to locate holes for installation.

2 – Select a large enough enclosure to allow for cooling.
- For totally enclosed enclosures, use approximately 2 cubic feet of space per horsepower.
- For ventilated enclosures with a circulation blower, the volume can be reduced to about one cubic foot per horsepower.

3 – Select a connection diagram that applies to your application and connect accordingly.
- Be careful with shielded cables. More than likely, the feedback shielded cables have been furnished as a part of the package. The shielded cable is a set of wires surrounded by a layer of braided wire or a foil wrapping which shields the signal wires within from electrical noise pick-up or prevents radiation of electrical noise energy.



Please note the shield connection. In some cases the shield only connects at one end, and the other end must be isolated from contact to any other wiring or the body of the conduit or junction box. There are other cases when the shield needs to be connected at both ends.

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INSTALLATION AND SET-UP (cont.)

4 – Motor and power wires should be selected based on the motor nameplate rating, or the expected current draw and wiring length. It is not recommended to use wires smaller than 18 AWG.

Current Rating	Wire Size
up to 5 Amp	18 AWG
5 to 10 Amp	16 AWG
10 to 15 Amp	14 AWG

These wiring sizes are suitable for up to 50 feet. For wire lengths of 50 feet to 200 feet, increase the wire size to avoid wire heating and degraded performance.

Warning: Check the supply voltage and make sure that it is within the drive's acceptable input power range.

5 – Initially make sure that the drive will not be enabled at power up until all drive settings have been verified. Also at this point, you should connect your PC with the furnished software installed, to establish a communication link for set-up parameter verification.

6 – While observing the indicator lights on the drive, turn the power **ON**. The Current Limit light should illuminate for a short period of time and then should shut OFF, and the Power indicator light should stay **ON**. The Fault indicator light may turn **ON** momentarily.

7 – Through the PC, running the furnished software, select "Read" and then accept the default ID# at the prompt.

8 – If the wires connecting the PC to the ServoLoc 3 are correct, all the factory setting parameters will be transferred to the screen of your PC. Otherwise, an error message will be displayed.

9 – Everything on the PC screen is self-explanatory, and we will discuss here the effect of each setting on the performance. **All of the factory settings will provide good performance with the PID (Proportional, Integral, Derivative) settings.**

10 – Since the drive is already set up, you may choose to skip the tuning procedure and continue by enabling the drive and applying the reference to initiate motion.

11 – Based on the nature of the application, you can select the torque or velocity control mode.

- Velocity Control Mode: In this mode the drive will compare the actual velocity of the motor to the commanded velocity reference input and then it will increase/decrease current in to the motor to maintain a zero velocity error.

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INSTALLATION AND SET-UP (cont.)

- Torque (Current) Mode: In this mode the drive will use the velocity/torque command reference input and scale it based on the current limit setting to provide the programmed current at the full command input.

TUNING

1 – From your PC, reset the following parameters to start-up settings.

Proportional Gain	2
Integral Gain	0
Derivative Gain	0
Accel Time	0
Decel Time	0
Dead Band	0
Current Limit	to match motor, each 10% = 1.5 Amp

Now select "Send" on the PC screen to send information to the drive.

2 – With zero velocity reference applied to the drive, enable the drive. The green Run indicator light should illuminate. The motor now should be without any motion.

3 – Increase velocity reference to force motor rotation. Continue increasing the velocity reference to its maximum.

4 – Disconnect the reference and reconnect (step function) and observe the response to the instantaneous velocity changes. Increase the proportional gain and repeat this procedure until erratic performance is attained. Erratic performance would be: overshooting, harsh metallic noise from the motor, excessive chatter and vibration in motion (not very smooth motor rotation). Once the erratic behavior is encountered, reduce the proportional gain until smooth operation is established.

5 – With the drive enabled and velocity reference at zero or disconnected, increase the integral gain from zero. As soon as the integral gain is applied, the motor will develop full torque at zero speed. Reconnect and disconnect the velocity reference input to the drive and observe the response. Increase the proportional gain to a point that when the velocity reference is disconnected, the motor overshoots, then backs up. This overshoot and back up should be very small and very quick. After the overshoot is observed, reduce the integral gain until the overshoot is eliminated.

