ENERGETIC PARTICLE FLUX EXPERIMENT (IMP-F & G)
January 28, 1965 - June 30, 1971

Final Technical Report On
NASA Grant NAS 5-9091

Principal Investigator:
Kinsey A. Anderson

Series 13, Issue 105

December 12, 1972

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For:
Goddard Space Flight Center

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Abstract

This report summarizes the technical aspects of the University of California IMP-F experiment aboard the Explorer-34 and the University of California IMP-G (S1) and IMP-G' (S2) experiments aboard the Explorer-41. The experiment detectors and electronics are discussed for each experiment as well as the fabrication, pre-flight and post-flight history. A description of the Ground Support Equipment is also given for each experiment.

Since these three experiments were essentially all different, this report is made up of three basic sections accordingly. The IMP-G experiment was essentially the IMP-F experiment with the addition of four Geiger-Mueller detectors and only the differences and additions from the IMP-F are discussed. Whereas, the IMP-G' was a supplementary experiment and differed completely from the IMP-F and IMP-G experiments.

It is concluded that the ground support equipment approach used for the IMP-F and IMP-G experiments where emphasis was placed on a thorough exercise and monitoring of the experiment operation during various testing phases provided a high degree of confidence and reliability in these experiments. (No known electronic failures have occurred during the spacecraft lifetime although some detector problems were experienced.)

The IMP-G ground support system with its greater emphasis on computer software proved to be a valuable experience in that it pointed out the difficulties in coordinating the writing and debugging efforts with a spacecraft prime contractor. As a result of this experience, in later projects, much of the test functions were incorporated into the experiment in order to reduce some of this software effort.

It is felt that the management approach used for the supplementary experiments, where the combined replacement experiments from two organizations were looked upon as a single experiment by the GSFC personnel, caused a great deal of difficulty throughout the program.

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Description of Detectors

The University of California IMP-F experiment aboard Explorer-34 contains two geiger-Mueller tubes, one of which looks directly at particle fluxes while the other observes the particle flux backscattered off an 8 mil gold foil. Protons lose energy in the gold foil without backscattering while electrons backscatter with high efficiency and little energy loss. With this arrangement, proton and electron fluxes can be identified and separated.

The open counter, GM2, and the scatter detector, GM1, are both pointing along the spin axis. GM1 is a Lionel 205 HT Geiger-Mueller tube with a standard thickness mica window while GM2 is a thin-window version of the same tube with an energy threshold of about one-half as high as for GM1. Thus for electrons it is possible to derive some energy spectrum information about the fluxes. A 4-inch ionization chamber completes the detector complement which is shown in Figure 1. Table 1 summarizes the characteristics of the detectors.

Geiger-Mueller Detectors

The Lionel 205 HT Geiger-Mueller detector has a cylindrical cathode of $\frac{1}{4}$'' inside diameter, and it is sensitive to radiation over the entire $\frac{1}{4}$'' diameter window. This tube has a 1.2-1.4 mg/cm^2 mica window, and a typical electron detection efficiency versus electron energy curve is shown in Figure 2. The threshold, arbitrarily defined as the 1/e efficiency point, is about 40 keV for these tubes. GM2 is a special thin-window (0.7 mg/cm^2 mica) modified Lionel

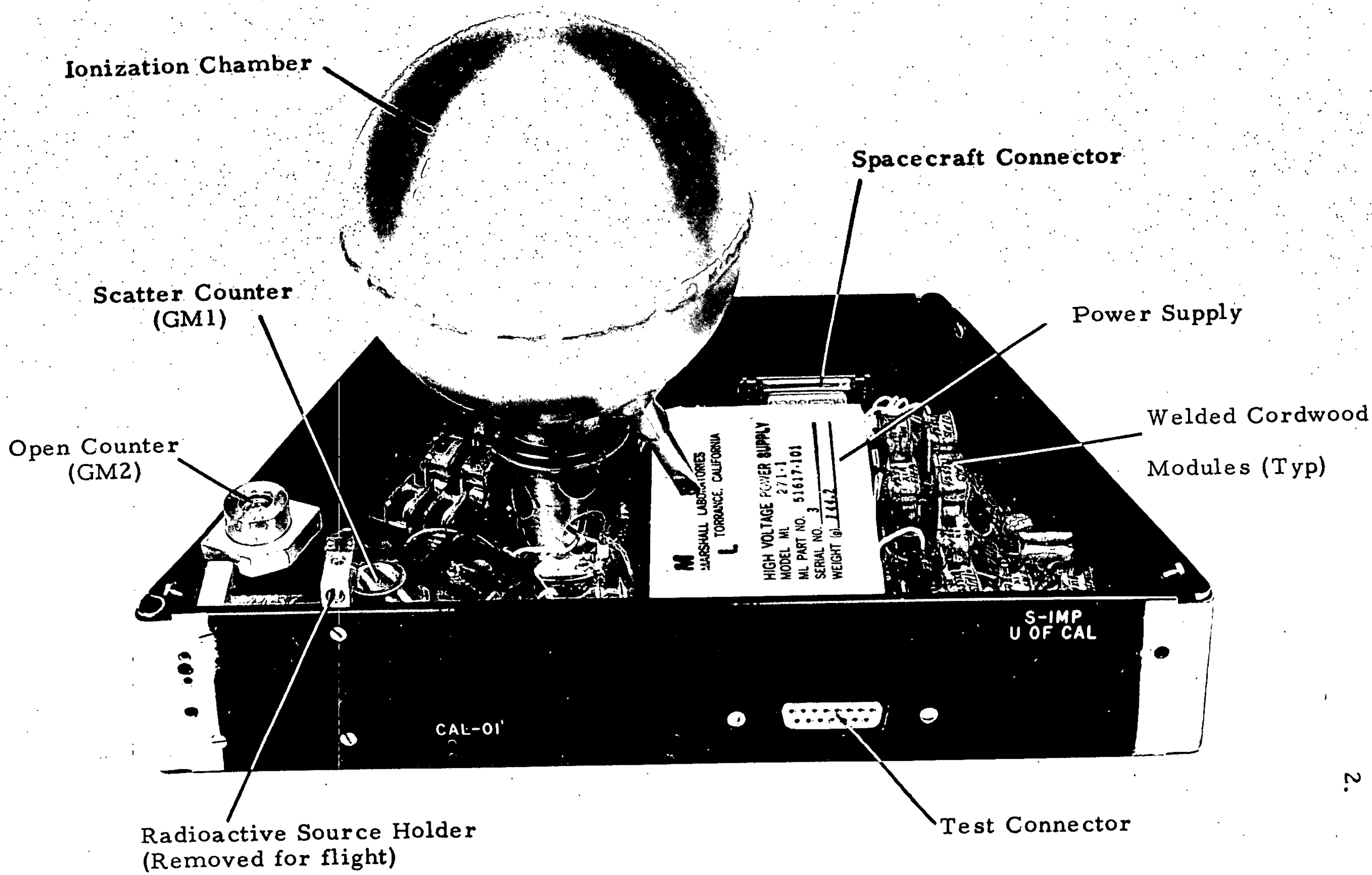


Figure 1 The IMP-F Experiment

Table 1

EXPLORER 34 DETECTOR CHARACTERISTICS

Detector Designation	Type of Detector	Window	Directional Sensitivity		Omnidirectional Sensitivity		Geometry Factor		Look Angle FWHM	Angle to Spin Axis
			Electrons	Protons	Electrons	Protons	Directional cm^2-ster	Omni-directional cm^2		
GM1	Lionel 205 HT GM tube in scatter configuration	1.4 mg/cm^2 mica	>45 keV	None	> 4 MeV	>40 MeV	3.6×10^{-2}	~0.75	~60°	20°
GM2	Lionel 205 HT thin window GM tube	0.7 mg/cm^2 mica	>22keV	>0.3 MeV	>4 MeV	>40 MeV	0.29	~0.75	~75°	0°
Ion Chamber	4" diameter spherical Neher-type integrating ion chamber	210 mg/cm^2 aluminum skin	---	---	> 0.7 MeV	>12 MeV Maximum sensitivity ~17 MeV	---	~80	---	---

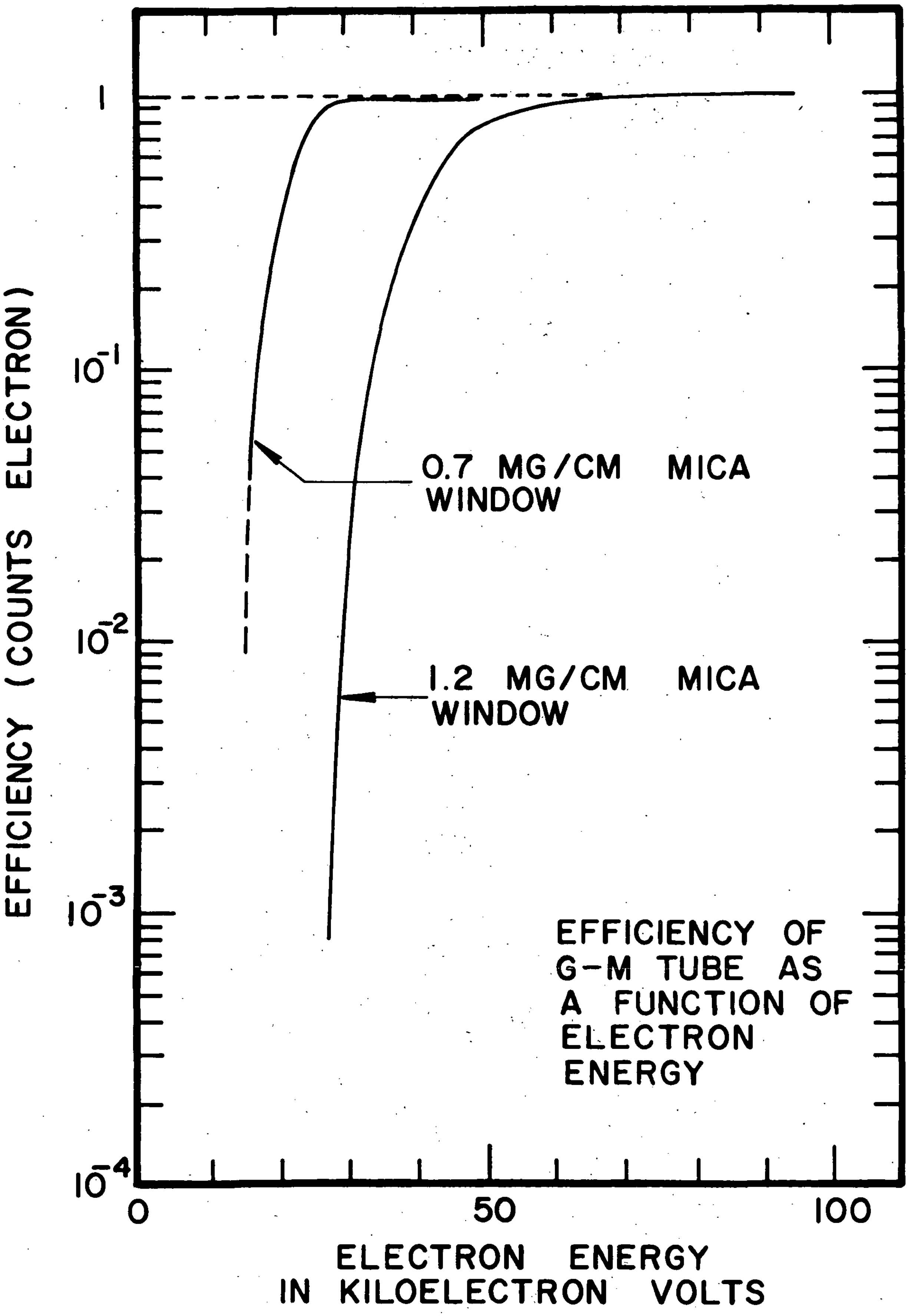


Figure 2 Typical GM Electron Detection Efficiency

205 HT. The window diameter has been necked down to 0.17" in order to support the mica window against pressure. Its response to electrons is also shown in Figure 2. As can be seen, its threshold is about 22 keV for electrons.

The proton response of these tubes is calculated from range energy curves given by Trower[1] after the tube window thicknesses are calibrated with an alpha-particle source.

The 8 mil gold scatter foil used in GM1 provides effective discrimination against protons. All particles seen by the counter must backscatter off the foil. Protons lose energy before they are scattered through large angles, as can be illustrated by calculating the rms scattering of a 10 MeV proton in a length equal to its range. From Fermi:[2]

$$\overline{\theta^2} \approx \frac{8\pi N D z^2 Z^2 e^4}{V^2 p^2} \ln \frac{a_o V p}{2Z^{4/3} z e^2}$$

where N = number of atoms per cm^3, D = length of travel (placed equal to the range), z = charge of particle = 1 for proton, Z = charge of scatter = 79 for gold, e = electron charge, V = velocity of particle, p = momentum of particle, and a_o = Bohr radius. We obtain

$$\sqrt{\overline{\theta^2}} \approx 0.2 \text{ radians} \approx 10^\circ$$

Tests on the efficiency of the scatter foil for proton rejection were conducted using a cyclotron beam of 4 MeV protons.[3] An upper limit of 0.1% was obtained for the proton detection efficiency. Furthermore the observation of solar proton events in space has confirmed that the count rate of the scatter counter due to backscattered protons is negligible.

Electrons backscatter off the gold foil with high efficiency. A well referenced treatment of electron scattering is contained in Siegbahn[4], and only the pertinent results will be mentioned here. The 8 mil gold foil is thick enough to insure saturation backscattering of electrons of a few MeV or lower energies. Fifty per cent of a normally incident beam of electrons and 70% of a diffuse beam will be backscattered from the gold foil. The angular distribution of the backscattered electrons will be approximately $\cos^2\theta$ in angular dependence. Neither the backscatter efficiency nor the angular distribution of the backscattered electrons is dependent on the energy of the incident electron. However, energy loss occurs in the scattering foil. Measurements indicate that for a heavy element such as gold the probable energy loss is about 5-10%, with about two-thirds of the particles losing less than 20% of their energy. The effect of this energy loss is two-fold:

1. The energy threshold of the scatter counters are about 5 keV higher than the bare GM tube, and
2. the counting efficiency versus electron energy curve is not quite as sharply falling.

Thus the scatter counter's (GM1) threshold is about 45 keV for electrons. From the above considerations the scattering efficiency would be expected to stay fairly constant over a wide range of electron energy above the threshold for the scatter counter. Figure 3 shows the measured efficiency versus energy for the IMP-3 scatter counter configuration[3], which is similar to the GM1 detectors flown here.

The GM tubes are shielded with 1.5 g/cm^2 of brass. This shielding is in addition to the spacecraft packaging and outer skin so that the total shielding is about 2.0 g/cm^2. Range-energy curves were used to determine the threshold energies for penetrating particles.[1]

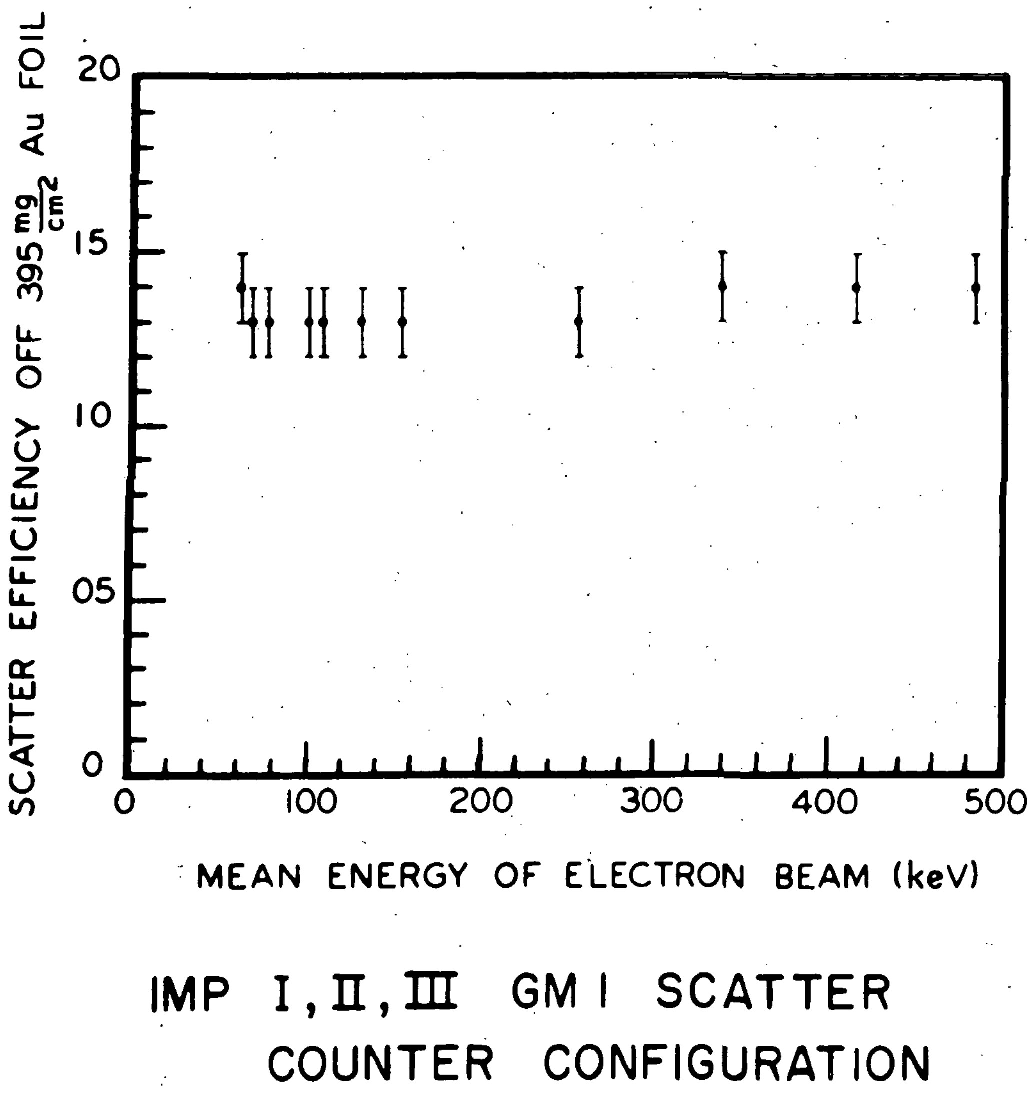


Figure 3 GM Scatter Counter Efficiency

The Geiger-Mueller tubes have dead times following a pulse. These dead times change at very high count rates since the voltage across the tube never recovers completely after a pulse before a new pulse starts. The variation of the count rate with flux is shown in Figure 4 for GM1 of the Explorer-34. The assumption of a constant dead time fits the curve well over the tube's useful dynamic range, and individually fitted dead times are used to correct the count rates of the detectors. These are entered as constants in the data processing format and are typically $\sim 10^{-4}$ seconds.

The GM detectors have a FWHM opening angle of $\sim 70^{\circ}$. In most applications, the GM data is treated as an omnidirectional average.

Ionization Chamber

A schematic of the ion chamber carried aboard Explorer-34 is shown in Figure 5. This is an integrating Neher-type ionization chamber. The operation of the chamber is straightforward. Before the ion chamber is energized, the tungsten whisker is not touching the collector (anode) and it is uncharged. When the + 700 volts is applied, the whisker is charged to this potential. The electrostatic force existing between the collector and the whisker attracts the whisker and charges the collector to + 700 volts which then repels the tungsten whisker. As the anode collects electrons from ionization in the chamber, the anode voltage drops until it reaches a critical voltage (about 500 V) which creates a powerful enough electrostatic force on the whisker to cause it to flick over and recharge the anode. The pulse created by

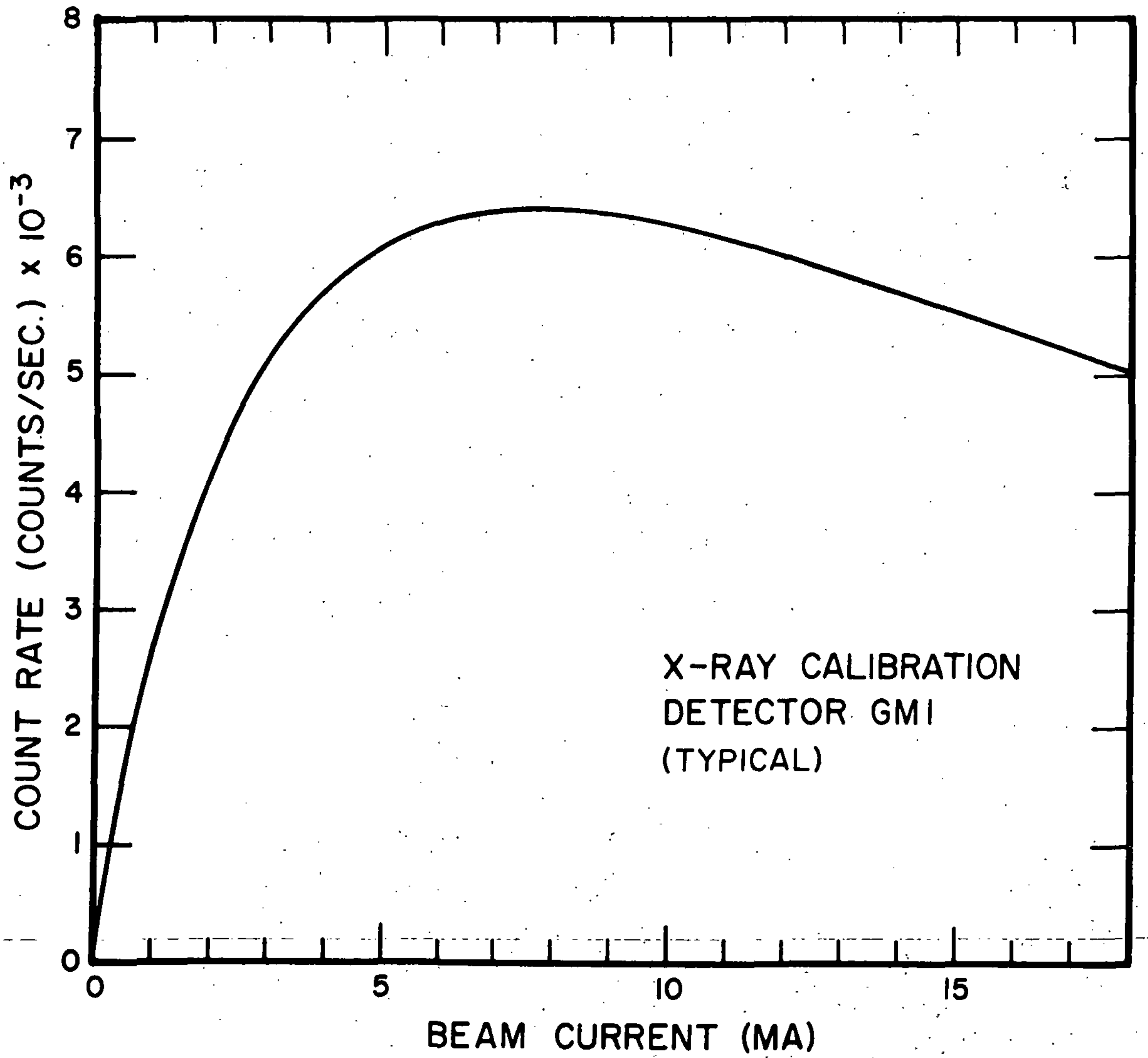
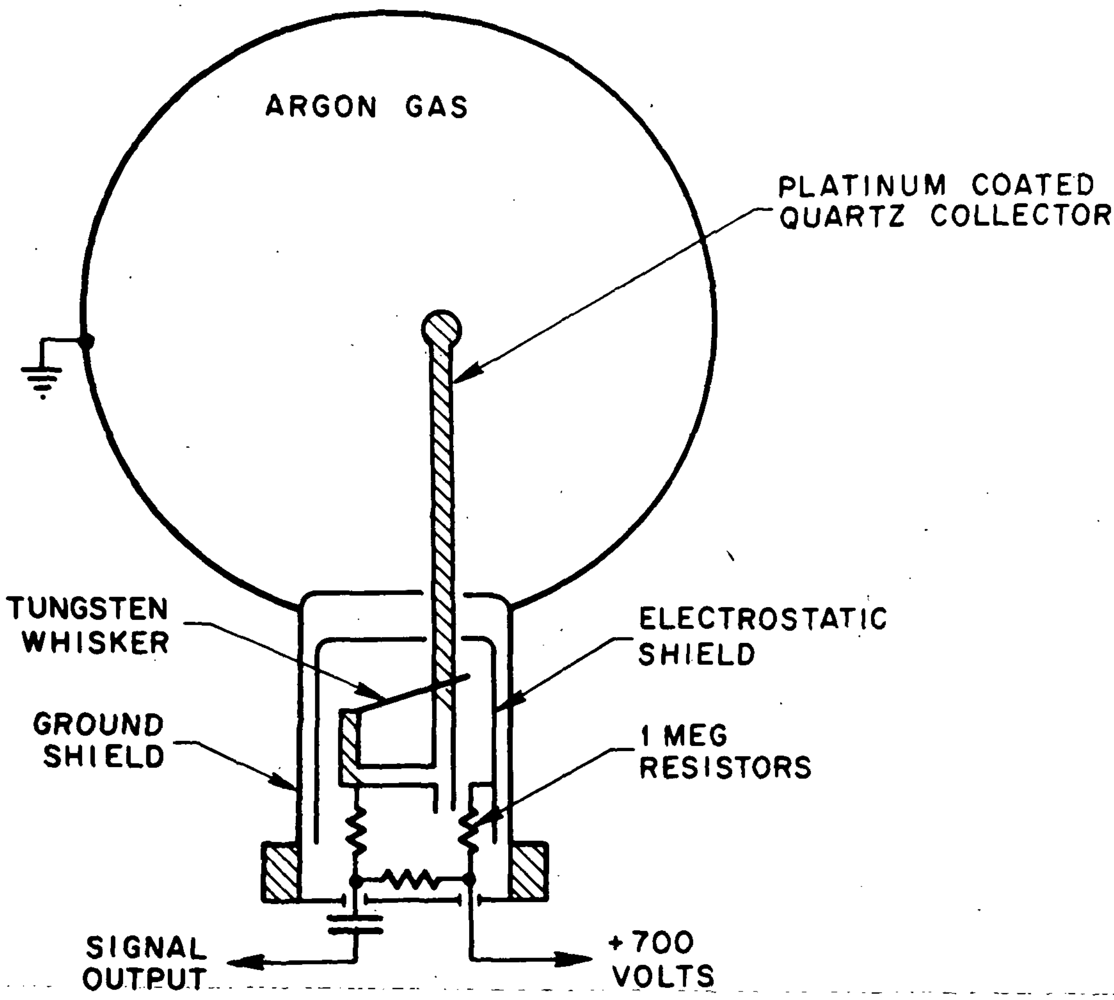


Figure 4 Typical GM Count Rate vs. Flux Calibration Curve



4" IONIZATION CHAMBER

Figure 5

the recharging is recorded and represents a specific amount of ionization in the chamber. The calibration curve of the Explorer-34 chamber is shown in Figure 6.

The response of the chamber to protons and electrons of different energies can be calculated. For very high energy (minimum ionizing) particles which penetrate the spacecraft the calculation is fairly simple. However, for low energy particles both the thickness of material surrounding the chamber, and the varying ionization loss of the particle with energy must be taken into account. The amount of energy lost in the chamber can be calculated from range-energy curves, and the material to be traversed before entering the chamber may be estimated from considerations of the ion chamber location on the spacecraft. Figure 7 gives the results of such calculations.

For the Explorer-34 ion chamber the time span between pulses is measured to milliseconds and read out every 10.24 seconds. Thus the time resolution of the Explorer-34 ion chamber is an inverse function of the radiation level. At galactic cosmic ray background levels the time resolution is about ten minutes.

Experiment Electronics Description

As indicated in the block diagram, Figure 8, each of the Geiger-Mueller detector pulse outputs is shaped and amplified by a pulse shaper (PS) and is then sent to its outputs driven stage (D) which provides the required electronic interface between the experiment and its accumulators. These accumulators are located in the Digital Data Processor (DDP) section of the spacecraft (S/C) encoder. The GM1 detector feeds the # 3a accumulator an "S-T" type 16 bit accumulator and, likewise,

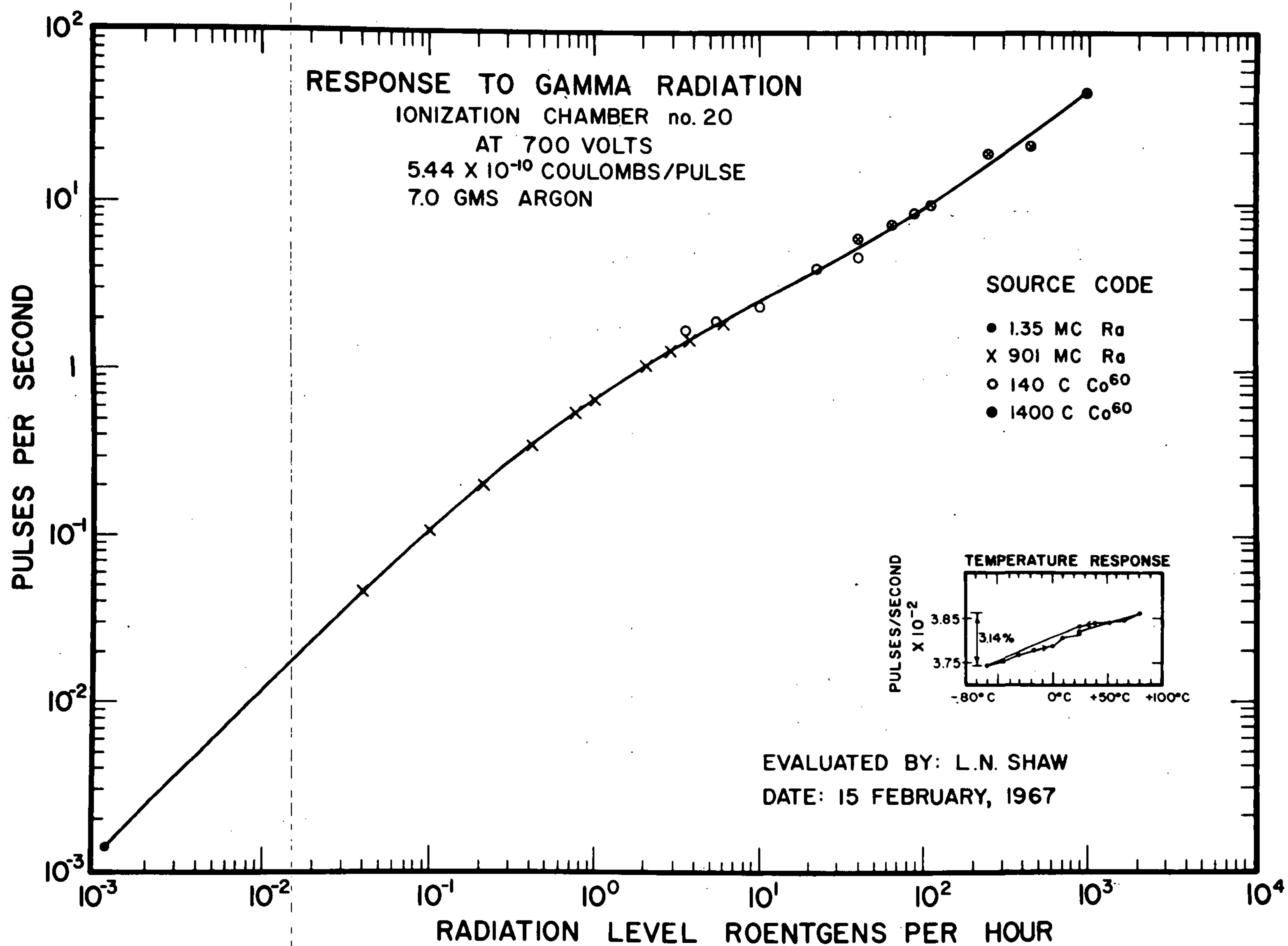


Figure 6 IMP-F Ionization Chamber Calibration

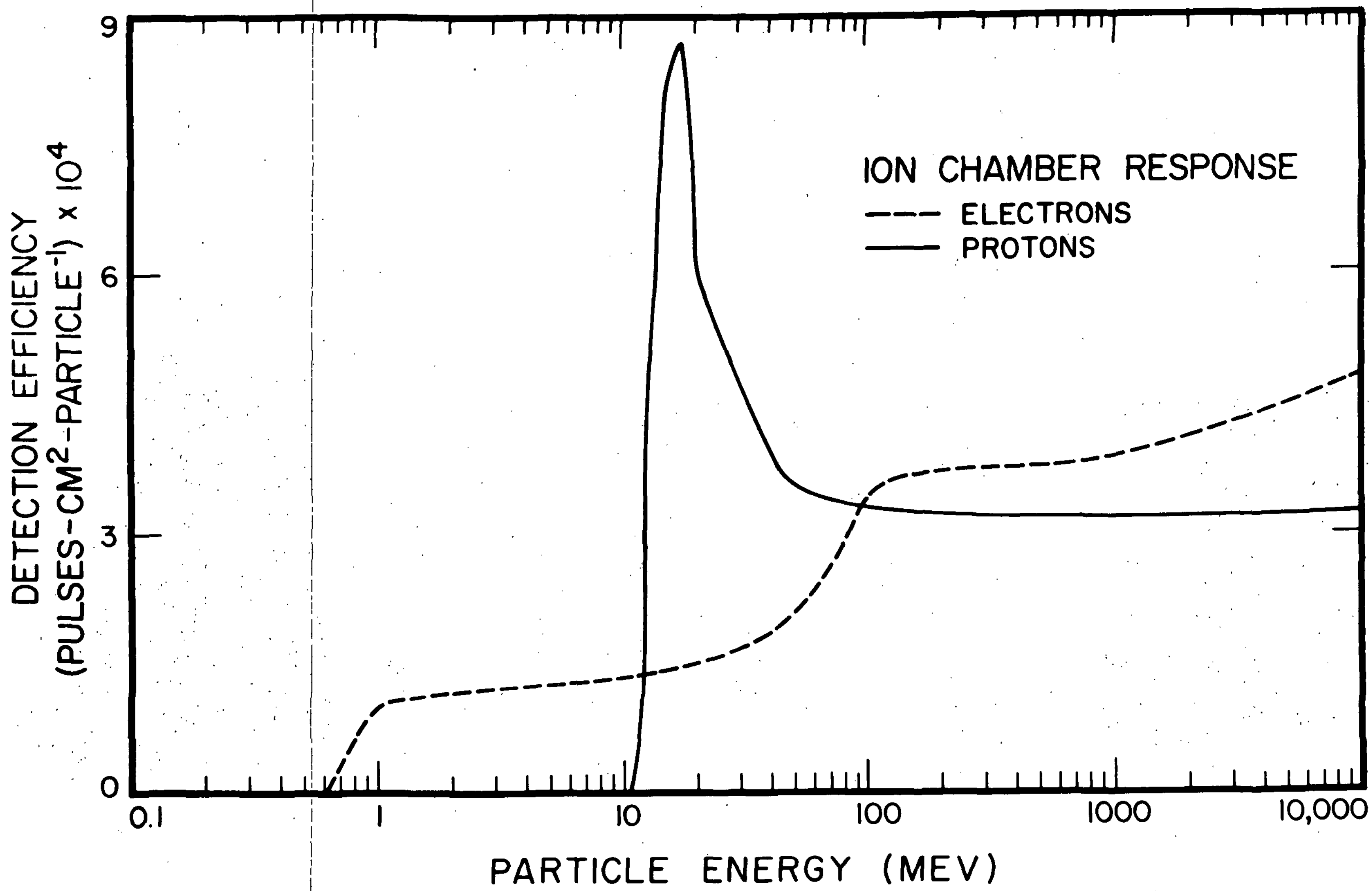


Figure 7 Ionization Chamber Proton-Electron Response

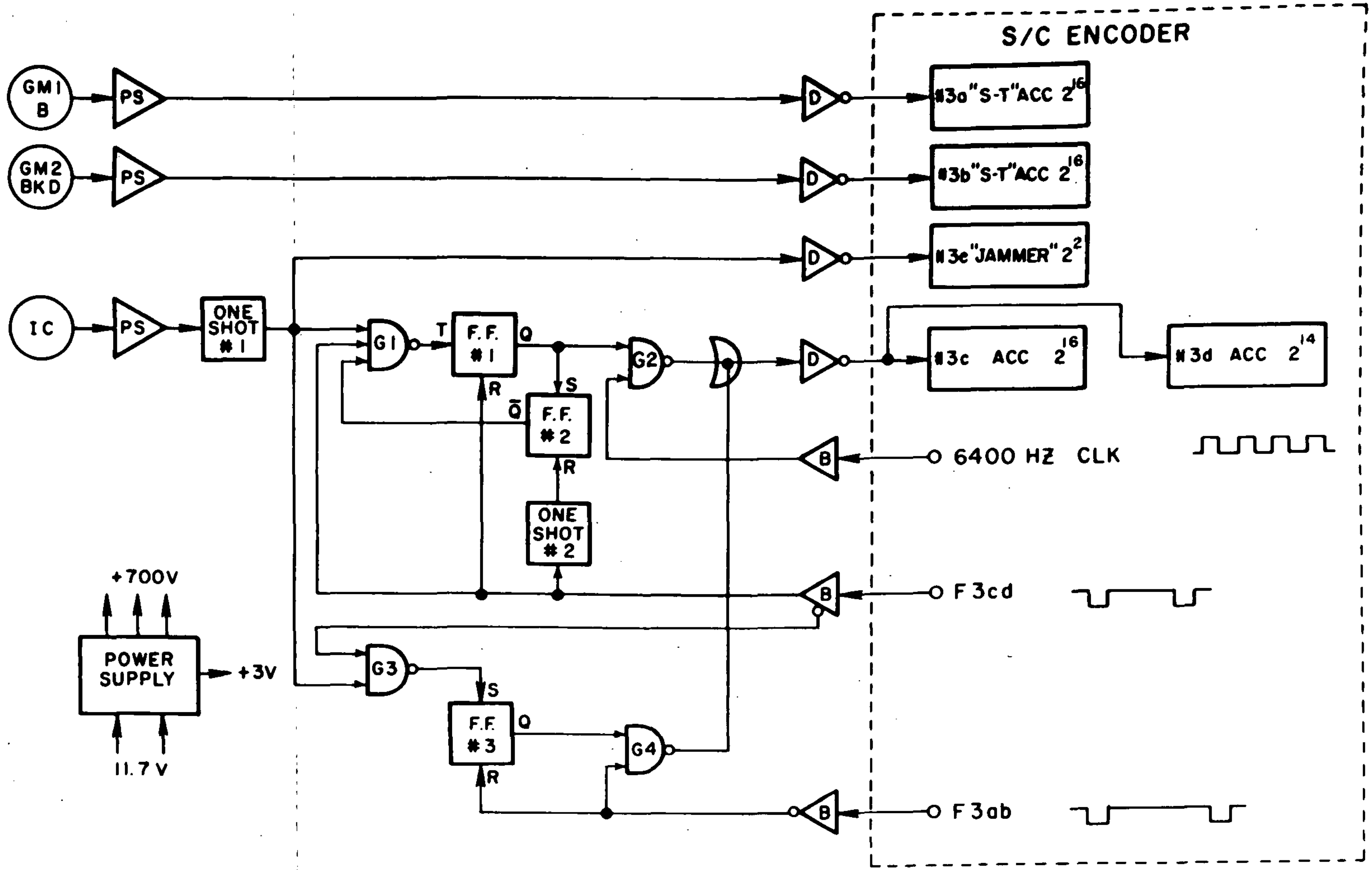


Figure 8 IMP-F Experiment Block Diagram

the #3b accumulator is used for the GM2 detector. The accumulation cycle is identical for these two accumulators and both are read-out every 10.24 seconds.

An "S-T" accumulator will count signal pulses or events ("S" mode) up to the capacity of the accumulator (2^{15}-1) and will then count clock pulses ("T" mode) for the rest of the accumulation period. This is illustrated in Figure 9. The purpose of the "T" mode is to allow for an immediate interpretation of an overflow condition (i.e., the number of input events during the accumulation time is greater than the accumulation capacity). This technique avoids the multiple foldover problems inherent in a conventional "S" mode accumulator.

From Figure 9a it can be seen that the last bit is used to control selection of either the events input or a 3200 Hz clock input to the accumulator. The accumulator is initially reset to zero and events are selected as the input. Accumulation then proceeds in this "S" mode until either (a) the end of the 9.92 second accumulation interval, or (b) until the accumulator has reached its maximum count of 2^{15}-1 events. If the maximum count has been reached, the next event will select the clock input and the accumulated results will then represent the time interval, T, indicated in Figure 9b. The clock frequency is chosen such that the accumulator will not overflow if counting clock pulses for 9.92 seconds, the maximum accumulation time. The accumulator input is "frozen" and readout by additional gating not shown during the 0.32 second interval. Thus, the last bit identifies the S or T mode for the 9.92 accumulation cycle. And, the average input event rate, R, is given as either

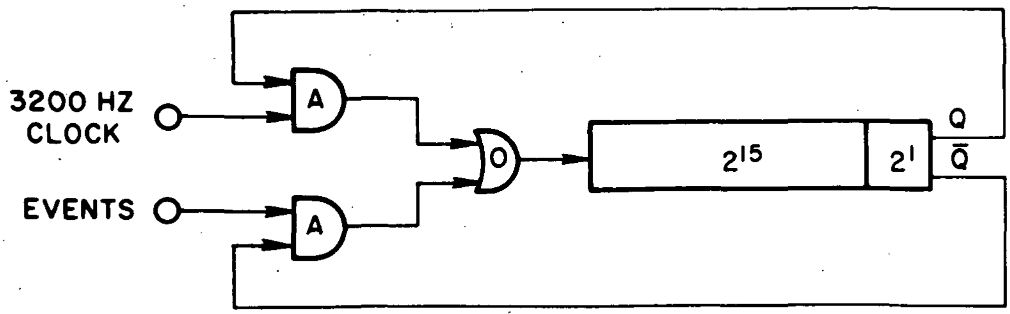


Figure 9a "S-T" Accumulator

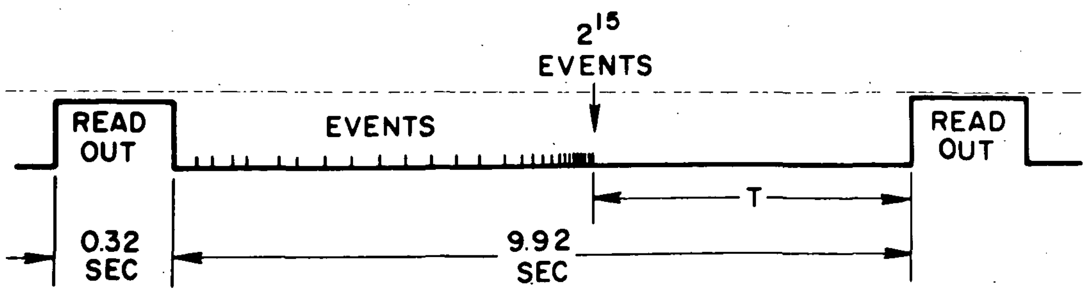


Figure 9b "S-T" Accumulator Timing

$$R = \frac{Ns}{9.92}$$

or,

$$R = \frac{2^{15}}{9.92 - (Nt/3200)}$$

where, Ns represents the accumulated counts (15 bits) in the "S" mode and Nt is the number of counts in the "T" mode.

Accumulators #3c, #3d and #3e provide a time interval measurement for the ionization chamber detector. Because of the low count rates and wide dynamic range of the detector, about 5×10^{-4} to 5×10^{1} Hz, a dual time base technique is used -- the 6400 Hz clock and the 10.24 second periodicity of the synchronization signals F3ab and F3cd. (See also Figure 10). The results presented in these accumulators will represent one of the following:

1. The elapsed time T_1 or T_2 between the ion chamber pulse and the start of the F3cd freeze and readout time.
2. The elapsed time T_3 between the first pair of ion chamber pulses occurring during the accumulation time of #3cd.
3. The presense of an ion chamber pulse that occurred during the freeze time of the #3cd accumulator, a "hidden" pulse.
4. No ion chamber pulse(s) during the last accumulation interval or freeze time of #3cd.

The ion chamber pulses are amplified, shaped and then fire a one shot multivibrator #1. This one shot provides a fixed deadtime to filter out any possible noise pulses from the detector.

One shot #1 drives a special 2 bit accumulator, #3e, a "jammer", via an output driver stage and its accumulation cycle is identical to that for #3c and #3d. It has only three possible states representing that

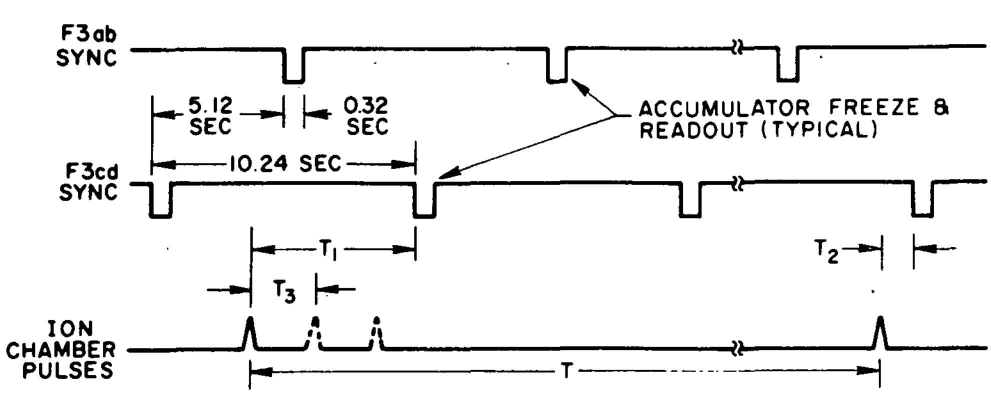


Figure 10 Ion Chamber Timing

either 0, 1, or 2 or more events occurred during the accumulation cycle and, thus, it serves to identify the results in accumulators #3c and #3d. These two accumulators are connected as a redundant pair, 14 bits only, in order to enhance data reduction.

Flip-Flops #1 and #2 are reset at the beginning (leading edge) of the freeze time F3cd. The synchronization signals F3ab, F3cd and the 6400 Hz clock each passes through an isolation buffer, B, which provides (a) optimum isolation between the experiment and the S/C encoder and (b) noise suppression. Flip-Flop #3 is reset on the trailing edge of F3ab. Gates G1 through G4 are initially closed. The occurrence of an ion chamber pulse, after the freeze time F3cd, will open the gate G1 and toggle Flip-Flop #1. This will open gate G2 and allow the 6400 Hz clock to be counted by the accumulators. Gate G2 is closed and the measurement cycle stopped by either (a) the beginning of a new F3cd cycle which will reset Flip-Flop #1 or (b) the occurrence of a second ion chamber pulse which will toggle Flip-Flop #1, close G2, set Flip-Flop #2, and close G1.

Since there is a reasonable probability of an ion chamber pulse occurring during the freeze and readout time of the accumulators #3c and #3d, a "hidden pulse," and, since this could be significant for interval measurements at low count rates, a means is provided to identify these pulses. Flip-Flop #3 and gates G3 and G4 are used for this purpose. If an ion chamber pulse occurs during the accumulator freeze time, gate G3 is opened and Flip-Flop #3 is set which enables gate G4. Gate G4 will pass the F3ab signal and produce a single count in the accumulators. For periods less than about 10 seconds this single count is insignificant and will be "covered up" by the 6400 Hz clock.

The general equation for computing the ion chamber period, T, when a single event has occurred during the accumulation time which is indicated by the accumulator #3e having a single count and #3c and #3d having > 1 counts is

$$T = \frac{(N_z + 1)(10.24) + (N_1 - N_2)\,6400}{N + 1}$$

where T = the period in seconds

N_2 = the present #3c readout

N_1 = the last #3c readout > 1 preceeding the present #3c readout

N_z = the number of #3e readouts which have been 0's or 1's between the N_1 and N_2 readouts

N = the number of #3c readouts which have been 1's between the N_1 and N_2 readouts.

If 2 or more pulses have occurred during a given #3c accumulation cycle, which is identified by accumulator #3e, the ion chamber period is given as

$$T = \frac{N_p}{6400}$$

where N_p = the accumulated count in #3c.

A DC to DC power converter operating at a nominal 4 kHz provides low voltage logic power and the high voltage for the three detectors. A full wave rectifier produces the +3volts DC for the logic circuits. A voltage quadrupler and a gaseous discharge regulator tube provices +700 volts DC for the detectors.

Detailed electrical and mechanical drawings are given in Appendix II.

Specifications

Various mechanical and electrical specifications of the experiment are as indicated below.

MECHANICAL - THERMAL

1. Total experiment weight, potted:	1.33 lbs
2. Overall dimensions:	10"W x 5.1"D x 6.2"H
3. Operating temperature range:	-60°C to +70°C

ELECTRICAL

1. Input power	
a. Voltage:	11.5 to 11.7 volts nominal ± 1% regulation
b. Current:	11.6 mA nominal
c. Power:	135 mW nominal
2. Synchronization signals F3ab and F3cd	
a. True state:	≤ - 2V @ 100kΩ
b. False state:	≥ + 5.5V @ 200kΩ
c. Rise and fall times:	≤ 30 μsec between +3v and -1.8v
d. Period:	10.24 seconds
e. True state width:	0.32 seconds
3. Clock signal	
a. TRUE state, FALSE state, rise and fall times:	same as F3ab and F3cd above
b. Frequency:	6400 Hz
c. Symmetry:	approx. 50%

4. Accumulator inputs

a. Amplitude:	+3.5V to +7V (6V nominal)
b. Pulse width:	2 to 3 μsec @ 50% amplitude
c. Rise and fall times:	0.2 to 2 μ sec between 10% to 90% amplitude
d. Base level:	-1.5V to +0.5 V
e. Maximum frequency:	25kHz average
f. Pulse pair resolution:	≤12.5 μsec

Telemetry

The University of California IMP-F experiment uses two 16 bit "S-T" accumulators, a 16 bit and a 14 bit "S" accumulator and a 2 bit "jammer" accumulator. (See Figures 8, 10, and 11.) The #3d accumulator is used as a redundant accumulator, 14 bits, for #3c. All accumulators are readout and reset twice per S/C sequence of 20.48 seconds. Thus, all three experiment detectors are readout once each 10.24 seconds. The "S-T" accumulators are reset to binary zeros while all others are reset to binary ones. The freeze time and readout of the #3c, #3d, and #3e accumulators lags the freeze time and readout of the #3a and #3b accumulators by 5.12 seconds. The #3a and #3b accumulators are frozen simultaneously and readout as successive 4 big (hexadecimal) bursts, the least significant bits first, into the telemetry stream. This is also true for the #3c, #3d, and #3e accumulators. Accumulator readouts occur in channels 4 through 7 inclusive during frames 2, 6, 10 and 14 as indicated in Figure 11.

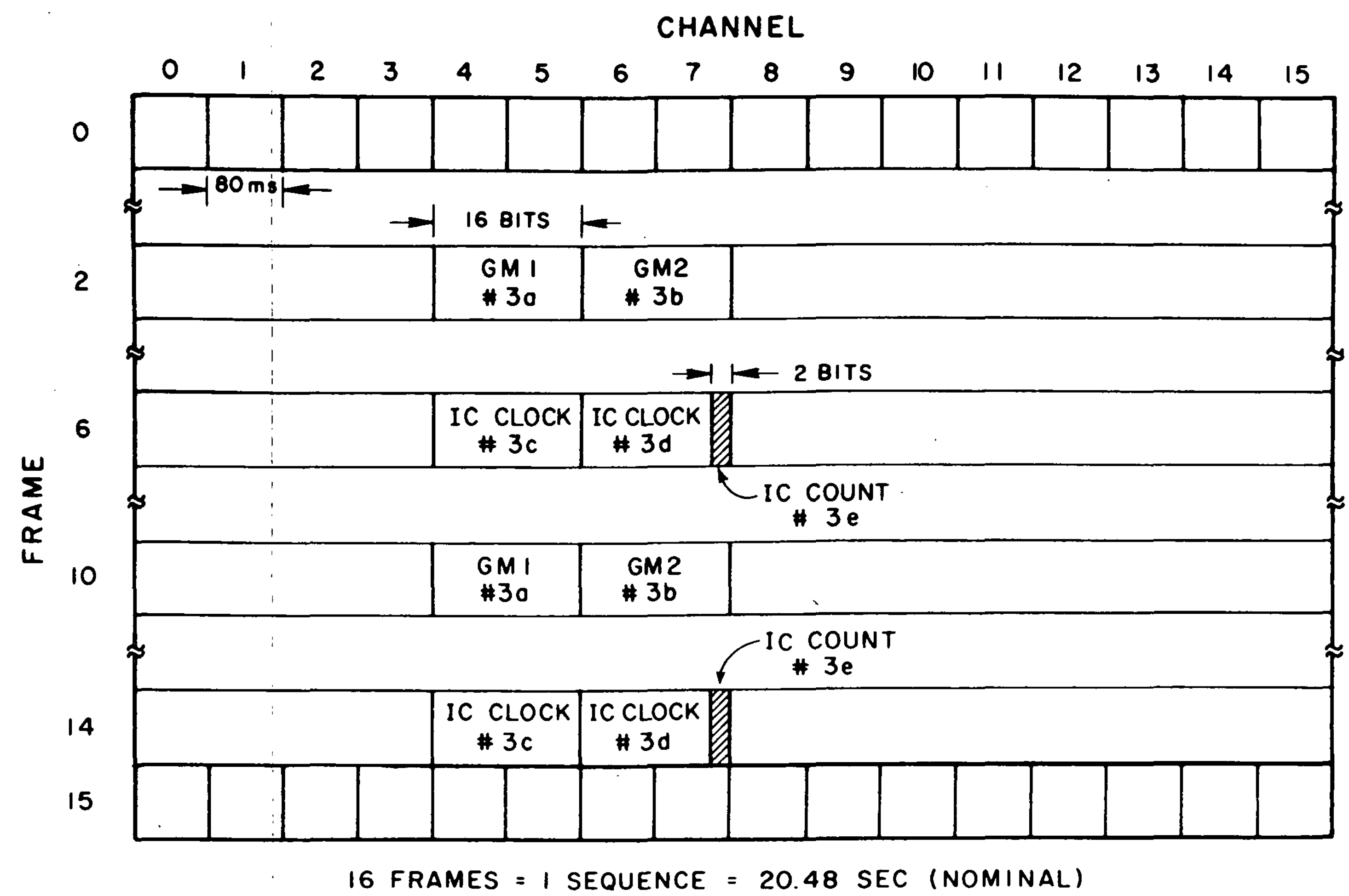


Figure 11 UCal IMP-F Telemetry Format

Ground Support Equipment

Ground support equipment for the IMP-F experiment consisted of two classes of equipment--(1) bench checkout equipment and (2) a set of deliverable Ground Support Equipment, GSE, that became part of the S/C GSE system. The bench checkout equipment consisted of a Bench Checkout Box, power supply, counters and other equipment as required. This Bench Checkout Box served as a basic experiment logic exercisor and was used for (a) acceptance testing during the fabrication phases, (b) evaluation and testing during environmental tests and calibration at UCAL and (c) for experiment operational verification and tests in the field as required. The deliverable UCAL GSE was supplied with the experiment to Goddard Space Flight Center, GSFC, and became part of the total S/C GSE system. This GSE generated electrical stimulation and controlled the application of this electrical stimulus and radioactive source stimulus to the experiment. This allowed for a continuous cycling operational test of the experiment during all integration and environmental test phases of the S/C up until launch.

The Bench Checkout Box was housed in a 8" x 6" x 4" box. It was built from discete components and power was supplied by a set of mercury batteries. A block diagram is given in Figure 12. The Geiger-Mueller, GM, channels could be independently stimulated at a fixed or variable rate via the inputs to experiment pulse shaper test points. Ion chamber channel stimulation was available either from the same signal source divided by 4 or a single event could be inserted from a one shot multivibrator. The clock sync could be driven at the nominal 6400 Hz rate from the 12.8 kHz oscillator and

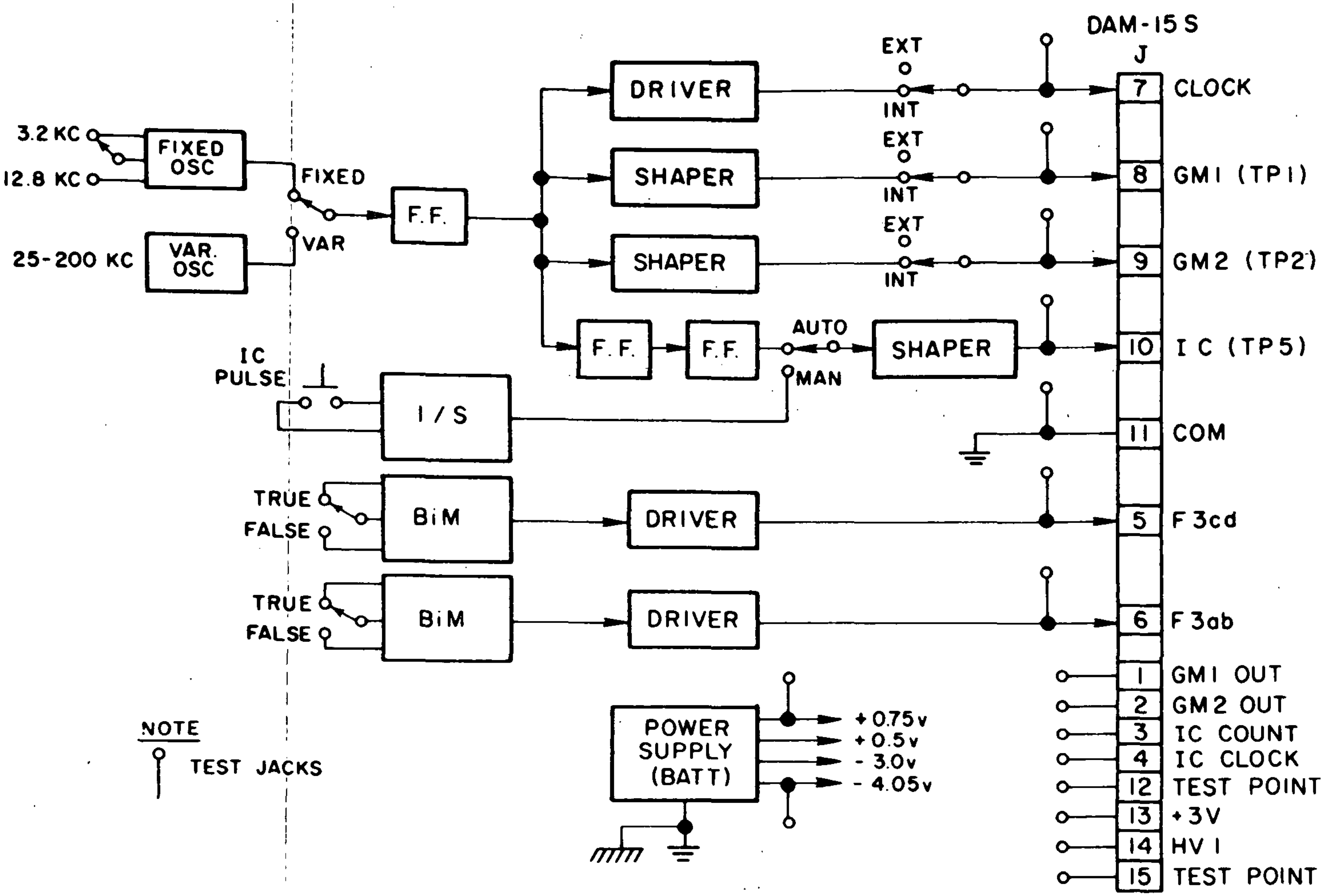


Figure 12 IMP-F Bench Checkout Box, Block Diagram

a divide by 2 Flip-Flop.* On-off operation of the F3ab and F3cd sync signals was provided for with the bistable multivibrators serving as switch noise filters. (Detailed drawings are given in Appendix II, g.v.).

The "deliverable" UCAL IMP-F GSE consisted of a rack mountable set of electronics, Figure 13, a Buffer Box, Figure 14, and appropriate cabling. The Buffer Box was attached and electrically connected to the experiment through the experiment test connector. This GSE was used to provide a complete operational checkout of the experiment and its DDP accumulators during all testing phases after delivery of the experiment to GSFC. All operational modes of the experiment and its DDP accumulators are checked by applying electrical stimulus to the experiment. Detector performance was evaluated by use of a 100 μc Co^{60} radioactive source. This source was held by a jig in the experiment in order to provide repeatable radioactive source stimulation. Both types of stimulus (electrical and source) were under automatic or manual control of the GSE. The manual mode of operation permitted application of any single stimulus condition to the experiment in order to facilitate debugging when necessary.

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*The reader should be aware that the IMP-F experiment and the AIMP-D & E experiments used identical electronics but they had slight differences in the external accumulator configuration, their timing, and their nomenclature. And, the same GSE was used for both projects with only nomenclature changes as required. Thus, many drawings used for IMP-F will have AIMP nomenclature and will include some features that are pecular to the AIMP. The AIMP accumulators were readout four times slower than IMP-F and used a 1600Hz clock. Simulation of this clock rate is provided for in the Bench Checkout Box. The following items are also equivalent for these projects. #5 sync = F3cd sync, #6 sync - F3ab sync, IC clock = #3c & 3d Acc's, IC count = #3e Acc, SIMP = IMP-F. A description of the AIMP is given in "Final Report for Energetic Particle Flux Experiment AIMP-D&E," NAS5-9077, Space Sciences Laboratory Series 11, Issue 75.

Figure 13 IMP-F Main GSE

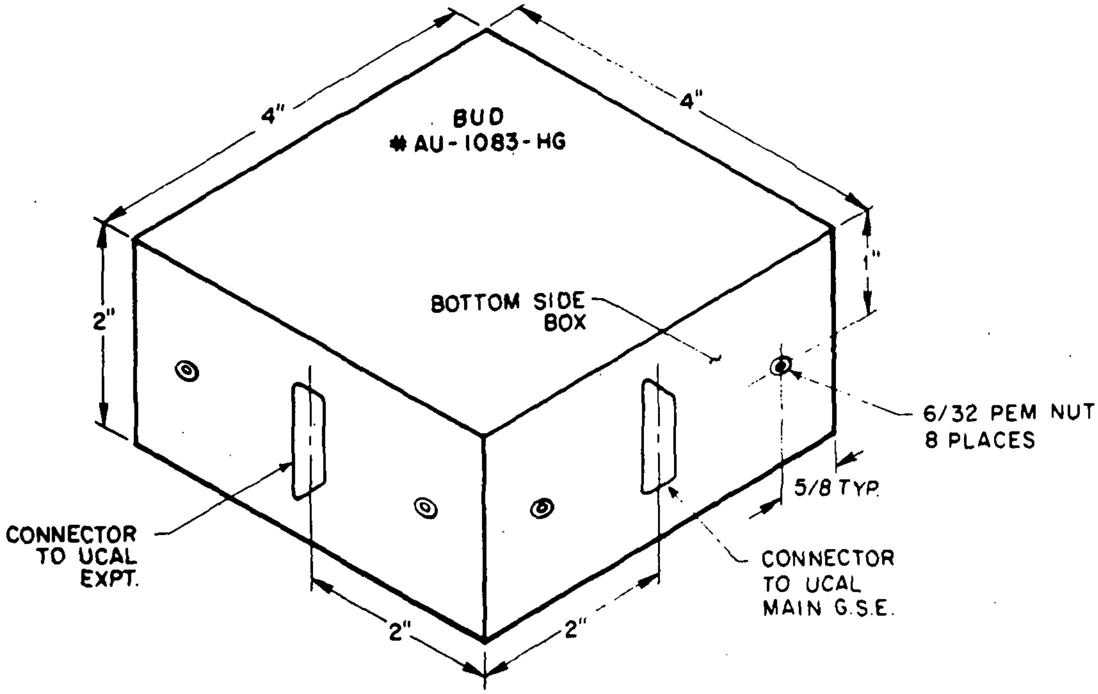

Figure 14 IMP-F GSE Buffer Box

A block diagram of this GSE is given in Figure 15. All electrical stimulus for the experiment is derived from 3 signals received from the Buffer Box--F3ab sync, F3cd sync, and the 6400 Hz clock. The F3ab and F3cd sync signals are delayed about 20μsec behind the 6400 Hz clock in a driver section (see detailed schematics) prior to use in the signal generation section in order to prevent noise spike generation during the transition time of the sync signals. Application of the generated signals at the proper time to the experiment is via the three switch sections which are controlled by the slave counter and matrix section. The slave counters receive S/C GSE signals (A, a_1, a_2, a_3 and a_4) which identify S/C sequences 0 through 15 the maximum number of sequences per cycle in the GSE. These signals and F3ab sync, F3cd sync are used to produce two slaved countdown chains in synchronism with the accumulator cycles in order to keep all stimulus in step with the accumulator cycles. The slaving action occurs within 10.24 seconds or less after turn-on or an interruption of any of the sync lines. The slave counter section also provides the electrical-source stimulus control via the Buffer Box.

On the front panel of the MAIN GSE box, Figure 13, are three switches for control of the operating mode - MANUAL SEQUENCE, MODE, and STIMULATION. With the MODE switch in the AUTO position and the STIMULATION switch in the BOTH position the GSE repeatedly cycles through 16 S/C sequences with 8 sequences of electrical stimulation and 8 sequences of source stimulation. If the STIMULATION switch is in the ELECTR. position, the GSE cycles continuously through the 8 sequences of electrical stimulation and

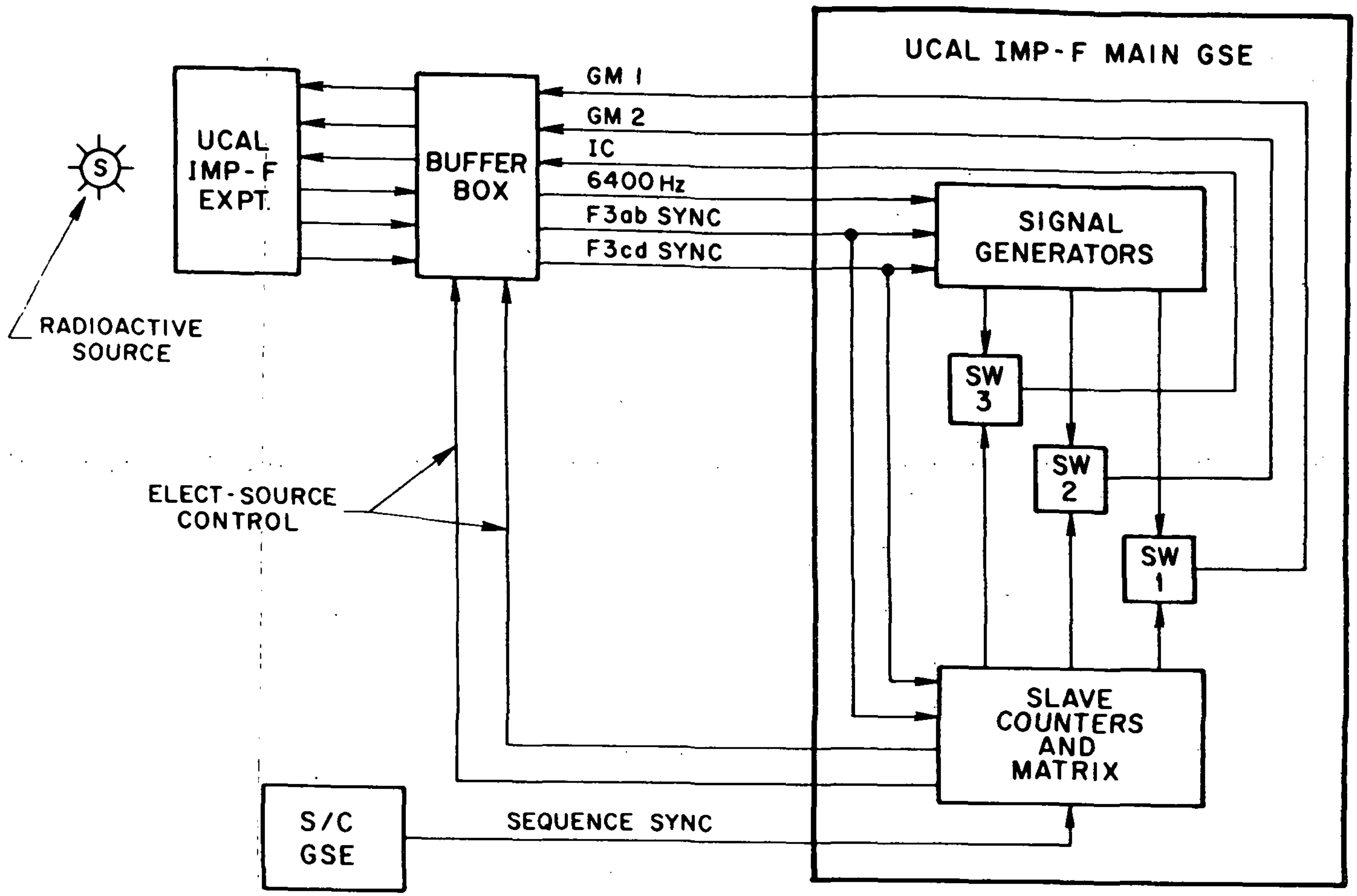

Figure 15 IMP-F GSE Block Diagram

with this switch in the SOURCE position only source stimulation is allowed. The 8 position MANUAL SEQUENCE switch provides for application of any one of the electrical stimulus conditions when the MODE switch is in MAN and the STIMULATION switch is in ELECTR.

Table 2 lists the stimulus signals, their use and the resultant accumulator readouts. The 3abS and 3abE designations represent a pulse generated at the start and the end respectively of the F3ab freeze time. Since this system is essentially a coherent system it is possible to predict very precise electrical readout limits as indicated in the table. Radioactive source limits were determined prior to delivery of the experiment with an in house source and then predicted and updated as required for the GSFC sources used during testing.

Fabrication and Qualification

The experiment electronics was fabricated by the subcontractor, Marshall Laboratories, Torrance, California. Welded, cordwood, 3 volt logic modules mounted on a double sided printed circuit board were housed in a standard GSFC supplied "D" frame. Visual and thermal tests were performed at the subcontractor's site prior to accepting delivery. The GM detectors are commercial items, whereas, the ionization chamber was fabricated at UCAL. The Geiger-Mueller detector housings and other miscellaneous hardware were also built in house. Integration of the detectors and electronics, high voltage potting, etc. was performed at UCAL. And, detector calibration, thermal and vacuum qualification tests were done in house. The experiment was potted (Ecco-foam), vibrated and magnetically qualified at GSFC. The ground support equipment was fabricated at UCAL.

TABLE 2. IMP-F GSE STIMULUS AND READOUTS

	ACCUMULATOR READOUTS				STIMULUS	
SEQ. NO.	#3a GM1	#3b GM2	#3c IC CLOCK	#3e IC COUNT	GM'S	ION CHAMBER
0	15359T* 15359T*	15359T* 15359T*	16** 16**	2 2	6400 Hz T MODE	400 Hz FAST RATE
1	15359T* 15359T*	0 0	32768* 32768*	1 1	6400 Hz and ZERO T MODE and X TALK	3abS SINGLE PULSE
2	0 0	15359T* 15359T*	30719* 30719*	1 1	ZERO and 6400 Hz T MODE and X TALK	3abE SINGLE PULSE
3	31743* 31743*	31743* 31743*	2049 2049	2 2	3200 Hz S MODE HIGH RATE	3abS + 3abE PULSE PAIR
4	3968* 3968*	3968* 3968*	30719* 0	1 0	400 Hz S MODE LOW RATE	3abE/2 SLOW RATE
5	2048 2048	2048 2048	30719* 0	1 0	6400 (3cd) BURST	3abE/2 SLOW RATE
6	1 1	1 1	1 1	0 0	3cdS SINGLE PULSE	3cdS HIDDEN PULSE
7	0 0	0 0	0 0	0 0	ZERO QUIET	ZERO QUIET
8 . . . 15	RS RS . . RS	RS RS . . RS	RS RS . . RS	RS RS . . RS	RADIOACTIVE SOURCE	

Limits: $^{*}{}^{+0}_{-1}$, $^{**}{}^{+1}_{-2}$, others ± 0

<u>History</u>

The experiment electronics was accepted from the subcontractor on February 24, 1966. Detectors were being mated with the electronics and preliminary tests performed from May 5, 1966 to July 19, 1966. During vacuum testing on August 19, 1966, the ionization chamber detector was found to be defective. This detector was replaced on September 13, 1966 and it was subsequently found to be marginal during tests performed between September 19 to November 18, 1966. The ionization chamber was replaced again on November 19, 1966. Thermal and vacuum qualification tests at UCAL were successively completed on November 28, 1966. The experiment was delivered to GSFC on November 29, 1966, potted, vibrated and magnetically qualified, and successively integrated into the S/C on November 30, 1966. During some of the testing phase at GSFC and at the Western Test Range, WTR, it was discovered that the ionization chamber exhibited some occasional double pulsing --the second pulse occurring about 150 to 200 μsec after the main pulse. This did not affect the basic calibration of the detector. It did produce undesirable, but, recognizable results in the accumulator outputs. This detector was not replaced due to the tight scheduling problems and the unavailability of a more suitable ionization chamber at the time. Final calibrations were performed at WTR on May 10, 1967 and the experiment was launched from WTR on May 24, 1967 at 07:06 hrs PDST.

The experiment functioned normally from launch until September 4, 1967. On that date as the spacecraft exited from the earth's magnetosphere, GM1, the scatter detector, went into a continuous discharge mode, counting $> 10^4$ cps. By September 14 the pulses from GM1 were too small to be counted by the electronics. By September 18, 1967 the count rate in GM2, the open counter, was limited to $\leqslant 10^2$ cps by the current drain due to GMl which had pulled down the power supply voltage. On September 27 the ionization chamber stopped counting; apparently also due to low power supply voltage. Data from GM2, although of limited usefulness, continued to be received through November 8, 1967.

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II. THE IMP-G (S1) EXPERIMENT ABOARD EXPLORER-41

Description of Detectors

The University of California experiment aboard Explorer-41 contains six Geiger-Mueller detectors, three, P1, P2, P3, pointed along the spin axis and three, E1, E2, E3, pointed perpendicular to the spin axis. Four detectors look directly at the particle fluxes while two, P2 and E2, observe the particle flux backscatter off an 8 mil gold foil. The backscatter detectors are only sensitive to electrons. With these six detectors, electron fluxes are measured in four integral energy intervals, protons in three integral energy intervals, and solar X-rays in two energy intervals.

Additionally, a 4" diameter ionization chamber identical to the one in the Explorer-34 experiment is included. The configuration of these detectors is shown in Figures 16 and 17 and the detector characteristics are given in Table 3.

Geiger-Mueller Detectors

All the Geiger-Mueller detectors are manufactured by LND, Inc. E1, E2, E3, P2, and P3 use the LND Model 7041 which are similar to the Lionel 205HT used in the Explorer-34 experiment. These GM detectors have a cylindrical cathode of $\frac{1}{4}$" inside diameter with a $\frac{1}{4}$" diameter mica window and are sensitive to radiation over the entire area of the window. Various thicknesses of mica windows and additional aluminum foils over the windows are used to obtain the energy thresholds desired. P1 is a LND 705 GM detector with cathode of inside diameter .093" and with an extra thin, 0.5 mg/cm^2 mica window. A discussion of the energy response and scattering technique is given in the previous section on Explorer-34. All these LND detectors are filled with neon and a trace

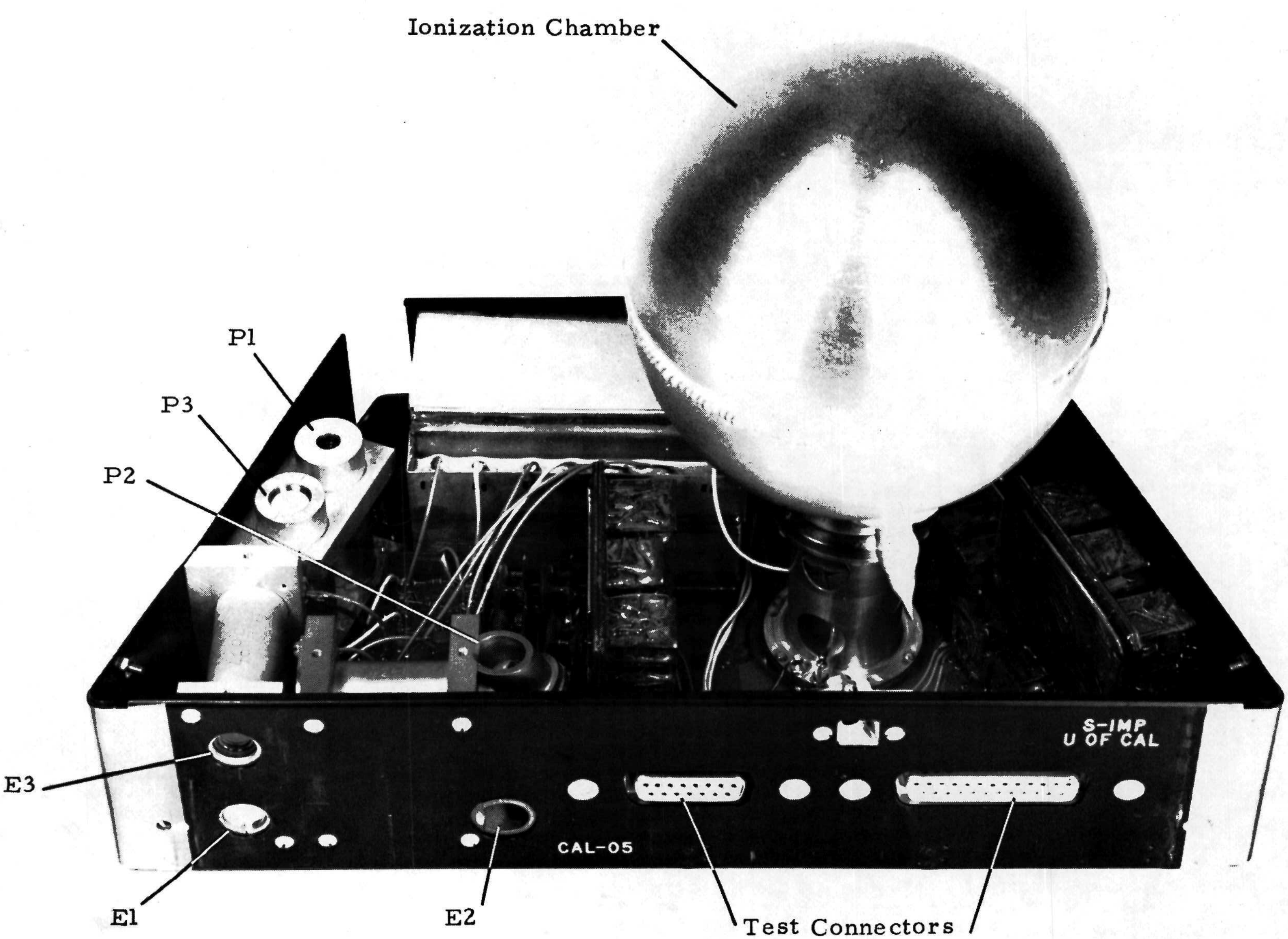


Figure 16 IMP-G Experiment, Front View

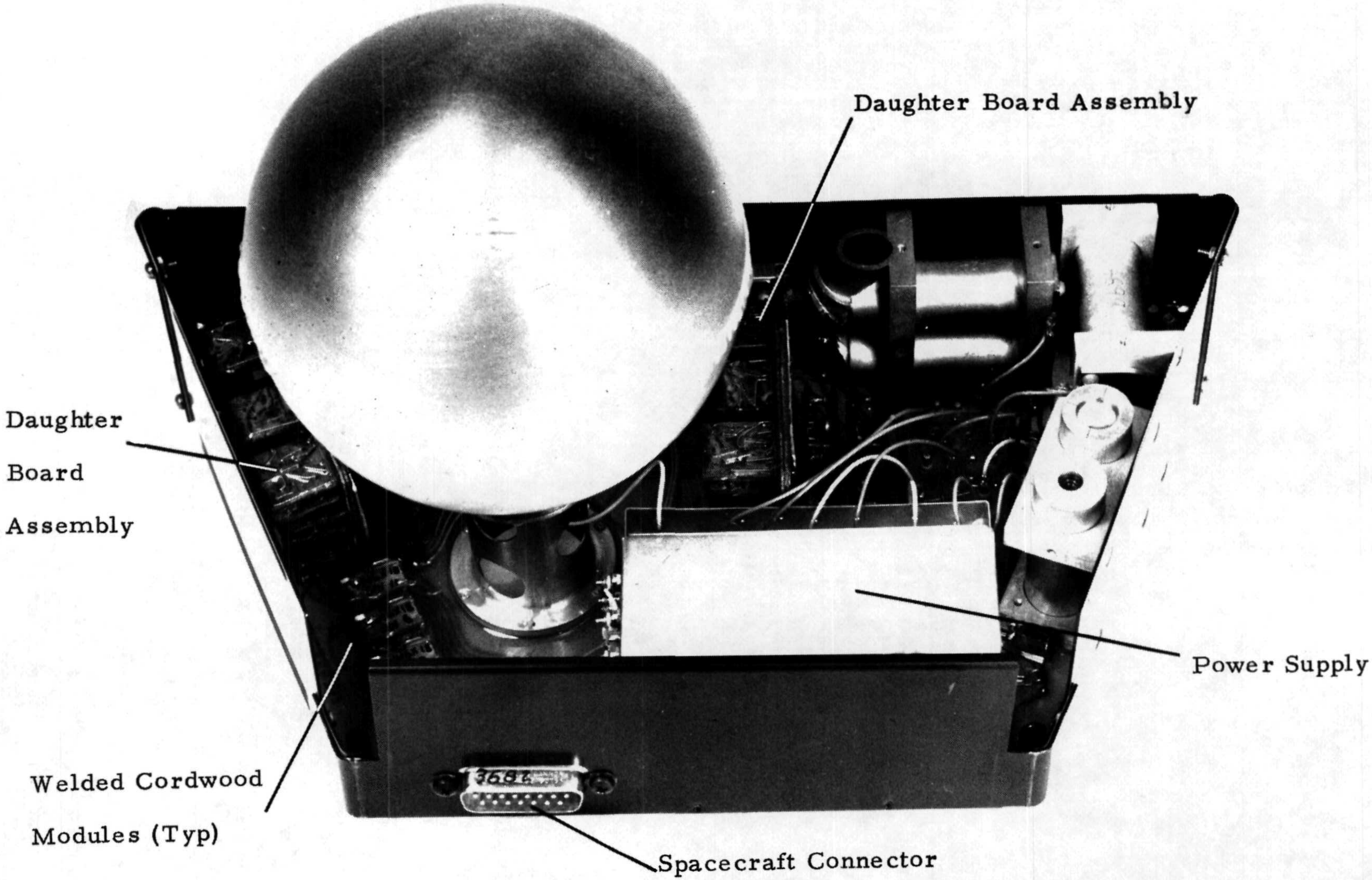


Figure 17 IMP-G Experiment, Rear View

Table 3

Explorer-41 Detector Characteristics

Detector Designation	Type of Detector	Window	Electrons	Protons	X-ray	Geometry Factor cm^2 ster	Look Angle FWHM	Angle to Spin Axis
P1	LND 705 GM tube	0.5 mg/cm^2 mica	>18 KeV	>0.25 MeV	None	2.7×10^{-2}	40^o	0^o
P2	LND 7041 GM tube in scatter configuration	1.5 mg/cm^2 mica	>45 KeV	---	None	6.3×10^{-2}	70^o	0^o
P3	LND 7041 GM tube with Al foil	3.0 mg/cm^2 mica and 4.5 mg/Al	>80 KeV	>1.5 MeV	None	0.75	70^o	0^o
E_1	LND 7041 GM tube, thick window	13 mg/cm^2 mica	>120 KeV	>2.3 MeV	3-20 KeV*	1.03	70^o	90^o
E_2	LND 7041 GM tube in scatter configuration	1.5 mg/cm^2	>45 KeV	---	None	6.5×10^{-2}	70^o	90^o
E_3	LND 7041 GM tube with Al foil	2.7 mg/cm^2 mica and 4.5 mg/Al	>80 KeV	>1.5 MeV	1-20 KeV*	0.86	70^o	90^o
IC	4" diameter spherical, Neher type integrating ionization chamber	210 mg/cm^2 Aluminum skin	>0.7 MeV	>12 MeV maximum sensitivity ~17 MeV	≥20 KeV	~80 cm^2 omnidirectional		

*X-ray range -- 0.1% efficiency points

of bromine quench gas. The use of bromine instead of the more standard chlorine contributes to more stable performance and flatter plateau slopes. The shielding for these detectors is identical to that for the Explorer-34 GM detectors.

The two open detectors which point perpendicular to the spin axis, E1 and E3, view the sun on every spin since the spin axis is oriented perpendicular to the ecliptic plane. These two detectors respond to solar X-rays in the 1 to 10 keV region, and in particular E3's background is predominantly due to quiet time soft X-rays.

The X-ray response of these counters can be calculated if the composition of the mica window and the fill gas is known. If an X-ray beam of intensity $I_o(\lambda)$ is incident on a material of thickness, ℓ, then the intensity of the penetrating beam is

$$I(\lambda) = I_o(\lambda) \exp[-\rho \ell \sigma(\lambda)]$$

where ρ = density of the material, and $\sigma(\lambda)$ = cross-section.

$$\sigma(\lambda) = \frac{1}{\rho} \Sigma_i \rho_i \sigma_i(\lambda)$$

where ρ_i = density of element i in the material and $\sigma_i(\lambda)$ = cross-section for element i.

For an X-ray to be counted by the Geiger-Mueller tube, it must penetrate the window and stop in the gas. Therefore, the counting efficiency is given by

$$\frac{I(\lambda)}{I_o(\lambda)} = \exp[-\rho \ell \sigma(\lambda)]_{mica} \left\{1 - \exp[-\rho \ell \sigma(\lambda)]_{gas}\right\}$$

Using the cross-sections kindly supplied by L. Acton (private communication), the calculation has been carried for E1 and E3. The resulting efficiency curve is shown in Figure 18.

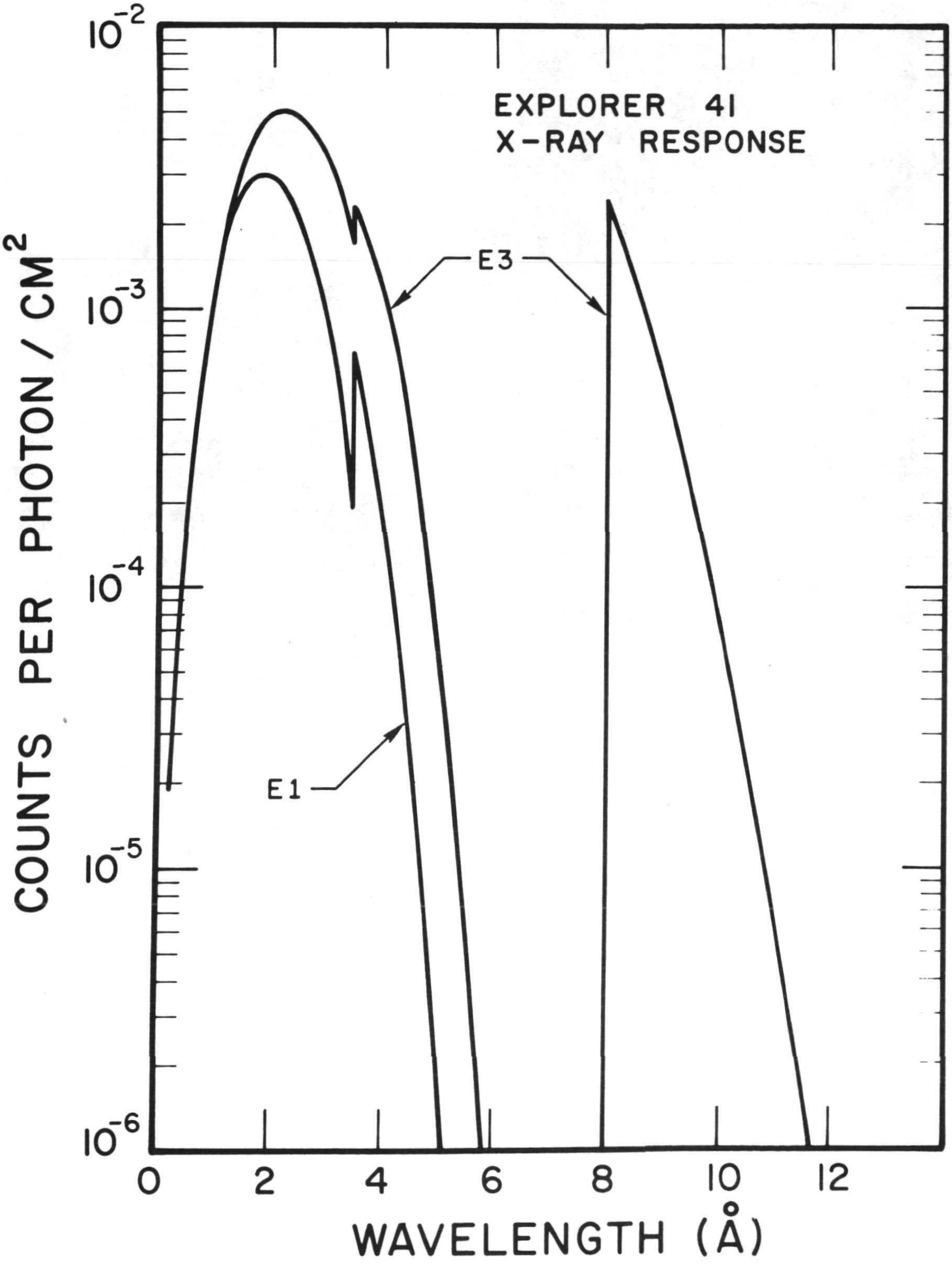


Figure 18 Explorer-41 X-ray Response

The accumulation period of the detectors is several times the spin period so that El, E2, E3 essentially average particle fluxes over a wide cone of directions. However, some pitch-angle information can be obtained through comparisons of E2 and P2 and E3 with P3.

Ionization Chamber

The ionization chamber is essentially identical to that in the Explorer 34 experiment. The calibration curve for the Explorer-41 chamber is given in Figure 19. The energy response is shown in Figure 7 of the section on Explorer-34.

Experiment Electronics Description

The block diagram of the University of California IMP-G experiment is given in Figure 20. It should be noted that this IMP-G electronics is very similar to that used for the IMP-F experiment--the principle difference being those changes necessary to accomodate the four additional detectors. Therefore, those sections previously discussed that are the same will not be repeated here (e.g., Ion Chamber logic, S-T accumulators, etc.).

