BT25538
ISSUE 2

RADIATION ASSESSMENT OF ISOCOM LIMITED OPTOCOUPLERS

(CS201, CD500, 4N55, 6N134 AND 6N140)

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BRITISH AEROSPACE (DYNAMICS) LIMITED

BRISTOL

RADIATION ASSESSMENT OF ISOCOM LIMITED OPTOCOUPLERS (CS201, CD500, 4N55, 6N134 AND 6N140)

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CONTENTS

1. INTRODUCTION

1.1 General

This report covers the radiation assessment of five optocouplers manufactured by ISOCOM Limited. The assessment was performed by the Radiation Effects Department of British Aerospace (Dynamics) Limited for ISOCOM.

1.2 Devices

The five device types assessed were:

a.	CS201	: Date Code 8909	(Single Optocoupler)
b.	CD500	: Date Code 8911	(Dual Optocoupler)
c.	4N55/L2	: Date Code 8835	(Dual Optocoupler)
d.	6N134/L2	: Date Code 8809	(Dual Optocoupler)
e.	6N140/L2	: Date Code 8829	(Quad Optocoupler)

Fifty samples of each device type were supplied to British Aerospace by ISOCOM for assessment to three radiation types.

2. OBJECTIVES

2.1 General.

The main objective of the assessment was to determine the susceptibility of the five device types to nuclear radiation. The results of these assessments may form the baseline for qualification to the radiation specifications associated with BS9000.

Electronic devices are susceptible to three distinct radiation types and the effects of earn radiation type were to be assessed for each device type.

2.2 Neutron Fluence.

Neutrons cause lattice damage in semiconductor devices; this damage results in a decrease in the minority carrier lifetime. This will result in a loss of output from the emitting devices, a loss of efficiency in the detector devices and a reduction of gain in bipolar amplification devices.

2. 3 Total Ionising Dose.

Ionising radiation causes bulk ionisation of all materials; this ionisation results in the electroluminescent efficiency. These defects will also cause a loss of efficiency in detector devices.

2. 4 Ionising Dose Rate.

At high rates of delivery of ionizing radiation, the ionisation within regions of high electric field will result in a flow of current (photocurrent); all semiconductor devices are susceptible to this photocurrent. Significant photocurrents are produced in the majority of device technologies at dose rates greater than 1E6 Rad(Si) /second.

Photocurrent flow may effect device operation in several ways, which may be prevalent depending on the radiation environment.

a. PHOTOCURRENT' MAGNITUDE

The flow of photocurrent is a possible cause of system malfunction and the photocurrent generation rate over a range of dose rates shall be determined.

b. TRANSIENT UPSET

Photocurrent flow may perturb voltage levels within a device and may manifest itself as a transient upset of output signals; this upset may persist for longer than the period of the radiation pulse due to the time dependent nature of photocurrent production. Depending on the magnitude and duration of this upset, this effect may cause system malfunction.

The dose rate at which upset occurs and the magnitude and duration at higher dose rates shall be determined.

c. BURN OUT

At very high rates of delivery (≃ lEl0 Rad(Si) /second) the photocurrent may be sufficient to cause burn out of active regions, metallisation or bond wires . Normally active region and metallisation burn out occurs rapidly (<l00μS) with bond wire burn out taking comparatively longer. Burn out results in destructive failure of a device and the survival of the device should be assessed at a suitably high dose rate.

The time taken for a device to burn out shall be determined, and the device shall be physically examined to determine the nature of the burn out.

Of the fifty samples of each device type supplied, each was numbered and the radiation assessment was split as follows:

Samples 1 to 3 : Control devices for neutron tests.

Samples 4 to 28 : Neutron tests.

Samples 29 to 38 : Linac tests.

Samples 39 to 49 : Total dose tests.

Sample 50 : Spare.

3. IRRADIATION FACILITIES

3. 1 Neutron Fluence

The pulsed neutron facility VIPER at AWE Aldermaston was used for the neutron irradiations (Reference 1). The output was energetic neutrons calibrated in terms of 1MeV equivalent damage in silicon. Throughout this report, the notation n/cm^2 is used for neutron fluence which is taken to be neutrons per square centimetre (1MeV equivalent damage in silicon). Dosimetry was provided by AWE staff in the form of sulphur tablets. The required fluences were achieved by placing devices at set distances from the facility.

3. 2 Total Ionising Dose

The Cobalt-60 source at the Royal Military College of science (Reference 2) was used for the total dose irradiations. The output was gamma rays having characteristic energies of 1.17 and 1.33MeV calibrated in terms of a radiation absorbed dose (energy deposited per unit mass) in silicon. Throughout this report, the notation Rad is used for accumulated total dose which is taken to be 100 ergs deposited per gramme of silicon. [NB: The SI unit Gray (joules per kilogramme) is equivalent to 100 Rads.] Dosimetry was provided by RMCS staff in the form of calibrated positions determined by measurements with an ionization chamber. The required total doses were achieved by placing the devices at a set distance from the source and irradiating for the appropriate time.

3.3 Ionising Radiation Dose Rate

The linear accelerator (LINAC) at AWE Aldermaston (Reference 3) was used for dose rate irradiations. The output was energetic electrons in the range 6-10MeV calibrated in terms of radiation absorbed dose in silicon per unit time. Throughout this report the notation Rad/s is used for dose rate which is taken to be 100 ergs deposited per gramme of silicon per second. Dosimetry was provided by British Aerospace in the form of NPL calibrated PIN diodes. The required dose rates were achieved by a combination of placing the devices at set distances from the LINAC exit window and the introduction of a thin aluminium scatter plate in the beam (in the latter case the beam energy was reduced from approximately 10MeV to 6MeV). Throughout the tests, the dose rate pulse was maintained as a nominally rectangular pulse of 200nS duration.

4. TEST PROCEDURES

4.1 General.

The test procedures for this assessment were based on those recommended in Reference 4. Detailed test methods employed for the assessments were based generally on standard test methods; MIL 883C methods 1017.2 (Neutron), 1019.3 (steady State Total Dose Irradiation) and 1023 (Dose Rate Response of Linear Microcircuits): MIL SID 750C methods 1015 (steady state Primary photocurrent), 1017 (Neutron Irradiation) and 1019 (steady State Total Dose). Specifically the methods were consistent with British Aerospace Working Instruction VW 827-02 (Radiation Test Methods for semiconductor Devices) which embodies the above procedures.

All tests were performed at ambient temperature. Devices 1 to 3 were allocated as control devices and were not irradiated. Device 50 was kept as a spare.

4. 2 Neutron Fluence

Twenty-five devices were to be assessed for neutron degradation.

Devices 4 to 8 were irradiated at 1E11 n/cm^2

Devices 9 to 13 were irradiated at 3El1 n/cm^2

Devices 14 to 18 were irradiated at lE12 n/cm^2

Devices 14 to 18 were irradiated at lE12 n/cm^2

Devices 24 to 28 were irradiated at 1E13 n/cm^2

The primary electrical parameters were measured before irradiation and within 12 hours of irradiation. The irradiations at 1El1, 3El1 and 1E13 were performed on the first pulse (RUN 1) and those at 1El2 and 3E12 were performed on a second pulse (RUN 2). Irradiations were performed with the device pins electrically shorted with conductive foam, and the ambient temperature was 25 ± 5°C.

4. 3 Total Dose

Eleven devices were to be assessed for total dose degradation. Devices 39 to 43 were irradiated in multiple steps, giving total doses of 10, 20, 30, 50, 100, 200, 300, 500 and 1000 kRad. Devices 44 and 45 were irradiated in a single 100 kRad step, 46 and 47 with a single 300 kRad step and 48 and 49 with a single 1000 kRad step. Primary electrical parameters were measured before irradiation and after each step (within 5 minutes). Devices 44 to 49 were irradiated in single steps to identify any annealing that nay have occurred during the multiple step irradiations. The devices were irradiated at 100 Rad/second ± 5% with an overall accuracy of 200 Rads Per step. The ambient temperature was 25 ± 2°C. Components were connected and biased in a typical configuration during irradiation.

4.4 Dose Rate.

Ten devices were to re assessed for dose rate response and degradation. Devices 29 and 30 were irradiated over a range of dose rates with device supplies at 5, 10 and 15V (if appropriate). Devices 31 to 39 were irradiated over a range of dose rates at the respective maximum supply voltage. Primary electrical parameters were measured before irradiation and after each range of dose rates at a given supply voltage. The pulse width was nominally rectangular of 200nS ± 10%. The ambient temperature was 25 ± 5°C. The devices were exposed with the input diode connections shorted and the photodetector configured in a worst case representative manner.

5. TEST EQUIPMENT

5.1 General.

The five device types were characterised pre and post irradiation using a GenRad 1735 Component Test System. The electrical characteristic test conditions are given for the five device types in Tables 1 to 5 and represent as close as possible the manufacturer's test conditions, as given on the respective device data sheets. The accuracies of the test system measurements are listed in Appendix A.

The data storage and subsequent statistical analysis was performed by a Hewlett Packard 300 series computer, interfacing to the component Test System via an RS232 interface.

Tables 6 to 10 give the results of performing the component characterisation tests with no device in the system. These tables show the compliance limits (voltages, currents, times) and indicate the variations between runs.

5. 2 Neutrons

The devices were irradiated unpowered and required no additional test equipment.

5. 3 Total Dose

The devices were irradiated in a powered condition with the configurations outlined in Figures 1 to 5. Five device sockets were available for each device type to allow for simultaneous multiple irradiations. The power supplies (Thurlby PL 320), and device supply currents were monitored via Fluke 75 digital multimeters.

5. 4 Dose Rate

The devices were irradiated in a powered condition with the configurations outlined in Figures 6 to 10. Output responses were monitored via resistors and 50 ohm terminated cables. Photocurrents were monitored using Tektronix CT2 current transformers. The dose rate was monitored by an NPL calibrated Marconi GDI PIN diode using the standard configuration outlined in Figure 11. All transient signals were captured via Tektronix 390AD digitisers and data was sent via an IEEE 488 interface to a Hewlett Packard 300 series computer for data capture and analysis.

6. DATA ANALYSIS

6.1 General.

Copious data was produced for this assessment and, as a whole, is unsuitable for inclusion in this report. Generally, the data has been reduced by calculation of the means and standard deviations.

The test results are shown in Tables 11 to 35 and are grouped for each device type. Any asterisks in place of data in the tables indicate that the test system measurement range or compliance limit was reached and the corresponding measurement was meaningless and hence not included.

The methods of data reduction applied to each set of test results are given below.

6. 2 Neutron Fluence

6. 2. 1 **Control Devices**

The means and standard deviations of the three control devices were calculated for each characterisation. Provided the difference from the pre-irradiation value was less than 5%, no action was required; if the control samples changed by > 5% then a correction factor was applied to the irradiated samples, for the respective run.

6. 2. 2 **Irradiated Devices**

The pre-irradiation means and standard deviations were calculated for Devices 4 to 28. Post irradiation analysis was performed by calculating the means and standard deviations of the ratio of post/pre irradiation values for the parameter measurements of each sample.

The tables give the pre-irradiation mean and standard deviations for each parameter measured and show the degradation ratio of the mean and standard deviations of the post irradiation parameter measurements. In addition, the upper or lower 95% confidence limit (mean ± (1. 65 x standard deviation); reference Appendix B) is shown as selected to reflect the worst degradation.

The tables also include a column with the heading, "limit ratio". This is the ratio by which the pre-irradiation mean measurement is within the maximum or minimum parameter limit, as defined in the Electrical Characteristics of the manufacturer's data sheets. This ratio gives an easy reference to determine where a parameter has degraded beyond the manufacturer's limits, although it must be considered that the pre-irradiation measurement and the post irradiation ratios are the mean values of a number of samples.

6. 3 Total Dose Tests

No control devices were considered necessary for the total dose tests as pre and post irradiation characterisations were performed at sufficiently close times to presume that ambient environment changes would not significantly influence the measurements.

The means and standard deviations were only calculated for a group of components that were exposed simultaneously. The tables give the pre-irradiation mean and standard deviations for each of the parameters measured and show the degradation ratio by the post irradiation mean and standard deviations for each parameter. In addition, the 95% confidence limits are shown for each post irradiation parameter measurements (mean ± (1.65 x standard deviation) reference Appendix B). The upper limit is shown where an increase in parametric value represents the degradation and conversely, the lower limit is shown where a decrease represents the degradation.

The tables also include a "limit ratio" column which shows the ratio by which the pre-irradiation mean measurement is within the maximum or minimum parameter limit, as defined in the Electrical characteristics of the manufacturer's data sheets. This ratio gives an easy reference to determine where a parameter has degraded beyond the manufacturers limits, although it must be considered that the pre-irradiation measurements and post-irradiation ratios are the mean values of a number of samples.

6. 4 Dose Rate Tests

No control devices were considered necessary for the dose rate tests as pre and post irradiation characterisations were performed at sufficiently close times to presume that ambient environment changes would not significantly influence the measurements.

Ten samples of each device were individually irradiated at a variety of increasing dose rates. The corresponding photocurrent Peak values and durations were recorded.

The tables give the mean and standard deviations for each device parameter measured before irradiation. After earn sequence of dose rate pulses, the degradation ratio of the mean and standard deviations of each device parameter are also shown. In addition, the upper or lower 95% confidence limit (mean ± (1.65 x standard deviation); reference Appendix B) is shown as selected to reflect the worst degradation.

The tables also include a "limit ratio" column which shows the ratio by which the pre-irradiation mean measurement is within the maximum or minimum parameter limit, as defined in the Electrical Characteristics of the manufacturer's data sheets. This ratio gives an easy reference to determine where a parameter has degraded beyond the manufacturers limits, although it must be considered that the pre- irradiation measurements and post-irradiation ratios are the mean values of a number of samples.

7. CS201 TEST RESULTS

7.1 Neutron Fluence

Table 11 shows the results for the neutron control devices, characterised prior to the neutron irradiation tests and repeated prior to re-characterisation of the irradiated components after Shot 1 (RUN 1) and Shot 2 (RUN 2) VIPER exposures. These results show any measurement changes due to ambient condition changes. Any changes greater than 5% were applied to the post irradiation results to compensate for non irradiation changes.

Table 12 contains the results of the neutron fluence tests. The asterisks indicate where the GenRad Test System t limits were reached and the data measurements were meaningless. It can be seen that the Current Transfer Ratios degrade significantly at law fluences, being out of specification at 1E11 n/cm^2. This is also evident by the fact that at 3E11 n/cm^2 the VCESAT measurement has been lost, implying that the output detector transistor is not being turned on. The Ton measurements also verify this. (Note that the ratios in excess of 2 represent the compliance limit of 25.60 microseconds, as shown in Table 6.)

None of the input diode characteristics measured went out of specification. Also, none of the output detector characteristics went out of specification. All of the "coupled" characteristics showed significant degradation, the most sensitive being the current transfer ratio.

7.2 Total Dose

Tables 13a and 13b contain the results of the total dose tests. Devices 39 to 43 were exposed up to 1M Rad in 9 increments and Devices 44 to 49 were exposed in pairs of 100k Rad, 300k Rad and 1M Rad.

The input diode characteristics all remain within specification with IR reducing to a level too low for the test system to measure accurately.

The output detector characteristics all remain within specification. The largest change was with ICEO.

The coupled characteristics experienced significant degradation, with the current transfer ratios out of specification at between 50 and 100k Rads and the Ton characteristic out of specification below 50k Rads.

Comparison of Tables 13a and 13b showed little annealing, if having occurred during the multiple step irradiations.

7.3 Dose Rate

The dose rate tests were performed with the input diode connections shorted together and the output transistor collector emitter voltage at +5, +10 and +15 volts with the collector current limited to 100mA in each case. Figure 6 shows the configuration for the +15V test. The photocurrent response of the output transistor varied little between +5V and +15V and so only two devices were tested at the different voltages. The other samples were all tested with +15V supply.

Table 14 contains the gamma dose rate test results performed at +15V, which shows that the CS201 survives the dose rates up to 6E9 Rad(Si)/second, with the photocurrent limited by the output transistor external collector current limiting resistor. (The effect of the current limiting is seen by the increase in photocurrent duration.) Appendix C, Figures Al to A3, show the CS201 photocurrent response at various dose rates.

Tables 15a and 15b show the parametric degradation experienced by the device as a result of the dose rate exposures. The current transfer ratios have degraded significantly. Each sequence of dose rate tests at each supply voltage accumulate approximately 2k Rads total dose for each device. Reference to Table 13a shows that the "dose rate" degradation occurs at a lower total dose for each device. This is contrary to the typical trend in semiconductors and so must be associated with optical coupling. This potential failure mechanism must be considered and a limit to the total dose delivered during a high dose rate transient should be applied, lower than the normal total dose susceptibility of the device.

8. CD500 TEST RESULTS

8.1 Neutron Fluence

Table 16 shows the CD500 pre-irradiation and post RUN 1 and RUN 2 characterisation measurements. These results reflect any ambient changes and are used to adjust the post irradiation measurements for parameters that exhibit a greater than 5% shift.

Table 17 shows the neutron fluence test results. The asterisks indicate where the GenRad Test System measurement limits were reached and the data considered meaningless. No manufacturer's data was available for Ton and Toff so no limit ratio is applied to these measurements. It is apparent that the current transfer ratio is the most susceptible characteristic, exceeding the limit ratio between 1E11 and 3E11 n/cm^2. The absence of data for VCESAT beyond 3E11 n/cm^2 is due to the CTR degradation preventing the output transistor from being turned on with the input diode current, If, as specified in the test conditions.

The Ton parameter saturates at the test system compliance limits at 1E11 n/cm^2. This corresponds to a turn on time of 25.6 microseconds.

The "coupled" characteristics were the only parameters that directly degraded beyond the limit ratios.

8.2 Total Dose

Tables 18a and 18b show the results of the total dose tests. Devices 39 to 43 were exposed up to 1M Rad in 9 increments and Devices 44 to 49 were exposed in pairs at 100k Rad, 300k Rad and 1M Rad.

The input diode characteristics all remain within specification, with the Ir characteristic occasionally being too low to record.

The output detector characteristics all remain within specification, with the largest change being in Iceo.

The coupled characteristics experienced significant degradation, with the current transfer ratios degradation exceeding their limit ratios between 200k Rad and 300k Rad (the sample group 44 to 49 showed slightly less CTR susceptibility; reference Table 18b). The Ton characteristic reached the measurement compliance limit as the CTR degraded but VCFSAT remained within the limit ratio up to between 500k Rad and 1M Rad.

Comparison of Tables 18a and 18b showed generally little annealing having occurred during the multiple step irradiations. In fact, the CTR degradation appeared to behave contrary to multiple step annealing, but was most probably due to the statistical uncertainties associated with the small sample quantity. However, differences were only of the order of 10% and so considered reasonable.