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TUNING (cont.)

Please remember, after each change of gain you must send the parameters to the drive.

Proportional gain refers to: the velocity reference input is subtracted from the actual velocity to develop a velocity error. This error is then scaled and multiplied by the proportional gain setting, and then summed with the integral and derivative terms, and then used as a direct current command to power the motor.

As is obvious, the higher the difference between the command and the feedback, the larger the current command. Also, the lower the difference, the lower the current. Therefore, with a zero velocity command and a slow motor movement by the load, there will be no torque produced. In order to correct this problem the integral term is introduced.

Integral gain refers to: the velocity reference input is subtracted from the actual velocity to develop a velocity error. This error is then accumulated each sample time and then scaled and multiplied by the integral gain setting to reduce the error to zero. In other words, the quickness at which the velocity error is reduced to zero is controlled by the integral term. The integral term is then summed with the proportional and derivative term, and then used as the current command to the motor.

Derivative gain only is needed if a sluggish response cannot be compensated for by the proportional and the integral terms.

Derivative gain refers to: the velocity reference input is subtracted from the actual velocity to develop a velocity error. This error is then subtracted from the previously sampled error to develop a rate of change of error. The calculated error is then scaled, and then multiplied by the derivative gain. The derivative term is summed with the proportional and integral terms, and this is used as the current command to the motor.

Note: The derivative term is usually not needed unless a high dynamic response is desired. Too large of a derivative gain will cause overshoot, excessive motor current, motor heating, and metallic noises from the motor.

Offset – This is to adjust for zero speed with zero command applied.

Current Limit – This setting should be adjusted to match the motor rated rms current. 0% to 99% equals 0 to Drive Rated Output Current. It should be noted that the drive will produce up to 200 % of the current setting for one second as needed. If the drive operates in excess of the set current, it will fold back to 100 %.

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TUNING (cont.)

Acceleration – This is the time that it will take the drive to accelerate to motor from zero speed to 2000 rpm.

Deceleration – This is the time that it will take the drive to bring the motor from 2000 rpm to zero speed.

Max. Speed – The input range of +/- 10VDC velocity command can be scaled using the max. speed setting. It should be noted that, this setting has no effect if the drive is set up for Torque / Current Mode of operation.

Dead Band – For applications using an external motion controller, set this parameter to zero. This parameter finds its use in applications where the torque/velocity command input is within a certain range (+/- 0.01 to +/- 0.50 VDC). The drive will assume an absolute zero torque/velocity command to prevent a servo drift.

DROP DOWN MENU BARS

Options:

1 – **Standard / Ratio Control** - Standard Mode to select for Velocity / Torque Control , or to configure drive for Electronic Gearing Mode. In this mode, the ratio field on the main page will be activated to allow the operator to set a ratio between two rotating axis (1st rotating axis, considered the master, generating two channel encoder signal in quadrature format, and the 2nd axis, or slave, being controlled with the drive.

2 - **Control Mode** – The Drive can be set up to operate in Closed Loop Velocity Mode, or Torque / Current Mode of operation.

3 – **Stop Mode** – Based on the nature of the application, it may be desirable to initiate a STOP (to disable the drive), while the motor is running at some speed.
Two Options are available:

A) Coast to Stop. When the drive is disabled, the drive will disable its output transistors and allow the motor to coast to a stop.

B) Ramp to Stop. When the drive is disabled, the drive will decelerate the motor to zero speed and then it will disable its power transistors.

Note: Applications requiring Decel to Stop and Hold Position, disconnect Reference rather than disabling.

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DROP DOWN MENU BARS (cont.)

4 – **Motor / Feedback Set up** – Clicking on this option, will open a page to select motor type and feedback type used, Resolver, Hall Encoder, Hall Feedback only or DC Tach, as well as, selecting the number of poles for Brushless motor option motor. If the Hall Encoder feedback is used, the encoder PPR must also be set for proper operation.

