BURNY®

ServoPak 150

Operation And Maintenance Manual

AO-73133
(REVISION E)

Cleveland Motion Controls
An IMC Company

Cleveland Motion Controls 1997
Burny Division
7550 Hub Parkway
Cleveland, Ohio 44125
Telephone: (216) 524-8800

Servopak 150

Documentation for compliance with the EMC Directive (EC)

These instructions must be followed during the installation of the Servopak 150 Drive system. This insures compliance with the EC 's EMC Directive, and provides the best protection against outside RFI interference. These installation procedures should be used for ALL installations.

Contents:

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ServoPak 150 -- Installation Instructions to insure compliance with EMC Directive

1. All Cabinet screws on the **ServoPak** enclosure must be installed and securely tightened.

2. All cables connected to the **ServoPak** must be supplied by Burny-Etek, or must be built to Burny-Etek cable specifications. Specific cable construction drawings will be supplied upon request.

3. All cables connected to the **ServoPak** must have external braid shielding, with metal ground clamps at each end of the cable to connect the braid to the equipment. Metal grounding clamps must fit tightly onto the external braid-- if clamp is loose, gently crimp the clamp onto the braid to provide a secure connection. Don't crimp any harder than necessary to avoid damaging the internal cable. (Customer supplied cables which do not use external braid must be approved by Burny-Etek).

   Armature/Tach cables (MO-06926-XXX and others) require a metal grounding clamp to be installed at both ends of the cable.

   - At the **ServoPak**, the clamp should be connected to the corner mounting screw of the amplifier where the cable is plugged into. Some heatsink assemblies will have a special grounding screw supplied for this purpose. As the cable exits from the connector plug, it should be bent into a small loop (about 100-125 mm dia.) so it can be routed past the corner mounting screw on the amplifier heatsink. The metal clamp is placed around the external cable braid shield and fastened securely with the mounting screw (again, some heatsinks will have a separate screw provided for this purpose.). See drawing AO-72104 for details on this connection.

   - At the Motor end of the cable, the external braid must be grounded to the motor mounting bracket using the metal cable clamp as shown in drawing AO-72106

   All other cables that connect to the back of the ServoPak enclosure must have their external braid grounded to the ServoPak enclosure with metal clamps:

   - Limit Switch Cables, Resolver cables, the drive interface cable and any other type of cable connected to the back of the **ServoPak** should have it's external braid shielding connected to one of the cabinet grounding screws provided on the back of the **ServoPak** enclosure-- using a metal, 360 degree contact grounding clamp. See drawing AO-72105.

4. The enclosure of the **ServoPak** must be grounded to the machine frame's earth ground connection point by a braided ground strap-- at least 12 mm in width. A wide flat ground strap provides a better RF ground path therefore a strap is preferred. The strap can be terminated with standard crimp terminals at both ends. The strap should connect to one of the chassis grounding screws on the back of the **ServoPak** per drawing AO-72102.

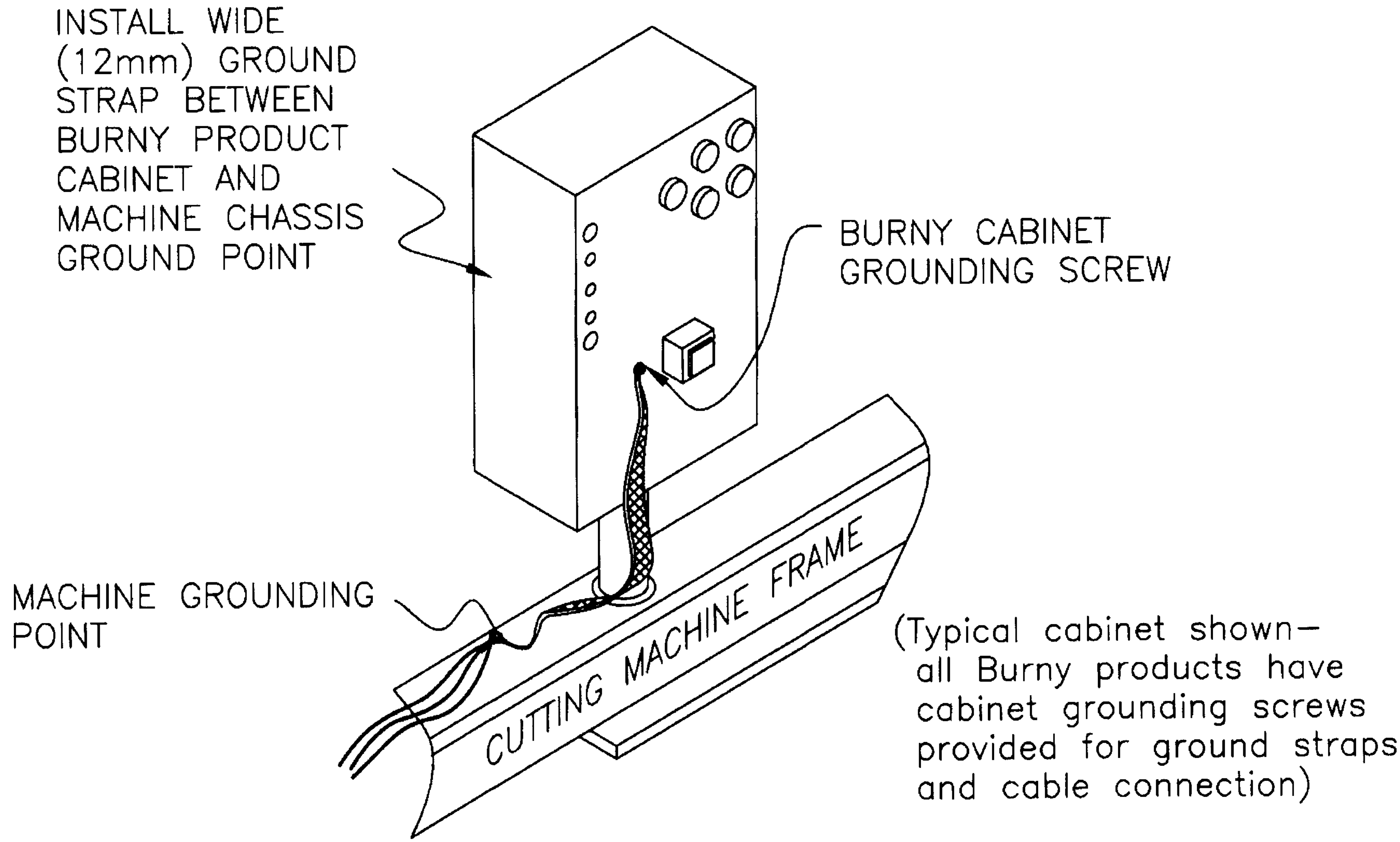
5. Any connectors on the back of any Burny-Etek product that do not have a cable connected must have plastic protective cover installed. This can either be the red disposable type or the attached screw thread covers.

6. If motor mounted encoders are used the MO-11124 Kit must be installed over the junction of the plastic connectors between the encoder cable, and the short lead coming from the encoder. This kit and instructions are shipped with each of the following cables, and are also shown on drawing AO-72107.

   Cables which require connector shield kit: MO-08798-XXX
   MO-09938-XXX

7. Service must be performed by trained authorized technicians only. Service technicians must wear a static grounding wristband connected to the equipment enclosure when removing or installing any boards or EPROMS in the system. All circuit cards must be shipped in protective anti-static shielding bags, and any card or part removed from a Burny-Etek product must be immediately placed into one of these anti-static bags. Any circuit card or electronic component returned for credit or repair must be shipped in an anti-static bag. If a circuit card is returned without the proper anti-static packaging, no warranty or credit will be issued. Contact Burny-Etek for specifications or help with anti-static packaging.

8. All motors used with the **ServoPak** must be supplied by Burny-Etek to insure compliance with the radiated emission requirements of the EMC Directive. If other than Burny-Etek supplied motors are used, it is the responsibility of the machine builder to test the motors in the system for compliance with the EMC directive.



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A	RELEASED		KJB	12-95

TOLERANCES (EXCEPT AS NOTED)
DECIMAL
X.X ± .030
X.XX ± .015
X.XXX ± .005
ANGULAR
± 0.5°
DO NOT SCALE DRAWING

Cleveland Motion Controls
An IMC Company
7550 HUB PARKWAY CLEVELAND, OHIO

MATERIAL	FINISH	SCALE	REF
NOTE	NOTE	1 : 1	

CUSTOMER INSTRUCTION
GROUND STRAP INSTALLATION

CAD DWG NO. : DXXX-XXXXX_X.DWG		SIZE	DRAWING NUMBER	REV
DRAWN BY KJB	APPROVED BY KJB	A	AO-72102	A
DATE 12/12/95	DATE 12/95	SHEET 1 OF 1		

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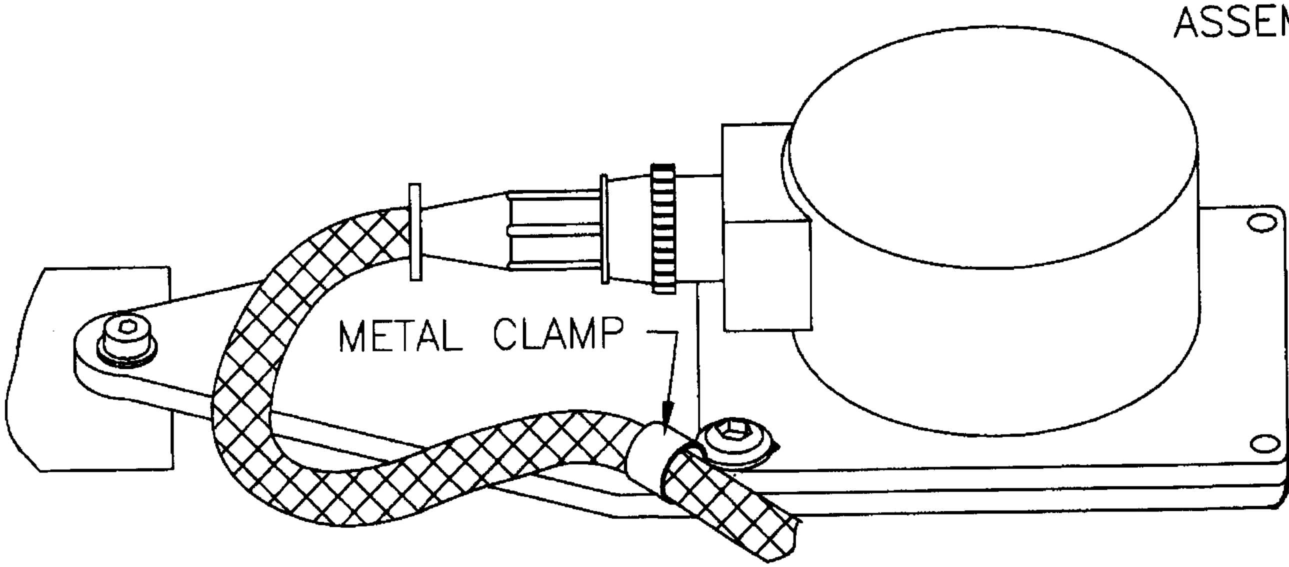

GROUND EXTERNAL CABLE SHIELD TO ENCODER BASE USING EXISTING HARDWARE AND 360° METAL CLAMP

METAL CLAMPS PROVIDED WITH ALL BURNY CABLE ASSEMBLIES

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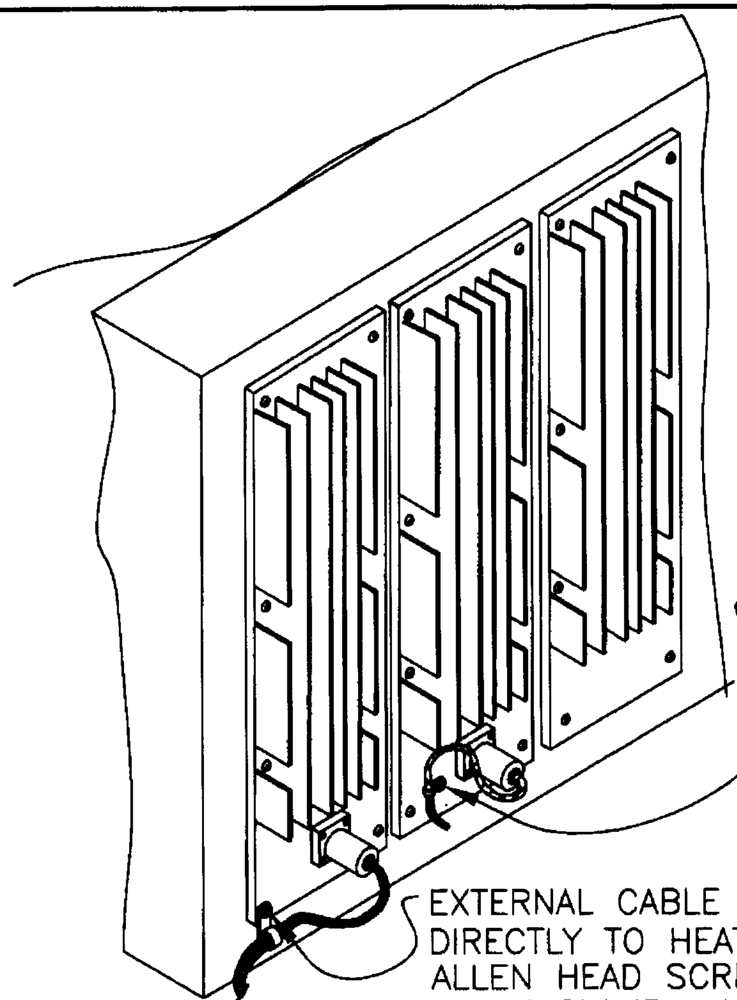
An EMC Company
7550 HUB PARKWAY CLEVELAND, OHIO

MATERIAL	FINISH	SCALE	REF
NOTE	NOTE	1 : 1	

RACK MOUNTED ENCODER CABLE GROUND CLAMP INSTRUCTIONS

CAD DWG NO. : DXXX-XXXXX_X.DWG		SIZE	DRAWING NUMBER	REV
DRAWN BY KJB	APPROVED BY KJB	A	AO-72103	A
DATE 12/95	DATE 12-95	SHEET 1 OF 1		



TYPICAL BACKPANEL ON BURNY 2.8 OR SERVOPAK 150.

NEW HEATSINK HAS CABLE GROUNDING SCREW PROVIDED – IF PRESENT,THIS SCREW SHOULD BE USED TO CONNECT EXTERNAL BRAID TO HEATSINK

EXTERNAL CABLE SHIELD GROUNDED DIRECTLY TO HEATSINK BY EXISTING ALLEN HEAD SCREW WITH 360° METAL CABLE CLAMP– ADD FLAT WASHER IF NECESSARY

METAL CLAMPS PROVIDED WITH ALL BURNY CABLE ASSEMBLIES.

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A	RELEASED		KJB	12-95

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MATERIAL	FINISH	SCALE	REF
NOTE	NOTE	1 : 1	

ServoPak MOTOR/TACH. GROUND

CAD DWG NO. : DXXX-XXXXX_X.DWG		SIZE	DRAWING NUMBER	REV
DRAWN BY KJB	APPROVED BY KJB	A	AO-72104	A
DATE 12-95	DATE 12-95	SHEET 1 OF 1		

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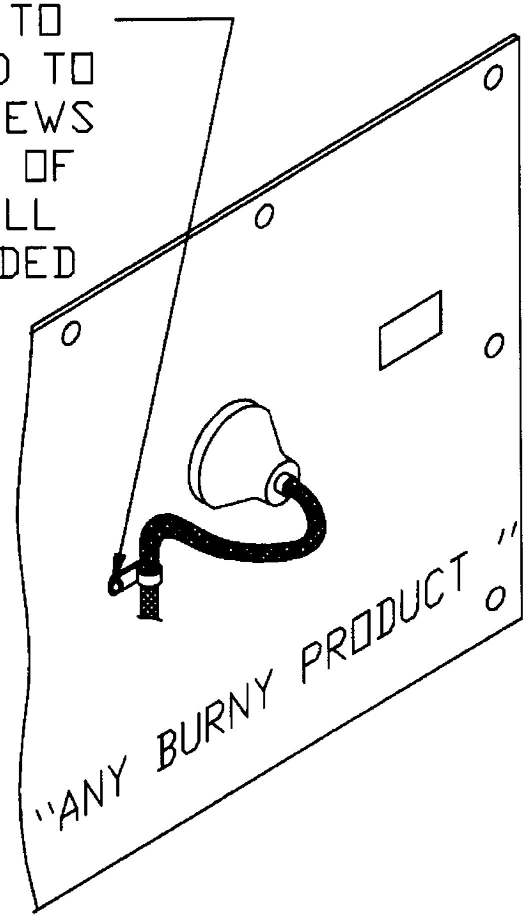
USE 360° METAL CLAMP TO GROUND EXTERNAL BRAID TO CABINET GROUNDING SCREWS PROVIDED ON THE BACK OF ALL BURNY PRODUCTS. ALL CABLES MUST BE GROUNDED IN THIS FASHION

METAL CLAMPS PROVIDED WITH ALL BURNY CABLE ASSEMBLIES



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An IMC Company
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MATERIAL	FINISH	SCALE	REF
NOTE	NOTE	1 : 1	

CABLE GROUND TO BACK OF CABINET

CAD DWG NO. : DXXX-XXXXX_X.DWG

DRAWN BY	APPROVED BY	SIZE	DRAWING NUMBER	REV
KJB	KJB	A	AO-72105	A
DATE 12-95	DATE 12-95	SHEET 1 OF 1		

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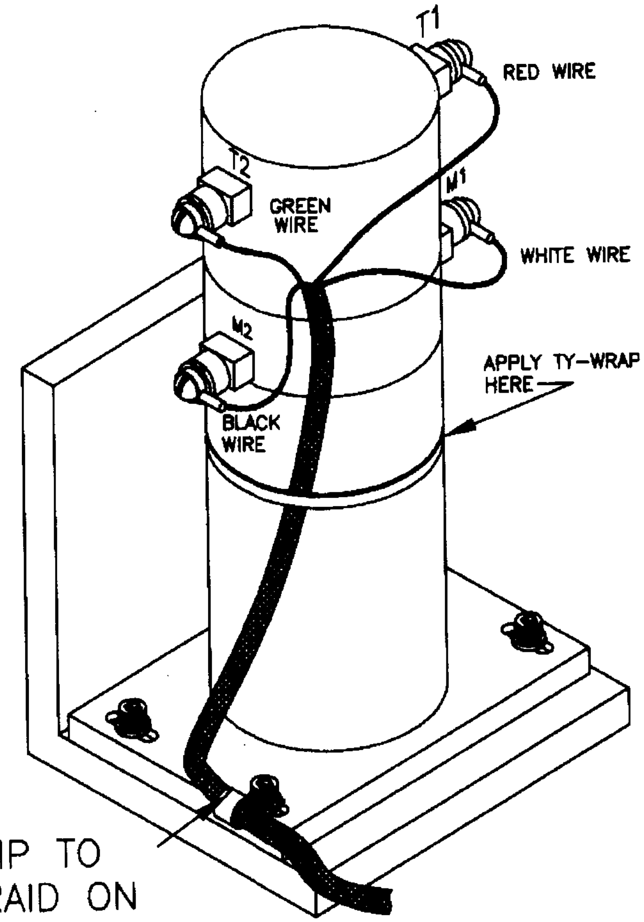

USE 360° METAL CLAMP TO GROUND EXTERNAL BRAID ON MOTOR/TACH. CABLE TO ONE OF THE SCREWS ON THE MOTOR MOUNTING PLATE AS SHOWN

METAL CLAMPS PROVIDED WITH ALL BURNY CABLE ASSEMBLIES

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MATERIAL	FINISH	SCALE	REF
NOTE	NOTE	1 : 1	

MOTOR CABLE GROUND CLAMP INSTALLATION (2630)

CAD DWG NO. : DXXX-XXXXX_X.DWG		SIZE	DRAWING NUMBER	REV
DRAWN BY KJB	APPROVED BY KJB	A	AO-72106	A
DATE 12-95	DATE 12-95	SHEET 1 OF 1		

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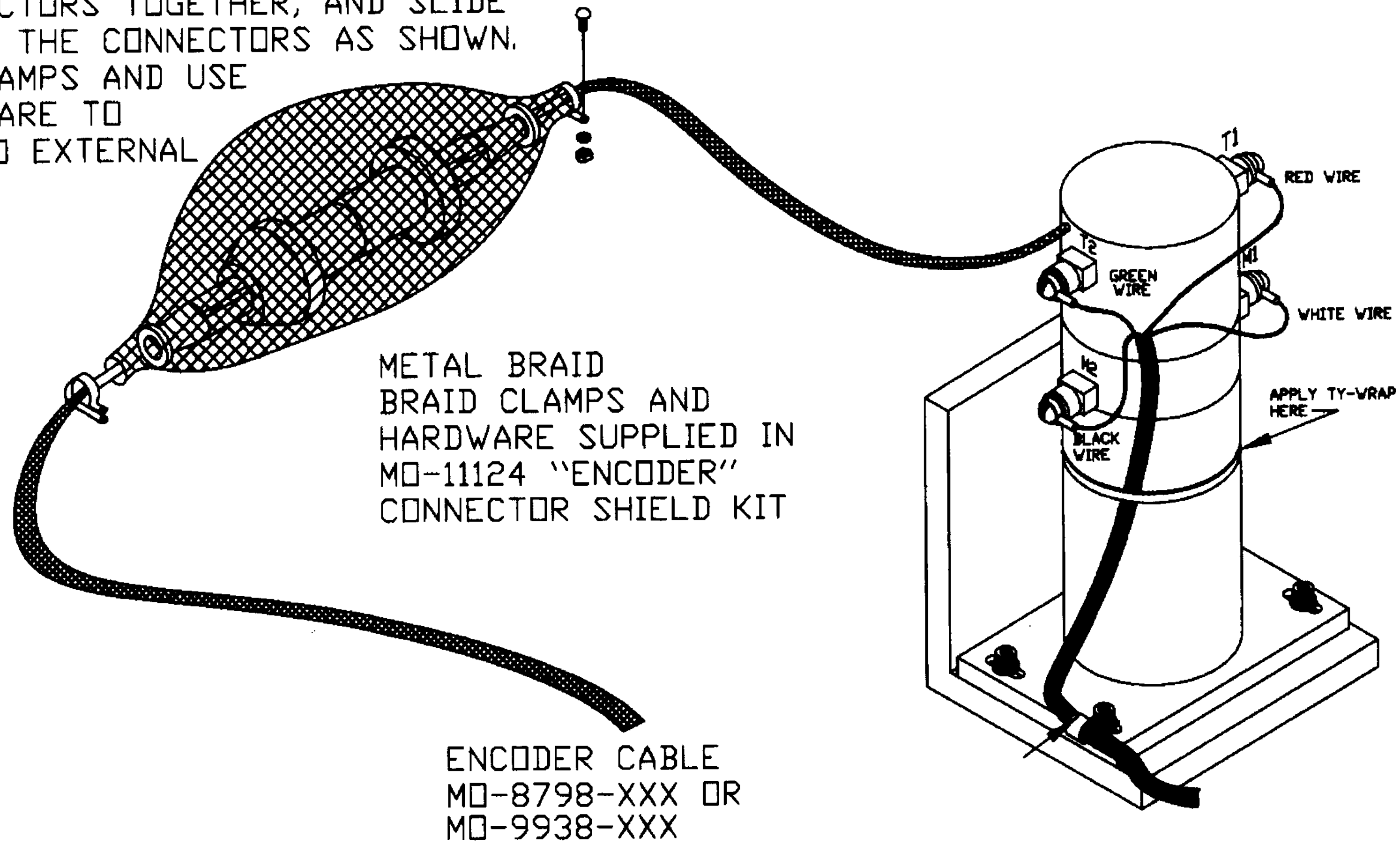
WITH CABLES DISCONNECTED, SLIDE METAL BRAID COMPLETLY ONTO THE ENCODER CABLE. PLUG THE CONNECTORS TOGETHER, AND SLIDE THE BRAID OVER THE CONNECTORS AS SHOWN. APPLY METAL CLAMPS AND USE SUPPLIED HARDWARE TO GROUND BRAID TO EXTERNAL CABLE SHIELD.



