New Folder Name MIT CIRCUIT DESIGNS

File

Caltech

California Institute of Technology
Pasadena, CA 91125

ligo memorandum

TO: Distribution

DATE: 2 January, 1991

FROM: M. E. Zucker

MAIL STOP/TELEPHONE: 130-33/4017

FILE: ~mike/elec/mitckt.tex

SUBJECT: MIT CIRCUIT DESIGNS

While I visited MIT last month David and I exchanged schematics of some electronic circuits developed in the two labs for the interferometer prototypes and other lab tests. The package I delivered was the *LIGO 40m Prototype Servo System Data Book,* which most of you already have, comprising the main elements of the three optical phase/frequency servos in the 40m prototype. There are copies in the 3rd floor library as well. David gave me a collection of circuits used in the rigid interferometer servos, plus some support circuits which serve in alignment and test functions. The final item, not described in David's list, is a list of changes made to the standard Caltech 12.33 MHz phase shifter to adapt it for operation at 15.6 MHz.

Our objective is to assemble a common catalog of circuit designs, categorized by function, and also by level of development, e.g. prototype, production version, unique or special–purpose instrument, etc.. Performance data, assembly notes, troubleshooting procedures, and so on will also be collected as appropriate.

If you have comments or need further information, please contact Jake, myself or David.

MEZ

Attachment:
MIT Electronics, DHS 12/18/90 (13 pages)

Distribution:
W. Althouse
J. Chapsky

R. Drever
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R. Spero
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R. Weiss
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MIT Electronics

DHS 12/18/90

This is a description of the general-purpose electronic circuits developed and in use at MIT, as of 12 Dec 90.

1) Filter-mixer box: This contains a pre-mixer low-pass at 22.8 MHz, a ZAY-1B Minicircuits mixer, and a post-mixer low-pass at 2.6 MHz. A fixed and an adjustable if output are available. It is in a single-width NIM-box. Construction: RF tight boxes, short BNC cables, T's and barrels. No circuit board.

2) Photodiode amplifier: This circuit contains an RF amplifier (good to at least some 30 MHz, RF gain of 100) and a d.c. photocurrent output. It has about 20μ amp equivalent noise current at 10 MHz. The photodiode is in a resonant circuit. Construction: PC boards in an RF tight box, feedthroughs for power.

3) High voltage video amplifier: Gain of 20, BW of 1 MHz using a PA85. ± 150 V_{pkpk} output. 6 $nV/\sqrt{Hz}$ input noise. Construction: hand-milled PC board and heat sink, six channels in single-width NIM.

4) Kilovolt slow amplifier: Gain of 70, BW of 1 kHz, $0 \rightarrow 950$kV output swing. Construction: PC board, three channels in a single-width NIM.

5) DC motor pulse driver: Takes input from a rotary shaft encoder, puts out bipolar pulses to drive gearhead motors. Allows remote alignment of mirror mounts. Construction: hand wired; one circuit, switchable to 10 motors, in single-width NIM.

6) Intra-cavity Pockels cell Frequency-stabilization circuit: This circuit provides the transfer function for the small-frame laser stabilization loop currently used. The output of this circuit is amplified by a commericial (Inrad) HV video amplifier. The UGF is about 1.3 MHz for the loop. Construction: hand wired on MIT 'matrix' board, in single-width NIM.

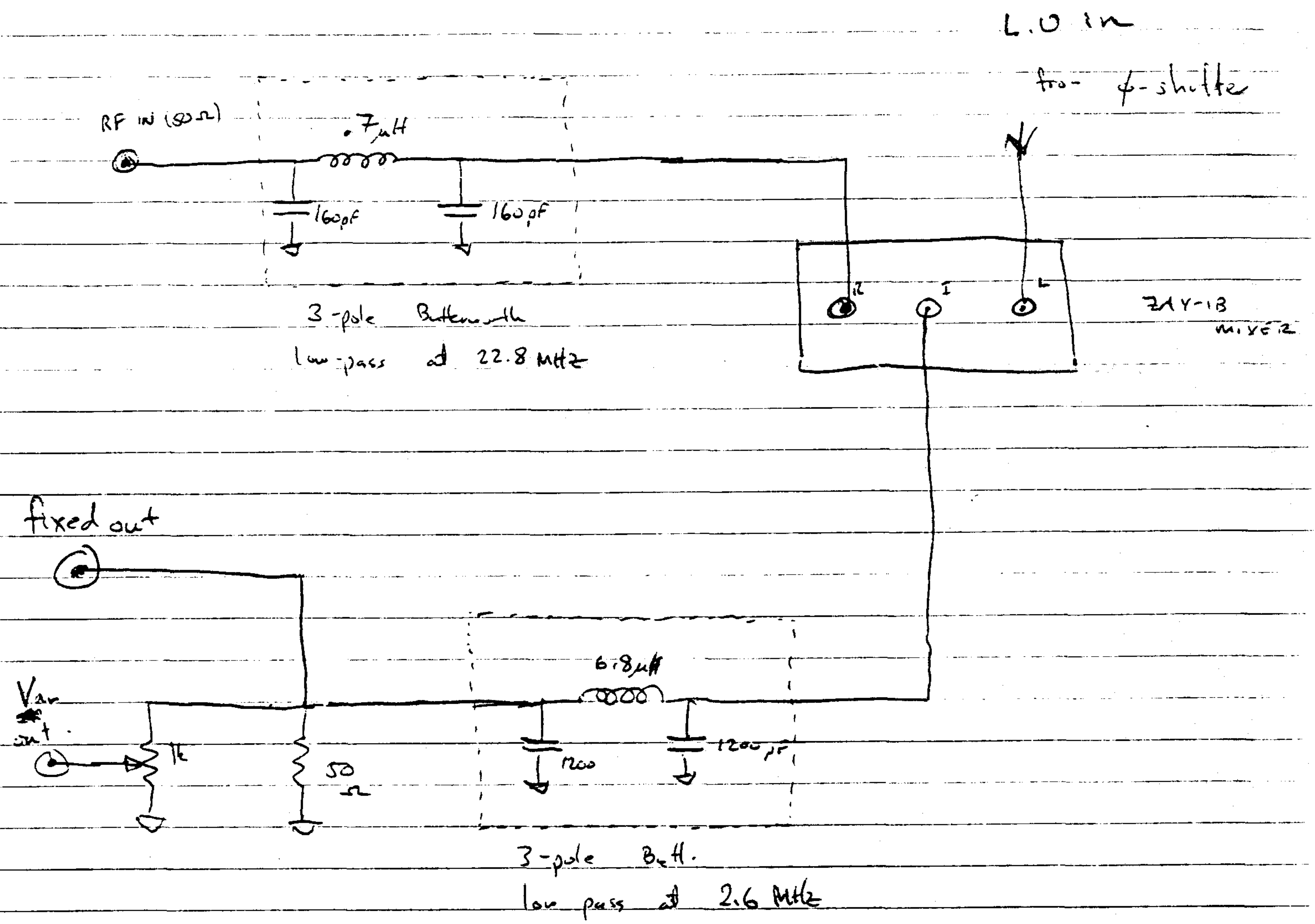
7) Quadrant diode sum and difference circuit: This circuit takes the 4 voltage signals from already-buffered quadrant diodes and resolves them into X, Y, and Sum outputs. Construction: hand wired on MIT 'matrix' board, 4 channels in single-width NIM.