5 – **Restore Default** – This is to reset all settings on the PC Screen to factor default settings.
Note: Please remember that the setting on the PC must be downloaded to the drive before they take effect.

ELECTRONIC GEARING

Through the furnished PC Software, the electronic gearing (Ratio) mode can be selected. In this mode, the drive will control a brushless DC Servo Motor with Resolver Feedback and will use the encoder feedback inputs as the master reference pulses. The controller in this mode will follow the two channel quadrature encoder input at the programmed ratio from 0.01:1 to 9.99:1. When 1.00 ratio is programmed, for each 1 master reference pulse, it would rotate the motor 0.001 revolution. The use of the derivative gain becomes very important in this mode and the use of a very low integral gain is advised.

INDICATORS

Following are the descriptions of the drive indicator lights (LED's).

C.L. CURRENT LIMIT
- RED This LED will illuminate when the drive is operating at or above the programmed current limit.

FAULT
- RED This LED will illuminate for all drive fault conditions.
  1 - AC power loss
  2 - Under voltage
  3 - Over voltage
  4 - Over current
  5 - Motor short
  6 - Motor over temperature

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INDICATORS (cont.)

POWER
YELLOW This LED will illuminate when power is applied to the drive and the internal power supply is OK.

RUN
GREEN This LED will illuminate when the drive is enabled (started).

TROUBLESHOOTING

1) The Yellow LED (Power) is not ON.
- 1 - Check incoming power to the drive.
- 2 - Make sure the terminals are plugged in snug.
- 3 - Blown line fuses inside the drive.
- 4 - Precharge circuitry fuse is blown inside the drive.

2) LED's on drive blinking when power is applied.
- 1 - Possible short on any of the power supply outputs, +5 vdc, +10 vdc, -10 vdc
- 2 - Short on encoder or Hall wiring.
- 3 - Line voltage too low.
  - *Disconnect TB1 and TB2 and if the line voltage is above 70 vac and the problem still exists, the problem is internal to the drive.
- 4 - Shorted power section; not allowing the DC Buss to charge

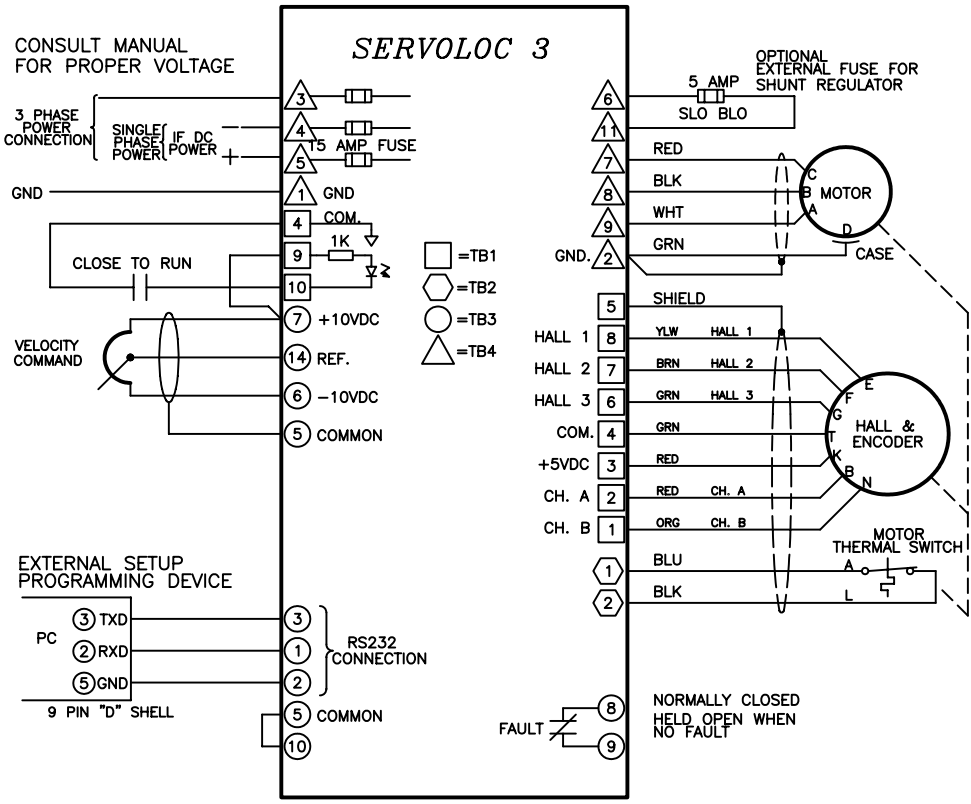
3) The Fault LED stays ON after power up (with drive **Disabled**)
- 1 - Low AC line voltage.
- 2 -AC line voltage too high.

