INSTRUCTION MANUAL

A721 SERIES
SERVO AMPLIFIERS
33084

This is a general manual describing a whole series of amplifiers and may be used in conjunction with drawings pertaining to various specific models.

CAUTION

The maintenance procedure described herein should be attempted only by highly skilled technicians using proper test equipment. Read your warranty provisions before starting, to avoid voiding your warranty.

WESTAMP INC.

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TABLE OF CONTENTS

WARRANTY PROVISIONS

WARRANTY - The Seller warrants that the articles delivered will be free from defects in material and workmanship under normal use and service. Seller's obligation under this warranty are limited to replacing and repairing, at its option, at its factory, any of said articles which shall within one (1) year after shipment be returned to the Seller's factory of origin, transportation charges prepaid, and which are, after eximination, disclosed to the Seller's satisfaction to be thus defective. THIS WARRANTY IS EXPRESSED IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING THE IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE, AND OF ALL OTHER OBLIGATIONS OR LIABILITIES ON THE SELLER'S PART AND IT NEITHER ASSUMES NOR AUTHORIZES ANY OTHER PERSON TO ASSUME FOR THE SELLER ANY OTHER LIABILITIES IN CONNECTION WITH THE SALE OF THE SAID ARTICLES.

This warranty shall not apply to any of such articles which shall have been repaired or altered, except by Seller, or which shall have been subjected to misuse, negligence, or accident. The aforementioned provisions do not extend the original warranty period of any article which has either been repaired or replaced by Seller.

FOREWARD

This is a general purpose manual, covering the theory and application of the A721 Series of Pulse Width Modulated Servo Amplifiers.

Each A7211 Pulse Width Modulated Amplifier consists of a chassis which contains the following:

A) The module which is made up of:
   1. Control & Output Circuit Board
   2. Optional Compensation Circuit Board
   3. Output Transistor Heatsink Assembly

B) The main chassis which is made up of:
   1. Bias Power Supply, +/- 15 VDC
   2. Main Bus Power Supply
   3. Power I/O Terminal Block
   4. Protective Fusing
   5. Blower (UL Listed)
   6. OPTIONAL Shunt Regulator

SPECIFICATIONS:

Model	A721X-17D	A721X-17F
1. Peak Current (available for 1-2 sec)	+/- 16 Amps DC	+/- 30 Amps DC
2. Peak Voltage	+/- 165 VDC	+/- 165 VDC
3. Continuous Current	+/- 10 Amps DC	+/- 15 Amps DC
4. Continuous Voltage	+/- 155 VDC	+/- 155 VDC
5. Continuous Power Output	1.5 KW (2.0HP)	2.3 KW (3.1HP)
6. Input Voltage for Bus Supply (includes + 10% allowable overvoltage)	30-120 VAC	30-120 VAC
7. Input Voltage for Fan & Bias Supply	120 VAC @ 2A	120 VAC @ 2A
8. Switching Frequency	16 KHz	5 KHz
9. Gain (Typical)		
Differential Input	4420 A/V	0-8290 A/V
Single Ended Input	4420 A/V	0-8290 A/V
Tachometer Input	4420 A/V	0-8290 A/V
10. Frequency Response	1500 Hz	500 Hz
11. Signal Input Voltage	+/- 10 VDC (Typical)	
12. Signal Input Impedance	46 K ohms (Minimum)	
13. Tach Input Impedance	11 K ohms (Minimum)	
14. Drift (Typical)	10 uV/deg. C	
15. Operating Temperature	50 Deg. C Max. Ambient	

Auxiliary Inputs:	Remote Disable (can disable all axes) External Reset Right Overtravel Limit Switch (RLM) Left Overtravel Limit Switch (LLM)
Auxiliary Outputs:	Current Monitor (1.6A/V-17D Model) (3A/V -17F Model) +/- 15 VDC (for customer use) Fault Sense (can be used to shut down all axes)
Protection:	Motor Shorts to Ground Bias-Low Voltage Bus-Overvoltage Bus-Undervoltage Surge Protection-Peak Current Limit RMS Current Limit-Overtemperature
Customer Adjustments:	(Multi-Turn Potentiometers) 1. Signal Gain (SIG) 2. Signal Balance (BAL)
Optional Customer Adjustments	3. Tach Gain (TACH) 4. Tach Loop Time Constant (TC) 5. Peak Current Limit (CLM)
Factory Adjustments:	1. RMS Current Limit 2. Current Loop Compensation 3. Surge Current Trip Point 4. Current Monitor Calibaration

TEST POINTS:

1. Velocity Error Amplifier Output
2. Current Error Amplifier Output
3. Signal Input
4. Tachometer input
5. PWM waveform
6. Triangle wave to modulator
7. Surge trip point
8. Motor current
9. Fault trip
10. Common

NOTES:

1. Peak current is available for 1 - 2 seconds
2. Frequency response is typical for the amplifier with no compensation. Servo compensation networks for most practical applications usually reduce the response.
3. Consult the factory for applications requiring continuous regeneration.
4. 120 VAC is for blower power and bias power. In certain applications it is possible to eliminate the power transformer and derive the bus power directly from the line.
5. Maximum output voltage is derived from 120 VAC bus source
6. The output voltage of the amplifier depends upon the AC voltage source for the bus power supply. The DC bus voltage is approximately 1.4 x VAC (rms) applied to bus power supply. Single axis model A7211 accepts only single phase power. Multi-axis models accept either single or three phase power.
7. If the motor has a 1.3 mhy (17D Model) or 2.0 mhy (17F model) an external inductor may not be required.
8. The output current monitor is capable of driving a zero center 3 milliampere ammeter. The scale factor for this output is 10 volts = peak rated current of drive. (17D model = 1.6 amps/volt) (17F model = 3 amps/volt)
9. FAULT CONDITIONS CAUSE A RED LIGHT (L.E.D.) TO LIGHT, AND THE AMPLIFIER TO SHUT DOWN.

MODEL	NO. OF AXES	CHASSIS SIZE INCHES		
		L	W	H
A7211	1	11.5	5.5	7.5
A7212	2	11.5	9.25	7.5
A7213/4	3 or 4	11.5	13.0	7.5
A7215/6	5 or 6	11.5	18.5	7.62

GENERAL DESCRIPTION:

The A721 amplifier is a current feedback, Pulse Width Modulated Servo Amplifier. Referring to the block diagram, the input to amplifier A3A may be connected differentially or single ended. The output of A3A is summed with a tach signal at the summing point.

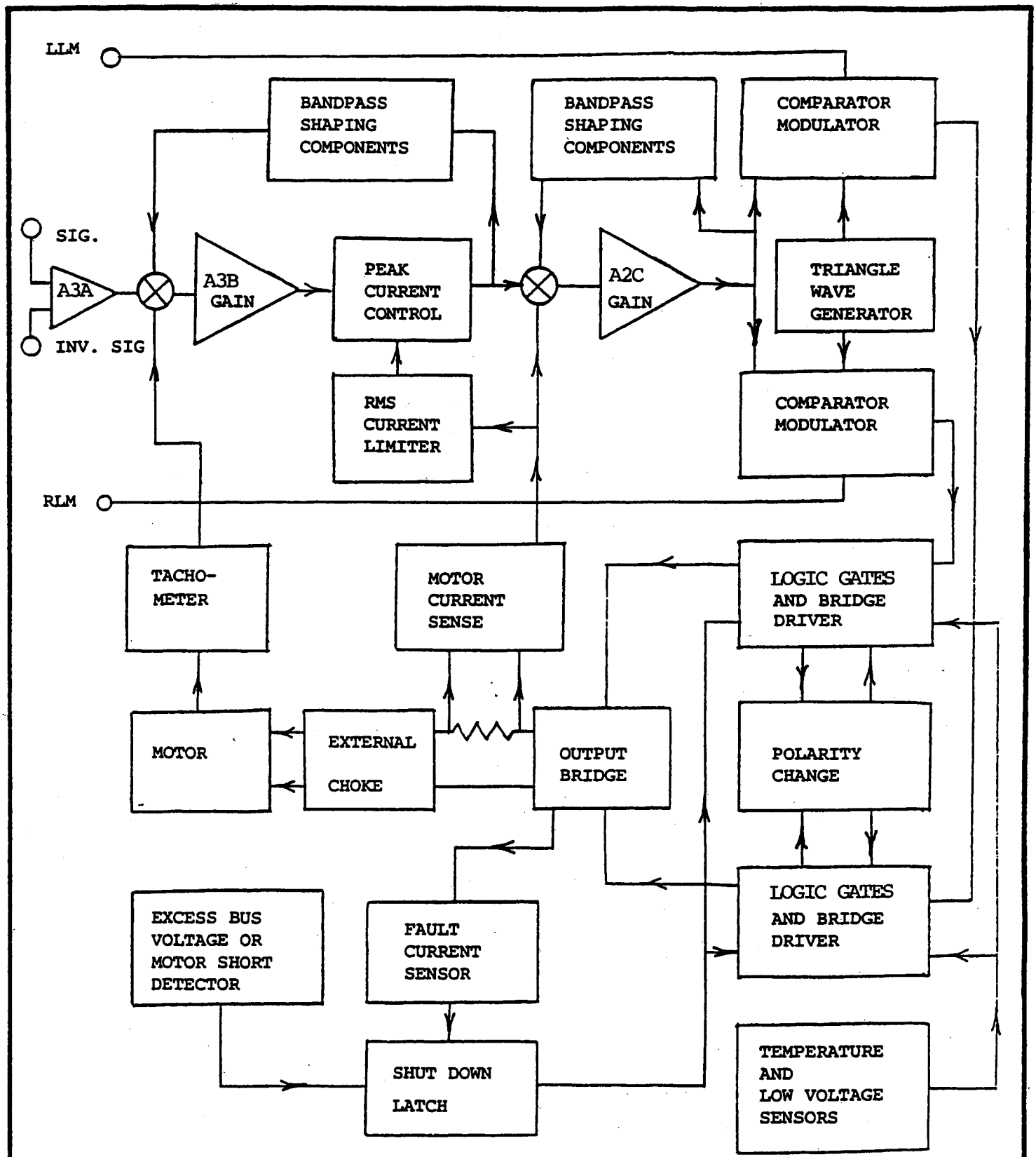
The input signal and the tachometer signal are of opposite polarity and are almost equal in magnitude. The difference between the input signal and the tachometer signal is a velocity error signal which is amplified by A3B.

The output of amplifier A3B is connected to a peak current control potentiometer for limiting the peak output current. This network also provides an RMS current shut-down capability that is adjustable. The bandpass shaping network components close the voltage feedback loop around amplifier A3B so that the amplifier and tachometer loops are stable.

The output of A3B is a current command signal which is summed with a current feedback signal at the input summing junction of A2C. The current feedback signal is derived from the motor current sensing circuit and is directly proportional to the motor armature current. The difference between the current command signal and the current feedback signal is the current error signal. This current error signal is then amplified by amplifier A2C. There is a shaping network around amplifier A2C which is used to set the stability and bandwidth of the current loop.