Commutation of the six Geiger-Mueller detectors into the #3a and #3b acculators is by means of a 2 pole 4 position electronic switch controlled by a matrix section which is driven by the CAL COM synchronization signal. The CAL COM signal switches every S/C sequence (i.e., 2 S/C sequences per cycle). However, the use of this signal was not sufficient to identify uniquely the GM detector positions in the telemetry format. (The CAL COM signal was the only available signal from the S/C encoder for this commutation--it was originally intended for use in the IMP-F prior to a reconfiguration of the #3a and #3b accumulators). A 3200 Hz signal, derived from the 6400 Hz clock, was

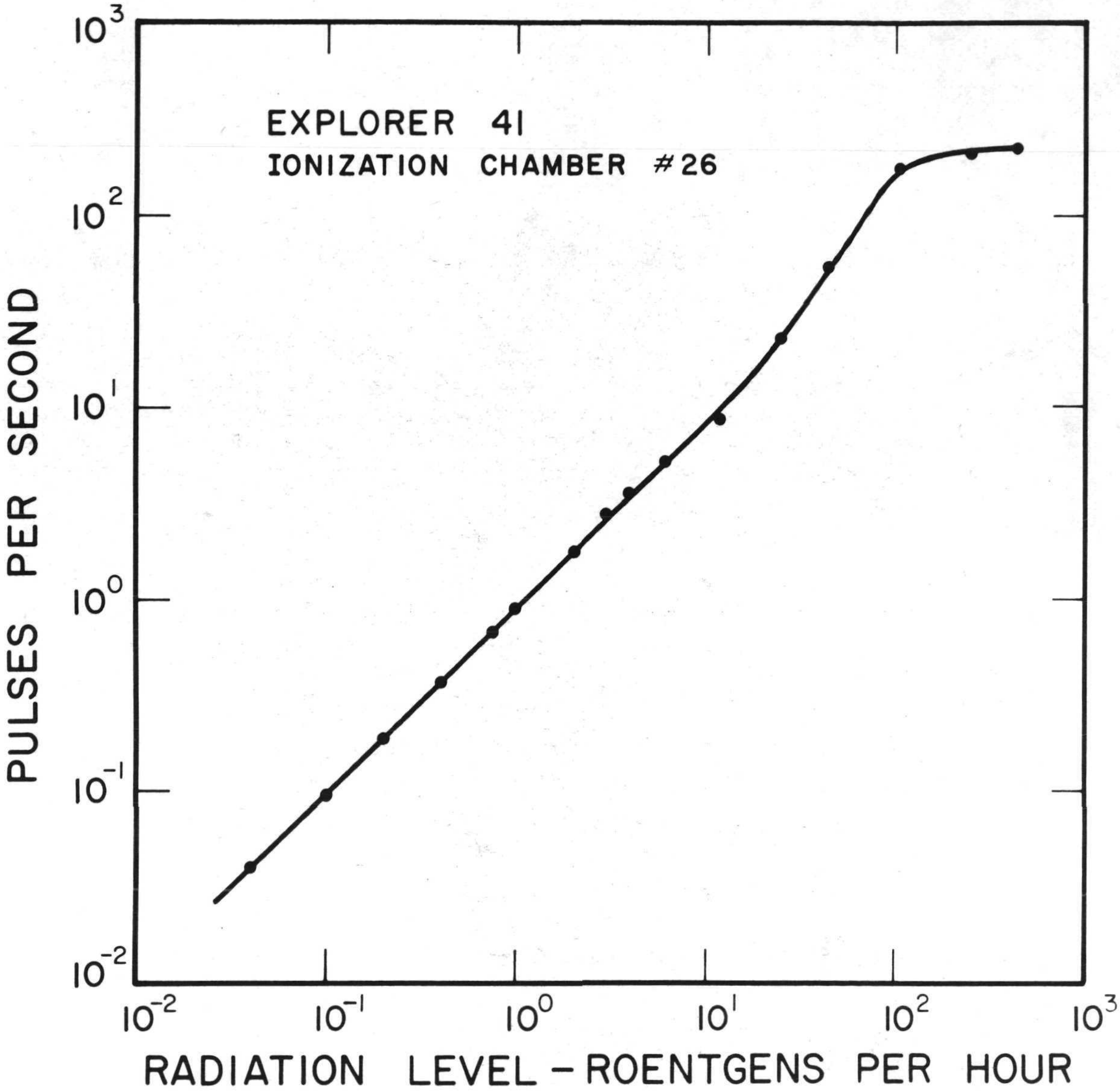


Figure 19 Explorer-41 Ionization Chamber Calibration

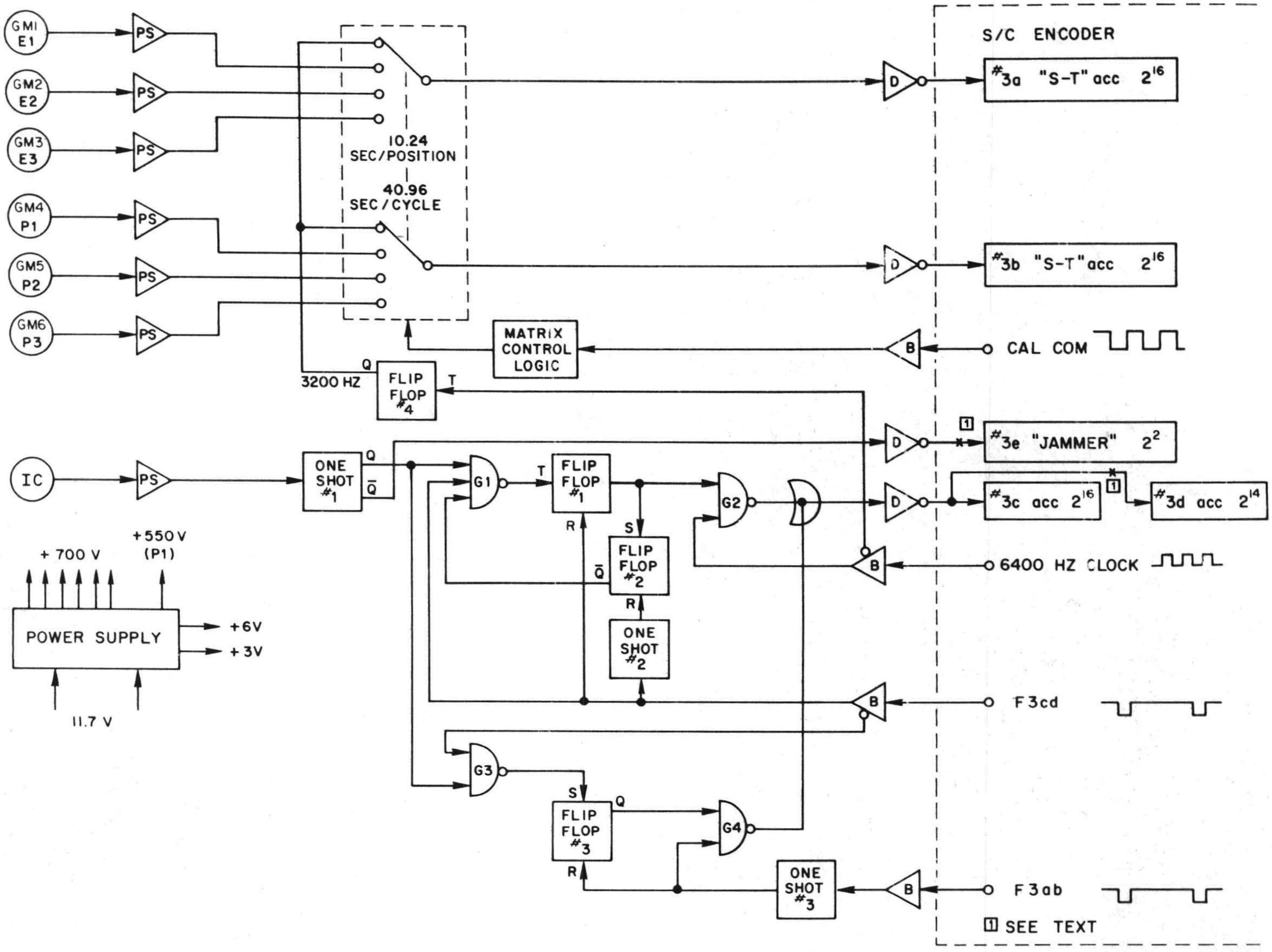


Figure 20 IMP-G Experiment Block Diagram

used as an additional commutator input signal to provide this identification. The 3200 Hz frequency was chosen rather than the 6400 Hz in order to provide an "S" mode accumulator output which gives a tighter limit for this ID. Since the accumulator ID outputs are redundant, they can also be used in data processing as a "noise" check on the data.

In the Ion Chamber logic section two minor changes were made: (a) a different phase from the One Shot #1 was used to drive the #3e, IC COUNT, output; and (b) the One Shot #3 was added. In addition, there was a change made in the accumulator configuration prior to launch. The #3e accumulator became defective late in the S/C testing phases. Because of the difficulty in making a repair of this accumulator in the S/C flight encoder and the inherent risk to the project as a whole, it was decided to disable the #3e accumulator and use the #3d accumulator in its place. This was easily accomplished by a simple external wiring change. Thus, as flown, the #3e accumulator was inactive, the #3d accumulator is used for the IC COUNT output, and the #3c accumulator was used for the IC CLOCK output.

The output drivers were also changed from a transformer coupled technique to a one shot plus a 6 volt driver combination. This was done in order to reduce some difficulties during the fabrication phases in the setting of the pulse width, rise and fall times for the output driver stages.

The power supply is very similar to that used in the IMP-F. Here, two additional gaseous discharge regulators were used to provide the additional high voltages, one of these being 550 volts which was required for the P1 detector. And a full wave rectifier was added to provide the +6 volts DC.

Specifications

Several of the mechanical and electrical specifications of the experiment are as indicated below.

MECHANICAL-THERMAL

1. Total experiment weight, potted:	2.52 lbs.
2. Overall dimensions:	10" W x 5.1" D x 6.5" H
3. Operating temperature range:	$-30^{\circ}C$ to $+70^{\circ}C$

ELECTRICAL

1. Input power	
a. Voltage:	11.5 to 11.7 volts nominal ± 1% regulation
b. Current:	29 mA nominal
c. Power:	340 mW nominal
2. Synchronization signals	
a. True state:	≤ -2v @ 100 KΩ
b. False state:	≥ +5v @ 200 KΩ
c. Rise and fall times:	≤ 30 μsec between +3v and -1.8v
d. F3ab and F3cd period:	10.24 seconds
True state width:	0.32 seconds
F3cd lags F3ab:	5.12 seconds

e. CLOCK

Frequency:	6400 Hz
Symmetry	approx. 50%

f. CAL COM

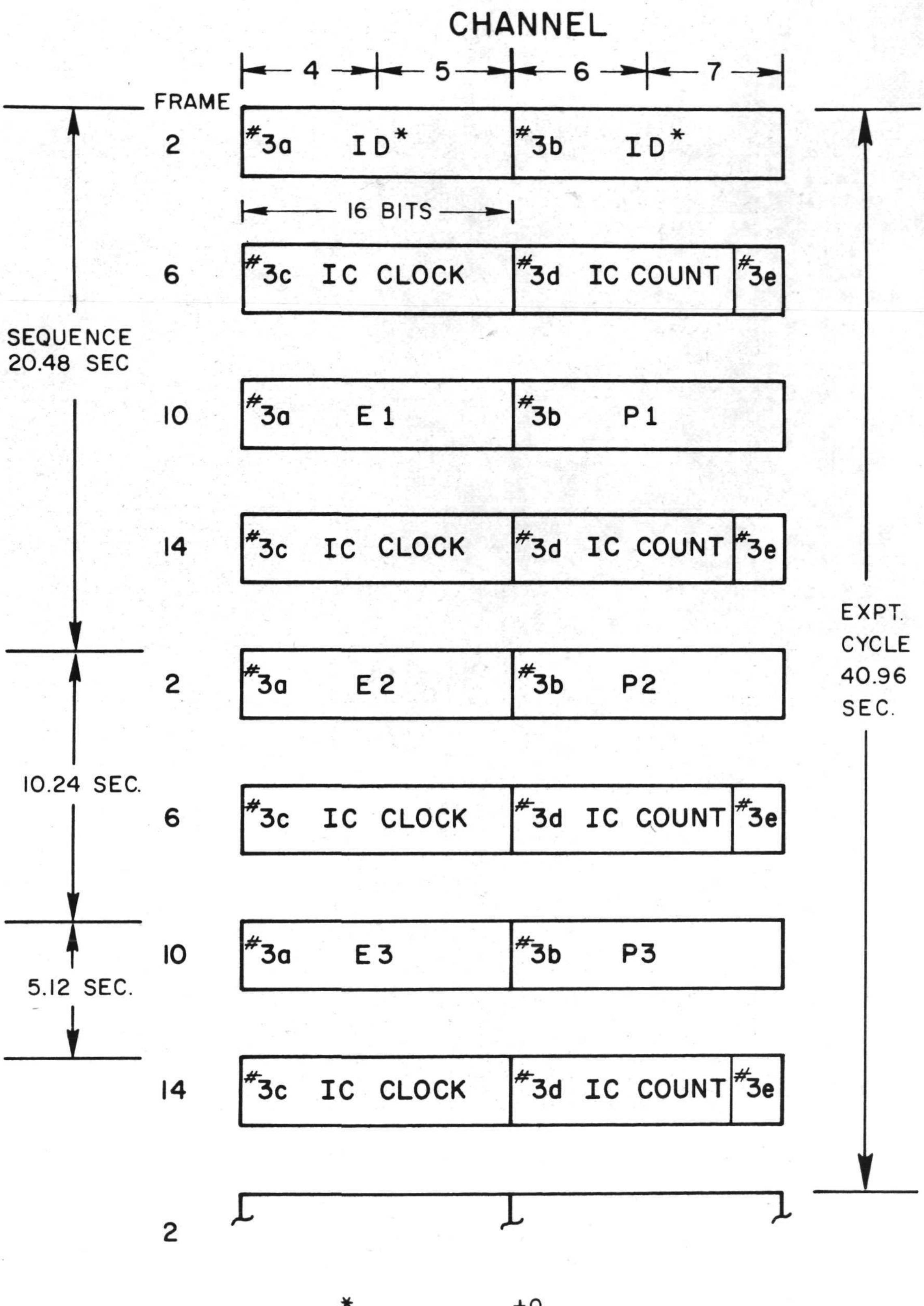
Period:	20.48 seconds
True state width:	10.24 seconds
False:	from Frame 2, Channel 8 through Frame 10, Channel 7

3. Output Pulses

a. Amplitude:	+3.5V to +7V (+6V nominal)
b. Pulse width	2.5 μsec ± 0.5 μsec @ 50% amplitude
c. Rise and fall times:	0.2 μsec to 2 μsec @ 10% and 90% amplitude
d. Maximum rates:	25 kHz average
e. Pulse pair resolution	10 μsec or better
f. Base level	-1.5V to +0.5V

Telemetry

The University of California IMP-G experiment uses two 16-bit "S-T" accumulators, a 16-bit "S" accumulator, and a 14-bit "S" accumulator (the 2-bit accumulator #3e is inactive). See Figures 20 and 21. All accumulators are readout and reset twice per S/C sequence of 20.48 seconds. The "S-T" accumulators are reset to binary zeroes, while the "S" accumulators are reset to binary ones. A complete experiment cycle requires 40.96 seconds. The beginning of the cycle is identified with a special ID readout (31743 $^{+0}_{-1}$) occurring in the #3a and #3b accumulators. The Ion Chamber data are readout four times per experiment cycle. Data from each of the GM detectors are accumulated for 9.92 seconds (10.24-0.32) every 40.96 seconds. Each of the accumulator



*ID = 31743^{+0}_{-1}

Figure 21 UCal IMP-G Telemetry Format

pairs (#3a-#3b and #3c-#3d) inputs are frozen simultaneously for 0.32 seconds every 10.24 seconds during which time the data are readout as successive 4-bit hexadecimal bursts with the least significant bits first. The freeze and readout times of the #3c and #3d accumulators lag the freeze and readout of the #3a and #3b accumulators by 5.12 seconds. The readouts occur in channels 4 through 7 inclusive during frames 2, 6, 10, and 14 as indicated.

Ground Support Equipment

The ground support equipment for the UCAL IMP-G experiment consisted of a Bench Checkout Box and a deliverable set of GSE that became part of the S/C GSE system. (Both types of equipment are similar in purpose and function to that which was used for the IMP-F project). Here, the basic Bench Checkout Box features have been expanded to include matrix control of the experiment and additional logic to simplify the Ion Chamber logic testing. A principle departure of the deliverable GSE, however, is the considerable effort that was expended on the UCAL softwave used in the S/C GSE computer (an SDS 920) in order to automate the UCAL GSE system. The motivation behind this softwave effort was twofold: (a) a desire by the GSFC personnel to automate the S/C GSE system if possible; and (b) the desire by UCAL to determine if this GSE system approach would be a reasonable one for future projects, namely the IMP-I.

The IMP-G Bench Checkout Box was housed in a 12" W x 7" D x 5" H box as illustrated in Figure 22. Power was supplied internally by a pair of mercury batteries sufficient for at least 125 hours of operation. This equipment used MOSFET integrated circuits, supplied by GSFC, which

Figure 22 IMP-G Bench Checkout Box

were surplus items from the AIMP D and E projects. Only two IC types were used: (a) a triple input gate; and (b) a master slave Flip Flop.

Referring to the block diagram in Figure 23, the matrix control section allowed for complete control of the experiment commutator section. By forcing Y and $\overline{Y}$ via the experiment test points and driving CAL COM, $\overline{X}$, it was possible to force the selection of any of the four commutator signal inputs. (The Y signal is the count down by two of CAL COM in the experiment). With the MATRIX CONTROL switch in the MAN position, the CAL COM line was driven (but not Y or $\overline{Y}$) which allowed TRUE FALSE control of CAL COM via the MAN switch. Putting the MATRIX CONTROL switch in the AUTO position allowed CAL COM to be driven at either the nominal fixed rate or at a variable rate (Y and $\overline{Y}$ not driven). The variable rate provided a speed up of 10 to 100 times the nominal commutator switching rate in order to facilitate testing. Manual operation of the F3ab and F3cd sync lines was provided for by means of two switches, Flip-Flops used as switch noise filters and appropriate interface drivers.

The GM channel stimulus control logic provides a means of applying stimulus derived from either the fixed 6.4 KHz oscillator or a variable oscillator to the six GM channels in various combinations. With the GM SELECT switch in the ALL position and the SELECT switch in the ON position, all six GM channels were driven by the selected stimulus. Whereas, placing the SELECT switch in the OFF position removed all GM stimulus. With the GM SELECT switch in any of the single channel positions and the SELECT switch in the ON (OTHERS OFF) position only that particular channel was driven. But putting the SELECT switch in the OFF (OTHERS ON) position provided complementary control--the five remaining channels were simultaneously driven while the single selected channel was not--

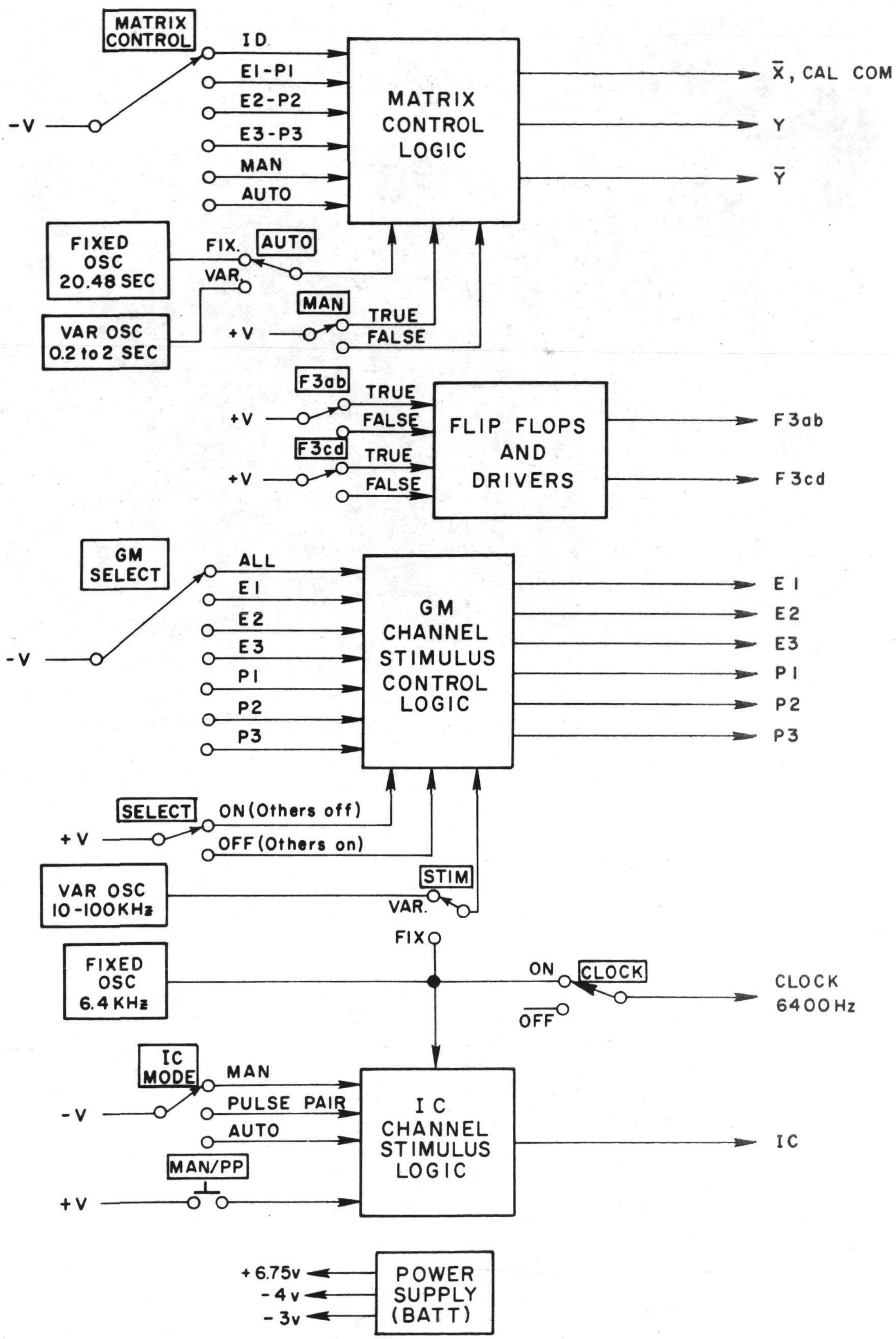


Figure 23 IMP-G Bench Checkout Box, Block Diagram

which provided a means of performing crosstalk checks in the GM channels. The fixed 6.4 KHz oscillator was also applied to the CLOCK switch for use as the 6400 Hz CLOCK synchronization signal to the experiment.

The IC channel stimulus logic operated in any of three possible modes. In the MAN mode, a single event was simulated each time the MAN/PP switch was pressed. In the PULSE PAIR mode, a pulse pair with a spacing of ten 6400 KHz CLOCK cycles was produced each time the MAN/PP switch was activated. The AUTO mode produced a continuous series of pulses with a spacing of 16 clock cycles.

Additional features of this Checkout Box included test points to monitor the experiment outputs and all experiment test points. And, the Checkout Box could also be used as a GM channel and IC channel stimulus source while the experiment was operating in the S/C.

The "deliverable" UCAL IMP-G GSE equipment consisted of a rack mountable set of electronics (Figure 24), a Buffer Box (Figure 25), and appropriate cabling. The Buffer Box was attached and electrically connected to the experiment by means of the 15 pin experiment test connector. As with the IMP-F, this GSE was used to provide a complete operational checkout of the experiment and its DDP accumulators during all testing phases after delivery of the experiment to GSFC. All operational modes of the experiment and its DDP accumulators were checked by applying electrical stimulus to the experiment. Detector performance was evaluated by use of a 100 μc Co^{60} radioactive source. This radioactive source was held by a jig in the experiment in order to provide repeatable stimulation. Both types of stimulus (electrical and source)

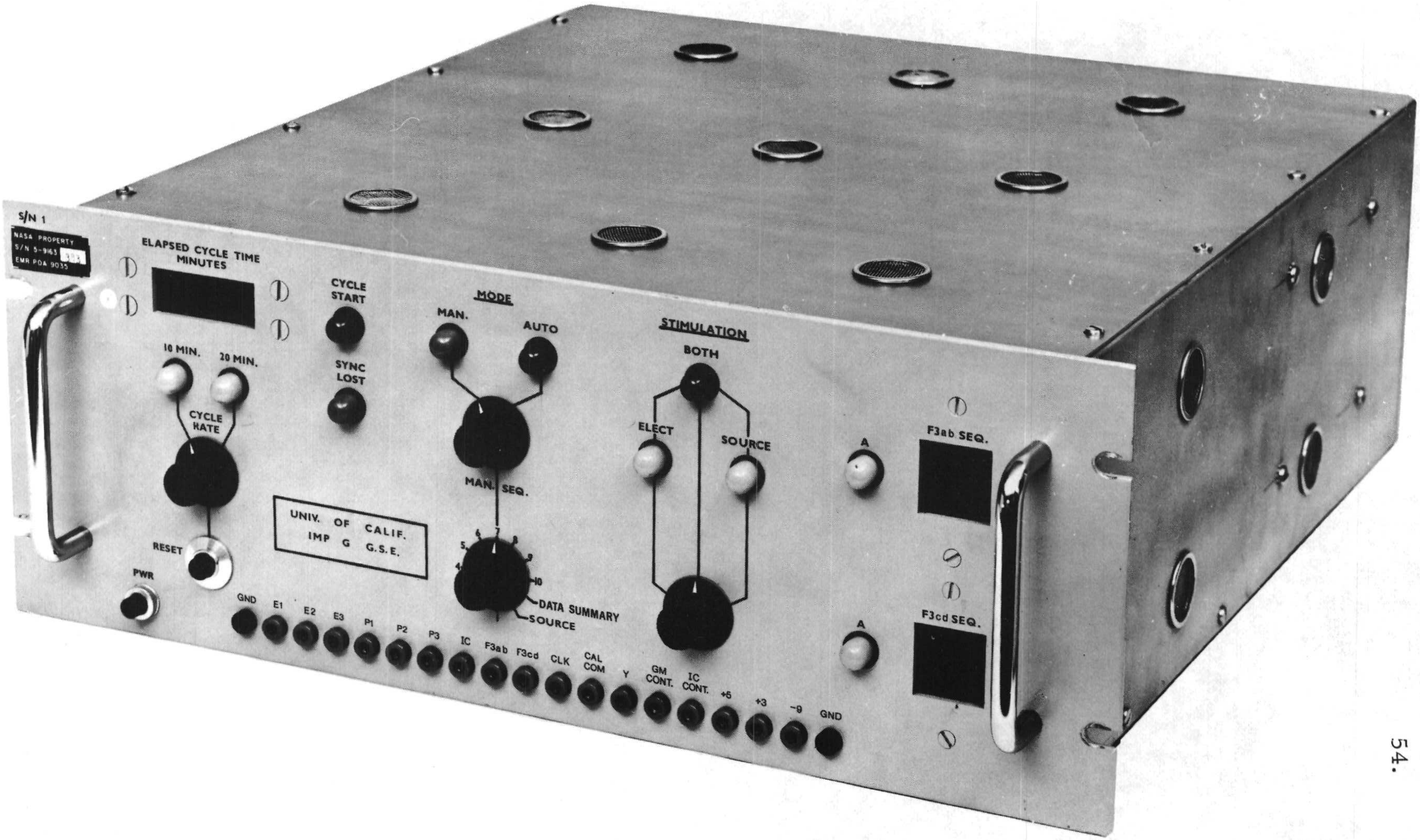


Figure 24 IMP-G Main GSE

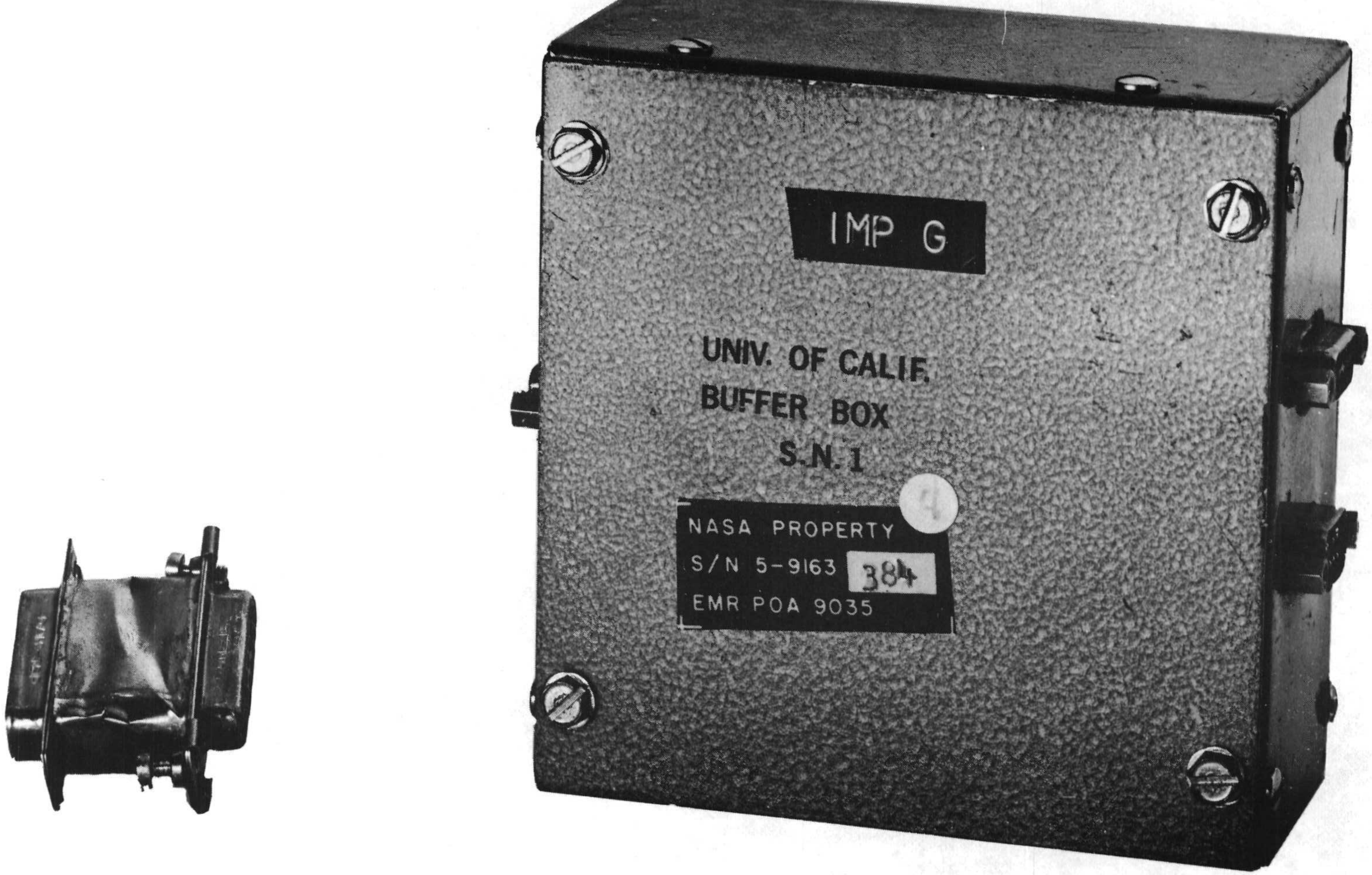


Figure 25 IMP-G GSE Buffer Box

were under automatic or manual control of the GSE. The manual mode of operation permitted application of any single stimulus condition to the experiment in order to facilitate debugging when necessary.

An integral part of this GSE system was the software used in the S/C GSE computer (an SDS 920). This software performed a comprehensive set of tests on the experimental data which lead to a GO or NO GO status for the experiment for each GSE stimulus cycle. The type of cycle was determined by the settings of the CYCLE RATE and STIMULATION switches and was approximately 10 or 20 minutes in length. The six possible stimulation cycles are illustrated in Figure 26. The electrical stimulus subcycle of 10 sequences was similar in concept to that used for the IMP-F experiment. It is illustrated in detail in Figure 27. All cycles were terminated by a special end cycle electrical stimulus which the software recognized. This forced a series of summary calculations and limit tests to be performed, the results of which were presented in a data summary printout which included the GO-NO GO status tag. Limit tests were made on the electrical stimulus data and also on the average rates and a statistical goodness of fit test (Chi Squared Test) for the source stimulation data. If a NO GO status was indicated, various pointers and flags were used to identify the nature of the problem.

This software system could also function in the absence of the GSE hardware. (The software included a test for this). In this case, the operating cycle would become a SOURCE cycle. The cycle rate was determined by a computer panel switch, CS16, which selected a 16 sequence or a 40 sequence source cycle. Additionally, a priority switch,

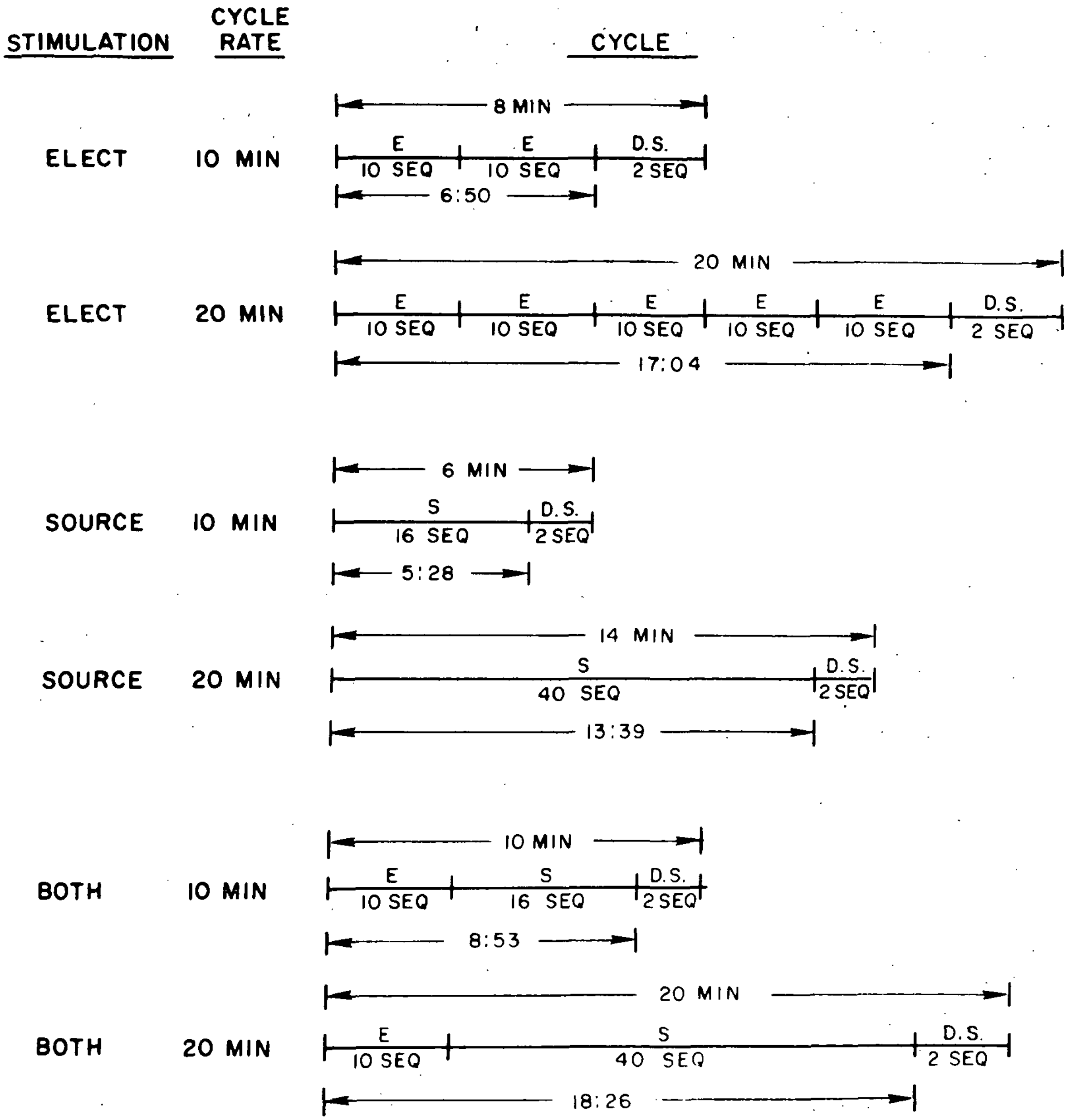


Figure 26 Basic IMP-G GSE Cycles

40.96 SEC (rows 1–2)

ELECT SEQ. NO.	GM CHECKS	STIMULATION	OUTPUTS 3a	OUTPUTS 3b	IC CHECKS	STIMULATION	OUTPUTS 3cd	OUTPUTS 3e	COMPT SENSE CONDITIONS
1	X-TALK @ OUTPUTS + "T" MODE "S" MODE CHECKS	6400 HZ - E1	15359T	0	S.P./2RO's	3abS/2	0 32768	0 1	(E1>K1)(P1<K2)
2		BURST - E2 3200 HZ - E3	2048 31743	0 0		3abS/2	0 32768	0 1	—
3	X-TALK @ INPUTS	6400HZ-E2,P2,E3,P3	0	0	X-TALK @ INPUT	—	0 0	0 0	—
4		6400 HZ-E1,P1,E3,P3 6400 HZ-E1,P1,E2,P2	0 0	0 0		—	0 0	0 0	—
5	X-TALK @ OUTPUTS + 'T' MODE 'S' MODE CHECKS	6400 HZ - P1	0	15359T	S.P.	3abS	32768 32768	1 1	(E1<K2)(P1>K1)
6		BURST - P2 3200 HZ - P3	0 0	2048 31743	D.P.	3abS + 3abE	2048 2048	2 2	—
7	QUIET	—	0	0	QUIET	—	0 0	0 0	—
8		—	0 0	0 0		—	0 0	0 0	—
9	1's	3cdS - E1, P1	1	1	FAST BURST	(200 HZ) (3ab)	32 32	2 2 [2]	$IC_1 > K3$
10		3cdS-E2,P2,E3,P3	1 1	1 1	HIDDEN	3 cdS	1 1	0 0	—

A	END CYCLE	6400 HZ - E1, P1	15359T	15359T	END CYCLE	(800 HZ) (3ab)	8 8	2 2 [3]	$(IC_1 = 8 \pm K4)$ + $(E1 = 15359T \pm K4)$ $(P1 = 15359T \pm K4)$
B	(DATA SUMMARY)	—	0 0	0 0	(DATA SUMMARY)	—	0 0	0 0	—

NOTES:

1. TYPICAL CONSTANTS ARE:
   K1 = 1000
   K2 = 10
   K3 = 20
   K4 = 3

[2] THESE ARE 64 FOR "MODIFIED" FLIGHT ENCODER (4-17-68), SN #04

[3] THESE ARE 256 FOR "MODIFIED" FLIGHT ENCODER (4-17-68), SN #04

Figure 27 IMP-G GSE Electrical Stimulus Format

PSW, was provided on the panel which would force the end of the present cycle and would start a new cycle as determined by the CS16 switch. A further discussion of the GSE software is given in Appendix I.

A block diagram of the IMP-G GSE hardware is given in Figure 28. All electrical stimulus signals are derived from the experiment signals $\overline{X}$ (CAL COM), Y, F3ab, F3cd, and the 6400 Hz clock. These stimulus signals were applied under control of the GM and IC commutators to the Output Drivers (7 ea) and hence to the Buffer Box and then the experiment. A Sync Lost section determined the validity of the GM and IC counter phases with respect to the CAL COM signal. In the event of an internal sync loss, the GSE cycle was automatically stopped and then restarted after regaining internal synchronization. A real time counter display used in conjunction with the F3ab and F3cd (GM and IC) counter displays and the cycle indicators provided a relative indication of the whereabouts of the GSE within a given cycle at any given time.

Rather than the use of counters slaved to the S/C GSE sequences (as was the case for the IMP-F GSE) for overall synchronization of the system, the IMP-G GSE system used four software tests. Three of these, ES1, ES5, and ES9, occurred in the electrical stimulation sequences 1, 5, and 9, respectively. The fourth, DS, occurred during the data summary stimulus.

These test conditions are illustrated in Figure 27.

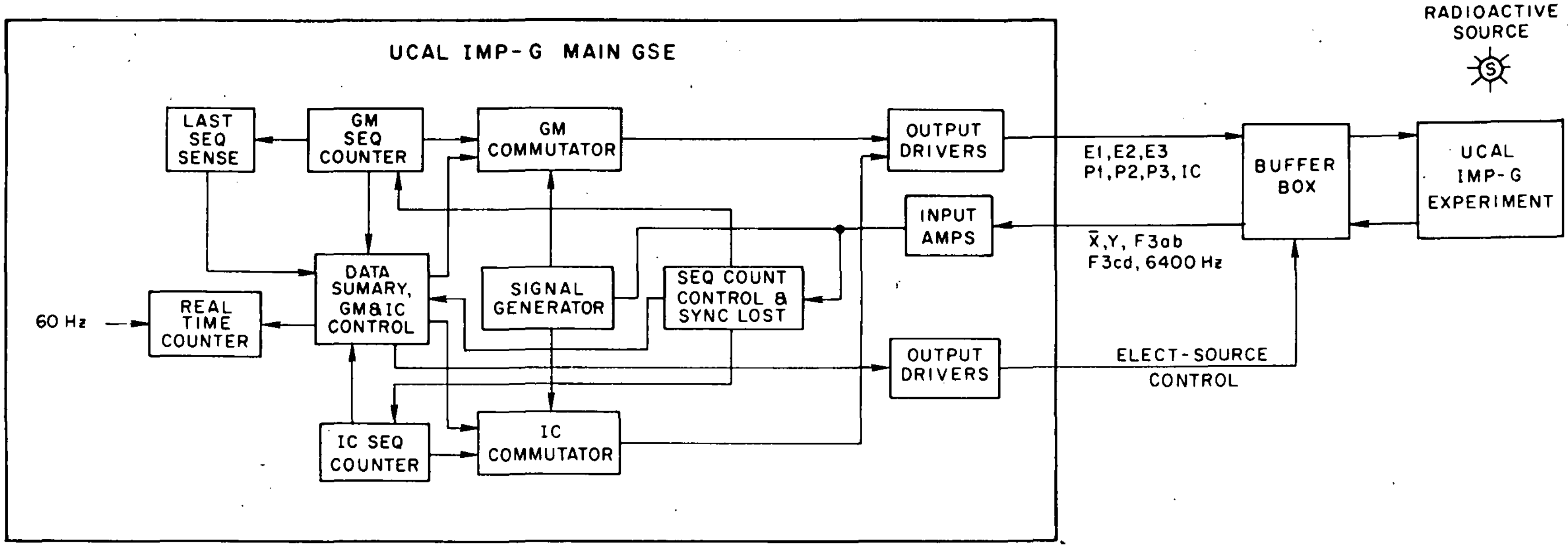


Figure 28 IMP-G GSE Block Diagram

Fabrication and Qualification

The experiment electronics were fabricated by the subcontractor, Marshall Laboratories, Torrance, California. Welded, cordwood, 3-volt logic modules were mounted on two welded subassemblies (daughter boards) and on the main printed circuit board (mother board). The daughter boards contained the commutator logic and the ion chamber logic, respectively. A GSFC supplied "D" frame housed the experiment and the assembly was potted solid with the Ecco-Foam for structural rigidity. Visual and thermal tests were performed at the subcontractor's site prior to accepting delivery. The GM detectors are commercial items, whereas the ion chamber was fabricated at UCAL. The housings for the Gieger-Mueller detectors and other miscellaneous hardware were also built in house. Integration of the detectors and electronics and final assembly were performed at UCAL.

Detector calibrations, thermal, and vacuum qualification tests were done in house. The experiment was potted, vibrated, and magnetically qualified at GSFC. Ground support equipment was fabricated at UCAL.

History

The experimental electronics were accepted from the subcontractor on September 14, 1967. Final assembly and preliminary testing took place from September 15 to October 8, 1967. Thermal and vacuum qualification tests were performed successively between October 9 to October 15, 1967. The experiment was delivered to GSFC on October 18, 1967. It was subsequently potted, vibrated on October 19 and magnetically qualified on October 20, 1967. While it was being integrated with the spacecraft on October 23, a malfunction was discovered. A defective electronic module (apparently the result of vibration tests) was replaced and the experiment integration was completed successively on October 24, 1967. Final calibrations were performed on May 20, 1968 at the Western Test Range and the experiment was successively launched from WTR on June 21, 1968 at 01:48 HRS PSDT.

All detectors functioned normally from launch to present (April, 1972) except for the ionization chamber. The chamber occasionally becomes intermittent or even ceases operation for periods of days to weeks. However, during times when pulses are observed from the chamber the response to incident radiation is normal. Apparently, the tungsten whisker occasionally sticks to the anode resulting in intermittent operation of the chamber.

III. The IMP-G' (S2) Experiment Aboard Explorer-41

Introduction

The University of California experiment flown aboard Explorer-41 was one of two experiments flown as replacements for the STL-TRW experiment which was on the IMP-F spacecraft. The other replacement experiment was supplied by the University of Iowa. An illustration of the University of California experiment is given in Figure 29.

Various "ground rules" were established by the GSFC IMP project management as to how this replacement would be made. First, it was necessary that the two replacement experiments, basically, appear as a single experiment to the spacecraft. As a result, the UCal experiment plugged into and interfaced electrically through the UIowa experiment. Additionally, these two experiments were restrained to the size, weight, power and electrical interface requirements that had been established for the STL-TRW experiment.

A number of problems were experienced in producing a flight qualified experiment. Some of this could be traced back to the restrictions imposed by the original ground rules. For example: (1) the severe size restraints placed on the UCal experiment led to many difficulties in the repairability of the experiment; (2) dependency on the UIowa experiment during qualification testing caused several problems.

Another significant factor was a time-management related problem. Originally it was expected that a flight qualified experiment would have to be available within 6 months or less. (A contract go ahead was given in September, 1967, with an anticipated launch of

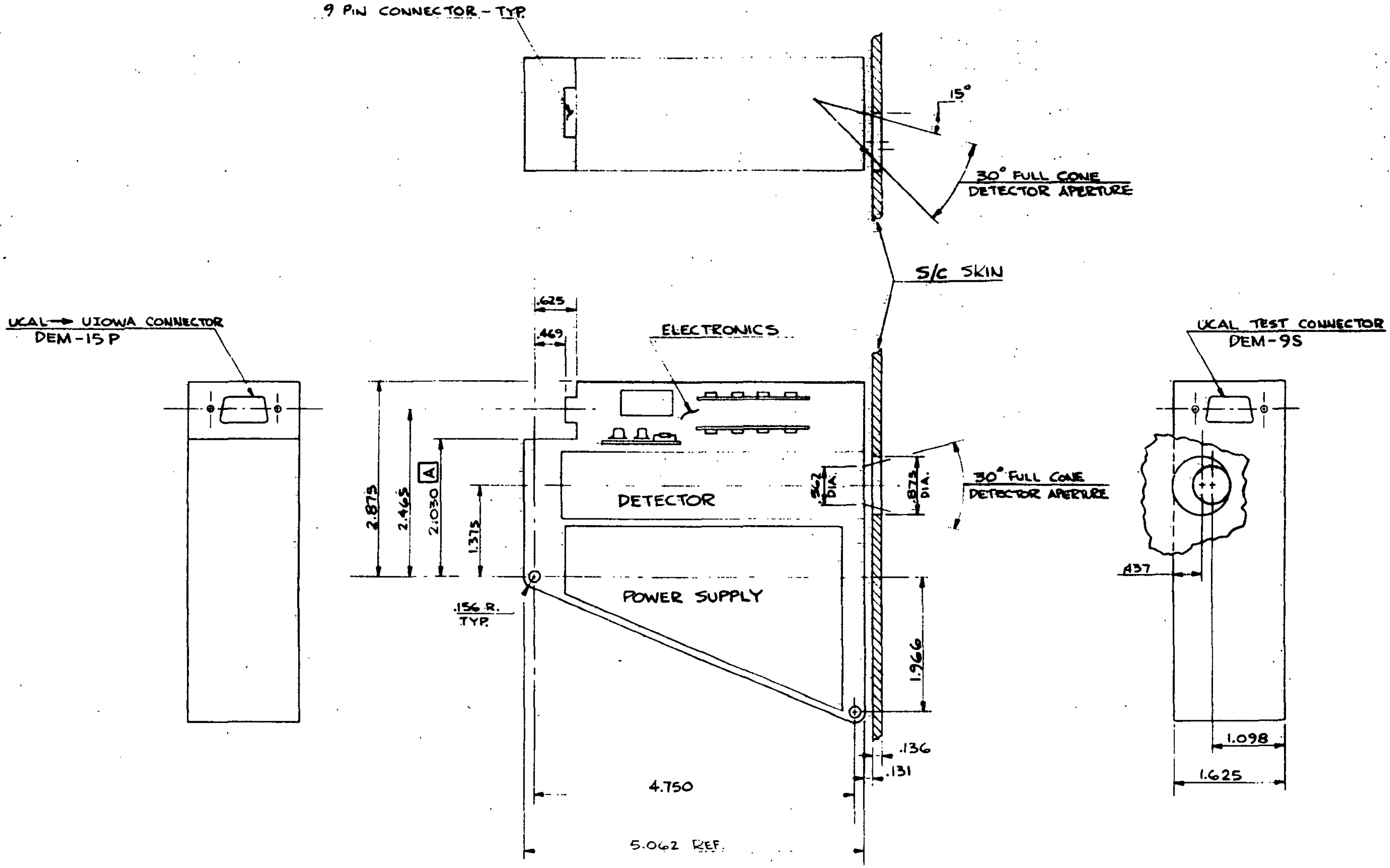


Figure 29 The IMP-G' Experiment

May, 1968.) Thus, a rather tight schedule was anticipated. However, the spacecraft schedule eventually slipped about 1 year. University of California attempted to take advantage of these spacecraft schedule slips by making several experiment modifications for the purpose of improving the science and engineering of the experiment. Some of these changes proved to be detrimental very late in the program. The experiment was never fully integrated into the spacecraft until a few weeks before launch. And, indeed, there was a serious interference problem from the UIowa to the UCal experiment which was the result of sensitivity modifications to the experiment that had been made several months earlier. These and other problems are pointed out in the Pre-Launch History section.

Description of the Detectors

This experiment consists of a parallel plate electrostatic analyzer with two funnel-mouthed channel multiplier detectors located at different distances along the analyzer plates to provide two energy windows for electrons. Figure 30 gives a schematic of the detector system and Table 4 summarizes the detector characteristics. The entrance aperture is pointed 30° above the satellite equatorial plane, and a sun shield is utilized to prevent solar ultraviolet radiation from entering the aperture. In addition the plates are coated with a lamp black coating to prevent scattered UV from entering the channel multipliers. The energy response is shown in Figure 31. The experiment was designed with large geocentric factors to detect low solar electron fluxes. In the magnetosphere the trapped radiation will saturate the channel multipliers and thereby shorten their lifetime. To increase the useful life of the experiment an automatic shutoff circuit was employed which turned off the high voltage to the plates and channel multiplier when the number of counts exceeded eight in 2 msec in channel 1.

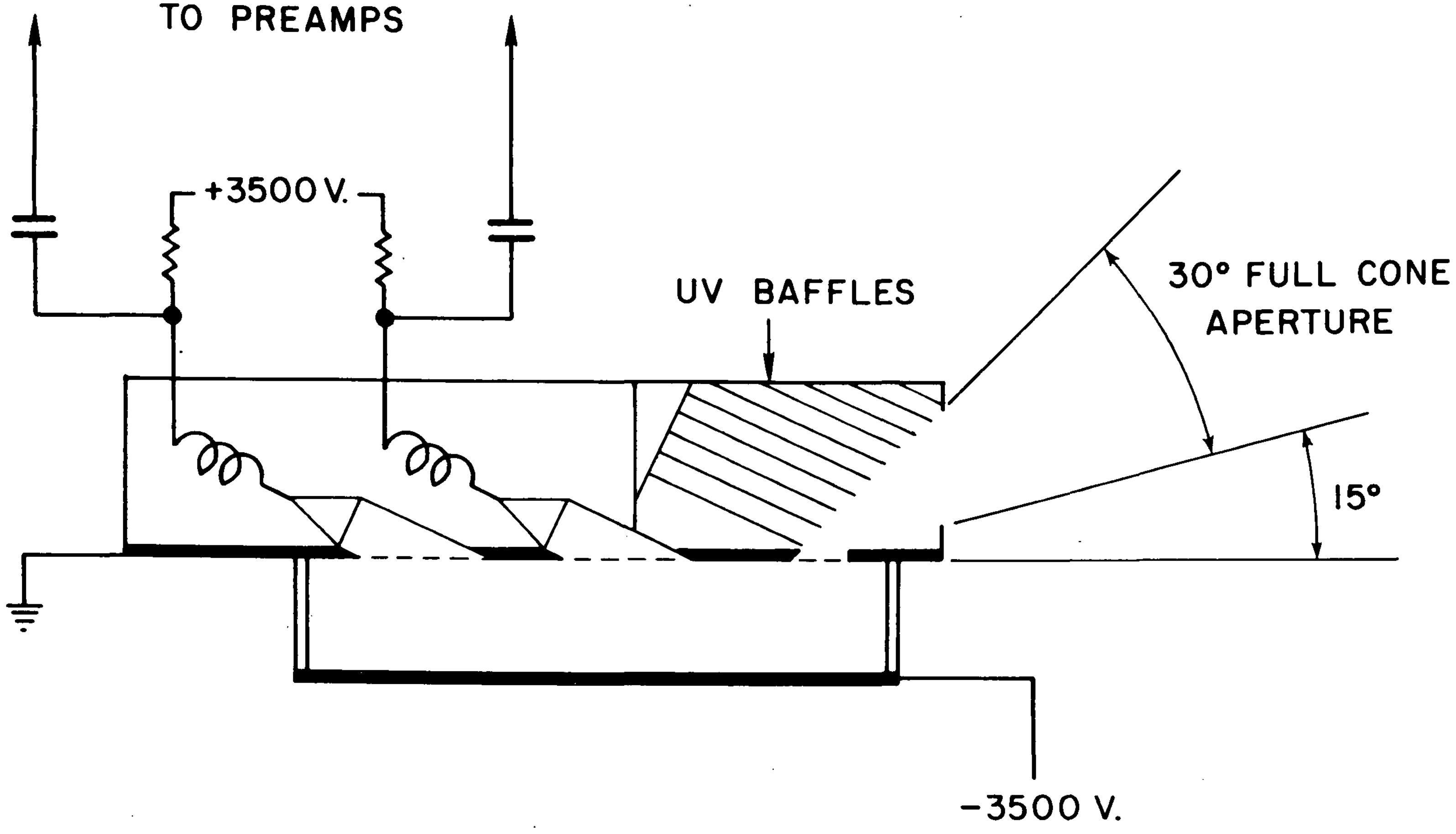


Figure 30 IMP-G' Electrostatic Analyzer

Table 4 IMP-G' Detector Characteristics

	Channel 1	Channel 2
Electron Energy Range (fwhm) keV	4 - 8	9 - 13
Geometric Factor (cm^2 ster)	0.05	0.013

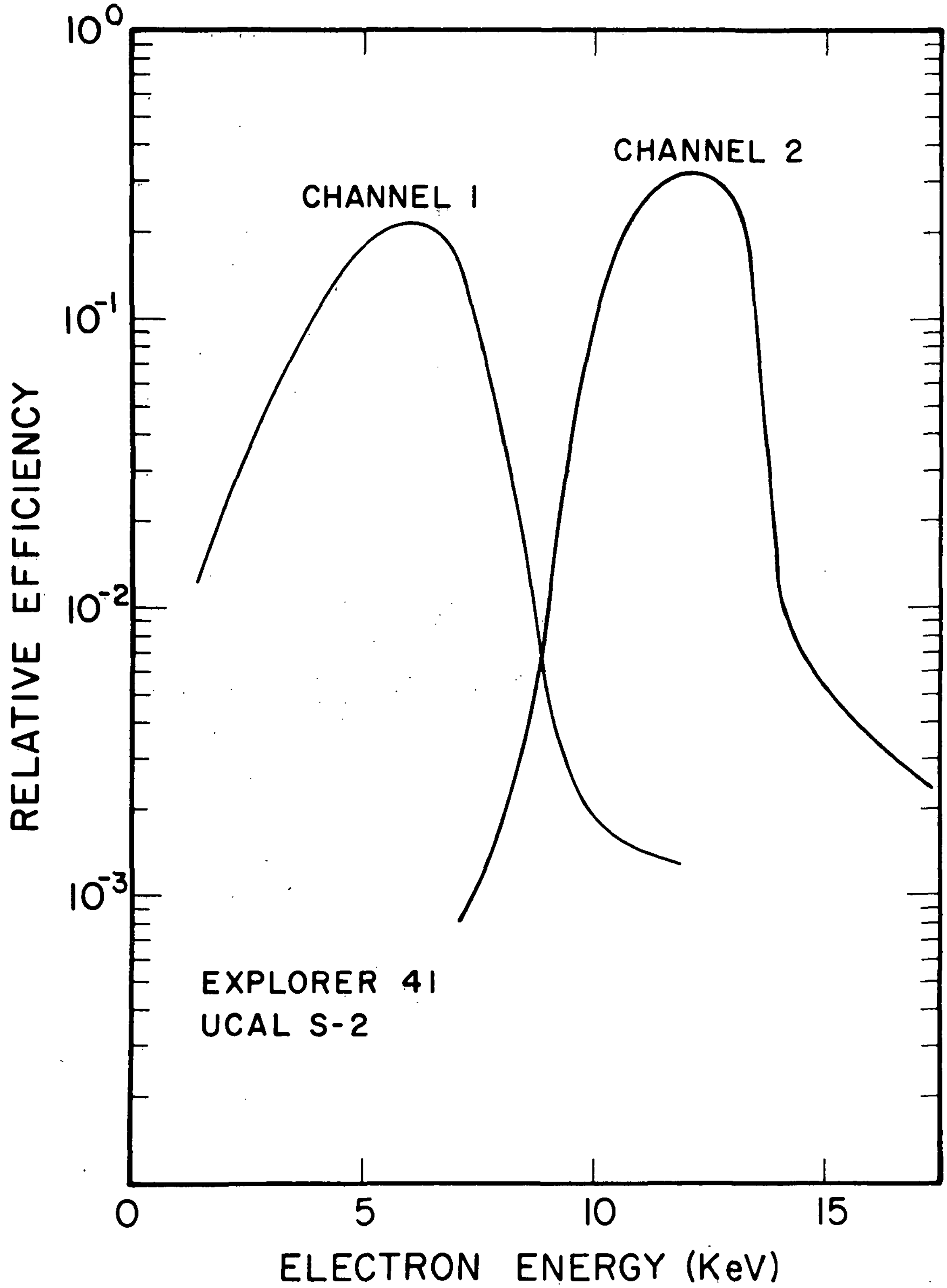


Figure 31 Energy Response of Electrostatic Analyzer

<u>Experiment Electronics Description</u>

Signals from each of the detectors are amplified and shaped by preamplifiers which feed AND gates as indicated in Figure 32. The AND gates are disabled during the STL freeze time of 0.48 seconds which overlaps the freeze and readout time of the accumulators. The gate outputs are prescaled by 16 and feed the output drivers, OD, which provide the drive to the #2a and #2b accumulators after passing through the UIowa experiment. (The #2a signal is subcomutated by UIowa--see below.) The detector data rates, R, for the accumulators is given as

$$R = (N \times 2^4)/(5.12 - 0.48)$$
$$= 3.448\,N$$

where N is the accumulated counts.

The output of the D1 detector preamplifier is monitored by an automatic high voltage shut off circuit. This signal feeds a 2^7 counter which is reset at a 500 Hz rate. If 2^6, 64, pulses are received within the 2 ms period, 32 kHz rate, the control Flip-Flop is set which turns off the high voltage and also resets the 2^{10} counter in the automatic turn on circuit. (It should be noted that as flown, the shutoff circuit actually responded to 8 pulses in 2 ms, 8 kHz rate -- see Pre-Launch History, par. 22.) After 2^{10} counts of the 5.12 second period freeze signal (i.e., 5243 seconds or 1 hr 27 min 23 sec) the control Flip-Flop is toggled to a reset condition which allows the high voltage to turn on.

The +3.5 kv used by the detectors and the -3.5 kv for the electrostatic plates was generated by a chopper driven DC to DC converter feeding two 5 stage voltage doublers. Voltage regulation of

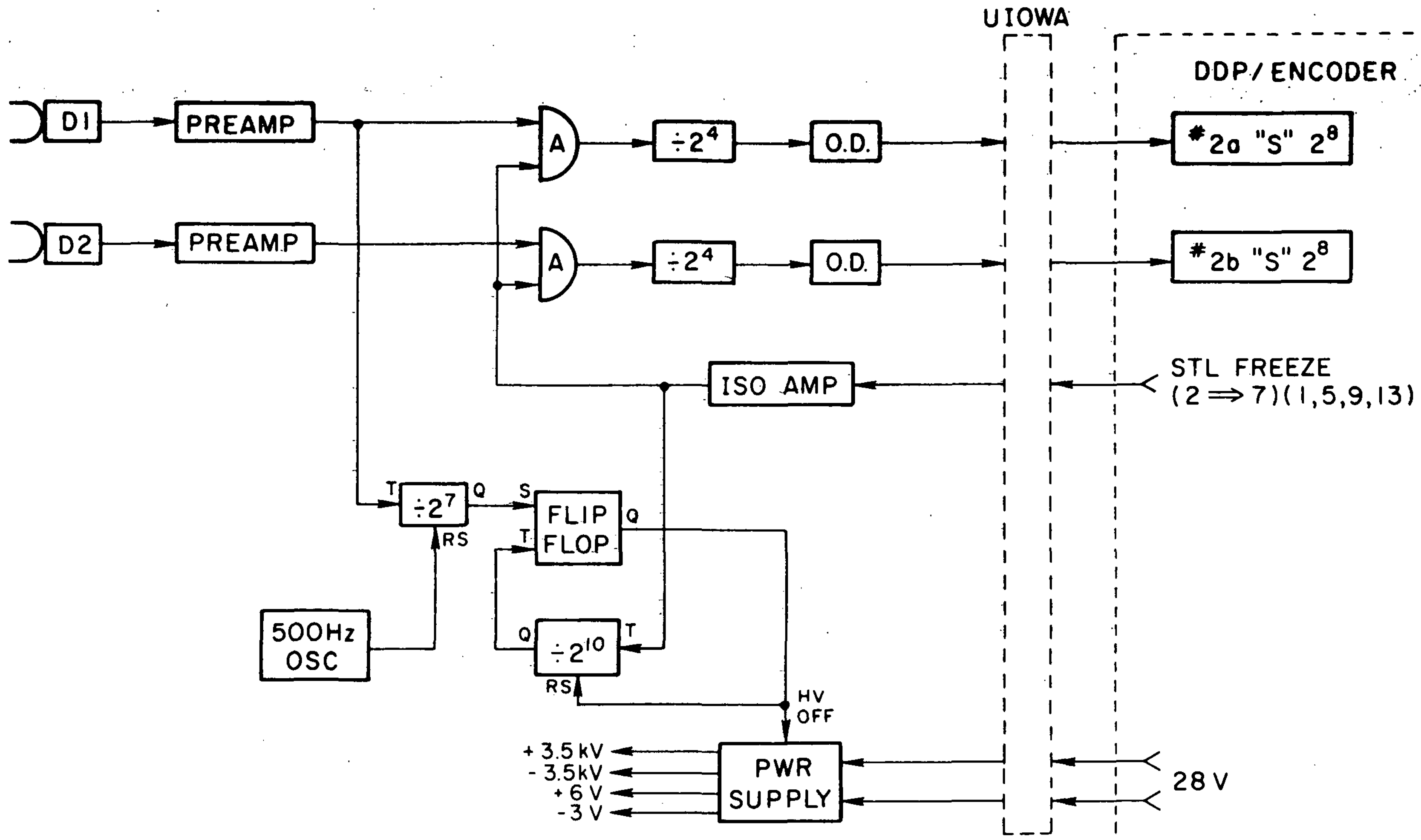


Figure 32 IMP-G' Experiment Block Diagram

both multipliers was provided by use of a 700 volt corona discharge regulator tube operating in the first stage of the +3.5 kv multiplier. (See detailed schematics in Appendix IV.) High voltage shut off control was provided by blocking the base feedback currents to the chopper transistors.

An additional chopper driven DC to DC converter using two full wave rectifiers produced the +6 volts and the +3 volts. A voltage doubler was used to generate +12 volts for operation of the HV shut off circuit within the power supply itself.

Specifications

MECHANICAL - THERMAL

1.	Total experiment weight, potted:	1.18 lbs
2.	Overall dimensions (excluding sun shield):	5.0" W x 5.1" D x 1.6" H
3.	Operating temperature range:	$-15^{\circ}C$ to $+45^{\circ}C$

ELECTRICAL

1.	Input power	
	a. Voltage:	28 volts ± 5% regulation
	b. Current:	25 mA
		14.2 mA (HV off)
	c. Power:	700 mW
		400 mW (HV off)

2. STL FREEZE sync signal

a. True state:	$\leq$ -3V @ 20 kΩ
b. False state:	$\geq$ +6.5V @ 10 kΩ
c. Rise and fall times:	< 5 μ sec
d. Period:	5.12 sec
e. True state width:	0.480 sec

3. Accumulation inputs

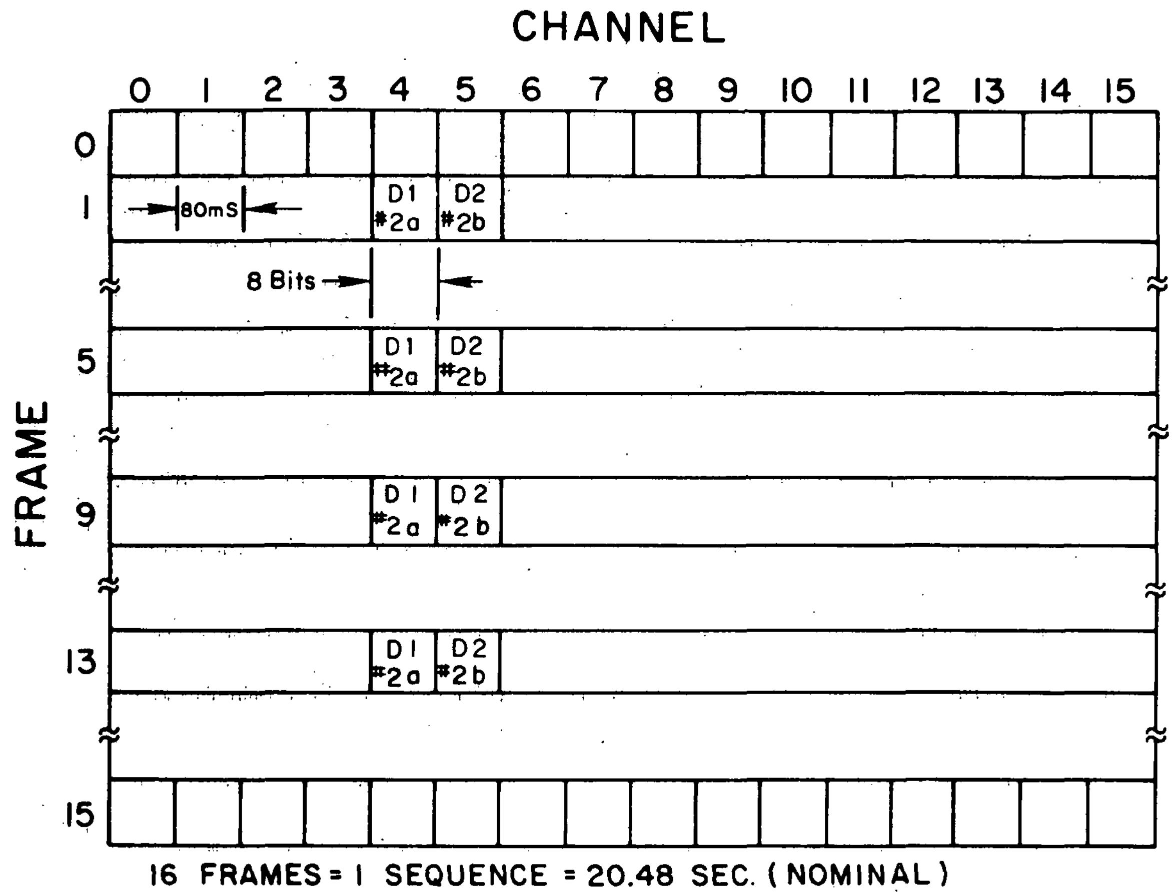
a. Amplitude:	+3.5V to +7V (6V nominal)
b. Pulse width:	> 3 μ sec @ 3.5 V
c. Base level:	-5V to +0.5 V
d. Maximum frequency:	51.2 kHz

Telemetry

The UCal IMP-G supplementary experiment uses two 8 bit "S" type accumulators #2a and #2b. The #2a accumulator is used for the D1 detector data and #2b is used for D2. As indicated in Figure 33, these accumulators are readout 4 times per S/C sequence, each 5.12 seconds, in sequences 0 through 7, only, of the 16 sequences. (In sequences 8 through 15, these telemetry slots are occupied by analog data.) Readouts occur during frames 1, 5, 9 and 13, however, D1 data is only present in frame 13 of sequence 0. (The UIowa experiment uses frames 1, 5, and 9 of sequence 0.) The accumulators are frozen simultaneously and readout as successive hexadecimal, 4 bit, bursts, the least significant bits first, into the telemetry stream. The accumulators are reset to binary ones after readout.

Ground Support Equipment

Ground support equipment for the IMP-G' experiment consisted of a Bench Checkout Box -- there was no deliverable set of GSE.



NOTE: Acc's #2a and #2b in Seq's 0 through 7 only (of 16). In Seq 0 D1 in Frame 13 only.

Figure 33 UCal IMP-G' Telemetry Format

This Bench Checkout Box, Figure 34, provided the basic functions to exercise the experiment. Stimulus to the detector channels was available at a 500 Hz or 1000 Hz rate. By use of the STIMULUS switch, stimulus could be applied to either data channel independently or to both channels at the same time. An additional switch disabled this stimulus and applied a 85 kHz signal to the D1 channel for checking the HV disable function in the experiment. The STL FREEZE signal could be applied at a 20 Hz rate or turned off via the FREEZE switch. Power was derived from a 6.2 volt zener diode.

Fabrication

All mechanical and electrical fabrication for this experiment was done in house at University of California. The channel multiplier detectors were commercial items; however, the electrostatic analyzer was fabricated in house. Electronic packaging included the use of the SN500 series of RTL logic and discrete component cordwood modules. The experiment was housed in a University of California built half "D" frame with top and bottom covers. High voltage potting was done at the University of California, whereas, final potting of the experiment with Eccofoam was done at GSFC. The Bench Checkout Box was fabricated at UCal.

Pre-Launch History and Qualification

The pre-launch history and qualification of the IMP-G' experiment is given in summary form in Table 5. And, further details are given in the referenced paragraphs below. The flight unit was SN#02; however, the history of both the SN#01 and SN#02 units is given since the successful qualification of the SN#02 unit was closely related to the SN#01 unit.

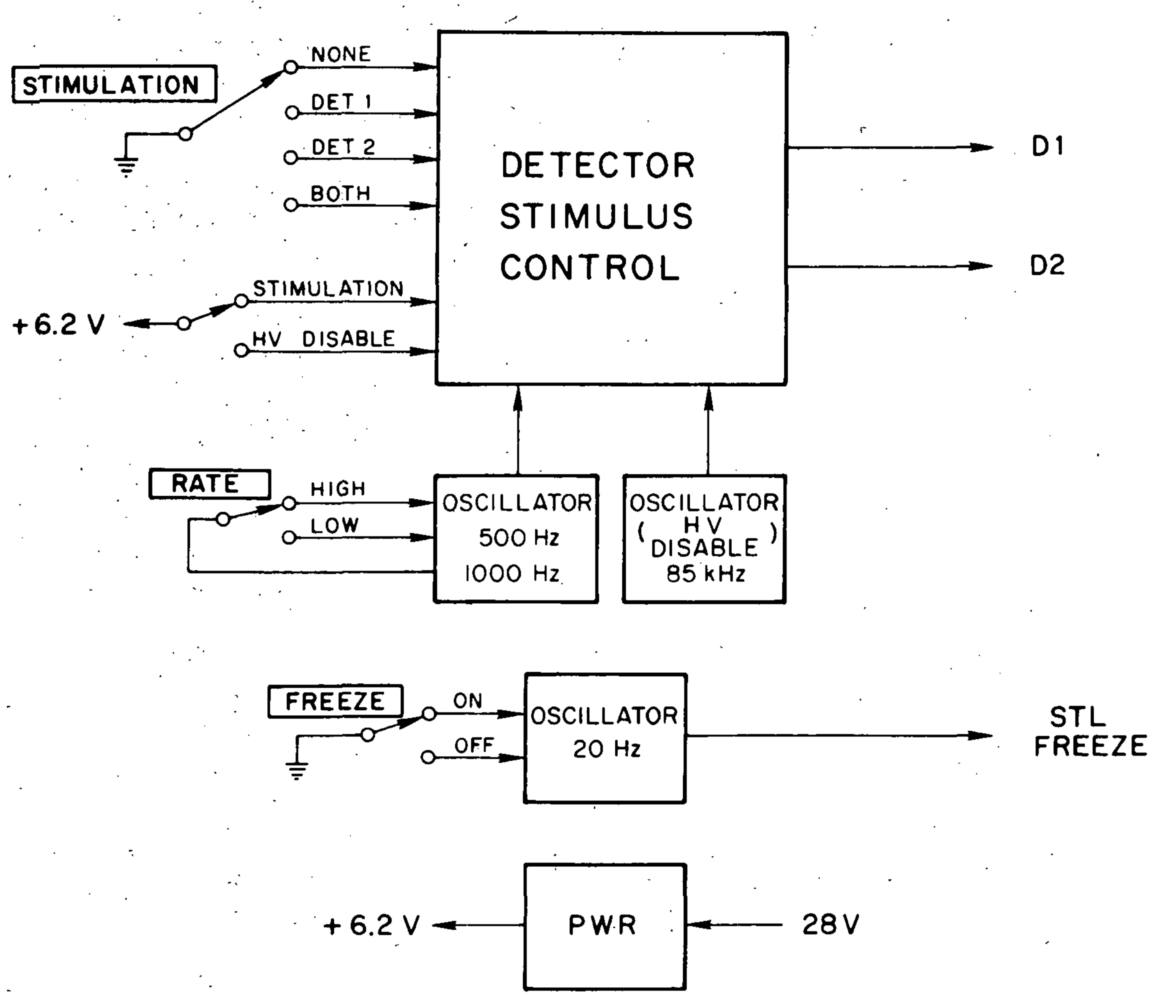


Figure 34 IMP-G' Bench Checkout Box Block Diagram

TABLE 5 HISTORY SUMMARY OF THE IMP-G' EXPERIMENT

DATE	S/N 01	S/N 02	ITEM	REF. PAR.
9/21-11/10/67	X		Fabrication	---
11/13/67	X		Magnetic tests and potting at GSFC. Magnetic test indicated stray fields from HV disable relay outside of specifications.	---
11/29/67	--	--	New HV disable circuit designed and approved by GSFC.	---
11/10-1/31/68		X	Fabrication	---
1/31-2/5/68		X	In house testing	---
2/8/68	X		Magnetic tests. Potting and vibration tests at GSFC.	---
2/9-9/25/68	X		HV disable circuit modified. Channeltron detectors replaced because of possible mechanical stress mounting problems.	
3/22-4/5/68		X	S/C ther-vac tests. Test aborted	1
4/9-4/11/68		X	Subsystem ther-vac test.	2
9/25-9/29/68	X		In house testing.	
10/1/68	X		Magnetic tests and potting at GSFC.	---
11/13-11/25/68	X		S/C ther-vac tests. Test aborted.	3
12/17-12/20/68	X		Subsystem ther-vac test at UCal. HV enable inoperative below +12°C.	---
12/27/68	X		In house tests and repairs	4
2/14/69	X		Potted and vibration tests at GSFC.	---
2/17-2/20/69	X		Subsystem ther-vac test of UCal-UIowa.	---
3/26-4/4/69	X		S/C ther-vac. Test aborted	5
1/7-1/10/69		X	Subsystem ther-vac test of UCal-UIowa. Test aborted.	6
2/20-4/5/69		X	Modifications to pre-amp sensitivity and HV supply	7
4/8/69		X	Magnetic tests, potting and vibration tests at GSFC.	---

TABLE 5 (cont)

DATE	S/N 01	S/N 02	ITEM	REF. PAR.
4/9/69	X	X	In house management changed. Both units in ther-vac at GSFC. Unit 01: input current spikes - corona? Unit 02: many HV turn-offs - noise?	8
4/9/69		X	Chamber vented and opened. Attempts to reduce noise problems by changes in the set up (cables, grounds, etc)	9
4/10/69		X	Ther-vac restart. HV turn-on problem.	10
4/11/69	X	X	Removed from ther-vac. Both units returned to UCal for debugging.	---
4/11/69	X	X	Started tests at UCal.	11
4/11-12/69		X	1st confirmation of continuous HV turn-off malfunction.	12
4/12/69		X	Top cover removed. And, 2 millisecond reset oscillator probed.	13
4/12/69	X		1st confirmation of I_{in} spikes.	14
4/12/69		X	Mother board electronics released from experiment frame. Malfunction gone!	15
4/14-4/15/69		X	Mother board remounted in frame. Further testing.	16
4/15/69	X		Excess counts observed in output channel due to corona.	17
4/17/69	X	X	GO-NO GO decision being made at UCal and GSFC.	18
		X	Ready for "transplant."	---
	X		NO-GO	---
4/18/69	X		Testing electronics -- FREEZE pulse problem.	19
4/18/69		X	Mother board transplant and electrical tests.	20
4/19/69		X	Thermal tests (UCal).	21
4/19/69		X	Ther-vac tests (UCal).	22
4/20/69		X	Returned to GSFC for potting, vibration and ther-vac.	23
4/23/69		X	Ther-vac set up -- X-talk problem.	24
4/24-5/1/69	X		Vac tests to find exact cause of corona problem.	25
4/25/69		X	Operational check in CTA S/C	26
4/25-5/6/69		X	Ther-vac tests at GSFC.	27

TABLE 5 (cont)

DATE	S/N 01	S/N 02	ITEM	REF. PAR.
5/6/69		X	T & E chamber lost vac. HV was on approximately 6 minutes.	28
5/6/69		X	Ther-vac restarted. (Chamber # 241).	---
5/6-5/9/69		X	Ther-vac (GSFC).	29
5/9/69		X	Final deperm, top cover removed and pictures taken for degassing analysis.	---
5/9/69		X	Experiment returned to UCal, Berk. for further X-talk checks.	---
5/12/69		X	X-talk checks.	30
5/15/69	X	X	Design review meeting at GSFC. Passed.	---
5/20/69		X	Integration at WTR. Interference pickup problem.	31
5/22-5/23/69		X	Interference tests and repair at UCal.	32
5/26/69		X	Integration.	---
6/21/69		X	Launch	33

1. During the S/C thermal-vacuum tests of 3/22 to 4/5/68, no data output was observed for the SN#02 unit. This was due to a blown fuse in the UIowa power line interface to the UCal experiment. (Malfunction report A-02756.)

2. A separate subsystem thermal vacuum test of UCal SN02 was performed. Six hours at -10°C and 3 hours at +40°C. Operation was satisfactory.

3. Spacecraft thermal-vacuum tests were being performed on the SN01 unit from 11/13 to 11/25/68. On 11/19 no counts were observed on detector #2 at low temperatures apparently due to a faulty Flip-Flop. (Malfunction report A-03360.) On 11/21 the high voltage would not turn on at low temperatures. This was due to a faulty Flip-Flop in the HV enable circuit. (Malfunction report A-03304.)

4. The SN01 experiment was returned to UCal on 12/27/68. Bench checks indicated both channels were operating. High voltage enable failure was diagnosed to be due to faulty Flip-Flops which were replaced. Possible high voltage arcing during accidental high voltage turn on in poor vacuum resulted in several more Flip-Flop failures. (Malfunction report A-03422.) Inspection of the high voltage supply indicated that potting compound (Silgard) was peeling off some areas of the circuit board. These portions of the board were repotted in RTV after the detector coupling capacitor was reoriented to eliminate some of the high voltage circuit board pads.

5. From 3/26 to 4/4/69 spacecraft thermal-vacuum tests were being performed on the SN01 unit. The experiment was operational until 4/1/69 during high temperature turn-on when the experiment drew excess current of ~5 mA and high counts were observed in channel 1.

6. A subsystem thermal-vacuum test of the combined UCal-UIowa experiments was performed from 1/7 to 1/10/69. Twenty-four hours at -10°C followed by 24 hours at +40°C. However, after 22 hours at +40°C the UIowa low voltage supply failed and, thus, terminated the test. (See Malfunction report A-003302.) The UCal unit operated satisfactorily throughout the test. No damage to unit was observed. Some anomalies were present in the data which were found to be due to the poor test equipment available and the long unshielded cabling used by UIowa.

7. The SN02 unit was returned to UCal on 2/20/69. More sensitive pre-amps were installed and the logic circuits were completely retested. The high voltage supply was revised to eliminate the air bubble problem found in the prototype supply. Both circuit boards were potted with RTV to eliminate peeling. Leads to detectors were mounted in shielded Kel-F boxes.

8. In house management was changed on 4/9/69 in order to place a high priority on this experiment. Both units were in subsystem thermal-vacuum tests at this time. The general problems being experienced were: Unit 01 -- input current spiking and/or drawing 5 to 10 mA excessive input current. Unit 02 -- various random automatic high voltage (HV) turn-offs.

It was concluded that the 01 unit probably had a corona problem and would require a laboratory analysis. Thus, efforts were concentrated on the 02 unit since this appeared to be an external interference problem. After a few preliminary tests (exchanged GSE, cables, etc.), it was obvious that the chamber would have to be vented and the door opened in order to further investigate the interference problem in this unit.

9. The chamber was vented and the door opened on April 9. It was discovered that the major interference source was the "MVRC" control system near this chamber (#241). The experiment HV would only stay on approximately 1 to 30 seconds with the MVRC on. Several techniques reduced the interference to a near acceptable level: (1) connecting the experiment frame to the signal common; (2) adding a series resistor to the FREEZE signal line; (3) capacitive filtering of the noise spikes on the 28 volt power buss (these were approximately 1 v p-p without filtering); (4) elimination of the ground loops in the set up.

After discussions with the IMP-G project office, it was decided that the MVRC could be left off during further ther-vac testing and preparations were made to restart the test.

10. The chamber door was closed by 1200 hours on 4/10. Power was applied to the experiment at 1800 hours. The HV would not stay on for more than about 0.5 second. Additional testing revealed that these HV turn-offs were not what was experienced before and that the most probable cause was a loss of the reset signal to the 2^{10} counter which would then allow the normal radioactive source rates to cause a HV turn-off in less than 1 second.

11. Preliminary checks were performed on both units on 4/11. Operation was normal. The 02 unit was then put into a cold soak and the 01 unit was put under vacuum conditions.

12. On 4/11 and at -12°C the 02 unit's automatic HV disable circuit malfunctioned. The HV would turn-off with "LO" GSE electrical stimulation. This confirmed the results at GSFC. This malfunction appeared to occur only below ambient temperatures.

13. The top cover was removed on 4/12 and the Eccofoam was removed from the electronics area to allow probing of the suspected 2 ms reset oscillator. While reporducing the failure mode on the bench with Propellon, it was confirmed that two stages of the oscillator were operating properly. The third stage was not accessible without removal of the mother board electronics from the experiment frame.

14. On 4/12, after the experiment had been in vacuum overnight, the door was opened to set up for a hot vacuum test. The door was closed and the temperature raised at 1330 hours. At about 1700 hours while at + 40°C and 1 x 10^{-6} mm Hg the first spiking of the input current began to occur.

15. The mother board electronics was released from the experiment frame to allow further testing (probing) of the malfunction. However, from this time on it was not possible to reproduce the previous failure mode after repeated efforts on 4/12, 4/13, and 4/14!

16. On 4/14 the mother board was remounted in the frame and further attempts were made to induce the failure mode throughout the day without success. It was decided by UCal that it would not be necessary to have an automatic HV disable function in this 02 experiment because of the high gain pre amps that were being used. (Laboratory testing of the degragation properties of the channeltrons -- simulated radiation belt passes -- showed that the experiment would operate satisfactorily under these conditions.) On the assumption that this unit could be flown without the automatic HV disable function (by cutting a single wire) a complete thermal test was then performed on this unit.

17. On 4/15 the first evidence of excess counts was observed in the channel outputs due to the corona problem while at -3°C and 6 x 10^{-7} mm Hg. The experiment had been under continuous vacuum for about three days at this time. In addition, the input current displayed the following conditions during these three days: (1) Normal input current (2) Excess input current (3) Random positive spiking from the normal input current level (4) Random negative spiking from the excess input current level (5) A general tendency to drift from the excess current level towards a normal current level (6) Very erratic spiking between these two current levels. It was during (6) that the excess channel counts were observed.

18. Various conversations were being held on 4/17 between the UCal and IMP-G project office personnel to decide whether these two experiments were worth pursuing further under the present conditions. It was decided that a final "all-out" attempt should be made to try and save at least one of these experiments. It would also be necessary to prove to a GSFC design review board that no corona problem could be expected in the flight unit. The plan was as follows:

The 01 Unit: This unit would undergo a quick vacuum check in the hopes that the corona problem was reproducible in approximately 1-3 hours. If this was the case, then a quick fix would be made on the assumption that we knew where the corona problem was. Then, the unit would go back into vacuum tests for at least 6 hours and if the corona problem did not reappear it would be assumed that the problem had been corrected.

The 02 Unit: It would be necessary to have an operational automatic HV disable circuit in this unit. It was not reasonable to expect to repair the present mother board electronics. This unit's mother board would be removed in preparation for a "transplant" of the mother board from the 01 unit. The high gain pre amps would be retained in this unit if the transplant were to take place.

The 02 unit was prepared for the transplant and the 01 unit was put back into a vacuum test. After 4-1/2 hours of vacuum testing on the 01 unit, no corona had occurred and a NO-GO decision had to be made on this unit.

19. Operational checks of the 01 mother board electronics were being performed on 4/18 in preparation of the transplant into the 02 unit. During this test a design problem was discovered with the interface of the FREEZE sync signal to the TI 510 Flip-Flop in the 2^{10} counter. (This is used for the automatic HV turn-on function.) It was found that the ISO SMP which was driving the 510 Flip-Flop would provide a fall time of only about 1 to 2 μs which is a border line condition for these Flip-Flops particularly at low temperatures. In order to preclude this problem of proper turn-on, it was determined that an additional 500 series gate would be necessary between the ISO AMP and the 510 Flip-Flop to provide adequate fall time. A 516 gate was added to the circuit by mounting it on a small p. c. board which was in turn mounted to the side of the mother board. This mounting technique was used to prevent any unnecessary disturbance of the integrated circuit logic which was already in place and potted on the mother board. A complete operational check of the mother board was then performed successfully.

20. The 01 mother board was transplanted into the 02 unit on 4/18. During testing of the electronics it was found that 2 adjacent magnet wires had developed an intermittent short. This was corrected by rerouting of these magnet wires. An operational bench check was then performed satisfactorily.

21. A thermal test was performed on the 02 unit with the HV kept in a disabled condition by means of a shorting plug on 4/19. Complete electrical performance was monitored throughout the test which consisted of 2 hours at -15°C and 1-1/2 hours at +45°C. Operation was normal.

22. A thermal-vacuum test was run on 4/19 and 4/20. The experiment was under vacuum conditions for 24 hours during this test. The test consisted of a +40°C hot soak for 13 hours and about 5 hours at -10 to +10°C. (There were equipment problems in holding a cold temperature with this vacuum system.) The input current was continuously monitored during the test and stimulation was provided by a radioactive source and an electron gun.

The significant results observed during the test were: (1) No evidence of corona was observed; (2) The channeltrons characteristically behaved as if they were "dirty" (water vapor or other gases present in the channels) when HV was first applied to them after only a few hours in vacuum. This characteristic produced some erratic and high counts for several minutes and typically would cause about two HV turn-offs before beginning to settle down. (3) The channeltrons continued to display a subdued erratic behavior during the 24 hour test which was particularly noticeable in channel 2. But, there was a general trend of both channeltrons to "clean up" the longer they were under vacuum and the longer they were run.

During this test one "problem" was noted with the automatic HV turn-off circuit. It was found that a turn-off would occur at a 4 KHz rate rather than at the 32 KHz rate as expected. (The turn-off rate is sensed by a 2^6 counter which is reset every 1-1/2 hours.) From discussions with UCal personnel it was discovered that three additional Flip-Flop stages (factor of 8) had been added to the counter some time ago. And, there was reason to believe that this 4 KHz turn-off rate had existed in both units since that time. It, thus, appeared likely that this problem was the result of a layout or wiring problem (e.g., no reset to these 3 stages) rather than a malfunction. It was decided that this condition should be left as is since (1) the turn-off at a lower rate would not harm the science of the experiment; (2) the turn-off at the 4 KHz rate otherwise appeared normal and consistent; (3) it would provide a faster turn-off if a corona problem ever existed; and (4) a major rework of the electronics would be required to correct this condition and sufficient time was not available due to the further extensive testing required at GSFC before the experiment could be considered qualified to fly.

23. The 02 unit was returned to GSFC on 4/20 for potting, vibration, and thermal-vacuum qualification. Potting was performed on the evening of 4/20. Vibration and CG measurements were completed on 4/21. At 1500 hours on 4/21 the thermal-vacuum test was being set up at T & E.

24. At about 1330 hours on 4/13 while performing operational tests of the experiment in the vacuum chamber prior to closing the door it was discovered that a cross-talk problem existed between both data channels. Electrical stimulation was being used from the GSE which

provides a "LO" rate of about 500 Hz and a "HI" rate of about 1 KHz. These signals are inserted at the outputs of the post amps where they enter the ÷ 16 prescaler (same in both channels). It was found that with stimulation of a single channel the X-talk rate on the non-stimulated channel was 1/16 the output rate of the stimulated channel (1/256 of the GSE stimulation rate).

After considerable testing to locate the X-talk mechanism, it was found that it was not entering through the cabling system. But, it had to be picked up at the pre amps since normal saturated signals were observed at their outputs during the X-talk conditions. The conclusion reached was that this X-talk was due to the high output pulse currents which induced X-talk internal to the experiment due to the large coax cable capacitive loads being used in the set up. This was confirmed by reducing these pulse currents with a 300 ohm series resistor in series with output leads at the experiment which stopped the X-talk.

Further investigation at the UCal laboratory revealed that the ground returns for the pre amps were in series with the output stage returns on the printed circuit layout. Also, the unloaded output pulse rise and fall times were about 100 ns. A simulated test was performed on the 01 mother board to determine the approximate impedance of this common return line. It was found that driving a 10 mA pulse with 100 ns rise and fall times through this line produced drops of about 3.5 mv and about 5 mv on the return lines of the pre amps. With about 150 pf loading on an output stage producing pulse currents of approximately 4.5 mA and a pre amp sensitivity of about 2 mv/100 ns, it was quite plausible that this was the mechanism being observed at GSFC.

As a result of the above, it was determined that a S/C interface check should be performed before proceeding to determine if this X-talk condition would exist in the S/C. (There was no information available at this time on either the UIowa or the encoder cabling capacitive loading to the UCal experiment.)

25. From 4/24 to 5/1 tests were being performed on the 01 unit to determine the exact cause of the corona problem. After running this unit at vacuum conditions for 24 hours, no corona was observed. It was then decided to disconnect the channeltron HV leads so that the experiment could be run at any pressure in the hopes that the corona could be induced again more quickly. (The channeltron HV lead areas were spot potted.) This technique proved to lead only to a "blind alley."

On 4/26 at 1830 hours the unit was put back under deep vacuum conditions and in a hot soak. At about 1900 hours on 4/27 input current spiking had begun to reappear. By 1100 hours on 4/28 the spiking had become sufficiently regular to make a correlation between the spiking and a visual observation of corona near the channel 1 area of HV stack. The temperature was then lowered slowly and at 1200 hours on 5/29 the input current went into the excess current mode and (a very weak) continuous corona was observed in the high voltage area. (It was very difficult to pinpoint the location of this corona at this time since it appeared to be coming through the Eccofoam.)