4) The Fault LED stays ON after power up (with drive **Enabled**)
- 1 - Low AC line voltage.
- 2 - AC line voltage too high.
- 3 - Shorted power block.
- 4 - Motor or motor wiring shorted.
- 5 - If the motor is starting with a heavy load, the AC power Wiring may not be of sufficient size.

5) The Fault LED turns ON when drive is enabled (started).
- -same as condition

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CONNECTION DIAGRAM

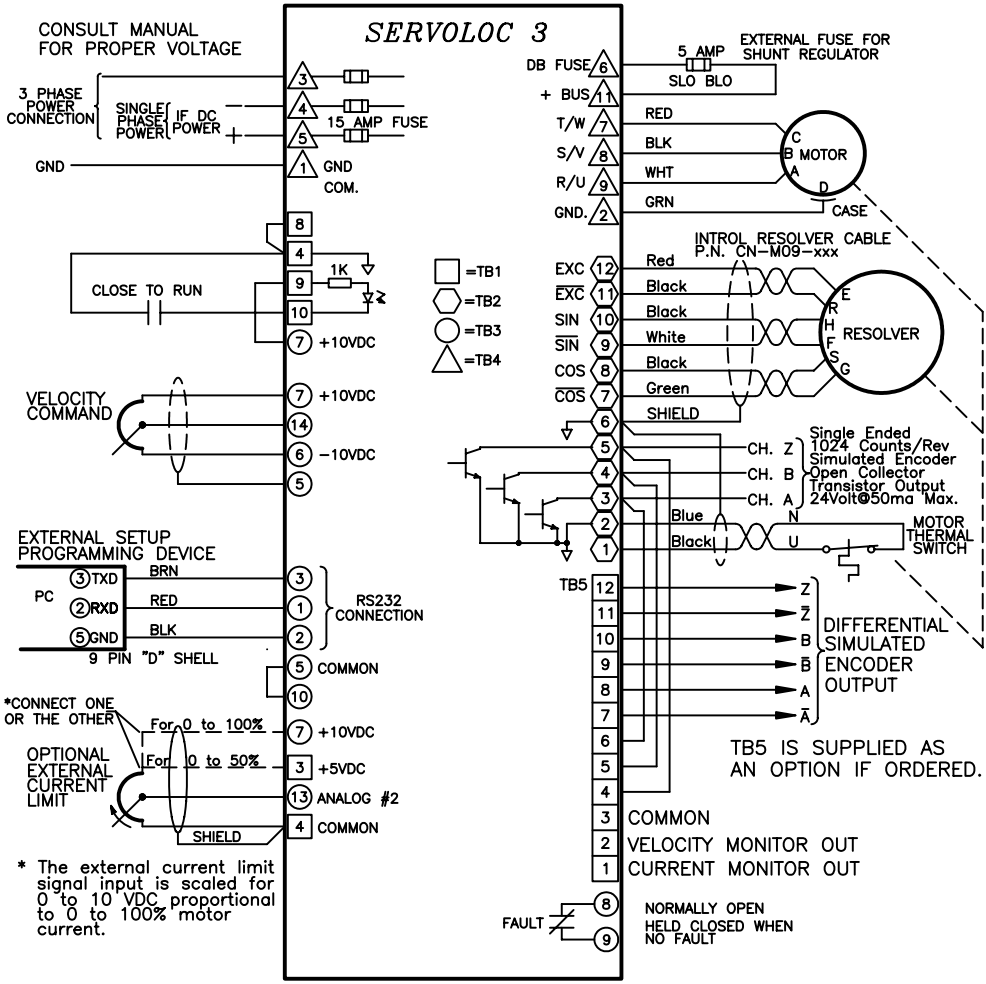


TO REVERSE DIRECTION OF MOTOR ROTATION:
REVERSE WIRING AT △8 & △9, 6 & 7, 1 & 2

Introl Design, Inc. LOCKPORT, NY.						