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A	RELEASED		JB	12-95

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7550 HUB PARKWAY CLEVELAND, OHIO

MATERIAL	FINISH	SCALE	REF
NOTE	NOTE	1 : 1	

CUSTOMER INSTRUCTION ENCODER CONNECTOR SHIELD

CAD DWG NO. : DXXX-XXXXX_X.DWG		SIZE	DRAWING NUMBER	REV
DRAWN BY KJB	APPROVED BY KJB	A	AO-72107	A
DATE 12-95	DATE 12-95	SHEET 1 OF 1		

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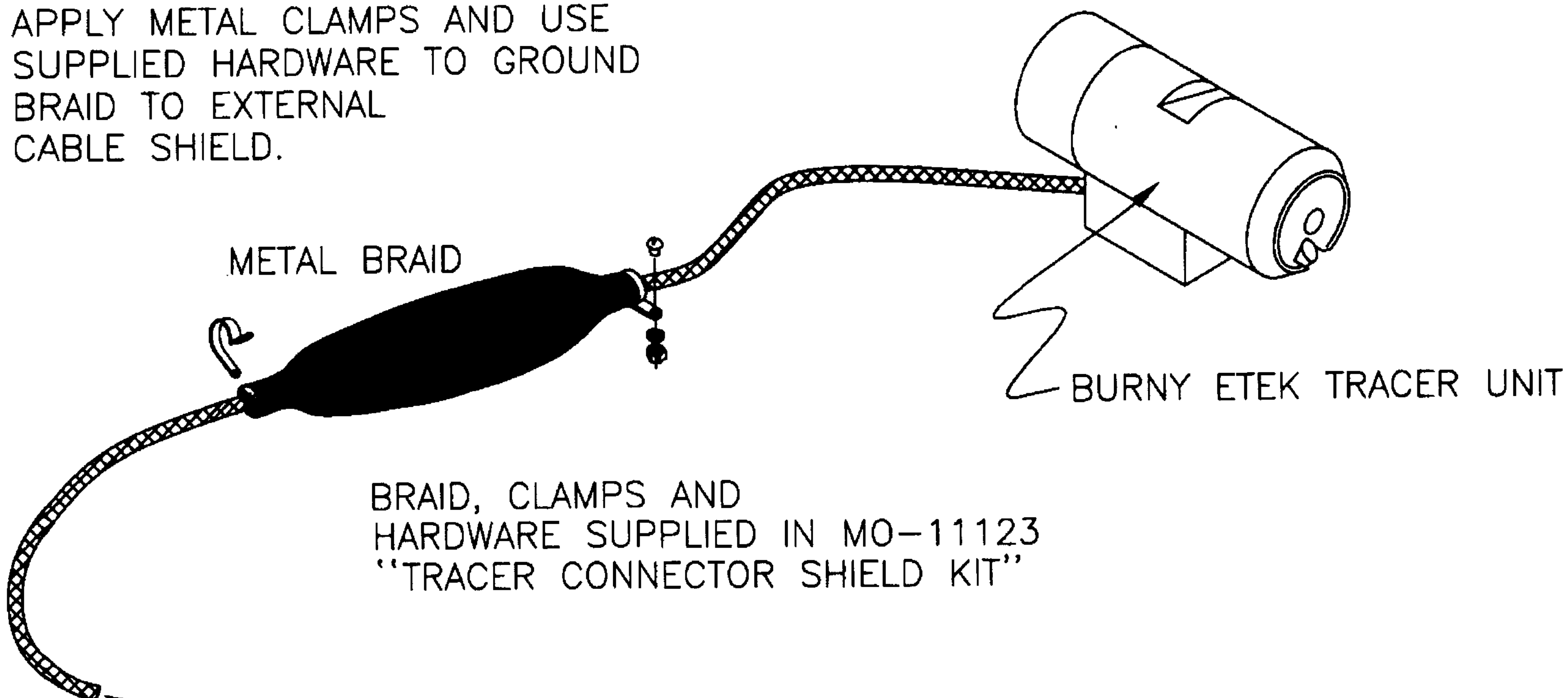
WITH CABLES DISCONNECTED,SLIDE METAL BRAID COMPLETLY ONTO THE TRACER CABLE.
PLUG THE CONNECTORS TOGETHER,AND SLIDE THE BRAID OVER THE CONNECTORS AS SHOWN.
APPLY METAL CLAMPS AND USE SUPPLIED HARDWARE TO GROUND BRAID TO EXTERNAL CABLE SHIELD.



BRAID, CLAMPS AND HARDWARE SUPPLIED IN MO-11123 "TRACER CONNECTOR SHIELD KIT"

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A	REV. KIT No.& CHG.No.	11478	KJB	12-95

TOLERANCES (EXCEPT AS NOTED)
DECIMAL
X.X ± .030
X.XX ± .015
X.XXX ± .005
ANGULAR
± 0.5°
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An IMC Company
7550 HUB PARKWAY CLEVELAND, OHIO

MATERIAL	FINISH	SCALE	REF
NOTE	NOTE	1 : 1	

CUSTOMER INSTRUCTION
TRACER CONNECTOR SHIELD

CAD DWG NO. : DXXX-XXXXX_X.DWG		SIZE	DRAWING NUMBER	REV
DRAWN BY KJB	APPROVED BY KJB	A	A0-72108	A
DATE 12-95	DATE 12-95	SHEET 1 OF 1		

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NOTE: This manual is used for both 2-AXIS and 3-AXIS ServoPak drive systems. Some of the documents are common to both systems while others apply to ONLY a 2 or 3 axis system. These are clearly labeled in the table of contents.

2-AXIS SYSTEM (MNA-04810) SCHEMATICS:

CO-24413 - MO-05153-0 POWER SUPPLY CARD SCHEMATIC

Used on 2-AXIS systems only- Includes the BUS supply, +/-15V supply only. Does not contain the resolver syncronization circuit.

DO-28125 - 2-AXIS SYSTEM CABINET WIRING

2-AXIS SYSTEM (MNA-06522) SCHEMATIC:

D0-24716 - 2 AXIS SYSTEM CABINET WIRING

3-AXIS SYSTEM (MNA-05233) SCHEMATICS:

DO-24273 - MO-5153-2 POWER SUPPLY W/SYNC CARD SCHEMATIC

Used on 3-AXIS systems- Includes BUS Supply, +/-15V supplies, and resolver syncronization circuit.

DO-24308 - 3-AXIS SYSTEM CABINET WIRING

3-AXIS SYSTEM (MNA-06508) SCHEMATIC:

D0-23901 - 3 AXIS SYSTEM CABINET WIRING

SERVOPAK 150 POWER JUMPERS

C0-24703 - SCHEMATIC OF POWER JUMPERS

2-AXIS DRIVE TUNEUP PROCEDURE

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The following "Tune-Up" procedure is recommended for both initial installation and whenever any electrical drive component is replaced. It can also be used to help diagnose problems if the performance of the machine has degraded from it's original level.

Before attempting this procedure, the user should be familiar with the Operation and Setup manuals for this control, as well as the ANA-73106 Servo-Pak Axis card manual (included at the end of this manual).

It is extremely important to check the mechanical systems on the machine before using this procedure. Problems which appear to be electrical can actually be due to mechanical causes (binding, misalignment, etc.). The following mechanical systems should be checked:

- All drive components are properly tightened. In particular, any pulleys, gears etc. are tight on their shafts, and all drive mounting hardware is tight.

- All bearings and slides rotate and move freely.

- Rails are properly installed and aligned per the manufacturers specifications.

- Drive pinions are properly "loaded" into the drive rack.

- All drive components rotate freely. This can be checked by disconnecting machine power and manually rotating the drive motor through one complete revolution of the output pinion. Reverse the direction and rotate the motor until the pinion is back in it's original position. There should be no excessive binding or sticking.

- Check that the feedback devices (encoders, resolvers or both) are properly installed, and that the loading on the pinions, or drive chains is correct. If belts or chains are used to drive the feedback devices, they should be adjusted to be "snug" and free of backlash but should not put excessive lateral pressure on the feedback devices bearings.

After checking the above, and repairing/aligning as necessary, proceed with the following adjustments.

1. Disconnect power from the CNC, machine drives, router,plasma or other tools.

2. Disengage all drives so the motors can turn freely without moving the cutting machine.

3. If this is a new machine, setup the standard parameters using the SERV10 procedures.

4. If an axis card is being replaced, set the jumpers to the same positions as the card being replaced. Also set the following pots:

   - GAIN to full CW

   - COMP to full CW

   - LIMIT to full CW

   - Set filter pots- NOTCH FREQUENCY,WIDTH,DEPTH approximately the same as card being replaced.

5. Unplug the encoder cables at the control station. Motor cables are connected at this point.

6. Apply AC power to the drive and CNC. Since the encoder cables are disconnected, the CNC control will output 0.00 volts for both the X and Y drive references. If any motor runs away at this point, it indicates that the polarity of the tachometer is backward. If this happens, remove AC power (press E-STOP), reverse the tach wires to the motor, and turn the AC power back on. The motor should now remain stationary.

7. Since the CNC drive references should still be 0.00 volts, if any motor movement at this point is caused by drift in the servo drive. If any drive is drifting at this point, adjust the BALANCE pot on the axis card to eliminate the drift.

8. Jog the machine in the +X direction and verify that the X motor rotates so the pinion would move the machine in the +X direction. If it rotates in the -X direction, reverse the X drive direction using SERV10 to change the setting of 'SD25-X DRIVE DIR'.

9. Jog the machine in the +Y direction and verify that the cross axis pinion rotates in a direction to move the machine in the +Y direction (to the left). Reverse the drive direction if necessary using SERV10 to change the setting of 'SD26-Y DRIVE DIR'.

10. Remove AC power (press the E-STOP).

11. Connect the X encoder cable to the control console.

12. Select DSPY01- X/Y DISPLAY to show the X/Y position. Press the "CLR" or "CE" button to clear the displays to 0.00.

13. Apply AC power and immediatly set the control to jog the machine in the +X direction. The display should show the X position counting in the positive (+) direction. If it counts negative, use SERV10 to change 'SD23-X ENC DIR'. Press "CYCLE STOP". The X motor should stop and remain stationary.

14. Remove AC power.

15. Connect the Y axis encoder cable to the control console.

16. Re-Apply AC power and immediatly set the control to jog the machine in the +Y direction. The display should show the Y position counting in the positive (+) direction. If the Y display counts negative, use SERV10 to change the setting of 'SD24-Y ENC DIR'. Press "CYCLE STOP". Both motors should be stationary.

17. Perform the SERV54 procedure.

18. Select the SERV51-SPD CAL procedure however when the readout prompts to press "CYCLE START", press the "RECYCLE" (RESET) instead. This clears out any previous calibration data.

19. Use the SERV97 routine to store the new settings so they aren't lost if the power is turned off.

20. Select SERV50-AXIS SPD and jog in the +X direction. Adjust the TACH pot on the cross axis amplifier card for the correct speed.

21. Change to jog in the +Y direction. Adjust the TACH pot on the cross axis amplifier card for the correct speed.

22. Remove AC power.

23. Engage the X and Y axis drives in the gear rack.

24. Re-apply AC power.

25. Confirm that the LIMIT pot on all drives is set to full CW for maximum current.

"IMPORTANT"

The GAIN and COMP adjustments are made using an oscilliscope. It is absolutely ESSENTIAL that an UNGROUNDED oscilliscope is used for these measurements. The chassis of the scope must not connect to the power line Earth ground either via a 3-prong grounded plug, or by resting the scope on the metal frame of the machine and grounding the scope chassis to the machine chassis. If the scope is inadvertently grounded, severe damage may be done to the axis card during the test.

26. Connect the scope probe and ground lead across each side of the motor armature of the axis to be adjusted. Set the time base and voltage scale so that one full cycle of the PWM waveform appears on the screen. Set the feedrate to maximum.

While alternately jogging back and forth, adjust the GAIN pot CCW until the multiple traces at the rising and falling edges of the waveform are fairly stable. Further stability can be obtained by turning the COMP pot CCW. (Wait several minutes -or adjust the other axis's and come back- and re-check the waveform to see if the thermal changes in the motor have influenced the stability. Adjust as necessary).

Repeat the procedure for both axis cards.

27. Run the machine the full length in both the rail and cross axis and watch for any problems. When the end of travel is reached, verify that the drive stops due to the electric limit switch and does not reach the hard stop. It is very important to check the operation of the limit switches since it prevents the machine from jamming at the end of travel in full current limit for an indefinite amount of time.

28. Run the SERV51-SPD CAL procedure. When done, use the SERV97 to store the results.

29. Check the squareness of the machine by tracing as large a square as possible and measuring the diagonals. They should be exactly the same length. If the squarness needs to be adjusted, re-align the cross carrige to the main truck per the manufacturers directions.

    Note, it is not necessary to draw the entire square, only the corners. Therefore, this test can be done with 4 small pieces of paper located at the corners of the square so only the corners will be drawn.

"IMPORTANT"

> After adjusting the square of the machine, run the machine over the full length of the rail axis and re-confirm that there is no binding or any type of interference. If possible, monitor the current on both axis motors (one at a time if necessary) as the machine is moved over the entire operating area. The current should remain well below 3 Amps at all times except for higher pulses when the machine is stopped or started. If the current rises unexpectedly, examine the machine at that point for binding or interference problems.

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3-AXIS DRIVE TUNEUP PROCEDURE

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The following "Tune-Up" procedure is recommended for both initial installation and whenever any electrical drive component is replaced. It can also be used to help diagnose problems if the performance of the machine has degraded from it's original level.

Before attempting this procedure, the user should be familiar with the Operation and Setup manuals for this control, as well as the ANA-73106 Servo-Pak Axis card manual (included in this manual).

It is extremely important to check the mechanical systems on the machine before using this procedure. Problems which appear to be electrical can actually be due to mechanical causes (binding, misalignment, etc.). The following mechanical systems should be checked:

- All drive components are properly tightened. In particular, any pulleys, gears etc. are tight on their shafts, and all drive mounting hardware is tight.

- All bearings and slides rotate and move freely.

- Rails are properly installed and aligned per the manufacturers specifications.

- Drive pinions are properly "loaded" into the drive rack.

- All drive components rotate freely. This can be checked by disconnecting machine power and manually rotating the drive motor through one complete revolution of the output pinion. Reverse the direction and rotate the motor until the pinion is back in it's original position. There should be no excessive binding or sticking.

- Check that the feedback devices (encoders, resolvers or both) are properly installed, and that the loading on the pinions, or drive chains is correct. If belts or chains are used to drive the feedback devices, they should be adjusted to be "snug" and free of backlash but should not put excessive lateral pressure on the feedback devices bearings.

After checking the above, and repairing/aligning as necessary, proceed with the following adjustments.

3-AXIS DRIVE TUNEUP PROCEDURE

1. Disconnect power from the CNC, machine drives, router,plasma or other tools.

2. Disengage all three drives so the motors can turn freely without moving the cutting machine.

3. If this is a new machine, setup the standard parameters using the SERV10 procedures.

4. If an axis card is being replaced, set the jumpers to the same positions as the card being replaced. Also set the following pots on the axis cards :

   - GAIN to full CW

   - COMP to full CW

   - LIMIT to full CW

   - Turn the GAIN pot on the power supply full CCW and the FAULT LEVEL pot to full CW.

   - Set filter pots- NOTCH FREQUENCY,WIDTH,DEPTH approximately the same as card being replaced.

5. Unplug the encoder and resolver cables at the control station. Motor cables are connected at this point.

6. The resolver syncronization signals connect to the Power Supply/Sync card (MO-5153-2) on terminal block 3TB. While the silkscreen on the PCB indicates a 3TB-A numbered 1-10, and a 3TB-B numbered 1-5, the wire harness uses a single 15 position terminal block to connect to both the A and B halves. Terminals 1-10 of the terminal block correspond to 3TB-A pins 1-10 while pins 11-15 of the terminal block correspond to 3TB-B pins 1-5. Since the terminal block is installed for all operations and tests, the remainder of this description will refer only to 3TB as the 15 position terminal block.

   Since the resolver cables are disconnected at this point, it is necessary to install a wire jumper in both the master and slave resolver connector on the back of the control console, from pin 3 to pin 6 in each connector, to create a perfectly in-phase resolver input to the card.

7. Apply AC power to the drive and CNC. Since the encoder cables are disconnected, the CNC control will output 0.00 volts for both the X and Y drive references. If any motor runs away at this point, it indicates that the polarity of the tachometer is backward. If this happens, remove AC power (press E-STOP), reverse the tach wires to the motor, and turn the AC power back on. The motor should now remain stationary.

8. Measure the voltage at 3TB-13 on the power supply card (common to 3TB-10) and adjust the BALANCE pot on the supply card for 0.00 volts output at 3TB-13.

9. Since the CNC drive references should still be 0.00 volts, if any motor movement at this point is caused by drift in the servo drive. If any drive is drifting at this point, adjust the BALANCE pot on the axis card to eliminate the drift.

10. Jog the machine in the +X direction and verify that the master X motor rotates so the pinion would move the machine in the +X direction. If it rotates in the -X direction, reverse the X drive direction using SERV10 to change the setting of 'SD25-X DRV DIR'. With the +X jog still running, verify that the slave motor also rotates to move the machine in the +X direction. If the slave motor rotates in the wrong direction, REMOVE AC POWER, then reverse the TACH and ARMATURE leads to the slave motor.

11. Jog the machine in the +Y direction and verify that the cross axis pinion rotates in a direction to move the machine in the +Y direction (to the left). Reverse the drive direction if necessary using SERV10 to change the setting of 'SD26-Y DRV DIR'.

12. Remove AC power (press the E-STOP).

13. Connect the X encoder cable to the control console.

14. Select DSPY01- X/Y DISPLAY to show the X/Y position. Press the "CLR" or "CE" button to clear the displays to 0.00.

15. Apply AC power and immediatly set the control to jog the machine in the +X direction. The display should show the X position counting in the positive (+) direction. If it counts negative, use SERV10 to change 'SD23-X ENC DIR'. Press "CYCLE STOP". The master X motor should stop and remain stationary.

16. Remove AC power.

17. Connect the Y axis encoder cable to the control console.

18. Re-Apply AC power and immediatly set the control to jog the machine in the +Y direction. The display should show the Y position counting in the positive (+) direction. If the Y display counts negative, use SERV10 to change the setting of 'SD24-Y ENC DIR'. Press "CYCLE START". Both motors should be stationary.

19. Perform the SERV54 procedure.

20. Select the SERV51-SPD CAL procedure however when the readout prompts to press "CYCLE START", press the "RECYCLE" (RESET) instead. This clears out any previous calibration data.

21. Select SERV50-AXIS SPD and jog in the +Y direction. Adjust the TACH pot on the cross axis amplifier card for the correct speed.

22. Now jog in the +X direction and adjust the TACH pot on the master X axis card for the correct speed display. Note- this only adjusts the master motor speed. The slave speed will be adjusted later using the resolver feedback as an indication of speed balance. However, the slave TACH pot can be set to approximately the same position as the master X TACH pot so the later adjustments will be easier.

23. Remove AC power

24. Remove the jumpers from the resolver plugs, and connect the resolver cables to the control cabinet.

25. Disconnect both the master and slave rail axis motor cables.

26. Re-apply AC power.

27. While monitoring the voltage at power supply 3TB-13, rotate the master motor until the voltage at 3TB-13 approaches 0 and shows a linear increase in volage if the motor is rotated further. CAUTION, there are two null points in the resolvers revolution. One is the normal point where the error voltage increases linearly as the resolver is moved from it's null position. The other null is 180 degrees away and will cause immediate reversals from full positive to full negative error voltage output as the resolver is moved to either side of the null. If this point is reached, continue turning the motor until the linear null is found and the voltage at 3TB-13 is 0.00.

28. While still displaying the X/Y position on the CNC with DSPY01, press the 'CLR' or 'CE' button to reset the readouts to 0.000. Turn the master X motor in the +X direction until the readout shows .25 inches in the X position display. Adjust the GAIN pot on the power supply card for 1.5 volts output at 3TB-13.

29. The master X resolver has just been rotated in th +X direction. To check the phasing of the slave resolver, rotate the slave X' motor so the pinion would again move the machine in the +X direction. As it is rotated, the error voltage at 3TB-13 should return to 0. If it increases, the phasing of the resolvers is backward and either the SIN or COS winding to the slave resolver must be reversed. Once done, repeat the nulling and directional check.

    Turn the slave motor until the voltage at 3TB-13 is again 1.50 volts to adjust the out-of-sync trip level.

30. Turn the FAULT LEVEL pot on the power supply card CCW slowly until the RED Out-of-Sync LED turns on. This sets the trip point at .25 inches of skew. Verify that the AC power is turned off when this out of sync condition occurs.

31. Rotate the slave motor until the error voltage at 3TB-13 returns to 0 Volts.

32. Remove the master X motor cable and the X encoder cable. Leave the slave X' motor cable installed.

33. Apply AC power. The slave X' motor may rotate a small amount to the null position of the resolvers however it should remain basically motionless. If it runs away, the direction of the error voltage from the resolver circuit must be reversed. This is accomplished by reversing the SIN winding on both the master and slave resolvers. These wires connect to pins 1 and 2 of the resolver connectors on the back of the drive. Reverse the wires going to pins 1 and 2 of the master resolver plug, and also reverse the wires going to pins 1 and 2 of the slave resolver plug. This can either be done at the plug or at the resolver. By inverting one winding of both resolvers, the direction of the error signal will be reversed.

    Once the connections are correct, check the operation of the circuit by rotating the master X motor (cable is still disconnected) and verify that the slave motor rotates to move the machine in the same direction down the rail.

34. Remove AC power.

35. Use the SERV97 routine to store the new settings so they aren't lost if the power is turned off.

36. Connect the master X motor cables and the X axis encoder cable. All cable should be connected at this point.

37. Re-apply AC power.

38. While still monitoring the voltage at 3TB-13 on the power supply, jog in the +X direction. Note that a voltage will develope at 3TB-13 which is proportional to the difference between the master and slave motor speeds. Adjust the TACH pot on the slave X′ axis card until the voltage at 3TB-13 returns to 0. Note that the voltage will fluctuate around the zero point as the resolver circuit corrects for errors, however the average of the readings should be around 0 volts.

    NOTE: If the slave speed is drastically different from the master when this test is started, it may cause the out-of-sync circuit to trip and stop the drives. To prevent this while the speed is being adjusted, hold the in the AC button-- there should be a contact from this button connected to pins 8 and 9 of the control receptacle to the out-of-sync relay and allows the drives to operate even though they are not aligned. Once the voltage at 3TB-13 has been reduced below the 1.5 volt trip level by adjusting the slave speed, the power on button can be released and the drives will continue to operate.

39. Remove AC power.

40. Engage the Y axis and master X axis drives in the gear rack. DO NOT engage the slave axis yet.

41. Re-apply AC power. CAUTION- the slave motor may rotate a small amount if the master motor was turned while engaging the rack.

42. Align the beam of the machine to be as close to square with the rails as possible. The squarness will be adjusted later however it's better to start with it fairly close.

43. Engage the slave X′ drive in the gear rack. If the teeth do mot mesh perfectly, loosen the slave resolver mounting screws and rotate the resolver slightly until the pinion is aligned with the rack. Re-tighten the resolver screws and engage the slave drive.

44. Confirm that the LIMIT pot on all drives is set to full CW for maximum current.

"IMPORTANT"

The GAIN and COMP adjustments are made using an oscilliscope. It is absolutely ESSENTIAL that an UNGROUNDED oscilliscope is used for these measurements. The chassis of the scope must not connect to the power line Earth ground either via a 3-prong grounded plug, or by resting the scope on the metal frame of the machine and grounding the scope chassis to the machine chassis. If the scope is inadvertently grounded, severe damage may be done to the axis card during the test.

45. Connect the scope probe and ground lead across each side of the motor armature of the axis to be adjusted. Set the time base and voltage scale so that one full cycle of the PWM waveform appears on the screen. Set the feedrate to maximum.

While alternately jogging back and forth, adjust the GAIN pot CCW until the multiple traces at the rising and falling edges of the waveform are fairly stable. Further stability can be obtained by turning the COMP pot CCW. (Wait several minutes -or adjust the other axis's and come back- and re-check the waveform to see if the thermal changes in the motor have influenced the stability. Adjust as necessary).

Repeat the procedure for all 3 axis cards.

46. Run the machine the full length in both the rail and cross axis and watch for any problems. When the end of travel is reached, verify that the drive stops due to the electric limit switch and does not reach the hard stop. It is very important to check the operation of the limit switches since it prevents the machine from jamming at the end of travel in full current limit for an indefinite amount of time.

47. Run the SERV51-SPD CAL procedure. When done, use the SERV97 to store the results.

48. Check the squareness of the machine by tracing as large a square as possible and measuring the diagonals. They should be exactly the same length. If the squarness needs to be adjusted, loosen the slave X resolver screws and rotate the resolver to cause the slave end of the machine to move in the necessary direction to reach square. Since there is no command to the master side at this point, it will remain stationary. Re-tighten the resolver screws and re-run the square again.

Note, it is not necessary to draw the entire square, only the corners. Therefore, this test can be done with 4 small pieces of paper located at the corners of the square so only the corners will be drawn.

"IMPORTANT"

After adjusting the square of the machine, run the machine over the full length of the rail axis and re-confirm that there is no binding or any type of interference. Another useful indication is to measure the current on the slave motor as the machine is moved over the entire rail length. Nominally, the current should be below 2-3 Amps at full speed, and the current should drop well below 1 amp when the machine is stopped at various points along the rail axis. Excessive current, particularly when the machine is stopped indicates a mechanical binding which is preventing the slave axis from aligning with the master. This condition must be corrected or machine performance will be very poor, and possible motor damage may occur.