8) kHz lockin: This is an audio-frequency lockin (up to 100 kHz) for use in servo systems (i.e., with a large-bandwidth if section). There are signal and lo inputs; two modulation outputs, with adjustable phase and amplitude; and demodulated and test point outputs. Construction: PC board, in a single-width NIM.

9) Accelerometer preamp: This is a low voltage- and current-noise preamp for accelerometers which has a differential output; and a differential receiver board. Conctruction: PC board in and rf-tight box for the preamp, PC board in double-width NIM for the differential receiver (three channels on one board for the latter).

COLOR OF FRONT PANEL

White Filter-Mixer
15.6 MHz Box



Frequency stabilization photodetector

Modifications 20 April 90

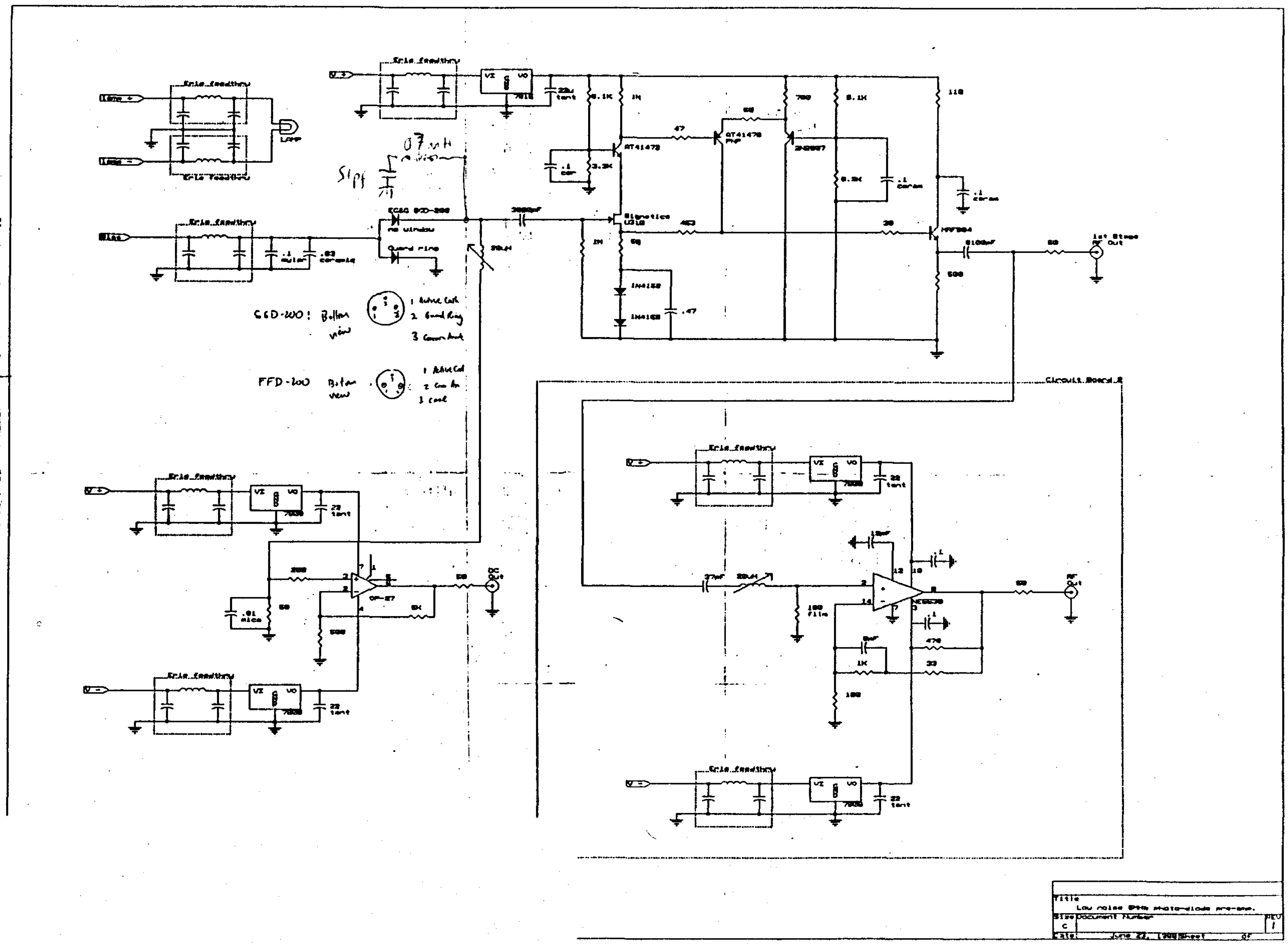
remove ".1 mylar" (was 0.25) in Bias filtering to allow inner bias.

Replace SGD-200 with DT110

Change 20μH (w35) to 1.5μH (#15) for resonance @ 12.33 MHz

Add LC to ground to filter 2ω (@24.66 MHz) using 51pf and #12 (~0.7μH)

Remove LC between stages



HIGH VOLTAGE VIDEO AMPLIFIER

③ SEPT 1988

NOTE: 1) SIX INDEPENDENT AMPLIFIERS FIT INTO A SINGLE WIDTH NIM BIN, NEED COOLING WITH FAN.