The output of amplifier A2C is applied to two comparator/modulators having inputs from a triangle wave generator. If the output of A2C is positive, one comparator/modulator outputs a pulse width modulated square wave, at the frequency of the triangle wave generator. If the output of A2C goes negative, the other comparator/ modulator outputs a pulse width modulated square wave. Signals derived from external left and right limit switches (LLM and RLM), inhibit the modulators and have the effect of inhibiting the output current in the proper polarity. The output of each comparator/ modulator drives the logic gates and Bridge Driver circuit which in turn drives the transistor output bridge. The polarity change sensor monitors the output of each bridge driver and prevents turn on of the opposite bridge driver (which would cause a short circuit across the bridge).

The output transistors are connected in an H bridge configuration. The current sensing resistor in series with the output, provides a signal proportional to armature current to the current loop amplifier (A2C). An additional fault current sensor, monitors the output current for fault conditions. Excessive current shuts down and latches the logic gates and turns off the bridge drivers. The external inductor filters the output current and limits the peak to peak ripple current.



BLOCK DIAGRAM

FIG # 1

PROTECTIVE FEATURES:

The A721X amplifier provides many advanced safety features. These safety features help protect personnel, machinery, motors and the amplifiers.

The amplifier will shut off and turn on the RED lights if:

1. Motor or motor leads short from either side of the armature to ground or with or without an external inductor.
2. The output leads of the amplifier are shorted together before the external inductor.
3. Bus power supply voltage exceeds a safe level. High bus voltage results from either a high AC line or excessive motor regeneration.
4. RMS current exceeds the amplifier rating.
5. Excessive ambient and heatsink temperature.
6. The sum of the two bias supplies is less than 28 volts.

NOTE: Under all of the above conditions, the unit shuts off with a RED light indication. Connecting the external reset line (J1-pin 13) to signal common with a momentary contact switch will reset the amplifier. The amplifier may also be reset by removing the bias power for 5 seconds and then re-applying bias power.

* If an external inductor is not used in series with the motor, the output transistors may be damaged - see the application note at the end of this manual.

The amplifier will shut off with no RED light if the bus supply is less than 43 VDC.

OTHER FEATURES:

CONNECTOR J1

Pin 1 - Signal Input (inverted with jumper J5 removed, with jumper installed at J5 pin 1 becomes signal common)
Pin 2 - Signal Input (non-inverted)
Pin 3 - Signal Input (Tach)
Pin 4 - Signal Common
Pin 5 - Optional External Current Limit (shorting this pin to ground reduces the current to a level pre-set by R80)
Pin 6 - LLM (Negative Signal Clamp)
Pin 7 - RLM (Positive Signal Clamp)
Pin 8 - Remote Shut-Down & Shut-Down Sense (Connecting this pin to common shuts down the amplifier. Sensing this pin for common potential indicates an internal amplifier shutdown)
Pin 9 - Signal Common
Pin 10 - + 15 VDC bias power

Pin 11 - Common
Pin 12 - - 15 VDC bias power
Pin 13 - External Reset (momentary connection to sig com resets)
Pin 14 - Signal Common
Pin 15 - Output Current Monitor (1.6 A/V Model 17D)
(3 A/V Model 17F)

CONNECTOR J2
This connector is provided with a 2 pin shorting plug. Connecting Pins 1 & 2 with the shorting plug makes the gain high. For more balance control leave the shorting plug off completely.

Connecting Pins 3 & 4 with the shorting plug lowers the gain by a factor of 1000.

The amplifier may be used as a current source power amplifier by shorting Pins 3 & 4 together. With the signal gain potentiometer set a maximum CW, the gain is approximately 4.42 amperes/volt (17D model) and 8.3 amperes/volt (17F model).

CONNECTOR J3
4 Pin Bias Supply Connector

Pin 1 - - 15 volts DC
Pin 2 - Common
Pin 3 - + 15 volts DC
Pin 4 - Spare

CONNECTOR J4
4 pin Load and Bus Connector

Pin 1 - Load
Pin 2 - Load
Pin 3 - - Bus Supply
Pin 4 - + Bus Supply

CONNECTOR J5
This is a 2 pin connector for selecting differential or single ended signal input. Units are supplied with a shorting plug installed (single ended). Removal of the shorting plug provides a differential input.

CONNECTOR J7
10 pin connector for installing the interface board.

CONNECTORS J8 & J9
J8 - 5 pin connector for fault monitor
J9 - 2 pin connector for fault monitor

With an additional interface board connected to J8 and J9, each fault indication can be monitored with seperate light indicator.

TPX TEST POINT

TP1 - Tachometer input signal test point
TP2 - Output of signal amplifier, A3A
TP3 - Output of velocity control amplifier, A3B
TP4 - Output of current error amplifier, A2C
TP5 - Motor current indication
TP6 - Surge current trip level
TP7 - Fault trip indication
TP8 - Triangle wave to modulator
TP9 - PWM waveform
TP10 - PWM waveform

POWER SUPPLY REGULATOR - - (SHUNT REGUALTOR) - - (OPTIONAL)

When a DC motor slows down or stops, the energy stored in the inertia of the armature is returned to the amplifier. This energy pumps up the bus power supply capacitor since the bus rectifier will not allow it to be returned to the line. If the bus voltage exceeds the trip level, the fault circuitry shuts down the amplifier and illuminates the red light. If the system performance requires operation under the conditions which caused the overvoltage sensor to trip, it may be necessary to install an optional shunt regulator.

INSTALLATION:

Each amplifier in the A721X Series comes with an individual installation drawing, which shows where the various connections for power input, signal input, tachometer input, fan and bias power input, and motor output must be made. While this manual may show in a general way how to make connections to the amplifier, it is imperative that the specific instructions that apply to your amplifier be followed with no exceptions. Always be certain to apply the correct input voltage and frequency. The input power transformer for all the amplifiers in the A721X Series are seperately mounted. It is possible to use one power transformer for several amplifier units if that transformer is sized properly. These transformers have dual voltage primaries and it is imperative that you make certain that the jumpers are on the correct transformer terminals for the input AC power source. The motor output is available on seperate terminals mounted on TB-401.

CAUTION: DO NOT USE GROUNDED TEST EQUIPMENT ON THE OUTPUT.
DO NOT CONNECT EITHER OF THE OUTPUTS TO GROUND.

The signal input is usually applied directly to Pin 2 of J1 and the input signal return is usually applied to Pin 1 of J1. The signal input to the amplifier may be connected either differentially or single ended. To connect the unit differentially, remove the shorting plug at J5. If the shorting plug is connected at J5, then the input to the amplifier is single ended and J1 pin 1 is connected to signal common.

The tachometer signal is applied to Pin 3 of J1 and the tachometer return is connected to Pin 4 of J1. The tachometer signal gain is fixed. If an adjustable tachometer input is required, an optional adjustable compensation board must be specified. Use shielded wires for signal and tachometer inputs to prevent stray pickup and noise from being introduced into the amplifier. The amplifier bandwidth will be anywhere from 500 or 1500Hz (no compensation) to a much lower frequency, depending upon the setting of the TC (time constant) potentiometer and the components in the servo compensation network. Typical installation drawings, illustrated on pages 11 through 14, may be used to wire up an amplifier motor combination.

In many cases an inductor is connected in series between the amplifier output and the motor. This inductor is required if the inductance of the motor is below the value recommended in note 7 of the specification sheet.

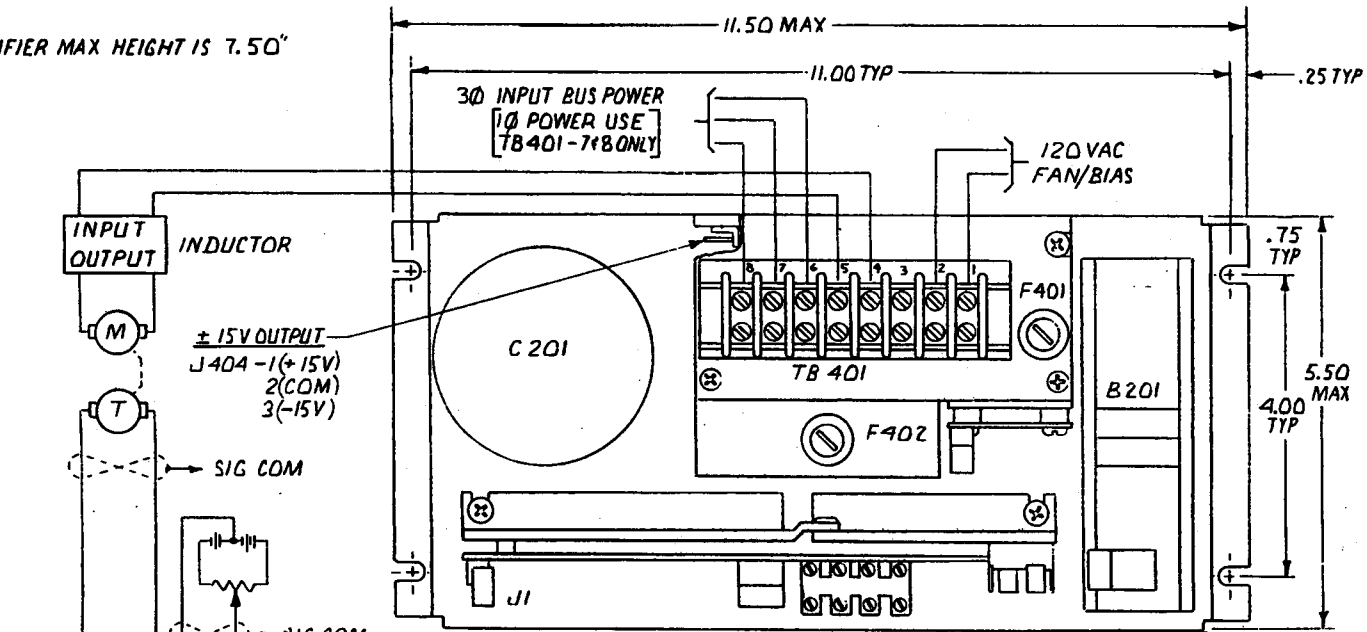
The amplifiers in this series requires 120 VAC, 2 amperes for the fan and bias power, (terminals 1 and 2 of TB 401).

The AC input power for the bus power supply may range from 30 VAC to 120 VAC (17D model) and 30 VAC to 120 VAC (17F model).