NO. 700 CC85 TITLE CONNECTION TO INTROL/ CSM/MTS/PARKER/CONTROL TECHNIQUES MOTOR WITH ENCODER FEEDBACK						
	DESCRIPTION	DATE	APPVD.	ERS	10-16-06	Ali	Ali
	REVISIONS			DRAWN	DATE	CHKD.	APPVD.

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CONNECTION DIAGRAM

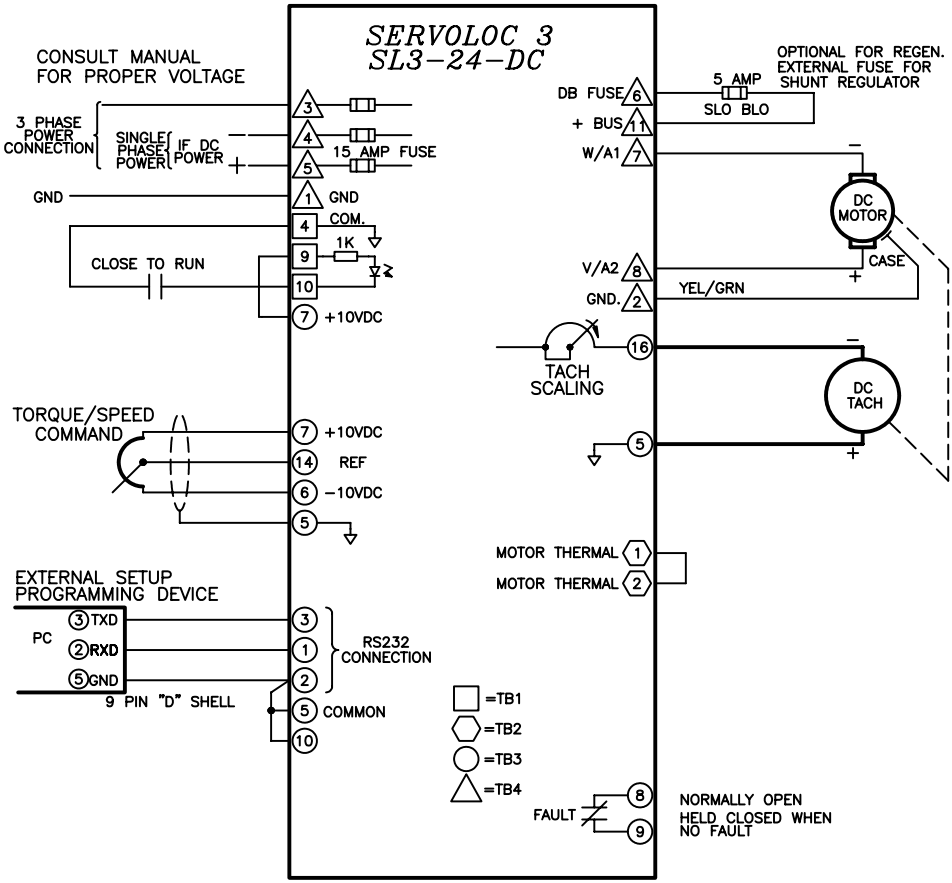


TO REVERSE DIRECTION OF MOTOR ROTATION FOR A GIVEN REFERENCE POLARITY:
REVERSE WIRING AT (7) & (9) AND (7) & (8)

Introl Design, Inc.	LOCKPORT, NY.				
NO. 700 CC86 TITLE CONNECTION TO INTROL/ CSM/MTS/PARKER MOTOR WITH RESOLVER FEEDBACK					
REVISIONS	DESCRIPTION	DATE	APPVD.	ERS DRAWN	10-16-06 DATE	Ali CHKD.	Ali APPVD.