On 5/1 the Eccofoam was carefully removed from the corona area and the unit was put back under vacuum conditions. The corona occurred almost immediately and was easily observed at this time.

The HV stack was removed from the experiment frame and inspected. It was found that the Sylgard potting had lifted from the pc board in this area and the corona path was visible on the pc board. It was noted that this ground line did not exist on the 02 unit pc board. (This area was milled off and replaced by shielded boxes for detector decoupling in the 02 unit.) Also, RTV was used for potting the sides of the pc boards on the 02 unit rather than Sylgard. Thus, this potential problem could not exist in the 02 unit.

26. On 4/25 an operational check was performed with the experiment in the CTA S/C and no X-talk problems were observed. It was therefore decided by the IMP-G project office that the thermal-vacuum test could be run with 910 Ω series resistors in the output lines to prevent X-talk in the test set up.

27. From 4/25 to 5/6 the GSFC thermal-vacuum qualification was being performed. The general observations were:

(1) The channeltrons displayed the expected "dirty" condition when first turned on with the resultant HV turn-offs until they settled down.

(2) Channel 2 tended to behave more erratically than channel 1. But, by 4/28 both channels were beginning to behave well based on satistical tests.

(3) Occasional HV turn-offs were experienced due to RF pick up in the T & E environment.

(4) More frequent HV turn-offs were experienced on 5/1 after the 8' x 8' chamber was put into operation. These turn-offs were reduced to an acceptable level by additional shielding of the outside cables to the GSE.

(5) A correlation between HV turn-offs and daytime working hours was observed.

(6) No evidence of a corona problem was observed.

(7) The detector performance improved the longer the experiment ran under vacuum conditions.

28. On 5/6 at about 0500 hours, vacuum was lost in the chamber due to a primary power failure in the T & E building. (The experiment had only about 12 hours to go before finishing these tests at that time.) As a result of the vacuum loss the HV had been on for about 370 seconds under a vacuum of only 150 to 200 microns. It was decided that a short recycle test would be necessary to complete the thermal-vacuum qualification as a result of this failure.

29. The thermal-vacuum recycle test was run from 5/6 to 5/9. The experiment was still operational and general observations were as noted before. The channeltrons recovered from the erratic behavior in about 1 hour.

30. A X-talk test was performed on 5/12 at UCal. It was found that about 210 pf loading on channel 1 would produce X-talk into channel 2. And, about 360 pf loading on channel 2 would produce X-talk into channel 1. This is in good agreement with the impedance measurements made on 4/23 (e.g., $(210/360) \approx 3/5$).

Further, it was learned from UIowa on 5/7 that the capacitive loading on channel 1 was nearly zero pico farads (looks into a 470 KΩ resistor in Iowa) and the loading on channel 2 was about 25-32 pf in their experiment. Also, from the project office it was found that the encoder cable loading for channel 2 would be about 50 pf. Thus, the total loading in channel 2 should be no more than about 82 pf and on channel 1 it is negligible. Therefore, it appeared that there was a safety factor of about 4 against potential X-talk.

31. During integration tests in the S/C on 5/20/69 high count rates were observed in both data channels. Further investigation revealed that this was probably due to UIowa converter spikes on the 28 volt line to the UCal experiment, and, that they were being picked up by the sensitive pre-amplifiers in the experiment. These spikes were observed to be approximately 0.4 volts p-p with a periodicity of 240 μsec.

32. The experiment was returned to UCal for simulation of this interference problem and for a possible solution. Simulation was successful and a simple fix consisting of 3 capacitors from the signal common to the frame ground provided an adequate safety margin.

33. The IMP-G launch took place on 6/21/69, 0148 hrs PDST from WTR. Plans were made to turn on the UCal-UIowa supplementary experiments on 6/26 for the first time.

Post-Launch History

From time of first turn on the experiment was observed to stay on only for short intervals (≤ several minutes) before being shut off by the automatic turn off. Below is an analysis of the behavior of the experiment:

1. First confirmed experimental data on orbit 3, day 181, 0550 UT sequence 65840 (0 sequence). Apparently before this time the experiment was turning on in UIowa sequences. Last observed turn-on is in orbit 15, day 222, 1825 UT sequence 241238. This was the end

of the orbit. Orbit 16 and thereafter had no turn on since the UIowa experiment failed in orbit 15.

2. The counting rate in interplanetary medium is fairly steady. However, statistical fluctuations are observed implying that the count rate observed is not due to pickup of a fixed frequency.

Average count rate (interplanetary medium)	$\sim$700 counts/sec	$\sim$ 35 counts/sec
Equivalent flux	3.5×10^3 (cm^2 sec ster keV)$^{-1}$ (4 to 8 keV)	6×10^2 (cm^2 sec ster keV)$^{-1}$ (9 to 13 keV)

3. The count rate in regions of terrestrial particles (as observed by the UCal S-1 experiment at energies above 20 keV) is much higher, indicating that the S-2 instrument is counting particles as designed.

4. Turn off rate was measured to be 4 KHz (average) during pre-flight tests. The observed background rate of $\sim$ 700 counts per second is compatible with turn-offs within several seconds (on the average) due to statistical fluctuations.

5. The source of the high background counting rate may be either particles or possibly scattered stray solar ultraviolet to which the channeltrons are sensitive. Stray solar UV as an explanation is somewhat incompatible with the steady count rate observed in channel 1 since presumably the count rate should show a strong spin period dependence, ranging from essentially no counts when the detector is pointed away from the sun to a very high count rate when the detector is pointed toward the sun. Particle fluxes of the magnitude reported here may be the source of the background since no observations have been made in this energy range with this sensitivity. Recent measurements by the Apollo 15 Subsatellite (Anderson et al., 1972) show that

the quiet time electron level in the interplanetary medium is $\sim 10^2$ $(cm^2$ sec ster keV$)^{-1}$ at 6 keV and ~ 50 at 13 keV, with variations of an order of magnitude.

Another possibility is a slight misalignment of the sun shield for the detector allowing extraneous indirect scattering (so as to explain the lack of strong spin dependence) of UV into the detector may be the source of the high background.

6. The loss of data after orbit 15 is very unfortunate in that the spacecraft would have been in the earth's magnetotail region within a few months. The magnetotail is free of trapped terrestrial radiation as well as being out of the solar wind. Therefore, if the background rate of the detector had been due to particles then it would have dropped to a low level in the magnetotail.

7. The loss of data for UCal S-2 after orbit 15 is clearly due to the failure of the UIowa low voltage supply. UIowa apparently puts the STL sync-freeze pulse through a gate before sending it to UCal S-2, contrary to our expectations from correspondence and conversations with both UIowa and GSFC. The STL sync-freeze pulse is used to turn on the UCal S-2 high voltage power supply.

REFERENCES

1. Anderson, K.A., L.M. Chase, R.P. Lin, J.E. McCoy, and R.E. McGuire, Solar-Wind and Interplanetary Electron Measurements on the Apollo 15 Subsatellite, J. Geophys. Res., 77, 4611, 1972.

Appendix I

The IMP-G' GSE Software

A flow diagram for the main loop of the software used by the UCal GSE is illustrated in Figure I-1. Three major paths should be noted (1) the data summary path on the left, (2) the background or source stimulus path in the center and (3) the electrical stimulus path on the right. A further breakdown of the data summary path is given in Figure I-2.

The program was entered once per S/C sequence and the initial test was to determine which of the two halfs of the data was available--the A or B sequence data. A data summary synchronization test was then performed. If DS data was present, the branch was made. Otherwise, the additional synchronization tests ES1, ES5 and ES9 were performed and the ESEQ was updated or set as required. (See Table I-1 for a description of the various mnemonics used and Table I-2 for the test equations.) If ES1, ES5, or ES9 was satisfied, then a test was made for loss of electrical synchronization and IED was set if true.

For sequences (ESEQ) other than 1, 5, 9, 10 and 11, the normal path was to update the EXIT counter, set the tags E and FF, reset SSEQ, and proceed with the electrical limit tests. The electrical limits are given in Table I-3. Additional items required for printout were then found, the appropriate data was printed, and a return was then made to the S/C GSE system software.

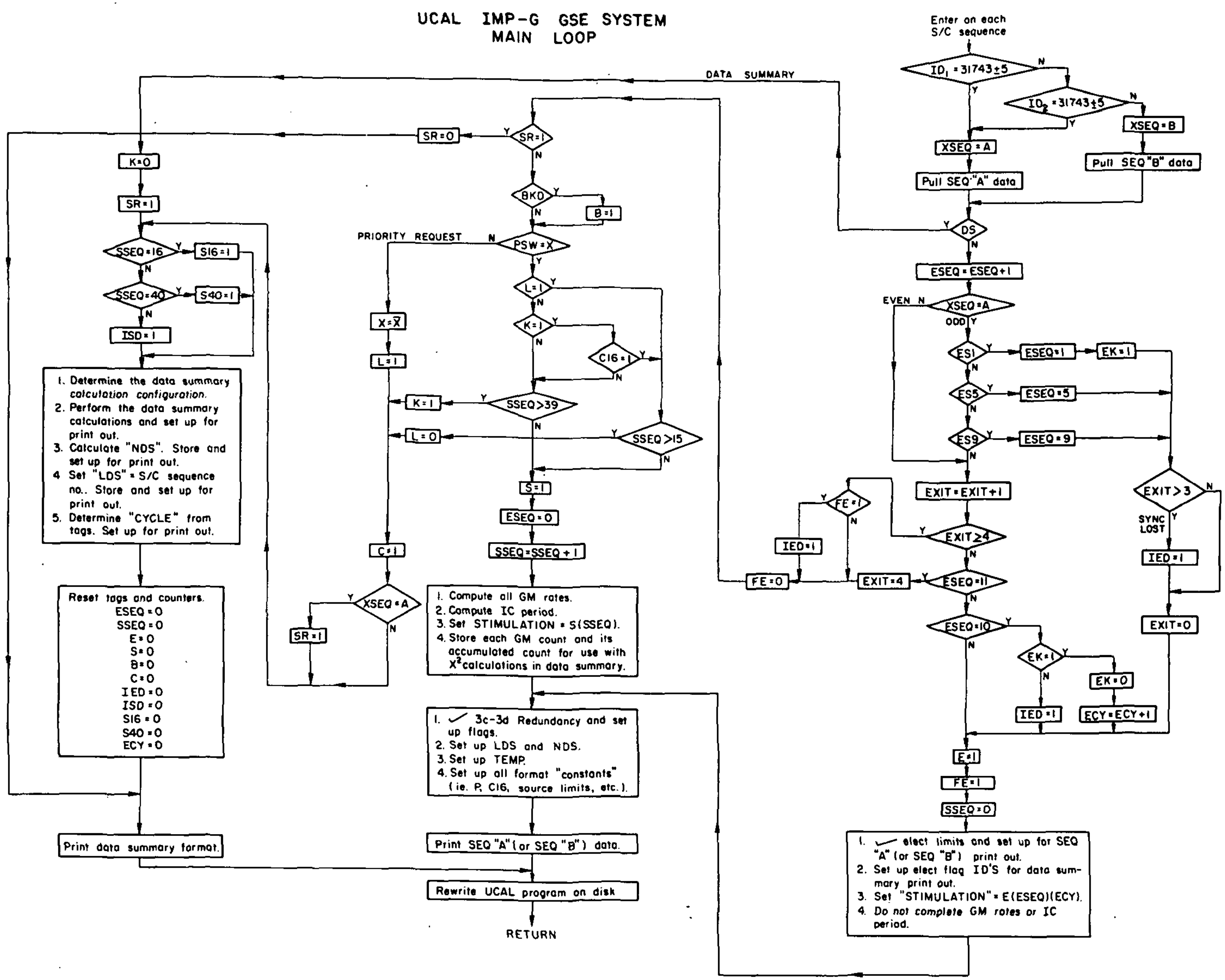


Figure I-1 UCal IMP-G GSE System, Main Loop

UCAL IMP-G GSE SYSTEM
DATA SUMMARY, LDS and NDS LOGIC

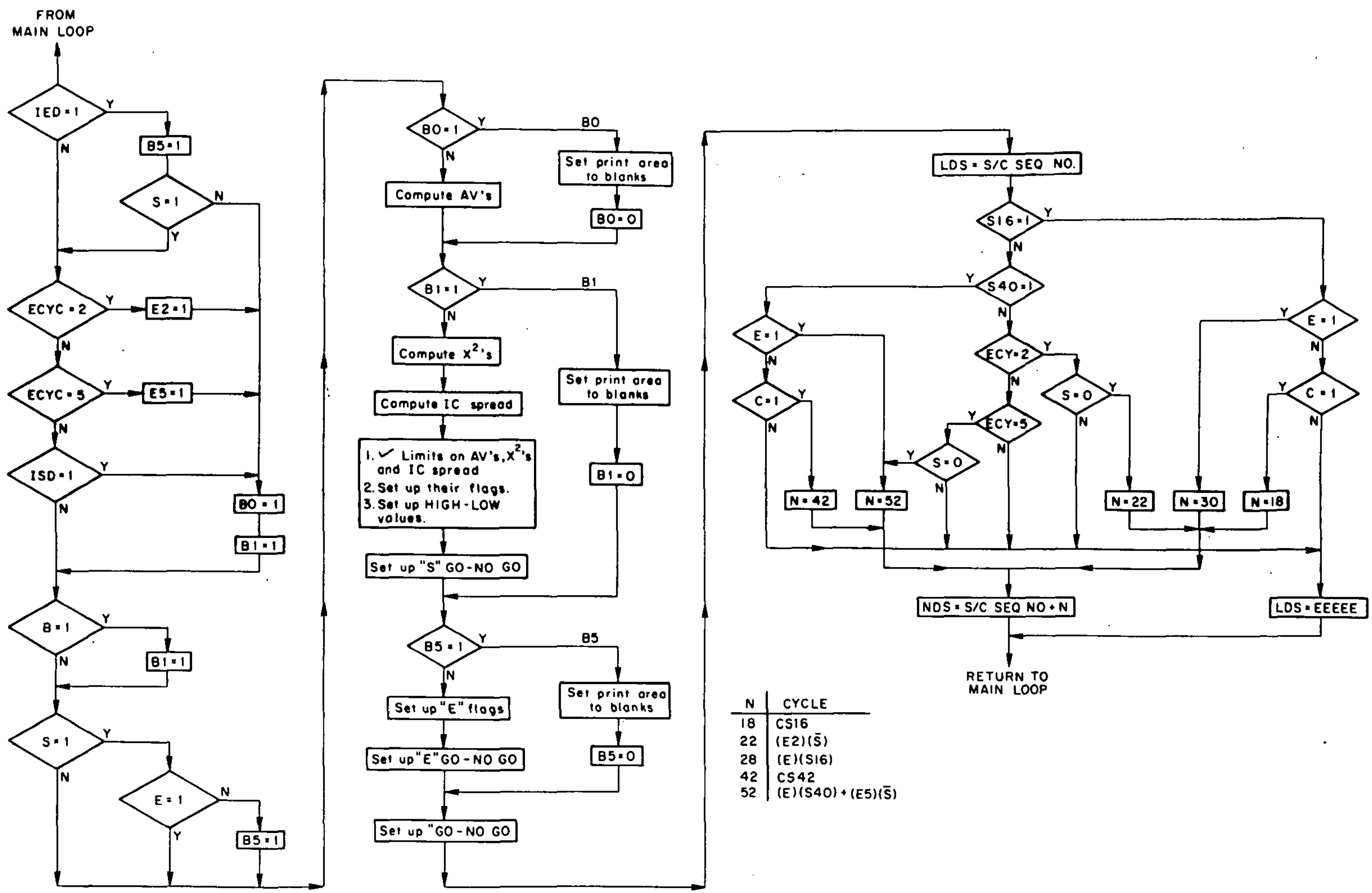


Figure I-2 UCal IMP-G GSE System, DS, LDS and NDS Logic

Table I-1
MNEMONICS

ITEM	TYPICAL VALUES	DESCRIPTION
B	O, 1	Background. A "1" indicates background data has occurred since the last DS. Set by BKD test.
BKD	T, F	Background data test. Test for background data under source conditions.
C	0,1	Computer control. A "1" indicates the system source cycle is under computer control (not GSE).
C16	0,1	A sense switch entry. A "1" indicates 16 seq source cycle request if computer controlled (no GSE) and a "0" indicates a 40 seq source cycle request.
DS	F, T	Data summary synchronization test. Test for presence of data summary GSE stimulus.
E	1, 0	Electrical. A "1" indicates at least 1 elect seq has occurred since the last DS.
ECY	0, ... 5	Electrical cycle. Indicates number of elapsed elect cycles (10 seq's). Normal values are 1, 2 or 5 at DS time.
Elect Limits	OFF, ON	"On" indicates the elect limit tests are active in the program. (A sense switch entry).
EK	0,1	A "1" indicates elect seq #1 sync achieved (ES1). Used to test for IED and to set ECY.
ESEQ	0, . . . 11	Electrical sequence. Indicates the presently assumed electrical sequence number.
ES1	F, T	Electrical sequence #1 synchronization test. A test for the presence of elect seq #1 GSE stimulus.

Table I-1 (cont.)

ITEM	TYPICAL VALUES	DESCRIPTION
ES5	F, T	Same as ES1 except for elect seq # 5.
ES9	F, T	Same as ES1 except for elect seq # 9.
EXIT	0, . . . 5	Exit counter. Used to exit to source branch after elect cycle or after loss of synchronization.
FE	0,1	First electrical. A "1" indicates at least 1 elect seq has occurred since the last DS.
IC_1, IC_2	--	The Ion Chamber data in frame # 6 and frame # 14 respectively, channels 4 & 5, sequence A.
IED	0,1	Insufficient electrical data. A "1" indicates insufficient elect data to perform elect limit tests.
ISD	0,1	Insufficient source data. A "1" indicates insufficient source data to perform source limit tests.
K	0,1	Forces a C40 source cycle to take place before the first C16 source cycle to insure that the GSE is not present.
K1, . . . K5		Constants used in the synchronization test equations.
L	0,1	A "1" allows only a C16 source cycle when a priority request is made.
LOS	S/C SEQ	Last data summary. Indicates the S/C sequence where the last data summary occurred.
NDS	S/C SEQ	Next data summary. Predicts where the next data summary will occur if the cycle is not changed.
PSW	0,1	Priority switch. A change of the switch position indicates a C16 source cycle has been requested.
R	0,1	Repeat. A "1" forces a redundant printout of the DS data (DS data not re-calculated).
S	0,1	Source. A "1" indicates at least 1 source seq has occurred since the last DS.

ITEM	TYPICAL VALUES	DESCRIPTION
Source Limits	OFF, ON	"On" indicates the source limit tests are active in the program. (A sense switch entry).
SR	0,1	Source repeat. A "1" allows a single repeat of the DS printout under source conditions for expt seq "B".
SSEQ	0,...41	Source sequence. Indicates presently assumed source sequence number.
STIMULATION	E01,..E50 SO1,..S40	Identifies the present electrical or source sequence.
S16	0,1	A "1" indicates 16 source sequences have occurred during the system cycle.
S40	0,1	A "1" indicates 40 source sequences have occurred during the system cycle.
X	0,1	Used with the PSW to test for an external priority request.
XSEQ	A,B	Experiment sequence. An "A" indicates the first seq of expt cycle (ID_1, ID_2, E1, and P1 data). A "B" indicates the second seq of expt cycle (E2, P2, E3 and P3 data).

Table I-2
Special Test Equations

$$ES1 = (E1 > K1) \cdot (P1 < K2)$$

$$ES5 = (E1 < K2) \cdot (P1 > K1)$$

$$ES9 = (IC_1 = K3 \pm K4) \cdot (IC_2 = K3 \pm K4)$$

$$DS = (IC_1 = 8 \pm K4) + \left[(E1 = 15359T \pm K4) \cdot (P1 = 15359T \pm K4)\right]$$

$$BKD = (E1 < K5) \cdot (P1 < K5)$$

K1 = 1000

K2 = 10

K3 = 32

K4 = 3

K5 = 10

Table I-3

UCAL IMP-G GSE

Electrical Limits

Elect Seq	Acc 3a	Acc 3b	Acc 3c	Acc 3d
1	ID $15359T^{+0}_{-1}$	ID 0	0 32768^{+0}_{-1}	0 1
2	2048 31743^{+0}_{-1}	0 0	0 32768^{+0}_{-1}	0 1
3	ID 0	ID 0	0 0	0 0
4	0 0	0 0	0 0	0 0
5	ID 0	ID $15359T^{+0}_{-1}$	32768^{+0}_{-1} 32768^{+0}_{-1}	1 1
6	0 0	2048 31743^{+0}_{-1}	2048 2048	2 2
7	ID 0	ID 0	0 0	0 0
8	0 0	0 0	0 0	0 0
9	ID 1	ID 1	32 32	64 64
10	1 1	1 1	1 1	0 0

NOTE:

1. ID = 31743^{+0}_{-1}
2. All limits are ± 0 except where noted.

If ESEQ was equal to 10, a test was made for the contiguity of the 10 electrical sequences. If the test was not satisfied, the IED tag was set. When ESEQ was equal to 11 (a background or source sequence), the EXIT counter was set to 4 in order to force further B or S sequences through the EXIT ≥ 4 test which, otherwise, functioned as an additional synchronization test path.

The printout format is illustrated in Figure I-3. For an electrical stimulus sequence the rates and IC period were not computed as indicated in the flow diagram. Listed in the A, B sequence printout were expected average rates and the high and low limits for the 7 detectors which were being used for data summary calculations. The type of stimulation was identified (e.g., E14, the fourth sequence in the second subcycle of electrical stimulus; S11, the eleventh sequence of source stimulation). Additional parameters of interest were listed on the right. These included an indication (ON, OFF) of whether the electrical and/or source limit tests were active in the program--these could be deactivated by operator intervention.

Once it was determined that source (or background) data was present, a test was made to determine if the last printout was a data summary printout. If it was, a branch was made which caused the second DS printout to occur. Otherwise, the BKD and priority request tests were made. If the PSW switch had been changed, a branch was made which set L, C and normally would set ISD. The appropriate calculations were then made for the data summary and the printout produced. Additional entries into the source branch would then proceed via the L = 1 branch which would force a 16 sequence source cycle ending with the data summary printout.

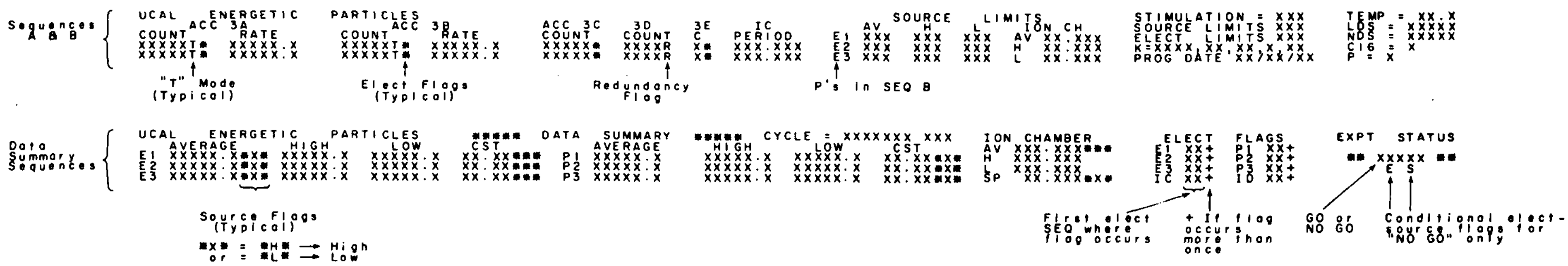


Figure I-3 UCal IMP-G GSE Printer Format

If no priority request had been made, the normal path through the source branch was through the SSEQ > 39 test, SSEQ would be updated and the various source calculations were performed. The cycle would then, normally, be ended by the DS test being satisfied. However, if the GSE hardware was not present the SSEQ > 39 branch was taken which set K and produced the data summary. With K set, additional source cycles were then under control of the C16 panel switch.

Entry into the data summary branch was normally via the DS test. SR was then set and the ISD test was made before proceeding with DS calculations. Figure I-2 gives the logic flow for the DS, LDS and NDS calculations. And, Table I-4 gives the functions performed versus the cycle conditions and the resulting branches that are required. The Chi Square calculation was computed as follows:

$$X^2 = \left[\sum_{i=1}^{n} (\overline{N} - Ni)^2\right] / \overline{N}$$

where n is 8 or 20 for the S16 and S40 cycles respectively, Ni is the detector counts, and $\overline{N}$ is the average detector counts from the previous cycle. The use of the previous cycle for $\overline{N}$ was required because of speed restrictions in the computer. This occasionally caused some X^2 values to be outside the limits used but this was not considered a significant problem. The 2% to 98% limits were used (i.e. 96% of the X^2 should fall inside the limits) and they are

Samples	Limits
8	1.564 to 16.622
20	8.567 to 33.687

		CONDITIONS									
		I	II	III	IV	V	VI	VII	VIII		
		ES 16 ES 40	S 16 S 40 CS 16 CS 40	E 2 E 5 ES ISD	ES 16B ES 40B	S 16B S 40B CS 16B CS 40B	ES 16 IED ES 40 IED	ES 16B IED ES 40B IED	E IED S ISD IED ISD		
F	Compute AV's	X	X	--	X	X	X	X	--	B0	B
U	Compute X^2's	X	X	--	--	--	X	--	--	B1	R
N	Compute IC spread	X	X	--	--	--	X	--	--	B1	A
C	Check Limits on AV's, X^2's, and IC spread Set up their Flags Compute and set up HIGH-LOW Values	X	X	--	--	--	X	--	--	B1	N
T / I	Set up The "S" GO-NO GO	X	X	--	--	--	X	--	--	B1	C
O	Set up The "E" Flags	X	--	X	X	--	--	--	--	B1	H
N	Set up The "E" GO-NO GO	X	--	X	X	--	--	--	--	B1	E
S	Set up The "GO-NO GO"	X	X	X	X	B	X	B	B	B5	S
	POSSIBLE GSE STIMULUS CONDITIONS	Both	Source	Elect Both ISD	Both-BKD	Source-BKD No GSE	Both-IED	Both-BKD -IED	Elect-IED Source-ISD Both-ISE		

NOTES:

X → function is performed

-- → function is not performed

B → set to blanks since "S" and "E" GO-NO GO's are indeterminable

Branch Equations:

$B0 = E2 + E5 + ISD + \overline{S}IED$

$B1 = B0 + B$

$B5 = \overline{E}S + IED$

Table I-4 Branch Conditions and Equations

The calculation of the IC spread was given as

$$S = (T_{max} - T_{min})(100/\overline{T})$$

where T_{max}, T_{min} and $\overline{T}$ are the maximum, minimum and average values respectively for the Ion Chamber periods during the cycle. The cycle identification word (see printout format) was found as follows:

X	X	X	X	X X	X	b	X	X	X		
1	2	3	4	5	6			7			Field number

Field 1 is set to "E" if the program variable E is 1.

" 2 is the value of the program variable ECY (i. e. 2 or 5).

" 3 is set to "C" if the program variable C is 1.

" 4 is set to "S" if the program variable S is 1.

" 5 is set to "16" if the program variable S16 is 1.

" 5 is set to "40" if the program variable S40 is 1.

" 6 is set to "B" if the program variable B is 1.

" 7 is set to "IES" if the program variables IED and ISD are both 1.

" 7 is set to "IED" if only the variable IED is 1.

" 7 is set to "ISD" if only the variable ISD is 1.

The electrical flags printout identified the first sequence where an error occurred for a given detector and if any additional errors had occurred during the cycle. If any of these were set, this caused the E and the NO-Go to be printed. The S and the NO-GO were set if any of the X^2 values, averages, or IC spread were outside their limits.

Appendix II
IMP-F Drawings

SIMP -	1	IMP-F Block Diagram, rev E
	2	GSE Main Electronics Block Diagram, rev A
	3	N/A
(AIMP) -	4	UC AIMP/SIMP Checkout Box
	101	N/A
	102	Detector Location & Look Angles, Ion Chamber Experiment
	103	Frame Details, UCal Experiment IMP-F & G
	104	N/A
	105	N/A
	106	Rear Mount Block, GM2, rev A
	107	Front Mount Block, GM2, rev A
(AIMP) -	108	Scattering Unit, rev A
	109	Stand, Ion Chamber
	110	N/A
	111	GM2 Tube Shield, rev A
	112	GM1 Tube Shield, rev A
	113	Front Bracket, GM1, rev A
	114	Rear Bracket, GM1, rev C
	115	Backscatter Cap Plate
(AIMP) -	116	Scattering Unit Cap Plate, rev A
	117	Source Mount, rev B
(AIMP) -	118	Drill Fixture, rev B
(AIMP) -	119	Calibration

(AIMP) -	120	Ion Chamber Assembly
(AIMP) -	121	Base, Collector, rev B
(AIMP) -	122	Collector Assembly, rev C
(AIMP) -	123	Stem
(AIMP) -	124	Electrostatic Shield
(AIMP) -	125	Collector Rod, rev B
(AIMP) -	126	Shield, Outer, rev A
(AIMP) -	127	Tube Socket, rev A
	128	N/A
(AIMP) -	129	Space Bushing, T.P. Connector, rev B
(AIMP) -	130	Anode Cushion, rev A
(AIMP) -	131	Cathode Cushion, Lionel 205 HT, rev A
(AIMP) -	132	Cathode Clip, Lionel 205 HT, rev B
(AIMP) -	133	Anode, rev C
(AIMP) -	134	Anode Clip, Lionel 205 HT, rev A
(AIMP) -	135	Cathode Clip, LND 704X
(AIMP) -	136	Cathode Cushion, LND
(AIMP) -	137	Protective Cap, GM1
(AIMP) -	138	Protective Cap, GM2
(AIMP) -	139	Ring, Clamping
	140	Template
	141	Spring, Source Mount
(AIMP) -	150	4" Sphere Assembly
(AIMP) -	151	Drawn Hemisphere, Top
(AIMP) -	152	Drawn Hemisphere, Bottom
(AIMP) -	153	Fill Tube

(AIMP) - 154 Schematic, 4" Ion Chamber

(AIMP) - 155 Charge Pulse Measurement

(AIMP) - 156 Ion Chamber, Base Oriéntation

200 SIMP Schematic,rev A

201 GSE Wiring Diagram, rev A

202 Cable, Experiment to GSFC Simulator

203 N/A

204 N/A

(AIMP) - 205 UC AIMP/SIMP Checkout Box, rev B

(AIMP) - 206 AIMP Cable Diagram, rev A

207 Drivers, GSE, rev A

208 Slave Counters and Matrix, GSE, rev A

209 Signal Generator, GSE, rev A

210 Electrical Switches, GSE, rev A

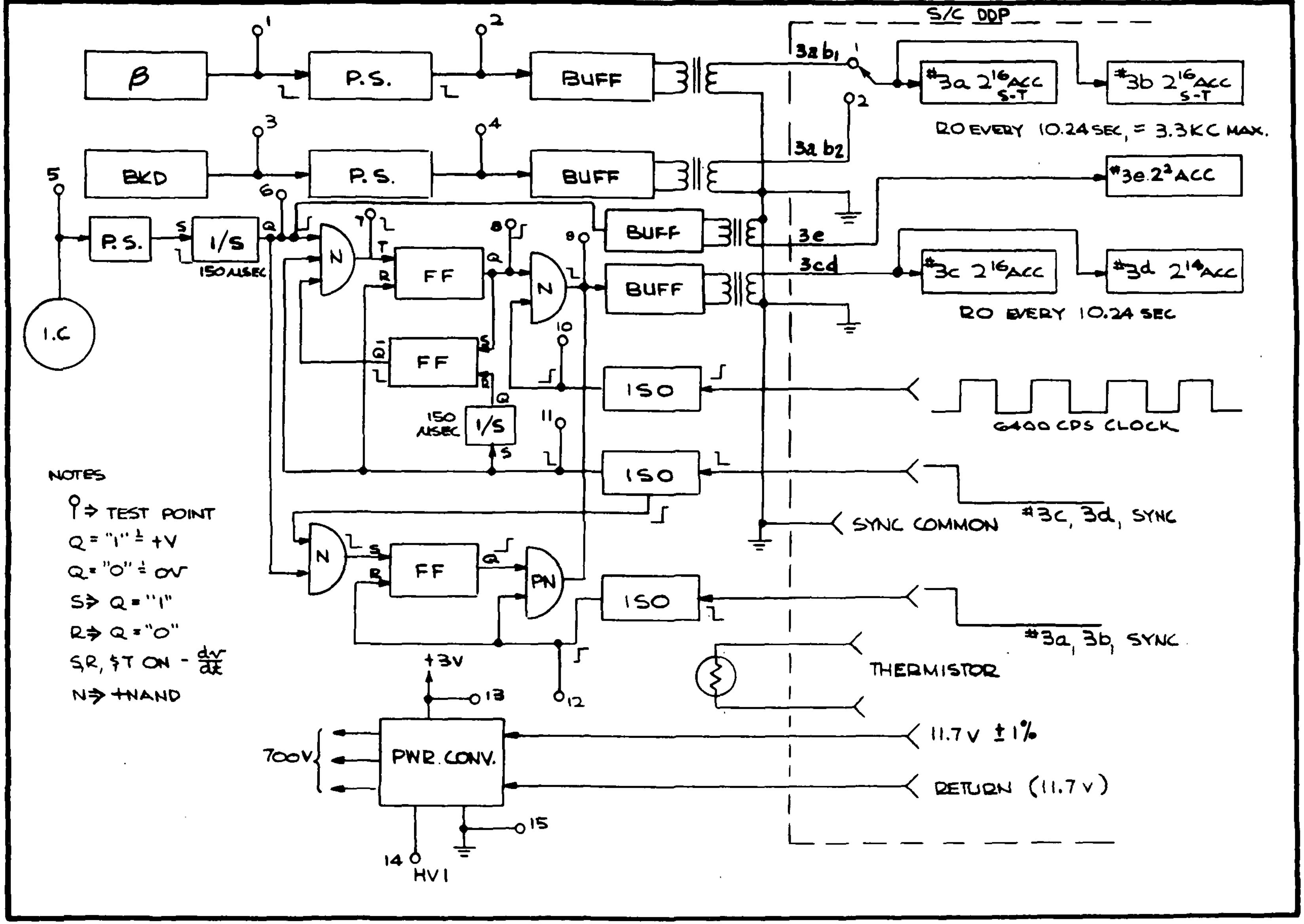
211 Mechanical Switches and Readouts, GSE, rev A

212 Buffer Box, GSE

213 Power Supply, GSE

214 Wiring Diagram, GSE

NO. SIMP-1	JOB IMP	APP. RJ Paul	SPACE SCIENCES LABORATORY	SCALE	DR. E. GEE	DATE 7 DEC 64
TITLE IMP F BLOCK DIAGRAM			UNIVERSITY OF CALIFORNIA	REQD.	[redacted] REV. E	5 JAN. 1967



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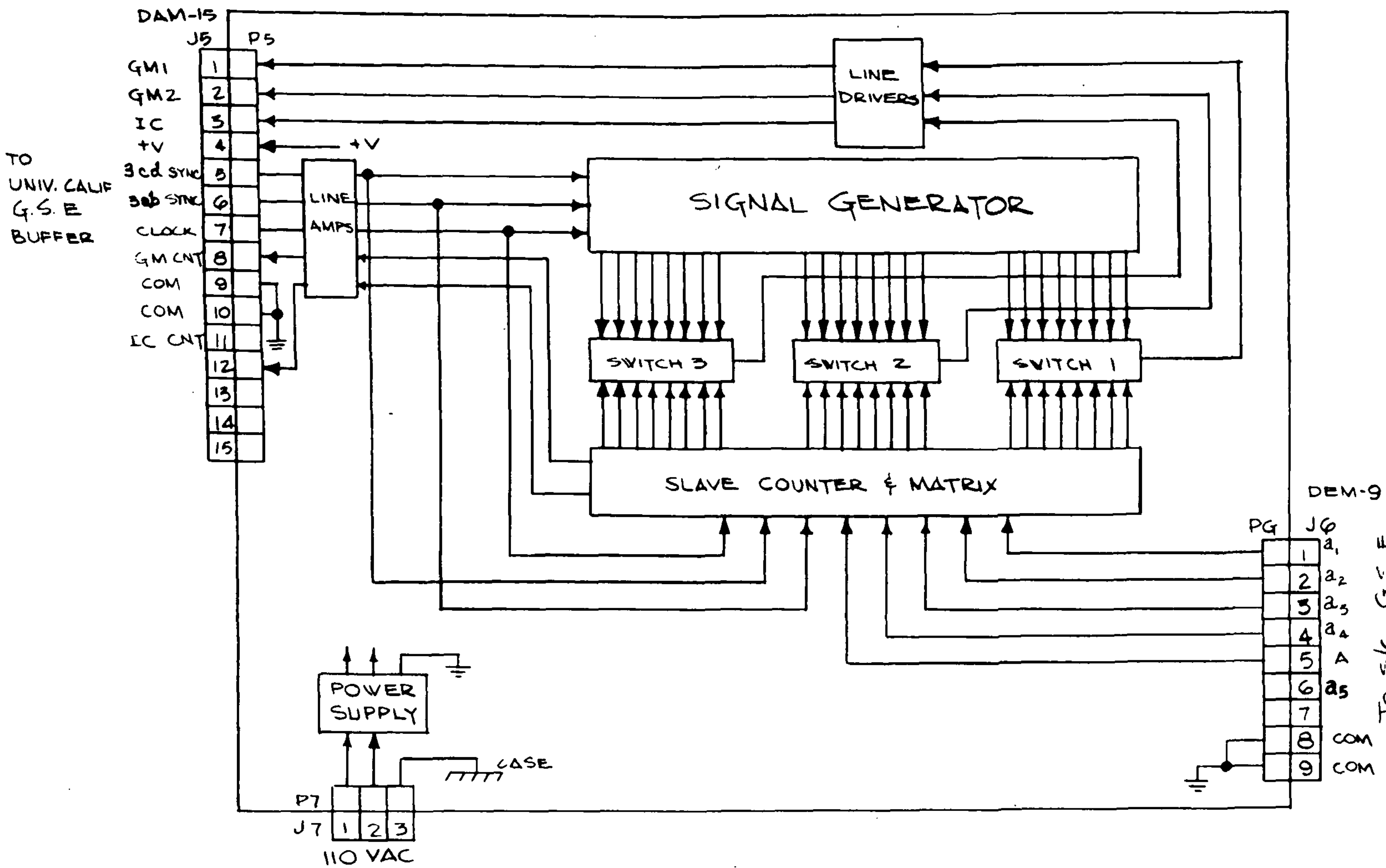

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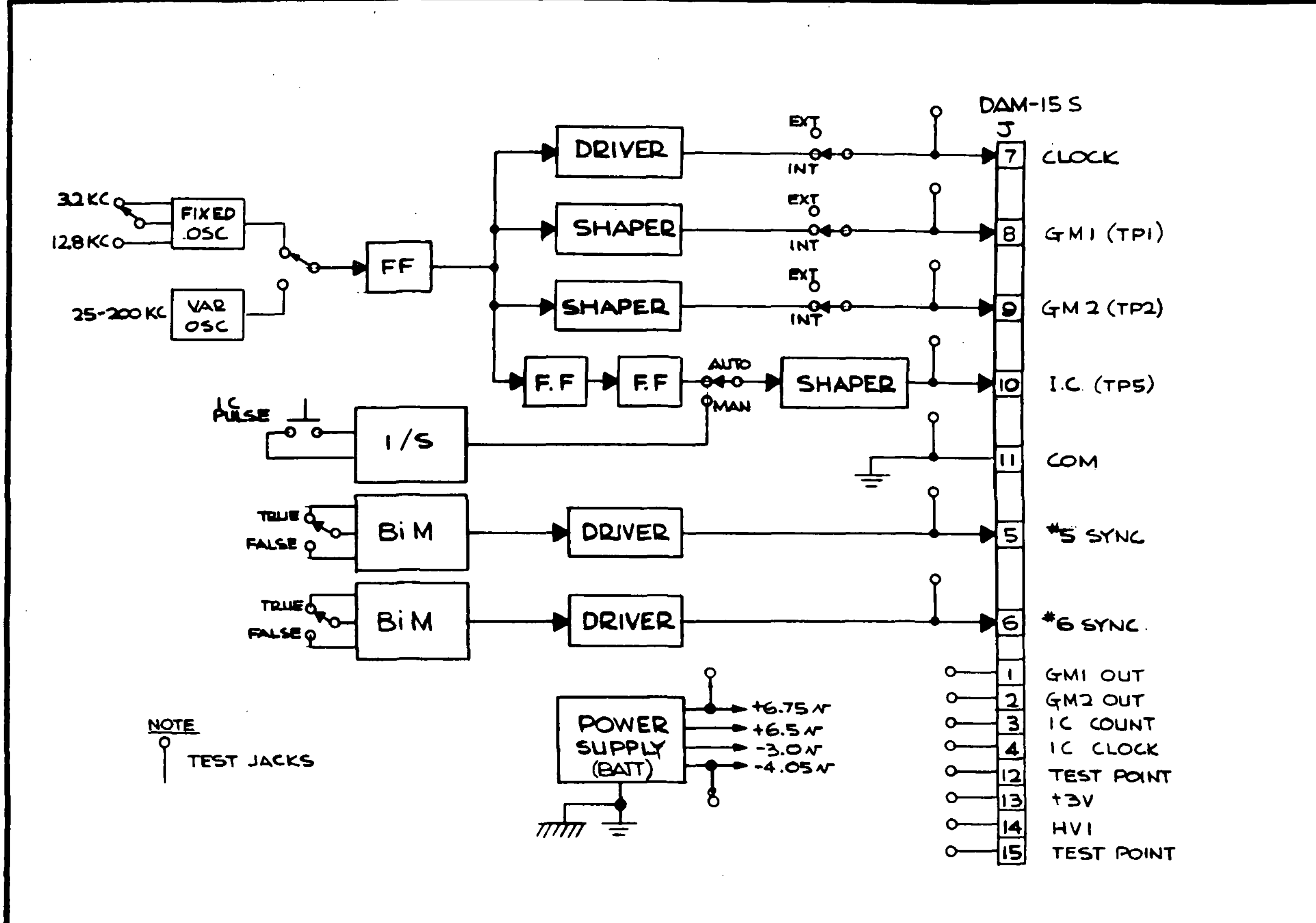
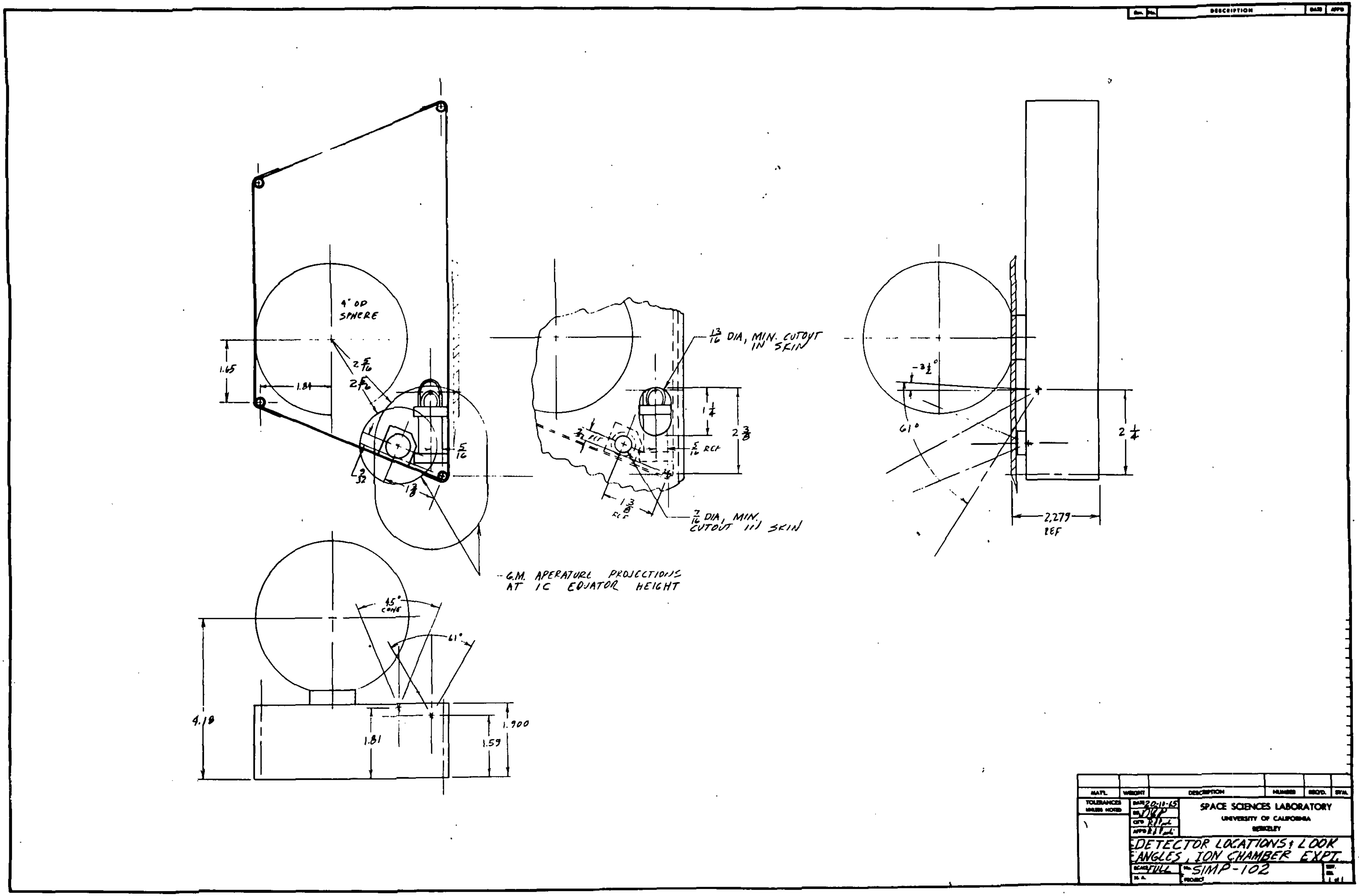
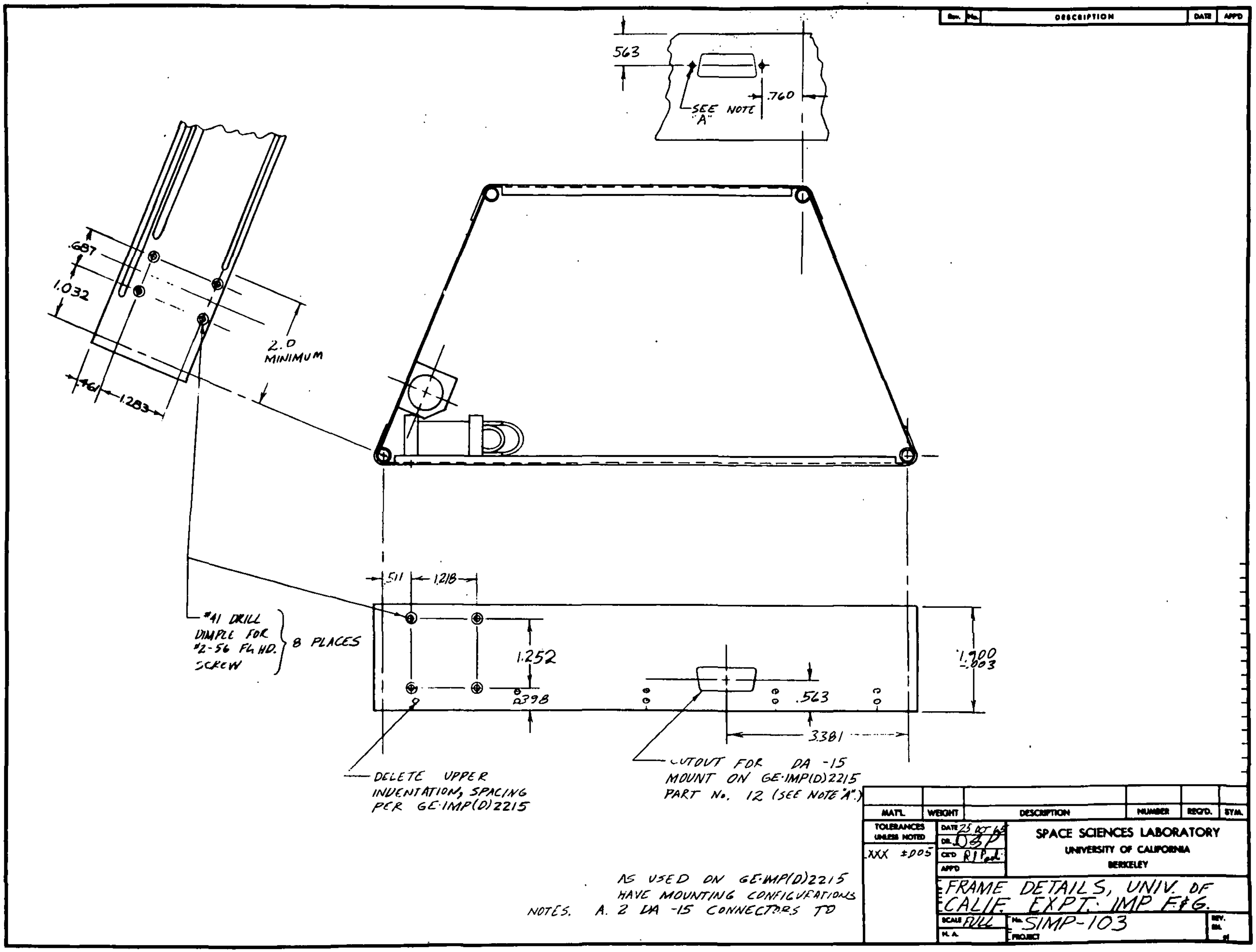
SCALE NONE	DR. E. GEE	DATE 7 MAY 65	
REQD.	MATL. —		



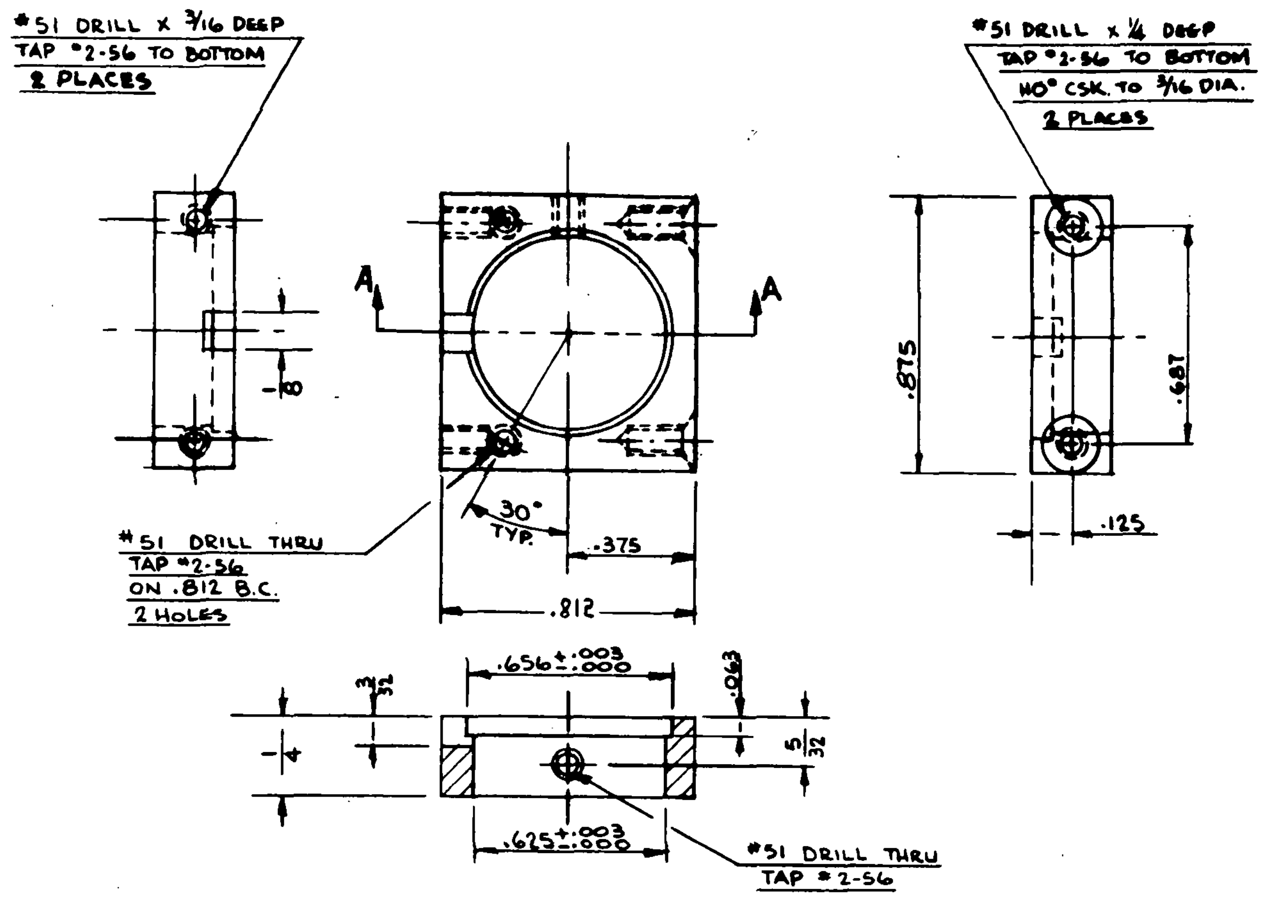

4" OD SPHERE
1.65
1.84
2 5/16
5/16
9/32
1 3/8
13/16 DIA, MIN. CUTOUT IN SKIN
1 1/4
2 3/8
5/16 REF
7/16 DIA, MIN. CUTOUT IN SKIN
-3 1/2°
61°
2 1/4
2.279 REF
G.M. APERATURE PROJECTIONS AT IC EQUATOR HEIGHT
45° CONE
61°
4.18
1.81
1.59
1.900
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY
DETECTOR LOCATIONS & LOOK ANGLES, ION CHAMBER EXPT.
SCALE FULL
SIMP-102
DATE 10-19-65



REV. | NO. | DESCRIPTION | DATE | APP'D
563
.760
SEE NOTE "A"
.687
1.032
2.0 MINIMUM
.461
1.283
.511
1.218
1.252
.398
.563
1.900 -.003
3.381
#41 DRILL DIMPLE FOR #2-56 FL HD. SCREW } 8 PLACES
DELETE UPPER INDENTATION, SPACING PER GE·IMP(D)2215
CUTOUT FOR DA -15 MOUNT ON GE·IMP(D)2215 PART No. 12 (SEE NOTE "A")
NOTES. A. 2 DA -15 CONNECTORS TO HAVE MOUNTING CONFIGURATIONS AS USED ON GE·IMP(D)2215
MAT'L | WEIGHT | DESCRIPTION | NUMBER | REQ'D. | SYM.
TOLERANCES UNLESS NOTED
.XXX ±.005
DATE 23 OCT 63
DR. DSP
CK'D RIP
APP'D
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY
FRAME DETAILS, UNIV. OF CALIF. EXPT. IMP F&G.
SCALE FULL
No. SIMP-103
N.A.
PROJECT
REV. SH.

NO. SIMP - 106	[redacted] REV. A 1 FEB. 66 APP. R.R.P.	SPACE SCIENCES LABORATORY	SCALE 2" = 1"	DR. R. TOY DATE DEC. 6, 1965
TITLE REAR MOUNT BLOCK, GM 2		UNIVERSITY OF CALIFORNIA	REQD.	MATL. AZ - 31 B

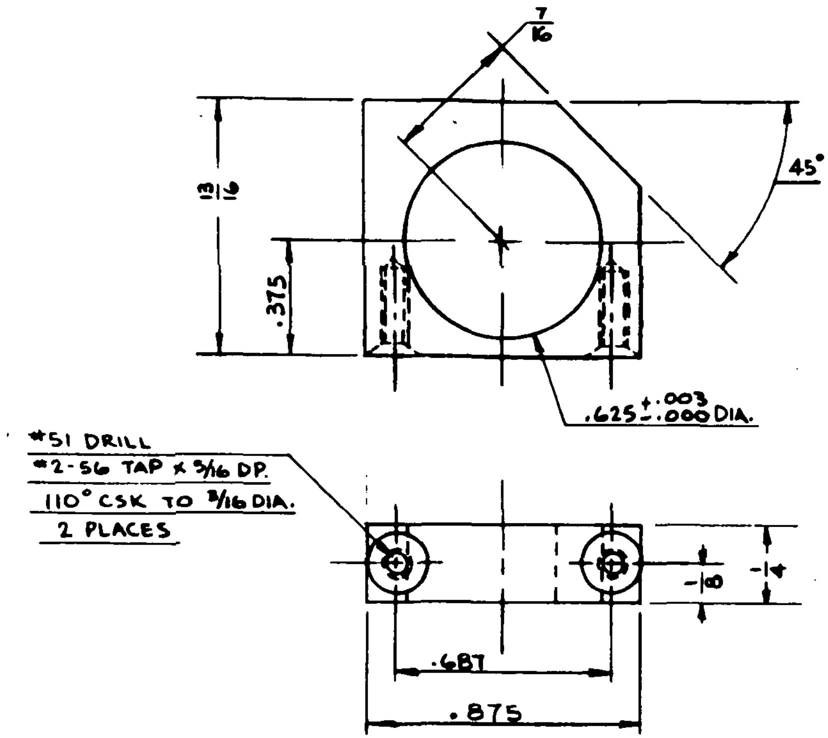
USE MAGNETICLY TESTED MAGNESIUM SECURE FROM PAOLI OR PELLINEN



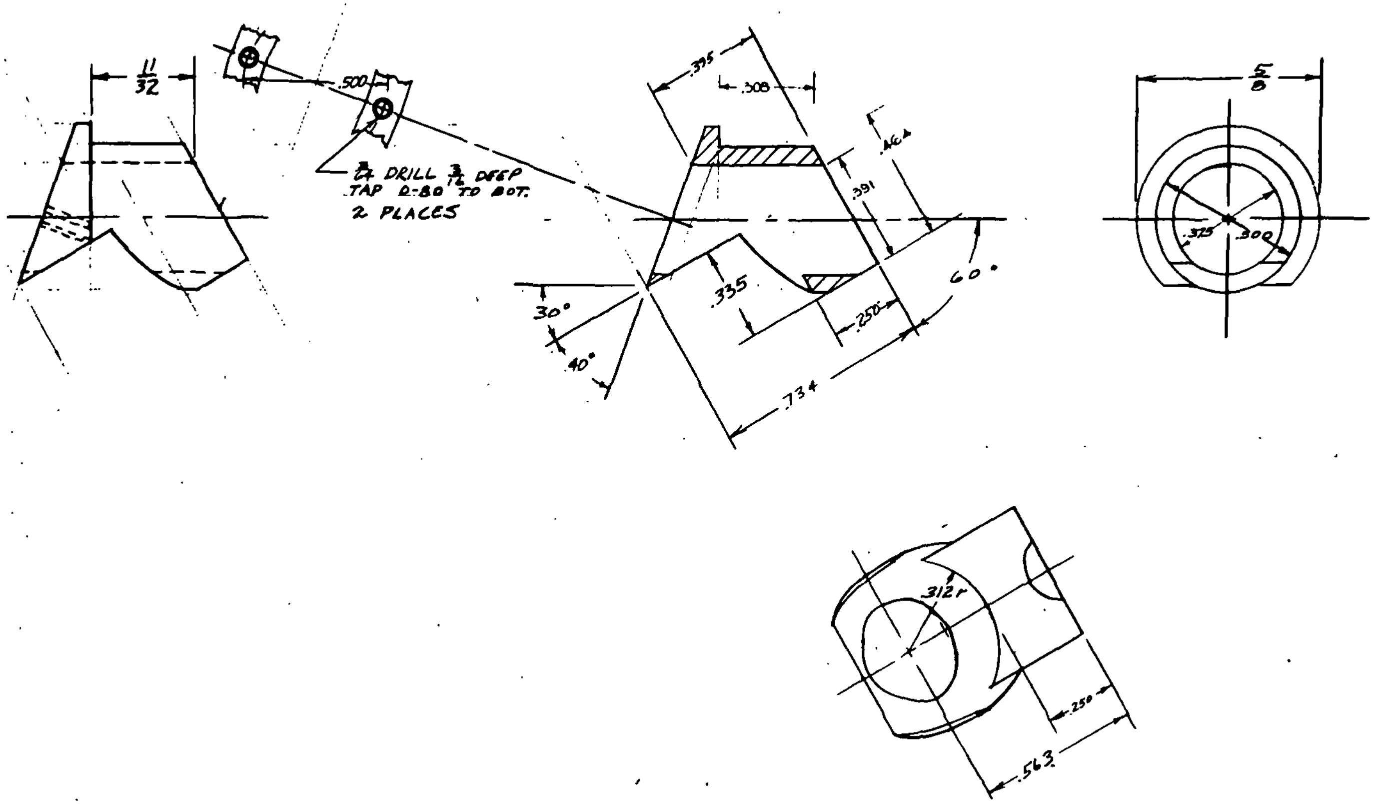
SEC. A-A

NO. SIMP-107	[redacted] REV. A 1 FEB. 66 APP. R.P	SPACE SCIENCES LABORATORY	SCALE 2" = 1"	DR. R.TOY DATE DEC. 3, 1965
TITLE FRONT MOUNT BLOCK, GM 2		UNIVERSITY OF CALIFORNIA	REQD.	MATL. AZ-31 B

USE MAGNETICLY TESTED MAGNESIUM SECURE FROM PAOLI OR PELLINEN



SYM.	No.	DESCRIPTION	DATE	APP'D
A		ADDED DUPLICATE DIMENSIONS	9-2?-6?	



NOTE: USE MAGNETICLY TESTED BRASS. SECURE FROM PAOLI OR PELLINEN

SEE NOTE 1					
MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

TOLERANCES UNLESS NOTED

DATE 18 FEB 65
DR. DBP
CH'D "
APP'D

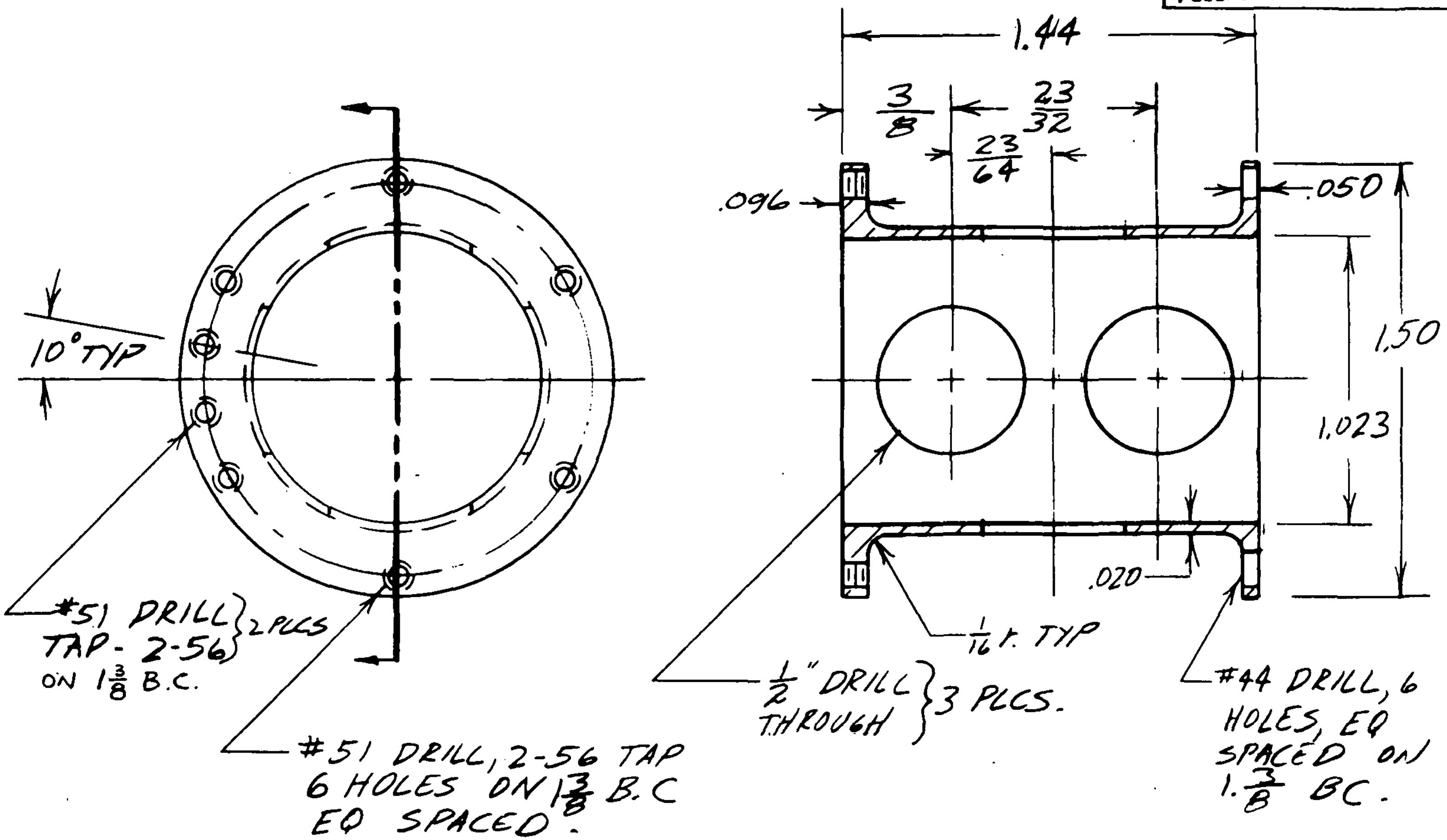
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

SCATTERING UNIT

SCALE 4 = 1
No. AIMP ... REV A
PROJECT ANCHORED IMP

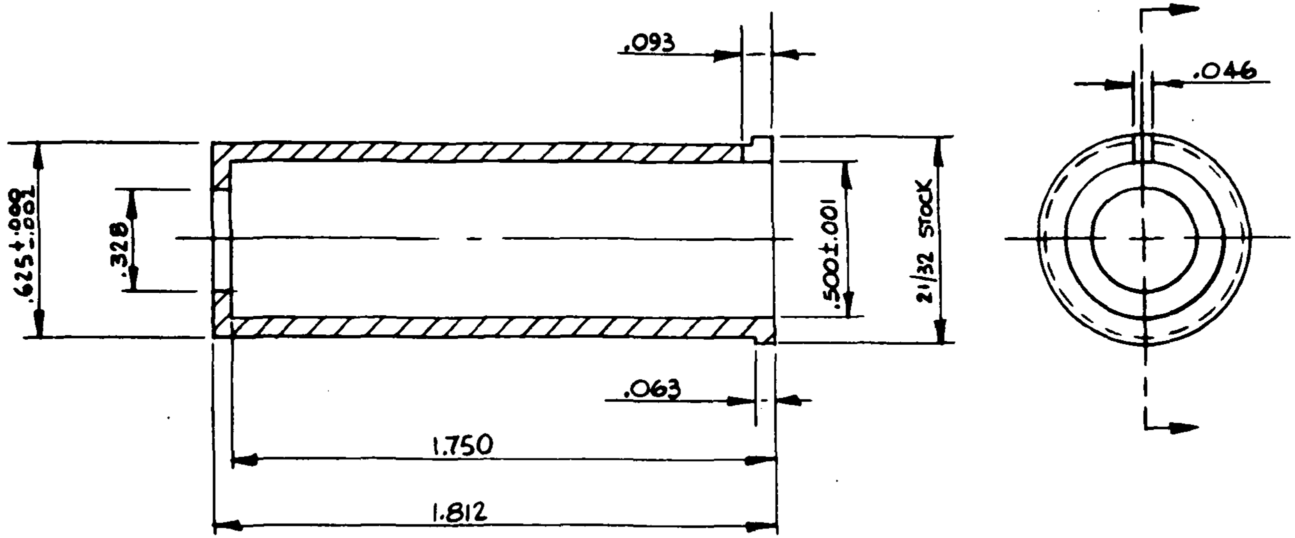
NO. SIMP 109	JOB SIMP APP. E.A.P.	SPACE SCIENCES LABORATORY	SCALE 2 = 1	DR. DATE
TITLE STAND, ION CHAMBER		UNIVERSITY OF CALIFORNIA	REQD.	MATL. A2-31 B

SECURE FROM PAOLI OR PELLINEN



NO. SIMP - 111	[redacted] REV. A 1 FEB. 66 APP.	SPACE SCIENCES LABORATORY	SCALE 2:1	DR. R. TOY DATE JAN. 11, 1966
TITLE GM2 TUBE SHIELD		UNIVERSITY OF CALIFORNIA	REQD.	MATL. BRASS

USE MAGNETICLY TESTED BRASS SECURED FROM PAOLI OR PELLINEN



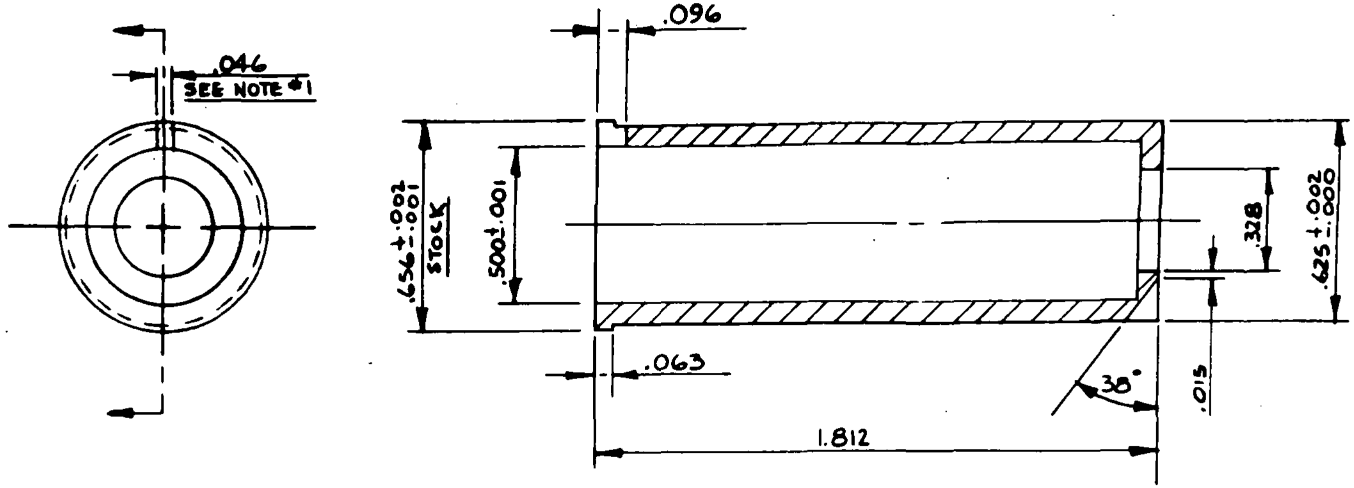
NOTES:

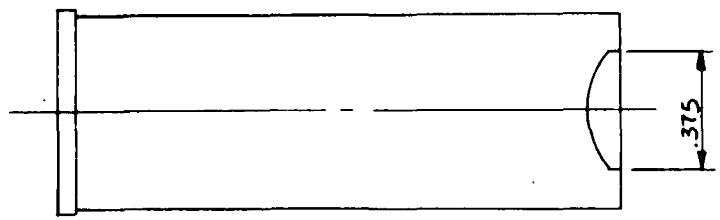
1- ROUND CORNERS OF SLOT INSIDE & OUT.

2- LOCATE SLOT WITH FIXTURE #118.

NO. SIMP - 112	[redacted] REV. A 1 FEB. 66 APP R Paoli	SPACE SCIENCES LABORATORY	SCALE 2 = 1	DR. R. TOY DATE JAN. 11, 1966
TITLE GM1 TUBE SHIELD		UNIVERSITY OF CALIFORNIA	REQD.	MATL. BRASS

USE MAGNETICLY TESTED BRASS SECURED FROM PAOLI OR PELLINEN





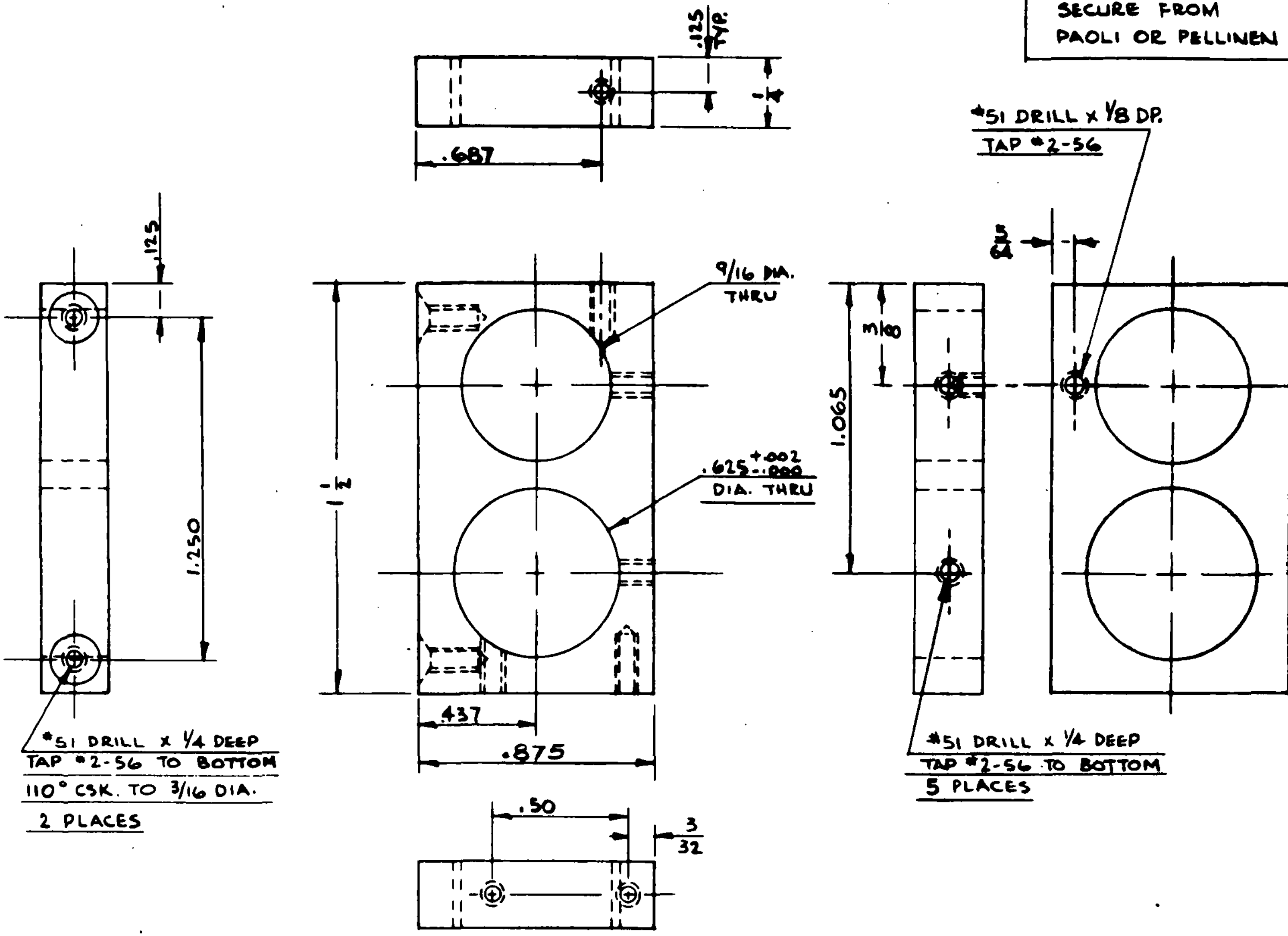
NOTES:

#1- ROUND CORNERS OF SLOT INSIDE AND OUT.

#2- LOCATE SLOT AND BEVEL CUT WITH FIXTURE #118.

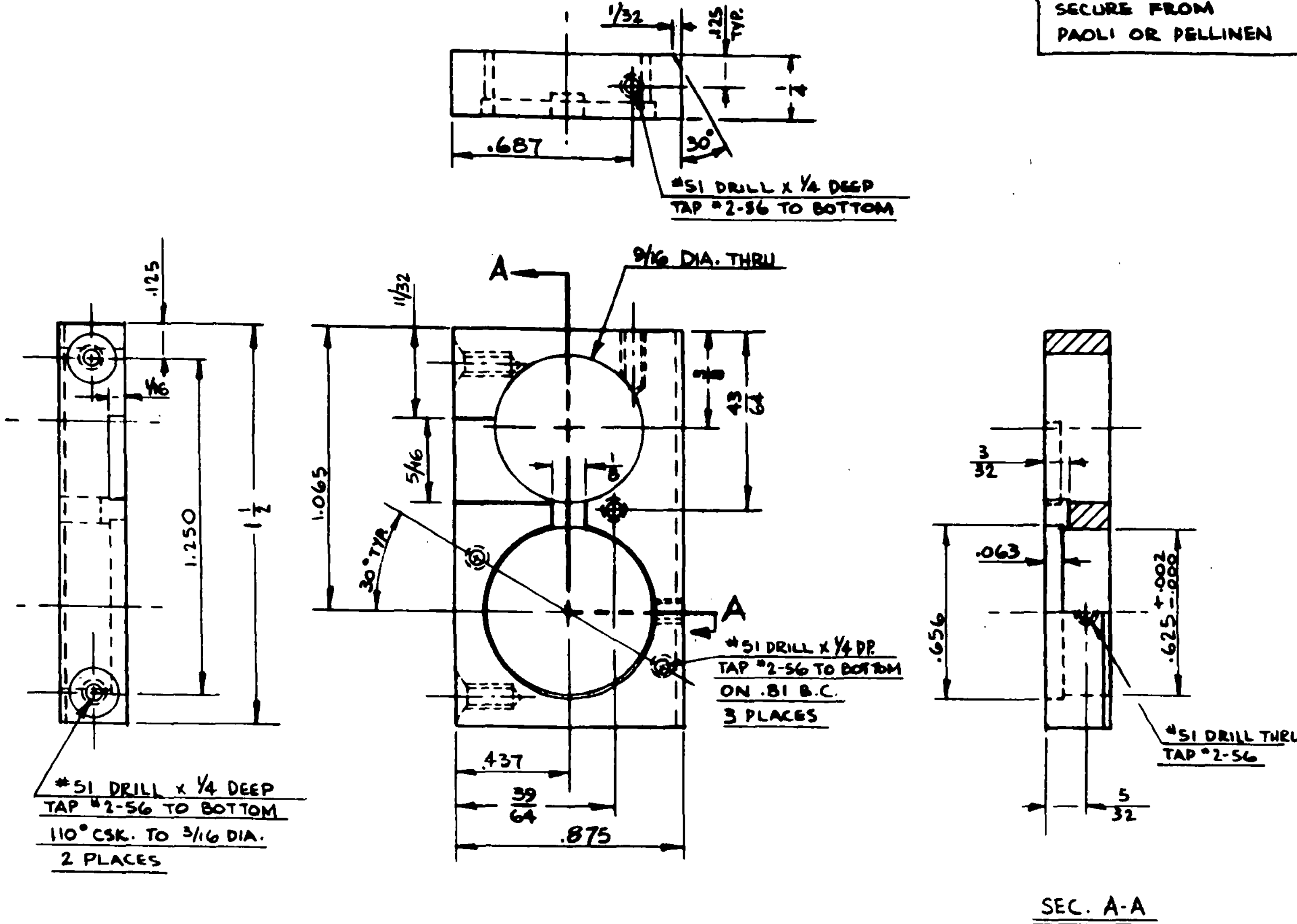
NO. SIMP - 113	[redacted] REV. A 1 FEB. 66 APP. RTP	SPACE SCIENCES LABORATORY	SCALE 2" = 1"	DR. R. TOY DATE DEC. 6, 1965
TITLE FRONT BRACKET, GM1		UNIVERSITY OF CALIFORNIA	REQD.	MATL. AZ - 31 B

SECURE FROM PAOLI OR PELLINEN



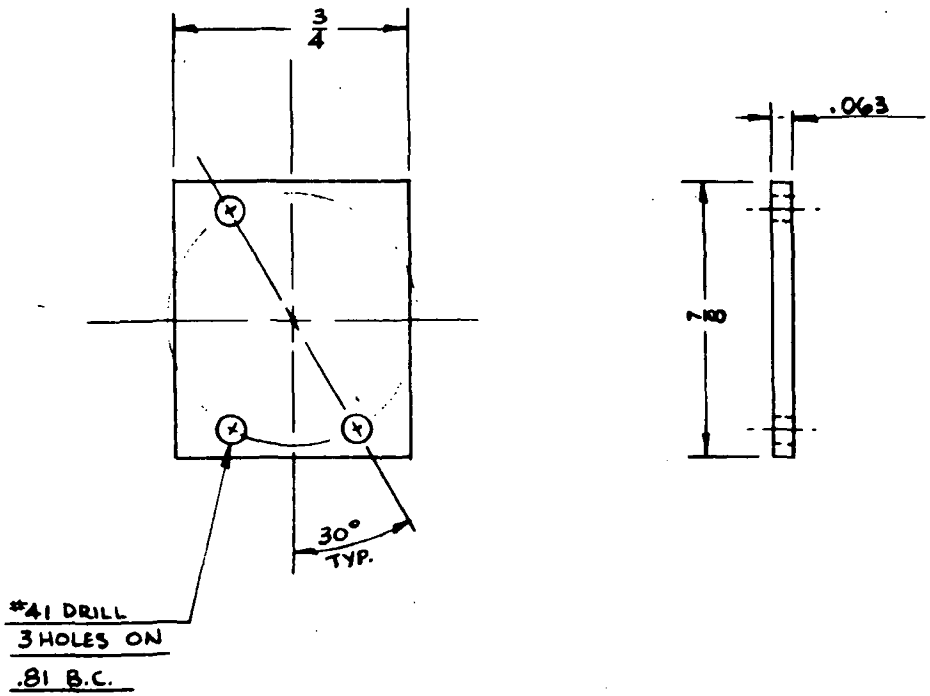
NO. SIMP - 114	[redacted] REV. C 7 JUNE 67 APP.	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	SCALE 2" = 1"	DR. R. TOY DATE DEC. 6, 1965
TITLE REAR BRACKET, GM I			REQD.	MATL. AZ-31 B

SECURE FROM PAOLI OR PELLINEN



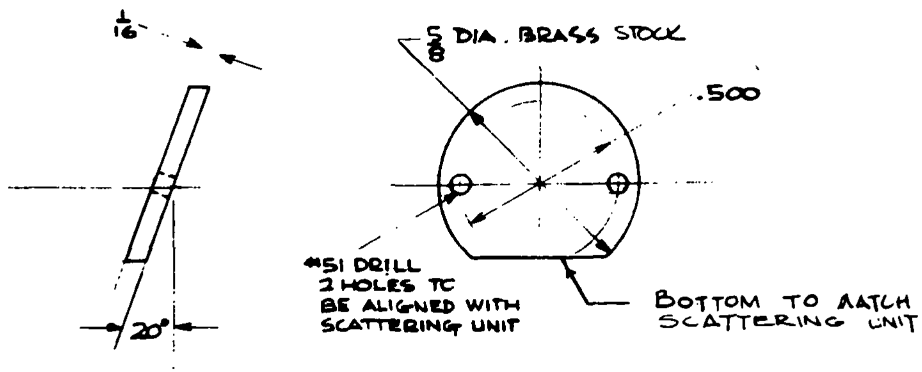
NO. SIMP - 115	JOB SIMP APP.	SPACE SCIENCES LABORATORY	SCALE 2" = 1"	DR. RON TOY DATE DEC. 3, 1965
TITLE BACKSCATTER CAP PLATE		UNIVERSITY OF CALIFORNIA	REQD.	MATL. BRASS

USE MAGNETICLY TESTED BRASS
SECURE FROM PAOLI OR PELLINEN

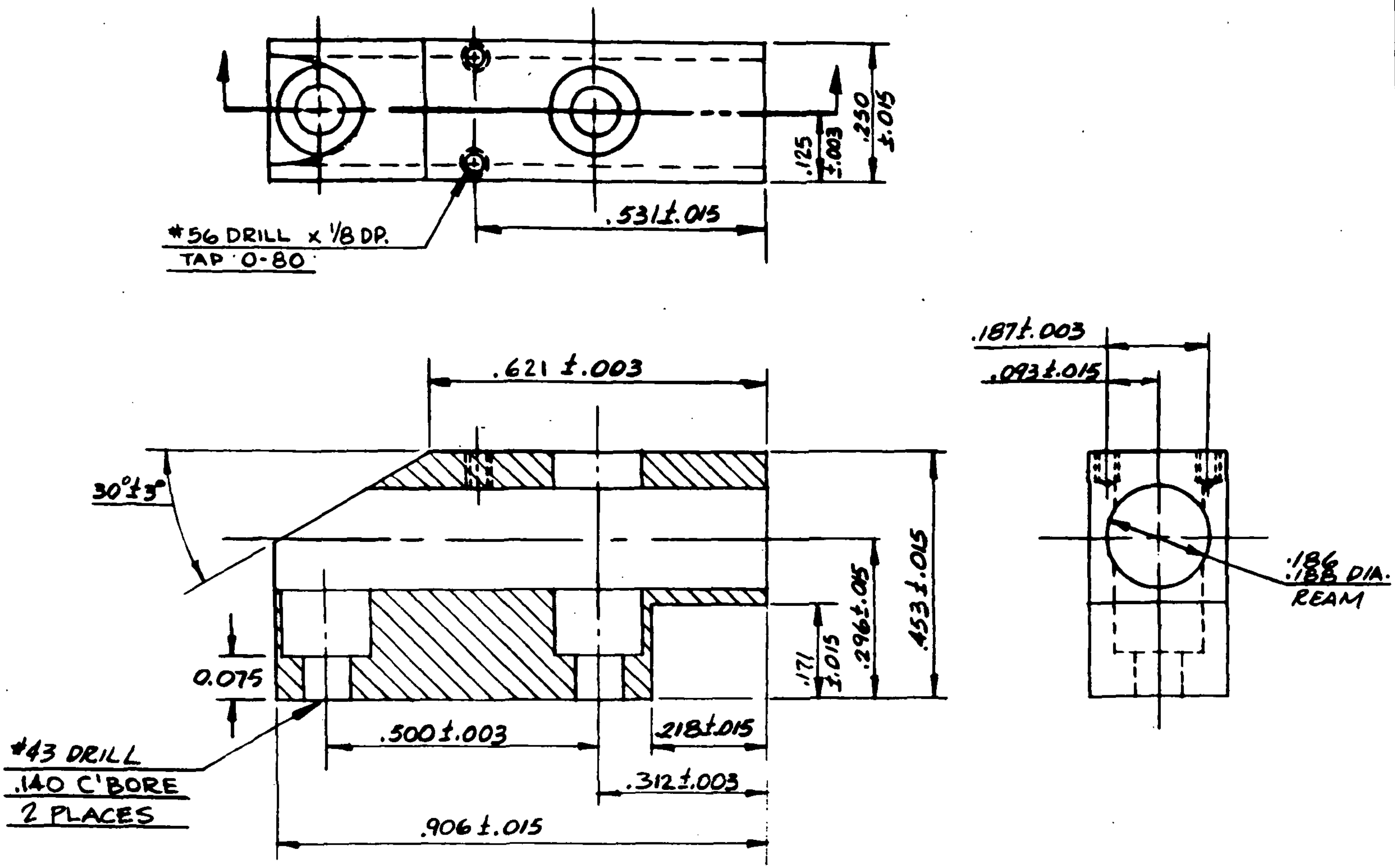


NO. AIMP 116 REV. A	JOB AIMP	APP.	SPACE SCIENCES LABORATORY	SCALE 2" = 1"	DR. E. GEE DATE 8 MAR 65
TITLE SCATTERING UNIT CAP PLATE			UNIVERSITY OF CALIFORNIA	REQD.	MATL BRASS

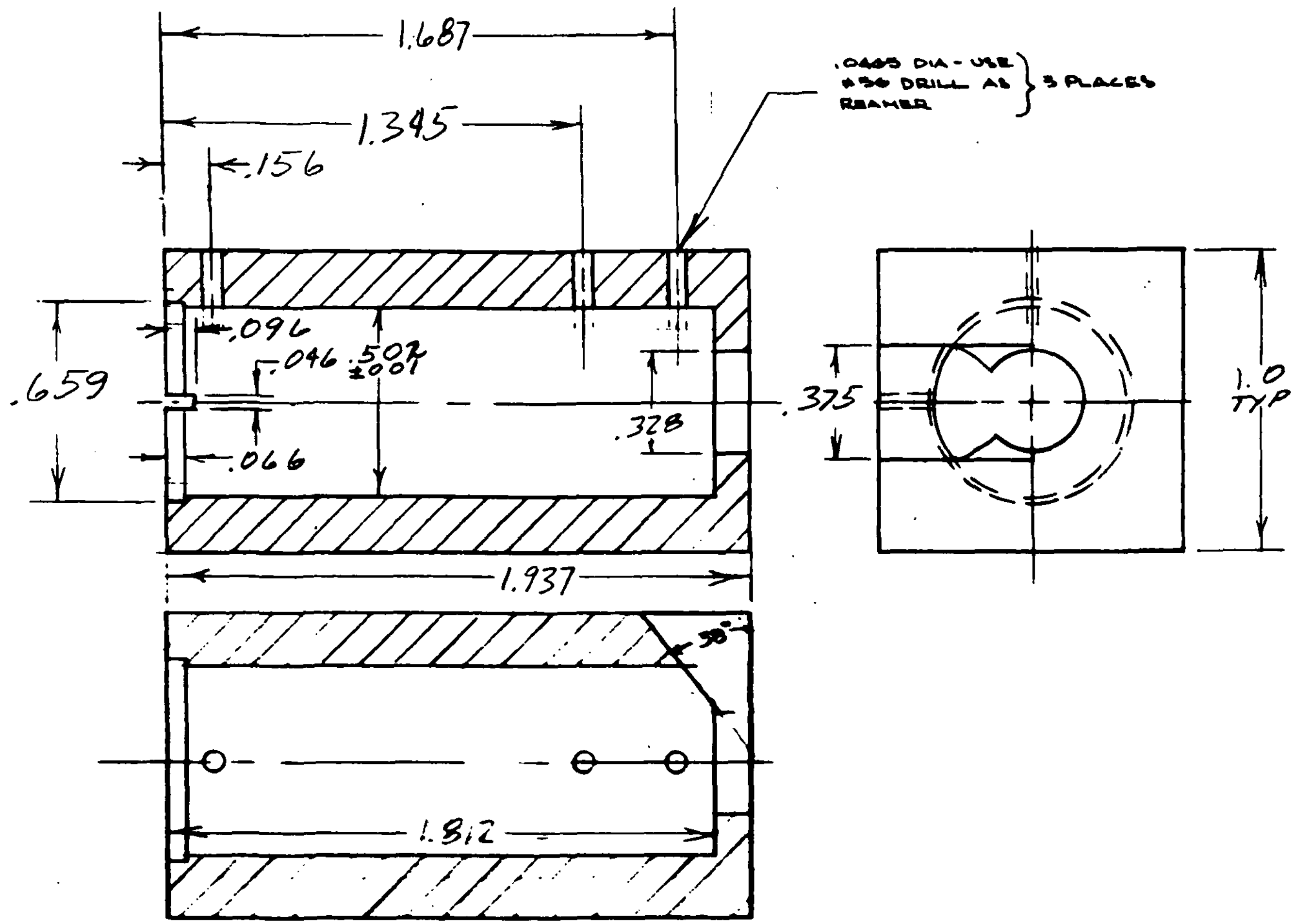
USE MAGNETICLY TESTED BRASS SECURED FROM PAOLI OR PELLINEN



NO. SIMP-117	[redacted] REV. B 22 AUG. 1966	APP'D [illegible]	SPACE SCIENCES LABORATORY	SCALE 4 = 1	DR. R. TOY	DATE JAN. 14, 1966
TITLE SOURCE MOUNT			UNIVERSITY OF CALIFORNIA	REQD.	MATL. 6061 - T6	



NO. AIMP 118 B	JOB AIMP	APP.	SPACE SCIENCES LABORATORY	SCALE 2 = 1	DR. DJP	DATE 7 MAR 65
TITLE DRILL FIXTURE			UNIVERSITY OF CALIFORNIA	REQD.	MAT'L. STEEL	

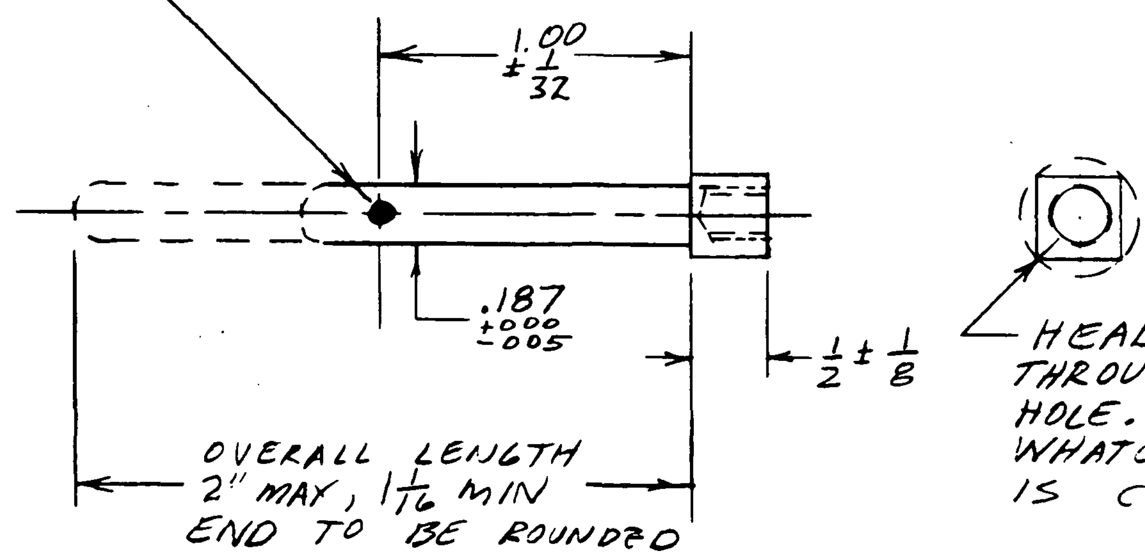


NO. AIMP-119	JOB AIMP	APP.	SPACE SCIENCES LABORATORY	SCALE 2=1	DR. DJP DATE 15MAR65
TITLE CALIBRATOR			UNIVERSITY OF CALIFORNIA	REQD.	MATL.