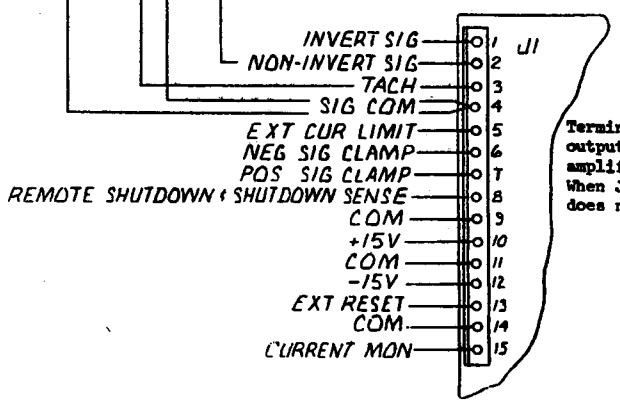
PLEASE CHECK ALL CONNECTIONS BEFORE POWER IS APPLIED.

REVISIONS			
LTR	DESCRIPTION	BY	DATE/APPR

NOTE: AMPLIFIER MAX HEIGHT IS 7.50"



FUSE DATA			
Model No.	Fuse	F401	F402
	Type	AGC	MDA
A7211-17xxx-xxx		2 Amp	10 Amp

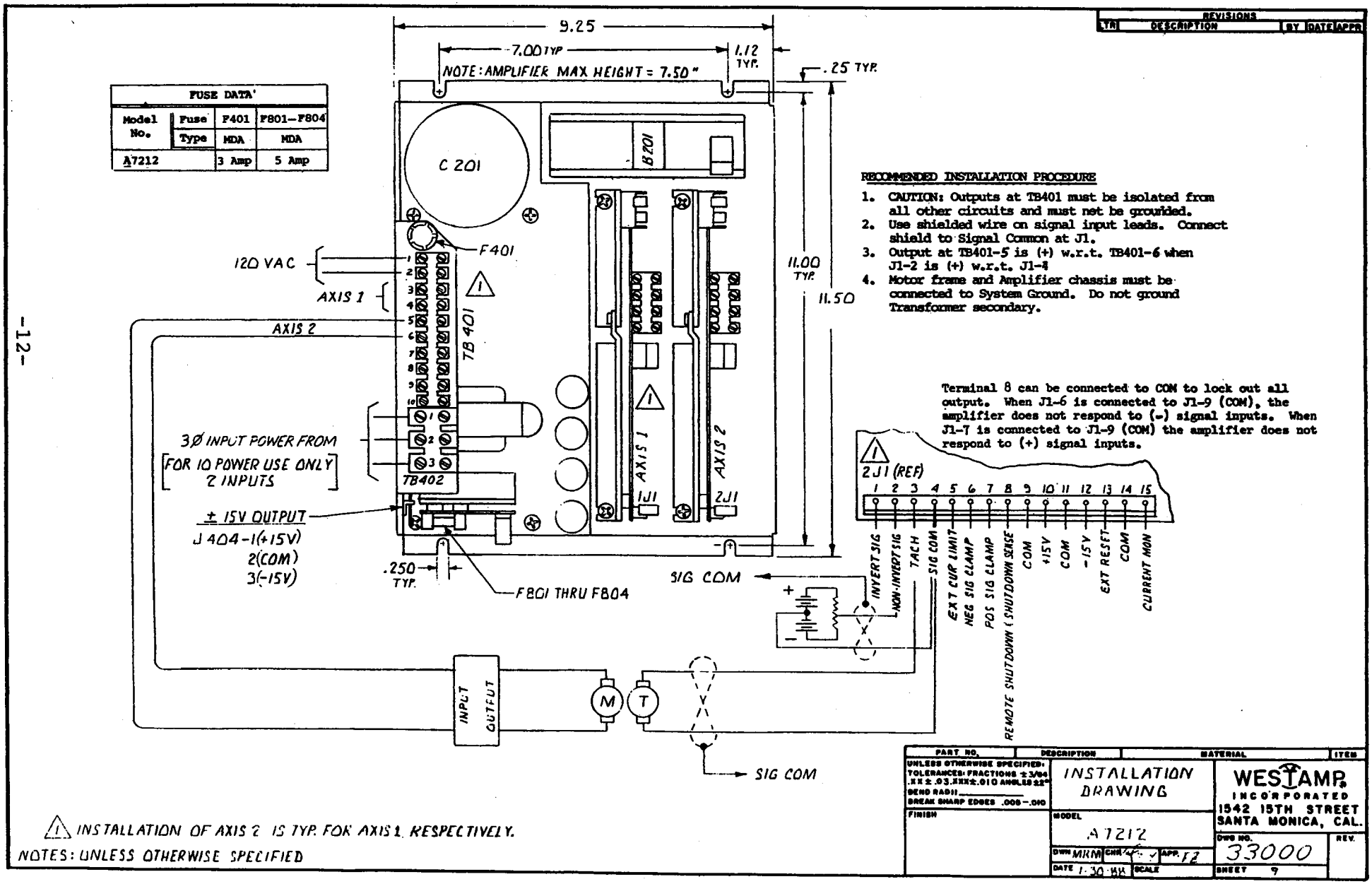


Terminal 8 can be connected to COM to lock out all output. When J1-6 is connected to J1-9 (COM), the amplifier does not respond to (-) signal inputs. When J1-7 is connected to J1-9 (COM) the amplifier does not respond to (+) signal inputs.

RECOMMENDED INSTALLATION PROCEDURE

1. CAUTION: Outputs at TB401 must be isolated from all other circuits and must not be grounded.
2. Use shielded wire on signal input leads, connect shield to Signal Common at J1.
3. Output at TB401-5 is (+) w.r.t. TB401-4 when J1-2 is (+) w.r.t. J1-4.
4. Motor frame and amplifier chassis must be connected to System Ground. Do not ground Transformer secondary.

PART NO.	DESCRIPTION	MATERIAL	ITEM
UNLESS OTHERWISE SPECIFIED: TOLERANCES: FRACTIONS ±1/64 .XX ± .03 .XXX ± .010 ANGLES ±2° BEND RADII BREAK SHARP EDGES .005-.010	INSTALLATION DRAWING		
FINISH	MODEL A7211		
	DWN MFM CHK J.L. APP. F.Z. DATE 2-11-88 SCALE NONE	WESTAMP INCORPORATED 1542 15TH STREET SANTA MONICA, CAL. DWG NO. 33000 SHEET A	REV.



FUSE DATA'			
Model No.	Fuse Type	F401 MDA	F801–F804 MDA
A7212		3 Amp	5 Amp

RECOMMENDED INSTALLATION PROCEDURE

1. CAUTION: Outputs at TB401 must be isolated from all other circuits and must not be grounded.
2. Use shielded wire on signal input leads. Connect shield to Signal Common at J1.
3. Output at TB401-5 is (+) w.r.t. TB401-6 when J1-2 is (+) w.r.t. J1-4
4. Motor frame and Amplifier chassis must be connected to System Ground. Do not ground Transformer secondary.

Terminal 8 can be connected to COM to lock out all output. When J1-6 is connected to J1-9 (COM), the amplifier does not respond to (-) signal inputs. When J1-7 is connected to J1-9 (COM) the amplifier does not respond to (+) signal inputs.

⚠1 INSTALLATION OF AXIS 2 IS TYP. FOR AXIS 1, RESPECTIVELY.

NOTES: UNLESS OTHERWISE SPECIFIED

REVISIONS			
LTR	DESCRIPTION	BY	DATE/APPR

PART NO.	DESCRIPTION	MATERIAL	ITEM

UNLESS OTHERWISE SPECIFIED: TOLERANCES: FRACTIONS ±3/64 .XX ± .03 .XXX ± .010 ANGLES ±2° BEND RADII _____ BREAK SHARP EDGES .005–.010 FINISH

INSTALLATION DRAWING

MODEL A7212

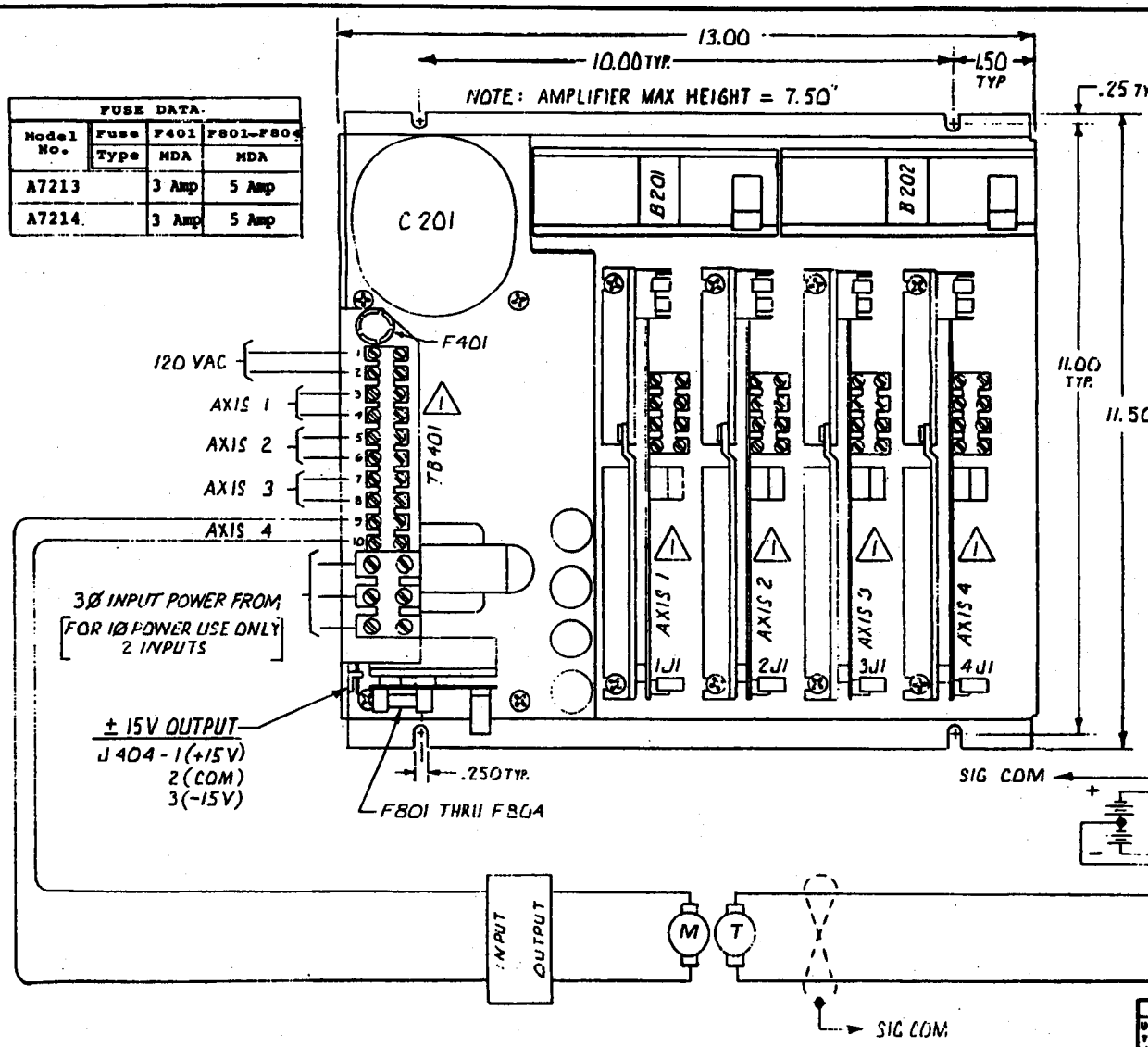
DWN MRM CHK APP. EZ DATE 1-30-84 SCALE

WESTAMP INCORPORATED
1542 15TH STREET
SANTA MONICA, CAL.

