Brushless Servo Amplifiers

MPA-460

MPA-05-460
MPA-09-460
MPA-15-460
MPA-25-460
MPA-35-460
MPA-50-460
MPA-75-460
MPA-100-460

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Automation Division

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0101

575-00025E

MPA-460 BRUSHLESS SERVO AMPLIFIER

Application

This manual is designed to help you install the MaxPlus™ MPA-460 amplifier.

Unpacking and Inspection

Carefully unpack the amplifier and inspect it for visible damage. Check items against the packing list. Report any missing or damaged items to your supplier.

Warranty and Service

The amplifier is warranted to be free from defects in workmanship and materials for a period of two years from the original shipment by MTS Automation.

During the warranty period, a defective amplifier unit will be repaired or replaced as outlined below.

Before requesting return authorization, please try to verify that the problem is within the amplifier, and not with external devices.

To arrange for repair or replacement, please contact:

MTS Automation Customer Service
(507) 354-1616
(800) 967-1785
Monday–Friday, 8:00–4:30 Central Time

- You must provide the model and serial number from the labels on the amplifier.
- You must provide an explanation as to why the unit is being returned.
- You will be issued a return authorization number which must be marked on the return shipment and on all correspondence.

Continued on next page

Warranty and Service (continued)

Service Under Warranty

- Return your defective unit, freight prepaid, and it will be repaired and returned within two weeks of receipt via regular UPS, freight prepaid.

- Upon request, a factory-repaired replacement unit will be sent via regular prepaid UPS, within 4 working days. Next day shipment for overnight delivery, freight collect, is available at an expediting charge of $100. The defective unit is to be returned via regular UPS, freight prepaid, upon your receipt of the replacement.

Non-Warranty Service

- Return your defective unit, freight prepaid, and it will be repaired on a time and material basis and returned within three weeks of receipt.

- OR contact your local distributor or MTS Automation Customer Service for a factory-repaired exchange unit, which is available at a flat rate price, assuming the defective unit is in repairable condition and is returned freight prepaid. Next day shipment for overnight delivery, freight collect, is available at an expediting charge of $100.

General Provisions

Except as specifically modified by this warranty statement, all MTS Automation Conditions of Sale and Warranty shall apply.

Introduction

MPA Amplifiers represent a series of amplifiers that are high performance, reliable, and efficient. The amplifiers are designed to be used with high performance brushless servo motors. Extreme care has been taken to assure robust operation. Design consideration for electrical transients have been implemented on the ac inputs and all I/O lines. MPA amplifiers operate over ac voltage ranges of 200 to 520 Vac from 45 to 65 Hz. The motor feedback device is a resolver to assure normal operation at elevated motor temperatures of 115° C for the case, and 155° C for the motor windings. The resolver allows for both position and velocity feedback. The motor is further protected by a thermal shutdown thermostat in the motor windings. The amplifier high power switching devices are state of the art IGBT modules. The logic supplies are switch mode designs reducing undesired heat. LED indicators for diagnostics are provided. Encoder simulated TTL compatible differential quadrature outputs plus an index output are provided for external pulse or position control. The amplifiers have inrush current protection to allow for normal turn on. This is especially worthwhile for multiple-axis applications. Consideration for dissipation of regenerative energy is included with internal shunt regulators.

Sizes

Model	Continuous Amps	Peak Amps
MPA-05-460	5	10
MPA-09-460	9	18
MPA-15-460	15	30
MPA-25-460	25	50
MPA-35-460	35	70
MPA-50-460	50	100
MPA-75-460	75	120
MPA-100-460	100	165

Features

- Efficient power conversion
- High frequency switching
- Resolver feedback
- Simulated encoder signals
- ± 10 volts for maximum velocity or torque
- 24 volt I/O for ±LIMIT, RESET, VEL/TORQUE mode
- 2 differential analog channels (command and auxiliary)
- LED diagnostic indicators
- Motor and amplifier thermal protection
- AC, I/O and bridge transient suppression
- Totally self contained space efficient design
- Simple screw terminal interface
- AC inrush protection
- Single or three-phase operation
- Simple one-turn visual adjustments

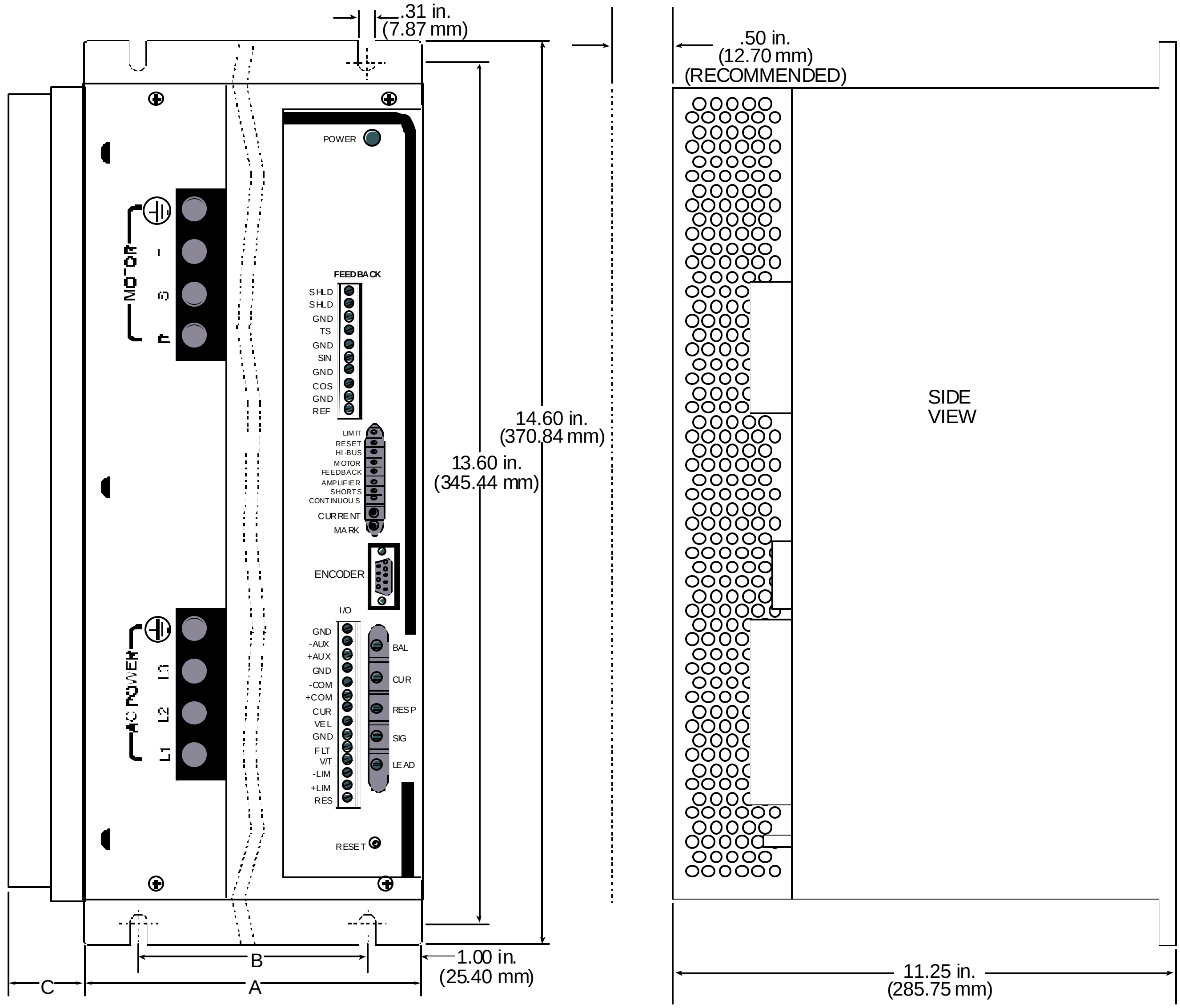
Specifications

Parameter	Specification
Operating Environment: Temperature Humidity	 0 to 45°C (32 to 113°F) Maximum, Ambient 0 to 95% noncondensing
Input/Output Interface: Analog Signals Velocity Command Input Auxiliary Input Velocity Output Current Output	 Differential input 0 to ±10 Vdc(15 Vdc Max) Differential input 0 to ±10 Vdc(15 Vdc Max) 2.7 volts per 1000 rpm 2.1 volts per 1000 rpm TAC gradient ("-14" option 14 bit mode) ±10 volts = ± Peak Current
24 Volt Logic:	Reset +Limit -Limit Velocity/Torque Select Fault Output (Open Collector)
Fault Protection:	Continuous Current Shorts (Stator) Amplifier Temperature Feedback Resolver Wiring Motor Thermal HI-BUS
Encoder Simulation:	TTL Differential Output Plus Index Phase Quadrature Line Count (select with jumper); Standard - 1024, 512, 256, and 128 Lines Available "-14" Option - 4096 Lines Available
Electrical Characteristics: Input Voltage	 200 to 520 Vac 45 to 65 Hz Single or Three Phase No Isolation Transformer Required
All Models:	Quasi Trapezoid with Torque Linearization Torque Ripple 5% Maximum
MPA-05-460: Output: Input:	 5 amps continuous; 10 amps peak; peak ≤ 1 second PWM frequency 15 kHz Single phase; 8 amps continuous max Three phase; 4 amps continuous max DC Bus is AC line dependent
MPA-09-460: Output: Input:	 9 amps continuous; 18 amps peak; peak ≤ 1 second PWM frequency 15 kHz Single phase, 11 amps continuous max Three phase; 9 amps continuous max DC Bus is AC line dependent

Parameter	Specification
MPA-15-460: Output: Input:	 15 amps continuous; 30 amps peak; peak ≤ 1 second PWM frequency 15 kHz Single phase; 18 amps continuous max Three phase; 11 amps continuous max DC Bus is AC line dependent
MPA-25-460: Output: Input	 25 amps continuous; 50 amps peak; peak ≤ 1 second PWM frequency 12 kHz Single phase; 30 amps continuous max Three phase; 18 amps continuous max DC Bus is AC line dependent
MPA-35-460: Output: Input:	 35 amps continuous; 70 amps peak; peak ≤ 1 second PWM frequency 12 kHz Single phase; 42 amps continuous max Three phase; 25 amps continuous max DC Bus is AC line dependent
MPA-50-460: Output: Input:	 50 amps continuous; 100 amps peak; peak ≤ 1 second PWM frequency 12 kHz Single phase; 60 amps continuous max Three phase; 35 amps continuous max DC Bus is AC line dependent
MPA-75-460: Output: Input:	 75 amps continuous; 120 amps peak; peak ≤ 1 second PWM frequency 10 kHz Three phase; 55 amps continuous max DC Bus is AC line dependent
MPA-100-460 Output: Input:	 100 amps continuous; 165 amps peak; peak ≤ 1 second PWM frequency 10 kHz Three phase; 70 amps continuous max DC Bus is AC line dependent
Motor/Amplifier Speed and Load Relationship:	The motors maximum speed is dependent on the bus voltage and motor KE by the following relationships. (AC Input)/(Motor KE vrms) = Max no load speed. Max no load speed * .75 = Maximum speed at continuous full load.
Adjustments:	0 - Peak Current Limit(CL) Response(RESP) Auxiliary(AUX) Signal(SIG) Balance(BAL)
Speed/Torque Regulation:	±5% Max Speed 200 rps (12 bit) or 60 rps (14 bit)

Parameter	Specification
Encoder Signals:	
Resolution	Standard (12 bit) 2-channel + mark Optional (14 bit) 2-channel + mark
Accuracy:	
Resolver Cable Length:	Max. Error:
15 foot	±20 minutes
25 foot	±20 minutes
50 foot	±30 minutes
100 foot	±40 minutes
Weight:	
MPA-05/09-460	12 lbs. max
MPA-15-460	14 lbs. max
MPA-25/35/50-460	20 lbs. max
MPA-75/100-460	45 lbs. max
Motor Inductors:	The MPA-05/09/15 models all have 2mH drum core inductors installed under the top cover. These versions do not need external inductors to protect the motor. For the MPA-25/35/50/75/100 models, the inductance line-to-line must be no less than 4mH. IND-100-.5mH IND-25-460-2mH One inductor in each line is typical. The turn ON times of the power switches can cause catastrophic destruction of motors. Inductors in RST of the motor leads limit the rise time and preserve the motor. All 460 volt motors should have inductors.

Mechanical Footprint



Summary of Amplifier Dimensions

Model	A in. (mm)	B in. (mm)	C in. (mm)
MPA-05/09/15-460	6.50 (165.10)	4.50 (114.30)	.53 (13.46)
MPA-25/35-460	8.50 (215.90)	6.50 (165.10)	.53 (13.46)
MPA-50-460	8.50 (215.90)	6.50 (165.10)	2.30 (58.42)

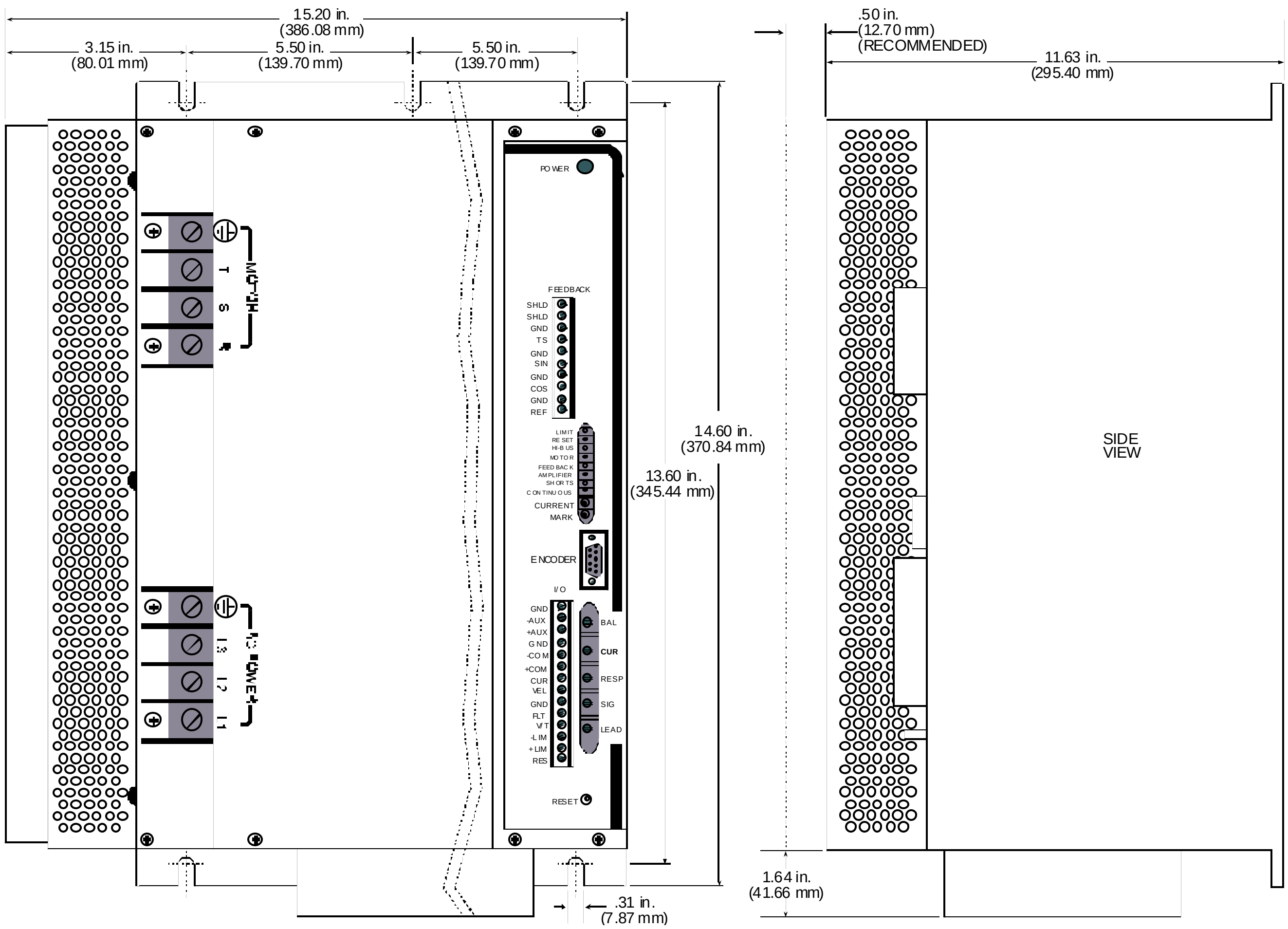
NOTE

If front cover is attached, additional clearance of .2 should be allowed.