8.3 Dose Rate

The dose rate tests were performed within input diode connections shorted together and the output transistor collector-emitter voltage at +5, +10 and +15 volts, with the collector current limited to 100mA in each case. Figure 7 shows the dose rate test circuit configured for +15V supply. The dual device was considered as two discrete devices for the purposes of the data analysis.

The photocurrent responses varied little by changing the supplies from +5V to +15V, so only two samples were tested across the voltage range whilst the other samples were tested at only +15V.

Table 19 shows the gamma dose rate test results performed at +15V. The device survived dose rates up to 6E9 Rad(Si)/second. The photocurrent levels reached the limit at 3E8 Rad/second. The effect of the current limit at higher dose rates is shown by the extended photocurrent duration. Appendix C, Figures A4 to A6, show the CD500 photocurrent response at various dose rates.

Tables 20a and 20b show the parametric degradation experienced by the device as a result of the dose rate exposures. None of the consequent permanent degradation resulting from the dose rate exceeded the limiting ratios. However, the CTR degradation is more severe for the accumulated total dose (approximately 2k Rads for each sequence of increasing dose rates) than the degradation experienced in the Cobalt 60 total dose tests (reference Table 18). A limit to the total dose accumulated should accompany any statement as to the dose rate susceptibility of the device. This limit would be lower than the actual total dose levels derived from the total dose tests.

9. 4N55 TEST RESULTS

The 4N55 is a dual channel device. All measurements contained in the tables are repeated for each channel and distinguished by the subscript 1 or 2, respectively.

9.1 Neutron Fluence

Table 21 shows the results for the neutron control devices, characterised prior to the neutron irradiation tests and then repeated prior to the re-characterisation of the irradiated components after RUN 1 and RUN 2 VIPER exposures. The results show any measurement changes due to ambient condition changes. Any changes greater than 5% were applied to the post irradiation results to compensate for non-irradiation changes.

Table 22 contains the results of the neutron fluence tests. Values shown as zero are where the parameter measurement is too small a value for the GenRad Test System configuration (eg Icch characteristics). The data shows that the 4N55 is quite tolerant to neutron fluence, with the current transfer ratios remaining within the limit ratio until between 3E12 and 1E13 n/cm^2. At this same level, the propagation delays have increased towards their limits.

9.2 Total Dose

Tables 23a and 23b contain the results of the total dose tests. Devices 39 to 43 were exposed in 9 increments up to 1M Rad and devices 44 to 49 were exposed in pairs at 100k Rad, 300k Rad and 1M Rad.

Although some degradation was detected, the 4N55 electrical characteristics remained within the manufacturer's specification limits up to 1M Rad total dose exposure. No significant annealing was observed due to the multiple step increments.

9.3 Dose Rate

The dose rate tests were performed with the input diode connections shorted together. Three photocurrents were measured (Figure 8); CT1 monitor shorted together. Three photocurrents were measured; CT1 monitoring the photocurrent in the Channel 1 detector diode, with Vcc = Vsupply; CT2 measuring the photocurrent in the Channel 1 output transistor, with Vo = Vsupply; CT3 measuring the photocurrent in the Channel 2 output transistor, with Vo = Vsupply and Vcc = 0 volts. The output transistor collector currents were limited to approximately 16mA. The dose rate tests were performed in Samples 29 and 30 with Vsupply at +5V, +10V and +15V. All other samples were tested with Vsupply at +15V.

Table 24 contains the gamma dose rate test results performed at +15V. These show that the 4N55 survives dose rates up to 6E9 Rads(Si)/second. Photocurrents were detectable in the Channel 1 transistor at lower dose rates than in the Channel 2 transistor. This is due to injected base current as a result of photocurrents in the biased detector diode. It can also be seen that photocurrent in the Channel 2 transistor, without any base current sourced from its detector diode, is not detectable until 1E9 Rad/second. The photocurrent in the Channel 1 detector diode far exceeds the maximum specification limit for the output transistor base current. Although this is a transient condition, if currents of these levels are likely to be damaging, recommendation should be made to limit the detector diode source current.

Tables 25a and 25b show little parameter degradation as a result of the associated total dose accompanying the dose rate tests. Appendix C, figures A7 to A8 show photocurrent responses.

10. 6N134 TEST RESULTS

No propagation delay measurements were performed for this part as the delays are too small for the GenRad Component Test System to measure. In addition, where the current transfer ratio measurements were beyond the capability of the Test System the data entries are with asterisks. (For the specified input current, the output current exceeded the measurement limits. This approximates to CTR = 320%.)

10.1 Neutron Fluence

Table 26 shows the results for the neutron control devices, characterised prior to the neutron irradiation tests and then repeated prior to the re-characterisation of the irradiated components after RUN 1 and RUN 2 VIPER exposures. The results show any measurement changes due to ambient condition changes. The Ioh parameter is the only one that varied by more than 5% but this characteristic varies considerably from device to device and measurement to measurement so was not compensated for.

Table 27 contains the results of the neutron fluence tests. The current transfer ratio did not degrade sufficiently to be measured by the test system (greater than 320%). All the other characteristics were well within the limit ratios.

10.2 Total Dose

Tables 28a and 28b contain the results of the total dose tests. Devices 39 to 43 were exposed in 9 increments up to 1M Rad and Devices 44 to 49 were exposed in pairs at 100k Rad, 300k Rad and 1M Rad.

Comparison of Tables 28a and 28b showed no annealing having occurred during the multiple step irradiations.

Although some slight degradation was detected, the 6N134 electrical characteristics remained well within the manufacturer's specification limits up to 1M Rad total dose exposure.

10.3 Dose Rate

The dose rate tests were performed with the device configured as shown in Figure 9. Channel 1 was biased (input diode shorted) to provide a high output and Channel 2 was biased to provide a low output (If approximately 13mA). The outputs of Channel 1 and Channel 2 (V01 and V02) were monitored to detect any transient upset caused by the dose rate.

Table 29 contains the results of the dose rate tests. The dose rate was monitored in the Vcc connection and had no external limit applied.

The 6N134 survived dose rates up to 6E9 Rad (Si)/second and the photocurrents caused little parametric degradation, as shown in Table 30 (all ratios are approximately one). The output experienced a transient upset, with the high output showing greater sensitivity. Appendix C, Figures A9 and A10 show 6N134 photocurrent responses and transient upsets for various dose rates.

11. 6N140 TEST RESULTS

The test result tables show asterisks where the GenRad Test System cannot perform measurements with the test conditions that we applied. For CTR measurements, this occurs when the output current exceeds the measurement limit. For propagation delays, this occurs when timings become too fast or longer than the measurement limits and for voltage measurements, this occurs when voltages are too small, relative to their normal values.

11.1 Neutron Fluence

Table 31 shows the results for the neutron control devices, characterised prior to the neutron irradiation tests and then repeated prior to the re-characterisation of the irradiated components after RUN 1 and RUN 2 VIPER exposures. Only selected parameters were monitored for control purposes. Due to damage to the control samples during test development, the data reduction ratios were not calculated and absolute values are given. The results show only small measurement changes due to ambient conditions, and there was no need to compensate for the ambient changes.

Table 32 contains the results of the neutron fluence tests. The current transfer ratios degraded below the limit ratio between 3E12 and 1E13 n/cm^2. As the CTR degraded, the propagation delays were extended.

11.2 Total Dose

Tables 33a and 33b contain the results of the total dose tests. Devices 39 to 43 were exposed in 9 increments up to 1M Rad and Devices 44 to 49 were exposed in pairs at l00k Rad, 300k Rad and 1M Rad.

The current transfer ratio, CTRl degraded to less than the limit ratio between 30k Rad and 50k Rad, CTR2 at between l00k Rad and 200k Rad and CTR3 at greater than 1M Rad. The parameter VOLl also degraded significantly at comparable exposures.

11.3 Dose Rate

The dose rate tests were performed with the device configured as shown in Figure 10. Channels 1 and 2 inputs were configured to set their outputs high and channels 3 to 4 biased to set their outputs low. The outputs of channel 1 (V0l) and channel 3 (V03) were monitored to detect transient upset. The photocurrent was monitored in the Vcc supply line, with no external current limiting. The supply voltage was set at +5V, +l0V and +l5V. (Figure 10 shows the +l5V configuration.)

Table 34 contains the results of the dose rate tests. The 6N140 survived dose rates up to 6E9 Rad(Si) /second, although large photocurrents were generated. The outputs experienced transient upsets, with the normally high output being more sensitive. The electrical characteristics suffered little degradation as a result of the dose rate tests.

Appendix C, Figures A11 to Al3 show photocurrent responses and transient upsets at various dose rates.

12. CONCLUSIONS

12.1 CS201

12.1.1 **Neutrons**

The CS201 is very susceptible to neutrons. This device would have to be significantly degraded to be specified hard to any appreciable neutron fluence level (eg. larger If and lower CTR).

12.1.2 **Total Dose**

Without any derating, the CS201 is hard to 50k Rad(Si).

12.1.3 **Dose Rate**

The CS201 is hard to 6E9 Rad(Si)/second, provided the accompanying high dose rate accumulated total dose does not exceed 2k Rad(Si). The output voltage will show transient upset (voltage drop) for the photocurrent duration (up to 14µS).

12.2 CD500

12.2.1 **Neutrons**

The CD500 is susceptible to neutrons, being hard only up to lEll n/cm^2. This device would have to be derated to be specified as hard to any higher fluence (eg. larger If and smaller CTR).

12.2.2 **Total Dose**

Without any derating, the CD500 is hard to 200k Rads(Si).

12.2.3 **Dose Rate**

The CD500 is hard to 6E9 Rad(Si)/second although any specification should apply a high dose rate accumulated dose rate not to exceed 6k Rad(Si). The output will show transient upset (voltage drop) for the photocurrent duration (up to 17µS).

12.3 4N55

12.3.1 **Neutrons**

The 4N55 is hard to 3E12 n/cm$^{2.}$

12.3.2 **Total Dose**

The 4N55 is hard to 1M Rad(Si).

12.3.3 **Dose Rate**

The 4N55 is hard to 6E9 Rad(Si)/second. The output will show transient upset (voltage drop) for the photocurrent duration (up to 5µS).

12.4 6N134

12.4.1 **Neutrons**

The 6N134 is hard to 1E13 n/cm^2.

12.4.2 **Total Dose**

The 6N134 is hard to 1M Rad(Si).

12.4.3 **Dose Rate**

The 6N134 is hard to 6E9 Rad(Si)/second. Photocurrent demands on Vcc are up to 1.5 Amps and up to 15 microseconds of transient upset to the outputs may be experienced.

12.5 6N140

12.5.1 **Neutrons**

The 6N140 is hard to 3E12 n/cm2

12.5.2 **Total Dose**

The 6N140 is hard to 30k Rad(Si). The hardness would be improved by degrading the characteristics (eg increased If for reduced CTR)

12.5.3 **Dose Rate**

The 6N140 is hard to 6E9 Rad(Si) /second. Photocurrent demands on Vcc are up to 5.2 Amps. Up to 9 microseconds of transient upset to the outputs may be experienced.