2) INPUT/OUTPUT BNC CONNECTORS NEED TO SHIELDED FROM EACH OTHER BY GROUND PLANE

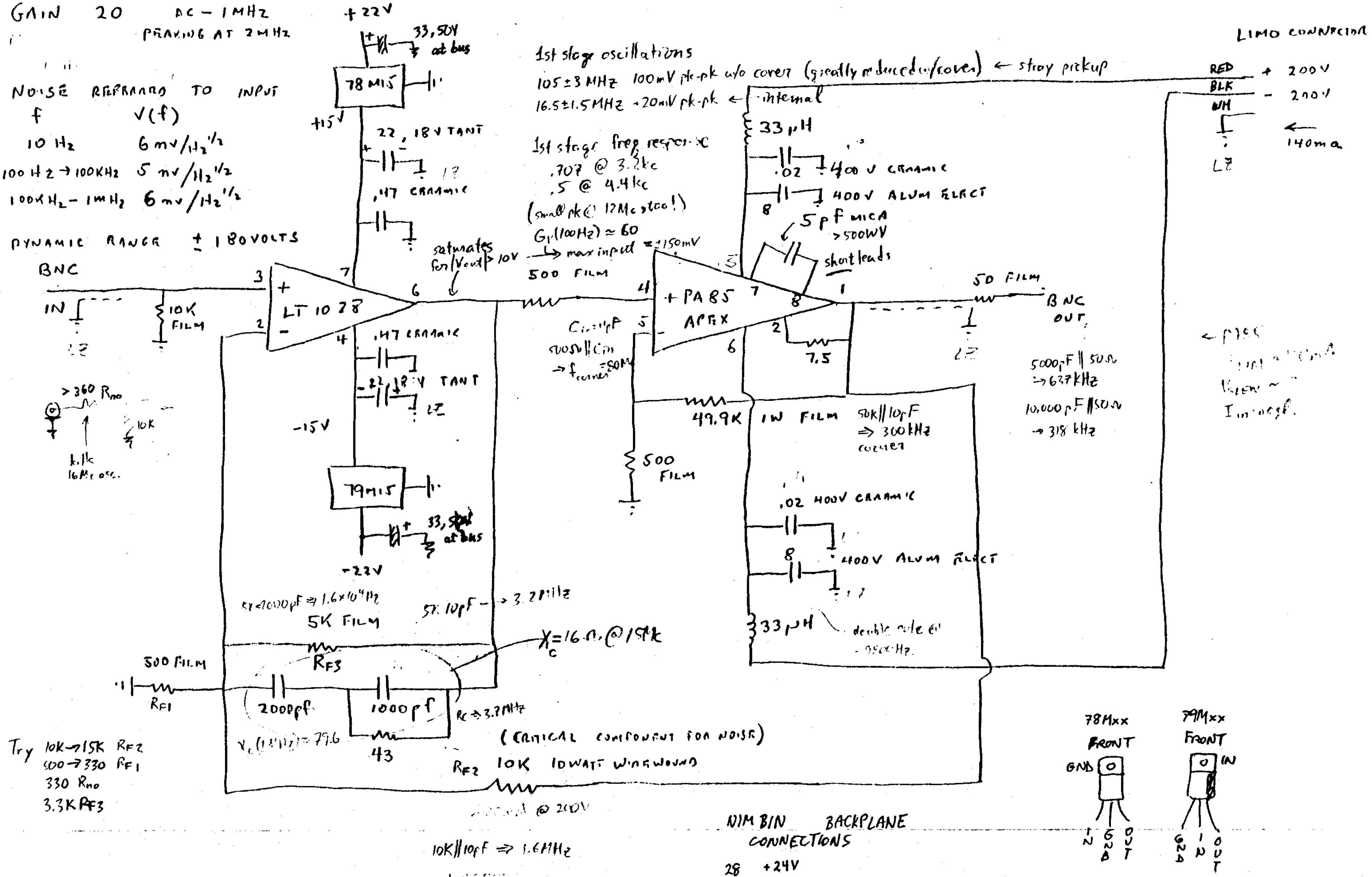
POWER DISSIPATION 9.5 WATTS

GAIN 20 DC – 1 MHz
PEAKING AT 2 MHz

NOISE REFERRED TO INPUT

f	V(f)
10 Hz	6 nV/Hz$^{1/2}$
100 Hz → 100 KHz	5 nV/Hz$^{1/2}$
100 KHz – 1 MHz	6 nV/Hz$^{1/2}$