Continued on next page

Mechanical Footprint (continued)

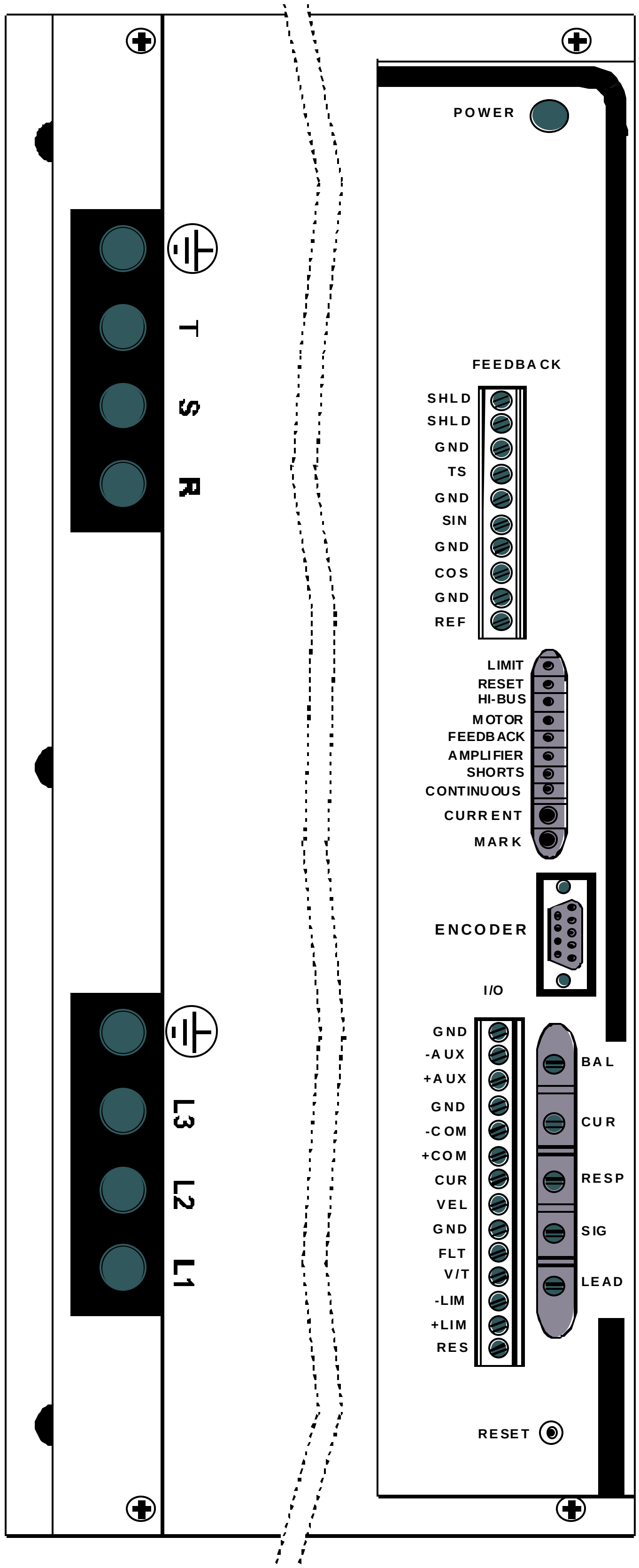
MPA-75/100-460



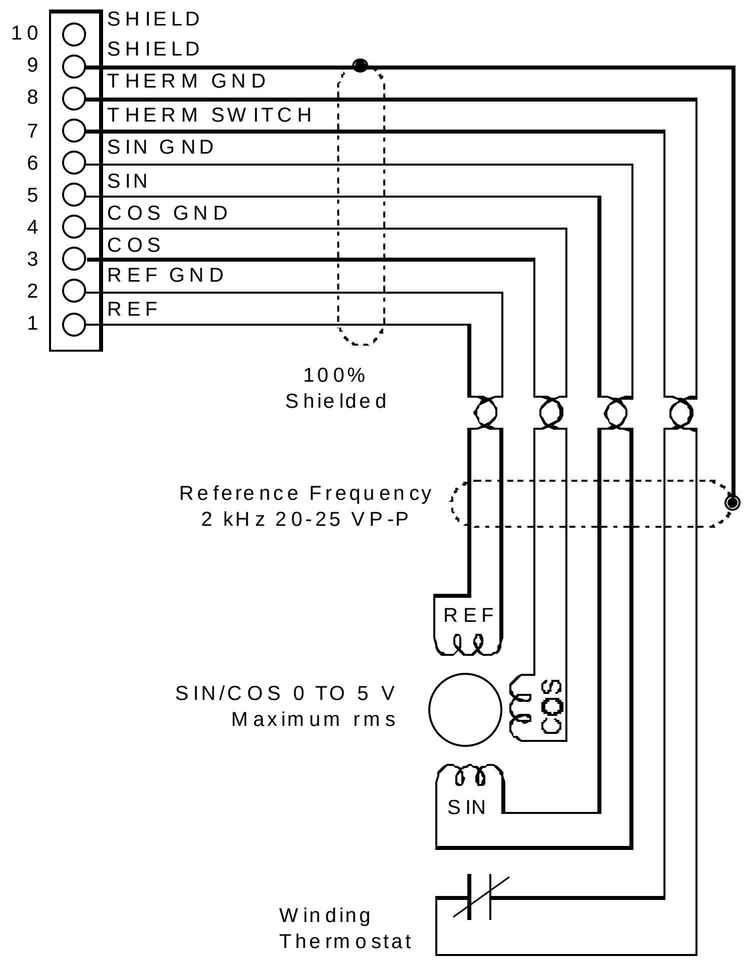
NOTE

If front cover is attached, additional clearance of .2 should be allowed.

Signal/Wiring Overview



Feedback Wiring



NOTE

100% shielded cable is foil and braid. The pairs do not have to be twisted. The resolver wiring should not be run adjacent to any non-shielded high voltage wires, such as the motor wires (RST). If the wiring cannot be separated, the RST motor leads should also be 100% shielded. It is highly recommended that factory cable sets or wiring be provided.

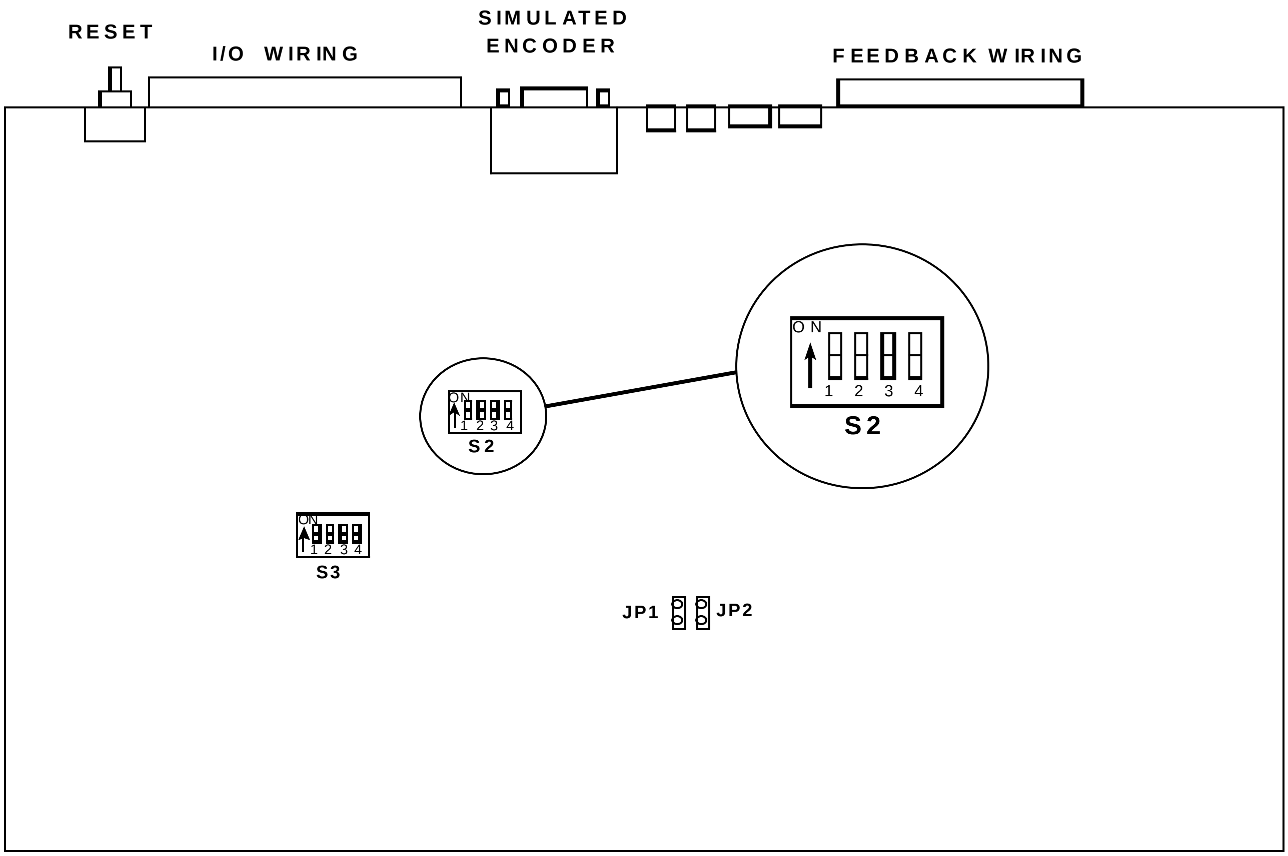
Thermostat

If the motor is equipped with a winding thermostat that is normally closed, it can be connected between terminals 7 and 8 of the feedback wiring connector. If an excess temperature thermal condition exists as indicated by an open thermostat, the amplifier is disabled.

Motors and Commutation

The amplifier can commutate 4-pole, 6-pole, 8-pole, and brush motors in its standard configuration and other factory options are available. DIP switch S2 allows for configuration changes and switches one and two determine the choice. Amplifiers are shipped set for 6-pole operation. Never change the switch settings of S2 with power ON.

FEEDBACK AND I/O CONTROL ASSEMBLY



DIP SWITCH 2

SW	1	2	3	Motor Type
	ON	ON	ON	8-POLE
	OFF	ON	ON	6-POLE (default)
	ON	OFF	ON	4-POLE
	OFF	OFF	OFF	BRUSH

All MTS Automation two-inch motors are 4-pole. The three-inch, four-inch, six-inch, and eight-inch motors are 6-pole motors.

For brush motor operation, no resolver alignment is required and the R lead connects to armature (+) and the T lead connects to armature (-). These connections will cause clockwise rotation from the shaft end of the motor.

Diagnostic Indicators

Mark (RED)

This is an output that comes ON at the resolver zero position and can be used in conjunction with alignment procedures. The zero position is about .5 degrees.

Current (BI-COLOR)

This is a bi-color LED that can be either red or green as a function of load. Red indicates positive torque and green indicates negative torque. The intensity increases with load.

There are eight faults that will disable the amplifier:

LED	INDICATION
CONTINUOUS	If a load condition exists that causes the amplifier to produce more than its continuous rating, this fault occurs.
STATOR SHORTS	If stator shorts or most major wiring errors of the stator occur, this fault occurs.
AMPLIFIER THERMAL	An 85° C thermostat is mounted to the amplifier's IGBT heat sink. If an excess temperature is sensed, this fault occurs.
FEEDBACK WIRING	For most resolver wiring errors, defective resolvers or tracking rate errors caused by the resolver, this fault occurs.
MOTOR THERMAL or OVERSPEED	If an excess thermal or adjustable condition exists in the motor, this fault occurs.
HI-BUS	If excess DC voltage or a failure of the shunt circuit occurs, this fault occurs.
RESET	During the first second of power up or if the reset input is active, this LED will be ON.
LIMIT	If either of the limit inputs are ON, This LED will be ON.

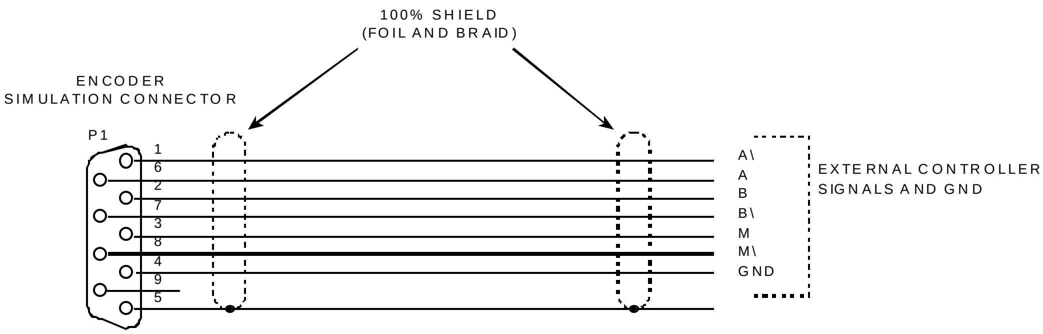
Power (GREEN)

If logic +5 Vdc is ON, then this LED is ON.

Simulated Encoder Signals

For external counting or position control, a 9-pin D type female connector that has TTL complimentary outputs is provided. This simulates quadrature encoder channel A and channel B signals. A differential mark signal is also available. These signals are RS422 compatible.

TYPICAL ENCODER CABLE



COMMENTS:

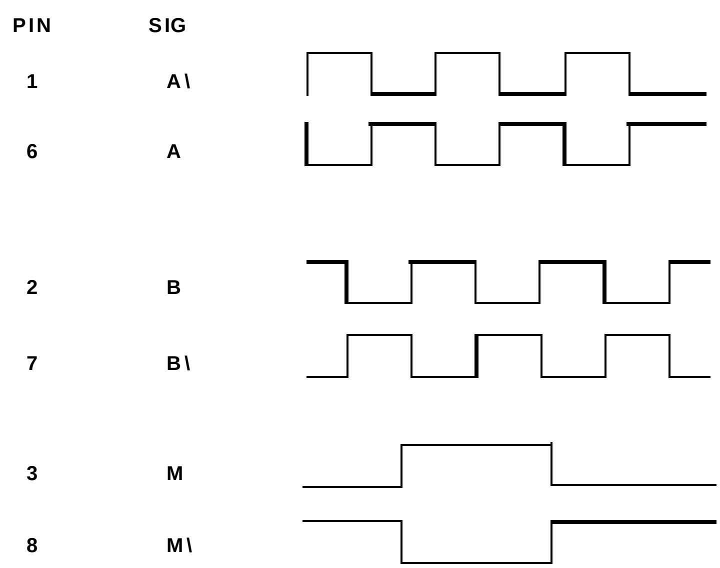
1) THE AMPLIFIER OUTPUTS ARE RS422 DIFFERENTIAL LINE DRIVER COMPATIBLE

2) THEY SHOULD BE CONNECTED TO COMPATIBLE DIFFERENTIAL RECEIVERS

3) THE BEST SHIELDING APPROACH WOULD BE TO CONNECT THE SHIELD AT THE AMPLIFIER END ONLY

4) ALL SIX WIRES AND A GND CONNECTION SHOULD BE CONNECTED AT THE CONTROLLER END

The phase relationship of channels A, B, and M is as follows for CW rotation:

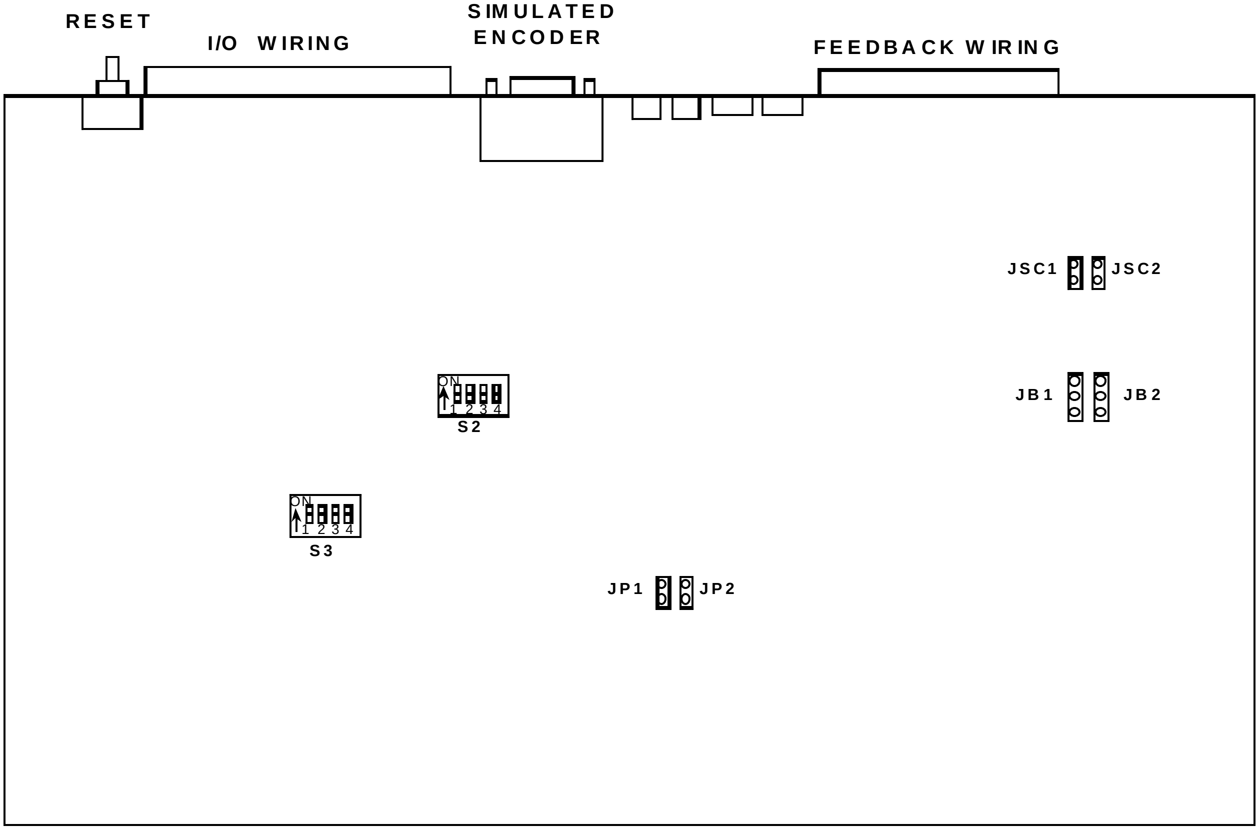


The marker pulse is about .5 degrees in width. The above illustration is for 1024 line condition(default).