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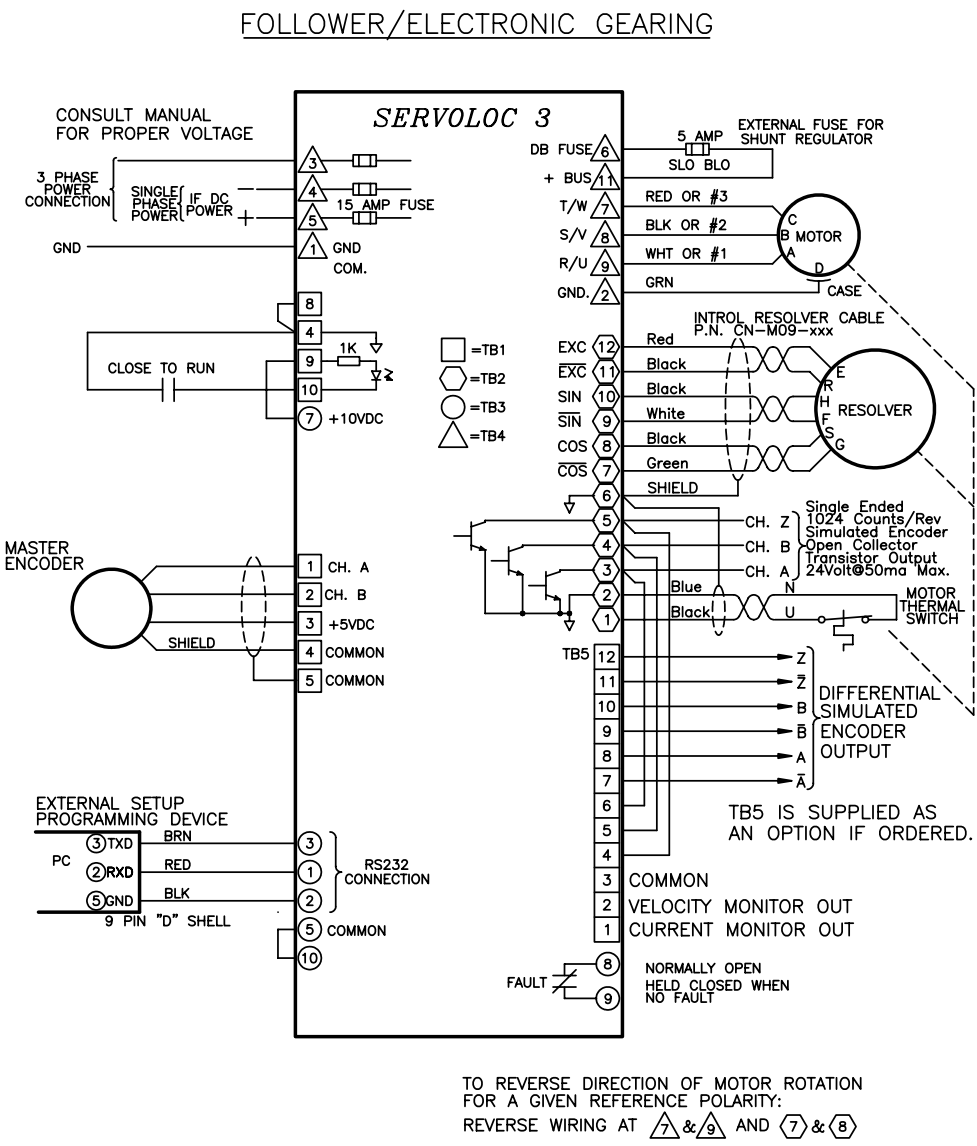
CONNECTION DIAGRAM



Introl Design, Inc.	LOCKPORT, NY.	
NO. 700 CC87 TITLE Recommended Connection Diagram for a DC Brush Motor w/ DC Tach Feedback		
DESCRIPTION / REVISIONS	DATE / APPVD.	
ERS DRAWN	10-16-06 DATE	Ali CHKD. / Ali APPVD.