DWG NO. 33000 REV.

SHEET 9

FUSE DATA			
Model No.	Fuse Type	F401 MDA	F801-F804 MDA
A7213		3 Amp	5 Amp
A7214		3 Amp	5 Amp



RECOMMENDED INSTALLATION PROCEDURE

1. CAUTION: Outputs at TB401 must be isolated from all other circuits and must not be grounded.
2. Use shielded wire on signal input leads, connect shield to Signal Common at J1.
3. Output at TB401-9 is (+) w.r.t. TB401-10 when 4J1-2 is (+) w.r.t. 4J1-4.
4. Motor frame and Amplifier chassis must be connected to System Ground. Do not ground Transformer Secondary.

Terminal 8 can be connected to COM to lock out all output. When J1-6 is connected to J1-9 (COM), the amplfier does not respond to (-) signal inputs. When J1-7 is connected to J1-9 (COM) the amplifier does not respond to (+) signal inputs.

/1 INSTALLATION OF AXIS 4 IS TYP FOR AXIS 1,2 & 3 RESPECTIVELY.

NOTES: UNLESS OTHERWISE SPECIFIED

REVISIONS				
LTR	DESCRIPTION	BY	DATE	APPD

PART NO.	DESCRIPTION	MATERIAL	ITEM

UNLESS OTHERWISE SPECIFIED: TOLERANCES: FRACTIONS ±1/64 .XX ±.03 .XXX ±.010 ANGLES ±2° BEND RADII _____ BREAK SHARP EDGES .000-.000 FINISH

INSTALLATION DRAWING

MODEL A7214 A7213

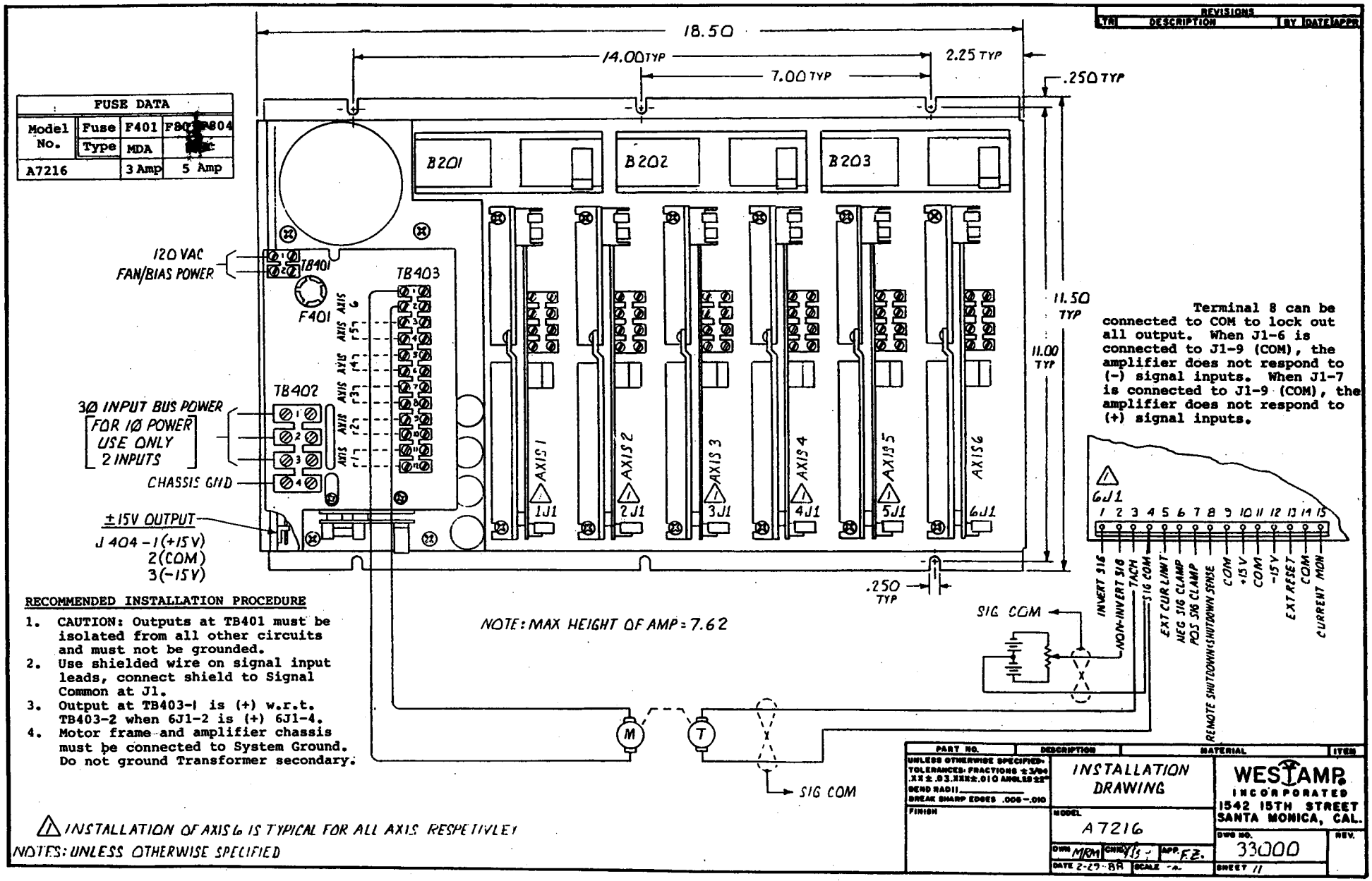
DWN MRM CHK APP. EZ

DATE 1-7-81 SCALE

WESTAMP INCORPORATED
1542 15TH STREET
SANTA MONICA, CAL.

DWG NO. 33000 REV.

SHEET 10



RECOMMENDED INSTALLATION PROCEDURE

1. CAUTION: Outputs at TB401 must be isolated from all other circuits and must not be grounded.
2. Use shielded wire on signal input leads, connect shield to Signal Common at J1.
3. Output at TB403-1 is (+) w.r.t. TB403-2 when 6J1-2 is (+) 6J1-4.
4. Motor frame and amplifier chassis must be connected to System Ground. Do not ground Transformer secondary.

⚠ INSTALLATION OF AXIS 6 IS TYPICAL FOR ALL AXIS RESPECTIVLEY

NOTES: UNLESS OTHERWISE SPECIFIED

ADJUSTMENTS:

The A721X Series of amplifiers have several different Compensation Boards available. The unit may be operated with any of these compensation boards or with compsneation components mounted on the main control card. In all cases there are always certain customer adjustments on the control card. Figure 3 illustrates the location of various adjustments. These adjustments are as follows:

SIG Signal Gain: Potentiometer R5 adjusts the signal gain. Turning R5 in a CW direction increases the signal gain.

BAL Balance: Potentiometer R23 is the balance control. It may be necessary to adjust the balance for zero output when zero input is applied. This should be adjusted after the Tach and Signal gains have been set.

Adjustable Compensation Board

Figure 4 shows the various adjustments available on the Adjustable Compensation Board. These adjustments are as follows:

TACH Tachometer Gain: Potentiometer R12 adjusts the tachometer loop gain. Turning R12 in a CW direction increases the tach loop gain.

TC Time Constant: Potentiometer R15 is the Time Constant potentiometer. The TC potentiometer is used to stablize the closed loop system. Turning R15 CW increases the Velocity Loop Bandwidth.

CLM Peak Current Limit: Potentiometer R28 adjusts the peak current output of the amplifier. With the potentiometer at the maximum CW position the amplifier outputs its maximum peak rated current. The peak output current is decreased by turning potentiometer R28 in a CCW direction.

*NOTE: R29 & R31 are factory adjustments and must not be altered.

Adjustable Compensation Taper Current Board

This Compensation Board is designed for applications that require tapered current limit in addition to adjustable compensation. The tapered current limit values must be computed by the Westamp Factory and are generally factory set.

DO NOT ATTEMPT TO SET THESE POTENTIOMETERS WITHOUT WESTAMPS COMPUTED VALUES.

See Figure 4 for the location of the various adjustments on the Adjustable Taper Current Board.

The TACH, TC, and CLM adjustments procedure is the same as the Adjustable Compensation Board.

NOTE: On all Westamp servo amplifiers, turning potentiometers in a CW (clockwise) direction increases the parameter that is being adjusted. Turning potentiometers in a CCW direction decreases the parameter being adjusted.

ADJUSTMENT PROCEDURE:

It is possible to compensate a servo system empirically without any theoretical evaluation of the system, provided that the system specifications are not stringent. For most applications, the procedure outlined in the Short Form "Set Up Procedure" will result in adequate servo performance. The A721X Series of servo amplifiers was designed to operate in very high performance servo systems. In order to achieve optimum servo performance, matching amplifier - motor - tachometer combinations are recommended. However, the A721X Series amplifiers will provide good performance with many DC motor - tachometer combinations, by merely adjusting the TC and the TACH gain potentiometers.

SHORT FORM SET-UP PROCEDURE
(All PWM Amplifiers)

1. Check input voltages and determine proper transformer connections.
2. Measure the voltages before applying power to the amplifier chassis.
3. Connect in accordance with the proper installation drawing.

   NOTE: All multi-turn pots are 20 turns nominal.

   THE FOLLOWING PROCEDURE IS WRITTEN FOR 20 TURN NOMINAL POTENTIOMETERS - YOU MUST READ THE SECTION IN THE BACK OF THIS MANUAL ON POTENTIOMETERS TO VERIFY THE TYPE OF POTENTIOMETERS (# OF TURNS) YOUR UNIT HAS.

4. Before applying power, adjust all potentiometers as follows:

   a) Current limit pot (CLM) - fully CCW
   b) "TC" pot - mid range (10 turns from either end)
   c) "TACH" pot - turn fully CCW then turn CW 5 turns
   d) "SIG" pot - mid range (10 turns from either end)

5. Apply power but DO NOT apply an input signal
6. To check for proper phasing of the tachometer and motor; turn the "CLM" pot CW very slowly. If the motor starts to run away, shut off the power and reverse the leads of either the motor or the tachometer.
7. Turn the power back on and repeat item 6. The motor should not rotate or may rotate very slowly (do not adjust the BAL pot at this time). Turn CLM pot to desired current.