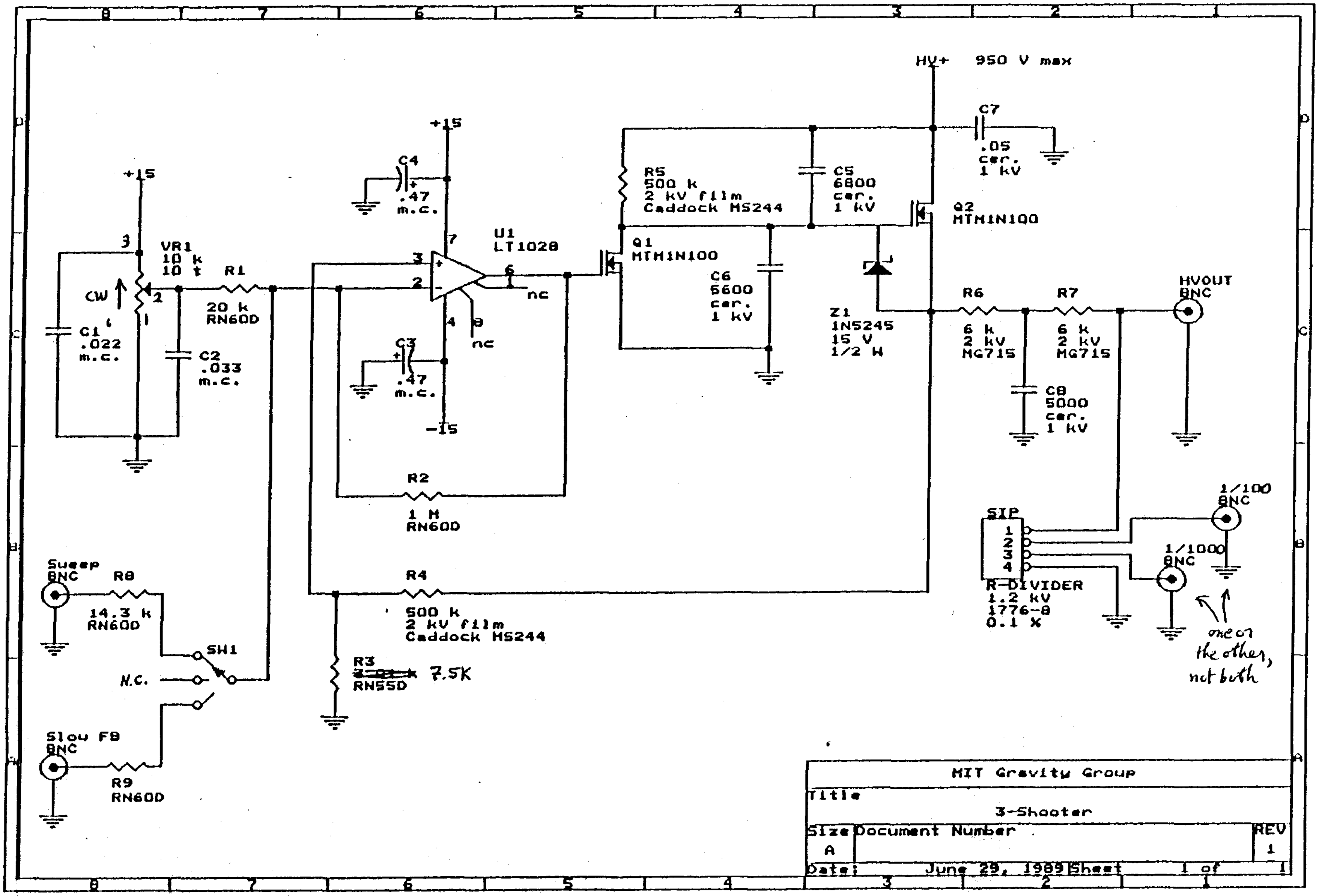
DYNAMIC RANGE ± 180 VOLTS



NIM BIN BACKPLANE CONNECTIONS

28	+24V
29	-24V
42	Gnd

Kilovolt slow amplifier

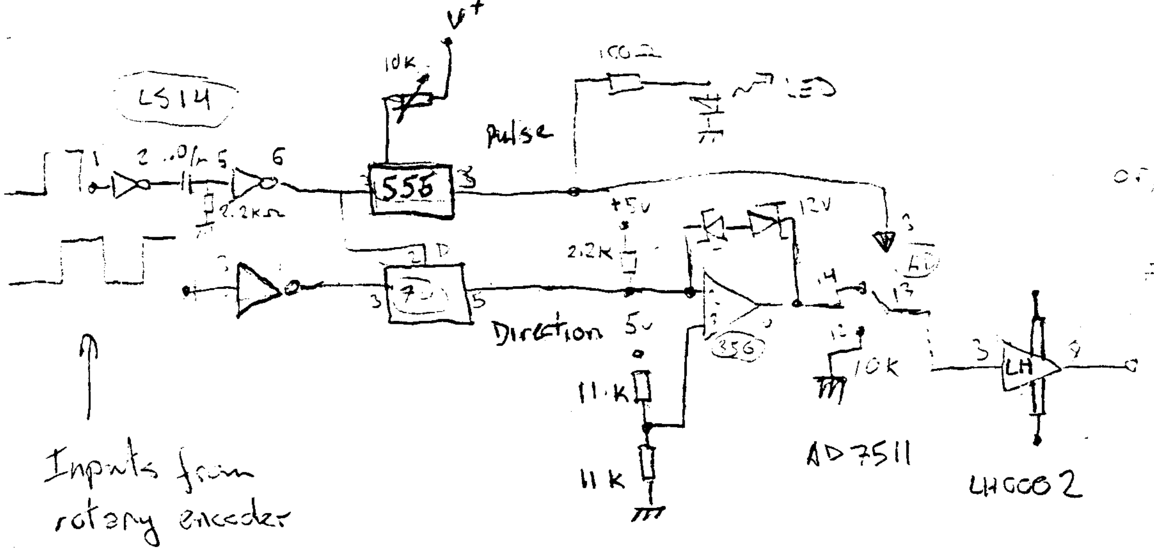


Off Resistances
(MTM1N100)
S-to-D ≈ 2MΩ
all others = ∞

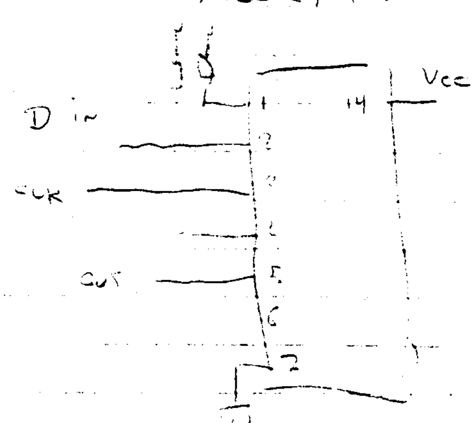
D.C. MOTOR PULSE DRIVER / SHAFT ENCODER INPUT

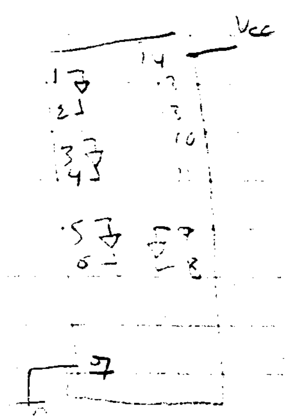
10 April 90

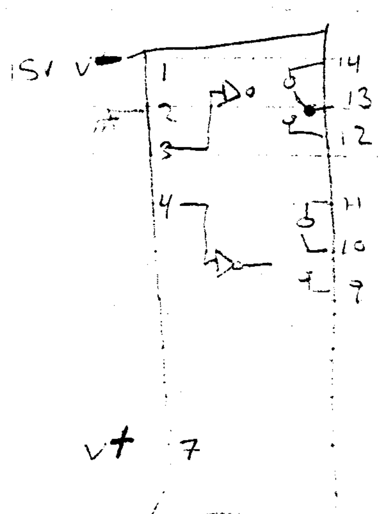
13 April

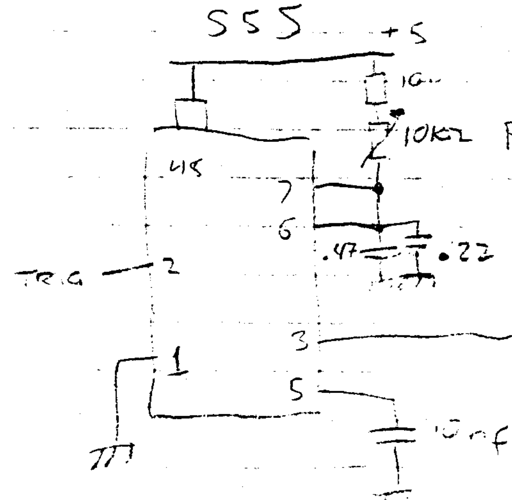


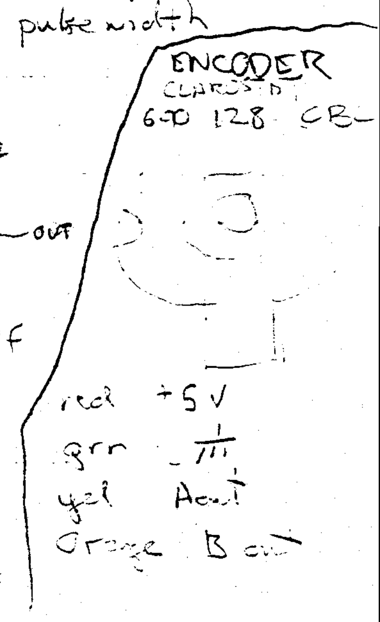
C: -24
B: +24
A: +12
Z: ⏚
1,2 inputs encoder
3 +5V out for
4 ground
5 1MΩ pulse width
6 output connector