100 MICRO CURRIES $C_o^{60} \pm 5\%$

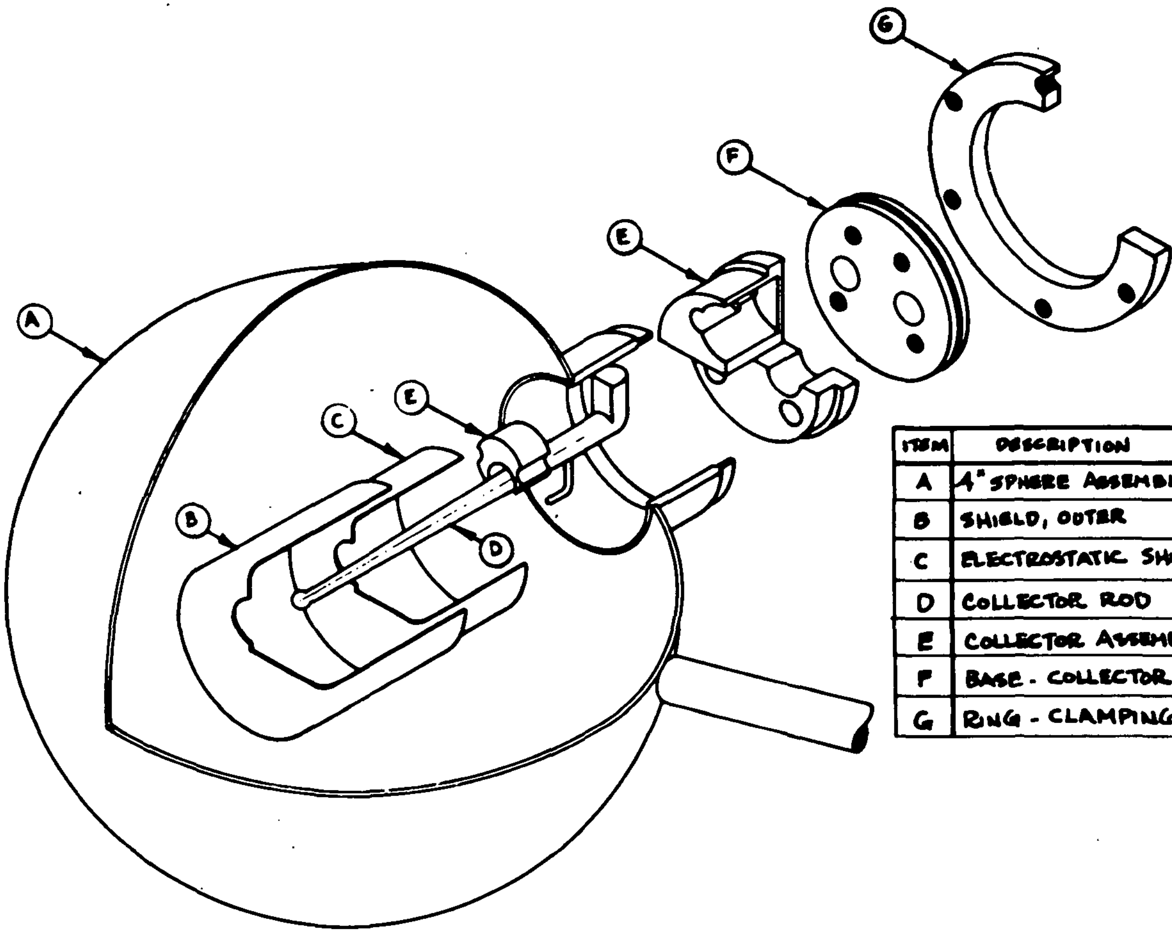
BODY TO BE NON-MAGNETIC STAINLESS STEEL. ACTIVITY TO BE SEALED IN TUBE BY WELDING OR SILVERSOLDERING

100 μ CURRIES C_o^{60} CENTER OF ACTIVITY AS INDICATED.



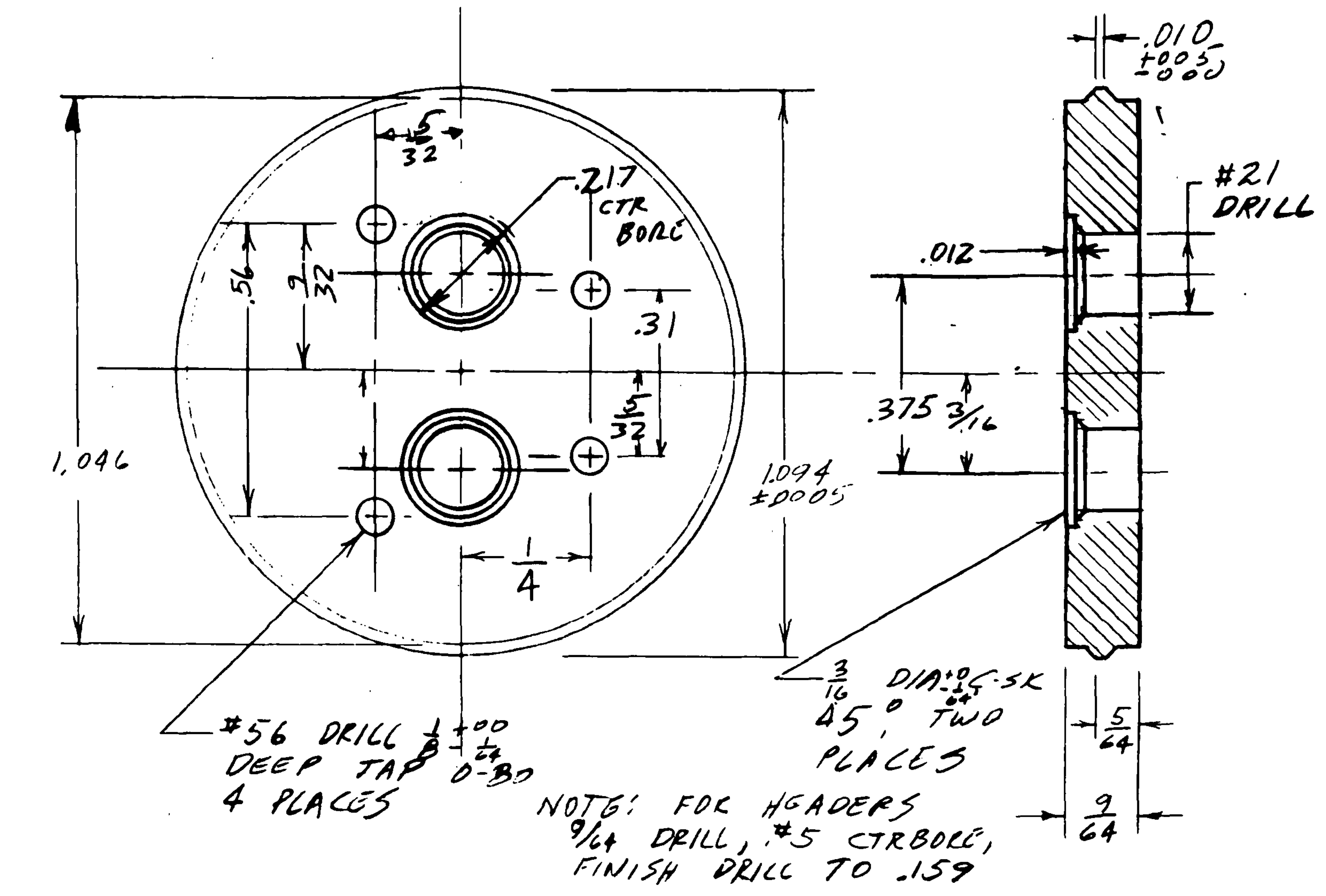
HEAD TO PASS THROUGH 3/8 DIA HOLE. THREADED WHATEVER SIZE IS CONVENIENT

NO. AIMP - 120	JOB	APP.	SPACE SCIENCES LABORATORY	SCALE NONE	DR. R. TOY	DATE 11 JULY 66
TITLE ION CHAMBER ASSEMBLY			UNIVERSITY OF CALIFORNIA	REQD.	REV. B 11 JULY 1966 REDRAWN	

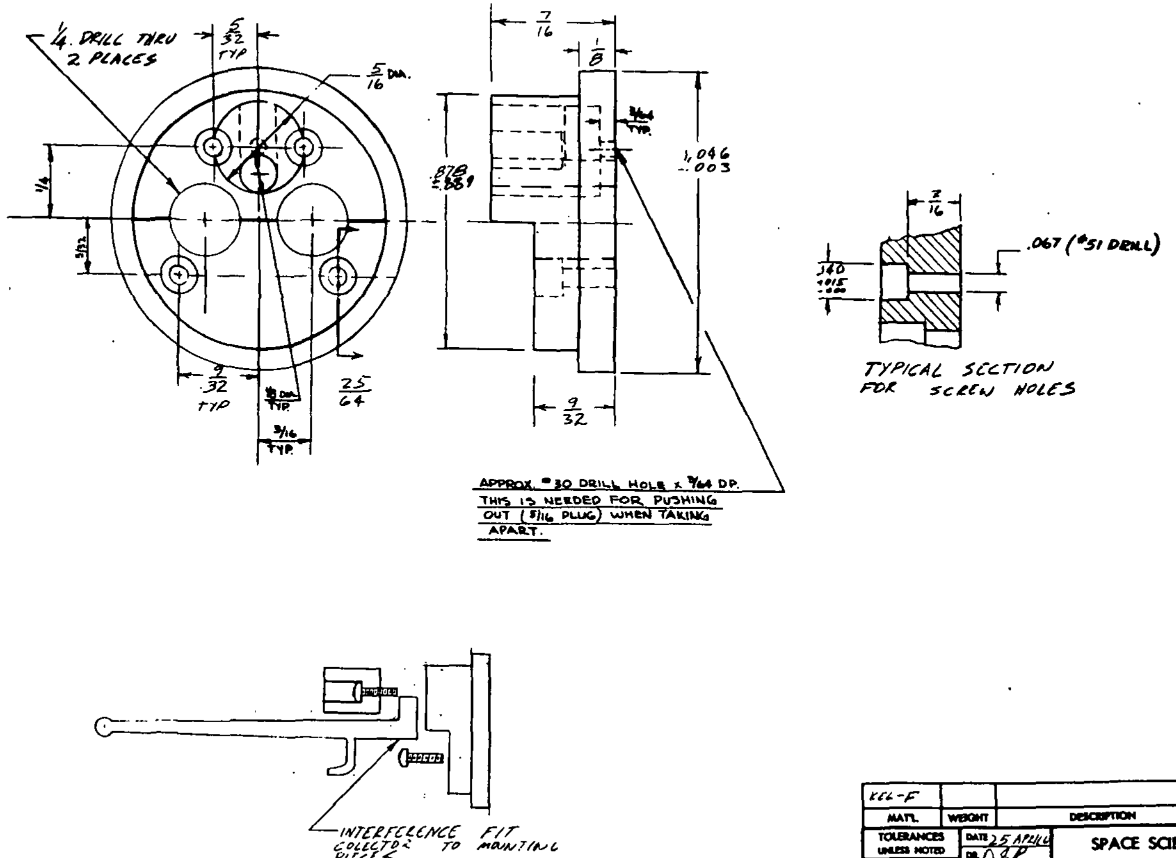


ITEM	DESCRIPTION	NUMBER	[illegible]
A	4" SPHERE ASSEMBLY	AIMP-150	1
B	SHIELD, OUTER	AIMP-126	1
C	ELECTROSTATIC SHIELD	AIMP-124	1
D	COLLECTOR ROD	AIMP-125	1
E	COLLECTOR ASSEMBLY	AIMP-122	1
F	BASE - COLLECTOR	AIMP-121	1
G	RING - CLAMPING	AIMP-139	1

NO. AIMP 121 B	JOB AIM P	APP.	SPACE SCIENCES LABORATORY	SCALE 4 = 1	DR. SMMR DATE 6-5
TITLE BASE - COLLECTOR			UNIVERSITY OF CALIFORNIA	REQD.	MATL. 304 STAINLESS SPECIAL STOCK



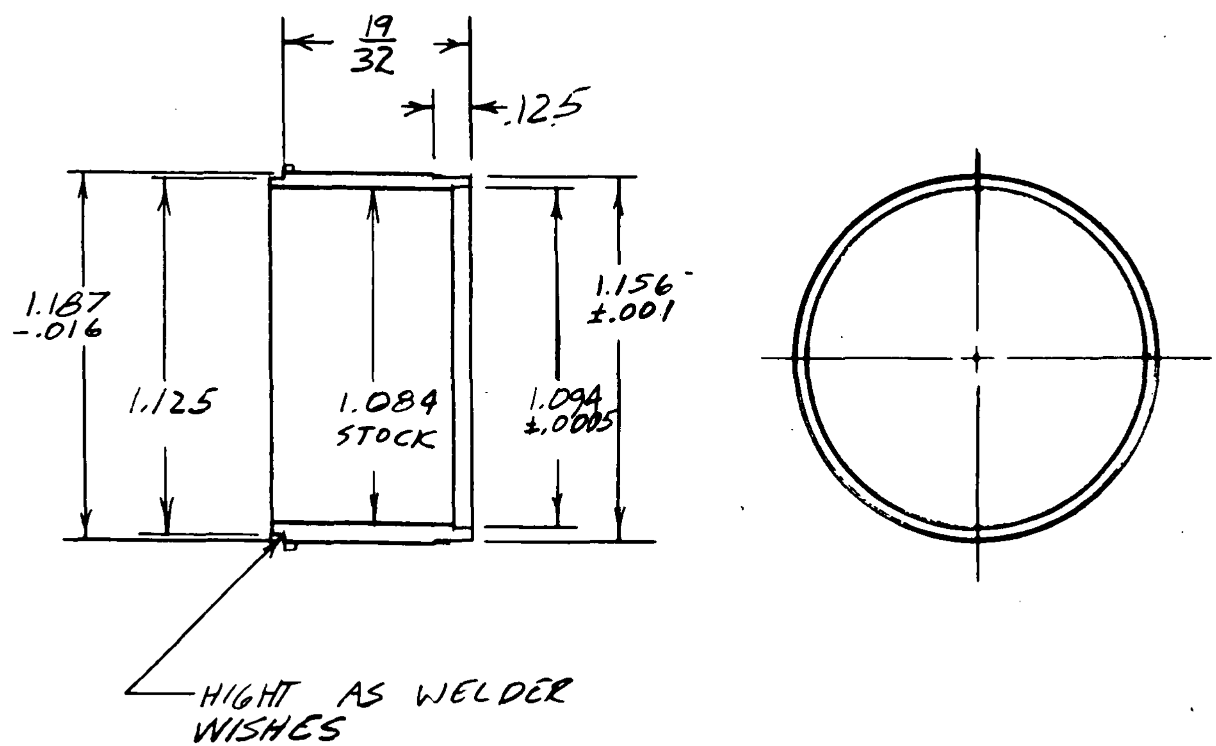
Rev.	No.	DESCRIPTION	DATE	APP'D
A		REDIMENSION C-BORE	3 JAN 65	
B	2	RELOCATE HEADER HOLES SCREW HOLE TO .086	13 [illegible] 66	
C		.067 (#51 DRILL) WAS .086 (#44 DRILL); #30 DRILL HOLE THRU ADDED; 3/64 DIM'S, 1/4 DIA'S, 1/8 DIA'S ADDED; 9/32 WAS 9/16.	11 Sep 1966	



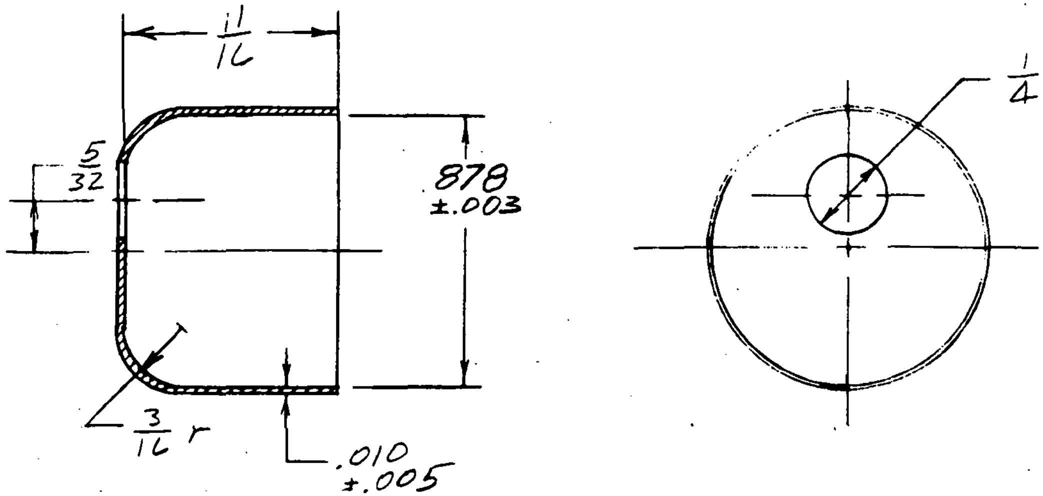
KEL-F					
MAT'L.	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

TOLERANCES UNLESS NOTED	DATE 25 APRIL	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA BERKELEY
	DR. DSP	
	CH'D	
	APP'D	
	COLLECTOR ASSY.	
	SCALE 4 = 1	No. AIMP 122 — REV. C, SH. 1 of 1
	N. A.	PROJECT AIMP

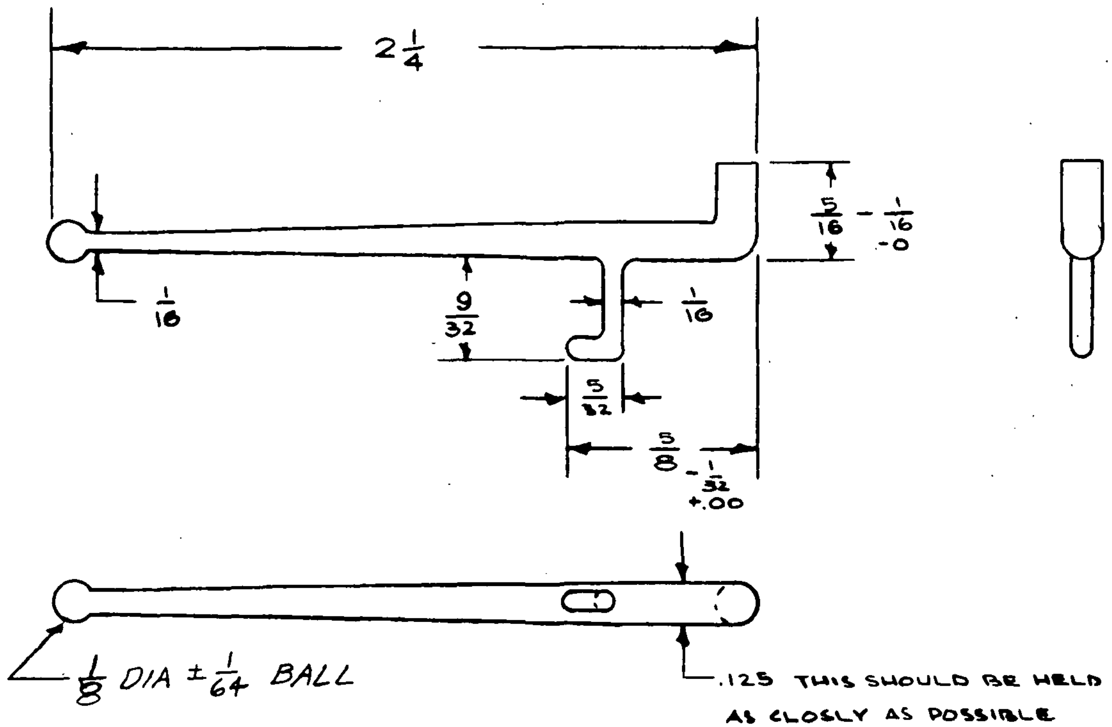
NO. AIMP 123	JOB AIMP	APP.	SPACE SCIENCES LABORATORY	SCALE 2 = 1	DR. DGP / DATE 4 MAR 65
TITLE STEM			UNIVERSITY OF CALIFORNIA	REQD.	MATL. 6061-T6



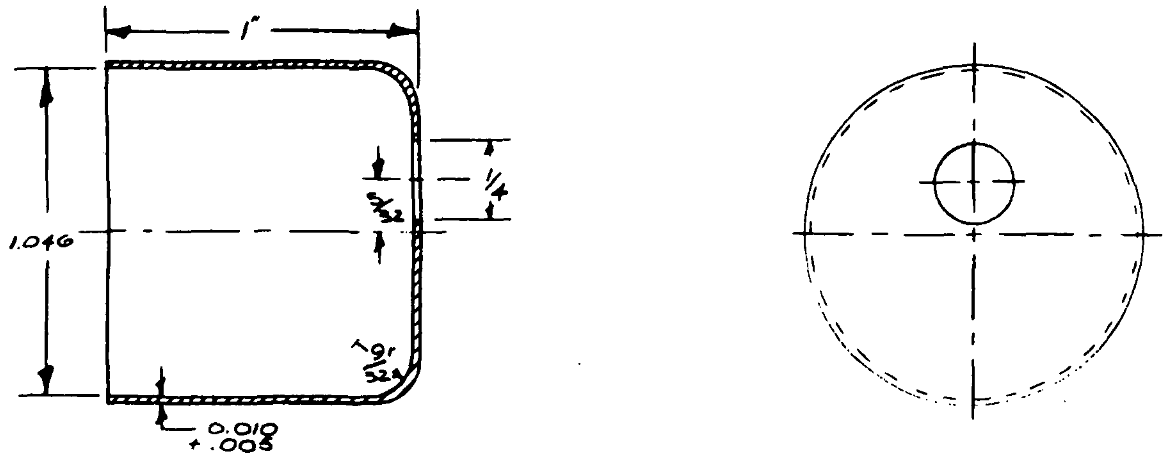
NO. AIMP 124	JOB AIMP APP.	SPACE SCIENCES LABORATORY	SCALE 2 = 1	DR. DATE
TITLE ELECTROSTATIC SHIELD		UNIVERSITY OF CALIFORNIA	REQD.	MATL. COPPER GOLD PLATE



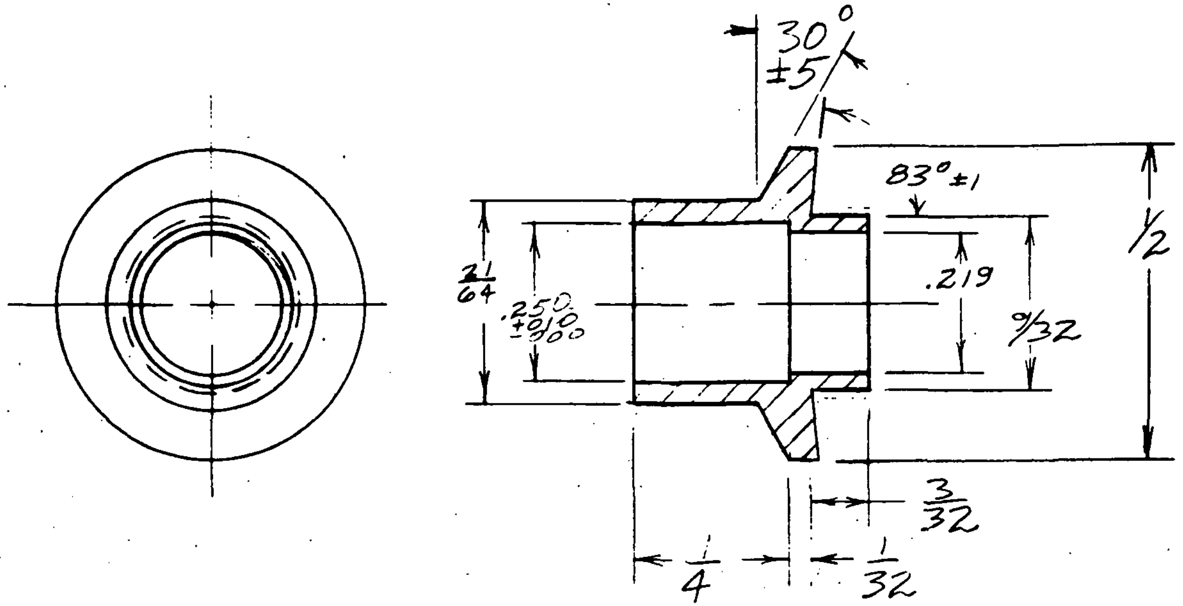
NO. AIMP 125 B	JOB AIMP APP.	SPACE SCIENCES LABORATORY	SCALE 2:1	DR. JACK DATE 10-4-65
TITLE COLLECTOR ROD		UNIVERSITY OF CALIFORNIA	REQD.	MATL. FUSED QUARTZ



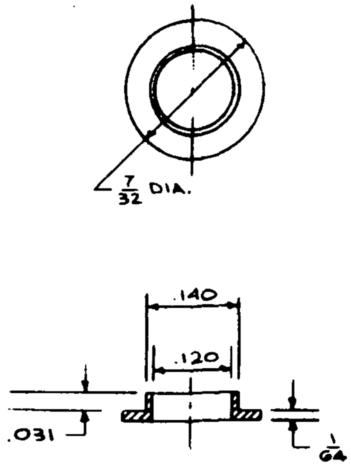
NO. AIMP 126 A	JOB AIMP	APP.	SPACE SCIENCES LABORATORY	SCALE 2"=1"	DR. JACK DATE 10-4-65
TITLE SHIELD, OUTER			UNIVERSITY OF CALIFORNIA	REQD.	MATL. COPPER GOLD PLATE



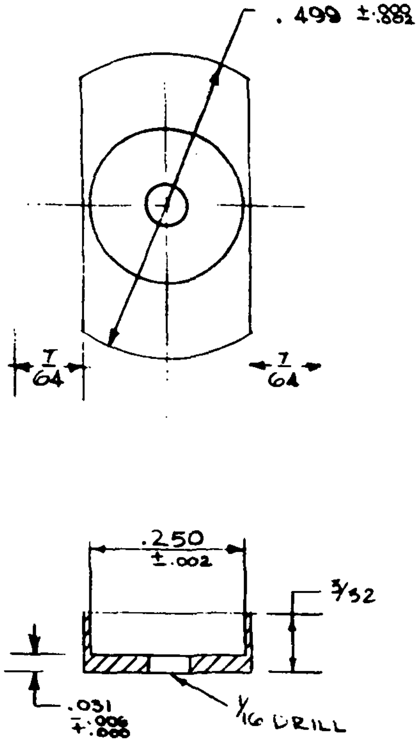
NO. AIMP 127 A	JOB AIMP	APP.	SPACE SCIENCES LABORATORY	SCALE 4 = 1	DR. — DATE 26 MAY
TITLE TUBE SOCKET			UNIVERSITY OF CALIFORNIA	REQD.	MATL. 6061



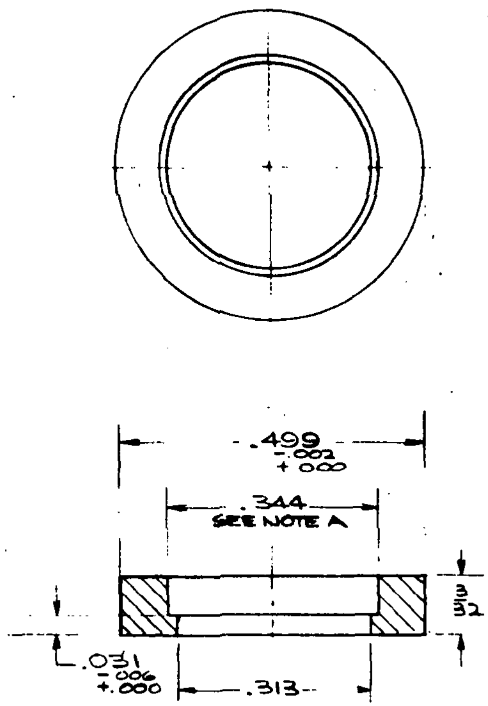
NO. AIMP 129B	JOB AIMP APP.	SPACE SCIENCES LABORATORY	SCALE 4" = 1"	DR. JACK DATE 10-4-65
TITLE SPACER BUSHING, T.D. CONNECTOR		UNIVERSITY OF CALIFORNIA	REQD.	MATL. AL



NO. AIMP 130 REV. A	JOB AIMP APP.	SPACE SCIENCES LABORATORY	SCALE 4" = 1"	DR. REV. A - TERRY 9-28-66 E. GEE DATE 4-27-64
TITLE ANODE CUSHION		UNIVERSITY OF CALIFORNIA	REQD.	MATL. KEL-F

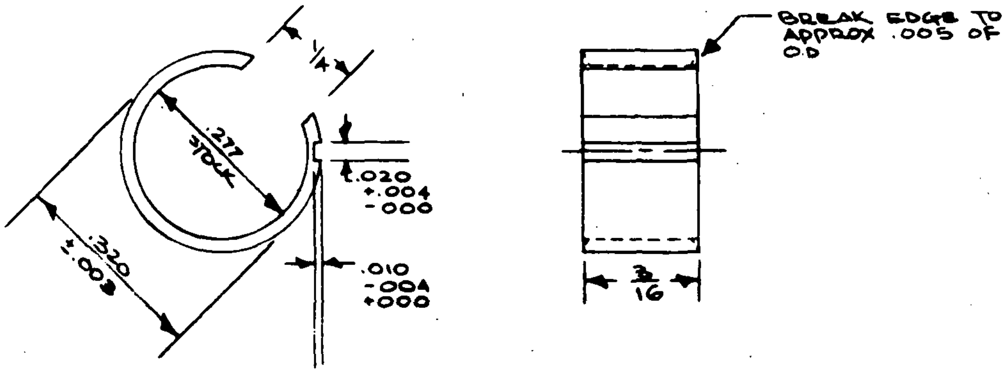


NO. AIMP 131 A	JOB AIMP APP.	SPACE SCIENCES LABORATORY	SCALE 4" = 1"	DR. E. GEE DATE 4-27-65
TITLE CATHODE CUSHION, LIONEL 205 HT		UNIVERSITY OF CALIFORNIA	REQD.	MATL. KEL-F

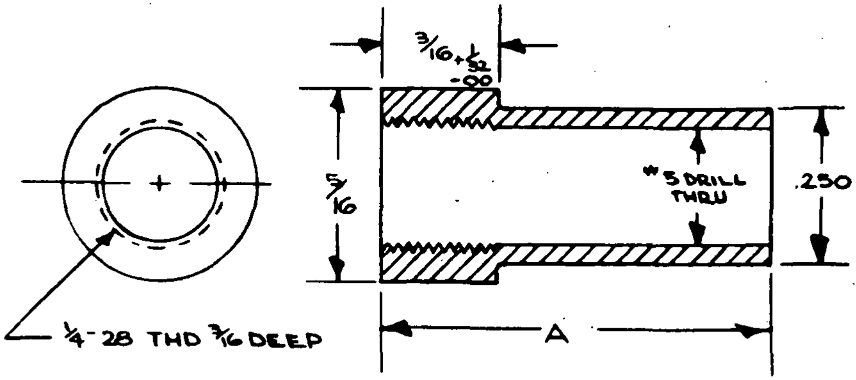


NOTE A
BORE TO BE FITTED
TO O.D. OF INDIVIDUAL
GM TUBE

NO. AIMP 132B	JOB AIMP APP.	SPACE SCIENCES LABORATORY	SCALE 4" = 1"	DR. JACK DATE 10-4-66
TITLE CATHODE CLIP, LIONEL 208 HT		UNIVERSITY OF CALIFORNIA	REQD.	MATL. BRASS



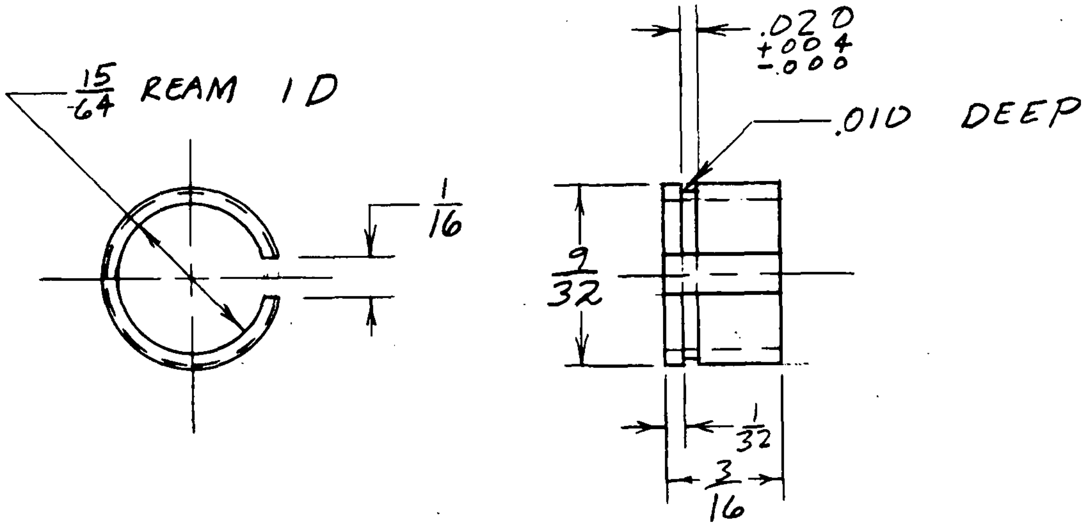
NO. AIMP-1331 REV.C	JOB AIMP APP.	SPACE SCIENCES LABORATORY	SCALE 4"=1"	DR. JACK DATE 10-5-65
TITLE ANODE		UNIVERSITY OF CALIFORNIA	REQD.	MATL. AL



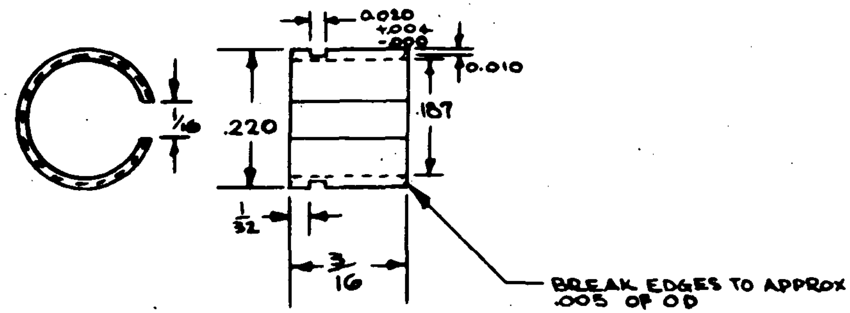
TUBE	A +.000 -.005	REQD.
LIONEL 250 HT	0.556	1
LIONEL 250 HT V. THIN WINDOW	0.498	6
LND 704 X	0.795	

NOTE: MACHINE CAPS SUPPLIED TO ABOVE DIMENSIONS.

NO. AIMP-134 A	JOB AIMP APP.	SPACE SCIENCES LABORATORY	SCALE	DR. DBL DATE 11 JUNE 65
TITLE ANODE CLIP, LIONEL 205HT		UNIVERSITY OF CALIFORNIA	REQD.	MAT'L HARD BRASS

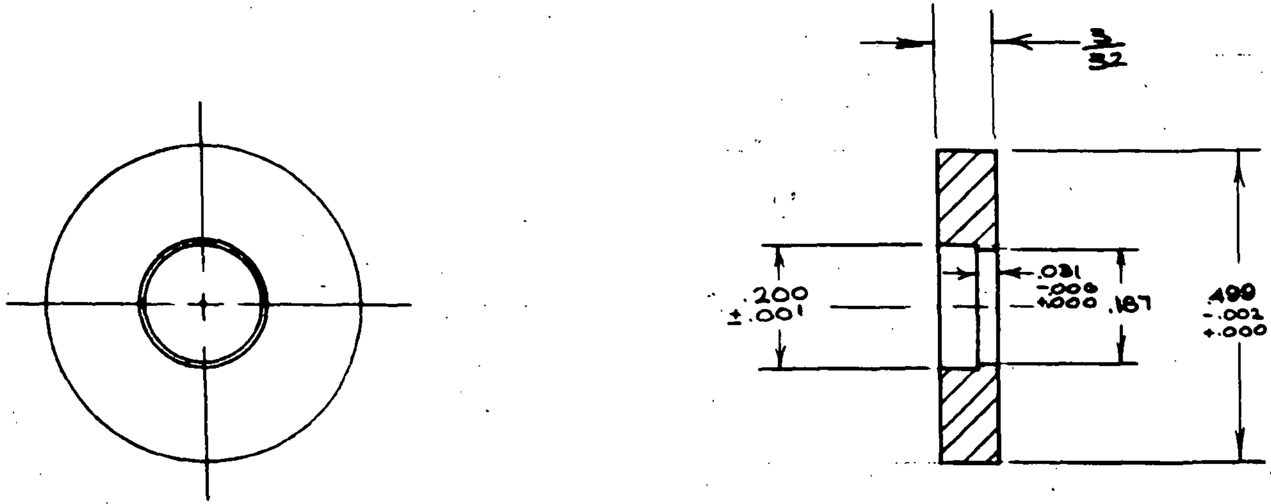


NO. AMP-13B	JOB AMP	APP.	SPACE SCIENCES LABORATORY	SCALE 4"=1"	DR. JACK	DATE 10-5-65
TITLE CATHODE CLIP, LND 704X			UNIVERSITY OF CALIFORNIA	REQD.	MATL. HARD BRASS	

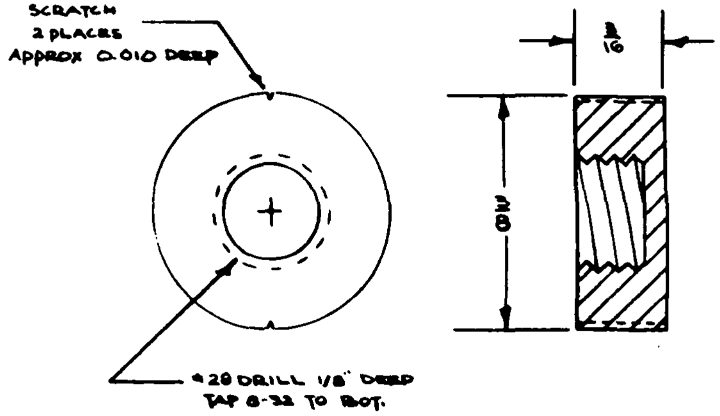


NOTE:
TURN OD FROM 1/4 OD x 21 GA
HARD BRASS TUBING

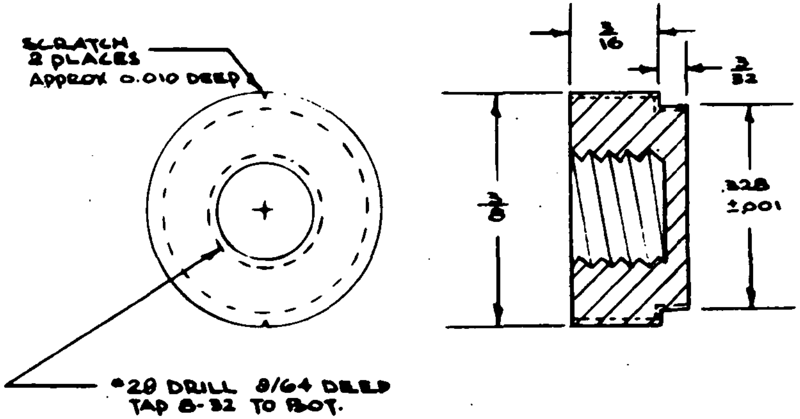
NO. AIMP-136	JOB AIMP	APP.	SPACE SCIENCES LABORATORY	SCALE 4 = 1	DR. DSB DATE 22 JULY 65
TITLE CATHODE CUSHION, LND			UNIVERSITY OF CALIFORNIA	REQD.	MATL. KEL-F



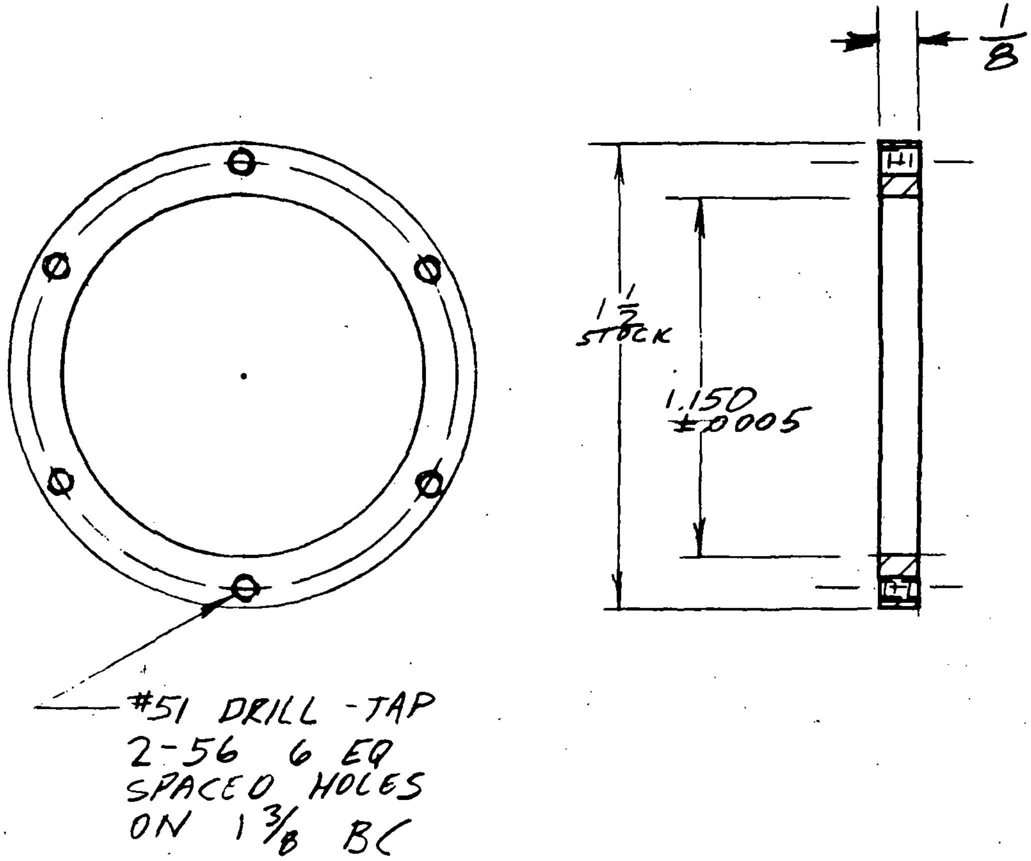
NO. AIMP-137	JOB AIMP	APP.	SPACE SCIENCES LABORATORY	SCALE 4"=1"	DR. JACK / DATE 10-7-68
TITLE PROTECTIVE CAP, GM I			UNIVERSITY OF CALIFORNIA	REQD.	MATL. NYLON



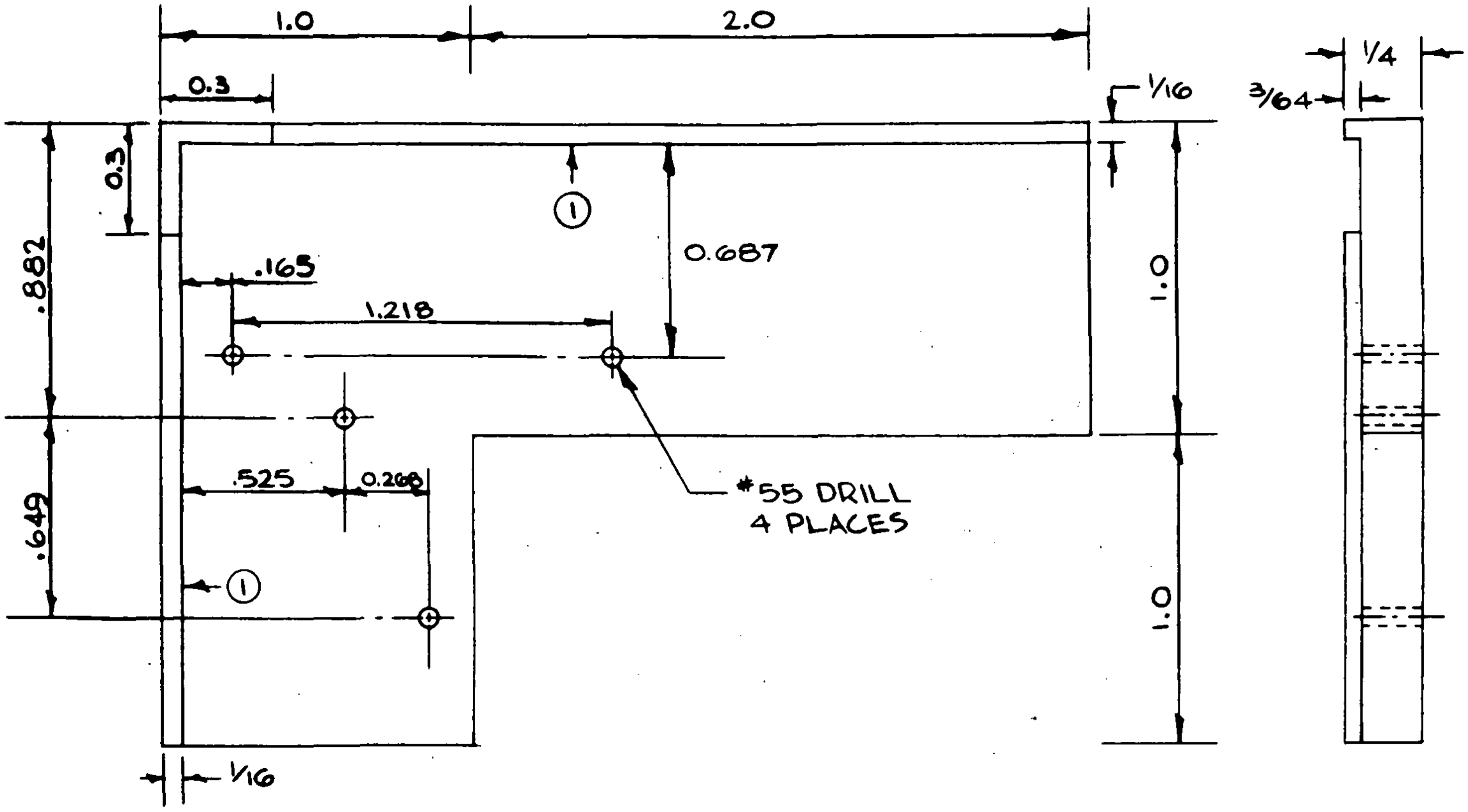
NO. AIMP-13B	JOB AIMP	APP.	SPACE SCIENCES LABORATORY	SCALE 4"=1"	DR. JACK — DATE 10-7-65
TITLE PROTECTIVE CAP, GM 2			UNIVERSITY OF CALIFORNIA	REQD.	MATL. NYLON



NO. AIMP - 139	JOB AIMP APP.	SPACE SCIENCES LABORATORY	SCALE 2=1	DR. DP DATE 7 OCT 65
TITLE RING - CLAMPING		UNIVERSITY OF CALIFORNIA	REQD.	MATL. SS - 304



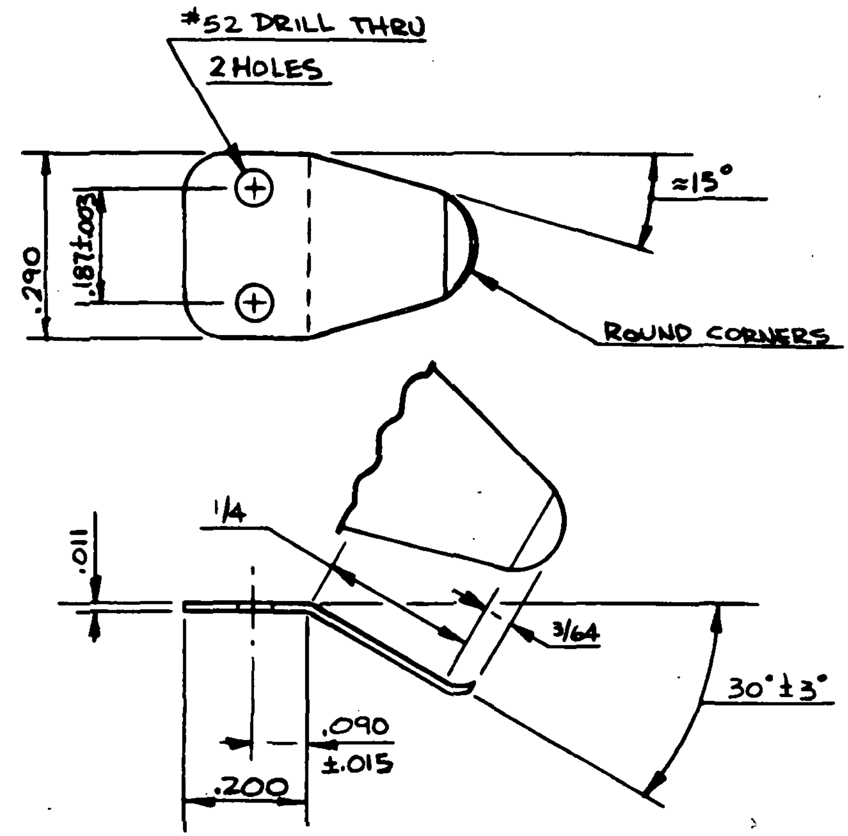
NO. SIMD-140	JOB SIMP	APP.	SPACE SCIENCES LABORATORY	SCALE 2"=1"	DR. VEIGA DATE 2-2-66
TITLE TEMPLATE			UNIVERSITY OF CALIFORNIA	REQD.	MATL. STEEL



NOTES:

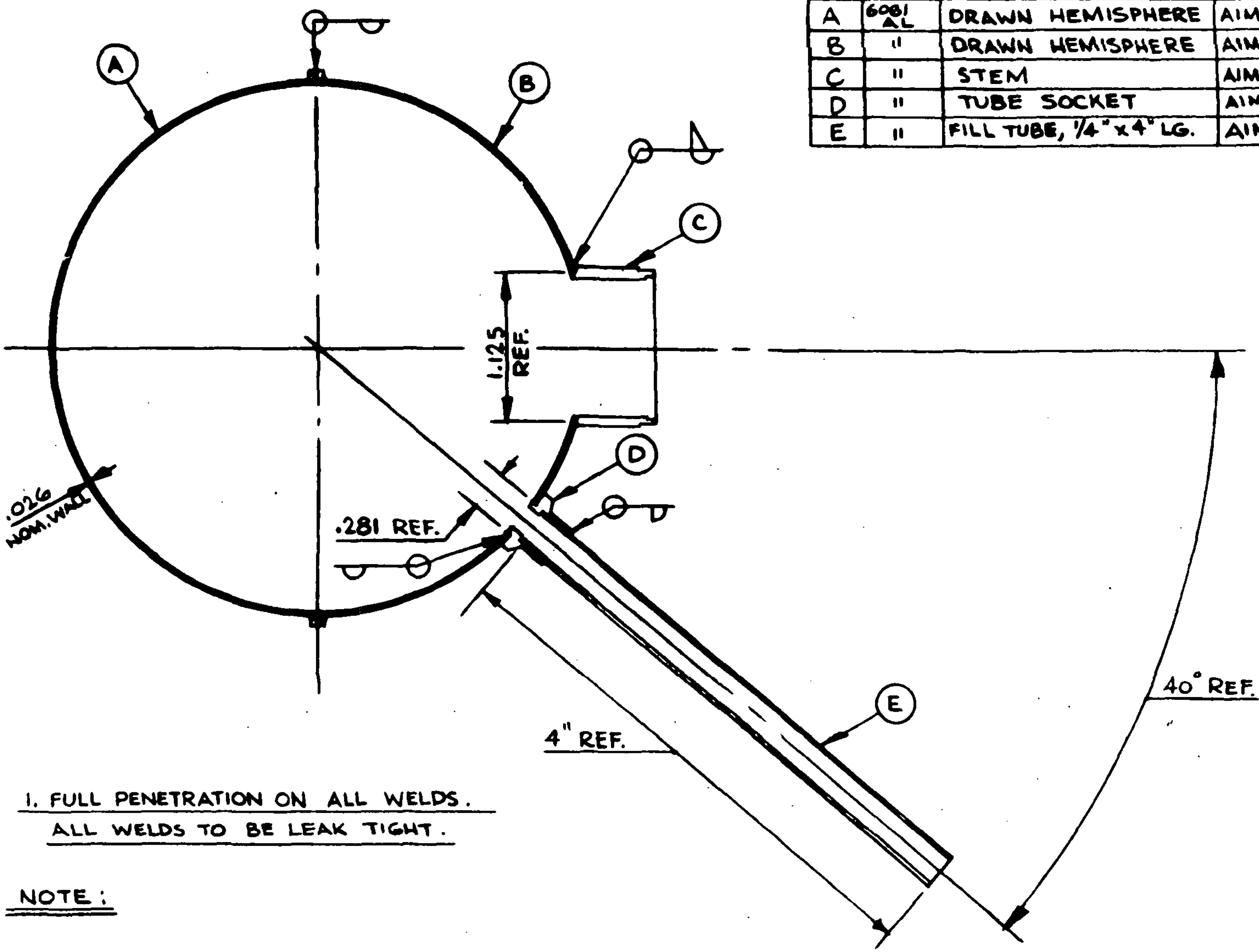
① THESE CORNERS SHARP -- ALL OTHERS MAY BE ROUNDED

NO. SIMP-141	JOB	APP. R.L.P.	SPACE SCIENCES LABORATORY	SCALE 4:1	DR. R. TOY	DATE SEP. 12, [redacted]
TITLE SPRING, SOURCE MOUNT			UNIVERSITY OF CALIFORNIA	REQD.	MATL. PHOSPHOR - BRONZE



NO. AIMP-150	JOB	APP.	SPACE SCIENCES LABORATORY	SCALE FULL	DR. R. TOY	DATE 8 JULY 1966
TITLE 4" SPHERE ASSEMBLY			UNIVERSITY OF CALIFORNIA	REQD.	MATL. 6061 AL-T6	

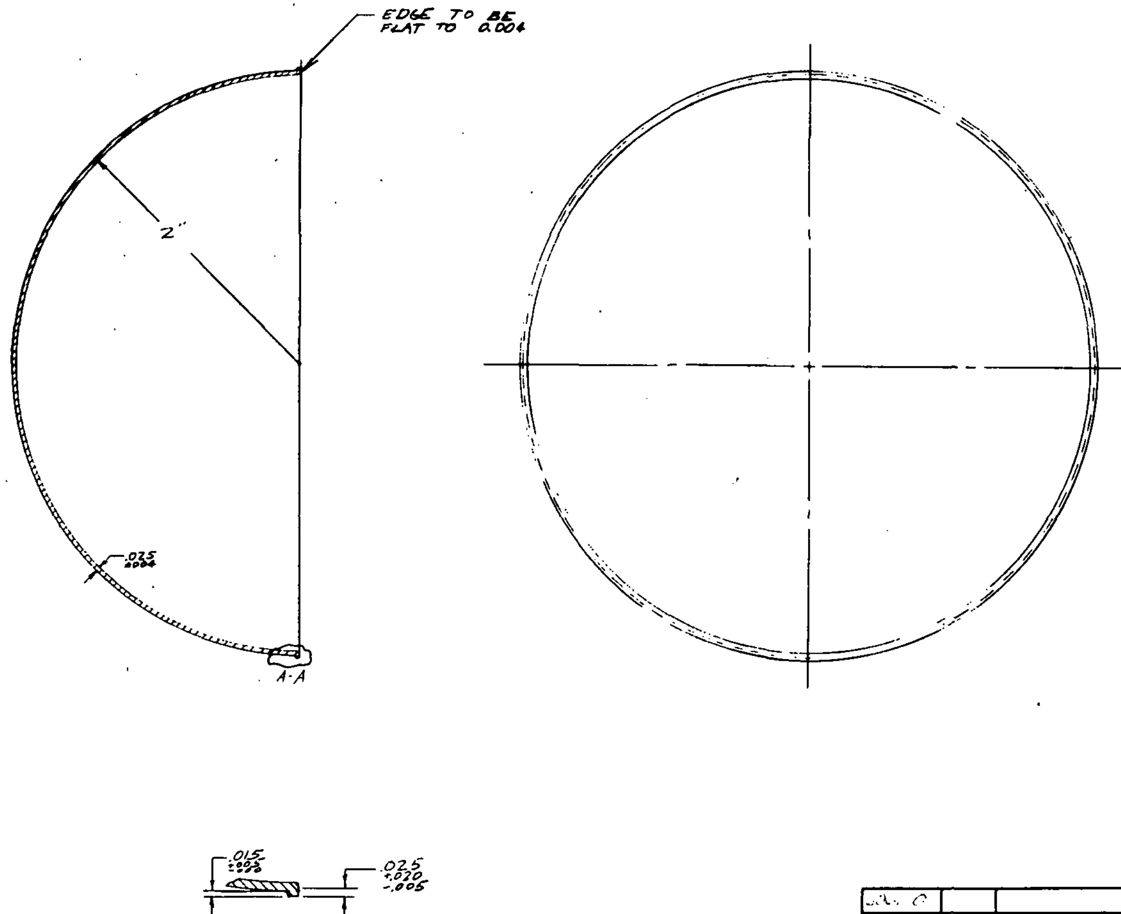
SYM.	MAT'L	DESCRIPTION	PART NO.	QTY.
A	6061 AL	DRAWN HEMISPHERE	AIMP-151	1
B	"	DRAWN HEMISPHERE	AIMP-152	1
C	"	STEM	AIMP-123	1
D	"	TUBE SOCKET	AIMP-127	1
E	"	FILL TUBE, 1/4" x 4" LG.	AIMP-153	1



1. FULL PENETRATION ON ALL WELDS.
ALL WELDS TO BE LEAK TIGHT.

NOTE:

Rev.	No.	DESCRIPTION	DATE	APP'D

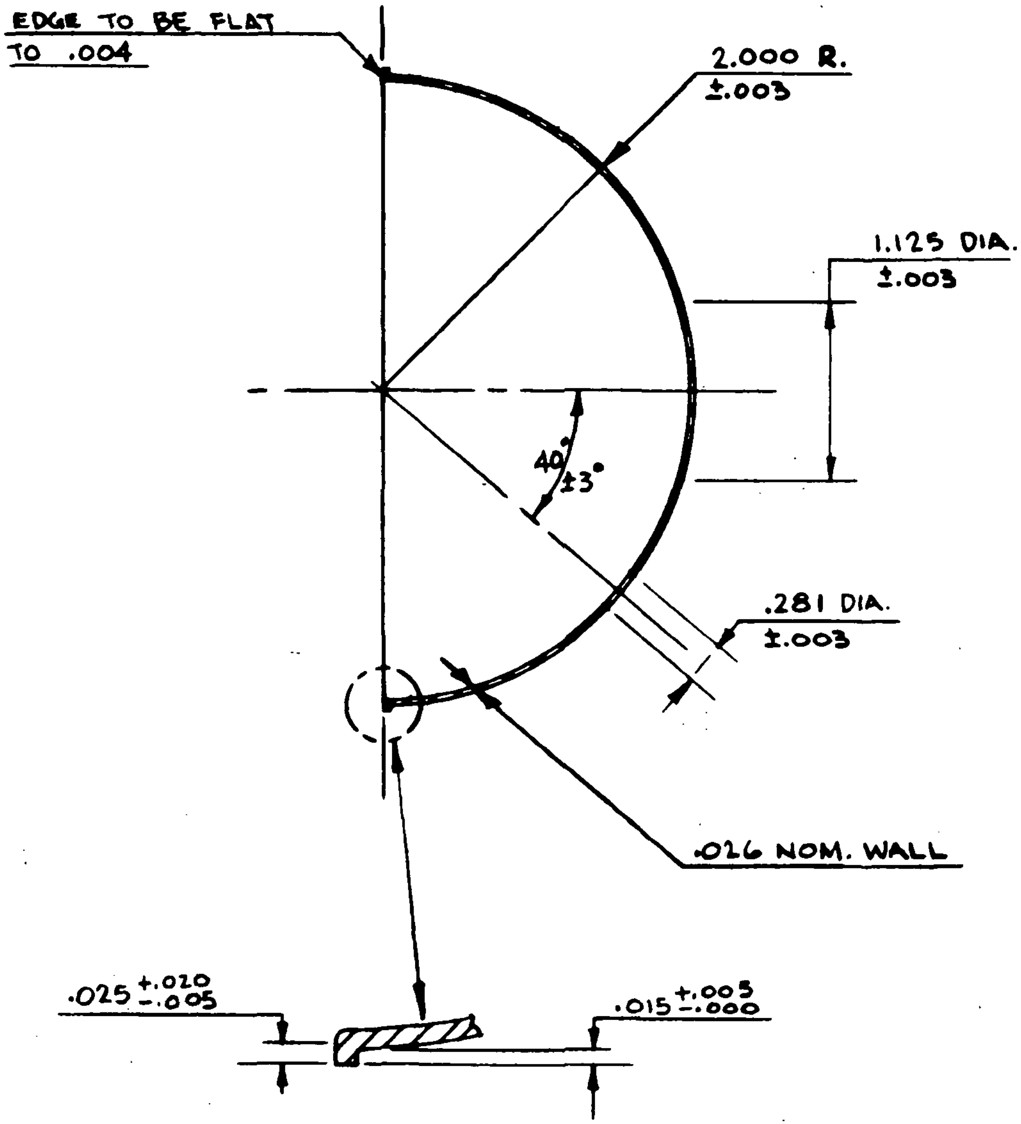


VIEW A-A

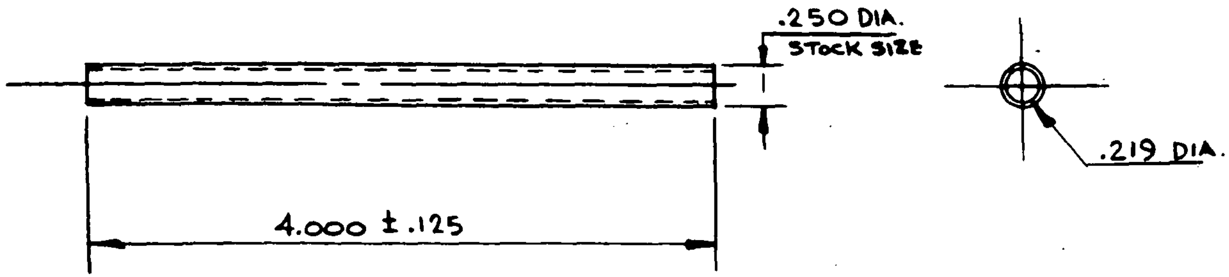
MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

TOLERANCES UNLESS NOTED	DATE DR. CK'D APP'D	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA BERKELEY
		DRAWN HEMISPHERE, TOP
	SCALE 2 = 1 N. A.	No. AIMP-151 PROJECT IMP
		REV. SH. of

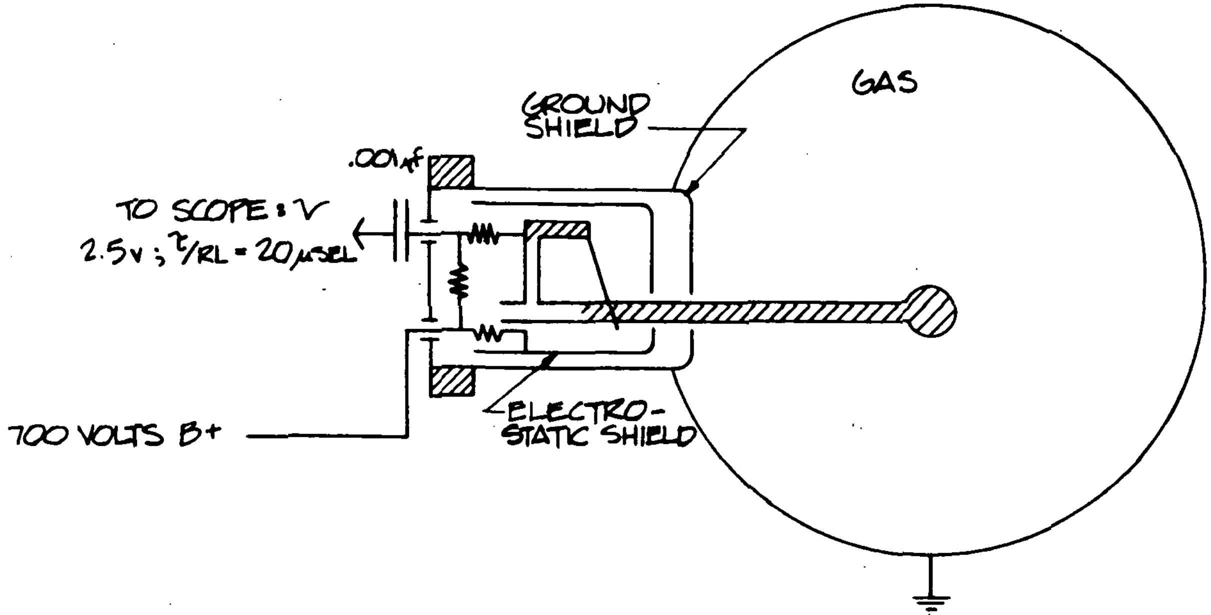
NO. AIMP-152	JOB APP.	SPACE SCIENCES LABORATORY	SCALE FULL	DR. R.TOY DATE 11 JULY 1966
TITLE DRAWN HEMISPHERE, BOTTOM		UNIVERSITY OF CALIFORNIA	REQD.	MATL. 6061 AL



NO. AIMP-153	JOB	APP.	SPACE SCIENCES LABORATORY	SCALE FULL	DR. R. TOY	DATE 11 JULY 1966
TITLE FILL TUBE			UNIVERSITY OF CALIFORNIA	REQD.	MATL. 6061 AL	



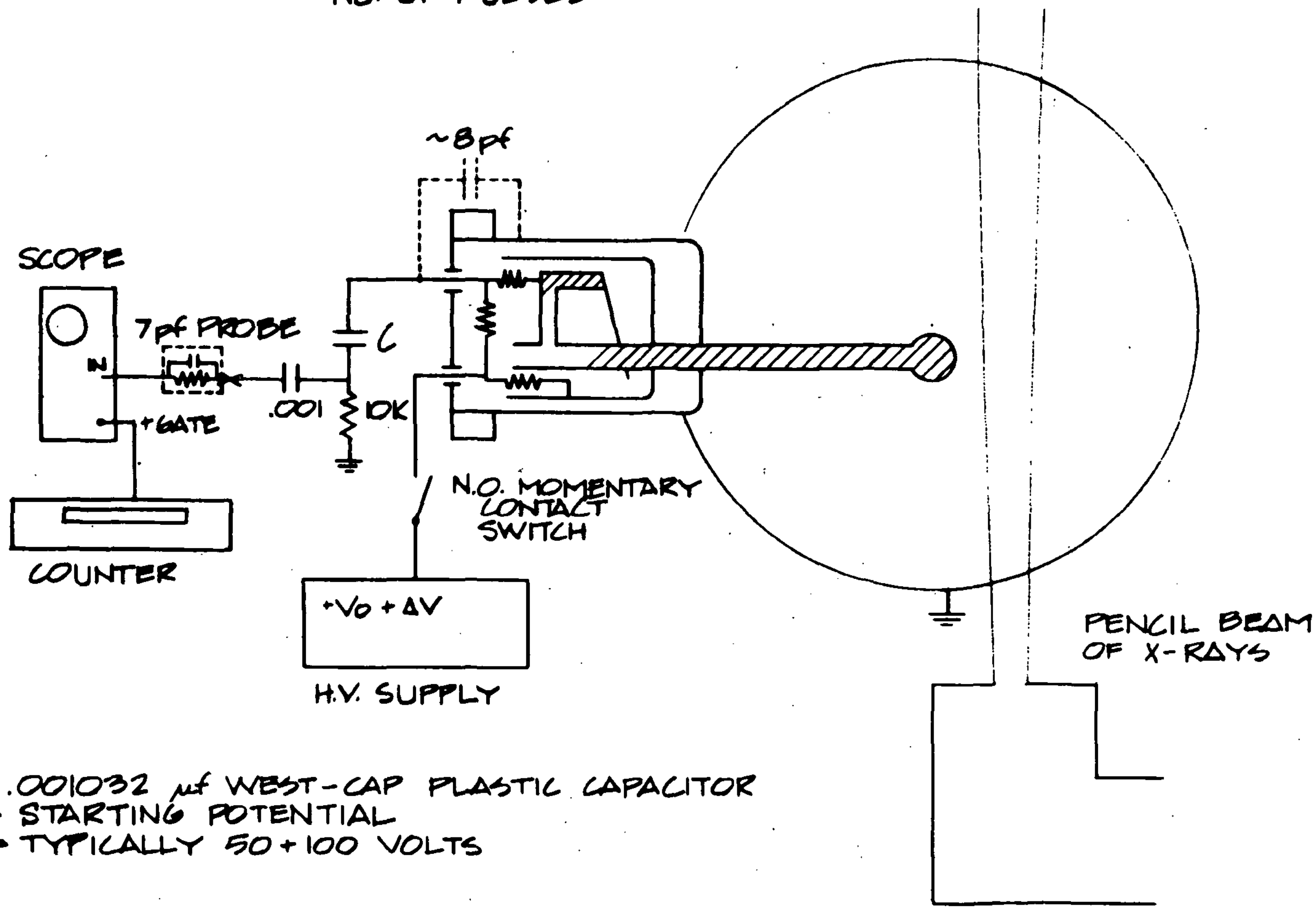
NO. AIMP-154	JOB I.M.P. APP.	SPACE SCIENCES LABORATORY	SCALE NONE	DR. QUICK DATE 7-8-66
TITLE SCHEMATIC, 4" ION CHAMBER		UNIVERSITY OF CALIFORNIA	REQD.	MATL.



DOSE/PULSE: ~0.2 MR/HR
FILL: 7.0 GMS. ARGON (~ 98 PSIG)
ALL RESISTORS: 1.0 MEG, 1/8 WATT
CHAMBER VOLUME: 525 CM^3
SHELL: .022 - .027 IN ALUMINUM
150 - 185 MG/CM^2
TEMPERATURE COEFICIENT: ~ +.015 %/°C
CHARGE/PULSE: $\sim 4.5 \times 10^{-10}$ COULOUMBS

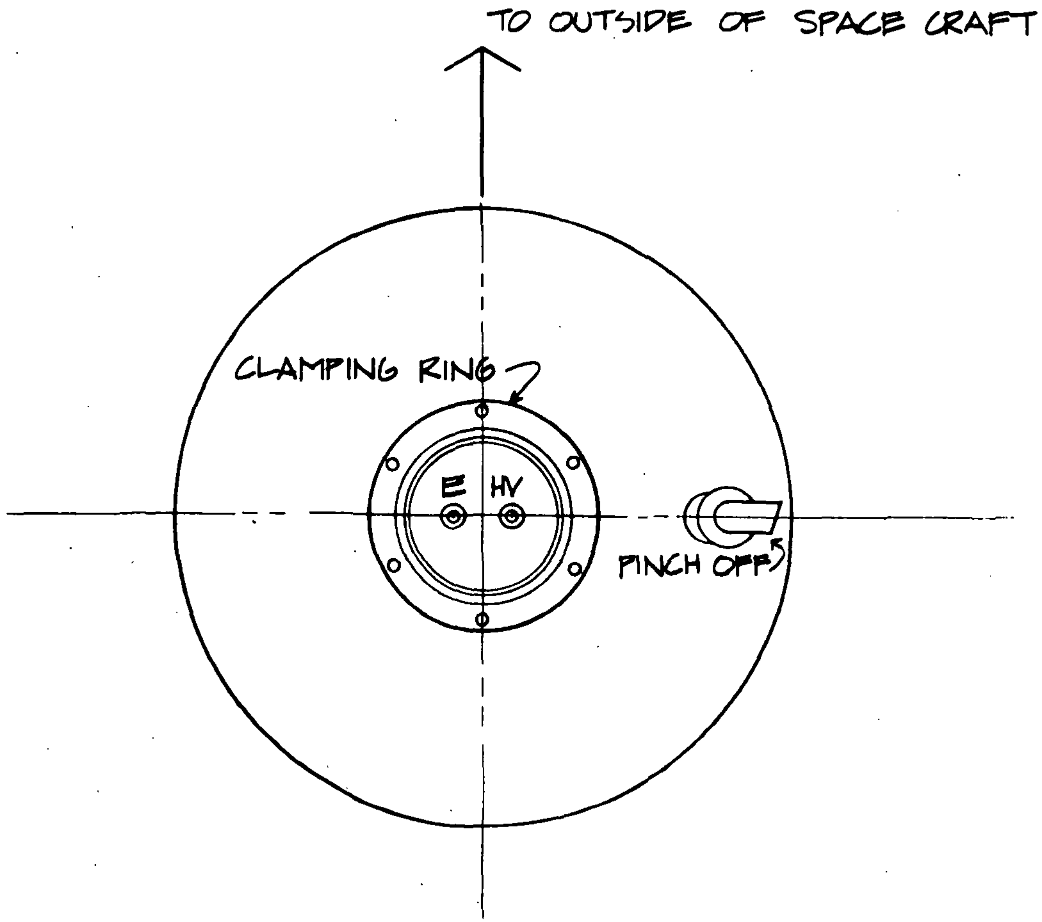
NO. AIMP-155	JOB IMP	APP.	SPACE SCIENCES LABORATORY	SCALE NONE	DR. QUICK DATE 7-10-66
TITLE CHARGE/PULSE MEASUREMENT			UNIVERSITY OF CALIFORNIA	REQD.	MATL.

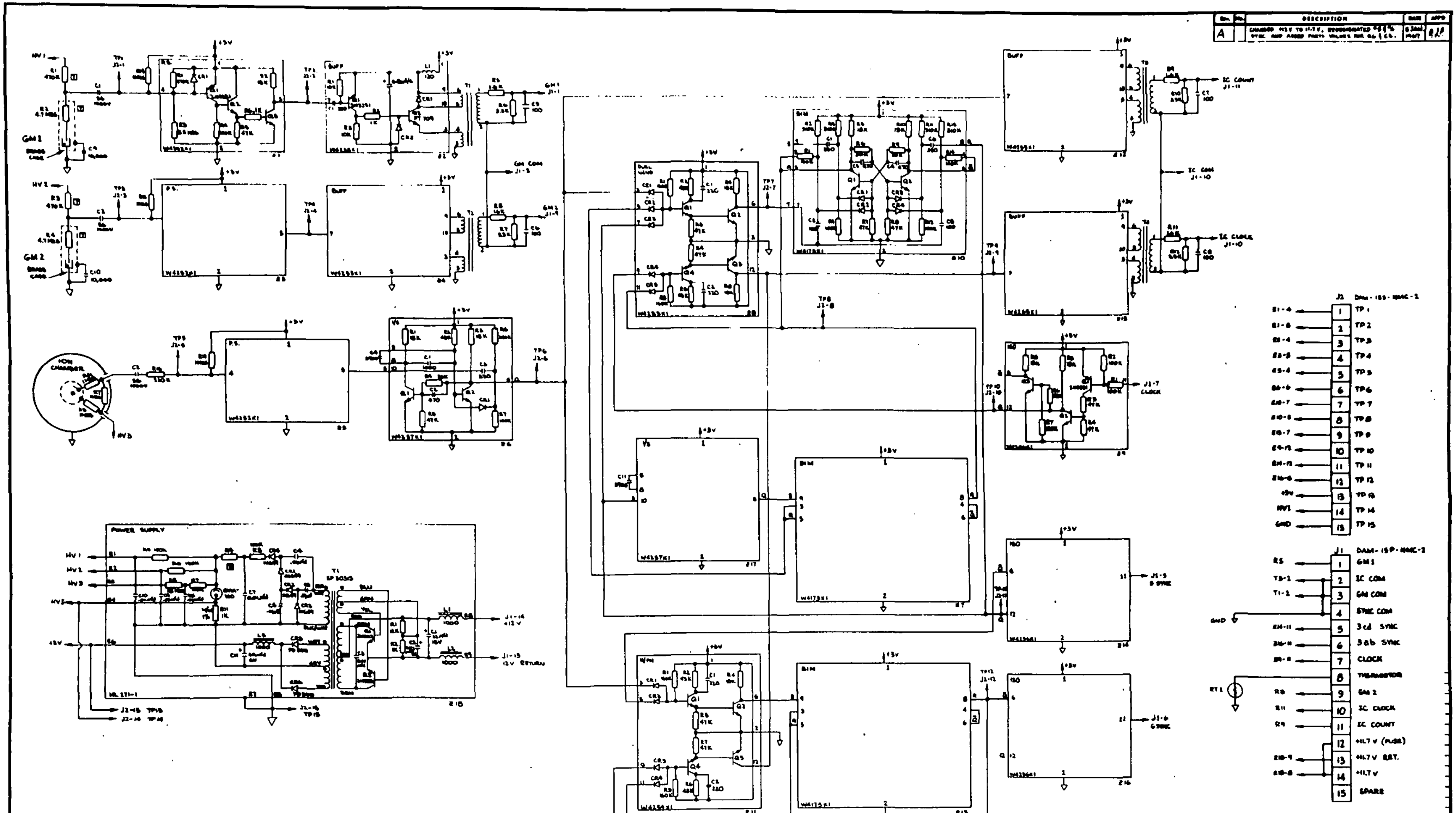
$$Q/\text{PULSE} = \frac{C_{\text{TOTAL}}\,\Delta V}{\text{No. OF PULSES}}$$



C = .001032 μf WEST-CAP PLASTIC CAPACITOR
V_0 = STARTING POTENTIAL
ΔV = TYPICALLY 50 + 100 VOLTS

NO. AIMP-156	JOB AIMP	APP.	SPACE SCIENCES LABORATORY	SCALE NONE	DR QUICK DATE 8-22-6
TITLE ION CHAMBER BASE ORIENTATION			UNIVERSITY OF CALIFORNIA	REQD.	MATL.





NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTANCE VALUES IN OHMS ±5%, 1/8 WATT.
2. ALL CAPACITANCE VALUES IN MICRO MICRO FARADS.
3. ALL INDUCTANCE VALUES IN HENRIES.
4. ALL TRANSISTORS ARE SP 10241.
5. ALL DIODES ARE TYPE MC 83.
6. TP : TEST POINT.
7. NOMINAL VALUE : SELECTED TO MATCH GM TUBE.
8. SELECTED VALUE.

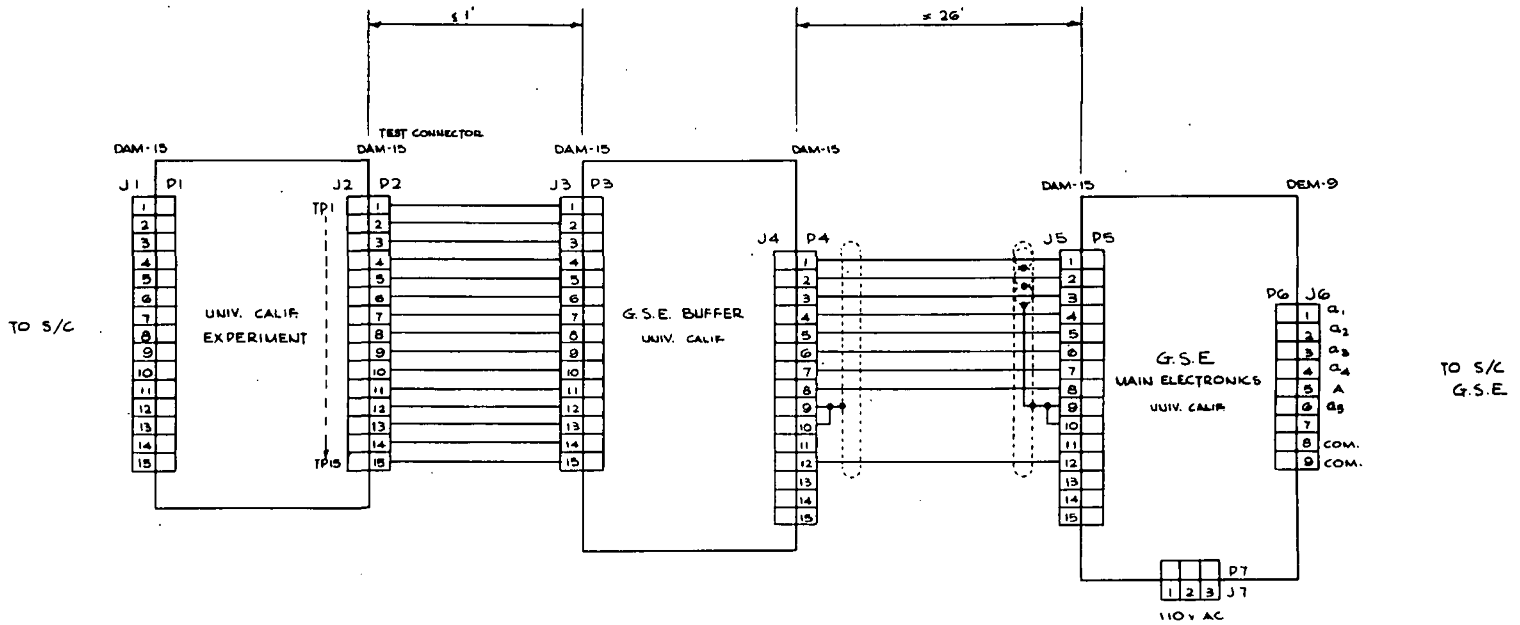
MATL.	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

SIMP SCHEMATIC

TOLERANCES UNLESS NOTED
DATE 25 JAN 66
DR. Q. TOY
CK'D
APPD
SCALE NONE
N.A.
No. SIMP - 300
PROJECT SIMP
REV. A
SH. 1 of 1

REV.	No.	DESCRIPTION	DATE	APP'D
A		ADDED a_5 ON J6.	[illegible] 1967	PJF



MATL.	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

TOLERANCES UNLESS NOTED

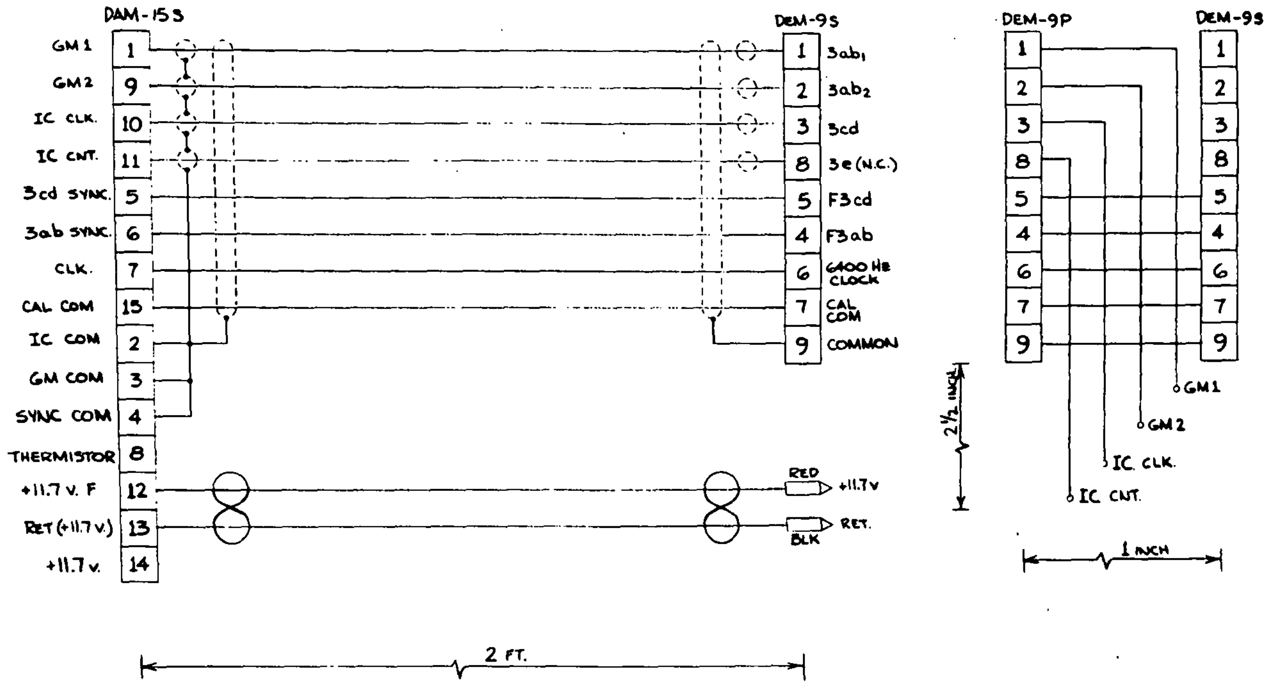
DATE 10-20-65
DR. J. VEIGA
CKD R. I. Paul
APP'D R. I. Paul

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

G.S.E. WIRING DIAGRAM

SCALE NONE
N.A.
No. SIMP-201
PROJECT SIMP
REV. A
SH. 1 of 1

DWG. NO. SIMP - 202



MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

TOLERANCES UNLESS NOTED

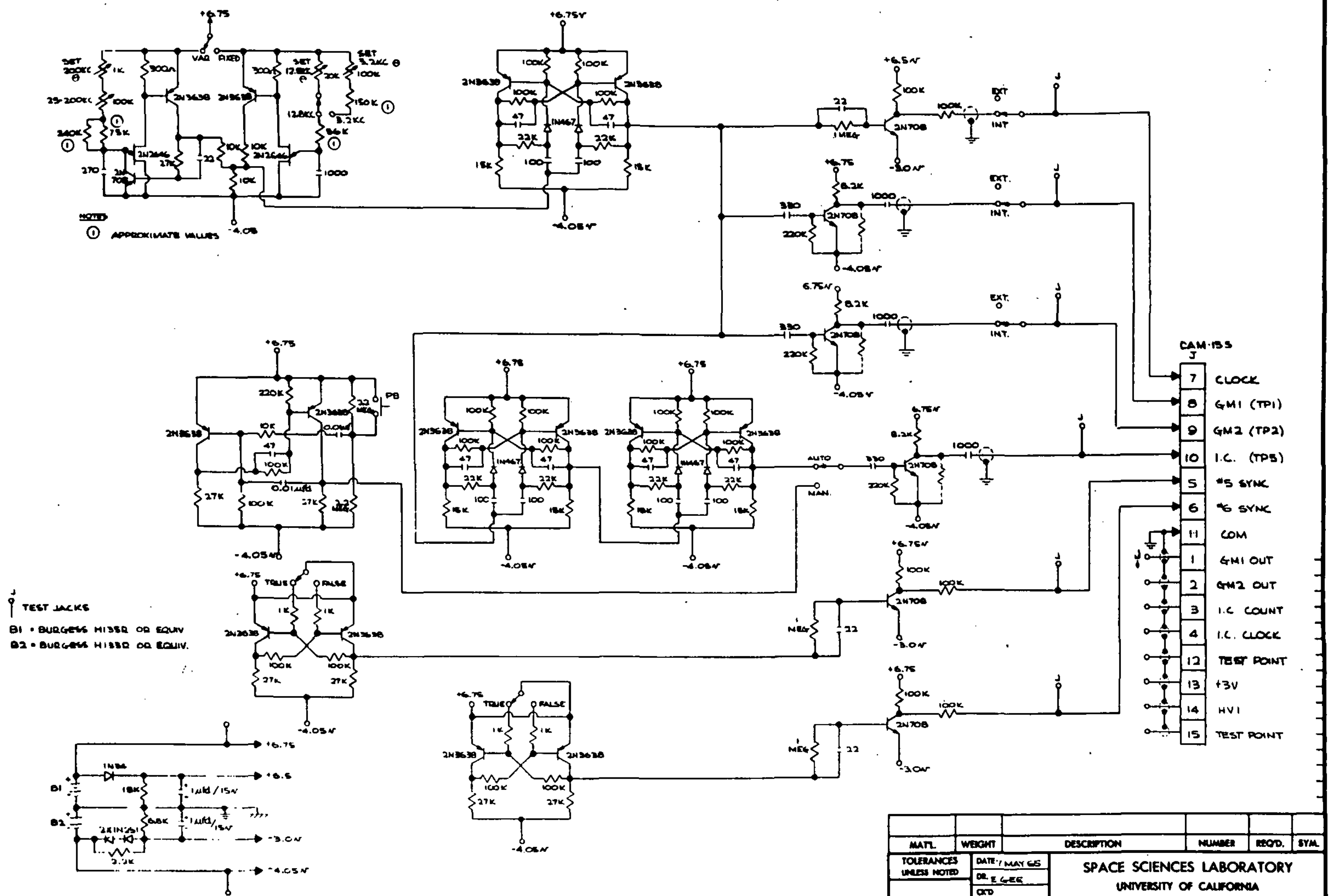
DATE 8-24-67
DR. GREEN
CK'D R. J. Paul
APP'D R. J. Paul

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

CABLE — EXPERIMENT TO GSFC SIMULATOR.