The above signals are TTL complimentary outputs from a DS26LS31 differential driver. The logic 0 is typically between 0 and .5 volts and logic 1 is typically between 3.3 and 4 volts.

There are two jumpers that determine the resolution of the simulated encoder signals (JP1 and JP2).

FEEDBACK AND I/O CONTROL ASSEMBLY



The amplifier is configured from the factory to be 1024 lines.

JP1	JP2	Configuration
IN	IN	1024 (default)
OUT	IN	512
IN	OUT	256
OUT	OUT	128

The normal factory configuration of 2-Channel quadrature provides for output resolution of 12 bits or 4096 counts per revolution. 14 bit resolution can be ordered by specifying a "-14" after the selected MPA amplifier (eg. MPA-09-460-14). With the "-14" option, the jumper configurations are as follows.

JP1	JP2	Configuration
IN	IN	4096

The maximum 2-Channel resolution with quadrature channels in this mode is 16,384. The maximum tracking rate of the amplifier is limited to 60 rps or 3600 rpm with the "-14" option.

Resolver Converter Resolution

Jumper	12-bit	14-bit
JSC1	IN	OUT
JSC2	OUT	IN
JB1	UP (1-2)	DOWN (2-3)
JB2	UP (1-2)	DOWN (2-3)

These jumpers determine the 12 or 14-bit mode. Unless specified, all amplifiers are preset for 12-bit mode. JSC1 and JSC2 determine the R-Digital resolution. JB1 and JB2 determine the origin of the signals for the encoder simulation; When they are DOWN (2-3), the encoder simulation is based on the two LSD's of the 14 bit mode. The encoder simulation jumpers JP1 and JP2 must also be IN. The line resolution is fixed at 4096 lines per channel. With the JB1 and JB2 jumpers in the UP (1-2) position, the two LSD's from the 12 bit mode are used for the encoder simulation and the JP1 and JP2 jumpers are used to alter the choices of the 12 bit mode.

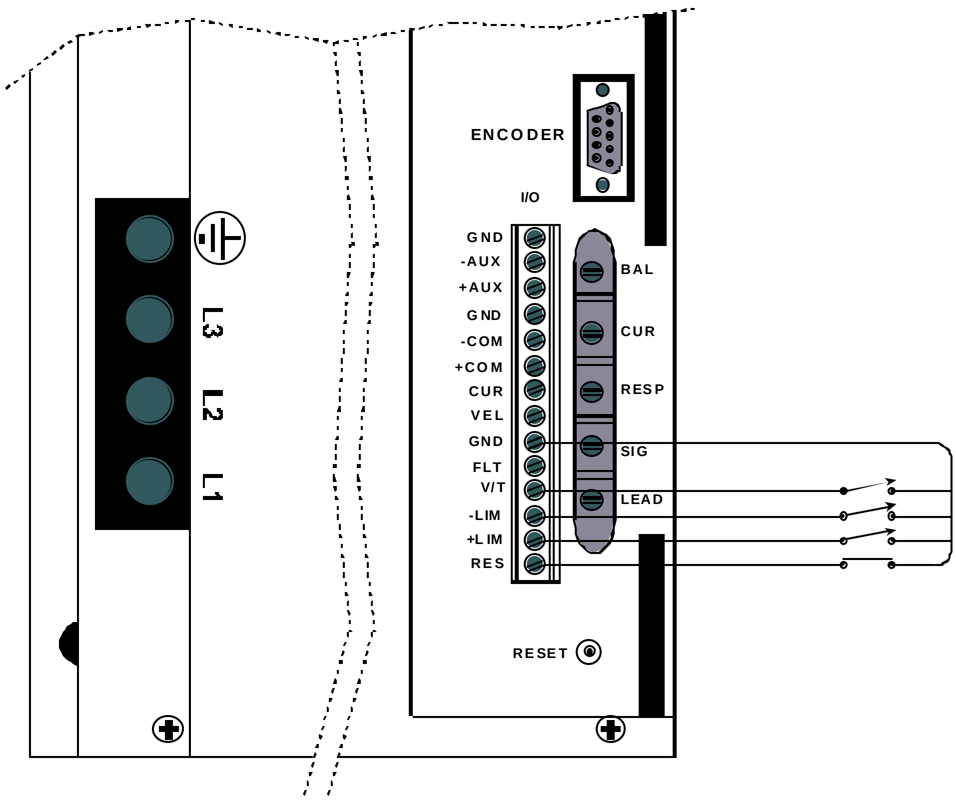
When the R-D converter is configured for 14 bit mode, JB1 and JB2 can be placed in the UP (1-2) position to allow for other encoder selection besides the normal 4096 lines per channel.

Changing to 14-bit mode cannot be accomplished as a user option on a standard amplifier. The -14 option must be provided.

I/O Wiring and Descriptions

The amplifier has four inputs and one output. These inputs and output are designed to interface to a 24 volt logic system. The amplifier is shipped so that the operation of the inputs is as follows.

With no wires connected to RESET, + LIMIT, - LIMIT, or VEL/TORQUE, the amplifier is enabled and normal operation will occur in a velocity mode. The inputs are activated by connecting them with a switch closure to any of the provided GND terminals.

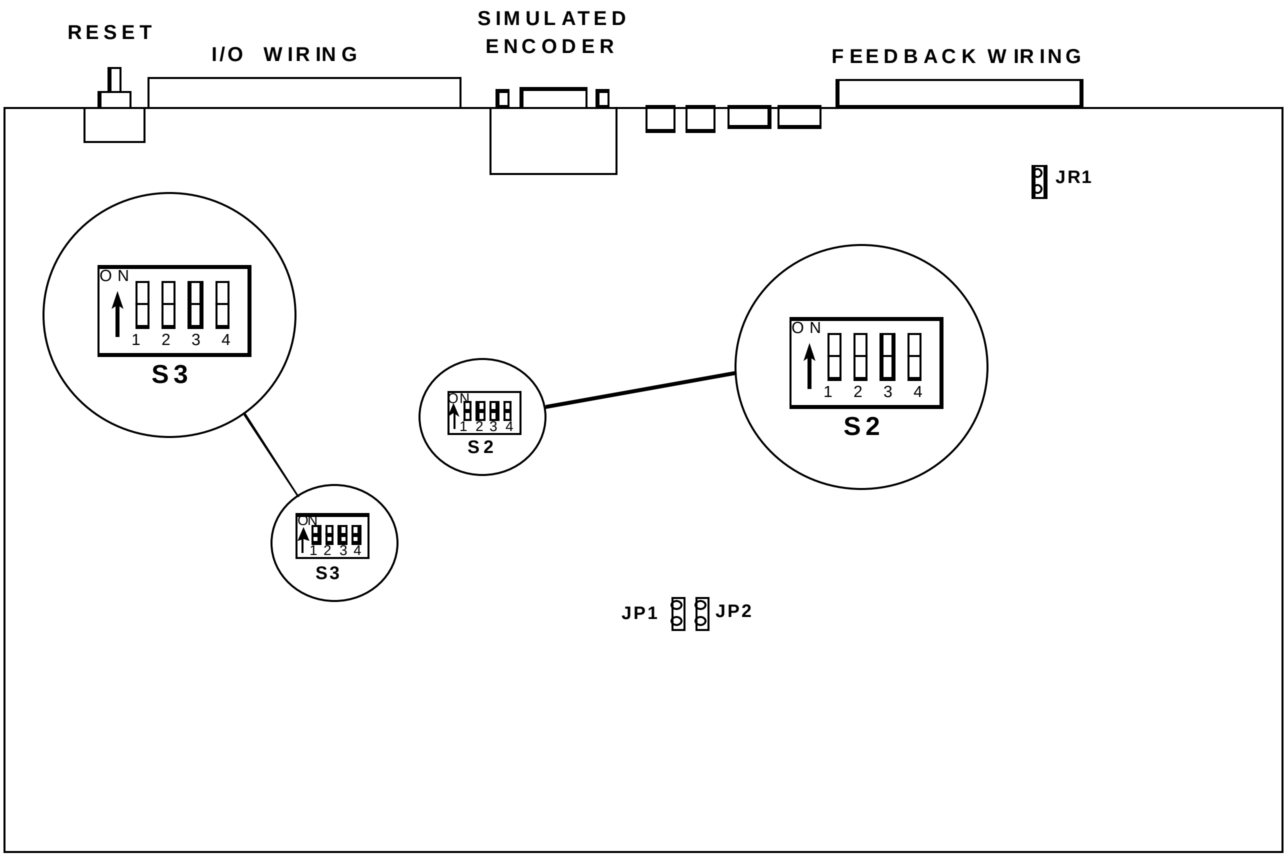


NOTE

The V/T is an input that determines the amplifier mode, Velocity/Torque mode. When the switch is open, the Velocity mode is selected. When the switch is closed, the Torque mode is selected.

As the polarity of the inputs may vary depending on the application, a DIP switch is provided to allow for an inversion of the function.

FEEDBACK AND I/O CONTROL ASSEMBLY



DIP switch S3 switches 1, 2, 3, and 4, are used for this purpose.

Input	Switch Number	Factory Setting
RESET	1	ON
+ LIMIT	2	ON
– LIMIT	3	ON
VEL/TORQUE	4	OFF

By setting switch 2 to the OFF position, the operation of the + LIMIT would change to be closed to run in a plus direction. This reversing characteristic is true for all four switches.

There is a FAULT output. This is equivalent to an open collector NPN transistor with its emitter connected to GND. This transistor can sink 2 amps and it can withstand 110 volts dc when OFF. When a fault occurs, this output turns ON. This output can also have its polarity inverted by switching the fourth switch on DIP switch S2. Once this is done, this output will be ON if no fault exists. This output would now be thought of as a READY output instead of a FAULT output. The normal fault operation occurs with S2-4 ON.

The purpose of inversion of this output is to allow for direct connection to fail safe brakes or other brake interlock circuits.

If this inverted output is used, consideration for the Power-Up Reset Input may be required. For example, during power-up a reset would disable faults. This same reset may then defeat the desired operation of the brake. With no faults and an inverted output selected, the brake output would be ON but power would not be applied to the motor. If the JR1 shorting pin is installed then a Reset/Disable condition is allowed to keep the output ON even though there is no fault.

RESET/ENABLE Conversion

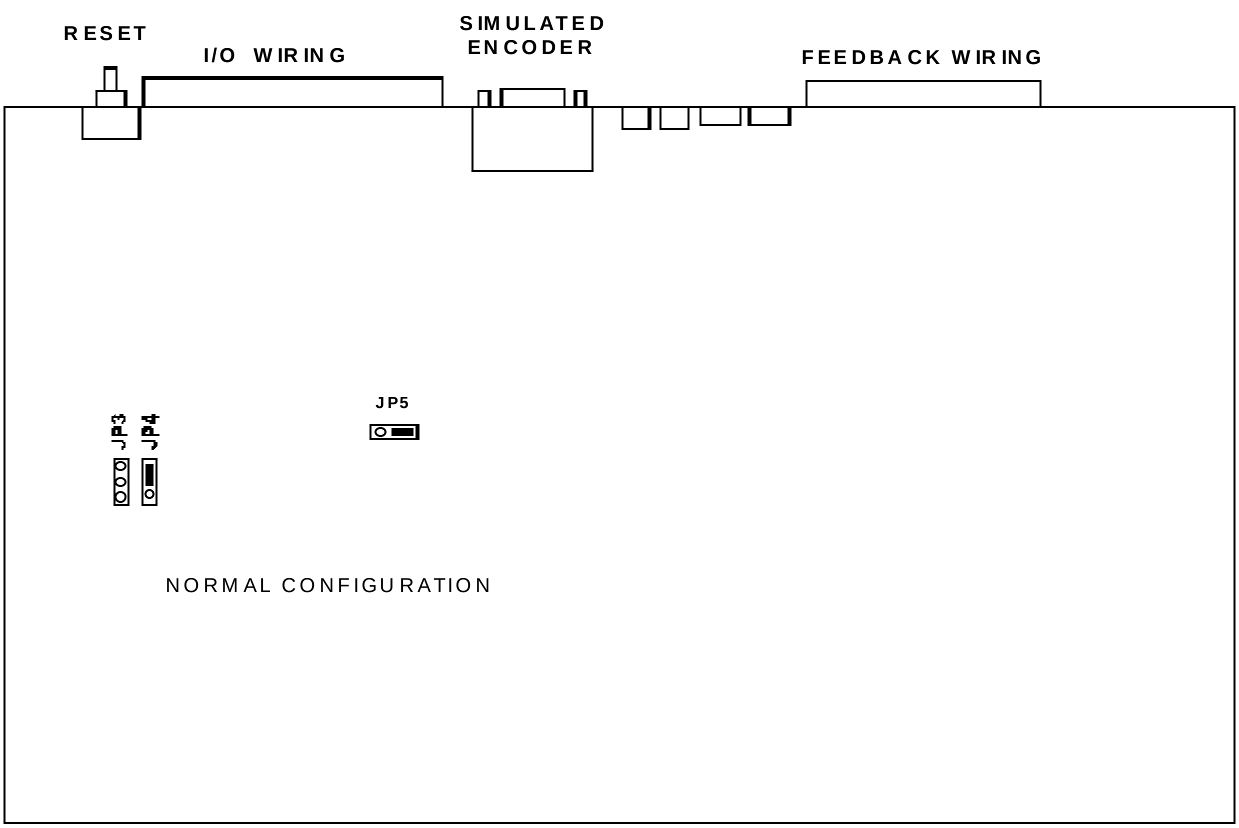
The most common conversion is to change the RESET input to an ENABLE input. If S3-1 is set to the OFF position, the RESET input must be connected to GND to ENABLE the amplifier.

Although the operation of this input is oriented as an amplifier enable input, during the time the input is not connected to GND, the amplifier is actually in the reset condition. During this time, the fault status indicators are also reset. In some applications, the amplifier fault output is used as a handshake signal to an external controller, and if a fault from the amplifier occurs, the external controller shuts OFF the ENABLE input immediately, and the particular fault that caused the fault is reset.

If the external controller logic cannot be changed and it is desirable to save the fault status indicators, the following header pin jumpers can be changed to reconfigure how the fault status indicators are cleared.

Alternative Fault Reset

ANF1.PCB, Rev A6 and higher:



The three header pin jumpers and JP3, JP4, and JP5; shorting pins are all connected as indicated.

Reset if AC Power is Cycled

If the JP4 header is removed, the faults will only clear when the logic supply power is removed and re-applied.

Reset on Enable Transition

By moving the JP3 and JP4 pins to the non-N position, the faults will clear on the transition of the ENABLE. The fault output will shut off if the condition that caused it is removed at this time.

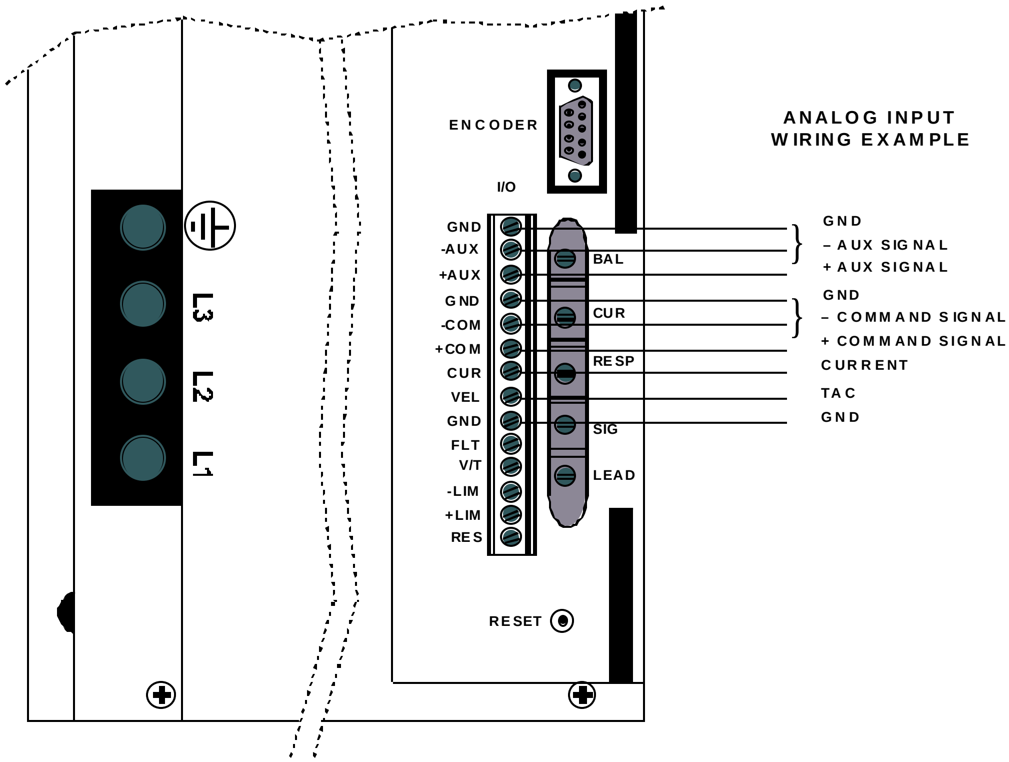
Reset via Unused +LIM Input

By moving the JP3, JP4 and JP5 pins to the non-N positions, the operation of the +LIM input is changed so that it becomes CLEAR FAULT STATUS input. Assuming that S3-2 is still ON, the CLEAR FAULT STATUS would clear by connecting the +LIM input to GND. The fault output would clear at this time if the fault condition was removed. The +LIM and -LIM inputs cannot be used as limits, they are disabled in favor of using the +LIM as a fault status clear. S3-2 can be switched to the OFF position and this would invert the operation of the fault clear so that it would have to be normally connected to GND and then be disconnected to clear the fault indicators.