49. Once the cross axis is squared, jog the machine to the end of the rails but just before the limit switch trips. Scribe the the position of the machine on the master and slave rails as a reference of the correct square position of the machine. If service is required at a later date, the machine can simply be re-aligned to these scribe marks without requiring the time consuming rectangle test.

"IMPORTANT"

It is essential that the scribe marks are made with the drive power ON, and without tripping either the electrical limit, or resting against a mechanical stop. This allows the square position as defined by the resolver alignment to be transfered to the rails for future reference.

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INSTRUCTIONS
SERVOPAK

ANA-73106 A

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WARRANTY AND LIMITATION OF LIABILITY

ALL EQUIPMENT IS SOLD SUBJECT TO THE MUTUAL AGREEMENT THAT IT IS WARRANTED BY THE COMPANY TO BE FREE FROM DEFECTS OF MATERIAL AND WORKMANSHIP BUT THE COMPANY SHALL NOT BE LIABLE FOR SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES OF ANY KIND UNDER THIS CONTRACT OR OTHERWISE. THE COMPANY'S LIABILITY SHALL BE LIMITED EXCLUSIVELY TO REPLACING OR REPAIRING WITHOUT CHARGE, AT ITS FACTORY OR ELSEWHERE AT ITS DISCRETION, ANY MATERIAL OR WORKMANSHIP DEFECTS WHICH BECOME APPARENT WITHIN ONE YEAR FROM THE DATE ON WHICH THE EQUIPMENT WAS SHIPPED, AND THE COMPANY SHALL HAVE NO LIABILITY FOR DAMAGES OF ANY KIND ARISING FROM THE INSTALLATION AND/OR USE OF THE APPARATUS BY ANYONE. THE BUYER BY THE ACCEPTANCE OF THE EQUIPMENT WILL ASSUME ALL LIABILITY FOR ANY DAMAGES WHICH MAY RESULT FROM ITS USE OR MISUSE BY THE BUYER, HIS OR ITS EMPLOYEES, OR BY OTHERS.

THE WARRANTIES OF THE COMPANY DO NOT COVER, AND THE COMPANY MAKES NO WARRANTY WITH RESPECT TO ANY DEFECT, FAILURE, DEFICIENCY OR ERROR WHICH IS:

(A) NOT REPORTED TO THE COMPANY WITHIN THE APPLICABLE WARRANTY PERIOD; OR

(B) DUE TO MISAPPLICATION, MODIFICATION, DIS-ASSEMBLY, ABUSE, IMPROPER INSTALLATION BY OTHERS, ABNORMAL CONDITIONS OF TEMPERATURE, DIRT, OR CORROSIVE MATTER; OR

(C) DUE TO OPERATION, EITHER INTENTIONAL OR OTHERWISE, ABOVE RATED CAPACITIES OR IN AN OTHERWISE IMPROPER MANNER.

THERE ARE NO OTHER WARRANTIES, EXPRESS OR IMPLIED INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

RECEIVING, HANDLING & STORAGE

Receiving - The equipment must be placed under adequate cover immediately upon receipt as packing cases are not suitable for outdoor or unprotected storage.

Examine the shipment carefully upon arrival and check items with the Packing List. Any shortage or damage should be reported promptly to the carrier and to the nearest CMC sales office.

Storage - If equipment is not being installed immediately, it should be stored in a clean, dry location. Precaution should be taken to prevent moisture from accumulating in the equipment. Moisture, dust or dirt is detrimental to the equipment operation.

SAFETY NOTICE

This equipment employs voltages which are dangerous and may be fatal if contacted by operating personnel. Caution should be exercised when working with the equipment. The following rules must be strictly observed.

1) Keep away from live circuits. Voltages up to 240 VAC may be present when power is on. DO NOT TOUCH any circuit board or chassis components with power applied.

2) Do not make any adjustments inside equipment unless thoroughly familiar with the equipment.

3) Do not service motor unless all power is off. Voltage may be present even though the motor is not rotating.

1.0 GENERAL DESCRIPTION

1.1 MEET THE SERVOPAK

SERVOPAK transistorized controllers are pulse width modulated (PWM), fast response, high performance industrial type servo amplifiers. They are designed specifically for use with low inertia and permanent magnet DC servomotors in NC, CNC or PC machine tool and robotics applications. The latest in power semiconductor technology is incorporated to provide a compact design which requires a minimum of space.

The SERVOPAK may be applied individually or grouped in a multi-axis system and operated from a common isolation power transformer or power supply. With high peak current capability and a wide range of tachometer input, it can easily be matched with a wide variety of motors. A CMC developed power transistor switching scheme ("Uni-Switching") is utilized which has several advantages over typical PWM controllers including higher frequency response, reduced switching losses, lower motor ripple current and reduced EMI.

Serviceability is assured by modular construction. Adjustments and LED diagnostic indicators are up front and directly accessible. A fault relay is provided with isolated FORM-C contacts for control system interlock. In addition, all circuit boards are plug-in and designed for interchangeability within the system to minimize spares requirements.

Standard features considered optional extras with many competitive units include individual bus power relays and an input notch filter to compensate for machine resonances. Optional features include axis synchronization and a built in shunt regulator to prevent motor and connected load inertia from causing the bus voltage to rise beyond acceptable limits during deceleration. Shunt regulating resistors are externally connected.

1.2 PROTECTIVE CIRCUITS

Adjustable Current Limit

Overtemperature

Armature Short Circuit

RMS Current Rollback

Axis Bridge Short Circuit

Short Circuit Across Output

Bus Supply Relay Interrupt

High/Low Bus Voltage

Synchronization Error

1.3 DIAGNOSTIC INDICATORS

Status LEDs	Fault LEDs
Bus Voltage Applied (Axis Card)	Short Circuit
Bus Voltage Present (Supply Card)	Bus Overvoltage
	Heatsink Overtemperature
	Sync Error (Supply Card)

1.4 ADJUSTMENTS

Individual Axis Card Potentiometers for:

Signal Scaling (SIG)

Tachometer Scaling (TACH)

Velocity Loop Gain (GAIN)

Balance (Offset) (BAL)

Velocity Loop Compensation (COMP)

Input Filter Frequency (FREQUENCY)

Current Limit (I LIM)

Input Filter Width (WDTH)

Input Filter Depth (DPH)

Individual Supply Card Potentiometer for:

Synchronization Signal Gain (GAIN)

Synchronization Fault Level (FAULT LEVEL)

1.5 ADDITIONAL BUILT-IN FEATURES

Axis Card:

Armature Current Level Test Point	TP1
Circuit Common Test Point	TP2

1.6 SERVOPAK AMPLIFIER SPECIFICATIONS

		MODEL DEPENDENT	
1. Continuous Current		2.5 ADC	5.0 ADC
2. Peak Current		5.0 ADC	10.0 ADC
3. Current Limit	Adjustable	0 to 5.0 ADC	10.0 ADC
4. Power Rating:			
Continuous		75 Watts	150 Watts
Peak		150 Watts	300 Watts
5. Output Voltage (Maximum)			27 VDC
6. DC Bus Voltage (Nominal)			37 VDC
7. Switching Frequency (Nominal)			5000 Hz
8. Drift (referred to input) with Temperature			7uV/degrees C
9. Offset			Adjustable to 0
10. Deadband (referred to input)			Zero
11. Input Impedances:			
Differential			100K Ohms
Tachometer (Minimum)			44K Ohms
12. Input Signal Scaling Range			48% to 100%
13. Tachometer Scaling			Selectable For:
1J1 to 1J2	16 VDC Full Scale		(7.0V/1000 RPM)
1J2 to 1J3	24 VDC Full Scale		(10.5V/1000 RPM)
1J Removed	35 VDC Full Scale		(15.0V/1000 RPM)
14. Tachometer Adjustment Range			60% to 110%
15. High/Low Speed Select Range (RPM/Volt Input)			5:1
16. Temperature Range:			
Operating			0 to 55 degrees C
Storage			-30 to +65 degrees C
17. Cooling			Natural Convection
18. Shunt Resistor:			15 Ohms
Continuous Power Dissipation			90 Watts
Bus Cut-In Threshold			45 VDC

Tachometer Voltage Level Test Point TP3

Drive Enable Input (ENABLE)

Fault Relay Output (Form C Contacts)

Two Input Pair Differential Input

Hi/Lo Speed Select (HI/LO SPEED) (5 to 1 Speed Reduction)

Jumper Selectable Input Filter

Jumper Selectable Speed Loop Compensation Ranges

Jumper Selectable Tachometer Feedback Ranges

Bus Power Relay

Right/Left Direction INHIBIT/BRAKE (RDD/LDD)

Drive Reset (RESET)

Isolated Current Feedback

Supply Card:

Optional Bus Regulator Circuits

Synchronization Circuits

Synchronization Output Enable

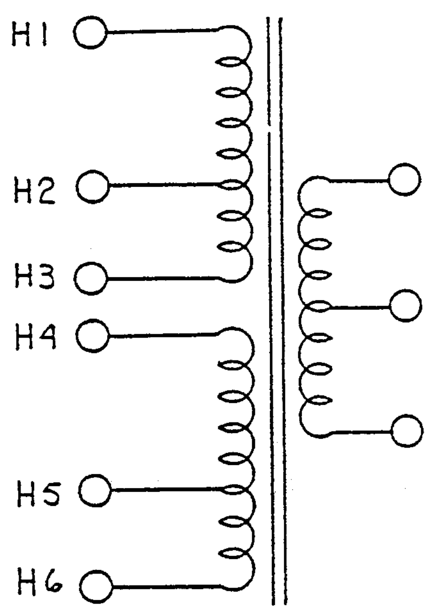
Sync Fault Relay Output (NC Contact)

1.7 POWER TRANSFORMER

The SERVOPAK requires an external isolation power transformer which provides an ungrounded source of single phase AC power to the internal full-wave bridge in the DC bus supply. A center-tapped 38 VAC at 1.40A transformer for the bias supply is also required.

Three bus supply transformers are available dependent on the size of the system supply. These are listed below along with the bias supply transformer. All transformers are constructed with reconnectable dual-primaries for 100/115/230 VAC input voltages.

Supply Rating	Rating	Secondary RMS Amps	Secondary Volts	CMC Part No.
15A	610VA	23.0	28 VAC	A14-14960
20A	875VA	33.0	28 VAC	B14-16560
30A	1300VA	49.0	28 VAC	A14-14961
ALL	50VA	1.40	38VAC-CT	B14-14971



TRANSFORMER

38VAC-CT	28VAC
X1	X1
X2	—
X3	X2

	AC INPUT POWER		
	100 VAC 1ø	115 VAC 1ø	230 VAC 1ø
JUMPER	H1 TO H4	H1 TO H4	H3 TO H4
JUMPER	H2 TO H5	H3 TO H6	—
CONNECT TO	H1 AND H5	H1 AND H6	H1 AND H6

FIGURE 1.1 PRIMARY JUMPER CONNECTIONS

19. Input Voltages:

Bias Supply	Reconnectable-Dual Primary
Bus Supply	100/115/230 VAC, +/-10%
	Single Phase, 50/60 Hz
	Ungrounded

20. Auxiliary Inputs:

Reset	(RESET)
Right Drive Disable/Brake (J4 Selects)	(RDD)
Left Drive Disable/Brake (J4 Selects)	(LDD)
Drive Enable	(ENABLE)
Low Speed Select	(HI/LO SPEED)
Sync. Output Enable (Supply Card)	(SYNC. ENABLE)

21. Auxiliary Outputs:

Axis Fault	Aux. Fault Contacts (Form C)
Supply Fault	Sync. Fault Contact (Norm. Closed)

22. LED Indicators:

Axis Card:

Power Bus Applied	1LED
Short Circuit	2LED
Heatsink Overtemp	2LED and 3LED
Power Bus Overvoltage	2LED and 3LED

Supply Card:

Power Bus Charged	1LED
Sync Error	2LED

23. Terminals:

Axis Card:

Bus Supply	1TB
Bias Supply	2TB
Control Signals	3TB
Motor Armature & Tach Feedback	1RECP

Supply Card:

Bus Supply	1TB
Bias Supply	2TB
Resolver Excitation & Feedback	3TBA
Sync Control Signals	3TBB
Power Input Connector	1RECP
Bus Regulation (Optional)	4TB

24. Size:

Axis Assembly	2-19/32W x 9-13/32H x 9-1/4D
Supply Assembly	2-19/32W x 9-13/32H x 8-3/4D

1.8 COMPONENT DESCRIPTION

The following is a brief functional description of the major SERVOPAK assembly components. All circuits are described in detail in the Theory of Operation, Section 4.0.

1.8.1 Main Circuit Board Assemblies, Axis and Supply - The two main circuit board assemblies contain all of the electronic components and circuitry necessary for controller operation. The boards are separately mounted and contain individual bus supply, bias supply, control signal, synchronization and bus regulator terminal blocks.

a) Axis Assembly

Major functional circuits of the axis assembly are:

1) Speed and current regulator circuits

2) Triangle generator and two-state modulator

3) Interlock circuitry to prevent controller turn-on unless operating parameters are correct and to turn off the controller if an abnormal condition develops.

4) User adjustments

5) Status and fault LEDs

6) Signal input notch filter

7) Output transistor base drive circuits

8) Armature current signal isolator

9) ±15 volt bias power supply filtering

10) Bus supply relay interrupt

11) Fault relay

12) Bus Voltage, Short Circuit and Overtemperature fault circuits

13) Excessive RMS current detection and limiting circuits

b) Supply Card Assembly

The major functional circuits of the supply card are:

1) Bus voltage supply filtering capacitors

2) Bias supply regulation and filtering (±15 VDC)

3) Bus supply bleeding resistors

4) Status and fault LEDs

5) Synchronization fault relay

6) Synchronization circuitry

7) User adjustments

8) Bus supply shunt regulator circuits (optional)

Shunt regulating resistors are externally mounted.

NOTE: SHUNT REGULATOR CIRCUITS SHOULD NOT BE USED WITHOUT SHUNTING RESISTORS IN PLACE AND CONNECTED.

1.8.2 Heatsink-Mounted Components

A) Axis Assembly

Heatsink-mounted semiconductor modules are electrically isolated from the chassis. These components are:

1) Output power transistors (Q10 thru Q13). Full current, high speed fly-back diodes, inversely connected, collector to emitter (RA1,RA2). An additional high speed flyback diode (34D) for parallel connection across the bus choke.

2) Overtemperature sensor switch.

B) Supply Assembly

Heatsink-mounted semiconductor modules are electrically isolated from the chassis. These components are:

1) Shunt regulator transistor and driver transistor.

2) Bias supply (+/-15 VDC) series pass transistors.

3) Single phase bus supply bridge rectifier.

1.8.3 Transformer Enclosure

In some applications the bus supply fusing and transformer; 100/115/230-28 VAC and the bias supply transformer; 100/115/230-38 VAC-CT, may be mounted in a separate enclosure.

2.0 CONTROLLER INSTALLATION AND WIRING

THIS EQUIPMENT SHOULD BE INSTALLED, ADJUSTED AND SERVICED BY QUALIFIED PERSONNEL FAMILIAR WITH ELECTRICAL EQUIPMENT AND THE CONTENTS OF THIS MANUAL.

2.1 MOUNTING

Mount the SERVOPAK controller in a vertical position with the printed circuit board in a clean, dry equipment enclosure, or like structure, and ensure that free air flow is allowed across the heatsink. Maximum ambient temperature should not exceed 55 degrees centigrade. Do not mount directly against components which radiate heat, or mount components directly above controller which would restrict air flow. Avoid areas where moisture, dirt or dust prevail. Never install the controller where combustible vapors are present. Provide accessibility to board-mounted screwdriver adjustments. Refer to the installation outline drawing in the back of this manual for mounting dimensions.

In multi-axis systems, controllers may be mounted adjacent to each other for minimum space but it is suggested that 1/4" separation between controllers be provided to allow easy removal later, if required.

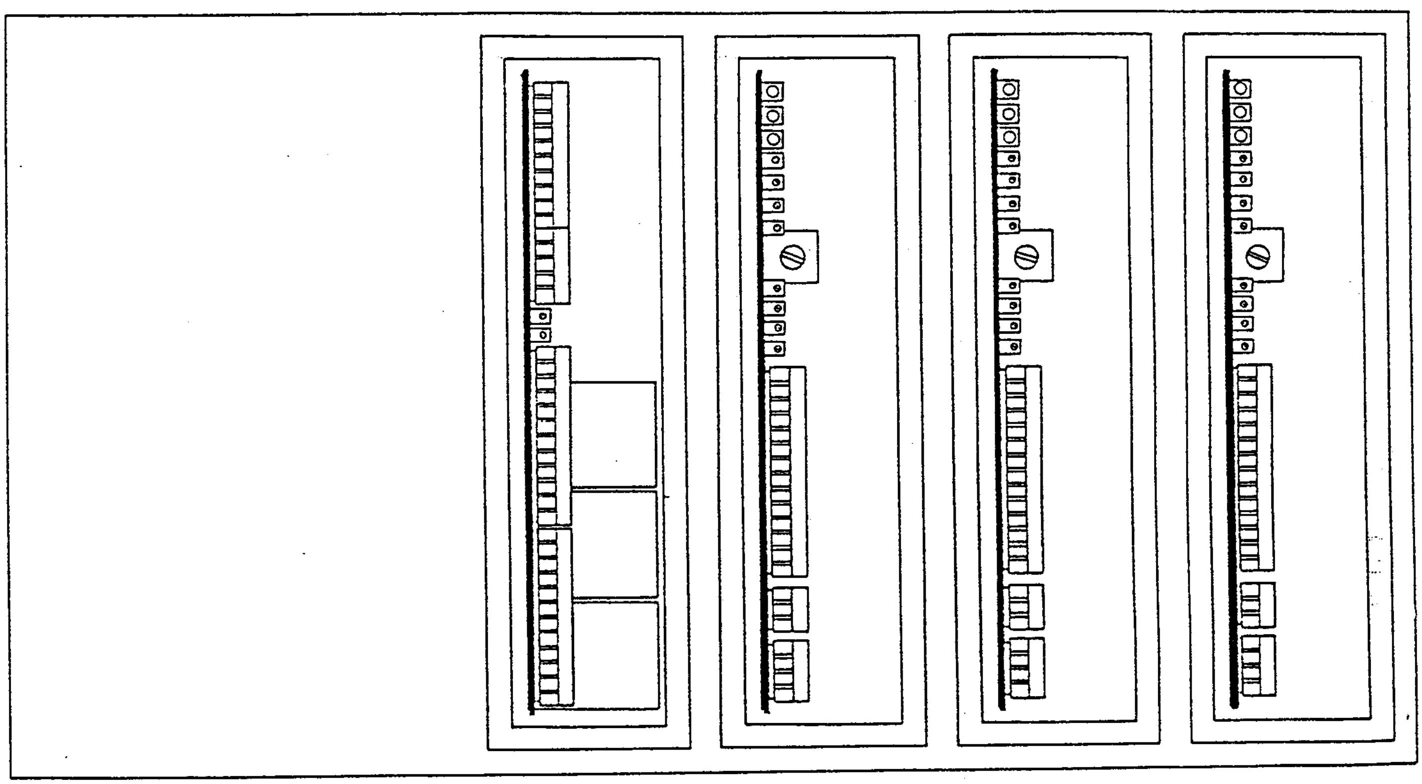


FIGURE 2-1. TYPICAL MULT-AXIS SYSTEM

2.2 POWER WIRING

Figures 2-2 through 2-4 show external wiring connections to the SERVOPAK controller.

NOTE THAT THESE FIGURES ARE TYPICAL AND ARE INCLUDED FOR ILLUSTRATIVE PURPOSES ONLY. ALWAYS REFER TO THE DRAWINGS FURNISHED WITH THE UNIT.

Wire in accordance with the requirements of the National Electrical Code (NEC) and any local requirements. Size as follows:

Armature Circuit	- Size for continuous rated motor current
AC Input Bus Power & Chassis Ground	- Size per the transformer KVA rating

Dynamic brake resistors dissipate heat and should be mounted to provide proper cooling.

The motor armature leads carry square wave voltages. In order to minimize radiated electrical noise, it is suggested that armature circuit wires be twisted pairs. Tachometer wires should be a shielded pair with the shield terminated at the axis amplifier only.

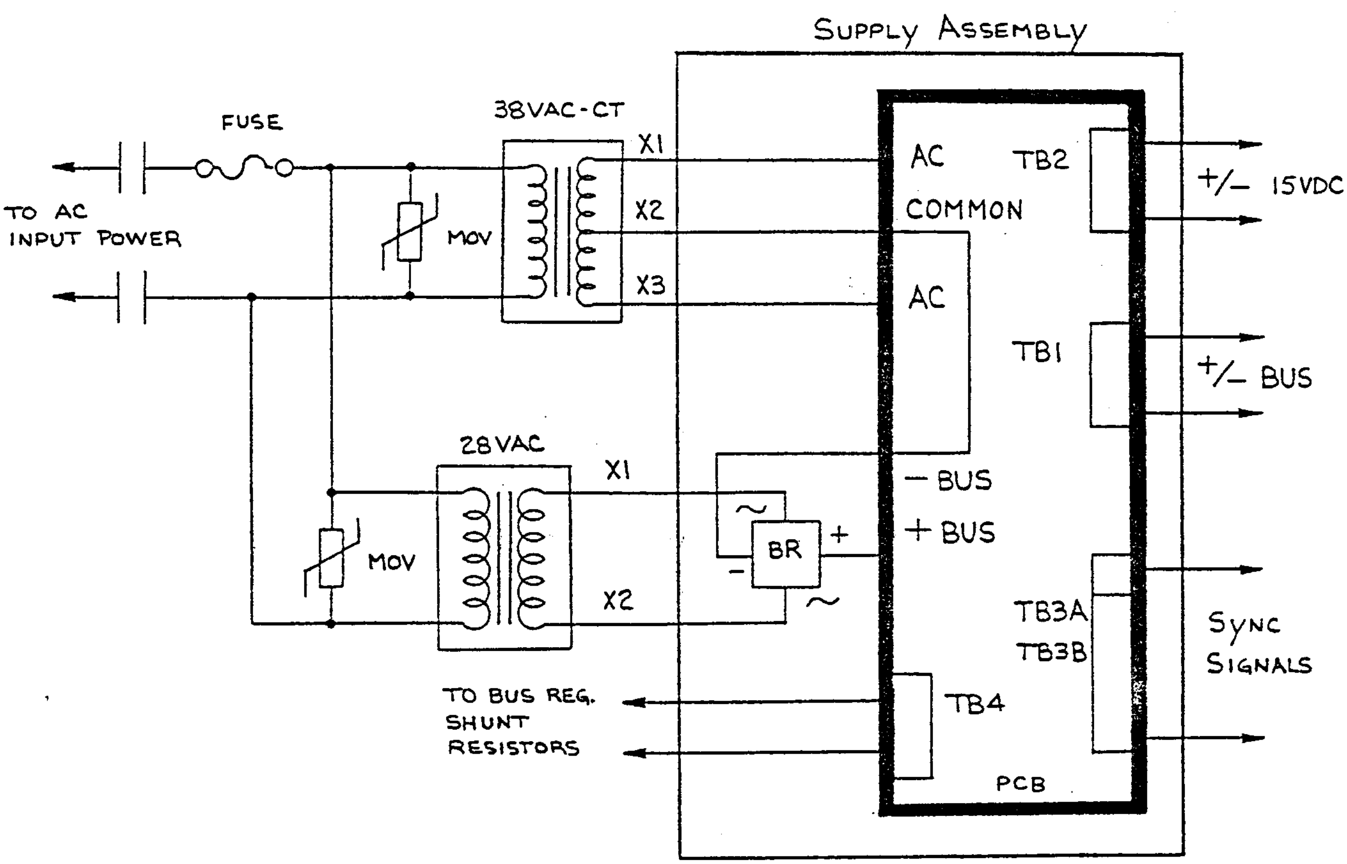


FIGURE 2-2. AC INPUT POWER CONNECTIONS

2.3 SIGNAL WIRING

Small gauge wire (18 to 22 AWG) can be used in the signal and monitor circuits. Command and tachometer wire should be twisted-shielded pairs with the shield terminated at only one end. The tachometer lead shield should be terminated at the axis amplifier. The command lead is most often terminated at the CNC when the differential input is used. Take care to run signal and tachometer wires in separate conduits from armature and AC input power wires to avoid noise pickup which can cause speed regulation errors.

