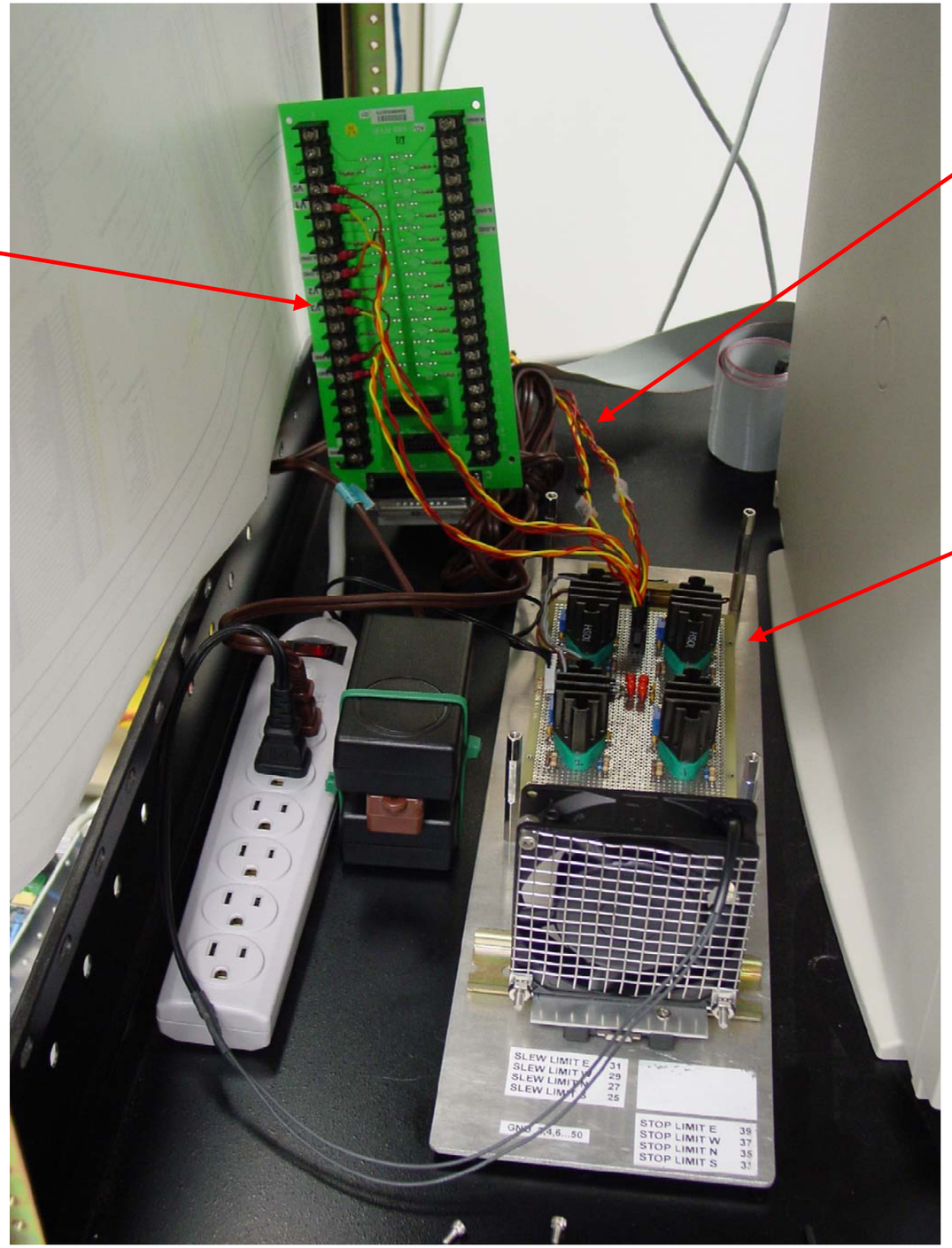
REVISION BLOCK			
REV	DESCRIPTION	DATE	INCORP. BY