Analog Inputs, Outputs and Adjustments

Inputs

There are two analog input channels; one for command and one for auxiliary. Both of these channels are differential inputs and both are summed with a TAC feedback differential amplifier that controls velocity.



Normal operation of the command signal is to apply a + voltage (pin #9) with respect to GND(pin #11) and get clockwise rotation of the shaft. ±10 volts is then used to control velocity and the SIG pot is used for velocity adjustments. If the + COMMAND voltage is applied to the - COMMAND signal input, then an opposite shaft rotation occurs.

The operation of the AUXILIARY ± inputs is the same as the COMMAND inputs. The normal purpose of the AUXILIARY inputs is to provide a second summing voltage to compensate/modify normal COMMAND voltage.

If the input for VEL/TORQUE is active and a torque mode is chosen then voltages applied to the COMMAND ± inputs control motor current. The SIG pot can now be used to adjust the amount. Normal operation in this mode assumes that 10 volts is peak current and 5 volts is the continuous current rating of the amplifier.

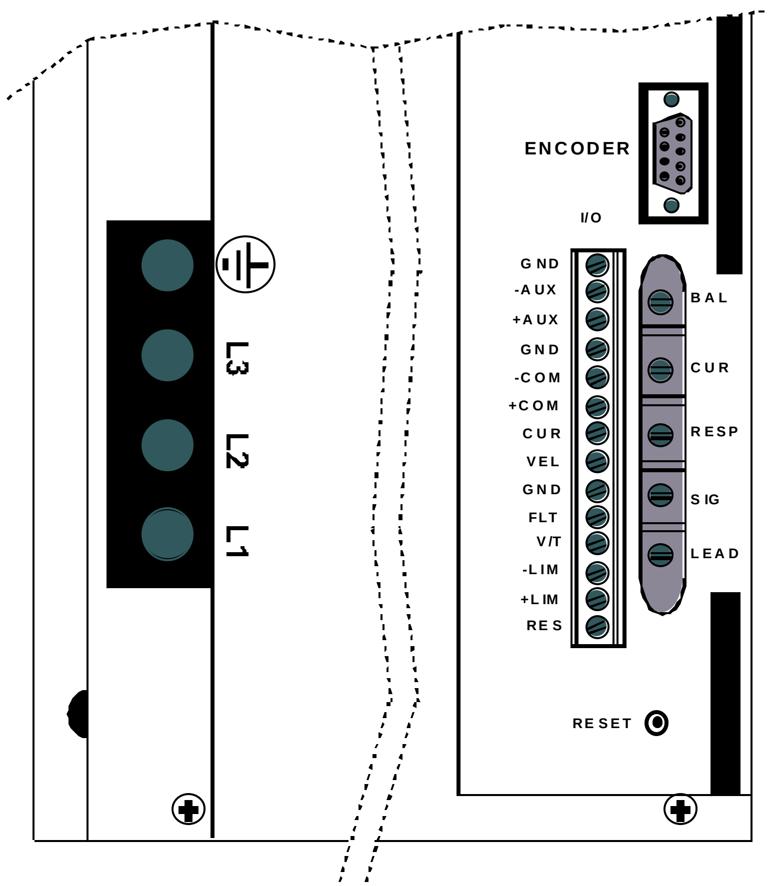
The current limit of the amplifier can be adjusted with the CUR pot from 0 (full CCW) to 100% (peak full CW). It is a good idea during start-up to adjust the CUR pot to its full CCW position and increase it slowly CW to assure normal operation.

During start-up the BAL adjustment can be used to reduce/stop any low speed CW/CCW drift caused by imbalance between the external command voltage and the amplifier.

Once connected to loads, the crispness of motion (step response) and stability can be optimized with the RESP and LEAD pots. Full CW is maximum response and full CCW is minimum LEAD.

The location of these adjustments is next to the I/O wiring.

FEEDBACK AND I/O CONTROL ASSEMBLY

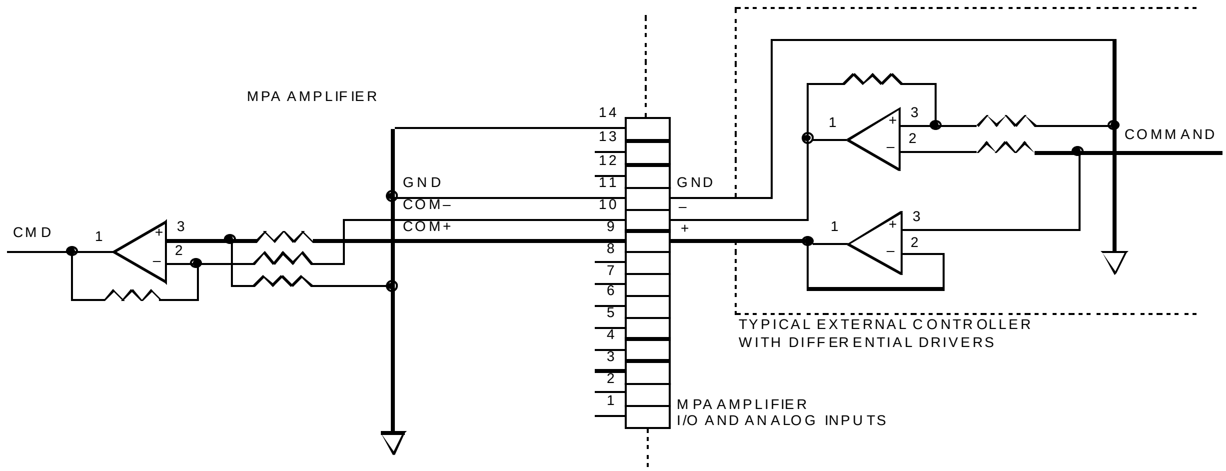


Outputs

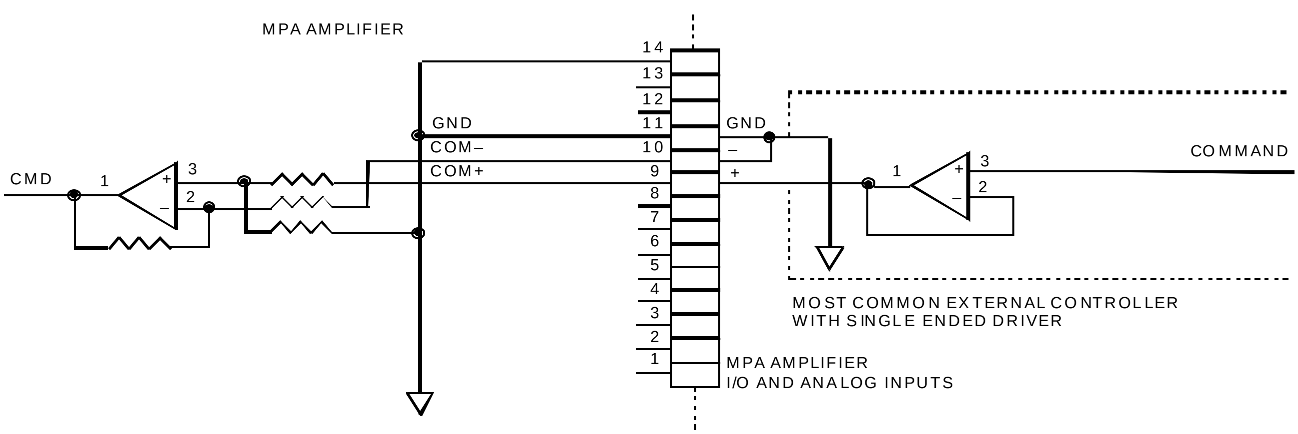
Two diagnostic outputs are the dc voltage proportional to velocity and the dc output proportional to current/torque. The nominal TAC gradient is 1.3 volts per thousand rpm. The current gradient is 10 volts equal peak.

Analog Inputs (Specific Interface Requirements)

The analog input channels consist of differential input amplifiers to allow controllers that have differential output drivers a three wire connection that excludes potential ground loops. When differential modes of operation are used, the command or auxiliary input is based on 5 volts equaling maximum input and the analog ground from the external controller must be connected to the MPA drives GND connection. A +5 volt connection to the COM+ terminal and a -5 volt connection to the COM- terminal is equal to a + 10 volts command voltage. The rotational direction of the motor will be CW viewed from the shaft end of the motor. To change directional rotation the COM+ and COM- connections must be reversed.



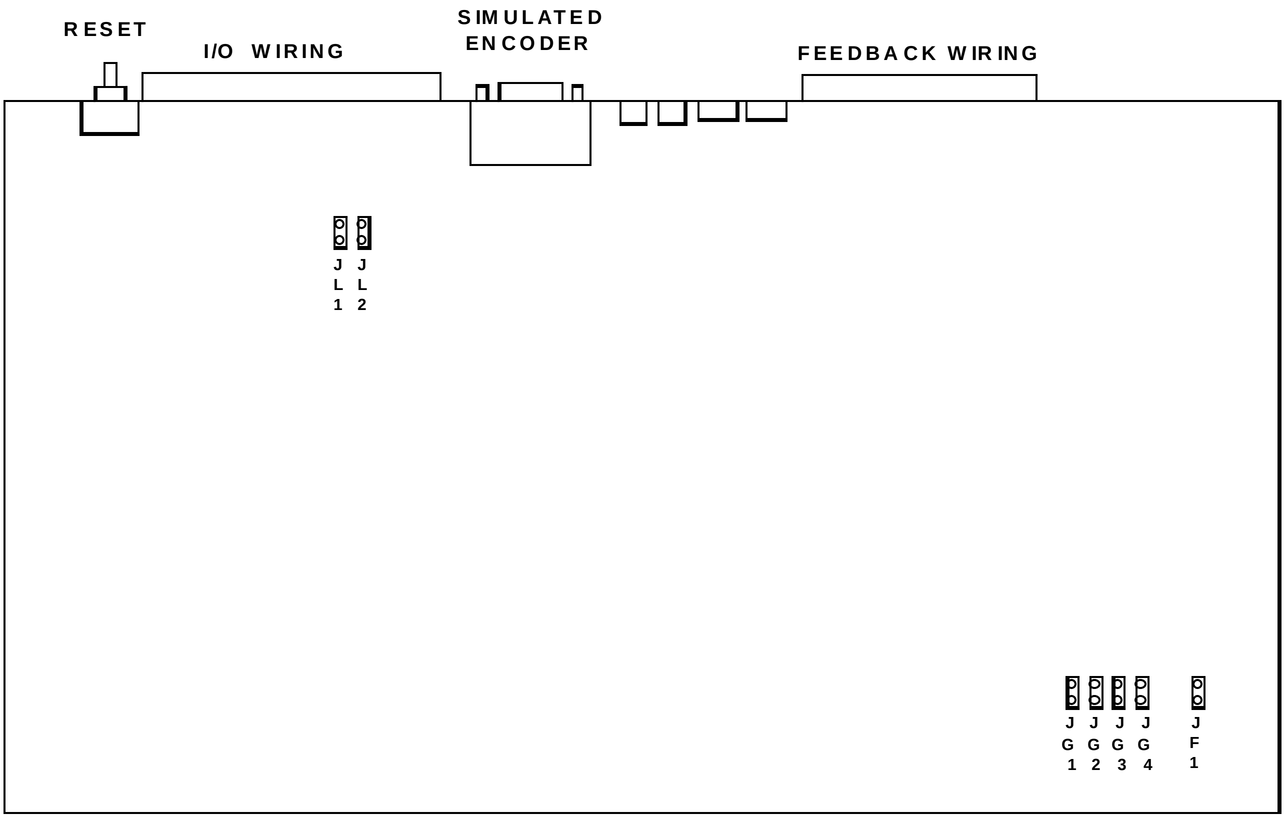
The most typical input to the command and auxiliary inputs is a simple two wire interface consisting of a command voltage with respect to a GND. The ground wire of this pair must be connected to the MPA GND terminal associated with the analog channel, and the command wire can be connected to either the COM+ or COM– input to determine the rotational characteristic required. A positive command voltage with respect to GND connected to the COM+ terminal will cause CW rotation as viewed from the shaft end of the motor. The unused input, COM+ or COM-, should be connected to GND.



TAC Gradient, Response, Lead

The control board for these amplifiers has jumpers that allow for various configurations of compensation and filter networks. The physical location of these jumpers is indicated on this figure.

FEEDBACK AND I/O CONTROL ASSEMBLY



Jumper Configurations

Lag Network – JL1 JL2

The JL1, JL2 jumpers and the (RESP) pot adjustment affect operation of the PID Loop's I Term. The JL1 jumper varies the integration capacitor. The JL2 jumper varies the integration resistor. The maximum integration occurs with the RESP pot full CCW. CW adjustment decreases integration, usually to a point of not being stable.

Jumper	Status	Configuration
JL1	IN	Maximum I
JL2	IN	Lowest Gain

TAC Gradient – JG1 JG2 JG3 JG4

These jumpers determine the TAC gradient that can be found from the table below:

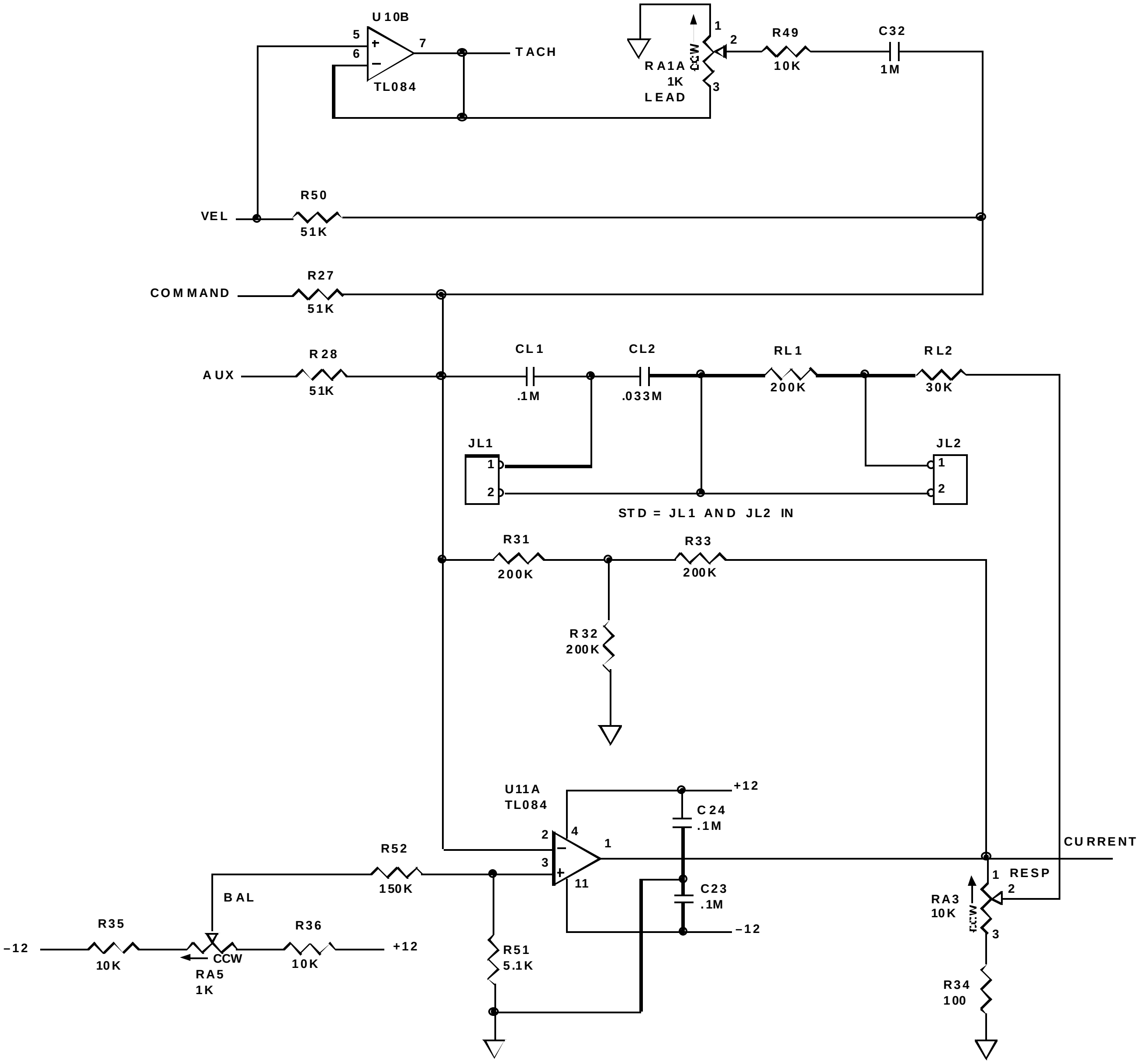
JG1	JG2	JG3	JG4	TAC Gradient (12-bit) V/KRPM	TAC Gradient (14-bit) V/KRPM
IN	IN	IN	OUT	0.9	2.1
IN	IN	OUT	IN	1.8	4.2
IN	IN	OUT	OUT	2.7 (default)	6.3
IN	OUT	IN	IN	3.6	8.4
IN	OUT	IN	OUT	4.5	10.5
IN	OUT	OUT	IN	5.4	N/A
IN	OUT	OUT	OUT	6.3	N/A
OUT	IN	IN	IN	7.2	N/A
OUT	IN	IN	OUT	8.1	N/A
OUT	IN	OUT	IN	9.0	N/A
OUT	IN	OUT	OUT	9.9	N/A

The maximum tracking rate of the resolver to digital converter in the 12-bit mode is 200 rps and is 60 rps in the 14-bit mode.