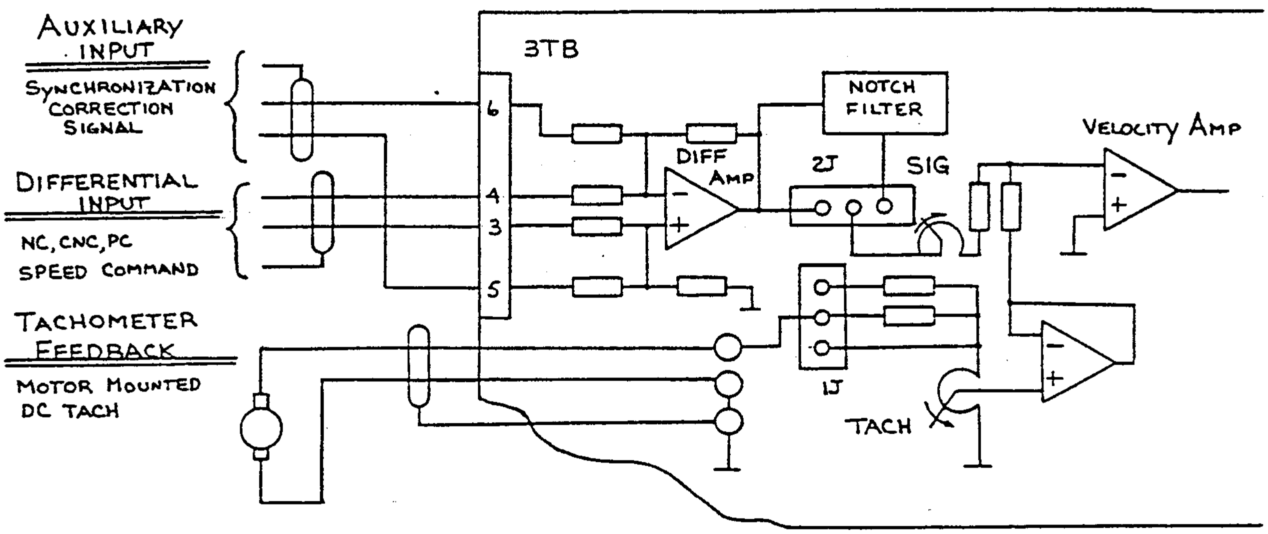


FIGURE 2-3. SIGNAL WIRING

2.3.1 ENABLE/DISABLE INPUTS (ENABLE/LDD, RDD, SYNC ENABLE)

The controller is shipped with the enable inputs connected in a "fail-safe" condition and requires a contact closure to signal common as shown in Figure 2-4. Open terminal voltage is +15 VDC. Impedance is 10K-ohms.

If no external interlocks are desired, simply wire the appropriate inputs to signal common.

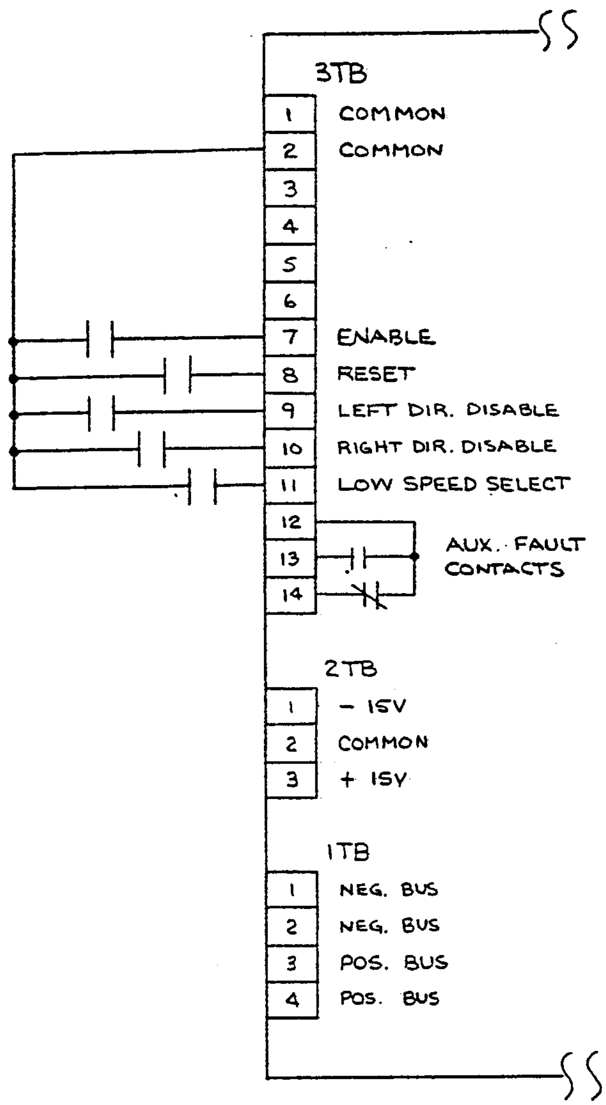


FIGURE 2-5.
ENABLE INPUT CONNECTIONS

<u>Left Drive Disable 3TB-9, Right Drive Disable 3TB-10 and Brake/Coast selection jumper J4</u>

Connect 3TB-9 or 3TB-10 to signal common to disable drive operation in the left or right direction. These inputs can be used for over-travel stops to prevent further operation in the inhibited direction but allow the drive to back away from the limit in the opposite direction. Limit Switches should be dry circuit type.

RDD - Inhibits/Brakes further operation in the positive direction where Motor Lead 1 is (+) with respect to ML 2.

LDD - Inhibits/Brakes further operation in the negative direction where ML 1 is (−) with respect to ML 2.

Two modes of direction limiting are provided and are selected by jumper J4 as follows:

J4 set to position 2-3: COAST-TO-STOP INHIBIT OPERATION

With the jumper set to position 2-3, the LDD and RDD inputs prevent further drive in the inhibited direction but DO NOT prevent the motor from coasting. With this setting, the machine limit switches must be designed to provide a maintained contact closure for a sufficient distance to allow the motor to COAST-TO-STOP once the switch is activated.

J4 set to position 1-2: BRAKE-TO-STOP INHIBIT OPERATION

With the jumper set to position 1-2, the LDD and RDD inputs act to both inhibit further operation in the inhibited direction, and cause the motor to be BRAKED at full current limit if it is coasting in the inhibited direction. Since the motor is powered to a stop, the amount of over-travel past the limit switch is greatly reduced.

Drive Enable, 3TB-7

ENABLE - When circuit is open, controller is completely disabled. Connect to signal common to enable output in either direction.

Sync Enable (Supply Card), 3TBB-1

When circuit is open, the signal output of the synchronization circuit is clamped to zero. Connection to signal common allows signal output.

2.3.2 Fault Relay and reset - Axis Card

The fault relay (FR) is energized if circuit board functions are normal and the controller is in a READY condition. A short circuit, bus overvoltage or heatsink overtemperature fault will open the fault relay and power relay (PR). A bus undervoltage does not affect the status of the relays. Faults are annunciated with LEDs as follows:

Power Bridge/Armature Short Circuit	- SC (2LED)
Heatsink Overtemperature	- OH (2LED AND 3LED)
*Power Bus Overvoltage	- PBE (2LED)

*If overvoltage is continuous, 3LED will also be on.

The OH fault will not reset until the heatsink returns to a proper temperature.

To reset the controller, either:

1) Remove and reapply power, or

2) Momentarily connect the reset line (RESET) 3TB-8 to common.

2.3.3 Fault Relay and Reset - Supply Card

The fault relay (FR) and 2LED will simultaneously energize when an adjustable limit, based on synchronization correction voltage, is reached.

To reset the synchronization circuits, the controllers must be powered down and the mechanical system realigned.

(A detailed explanation of these fault conditions is included in Section 5.)

3.0 START-UP AND ADJUSTMENT

SAFETY-NOTICE: THIS EQUIPMENT SHOULD BE INSTALLED, ADJUSTED AND SERVICED BY QUALIFIED PERSONNEL FAMILIAR WITH ELECTRICAL EQUIPMENT AND THE CONTENTS OF THIS MANUAL. VOLTAGES OF 230 VAC, 115 VAC, 100 VAC, and 40 VDC MAY BE PRESET. USE APPROPRIATE HIGH VOLTAGE PRECAUTIONS.

FOLLOW THESE SAFETY PRECAUTIONS!

- Work on one axis at a time. Disconnect the others.
- Check all power and signal wiring. Check for loose wire strands or debris which may have accidentally fallen into the controller during installation.
- Verify that motor and drive mechanism is clear of obstruction. Remove any loose parts or shaft keys which could fly off and cause injury. If the motor is connected to an axis lead screw, place at approximately mid-travel.
- Be prepared to immediately stop the drive and turn off power. When starting a system for the first time, the motor may accelerate to a high speed or run in the wrong direction due to improper or missing connections.
- Make certain chassis is properly grounded.
- Don't touch or short the bus capacitors or the bus connector on any axis (1TB on either assembly).

Test Equipment

Digital Multimeter (DMM) or Volt-Ohmmeter (VOM such as Simpson Model 260.

Preliminary Adjustments

Adjustments are clearly labelled and are located at the edge of the circuit board.

Initially set as follows:

Balance (BAL)	- As Shipped
Tachometer (TACH)	- Full CCW
Frequency (FREQUENCY)	- Full CCW
Gain (GAIN)	- Full CCW
Current Limit (I LIM)	- Full CCW
Speed Loop Compensation (COMP)	- As Shipped
Width (WDTH)	- Full CW
Depth (DPTH)	- Full CW
Signal (SIG)	- Full CW
Sync Error Adjust (FAULT LEVEL)	- Full CW
Sync Gain (GAIN)	- Full CCW

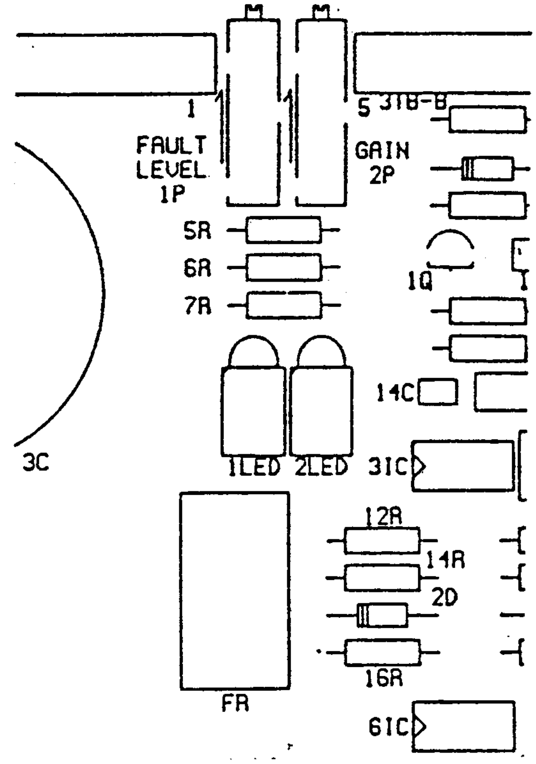
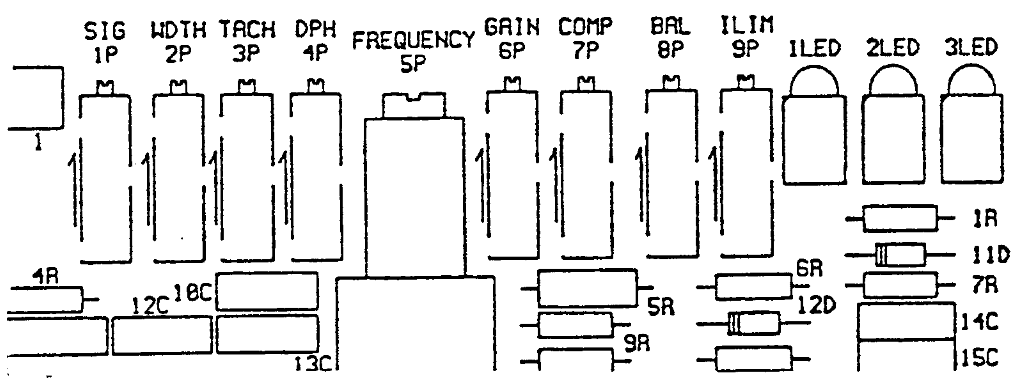


FIGURE 3-1.
CUSTOMER ADJUSTMENTS
SUPPLY ASSEMBLY

FIGURE 3-2.
CUSTOMER ADJUSTMENTS
AXIS ASSEMBLY



3.1 PRELIMINARY CHECKS, POWER OFF

1) Verify that the input speed command signal reaches the controller terminal strip.

3.2 PRELIMINARY CHECKS, POWER ON

1) Remove bus supply primary fuse.

2) Apply 38 VAC-CT input power to the controller. Verify proper voltage levels by measuring with the VOM or DVM.

   Bias Voltage — 2TB-3 to TP2, -15 VDC
   2TB-1 to TP2, +15 VDC

3) Note that the LEDs are not on.

4) Remove power, replace bus fuse, ensure Motor Armature and Tach are connected.

5) Reapply power. Note that the bus relay energizes and both 1LEDs are on.

NOTE: NON-LIGHTING OF 1LED DOES NOT MEAN THAT BUS VOLTAGE IS REMOVED FROM AN AXIS ASSEMBLY; THE VOLTAGE IS REMOVED FROM THE POWER TRANSISTORS ONLY.

6) Verify the 37 VDC voltage with the VOM or DVM on 1TB-4 to TP2.

3.3 MOTOR OPERATING CHECKS

CAUTION: If any problem is encountered during startup, DO NOT JUMPER OUT ANY SAFETY INTERLOCK CIRCUITRY. Refer to troubleshooting guidelines in Section 5 of this manual.

1) Enable input at 3TB-7.

2) The motor should remain at zero speed. LED indicators 2LED and 3LED should be off. 1LED on both assemblies should be on.

3) Apply a small speed command (approximately 10%). Rotate the Current Limit (I LIM) adjustment clockwise a small amount. The motor speed should slowly increase and stabilize.

   If the motor starts to accelerate to a high speed, remove enable and reverse the tachometer connections. If the motor speed stabilizes but rotation is incorrect for a given polarity of speed command, reverse both the tachometer and the armature connections.

4) Check axis travel limit switch interlocks, LDD and RDD, if used.

5) Apply a zero voltage speed command signal or short circuit the differential speed inputs and turn the Balance (BAL) adjustment to eliminate any motor rotation.

6) Increase the speed/command signal to maximum and increase the Tachometer (TACH) adjustment for full motor speed.

   NOTE: If a high output (volt/1000 RPM) tachometer is used, it may be necessary to select a different tachometer scaling, per jumper 1J, to achieve the desired speed. (See amplifier specifications, Sec. 1.6))

CAUTION: DO NOT OVERSPEED THE MOTOR.

7) Increase the Current Limit adjustment (I LIM) to the full CW position.

8) Slowly increase the gain (GAIN) adjustment, axis card, CW until the system starts to become unstable (speed oscillation).

NOTE: This adjustment is best made by abruptly applying and removing low level speed command signals so that the axis receives "step" commands. The response can be monitored with a scope connected from TP3 to TP2. The best duplication of the input signal, 3TB-3 to 3TB-4, is the desired result. Adjustments should be checked with drive in high and lo speed operation. (Hi/Lo speed select).

If the system is always unstable or sluggish, an adjustment of the speed loop compensation (COMP) should be made and the gain pot (GAIN) readjusted. Continued oscillation or sluggishness may require a different jumper selection on 3J.

3J Removed	Comp. Range	20 to 100 Rad./Sec.
3J1 to 3J2	Comp. Range	7 to 30 Rad./Sec.
3J2 to 3J3	Comp. Range	2 to 9 Rad./Sec.

The SERVOPAK should now be ready for connection into the position control loop.

9) With the position loop in control, apply abrupt speed and/or direction commands and monitor the results for position overshoots and/or ringing caused by the resonance of the machine.

NOTE: These machine resonances are most commonly observed on X-Y cutting machines with cantilievered cutting arms.

If the performance is not as desired, use of the input notch filter may be made by connecting 2J2 to 2J3.

10) Tuning of the input notch filter is made by three potentiometers; (FREQUENCY), (WDTH) and (DPTH) as follows:

The (FREQUENCY), 5P, adjusts the center frequency on the notch; CW lowers the frequency.

The (DPTH), 4P, adjusts the attenuation at the above frequency; CW decreases the attenuation.

The (WDTH), 2P, adjusts the range of frequencies which are affected around the notch frequency; CW widens the range of affected frequencies.

Adjustment of all three may be required for desired response.

4.0 THEORY OF OPERATION

The SERVOPAK PWM controller is a switching power transistor amplifier used to control the speed and torque of DC servo motors. Integration of a SERVOPAK into a typical computer controlled system is shown in Figure 4-1. A detailed discussion of all SERVOPAK circuitry follows in this Section.

The SERVOPAK contains two principal components, the axis assembly and the supply assembly.

4.1 AXIS ASSEMBLY

The Axis Assembly includes control, fault protection, and power circuitry. Figure 4-4 shows a block diagram. This assembly contains the velocity and current amplifiers, the PWM switching waveform circuits and the enable/disable control functions. Fault protection circuitry consists of the fault sensors, latch circuits and LED annunciators. A description of the PWM modulation technique follows.

4.1.1 PWM Modulation (Uni-Switching)

PWM indicates pulse-width modulation which is the operating mode of each transistor in the controller. In a PWM controller, a power transistor bridge switches a fixed DC bus supply to the motor load at a constant frequency with varying on-off ratio for output power control. The SERVOPAK differs from other controllers of its type in that two types of switching techniques (standard-H and Uni-Switching) are employed.

The first type, the Standard-H Bridge, is where alternating diagonal pairs of output transistors are switched on and off. Differences in the time duration of the turn-on pulses, between pairs, determines output voltage and current polarity (assuming a R-L load). This PWM switching scheme is present over the first 20% of full output voltage. The advantages of this method are to provide higher gain and higher torque systems at low speeds. At higher output voltages the Uni-Switching technique is employed.

Uni-Switching requires that only one output transistor be used, rather than two, to control current from the bus to the load for a given output polarity. This improved switching concept results in:

1) Lower switching losses - less power dissipation

2) Lower ripple current - less motor heating and lower output inductance required.

3) Lower EMI (Electromagnetic Interference).

4) Higher gain-bandwidth product - better system response.

Controller output lines are switched to the power bus with transistors LDR, RDR, LDI and RDI. Their switching action is determined by a two-state modulator shown in Figure 4-3. It sums the output of the current error amplifier with a triangular waveform and compares it to fixed references - one for each output polarity. A positive voltage signal from the current error amplifier causes the left drive, LDR, and right drive inverted, RDI, transistors to be on. The output voltage is then positive. Similarly, a negative voltage signal operates transistors RDR and LDI, resulting in a negative output voltage. Figure 4-3 also illustrates typical output voltage and current as the modulator input is raised.

The two state modulation configuration always allows one of the lower transistors to be on. This fact enables a common DC bias to be developed which reverse-biases the lower transistor which is open. The reverse bias, in turn, reduces the collector-emitter capacitance resulting in significantly less switching losses than a standard two-state diagonal drive.

4.1.2 Current Error Amplifier

The current error amplifier is shown in block diagram form in Figure 4-2. This amplifier sums the current command signal with the current feedback signal from the current sense coupler. It frequency-compensates the resulting signal with feedback components and applies it to the modulator circuit as described in the preceeding paragraphs. The current command signal is actually the output of the velocity control amplifier. Output current to the motor is, therefore, directly determined by this signal. Component tolerance errors are trimmed out at factory test so that the maximum current command signal corresponds to the peak rating of the drive. Current can be reduced from peak output down to zero via the Current Limit (I LIM) potentiometer.