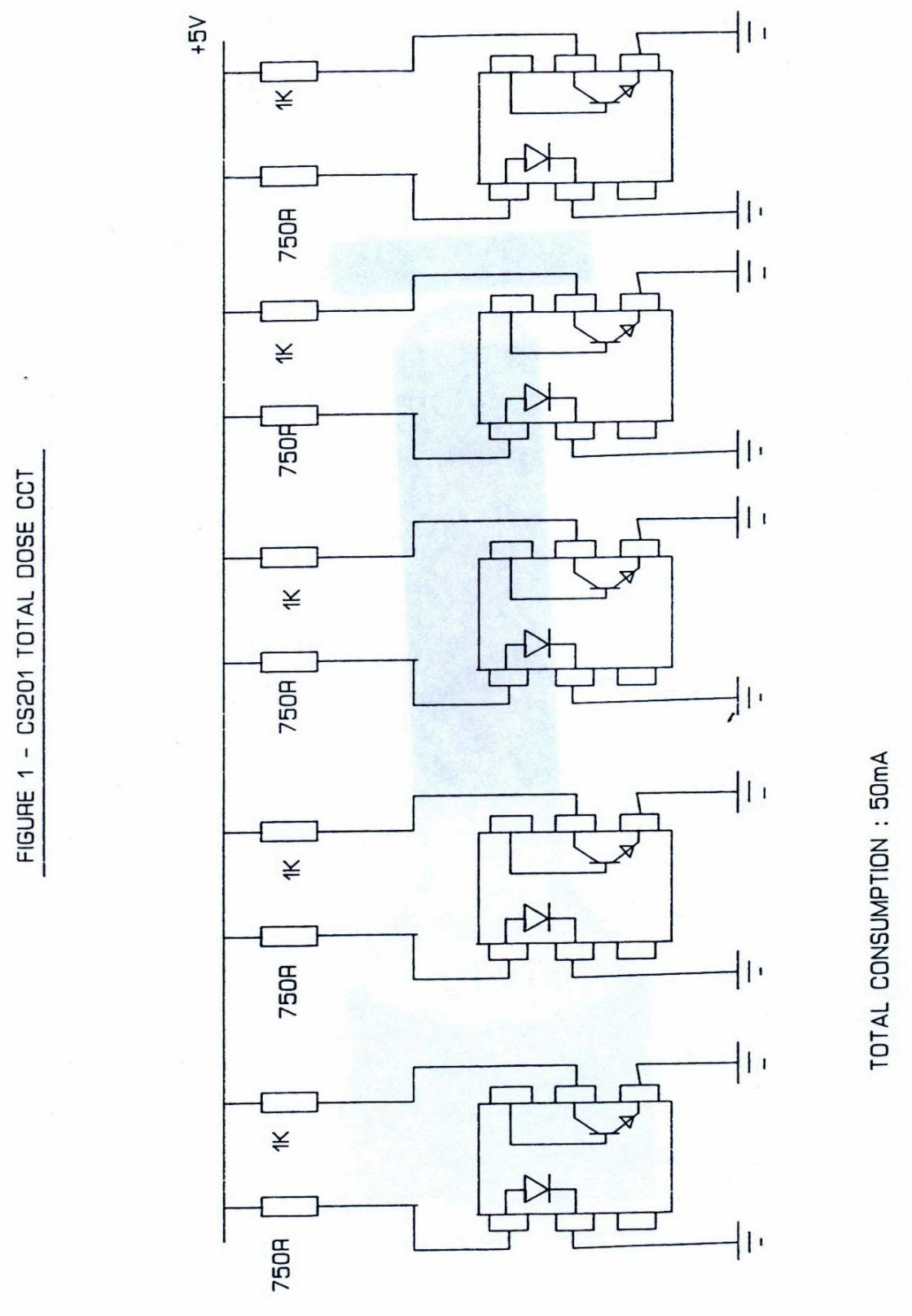

FIGURE 1 - CS201 TOTAL DOSE CCT

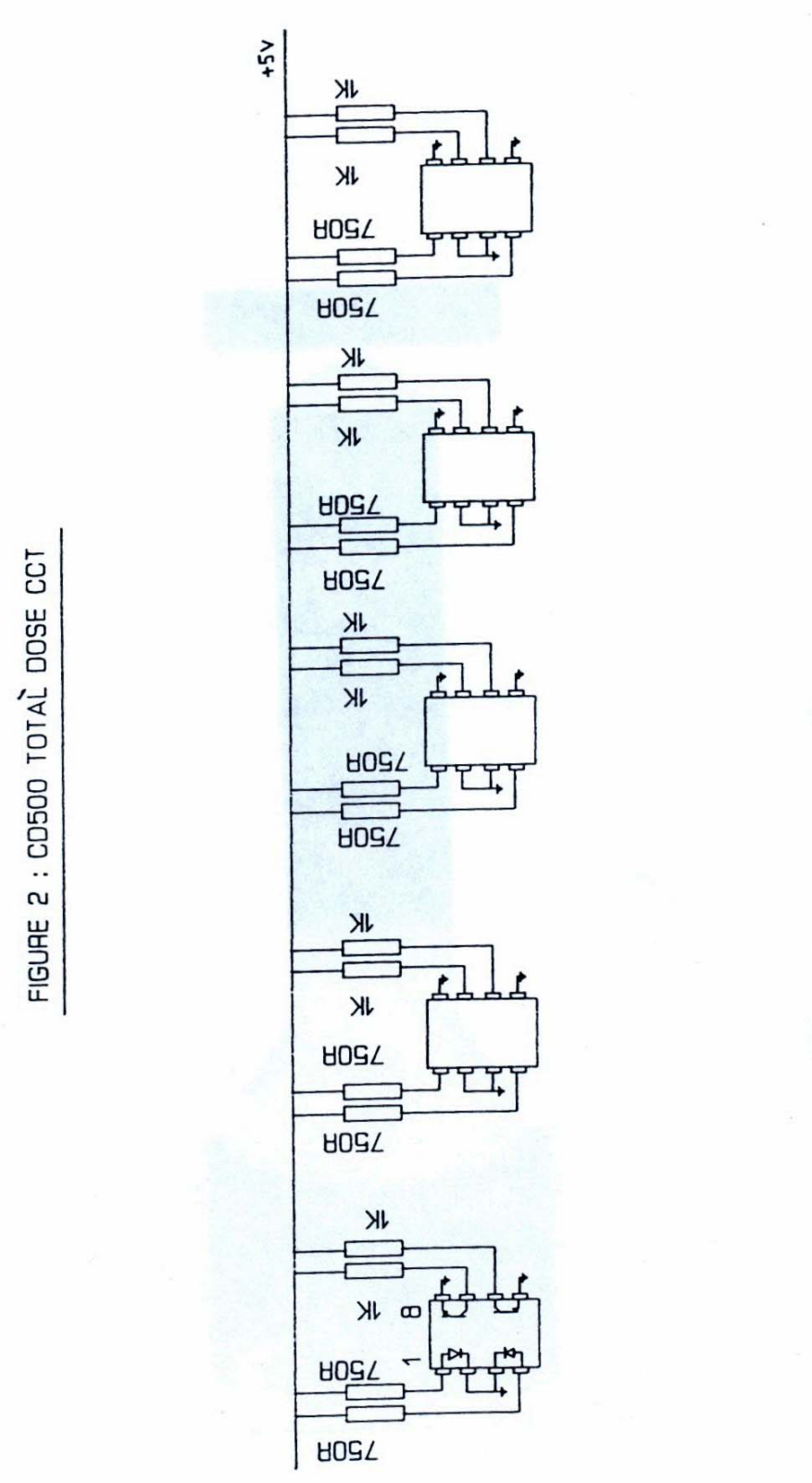

FIGURE 2 : CD500 TOTAL DOSE CCT

TOTAL CONSUMPTION : 100mA

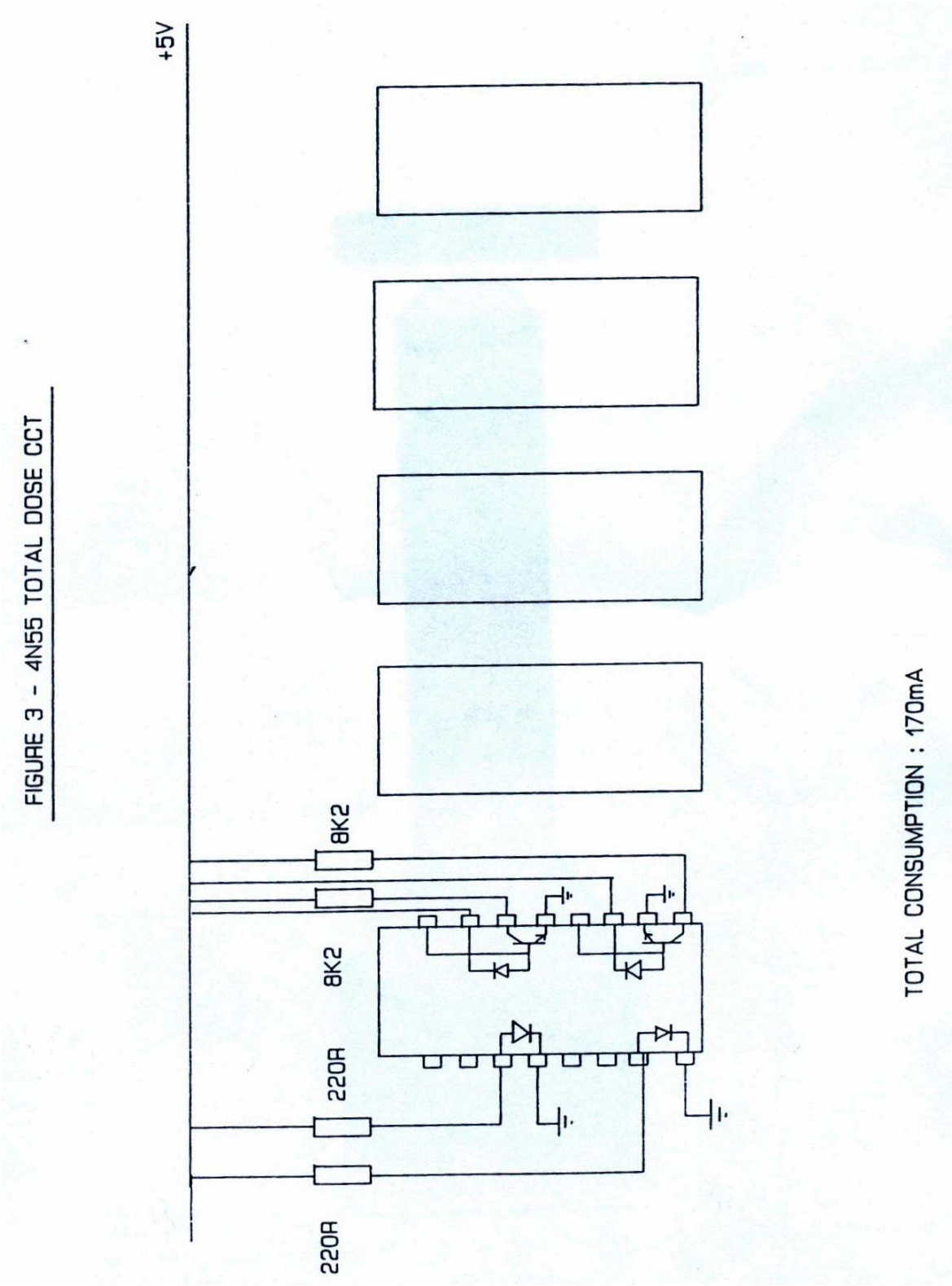

FIGURE 3 - 4N55 TOTAL DOSE CCT

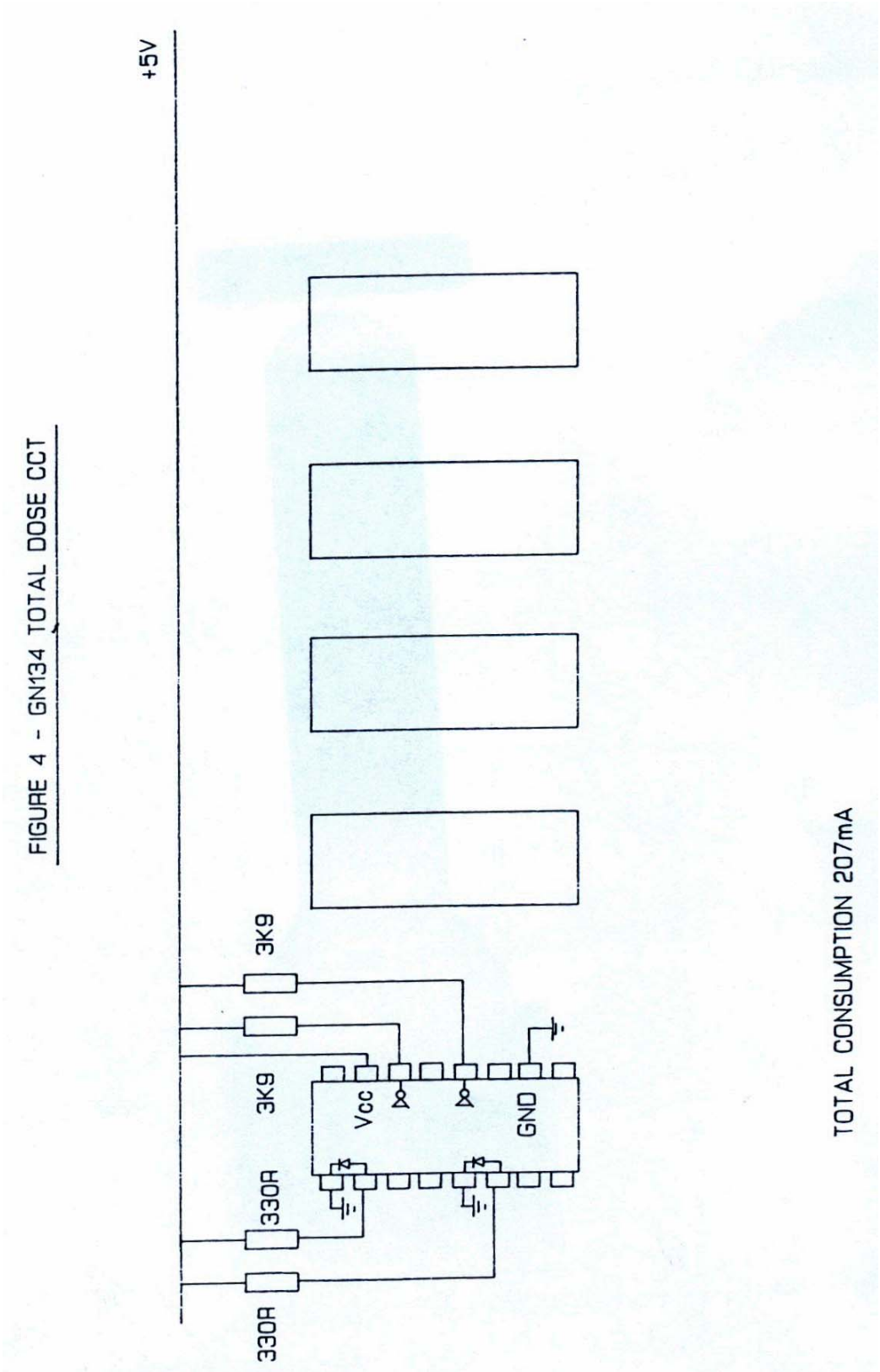

FIGURE 4 - GN134 TOTAL DOSE CCT

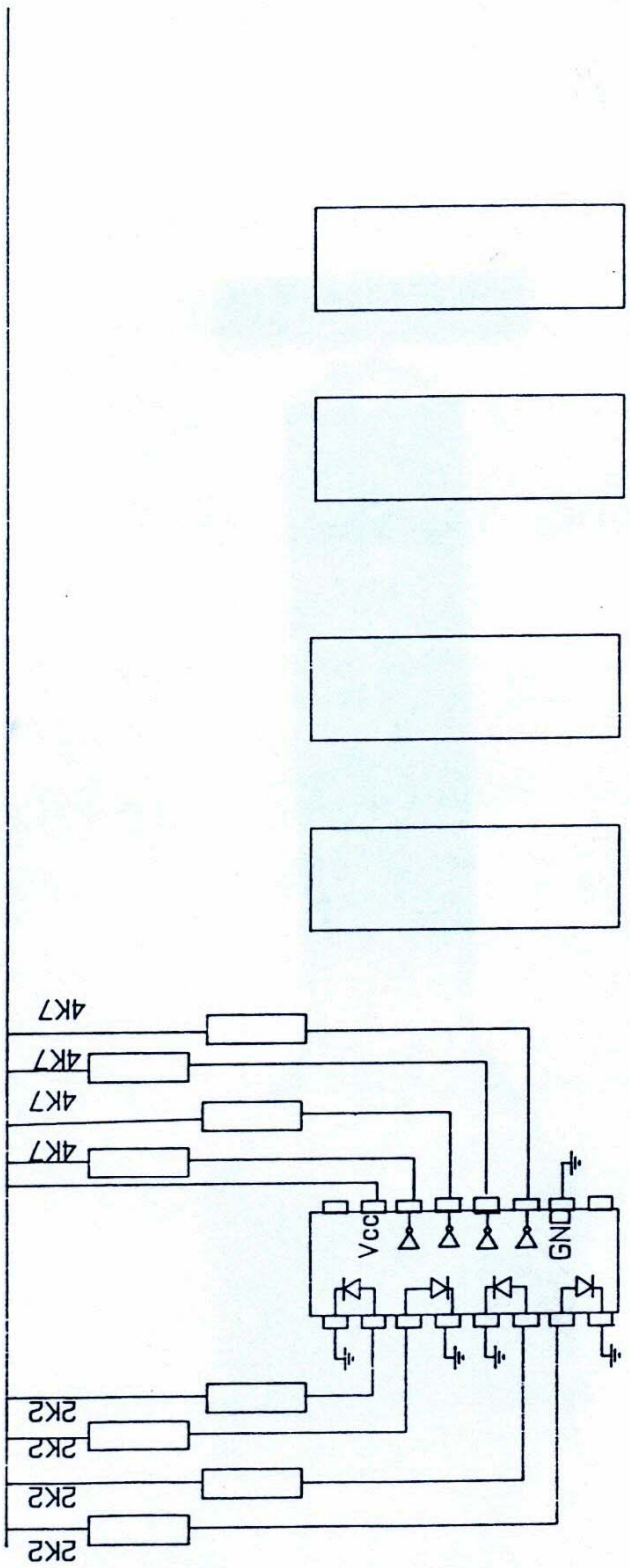

FIGURE 5 : 6N140 TOTAL DOSE CCT

TOTAL CONSUMPTION : 54mA

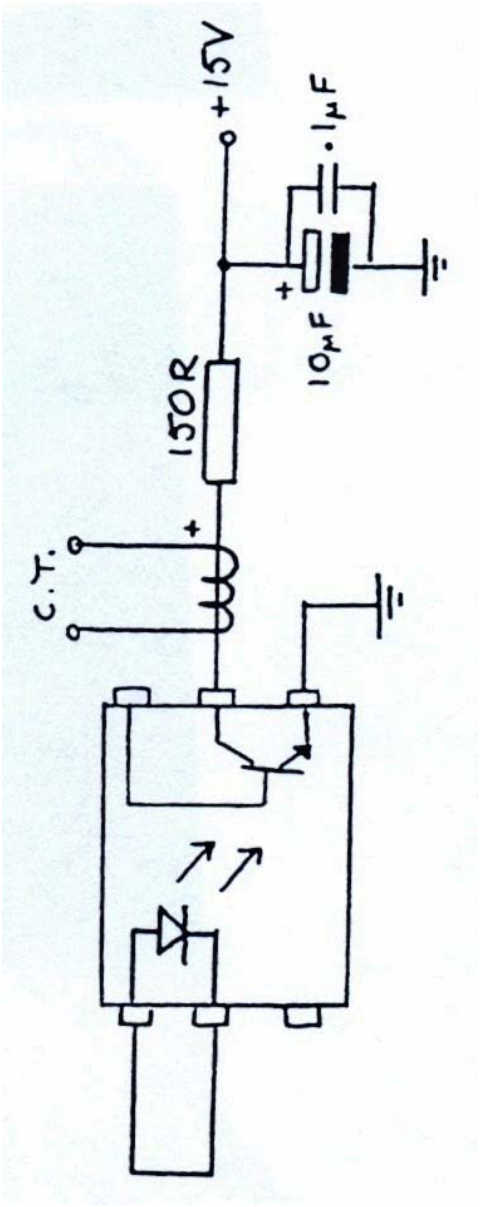

FIGURE 6: CS201 DOSE RATE TEST CIRCUIT

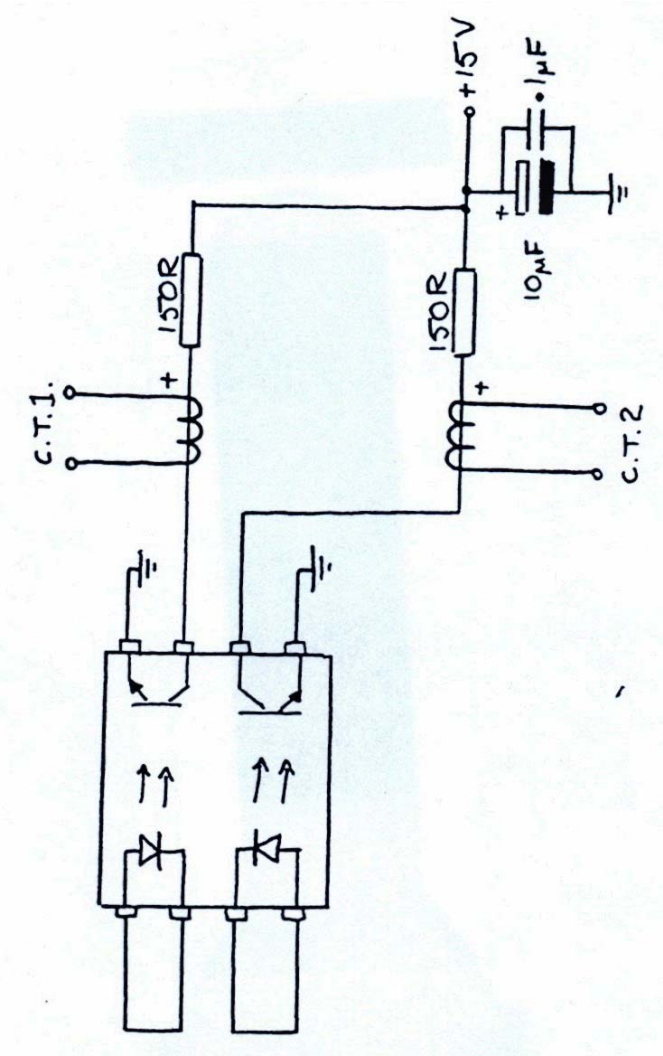

FIGURE 7: CD500 DOSE RATE TEST CIRCUIT

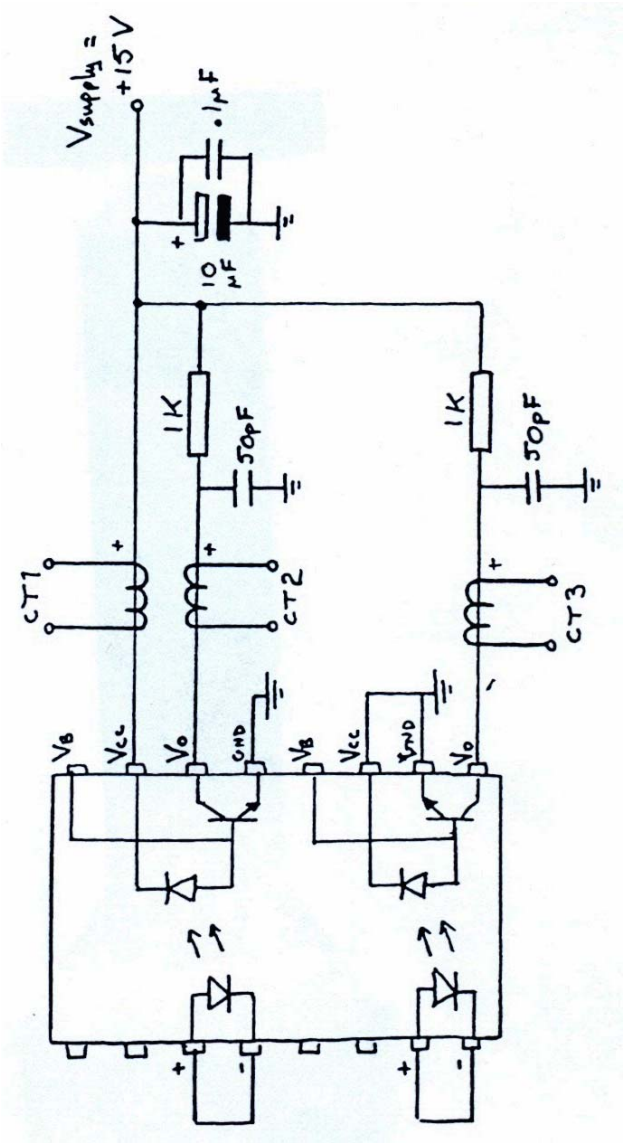

FIGURE 8: 4N55 DOSE RATE TEST CIRCUIT

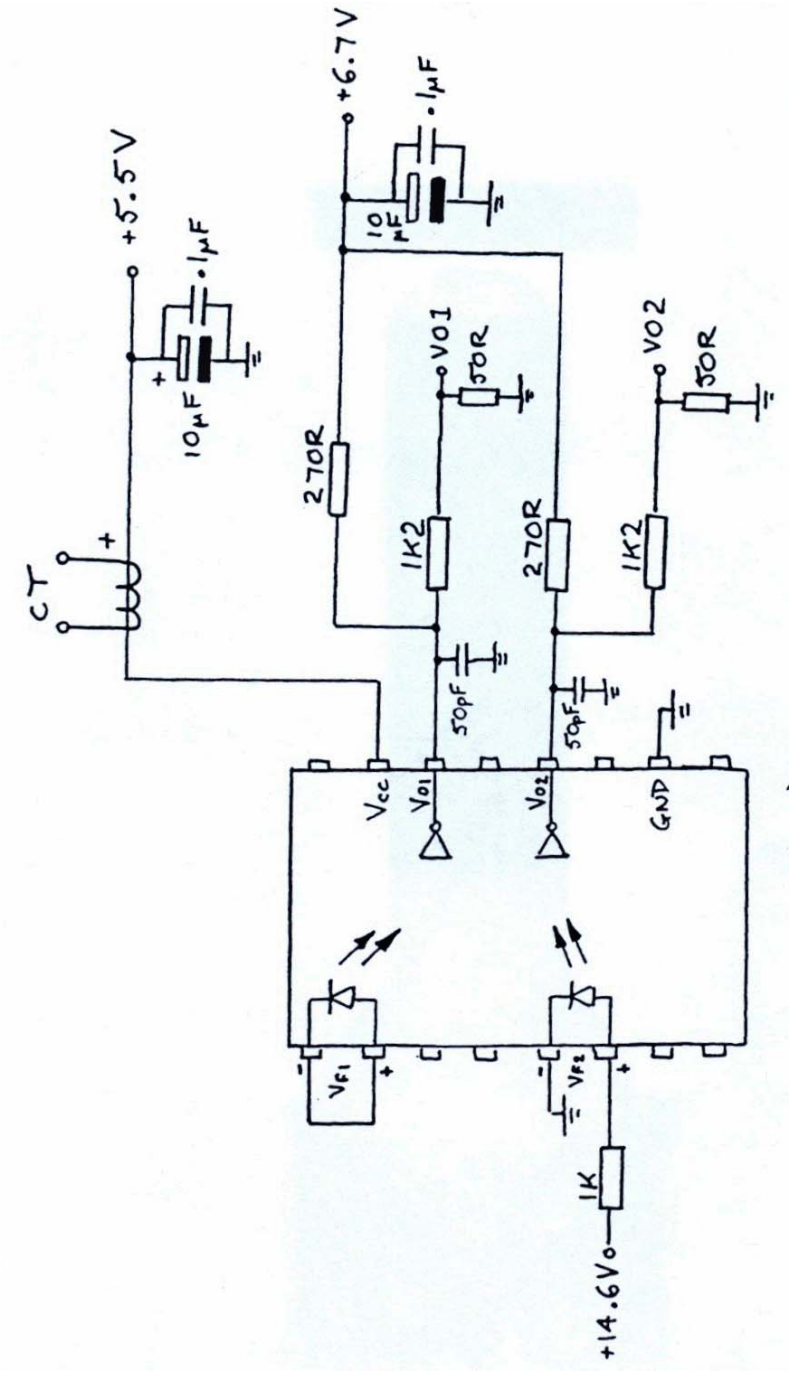

FIGURE 9: 6N134 DOSE RATE TEST CIRCUIT

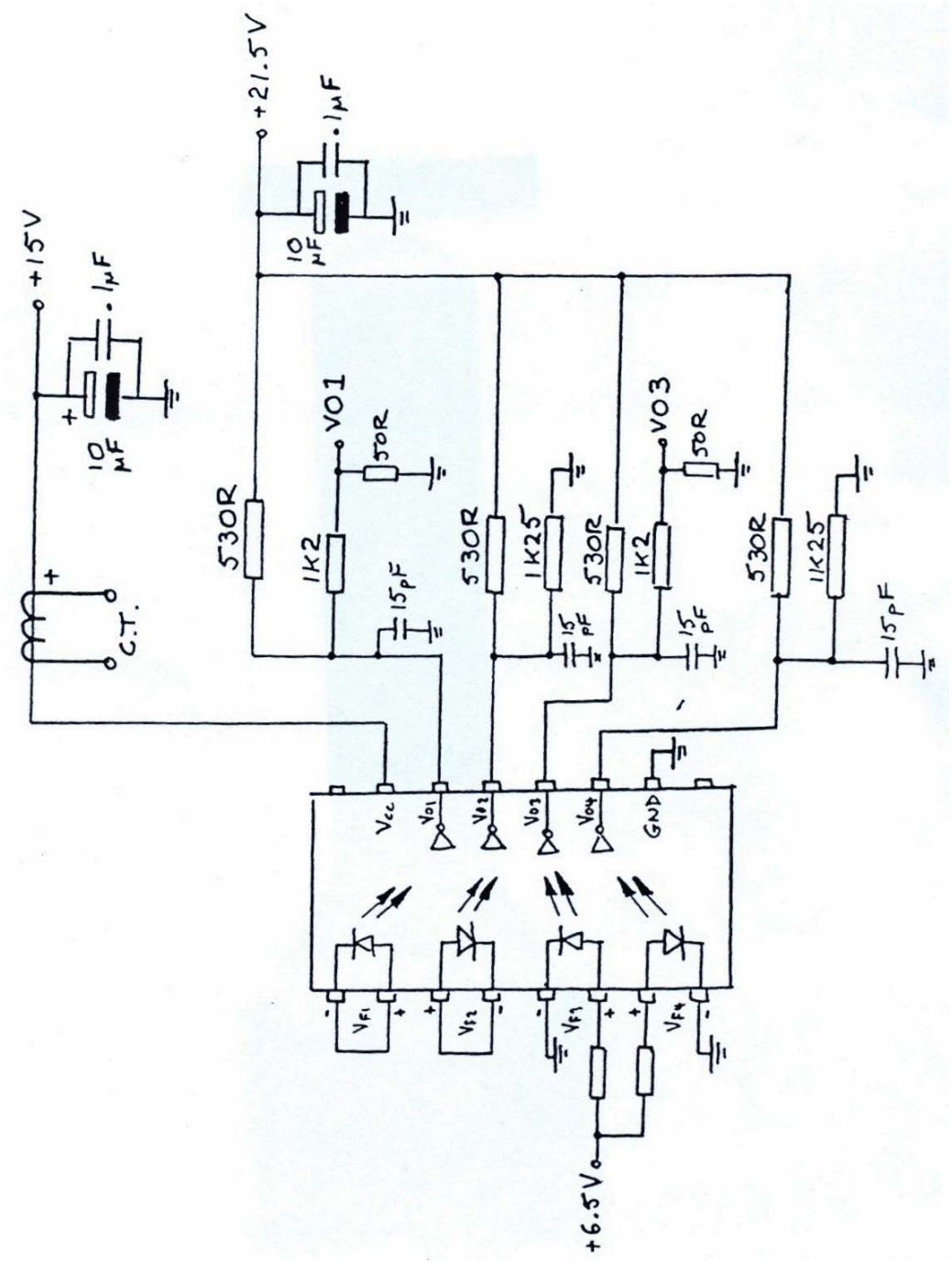

FIGURE 10: 6N140 DOSE RATE TEST CIRCUIT

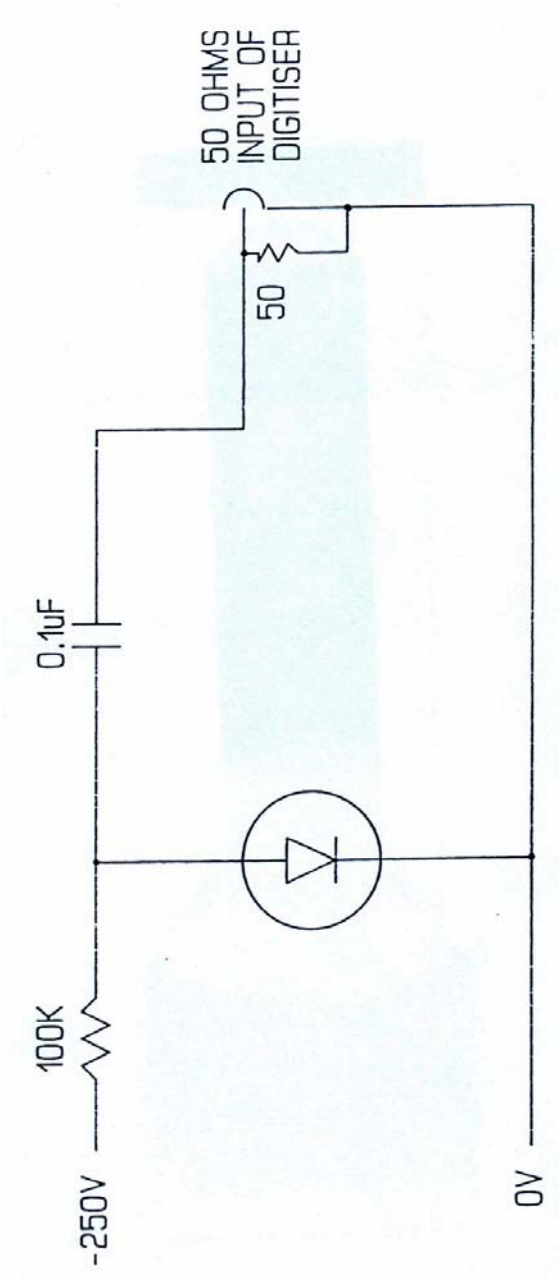

FIGURE 11: STANDARD GD1 PIN DETECTOR DIODE CONFIGURATION

TABLE 1:

CS201 ELECTRICAL CHARACTERISTIC TEST CONDITIONS

PARAMETER	TEST CONDITION
INPUT DIODE	
Forward Voltage, Vf	If = 10mA
Reverse Breakdown Voltage, BVR	Ir = 0.1mA
Reverse Current, Ir	Vr = 3V
OUTPUT DETECTOR	
Collector-Emitter Breakdown Voltage, BVCEO	Ic = 1mA
Collector-Base Breakdown Voltage, BVCBO	Ib = 0.1mA
Emitter-Collector Breakdown Voltage, BVECO	Ie = 0.1mA
Emitter-Base Breakdown Voltage, BVEBO	Ib = 0.1mA
Collector-Emitter Leakage Current, ICEO	Vce = 20V, If = 0
COUPLED	
DC Current Transfer Ratio 1, CTR1	If = 10mA, Vce = 5V
DC Current Transfer Ratio 2, CTR2	If = 1mA, Vce = 5V
Collector-Emitter Saturation Voltage, VCESAT	If = 10mA, Ic = 2.5mA
Turn On Time, Ton	Vcc = 5V, If = 5mA, R1 = 1k ohm, Vsense = 0.83V
Turn Off Time, Toff	Vcc = 5V, If = 5mA, R1 = 1k ohm, Vsense = 4.3V

TABLE 2:

CD500 ELECTRICAL CHARACTERISTIC TEST CONDITIONS

PARAMETER	TEST CONDITION
Forward Voltage (Vf)	If = 20mA
Reverse Breakdown Voltage (Vr)	Ir = 0.1mA
Reverse Current (Ir)	Vcr = 3V
Collector-Emitter Leakage Current (ICEO)	Vcc = 10V, If = 0A
Collector-Emitter Breakdown Voltage (BVCEO)	Ic = 1mA
Emitter-Collector Breakdown Voltage (BVECO)	Ie = 0.1mA
Current Transfer Ratio 1 (CTR)	If = 10mA, Vce = 5V
Current Transfer Ratio 2 (CTR)	If = 1mA, Vce = 5V
Collector-Emitter Saturation Voltage (VCESAT)	If = 16mA, Ic = 2mA
Turn On Time	Vcc = 5V, R1 = 1k ohm, If = 5mA, Vsense = 0.83V
Turn Off Time	Vcc = 5V, R1 = 1k ohm, If = 5mA, Vsense = 4.3V

TABLE 3:

4N55 ELECTRICAL CHARACTERISTIC TEST CONDITIONS

PARAMETER	TEST CONDITION
Low Level Supply Current (ICCL)	Vcc = 18V, If = 20mA, Lf = 20mA
High Level Supply Current (ICCH)	Vcc = 18V, If = 20mA, Lf = 0A
High Level Output Current (IOH)	Vcc = 18V, If = 0, Lf = 20mA
High Level Output Leakage Current (IOHL)	Vcc = 18V, If = 250µA, Lf = 20mA
Input Forward Voltage (Vf)	If = 20mA
Input Reverse Breakdown Voltage (Vbr)	Ir = 50µA
Current Transfer Ratio (CTR)	Vo = 0.4V, If = 16mA, Vcc = 4.5V
Propagation Delay Time to High Output Level (tPLH)	R1 = 8.2k ohms, C1 = 50pF, If = 16mA, Vcc = 5V, Vsense = 2V
Propagation Delay Time to Low Output Level (tPHL)	R1 = 8.2k ohms, C1 = 50pF, If = 16mA, Vcc = 5V, Vsense = 800mV

NOTE: Lf is used to represent If of other channel.

TABLE 4:

6N134 ELECTRICAL CHARACTERISTIC TEST CONDITIONS

PARAMETER	TEST CONDITION
High Level Output Current (IOH)	Vcc = 5.5V, If = 250µA, Vo = 5.5V
Input Reverse Breakdown Voltage (Vbr)	Ir = 50µA
High Level Supply Current (ICCH)	Vcc = 5.5V, If = 0
Low Level Supply Current (ICCC)	Vcc = 5.5V, If =20mA
Low Level Output Voltage (Vol)	Vcc = 5.5V, If = 10mA, Iol = 10mA
Input Forward Voltage (Vf)	If = 20mA
Current Transfer Ratio (CTR)	Vo = 0.6V, If = 10mA, Vcc = 5.5V

TABLE 5:

6N140 ELECTRICAL CHARACTERISTIC TEST CONDITIONS

PARAMETER	TEST CONDITION
High Level Output Current (IOH)	Vcc = 18V, Vo = 18V, If = 2µA
Low Level Output Voltage 1 (VOL1)	If = 0.5mA, Iol = 1.5mA, Vcc = 4.5V
Low Level Output Voltage 2 (VOL2)	If = 5mA, Iol = 10mA, Vcc = 4.5V
High Level Supply Current (ICCH)	Vcc = 18V, If = 0
Low level Supply Current (ICCC)	Vcc = 18V, If = 1.6mA
Input Forward Voltage (Vf)	If = 1.6mA
Input Reverse Breakdown Voltage (Vbr)	Ir = 50µA
Current Transfer Ratio 1	Vcc = 4.5V, Vo = 0.4V, If = 0.5mA
Current Transfer Ratio 2	Vcc = 4.5V, Vo = 0.4V, If = 1.6mA
Current Transfer Ratio 3	Vcc = 4.5V, Vo = 0.4V, If = 5mA

TABLE 6:

CS201 CHARACTERISATION COMPLIANCE LIMITS (NO DEVICE)

PARAMETER		PRE IRRAD	RUN 1	RUN 2
ICEO	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
VF	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