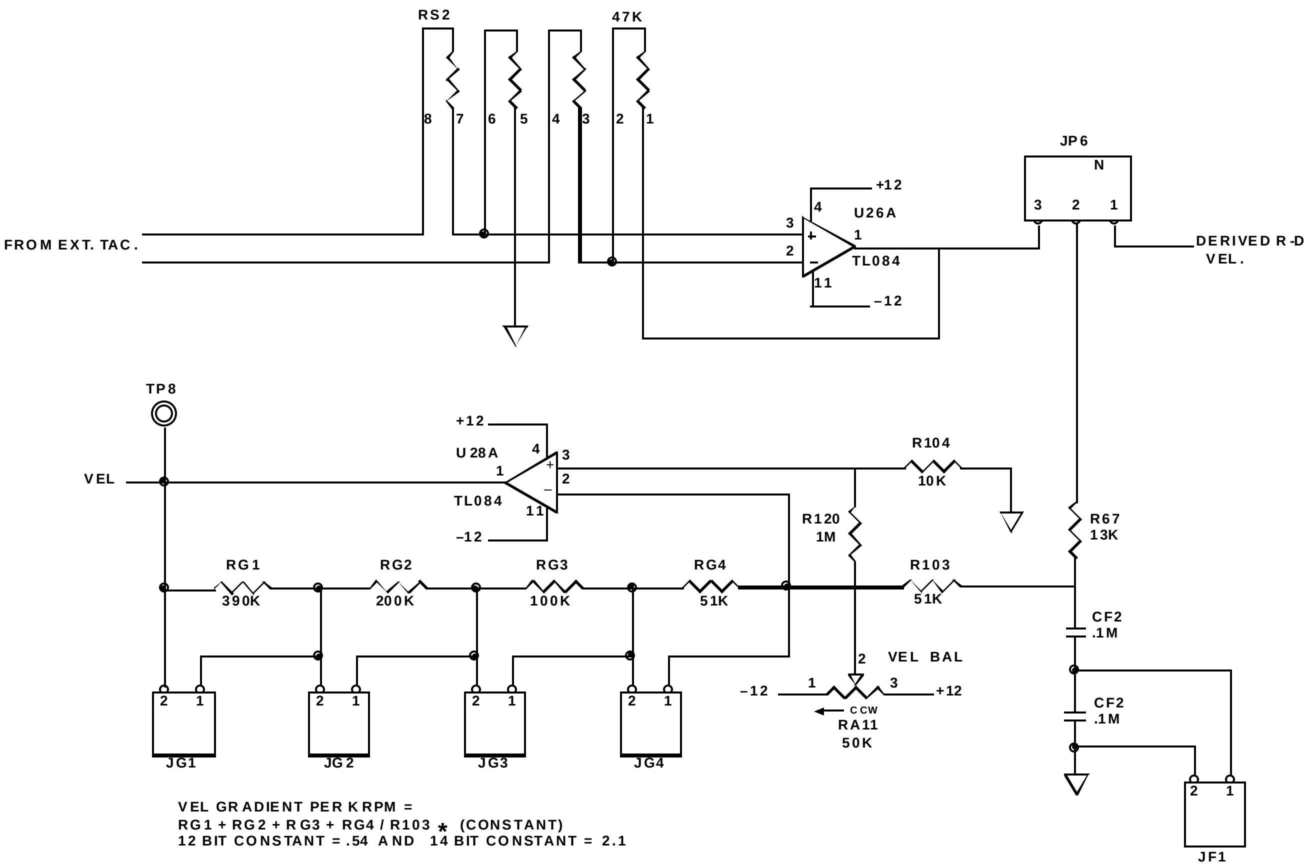
TAC Filter – JF1

With JF1 IN the TAC filter is maximum and with it OUT the TAC filter is minimum. For smaller motors minimal TAC filtering improves response.

Response/Lead Compensation



TAC Gradient



VEL GRADIENT PER KRPM =
RG1 + RG2 + RG3 + RG4 / R103 * (CONSTANT)
12 BIT CONSTANT = .54 AND 14 BIT CONSTANT = 2.1

Set-Up

This procedure assumes that the amplifier is being used in the velocity mode otherwise the external controller would resolve PID gains for the amplifier and the amplifier would be in the TORQUE mode.

The USER adjustments are set as follows for shipping.

LEAD	CCW	(no lead)
SIG	MID	
RESP	MID	
CUR	MID	
BAL	MID	

The procedure that is used to determine the actual SWITCH settings and USER adjustments is load and application dependent.

The best method to determine these is based on testing with Voltmeters and Oscilloscope for observing the TAC and command signal. P (proportional gain) is determined by the TAC and signal gains. An oscilloscope can be used to monitor the TAC signal for over or under damping. The I (integral gain) is controlled by the RESP pot and the jumper settings of JL1 and JL2. The D (derivative gain) is determined by the adjustment of the LEAD pot.

An abbreviated method that allows for reasonable success is:

1. Determine the TAC gain for the application and set the JG1, 2, 3, and 4 jumpers accordingly. Amplifier saturation is based on 10 volts of either signal or TAC. With the TAC jumpers set for normal operation, the TAC gradient is 2.7 volts per thousand and saturation will occur at 10 volts max / 2.7 volts per Krpm = 3.7 Krpm. The motor's KE, and the amplifier's bus voltage will also limit the maximum speed.

   The amount of TAC gain alters the drive's proportional gain, and under most conditions higher TAC gains allow control of larger inertia. Since TAC gain compared to signal gain also controls velocity, the external controller's dc voltage proportional to velocity is an issue to consider. In some controllers a KF (feedforward term) is available. This term is a pre-computed voltage that is the velocity component. The controller's KP term adds or subtracts from this existing KF term, based on encoder count error, a voltage that forces correction. For this type of controller, the best possible performance can be achieved by having high TAC gain and minimum KP. Following errors are adjusted out with the drive's SIG adjustment when running at a known speed, and the BAL adjustment can be used to zero following error at zero velocity.

   Some controllers have no KF term and run error loops. Motion occurs as a result of the error over time, and for each time interval more error occurs causing higher speed. For this type of control, high TAC gains would generally deteriorate performance as the key to running is to make the same following errors at the same times. This type of control is very common. In several instances the difficulty in setup is that the external controller has no KP or KF term and the drive's KP is the only way of achieving stability. The drive's KP is determined by the TAC gain, SIG/AUX pot, LEAD pot. The best process would be to start out with the lowest TAC gain. Adjustment of the SIG/AUX input, RESP, and LEAD should cause normal operation.

Continued on next page

Set-Up (continued)

2. The TAC filter jumper JF1 is usually IN (maximum filter). Removing JF1 decreases the filtering and is primarily intended to accommodate the brushless TAC option. In very fast applications, removing JF1 can improve bandwidth, but it depends on load conditions and various sized motors. Reducing filtering also leads to more audible noise. JL1 and JL2 should be IN for maximum integration, (I).

3. We would next set the RESP and CUR pots full CCW and assure that the LEAD pot is full CCW. The BAL pot and SIG pot are in the MID.

4. Power up the amplifier.

5. Slowly turn the CUR pot towards the middle position while observing the following.

    a. it may be necessary to increase the RESP adjustment to achieve stability or to minimize oscillation or vibration.

    b. if the instability is substantially improved but not good enough, the LEAD adjustment can be increased.

6. If operation is improved but not good enough, the process can be repeated from Step 3 after removing JL1. This decreases integration.

7. If operation is again improved but still not good enough, the process can be repeated from Step 3 after removing JL2. This increases gain.

8. If you are unable to achieve the speed you want, you may have to increase the SIG pot to have an 8-10 volt command signal equal the amplifiers maximum velocity.

9. You can also continue to increase the CUR adjust as operation is improved.

AC Input and Internal Protection

A branch circuit disconnect must be provided in front of the amplifier. For the MPA-25/35/50, either single phase or three phase power can be applied.

Model	Single Phase	Three Phase
MPA-05-460	8 amps	4 amps
MPA-09-460	11 amps	7 amps
MPA-15-460	18 amps	11 amps
MPA-25-460	30 amps	18 amps
MPA-35-460	42 amps	25 amps
MPA-50-460	60 amps	35 amps
MPA-75-460		55 amps
MPA-100-460		70 amps

NOTE

Use the table above as a guideline when selecting the size of disconnecting devices. The current rating of the device must to be equal to or higher than (closest match) the values in the table. Make sure that the device has the appropriate voltage rating. Use only slow blow fuses or thermal type breakers.

AC power wiring must be consistent with any local codes, national electric codes, and be able to withstand the voltage current ratings applied.

A ⏚ (ground) terminal is supplied and should be connected to earth ground.

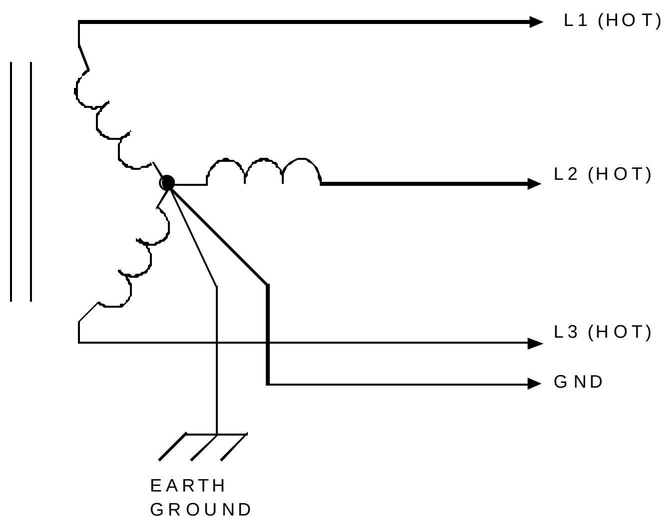
Internal Protection

These amplifiers have internal AC Input fuses and a shunt fuse internal to the rear cover. All of these fuses are intended to avoid catastrophic failures. In the event that any of these fuses becomes defective, the amplifier must be repaired by a factory technician.

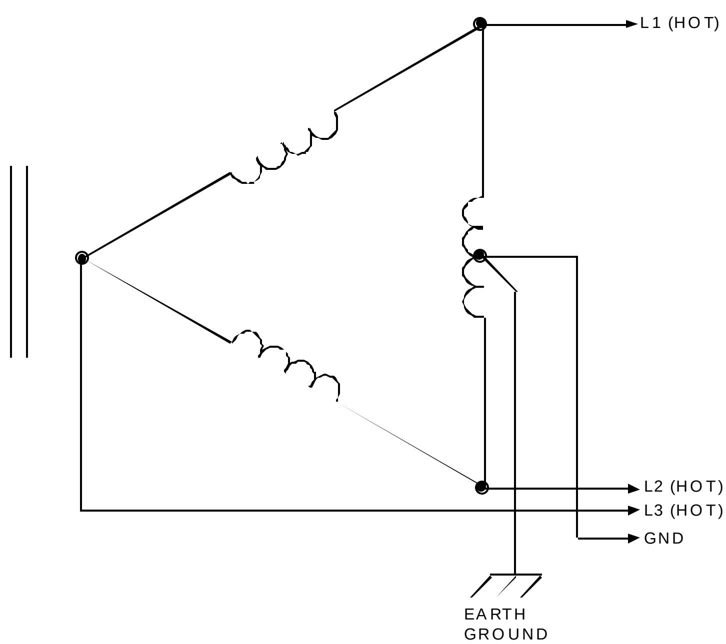
Grounding

The ac supply source for the amplifier is supposed to be bonded to earth ground.

Typical WYE Secondary



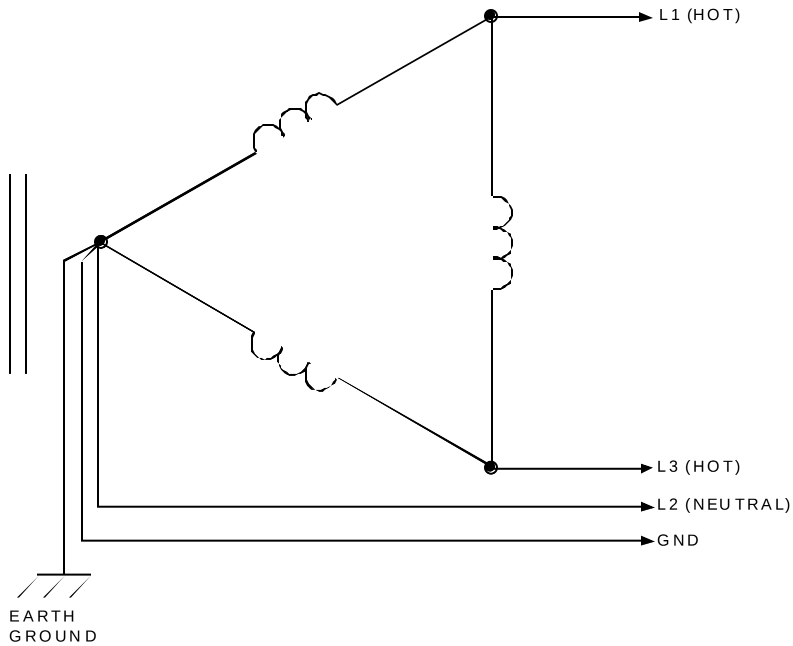
Typical Delta Secondary



These are the two most typical transformer configurations and failure to ground these properly could void warranty.

The MPA amplifier does not care where the earth ground is. This example is a delta secondary.

Delta Secondary



In this example L2 became ground.

Power/Grounding Requirements

The following information covers the grounding requirements of 3-phase servo amplifiers manufactured by MTS Automation. It has been found when an amplifier has been connected to a transformer with an ungrounded secondary, premature amplifier failure will occur.

The 3-phase MPA amplifiers require the AC power (L1, L2, L3, and Ground) be derived from a transformer which has it's secondary intentionally bonded to earth ground. This means that some point on the secondary must be connected to an earth ground with no exceptions (see examples A1, A2, A3). Do not assume just because there are three power leads with a ground available at an installation, that this is a valid configuration. Some facilities are supplied with 13,200 volts AC which is reduced to 460 volts AC via a transformer. However, the secondary of this transformer usually is not grounded as in an ungrounded delta secondary (Example U3). Each installation or facility is unique and the power distribution must be inspected or measured to make sure the transformer secondary is, in fact, tied to earth ground. A machine or system built and tested at one facility, may fail at another site due to incorrect transformer configurations.

There are two common transformer secondary configurations. They are the Wye and the Delta secondary. Most problems are found with an ungrounded Delta secondary connection. The examples show acceptable (A1, A2, and A3) and unacceptable (U1, U2, U3) configurations.

If it is not possible to visually inspect the transformer configuration, you can electrically measure the line voltages to verify a correctly grounded transformer secondary.

A properly grounded secondary (wye or delta) will have certain voltage characteristics when measured with an AC voltmeter:

- A properly grounded wye secondary will read the same voltages when measuring all three legs, phase to ground (A1).

- A properly grounded wye or delta secondary will read the same voltage when measuring all three legs phase to phase (A1, A2, A3).

A properly grounded delta with high leg (A2) and delta with grounded leg (A3) show different characteristics when measuring phase to ground.

- In example A2 (Delta with high leg), the two low legs (L1 and L2) must be the same voltage when measured phase to ground.

- In example A2 (Delta with high leg), the high leg (L3), when measured phase to ground, will read twice the value of L1 or L2 to ground.

- In example A3 (Delta with grounded leg), L1 and L2 must be the same voltage when measured phase to ground.

