REFERENCE ONLY

M4020

EFA427 630D1192

GENERAL DESCRIPTION:

The model M4020 is a linear bipolar DC amplifier. It requires a bus voltage of +/- 40V DC and is capable of motor currents to 20A peak and 5A continuous. It has 3 inverting variable gain inputs and one non-inverting variable gain input. The unit requires an external bus power supply to operate. It typically is used with a TA3-OEM baseplate (EFA451) which supplies the +/- 40V DC to the amplifier. The baseplate also is the interface for external connections to the amplifier.

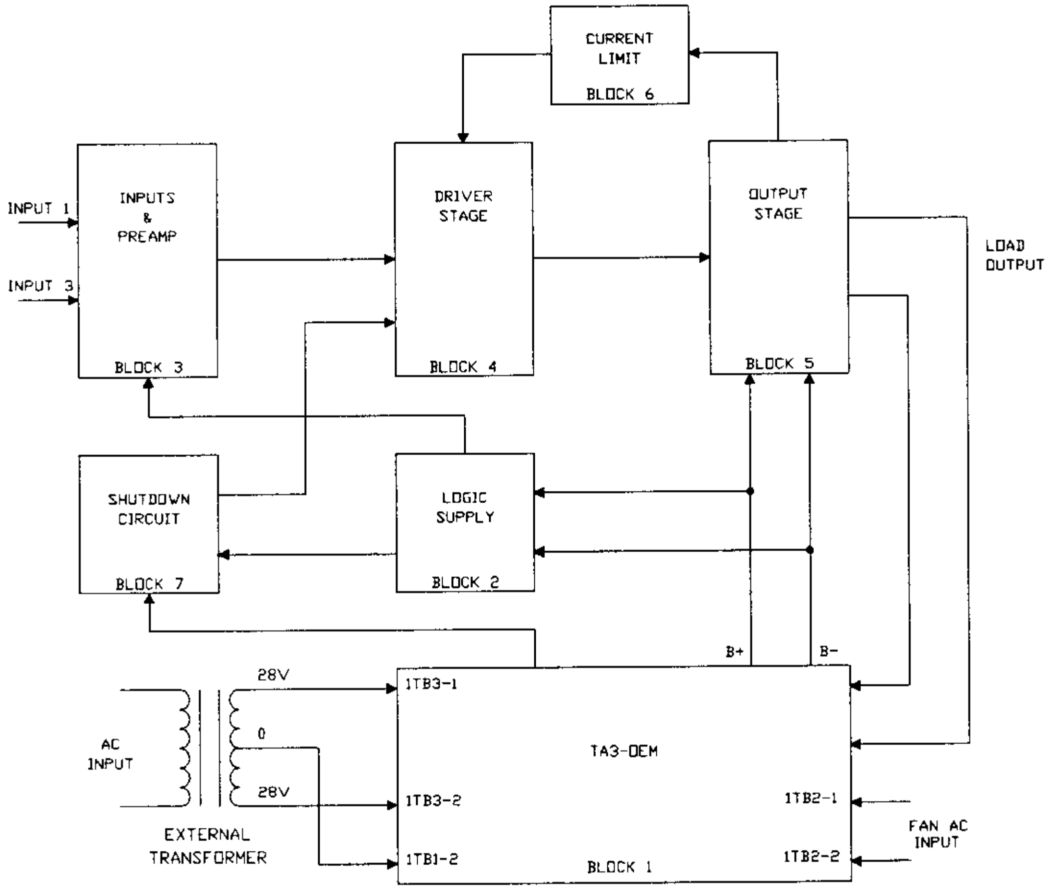
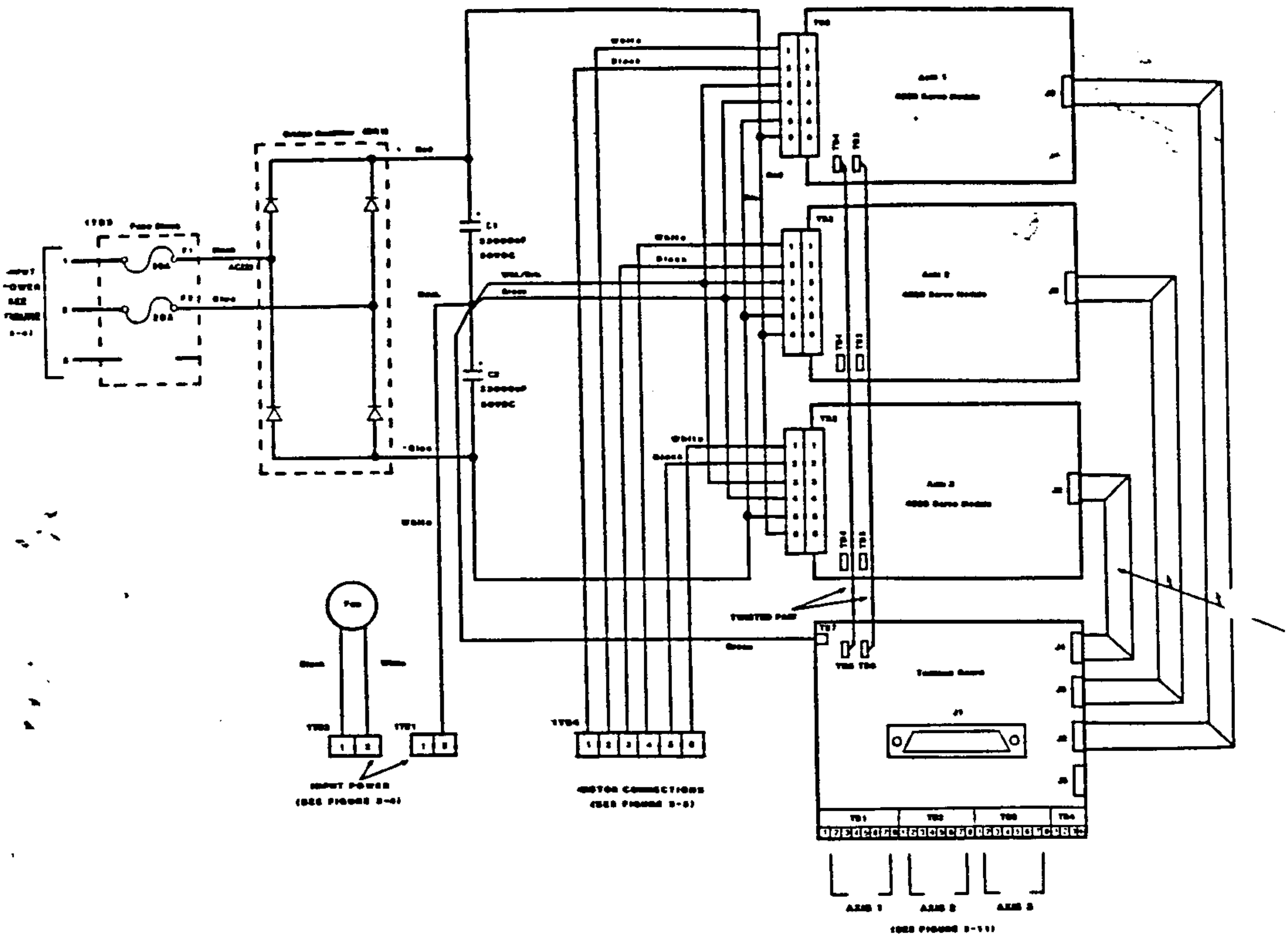