SCALE NONE
No. SIMP - 202
PROJECT

Rev.	No.	DESCRIPTION	DATE	APP'D
A	1	DELETED 3.3K AND IN34 FR. GM1, GM2, IC.	8-1-66	[illegible]
A	2	ADDED SHIELD ON CLK, GM1, GM2, IC	8-11-66	[illegible]
B	1	ADDED SHIELDS, DELETED #5 & 6 SWITCHES	9-2-66	[illegible]



MATL.	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

TOLERANCES UNLESS NOTED

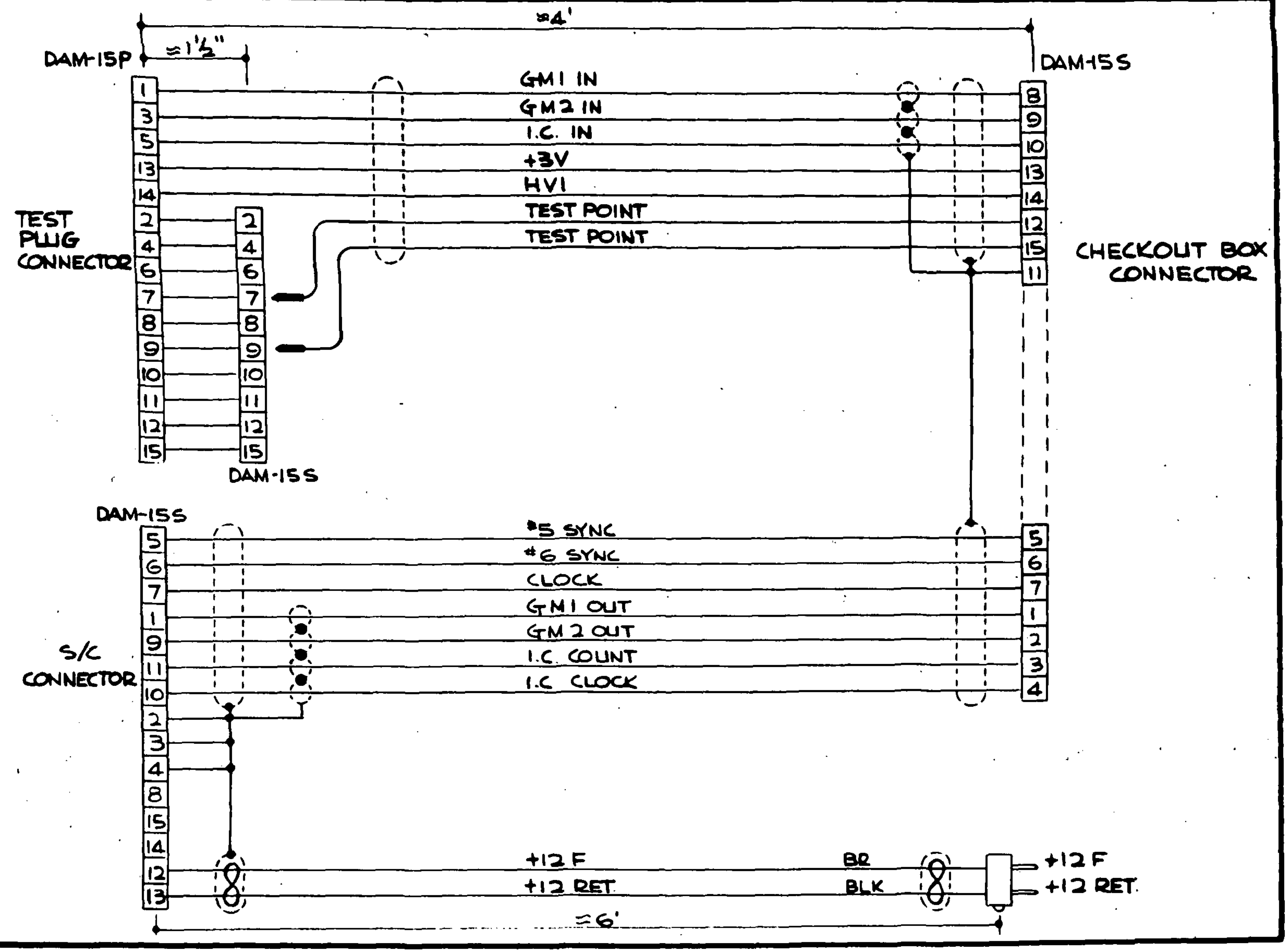
DATE 7 MAY 65
DR. E GEE
CK'D
APP'D R J Paoli

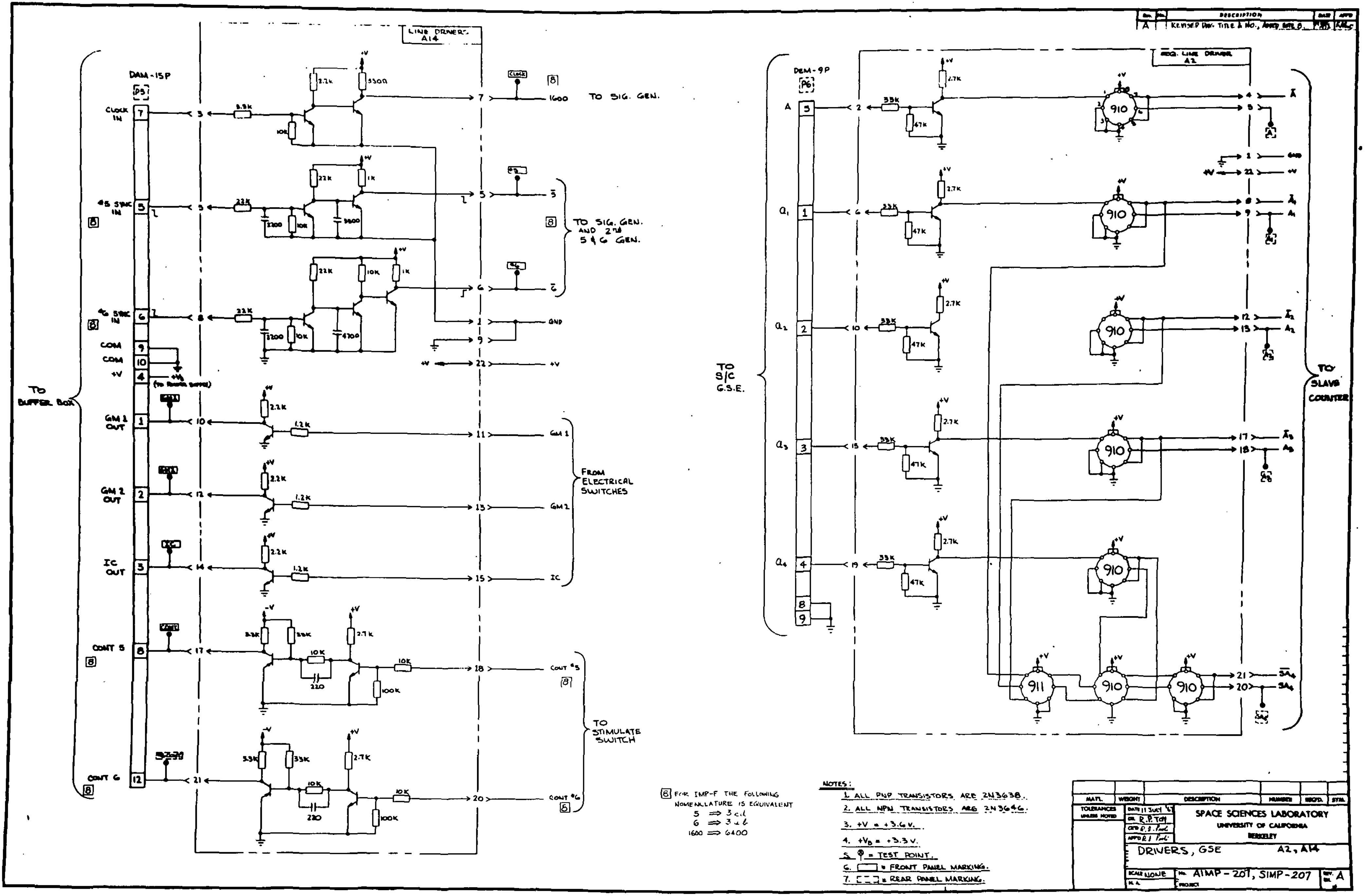
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

U.C. AIMP/SIMP CHECKOUT BOX

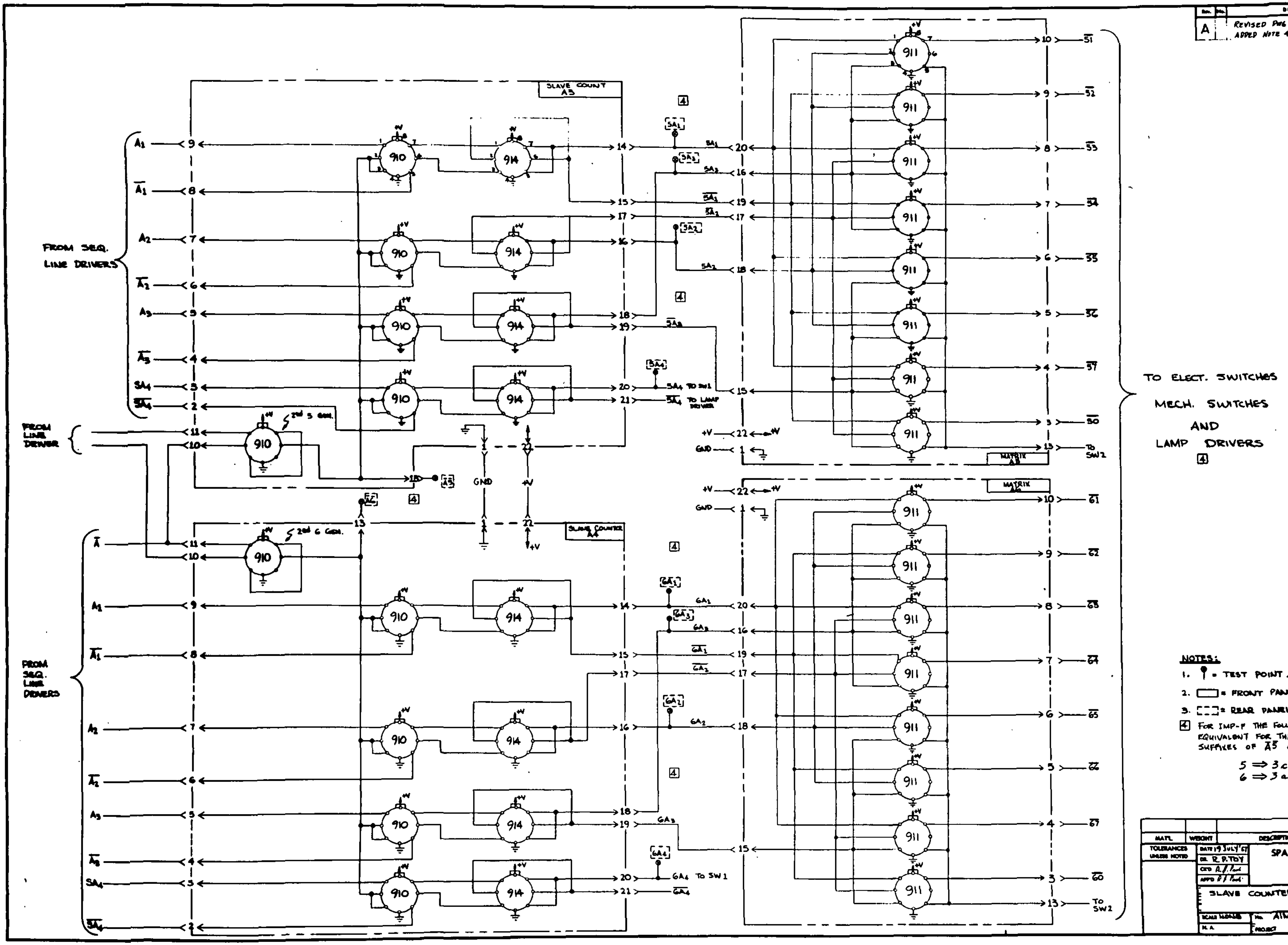
SCALE NONE
N.A. —
No. AIMP-205 REV B
PROJECT AIMP
REV.
SH. 1 of 1

NO. AIMP 206 REVA	JOB AIMP	APP. RJPaoli	SPACE SCIENCES LABORATORY	SCALE NONE	DR. EGEE DATE 10 MAY 65
TITLE AIMP CABLE DIAGRAM			UNIVERSITY OF CALIFORNIA	REQD. —	MATL. —




LINE DRIVERS A14
DAM-15P
P5
CLOCK IN
+S SYNC IN
+S SYNC IN
COM
COM
+V
GM 1 OUT
GM 2 OUT
IC OUT
CONT 5
CONT 6
TO BUFFER BOX
TO SIG. GEN.
TO SIG. GEN. AND 2ND 5 & 6 GEN.
FROM ELECTRICAL SWITCHES
TO STIMULATE SWITCH
DEM-9P
P6
TO S/C G.S.E.
REQ. LINE DRIVER A2
TO SLAVE COUNTER
910
911
KEVISED DWG. TITLE & NO.
8 FOR IMP-F THE FOLLOWING NOMENCLATURE IS EQUIVALENT
5 ⟹ 3 c.d
6 ⟹ 3 + b
1600 ⟹ 6400
NOTES:
1. ALL PNP TRANSISTORS ARE 2N3638.
2. ALL NPN TRANSISTORS ARE 2N3646.
3. +V = +3.6 V.
4. +V_B = +3.3 V.
5. ⊕ = TEST POINT.
6. [ ] = FRONT PANEL MARKING.
7. [- -] = REAR PANEL MARKING.
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY
DATE 11 JULY '67
DR. R.P. TOY
DRIVERS, GSE A2, A14
SCALE NONE
AIMP-201, SIMP-207
REV. A

REV.		DESCRIPTION	DATE	APPD
A		Revised Dwg Title & No., Added Note 4.	18 ... 1972	



NOTES:

1. (test point symbol) = TEST POINT.
2. (solid box) = FRONT PANEL MARKING.
3. (dashed box) = REAR PANEL MARKING.
4. For IMP-F the following nomenclature is equivalent for the prefixes (and for the suffixes of $\bar{A}5$ and $\bar{A}6$).

$5 \Rightarrow 3cd$
$6 \Rightarrow 3ab$

MATL.	WEIGHT	DESCRIPTION	NUMBER	REQD.	ITEM

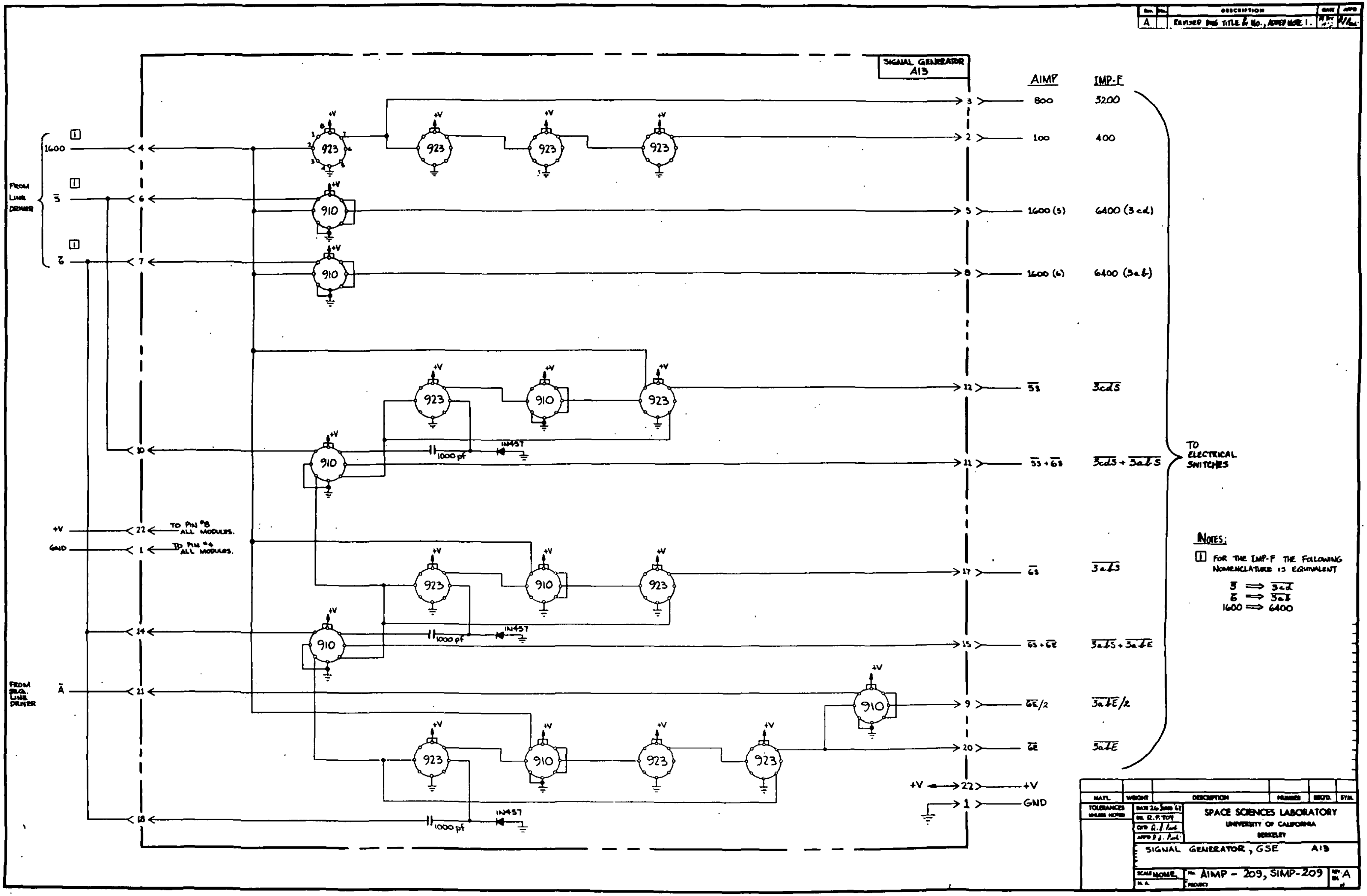
TOLERANCES UNLESS NOTED

DATE 19 JULY '67
DR. R. P. TOY
CKD A. J. ...
APPD ...

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

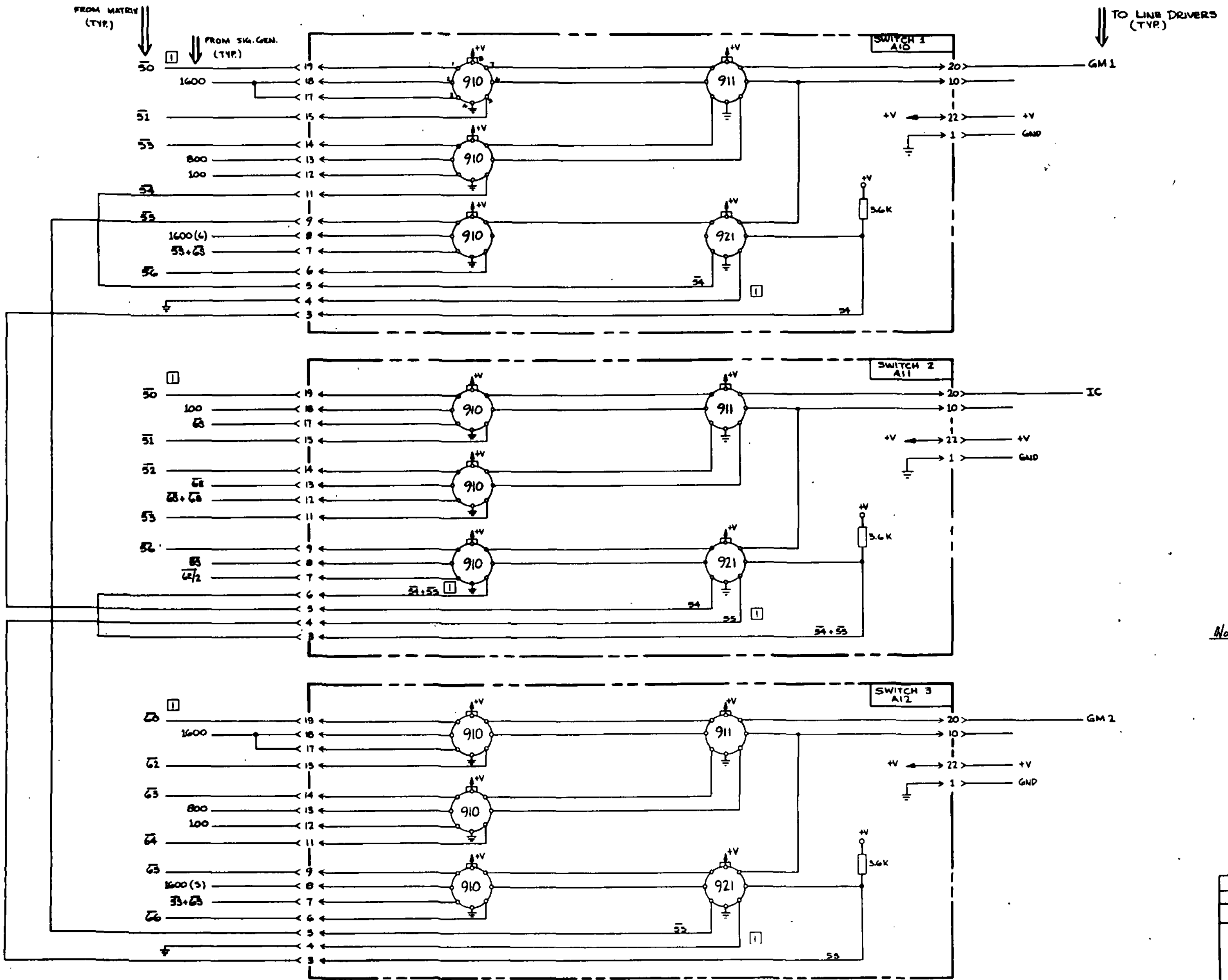
SLAVE COUNTERS & MATRIX, GSE A3, A4, A5, A6

SCALE NONE
N.A.
No. AIMP - 208, SIMP 208
PROJECT
REV. LTR. A



A | REVISED DWG TITLE & NO., ADDED NOTE 1.
SIGNAL GENERATOR A13
AIMP
IMP-F
800
3200
100
400
1600 (5)
6400 (3cd)
1600 (6)
6400 (3ab)
TO ELECTRICAL SWITCHES
FROM LINE DRIVER
1600
FROM SEQ. LINE DRIVER
+V
GND
TO PIN #8 ALL MODULES.
TO PIN #4 ALL MODULES.
923
910
1000 pf
1N457
NOTES:
1 FOR THE IMP-F THE FOLLOWING NOMENCLATURE IS EQUIVALENT
1600 ⟹ 6400
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY
SIGNAL GENERATOR, GSE A13
AIMP - 209, SIMP-209
SCALE NONE
REV A

		DESCRIPTION	DATE	APPD
A		REVISED DWG TITLE & NO., ADDED NOTE 1.	1972	



NOTES:

1. FOR THE IMP-F THE FOLLOWING NOMENCLATURE IS EQUIVALENT.

ALL 5 PREFIXES ⇒ 3cd
ALL 6 PREFIXES ⇒ 3ab
EXCEPT $\overline{55} + \overline{63} \Rightarrow \overline{3cd5}$
AND 1600 ⇒ 6400
800 ⇒ 3200
100 ⇒ 400

MATL	WEIGHT	DESCRIPTION	NUMBER	REQD.	STA.

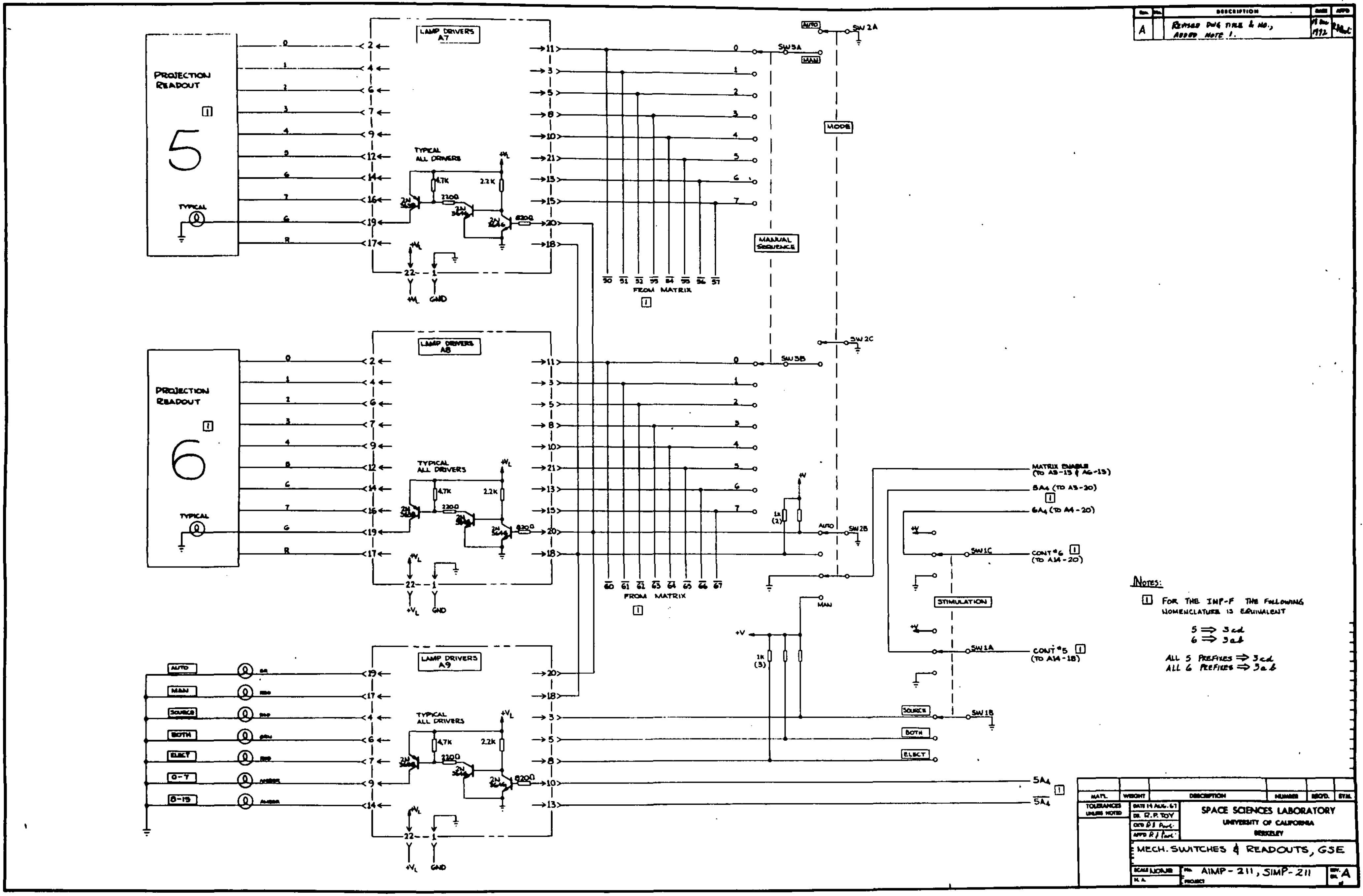
TOLERANCES UNLESS NOTED

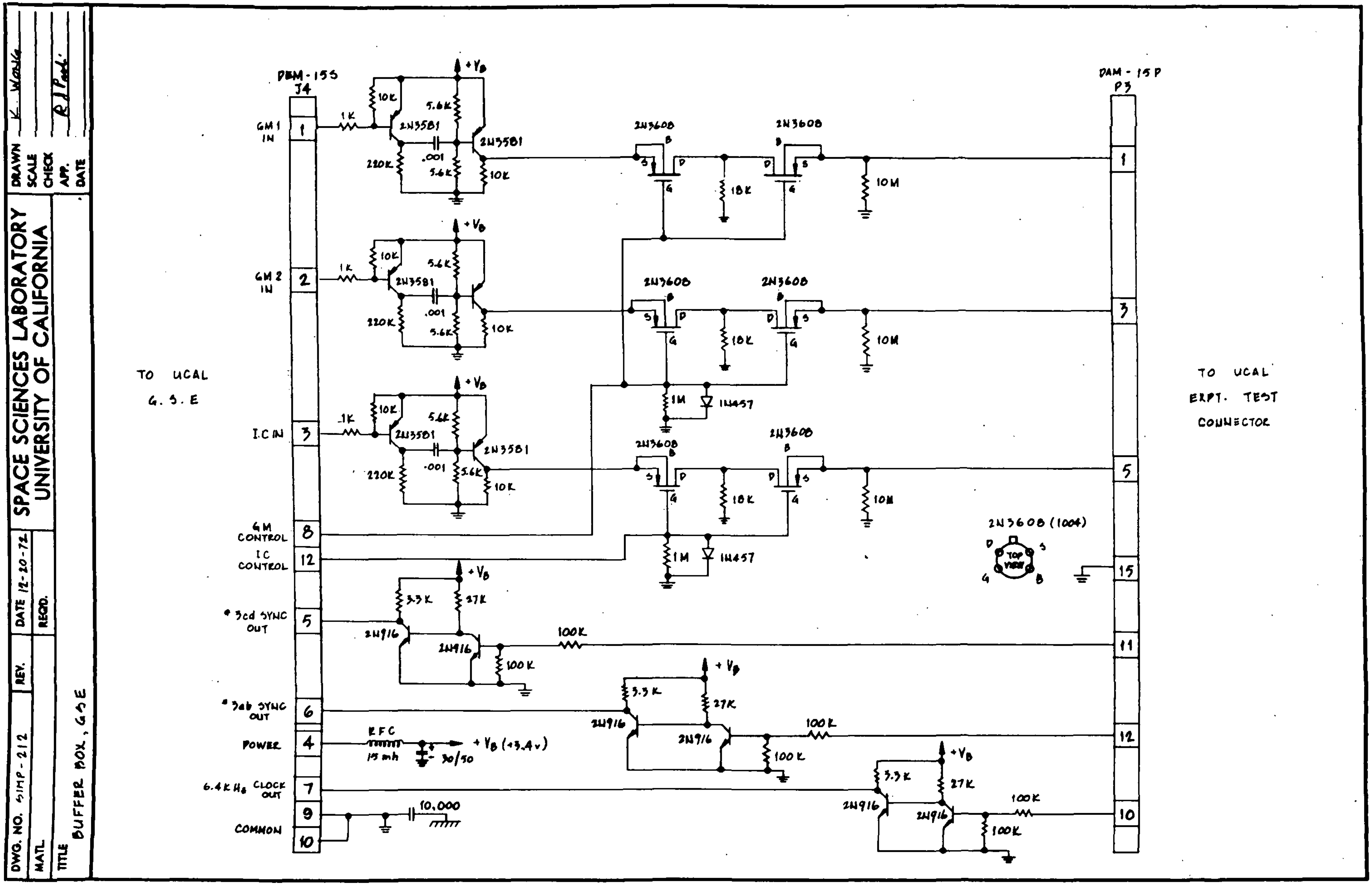
DATE 23 JUNE 69 · DR R.P. TON · CHD R J Paul · APPD R J Paul

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

ELECTRICAL SWITCHES, GSE A10, A11, A12

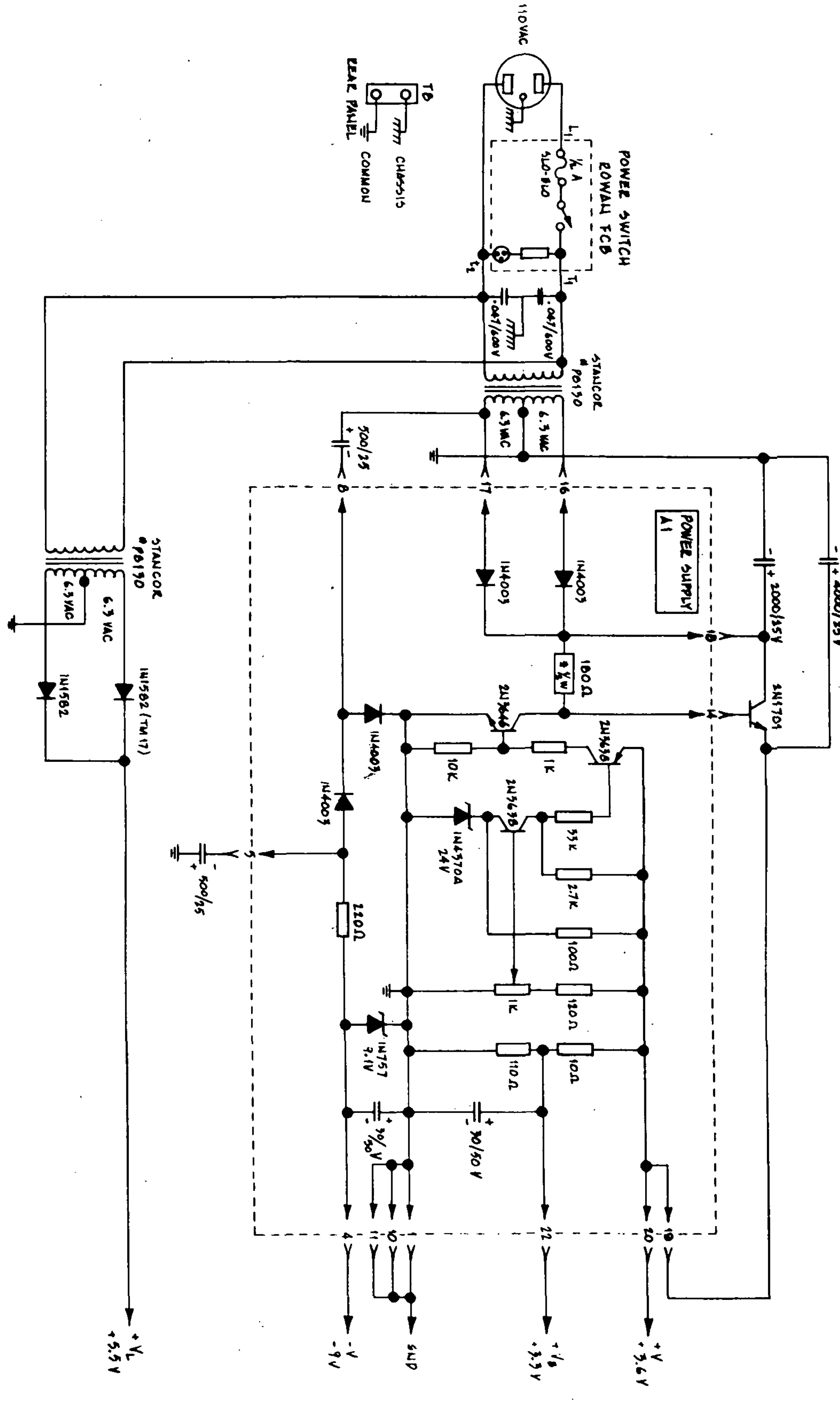
SCALE NONE · NO. AIMP-210, SIMP-210 · REV. A

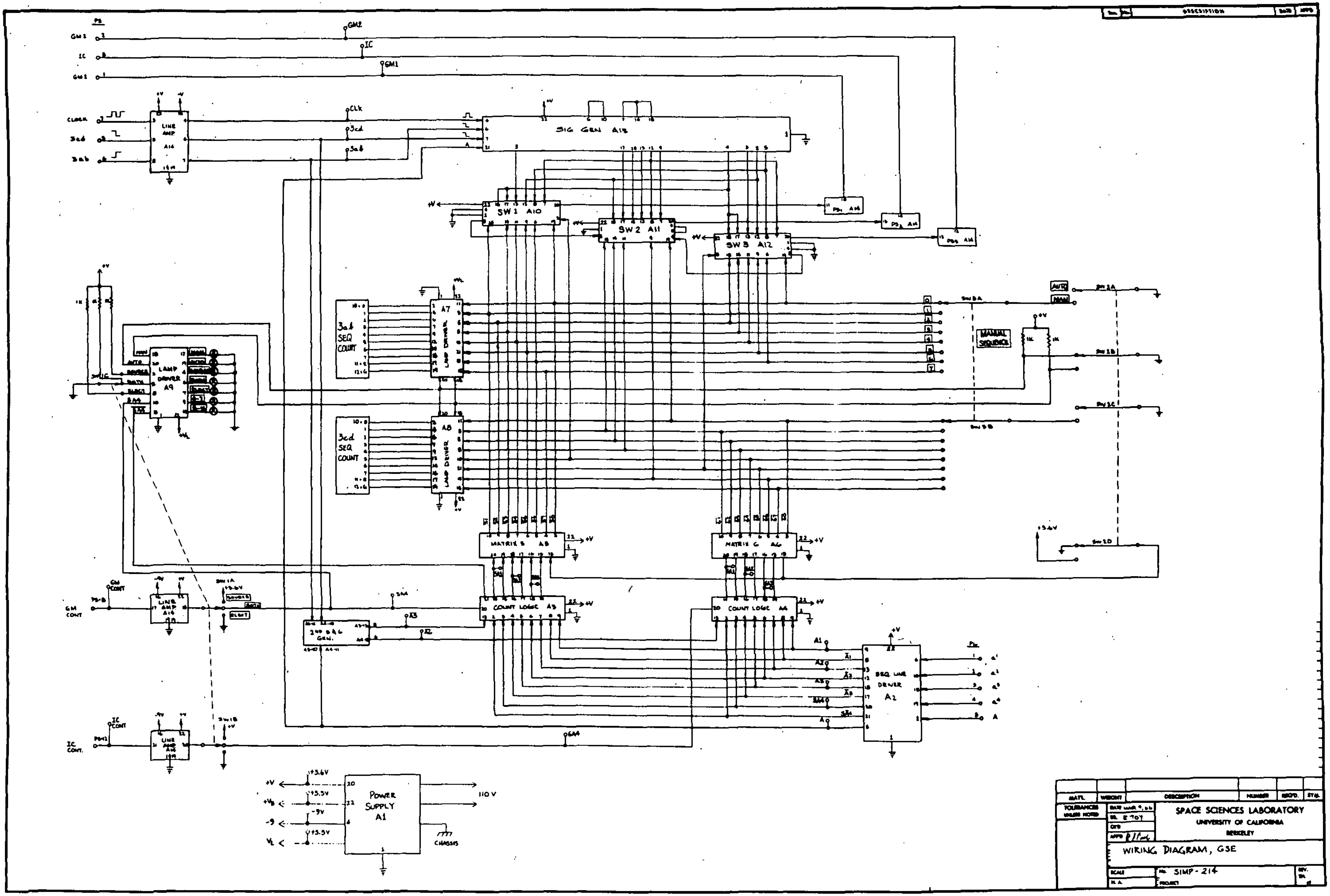

REVISED DWG TITLE & NO., ADDED NOTE 1.
PROJECTION READOUT
5
TYPICAL
LAMP DRIVERS A7
TYPICAL ALL DRIVERS
4.7K
2.2K
2200
8200
FROM MATRIX
SW 2A
AUTO
MAN
SW 5A
MODE
MANUAL SEQUENCE
PROJECTION READOUT
6
LAMP DRIVERS A8
SW 2C
SW 5B
SW 2B
MATRIX ENABLE (TO A3-13 & A6-13)
8A4 (TO A3-20)
6A4 (TO A4-20)
SW 1C
CONT #6 (TO A14-20)
STIMULATION
SW 1A
CONT #5 (TO A14-18)
SW 1B
LAMP DRIVERS A9
AUTO
MAN
SOURCE
BOTH
ELECT
0-7
8-15
SOURCE
BOTH
ELECT
GND
NOTES:
1 FOR THE IMP-F THE FOLLOWING NOMENCLATURE IS EQUIVALENT
5 ⇒ 3cd
6 ⇒ 3ab
ALL 5 PREFIXES ⇒ 3cd
ALL 6 PREFIXES ⇒ 3ab
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY
DATE 14 AUG. 67
DR. R.P. TOY
MECH. SWITCHES & READOUTS, GSE
AIMP-211, SIMP-211
A



SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
DRAWN K. Wong
SCALE
CHECK
APP.
DATE
DATE 12-20-72
REQD.
REV.
DWG. NO. SIMP-212
MATL.
TITLE BUFFER BOX, GSE
DBM-15S
J4
DAM-15P
P3
TO UCAL G.S.E
TO UCAL EXPT. TEST CONNECTOR
GM 1 IN
GM 2 IN
I.C IN
GM CONTROL
IC CONTROL
* 3cd SYNC OUT
* 3ab SYNC OUT
POWER
6.4 K Hz CLOCK OUT
COMMON
+V_B
+V_B (+3.4 v)
RFC
15 mh
30/50
10,000
1K
10K
220K
5.6K
.001
2N3581
2N3608
18K
10M
1M
1N457
3.3K
27K
100K
2N916
2N3608 (1004)
TOP VIEW
D S G B

DWG. NO. AIMP-213, 504P-213	REV.	DATE 12/26/72	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	DRAWN K Wong
MATL.		REQD.		SCALE
				CHECK
TITLE POWER SUPPLY, GSE				APP. R J Pasli
				DATE




GM2
IC
GM1
CLOCK
3cd
3ab
LINE AMP A14
SIG GEN A13
SW1 A10
SW2 A11
SW3 A12
LAMP DRIVER A9
3ab SEQ COUNT
A7 LAMP DRIVER
3cd SEQ COUNT
A8 LAMP DRIVER
AUTO
MAN
MANUAL SEQUENCE
MATRIX 5 A5
MATRIX 6 A6
COUNT LOGIC A3
COUNT LOGIC A4
2nd 3 & 6 GEN.
GM CONT
IC CONT.
SEQ LINE DRIVER A2
POWER SUPPLY A1
+3.6V
+3.5V
-9V
110 V
CHASSIS
DESCRIPTION
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY
WIRING DIAGRAM, GSE
SIMP-214

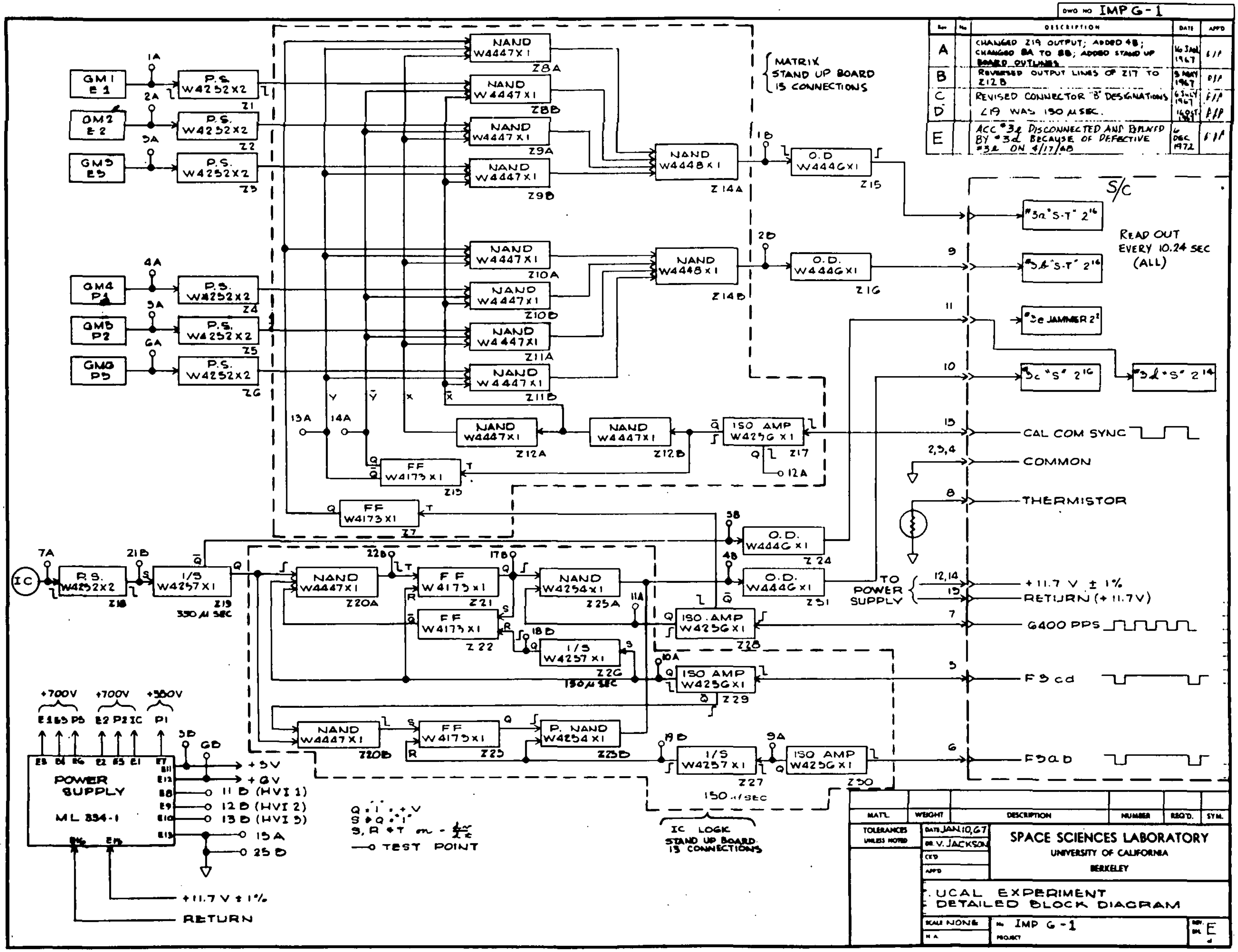
Appendix III

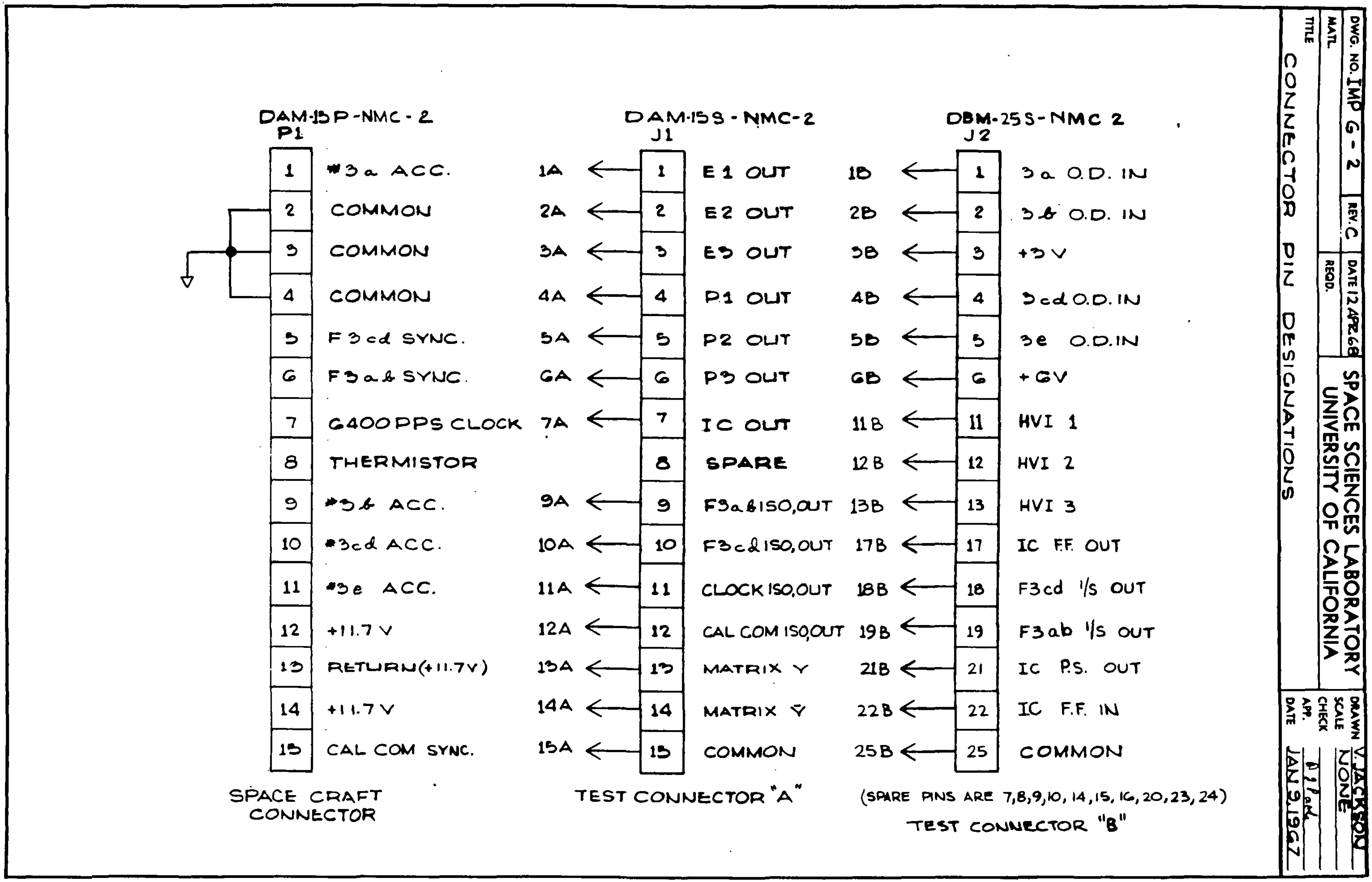
IMP-G (S1) Drawing List

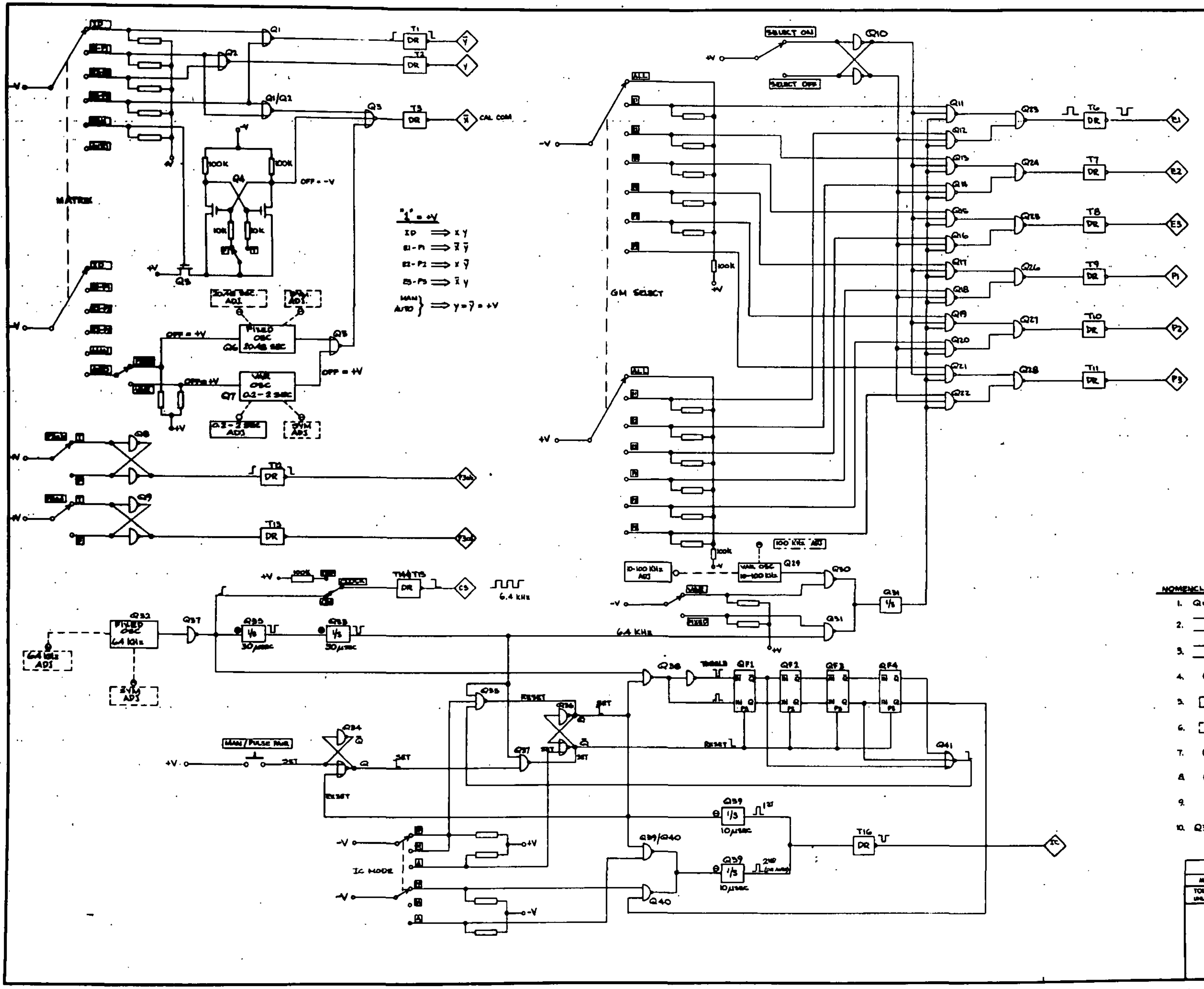
IMP G -	1	UCal Experiment Detailed Block Diagram, rev D
	2	Connector Pin Designations, rev C
	3	UCal IMP-G Checkout Box Logic Schematic
	4	UCal Telemetry Format and Timing
	5	IMP-G GSE UCal Format
IMP G -	101	Frame Details, Coutouts and Detector Mounting
	102	Aperature Locations and Cover Cououts, rev A
	103	NA
	104	Top Bracket, P1-P3, rev B
	105	Bottom Bracket, P1-P3, rev B
	106	Front Bracket, E1-E3, rev B
	107	Circuit Board, rev C
	108	Potting Cup
	109	Rear Bracket, E1-E3, rev A
	110	Right Bracket, P2-E2, rev C
	111	Left Bracket, P2-E2, rev B
	112	Cap, P1-P3
	113	Cap, E1-E3 and P2-E2
	114	P1 Shield
	115	P3 Shield
	116	E1 Shield
	117	E3 Shield
	118	P2 Shield
	119	E2 Shield
	120	Fixture, Shield

IMP G - 121	Drill Fixture, P.C. Board, rev A
122	Connector Bracket, 15 Pin
123	Connector Bracket, 25 Pin
124	Scattering Unit
125	Scattering Unit Cap Plate
126	P1 Cathode Clip
127	Cathode Clip
128	P1 Cathode Cushion
129	Cathode Cushion
130	Anode Clip
131	Anode Cushion
132	Anode Insulator, rev A
133	Anode Rod
134	Stand, Ion Chamber
135	Source Holder Assembly
136	P1, P3 Potting Cover
137	P1, P3 Protective Cover
138	P1 Aperature
139	E2-P2 Protective Cover
140	E1-E3 Protective Cover
141	Drill Jig, P1 Aperature
142	E3, P3 Foil Assembly

IMP G - 201	UCal IMP-G Checkout Box Freeze and Matrix Control Cirtuic Schematic
202	UCal IMP-G Checkout Box GM-Control Circuit Schematic
203	UCal IMP-G Checkout Box IC Control Circuit Schematic


DWG NO IMP G-1
A CHANGED Z19 OUTPUT; ADDED 4B; CHANGED 8A TO 8B; ADDED STAND UP BOARD OUTLINES
B REVERSED OUTPUT LINES OF Z17 TO Z12B
C REVISED CONNECTOR "B" DESIGNATIONS
D Z19 WAS 150 μ SEC.
E ACC #3a DISCONNECTED AND REPLACED BY #3d BECAUSE OF DEFECTIVE #3a ON 4/17/68
MATRIX STAND UP BOARD 15 CONNECTIONS
GM1 E1
GM2 E2
GM3 E3
GM4 P1
GM5 P2
GM6 P3
P.S. W4252X2
NAND W4447X1
NAND W4448X1
O.D. W4446X1
FF W4173X1
150 AMP W4256X1
1/3 W4257X1
NAND W4254X1
P. NAND W4254X1
S/C
#3a "S-T" 2^16
#3b "S-T" 2^16
#3e JAMMER 2^2
#3c "S" 2^16
#3d "S" 2^14
READ OUT EVERY 10.24 SEC (ALL)
CAL COM SYNC
COMMON
THERMISTOR
TO POWER SUPPLY
+11.7 V ± 1%
RETURN (+11.7V)
6400 PPS
F3cd
F3ab
IC
R.S. W4252X2
350 μ SEC
150 μ SEC
IC LOGIC STAND UP BOARD 13 CONNECTIONS
POWER SUPPLY ML 834-1
+700V +700V +350V
+5V
+6V
11 B (HV1 1)
12 B (HV1 2)
13 B (HV1 3)
15 A
25 B
+11.7 V ± 1%
RETURN
—o TEST POINT
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY
UCAL EXPERIMENT
DETAILED BLOCK DIAGRAM
DATE JAN.10,67
DR V. JACKSON
SCALE NONE
NO IMP G-1
REV E


DAM-15P-NMC-2
P1
1 #3a ACC.
2 COMMON
3 COMMON
4 COMMON
5 F3cd SYNC.
6 F3ab SYNC.
7 6400 PPS CLOCK
8 THERMISTOR
9 #3b ACC.
10 #3cd ACC.
11 #3e ACC.
12 +11.7 V
13 RETURN (+11.7 V)
14 +11.7 V
15 CAL COM SYNC.
SPACE CRAFT CONNECTOR
DAM-15S-NMC-2
J1
1A 1 E1 OUT
2A 2 E2 OUT
3A 3 E3 OUT
4A 4 P1 OUT
5A 5 P2 OUT
6A 6 P3 OUT
7A 7 IC OUT
8 SPARE
9A 9 F3ab ISO. OUT
10A 10 F3cd ISO. OUT
11A 11 CLOCK ISO. OUT
12A 12 CAL COM ISO. OUT
13A 13 MATRIX Y
14A 14 MATRIX Ȳ
15A 15 COMMON
TEST CONNECTOR "A"
DBM-25S-NMC 2
J2
1B 1 3a O.D. IN
2B 2 3b O.D. IN
3B 3 +3 V
4B 4 3cd O.D. IN
5B 5 3e O.D. IN
6B 6 +6 V
11B 11 HVI 1
12B 12 HVI 2
13B 13 HVI 3
17B 17 IC F.F. OUT
18B 18 F3cd 1/s OUT
19B 19 F3ab 1/s OUT
21B 21 IC P.S. OUT
22B 22 IC F.F. IN
25B 25 COMMON
(SPARE PINS ARE 7,8,9,10,14,15,16,20,23,24)
TEST CONNECTOR "B"
DWG. NO. IMP G-2
REV. C
DATE 12 APR. 68
MATL.
REQD.
TITLE CONNECTOR PIN DESIGNATIONS
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
DRAWN V. JACKSON
SCALE NONE
CHECK
APP.
DATE JAN 9 1967



NOTES:

1. +V = +6.75 V
   -V = -4.05 V

2. ALL RESISTOR ARE .1 MEG UNLESS OTHERWISE STATED.

RIPPLE COUNTER TRUTH TABLE

COUNT	2^0	2^1	2^2	2^3
RESET	1	1	1	1
1	0	0	0	0
2	1	0	0	0
3	0	1	0	0
4	1	1	0	0
5	0	0	1	0
6	1	0	1	0
7	0	1	1	0
8	1	1	1	0
9	0	0	0	1
10	◇	0	◆	◇

NOMENCLATURE:

1. Q = "1" = -V.
2. (gate symbol) DENOTES NEGATIVE NAND.
3. (gate symbol) DENOTES NEGATIVE NOR.
4. ⊖ TRIGGERS ON NEGATIVE EXCURSION.
5. ▭ DENOTES FRONT PANEL MARKING.
6. [- - -] DENOTES REAR PANEL MARKING.
7. ○--- DENOTES FRONT PANEL CONTROL.
8. ⊖--- DENOTES SCREWDRIVER ADJUSTMENT.
9. ◇ DENOTES OUTPUT.
10. Q3 ⟹ DENOTES MODULE CAN No. 3.

MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

TOLERANCES UNLESS NOTED

DATE 29 MAY 67
DR. R.P. TOY
CK'D
APPD

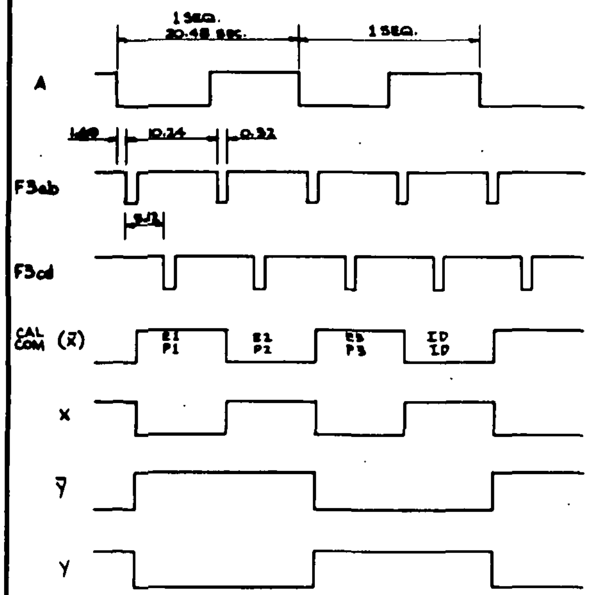
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

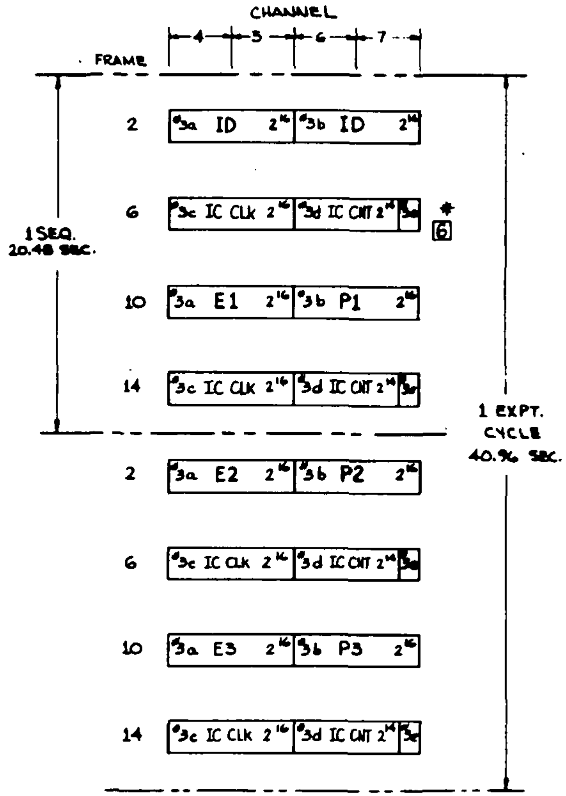
UCAL IMP G CHECKOUT BOX
LOGIC SCHEMATIC

SCALE NONE
No. IMP G - 3
PROJECT

DWG NO. IMP G-4 REV. A

REV.	NO.	DESCRIPTION	DATE	APPD
A		CHANGED IC DESIGNATIONS AND ADDED NOTE 6.	11-2-72	





NOTES:

1. ID ⟹ BEGINNING OF CYCLE IDENTIFICATION (OUTPUT = 31744 $^{+0}_{-1}$).
2. E1, E2, E3 ⟹ EQUATORIAL DETECTORS #1, #2, AND #3 RESPECTIVELY.
3. P1, P2, P3 ⟹ POLAR DETECTORS #1, #2, AND #3 RESPECTIVELY.
4. IC ⟹ IC CLOCK OUTPUT.
5. * THE #3e ACCUMULATOR IS A 2 BIT JAMMER FOR THE IC COUNT OUTPUT.

[6] IN THE IMP-G FLIGHT CONFIGURATION THE #3e ACCUMULATOR WAS DEACTIVATED AND ITS FUNCTION REPLACED BY THE #3d ACCUMULATOR IN THE ENCODER SN#04 ON 4/17/68 DUE TO A MALFUNCTION OF THE #3e ACCUMULATOR PRIOR TO LAUNCH.

MATL.	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

TOLERANCES UNLESS NOTED

DATE 6 JULY 67
DR. R.P. TOY
CHD E.J. Paul
APPD D.J. Paul

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

UCAL TELEMETRY FORMAT AND TIMING

SCALE NONE
NO. IMP G-4
PROJECT
REV. A

Rev.	No.	Description	Date	Appd
A		ADDED SN FOR MODIFIED ENCODER.	MAY 1969	R.H.

DWG. NO. IMP G-5

40.96 SEC

ELECT SEQ NO	GM CHECKS	STIMULATION	OUTPUTS 3a	OUTPUTS 3b	IC CHECKS	STIMULATION	OUTPUTS 3cd	OUTPUTS 3e	COMPT SENSE CONDITIONS
1	X-TALK & OUTPUTS + "T" MODE "S" MODE CHECKS	6400 HZ - E1	15359T	0	S.P./2RO's	3abS/2	0 32768	0 1	(E1>K1)(P1<K2)
2		BURST - E2 3200 HZ - E3	2048 31743	0 0		3abS/2	0 32768	0 1	—
3	X-TALK & INPUTS	6400HZ-E2,P2,E3,P3	0	0	X-TALK & INPUT	—	0 0	0 0	—
4		6400 HZ - E1,P1,E3,P3 6400 HZ - E1,P1,E2,P2	0 0	0 0		—	0 0	0 0	—
5	X-TALK & OUTPUTS + "T" MODE "S" MODE CHECKS	6400 HZ - P1	0	15359T	S.P.	3abS	32768 32768	1 1	(E1<K2)(P1>K1)
6		BURST - P2 3200 HZ - P3	0 0	2048 31743	D.P.	3abS + 3abE	2048 2048	2 2	—
7	QUIET	—	0	0	QUIET	—	0 0	0 0	—
8		—	0 0	0 0		—	0 0	0 0	—
9	1's	3cdS - E1,P1	1	1	FAST BURST	(200 HZ)(3ab)	32 32	2 2 [2]	$IC_1 > K3$
10		3cdS-E2,P2,E3,P3	1 1	1 1	HIDDEN	3cdS	1 1	0 0	—

A	END CYCLE (DATA SUMMARY)	6400 HZ - E1,P1	15359T	15359T	END CYCLE (DATA SUMMARY)	(800 HZ)(3ab)	8 8	2 2 [3]	$(IC_1 = 8 \pm K4)$ + (E1 = 15359T ± K4) (P1 = 15359T ± K4)
B		—	0 0	0 0		—	0 0	0 0	—

NOTES:

1. TYPICAL CONSTANTS ARE
   K1 = 1000
   K2 = 10
   K3 = 20
   K4 = 3

[2] THESE ARE 64 FOR "MODIFIED" FLIGHT ENCODER (4-17-68), SN #04

[3] THESE ARE 256 FOR "MODIFIED" FLIGHT ENCODER (4-17-68), SN #04

MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

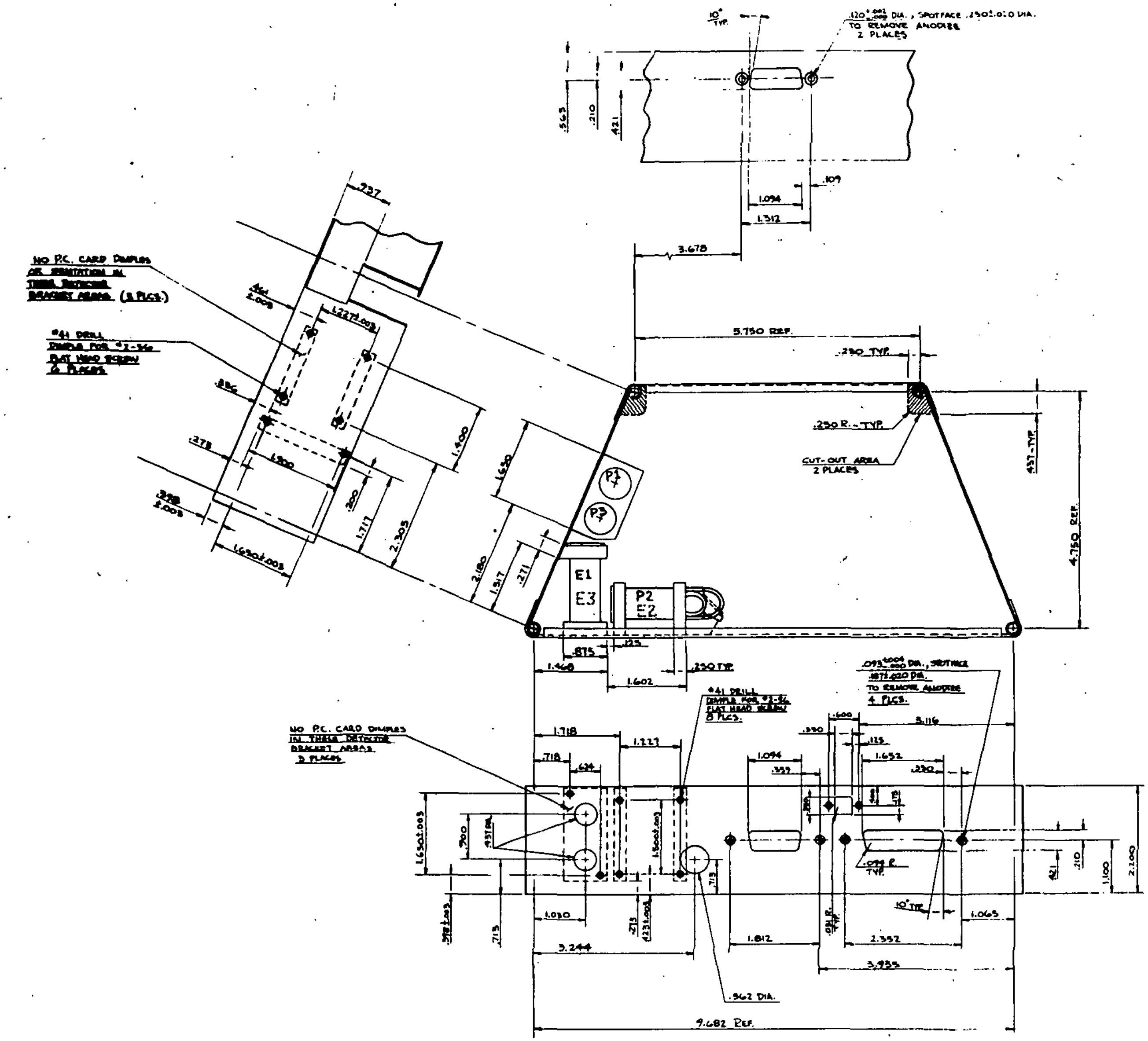
TOLERANCES UNLESS NOTED

DATE 15 APRIL 68
DR. C.E. ECKHARDT
CK'D R.J.P.
APP'D R.J.P.

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

IMP-G G.S.E.
UCAL FORMAT

SCALE NONE
No. IMP G-5
REV. A



MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

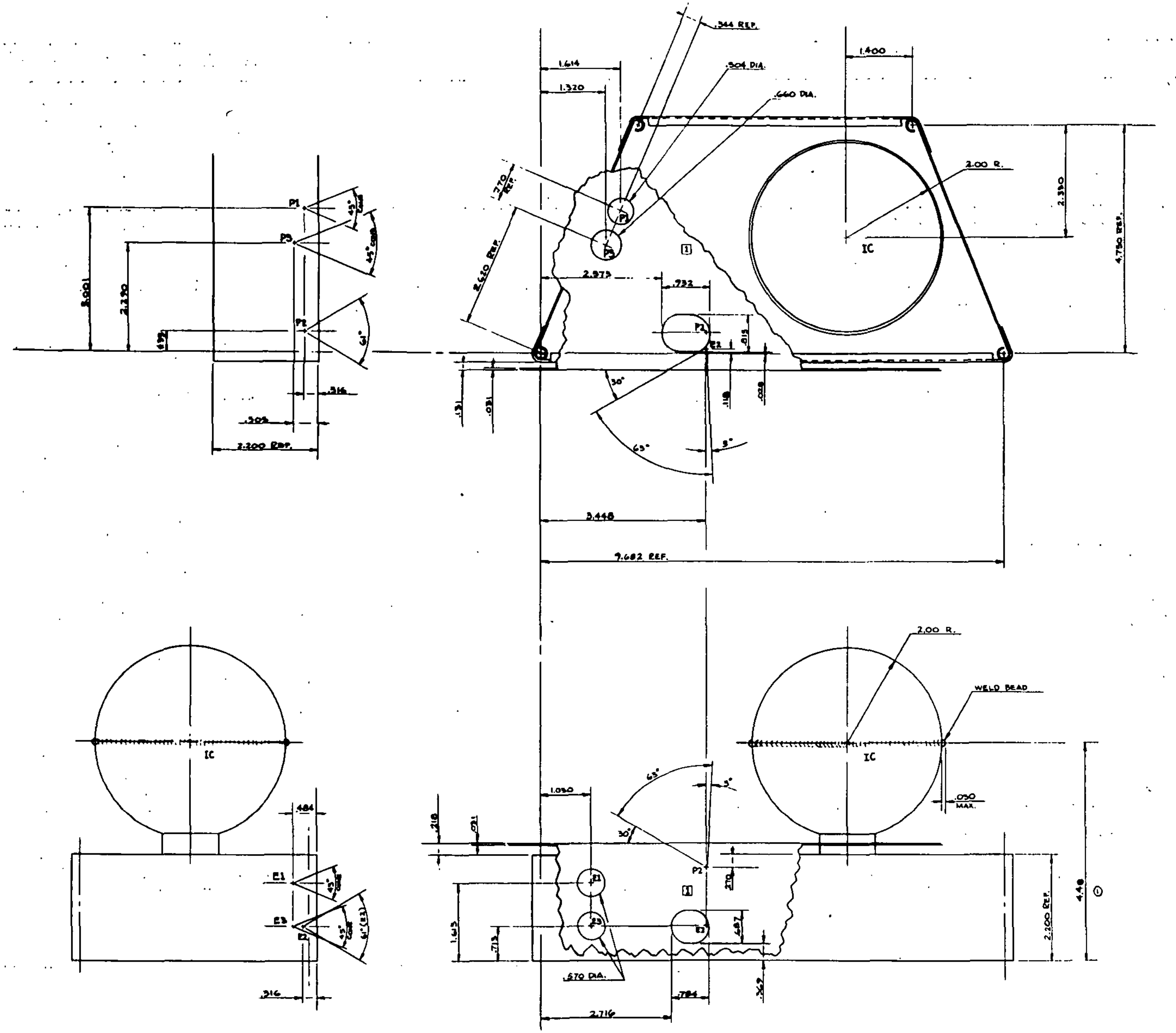
TOLERANCES UNLESS NOTED

DATE 7 JULY 1967
DR. R.P. Toy
CKD
APPD

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

FRAME DETAILS — CUTOUTS AND DETECTOR MOUNTING

SCALE FULL
No. IMP G — 101
PROJECT



NOTES:

1. ALL APERATURE CUT OUT SIZES INDICATED ARE MINIMUM SIZES TO ALLOW 1/32 RADIAL (OR POSITION) TOLERANCE AND ASSURE COVER POSITIONS AS INDICATED.

REV.	No.	DESCRIPTION	DATE	APPD
A	1	[illegible] 468		

MATL.	WEIGHT	DESCRIPTION	NUMBER	REQD.	SYM.

TOLERANCES UNLESS NOTED

DATE 11 JULY '67
DR. R. P. TOY
CKD R. J. Paul
APPD R. J. Paul

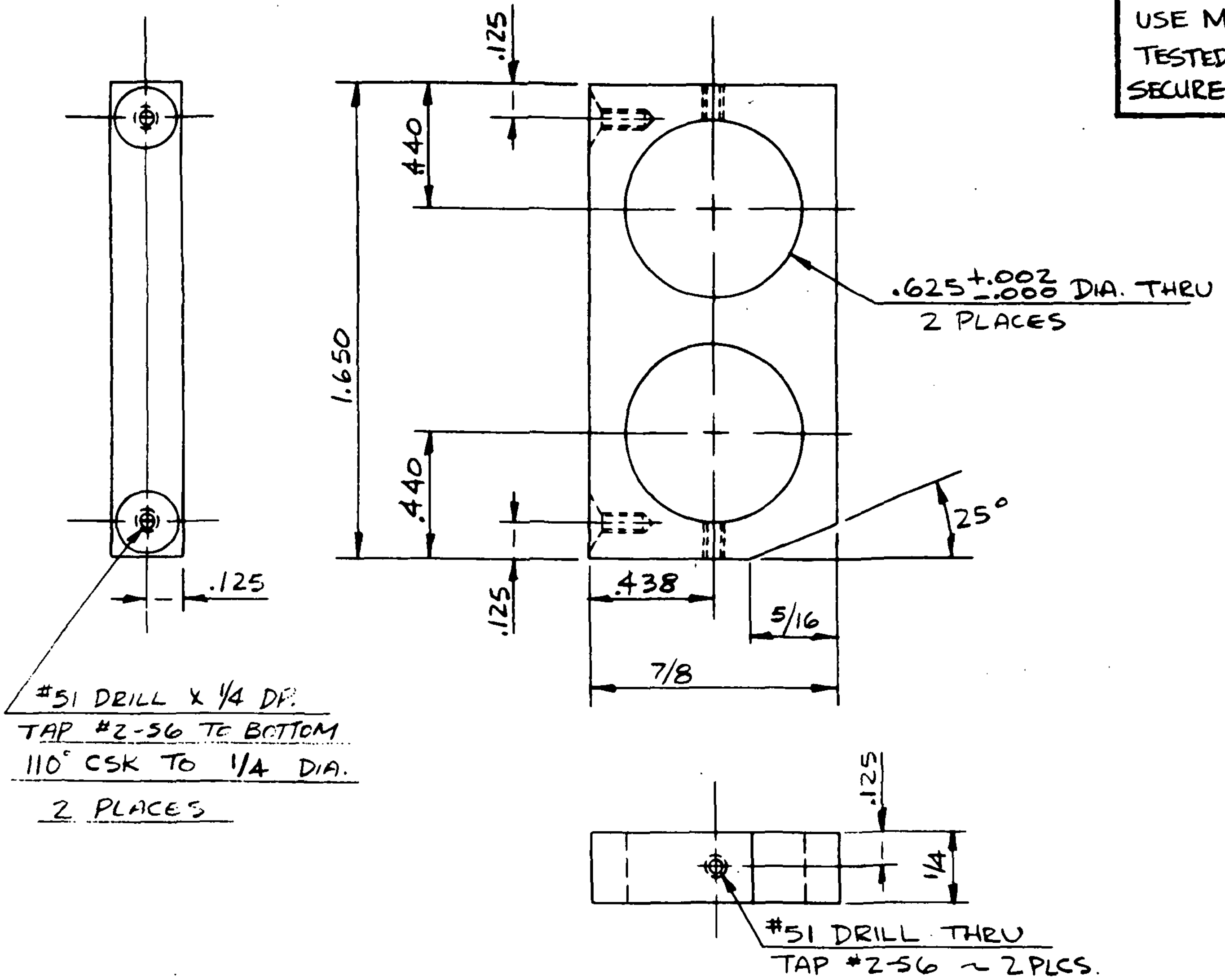
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

APERATURE LOCATIONS & COVER CUTOUTS

SCALE FULL
N.A.
No. IMP G-102
PROJECT
REV. LTR. A

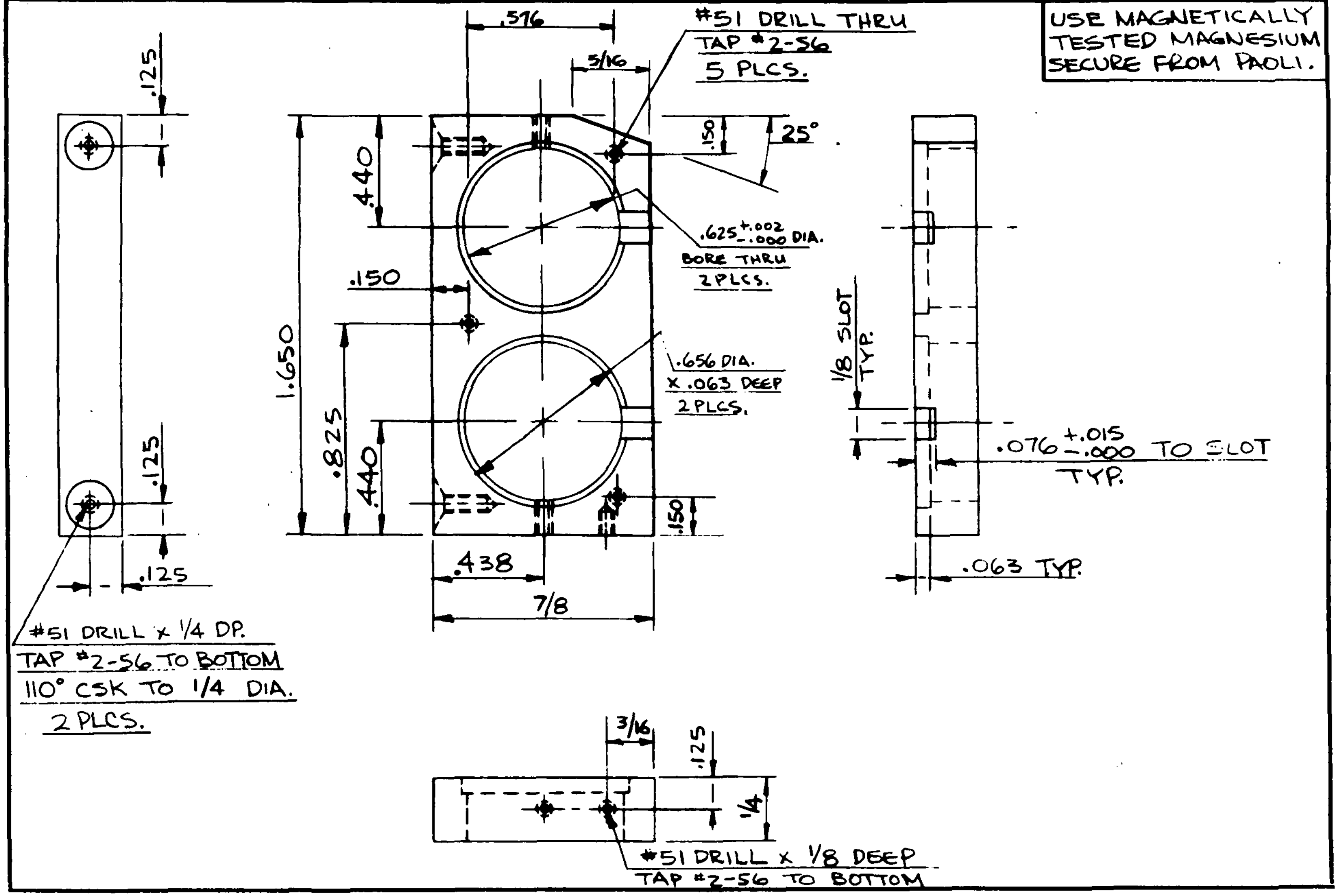
DWG. NO. IMP G-104	REV. B	DATE 16 OCT. 67	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	DRAWN R.P. TOY
MATL. AZ-31 B		REQD.		SCALE 2" = 1"
TITLE TOP BRACKET, P1 - P3				CHECK R J Paoli
				APP. R J Paoli
				DATE 3 AUG. 1967

USE MAGNETICALLY TESTED MAGNESIUM SECURE FROM PAOLI.



DWG. NO. IMP G-105	REV. B	DATE 16 OCT. 67	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	DRAWN R. P. TOY
MATL AZ-31 B		REQD.		SCALE 2" = 1"
TITLE BOTTOM BRACKET, P1 - P3				CHECK R. I. Paoli
				APP. R. I. Paoli
				DATE 9 AUG. 1967

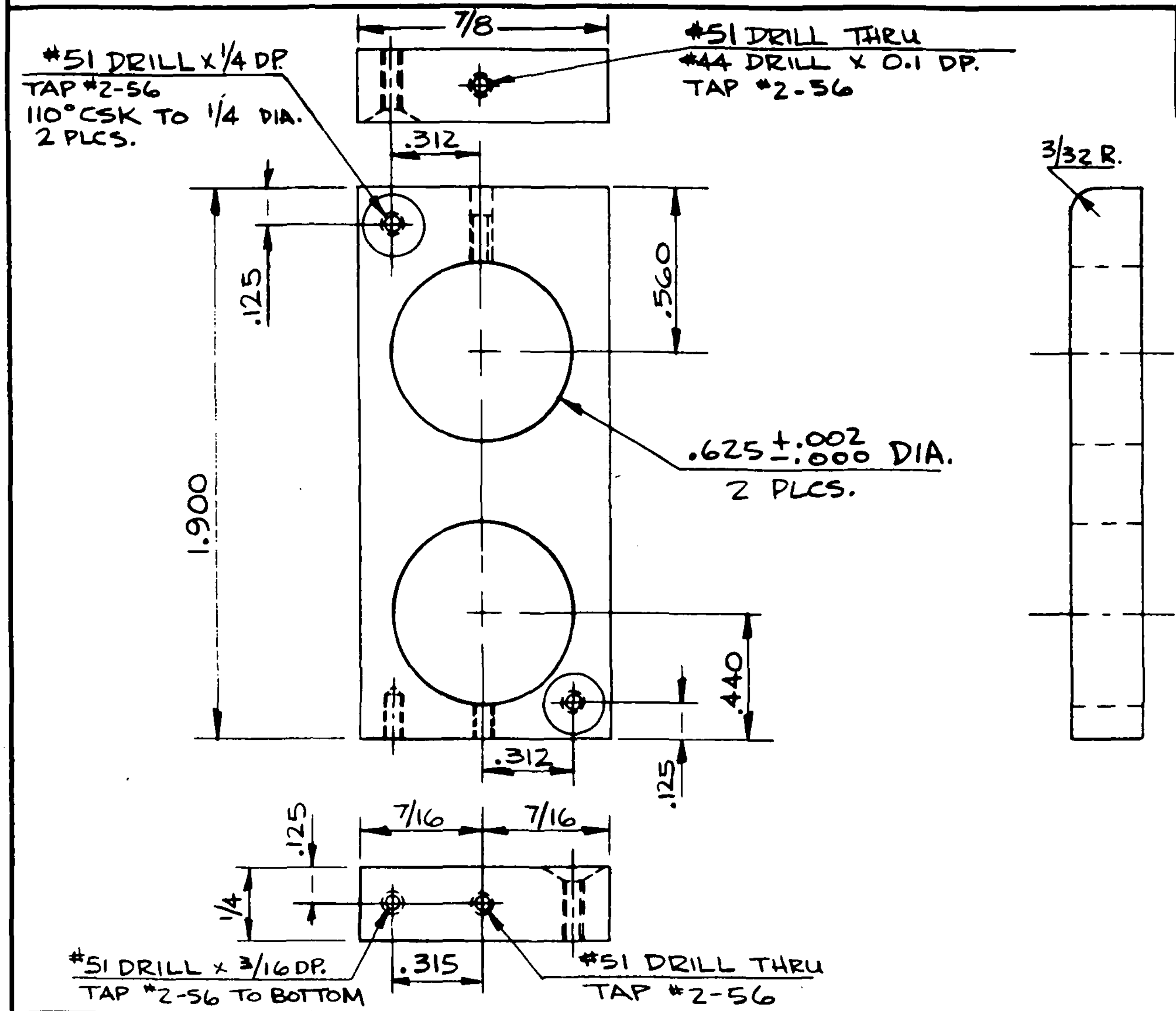
USE MAGNETICALLY TESTED MAGNESIUM SECURE FROM PAOLI.