If the measured voltages at the installation do not correspond with the above, or the transformer secondary is, in fact, ungrounded, one of the following steps must be done:

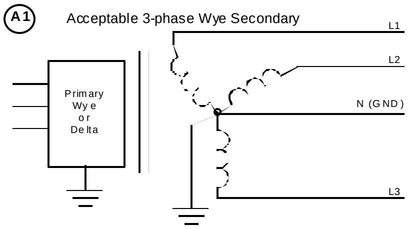
A) Ground the secondary of the transformer if it is electrically and mechanically possible.
B) Add an isolation transformer and ground the secondary per acceptable connection.

If unsure, ask a licensed electrician to perform the above steps.

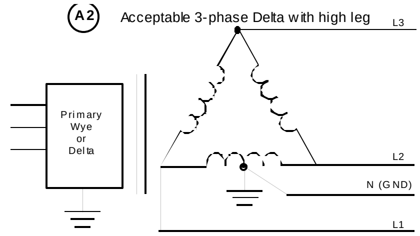
Example 1 shows a typical factory configuration. It shows a ungrounded delta secondary and there is existing equipment already running on line. This equipment could be simple 3-phase induction motors where an ungrounded secondary is not an issue. However, before a 3-phase MPA amplifier, or a machine utilizing 3-phase amplifiers, can be connected, an isolation transformer, with a grounded secondary must be installed.

Everyone, (OEM's, End users, etc.) must be made aware of this possible situation when a machine is installed at a customer's site. The power distribution needs to be known and a transformer, with a grounded secondary, may need to be added to the system before power is applied.

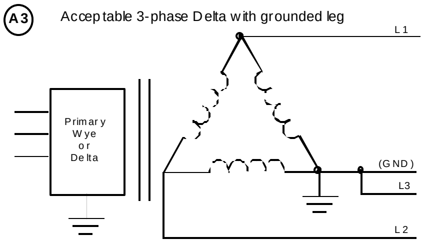
A1 Acceptable 3-phase Wye Secondary



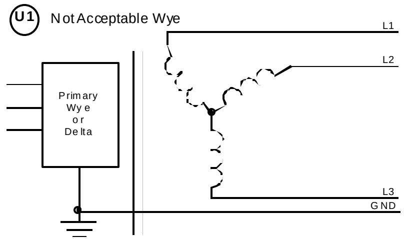
A2 Acceptable 3-phase Delta with high leg



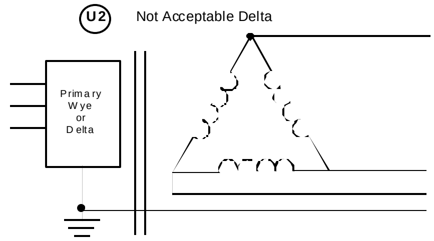
A3 Acceptable 3-phase Delta with grounded leg



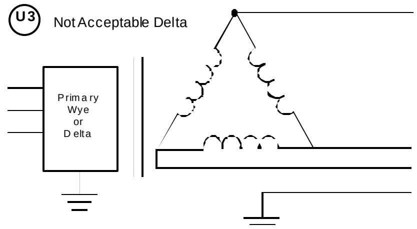
U1 Not Acceptable Wye



U2 Not Acceptable Delta



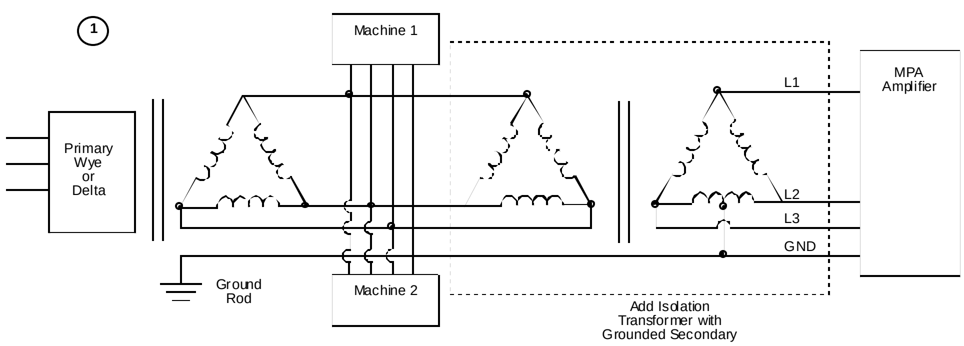
U3 Not Acceptable Delta



If you find one of the unacceptable connections above, you must:

A. Ground the secondary if possible
B. Add an isolation transformer per acceptable connection (See example 1 below)

1



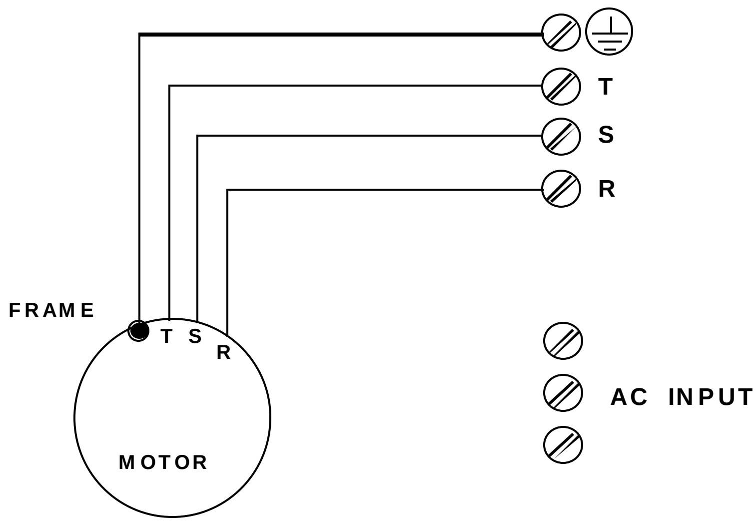
Stator Wiring

The locked rotor stator current is equal to the amplifiers continuous rating and for either low speed or locked rotor conditions the stator must withstand this continuous rating. Derating the stator/wiring for three-phase operation is not allowed.

Model	Locked Rotor
MPA-05-460	5 amps

MPA-09-460	9 amps
MPA-15-460	15 amps
MPA-25-460	25 amps
MPA-35-460	35 amps
MPA-50-460	50 amps
MPA-75-460	75 amps
MPA-100-460	100 amps

For operation at 460 Vac, it is recommended that the stator wiring insulation withstand 600 volts.



A GND connection is supplied as a means to ground the motor frame to earth ground.

If shielded cable is not used, it is recommended that the RST and GND wires be twisted.

NOTE

If the resolver feedback wiring is to be run adjacent to the RST motor wiring, then the motor wiring should be 100% shielded (foil and braid).

Shunt Loads

Regenerative energy during deceleration causes the normal voltage on the drives bus to increase. The amount of energy is application dependent and relates to total inertia. In general the drives internal shunt load can dissipate this energy within the constraint that the load inertia is not more than 20 times that of the rotor, but this is only a guideline. The deceleration rate of the load determines the rate that voltage rises in the bus capacitors.

The voltage on the bus is sensed and when it becomes too high a solid state device turns on that causes a load to be placed in parallel with the bus. There are three protection devices that are used to protect the drive from this application dependent loading. The shunt loads are thermally protected to 85° maximum, there is a fuse in series with the shunt load to limit average power in the shunt and if this fuse blows then another circuit measures the bus for an even higher voltage and a HI-BUS fault occurs and disables the drive.

For 460 volt drive products the shunt is turned on at 780 Vdc and turns off at 750 Vdc. A hi bus fault occurs if the bus goes over 860 Vdc.

Model	**Load ohms**	**Fuse amps**	**Peak amps**	**Bus Capacitors MFD (min)**	**Continuous Watts**
MPA-05-460	48	LPCC-3	16.2	600	400
MPA-09-460	48	LPCC-3	16.2	1100	400
MPA-15-460	48	LPCC-3	16.2	1700	800
MPA-25-460	24	LPCC-5	30.0	1600	1500
MPA-35-460	24	LPCC-5	30.0	2200	1500
MPA-50-460	16	LPCC-8	48.7	3300	2000
MPA-75-460	8	NOS-20	48.7	5000	2000
MPA-100-460	8	NOS-20	48.7	6800	2000

External Shunt Load

Model	**Load ohms**	**Fuse amps**	**Peak amps**	**Bus Capacitors MFD (min)**	**Continuous Watts**
EXS-50-460	16	LPCC-8	49	–	2400
EXS-100-460	8	NOS-20	90	–	8000

Thermal Characteristics

The drives are specified to operate at a 45° C ambient. This is not a maximum safe operating specification. There are no parts in the drive that cannot operate at a 60° C temperature. The absolute maximum temperatures that the drive can operate at are determined by thermal switches on the bridge switch power devices (IGBT's) and on the shunt loads. These thermal switches open and disable the drive at 85° C.

At temperatures above 45° C the amplifier's ability to produce its continuous rating is impaired by the heat rise from the ambient temperature. The amplifier will thermally shut down once the 85° C condition is sensed at either the bridge or the shunt load.

A guideline for enclosures would be to assume that the amplifiers thermal losses are equal to 15% of the load power +50 watts. The 50 watts is required for the logic supplies.

If the application is causing bus pumping and the shunts are being used the thermal rise from the shunts is restricted to 85° C and the actual power rating of the shunt load. Add the Continuous Watts from the **Shunt Loads** to the amplifier thermal losses if the application is bus pumping.

The drives can be supplied with different shunt loads as options and in some instances it is a requirement to mount the shunt loads external of the amplifier.

"-EXS" Option

In high inertia applications, energy stored in the load must be dissipated in the amplifier's bridge, bus capacitance and parallel shunt load. In certain machining operations, multiple passes are required and the heat rise from this energy cannot be dissipated in the amplifiers internal shunt without causing an amplifier thermal fault. The "-EXS" option provides a means of mounting the shunt load outside of the amplifier.

The "-EXS" suffix applied to the amplifier model provides for the interconnection of the external shunt load.

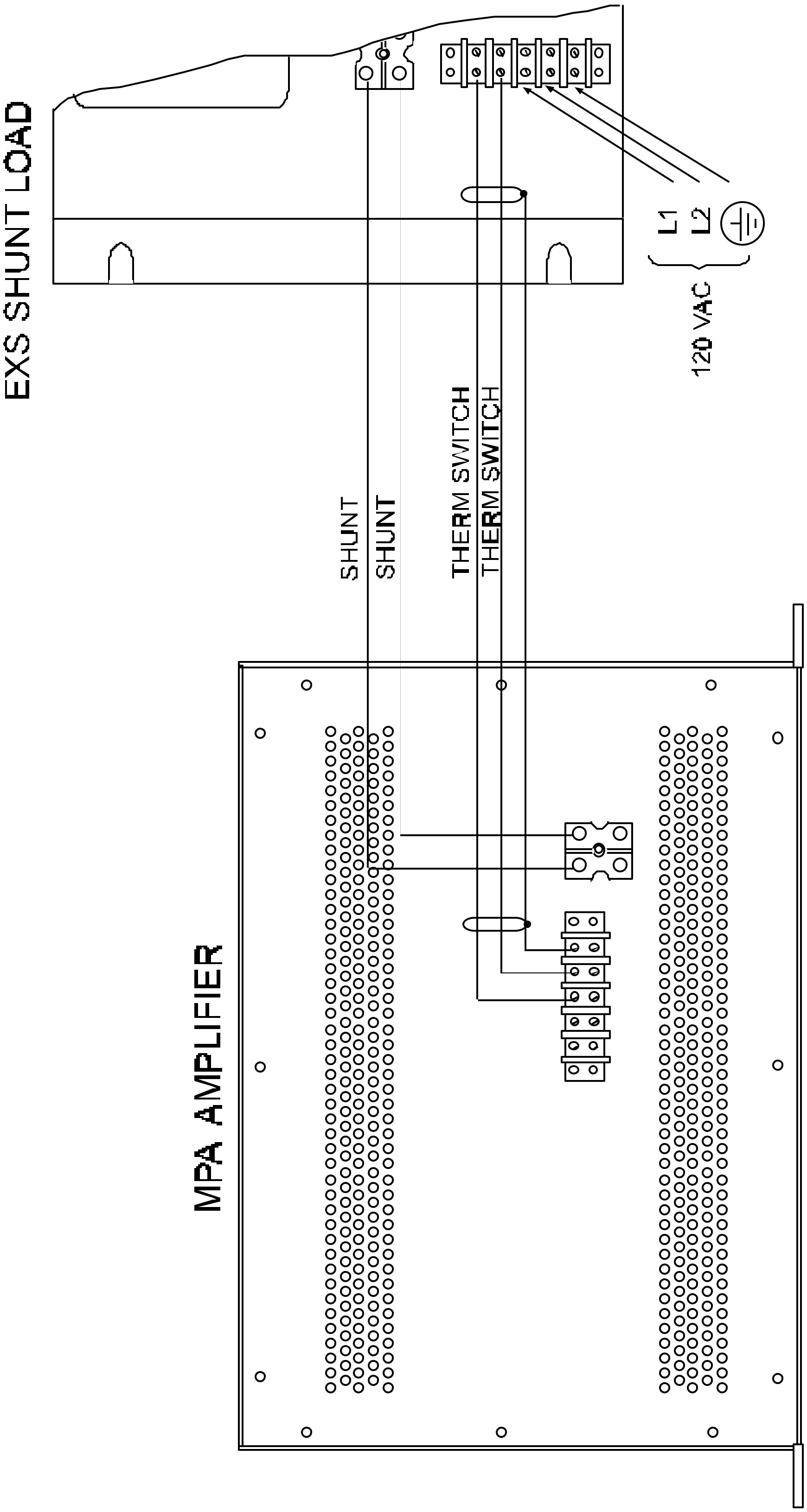
There are two available external shunt loads; designated as:

EXS-50-460
EXS-100-460

This shunt load has two 100 cfm fans and electric heaters for load resistors. It is equipped with a thermal shunt down switch.

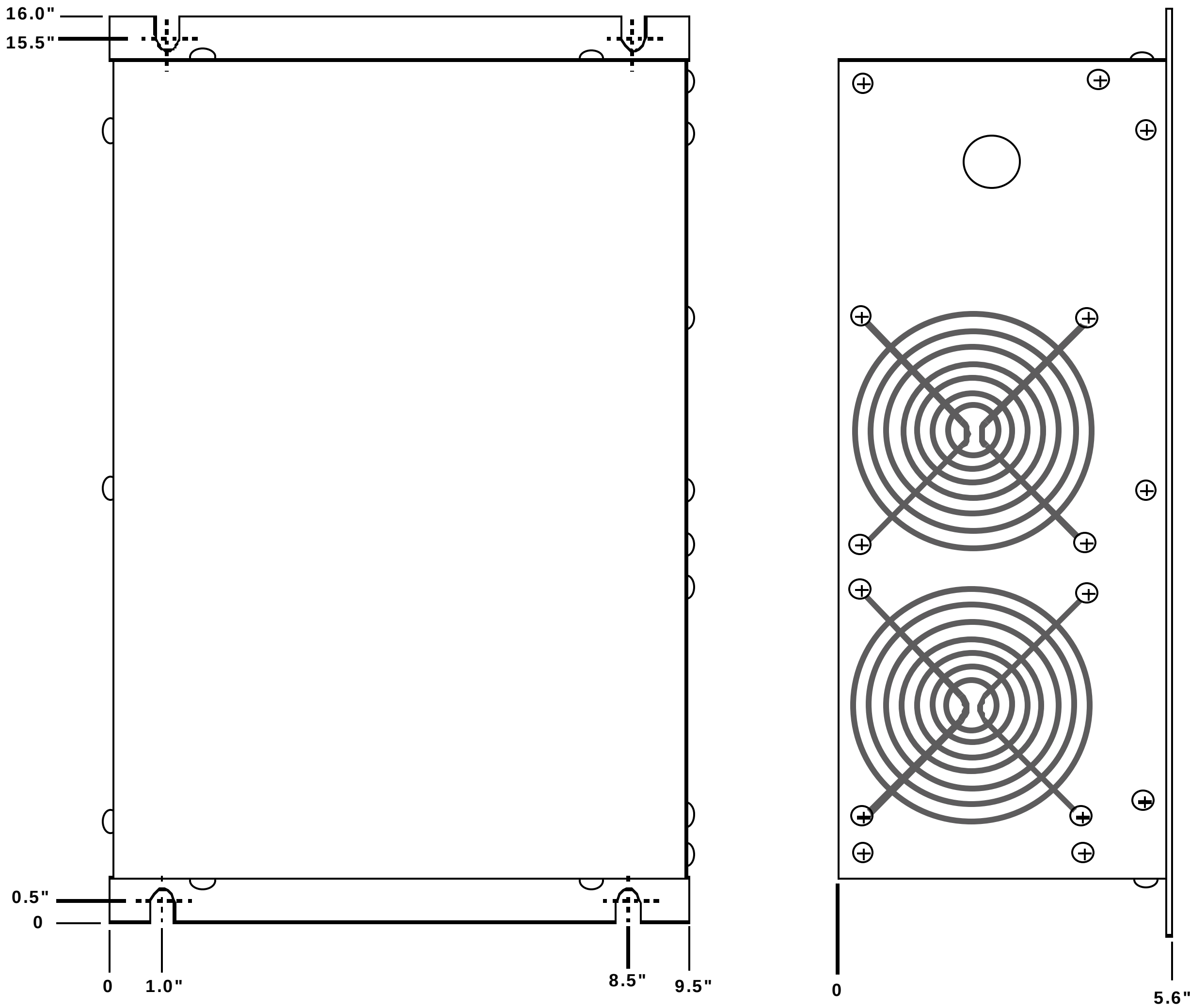
The shunt load should be mounted external to the amplifier enclosure but within four feet of the amplifier. The wiring can be accessed through a 3/4" seal tight connection with an optional cover or it can be wired directly.