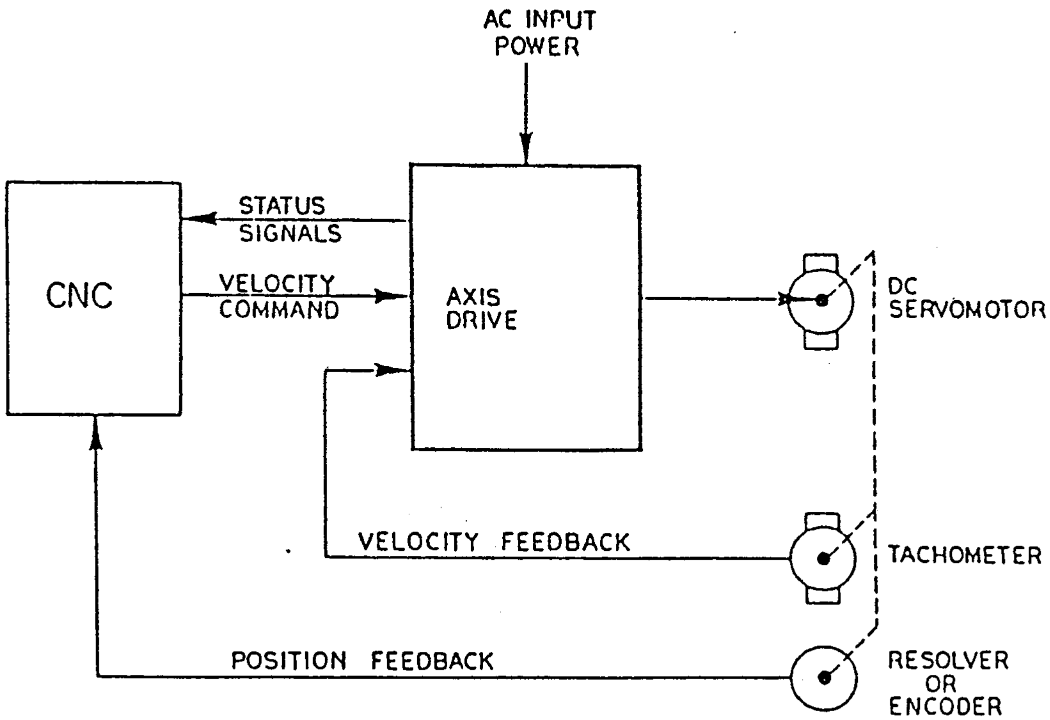


FIGURE 4-1. INTEGRATION OF SERVOPAK CONTROLLER IN TYPICAL SYSTEM

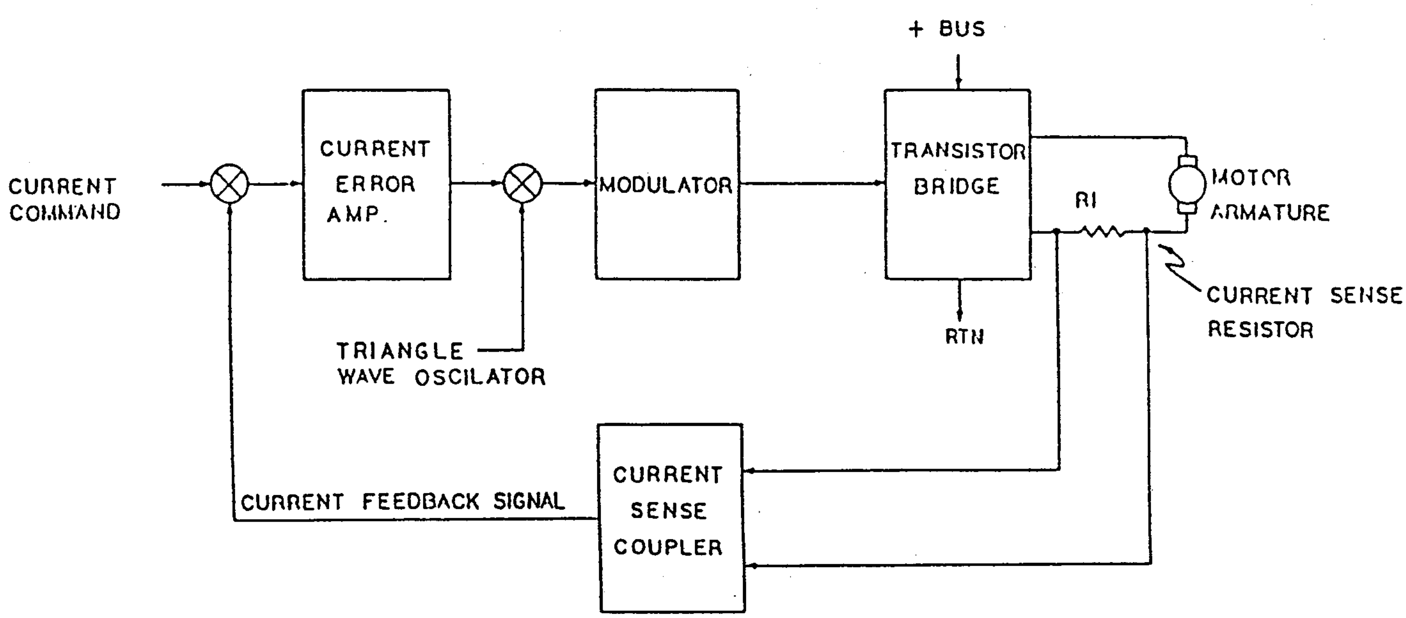


FIGURE 4-2. THE PWM CURRENT LOOP BLOCK DIAGRAM

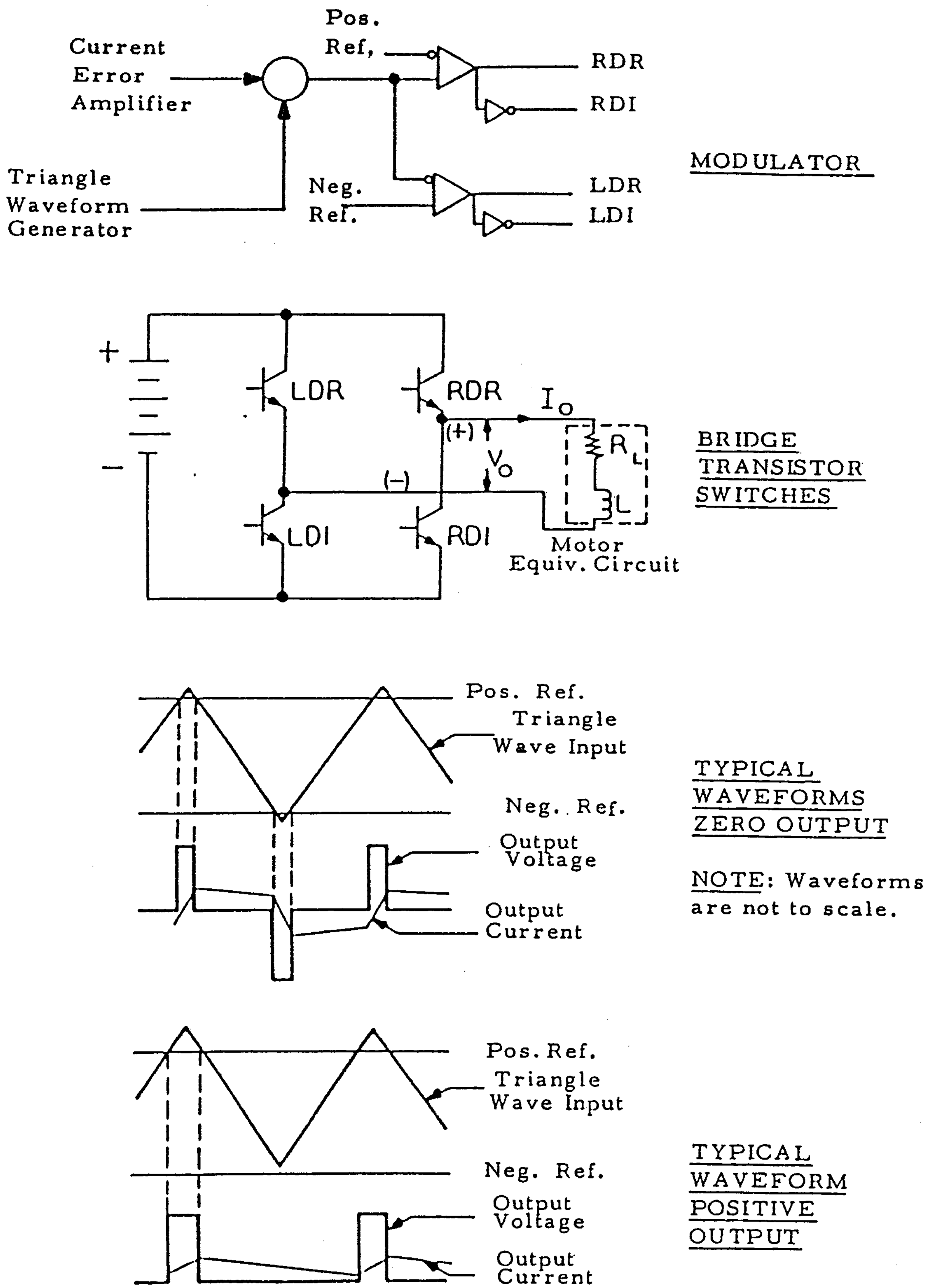


FIGURE 4-3. THE MODULATOR & BRIDGE SWITCHES WITH TYPICAL WAVEFORMS

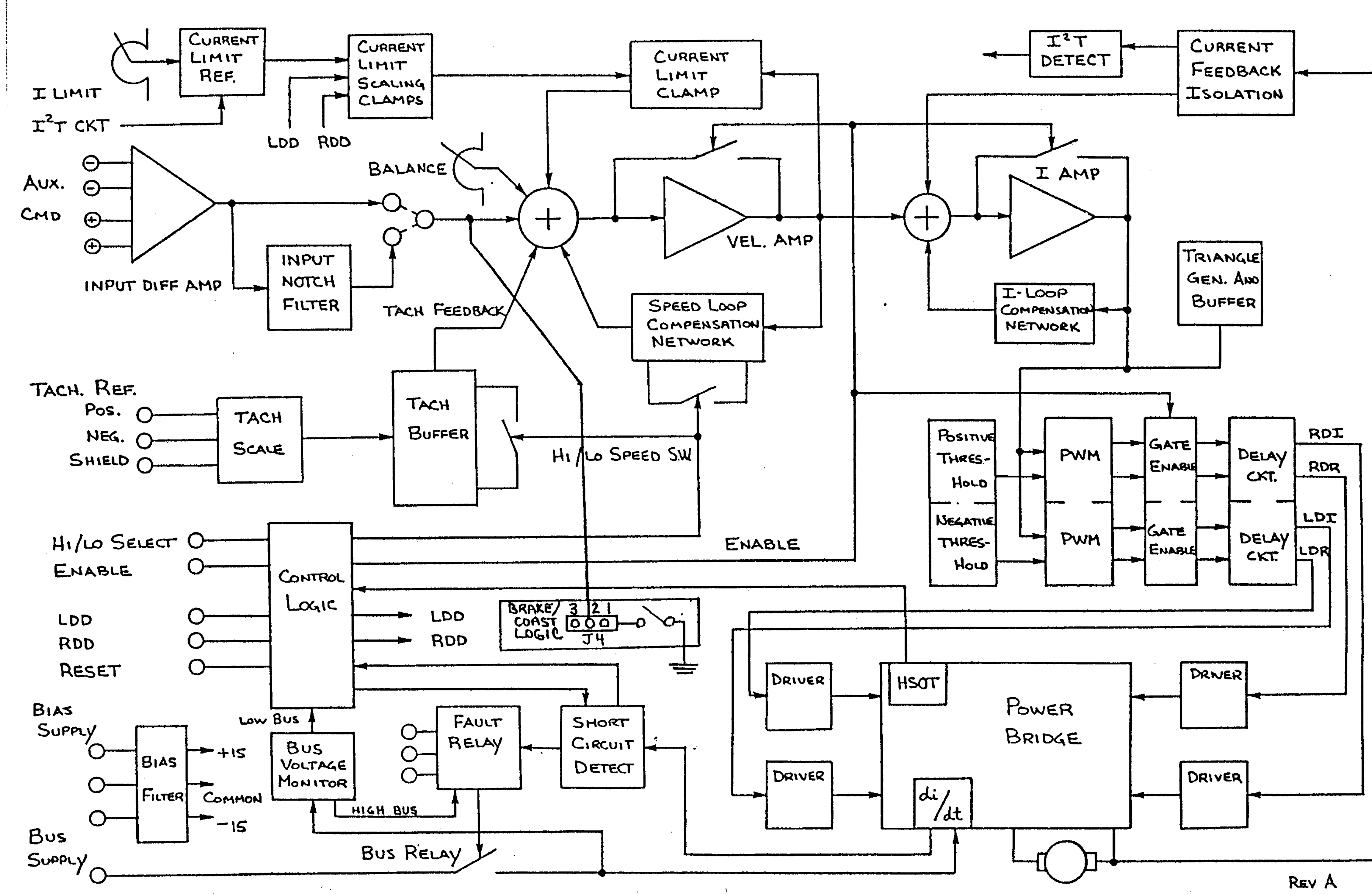


FIGURE 4-4. AXIS ASSEMBLY BLOCK DIAGRAM

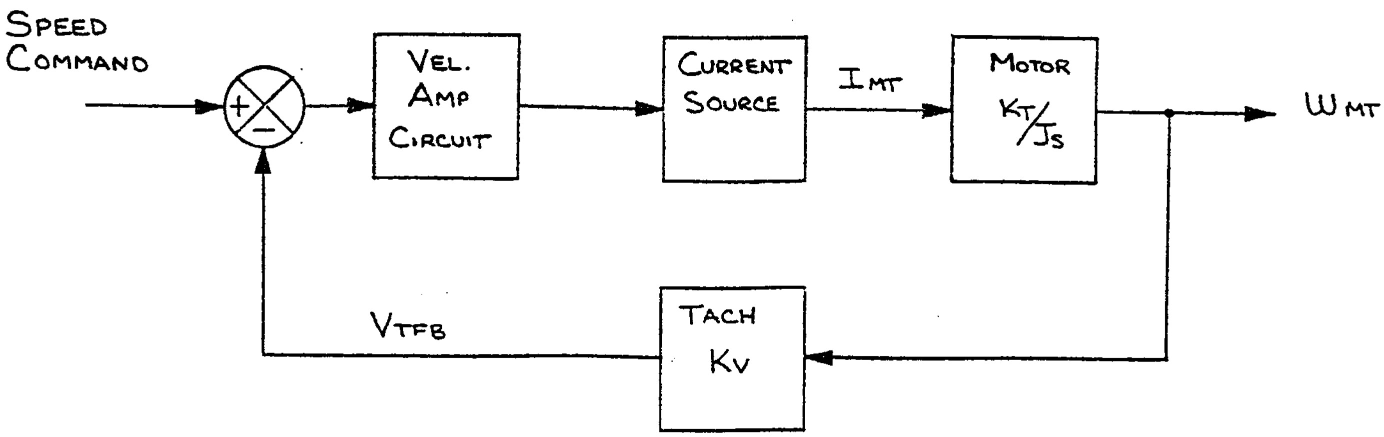


FIGURE 4-5. VELOCITY LOOP

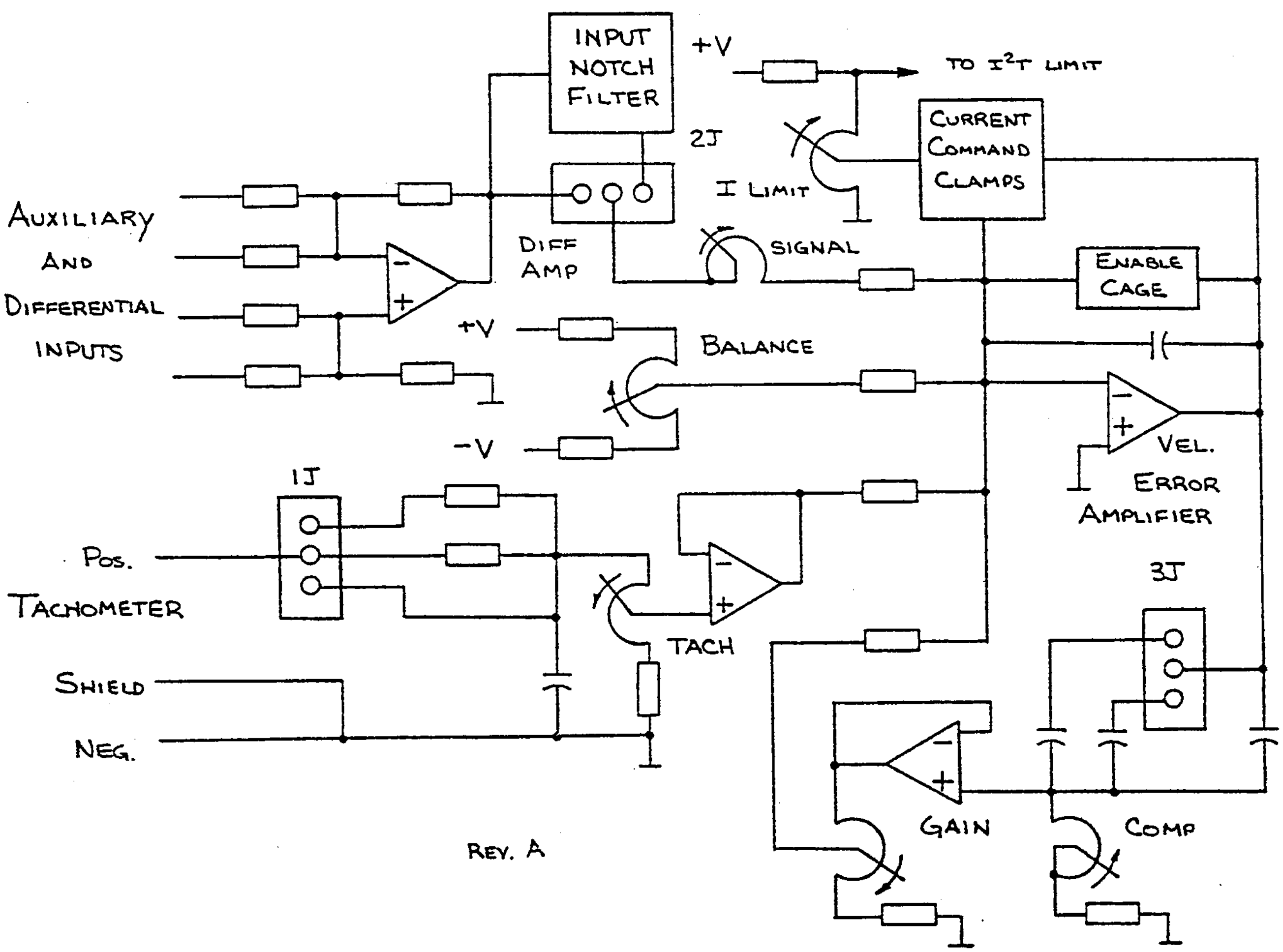


FIGURE 4-6. VELOCITY AMPLIFIER CIRCUIT

4.1.3 Velocity Control Amplifier

The velocity control amplifier, shown in Figure 4-6, has two connected inputs: the velocity and auxiliary input commands from the differential amplifier, scaled by the signal (SIG) potentiometer, and the tachometer feedback signal. The differential amplifier connection is used for the velocity command signal in order to minimize the possibility of conducting noise back to the CNC electronics hardware. The auxiliary input can be used for a trimming speed command signal, synchronized speed operation, or for eliminating the hunting tendency about the least significant bit when the drive is connected in a position loop. The tachometer feedback signal is scaled with potentiometer (TACH) and jumper 1J so that a wide range of tachometer scale factors can be accommodated without component value changes. As described earlier, the velocity amplifier output is actually the motor current command signal. It is, therefore, accurately and symmetrically clamped to control peak output current.

The open loop frequency response as derived from Figure 4-5 must vary from one system to the next because of: 1) the motor tach inertia, J; 2) the motor gain, Kt, and 3) the tach gain, Kv. The response curve of Figure 4-7 illustrates how the system conveniently compensates motor-load combinations with a reflected inertia to motor inertia ratio (Jr/Jm) range of 20:1 with proper compensation selection and gain adjustment.

4.1.4 Hi/Lo Speed Select

The Hi/Lo Speed Select Signal activates low speed operation when connected to circuit common. When activated, the control feedback is automatically rescaled to allow 0 to 20% (of rated full speed) operation using the same 0-10 VDC input; 10 VDC will now provide 20% speed. Simultaneously, the forward loop gain is equivalently lowered to keep over-all system response equal.

The benefit of using this input is to allow better control of lower speeds by raising the output to signal noise ratio by 14 db. (factor of five).

4.1.5 Left, Right Drive Disable/Enable

By connecting the Left Drive Disable (LDD) at 3TB-9, or Right Drive Disable (RDD) at 3TB-10, to signal common, Figures 2-5, drive operation in that direction of rotation is inhibited. (ENABLE), 3TB-7, activates motion in both directions.

RDD inhibits positive (+) output voltage at ML1 with respect to ML2. (See Section 2.3.1 for Brake/Coast Select)

LDD inhibits negative (-) output voltage at ML1 with respect to ML2. (See Section 2.3.1 for Brake/Coast Select)

Enable activates both positive (+) and negative (-) output voltage at ML1 with respect to ML2.

These LDD and RDD inputs are normally connected to machine-mounted limit switches to allow an axis to back out of an overtravel condition.

4.1.6 Input Notch Filter

With certain applications, the fast response, high torque capabilities of the servoamplifier may cause machine resonances responding to step-like inputs (X-Y cutting machines typical).

The use of the notch filter is to eliminate, from the input reference, those frequencies of the input signals which excite the machine resonances.

The proper center frequency, breadth of frequencies and attenuation factor of the notch filter are adjusted by the (FREQUENCY), (WDTH), and (DPTH) potentiometers.

4.1.7 Fault Section

The fault section contains the fault latch circuitry and LED indicators for the various fault modes.

The fault designators and their corresponding fault modes are:

SC - Short Current - 3LED
OH - Heatsink Overtemperature - 2LED AND 3LED
*PBE - Power Bus Overvoltage - 2LED
*If overvoltage is continuous, 3LED will also be on.

A short circuit fault (SC) is set if the motor armature and/or the power bridge is shorted. In either case, the power transistors are protected from destructive current levels.

A bus overvoltage fault (PBE) occurs if the bus voltage applied to the servoamplifier exceeds the factory set fault level.

A small, normally closed thermostat activates the heatsink overtemperature if the heatsink temperature exceeds a predetermined threshold.

If a fault occurs, it latches the corresponding LED, releases the fault relay (FR), disables the drive and drops out the bus relay (PR). Form-C fault relay contacts are brought out externally for customer use.

If an OH fault occurs, it cannot be reset, until a cooler heatsink temperature is reached. When the heatsink temperature reduces sufficiently, 3LED will turn-off and the amplifier can then be reset.

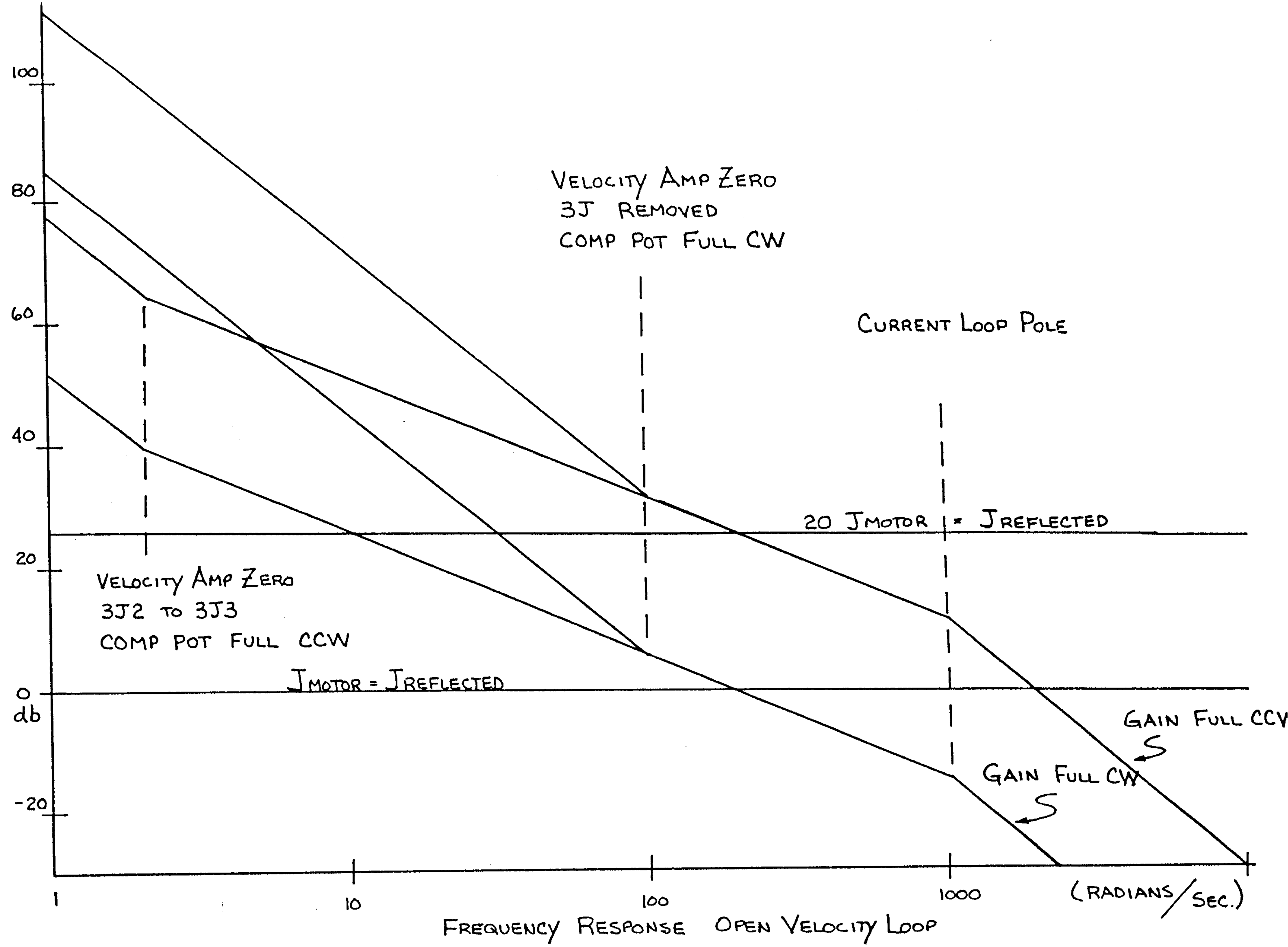

100
80
60
40
20
0
db
-20
1
10
100
1000
(RADIANS/SEC.)
VELOCITY AMP ZERO
3J REMOVED
COMP POT FULL CW
CURRENT LOOP POLE
20 JMOTOR = JREFLECTED
VELOCITY AMP ZERO
3J2 TO 3J3
COMP POT FULL CCW
JMOTOR = JREFLECTED
GAIN FULL CCW
GAIN FULL CW
FREQUENCY RESPONSE OPEN VELOCITY LOOP

FIGURE 4-7

If a PBE fault occurs, it can be reset as soon as the bus voltage input returns to an acceptable level. Until this condition is met, and the amplifier is reset, 2LED and 3LED will remain on.

Each of the above faults are initially cleared upon power up with an RC timer, if a system fault exists, it will immediately trip its latch circuit and inhibit drive operation.

The Power Bus fault applied (PBU), 1LED, is turned-off and the drive disabled if an excessively low bus voltage is detected. The drive remains disabled until the proper bus voltage level returns.

4.1.8 Transistor Drivers

The output transistor drivers are non-isolated from the control circuit. The output base drive circuit prevents output transistor saturation to provide reliable and enhanced switching of the power transistors. This mode of operation also minimizes both switching losses and storage time.

4.1.9 Current Sense Coupler

The current flowing through the motor lines must be sensed and applied as a feedback signal to the current error amplifier. The motor line voltage, however, is constantly being switched between the positive bus and the bus return. This high voltage must be rejected while the motor current is sensed. The current sense coupler circuit shown in Figure 4-8 does this job by sensing current through a low resistance series resistor. The circuit operates a modulator-demodulator with an operating carrier frequency of approximately 1 MHz. The signal on the shunt is transferred through, and isolated by, transformer T1 with transistor switches Q4 and Q5. Figure 4-4 shows the current loop block diagram.

4.1.10 RMS Current Limit

Circuitry is contained on each axis card to monitor the armature current level. When the continuous RMS current rating of the drive is exceeded, the current limit level is automatically lowered.

The circuitry is based on a stalled motor condition and a normal operating current of 20% current limit. Once the RMS current rating has been exceeded the controller will automatically lower the output current to 40% current limit. The controller will remain at this level and will not activate an internal reset delay until the load current drops to 25% or less. The reset delay is based on the load current; lower load currents provide a faster reset.

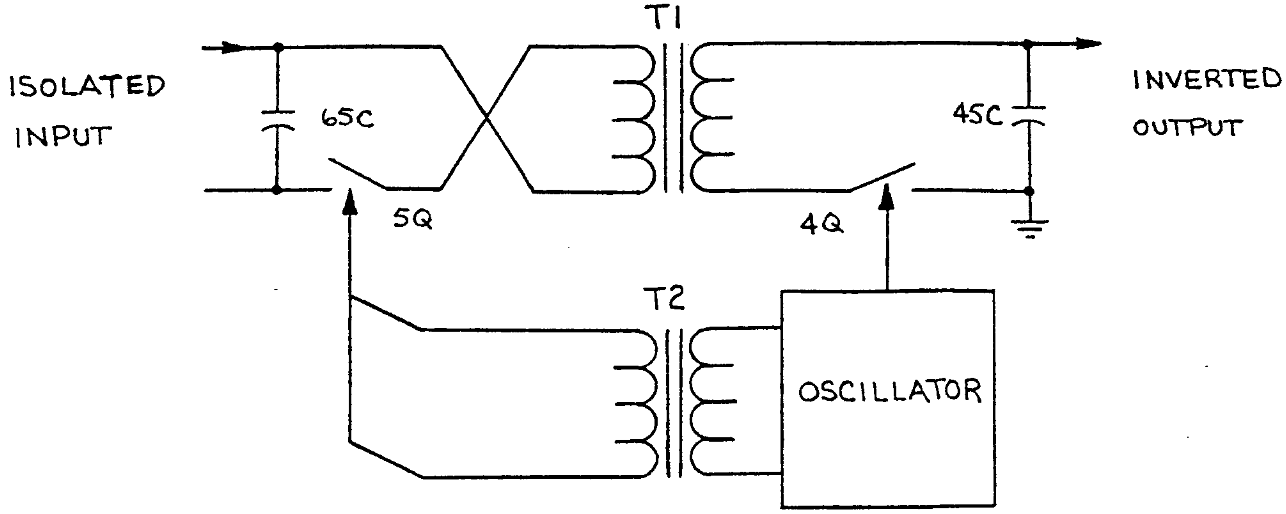


FIGURE 4-8. CURRENT SENSE COUPLER

4.1.11 Short Circuit Sensor

A short circuit sensor is incorporated on each axis board to shut down the drive if the normal peak output current is exceeded. Current sensing is accomplished by means of a low valued resistor in series with the positive bus. A small voltage drop occurs across this resistance each time a surge current occurs. The drop is applied to a comparator with a hysteresis latch. The surge causes the latch to be set and the output to be inhibited if the current exceeds a threshold for a predetermined time interval. The short circuit fault LED, 2LED, also activates. To clear the fault, the drive must be reset by: 1) momentarily connecting the (RESET) line to common; or 2) by removing and reapplying power.