   CLM pot setting allows the amplifier to deliver peak currents as shown in the following example:

Example:

20 Turn Pot	12 Turn Pot
3 Turns CW = 30% Peak Current	1.8 Turns CW = 30% I Current
6 Turns CW = 60% " "	3.6 Turns CW = 60% " "
10 Turns CW = 85% " "	6.0 Turns CW = 85% " "
14 Turns CW = 95% " "	8.5 Turns CW = 95% " "

8. If the motor shaft rotates slowly with no signal applied, adjust the (BAL) pot until the motor stops.

9. With zero input signal, turn "TC" pot CW until the motor shaft starts to oscillate at high frequency. Turn CCW until the oscillation stops. Turn 1/2 turn additional in a CCW direction.

   IMPORTANT - - IF TC IS FULLY CCW AND THE SYSTEM IS STILL OSCILLATING AT HIGH FREQUENCY, SEE NOTES ON PAGE 20.

10. Apply a small signal and observe motor shaft.

11. Increase or decrease tach gain pot for desired results.

    a) Increasing TACH (turning pot CW) provides quicker settling time (higher bandwidth).

    b) Decreasing TACH (turning pot CCW) provides slower settling time (lower bandwidth).

12. When the tachometer response is proper, do not change the TACH pot further.

13. If the motor drifts after the SIG and TACH pots have been set, it may be necessary to re-adjust the (BAL) balance pot.

14. Run the motor at a higher speed. If it runs smoothly, the system is adjusted properly. A rough sound indicates either the TC or the TACH is too far CW.

15. Set the required speed of the system by adjusting the SIG potentiometer. Turning the pot CW will increase the motor speed.

16. This completes the short form set up. It is recommended that the adjustments be recorded on the form on page 36.

DETAILED SET-UP PROCEDURE

If your system requires a more accurate TACH adjustment, the following procedure should be followed:

1. Perform Steps 1-10 on the previous page.
2. Apply a small signal until the motor rotates. Observe the tachometer signal on an oscilloscope.

   NOTE: Refer to Helpful Hints Section.

3. If the tach loop is overdamped, turn the TACH pot CW until one overshoot appears. The system is now set up for maximum bandwidth in the tachometer loop.
4. If overshoot in the tachometer loop is objectionable, then adjust the TACH pot CCW until the overshoot is eliminated.

   NOTE: One overshoot in the tachometer loop does not necessarily mean the position loop will overshoot.

5. IF THE SYSTEM IS NOT PERFORMING PROPERLY AND IS MECHANICALLY SOUND, SEE NOTES AT THE END OF THIS SECTION.
6. If motor shaft rotates slowly with no signal input, it may be necessary to re-adjust the BAL pot until the motor stops.
7. Recalibrate the SIG signal gain pot to obtain the proper output speed.
8. All other adjustments are factory set and should not be altered.

CAUTION: POWER MUST BE OFF WHEN REMOVING MODULES OR CHANGING COMPONENTS.

NOTES:

1. Check system for backlash, wind-up, lost motion, bad coupling or other mechanical problems.

   AFTER PERFORMING ANY OF THE FOLLOWING CHANGES, REPEAT THE SET-UP PROCEDURE - START WITH STEP 4 ON PAGE 18.

2. If the system exhibits a high frequency oscillation even though the TC pot is fully CCW (this may be due to motor resonance) increases C7. It may be necessary to add C3 = 2 mfd. and C5 = .22 mfd.
3. If the system requires more DC gain:
   a) Increase C6 to approximately 1.5 times and decrease R11 to approximately .75 times. You might have to increase C7 as shown in note 2.
   b) Reduce value of R75. Caution! The balance adjustment will become more sensitive.
4. If the system has high inertia, or a high inertia motor is being used, it may be necessary to change C6 and R11. Reference note 3a above.

SET-UP PROCEDURE USING RESISTIVE MEASUREMENTS

This set up procedure is used only after the desired settings for the SIG, TACH, TC and CLM potentiometers have been established. Use either the Short Form or Detailed Set-Up Procedure to determine these settings. DO NOT USE GROUNDED TEST EQUIPMENT

1. Remove all power. Measure and record the resistance values as indicated in the following steps. The ohm meter common should be connected to the wire hoop common on the upper left hand corner of the main control board.

2. SIG Potentiometer: Measure and record the resistance from TP2 to the wire hoop common (4.47K to 4.93K ohms). _____

3. TACH Potentiometer: Measure and record the resistance from TP1 on the interface board to common (0.0 to 14K ohms). _____

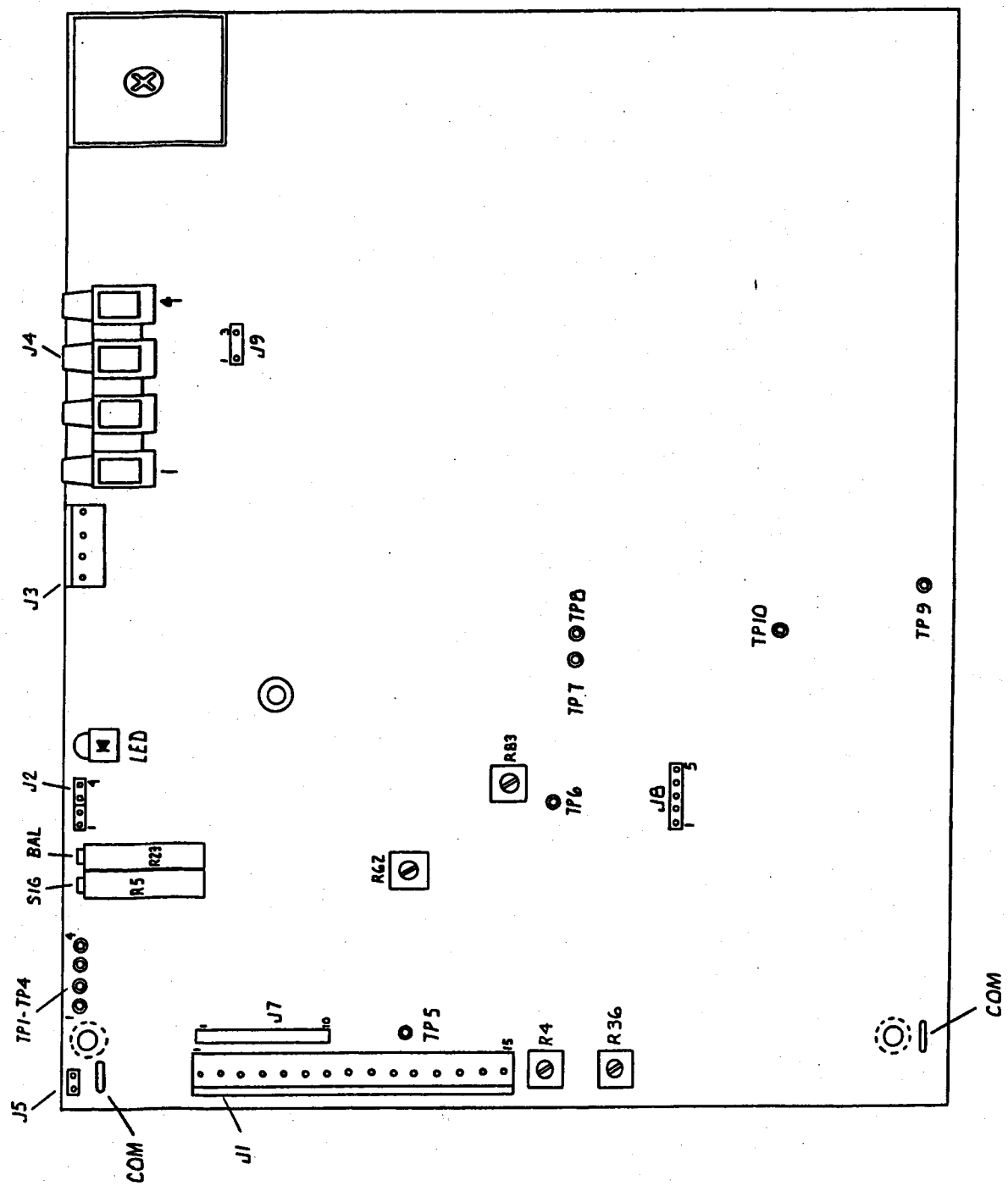
4. TC Potentiometer: Measure and record the resistance from TP2 on the interface board to common (100.0 to 2.0K ohms). _____

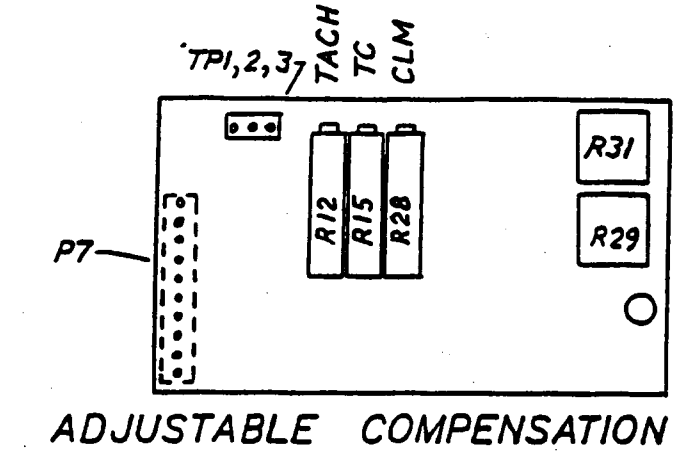
5. CLM Potentiometer: Measure and record the resistance from TP3 on the interface board to TP1 of the main control board (100.0 to 2.0K ohms). _____

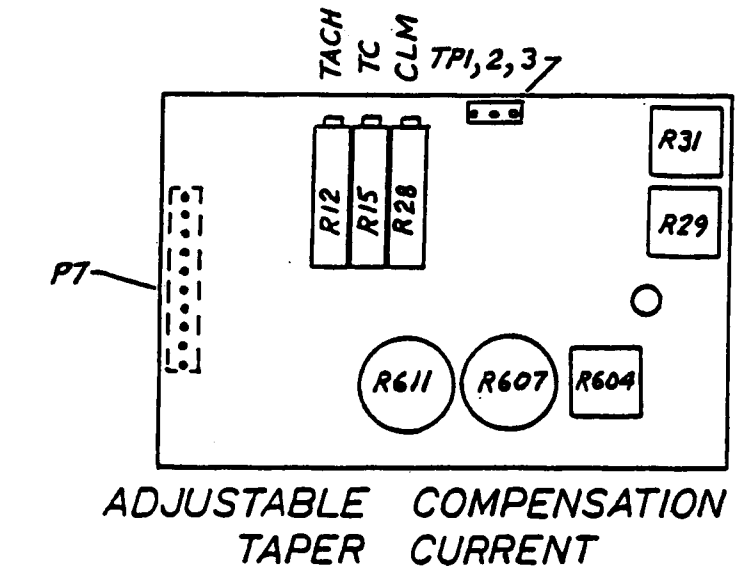
6. To adjust a new board, set the potentiometers to the values determined in steps 2 through 5. NOTE! The TC and CLM adjustments interact and must be adjusted several times to achieve the desired results.