Shunt/Amplifier Wiring



MODEL	SHUNT WIRE GA.
EXS-50-460	10
EXS-100-460	8

EXS-50/100-460 Mechanical Footprint

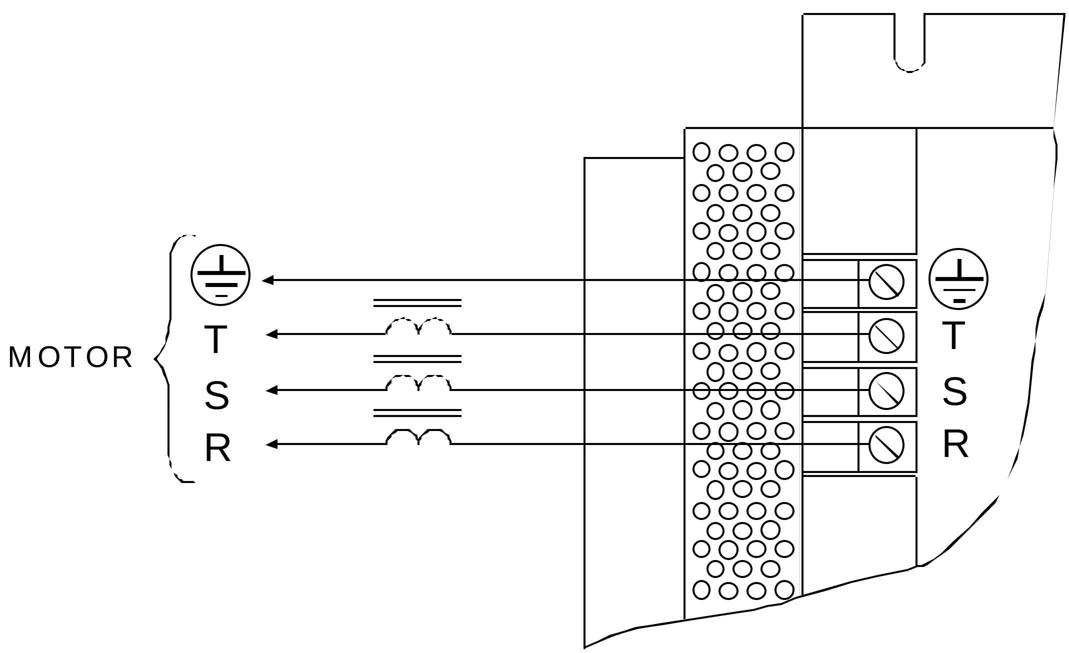


External Inductors

External inductors can be placed in the amplifier R, S and T leads to assure that the minimum inductance specification is assured. The MPA-05/09/15 models all have 2mH drum core inductors installed under the top cover. These versions do not need external inductors to protect the motor. For the MPA-24/35/50/75/100 models, the inductance line-to-line must be no less than 4mH.

One inductor in each line is typical. The turn ON times of the power switches can cause catastrophic destruction of motors. Inductors in RST of the motor leads limit the rise time and preserve the motor. All 460 volt motors should have inductors.

Since the inductors can become very hot, it is recommended that they be wired external to the amplifier enclosure.

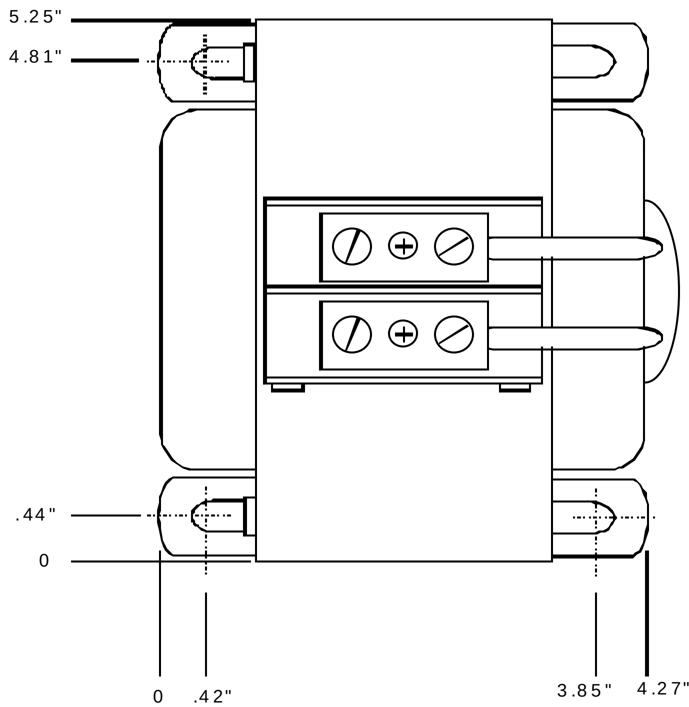


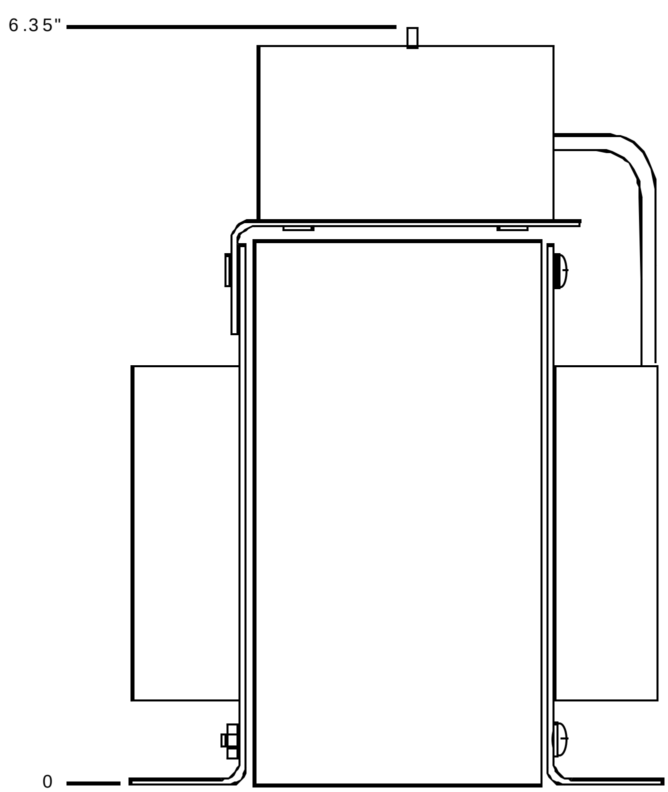
Typical MPA Motor Connections

IND-100-.5mH
IND-25-460-2mH

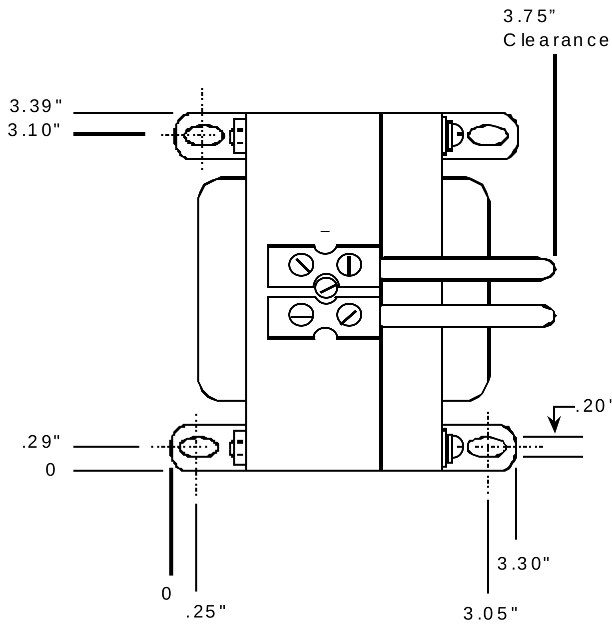
Inductor Mechanical Footprint (loose parts)

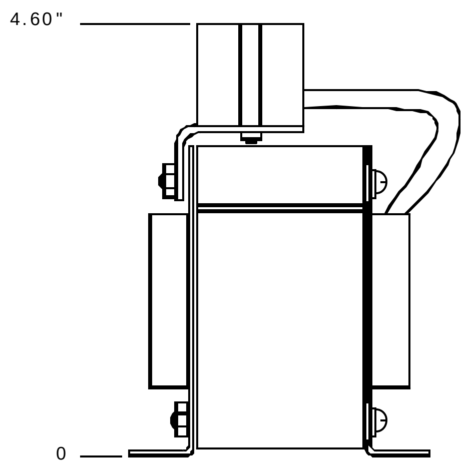
Typical: **IND-100-.5mH**





Typical: IND-25-460-2mH

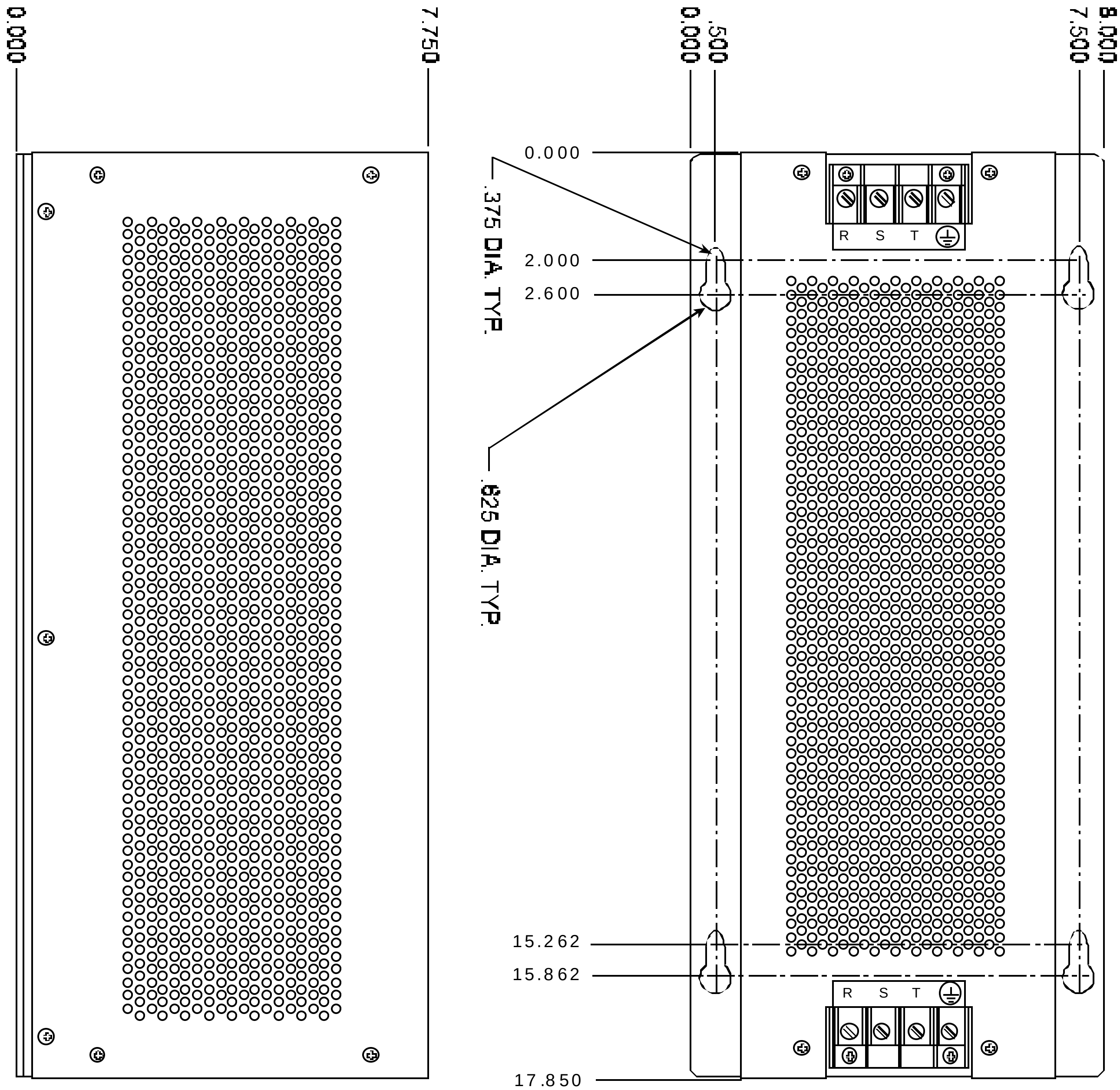




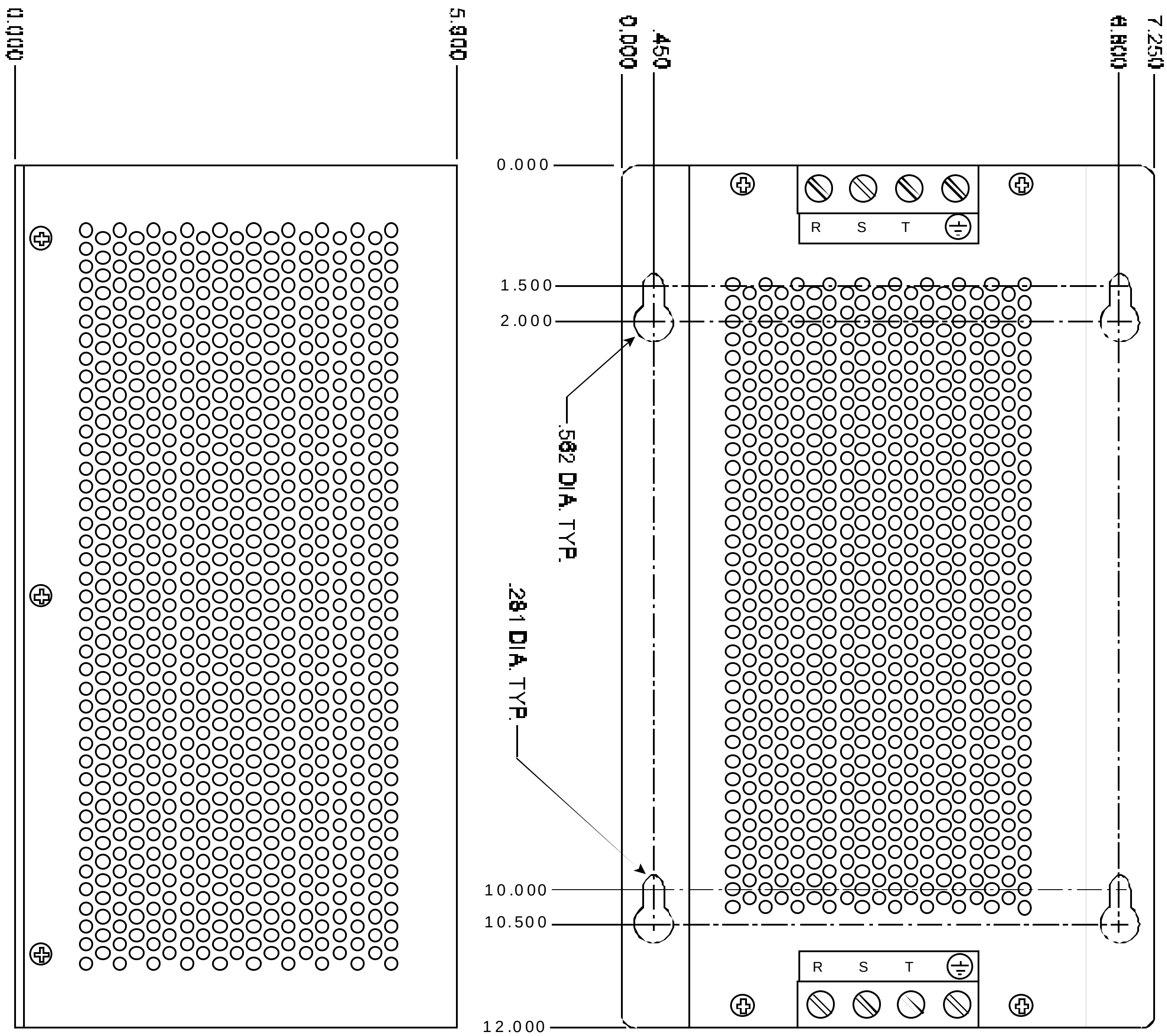
Inductor Box IBX-100-.5mH

In applications where other equipment is supplied in the same enclosure and there is a requirement to reduce the effects of radiated noise, the inductors are available pre-mounted in an enclosure.

To properly reduce the affects of radiated noise, the motor cable, RST, and GND, must be in a 100% shielded cable.



Inductor Box IBX-50-1mH



"-S" Separated Supply Option

The -S option amplifier allows for the removal of the dc voltages from the power devices within the amplifier that form the outputs RST. This is accomplished by removing the main ac (bridge) input. The amplifier should be disabled prior to the removal of power and should not be enabled until this power is restored. Unless this process is followed an erratic start up (Jerking) of the motor shaft can occur because if the logic and amplifier are enabled with no available power for the bridge power device the logic states produce maximum outputs to null the current and velocity loops. If the power to the bridge is restored during this condition the motor may jerk. The reset/enable input of the MPA amplifier forces the logic states to minimal levels.