4.1.12 Input Bus Relay

The input bus relay (PR) serves to interrupt the application of bus power to the power output transistors when a fault occurs. The relay is energized upon power-up if a fault does not exist.

Bus power is always connected to the positive return of the flyback diode doublers (RA1 and RA2) so that stored energy within the armature circuit can be absorbed by the bus capacitors.

4.1.13 Bus Supply Choke

The bus supply series-connected choke limits the time rate of change of current from the positive bus. This serves to limit fault currents to a safe level, providing time for the fault circuits to react.

4.1.14 Bias Supply Filter Capacitance

Capacitors, 100 MFD electrolytic and 1 MFD tantalum, are connected in parallel across the +/- 15 VDC supply inputs to filter and hold up the DC supplies.

4.1.15 Power Transistor Bridge

Power switching and control is obtained through two pairs of power transistors. To provide for full four quadrant operation, inverse parallel diodes are connected from each armature output to Pos. and Neg. Bus.

4.2 SUPPLY ASSEMBLY

The supply assembly includes the bus supply filter capacitance; bias supply rectification, regulation and filter capacitance and the optional circuitry for bus regulation and synchronization.

4.2.1 Bus Capacitance

The supply card bus capacitors are high frequency, high RMS ripple current, low ESR aluminum electrolytics. They are parallel connected for increased capacitance and ripple current.

4.2.2 Bias Supply

The DC rectification, regulation and filtering necessary to create the +/-15 VDC, 1.0 ADC supplies is fully accomplished on the assembly.

The series pass transistors are mounted on the heatsink, while AC rectification, capacitive filtering and the regulators themselves are on the printed circuit board.

4.2.3 Shunt Regulator

The armature in a running motor contains kinetic energy. If the motor is decelerated, this energy is dissipated in 1) the armature total loop resistance, and 2) the bus capacitor. At high current levels, the motor energy is often dissipated in the armature resistance only. However, at low current levels during deceleration the energy cannot be dissipated resistively. The motor energy is then transferred to the bus capacitor by pumping up or increasing the bus capacitor voltage. If this voltage becomes too high, catastrophic failures of the power semiconductors and bus capacitors may occur. To eliminate this condition, additional bus capcitance can be connected to limit the voltage (square of the voltage rise is proportional to the capacitance) or a shunt regulator is used to clamp the bus voltage to a safe level.

The Shunt Regulator consists of a voltage comparator and external load resistors which are driven by a power transistor. The comparator operates to turn on the transistors only if the bus voltage exceeds the trip level. The excessive motor-load energy is then dissipated in the resistor(s). The external resistance should never be disconnected from the PCB while the drive is operated.

The clamp voltage is factory-adjusted to the specified level. (Approximately 45 volts for a 37 volt bus.) The reference is controlled by a double zener clamp which is stable with ambient temperature change. The unit uses remote sensing at the bus capacitor to eliminate noise which might otherwise occur on the bus power lines. The combination of fuse protection and shunt resistors, 15 ohms, 150 watts, combine to provide a continuous power dissipation of 90 watts.

4.2.4 Synchronization Circuits

The synchronization circuitry is used in applications where two motors are to move in a synchronized motion (three axis cutting machines typical) using resolver feedback. The circuitry can be broken into two functions. The first half is the generation of the sine and cosine waveforms for the resolver inputs. The second half operates off the resolver feedbacks.

The resolver outputs are squared and converted into a series of pulses. These pulses are then logically compared and converted into an analog signal of sufficient magnitude and polarity to correct the speed of one of the two drives through the AUXILIARY DIFFERENTIAL INPUT terminals, 3TB-6 and 3TB-5.

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5.0 SERVICE & MAINTENANCE

SAFETY NOTICE: THIS EQUIPMENT SHOULD BE INSTALLED, ADJUSTED AND SERVICED BY QUALIFIED PERSONNEL FAMILIAR WITH ELECTRICAL EQUIPMENT AND THE CONTENTS OF THIS MANUAL.

Remove all power -- 100/115/230 VAC Input Voltage
38VAC-CT Bias Voltage
28VAC Bus Voltage

before performing any maintenance work on controller or motor.

Check for shorts and loose connections before applying power if any changes have been made. Use ground isolated test equipment.

5.0.1 Periodic Maintenance and Servicing

The only periodic maintenance for the SERVOPAK Controller is an occasional inspection for accumulated dust or dirt on heatsinks and circuit boards. For maximum efficiency, heatsinks must be kept clean. Also, shop dust in some environments tends to be electrically conductive and can cause controller malfunction. If cleaning is needed, carefully vacuum loose dirt or use dry compressed air. The Servopak circuit boards are designed for easy and straight-forward servicing. Modules are interconnected for easy removal.

5.1 ADJUSTMENTS

Adjustments are readily accessible at the top of the circuit board. LED's provide immediate indication of controller status and fault conditions.

5.1.1 Circuit Abbreviations and Terminology

The module interface signal points and adjustments are identified on the diagram and silk-screened on the circuit board with a symbol. The description of designations is as follows:

1) Potentiometer Adjustments

TACH - Designates the DC gain control connected to the tachometer circuit. Typically, the TACH pot is initially turned fully counter-clockwise.

BAL - Designates balance or input offset adjustment. This is used to stop the motor from drifting in a velocity control loop, with zero speed reference.

SIG - Designates the input reference signal scaling adjustment. Full CW will provide 100% output velocity while full CCW will reduce the output velocity 52%.

GAIN - Designates internal velocity loop gain. This is normally turned clockwise until the system oscillates. Then the adjustment is backed off approximately 10%.

I LIM - Designates the output current limit or the maximum peak current allowed to the motor armature.

COMP - Designates internal velocity loop frequency compensation. This is used in conjunction with the gain pot for system stability.

FREQUENCY - Designates the frequency of operation adjustment for the input notch filter.

WDTH - Designates the width, or the range of frequencies around the notch filter operating point, which are affected.

DPTH - Designates the attenuation factor of the notch frequencies.

FAULT LEVEL (supply assy.) - Designates the sync correction voltage at which the system is considered "out of sync" and a fault is activated.

GAIN (supply assy.) - Designates the sensitivity adjustment of the synchronization correction signal scaling.

2) Customer Interface Signals

COM - Designates circuit common and tachometer or bus supply return connection.

DIFF/ INPUT - Designates differential input speed command terminals.

AUX DIFF INPUT - Designates the auxiliary differential input connections used for synchronized speed operation.

LDD - Designates left drive disable. This line disables negative (-) output voltage at ML1 with respect to ML2.

RDD - Designates right drive disable. This line disables positive (+) output voltage at ML1 with respect to ML2.

ENABLE	- Designates drive enable. This line enables both polarities of output voltage.
RESET	- Designates a reset signal. Normally, the line is pulled to ground and then released.
SYNC ENABLE (supply card)	- Designates the synchronization-output signal zero output clamp release.

5.2 Status and Fault LED Indicators Axis Card

Status LEDs

1LED	Bus Supply Applied

Fault LEDs

2LED	Short circuit
2LED AND 3LED	Heatsink overtemperature
2LED AND 3LED	Bus Supply Overvoltage

Status and Fault LED Indicators Supply Card

1LED	Bus Supply Present
2LED	Synchronization Fault

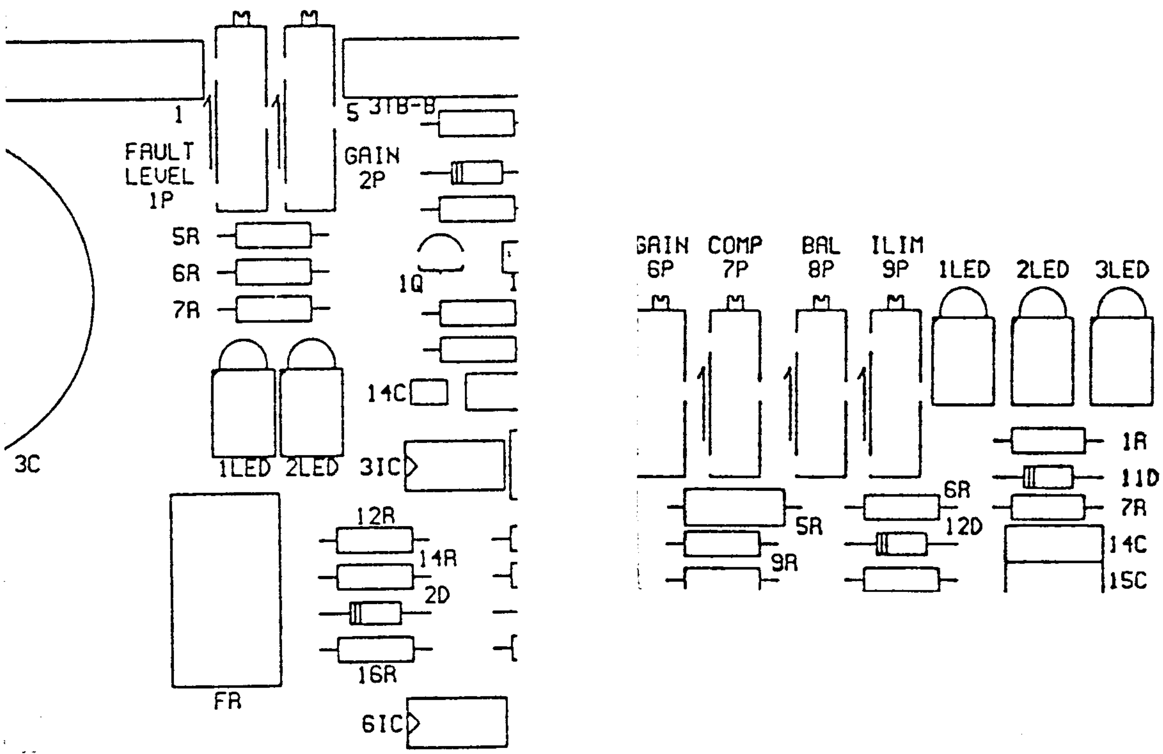

FIGURE 5-2. STATUS & FAULT LED INDICATORS

5.3 TROUBLESHOOTING CHART

FAULT 1 - POWER BUS APPLIED - 1LED

Probable Cause - The 1LED indicator operates at normal bus voltages but will turn off and disable the drive when the voltage is too low. Also, an open or loosely connected bus connection will result in bus voltage noises. This, in turn, could momentarily disable the drive.

Corrective Action - Check bus connectors 1TB. Measure DC bus voltage to the controller to verify that it corresponds to the specified value. Check fault relay contacts for fault condition.

FAULT 2 - SHORT CIRCUIT INDICATOR - 2LED

Probable Cause - The short circuit indicator operates if a 160% bus surge current occurs for more than 4 microseconds on the output bridge. The surge current is often caused by shorting the axis drive output lines. The surge can also occur if an output transistor is shorted.

Corrective Action - Check the bridge output lines and the collector/emitter junction of the output bridge transistors for the shorted condition with an ohmmeter. Replace axis assembly if shorted transistor is found.

Alternative Cause - Momentary bus overvoltage. See fault No. 4 below.

FAULT 3 - OVERTEMPERATURE INDICATOR - 2LED AND 3LED

Probable Cause - The overtemperature indicator operates if the heatsink temperature rises above safe levels. The heat transducer is a normally closed thermostat which recloses approximately 10 degrees Centigrade below the opening temperature. After the fault clears, the system can be reset and enabled.

Corrective Action - Check incorrect installation of controller which blocks airflow across the heatsink and for excessive dirt accumulation on heatsink. Check for heat producing components within the enclosure which may cause the maximum ambient temperature rating of the controller to be exceeded.

FAULT 4 - POWER BUS OVERVOLTAGE - 2LED AND 3LED

Probable Cause - The bus overvoltage indicators turn on if the power bus voltage being applied to the assembly is beyond safe operating levels. The circuits will prevent the amplifier from being reset until the bus voltage is correct and the amplifier powered down.

Corrective Action - Check power bus transformer for correct voltage tapping (see Section 1.7). Check shunt regulator fuse and shunt resistors. Shunt regulator ratings may be exceeded by too low of a resistance or too high of a motor energy. Finally, loose bus power connectors at 1TB may induce random noise.

FAULT 5 - FUSE (F1) OPEN SHUNT REGULATOR FUSE

Probable Cause - Excessive load inertia connected to the motor. Shorted shunt regulator transistor. Improper shunt resistor sizing.

Corrective Action - Check power bus transformer for correct voltage tapping (see Section 2.2). Check shunt regulator fuse and shunt resistors. Shunt regulator ratings may be exceeded by too low of a resistance or too high of a motor energy. Finaly, loose bus power connectors at 1TB may induce random noise.

FAULT 6 - SQUEALING OR UNSTABLE MOTOR OPERATION

Probable Cause - The instability usually occurs if the gain or compensation adjustments are incorrect.

Corrective Action - Solutions to this problem consist of turning the gain adjustment (GAIN) or the compensation adjustment (COMP). See section 3.3, step 8.

FAULT 7 - MOTOR ROTATES AGAINST EXTERNAL TORQUE DISTURBANCE WITH ZERO VELOCITY COMMAND

Probable Cause - This is a positive feedback problem in the tachometer loop. Unshielded or improperly grounded shield wires can pick up motor switching pulses and cause the motor rotation.

Corrective Action - Use twisted-shielded pair for tachometer signal wiring. Connect shield to common at controller end only.

FAULT 8 - NO OUTPUT, ONE DIRECTION

Probable Cause - The LDD or RDD lines, when activated, will cause this to happen. However, an open bridge transistor produces the same effect.

Corrective Action - Check interface connections to CNC. If found not grounded, verify that the base-emitter junction of each output transistor exhibits the same forward resistance as the others.

FAULT 9 - MOTOR RUNS AT UNCONTROLLED HIGH SPEED

Probable Cause - The runaway motor condition is caused either by a reversed tachometer connection, or by the tachometer connection not being complete.

Corrective Action - Retry the system with tachometer leads reversed. If this does not correct the problem, verify that the tachometer signal occurs is present from TP3 to TP2.

FAULT 10 - MOTOR EXHIBITS A DEAD ZONE

Probable Cause - The dead zone condition appears if the current loop gain is too low. This can be caused by the output inductance being too large.

Corrective Action - Check armature loop output inductance. (Consult CMC's factory for assistance).

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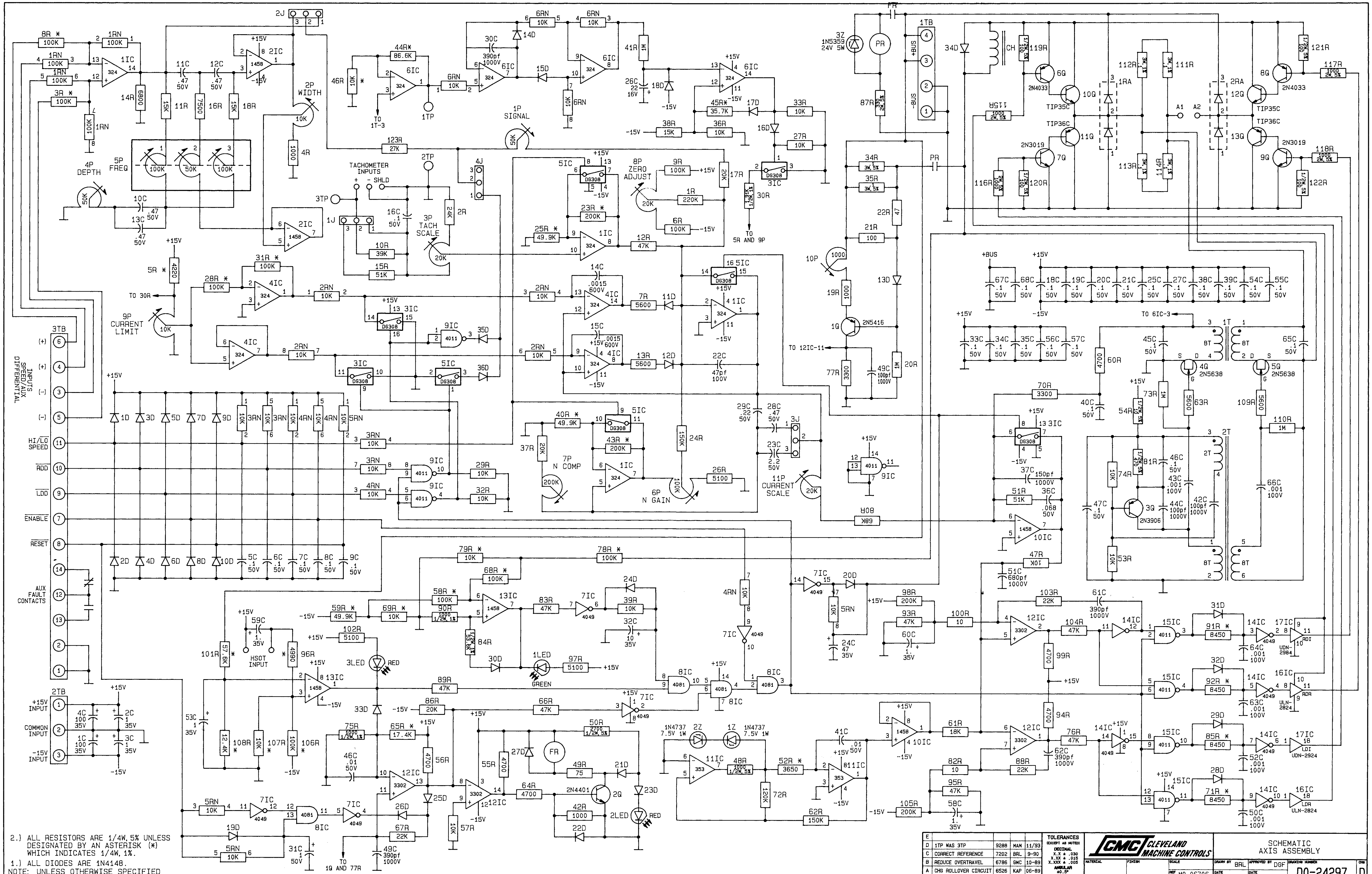

2.) ALL RESISTORS ARE 1/4W, 5% UNLESS DESIGNATED BY AN ASTERISK (*) WHICH INDICATES 1/4W, 1%.

1.) ALL DIODES ARE 1N4148.

NOTE: UNLESS OTHERWISE SPECIFIED

SYM	REVISION	ECO	BY	DATE
E				
D	1TP WAS 3TP	9288	MAM	11/93
C	CORRECT REFERENCE	7202	BRL	9-90
B	REDUCE OVERTRAVEL	6786	GMC	10-89
A	CHG ROLLOVER CIRCUIT	6526	KAP	06-89

TOLERANCES (EXCEPT AS NOTED) DECIMAL X.X ± .030 X.XX ± .015 X.XXX ± .005 ANGULAR ±0.5° DO NOT SCALE DRAWING

CMC CLEVELAND MACHINE CONTROLS

MATERIAL | FINISH | SCALE

SCHEMATIC AXIS ASSEMBLY

DRAWN BY BRL | APPROVED BY DGF | DRAWING NUMBER D0-24297 | CHG D

REF MO-06706 | DATE 10-14-88 | DATE 10-17-88

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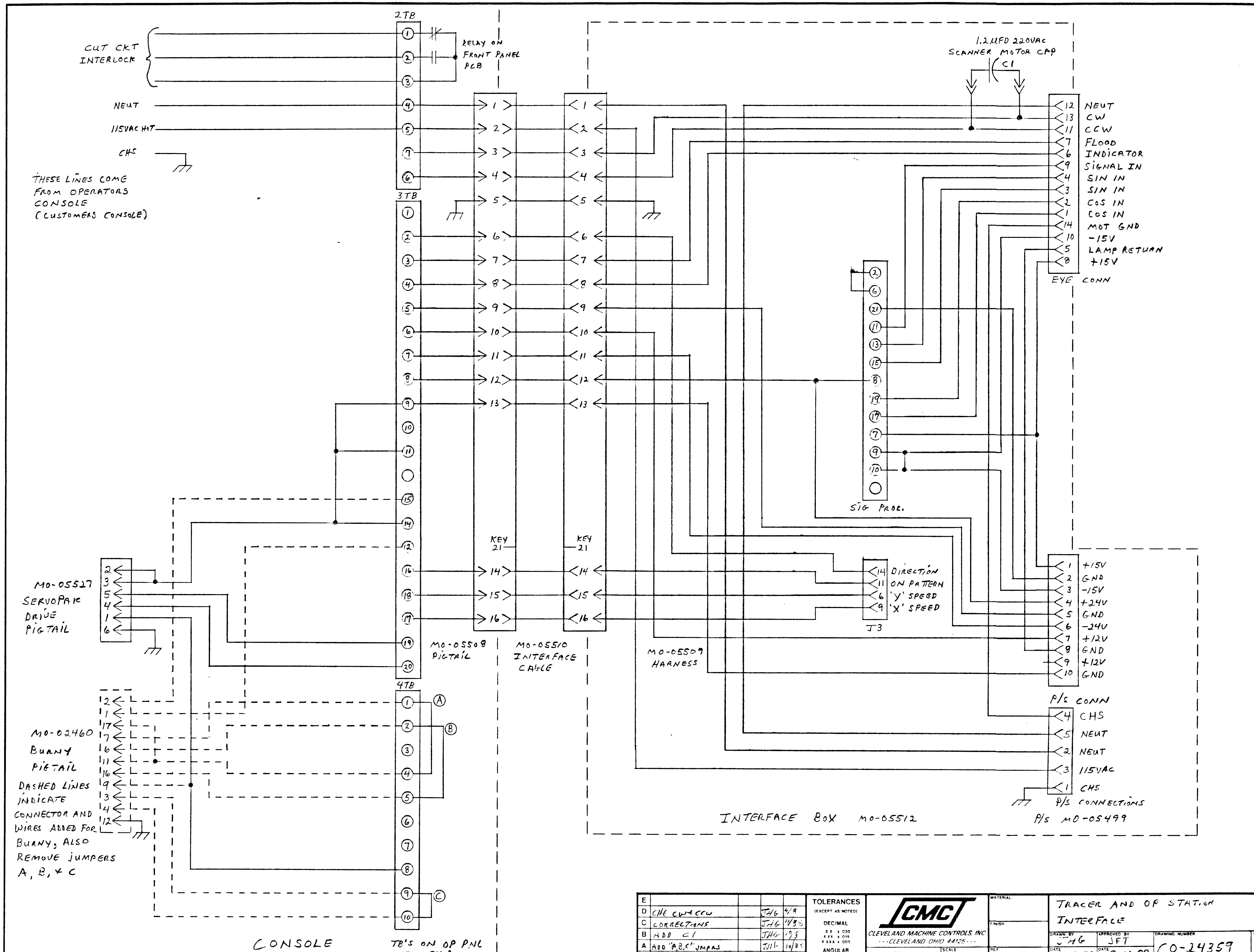
2TB
CUT CKT INTERLOCK
RELAY ON FRONT PANEL PCB
NEUT
115VAC HOT
CHS
THESE LINES COME FROM OPERATORS CONSOLE (CUSTOMERS CONSOLE)
3TB
1.2 MFD 220VAC SCANNER MOTOR CAP
C1
NEUT
CW
CCW
FLOOD
INDICATOR
SIGNAL IN
SIN IN
SIN IN
COS IN
COS IN
MOT GND
-15V
LAMP RETURN
+15V
EYE CONN
SIG PROC.
KEY 21
KEY 21
DIRECTION
ON PATTERN
'Y' SPEED
'X' SPEED
J3
+15V
GND
-15V
+24V
GND
-24V
+12V
GND
+12V
GND
MO-05527 SERVOPAK DRIVE PIGTAIL
MO-05508 PIGTAIL
MO-05510 INTERFACE CABLE
MO-05509 HARNESS
P/S CONN
CHS
NEUT
NEUT
115VAC
CHS
P/S CONNECTIONS
4TB
MO-02460 BURNY PIGTAIL
DASHED LINES INDICATE CONNECTOR AND WIRES ADDED FOR BURNY, ALSO REMOVE JUMPERS A, B, & C
INTERFACE BOX MO-05512
P/S MO-05499
CONSOLE
TB'S ON OP PNL MNB-05162
E
D CHG CW & CCW JHG
C CORRECTIONS JHG
B ADD C1 JHG
A ADD "A,B,C" JMPRS JJH
SYM REVISION ECO BY DATE
TOLERANCES (EXCEPT AS NOTED)
DECIMAL
ANGULAR
CMC
CLEVELAND MACHINE CONTROLS INC
CLEVELAND OHIO 44125
DO NOT SCALE DRAWING
MATERIAL
FINISH
SCALE
REF MO-04714
TRACER AND OP STATION INTERFACE
DRAWN BY JHG
APPROVED BY JFT
DATE 9-29-89
DATE 8-4-89
DRAWING NUMBER CO-24359
CHG D