VCESAT	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
CTR 1	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
CTR 2	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
BVECO	Mean	-69.00V	.9783	.9696
	SD	0.00V	.0000	.0000
	95%		.9783	.9696
BVCBO	Mean	114.00V	.9737	.9737
	SD	0.00V	.0000	.0000
	95%		.9737	.9737
BVCEO	Mean	119.00V	.9748	.9664
	SD	1.35µV	.0000	.0000
	95%		.9748	.9664
BVEBO	Mean	69.90V	.9599	.9485
	SD	0.00V	.0000	.0000
	95%		.9599	.9485
BVR	Mean	-68.90V	.9797	.9695
	SD	0.00V	.0000	.0000
	95%		.9797	.9695
IR	Mean	91.50pA	*****	*****
	SD	0.00A	*****	*****
	95%		*****	*****
TON	Mean	25.60µS	1.000	1.000
	SD	0.00S	.0000	.0000
	95%		1.000	1.000
TOFF	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****

TABLE 7:

CD500 CHARACTERISATION COMPLIANCE LIMITS (NO DEVICE)

PARAMETER		PRE IRRAD	RUN 1	RUN 2
ICEO	Mean	762.00pA	*****	*****
	SD	0.00A	*****	*****
	95%		*****	*****
VF	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
VCESAT	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
CTR 1	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
CTR 2	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
BVECO	Mean	-68.90V	.9826	.9746
	SD	0.00V	.0000	.0000
	95%		.9826	.9734
BVCEO	Mean	119.00V	.9748	.9748
	SD	1.35µV	.0000	.0000
	95%		.9748	.9748
BVR	Mean	-68.90V	.9869	.9768
	SD	0.00V	.0000	.0000
	95%		.9869	.9768
IR	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
TON	Mean	25.60µS	1.000	1.000
	SD	0.00S	.0000	.0000
	95%		1.000	1.000
TOFF	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****

TABLE 8:

4N55 CHARACTERISATION COMPLIANCE LIMITS (NO DEVICE)

PARAMETER		PRE IRRAD	RUN 1	RUN 2
ICCL1	Mean	0.00A	*****	*****
	SD	0.00A	*****	*****
	95%		*****	*****
ICCL2	Mean	152.00nA	.6020	1.303
	SD	0.00A	.0000	.0000
	95%		.6020	1.303
ICCH1	Mean	0.00A	*****	*****
	SD	0.00A	*****	*****
	95%		*****	*****
ICCH2	Mean	0.00A	*****	*****
	SD	0.00A	*****	*****
	95%		*****	*****
IOH1	Mean	0.00A	*****	*****
	SD	0.00A	*****	*****
	95%		*****	*****
IOH2	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
IOHL1	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
IOHL2	Mean	106.00	.7189	2.009
	SD	0.00A	.0000	.0000
	95%		.7189	2.009
VF1	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
VF2	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
VBR1	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
VBR2	Mean	-39.20V	*****	*****
	SD	476.84nV	*****	*****
	95%		*****	*****
CTR1	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
CTR2	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****

TABLE 8:

4N55 CHARACTERISATION COMPLIANCE LIMITS (NO DEVICE) CONTINUED

PARAMETER		PRE IRRAD	RUN 1	RUN 2
TPLH1	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
TPLH2	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
TPHL1	Mean	25.60µS	1.000	1.000
	SD	0.00S	.0000	.0000
	95%		1.000	1.000
TPHL2	Mean	25.60µS	1.000	1.000
	SD	0.00S	.0000	.0000
	95%		1.000	1.000

TABLE 9:

6N134 CHARACTERISATION COMPLIANCE LIMITS (NO DEVICE)

PARAMETER		PRE IRRAD	RUN 1	RUN 2
ICCH	Mean	46.80µA	1.250	.3333
	SD	0.00A	.0000	.0000
	95%		1.250	.3333
ICCL	Mean	74.20µA	.1053	.1053
	SD	0.00A	.0000	.0000
	95%		.1053	.1053
IOH	Mean	674.00pA	*****	1.000
	SD	0.00A	*****	.0000
	95%		*****	1.000
VOL	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
VF	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
VR	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
CTR	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****

TABLE 10:

6N140 CHARACTERISATION COMPLIANCE LIMITS (NO DEVICE)

PARAMETER		PRE IRRAD	RUN 1	RUN 2
ICCH	Mean	0.00A	*****	*****
	SD	0.00A	*****	*****
	95%		*****	*****
ICCL	Mean	22.20µA	1.027	.9324
	SD	0.00A	.0000	.0000
	95%		1.027	.9324
IOH	Mean	449.33pA	1.000	2.995
	SD	317.73pA	.0000	2.941
	95%		1.000	7.848
VOL1	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
VOL2	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
VF	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
VR	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
CTR 1	Mean	1.17%	*****	*****
	SD	14.90n%	*****	*****
	95%		*****	*****
CTR 2	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
CTR 3	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
TPLH1	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
TPHL1	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
TPLH2	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
TPHL2	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****

TABLE 11:

CS201 NEUTRON CONTROL DEVICES

PARAMETER		PRE IRRAD	RUN 1	RUN 2
ICEO	Mean	1.46nA	4.267	9.813
	SD	1.06nA	2.809	.4692
	95%		8.903	10.59
VF	Mean	1.16V	1.009	1.009
	SD	0.00V	.0000	.0000
	95%		1.009	1.009
VCESAT	Mean	111.33mV	.9670	.9731
	SD	1.25mV	.0046	.0073
	95%		.9596	.9610
CTR 1	Mean	171.67%	1.014	1.008
	SD	5.19%	.0030	.0029
	95%		1.019	1.013
CTR 2	Mean	80.07%	1.063	1.052
	SD	9.59%	.0158	.0148
	95%		1.089	1.077
BVECO	Mean	-8.51V	.9984	.9988
	SD	16.33mV	.0006	.0010
	95%		.9975	.9972
BVCBO	Mean	114.00V	.9766	.9678
	SD	0.00V	.0041	.0041
	95%		.9698	.9610
BVCEO	Mean	84.40V	.9964	.9976
	SD	1.64V	.0001	.0000
	95%		.9963	.9976
BVEBO	Mean	8.01V	.9938	.9946
	SD	17.00mV	.0010	.0006
	95%		.9921	.9936
BVR	Mean	-56.50V	.9906	.9923
	SD	12.09V	.0027	.0013
	95%		.9862	.9902
IR	Mean	396.33pA	.1544	1.347
	SD	351.33pA	.1187	.0000
	95%		<0	1.347
TON	Mean	12.80µS	1.000	1.000
	SD	0.00S	.0000	.0000
	95%		1.000	1.000
TOFF	Mean	23.20µS	.9235	.9235
	SD	2.36µS	0.564	0.564
	95%		.8303	.8303

TABLE 12:

CS201 NEUTRON FLUENCE

PARAMETER		PRE IRRAD	1E11 n/cm^2	3E11 n/cm^2	1E12 n/cm^2	3E12 n/cm^2	1E13 n/cm^2	LIMIT RATIO
ICEO	Mean	12.84nA	.7695	.4677	.4505	.5544	.3130	7.79
	SD	7.29nA	.3951	.6910	.3273	.2719	.1764	
	95%		.1177	<0	<0	.1057	.0219	
VF	Mean	1.16V	1.007	.9896	.9706	.9687	.9448	1.21, 0.43
	SD	8.89mV	.0136	.0034	.0070	.0210	.0118	
	95%		1.029	.9840	.9590	.9340	.9254	
VCESAT	Mean	112.28mV	1.517	*****	*****	*****	*****	2.67
	SD	3.38mV	.0301	*****	*****	*****	*****	
	95%		1.567	*****	*****	*****	*****	
CTR 1	Mean	168.08%	.3706	.0907	*****	*****	*****	0.59
	SD	15.98%	.0133	.0076	*****	*****	*****	
	95%		.3487	.0782	*****	*****	*****	
CTR 2	Mean	82.33%	.1987	.0322	.0130	.0149	*****	0.48
	SD	9.41%	.0149	.0033	.0015	.0000	*****	
	95%		.1741	.0268	.0105	.0149	*****	
BVECO	Mean	-8.49V	.9995	.9986	.9965	.9941	.9899	0.82
	SD	9.43mV	.0006	.0005	.0000	.0000	.0006	
	95%		.9986	.9978	.9965	.9941	.9889	
BVCBO	Mean	113.92V	.9825	.9825	.9649	.9719	.9860	0.61
	SD	391.92mV	.0000	.0000	.0000	.0035	.0069	
	95%		.9825	.9825	.9649	.9661	.9746	
BVCEO	Mean	82.94V	1.012	1.041	1.120	1.249	1.411	0.60
	SD	331.06mV	.0008	.0014	.0030	.0092	.0027	
	95%		1.013	1.043	1.125	1.264	1.415	
BVEBO	Mean	7.98V	.9940	.9942	.9952	.9960	.9952	0.63
	SD	11.89mV	.0005	.0006	.0005	.0005	.0012	
	95%		.9932	.9932	.9944	.9952	.9932	
BVR	Mean	-41.84V	.9970	1.026	1.036	1.038	1.001	0.17
	SD	20.16V	.0101	.0664	.0835	.0436	.0166	
	95%		.9802	1.136	1.173	1.110	1.029	
IR	Mean	308.05pA	.2007	3.048	30.00	17.83	*****	32.4
	SD	380.43pA	.0000	2.952	.0000	10.17	*****	
	95%		.2007	7.919	30.00	34.61	*****	
TON	Mean	12.43µS	1.966	2.274	2.000	2.272	2.000	1.21
	SD	1.44µS	.0686	.5474	.0000	.5438	.0000	
	95%		2.079	3.177	2.000	3.169	2.000	
TOFF	Mean	23.58µS	.2860	*****	*****	*****	*****	1.91
	SD	1.36µS	.0471	*****	*****	*****	*****	
	95%		.2083	*****	*****	*****	*****	

TABLE 13a:

CS201 TOTAL DOSE, SMALL INCREMENTS

PARAMETER		PRE IRRAD	10 kRAD	20 kRAD	30 kRAD	50 kRAD	100 kRAD	200 kRAD	300 kRAD	500 kRAD	1 MRAD	LIMIT RATIO
ICEO	Mean	7.82nA	1.949	2.593	2.322	3.219	3.107	1.979	5.856	3.551	3.026	12.79
	SD	6.19nA	1.868	2.128	2.375	2.897	2.900	.7646	4.973	3.097	2.027	
	95%		5.031	6.104	6.240	7.999	7.892	3.240	14.06	8.661	6.371	
VF	Mean	1.16V	.9966	1.003	.9949	.9966	.9949	.9931	.9777	.9811	.9691	1.21, 0.43
	SD	12.00mV	.0068	.0042	.0042	.0042	.0042	.0034	.0041	.0064	.0069	
	95%		.9853	1.010	.9880	.9897	.9880	.9874	.9710	.9706	.9576	
VCESAT	Mean	108.60mV	1.050	1.075	1.123	1.175	1.338	1.572	1.902	*****	*****	2.76
	SD	2.64mV	.0074	.0040	.0047	.0053	.0091	.0137	.0379	*****	*****	
	95%		1.062	1.082	1.131	1.183	1.353	1.594	1.965	*****	*****	
CTR 1	Mean	175.00%	.9223	.8617	.8056	.7119	.5370	.3439	.2230	.1186	.0404	0.57
	SD	12.25%	.0049	.0051	.0059	.0080	.0083	.0099	.0083	.0054	.0025	
	95%		.9143	.8533	.7958	.6987	.5234	.3275	.2094	.1098	.0363	
CTR 2	Mean	89.10%	.8845	.8112	.7303	.6279	.4338	.2606	.1630	.0840	.0265	0.45
	SD	8.45%	.0108	.0115	.0065	.0100	.0108	.0102	.0110	.0041	.0035	
	95%		.8666	.7922	.7195	.6114	.4160	.2438	.1449	.0772	.0207	
BVECO	Mean	-8.48V	1.000	1.000	1.001	1.001	1.002	1.001	1.003	1.001	1.003	0.82
	SD	11.66mV	.0009	.0005	.0005	.0007	.0006	.0007	.0006	.0009	.0005	
	95%		1.002	1.001	1.002	1.002	1.003	1.002	1.004	1.003	1.003	
BVCBO	Mean	114.00V	.9930	1.000	.9947	1.000	.9947	1.005	1.000	1.002	1.000	0.61
	SD	0.00V	.0035	.0000	.0043	.0000	.0043	.0043	.0000	.0035	.0000	
	95%		.9872	1.000	.9876	1.000	.9876	1.012	1.000	1.008	1.000	
BVCEO	Mean	82.94V	1.003	1.004	1.006	1.007	1.012	1.019	1.029	1.043	1.077	0.60
	SD	300.67mV	.0012	.0006	.0005	.0005	.0005	.0009	.0005	.0008	.0012	
	95%		1.005	1.005	1.007	1.008	1.013	1.020	1.030	1.045	1.079	
BVEBO	Mean	7.95V	1.002	1.002	1.003	1.003	1.004	1.003	1.005	1.003	1.005	0.63
	SD	8.00mV	.0005	.0005	.0006	.0000	.0005	.0000	.0000	.0006	.0005	
	95%		1.003	1.002	1.004	1.003	1.005	1.003	1.005	1.004	1.006	
BVR	Mean	-50.10V	.9963	.9950	.9867	1.003	1.011	1.005	.9992	1.008	1.006	0.14
	SD	17.22V	.0179	.0076	.0340	.0264	.0292	.0338	.0507	.0393	.0464	
	95%		.9669	.9825	.9406	1.047	1.059	1.061	.9156	1.073	1.082	
IR	Mean	533.50pA	.1201	.0000	1.201	.8806	.3000	1.900	1.560	*****	.7504	18.8
	SD	228.50pA	.0000	.0000	.0000	.0000	.0000	1.100	1.240	*****	.4504	
	95%		.1201	.0000	1.201	.8806	.3000	3.715	3.606	*****	.0072	
TON	Mean	12.80µS	1.000	1.003	1.045	1.217	1.972	2.000	2.000	2.000	2.000	1.17
	SD	0.00S	.0000	.0062	.0727	.1814	.0358	.0000	.0000	.0000	.0000	
	95%		1.000	1.013	1.165	1.516	2.031	2.000	2.000	2.000	2.000	
TOFF	Mean	22.72µS	.9502	.8841	.8588	.7670	.5765	.3376	.1678	*****	*****	1.98
	SD	1.09µS	.0188	.0050	.0067	.0209	.0200	.0152	.0263	*****	*****	
	95%		.9192	.8859	.8478	.7326	.5434	.3125	.1244	*****	*****	

TABLE 13b:

CS201 TOTAL DOSE - LARGE INCREMENTS

PARAMETER		PRE IRRAD	100 kRAD	300 kRAD	1 MRAD	LIMIT RATIO
ICEO	Mean	8.32nA	4.960	3.003	1.180	12.02
	SD	5.41nA	4.240	.7447	.1740	
	95%		11.96	4.232	1.467	
VF	Mean	1.16V	.9957	.9870	.9742	1.21, 0.43
	SD	7.45mV	.0043	.0044	.0001	
	95%		.9887	.9797	.9741	
VCESAT	Mean	111.83mV	1.296	1.763	*****	2.68
	SD	687.18µV	.0076	.1021	*****	
	95%		1.309	1.931	*****	
CTR 1	Mean	163.67%	.5407	.2429	.0402	0.61
	SD	3.04%	.0013	.0254	.0015	
	95%		.5385	.2009	.0377	
CTR 2	Mean	82.60%	.4491	.1787	.0279	0.48
	SD	1.80%	.0091	.0201	.0004	
	95%		.4340	.1455	.0273	
BVECO	Mean	-8.48V	1.001	1.001	1.002	0.82
	SD	4.71mV	.0000	.0000	.0006	
	95%		1.001	1.001	1.003	
BVCBO	Mean	114.00V	1.009	1.009	1.004	0.61
	SD	0.00V	.0000	.0000	.0044	
	95%		1.009	1.009	1.012	
BVCEO	Mean	82.85V	1.011	1.027	1.076	0.60
	SD	150.00mV	.0006	.0006	.0012	
	95%		1.012	1.028	1.078	
BVEBO	Mean	7.96V	1.002	1.001	1.001	0.63
	SD	4.71mV	.0006	.0006	.0000	
	95%		1.003	1.002	1.001	
BVR	Mean	-47.68V	1.002	1.004	.9960	0.15
	SD	18.88V	.0015	.0035	.0007	
	95%		1.004	1.009	.9948	
IR	Mean	915.00pA	.0333	*****	*****	10.93
	SD	0.00A	.0000	*****	*****	
	95%		.0333	*****	*****	
TON	Mean	12.80µS	2.000	2.000	2.000	1.17
	SD	0.00S	.0000	.0000	.0000	
	95%		2.000	2.000	2.000	
TOFF	Mean	22.67µS	.5635	.1736	*****	1.98
	SD	1.36µS	.0079	.0486	*****	
	95%		.5504	.0934	*****	

TABLE 14:

CS201 TYPICAL GAMMA DOSE RATE TEST RESULTS

APPROXIMATE DOSE RATE (RADS/SEC)	MAXIMUM PHOTOCURRENT (mA)	DURATION OF PHOTOCURRENT PULSE (µS)	PHOTOCURRENT GENERATION RATE (AMPS PER RAD/SEC)
1E6	4	-	4E-9
3E6	12	-	4E-9
1E7	50	5	5E-9
3E7	75	6	2.5E-9
1E8	85	6	8.5E-10
3E8	100	7	-
1E9	100	10	-
3E9	100	12	-
6E9	100	14	-

NOTE: Photocurrent limited to 100mA maximum.

TABLE 15a:

CS201 DOSE RATE, SAMPLES 29 AND 30

PARAMETER		PRE IRRAD	@ 5V	@ 10V	@ 15V	LIMIT RATIO
ICEO	Mean	19.98nA	1.092	2.572	2.601	5.0
	SD	12.63nA	.1382	1.986	2.324	
	95%		1.320	5.849	6.436	
VF	Mean	1.17V	.9830	.9830	.9788	1.2, 0.6
	SD	15.00mV	.0002	.0002	.0040	
	95%		.9826	.9826	.9722	
VCESAT	Mean	113.00mV	1.182	1.256	1.327	2.65
	SD	3.00mV	.0092	.0197	.0267	
	95%		1.197	1.289	1.371	
CTR1	Mean	174.00%	.6563	.5335	.4620	0.57
	SD	18.00%	.0104	.0238	.0255	
	95%		.6391	.4941	.4200	
CTR2	Mean	88.40%	.5431	.4179	.3531	0.45
	SD	8.60%	.0008	.0295	.0335	
	95%		.5418	.3693	.2978	
BVECO	Mean	-8.50V	1.003	1.003	1.003	0.82
	SD	0.00V	.0006	.0006	.0006	
	95%		1.004	1.004	1.004	
BVCBO	Mean	113.00V	1.004	1.009	1.004	0.62
	SD	0.00V	.0044	.0000	.0044	
	95%		1.012	1.009	1.012	
BVCEO	Mean	81.10V	1.006	1.006	1.009	0.62
	SD	1.20V	.0005	.0011	.0005	
	95%		1.006	1.008	1.010	
BVEBO	Mean	8.00V	1.004	1.003	1.004	0.62
	SD	0.00V	.0000	.0006	.0012	
	95%		1.004	1.004	1.006	
BVR	Mean	-43.70V	1.003	1.001	1.001	0.16
	SD	5.40V	.0007	.0013	.0013	
	95%		1.005	1.003	1.003	
IR	Mean	0.00A	*****	*****	*****	-
	SD	0.00A	*****	*****	*****	
	95%		*****	*****	*****	
TON	Mean	12.80µS	1.629	1.852	2.000	1.17
	SD	0.00S	.2773	.1484	.0000	
	95%		2.087	2.096	2.000	
TOFF	Mean	23.60µS	.7442	.6550	.5063	1.91
	SD	1.20µS	.0300	.1192	.0421	
	95%		.6948	.4582	.4370	

TABLE 15b:

CS201 DOSE RATE, SAMPLES 31 TO 38

PARAMETER		PRE IRRAD	@ 15V	LIMIT RATIO
ICEO	Mean	12.03nA	1.982	8.31
	SD	5.26nA	1.039	
	95%		3.697	
VF	Mean	1.16V	.9935	1.21, 0.43
	SD	14.90nV	.0037	
	95%		.9874	
VCESAT	Mean	113.63mV	1.078	2.65
	SD	2.18mV	.0064	
	95%		1.089	
CTR1	Mean	167.00%	.8223	0.6
	SD	11.22%	.0107	
	95%		.8047	
CTR2	Mean	83.20%	.7387	0.48
	SD	6.25%	.0168	
	95%		.7111	
BVECO	Mean	-8.49V	1.002	0.82
	SD	5.00mV	.0007	
	95%		1.003	
BVCBO	Mean	113.00V	1.008	0.62
	SD	0.00V	.0029	
	95%		1.013	
BVCEO	Mean	83.21V	1.003	0.6
	SD	226.04mV	.0010	
	95%		1.005	
BVEBO	Mean	7.98V	1.002	0.63
	SD	7.07mV	.0005	
	95%		1.002	
BVR	Mean	-50.65V	1.010	0.14
	SD	14.81V	.0140	
	95%		1.033	
IR	Mean	359.90pA	2.790	27.8
	SD	363.14pA	1.957	
	95%		5.018	
TON	Mean	12.80µS	1.076	1.17
	SD	0.00S	0.663	
	95%		1.186	
TOFF	Mean	22.90µS	.8772	1.96
	SD	1.20µS	.0197	
	95%		.8447	

TABLE 16:

CD500 CONTROL DEVICES

PARAMETER		PRE IRRAD	RUN 1	RUN 2
ICEO	Mean	81.33pA	9.510	12.73
	SD	76.08pA	9.343	7.268
	95%		24.93	24.72
VF	Mean	1.20V	1.008	1.010
	SD	5.00Mv	.0000	.0031
	95%		1.008	1.015
VCESAT	Mean	89.47mV	.9681	.9628
	SD	16.74mV	.0029	.0058
	95%		.9633	.9533
CTR 1	Mean	175.25%	1.027	1.030
	SD	27.51%	.0098	.0131
	95%		1.043	1.052
CTR 2	Mean	89.80%	1.066	1.074
	SD	40.71%	.0098	.0119
	95%		1.082	1.093
BVECO	Mean	-8.52V	1.000	1.000
	SD	101.93mV	.0000	.0000
	95%		1.000	1.000
BVCEO	Mean	79.37V	.9975	.9973
	SD	5.73V	.0010	.0005
	95%		.9958	.9965
BVR	Mean	-41.60V	.9771	.9349
	SD	13.93V	.0284	.1198
	95%		.9301	.7373
IR	Mean	106.75pA	*****	4.246
	SD	15.25pA	*****	.0000
	95%		*****	4.246
TON	Mean	8.89µS	.8642	.8820
	SD	4.53µS	.1274	.1112
	95%		.6540	.6985
TOFF	Mean	25.73µS	.9870	.9813
	SD	9.09µS	.0139	.0144
	95%		.9642	.9575

TABLE 17:

CD500 NEUTRON FLUENCE TESTS

PARAMETER		PRE IRRAD	1E11 n/cm^2	3E11 n/cm^2	1E12 n/cm^2	3E12 n/cm^2	1E13 n/cm^2	LIMIT RATIO
ICEO	Mean	604.91pA	10.46	4.717	4.141	1.350	17.89	82.66
	SD	556.58pA	10.74	6.264	3.431	.5664	11.71	
	95%		28.17	15.05	9.801	2.284	37.21	
VF	Mean	1.20V	1.003	.9942	.9908	.9973	.9691	1.25, 0.58
	SD	6.44mV	.0038	.0038	.0087	.0356	.0248	
	95%		1.009	.9879	.9765	.9386	.9282	
VCESAT	Mean	80.85mV	1.491	2.701	*****	*****	*****	3.71
	SD	14.77mV	.0655	.2391	*****	*****	*****	
	95%		1.599	3.095	*****	*****	*****	
CTR 1	Mean	214.16%	.3610	.0776	*****	*****	*****	0.233
	SD	66.15%	.0099	.0111	*****	*****	*****	
	95%		.3447	.0592	*****	*****	*****	
CTR 2	Mean	109.23%	.1959	.0320	.0079	*****	*****	0.183
	SD	43.33%	.0030	.0110	.0006	*****	*****	
	95%		.1910	.0139	.0069	*****	*****	
BVECO	Mean	-8.59V	.9997	.9998	.9972	.9941	.9909	0.815
	SD	123.64mV	.0005	.0005	.0006	.0010	.0010	
	95%		.9988	.9990	.9963	.9925	.9893	
BVCEO	Mean	76.95V	1.016	1.038	1.143	1.267	1.490	0.520
	SD	6.01V	.0022	.0090	.0101	.0184	.1196	
	95%		1.020	1.053	1.161	1.297	1.687	
BVR	Mean	-38.08V	.9917	.9924	.9898	.9890	.9951	0.131
	SD	13.92V	.0023	.0170	.0024	.0137	.0048	
	95%		.9879	.9644	.9858	.9663	.9872	
IR	Mean	214.74pA	.3665	.6020	6.389	*****	.4794	46.57
	SD	185.09pA	.3665	.0000	5.680	*****	.2853	
	95%		<0	.6020	15.76	*****	.0087	
TON	Mean	7.49µS	4.647	3.822	4.262	3.659	4.323	-
	SD	4.80µS	.4351	1.211	1.562	1.368	1.065	
	95%		5.365	5.820	6.839	5.917	6.080	
TOFF	Mean	30.14µS	.4549	*****	*****	*****	*****	-
	SD	10.35µS	.0503	*****	*****	*****	*****	
	95%		.3719	*****	*****	*****	*****	

TABLE 18a:

CD500 TOTAL DOSE, SMALL INCREMENTS

PARAMETER		PRE IRRAD	10 kRAD	20 kRAD	30 kRAD	50 kRAD	100 kRAD	200 kRAD	300 kRAD	500 kRAD	1 MRAD	LIMIT RATIO
ICEO	Mean	772.00pA	4.789	4.696	11.51	11.22	12.91	22.31	38.13	38.40	46.94	64.
	SD	704.53pA	4.591	5.957	13.79	12.98	14.95	23.50	41.56	41.33	50.78	
	95%		12.36	14.52	34.26	32.63	37.59	61.08	106.7	106.6	130.7	
VF	Mean	1.20V	1.000	1.003	1.000	.9992	.9967	.9934	.9892	.9875	.9825	1.25
	SD	6.32mV	.0000	.0038	.0000	.0025	.0041	.0050	.0038	.0041	.0058	
	95%		1.000	1.009	1.000	.9951	.9900	.9852	.9830	.9807	.9729	
VCESAT	Mean	94.66mV	1.036	1.048	1.086	1.122	1.239	1.414	1.621	1.948	3.531	3.17
	SD	14.19mV	.0104	.0243	.0277	.0452	.0787	.1387	.2066	.2569	.1223	
	95%		1.055	1.088	1.132	1.197	1.369	1.643	1.962	2.371	3.733	
CTR 1	Mean	172.38%	.9323	.8830	.8236	.7405	.5696	.3793	.2559	.1425	.0509	0.29
	SD	35.55%	.0042	.0098	.0090	.0167	.0207	.0239	.0211	.0165	.0074	
	95%		.9253	.8669	.8087	.7130	.5354	.3399	.2211	.1154	.0386	
CTR 2	Mean	78.63%	.9230	.8724	.7998	.7086	.5278	.3469	.2322	.1230	.0407	0.25
	SD	44.37%	.0114	.0258	.0323	.0410	.0471	.0542	.0453	.0316	.0151	
	95%		.9042	.8297	.7466	.6410	.4501	.2576	.1575	.0708	.0158	
BVECO	Mean	-8.49V	1.000	.9998	1.000	1.000	1.001	1.001	1.002	1.001	1.001	0.82
	SD	103.36mV	.0007	.0007	.0008	.0006	.0006	.0009	.0008	.0010	.0010	
	95%		1.001	.9986	1.002	1.001	1.002	1.002	1.003	1.003	1.003	
BVCEO	Mean	79.47V	1.002	1.002	1.004	1.005	1.010	1.018	1.028	1.045	1.079	0.50
	SD	4.39V	.0008	.0015	.0018	.0022	.0026	.0037	.0046	.0066	.0101	
	95%		1.003	1.005	1.007	1.009	1.015	1.024	1.036	1.056	1.095	
BVR	Mean	-28.03V	.9975	.9947	.9975	.9955	.9970	.9963	.9981	.9963	.9967	0.178
	SD	4.69V	.0017	.0018	.0017	.0028	.0033	.0022	.0020	.0022	.0025	
	95%		.9948	.9917	.9948	.9909	.9916	.9926	.9948	.9926	.9926	
IR	Mean	396.20pA	.5201	.4104	.6455	*****	1.154	.8172	*****	.0938	.7000	25.25
	SD	153.31pA	.4291	.4275	.3707	*****	.0000	.5282	*****	.0938	.0000	
	95%		<0	<0	.0338	*****	1.154	<0	*****	<0	.7000	
TON	Mean	9.69µS	1.026	1.202	1.486	1.633	2.303	3.062	3.201	3.201	3.201	-
	SD	4.19µS	.0612	.1243	.2410	.2397	.6031	1.188	1.366	1.366	1.366	
	95%		1.127	1.407	1.884	2.028	3.298	5.022	5.455	5.455	5.455	
TOFF	Mean	21.76µS	.9646	.9126	.8839	.8100	.6529	.4219	.2597	.0692	*****	-
	SD	8.84µS	.0241	.0316	.0413	.0493	.0550	.0582	.0624	.0277	*****	
	95%		.9248	.8604	.8158	.7286	.5622	.3259	.1568	.0235	*****	

TABLE 18b:

CD500 TOTAL DOSE, LARGE INCREMENTS

PARAMETER		PRE IRRAD	100 kRAD	300 kRAD	1 MRAD	LIMIT RATIO
ICEO	Mean	443.80pA	*****	79.21	7.264	112.66
	SD	450.17pA	*****	45.22	.3021	
	95%		*****	153.8	7.762	
VF	Mean	1.20V	1.000	.9917	.9770	1.25, 0.58
	SD	7.99mV	.0000	.0001	.0035	
	95%		1.000	.9916	.9712	
VCESAT	Mean	82.83mV	1.263	1.617	*****	3.62
	SD	13.89mV	.0093	.0745	*****	
	95%		1.279	1.740	*****	
CTR 1	Mean	201.71%	.5174	.2613	.0428	0.248
	SD	44.31%	.0000	.0043	.0006	
	95%		.5174	.2543	.0418	
CTR 2	Mean	104.58%	.4826	.2127	.0387	0.191
	SD	40.24%	.0082	.0305	.0030	
	95%		.4690	.1622	.0337	
BVECO	Mean	-8.56V	.9997	1.001	1.001	0.818
	SD	138.67mV	.0005	.0006	.0006	
	95%		.9989	1.002	1.002	
BVCEO	Mean	78.20V	1.008	1.025	1.066	0.512
	SD	4.85V	.0025	.0034	.0046	
	95%		1.012	1.030	1.074	
BVR	Mean	-33.74V	.9926	.9931	.8951	0.148
	SD	13.73V	.0021	.0034	.0031	
	95%		.9891	.9876	.9900	
IR	Mean	204.57pA	.3673	4.246	.8312	48.88
	SD	150.75pA	.0340	.0000	.6310	
	95%		.3112	4.246	<0	
TON	Mean	6.64µS	2.072	3.783	3.807	-
	SD	2.34µS	.2791	1.446	.5798	
	95%		2.533	6.168	4.764	
TOFF	Mean	26.67µS	.6888	.2514	*****	-
	SD	9.64µS	.0270	.0384	*****	
	95%		.6442	.1881	*****	

TABLE 19:

CD500 TYPICAL GAMMA DOSE RATE TEST RESULTS

APPROXIMATE DOSE RATE (RADS/SEC)	MAXIMUM PHOTOCURRENT (mA)	DURATION OF PHOTOCURRENT PULSE (µs)	PHOTOCURRENT GENERATION RATE (AMPS PER RAD/SEC)
1E6	7	-	7E-9
3E6	22	5	7.3E-9
1E7	65	7	6.5E-9
3E7	75	7	2.5E-9
1E8	85	8	8.5E-10
3E8	95	9	-
1E9	95	12	-
3E9	95	15	-
6E9	95	17	-

NOTE: Photocurrent limited to 100mA (approximately) maximum.

TABLE 20a:

CD500 DOSE RATE, SAMPLES 29 TO 30

PARAMETER		PRE IRRAD	@ 5V	@ 10V	@ 15V	LIMIT RATIO
ICEO	Mean	314.67pA	4.882	5.967	14.63	159.24
	SD	125.34pA	3.801	3.598	12.78	
	95%		11.15	11.90	35.71	
VF	Mean	1.20V	.9917	.9917	.9896	1.25, 0.58
	SD	0.00mV	.0000	.0000	.0036	
	95%		.9917	.9917	.9836	
VCESAT	Mean	74.85mV	1.141	1.231	1.336	4.01
	SD	2.11mV	.0055	.0104	.0056	
	95%		1.151	1.248	1.345	
CTR1	Mean	283.00%	.7411	.5886	.4672	0.1767
	SD	15.70	.0037	.0133	.0102	
	95%		.7350	.5666	.4504	
CTR2	Mean	114.50%	.6626	.5091	.3919	0.1747
	SD	7.76%	.0062	.0135	.0101	
	95%		.6524	.4867	.3753	
BVECO	Mean	-8.57V	1.002	1.002	1.003	0.8168
	SD	115.22mV	.0000	.0000	.0005	
	95%		1.002	1.002	1.004	
BVCEO	Mean	76.45V	1.003	1.004	1.005	0.523
	SD	3.00V	.0007	.0006	.0009	
	95%		1.004	1.005	1.007	
BVR	Mean	-45.05V	1.006	1.005	1.006	0.111
	SD	12.02V	.0038	.0039	.0035	
	95%		1.013	1.011	1.012	
IR	Mean	320.00pA	*****	.1250	1.303	31.25
	SD	168.00pA	*****	.0000	1.303	
	95%		*****	.1250	3.452	
TON	Mean	5.50µS	1.414	2.366	3.475	-
	SD	254.60nS	.0223	.0812	.6184	
	95%		1.451	2.500	4.496	
TOFF	Mean	32.00µS	.8932	.9061	.6606	-
	SD	1.26µS	0.479	.0440	.0600	
	95%		.8143	.7335	.5616	

TABLE 20b:

CD500 DOSE RATE, SAMPLES 31 TO 38

PARAMETER		PRE IRRAD	@ 15V	LIMIT RATIO
ICEO	Mean	821.71pA	1.733	60.85
	SD	754.83pA	3.133	
	95%		6.903	
VF	Mean	1.19V	.9937	1.26, 0.59
	SD	5.00mV	.0036	
	95%		.9878	
VCESAT	Mean	83.50mV	1.113	3.593
	SD	9.54mV	.0164	
	95%		1.140	
CTR1	Mean	202.27%	.7569	0.247
	SD	59.79%	.0241	
	95%		.7172	
CTR2	Mean	97.48%	.6963	0.205
	SD	41.26%	.0311	
	95%		.6449	
BVECO	Mean	-8.54V	1.002	0.8197
	SD	125.53mV	.0006	
	95%		1.003	
BVCEO	Mean	80.34V	1.002	0.498
	SD	6.90V	.0006	
	95%		1.003	
BVR	Mean	-50.49V	.9802	0.099
	SD	13.81V	.0853	
	95%		.8394	
IR	Mean	36.50pA	.0000	273.9
	SD	58.95pA	.0000	
	95%		.0000	
TON	Mean	7.44µS	1.585	-
	SD	3.30µS	.3019	
	95%		2.083	
TOFF	Mean	27.30µS	.8540	-
	SD	10.24µS	.0813	
	95%		.7198	

TABLE 21:

4N55 CONTROL DEVICES

PARAMETER		PRE IRRAD	RUN 1	RUN 2
ICCL1	Mean	62.20µA	1.025	1.035
	SD	282.84µA	.0151	.0084
	95%		1.050	1.049
ICCL2	Mean	60.00µA	1.025	1.035
	SD	5.37µA	.0146	.0084
	95%		1.049	1.049
ICCH1	Mean	224.67pA	.0000	1.000
	SD	317.73pA	.0000	.0000
	95%		.0000	1.000
ICCH2	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****
IOH1	Mean	3.03nA	1.790	3.340
	SD	1.69nA	.2177	2.198
	95%		2.149	6.966
IOH2	Mean	2.36nA	1.000	.9171
	SD	1.68nA	.0000	.0829
	95%		1.000	.7803
IOHL1	Mean	51.90µA	1.008	1.019
	SD	9.20µA	.0006	.0005
	95%		1.009	1.020
IOHL2	Mean	55.90µA	1.008	1.021
	SD	4.60µA	.0065	.0108
	95%		1.019	1.038
VF1	Mean	1.57V	1.002	1.006
	SD	0.00V	.0030	.0000
	95%		1.007	1.006
VF2	Mean	1.57V	1.006	1.006
	SD	0.00V	.0000	.0000
	95%		1.006	1.006
VBR1	Mean	-21.20V	.9953	.9920
	SD	860.23mV	.0002	.0049
	95%		.9950	.9839
VBR2	Mean	-22.70V	.9956	.9942
	SD	1.90V	.0004	.0015
	95%		.9950	.9917
CTR1	Mean	20.60%	1.013	1.018
	SD	1.28%	.0068	.0031
	95%		1.025	1.023
CTR2	Mean	15.90%	1.033	1.039
	SD	7.02%	.0402	.0341
	95%		1.100	1.095

TABLE 21:

4N55 CONTROL DEVICES (CONTINUED)

PARAMETER		PRE IRRAD	RUN 1	RUN 2
TPLH1	Mean	11.87µS	.9900	.9867
	SD	9.71µS	.0081	.0094
	95%		.9766	.9712
TPLH2	Mean	3.10µS	.9963	.9813
	SD	1.90µS	.0052	.0138
	95%		.9878	.9585
TPHL1	Mean	250.07nS	.9827	.9775
	SD	107.40nS	.0183	.0038
	95%		.9524	.9713
TPHL2	Mean	327.33nS	.9817	.9706
	SD	31.03nS	.0185	.0203
	95%		.9512	.9371

TABLE 22:

4N55 NEUTRON FLUENCE

PARAMETER		PRE IRRAD	1E11 n/cm^2	3E11 n/cm^2	1E12 n/cm^2	3E12 n/cm^2	1E13 n/cm^2	LIMIT RATIO
ICCL1	Mean	63.78µA	.9978	.9067	.7166	.5094	.2303	3.13
	SD	6.41µA	.0034	.0134	.0177	.0159	.0130	
	95%		.9823	.8846	.6875	.4832	.2088	
ICCL2	Mean	62.91µA	.9943	.9111	.7286	.5180	.2396	3.18
	SD	6.89µA	.0078	.0119	.0089	.0238	.0152	
	95%		.9814	.8915	.7139	.4788	.2144	
ICCH1	Mean	531.26pA	.0000	.9960	1.000	1.164	5.249	18.8
	SD	412.03pA	.0000	.8117	.0000	.6173	.4304	
	95%		.0000	<0	1.000	2.182	5.959	
ICCH2	Mean	319.26pA	.0000	1.000	1.000	1.988	3.991	31.3
	SD	336.53pA	.0000	.0000	.0000	.0000	.0000	
	95%		.0000	1.000	1.000	1.988	3.991	
IOH1	Mean	6.90nA	1.106	1.766	3.103	6.372	9.125	14492.7
	SD	18.17nA	.2258	.5558	1.005	3.111	3.270	
	95%		1.479	2.684	4.761	11.51	14.52	
IOH2	Mean	2.83nA	5.191	2.509	6.778	14.79	18.36	35335.7
	SD	6.25nA	6.404	2.509	6.778	14.79	18.36	
	95%		15.76	4.286	12.87	25.28	26.83	
IOHL1	Mean	56.93µA	.9604	.8861	.6535	.3724	.0698	4.39
	SD	8.37µA	.0091	.0182	.0422	.0255	.0085	
	95%		.9454	.8561	.5839	.3302	.0557	
IOHL2	Mean	55.86µA	.9656	.8972	.6500	.3744	.0718	4.47
	SD	9.78µA	.0089	.0183	.0352	.0418	0.100	
	95%		.9509	.8670	.5920	.3054	.0553	
VF1	Mean	1.57V	1.003	1.004	1.003	1.000	.9873	1.14
	SD	2.71mV	.0031	.0031	.0031	.0040	.0000	
	95%		1.008	1.009	1.008	1.007	.9873	
VF2	Mean	1.57V	1.004	1.004	1.004	1.000	.9936	1.14
	SD	3.92mV	.0031	.0031	.0031	.0000	.0070	
	95%		1.009	1.009	1.009	1.000	.9821	
VBR1	Mean	-21.80V	.9956	1.001	.9938	.9903	.9938	0.137
	SD	1.51V	.0039	.0077	.0058	.0057	.0111	
	95%		.9892	1.014	.9842	.9808	.9755	
VBR2	Mean	-21.41V	.9931	.9940	.9906	.9941	.9896	0.140
	SD	1.77V	.0031	.0137	.0008	.0062	.0032	
	95%		.9880	.9714	.9893	.9839	.9842	
CTR1	Mean	21.14%	.9890	.9443	.8170	.6343	.2833	0.425
	SD	1.38%	.0068	.0030	.0110	.0110	.0147	
	95%		.9778	.9393	.7888	.6161	.2591	
CTR2	Mean	20.93%	.9966	.9335	.8171	.6352	.2867	0.430
	SD	1.51%	.0097	.0093	.0056	.0227	.0159	
	95%		.9806	.9182	.8079	.5977	.2605	

TABLE 22:

4N55 NEUTRON FLUENCE (CONTINUED)

PARAMETER		PRE IRRAD	1E11 n/cm^2	3E11 n/cm^2	1E12 n/cm^2	3E12 n/cm^2	1E13 n/cm^2	LIMIT RATIO
TPLH1	Mean	5.01µS	.9271	.8390	.6367	.4405	.2055	1.19
	SD	226.96nS	.0120	.0145	.0170	.0116	.0061	
	95%		.9072	.8151	.6087	.4213	.1955	
TPLH2	Mean	4.46µS	.9186	.8270	.6018	.3923	.1834	1.34
	SD	174.63nV	.0091	.0088	.0124	.0205	.0035	
	95%		.9036	.8125	.5814	.3590	.1776	
TPHL1	Mean	331.32nS	1.003	1.049	1.239	1.719	5.026	6.04
	SD	26.20nS	.0028	.0071	.0210	.0614	.5477	
	95%		1.008	1.060	1.274	1.820	5.930	
TPHL2	Mean	298.16nS	.9975	1.062	1.220	1.673	4.238	6.71
	SD	22.87nS	.0031	.0229	.0180	.1018	.4906	
	95%		.9924	1.100	1.250	1.841	5.047	