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CONNECTION DIAGRAM



TO REVERSE DIRECTION OF MOTOR ROTATION FOR A GIVEN REFERENCE POLARITY:
REVERSE WIRING AT 7 & 9 AND 7 & 8

Introl Design, Inc. LOCKPORT, NY.

NO. 700 CC88
TITLE CONNECTION TO INTROL/ CSM/MTS/PARKER MOTOR WITH RESOLVER FEEDBACK

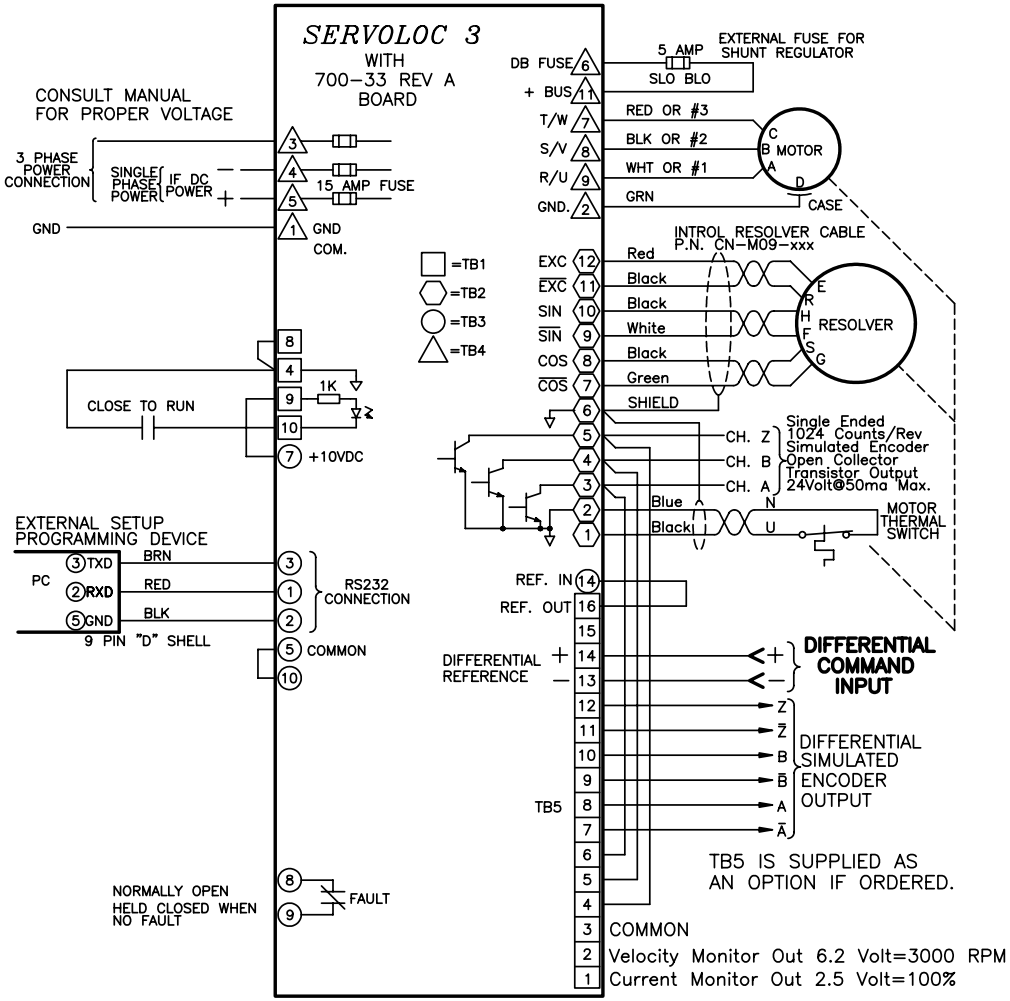
	DESCRIPTION	DATE	APPVD.
A	Added pin no's to motor wires.	6-27-07	*Ali*

REVISIONS

ERS	10-16-06	*Ali*	*Ali*
DRAWN	DATE	CHKD.	APPVD.