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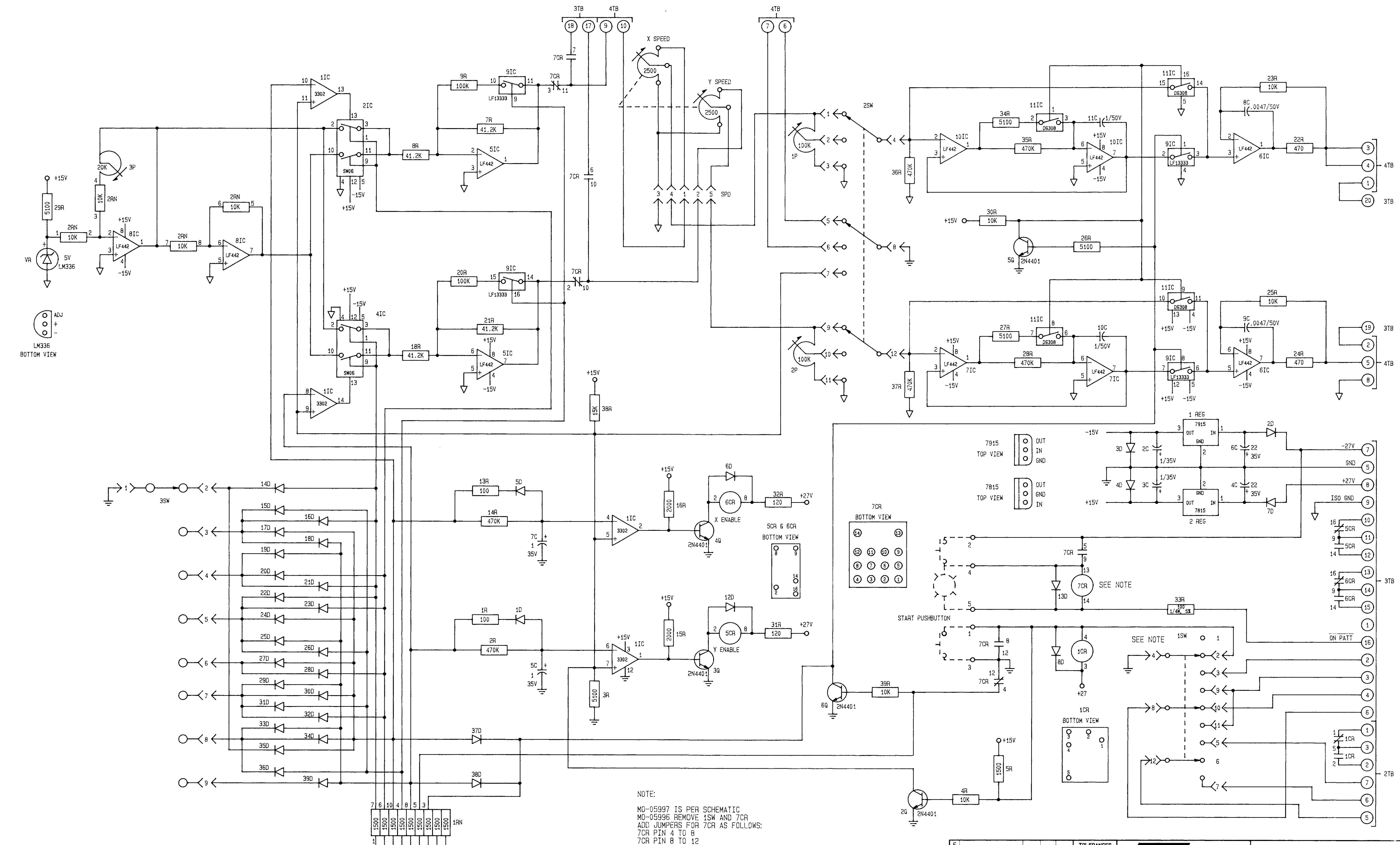

NOTE:

MO-05997 IS PER SCHEMATIC
MO-05996 REMOVE 1SW AND 7CR
ADD JUMPERS FOR 7CR AS FOLLOWS:
7CR PIN 4 TO 8
7CR PIN 8 TO 12
7CR PIN 3 TO 11
7CR PIN 2 TO 10
(REFERENCE BOTTOM VIEW OF 7CR)

SYM	REVISION	ECO	BY	DATE
E				
D	SWAP 2 AND 3 ON 2TB	9417	JHG	01/94
C	ADD NOTE	7098	JHG	8/90
B	CORRECT START CKT	6716	JHG	11/89
A	CORRECTIONS		JHG	8/89

TOLERANCES (EXCEPT AS NOTED)
DECIMAL
X.X ± .030
X.XX ± .015
X.XXX ± .005
ANGULAR ±0.5°
DO NOT SCALE DRAWING

CMC CLEVELAND MACHINE CONTROLS

REVISED TRACER OPERATORS PANEL

MATERIAL	FINISH	SCALE	DRAWN BY	APPROVED BY	DRAWING NUMBER	CHG
		REF SEE NOTE	JHG DATE 6-30-89	KqK DATE 1-5-94	DO-24508	D

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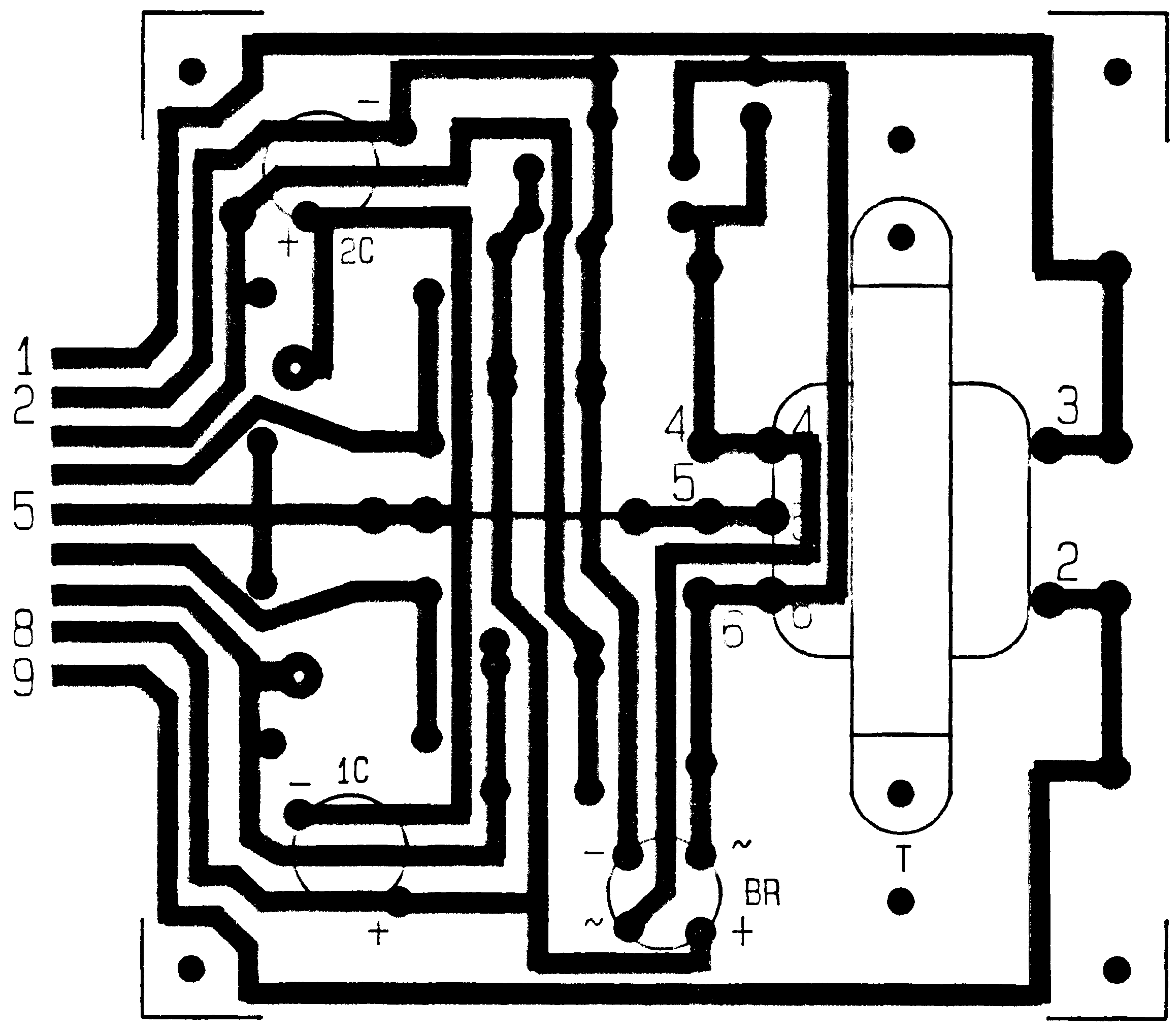
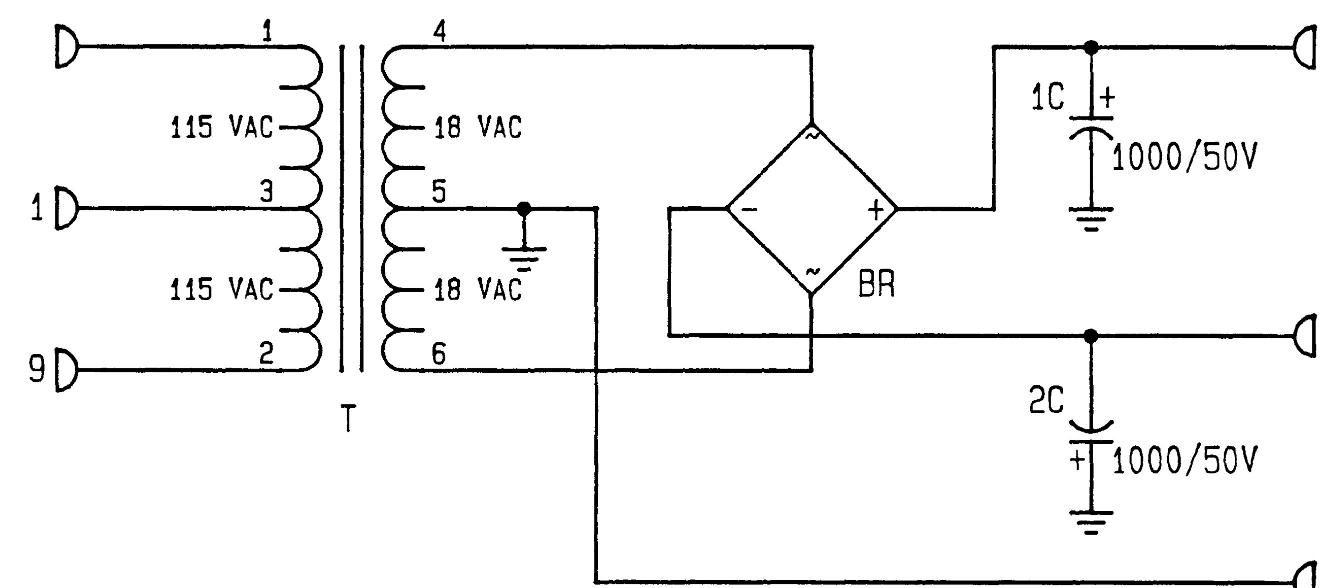


TOP VIEW OF ASSEMBLY



SYM	REVISION	ECO	BY	DATE
E				
D				
C	CORRECT 2C DESIGNATION	8043	KAP	06/92
B	CORRECT DESIGNATIONS	7830	JJS	11/91
A	SWAP PINS 2 AND 8	——	JHG	01/90

TOLERANCES
(EXCEPT AS NOTED)
DECIMAL
X.X ± .030
X.XX ± .015
X.XXX ± .005
ANGULAR
±0.5°
DO NOT SCALE DRAWING

CMC CLEVELAND MACHINE CONTROLS

SCHEMATIC ASSEMBLY,
OPERATORS PANEL UNREG POWER SUPPLY NC

MATERIAL	FINISH	SCALE	DRAWN BY	APPROVED BY	DRAWING NUMBER	CHG
		REF M0-06084	JHG DATE 08-07-89	KAK DATE 6-17-92	B0-21220	C

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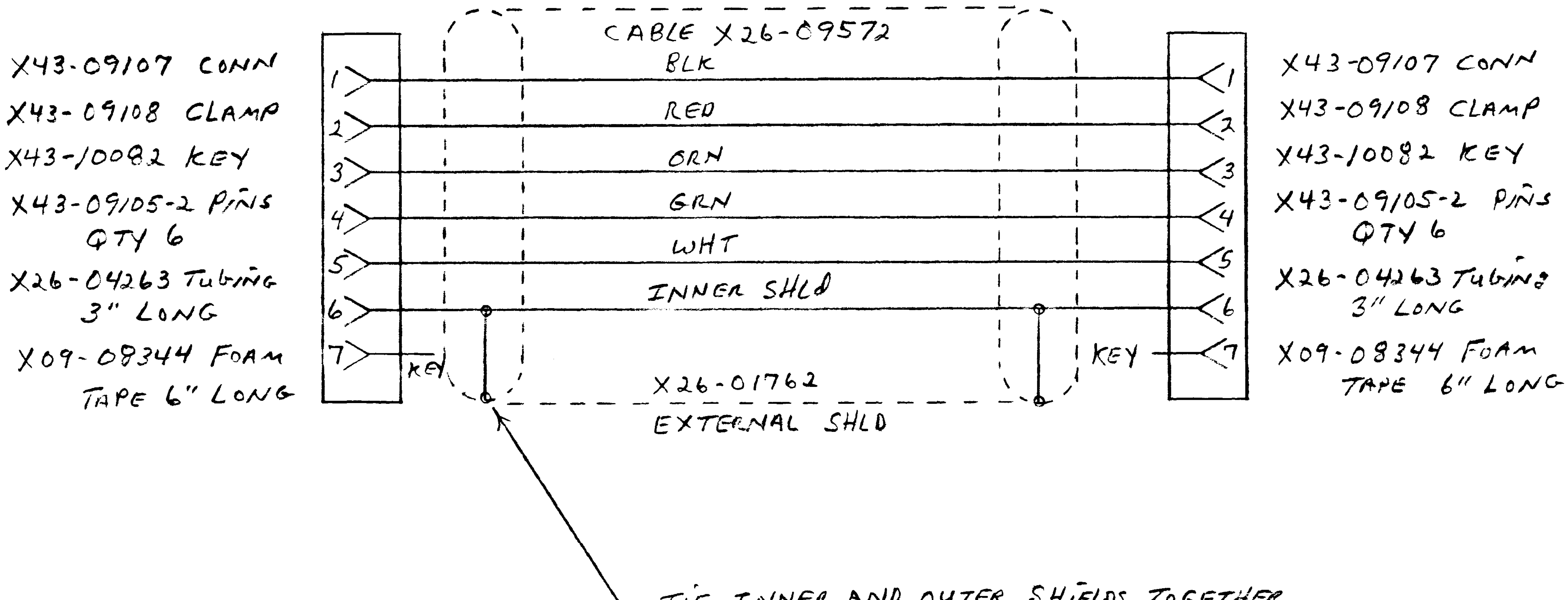

TIE INNER AND OUTER SHIELDS TOGETHER. THEN TIE TO PIN 6 ON BOTH ENDS USING A26-00143-06

X01-11726 CABLE CLAMP (QTY 2) DO NOT INSTALL: ATTACH LOOSE WITH STA-TIE

SYM	REVISION	ECO	BY	DATE
E				
D				
C				
B				
A				

TOLERANCES (EXCEPT AS NOTED)
DECIMAL
X.X ±.030
X.XX ±.015
X.XXX ±.005
ANGULAR ±.5°

CMC
CLEVELAND MACHINE CONTROLS, INC.
• • • CLEVELAND, OHIO 44125 • • •

DO NOT SCALE DRAWING | SCALE

MATERIAL

FINISH

REF 90-05530

CABLE, DRIVE SERVO-PAK TO NC OPERATORS PANEL

DRAWN BY	APPROVED BY	DRAWING NUMBER	CHG
JHG	JFT	A0-24361	
DATE 10-2-90	DATE 9-27-90		

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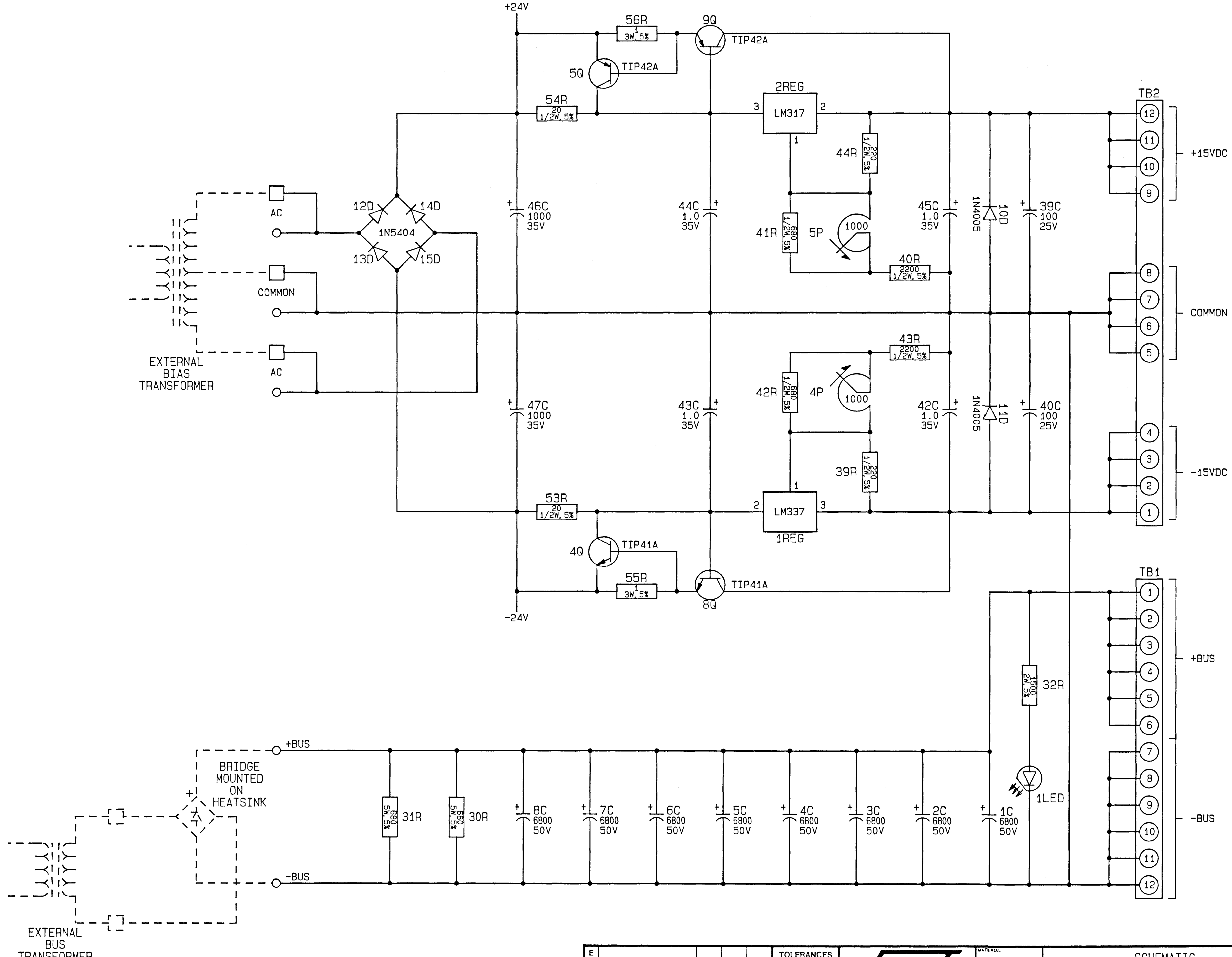

SYM	REVISION	ECO	BY	DATE
E				
D				
C				
B				
A				

TOLERANCES (EXCEPT AS NOTED)
DECIMAL
X.X ± .030
X.XX ± .015
X.XXX ± .005
ANGULAR ± 5°

CMC
CLEVELAND MACHINE CONTROLS INC
CLEVELAND, OHIO 44125
DO NOT SCALE DRAWING
SCALE
MATERIAL
FINISH
REF

SCHEMATIC
SERVO SUPPLY CARD

DRAWN BY: BRL
DATE: 2-2-89
APPROVED BY: RDM
DATE: 2-FEB-89
DRAWING NUMBER: CO-24413
CHG

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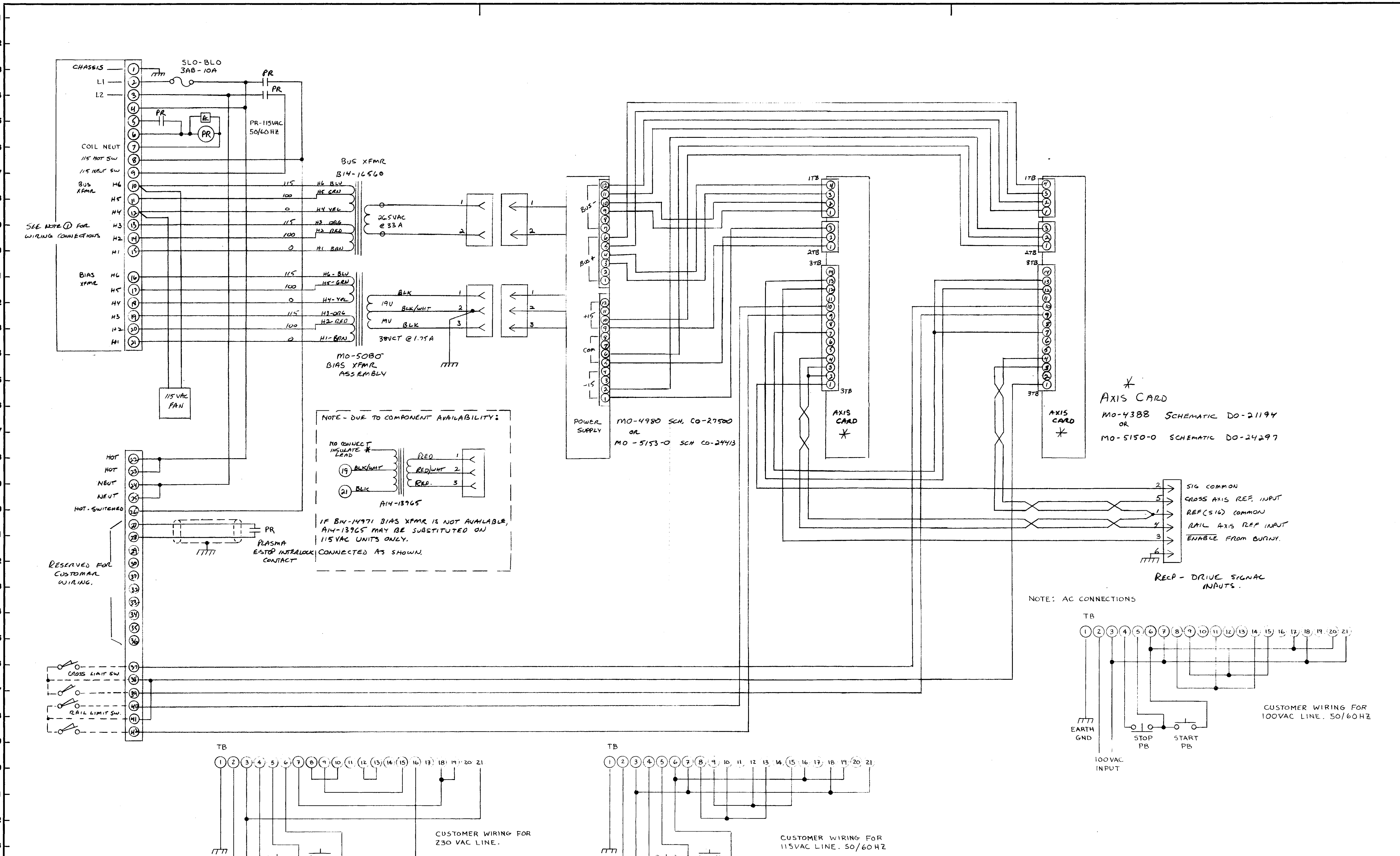