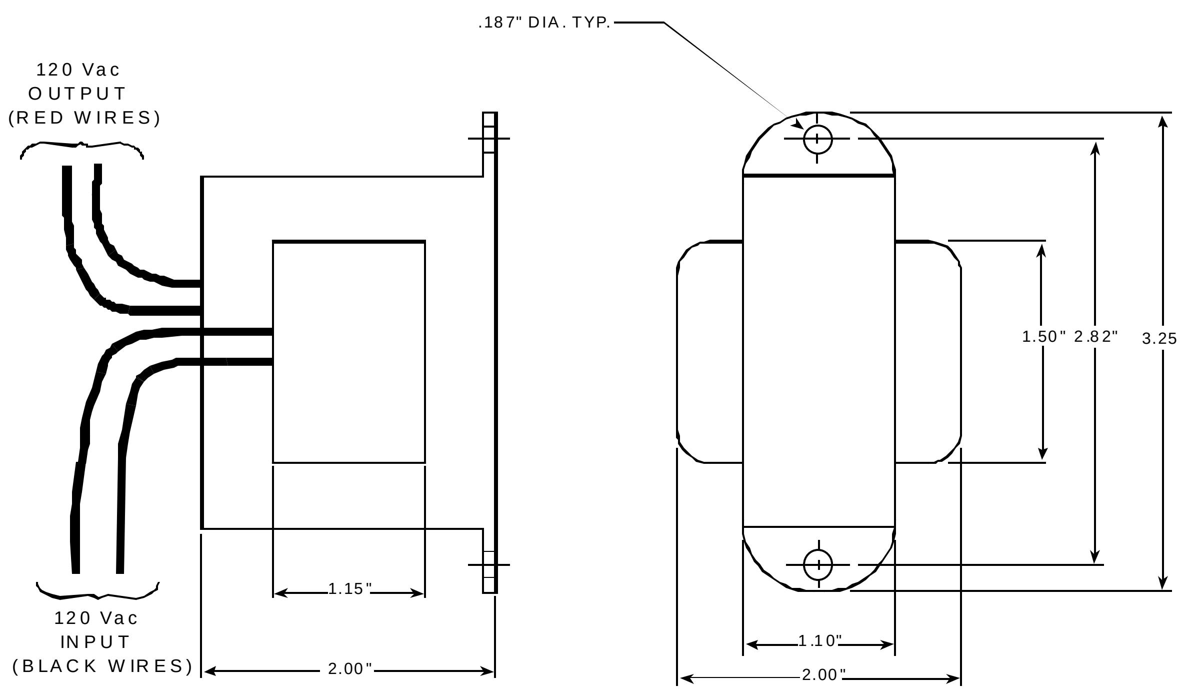
The MPA amplifier that has this option will have two additional terminals identified with an isolated 120 Vac input sticker. This is a low power (50-100 V-A) 120 volt input that cannot be connected to earth ground. Each MPA amplifier should have an isolation transformer to supply the isolated 120 Vac source. A 50 to 100 VA rated transformer that operates from either a 240 or 480 Vac input would be sufficient.

A. The separated supply is returned to ground through the amplifiers internal connection. The ac line source for the amplifier should be bonded to earth ground.

B. This is a class 2 circuit that can only supply 100 VA max.

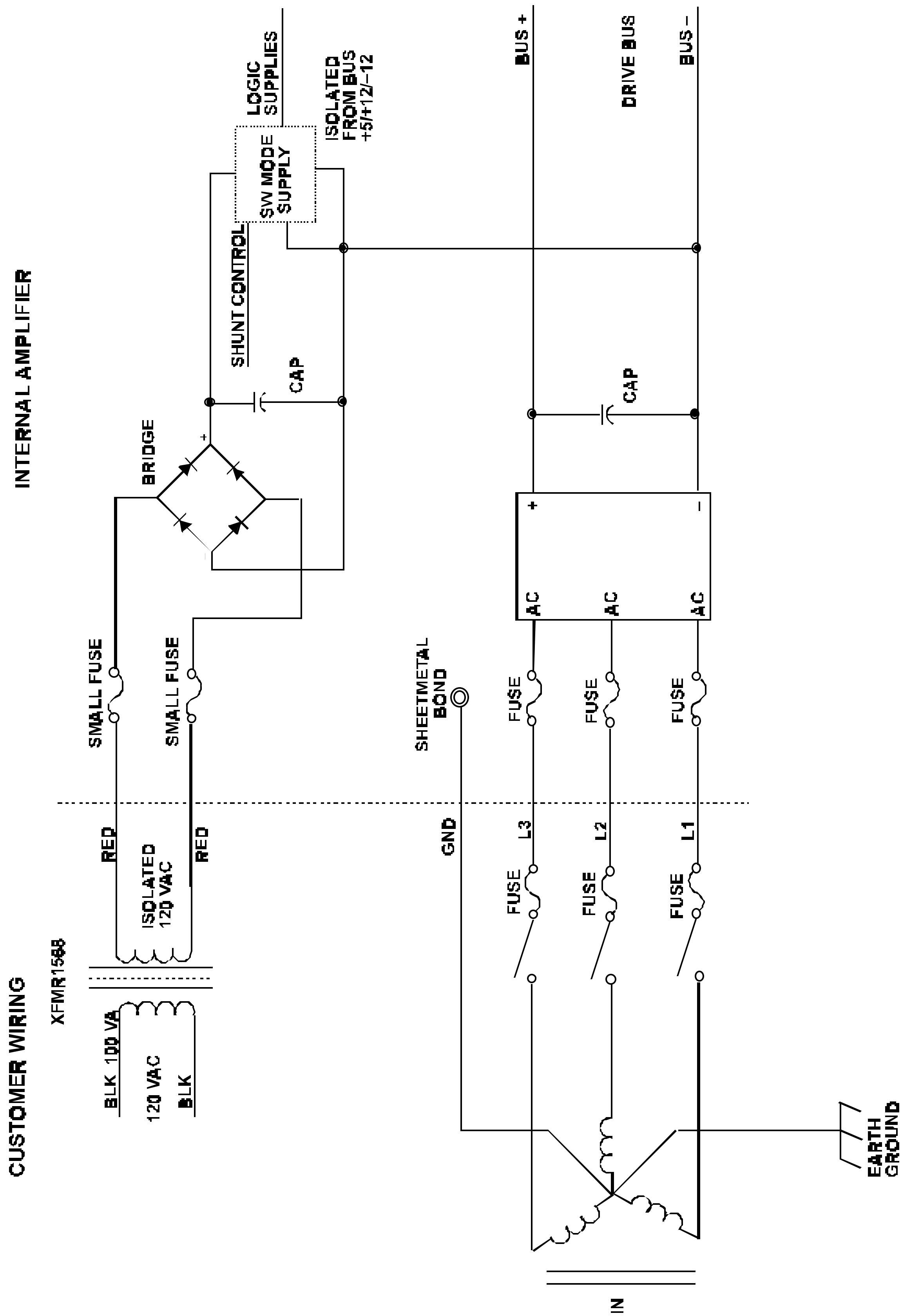
C. The wiring for this circuit is internal to the enclosure.

MTS Automation can supply the isolation transformer. The part number is 119971-97.



This transformer is for 120 Vac single-phase operation only.

Typical "–S" Three Phase 460V Amplifiers



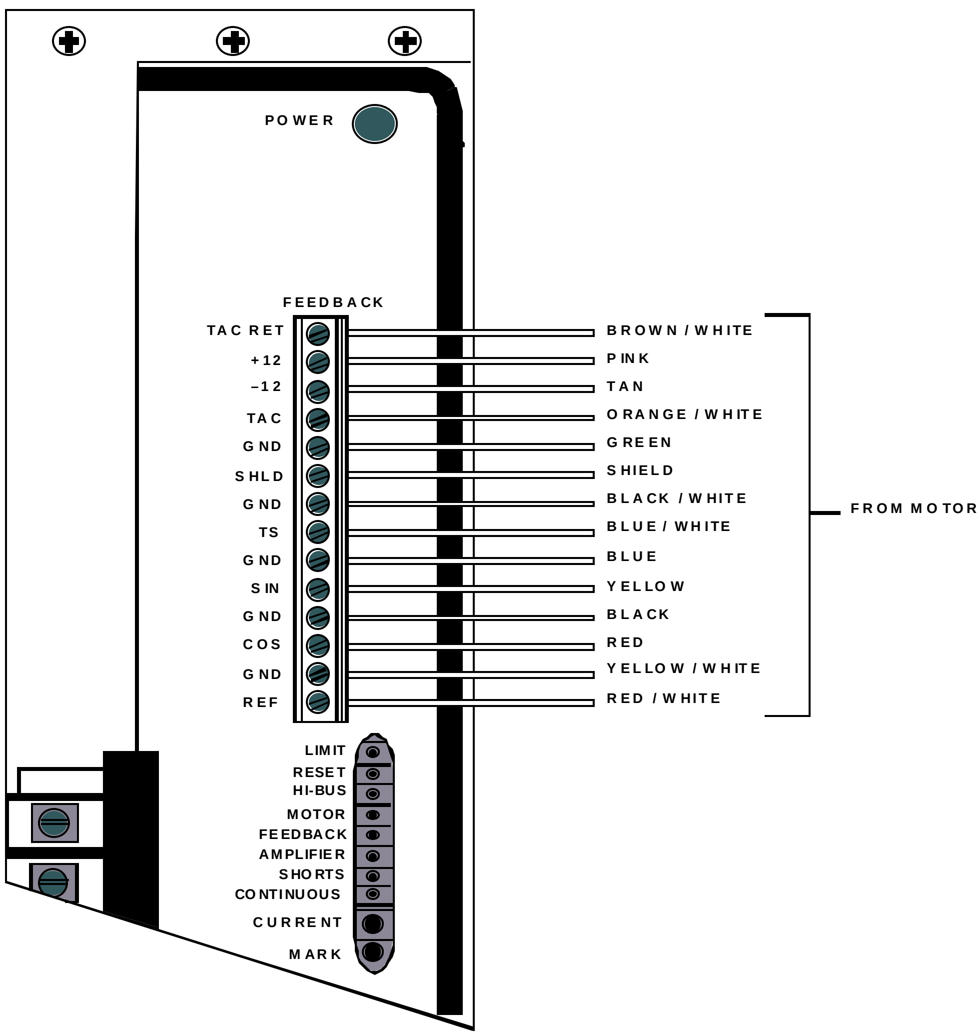
"-T" Brushless TAC Option

The MPA amplifiers use resolver feedback. The resolver provides positional information for commutation of the motor, simulated encoder signals and a velocity signal for the amplifier when the velocity mode is selected.

In some instances, the quality of the velocity signal derived from the resolver to digital converter compromises performance because of 2-Pole cyclic position ripple. The 2 kHz excitation frequency used for the resolver reference may also be effected.

For the most demanding applications, the motors can be instrumented with a brushless tachometer to improve the quality of the velocity signal when the MPA amplifier is provided with the "-T" option. The feedback wiring is extended to facilitate the additional signals.

Typical Feedback Wiring



Start-Up

Once normal wiring is verified, power can be applied to the amplifier.

Assure the DIP switch and jumpers are set as required. Default settings are for 6 pole motors on most MPA amplifiers; 4 pole motors on the MPA-05. Inputs Reset, +Limit, and -Limit are not going to disable the amplifier if they are not connected. Never change the settings of DIP switch 2 with power ON.

The CUR and RESP adjustments are turned down (CCW). CUR is 50% and RESP is minimal.

It is recommended that CUR be turned to its full CCW position. Once power is applied, CUR can be slowly increased in a CW direction to achieve shaft torque. Crispness can be increased by a CW adjustment of RESP.

For start-up verification of wiring with external position controls the following simple test can be used to verify the phase relationship.

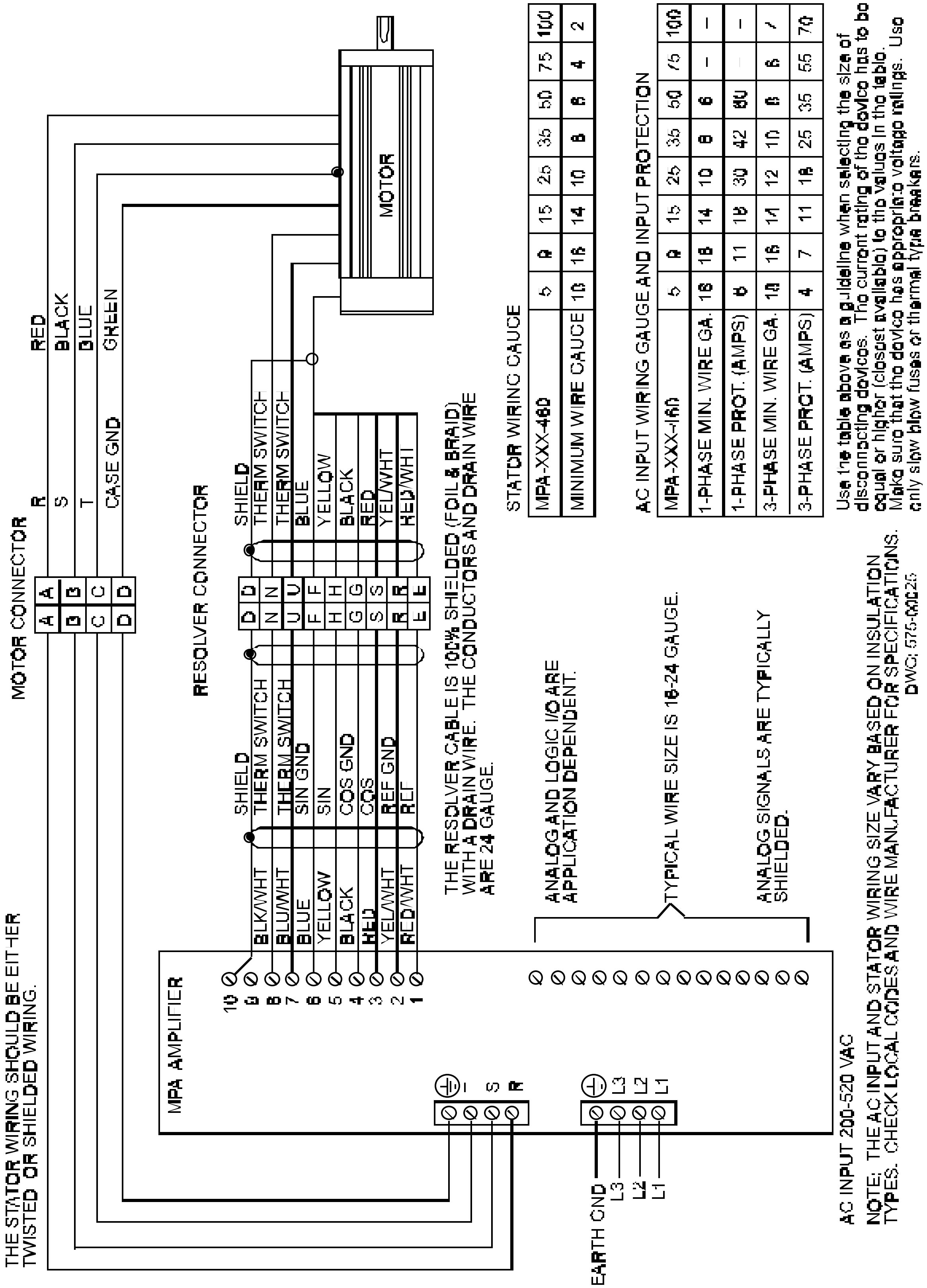
With the current limit turned full CCW or with the RST wiring disconnected, a CW rotation of the motor shaft will produce a negative command voltage at pin #9 (SIG) to pin #11 (GND) on the I/O (J1) connector. For a CCW rotation, a positive command must occur. The rotation is started from a null, or a close to zero shaft position. If the relationship is wrong, there are two choices:

1. interchange the A, A\ and B, B\ signals at the simulated encoder.

2. use the command - input for signal and pin #11 is still ground.

Either method works, but the first method still assures that positive command voltages cause CW rotation of the motor shaft as viewed from the shaft end of the motor.

Typical Wiring – Dual Connector



STATOR WIRING GAUGE

MPA-XXX-460	5	8	15	25	35	50	75	100
MINIMUM WIRE GAUGE	16	16	14	10	8	6	4	2

AC INPUT WIRING GAUGE AND INPUT PROTECTION

MPA-XXX-460	5	8	15	25	35	50	75	100
1-PHASE MIN. WIRE GA.	18	18	14	10	8	6	—	—
1-PHASE PROT. (AMPS)	6	11	18	30	42	60	—	—
3-PHASE MIN. WIRE GA.	18	16	14	12	10	8	6	4
3-PHASE PROT. (AMPS)	4	7	11	18	25	35	55	70

Use the table above as a guideline when selecting the size of disconnecting devices. The current rating of the device has to be equal or higher (closest available) to the values in the table. Make sure that the device has appropriate voltage ratings. Use only slow blow fuses or thermal type breakers.