1. Unless otherwise stated:
   Resistors are 1/8 Watt, 1% tolerance
   Capacitors are 50V, 10% tolerance

2. Parts list is a nominal list. Substitute equal, tighter tolerance, higher power, or higher voltage parts as desired.

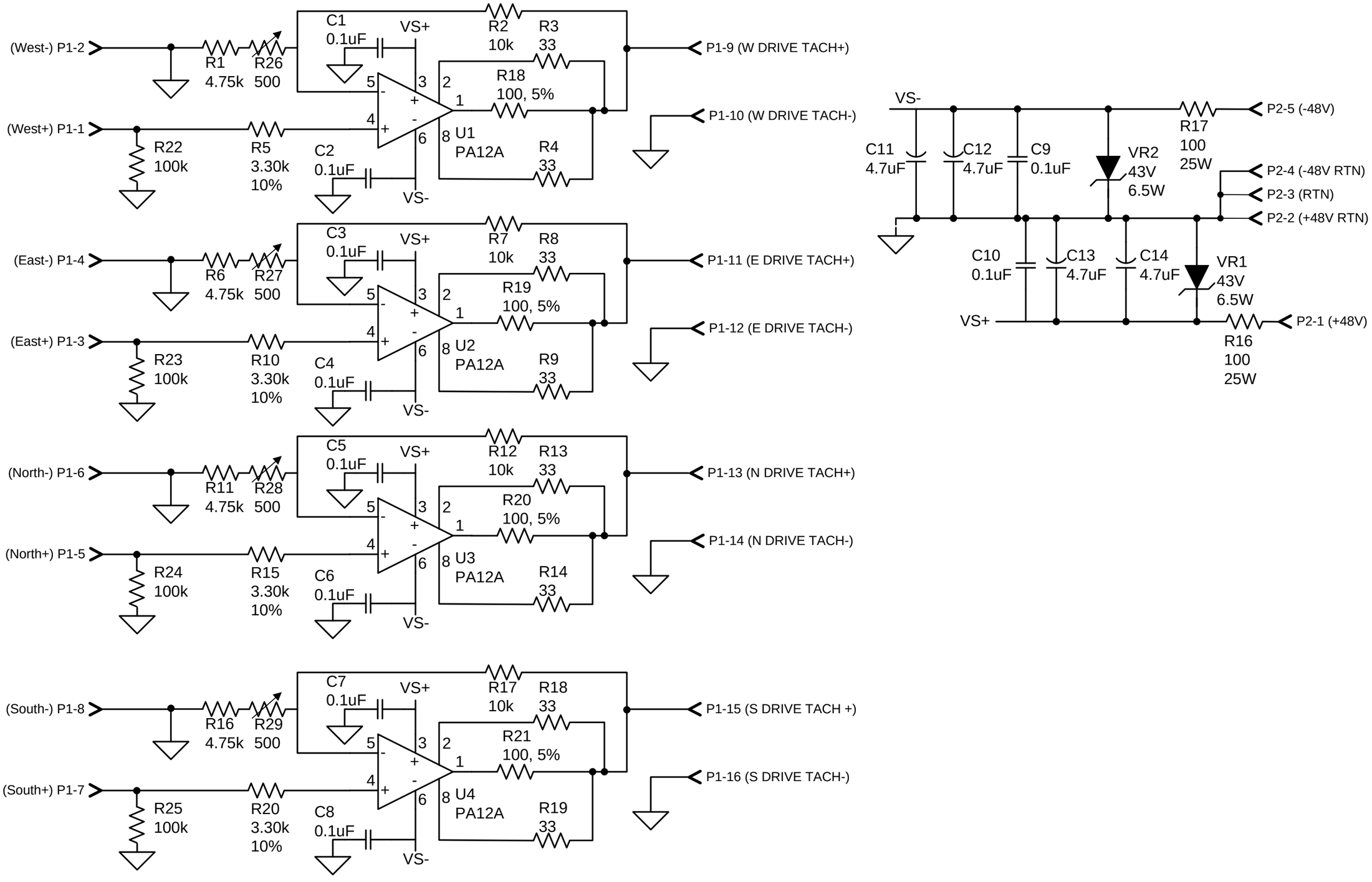


University of Hawaii
Institute for Astronomy

DWG #	REV	TITLE
TCS3-2312	-	TCS3 Lab Tachometer Amplifier & Cables

ENGINEER	LAST EDIT	SIZE	SHEET
E. Warmbier	7/20/2009 4:40:33 PM	B	1 of 5

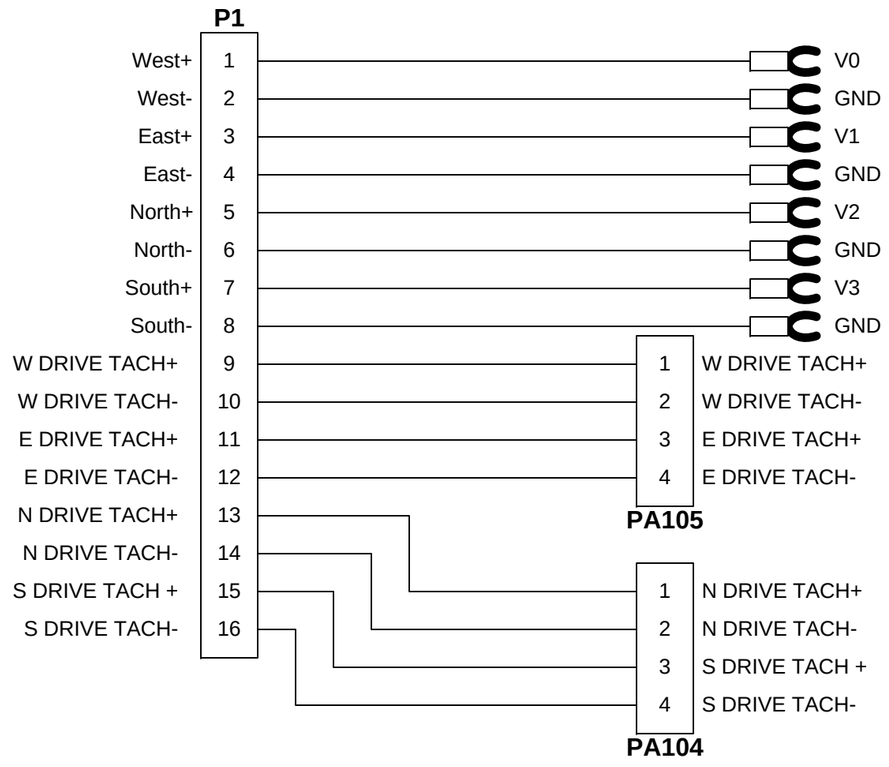
FILE: Y:\public_html\tcs3\Design\T3-2312_Lab_Tachometer_Amplifier.vsd



NOTE: Adjust gain of each stage to 3.0, using the pot.

DWG #	REV	SIZE	SHEET
TCS3-2312	-	B	2 of 5

Amplifier Board



From Tachometer Simulator DAC Board

To Servo Box

To Servo Box

DWG #	REV	SIZE	SHEET
TCS3-2312	**-**	**B**	3 of 5

PARTS LIST

FIND #	QTY	Part #	Description	Ref Des	Comment
1	8	-	Resistor, 33 Ω, 1/8W, 1%	R3,4,8,9,13,14,18,19	