FIG 3: M4020 BLOCK DIAGRAM

C1FIG3



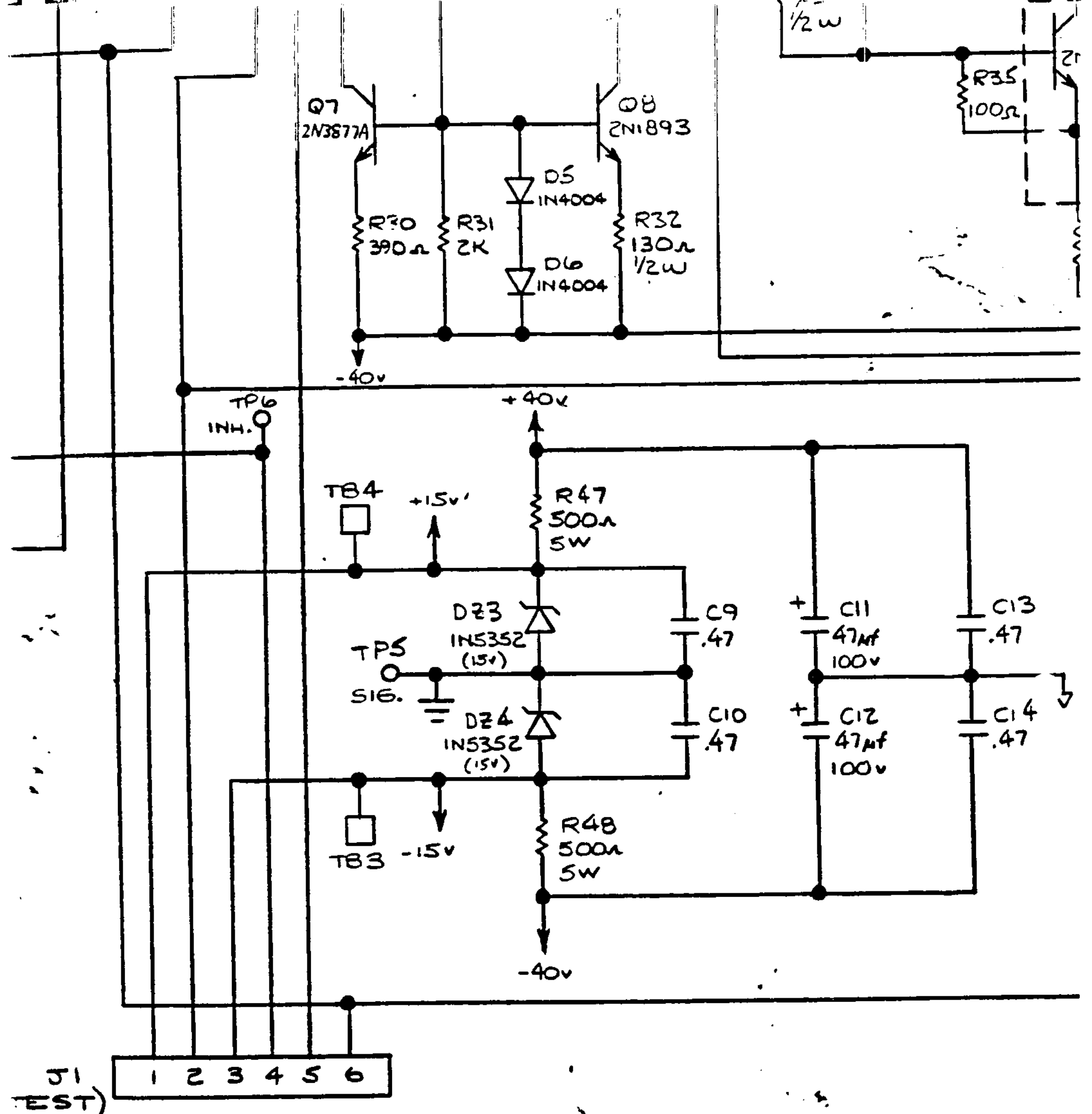
TWISTED PAIR
INPUT POWER
MOTOR CONNECTIONS
AXIS 1
AXIS 2
AXIS 3

BLOCK DESCRIPTION:

BLOCK 1: TA3-OEM

This is the baseplate for the M4020. It is capable of handling up to 3 amplifiers. When connected to a center tapped 56V transformer, it generates the +/- 40V DC bus voltage for the amplifier. It also requires 115V AC for the cooling fan. It has the interface for motor connections to the amplifier as well as the interface to the amplifier input connections.