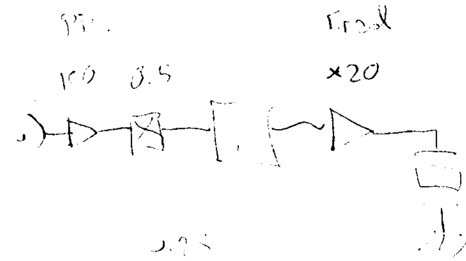


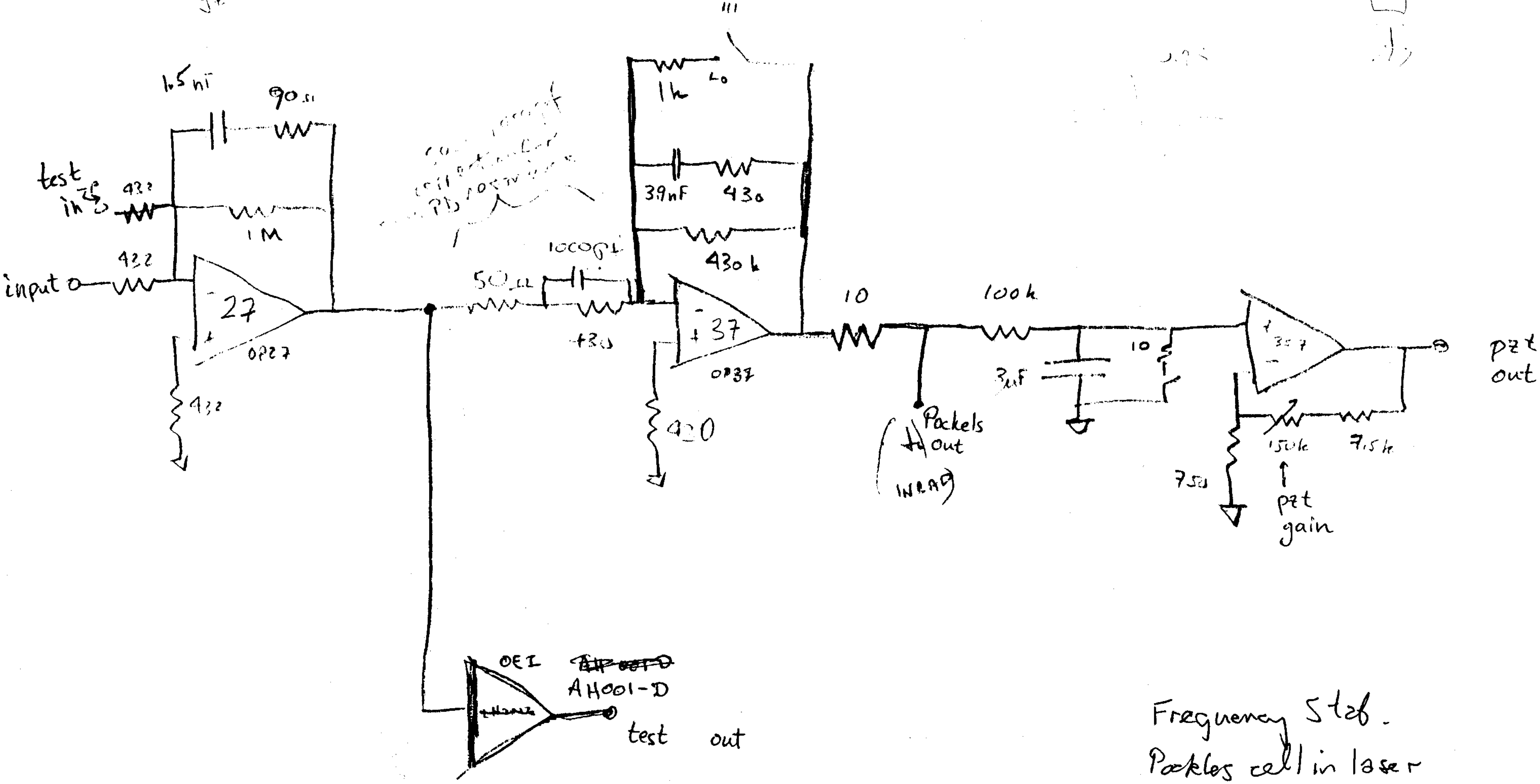
INTRA-CAVITY
Pockels cell F.S.