SYM	REVISION	ECO	BY	DATE	SYM	REVISION	ECO	BY	DATE
					E	CORR LIMIT SW		RDM	6-88
					D	CHG TO MATCH HARNESS		RDM	6-88
					C	CORR, 3TB			
G	ADD NEW CARD BOMS	6567	RDM	3-89	B	CORR. RECP 4,5			
F	MODIFY FOR 230VAC	6316	JJS	10-88	A	REVISED		RDM	4-7-88

TOLERANCES (EXCEPT AS NOTED)
DECIMAL
X.X ±.030
X.XX ±.015
X.XXX ±.005
ANGULAR ±.5°

CMC
CLEVELAND MACHINE CONTROLS, INC.
···CLEVELAND, OHIO 44125···
DO NOT SCALE DRAWING

SCHEMATIC, SERVO-PAK
2-AXIS DRIVE SYSTEM

REF MNA-04810 | DRAWN BY RDM | DATE 4-5-88 | APPROVED BY RDM | DATE 6-22-88 | DRAWING NUMBER DO-28125 | CHG G

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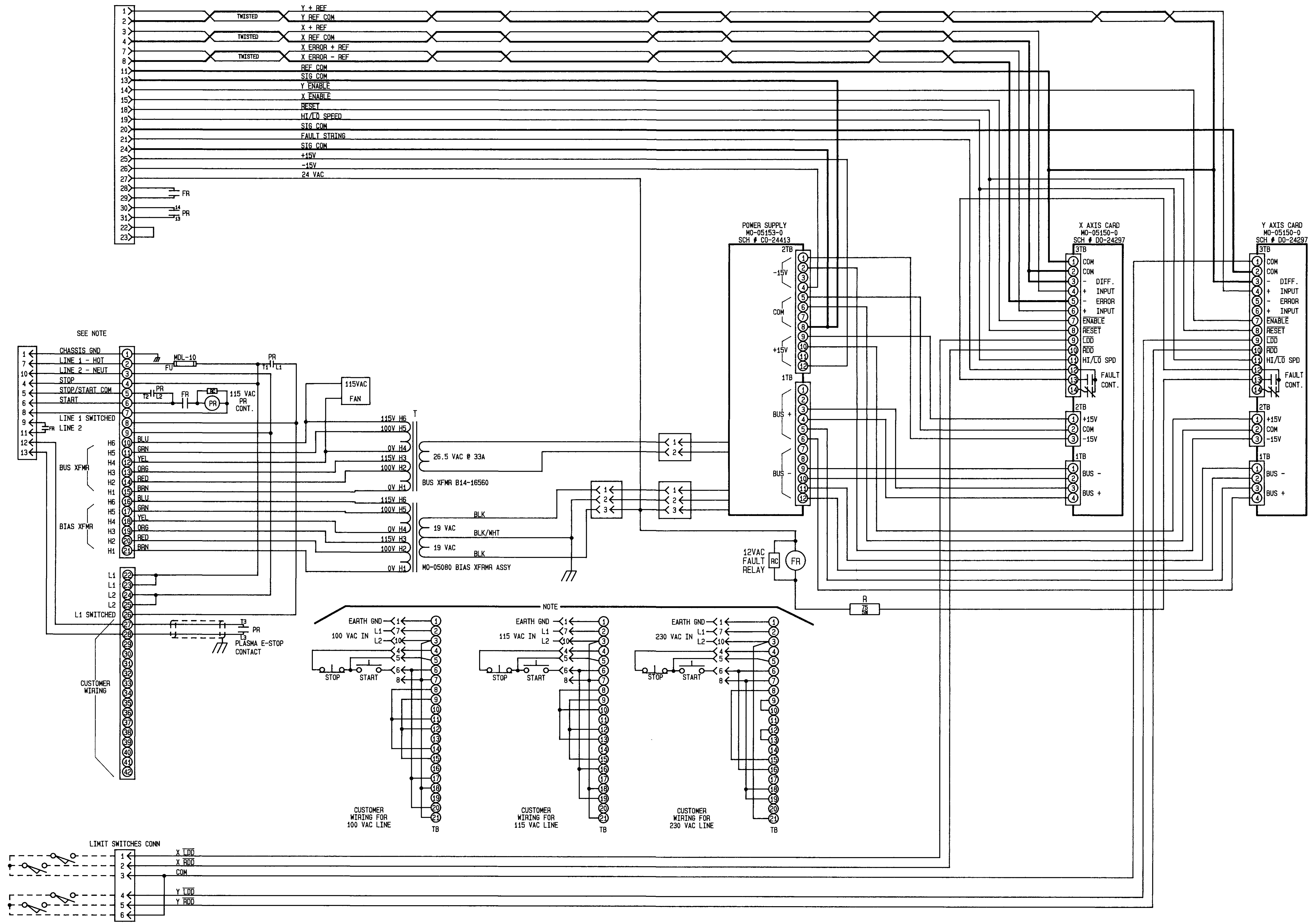

SYM	REVISION	ECO	BY	DATE
E				
D				
C	CORRECT LIMIT SW WIRING	8172	KAP	06/92
B	12V FAULT RELAY	7957	JJS	02/92
A	CORRECTIONS	---	JHG	10/90

TOLERANCES (EXCEPT AS NOTED)
DECIMAL
X.X ± .030
X.XX ± .015
X.XXX ± .005
ANGULAR ±0.5°
DO NOT SCALE DRAWING

CMC CLEVELAND MACHINE CONTROLS

SCHEMATIC, SERVOPAK WITH EXTERNAL CONNECTORS, 2 AXIS SYSTEM — NC

MATERIAL	FINISH	SCALE	DRAWN BY	APPROVED BY	DRAWING NUMBER	CHG
		REF MNA-06522	JHG, DATE 05-02-90	KAK, DATE 6-17-92	DO-24716	C

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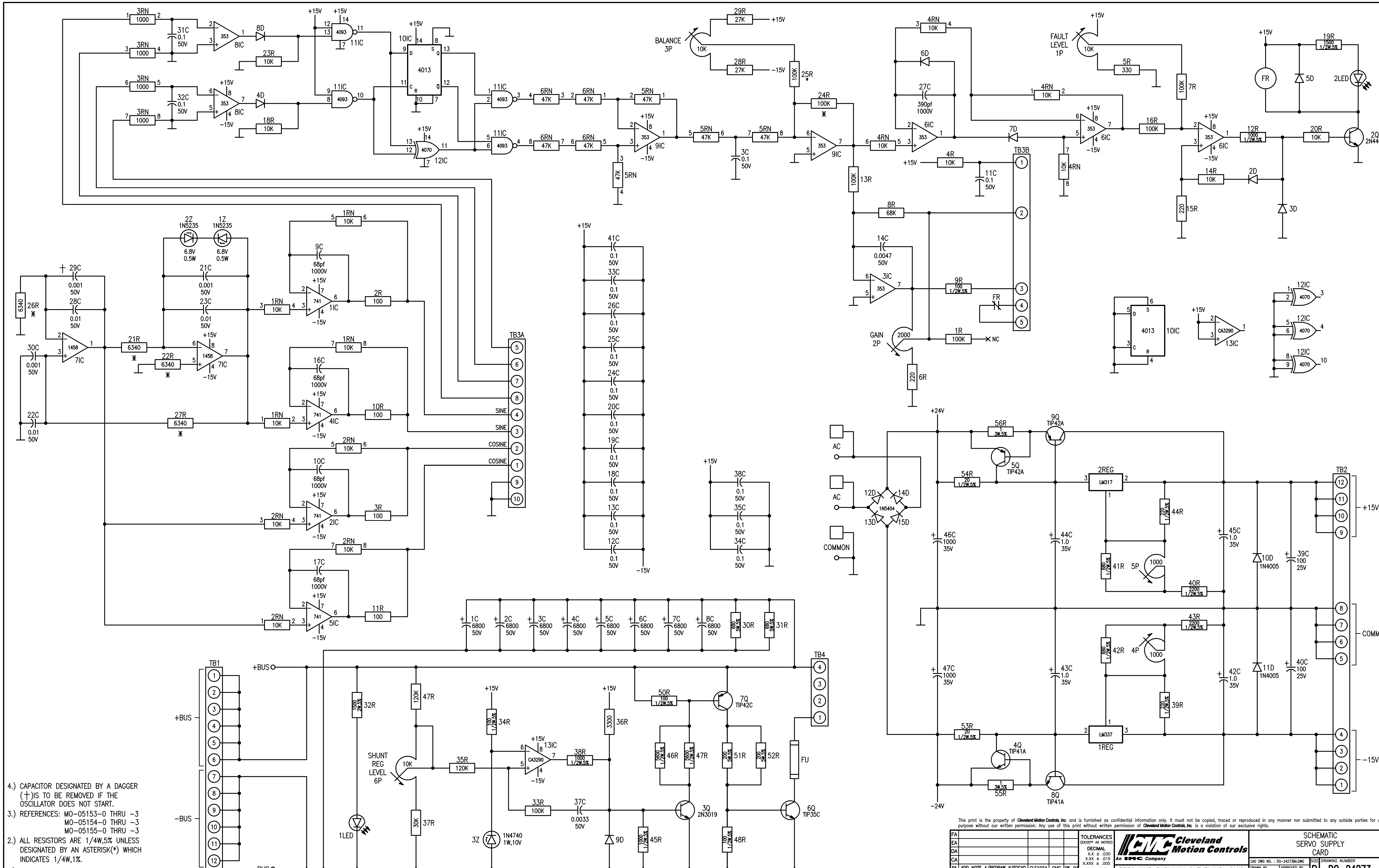


4.) CAPACITOR DESIGNATED BY A DAGGER (†)IS TO BE REMOVED IF THE OSCILLATOR DOES NOT START.
3.) REFERENCES: MO-05153-0 THRU -3
MO-05154-0 THRU -3
MO-05155-0 THRU -3
2.) ALL RESISTORS ARE 1/4W,5% UNLESS DESIGNATED BY AN ASTERISK(*) WHICH INDICATES 1/4W,1%.
1.) ALL DIODES ARE 1N4148.
NOTE: UNLESS OTHERWISE SPECIFIED.

SYM	REVISION	ECO	BY	DATE
FA				
EA				
DA				
CA				
BA	ADD NOTE 4/REDRAW AUTOCAD	CLE1924	GMC	05-01
AA	+15V TO 13IC-2,3	6460	GMC	03-89

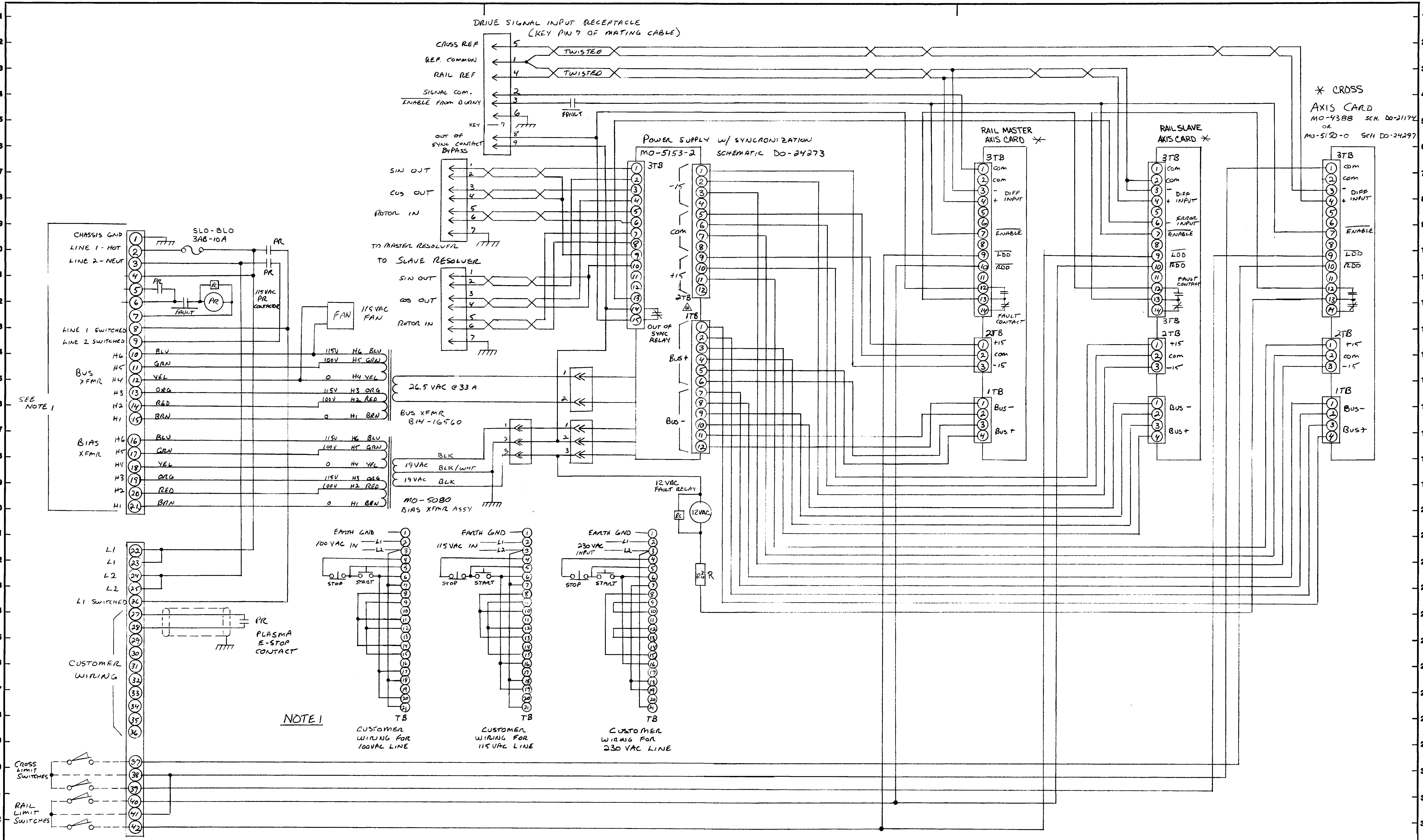
TOLERANCES (EXCEPT AS NOTED)
DECIMAL .X.X ± .030 X.XX ± .015 X.XXX ± .005
ANGULAR ± 0.5°
DO NOT SCALE DRAWING

CMC Cleveland Motion Controls
An IMC Company
7550 HUB PARKWAY CLEVELAND, OHIO

MATERIAL | FINISH | SCALE NONE | REF NOTE 3

SCHEMATIC
SERVO SUPPLY
CARD

CAD DWG NO.: D0-24273BA.DWG
SIZE D | DRAWING NUMBER D0-24273 | REV BA
DRAWN BY BRL | DATE 09-24-88
APPROVED BY KAK | DATE 03-22-81
SHEET 1 OF 1



SYM	REVISION	ECO	BY	DATE	SYM	REVISION	ECO	BY	DATE
MA					FA	ADD 75 OHM RESISTOR	8193	KAP	06/92
LA					EA	CORRECT DIFF INPUT WIRING	6654	KAP	07/89
KA					DA	ADD NEW AXIS P/N	6567	RDM	03/89
JA					CA	N.C. OUT OF SYNC	---	RDM	09/88
HA					BA	ADD FAULT RELAY	---	RDM	09/88
GA	CORRECT TB DESIGNATIONS	CLE1379	KAP	01/00	AA	SWITCH SLAVE SIN	---	RDM	06/88

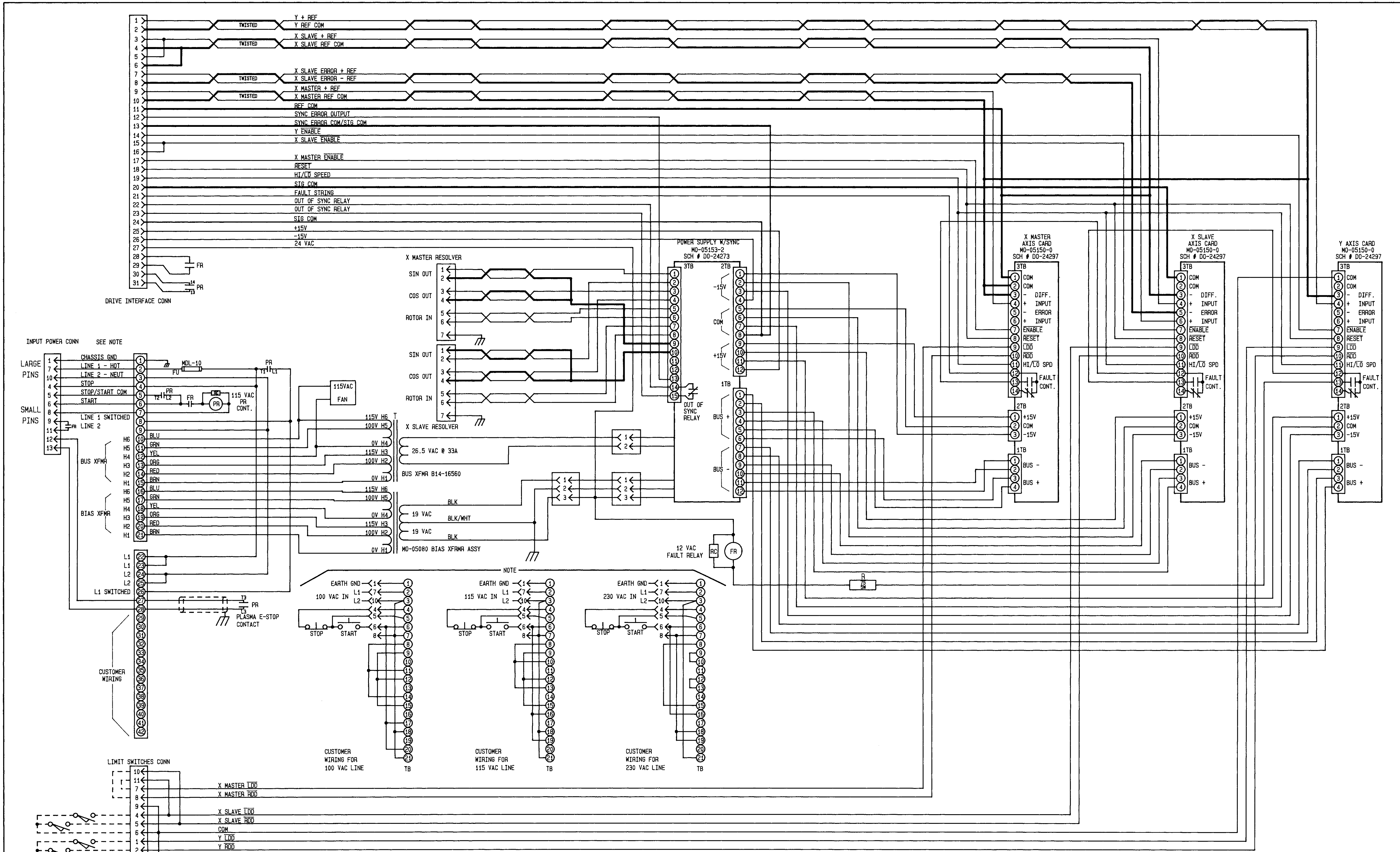
TOLERANCES (EXCEPT AS NOTED)
DECIMAL
X.X ± .030
X.XX ± .015
X.XXX ± .005
ANGULAR ± 0.5°
DO NOT SCALE DRAWING

Cleveland Motion Controls
An IMC Company
7550 HUB PARKWAY CLEVELAND, OHIO

SCHEMATIC,
SERVO-PAK, 3 AXIS SYSTEM

CAD DWG NO.: DO-24308GA.TIF		SIZE	DRAWING NUMBER	REV
DRAWN BY RDM	APPROVED BY RDM	D	DO-24308	GA
DATE 06-24-88	DATE 01-27-89	SHEET 1 OF 1		

MATERIAL | FINISH | SCALE | REF MNA-05233



SYM	REVISION	ECO	BY	DATE
E				
D	1TB, 2TB REVERSED	9204	KAP	10/93
C	LABEL CORRECTIONS	8635	JHG	02/93
B	12V FAULT RELAY	7957	JJS	02/92
A	CORRECTIONS	——	JHG	10/90

TOLERANCES (EXCEPT AS NOTED)
DECIMAL
X.X ± .030
X.XX ± .015
X.XXX ± .005
ANGULAR ±0.5°
DO NOT SCALE DRAWING

CMC CLEVELAND MACHINE CONTROLS

SCHEMATIC, SERVOPAK WITH EXTERNAL CONNECTORS, 3 AXIS SYSTEM

MATERIAL	FINISH	SCALE	DRAWN BY	APPROVED BY	DRAWING NUMBER	CHG
		REF MNA-06508	JHG DATE 02 MAY 90	JHG DATE 02 FEB 93	DO-23901	D

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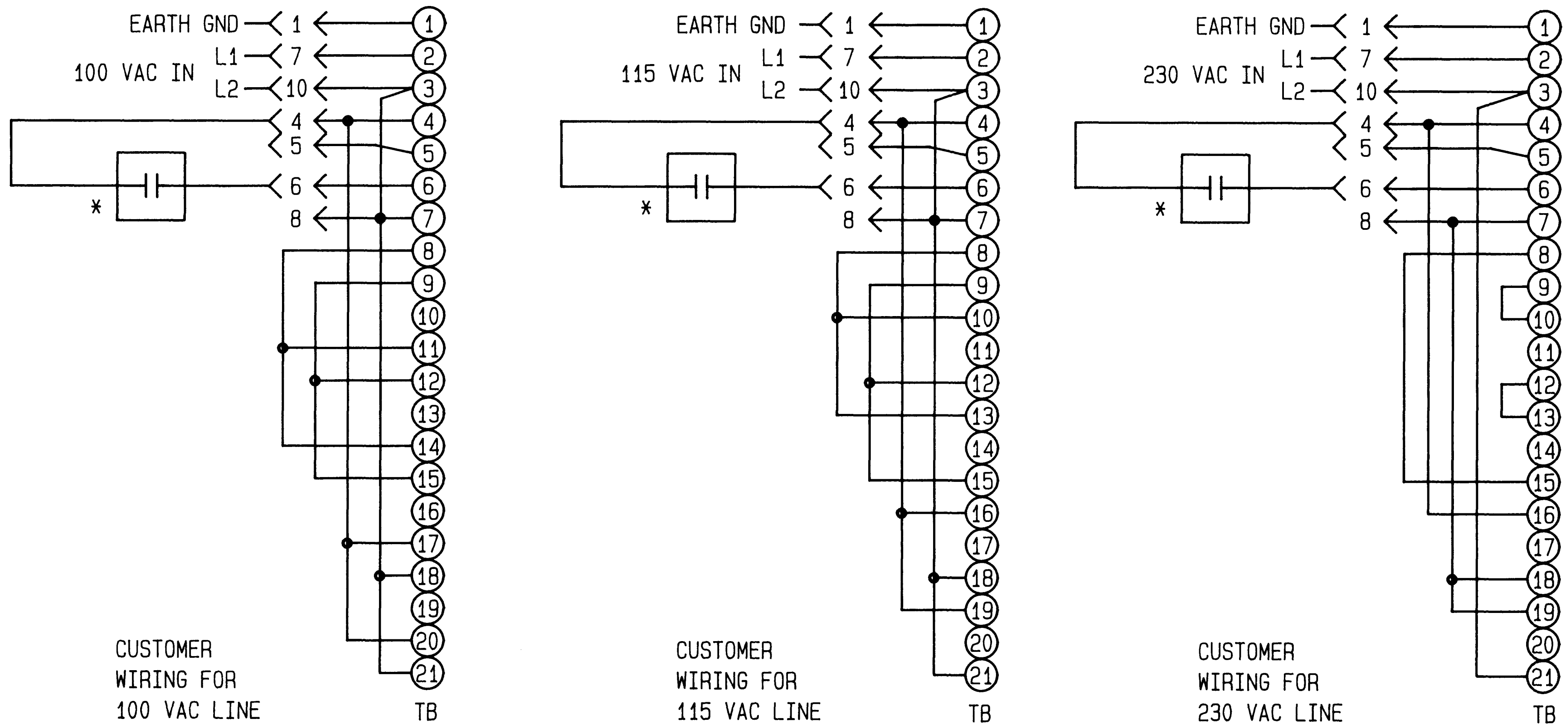

* ISOLATED CONTACT TO CONTROL SERVO DRIVE
LOCATED WITHIN REPLICATOR/OPERATORS CONTROL/
CHOP TOP.

SYM	REVISION	ECO	BY	DATE
E				
D				
C				
B				
A				

TOLERANCES (EXCEPT AS NOTED)
DECIMAL
X.X ± .030
X.XX ± .015
X.XXX ± .005
ANGULAR ±0.5°
DO NOT SCALE DRAWING

CMC CLEVELAND MACHINE CONTROLS

SCHEMATIC SP150 POWER JUMPERS

MATERIAL | FINISH | SCALE | REF

DRAWN BY JHG | DATE 05-05-92 | APPROVED BY SPR | DATE 5-11-92 | DRAWING NUMBER CO-24703 | CHG

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