1TB1 - AC neutral input
1TB2 - fan AC input
1TB3 - AC input fuseblock
1TB4 - motor interface connector
BR1 - power supply bridge rectifier
C1,C2 - bus voltage filter capacitors



1/2 W
R35
100Ω
Q7
2N3877A
Q8
2N1893
D5
1N4004
D6
1N4004
R30
390Ω
R31
2K
R32
130Ω
1/2W
-40v
TP6
INH.
+40v
TB4
+15v'
R47
500Ω
5W
DZ3
1N5352
(15v)
C9
.47
C11
47μf
100v
C13
.47
TP5
SIG.
DZ4
1N5352
(15v)
C10
.47
C12
47μf
100v
C14
.47
TB3
-15v
R48
500Ω
5W
-40v
J1
1 2 3 4 5 6
EST)

BLOCK 2: LOGIC POWER SUPPLY

This section develops the +/- 15V DC power supplies for the amplifier from the +/- 40V DC bus.

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DZ3,DZ4 -           +/- 15V zener diode regulators
C9,C10 -            +/- 15V filter capacitors
C11,C12,C13,C14 - +/- 40V filter capacitors
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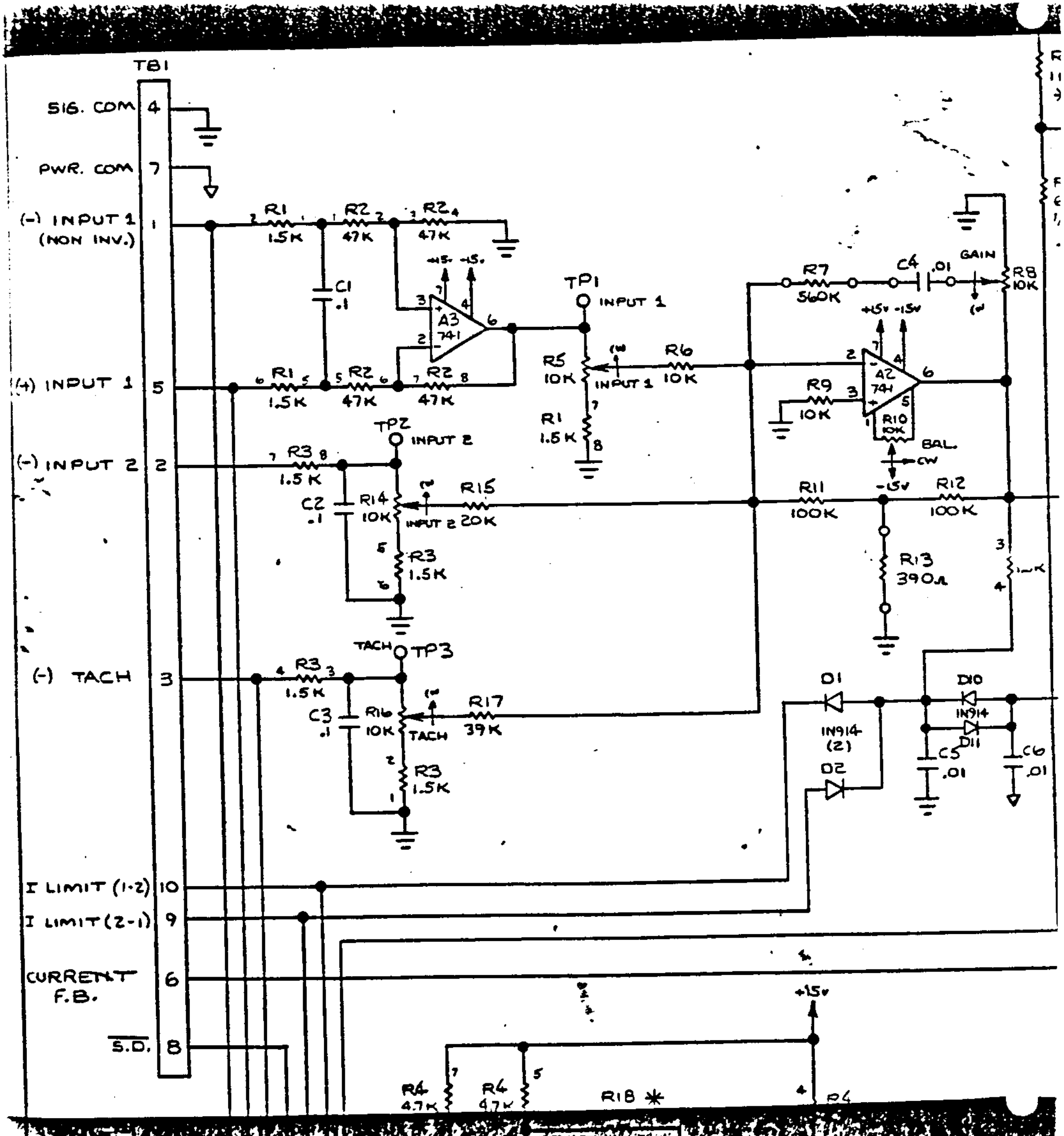
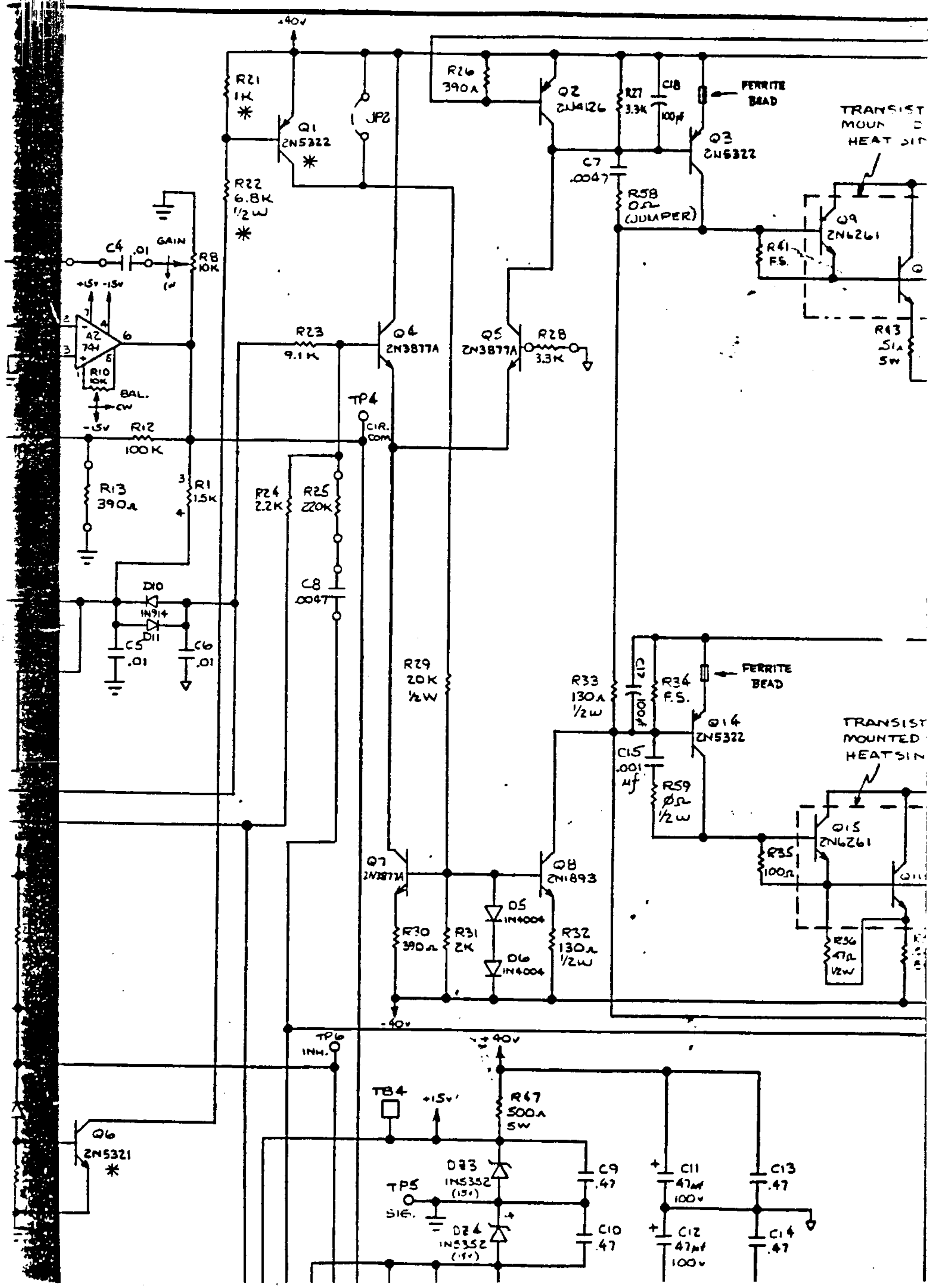