$f_p = 100$ Hz
$f_z = 180$ kHz

Hi pass: $f_z = 10$ Hz

Lo pass: $f_p = 30$ kHz
$f_z = 100$ kHz

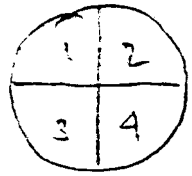


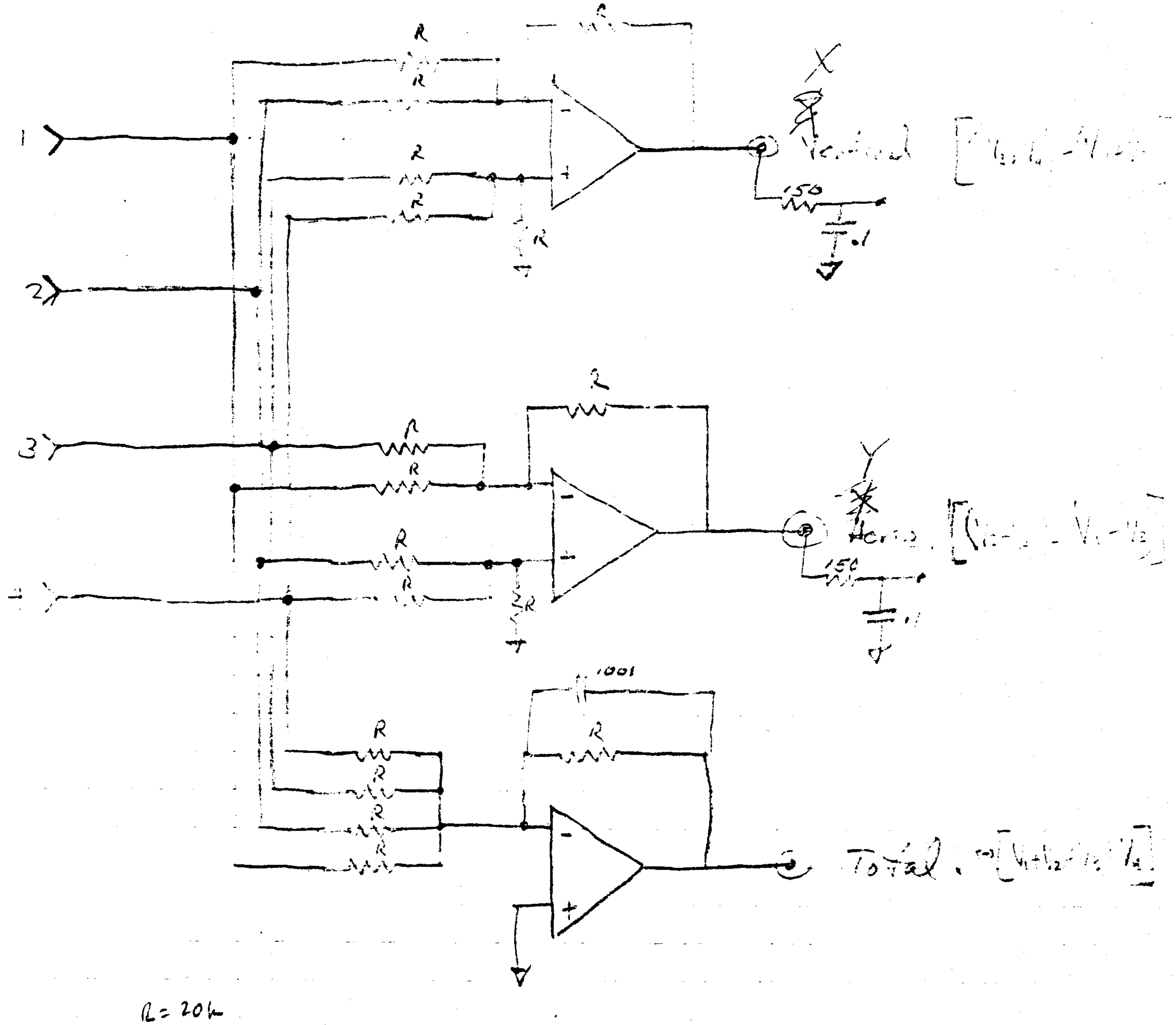


Frequency Stab.
Pockles cell in laser

As of 24 Apr 90

Quadrant det[illegible]
Σ + Diff



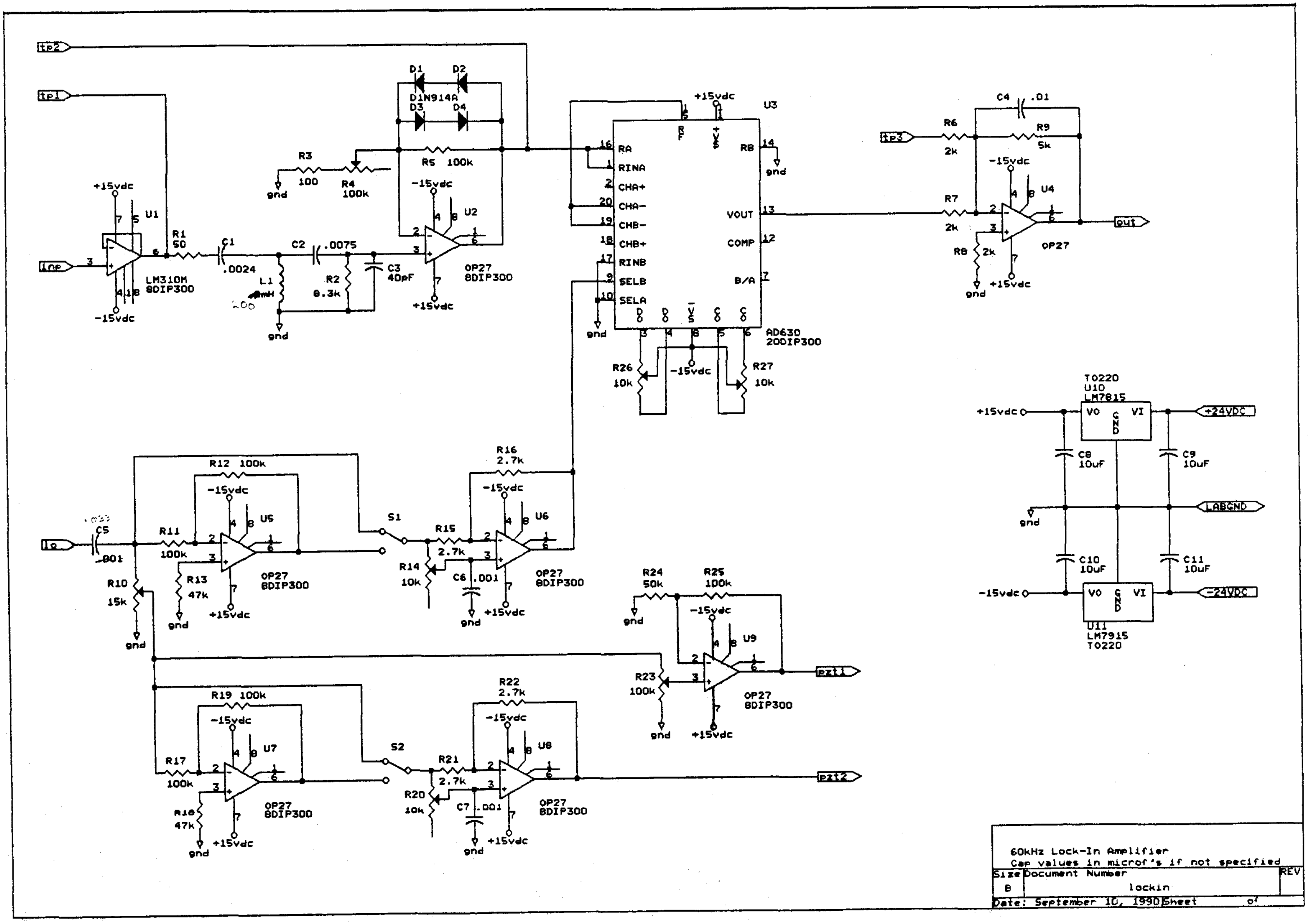


Back panel:
D connector:
4 inputs (x 4)
+ 15 V
- 15 V
gnd

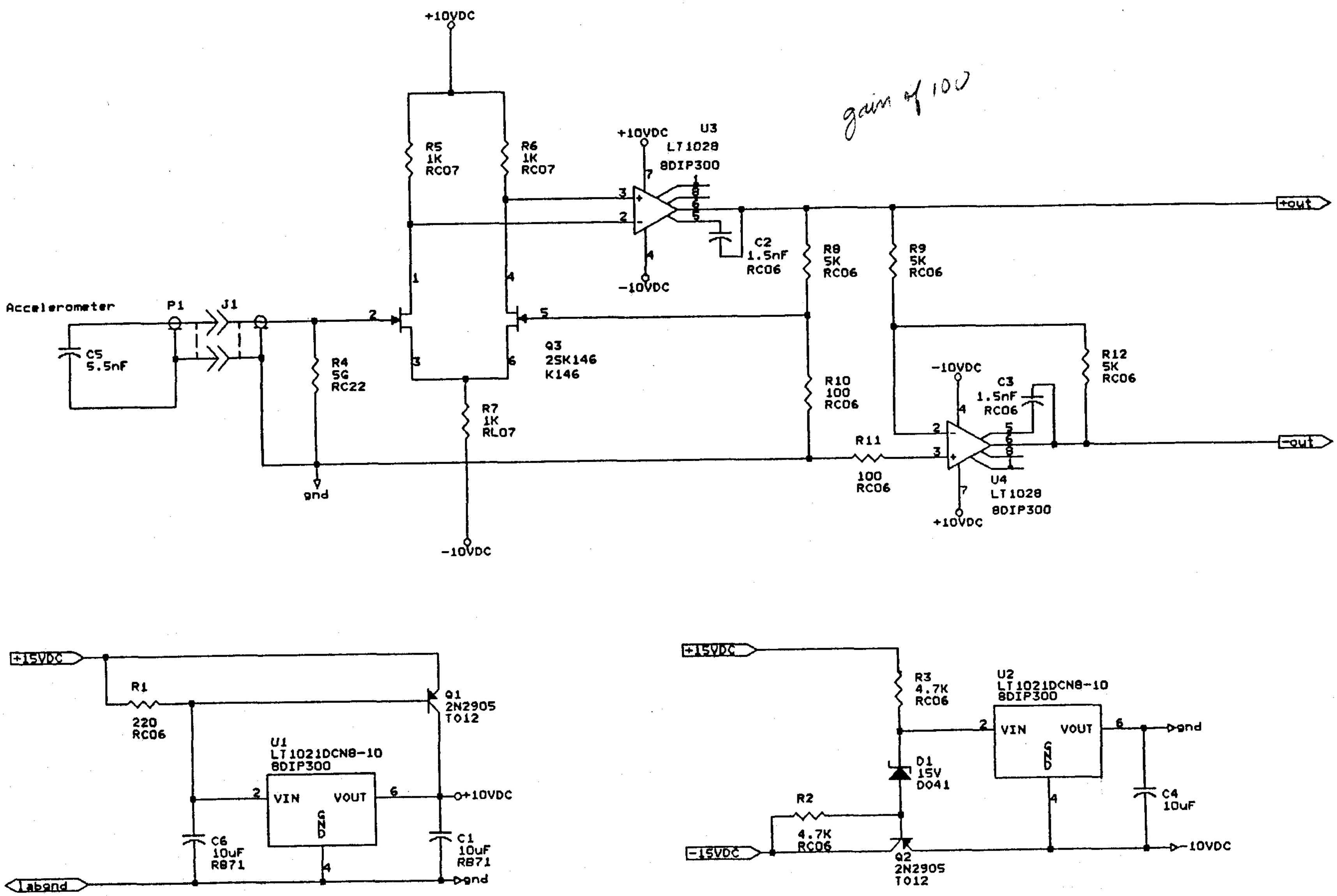
Front panel:
3 BNC's
1 3 pole, 4 pos. rotary.