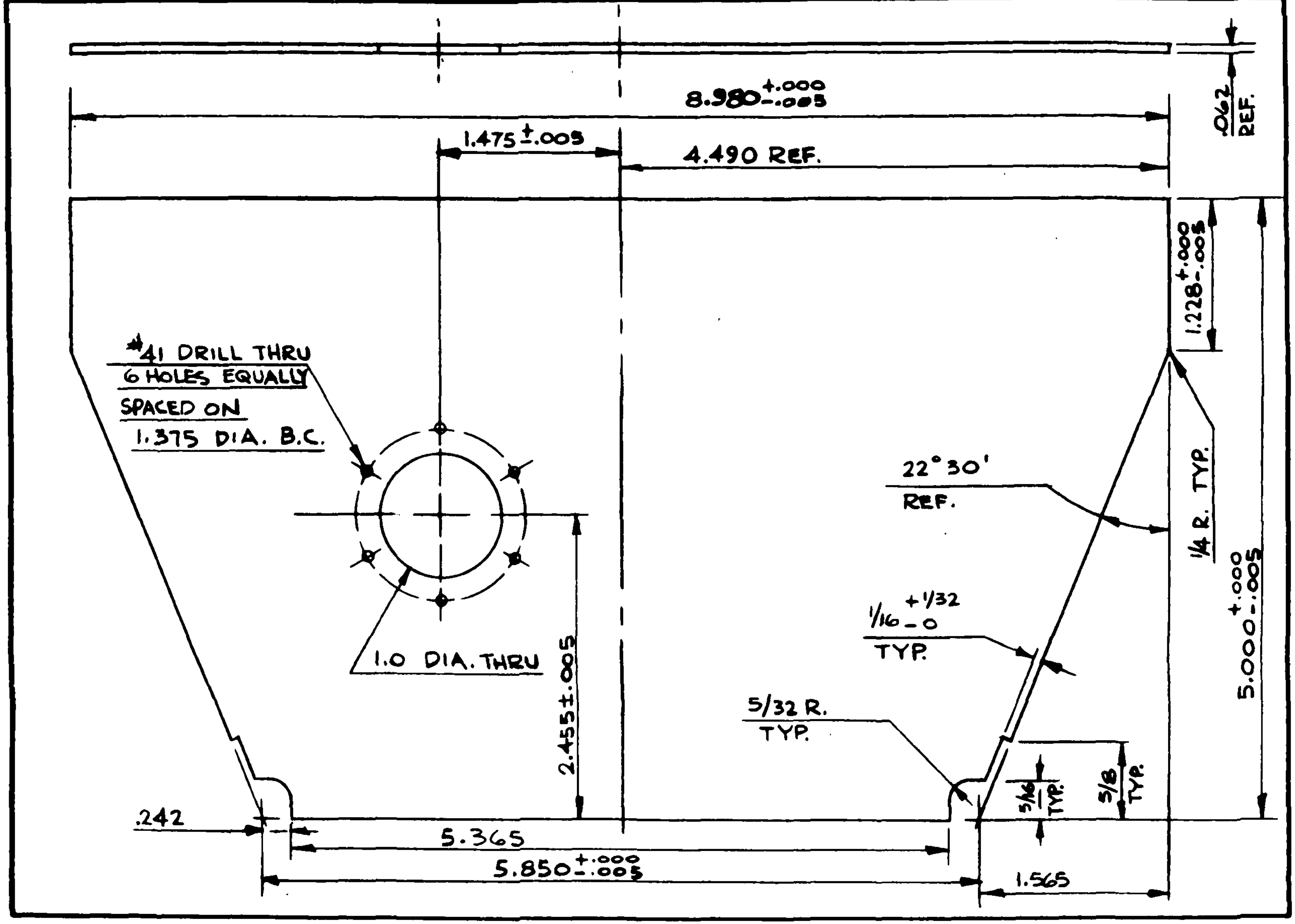
DWG. NO. IMP G-106	REV. B	DATE 16 OCT. 67	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA
MATL. AZ-31 B		REQD.	
TITLE FRONT BRACKET, E1-E3			

DRAWN R. P. TOY
SCALE 2" = 1"
CHECK R. J. Paoli
APP. R. J. Paoli
DATE 4 AUG. 1967

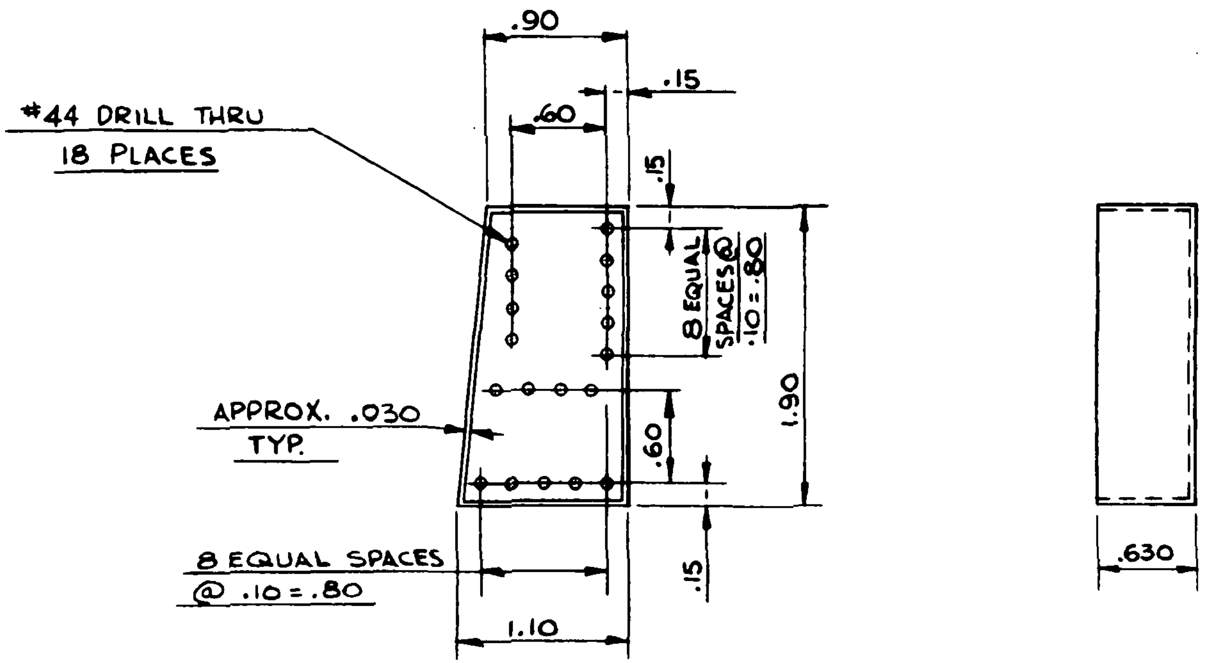
USE MAGNETICALLY TESTED MAGNESIUM SECURE FROM PAOLI



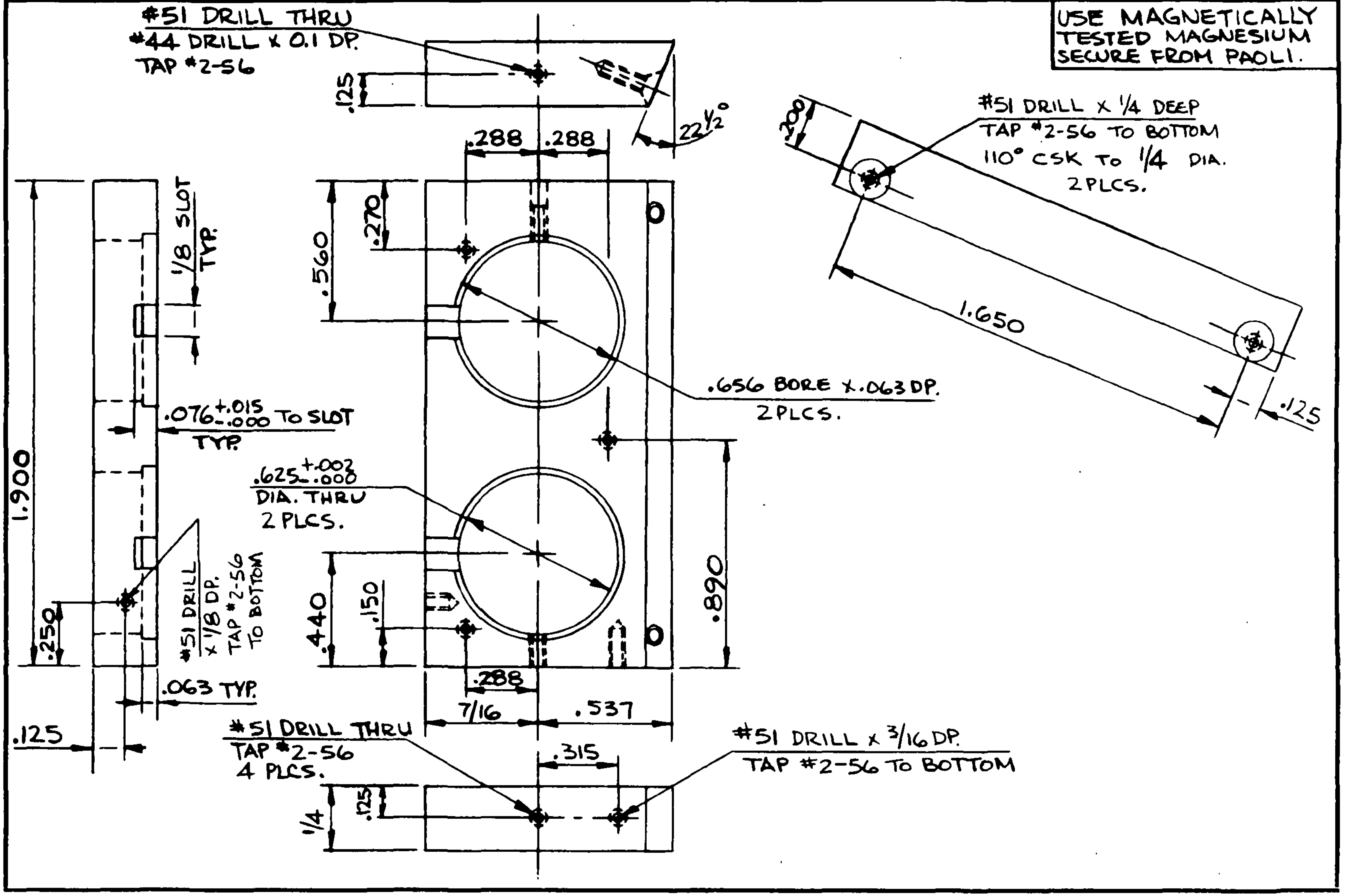
NO. IMP G - 107	JOB APP.	SPACE SCIENCES LABORATORY	SCALE FULL	DR. R. TOY DATE 11 JAN. 1967
TITLE CIRCUIT BOARD		UNIVERSITY OF CALIFORNIA	REQD.	REV. C 26 JULY '67



NO. IMP G - 108	JOB	SPACE SCIENCES LABORATORY	SCALE FULL	DR. R.TOY DATE 12 JAN. 67
TITLE POTTING CUP		UNIVERSITY OF CALIFORNIA	REQD.	MATL.



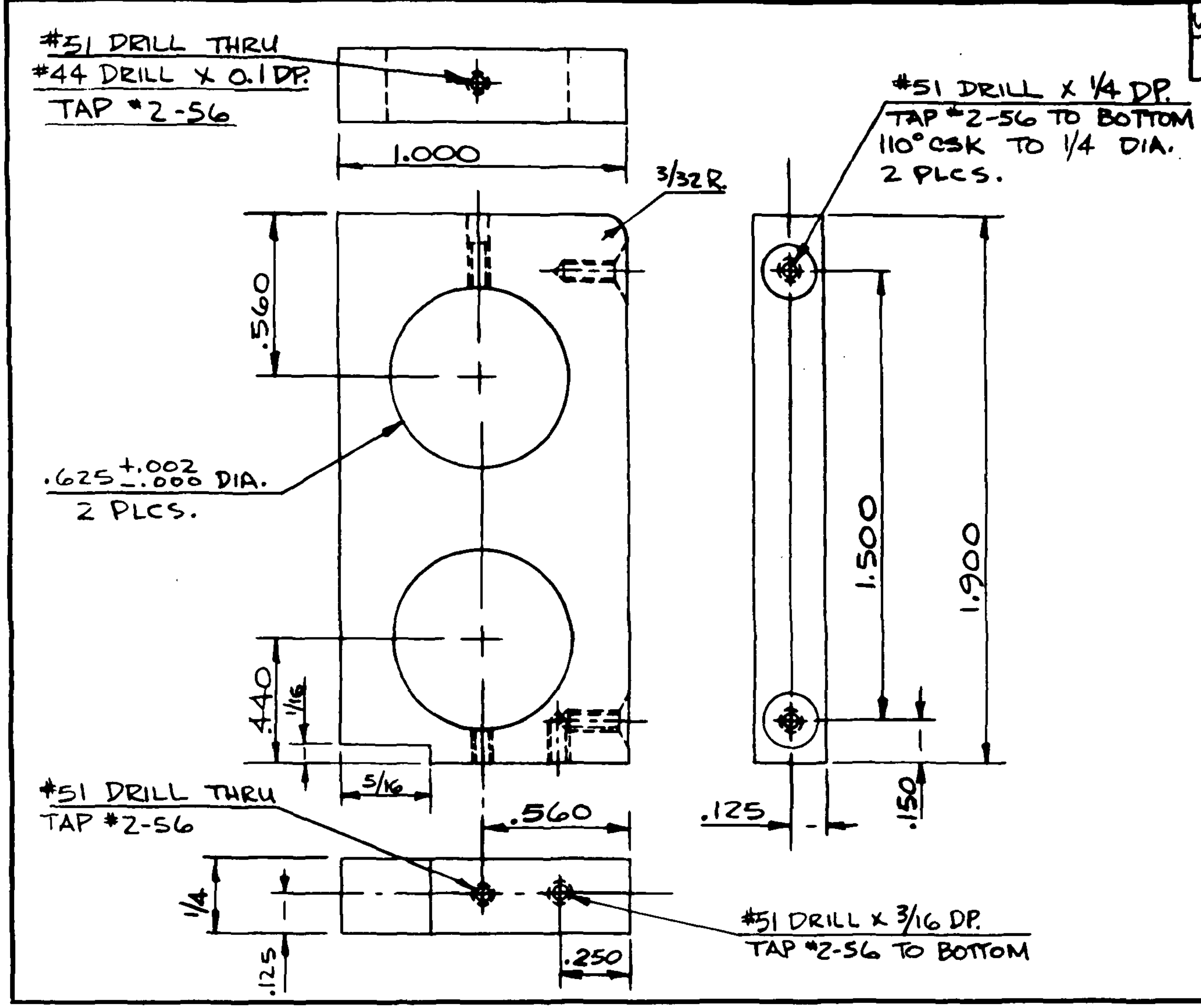
DWG. NO. IMP G-109	REV. A	DATE 16 OCT. 67	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	DRAWN R. P. TOY
MATL. AZ-31B		REQD.		SCALE 2" = 1"
TITLE REAR BRACKET, E1—E3				CHECK R.J. Paoli
				APP. R.J. Paoli
				DATE 10 AUG. 1967



DWG. NO. IMP G-110	REV. C	DATE 16 OCT. 67	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA
MATL. AZ-31B		REQD.	
TITLE RIGHT BRACKET, P2-E2			

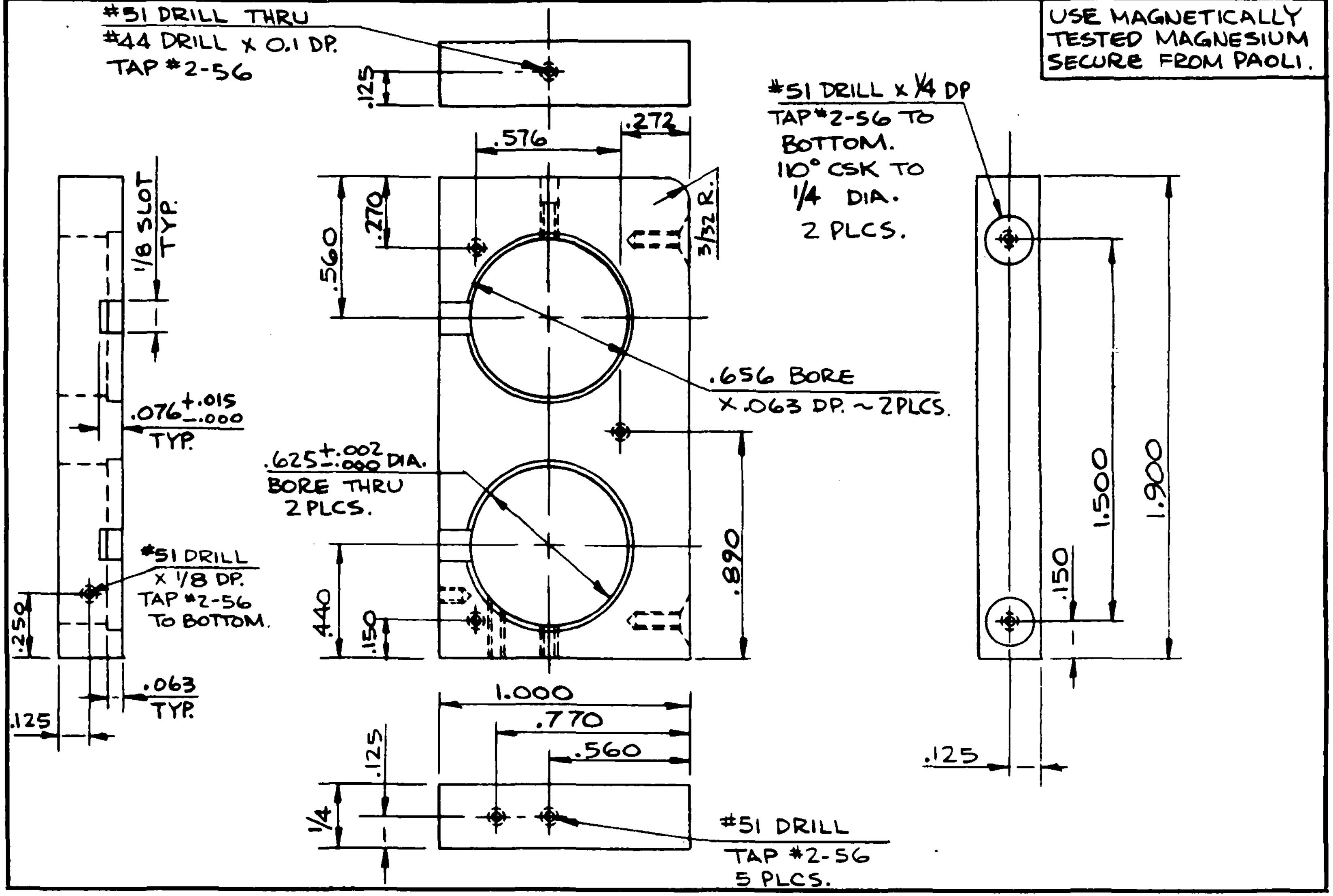
DRAWN K. P. TOY
SCALE 2" = 1"
CHECK R. J. Paoli
APP. R. J. Paoli
DATE 4 AUG. 1967

USE MAGNETICALLY TESTED MAGNESIUM SECURE FROM PAOLI.



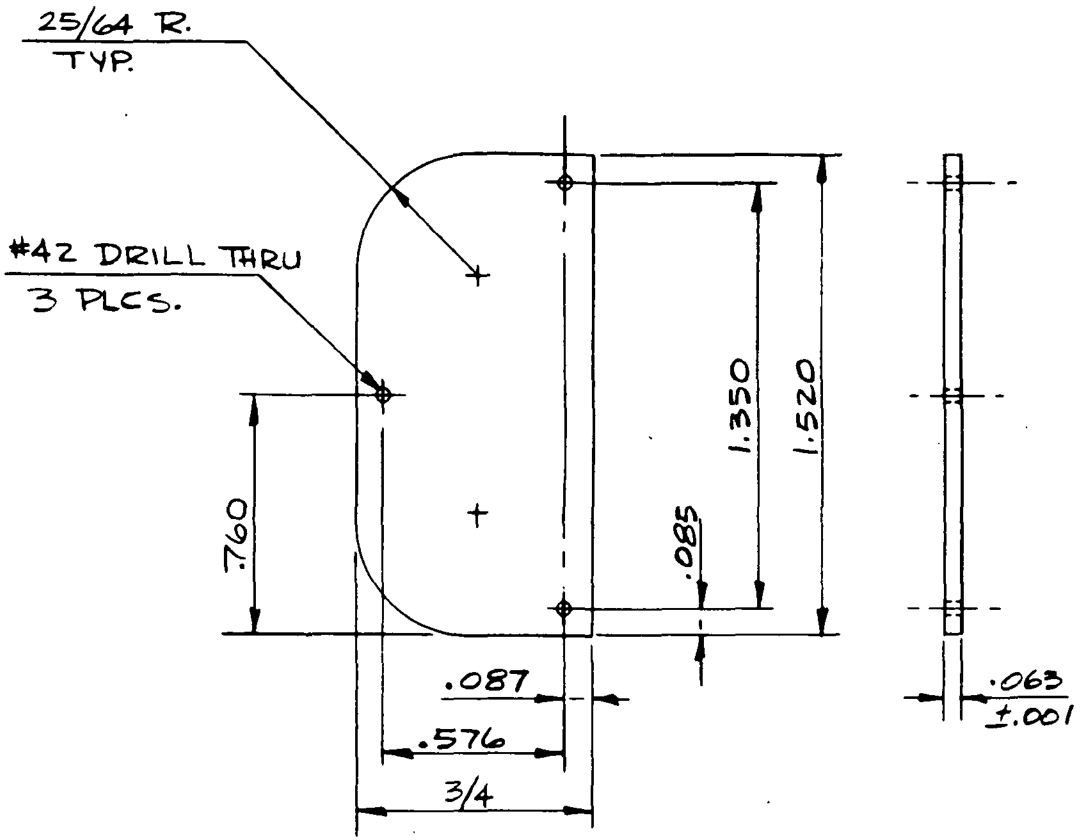
DWG. NO. IMP G-111	REV. B	DATE 16 OCT. 67	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	DRAWN R.P. TOY
MATL. AZ-31B		REQD.		SCALE 2" = 1"
TITLE LEFT BRACKET, P2-E2				CHECK R. J. Paoli
				APP. R. J. Paoli
				DATE 10 AUG. 1967

USE MAGNETICALLY TESTED MAGNESIUM SECURE FROM PAOLI.



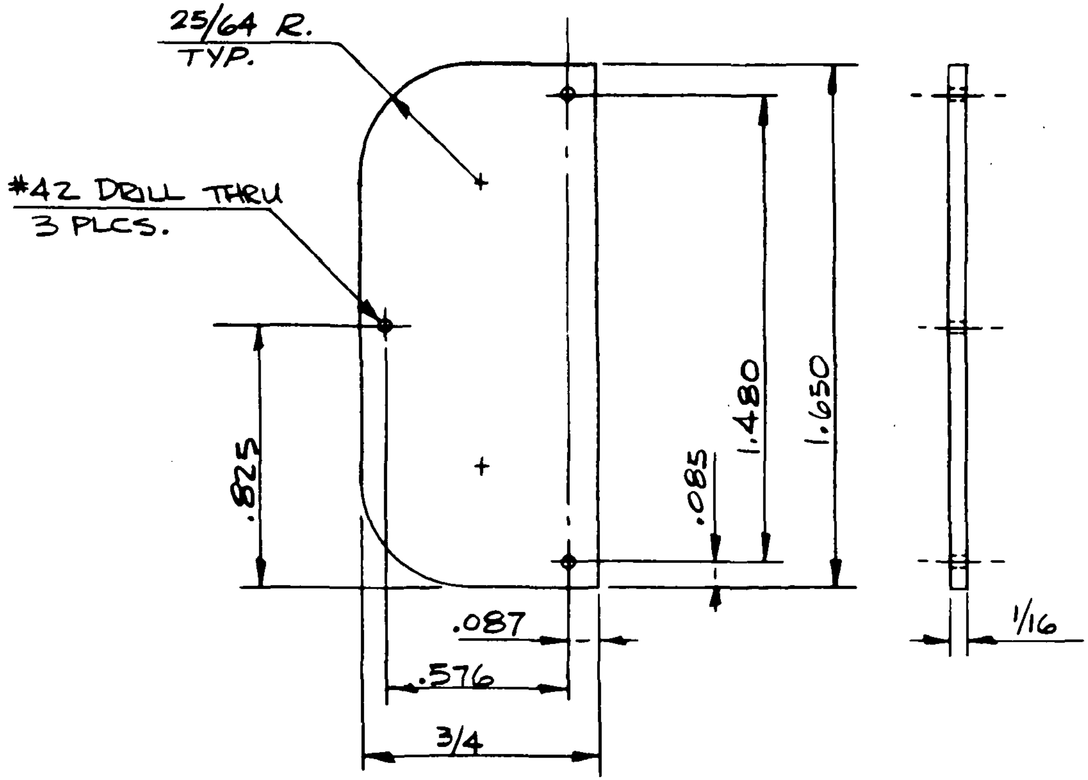
DWG. NO. IMP G-112	REV.	DATE	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	DRAWN R. P. TOY
MATL. BRASS		REQD.		SCALE 2" = 1"
TITLE CAP, P1 - P3				CHECK R. J. Paoli
				APP. R. J. Paoli
				DATE 4 AUG. 1967

USE MAGNETICALLY TESTED BRASS SECURE FROM PAOLI.



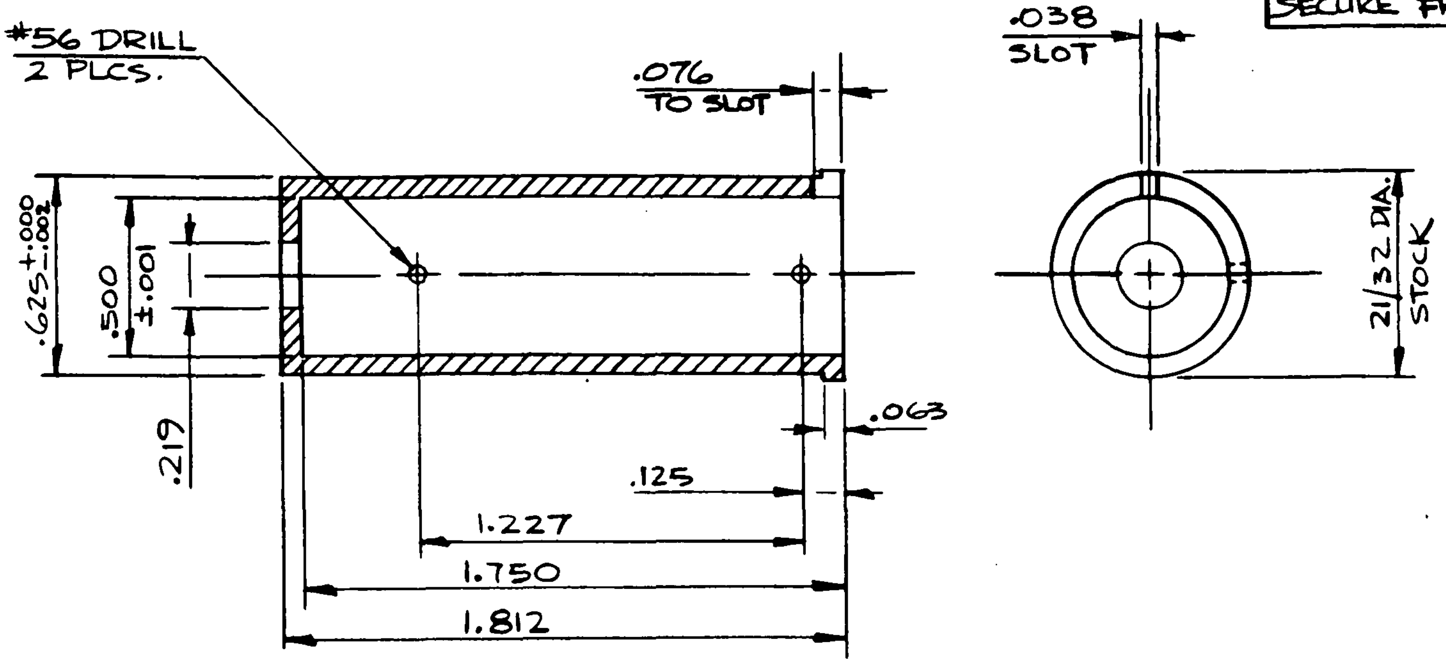
DWG. NO. IMP G-113	REV.	DATE	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	DRAWN R. P. TOY
MATL. BRASS		REQD.		SCALE 2" = 1"
TITLE CAP, E1-E3 AND P2-E2				CHECK R. J. Paol
				APP. R. J. Paol
				DATE 4 AUG. 1967

USE MAGNETICALLY TESTED BRASS SECURE FROM PAOLI.



DWG. NO. IMP G-114	REV.	DATE	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	DRAWN R. P. TOY SCALE 2" = 1" CHECK R. J. Paoli APP. R. J. Paoli DATE 4 AUG. 1967
MATL. BRASS		REQD.		
TITLE P 1 SHIELD				

USE MAGNETICALLY TESTED BRASS SECURE FROM PAOLI.

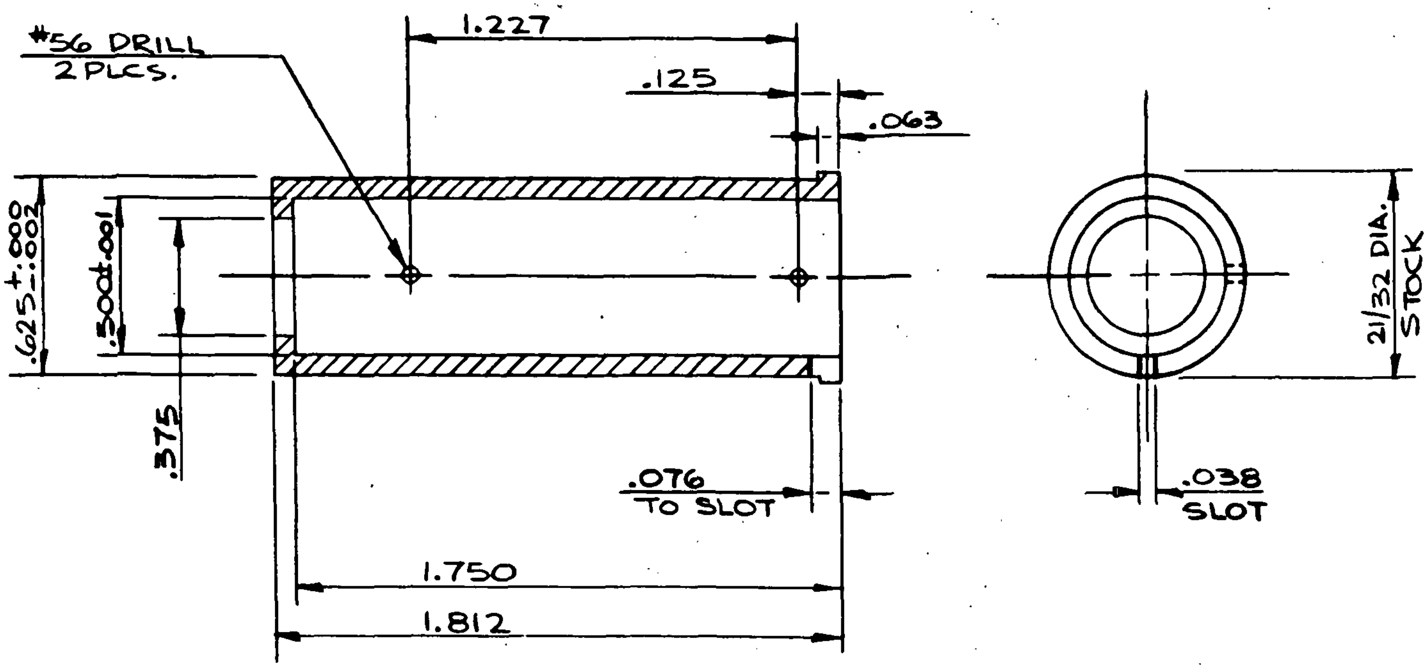


NOTES:

1. ROUND INSIDE & OUTSIDE CORNERS OF SLOT.
2. LOCATE DRILLED HOLES & SLOT WITH FIXTURE # IMP G-120.

DWG. NO. IMP G-115	REV.	DATE	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	DRAWN R.P. TOY SCALE 2" = 1" CHECK R. J. Paoli APP. R. J. Paoli DATE 7 AUG. 1967
MATL. BRASS		REQD.		
TITLE P3 SHIELD				

USE MAGNETICALLY TESTED BRASS SECURE FROM PAOLI.

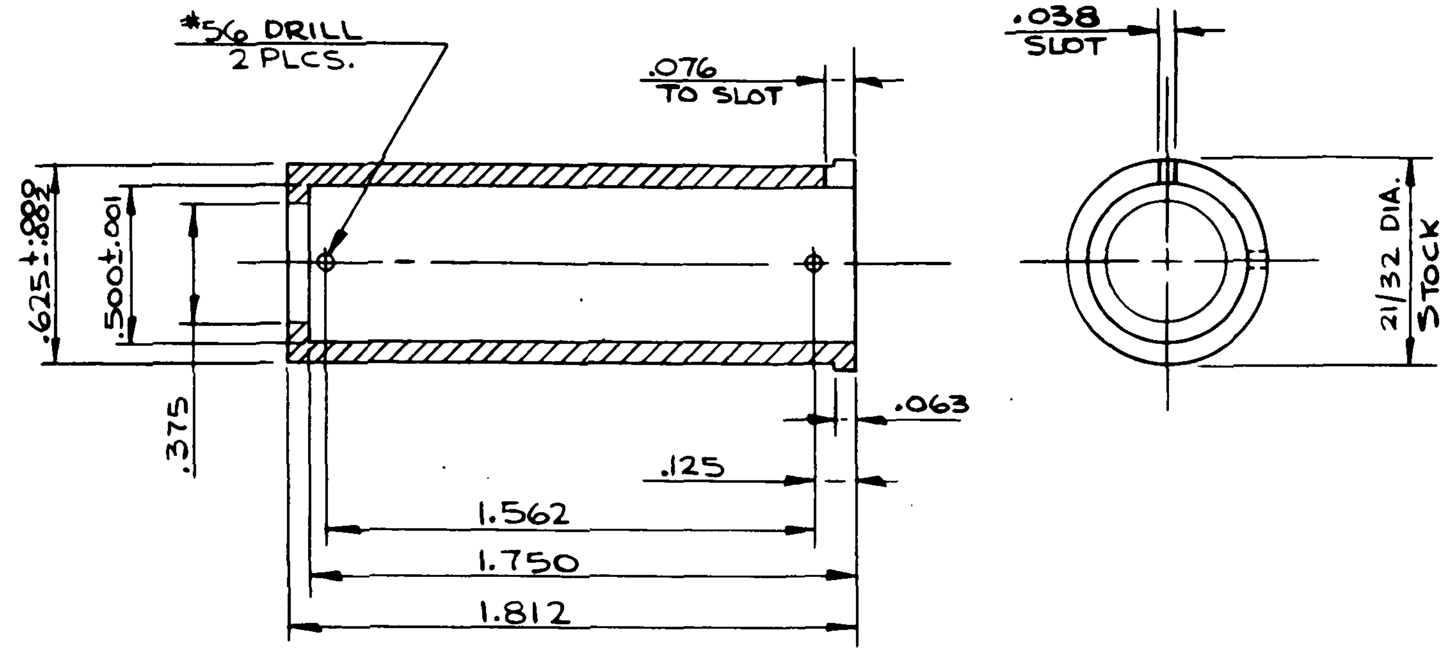


NOTES:

1. ROUND INSIDE & OUTSIDE CORNERS OF SLOT.
2. LOCATE DRILLED HOLES & SLOT WITH FIXTURE #IMP G-120.

DWG. NO. IMP G-116	REV.	DATE	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	DRAWN R. P. TOY SCALE 2" = 1" CHECK R. J. Paoli APP. R. J. Paoli DATE 7 AUG. 1967
MATL. BRASS		REQD.		
TITLE E 1 SHIELD				

USE MAGNETICALLY TESTED BRASS SECURE FROM PAOLI.



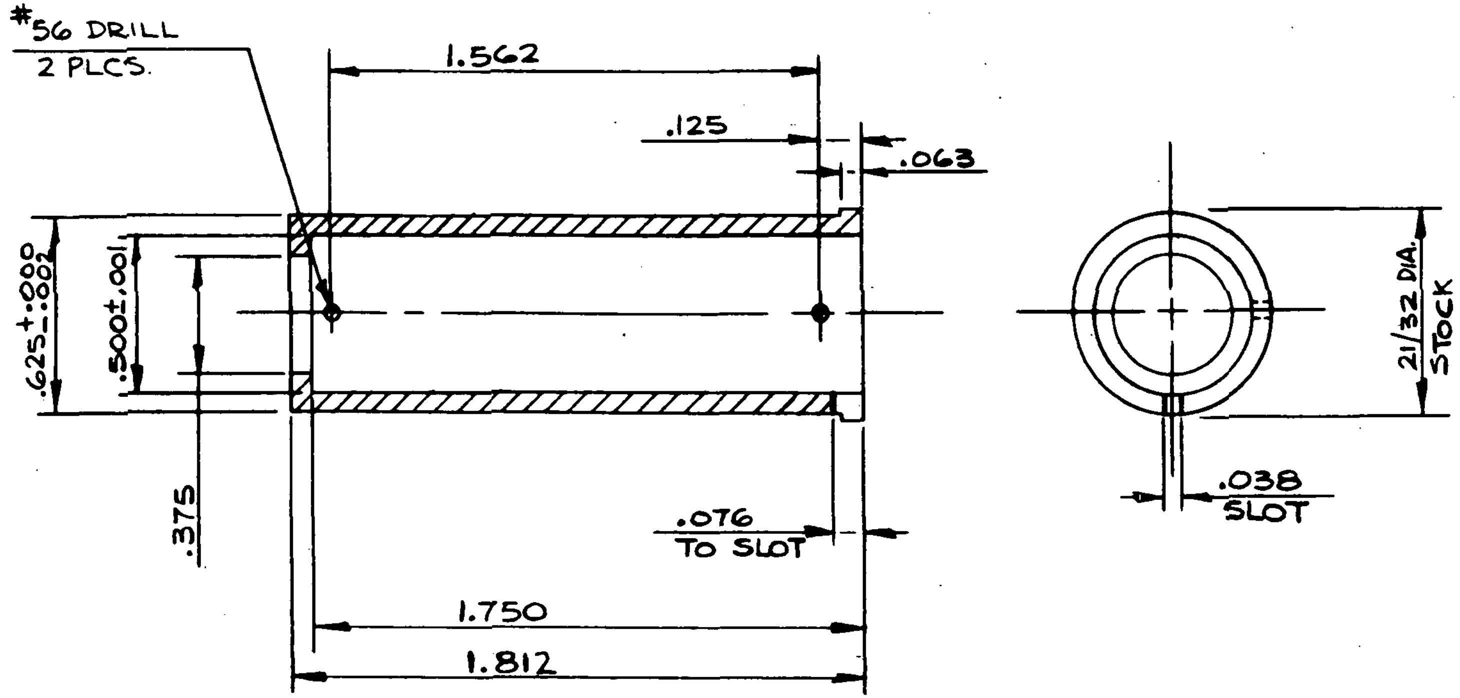
NOTES:

1. ROUND INSIDE & OUTSIDE CORNERS OF SLOT.
2. LOCATE DRILLED HOLES & SLOT WITH FIXTURE #IMP G-120.

DWG. NO. IMP G-117	REV.	DATE	**SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA**
MATL. BRASS		REQD.	
TITLE E3 SHIELD			

DRAWN	R. P. TOY
SCALE	2" = 1"
CHECK	R. J. Paoli
APP.	R. J. Paoli
DATE	7 AUG. 1967

USE MAGNETICALLY TESTED BRASS SECURE FROM PAOLI.

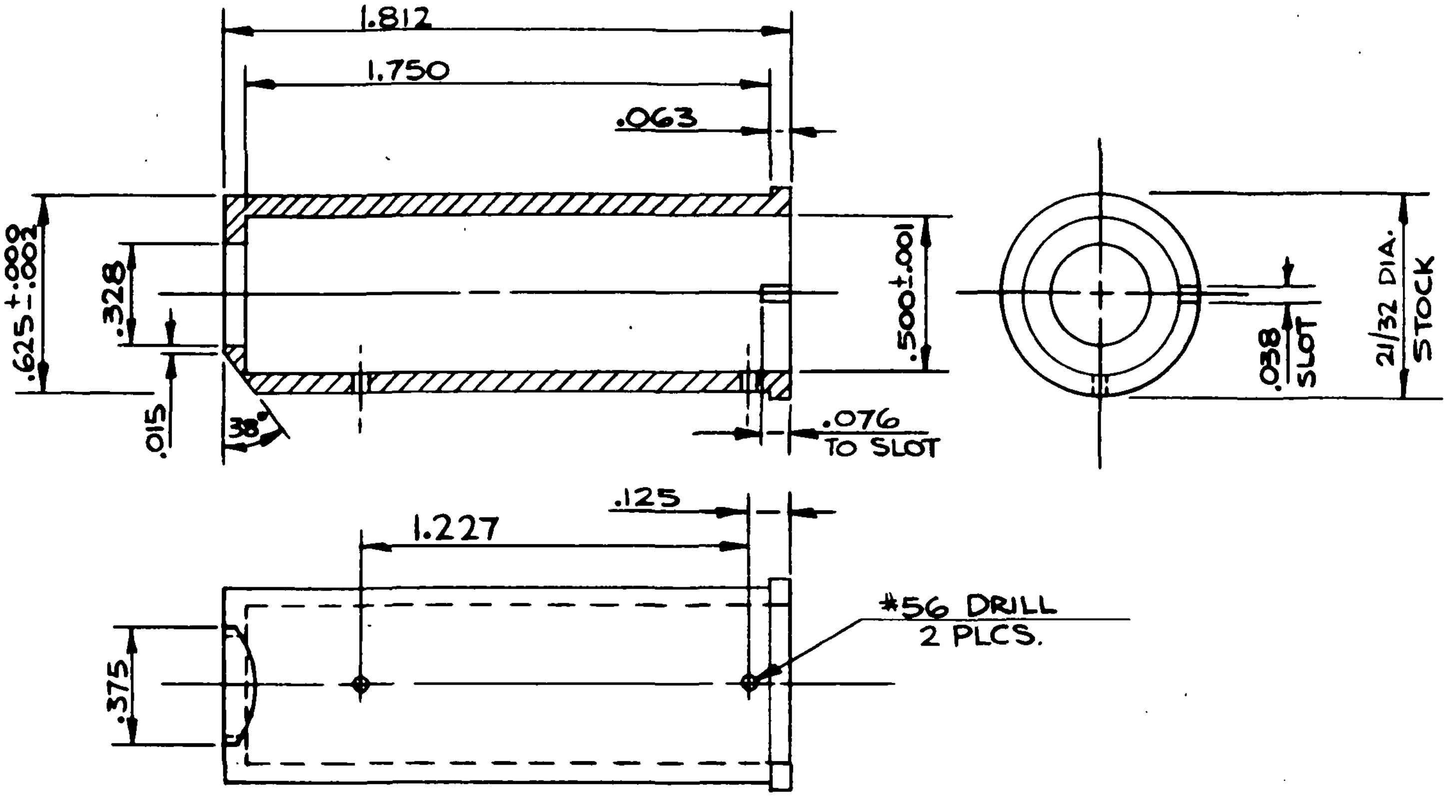


NOTES:

1. ROUND INSIDE & OUTSIDE CORNERS OF SLOT.
2. LOCATE DRILLED HOLES & SLOT WITH FIXTURE #IMP G-120.

DWG. NO. IMP G-118	REV.	DATE	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	DRAWN	R. P. TOY
MATL. BRASS		REQD.		SCALE	2" = 1"
TITLE P2 SHIELD				CHECK	R. L. Paoli
				APP.	R. L. Paoli
				DATE	7 AUG. 1967

USE MAGNETICALLY TESTED BRASS SECURE FROM PAOLI.

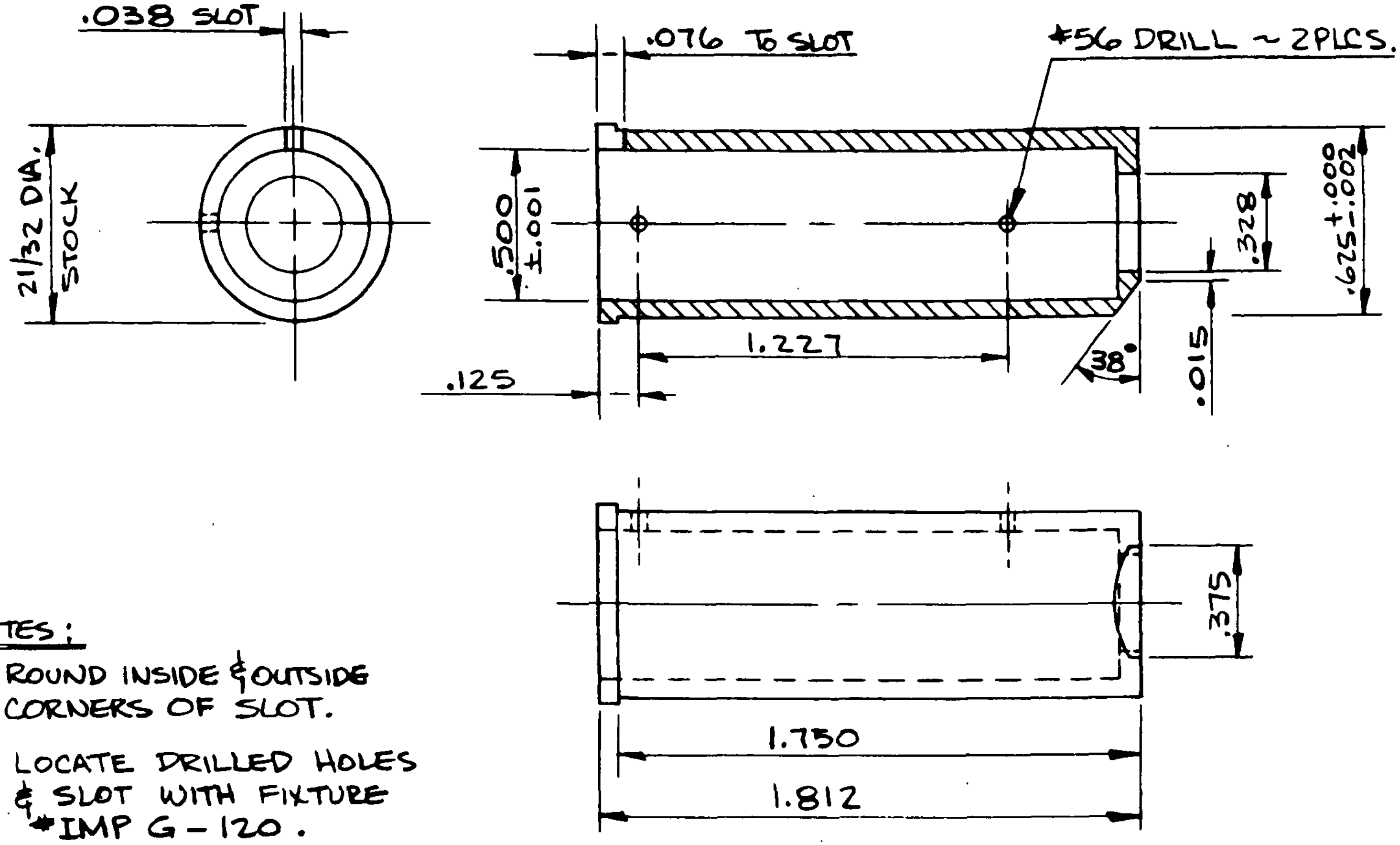


NOTES:

1. ROUND INSIDE & OUTSIDE CORNERS OF SLOT.
2. LOCATE DRILLED HOLES & SLOT WITH FIXTURE #IMP G-120.

DWG. NO. IMP G-119	REV.	DATE	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	DRAWN R.P. TOY
MATL. BRASS		REQD.		SCALE 2" = 1"
TITLE E 2 SHIELD				CHECK R J Paoli
				APP. R J Paoli
				DATE 8 AUG. 1967

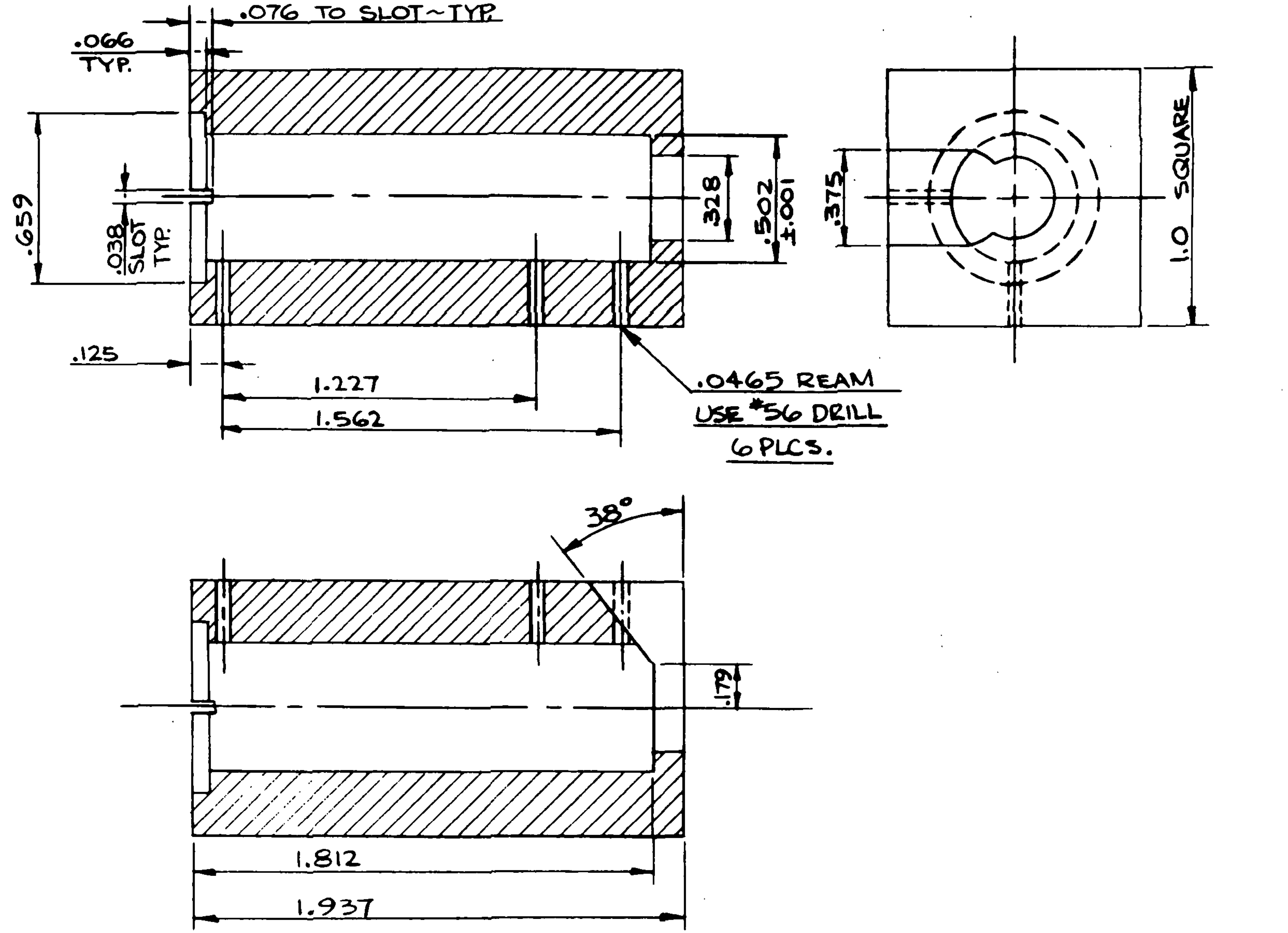
USE MAGNETICALLY TESTED BRASS SECURE FROM PAOLI.

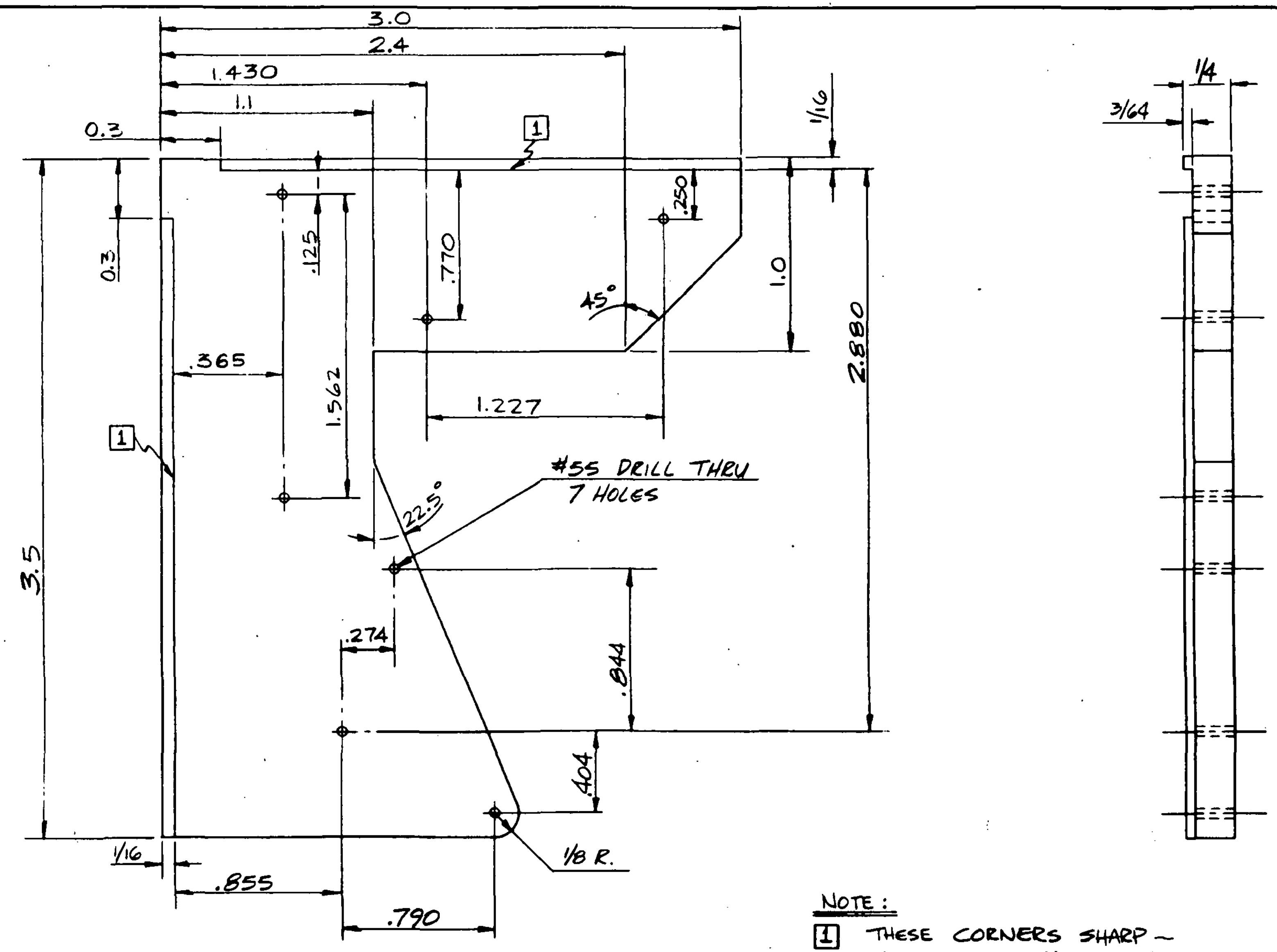


NOTES:

1. ROUND INSIDE & OUTSIDE CORNERS OF SLOT.
2. LOCATE DRILLED HOLES & SLOT WITH FIXTURE #IMP G-120.

NO. IMP G-120	JOB	APP	SPACE SCIENCES LABORATORY	SCALE 2" = 1"	DR. R.P. TOY DATE 9 AUG. 67
TITLE FIXTURE, SHIELDS			UNIVERSITY OF CALIFORNIA	REQD.	MATL. STEEL





NOTE:

[1] THESE CORNERS SHARP – ALL OTHERS MAY BE ROUNDED.

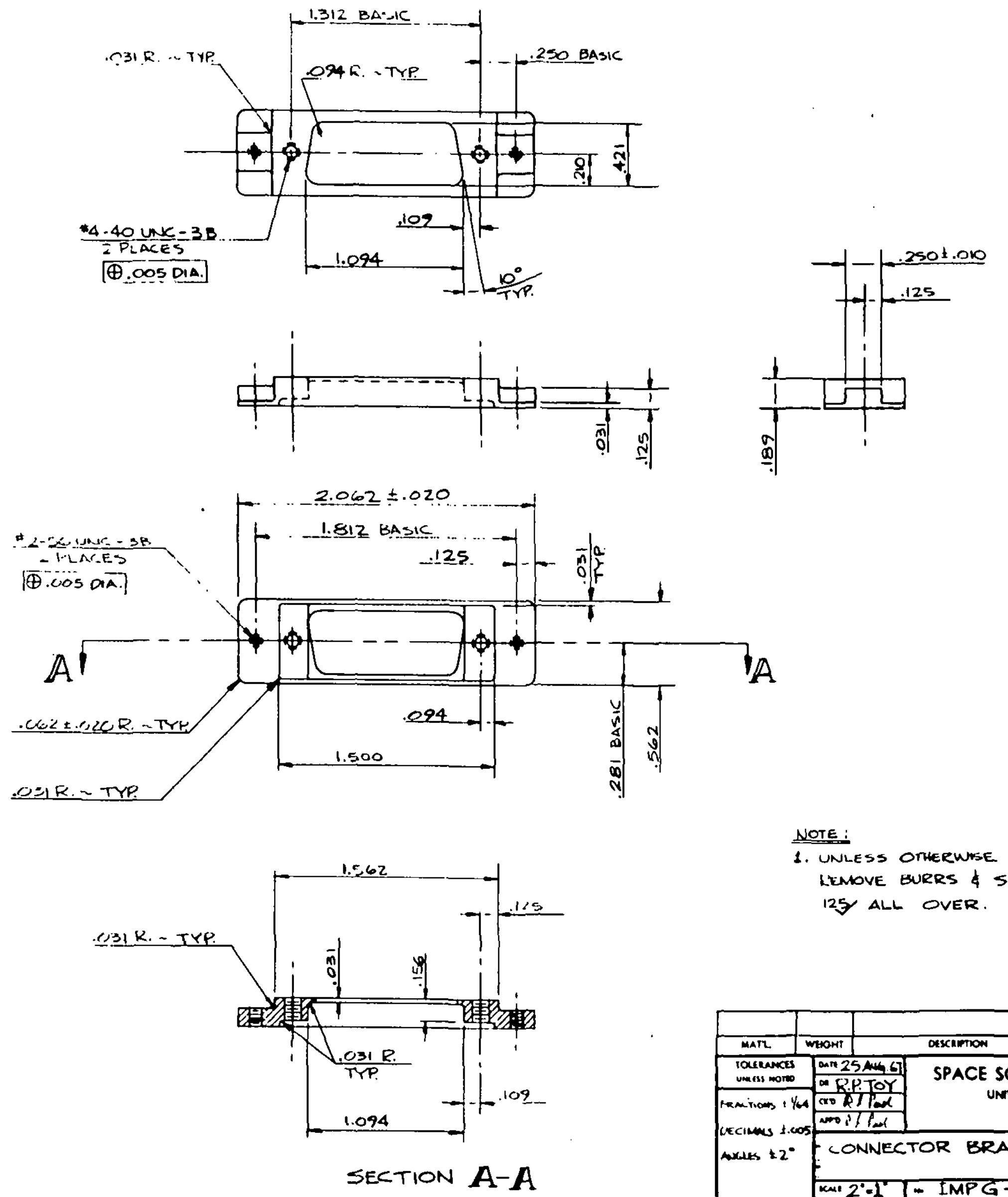
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA

DWG. NO. IMP G-121 | REV. A | DATE
MATL. STEEL | REQD.
TITLE DRILL FIXTURE, P.C. BOARD

DRAWN
SCALE 2 = 1"
CHECK
APP.
DATE

DWG NO IMPG-122

REV	NO	DESCRIPTION	DATE	APP'D



NOTE:
1. UNLESS OTHERWISE SPECIFIED:
REMOVE BURRS & SHARP EDGES .005 R.
125 ALL OVER.

MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

TOLERANCES UNLESS NOTED
FRACTIONS ± 1/64
DECIMALS ±.005
ANGLES ±2°

DATE 25 Aug 67
DR R.P. TOY
CKD R.J. Paul
APPD R.J. Paul

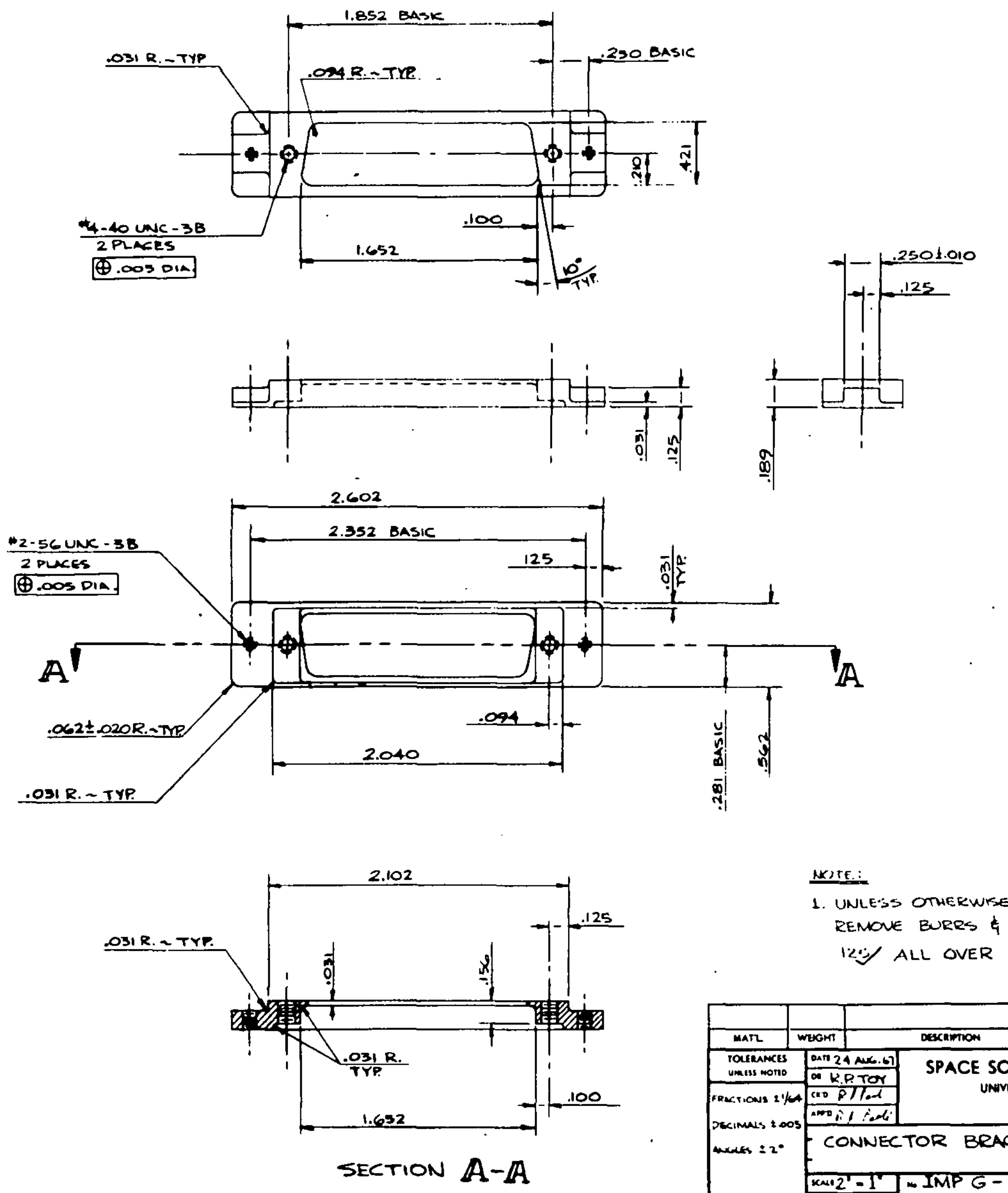
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

CONNECTOR BRACKET, 15 PIN

SCALE 2"=1"
NO. IMPG-122
PROJECT

DWG NO IMP G-123

REV	NO	DESCRIPTION	DATE	APP'D

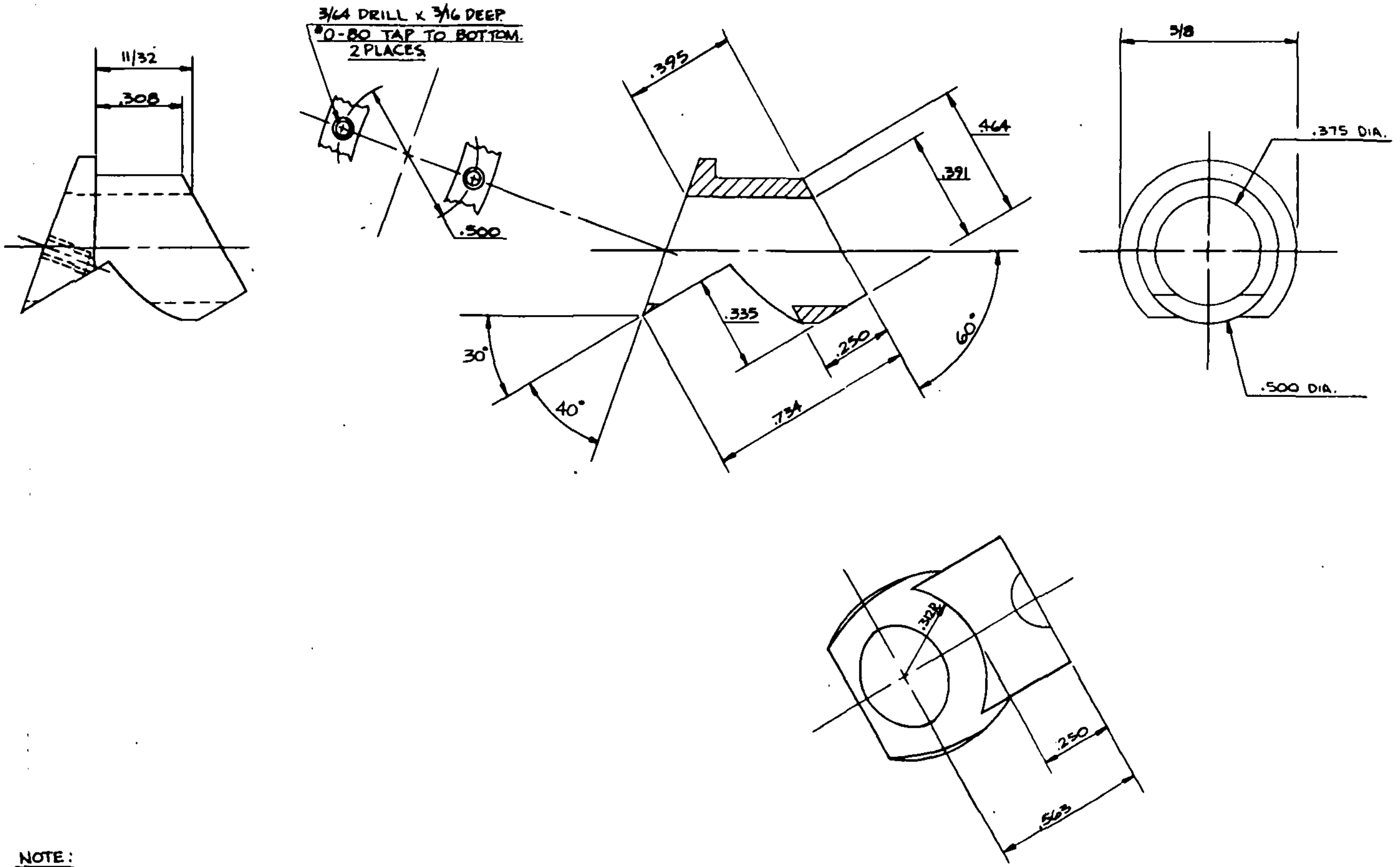


NOTE:
1. UNLESS OTHERWISE SPECIFIED:
REMOVE BURRS & SHARP EDGES .005R.
125√ ALL OVER

MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

TOLERANCES UNLESS NOTED	DATE 24 AUG. 67	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA BERKELEY
FRACTIONS ±1/64	DR K.R.TOY	
DECIMALS ±.005	CKD R/Ford	
ANGLES ±2°	APP'D R.J. Ford	CONNECTOR BRACKET, 25 PIN
	SCALE 2" = 1"	NO IMP G-123
	N A	PROJECT

DWG NO IMP G - 124



NOTE:

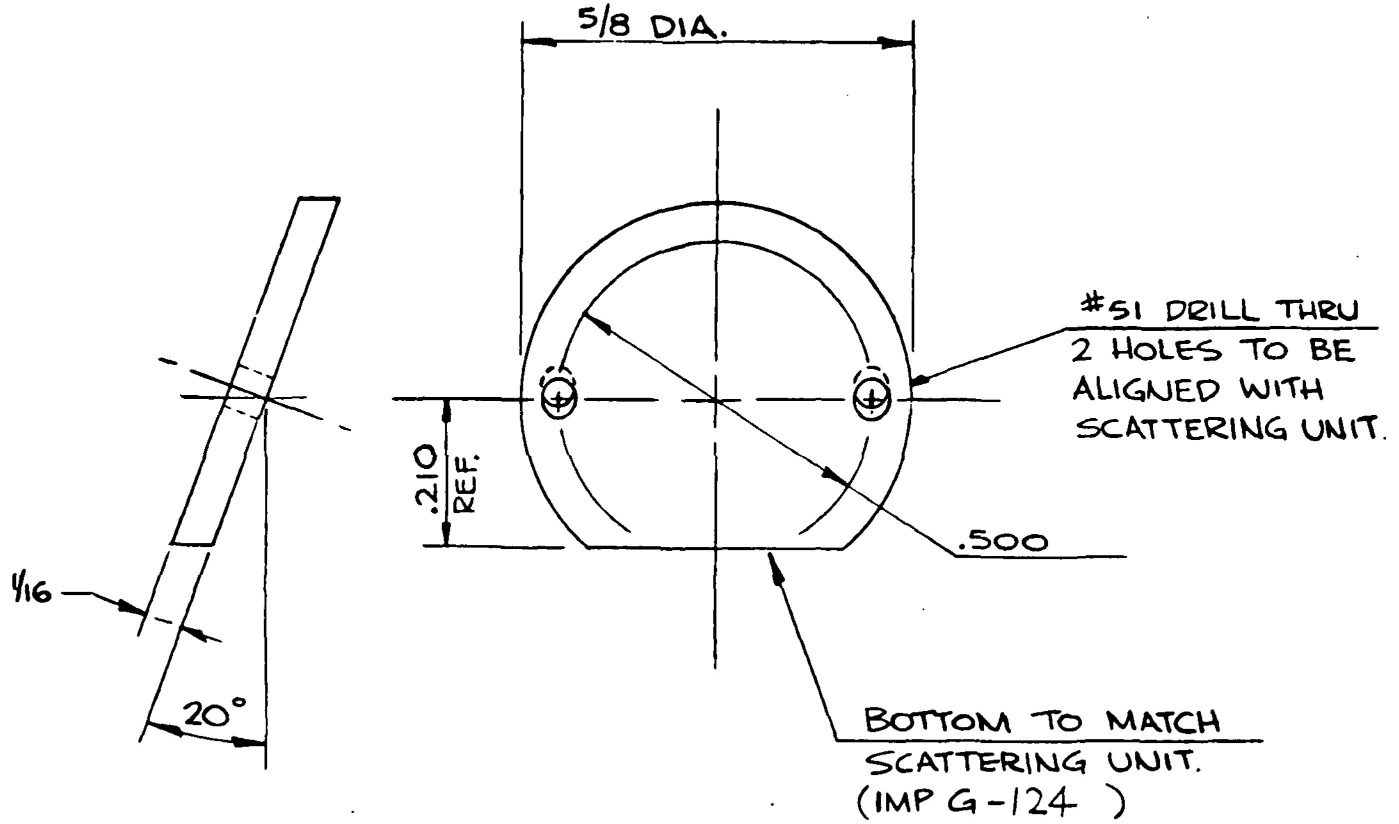
1. USE MAGNETICLY TESTED BRASS. SECURE FROM PAOLI.

SEE NOTE #1					
MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

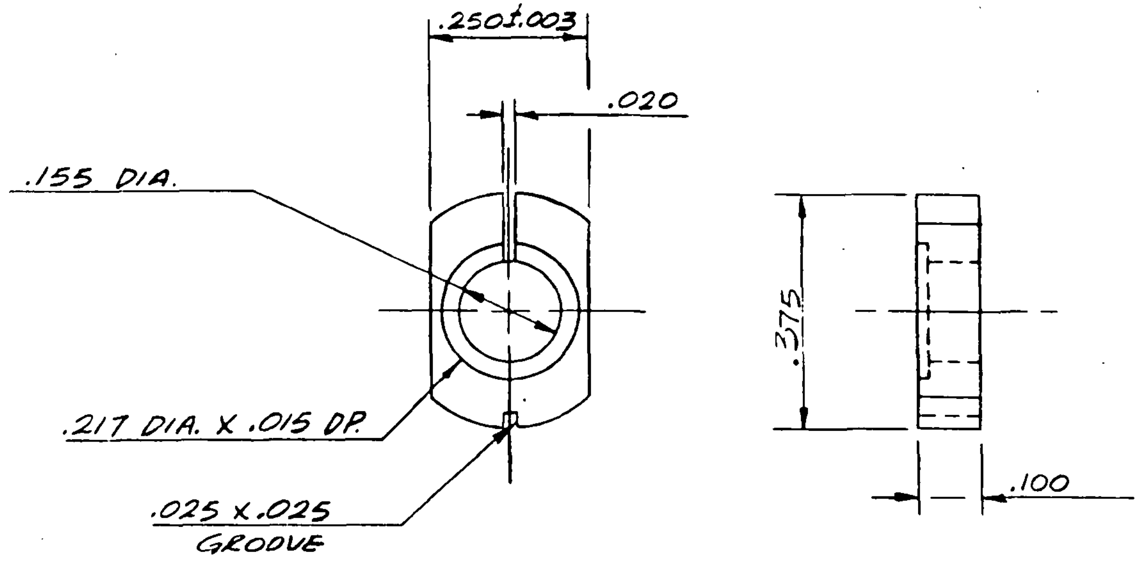
TOLERANCES UNLESS NOTED	DATE 20 NOV. 67 DR. R. TOY CK'D P. J. Paoli APP'D P. J. Paoli
SPACE SCIENCES LABORATORY	UNIVERSITY OF CALIFORNIA, BERKELEY
SCATTERING UNIT	
SCALE 4:1	NO. IMP G - 124
N.A.	PROJECT IMP F&G

NO. IMP G-125	JOB	APP. R J Paoli	SPACE SCIENCES LABORATORY	SCALE 4:1	DR. R. TOY	DATE 27 OCT. 67
TITLE SCATTERING UNIT CAP PLATE			UNIVERSITY OF CALIFORNIA	REQD.	MATL. BRASS	

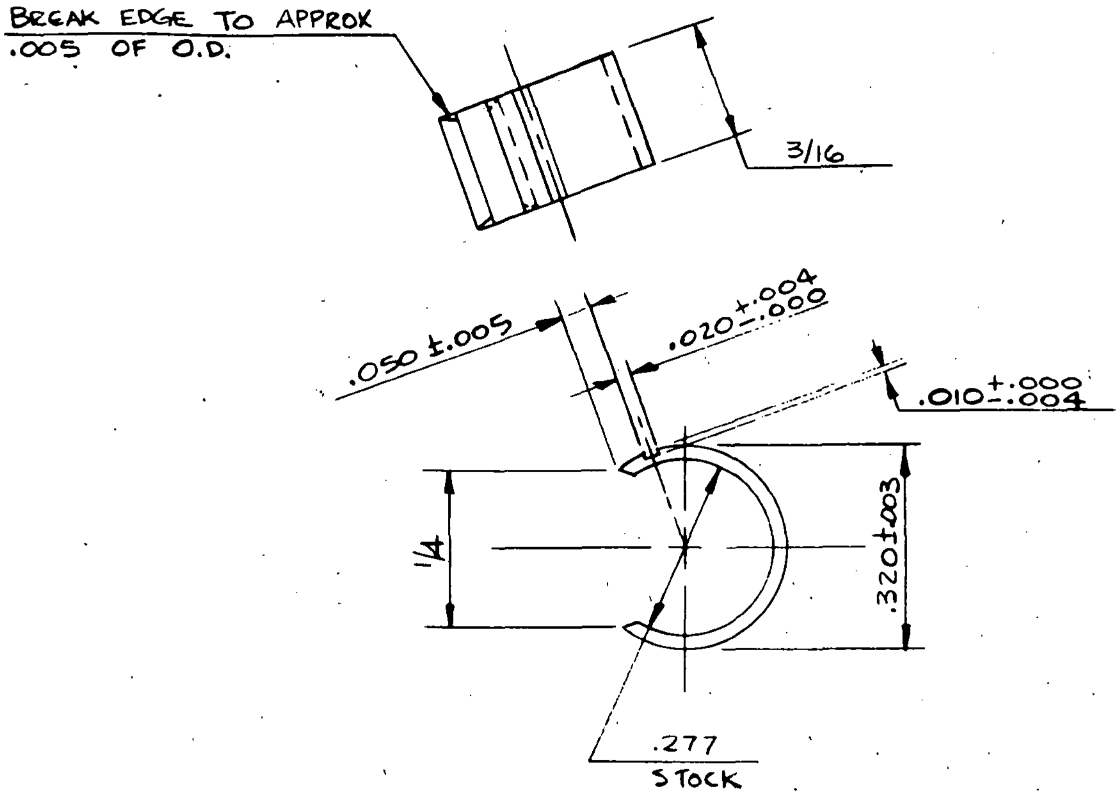
USE MAGNETICLY TESTED BRASS. SECURED FROM PAOLI.



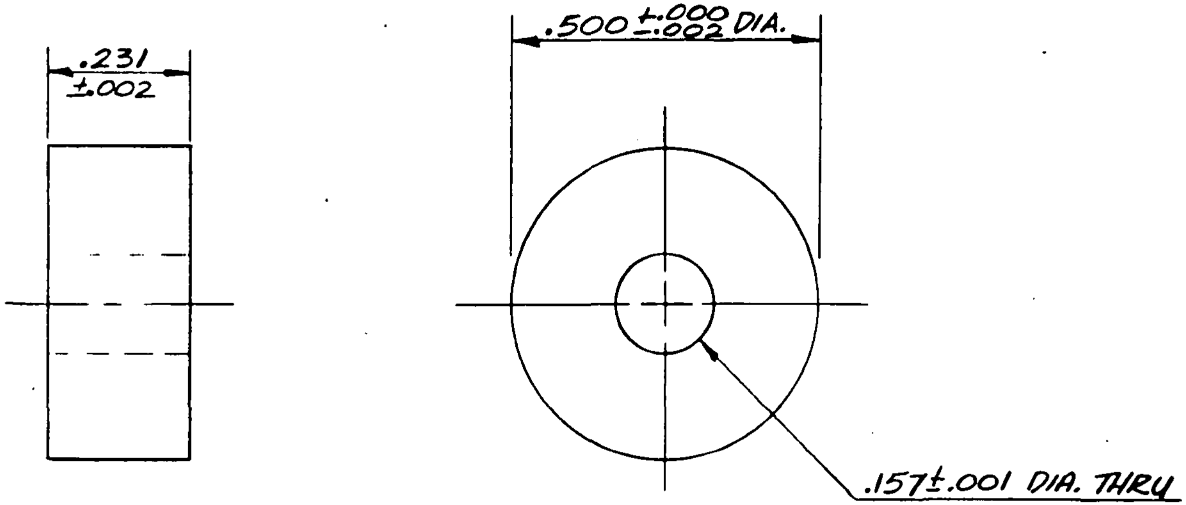
DWG. NO. IMP G-126	REV.	DATE	SPACE SCIENCES LABORATORY	DRAWN	R. P. TOY
MATL. BRASS		REQD.	UNIVERSITY OF CALIFORNIA	SCALE	4" = 1"
TITLE P 1 CATHODE CLIP				CHECK	R. I. Park
				APP.	R. I. Park
				DATE	17 AUG. 67



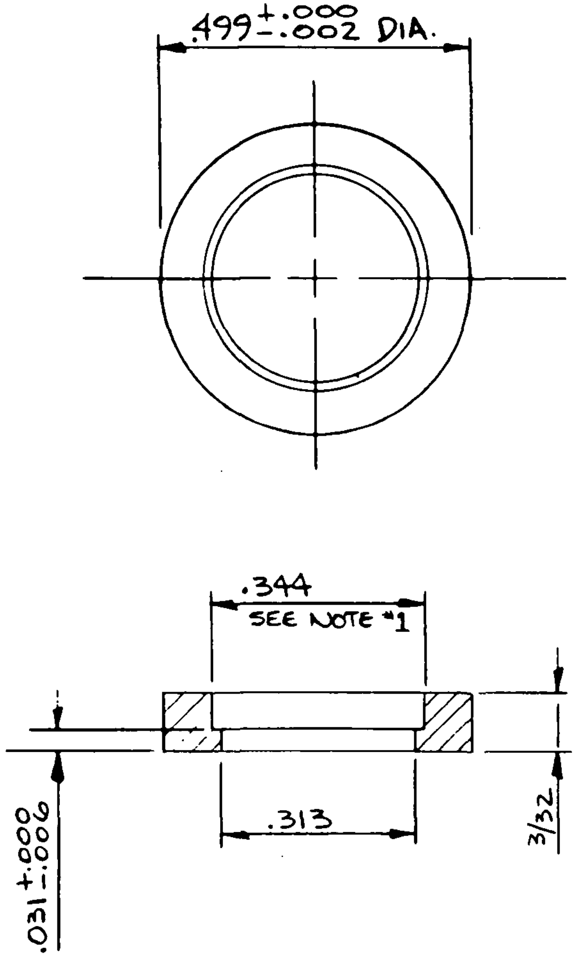
DWG. NO. IMP G-127	REV.	DATE	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	DRAWN R. P. TOY
MATL. HARD BRASS		REQD.		SCALE 4" = 1"
TITLE CATHODE CLIP				CHECK R. J. Paul
				APP. R. J. Paul
				DATE 18 AUG. 67



DWG. NO. IMP G-128	REV.	DATE	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	DRAWN R.P. TOY
MATL. KEL - F		REQD.		SCALE 4" = 1"
TITLE P1 - CATHODE CUSHION				CHECK R.P. Pauli
				APP. R.J. Pauli
				DATE 17 AUG. 67



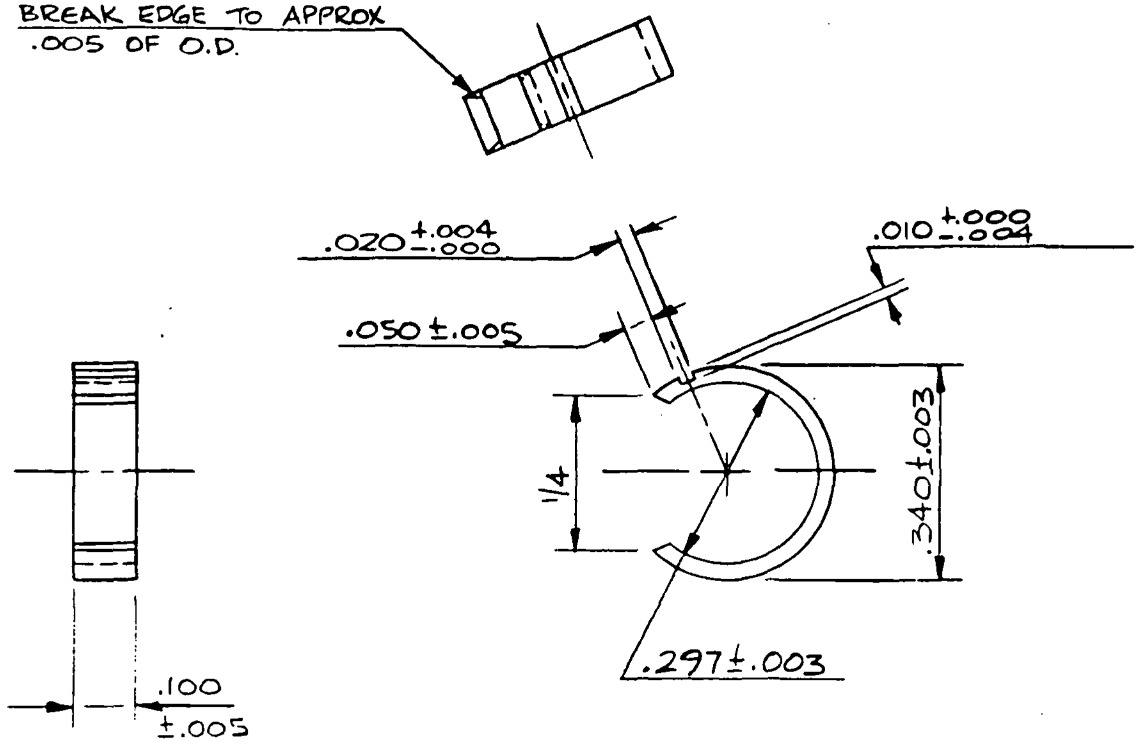
DWG. NO. IMPG-129	REV.	DATE	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	DRAWN	R.P. TOY
MATL. KEL-F		REQD.		SCALE	4" = 1"
TITLE CATHODE CUSHION				CHECK	R. J. Paol
				APP.	R. J. Paol
				DATE	18 AUG. 67



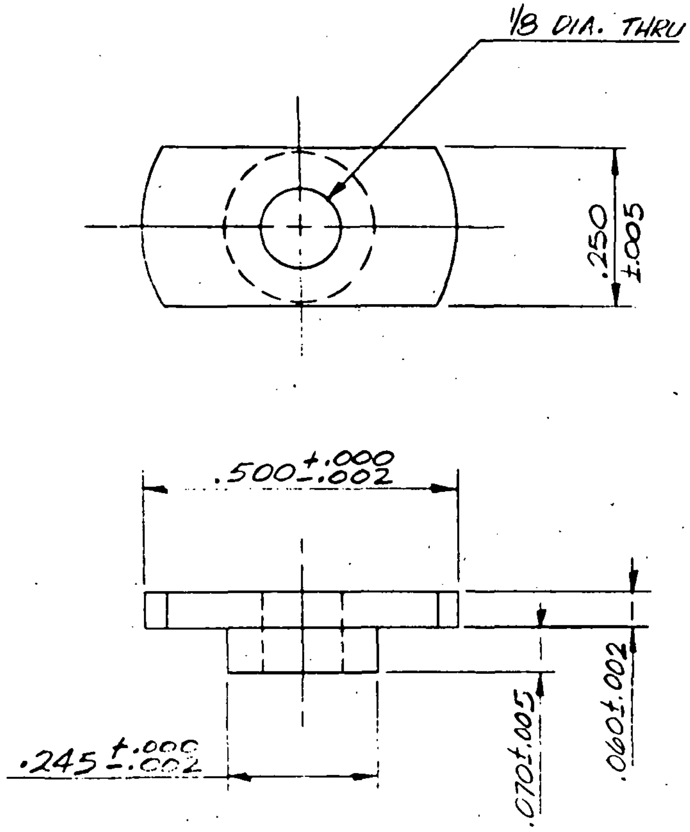
NOTE :

1. BORE TO BE FITTED TO O.D. OF INDIVIDUAL GM TUBE.

DWG. NO. IMP G-130	REV.	DATE	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	DRAWN R. P. TOY
MATL. HARD BRASS		REQD.		SCALE 4" = 1"
TITLE ANODE CLIP				CHECK R. J. Pauli
				APP. R. J. Pauli
				DATE 18 AUG. 67



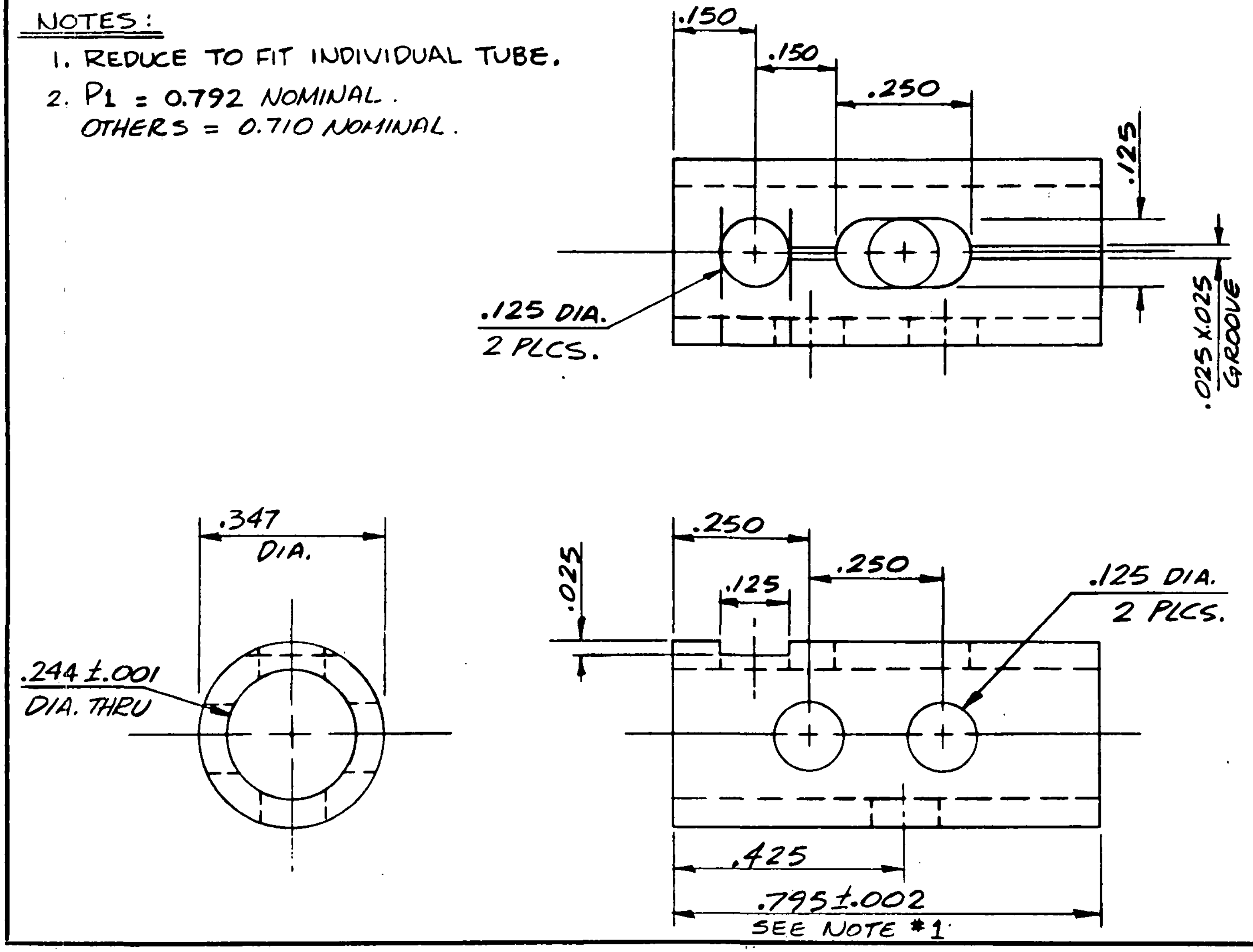
DWG. NO. 1MPG - 131	REV.	DATE	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	DRAWN R. P. TOY
MATL. KEL - F		REQD.		SCALE 4" = 1"
TITLE ANODE CUSHION				CHECK R. J. Paol
				APP. R. J. Paoli
				DATE 17 AUG. 67



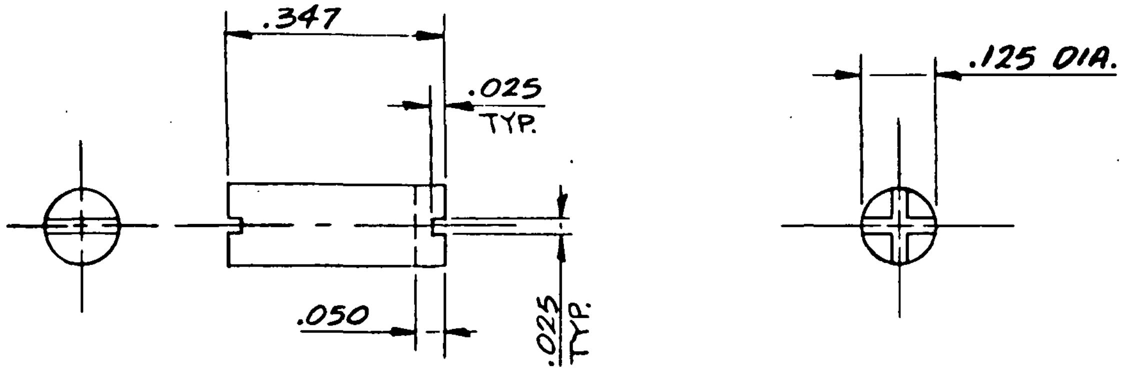
DWG. NO. IMP G-132	REV. A	DATE 16 OCT. 67	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	DRAWN R.P. TOY
MATL. KEL-F		REQD.		SCALE 4" = 1"
TITLE ANODE INSULATOR				CHECK R.J. Paoli
				APP. R.J. Paoli
				DATE 17 AUG. 67

NOTES:

1. REDUCE TO FIT INDIVIDUAL TUBE.
2. P1 = 0.792 NOMINAL.
   OTHERS = 0.710 NOMINAL.

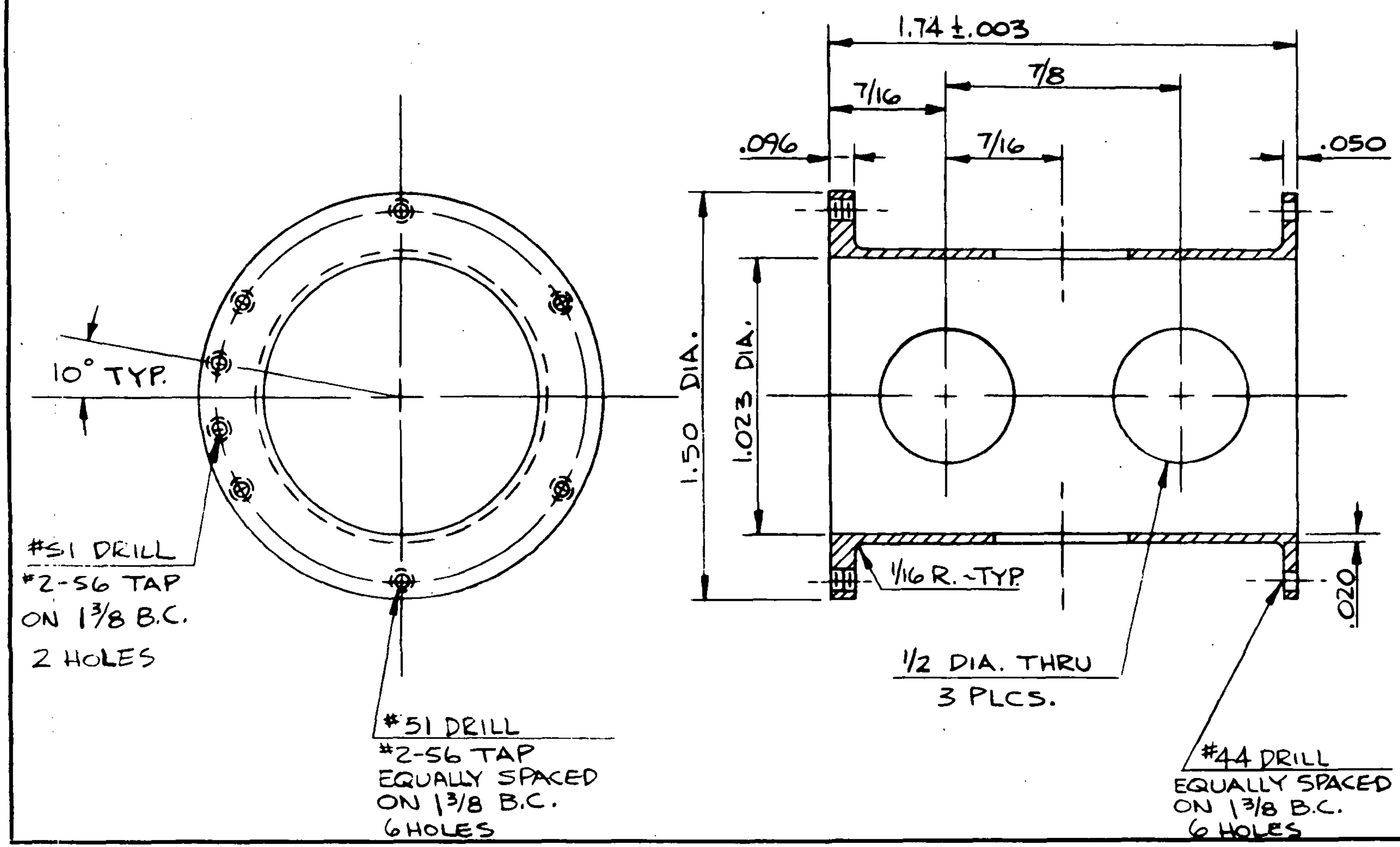


DWG. NO. IMP G - 133	REV.	DATE	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	DRAWN R. P. TOY
MATL. BRASS		REQD.		SCALE 4" = 1"
TITLE ANODE ROD				CHECK R. L. Pack
				APP. R. L. Pack
				DATE 17 AUG. 67



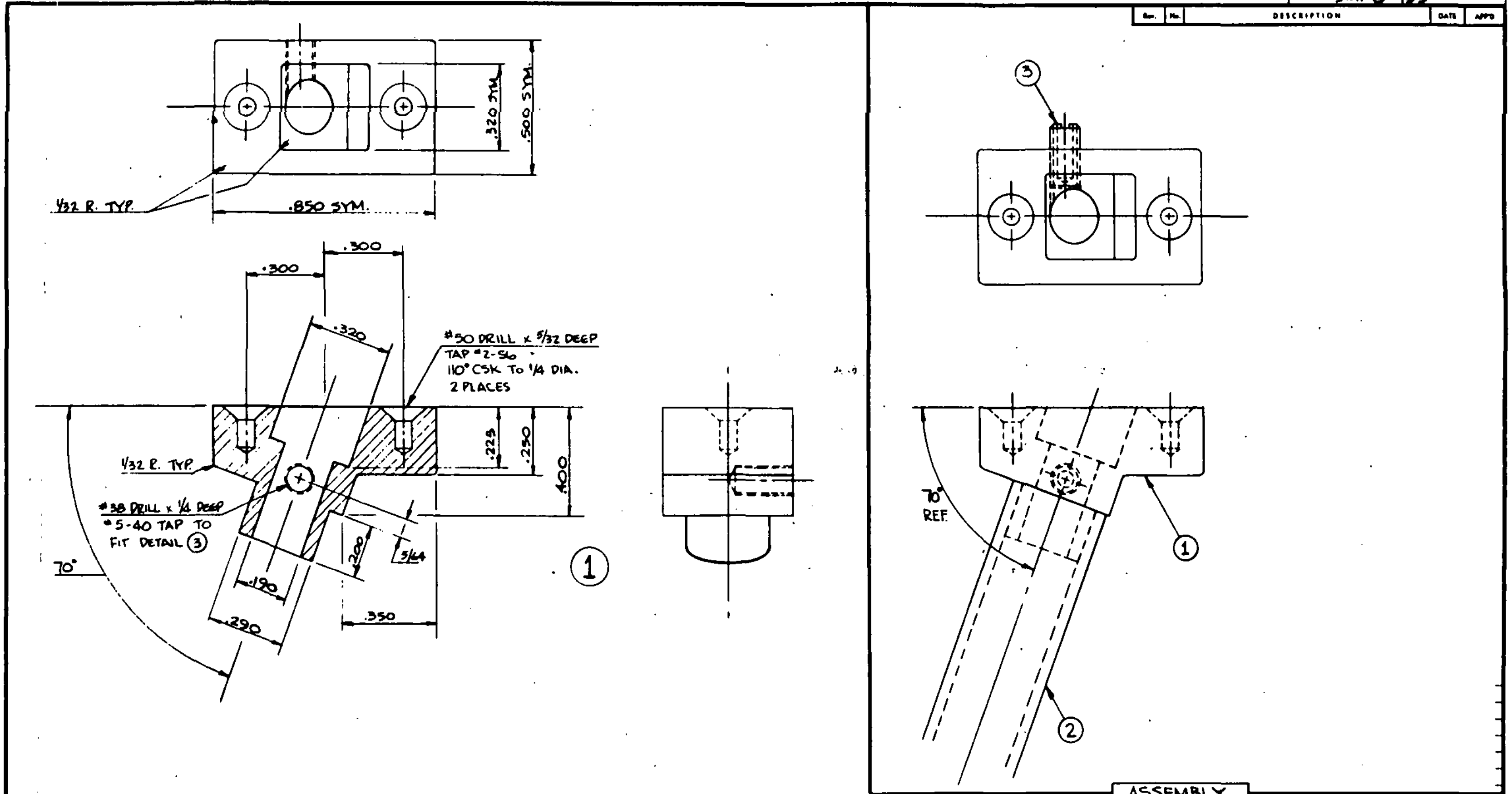
DWG. NO. IMP G-134	REV.	DATE	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	DRAWN	R. P. TOY
MATL. AZ-31 B		REQD.		SCALE	2" = 1"
TITLE STAND, ION CHAMBER				CHECK	
				APP.	
				DATE	25 AUG. 67

USE MAGNETICALLY TESTED MAGNESIUM SECURE FROM PAOLI.