TB1
SIG. COM 4
PWR. COM 7
(-) INPUT 1 (NON INV.) 1
(+) INPUT 1 5
(-) INPUT 2 2
(-) TACH 3
I LIMIT (1-2) 10
I LIMIT (2-1) 9
CURRENT F.B. 6
S.D. 8
R1 1.5K
R2 47K
C1 .1
A3 741
TP1 INPUT 1
R5 10K
R6 10K
TP2 INPUT 2
R3 1.5K
C2 .1
R14 10K
R15 20K
C3 .1
R16 10K
R17 39K
TACH TP3
R7 560K
C4 .01
GAIN
R8 10K
A2 741
R9 10K
R10 10K
BAL.
R11 100K
R12 100K
R13 390Ω
D1
D2
IN914 (2)
D10
D11
C5 .01
C6 .01
R4 4.7K
R18 *
+15v
-15v

BLOCK 3: INPUTS & PREAMP

This section is the "user interface" of the amplifier. With an input voltage applied to it, a current command for the output stage is generated.

Input 1 -	variable gain input network (typically TB1-1 is command input and TB1-5 is connected to ground)
Input 2 -	variable gain resistor network typically not used
Input 3 -	variable gain resistor network typically used for tach input.
A3 -	input 1 preamp
A2 -	amplifier preamp
R7,R8,C4 -	variable AC gain feedback network of preamp
R11,R12,R13 -	DC gain feedback network of preamp
R10 -	preamp balance pot
D1,D2 -	external motor current limiting diodes

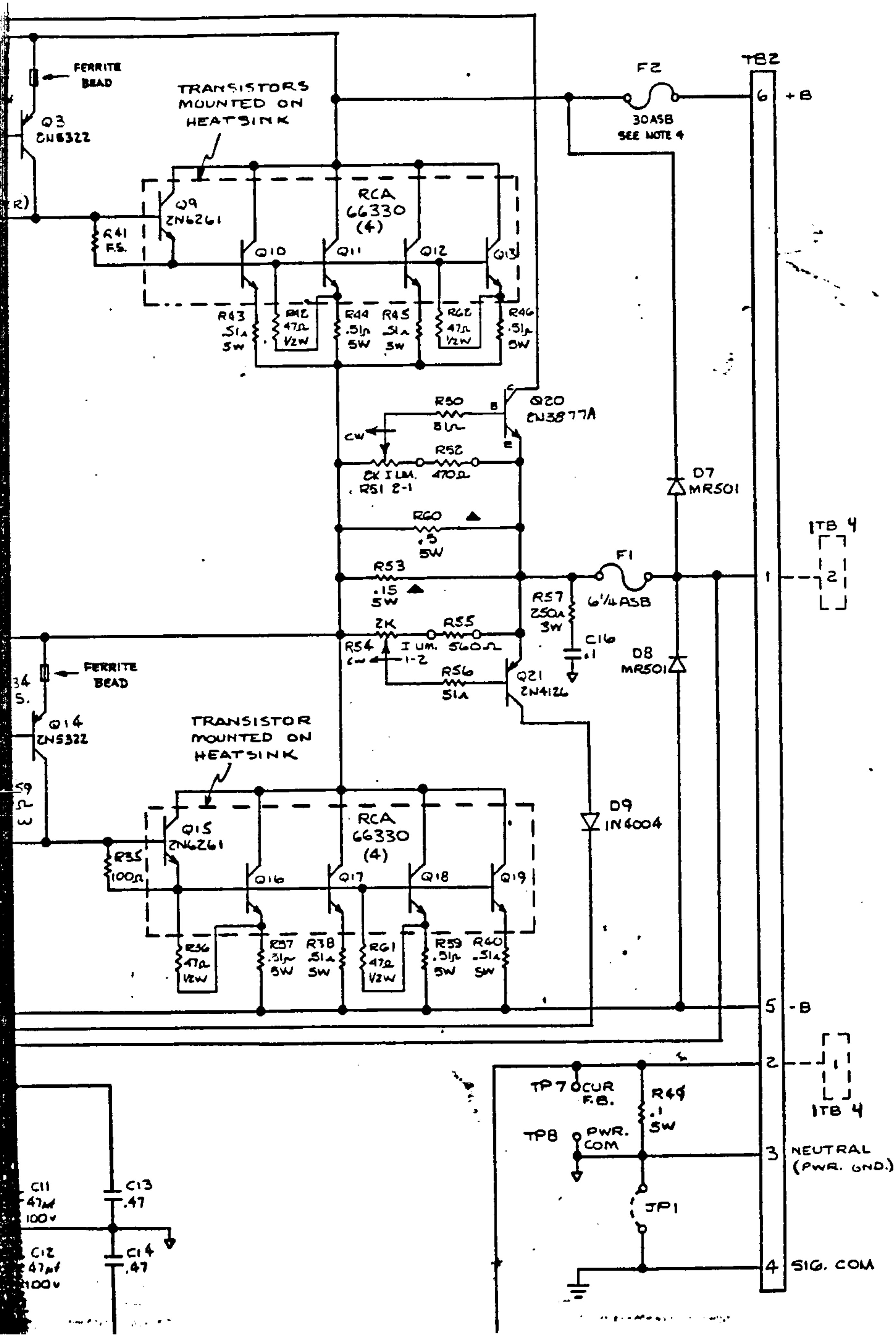


+40v
R21
1K
Q1
2N5322
JP2
R26
390Ω
Q2
2N4126
R27
3.3K
C18
100pf
FERRITE BEAD
Q3
2N6322
TRANSIST
MOUN
HEAT
C7
.0047
R58
0Ω
(JUMPER)
R22
6.8K
1/2W
Q9
2N6261
R41
F.S.
C4
.01
GAIN
R8
10K
+15v
-15v
A2
741
R10
10K
BAL.
CW
R23
9.1K
Q4
2N3877A
Q5
2N3877A
R28
3.3K
R43
.51Ω
5W
TP4
CIR. COM
-15v
R12
100K
R13
390Ω
R1
1.5K
R24
2.2K
R25
220K
D10
1N914
D11
C5
.01
C6
.01
C8
.0047
R29
20K
1/2W
R33
130Ω
1/2W
C17
100pf
R34
F.S.
FERRITE BEAD
Q14
2N5322
TRANSIST
MOUNTED
HEATSIN
C15
.001
μf
R59
0Ω
1/2W
Q15
2N6261
R35
100Ω
Q7
2N3877A
Q8
2N1893
D5
1N4004
D6
1N4004
R30
390Ω
R31
2K
R32
130Ω
1/2W
R36
47Ω
1/2W
-40v
TP6
INH.
+40v
TB4
+15v
R47
500Ω
5W
D23
1N5352
(15v)
D24
1N5352
(15v)
C9
.47
C10
.47
TP5
SIG.
C11
47μf
100v
C12
47μf
100v
C13
.47
C14
.47
Q6
2N5321

BLOCK 4: DRIVER STAGE

This stage takes the current command from the preamp and controls the drive transistors for the output stage.