7. Remove the ohm meter and turn CLM fully CCW. Apply power and slowly turn CLM clockwise. If the motor starts to run away, turn off power and reverse either the motor or the tach leads. Turn power back on to verify that the motor does not run away.

8. Turn power off and re-adjust the CLM potentiometer as in step 5. Remove the ohm meter and apply power. If the motor shaft rotates slowly with no signal applied, adjust the BAL potentiometer until the motor stops. Remove power and repeat step 6 to insure TC and CLM are set at the proper values.


J4
J9
J3
LED
J2
SIG BAL
R23
R5
TP1-TP4
J5
COM
J1
J7
TP5
R4
R36
R62
R83
TP6
TP7
TP8
J8
TP10
TP9
COM





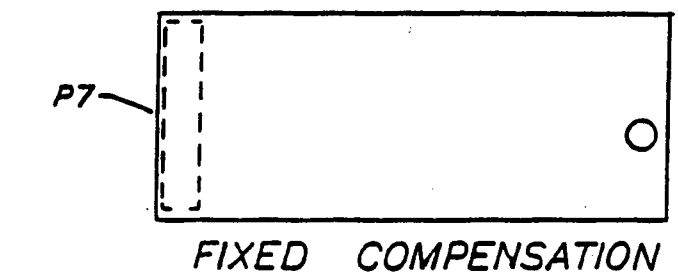


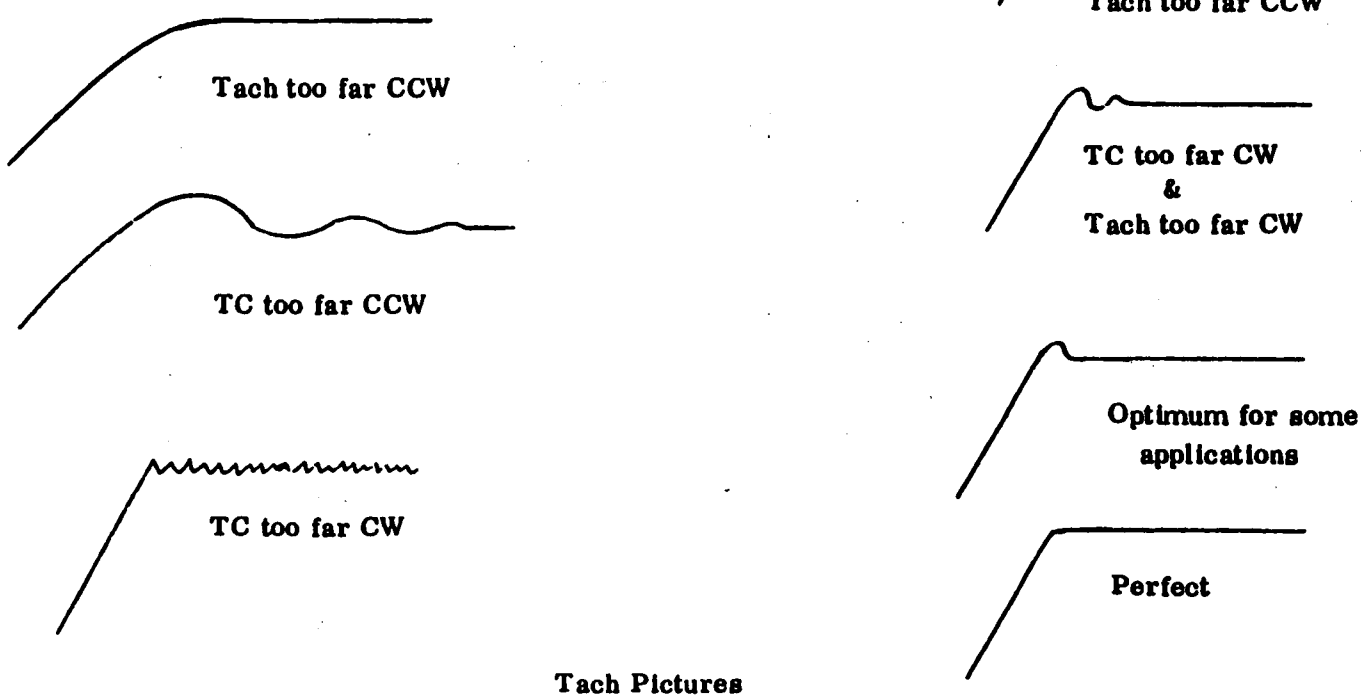
Figure 4 Interface Board Layout

HELPFUL HINTS:

1. Tachometer should be observed on an oscilloscope where sweep speed is set at .1 seconds/centimeter and adjust the vertical attenuator to provide a convenient displacement in response to the signal input.

2. Small step input commands may be provided with a DC simulator (battery box) while observing the tach response on the oscilloscope.

3. Typical pictures you will see on oscilloscope of tach profiles.



Tach Pictures

RMS CURRENT ADJUSTMENT BY RESISTANCE MEASUREMENT

For many applications, the rated RMS current of the amplifier is greater than the motor it is driving. If motor protection, external to the amplifier, is not provided, it is recommended that the RMS current limit be adjusted to equal the motor rating. Adjust R36 on the main control board to the values indicated in the table. Connect the ohm meter to the left side of R36 and the anode of CR11.

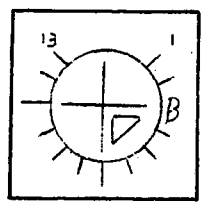
A721X-17F 15.0 Amperes Rated

Current	Resistance	Position of the Pot (R36)
3.5 Amperes	8.25 K ohms	1
6	5.68	5
8	4.50	7
10	3.23	9
12	1.64	10.5
15	0.87	11

A721X-17D 10.0 Amperes Rated

Current	Resistance	Position of the Pot (R36)
3.5 Amperes	8.24 K ohms	1
4	7.28	3
5	6.51	3.5
6	5.72	4.5
7	4.82	6
8	4.14	7
9	3.39	8.5
10	2.99	9

NOTE: Due to circuit tolerances, the minimum value of current may not be achievable! R36 is a factory adjustment and is sealed. The seal must be broken to perform the adjustment. CAUTION! The rating of the amplifier can be exceeded if this adjustment is not performed properly.



R 36

TROUBLE SHOOTING:

Refer to the appropriate installation drawings, board layout drawings and schematic contained in this manual.

1. Examine the unit visually for loose connections, broken wires or damaged components. Verify that Pins 5, 6, 7 and 8 are not being held at ground by external equipment.

2. If the fault indicator red light is on, read over the Protective Features and Other Features Sections. Determine the reason for the trip indication. Do not merely reset the amplifier: permanent damage could result. The following are typical reasons for a fault trip indication:

   a) +/- 15 VDC bias supply is low
   b) High bus voltage
   c) Faulty output transistors
   d) Faulty motor
   e) Over temperature

   Steps 3) through 6) are a systematic check of each of these potential faults.

3. A low or faulty bias supply may be the result of:

   a) No 120 VAC supply
   b) Blown bias supply/fan fuse - F401
   c) Faulty bias supply
   d) Excessive load

   Check the bias supply fuse (F401) and measure the 120 VAC input. If the input voltage and fuse are proper and the output voltage is low, measure the load current on each of the outputs.

   Return the bias supply to the factory for repair if the load currents are within specification and the outputs are low. If load currents are excessive, determine the cause by disconnecting the external load and each of the output modules while monitoring load current. The output module assembly draws approximately 0.4 amperes. A higher current draw indicates a faulty module.

4. Problems with the bus voltage can be attributed to one of the following:

   a) Transformer wiring incorrect
   b) Faulty transformer
   c) Faulty rectifiers
   d) Faulty shunt regulator

   Verify that the transformer is wired properly. Measure the bus voltage and the input bus power voltage including the isolation transformer primary (to verify the transformer). On three phase input power, make sure to measure all three line to line voltages. If one phase is missing or low, it can reduce the bus voltage considerably. For single phase input power, the bus voltage will normally vary from 60% to 140% of the input bus power depending on the load on the amplifier; for three phase power, 120% to 140%. Bus voltages signific ntly different indicate a problem with the bus rectifier (if input bus power is proper).

The amplifier will experience an overvoltage trip if the shunt regulator is faulty; the trip will occur during a period when the motor is decelerating. If fault trips are experienced during decel periods, check the shunt regulator fuses (F801-F804). If the fuses check good, monitor the bus voltage with an oscilloscope while the motor is running. Voltage on the bus will build up during decel periods if the shunt regulator is not sized properly.

5. Faulty output transistors will cause a fault trip immediately upon application of power. Disconnect the motor from the amplifier and reapply power. If the fault indication still exists, return the entire module to the factory for repair.

6. Motor failures will cause a fault trip even though the system may appear to operate properly in all other respects. Shorted, grounded or open armature windings will cause a fault trip either at power turn on or while the motor is running. Brush dust buildup on the brush rigging will appear as a grounded armature. Inspect the motor for burn spots in the winding or evidence of arcing. Commutation problems will leave a brown residue on the brushes and the face of the brush will be dull and rough rather than smooth and shiney. Commutation problems can be caused by faulty armature windings or improper application of the motor.

MULTI-AXIS SYSTEMS:

Trouble shooting a multi-axis system can create some unique situations since over bus voltage or a low bias supply may cause one or more modules to indicate a fault trip. When one or more modules trip or random modules trip, check the bias supply and shunt regulator as outlined in steps 3) and 4). If the bias supply and shunt regulator check good, it is possible that the shunt regulator may be sized improperly.