(8)

Kiloherty Lockin



9a

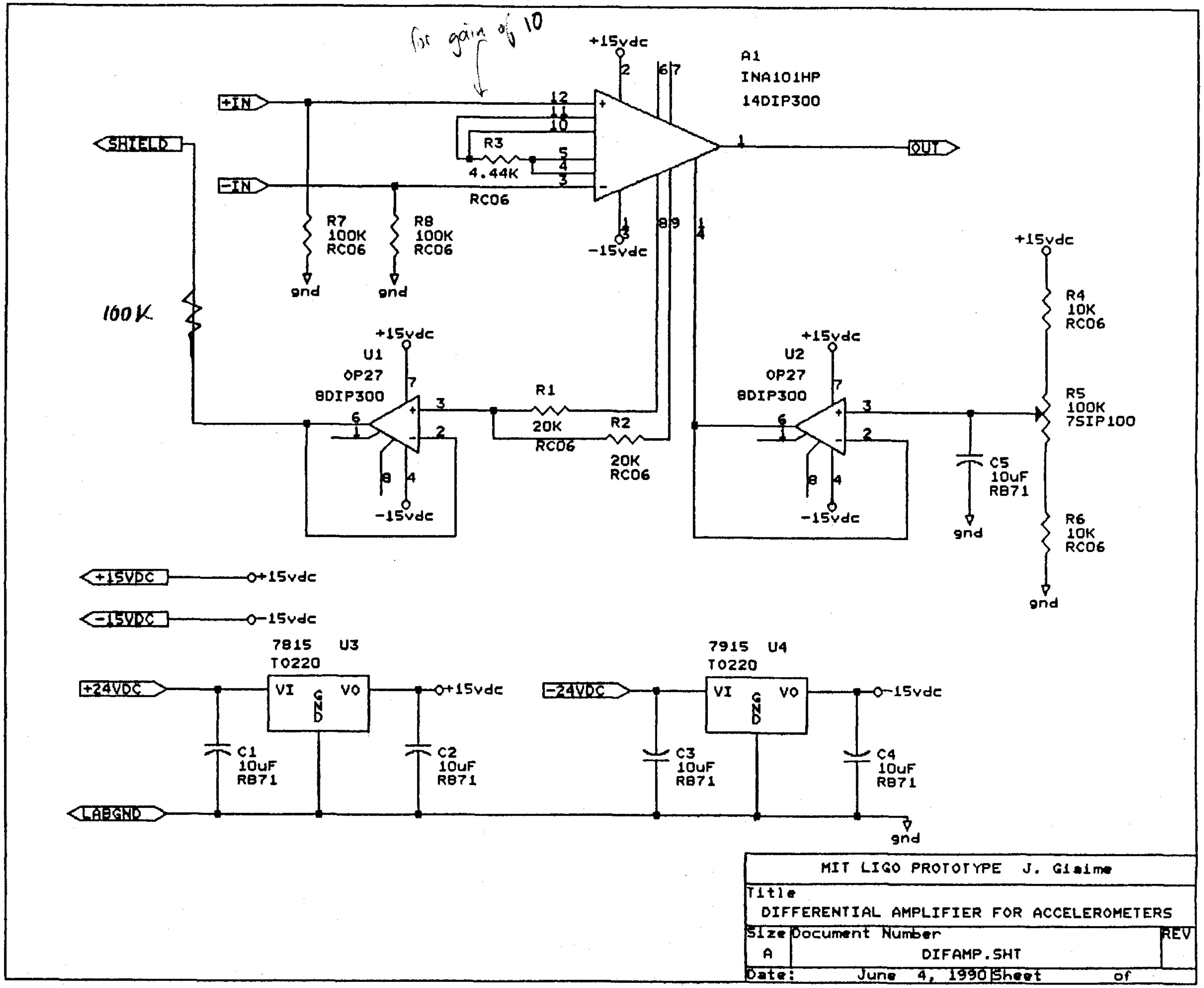


MIT LIGO Prototype		
J. Giaime		
Title: preamp for accelerometer		
Size: B	Document Number: acamp.sht	REV: A
Date: June 5, 1990	Sheet of	