Q7,Q8 -	constant current source generator
Q4,Q5 -	pre drive transistors for output stage
Q3,Q9,Q14,Q15 -	drive transistors
R25,C8 -	output stage AC feedback network
R24 -	motor current feedback resistor
Q1 -	amplifier shutdown transistor

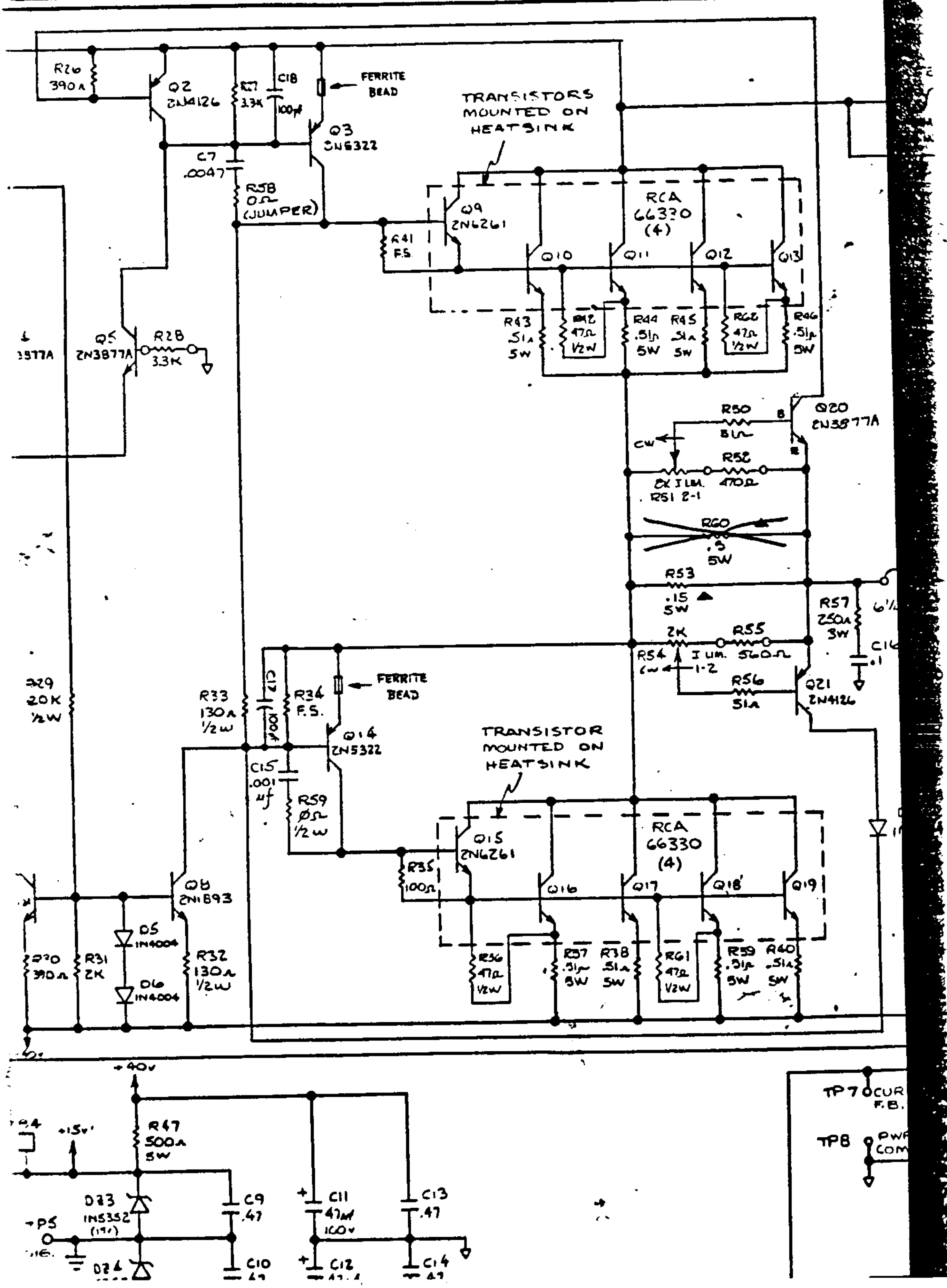


FERRITE BEAD
Q3 2N5322
TRANSISTORS MOUNTED ON HEATSINK
Q9 2N6261
R41 F.S.
RCA 66330 (4)
Q10
Q11
Q12
Q13
R43 .51Ω 5W
R42 47Ω 1/2W
R44 .51Ω 5W
R45 .51Ω 5W
R62 47Ω 1/2W
R46 .51Ω 5W
F2
30ASB SEE NOTE 4
TB2
6 +B
Q20 2N3877A
R50 81Ω
CW
R52 470Ω
2K I LM. R51 2-1
D7 MR501
R60 .5 5W
R53 .15 5W
F1
6 1/4 ASB
1TB 4
R57 250Ω 3W
C16 .1
2K
R55 560Ω
R54 CW I LM. 1-2
R56 51Ω
Q21 2N4126
D8 MR501
FERRITE BEAD
Q14 2N5322
TRANSISTOR MOUNTED ON HEATSINK
D9 1N4004
Q15 2N6261
R35 100Ω
RCA 66330 (4)
Q16
Q17
Q18
Q19
R36 47Ω 1/2W
R37 .51Ω 5W
R38 .51Ω 5W
R61 47Ω 1/2W
R39 .51Ω 5W
R40 .51Ω 5W
5 -B
2
TP7 CUR F.B.
R49 .1 5W
1TB 4
TP8 PWR. COM
3 NEUTRAL (PWR. GND.)
JP1
4 SIG. COM
C11 47μf 100v
C12 47μf 100v
C13 .47
C14 .47

BLOCK 5: OUTPUT STAGE

This section is made up of two banks of transistors. As each bank is turned on, it creates a path for current flow through the motor causing it to rotate.