2	4	-	Resistor, 10kΩ, 1/8W, 1%	R2,7,12,17	
3	4	-	Resistor, 4.75kΩ, 1/8W, 1%	R1,6,11,16	
4	2	-	Resistor, 100 Ω, 25W, 1%	R18,19,29,21	
5	4	-	Resistor, 3.30kΩ, 1/8W, 10%	R5,10,15,20	
6	4	PA12A	Power amplifier	U1-4	
7	4	-	Capacitor, tantalum, 4.7 uF, 50V	C11-14	
8	10	-	Capacitor, ceramic, 0.1uF, 50V	C1-10	
9	4	-	Resistor, 33 Ω, 1/8W, 5%	R18-21	
10	2	1.5KE43A	Zener Diode, 43V	VR1, VR2	
11	4	-	Resistor, 100 kΩ, 1/8W, 1%	R22,23,24,25	
12	4	-	Potentiometer, 500Ω	R26,27,28,29	
13	1	-	Connector, Molex, 16 pin	P1	
14	1	-	Connector, Molex, 5 pin	P2	
15	1	MS3116F20-39SW	Connector, 39 socket	PA105	
16	1	MS3116F20-39SZ	Connector, 39 socket	PA104	
17	1	-	Fan, AC	-	
18	2	PW148RA4803B01	Power Supply, 48V	-	
19	8	-	Crimp on fork terminals	-	

DWG #	REV	SIZE	SHEET
TCS3-2312	-	B	4 of 5

CURRENT LIMITING

Since this is driving a high impedance load (A/D input), let's set the current limit to something low like 20mA.