9a

as built

96



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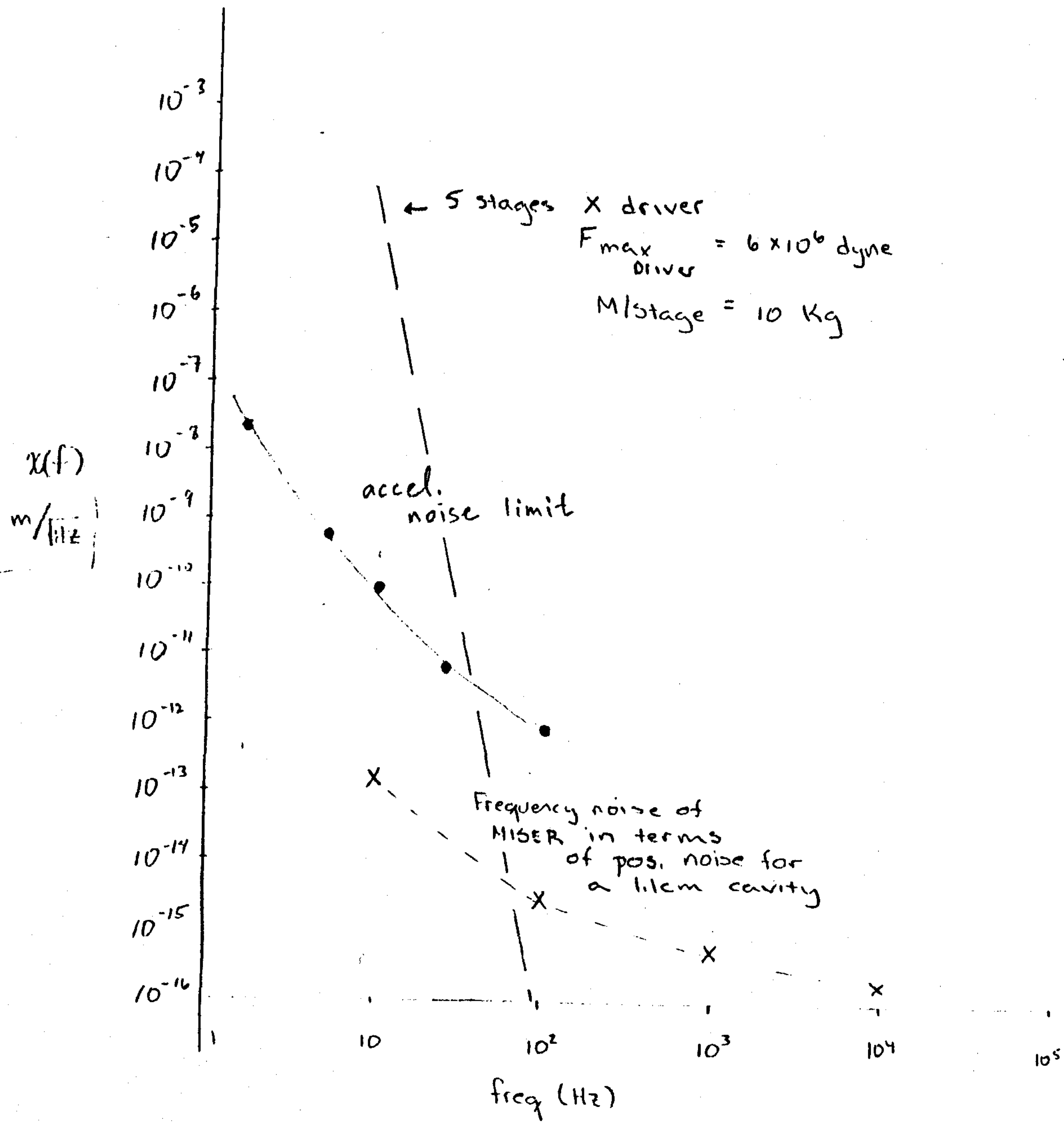
4/25/90



Accelerometer noise (J.G.)

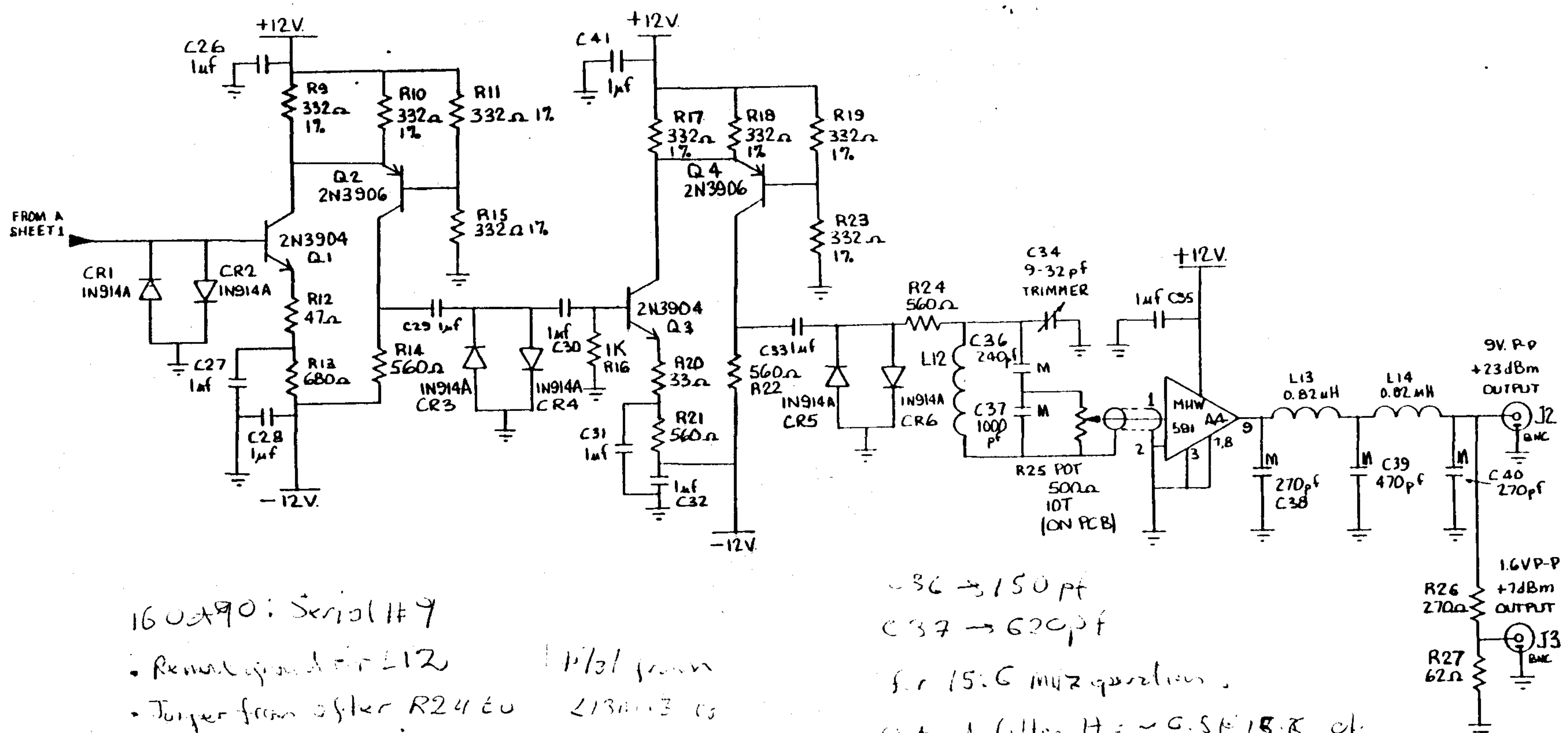
$$\frac{G\ V(f)}{(2\pi f)^2} = x(f)$$

$G \cong 54.4\ \frac{m/sec^2}{V}$ (without diff. amp)

Interferometric Accel. (M.S.)

1.1 cm cavity

$$x(f) = \frac{\Delta\nu}{\nu_0}\,\ell$$



160490: Serial #9

- Removed ground for L12
- Jumper from after R24 to top of R25 pot
- C38 → 150
  C39 → 240
  C40 → 150
- 39Ω in series between L14 and J2

P/31 from 213 MHz to 212 MHz

20 v pk-pk unloaded
18 v pk-pk 50Ω load

C36 → 150 pf
C37 → 620 pf
for 15.6 MHz operation.
Output filter H = ~6.5 @ 15.6, ok.

LAST NO. USED
A4
Q4
J3
L14
CR6
C40
R27

(10)

CALIFORNIA INSTITUTE OF TECHNOLOGY
GRAVITATIONAL PHYSICS

12.33 MHZ. LIMITER PHASE SHIFTER SHEET 2

DRAWN BY B.T.	DATE 11-6-87	DRAWING NO. -2
CHECKED BY	SCALE	
APPROVED BY	W.O.	

87-1106-2