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CONNECTION DIAGRAM



TO REVERSE DIRECTION OF MOTOR ROTATION
FOR A GIVEN REFERENCE POLARITY:
REVERSE WIRING AT (7) & (9) AND (7) & (8)

A	Removed pot. connections and added notes for clarification.	5-20-08	*Ali*

DESCRIPTION	DATE	APPVD.
REVISIONS		

Introl Design, Inc. LOCKPORT, NY.

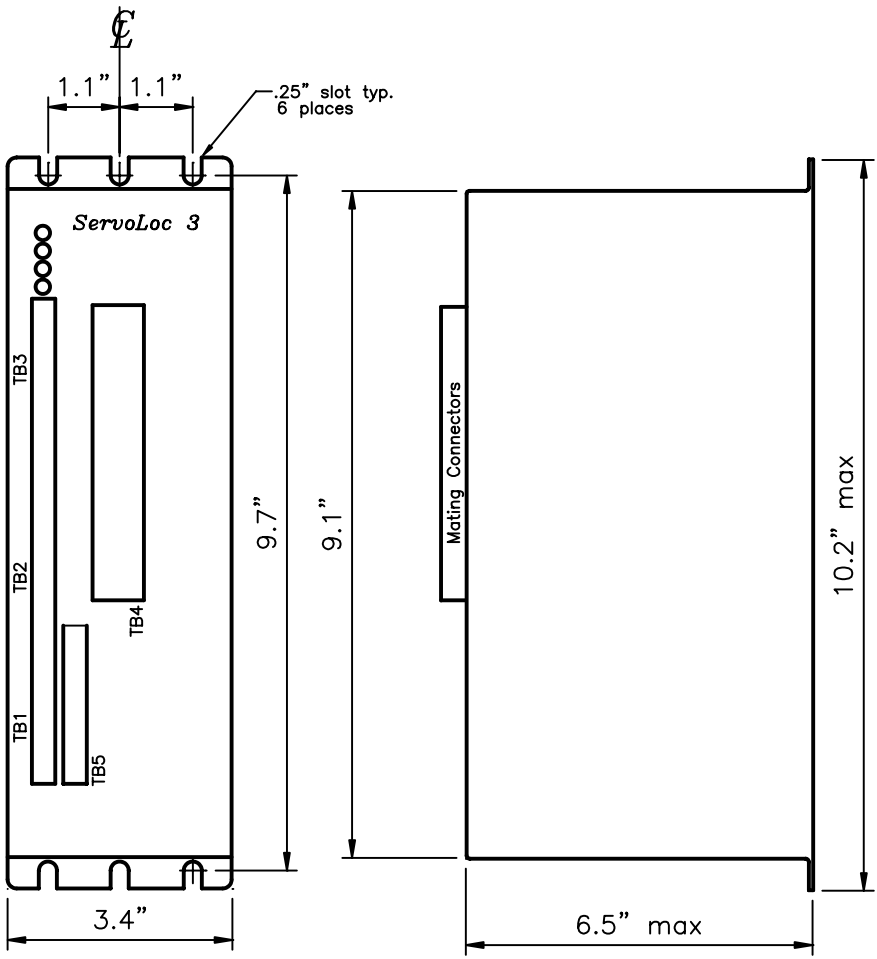
NO. 700 CC98

TITLE CONNECTION TO INTROL/ CSM/MTS/PARKER MOTOR WITH RESOLVER FEEDBACK

ERS	2-19-08	*Ali*	*Ali*
DRAWN	DATE	CHKD.	APPVD.

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MOUNTING DIMENSIONS



Introl Design, Inc. LOCKPORT, NY.						
NO. SL3 DD TITLE CONNECTION TO INTROL/ DRAWING						
	DESCRIPTION	DATE	APPVD.	ERS DRAWN	10-16-06 DATE	Ali CHKD.	Ali APPVD.
	REVISIONS						

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