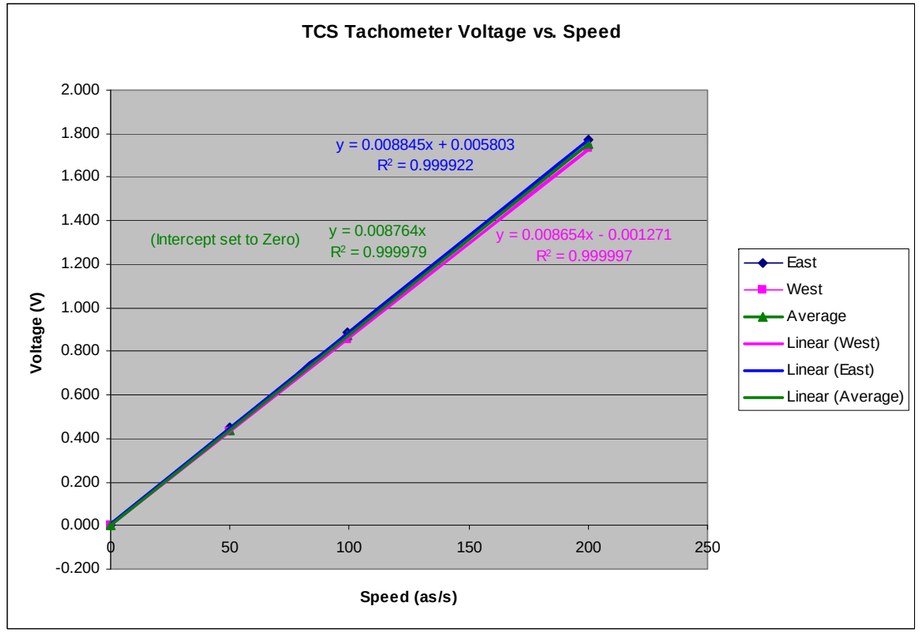
From previous calculations, our gain is 3 and maximum D/A output is 10V. Therefore, the maximum output voltage is 30V.

Using the equation from the PA12 datasheet for the current limit and entering our parameters:

$$R_{CL} = 0.65 / I_{CL}$$
$$R_{CL} = 0.65 / 0.020$$
$$R_{CL} = 32.5\Omega$$
$$R_{CL} \approx 33\Omega$$

POWER SUPPLY INPUT PROTECTION

The PA12 amplifiers can have +/-50 supplies max. +/-48V leaves only 4V of margin. The maximum voltage that needs to be output is about 27V (see below right). Therefore a simple resistor/zener combination will work to drop and clamp the voltage. 100 Ω, 25W resistors were found in the lab. With about 100mA of quiescent current draw, this equals 10V (100mA x 100Ω) of drop on each supply, or +/-38V approximately. This leaves 38V – 27V = 11V of margin that is sufficient for op-amp headroom, small variations in quiescent current over time, etc. Since the op-amps power high impedance loads, no additional current will be drawn from the supplies, so having a large resistance in series will not lead to large supply voltage fluctuations. Placing a 43V zener after the resistor will clamp the voltage to a safe level if the voltage supplied is too high.



MAXIMUM OUTPUT VOLTAGE

The slope of the tachometer is about 8.764mV/(arcsec/s).
Current TCS1 slew speeds are in excess of 2500 arcsec/s and the TCS3 maximum velocity could be raised to a similar value. Therefore, the lab setup should be capable of simulating at least 3000 arcsec/s for the overspeed.

3000 arcsec/s * 8.764mV/(arcsec/s) = 26.29 V

AMPLIFIER GAIN

The lab system can currently output up to 10V maximum.
Therefore the gain of the amplifier must be:

Min_Gain= 26.29/10 = 2.629

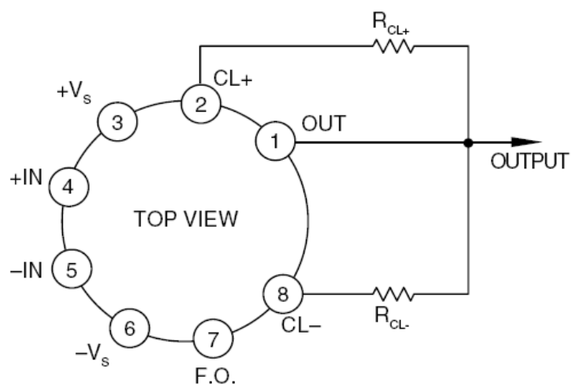
For margin, round the gain up to 3.

The amplifier is a non-inverting configuration with a gain of:
Gain=1+(Rf/Rs)

Entering in the desired gain of 3 will result in a resistor ratio of:
3=1+(Rf/Rs)
2=Rf/Rs

PA12 Amplifier Pinout

EXTERNAL CONNECTIONS



DWG #	REV	SIZE	SHEET
TCS3-2312	-	B	5 of 5