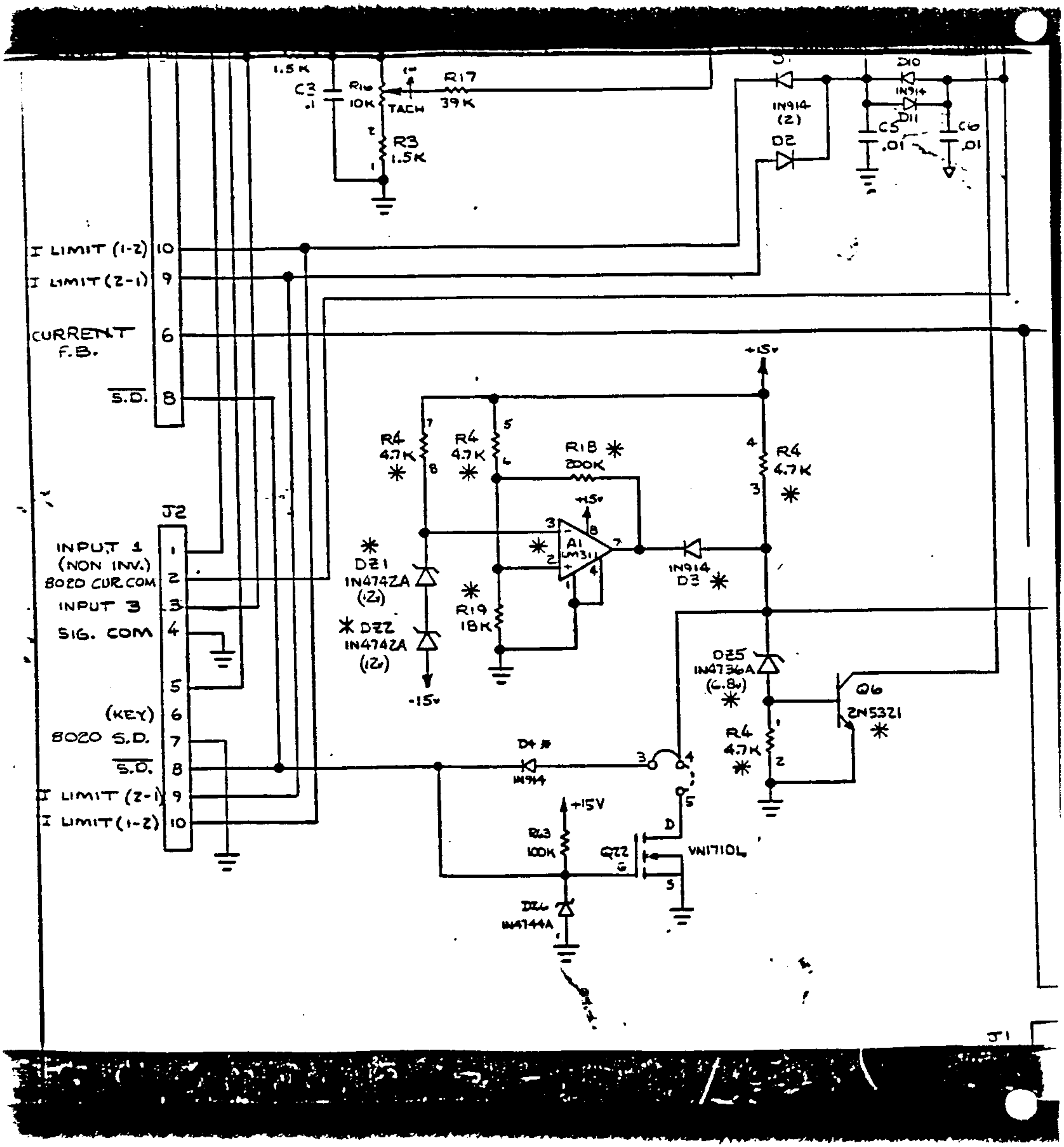
Q10,Q11,Q12,Q13 -	output transistors for current flow from 1TB4-2 to 1TB4-1
Q16,Q17,Q18,Q19 -	output transistors for current flow from 1TB4-1 to 1TB4-2
D7,D8 -	flyback diodes
F1 -	load fuse
R49 -	current sense resistor
1TB4-2 (TB2-1) -	load hi motor connection (motor -)
1TB4-1 (TB2-2) -	load lo motor connection (motor +)


R26 390Ω
Q2 2N4126
R27 3.3K
C18 100pf
FERRITE BEAD
Q3 2N6322
TRANSISTORS MOUNTED ON HEATSINK
C7 .0047
R58 0Ω (JUMPER)
Q9 2N6261
RCA 66330 (4)
R41 F.S.
Q10
Q11
Q12
Q13
R43 .51Ω 5W
R42 47Ω 1/2W
R44 .51Ω 5W
R45 .51Ω 5W
R62 47Ω 1/2W
R46 .51Ω 5W
Q5 2N3877A
R28 3.3K
Q20 2N3877A
R50 51Ω
CW
R52 470Ω
EX I LIM.
R51 2-1
R60 .5 5W
R53 .15 5W
R57 250Ω 3W
R55 560Ω
R54 2K
I LIM. 1-2
R56 51Ω
Q21 2N4126
R29 20K 1/2W
R33 130Ω 1/2W
C17 .001
R34 F.S.
FERRITE BEAD
Q14 2N5322
TRANSISTOR MOUNTED ON HEATSINK
C15 .001 uf
R59 0Ω 1/2W
Q15 2N6261
RCA 66330 (4)
R35 100Ω
Q16
Q17
Q18
Q19
Q8 2N1893
D5 1N4004
D6 1N4004
R30 390Ω
R31 2K
R32 130Ω 1/2W
R36 47Ω 1/2W
R37 .51Ω 5W
R38 .51Ω 5W
R61 47Ω 1/2W
R39 .51Ω 5W
R40 .51Ω 5W
+40v
+15v
R47 500Ω 5W
D23 1N5352
C9 .47
C11 47uf 100v
C13 .47
+P5
C10
C12
C14
TP7
TP8

BLOCK 6: CURRENT LIMIT

This section senses motor current and limits it to a level determined by the current limit adjustment pots.