TYPICAL INSTALLATION AND FIELD PROBLEMS

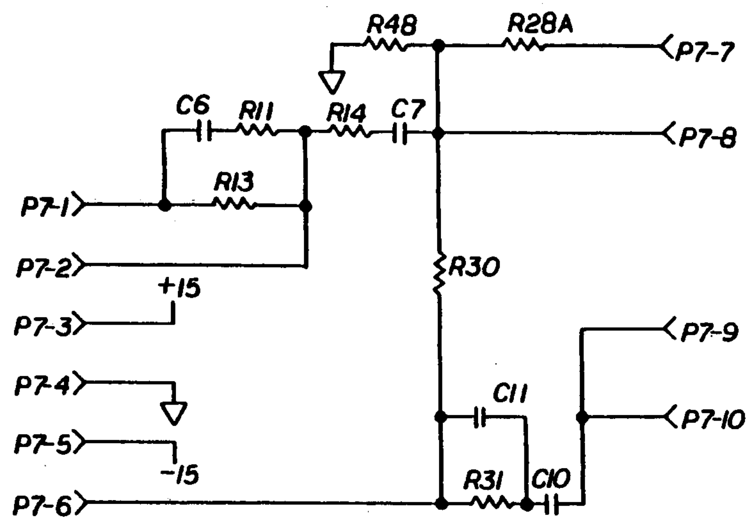
SYMPTOM	CAUSE
High bus voltage	Faulty shunt regulator Wrong transformer tap Shunt regulator sized imcorrectly
Excessive surge currents	Either motor line grounded Output leads shorted before inductor Faulty output transistor
Excessive currents at high motor speeds	Exceeded safe commutation zone of motor Faulty motor
Excessive RMS current	Excessive duty cycle Faulty motor Shorted motor lines after inductor Improper compensation
Over Temperature	Fan obstructed or faulty Ambient temperature too high
Low bias supply	Overload on bias supply Faulty bias supply
Low bus voltage	Power line sag Faulty line rectifiers

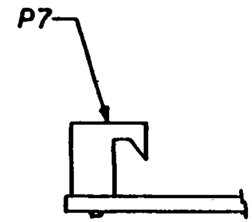
NOTE:

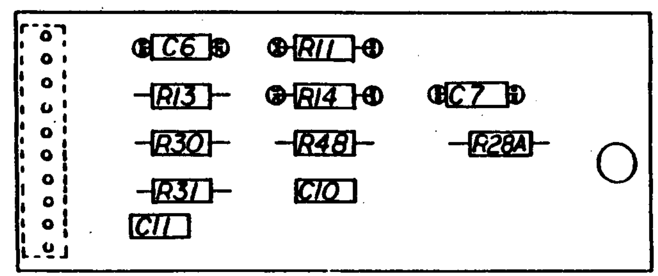
All of the above conditions will result in a fault trip with indication with the exception of low bus voltage. Low bus voltage will not give a fault trip indication but will shut off the amplifier. (see page 7)

TO RE-SET DRIVE:

Momentarily connect pin 13 to pin 11 on J1 or remove bias power, wait approximately 15 seconds, then re-apply power. Drive will restart if the fault condition has cleared.







FOR ELECTRICAL PARTS LIST SEE EPL33035

FIXED COMPENSATION BOARD

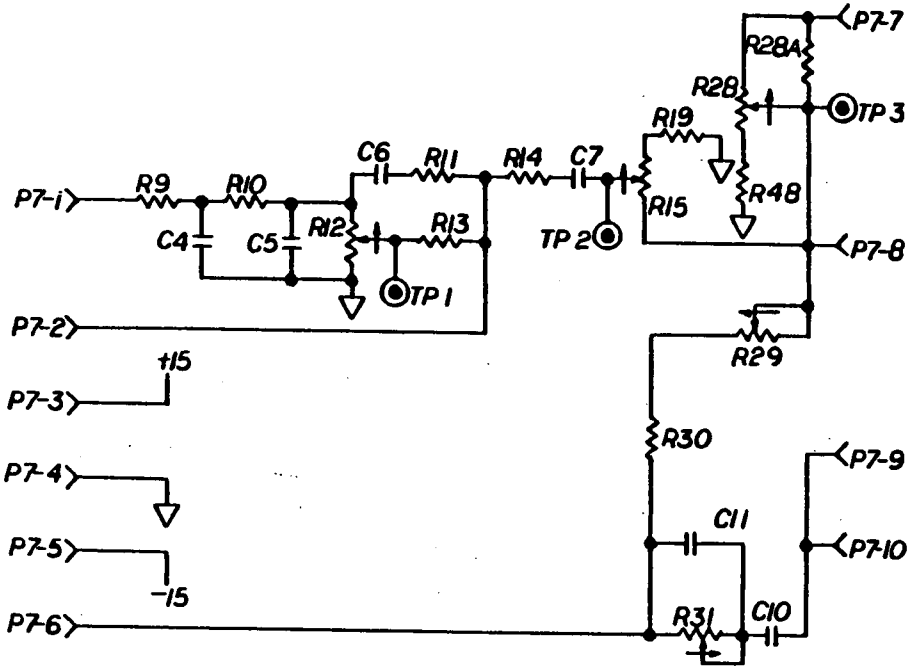
A721x

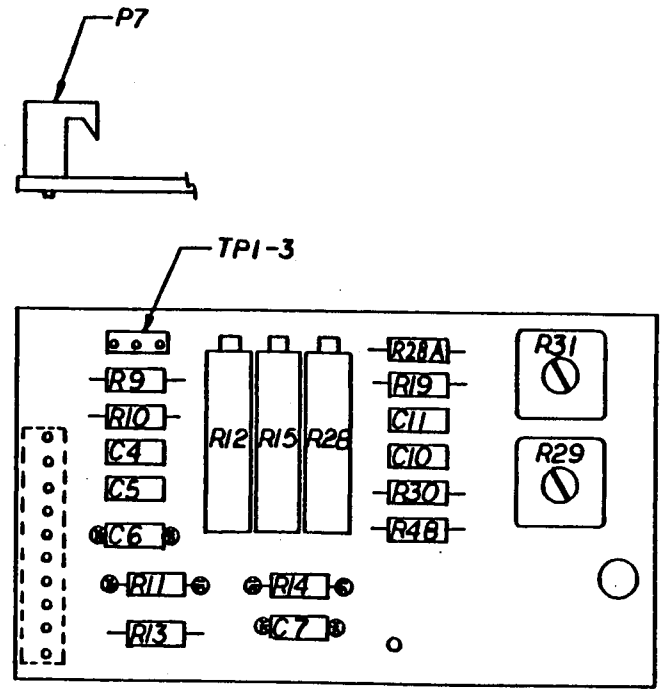
WESTAMR INCORPORATED
1642 18TH STREET
SANTA MONICA, CAL.

33035

OA 4-15-84 SHEET 1 OF 1

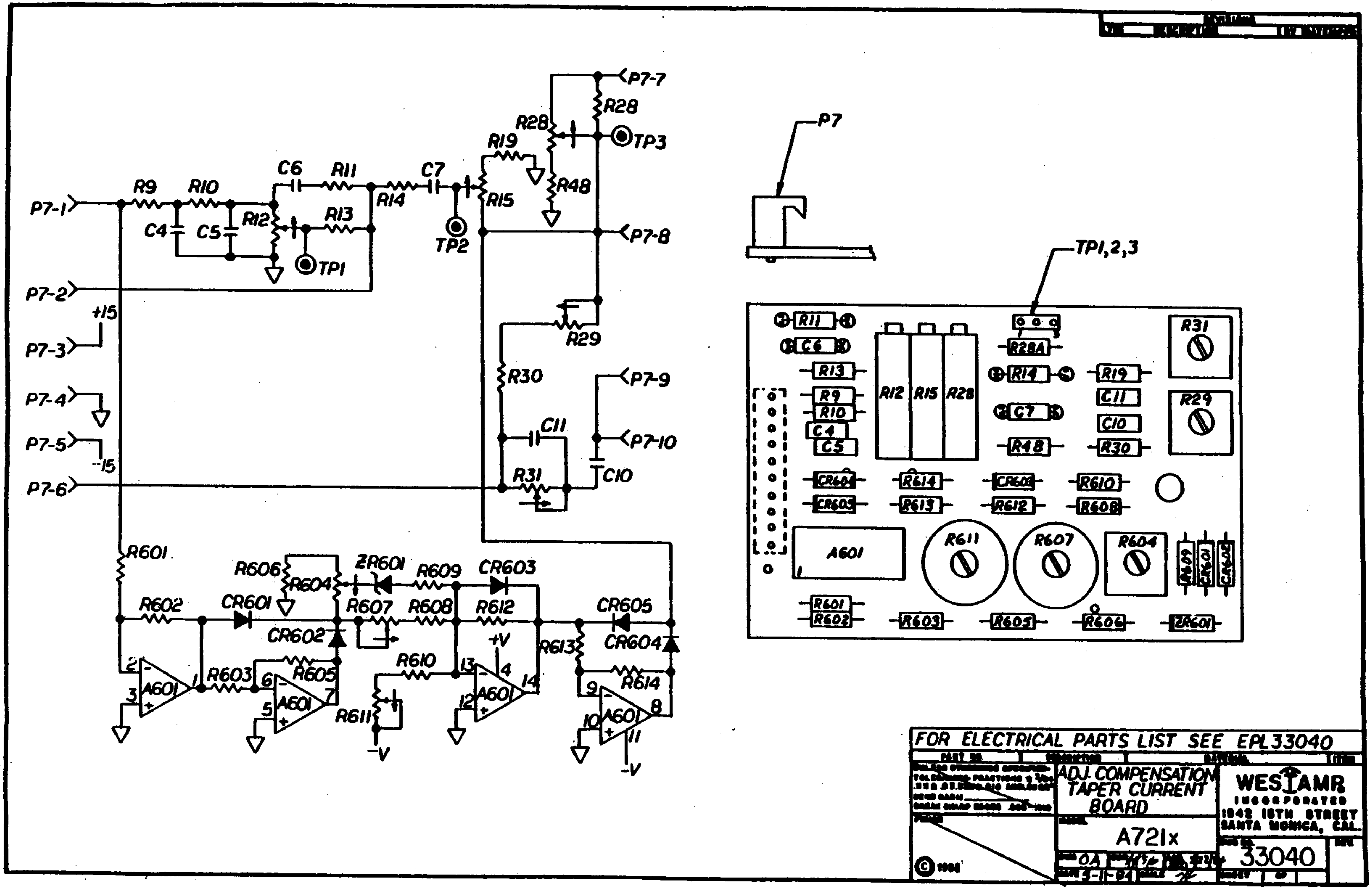
REVISIONS			
LTR	DESCRIPTION	BY	DATE/APPROVED
A	ADDED R28A	J.K.	5-4-84