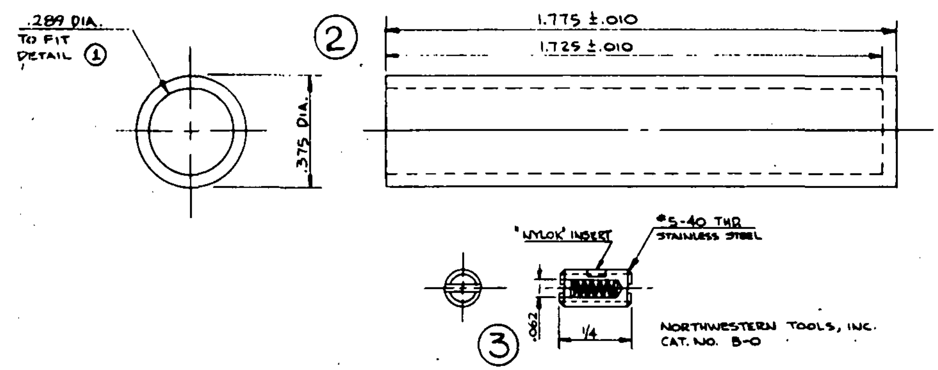


DWG. NO IMP G-135

REV.	No.	DESCRIPTION	DATE	APP'D



ASSEMBLY



MAT'L.	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.
STAINLESS STEEL		SPRING BALL PLUNGER, #5-40 x 1/4 LG.		1	3
KEL-F				1	2
ALUM		SOURCE HOLDER		1	1

TOLERANCES UNLESS NOTED

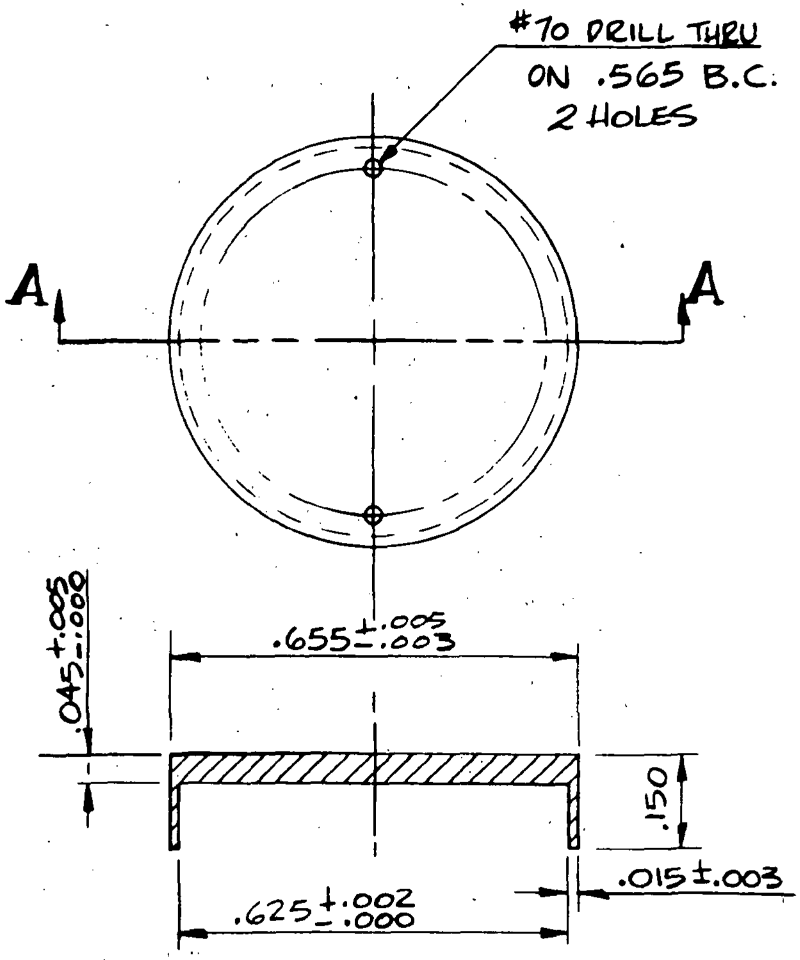
DATE 3 Nov. 67
DR. R. Toy
CK'D R. J. Paul
APP'D R. J. Paul

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

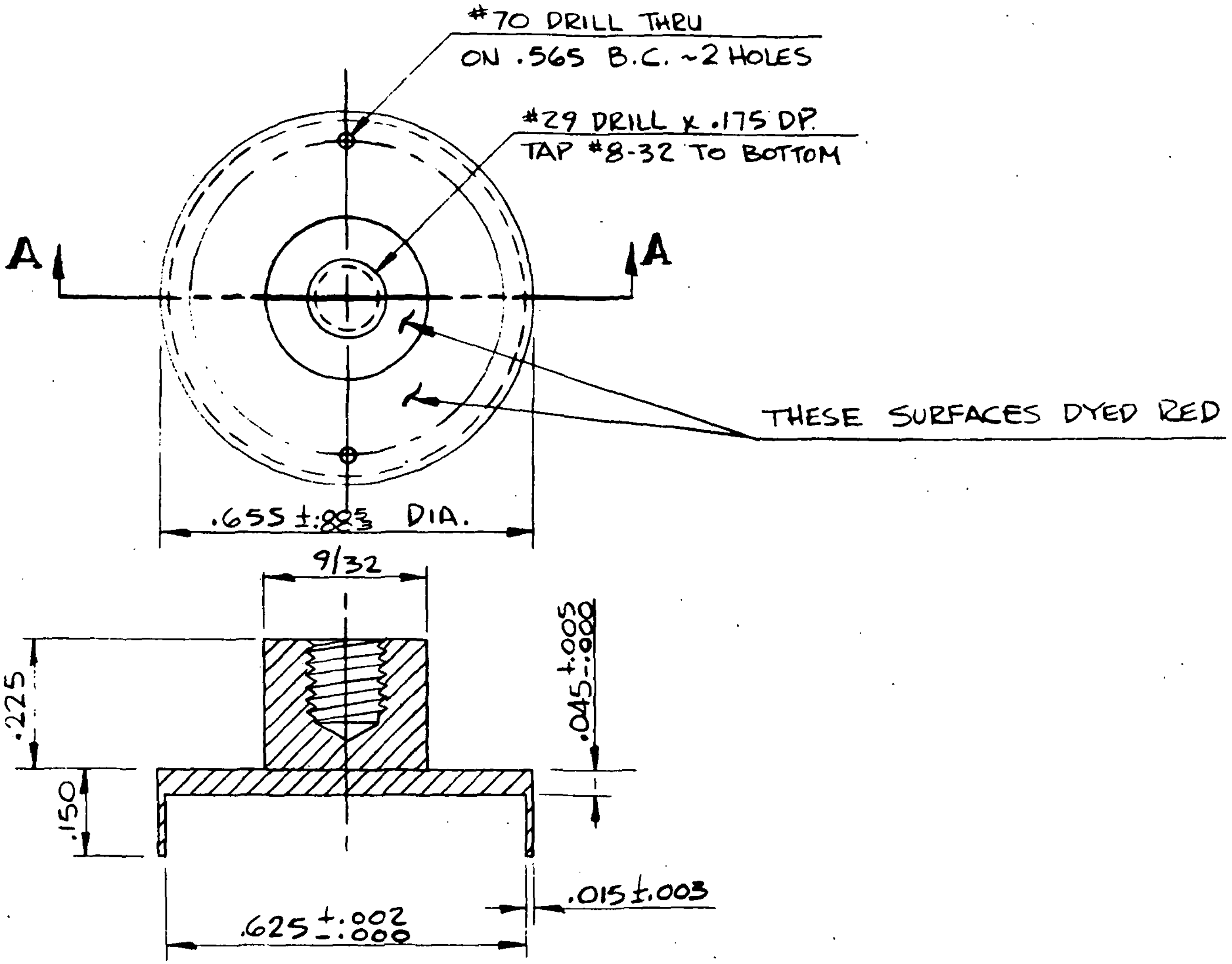
SOURCE HOLDER ASM.

SCALE 4:1
N.A.
No. IMP G-135
PROJECT
REV.
SH.

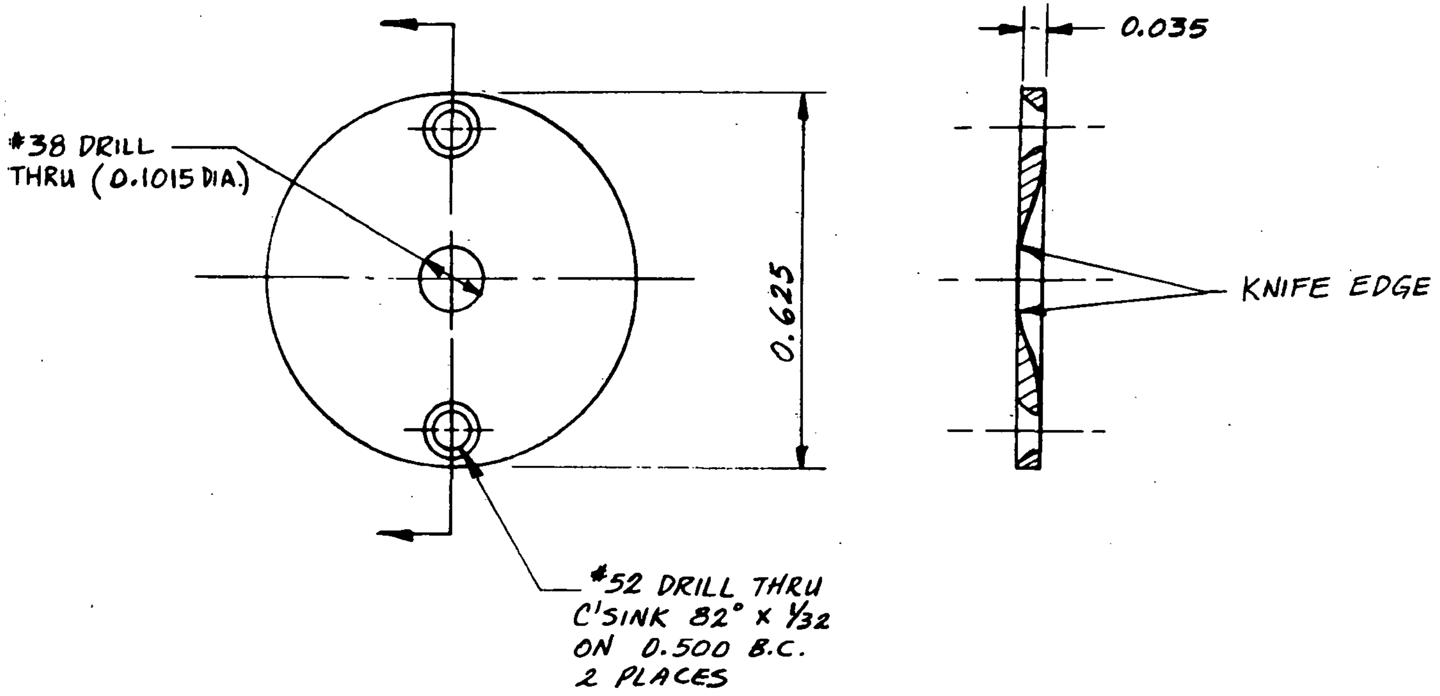
NO. IMPG-136	JOB APP R.J.Paul	SPACE SCIENCES LABORATORY	SCALE 4:1	DR. R. TOY DATE 27 OCT. 67
TITLE P1, P3 POTTING COVER		UNIVERSITY OF CALIFORNIA	REQD	MATL KEL-F



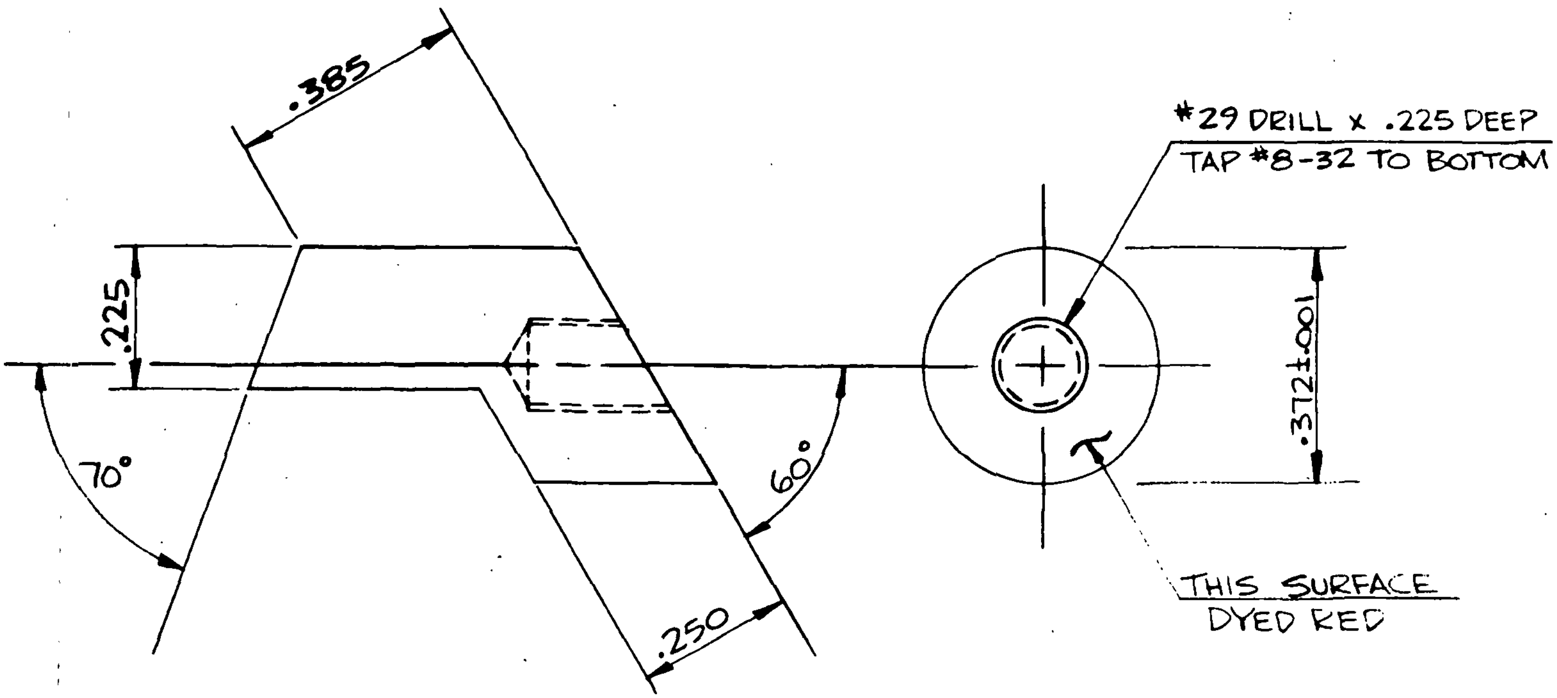
NO. IMP G-137	JOB	APP.	SPACE SCIENCES LABORATORY	SCALE 4:1	DR. R. TOY	DATE 27 OCT. 67
TITLE P1, P3 PROTECTIVE COVER			UNIVERSITY OF CALIFORNIA	REQD.	MATL. KEL-F	



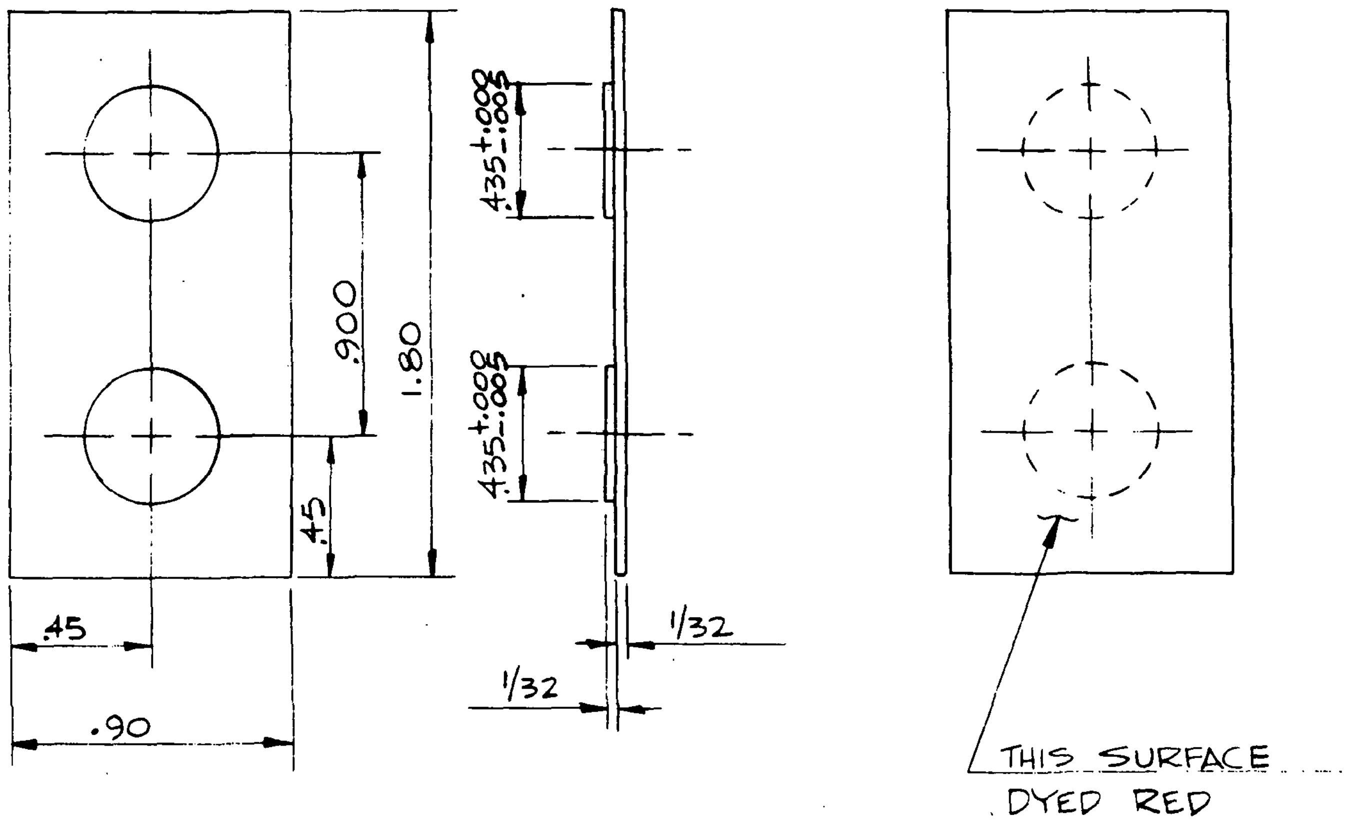
NO. IMPG-138	JOB	APP. RAP	SPACE SCIENCES LABORATORY	SCALE 4:1	DR. RPT DATE 14 DEC. 72
TITLE P1 APERTURE			UNIVERSITY OF CALIFORNIA	REQD.	MATL BRASS



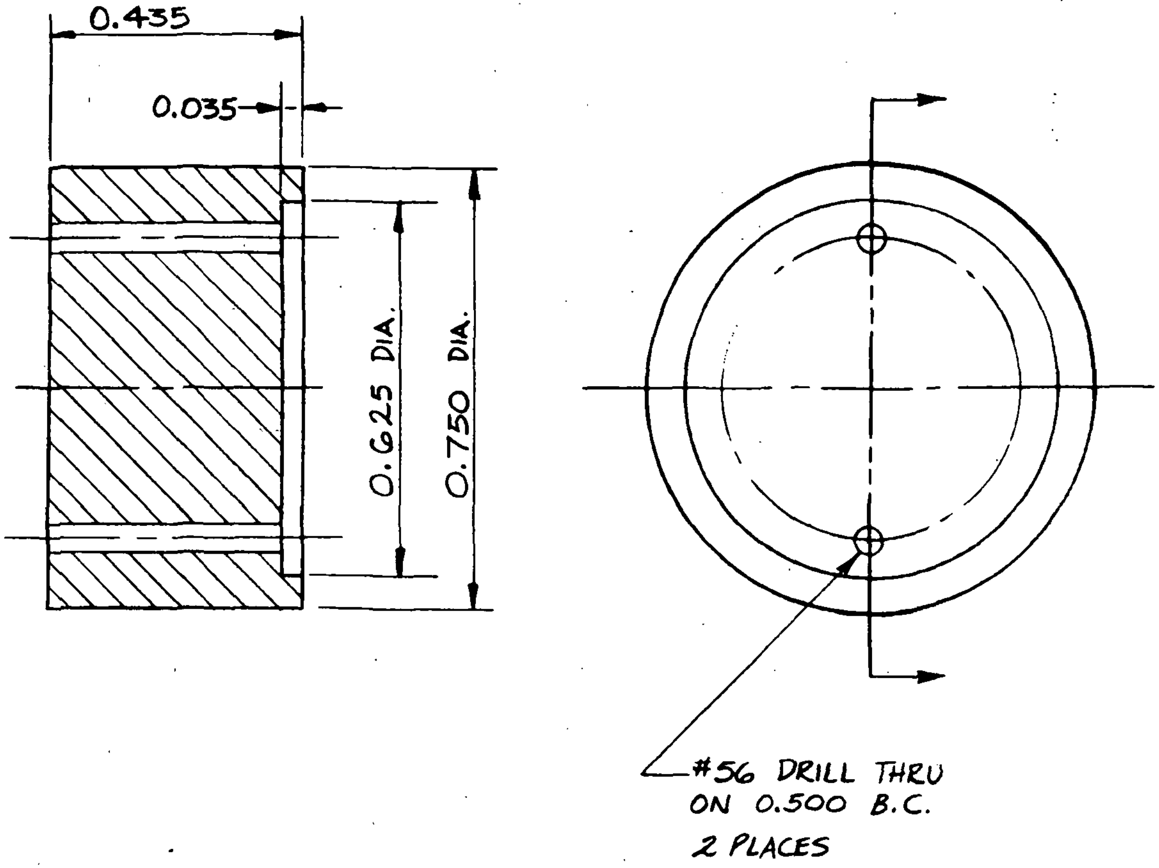
NO. IMP G-139	JOB	APP.	SPACE SCIENCES LABORATORY	SCALE 4:1	DR. R. TOY	DATE 1 NOV. 1967
TITLE E2, P2 PROTECTIVE COVER			UNIVERSITY OF CALIFORNIA	REQD.	MATL. KEL-F	



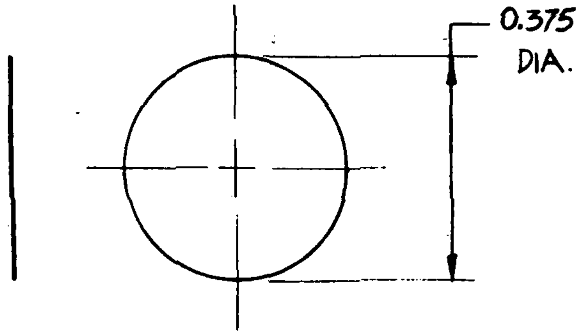
NO. IMP G-140	JOB APP. R.T. Paul	SPACE SCIENCES LABORATORY	SCALE 2:1	DR. R.P. TOY DATE 27 OCT. 67
TITLE E1-E3 PROTECTIVE COVER		UNIVERSITY OF CALIFORNIA	REQD.	MATL. AL



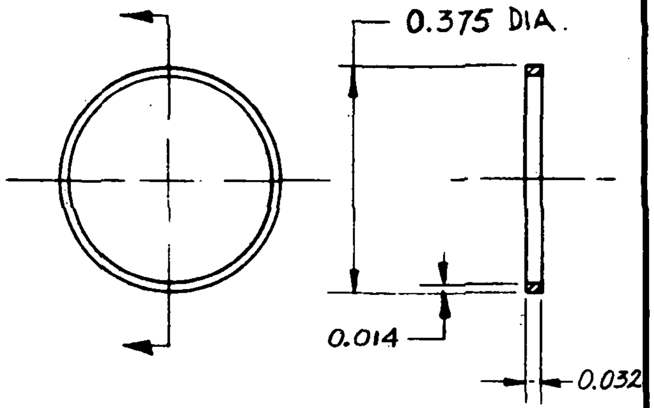
NO. IMPG-141	JOB	APP. RJP	SPACE SCIENCES LABORATORY	SCALE 4:1	DR. RPT DATE 13 DEC. 72
TITLE DRILL JIG, P1 APERTURE			UNIVERSITY OF CALIFORNIA	REQD.	MATL. STEEL



NO. IMPG-142	JOB	APP. RLC	SPACE SCIENCES LABORATORY	SCALE 4:1	DR. RPT DATE 13 DEC. 72
TITLE E3, P3 FOIL ASSEMBLY			UNIVERSITY OF CALIFORNIA	REQD.	MATL. —



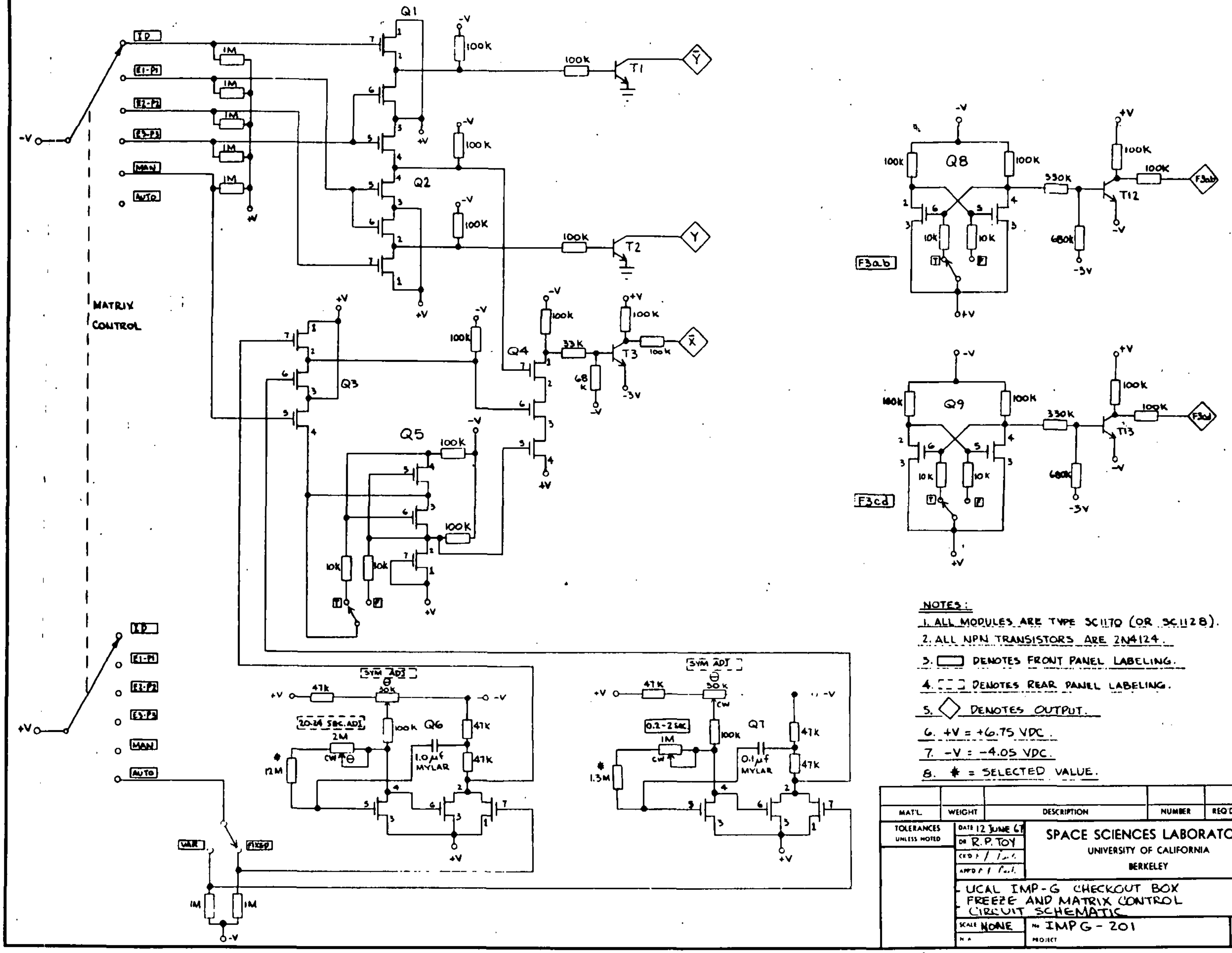
1 MIL ALUM FOIL



BRASS RETAINER RING

DWG NO IMP G-201

REV	NO	DESCRIPTION	DATE	APP'D



NOTES:

1. ALL MODULES ARE TYPE SC1170 (OR SC1128).
2. ALL NPN TRANSISTORS ARE 2N4124.
3. ▭ DENOTES FRONT PANEL LABELING.
4. ⌐ ¬ DENOTES REAR PANEL LABELING.
5. ◇ DENOTES OUTPUT.
6. +V = +6.75 VDC.
7. -V = -4.05 VDC.
8. ✱ = SELECTED VALUE.

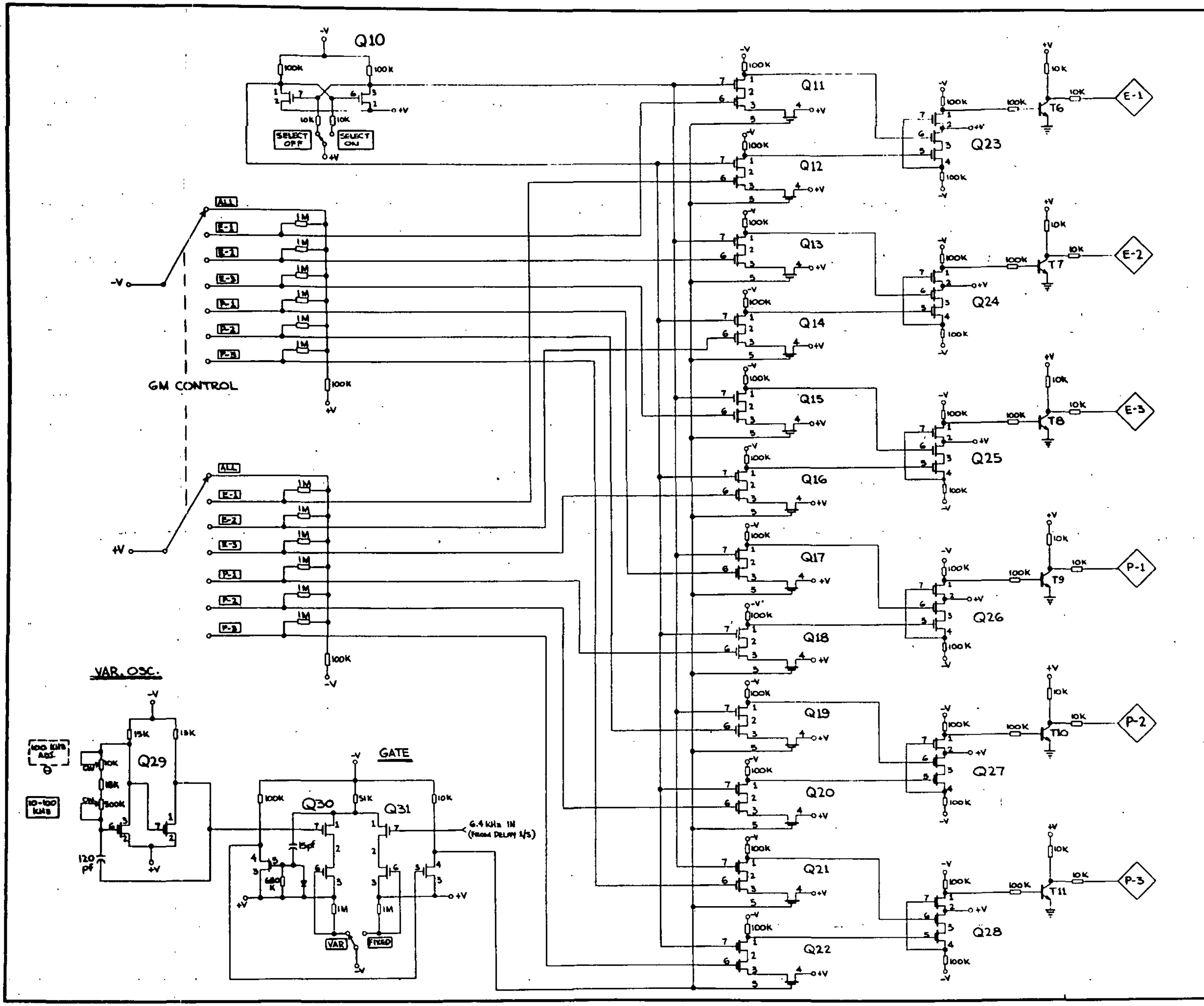
MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

TOLERANCES UNLESS NOTED	DATE 12 JUNE 67
	DR R. P. TOY
	CKD
	APPD

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

UCAL IMP-G CHECKOUT BOX FREEZE AND MATRIX CONTROL CIRCUIT SCHEMATIC

SCALE NONE | NO IMP G - 201 | REV.
PROJECT



NOTES:

1. ALL GATE MODULES ARE GME TYPE #SC1170 (OR #SC1128) OR AMI TYPE #C2002.
2. ALL NPN TRANSISTORS ARE 2N4124.
3. ALL DIODES ARE 1N914 A.
4. ▭ DENOTES FRONT PANEL MARKING.
5. [ ] DENOTES REAR PANEL MARKING.
6. ◇ DENOTES OUTPUT.
7. +V = +6.75 VDC.
8. -V = -4.05 VDC.

MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	ITEM

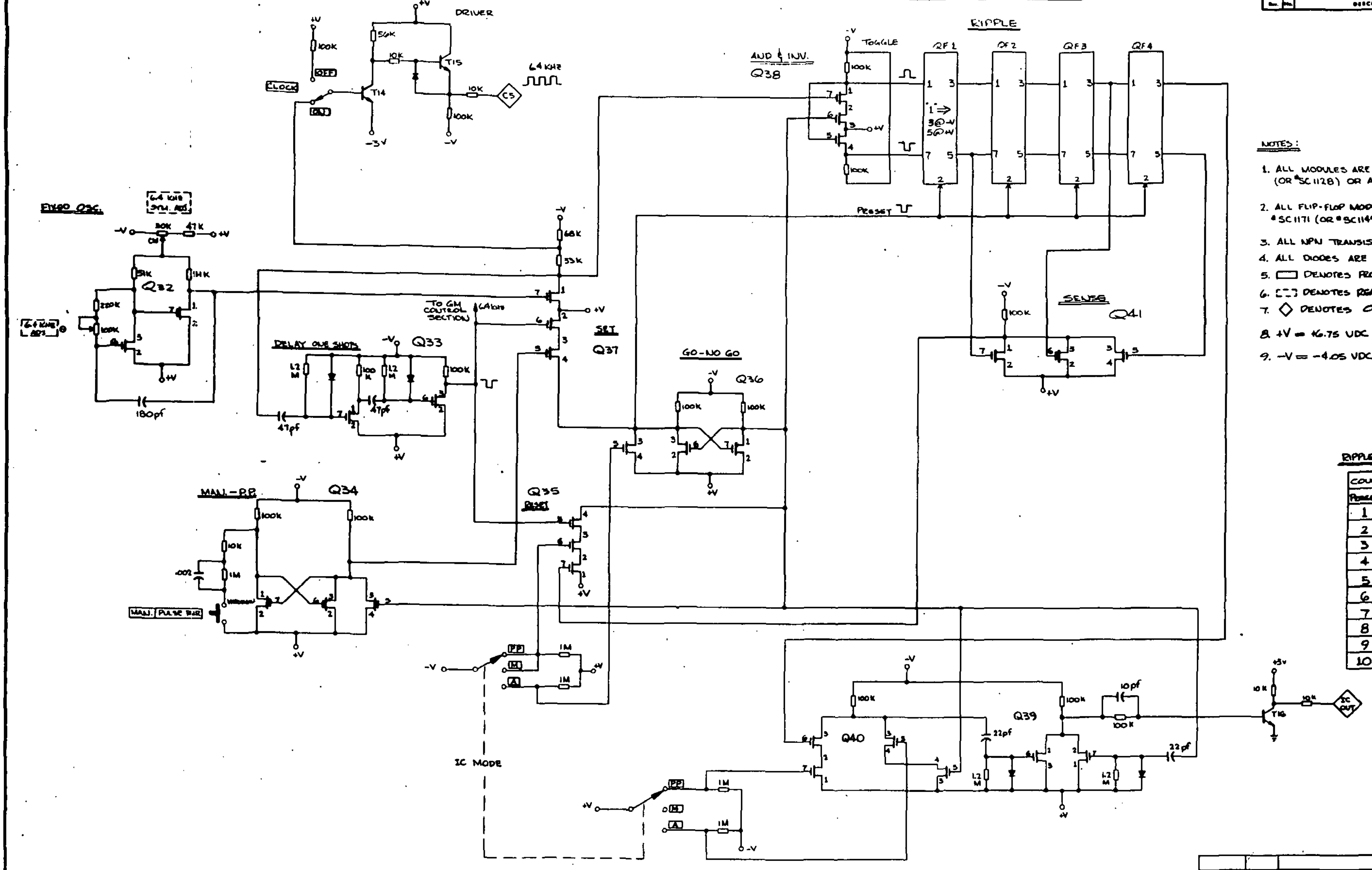
TOLERANCES UNLESS NOTED

DATE 1 AUG. 67
DR. R.P.TOY
CK'D
APP'D

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

UCAL IMP G CHECKOUT BOX
GM-CONTROL CIRCUIT SCHEMATIC

SCALE NONE
No. IMP·G – 202
PROJECT



NOTES:

1. ALL MODULES ARE GME TYPE #SC1170 (OR #SC1128) OR AMI TYPE #C2002.
2. ALL FLIP-FLOP MODULES ARE GME TYPE #SC1171 (OR #SC1149) OR AMI TYPE #C2008.
3. ALL NPN TRANSISTORS ARE 2N4124.
4. ALL DIODES ARE IN914A.
5. ▭ DENOTES FRONT PANEL LABELING.
6. [ ] DENOTES REAR PANEL LABELING.
7. ◇ DENOTES OUTPUT.
8. +V = +6.75 VDC.
9. −V = −4.05 VDC.

RIPPLE COUNTER TRUTH TABLE

COUNT	2^0	2^1	2^2	2^3
PRESET	1	1	1	1
1	0	0	0	0
2	1	0	0	0
3	0	1	0	0
4	1	1	0	0
5	0	0	1	0
6	1	0	1	0
7	0	1	1	0
8	1	1	1	0
9	0	0	0	1
10	◇1	0	◇[illegible]	◇1

SENSE

MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

TOLERANCES UNLESS NOTED

DATE 21 AUG. 67
DR. R.P. TOY
CKD RJ Paul
APPD RJ Paul

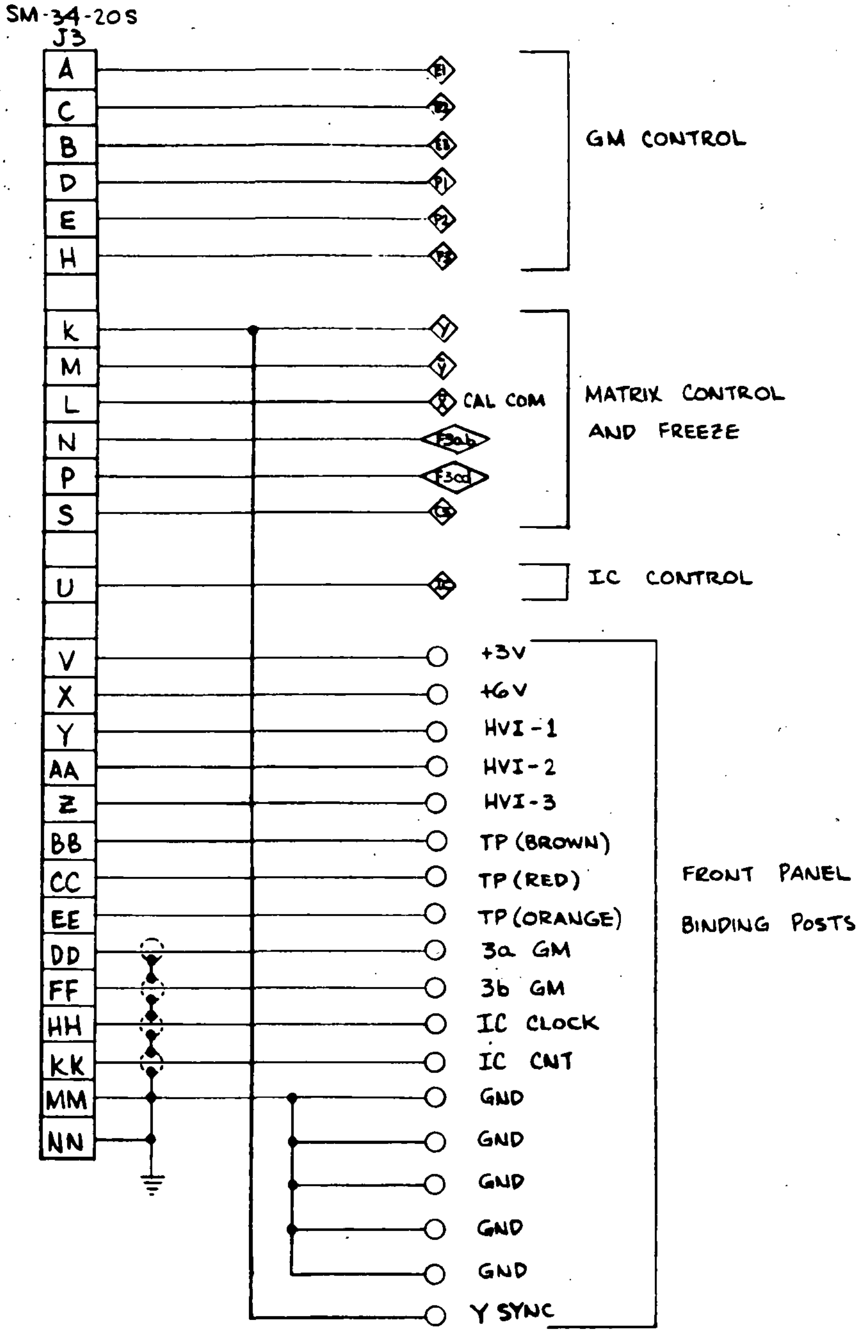
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

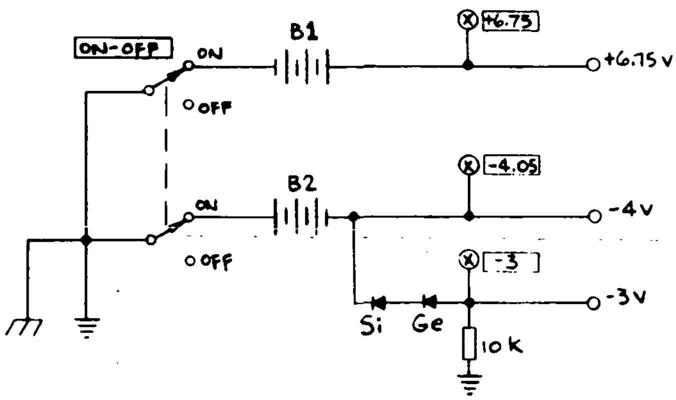
UCAL IMP G CHECKOUT BOX
IC CONTROL CIRCUIT SCHEMATIC

SCALE NONE
No. IMP G – 203
PROJECT
REV.

DWG. NO. IMP G - 204	REV.	DATE	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	DRAWN R.P. TOY SCALE NONE CHECK APP. DATE 29 MAY 1967
MATL.		REQD.		

TITLE UCAL IMP G CHECKOUT BOX
CONNECTOR WIRING & POWER SUPPLY





B1 = BURGESS H135 R OR EQUIVALENT.

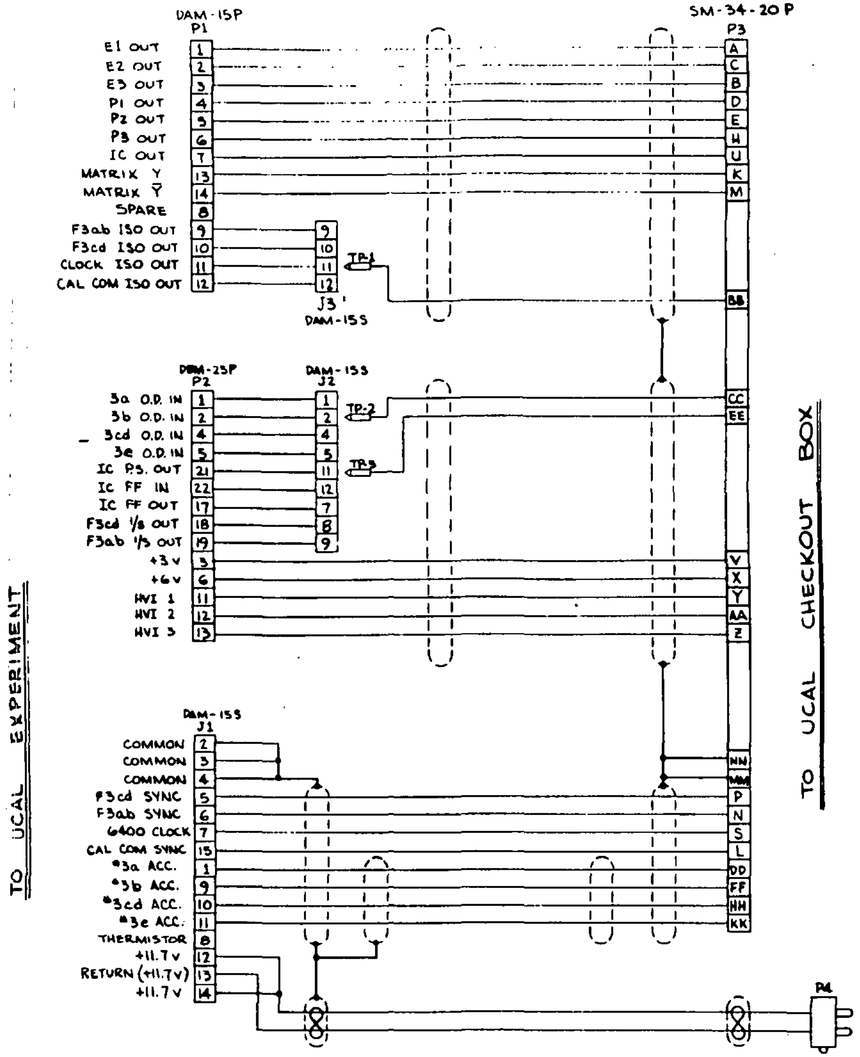
B2 = BURGESS H133R OR EQUIVALENT.

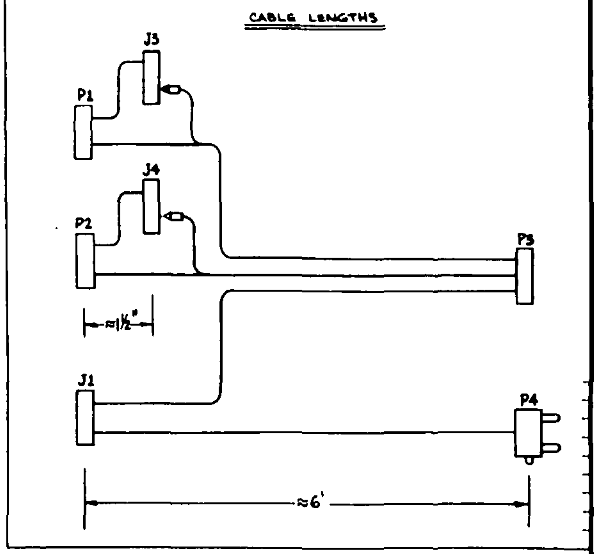
▭ DENOTES FRONT PANEL MARKING.

⊗ DENOTES FRONT PANEL TEST POINT.

DWG NO IMPG-205

REV.	NO.	DESCRIPTION	DATE	APPD
A		P2 CHANGED FROM 15P TO 25P; J2 REVISED.	JULY 26 1967	R.J.P.
B		ADDED TP CALL OUTS. CORRECTED P2 CALL OUT.	OCT. 16 1967	R.J.P.





MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

TOLERANCES UNLESS NOTED

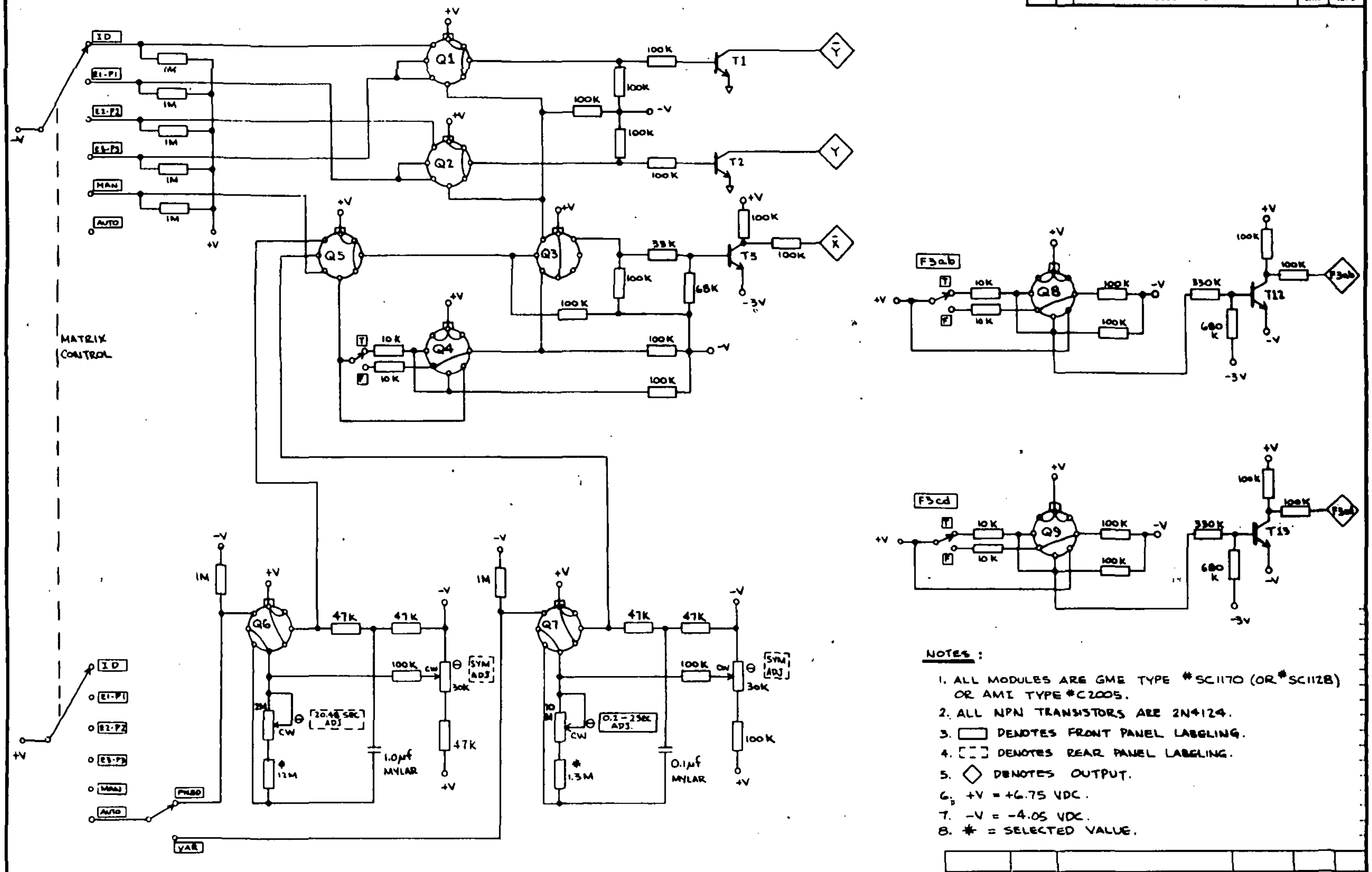
DATE 31 MAY '67
DR. R.P. TOY
CKD R J Paul
APPD R J Paul

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

UCAL IMP G CHECKOUT BOX
CABLE DIAGRAM

SCALE NONE
NO. IMP G – 205
REV. B

DWG NO IMP G-206



NOTES :

1. ALL MODULES ARE GME TYPE #SC1170 (OR #SC1128) OR AMI TYPE #C2005.
2. ALL NPN TRANSISTORS ARE 2N4124.
3. ▭ DENOTES FRONT PANEL LABELING.
4. [ ] DENOTES REAR PANEL LABELING.
5. ◇ DENOTES OUTPUT.
6. +V = +6.75 VDC.
7. -V = -4.05 VDC.
8. * = SELECTED VALUE.

MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

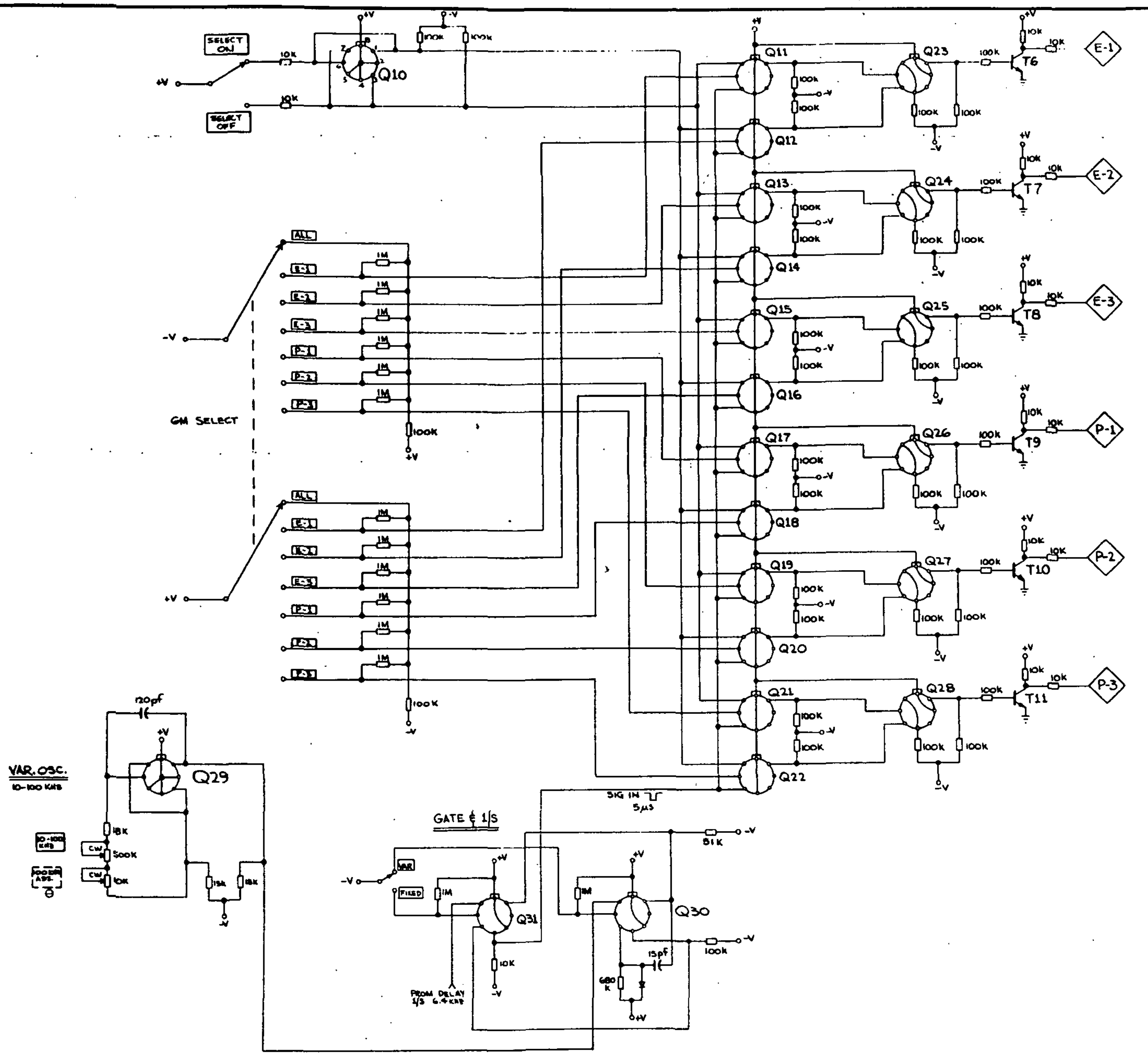
TOLERANCES UNLESS NOTED

DATE 15 JUNE 67
DR. R.P. TOY
CKD P J Paul
APPD P J Paul

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

UCAL IMP-G CHECKOUT BOX
FREEZE AND MATRIX CONTROL
WIRING DIAGRAM

SCALE NONE
NO. IMP G - 206
PROJECT



NOTES:

1. ALL GATE MODULES ARE GME TYPE #SC1170 (OR #SC1128) OR AMI TYPE #C2002.
2. ALL NPN TRANSISTORS ARE 2N4124.
3. ALL DIODES ARE IN914A.
4. ▭ DENOTES FRONT PANEL MARKING.
5. [ ] DENOTES REAR PANEL MARKING.
6. ◇ DENOTES OUTPUT.
7. +V = +6.75 VDC.
8. -V = -4.06 VDC.

MATL.	WEIGHT	DESCRIPTION	NUMBER	REQD.	SYM.

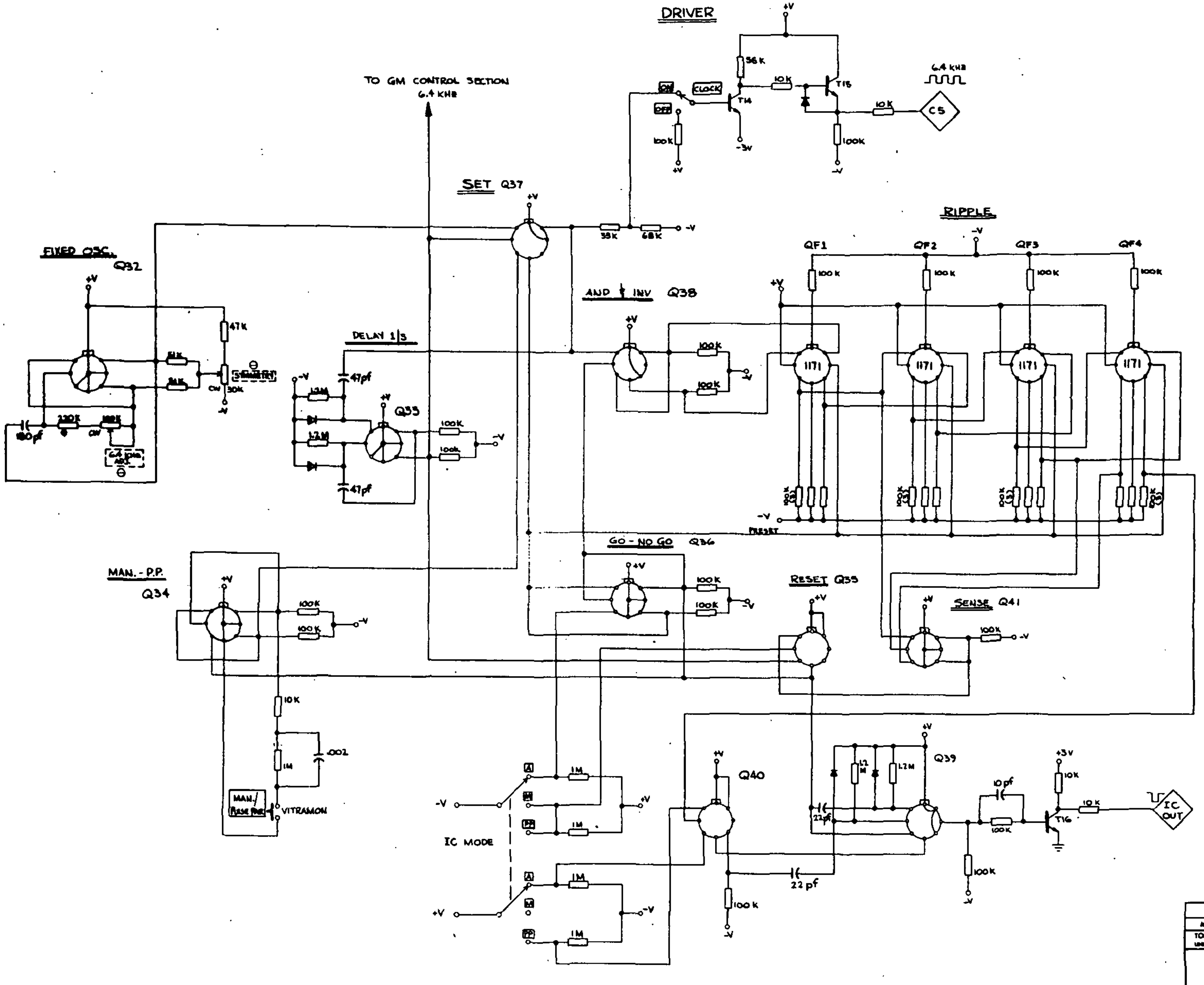
TOLERANCES UNLESS NOTED

DATE 3 AUG. 67
DR R. P. TOY
CKD
APPD

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

UCAL IMP G CHECKOUT BOX
GM-CONTROL WIRING DIAGRAM

SCALE NONE
No. IMP G - 207
N. A.
PROJECT
REV.



10. −V = −4.05 VDC.

9. +V = +6.75 VDC.

8. ◇ DENOTES OUTPUT.

7. ⬚ DENOTES REAR PANEL LABELING.

6. ▭ DENOTES FRONT PANEL LABELING.

6. ALL DIODES ARE 1N914A.

4. ALL NPN TRANSISTORS ARE 2N4124.

3. ALL MODULES ARE SHOWN AS BOTTOM VIEW.

2. ALL FLIP-FLOP MODULES ARE GME TYPE #SC1171 (OR #SC1149) OR AMI TYPE #C2005.

1. ALL GATE MODULES ARE GME TYPE #SC1170 (OR #SC1128) OR AMI TYPE #C2002.

NOTES:

MATL.	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	STK.

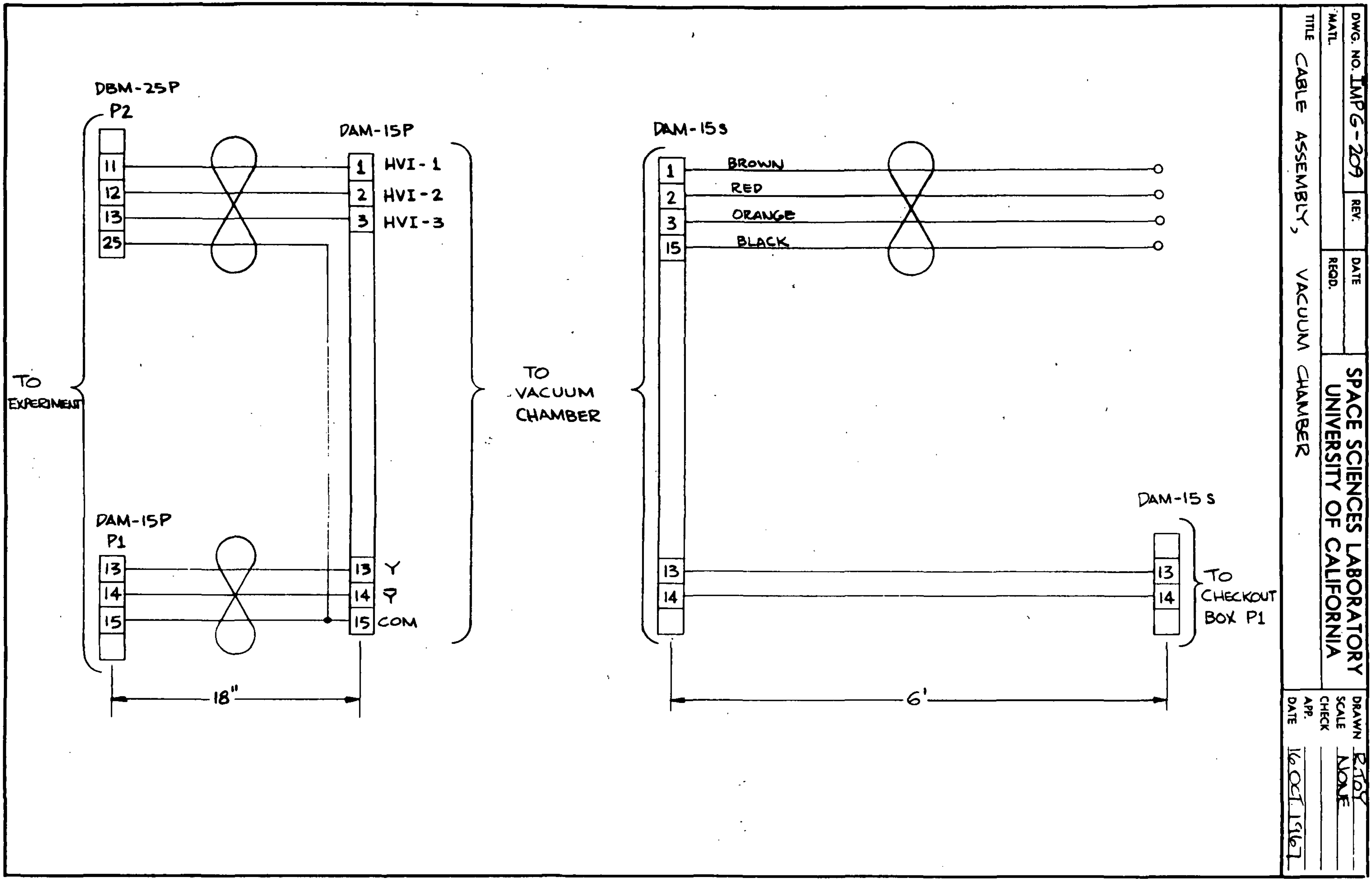
TOLERANCES UNLESS NOTED

DATE 25 MAY 67
DR. R.P. TOY
CK'D P.J. Park
APP'D P.J. Park

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

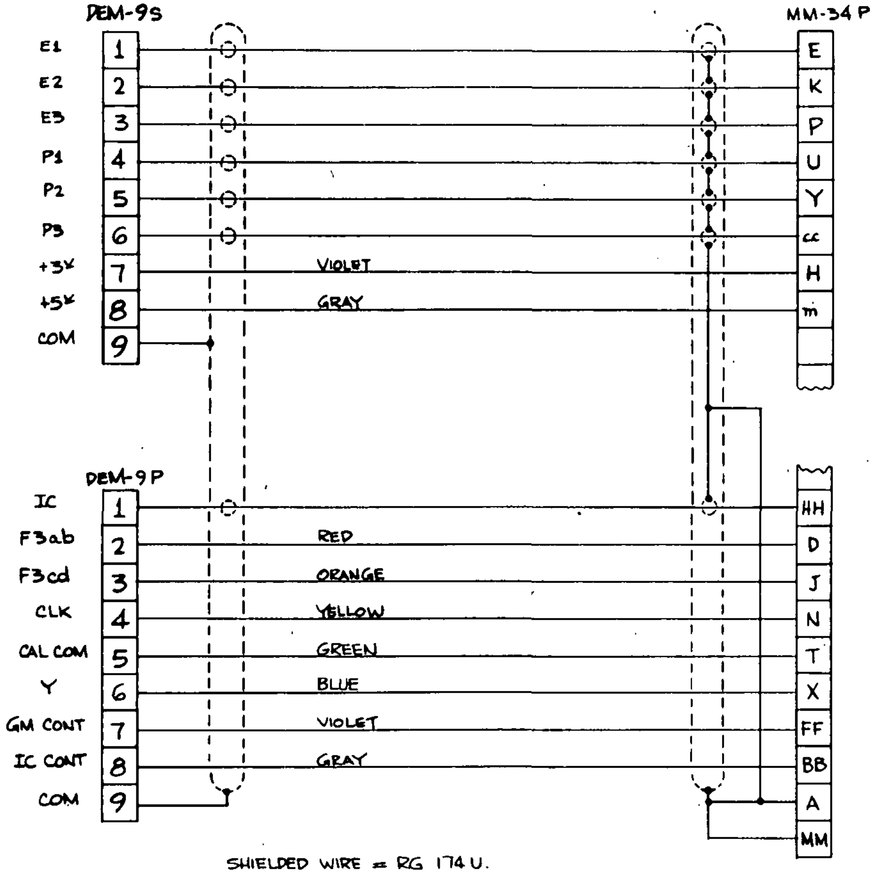
UCAL IMP G CHECKOUT BOX
IC CONTROL WIRING DIAGRAM.

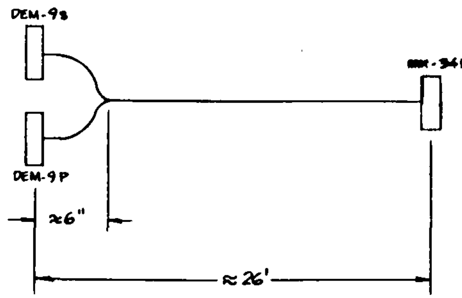
SCALE NONE
No. IMP G - 20B
PROJECT
REV.


DBM-25P
P2
11
12
13
25
DAM-15P
1 HVI-1
2 HVI-2
3 HVI-3
13 Y
14 ♀
15 COM
DAM-15P
P1
13
14
15
TO EXPERIMENT
TO VACUUM CHAMBER
18"
DAM-15S
1 BROWN
2 RED
3 ORANGE
15 BLACK
13
14
DAM-15 S
13
14
TO CHECKOUT BOX P1
6'
DWG. NO. IMPG-209
REV.
MATL.
TITLE CABLE ASSEMBLY, VACUUM CHAMBER
DATE
REQD.
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
DRAWN
SCALE NONE
CHECK
APP.
DATE 16 OCT 1967

DWG NO IMP G - 210

REV.	NO.	DESCRIPTION	DATE	APP'D





SHIELDED WIRE = RG 174 U.
OUTSIDE SHIELD = BRAID (ALPHA, BELDEN).
ALL OTHERS = #24 RAYCHEM.

1. RUN OUTSIDE SHIELD ALL THE WAY TO CONNECTORS.

NOTE:

MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

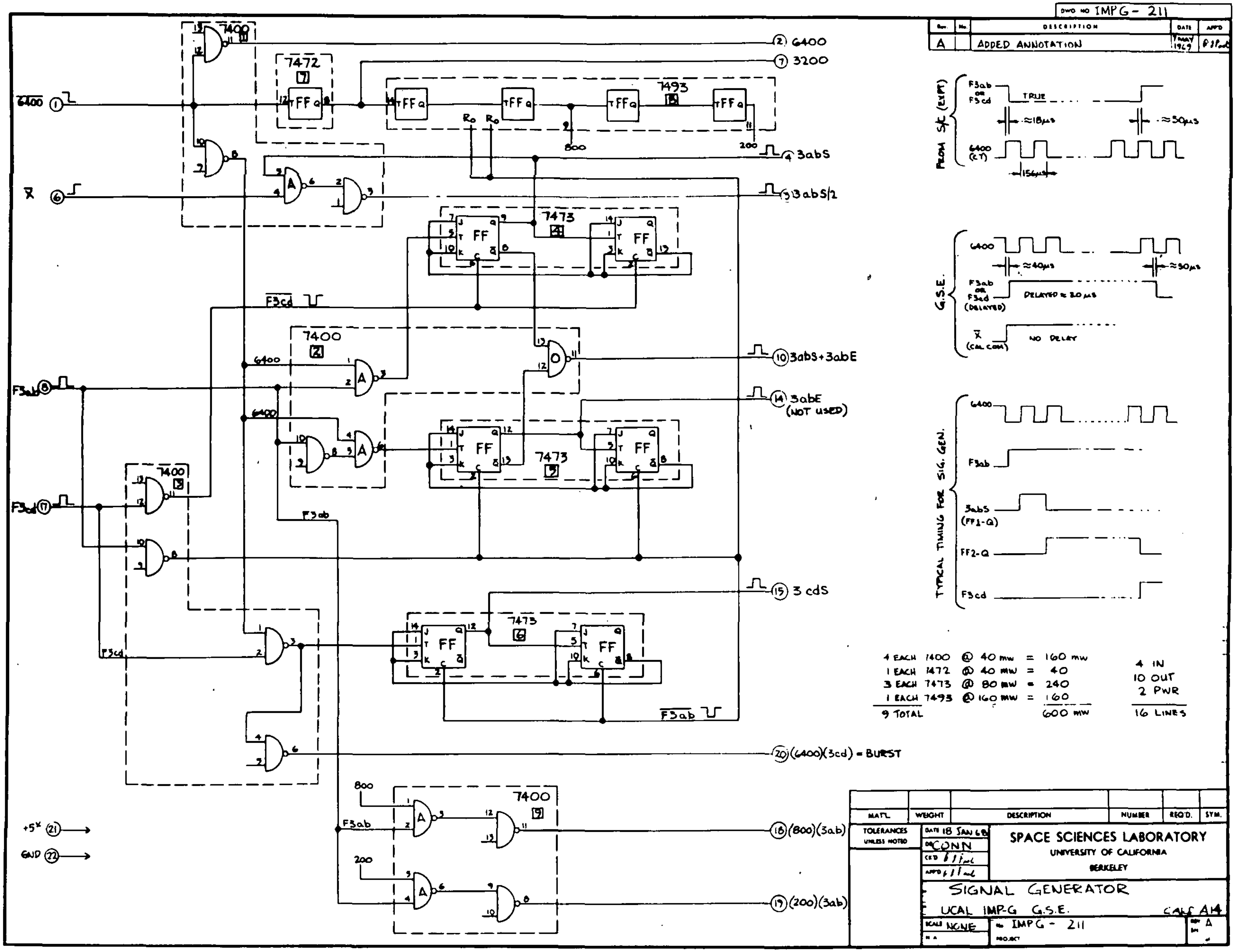
TOLERANCES UNLESS NOTED

DATE 8 DEC 67
DR. R.P. TOY
CK'D P. J. Paul
APP'D P. J. Paul

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

G.S.E. CABLE

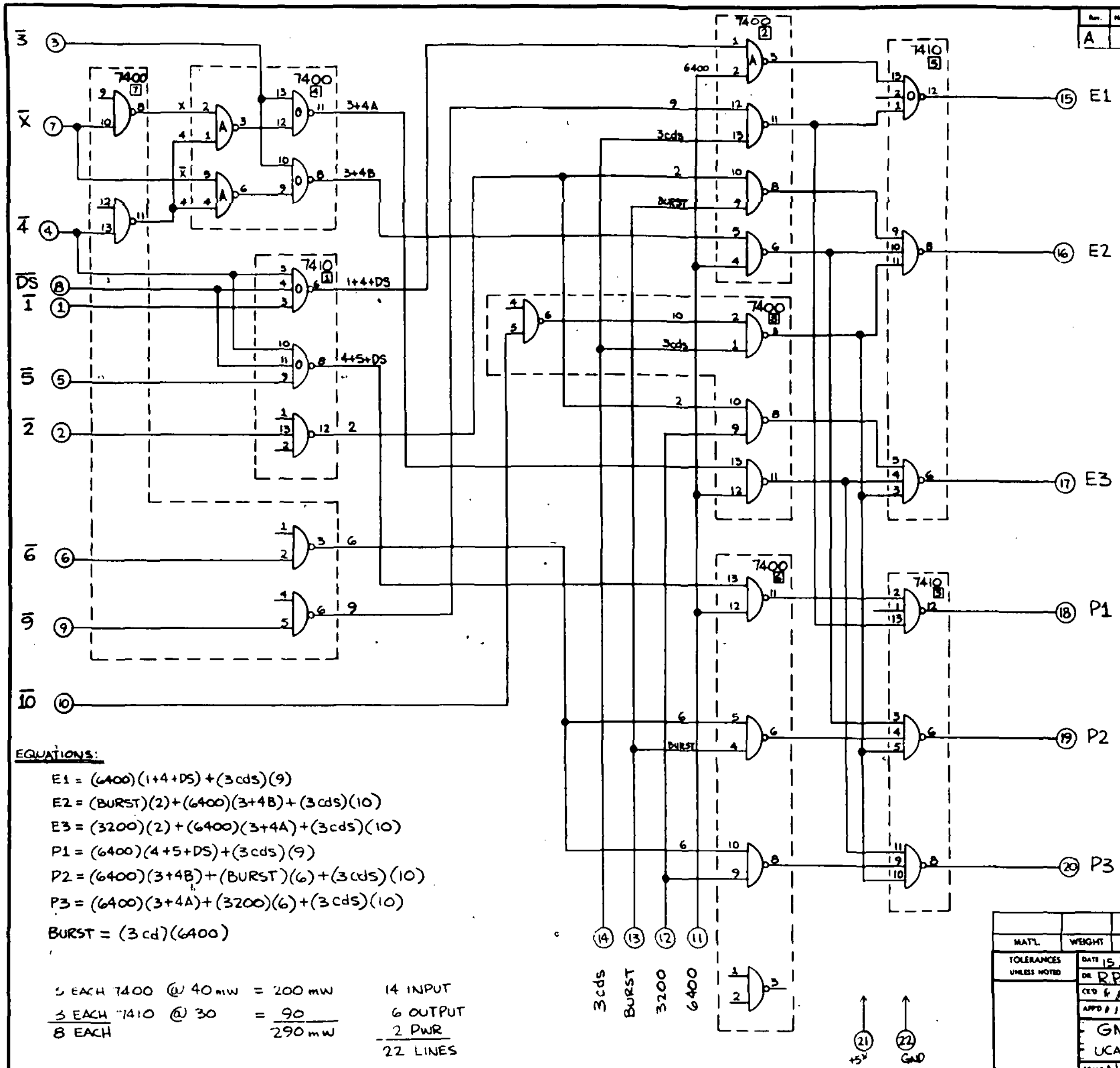
SCALE NONE
No. IMP G - 210
PROJECT
REV.
SH.