R51 -	1TB4-2 to 1TB4-1	current limit pot
Q20,Q2 -	1TB4-2 to 1TB4-1	current limit transistor
R54 -	1TB4-1 to 1TB4-2	current limit pot
Q21 -	1TB4-1 to 1TB4-2	current limit transistor



1.5K
C3
.1
R16
10K
TACH
R17
39K
R3
1.5K
IN914
(2)
D2
D10
IN914
D11
C5
.01
C6
.01
I LIMIT (1-2) 10
I LIMIT (2-1) 9
CURRENT F.B. 6
S.D. 8
+15v
R4
4.7K
R18
200K
A1
LM311
IN914
D3
DZ1
IN4742A
(12v)
DZ2
IN4742A
(12v)
-15v
R19
18K
DZ5
IN4736A
(6.8v)
Q6
2N5321
J2
INPUT 1 (NON INV.) 1
8020 CUR.COM 2
INPUT 3 3
SIG. COM 4
5
(KEY) 6
8020 S.D. 7
S.D. 8
I LIMIT (2-1) 9
I LIMIT (1-2) 10
D4
IN914
+15V
R63
100K
Q22
VN1710L
DZ6
IN4744A
J1

BLOCK 7: SHUTDOWN CIRCUIT

This circuit will shutdown the amplifier if the logic supply levels drop or if commanded by an external shutdown. Jumper 3-4 is installed for SD-N input and jumper 4-5 is installed for SD input.

J2-8,TB1-8 -	external shutdown input
Q22 -	mosfet (used for inverting signal for shutdown input)
A1 -	logic supply shutdown comparitor
DZ1,DZ2 -	reference voltage generator for A1
Q6 -	amplifier shutdown transistor

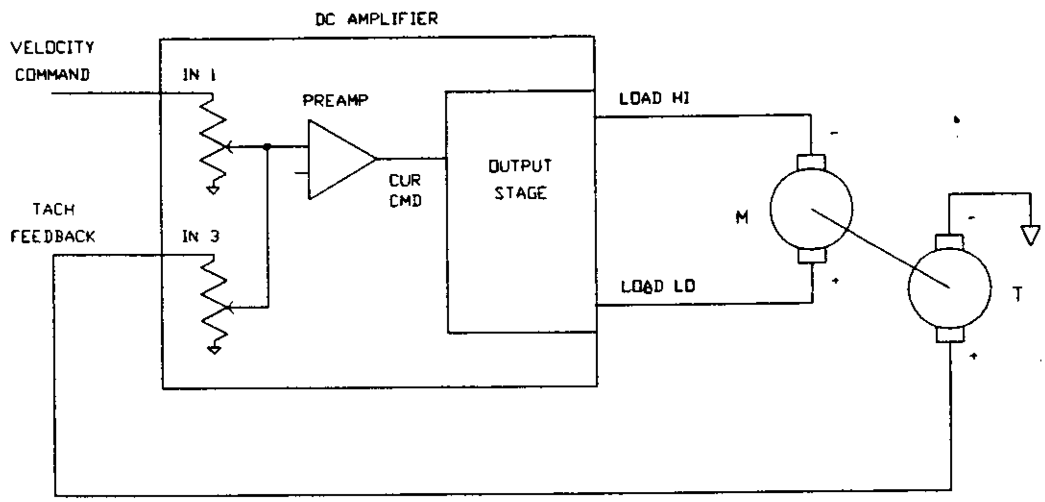


FIG 4: RATE LOOP BLOCK DIGARAM

C1FIG4

RATE LOOP THEORY:

A rate loop consists of an input command to a DC amplifier driving a DC motor that generates negative tach feedback.

The rate loop block diagram shows the typical rate loop configuration. Input 1 being a velocity command input, input 3 used as a tach feedback input. The positive lead of the motor is connected to load lo and the negative lead is connected to load high. As an input is applied to the amplifier, the preamp will output a current command that will command one side of the output transistors to come on. This will start current flow in the motor causing it to rotate. As the motor rotates, a tach voltage will be generated. The tach is then fed back to input 3. The tach voltage, being of equal and opposite polarity as the command input (negative feedback), will cancel it as they are summed in the preamp stage. This will decrease the current command on the preamp output.

Without tach feedback, any input command would cause the preamp to saturate. The current command would then be at maximum, causing the output transistors to fully turn on. The amplifier would be saturated and the motor in a runaway condition. Even though the current command would be at maximum, the actual motor current would be low. This is because as the motor rotates, a back EMF voltage is generated by the motor. The actual motor current would be determined by the following formula:

$$\frac{\text{APPLIED MOTOR VOLTAGE} - \text{BACK EMF VOLTAGE}}{\text{MOTOR RESISTANCE}}$$

With the amplifier saturated, the full bus voltage would be across the motor. With the motor resistance being constant, the motor current would be a factor of the difference in applied motor voltage to back EMF voltage. This would limit the current to whatever it takes to to overcome internal motor friction which would cause the motor to slow down. This slowing of the motor causes less back EMF voltage to be generated. With less back EMF voltage than applied motor voltage, a motor current will result.

SECTION 2: STEPPING DRIVES

SECTION 3: CONTROLLERS