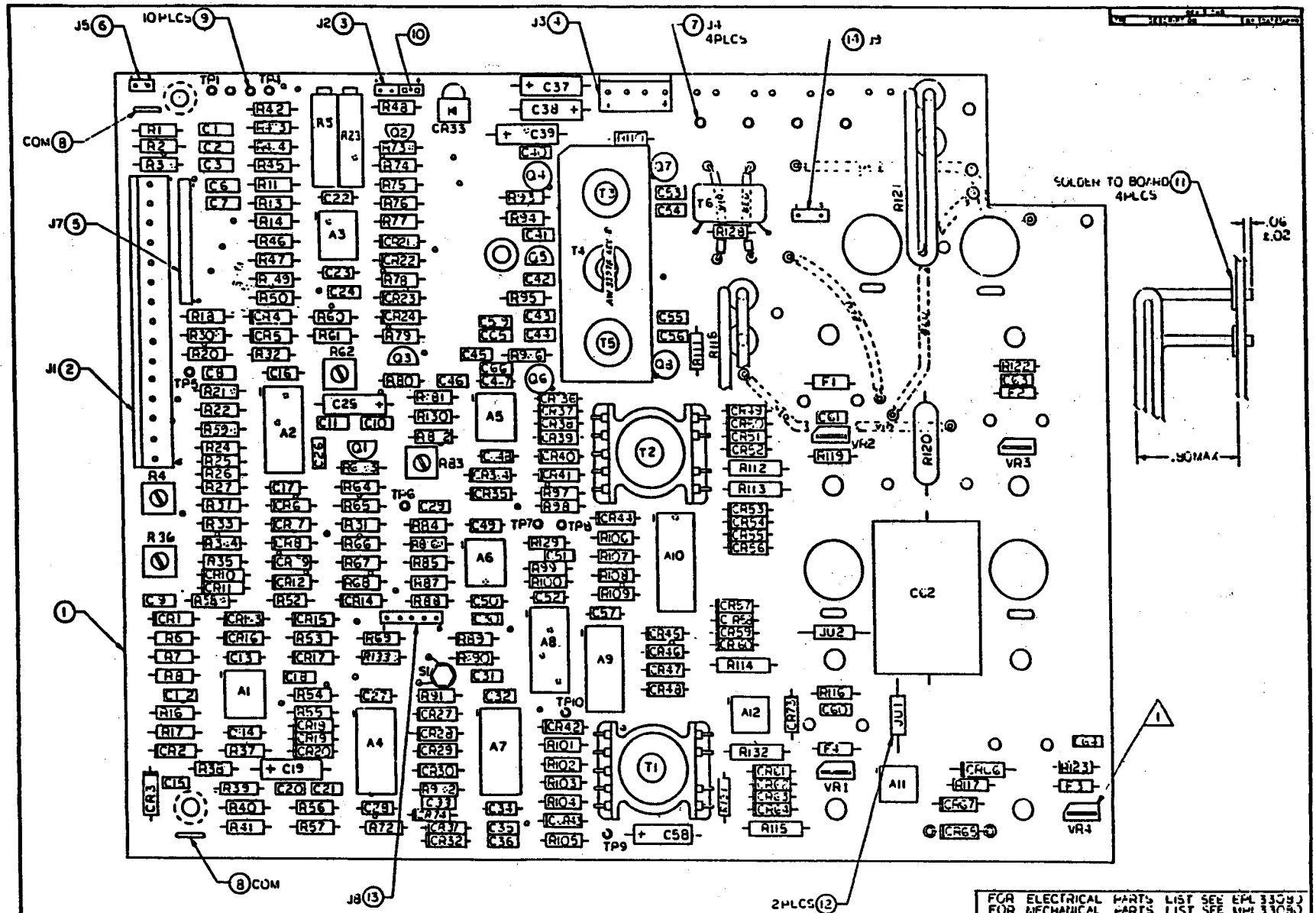




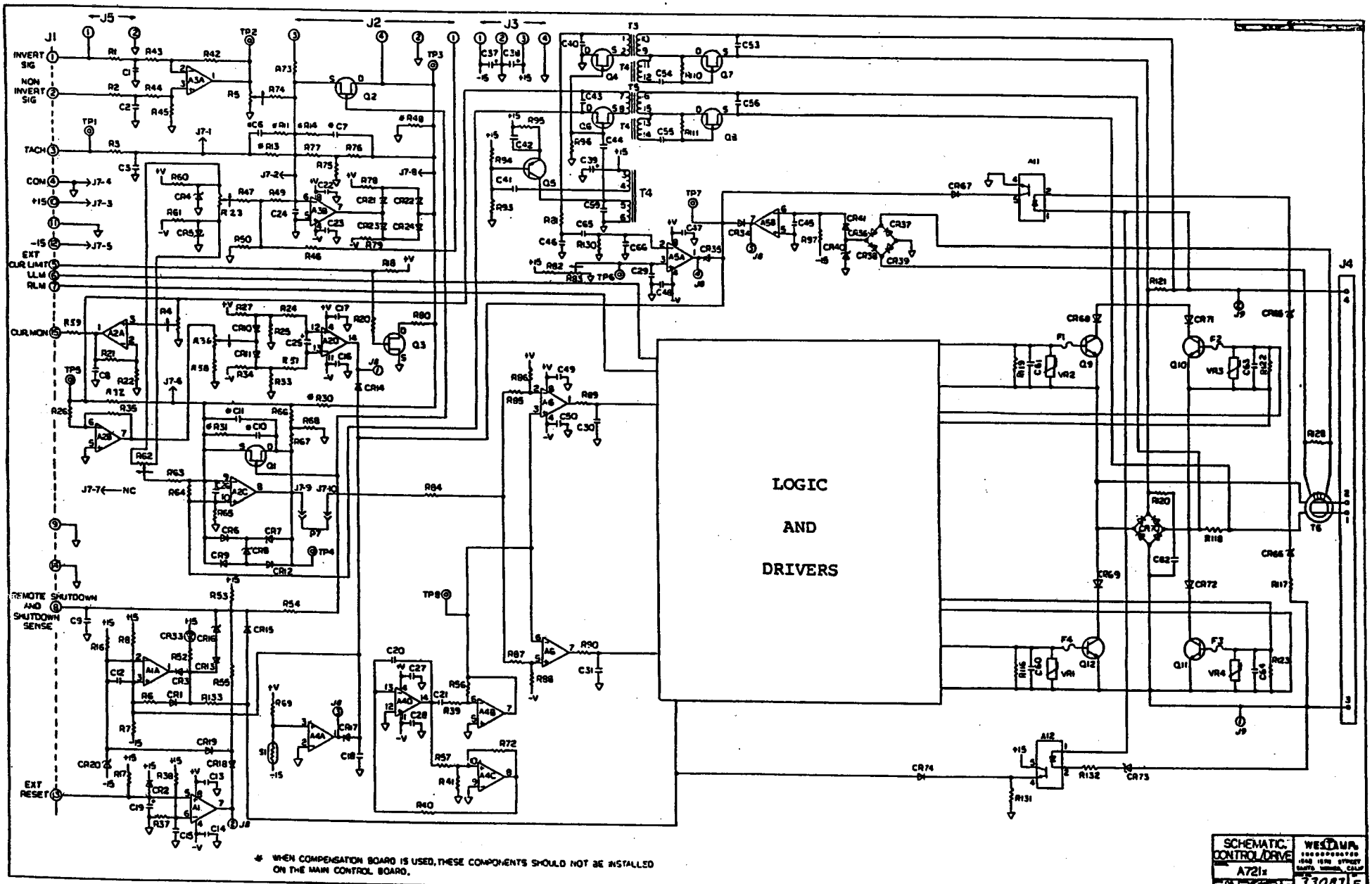
FOR ELECTRICAL PARTS LIST SEE EPL 33030

ADJUSTABLE COMPENSATION BOARD		WESTAMR INCORPORATED 1542 16TH STREET SANTA MONICA, CAL.	
FIRST USED ON A721		33030	A
DR OA			
DATE 4-13-84	SCALE 2:1	SHEET 1 OF 1	


P7-1
P7-2
P7-3
P7-4
P7-5
P7-6
P7-7
P7-8
P7-9
P7-10
+15
-15
R9
R10
C4
C5
R12
C6
R11
R13
TP1
R14
C7
TP2
R15
R19
R28
R48
TP3
R29
R30
C11
R31
C10
R601
R602
CR601
R603
R606
R604
ZR601
R609
CR603
R607
R608
R612
CR602
R605
R610
R611
+V
-V
R613
CR605
CR604
R614
A601
P7
TP1,2,3
R28A
FOR ELECTRICAL PARTS LIST SEE EPL33040
ADJ. COMPENSATION TAPER CURRENT BOARD
A721x
WESTAMR INCORPORATED
1842 15TH STREET SANTA MONICA, CAL.
33040
5-11-84



NOTES: UNLESS OTHERWISE SPECIFIED
5. ALL TRANSISTORS TO BE AS CLOSE TO BOARD AS POSSIBLE
4. INSTALL ALL CAPACITORS FLUSH TO BOARD
3. DELETED
2. ALL JUMPERS TO BE 16GA TEFLON
1. ORIENT VR1 THRU VR4 AS SHOWN



* WHEN COMPENSATION BOARD IS USED, THESE COMPONENTS SHOULD NOT BE INSTALLED ON THE MAIN CONTROL BOARD.

MULTI-TURN POTENTIOMETERS

Various manufacturers' potentiometers may be used in the amplifier.

Please refer to the following chart:

MANUFACTURER	POT COLOR	NOMINAL # OF TURNS	OVERTRAVEL DEAD-ZONE
Weston	Light Green	12	0
Beckman	Light Gray	20	0
VRN	Dark Green	20	0
Spectrol	Tan	20	4 - 5 Turns

Set-up procedures are often established based on counting the number of turns from the counter clockwise end to the set point. Spectrol potentiometers have a 4 to 5 inactive section at the end.

If your amplifier has a tan Spectrol pot, you must turn the potentiometer adjustment screw 4 to 5 turns from the counter clockwise end before any resistance change will occur.

APPLICATION NOTE: SERIES INDUCTORS

The use of an inductor in series with the motor armature provides several benefits:

1) Ripple current is reduced
2) Amplifier is protected against motor shorts or grounds
3) Armature commutation is imporved and RFI is reduced

The Westamp A721 Series of amplifiers are designed for a maximum ripple current of 20% (peak to peak) of the peak current rating. The ripple current will be larger if the armature circuit inductance is less than the specified minimum. Since the current surge trip level is set at 130% of the peak rating, it is possible for the amplifier to fault trip with the increased current ripple. A second possibility that exists is for the ripple current to exceed the level occasionally, resulting in nuisance trips. A far more disastrous effect will be experienced if the ripple currents are such that the surge trip level is not exceeded, but they are high enough to cause secondary breakdown in the output transistors. Secondary breakdown in trnasistors is a catastrophic failure.

When a motor armature winding becomes shorted or grounded. the inductance is reduced, creating the same effect as discussed previously. If a series inductor is used, this effect is less pronounced and will prevent the amplifier from failing along with the motor.

Armature commutation is improved with an external inductor since the inductor forms a low pass filter with the armature and reduces the ripple voltage. The result is longer brush and commutator life and improved commutation. For the same reason, RFI is reduced; the high frequency component of the PWM waveform is filtered out.

One other factor must be considered when evaluating the requirement of an external inductor: the frequency response characteristics of the current loop. The overall current loop stability depends upon the armature circuit L/R time constant. If the time constant is too high, the current loop response will become oscillatory. This will reduce the reliability of the amplifier and could cause nuisance trips.

To summerize, the benefits of using a series inductor far outweigh the additional cost.

Customer_____ Amplifier Model_____

Machine_____

AMPLIFIER SETTINGS

AXIS	# 1	# 2	# 3	# 4
Module P/N if known				
Potentiometer Settings from fully CCW position				
Aux Pot				
Signal Pot Differential Input YES/NO				
Tach Pot				
Tc Pot				
Current Limit Pot				

SPECIAL NOTES: Here you might want to indicate the overall # of turns of the pots. See Application Note section on pots.

You might want to copy this page and put it with the machine. DATE_____