DWG NO IMPG-211
A ADDED ANNOTATION
6400 ①
X̄ ⑥
F3ab ⑧
F3cd ⑰
7400
7472
7493
7473
FF
800
200
② 6400
⑦ 3200
④ 3abS
⑤ 3abS/2
⑩ 3abS+3abE
⑭ 3abE (NOT USED)
⑮ 3 cdS
⑳ (6400)(3cd) = BURST
⑱ (800)(3ab)
⑲ (200)(3ab)
+5V ㉑
GND ㉒
FROM S/C (EXPT)
TRUE
≈18μs
≈50μs
156μs
G.S.E.
DELAYED ≈ 30μs
NO DELAY
TYPICAL TIMING FOR SIG. GEN.
4 EACH 7400 @ 40 mw = 160 mw
1 EACH 7472 @ 40 mw = 40
3 EACH 7473 @ 80 mw = 240
1 EACH 7493 @ 160 mw = 160
9 TOTAL 600 mw
4 IN
10 OUT
2 PWR
16 LINES
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY
SIGNAL GENERATOR
UCAL IMP-G G.S.E.
DATE 18 JAN 68
CONN
SCALE NONE
IMPG - 211

DWG NO IMPG-212

REV.	NO.	DESCRIPTION	DATE	APPD
A		ADDED ANNOTATION.	7 MAY 1969	P.I. Paul



EQUATIONS:

E1 = (6400)(1+4+DS)+(3cds)(9)

E2 = (BURST)(2)+(6400)(3+4B)+(3cds)(10)

E3 = (3200)(2)+(6400)(3+4A)+(3cds)(10)

P1 = (6400)(4+5+DS)+(3cds)(9)

P2 = (6400)(3+4B)+(BURST)(6)+(3cds)(10)

P3 = (6400)(3+4A)+(3200)(6)+(3cds)(10)

BURST = (3cd)(6400)

5 EACH 7400 @ 40 mw = 200 mW
3 EACH 7410 @ 30 = 90
8 EACH 290 mW

14 INPUT
6 OUTPUT
2 PWR
22 LINES

MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

TOLERANCES UNLESS NOTED

DATE 15 JAN. 68
DR R.P. TOY

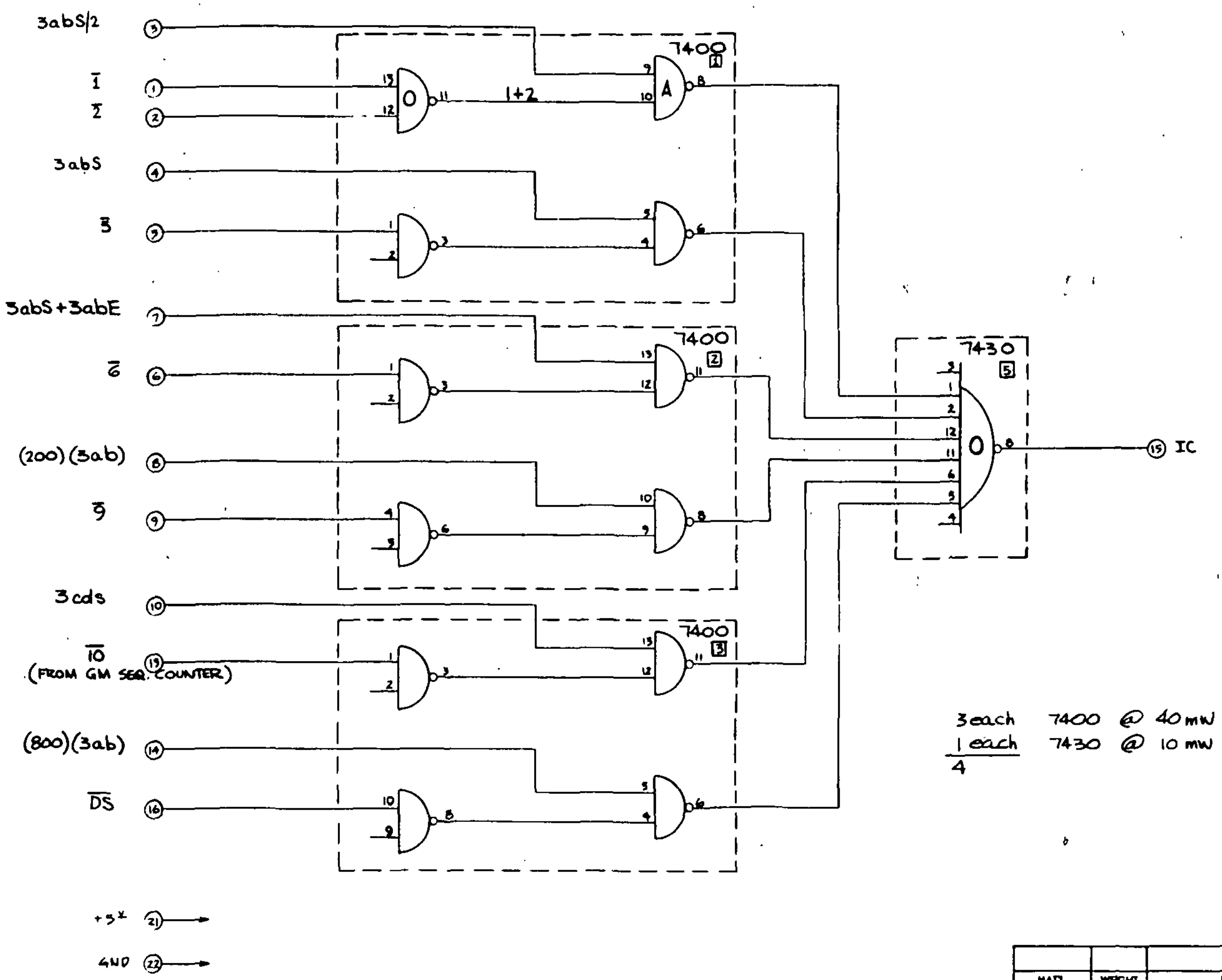
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

GM OUTPUT COMMUTATOR.
UCAL IMP-G G.S.E. CARD A13

SCALE NONE
NO. IMP G-212
REV. A

DWG NO. IMPG – 213

REV.	NO.	DESCRIPTION	DATE	APPD
A		ADDED ANNOTATION.	7 MAY 1969	P.J. Paul



3 each 7400 @ 40 mW = 120 mW
1 each 7430 @ 10 mW = 10
4 — 130 mW

13 IN
1 OUT
2 PWR
16 LINES

EQUATION:

IC = (3abS/2) (1+2) + (3abS)(5) + [(3abS)+(3abE)] (6)+(200)(3ab)(9)+(3cdS) (10)+(800)(3ab)(DS)

MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

TOLERANCES UNLESS NOTED

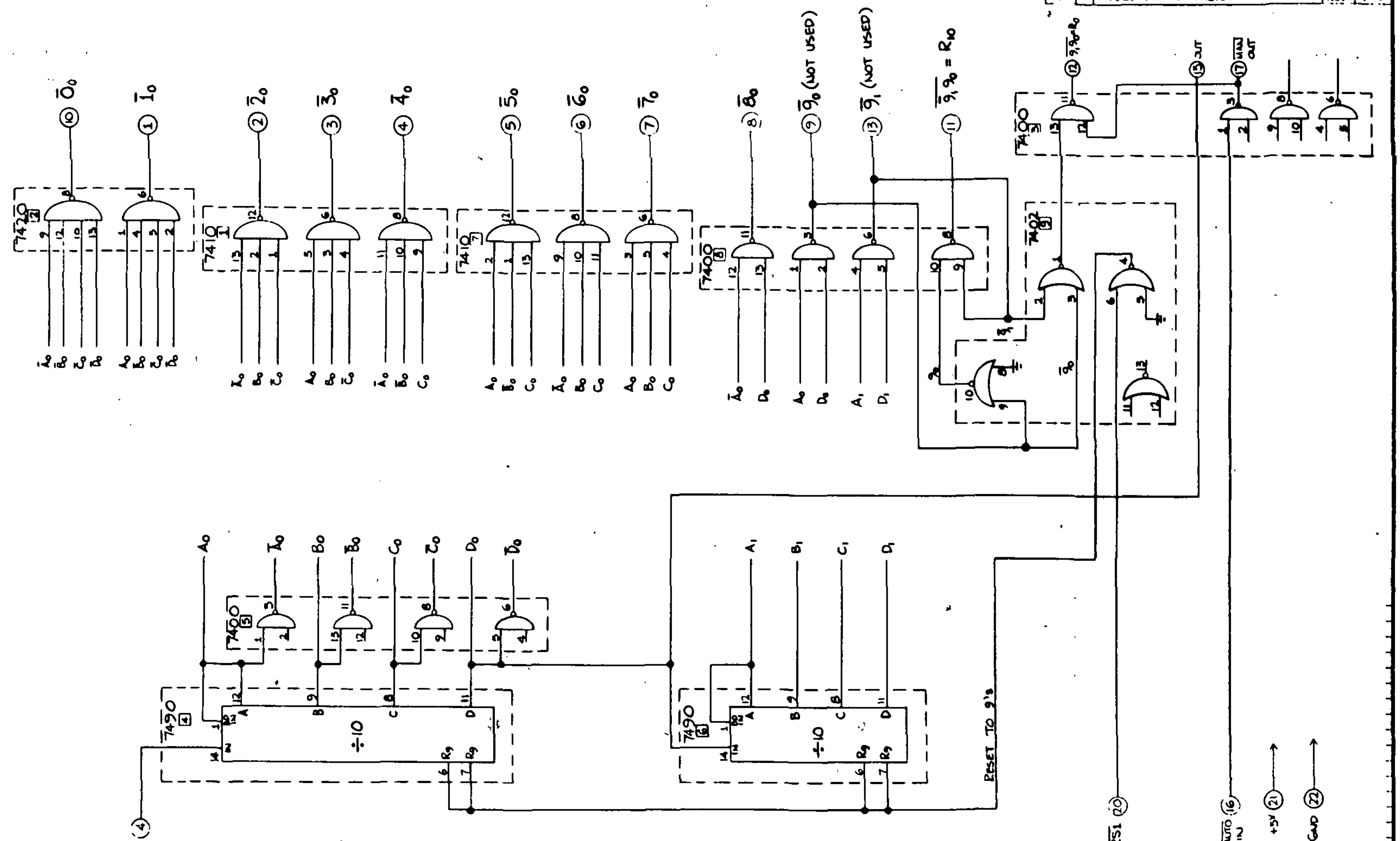
DATE 16 JAN 68
DR. CONN
CKD R. J. Paul
APPD P. J. Paul

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

IC COMMUTATOR
UCAL IMP-G G.S.E. CARD A15

SCALE NONE
NO. IMP G – 213
REV. A
PROJECT

REV.	NO.	DESCRIPTION	DATE	APPD
A		ADDED ANNOTATION		



5 EACH 7400 @ 40 mw = 120 mw
1 EACH 7402 @ 48 = 48
2 EACH 7410 @ 30 = 60
1 EACH 7420 @ 20 = 20
2 EACH 7490 @ 160 = 320
9 — 568 mw

3 IN
15 OUT
2 PWR
20 LINES

MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

TOLERANCES UNLESS NOTED

DATE 18 JAN 68
DR. R. TOY
CKD R J Pauls
APPD R J Pauls

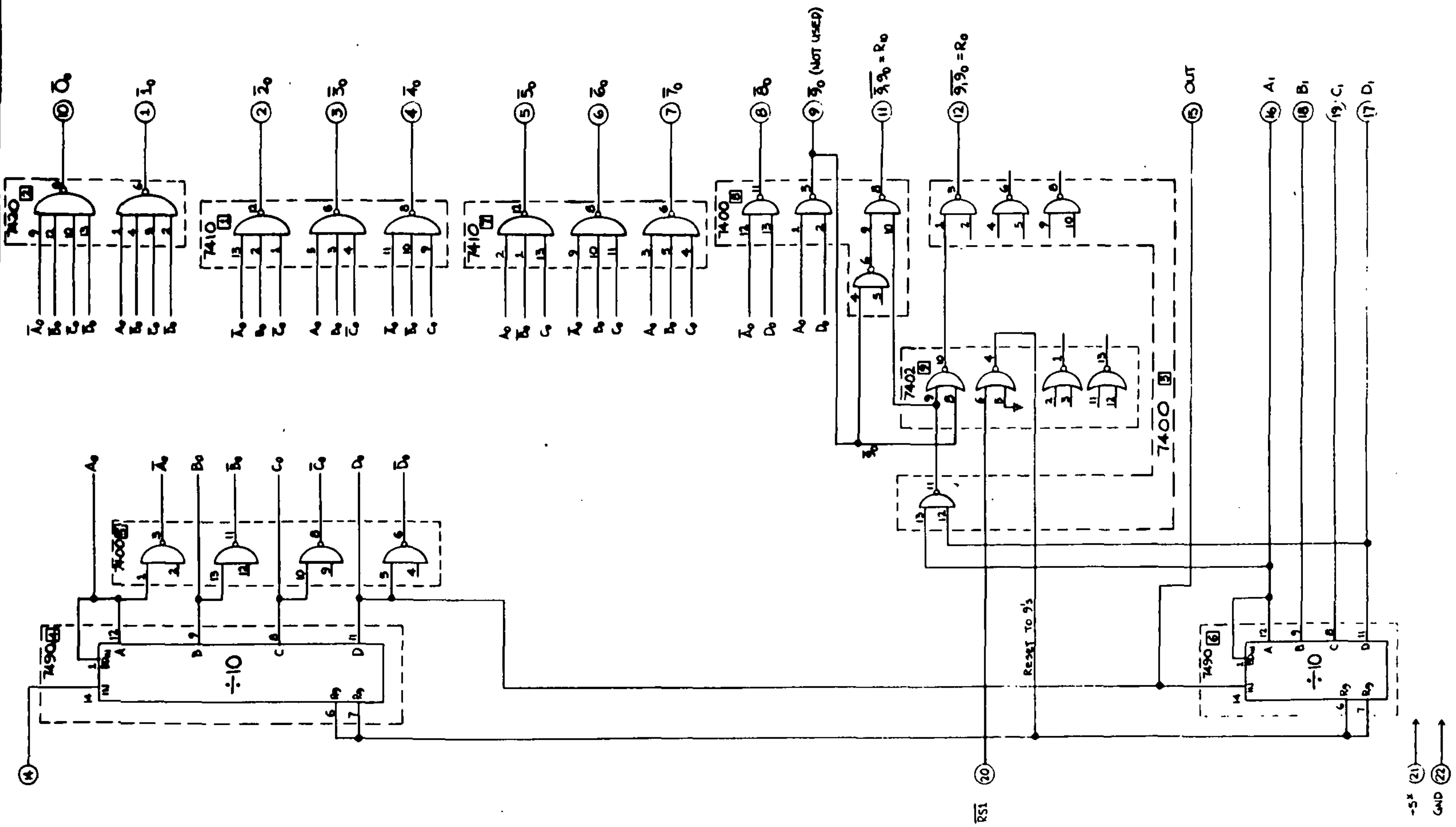
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

IC SEQ COUNTER AND DECODER
UCAL IMP-G G.S.E. CARD A16

SCALE NONE
NO. IMP G - 214
REV. A

DWG. NO. IMP G - 214

DWG NO IMPG-215



3 EACH	7400	x 40 mw	= 120 mw		3 IN
1 EA.	7402	x 48	48		17 OUT
2 EA.	7410	x 30	60		2 PWR
1 EA.	7420	x 20	20		
2 EA.	7490	x 160	320		
9 TOTAL			568 mw		22 LINES TOTAL

MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

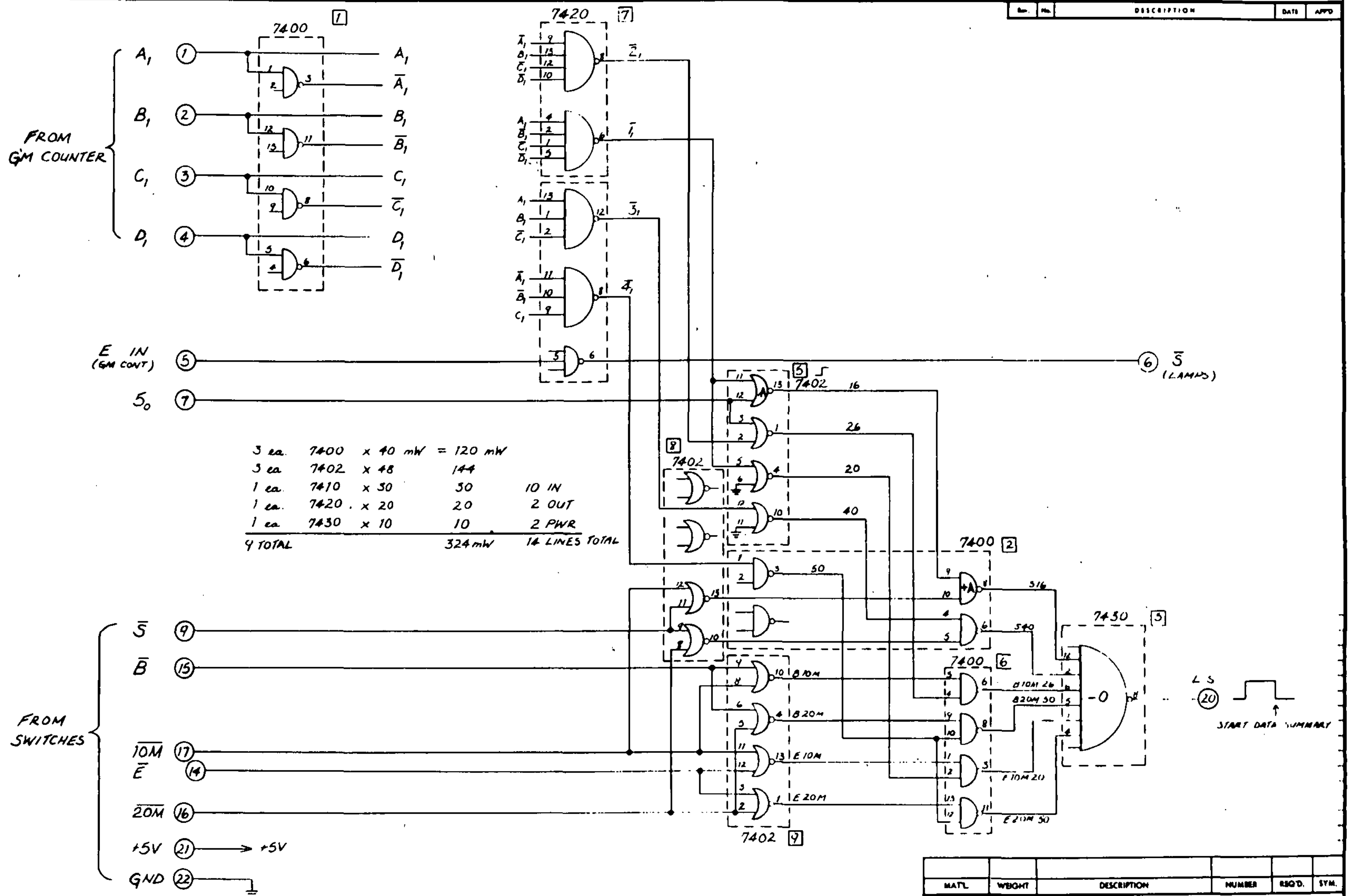
TOLERANCES UNLESS NOTED
DATE 7 MAY 69
DR. R.P.T.

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

CARD A12

IMP-G G.S.E.
GM SEQUENCE COUNTER AND DECODER

SCALE NONE
NO. IMP G-215



MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

TOLERANCES UNLESS NOTED

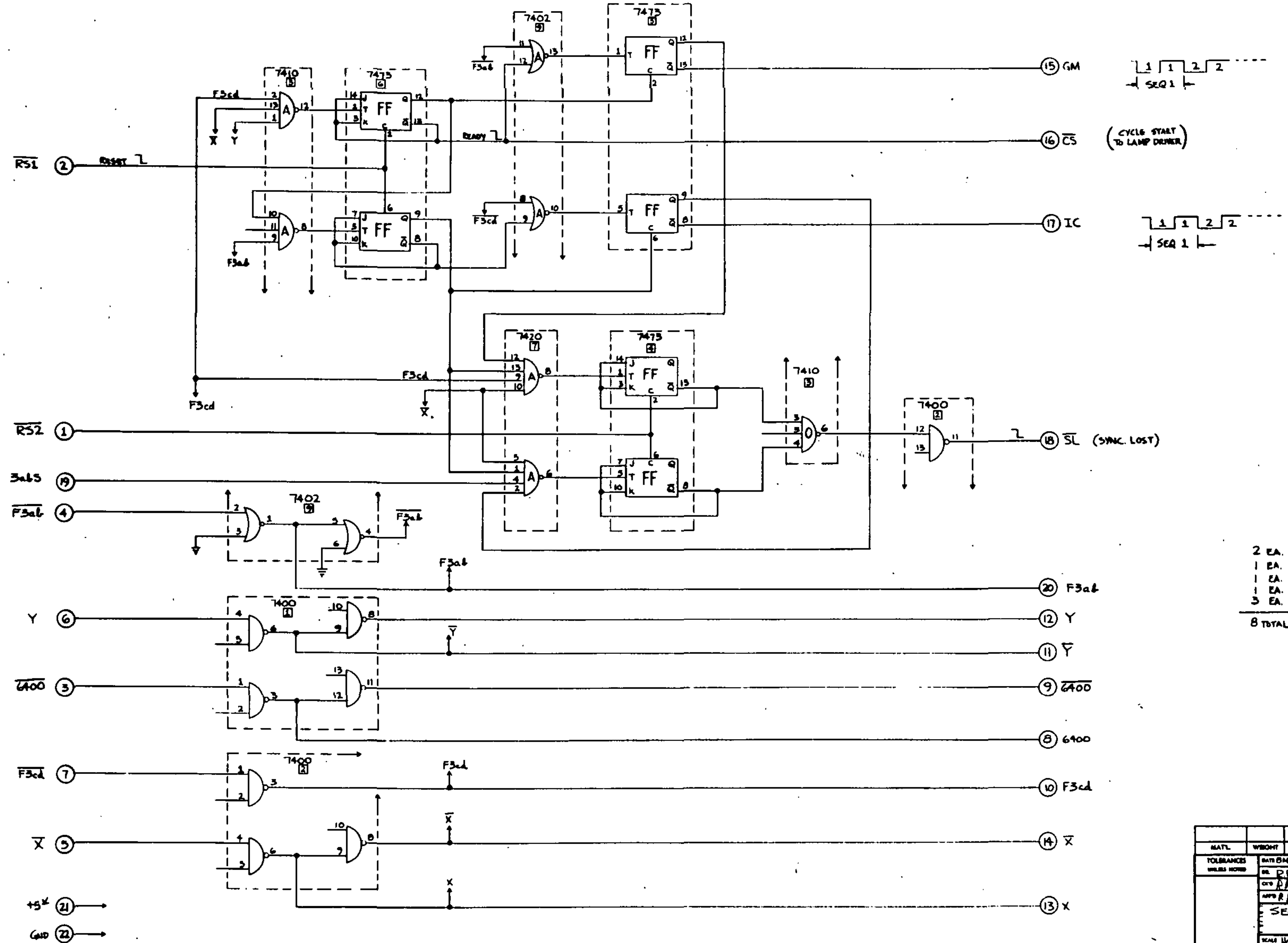
DATE 10/26/72
DR YM
CK'D
APP'D

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

GM COUNTER DECODER AND LAST SEQ SENSE IMP

SCALE
NO.
PROJECT
REV.

IMPG-217

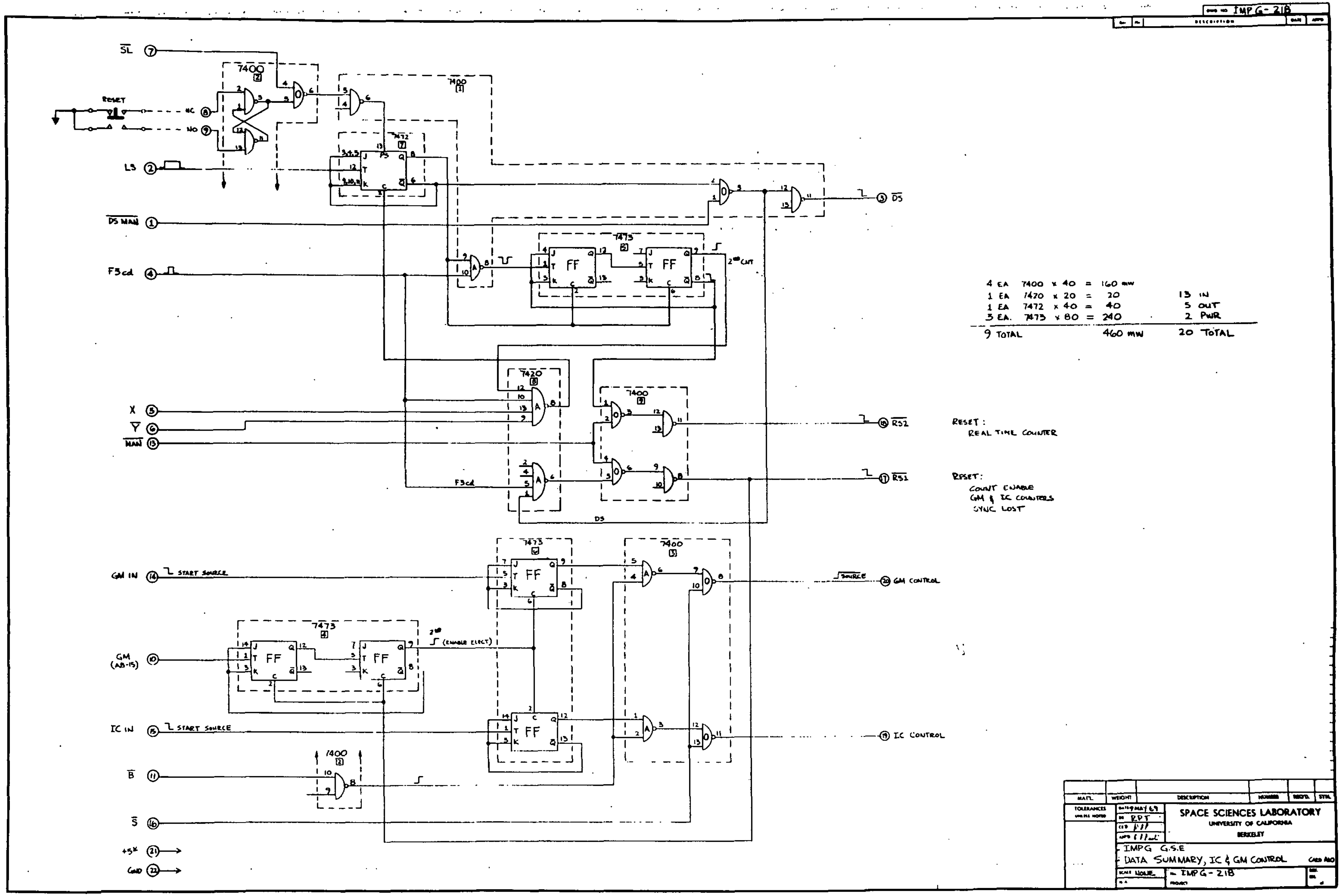


2 EA.	7400	x 40 mw	= 80 mw	
1 EA.	7402	48	96	
1 EA.	7410	30	30	7 IN
1 EA.	7420	20	20	13 OUT
3 EA.	7473	80	240	2 PWR
8 TOTAL			466 mw	22 TOTAL LINES

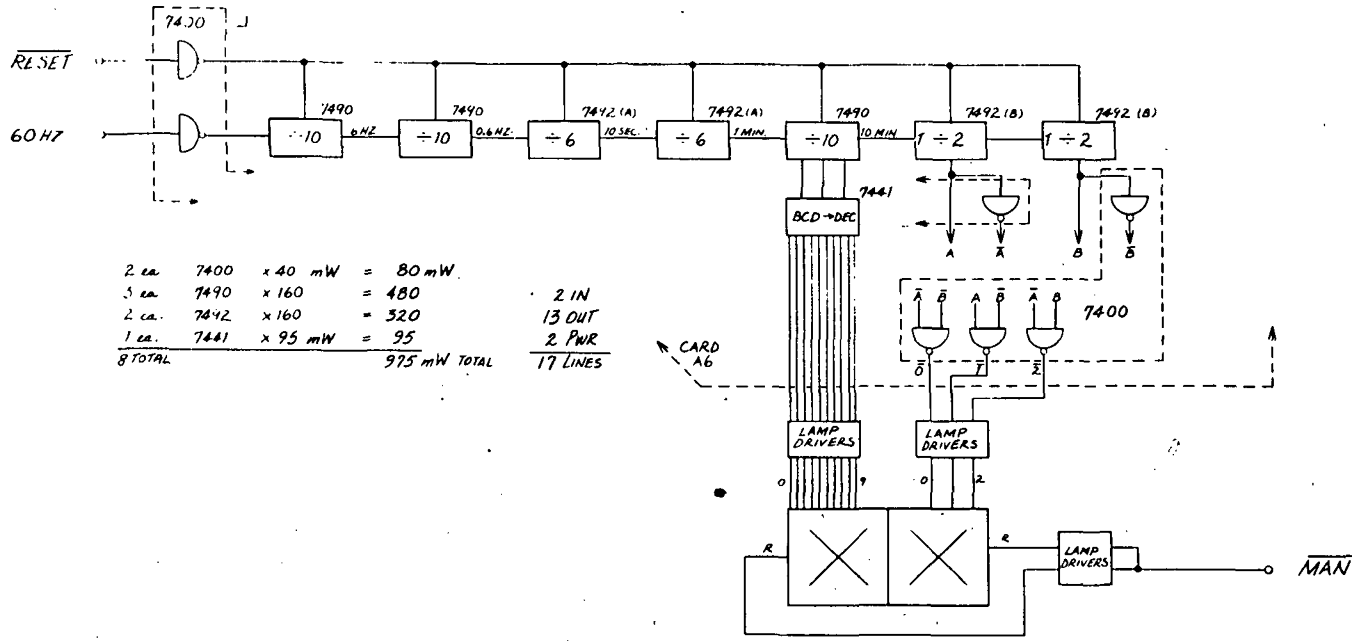
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

SEQ COUNT CONTROL & SYNC LOST
CARD A8

DATE 8 MAY 69
SCALE NONE
NO. IMPG-217



IMPG-21B
SL
RESET
NC
NO
LS
DS MAN
F5cd
X
Y
MAN
GM IN
START SOURCE
GM (AB-15)
IC IN
START SOURCE
B
S
+5V
GND
7400
7472
7473
7420
FF
2nd CNT
2nd (ENABLE ELECT)
DS
RS2
RS1
GM CONTROL
IC CONTROL
SOURCE
RESET: REAL TIME COUNTER
RESET: COUNT ENABLE GM & IC COUNTERS SYNC LOST
4 EA 7400 x 40 = 160 mw
1 EA 7420 x 20 = 20
1 EA 7472 x 40 = 40
3 EA. 7473 x 80 = 240
9 TOTAL 460 mw
13 IN
5 OUT
2 PWR
20 TOTAL
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY
IMPG G.S.E
DATA SUMMARY, IC & GM CONTROL
IMPG-21B



2 ea.	7400	x 40 mW	=	80 mW
3 ea.	7490	x 160	=	480
2 ea.	7492	x 160	=	320
1 ea.	7441	x 95 mW	=	95
8 TOTAL				975 mW TOTAL

2 IN
13 OUT
2 PWR
17 LINES

MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

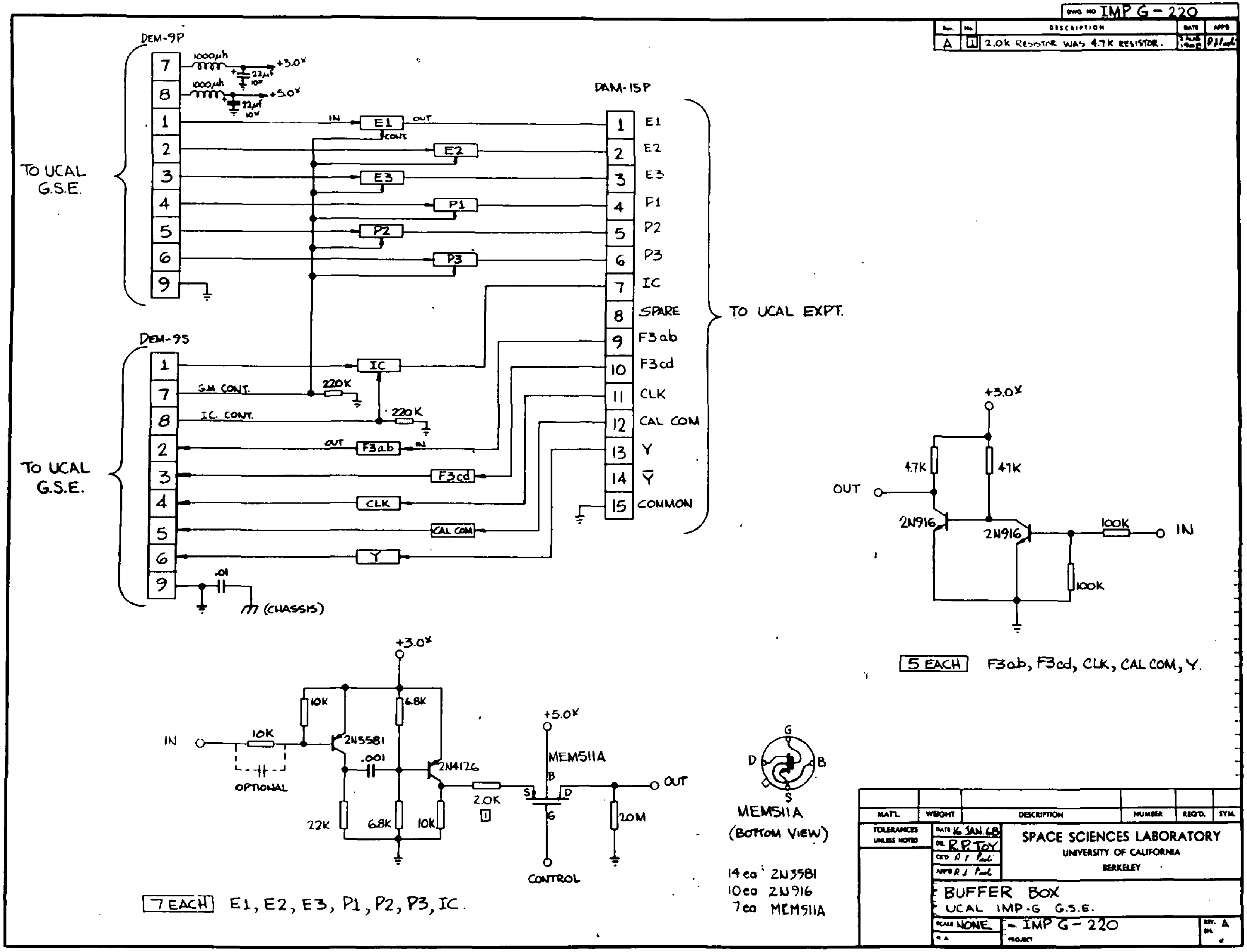
TOLERANCES UNLESS NOTED

DATE 10/26/72
DR. Y.M.
CK'D R J Pod
APP'D R J Pod

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

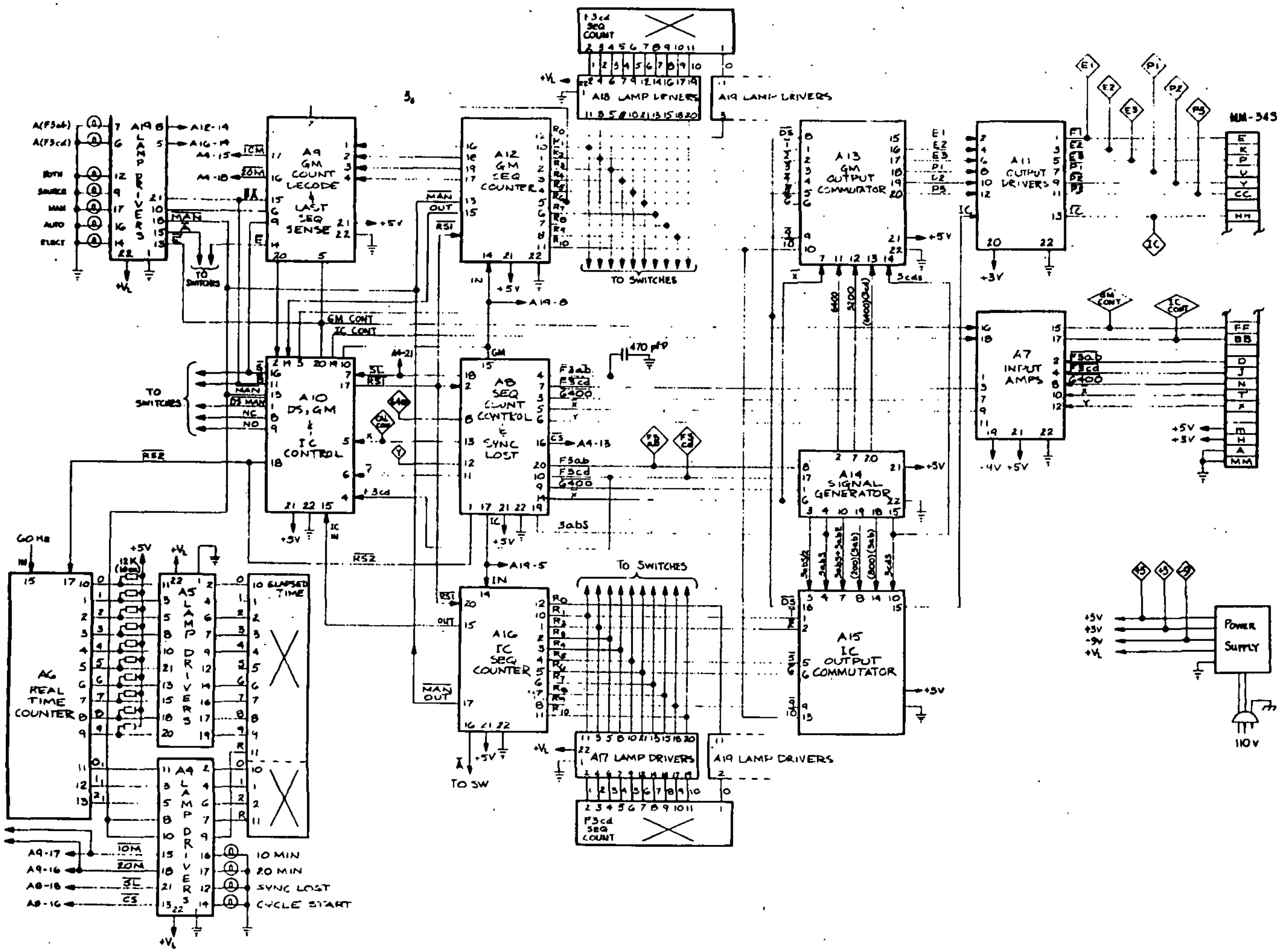
REAL TIME COUNTER
IMP-G G.S.E. CARD A6

SCALE N.A.
No. IMP G-219
PROJECT



DWG NO IMP G-220
REV. A
DESCRIPTION: 2.0K RESISTOR WAS 4.7K RESISTOR.
DEM-9P
1000µh
+3.0V
+5.0V
22µf 10V
TO UCAL G.S.E.
DAM-15P
E1
E2
E3
P1
P2
P3
IC
SPARE
F3ab
F3cd
CLK
CAL COM
Y
COMMON
TO UCAL EXPT.
IN
OUT
CONT
DEM-9S
G.M. CONT.
I.C. CONT.
220K
.01
(CHASSIS)
+3.0V
4.7K
47K
OUT
2N916
100K
IN
5 EACH F3ab, F3cd, CLK, CAL COM, Y.
10K
6.8K
2N3581
.001
2N4126
OPTIONAL
22K
2.0K
+5.0V
MEM511A
B
S
D
G
20M
CONTROL
MEM511A (BOTTOM VIEW)
14 ea 2N3581
10 ea 2N916
7 ea MEM511A
7 EACH E1, E2, E3, P1, P2, P3, IC.
MAT'L
WEIGHT
DESCRIPTION
NUMBER
REQ'D.
SYM.
TOLERANCES UNLESS NOTED
DATE 16 JAN 68
DR R.P. TOY
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY
BUFFER BOX
UCAL IMP-G G.S.E.
SCALE NONE
NO. IMP G-220
REV. A

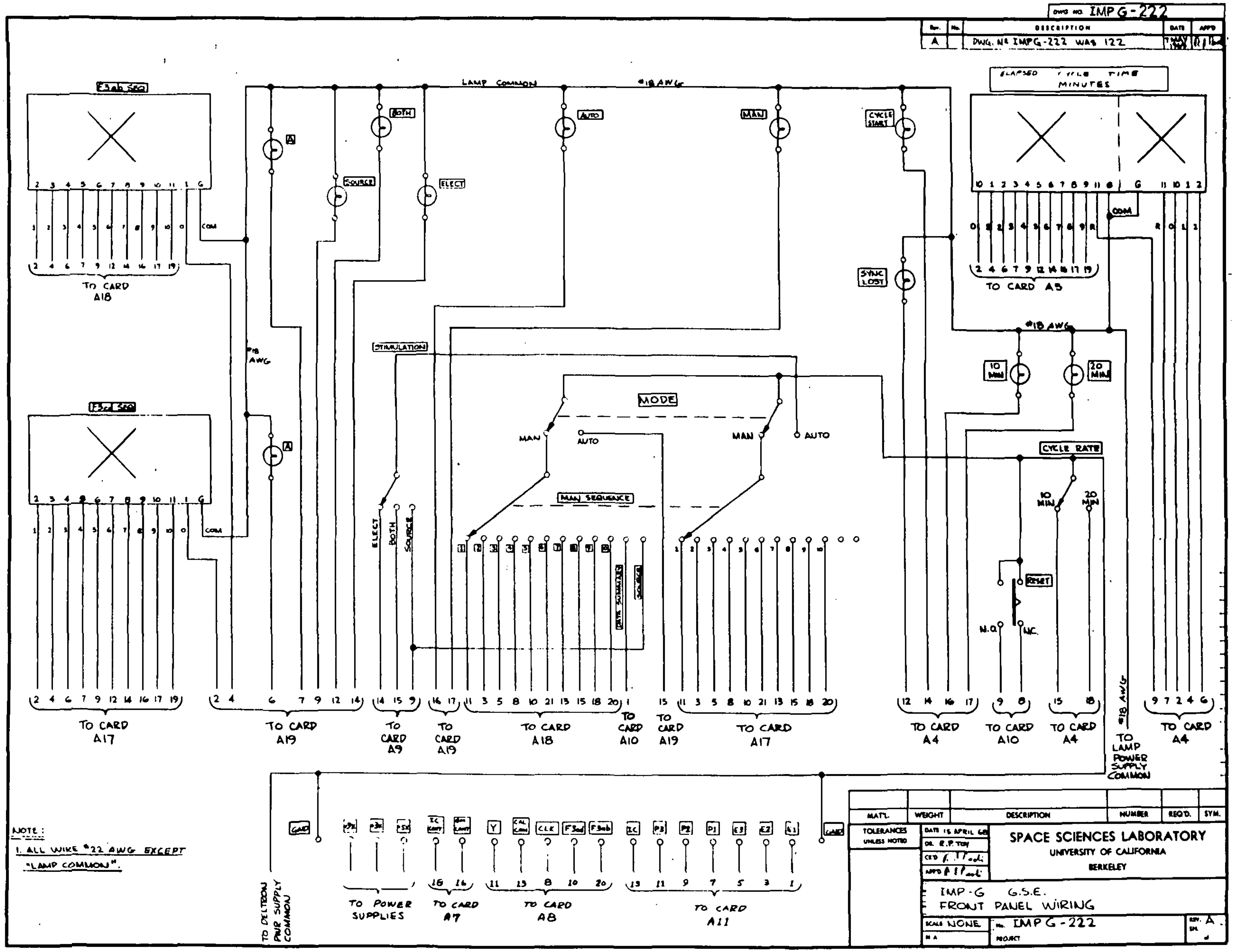
IMPG-221



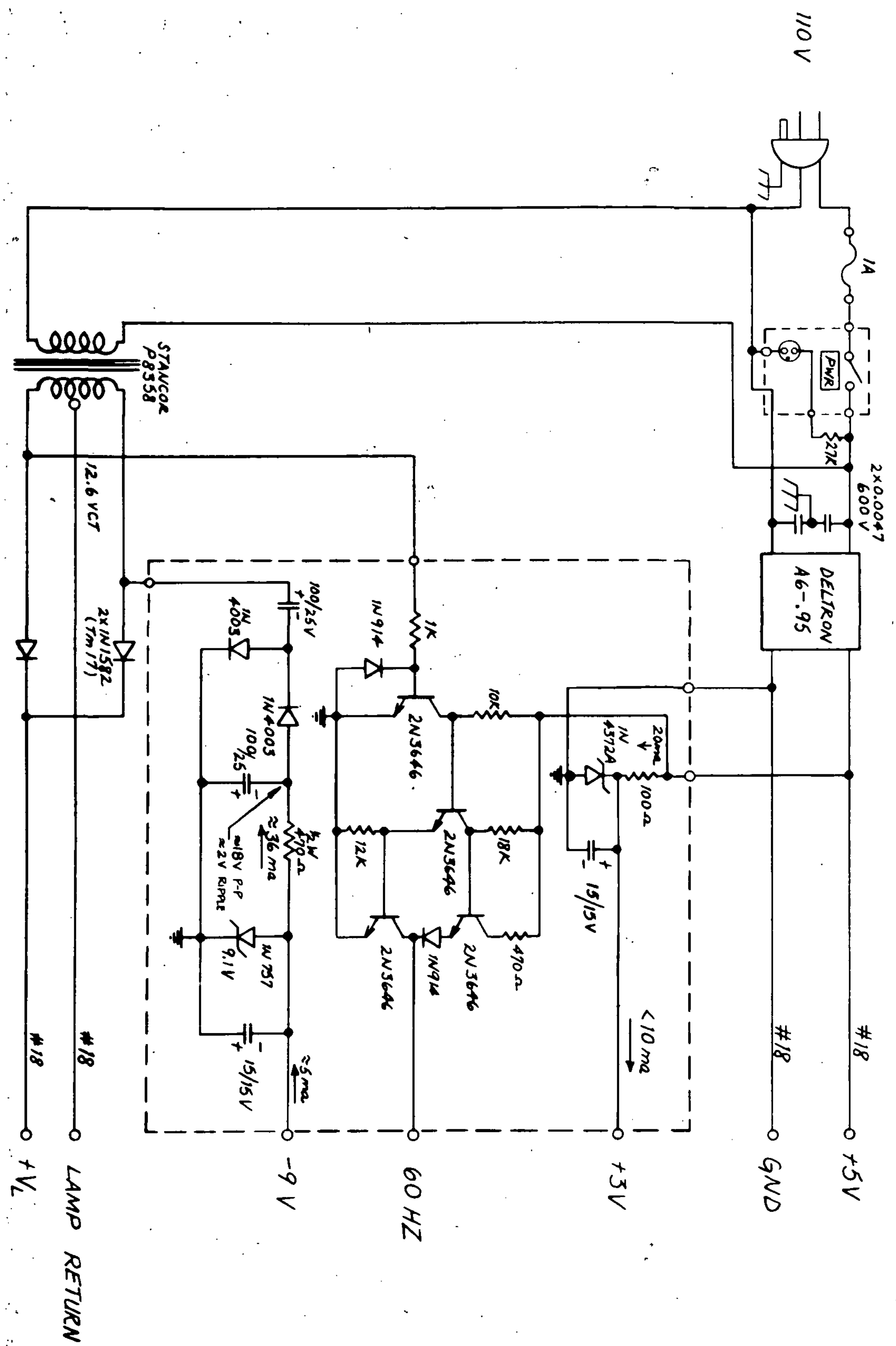
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

WIRING DIAGRAM, IMP-G G.S.E.

IMPG-221

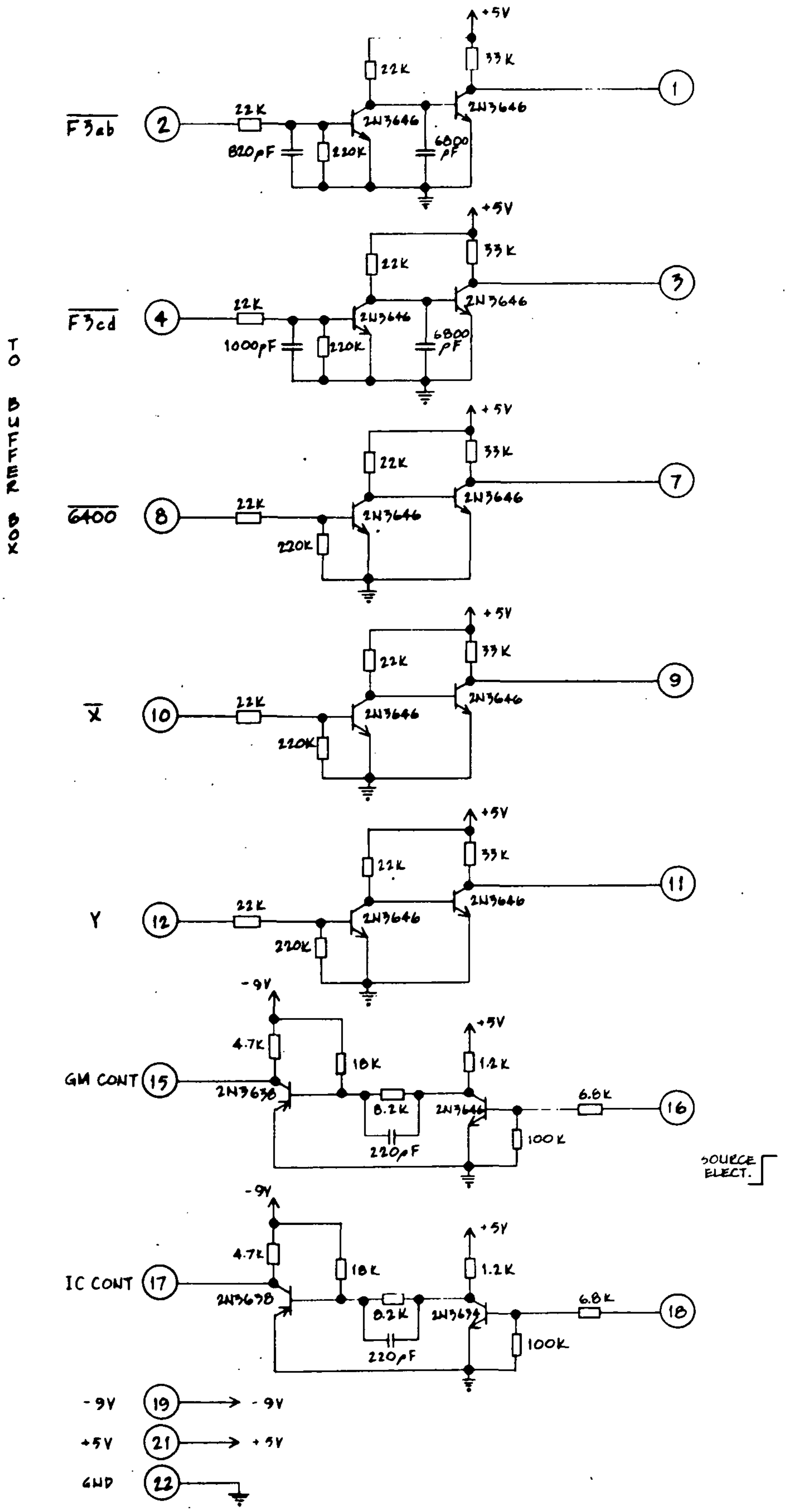

DWG NO. IMP G-222
REV. A DWG. Nº IMPG-222 WAS 122
LAMP COMMON
#18 AWG
F3ab SEG
F3cd SEG
ELAPSED CYCLE TIME MINUTES
BOTH
AUTO
MAN
CYCLE START
SOURCE
ELECT
SYNC LOST
STIMULATION
10 MIN
20 MIN
MODE
MAN
AUTO
MAN SEQUENCE
CYCLE RATE
RESET
N.O.
N.C.
COM
TO CARD A18
TO CARD A5
TO CARD A17
TO CARD A19
TO CARD A9
TO CARD A10
TO CARD A4
TO LAMP POWER SUPPLY COMMON
TO DELTRON PWR SUPPLY COMMON
TO POWER SUPPLIES
TO CARD A7
TO CARD A8
TO CARD A11
NOTE:
1. ALL WIRE #22 AWG EXCEPT "LAMP COMMON".
MAT'L WEIGHT DESCRIPTION NUMBER REQ'D. SYM.
TOLERANCES UNLESS NOTED
DATE 15 APRIL 68
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY
IMP-G G.S.E.
FRONT PANEL WIRING
SCALE NONE
NO. IMPG-222
REV. A

DWG. NO. IMP G-223	REV.	DATE 12/6/67	SPACE SCIENCES LABORATORY UNIVERSITY OF CALIFORNIA	DRAWN	Y. MINAMIHALA
MATL.		REQD.		SCALE	
				CHECK	R J Pedl
TITLE POWER SUPPLIES IMP G G.S.E.				APP.	R J Pedl
				DATE	10/27/72

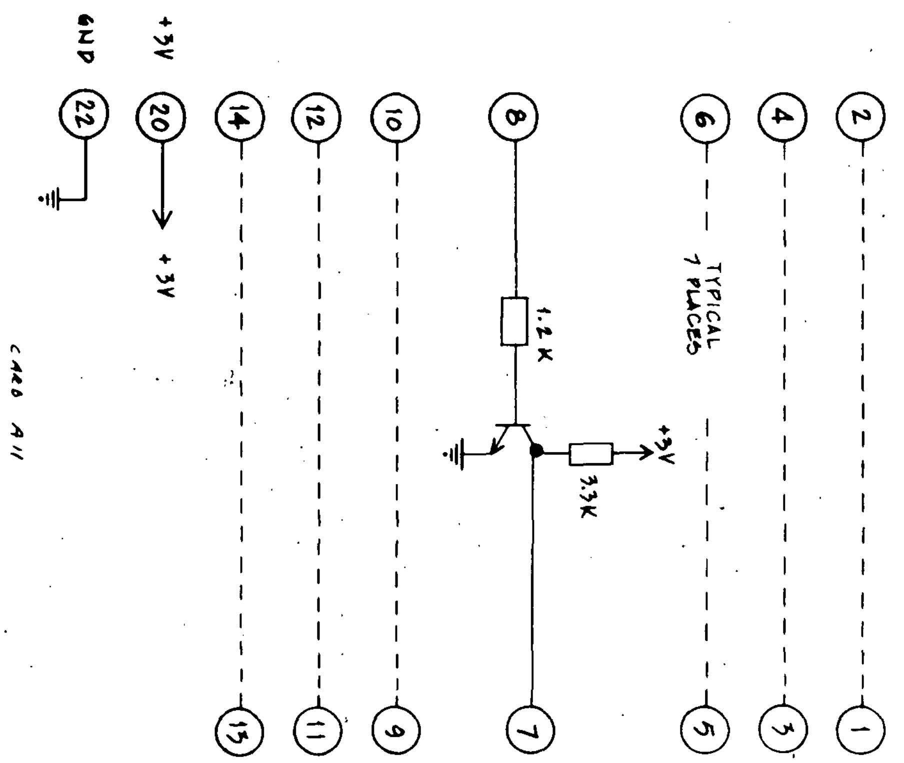


DWG. NO. IMP-G 224	REV.	DATE 11-3-72	DRAWN K. WONG
MATL.	REQD.		SCALE
			CHECK R.J. Paul
TITLE INPUTS AMPS + GM-IC CONTROL, UCAL IMP-G GSE CARD A7			APP. R.J. Paul
			DATE 11/9/72

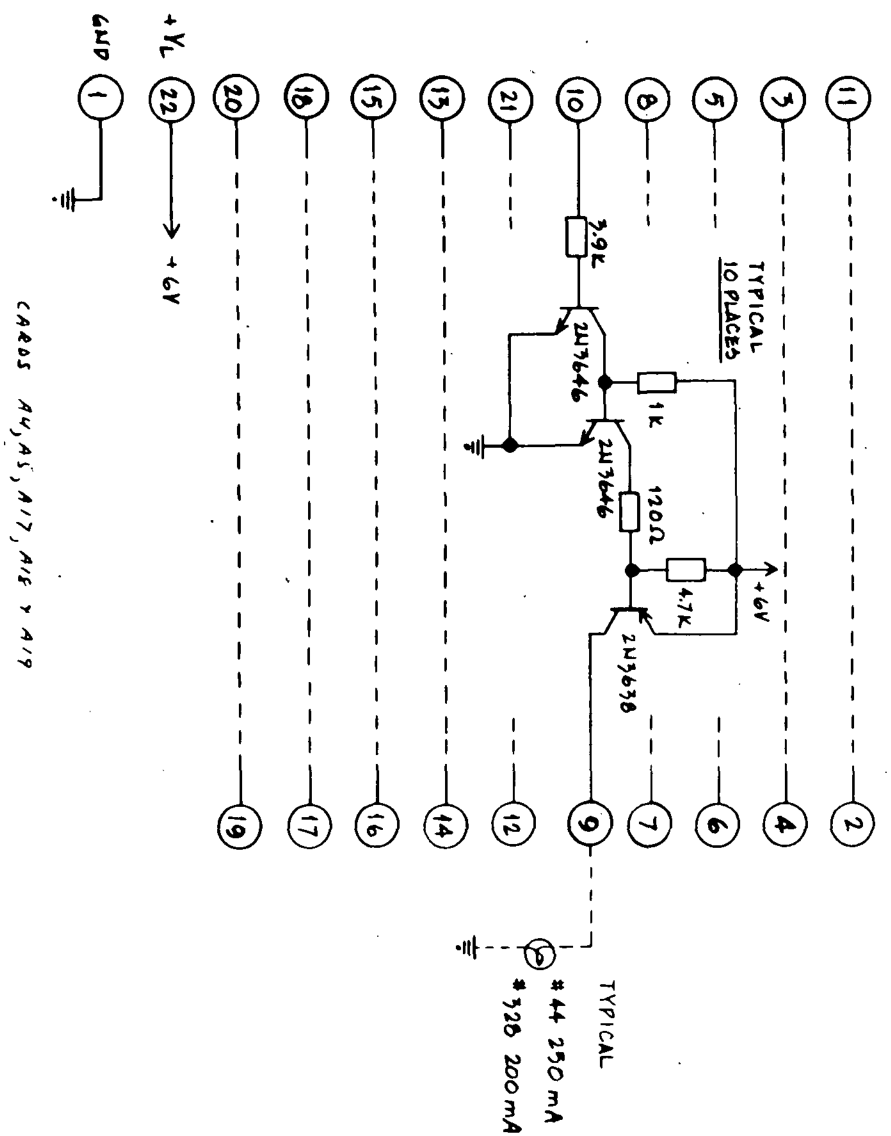
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA



NO. IMP G-225	JOB	APP.	SPACE SCIENCES LABORATORY	SCALE	DR. K. WONG	DATE 11-2-72
TITLE OUTPUT DRIVERS, UCAL IMP-G GSE		CARD A11	UNIVERSITY OF CALIFORNIA	REQD.	MATL.	



NO. IMP G - 226	JOB APP.	SPACE SCIENCES LABORATORY	SCALE	DR. K. WONG DATE 11-2-72
TITLE LAMP DRIVERS, UCAL IMP-G GSE		UNIVERSITY OF CALIFORNIA	REQD.	MATL.



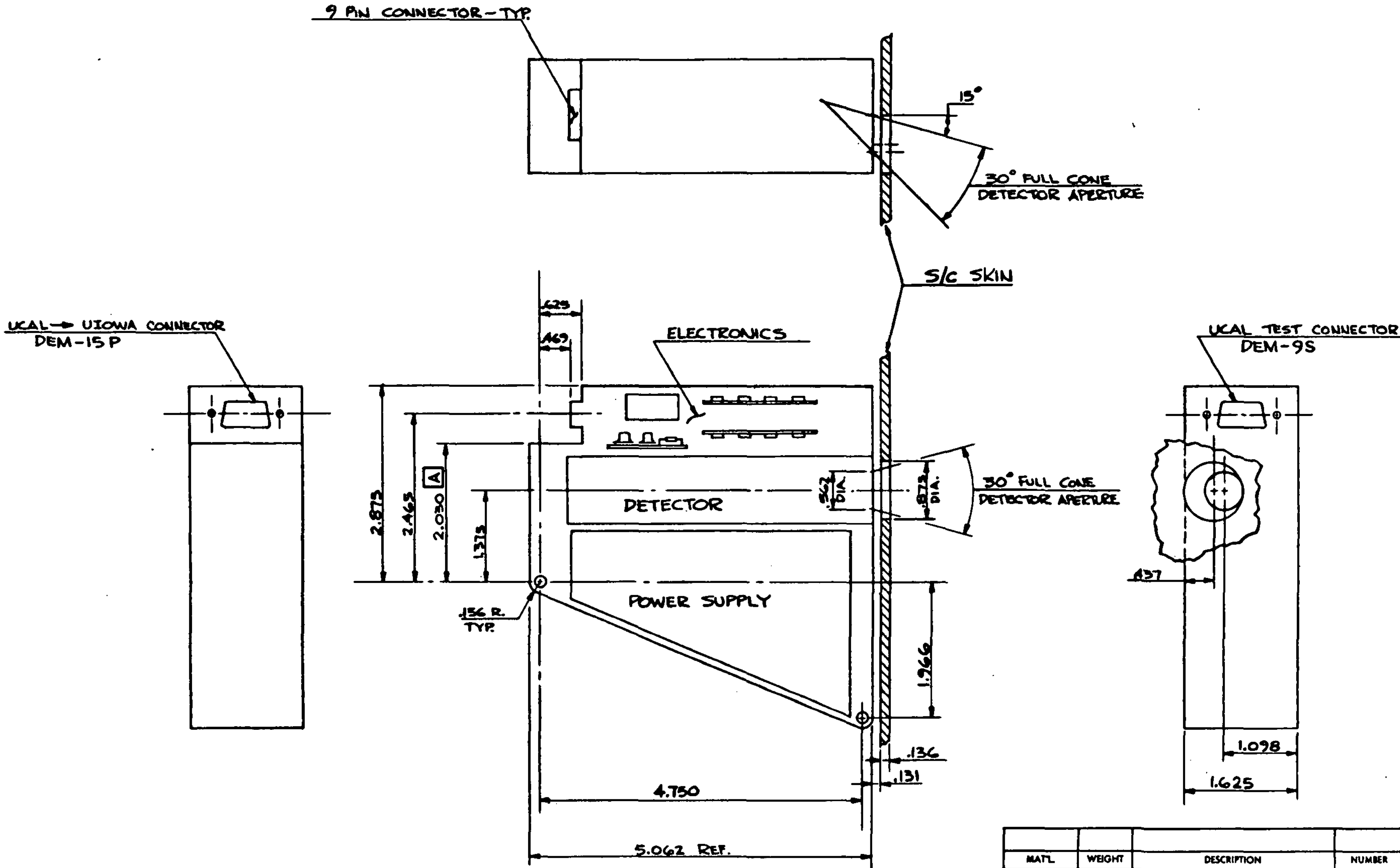
Appendix IV

IMP-G' (S2) Drawing List

IMP GS - 100	UCal IMP-G Supplementary Experiment Frame Outline, rev A
101	UCal IMP-G Supplementary Experiment Main Housing
102	UCal IMP-G Supplementary Experiment Top Cover
103	UCal IMP-G Supplementary Experiment Sun Shield
IMP GS - 201	UCal IMP-G Supplementary Experiment, S/N 2 Schematic, revB
202	UCal IMP-G Supplementary Experiment Power Supply, rev C
203	NA
204	S/C and Test Cables
IMP GS - 300	Checkout Box, S/N 1, rev B
301	NA
302	S/C Connector Cable and Test Connector Cable, rev A

Rev.	No.	DESCRIPTION	DATE	APP'D
A		CONNECTOR INDENT DIMENSION CHANGED FROM 1.937 TO 2.030.	11 OCT. 1967	R.R.H.

DWG. NO. IMP GS-100



MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

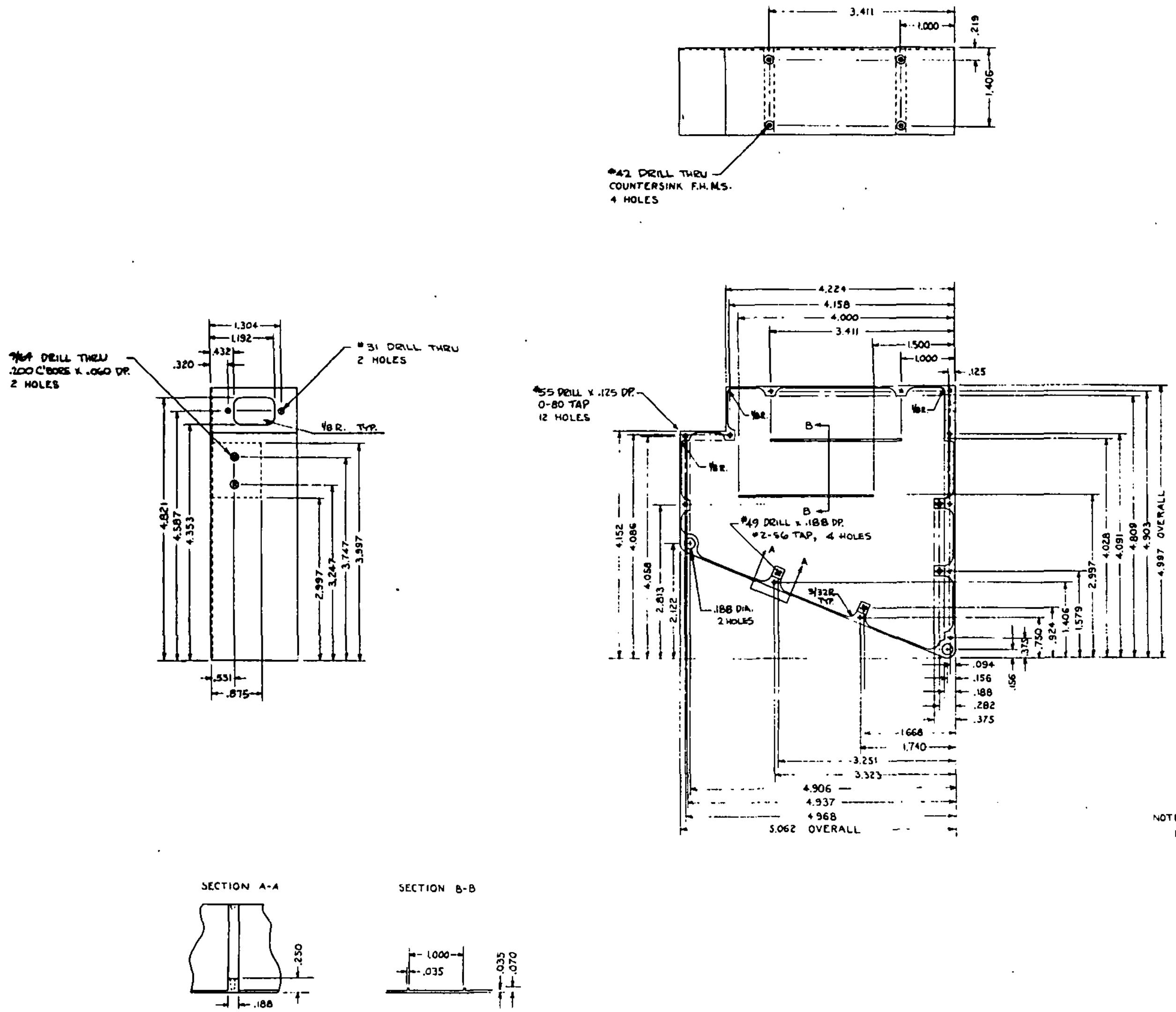
TOLERANCES UNLESS NOTED: DECIMALS ±.005, ANGLES ±1/2°

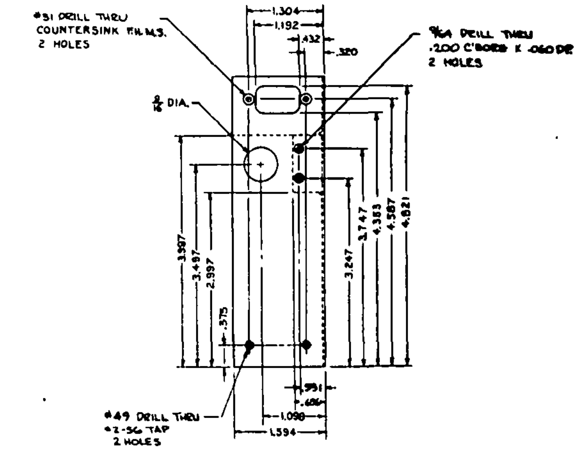
DATE 27 SEPT 67 · DR. R.P. TOY · CK'D Harrower · APP'D Harrower

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

UCAL IMP G SUPPLEMENTARY EXPERIMENT
FRAME OUTLINE

SCALE FULL · No. IMP GS-100 · REV. A
N.A. · PROJECT LIN / HARROWER





NOTES

1. ALL THIN WALL SECTIONS ARE .035 THICK.

MAGNESIUM					
MATL.	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

TOLERANCES UNLESS NOTED ±.005

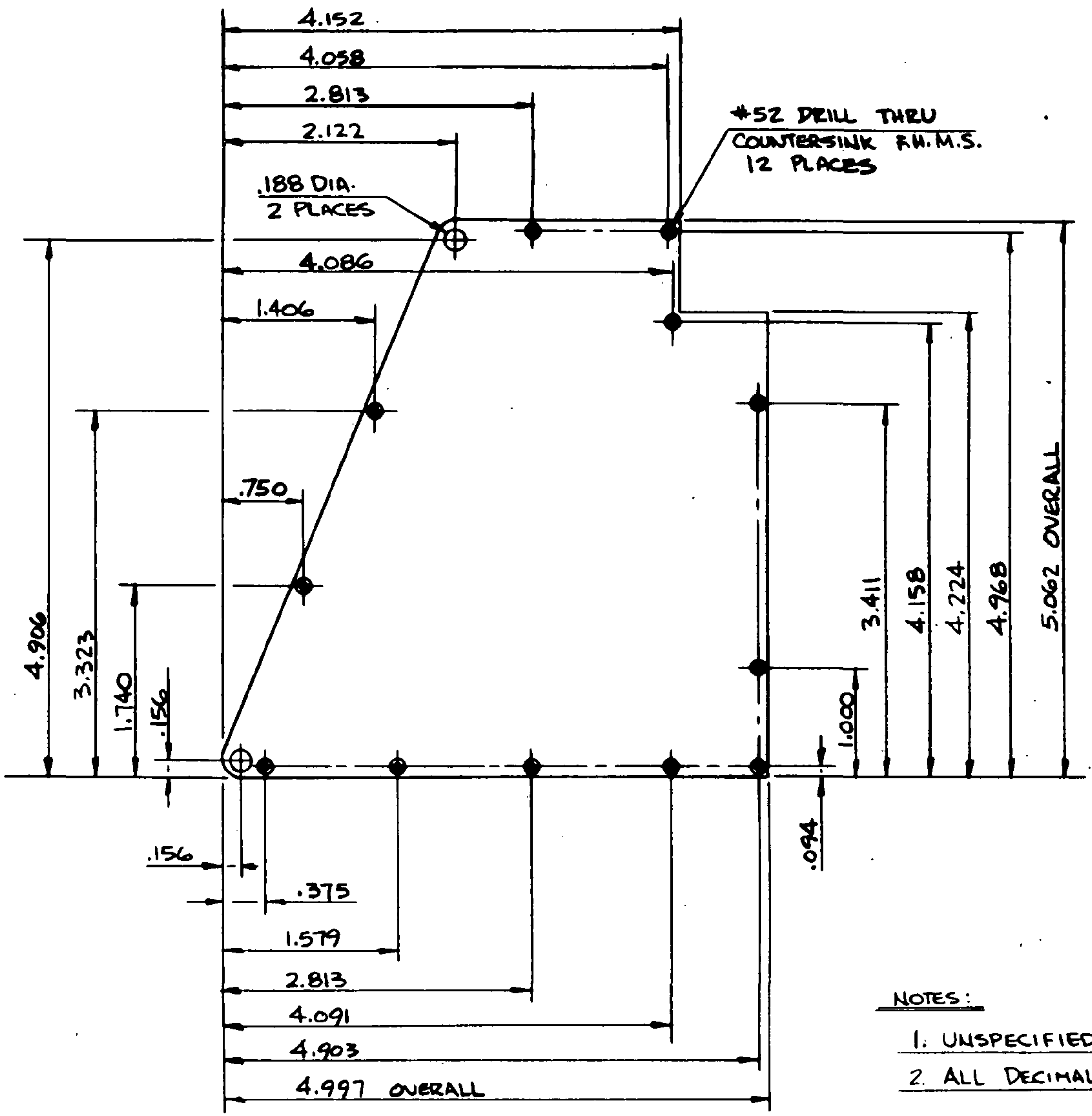
DATE 10-27-67

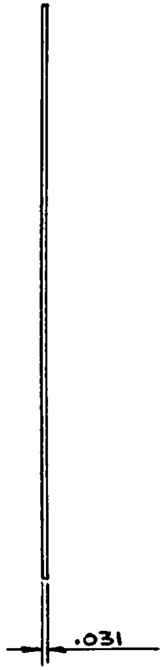
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

UCAL IMP G SUPPLEMENTARY EXPERIMENT MAIN HOUSING

SCALE FULL — NO. IMP GS-101

PROJECT LIN/HARROWER





NOTES:

1. UNSPECIFIED RADII TO BE .156±.005R.
2. ALL DECIMAL TOLERANCES TO BE ±.005.

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA

DWG. NO. IMP GS-102 | REV. | DATE | REQD.

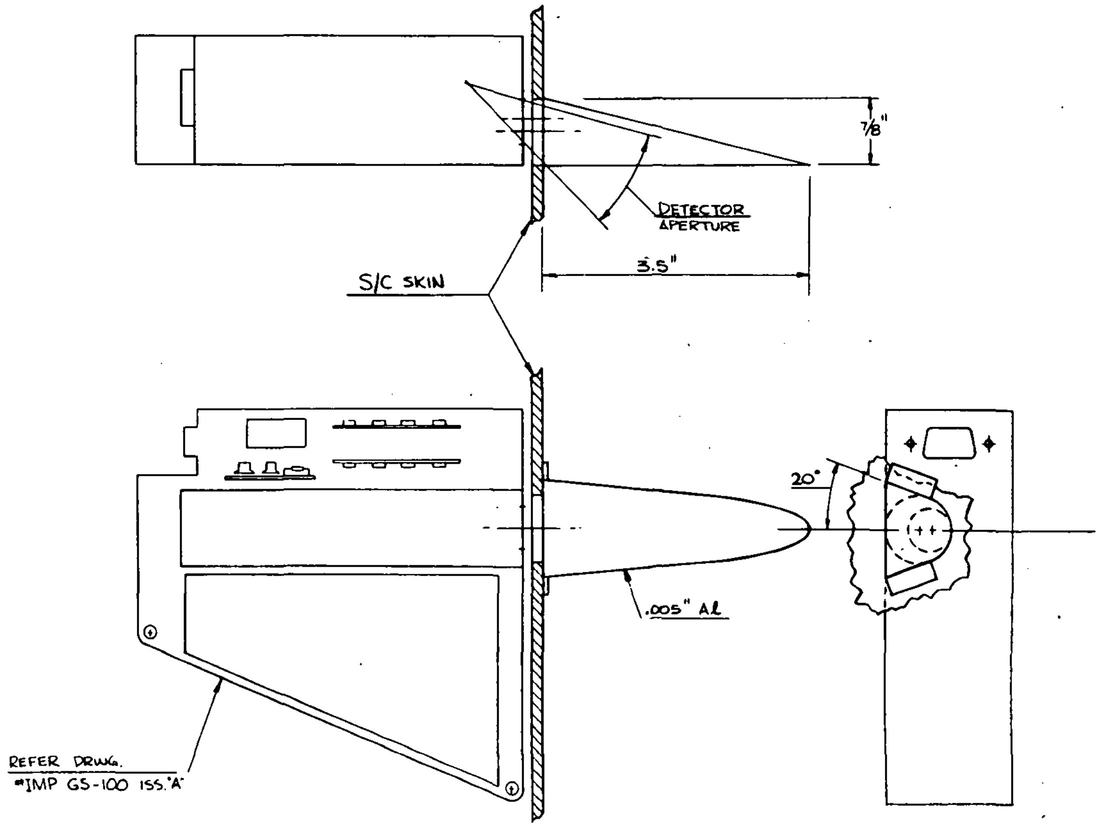
MAT'L MAGNESIUM

TITLE UCAL IMP G. SUPPLEMENTARY EXPERIMENT
TOP COVER

DRAWN
SCALE Full
CHECK
APP.
DATE 31 OCT. 1967

DWG. NO. IMP GS-103

Rev.	No.	DESCRIPTION	DATE	APP'D



MATL.	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

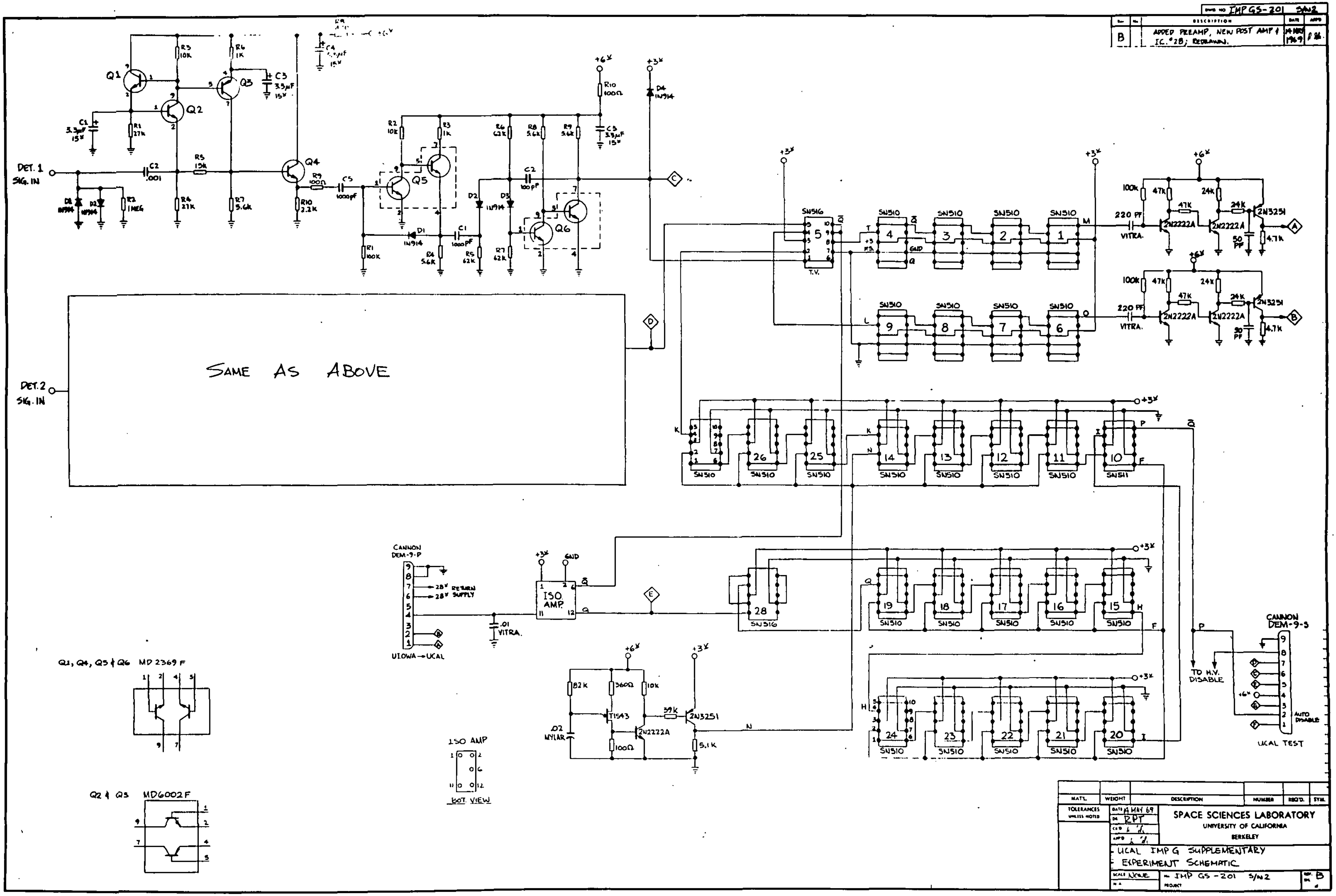
TOLERANCES UNLESS NOTED
DECIMALS ±.005
ANGLES ±1/2°
FRACTIONS ±1/64

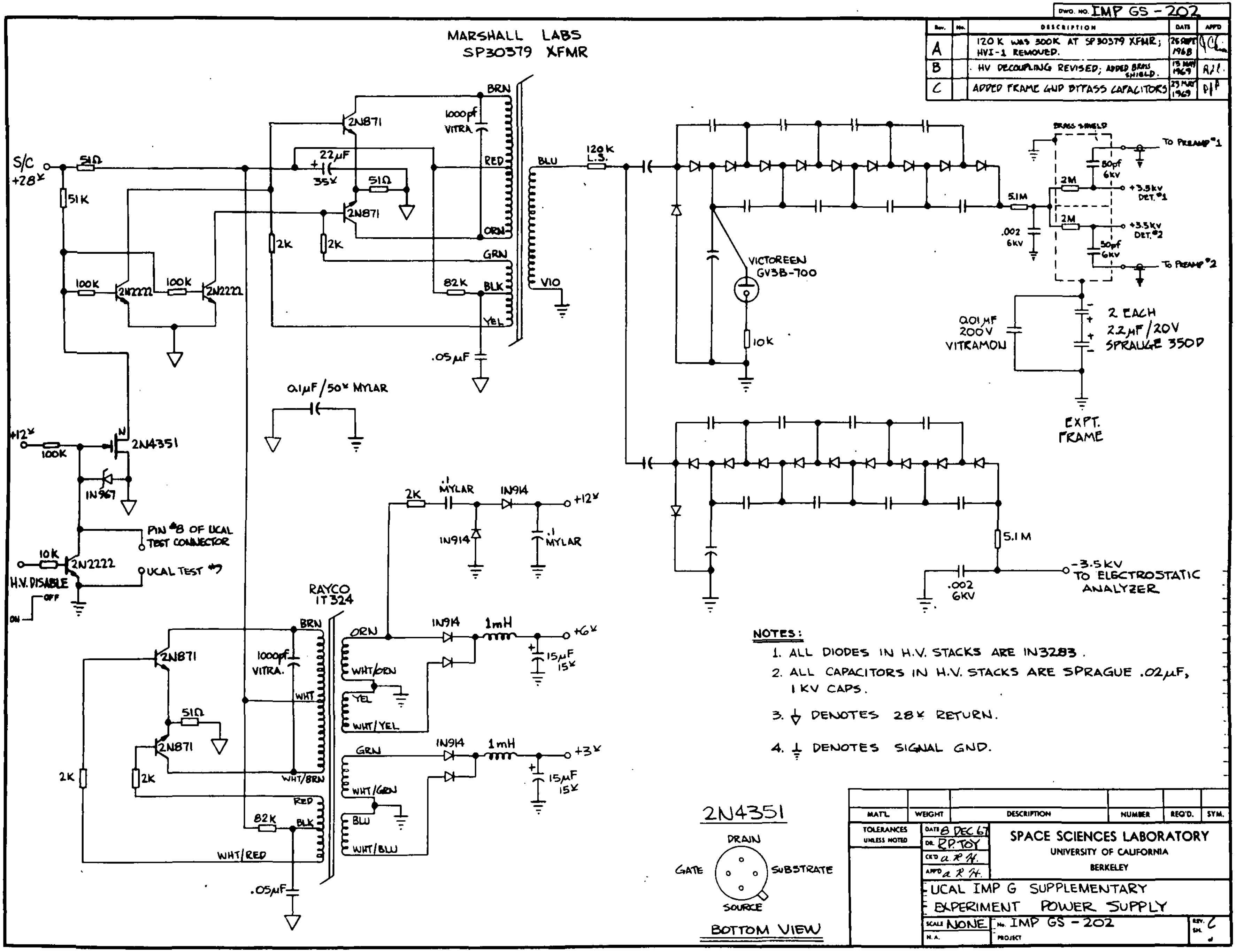
DATE 4 JAN. 68
DR. R.P. TOY
CK'D R.P. LIN
APP'D R.P. LIN

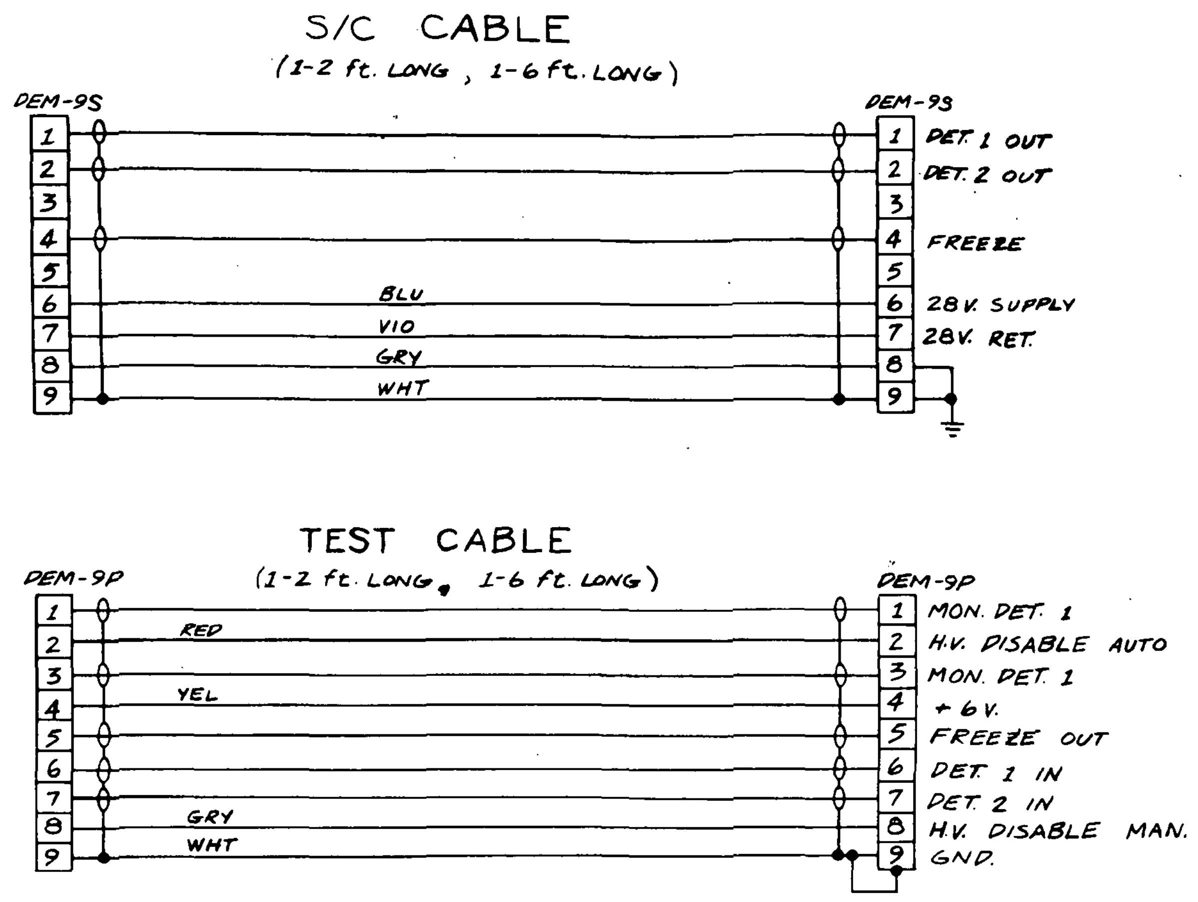
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY

UCAL IMP G SUPPLEMENTARY EXPERIMENT
SUN SHIELD

SCALE FULL
N.A.
No. IMP GS-103
PROJECT R. LIN
REV.
SH.


IMP GS-201 S/N2
B ADDED PREAMP, NEW POST AMP & I.C. #28; REDRAWN.
DET. 1 SIG. IN
DET. 2 SIG. IN
SAME AS ABOVE
CANNON DEM-9-P
UIOWA → UCAL
ISO AMP
CANNON DEM-9-S
UCAL TEST
TO H.V. DISABLE
AUTO DISABLE
Q1, Q4, Q5 & Q6 MD 2369 F
Q2 & Q3 MD6002F
ISO AMP BOT. VIEW
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY
UCAL IMP G SUPPLEMENTARY EXPERIMENT SCHEMATIC
IMP GS-201 S/N2


DWG. NO. IMP GS - 202
REV. | DESCRIPTION | DATE | APPD
A | 120 K WAS 300K AT SP30379 XFMR; HVI-1 REMOVED. | 26 SEPT 1968
B | HV DECOUPLING REVISED; ADDED BRASS SHIELD. | 13 MAY 1969
C | ADDED FRAME GND BYPASS CAPACITORS | 23 MAY 1969
MARSHALL LABS
SP30379 XFMR
S/C
+28V
51Ω
51K
2N871
1000pf
VITRA
22μF
35V
51Ω
2N871
2k
2k
BRN
RED
ORN
GRN
BLK
YEL
BLU
VIO
82K
100k
2N2222
100k
2N2222
.05μF
0.1μF/50V MYLAR
+12V
100K
2N4351
1N967
PIN #8 OF UCAL TEST CONNECTOR
10k
2N2222
UCAL TEST #7
H.V. DISABLE
OFF
ON
120K
L.S.
BRASS SHIELD
TO PREAMP #1
80pf
6kV
2M
+3.5kV
DET. #1
5.1M
.002
6kV
2M
+3.5kV
DET. #2
50pf
6kV
TO PREAMP #2
VICTOREEN
GV3B-700
10K
.001μF
200V
VITRAMON
2 EACH
2.2μF/20V
SPRAGUE 350D
EXPT.
FRAME
2K
.1
MYLAR
1N914
+12V
1N914
.1
MYLAR
5.1M
-3.5kV
TO ELECTROSTATIC
ANALYZER
.002
6kV
RAYCO
IT324
BRN
ORN
1N914
1mH
+6V
15μF
15V
WHT/ORN
YEL
WHT/YEL
2N871
1000pf
VITRA.
WHT
51Ω
2N871
2K
2k
WHT/BRN
GRN
1N914
1mH
+3V
15μF
15V
WHT/GRN
BLU
WHT/BLU
RED
82K
BLK
WHT/RED
.05μF
NOTES:
1. ALL DIODES IN H.V. STACKS ARE 1N3283.
2. ALL CAPACITORS IN H.V. STACKS ARE SPRAGUE .02μF, 1KV CAPS.
3. ⏚ DENOTES 28V RETURN.
4. ⏚ DENOTES SIGNAL GND.
2N4351
DRAIN
GATE
SUBSTRATE
SOURCE
BOTTOM VIEW
MAT'L | WEIGHT | DESCRIPTION | NUMBER | REQ'D. | SYM.
TOLERANCES UNLESS NOTED
DATE 8 DEC 67
DR. R.P. TOY
SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY
UCAL IMP G SUPPLEMENTARY
EXPERIMENT POWER SUPPLY
SCALE NONE
NO. IMP GS - 202
REV. C
PROJECT



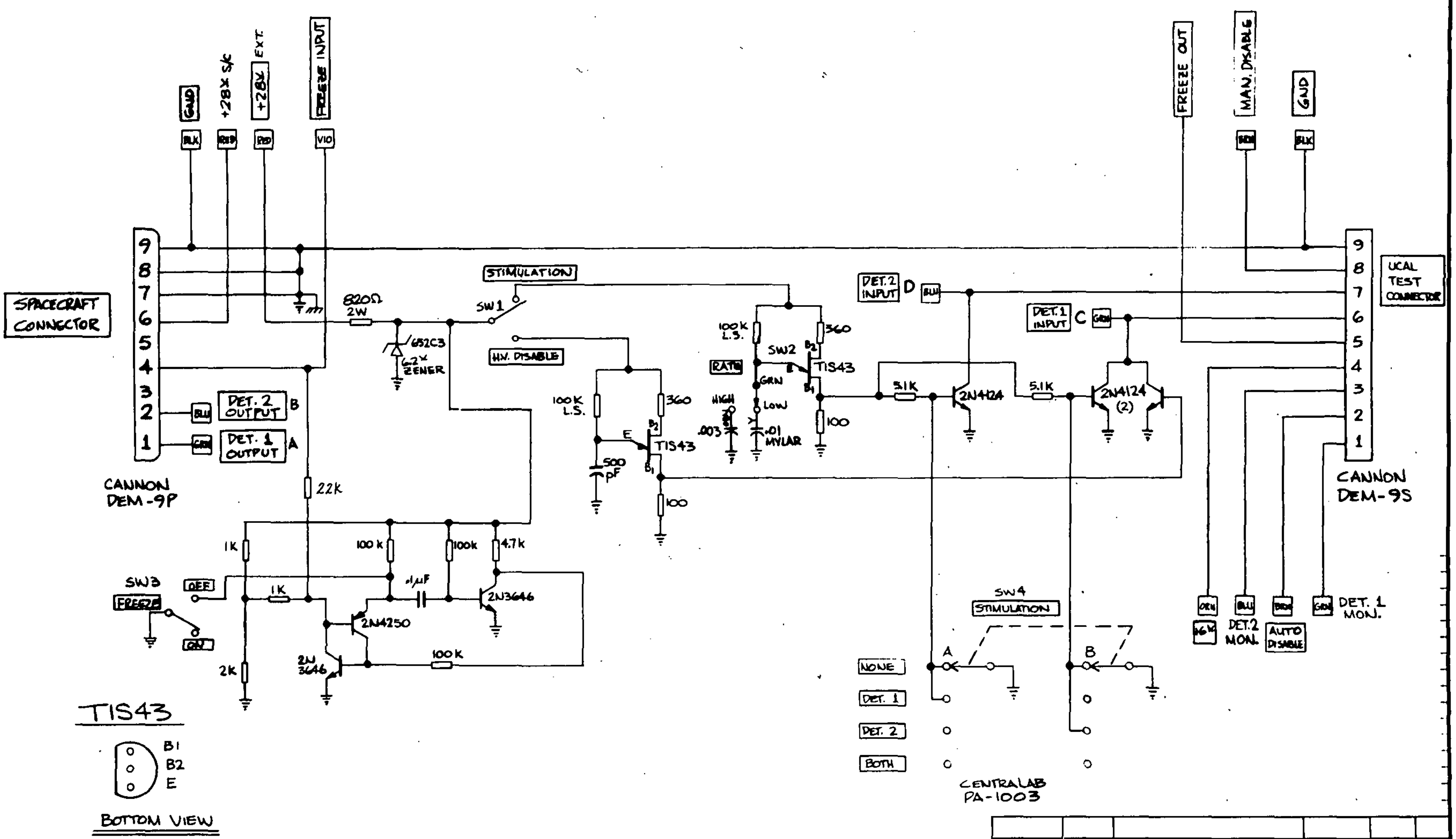
DWG. NO. IMP63-204 | REV. | DATE
MATL. | REQD.
TITLE S/C AND TEST CABLES

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA

DRAWN GREEN
SCALE NONE
CHECK
APP.
DATE 2-14-69

DWG. NO. IMP GS-300 REV. B

REV.	NO.	DESCRIPTION	DATE	APPD
A		FREEZE PULSE GENERATOR CIRCUIT REDESIGNED.	24 SEPT. 68	[illegible]
B		ADDED 22K RESISTOR TO OUTPUT OF FREEZE LINE.	11 APRIL 1969	[illegible]



MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

TOLERANCES UNLESS NOTED

DATE 9 DEC 67
DR. R.P. TOY
CK'D [illegible]
APPD [illegible]

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BERKELEY

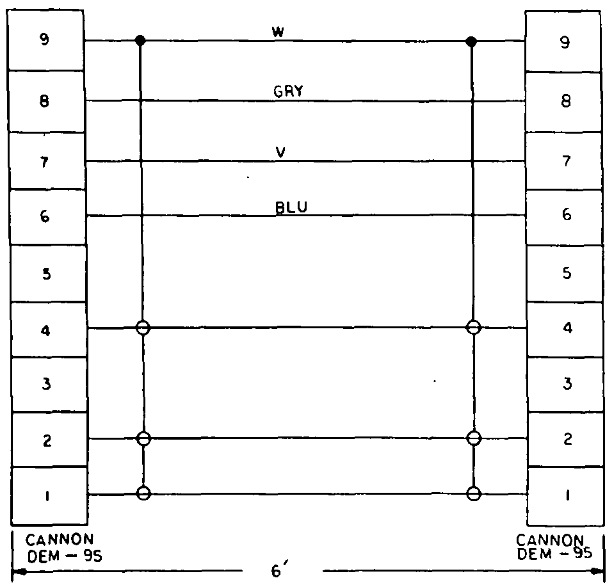
CHECKOUT BOX S/N 1

SCALE NONE
N.A.
No. IMP GS-300
PROJECT
REV. B
SH.

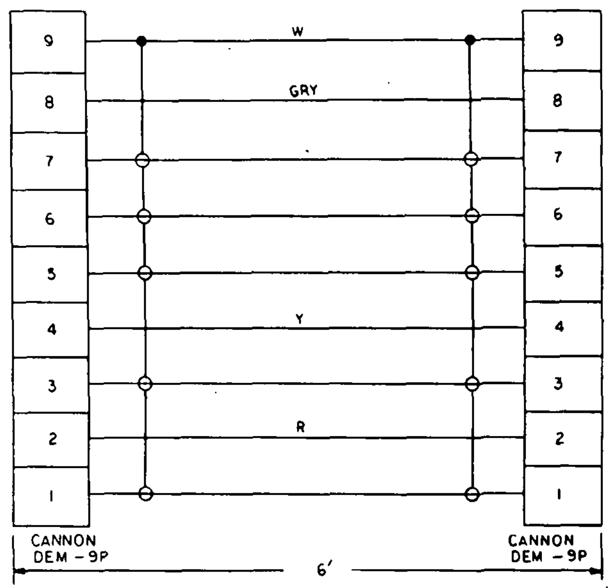
DWG. NO. IMP GS-302

Rev.	No.	DESCRIPTION	DATE	APP'D
A		DWG # IMP GS-302 WAS IMP GS-301.	7 MAR. 1969	

S/C CONNECTOR CABLE



TEST CONNECTOR CABLE



MAT'L	WEIGHT	DESCRIPTION	NUMBER	REQ'D.	SYM.

TOLERANCES UNLESS NOTED

DATE 9-17-68
DR. ECKHARDT
CK'D
APP'D

SPACE SCIENCES LABORATORY
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BERKELEY

S/C CONNECTOR CABLE . AND TEST CONNECTOR CABLE

SCALE NONE
N.A.
No. IMP GS-302
PROJECT
REV. A
SH.