TABLE 23a:

4N55 TOTAL DOSE, SMALL INCREMENTS

PARAMETER		PRE IRRAD	10 kRAD	20 kRAD	30 kRAD	50 kRAD	100 kRAD	200 kRAD	300 kRAD	500 kRAD	1 MRAD	LIMIT RATIO
ICCL1	Mean	68.98µA	.9829	.9650	.9546	.9361	.9128	.9004	.8939	.8974	.8971	2.24
	SD	8.74µA	.0052	.0036	.0042	.0036	.0038	.0031	.0027	.0041	.0037	
	95%		.9743	.9590	.9477	.9302	.9065	.8952	.8895	.8906	.8909	
ICCL2	Mean	61.18µA	.9813	.9645	.9545	.9364	.9146	.9027	.8859	.8997	.8997	3.26
	SD	7.77µA	.0048	.0031	.0027	.0042	.0033	.0040	.0029	.0050	.0038	
	95%		.9734	.9594	.9500	.9295	.9091	.6962	.8912	.8915	.8934	
ICCH1	Mean	404.40pA	.3333	1.000	.6667	1.000	1.000	1.988	3.328	2.661	3.660	24.75
	SD	330.19pA	.4714	.0000	.4714	.0000	.0000	.0000	.4686	.4756	.4686	
	95%		<0	1.000	<0	1.000	1.000	1.988	4.102	3.445	4.433	
ICCH2	Mean	674.00pA	.7500	.9976	.8000	.9976	1.198	1.988	2.593	2.994	3.593	14.83
	SD	0.00A	.4330	.6287	.4000	.6287	.3953	.0000	.4943	.6334	.4870	
	95%		.0355	<0	.1400	<0	1.850	1.988	3.409	4.039	4.397	
IOH1	Mean	2.29nA	1.403	1.337	1.253	1.436	1.671	2.107	2.543	2.844	3.916	43668.1
	SD	1.01nA	.5674	.2811	.4503	.4932	.6456	.9104	.9598	1.124	1.575	
	95%		2.339	1.800	1.996	2.250	2.737	3.609	4.127	4.699	6.515	
IOH2	Mean	1.75nA	.7155	1.055	1.182	1.307	1.648	2.190	2.856	2.981	4.060	57142.8
	SD	1.57nA	.2185	.2859	.3406	.4942	.6225	.8761	1.155	1.244	1.722	
	95%		.3549	1.527	1.744	2.123	2.675	3.635	4.761	5.033	6.901	
IOHL1	Mean	54.84µA	.7478	.6174	.5375	.4400	.3124	.2308	.1934	.1684	.1633	4.55
	SD	6.04µA	.0345	.0310	.0284	.0260	.0217	.0209	.0186	.0162	.0165	
	95%		.6908	.5663	.4906	.3971	.2766	.1963	.1627	.1417	.1362	
IOHL2	Mean	45.84µA	.7267	.6008	.5231	.4258	.2970	.2188	.1806	.1568	.1515	5.45
	SD	10.22µA	.0083	.0130	.0121	.0101	.0100	.0099	.0109	.0096	.0091	
	95%		.7131	.5793	.5031	.4092	.2804	.2025	.1627	.1409	.1365	
VF1	Mean	1.57V	1.000	1.000	1.000	1.000	1.001	1.003	.9987	1.000	1.000	1.14
	SD	4.90mV	.0000	.0000	.0000	.0000	.0025	.0051	.0025	.0000	.0000	
	95%		1.000	1.000	1.000	1.000	1.005	1.011	.9946	1.000	1.000	
VF2	Mean	1.57V	1.001	1.001	1.003	1.003	1.003	1.001	1.000	1.000	1.000	1.14
	SD	6.32mV	.0025	.0025	.0031	.0031	.0031	.0025	.0000	.0000	.0000	
	95%		1.005	1.005	1.008	1.008	1.008	1.005	1.000	1.000	1.000	
VBR1	Mean	-21.28V	1.001	1.004	1.000	1.002	1.004	1.003	1.002	.9965	1.002	0.141
	SD	2.50V	.0081	.0087	.0079	.0068	.0082	.0089	.0068	.0058	.0084	
	95%		1.014	1.019	1.013	1.014	1.017	1.018	1.014	.9869	1.016	
VBR2	Mean	-21.20V	.9952	.9964	.9952	.9962	.9970	.9972	.9878	.9972	.9941	0.141
	SD	2.39V	.0006	.0018	.0006	.0038	.0025	.0023	.0038	.0023	.0028	
	95%		.9943	.9933	.9943	.9900	.9928	.9934	.9915	.9934	.9895	
CTR1	Mean	21.64%	.9543	.9108	.8792	.8283	.7460	.6830	.6572	.6352	.6361	0.415
	SD	1.61%	.0202	.0214	.0225	.0234	.0244	.0255	.0241	.0235	.0219	
	95%		.9210	.8754	.8421	.7897	.7057	.6409	.6174	.5964	.6000	
CTR2	Mean	20.18%	.9427	.8982	.8664	.8115	.7425	.6754	.6392	.6206	.6188	0.445
	SD	1.53%	.0106	.0092	.0121	.0159	.0143	.0160	.0168	.0171	.0115	
	95%		.9253	.8831	.8464	.7853	.7189	.6490	.6115	.5923	.5998	
TPLH1	Mean	4.85µS	.6577	.5338	.4553	.3607	.2781	.2412	.2368	.2408	.2857	1.23
	SD	135.65nS	.0140	.0114	.0151	.0075	.0095	.0057	.0106	.0058	.0122	
	95%		.6345	.5150	.4304	.3482	.2624	2317	.2194	.2311	.2655	
TPLH2	Mean	4.23µS	.6503	.5083	.4260	.3381	.2530	.2279	.2178	.2301	.2767	1.41
	SD	115.31nS	.0096	.0120	.0094	.0109	.0070	.0039	.0041	.0065	.0068	
	95%		.6345	.4885	.4104	.3200	.2414	.2214	.2110	.2194	.2655	
TPHL1	Mean	322.20nS	1.023	1.049	1.064	1.101	1.155	1.219	1.260	1.279	1.275	6.21
	SD	29.96nS	.0265	.0240	.0269	.0273	.0562	.0611	.0498	.0484	0.505	
	95%		1.067	1.089	1.108	1.146	1.248	1.320	1.343	1.359	1.359	
TPHL2	Mean	312.00nS	1.008	1.048	1.061	1.096	1.160	1.228	1.257	1.281	1.275	6.4
	SD	31.88nS	.0053	.0165	0.155	.0179	.0381	.0329	.0312	.0257	.0228	
	95%		1.017	1.075	1.087	1.126	1.223	1.282	1.308	1.323	1.313	

TABLE 23b:

4N55 TOTAL DOSE, LARGE INCREMENTS

PARAMETER		PRE IRRAD	100 kRAD	300 kRAD	1 MRAD	LIMIT RATIO
ICCL1	Mean	67.18µA	.9288	.9114	.8966	2.97
	SD	9.50µA	.0012	.0003	.0004	
	95%		.9268	.9110	.8960	
ICCL2	Mean	68.88µA	.9286	.9147	.9009	2.90
	SD	4.69µA	.0013	.0009	.0006	
	95%		.9264	.9133	.8999	
ICCH1	Mean	674.00pA	1.988	2.997	5.000	14.83
	SD	0.00A	.0000	.0000	.0000	
	95%		1.988	2.997	5.000	
ICCH2	Mean	268.00pA	.5030	*****	*****	37.31
	SD	536.00pA	.0000	*****	*****	
	95%		.5030	*****	*****	
IOH1	Mean	2.24nA	.9149	1.838	2.632	44642.8
	SD	502.37pA	.4168	.1896	.1264	
	95%		.2272	2.118	2.841	
IOH2	Mean	672.67pA	2.252	5.000	10.00	148.66
	SD	386.83pA	.7448	.0000	.0000	
	95%		3.481	5.000	10.00	
IOHL1	Mean	56.45µA	.3216	.1943	.1356	4.42
	SD	13.45µA	.0118	.0065	.0293	
	95%		.3021	.1836	.0873	
IOHL2	Mean	60.85µA	.3228	.1991	.1427	4.10
	SD	6.63µA	.0033	.0044	.0161	
	95%		.3173	.1918	.1161	
VF1	Mean	1.57V	1.000	1.006	1.003	1.14
	SD	5.77mV	.0000	.0000	.0032	
	95%		1.000	1.006	1.008	
VF2	Mean	1.57V	1.006	1.003	1.000	1.14
	SD	4.71mV	.0000	.0032	.0000	
	95%		1.006	1.008	1.000	
VBR1	Mean	-19.40V	.9933	.9978	.9957	0.154
	SD	3.93V	.0023	.0022	.0043	
	95%		.9895	.9941	.9985	
VBR2	Mean	-19.55V	.9977	1.005	1.008	0.153
	SD	3.92V	.0023	.0050	.0080	
	95%		.9940	1.013	1.021	
CTR1	Mean	21.18%	.7529	.6606	.6180	0.424
	SD	1.65%	.0126	.0061	.0180	
	95%		.7322	.6506	.5883	
CTR2	Mean	21.85%	.7469	.6591	.6285	0.411
	SD	1.04%	.0019	.0029	.0040	
	95%		.7437	.6544	.6218	

TABLE 23b:

4N55 TOTAL DOSE, LARGE INCREMENTS (CONTINUED)

PARAMETER		PRE IRRAD	100 kRAD	300 kRAD	1 MRAD	LIMIT RATIO
TPLH1	Mean	4.91µS	.2721	.2262	.2615	1.22
	SD	200.00nS	.0038	.0046	.0200	
	95%		.2658	.2186	.2285	
TPLH2	Mean	4.43µS	.2582	.2132	.2634	1.35
	SD	177.17nS	.0007	.0002	.0065	
	95%		.2571	.2128	.2527	
TPHL1	Mean	329.67nS	1.119	1.236	1.308	6.07
	SD	39.08nS	.0412	.0293	.0533	
	95%		1.188	1.284	1.396	
TPHL2	Mean	285.83nS	1.121	1.185	1.255	7.01
	SD	14.53nS	.0241	.0059	.0335	
	95%		1.161	1.195	1.310	

TABLE 24:

4N55 TYPICAL GAMMA DOSE RATE TEST RESULTS

APPROXIMATE DOSE RATE (RADS/SEC)	MAXIMUM PHOTOCURRENT (mA)			DURATION OF PHOTOCURRENT PULSE (µs)		PHOTOCURRENT GENERATION RATE (AMPS PER RAD/SEC)		
	CT1	CT2	CT3	CT2	CT3	CT1	CT2	CT3
1E6	0	0	0	-	-	-	-	-
3E6	0	0	0	-	-	-	-	-
1E7	0	0	0	-	-	-	-	-
3E7	0	5	0	-	-	-	1.6E-10	-
1E8	10	10	0	0.5	-	1E-10	1E-10	-
3E8	55	15	0	0.75	-	1.8E-10	-	-
1E9	240	15	10	1.0	0.5	2.4E-10	-	1E-11
3E9	900	15	15	2.0	3.0	3E-10	-	-
6E9	1550	15	15	4.0	5.0	2.6E-10	-	-

NOTE: Photocurrent limited to approximately 16mA maximum in CT2 CT3.

TABLE 25a:

4N55 DOSE RATE, SAMPLES 29 AND 30

PARAMETER		PRE IRRAD	@ 5V	@ 10V	@ 15V	LIMIT RATIO
ICCL1	Mean	63.15µA	.9895	.9677	.9756	3.16
	SD	4.55µA	.0031	.0087	.0022	
	95%		.9843	.9534	.9720	
ICCL2	Mean	61.60µA	.9885	.9622	.9697	3.24
	SD	5.90µA	.0011	.0052	.0052	
	95%		.9867	.9535	.9611	
ICCH1	Mean	674.00pA	.0000	1.000	1.000	14.83
	SD	0.00A	.0000	.0000	.0000	
	95%		.0000	1.000	1.000	
ICCH2	Mean	570.00pA	.5030	1.000	1.000	14.92
	SD	670.00pA	.0000	.0000	.0000	
	95%		.5030	1.000	1.000	
IOH1	Mean	25.64nA	.4378	.4677	.4275	3906.25
	SD	19.57nA	.2171	.2469	.0947	
	95%		.0797	.0603	.2712	
IOH2	Mean	32.72nA	.6563	.8682	.7941	3058.10
	SD	31.38nA	.1533	.1318	.2059	
	95%		.4033	.6507	.4543	
IOHL1	Mean	55.45µA	.8462	.7694	.6752	4.50
	SD	4.05µA	.0076	.0087	.0096	
	95%		.8336	.7550	.6593	
IOHL2	Mean	52.50µA	.8095	.7245	.6256	4.76
	SD	6.80µA	.0152	.0024	.0067	
	95%		.7845	.7206	.6145	
VF1	Mean	1.56V	1.000	1.000	1.003	1.15
	SD	0.00V	.0000	.0000	.0032	
	95%		1.000	1.000	1.008	
VF2	Mean	1.57V	1.000	1.000	1.000	1.14
	SD	5.00mV	.0000	.0000	.0000	
	95%		1.000	1.000	1.000	
VBR1	Mean	-24.10V	.9980	1.000	1.002	0.124
	SD	700.00mV	.0020	.0000	.0020	
	95%		.9947	1.000	.0020	
VBR2	Mean	-24.35V	.9980	1.000	.9960	0.123
	SD	750.00mV	.0020	.0000	.0040	
	95%		.9947	1.000	.8894	
CTR1	Mean	20.85%	.9735	.9543	.9305	0.431
	SD	650.00m%	.0032	.0038	.0002	
	95%		.9682	.9480	.9301	
CTR2	Mean	20.50%	.9707	.9437	.9148	0.439
	SD	900.00m%	.0013	.0049	.0036	
	95%		.9686	.9356	.9089	

TABLE 25a:

4N55 DOSE RATE, SAMPLES 29 AND 30 (CONTINUED)

PARAMETER		PRE IRRAD	@ 5V	@ 10V	@ 15V	LIMIT RATIO
TPLH1	Mean	4.96µS	.8994	.8085	.7075	1.20
	SD	50.00nS	.0191	.0082	.0130	
	95%		.8678	.7951	.6860	
TPLH2	Mean	4.41µS	.8571	.7619	.6485	1.36
	SD	0.00S	.0159	.0113	.0113	
	95%		.8310	.7432	.6298	
TPHL1	Mean	336.00nS	1.006	1.008	1.037	5.95
	SD	19.00nS	.0003	.0204	.0083	
	95%		1.007	1.041	.0083	
TPHL2	Mean	302.00nS	1.024	1.048	1.060	6.62
	SD	13.00nS	.0172	.0095	.0189	
	95%		1.052	1.063	1.092	

TABLE 25b:

4N55 DOSE RATE, SAMPLES 31 TO 38

PARAMETER		PRE IRRAD	@ 15V	LIMIT RATIO
ICCL1	Mean	60.11µA	.9781	3.33
	SD	5.63µA	.0111	
	95%		.9598	
ICCL2	Mean	59.20µA	.9763	3.38
	SD	5.85µA	.0138	
	95%		.9536	
ICCH1	Mean	504.50pA	1.000	19.82
	SD	443.92pA	.0000	
	95%		1.000	
ICCH2	Mean	808.40pA	1.247	12.37
	SD	659.65pA	.4279	
	95%		1.953	
IOH1	Mean	28.57nA	1.127	3500.2
	SD	66.69nA	.3463	
	95%		1.698	
IOH2	Mean	20.14nA	1.323	4965.2
	SD	48.71nA	.4641	
	95%		2.088	
IOHL1	Mean	55.34µA	.7666	4.52
	SD	4.63µA	.0684	
	95%		.6537	
IOHL2	Mean	54.76µA	.7382	4.56
	SD	5.82µA	.0699	
	95%		.6229	
VF1	Mean	1.56V	1.002	1.15
	SD	5.00mV	.0031	
	95%		1.008	
VF2	Mean	1.57V	.9976	1.15
	SD	5.99mV	.0044	
	95%		.9903	
VBR1	Mean	-23.21V	.9984	0.129
	SD	1.82V	.0030	
	95%		.9935	
VBR2	Mean	-23.35V	.9993	0.128
	SD	1.76V	.0044	
	95%		.9920	
CTR1	Mean	20.65%	.9567	0.436
	SD	975.96m%	.0214	
	95%		.9214	
CTR2	Mean	20.34%	.9498	0.442
	SD	1.28%	.0173	
	95%		.9213	

TABLE 25b:

4N55 DOSE RATE, SAMPLES 31 TO 38 (CONTINUED)

PARAMETER		PRE IRRAD	@ 15V	LIMIT RATIO
TPLH1	Mean	5.05µS	.8191	1.19
	SD	131.70nS	.0795	
	95%		.6878	
TPLH2	Mean	4.48µS	.7907	1.34
	SD	123.67n	.0795	
	95%		.6878	
TPHL1	Mean	343.75nS	1.039	5.82
	SD	24.4nS	.0234	
	95%		1.077	
TPHL2	Mean	311.88nS	1.023	6.41
	SD	20.45nS	.0155	
	95%		1.049	

TABLE 26:

6N134 CONTROL DEVICES

PARAMETER		PRE IRRAD	RUN 1	RUN 2
ICCH	Mean	15.13mA	1.004	1.002
	SD	188.56µA	.0031	.0031
	95%		1.010	1.007
ICCL	Mean	25.40mA	1.000	1.008
	SD	1.40mA	.0033	.0004
	95%		1.006	1.009
IOH	Mean	168.50pA	.2485	.0000
	SD	291.85pA	.7515	.0000
	95%		<0	.0000
VOL	Mean	272.17mV	1.000	1.003
	SD	7.58mV	.0043	.0033
	95%		1.007	1.009
VF	Mean	1.60V	.9990	1.001
	SD	3.73mV	.0043	.0023
	95%		.9919	1.005
VR	Mean	-17.02V	.9981	.9934
	SD	1.56V	.0101	.0097
	95%		.9814	.9773
CTR	Mean	*****	*****	*****
	SD	*****	*****	*****
	95%		*****	*****

TABLE 27:

6N134 NEUTRON FLUENCE

PARAMETER		PRE IRRAD	1E11 n/cm^2	3E11 n/cm^2	1E12 n/cm^2	3E12 n/cm^2	1E13 n/cm^2	LIMIT RATIO
ICCH	Mean	15.13mA	1.003	1.003	1.001	1.003	.9960	1.85
	SD	276.72µA	.0065	.0033	.0065	.0068	.0090	
	95%		1.013	1.008	1.012	1.014	.9812	
ICCL	Mean	25.41mA	1.002	.9978	.9808	.9426	.7903	1.41
	SD	990.72µA	.0040	.0053	.0087	.0195	.0218	
	95%		1.008	.9890	.9665	.9104	.7543	
IOH	Mean	441.59pA	.0000	1.000	.5000	*****	1.000	566.8
	SD	320.36pA	.0000	.0000	.5000	*****	.0000	
	95%		.0000	1.000	<0	*****	1.000	
VOL	Mean	273.52mV	1.003	1.005	1.001	.9953	1.017	2.19
	SD	8.84mV	.0077	.0103	.0036	.0138	.0061	
	95%		1.015	1.022	1.007	.9726	1.027	
VF	Mean	1.60V	1.001	.9994	.9975	.9884	.9850	1.09
	SD	6.32mV	.0019	.0019	.0031	.0029	.0030	
	95%		1.004	.9963	.9924	.9847	.9800	
VR	Mean	-16.20V	.9987	1.002	1.001	.9983	1.003	0.308
	SD	1.51V	.0046	.0027	.0038	.0098	.0032	
	95%		.9912	1.006	1.007	.9821	1.008	
CTR	Mean	*****	*****	*****	*****	*****	*****	
	SD	*****	*****	*****	*****	*****	*****	
	95%		*****	*****	*****	*****	*****	

TABLE 28a:

6N134 TOTAL DOSE, SMALL INCREMENTS

PARAMETER		PRE IRRAD	10 kRAD	20 kRAD	30 kRAD	50 kRAD	100 kRAD	200 kRAD	300 kRAD	500 kRAD	1 MRAD	LIMIT RATIO
ICCH	Mean	15.12mA	1.000	.9973	.9986	.9947	.9934	.9828	.9789	.9682	.9550	1.85
	SD	193.91µA	.0042	.0053	.0050	.0050	.0042	.0033	.0024	.0053	.0055	
	95%		.9931	.9885	.9905	.9865	.9863	.9774	.9749	.9595	.9459	
ICCL	Mean	25.56mA	.9992	.9954	.9953	.9977	.9922	.9828	.9758	.9624	.9507	1.40
	SD	859.30µA	.0015	.0037	.0015	.0031	.0034	.0018	.0024	.0027	.0030	
	95%		.9967	.9893	.9929	.9925	.9867	.9799	.9718	.9579	.9458	
IOH	Mean	134.80pA	.0000	*****	.0000	1.000	.0000	1.988	*****	.0000	.0000	1865.8
	SD	269.60pA	.0000	*****	.0000	.0000	.0000	.0000	*****	.0000	.0000	
	95%		.0000	*****	.0000	1.000	.0000	1.988	*****	.0000	.0000	
VOL	Mean	268.80mV	1.007	1.006	1.007	1.007	1.009	1.008	1.013	1.017	1.025	2.23
	SD	8.61mV	.0030	.0041	.0039	.0035	.0034	.0019	.0024	.0029	.0029	
	95%		1.012	1.013	1.013	1.013	1.014	1.011	1.017	1.022	1.031	
VF	Mean	1.60V	1.003	1.002	1.002	1.002	1.001	1.000	1.002	1.002	1.002	1.09
	SD	6.40mV	.0031	.0029	.0029	.0029	.0025	.0028	.0029	.0029	.0029	
	95%		1.008	1.007	1.007	1.007	1.005	1.005	1.007	1.007	1.007	
VR	Mean	-16.76V	.9982	.9982	1.004	1.003	.9988	1.000	.9988	1.002	.9970	0.298
	SD	1.05V	.0055	.0038	.0173	.0154	.0037	.0066	.0037	.0117	.0030	
	95%		.9892	.9919	1.032	1.029	.9927	1.011	.9927	1.022	.9922	
CTR	Mean	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	-
	SD	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	
	95%		*****	*****	*****	*****	*****	*****	*****	*****	*****	

TABLE 28b:

6N134 TOTAL DOSE, LARGE INCREMENTS

PARAMETER		PRE IRRAD	100 kRAD	300 kRAD	1 MRAD	LIMIT RATIO
ICCH	Mean	15.13mA	1.000	.9768	.9503	1.85
	SD	110.55µA	.0066	.0035	.0103	
	95%		.9891	.9711	.9333	
ICCL	Mean	25.35mA	.9981	.9878	.9389	1.42
	SD	1.18mA	.0019	.0047	.0184	
	95%		.9950	.9800	.9085	
IOH	Mean	112.33pA	1.000	*****	*****	2232.1
	SD	251.18pA	.0000	*****	*****	
	95%		1.000	*****	*****	
VOL	Mean	269.83mV	1.009	1.015	1.027	2.22
	SD	7.73mV	.0032	.0031	.0088	
	95%		1.014	1.020	1.042	
VF	Mean	1.59V	1.003	1.002	1.000	1.10
	SD	10.37mV	.0031	.0027	.0000	
	95%		1.008	1.006	1.000	
VR	Mean	-15.71V	.9972	.9972	.9968	0.318
	SD	1.73V	.0057	.0028	.0032	
	95%		.9878	.9925	.9915	
CTR	Mean	*****	*****	*****	*****	-
	SD	*****	*****	*****	*****	
	95%		*****	*****	*****	

TABLE 29:

6N134 TYPICAL GAMMA DOSE RATE TEST RESULTS

APPROXIMATE DOSE RATE (RADS/SEC)	MAXIMUM PHOTOCURRENT (mA)	DURATION OF OUTPUT UPSET (µS)		PHOTOCURRENT GENERATION RATE (AMPS PER RAD/SEC)
		VO1	VO2	
1E6	10	1.0	-	1E-8
3E6	10	2.0	-	3.3E-9
1E7	10	3.0	-	1E-9
3E7	15	4.0	-	5E-10
1E8	30	5.5	-	3E-10
3E8	60	8.0	0.5	2E-10
1E9	200	9.0	3.0	2E-10
3E9	900	13.0	7.0	3E-10
6E9	1500	15.0	9.0	2.5E-10

TABLE 30:

6N134 DOSE RATE

PARAMETER		PRE IRRAD	@ 5V
ICCH	Mean	15.02mA	1.001
	SD	208.81µA	.0040
	95%		1.008
ICCL	Mean	24.60mA	1.001
	SD	965.40µA	.0066
	95%		1.011
IOH	Mean	356.82pA	.6667
	SD	336.42pA	.4714
	95%		<0
VOL	Mean	270.40mV	.9962
	SD	6.70mV	.0052
	95%		.9876
VF	Mean	1.59V	1.000
	SD	8.29mV	.0035
	95%		1.006
VR	Mean	-16.38V	1.001
	SD	1.03V	.0029
	95%		1.006
CTR	Mean	*****	*****
	SD	*****	*****
	95%		*****

TABLE 31:

6N140 CONTROL DEVICES

PARAMETER		RUN 1	RIN 2
IOH	Mean	524.22pA	942.6pA
	SD	280.21pA	1.542nA
	95%	986.56pA	3.487nA
VF	Mean	1.47V	1.47V
	SD	.0067V	.0071V
	95%	1.481V	1.481V
VR	Mean	-15.39V	-15.39V
	SD	.659V	.5632V
	95%	-16.477V	-16.319V

TABLE 32:

6N140 NEUTRON TESTS

PARAMETER		PRE IRRAD	1E11 n/cm^2	3E11 n/cm^2	1E12 n/cm^2	3E12 n/cm^2	1E13 n/cm^2	LIMIT RATIO
ICCH	Mean	2.53nA	2.835	8.190	20.45	28.23	63.76	16000.0
	SD	6.94nA	1.781	3.379	8.104	17.74	25.31	
	95%		5.774	13.77	33.82	67.49	105.6	
ICCL	Mean	2.96mA	.9524	.8275	.6701	.3766	.0822	1.35
	SD	359.74µA	.0028	.0886	.0221	.0164	.0053	
	95%		.9478	.6814	.6336	.3495	.0735	
IOH	Mean	499.55pA	.6659	.7134	.5352	1.113	1.165	501002.0
	SD	380.43pA	.5945	1.017	.6550	.5554	.3683	
	95%		< 0	< 0	< 0	2.029	1.772	
VOL1	Mean	29.47mV	1.049	1.148	1.562	3.320	*****	13.57
	SD	3.32mV	.0068	.0150	.0535	.4810	*****	
	95%		1.061	1.172	1.650	4.114	*****	
VOL2	Mean	82.09mV	.9556	.6263	1.019	1.063	2.426	4.87
	SD	1.26mV	.2128	.4869	.2271	.4330	1.050	
	95%		.6045	< 0	1.394	1.777	4.158	
VF	Mean	1.46V	1.002	1.000	1.000	.9942	.9856	1.16
	SD	4.00mV	.0031	.0000	.0000	.0024	.0020	
	95%		1.007	1.000	1.000	.9902	.9823	
VR	Mean	-15.21V	1.004	.9720	1.005	1.005	1.005	.0328
	SD	930.29mV	.0086	.1375	.0061	.0069	.0061	
	95%		1.018	.7452	1.015	1.016	1.015	
CTR1	Mean	2.79k%	.9642	.8966	.6941	.3432	.0027	0.107
	SD	389.04%	.0057	.0094	.0265	.0555	.0015	
	95%		.9548	.8811	.6504	.2517	.0002	
CTR2	Mean	1.79k%	.9729	.9218	.7694	.4516	.0801	0.167
	SD	99.39%	.0041	.0055	.0078	.0043	.0091	
	95%		.9661	.9127	.7566	.4545	.0650	
CTR3	Mean	*****	*****	*****	*****	*****	*****	-
	SD	*****	*****	*****	*****	*****	*****	
	95%		*****	*****	*****	*****	*****	
TPLH1	Mean	2.53µS	.9420	.8581	.4435	*****	*****	23.71
	SD	970.60nS	.2120	.1602	.1085	*****	*****	
	95%		.5922	.5938	.2644	*****	*****	
TPLH1	Mean	13.53µS	1.015	1.077	1.280	2.061	*****	7.39
	SD	1.51µS	.0266	.0276	.0456	.1949	*****	
	95%		1.059	1.122	1.355	2.382	*****	
TPLH2	Mean	4.15µS	1.018	1.007	.9072	.6031	.1589	4.81
	SD	765.85µS	.0348	.0478	.0798	.0570	.0166	
	95%		1.075	1.085	.7755	.5080	.1315	
TPLH2	Mean	662.28nS	1.034	1.119	1.375	2.080	4.854	7.55
	SD	73.73nS	.0091	.0095	.0411	.1095	.4142	
	95%		1.049	1.134	1.443	2.261	5.537	

TABLE 33a:

6N140 TOTAL DOSE TESTS, SMALL INCREMENTS

PARAMETER		PRE IRRAD	10 kRAD	20 kRAD	30 kRAD	50 kRAD	100 kRAD	200 kRAD	300 kRAD	500 kRAD	1 MRAD	LIMIT RATIO
ICCH	Mean	805.60pA	1.626	3.255	2.999	5.387	7.267	23.03	21.75	58.64	225.9	49689.4
	SD	500.96pA	.8182	1.087	.9918	1.181	2.853	4.483	10.45	28.41	264.0	
	95%		2.976	5.048	4.636	7.336	11.97	30.43	39.00	105.5	661.6	
ICCL	Mean	3.04mA	.5345	.3797	.3185	.2369	.1658	.1108	.0954	.0808	.0956	1.31
	SD	326.72µA	.0137	.0110	.0106	.0101	.0088	.0051	.0054	.0066	.0154	
	95%		.5120	.3615	.3009	.2202	.1512	.1024	.0865	.0699	.0701	
IOH	Mean	471.80pA	.8425	.9277	.9277	1.211	1.423	2.204	2.132	3.208	2.421	530785.6
	SD	308.87pA	.8586	.4554	.4554	.5531	.4890	.4140	.3530	.6737	.4993	
	95%		< 0	.1763	.1763	2.124	2.230	2.887	2.715	4.320	3.244	
VOL1	Mean	29.25mV	2.200	3.272	4.333	6.902	*****	*****	*****	*****	*****	13.67
	SD	2.32mV	.3036	.2578	.3171	.0000	*****	*****	*****	*****	*****	
	95%		2.701	3.697	4.856	6.902	*****	*****	*****	*****	*****	
VOL2	Mean	81.29mV	1.064	1.150	1.194	1.319	1.506	1.770	1.873..	2.031	1.828	4.92
	SD	862.13µV	.0112	.0126	.0174	.0210	.0486	.0636	.0969	.1183	.1100	
	95%		1.082	1.171	1.223	1.354	1.586	1.875	2.033	2.226	2.009	
VF	Mean	1.46V	1.006	1.000	1.004	1.000	1.003	.9966	1.003	.9986	1.004	1.16
	SD	3.16mV	.0033	.0015	.0034	.0015	.0034	.0034	.0034	.0035	.0034	
	95%		1.011	1.003	1.009	1.003	1.009	.9909	1.009	.9929	1.010	
VR	Mean	-15.83V	.9989	1.007	1.003	1.006	1.001	1.007	1.002	1.004	.9978	0.315
	SD	1.21V	.0078	.0100	.0085	.0081	.0106	.0093	.0077	.0058	.0064	
	95%		.9860	1.024	1.017	1.019	1.019	1.023	1.015	1.014	.9873	
CTR1	Mean	2.81k%	.4196	.2378	.1529	.0704	.0161	.0024	.0010	.0010	.0011	0.106
	SD	309.36%	.0713	.0634	.0477	.0264	.0071	.0012	.0005	.0003	.0007	
	95%		.3019	.1333	.0742	.0268	.0044	.0005	.0003	.0005	.0000	
CTR2	Mean	1.89k%	.6825	.5148	.4190	.2942	.1704	.0905	.0630	.0498	.0725	0.158
	SD	21.58µ%	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	
	95%		.6825	.5148	.4190	.2942	.1704	.0905	.0630	.0498	.0725	
CTR3	Mean	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	-
	SD	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	
	95%		*****	*****	*****	*****	*****	*****	*****	*****	*****	
TPLH1	Mean	2.68µS	.2012	*****	*****	*****	*****	*****	*****	*****	*****	22.38
	SD	955.82nS	.0000	*****	*****	*****	*****	*****	*****	*****	*****	
	95%		.2012	*****	*****	*****	*****	*****	*****	*****	*****	
TPHL1	Mean	14.12µS	1.200	1.625	*****	*****	*****	*****	*****	*****	*****	23.09
	SD	1.30µS	.1221	.0000	*****	*****	*****	*****	*****	*****	*****	
	95%		1.402	1.625	*****	*****	*****	*****	*****	*****	*****	
TPLH2	Mean	4.33µS	.5354	.3647	.2743	.1980	.1272	.0910	.0719	.0650	.0775	4.61
	SD	8.95.37nS	.0486	.0345	.0280	.0205	.0139	.0101	.0078	.0078	.0141	
	95%		.4552	.3078	.2281	.1641	.1044	.0743	.0591	.0520	.0543	
TPHL2	Mean	670.25nS	1.263	1.351	1.381	1.460	1.524	1.632	1.634	1.702	1.619	7.46
	SD	75.90nS	.0744	.0937	.1053	.1166	.1254	.1417	.1408	.1622	.1795	
	95%		1.386	1.505	1.554	1.853	1.731	1.866	1.867	1.969	1.914	

TABLE 33b:

6N140 TOTAL DOSE TESTS, LARGE INCREMENTS

PARAMETER		PRE IRRAD	100 kRAD	300 kRAD	1 MRAD	LIMIT RATIO
ICCH	Mean	1.68nA	5.170	22.48	28.34	23809.5
	SD	1.08nA	1.833	.5193	6.530	
	95%		8.195	23.33	38.11	
ICCL	Mean	2.95mA	.1624	.0995	.0757	1.35
	SD	257.13µA	.0027	.0011	.0025	
	95%		.1580	.0976	.0716	
IOH	Mean	645.58pA	1.281	1.850	3.432	387596.9
	SD	235.65pA	.6947	.6366	.8400	
	95%		2.427	21.900	4.818	
VOL1	Mean	29.98mV	*****	*****	*****	13.34
	SD	2.41mV	*****	*****	*****	
	95%		*****	*****	*****	
VOL2	Mean	81.71mV	1.526	1.827	2.044	4.89
	SD	1.00mV	.0464	.1082	.1494	
	95%		1.602	2.006	2.291	
VF	Mean	1.46V	1.008	1.008	1.001	1.16
	SD	2.00mV	.0041	.0023	.0023	
	95%		1.014	1.011	1.005	
VR	Mean	-15.44V	1.002	1.002	.9937	0.323
	SD	919.20mV	.0090	.0030	.0054	
	95%		1.017	1.007	.9848	
CTR1	Mean	2.70k%	.0098	.0016	.0011	0.111
	SD	325.50%	.0058	.0005	.0004	
	95%		.0002	.0007	.0004	
CTR2	Mean	1.89k%	.1581	*****	.0442	0.158
	SD	47.03%	.0324	*****	.0018	
	95%		.1047	*****	.0413	
CTR3	Mean	*****	*****	*****	*****	-
	SD	*****	*****	*****	*****	
	95%		*****	*****	*****	
TPLH1	Mean	2.23µS	*****	*****	*****	26.9
	SD	664.50nS	*****	*****	*****	
	95%		*****	*****	*****	
TPHL1	Mean	13.90µS	*****	*****	*****	7.19
	SD	1.44µS	*****	*****	*****	
	95%		*****	*****	*****	
TPLH2	Mean	4.05µS	.1372	.0719	.0648	4.93
	SD	545.40nS	.0114	.0066	.0069	
	95%		.1184	.0610	.0534	
TPHL2	Mean	675.82nS	1.423	1.600	1.803	7.47
	SD	71.80nS	.0564	.0396	.0905	
	95%		1.516	1.665	1.952	

TABLE 34:

6N140 TYPICAL GAMMA DOSE RATE TEST RESULTS

APPROXIMATE DOSE RATE (RADS/SEC)	MAXIMUM PHOTOCURRENT (mA)	DURATION OF OUTPUT UPSET (µs)		PHOTOCURRENT GENERATION RATE (AMPS PER RAD/SEC)
		VO1	VO3	
1E6	5	-	-	5E-9
3E6	20	1.0	-	6.7E-9
1E7	45	1.0	-	4.5E-9
3E7	85	1.0	-	2.8E-9
1E8	180	1.0	2.0	1.8E-9
3E8	480	1.0	3.0	1.6E-9
1E9	1200	2.0	3.0	1.2E-9
3E9	3100	3.0	≃ 6	1E-9
6E9	5200	5.0	≃ 9	8.7E-10

TABLE 35a:

6N140 DOSE RATE, DEVICES 29 AND 30

PARAMETER		PRE IRRAD	@ 5V	@ 10V	@ 15V	LIMIT RATIO
ICCH	Mean	2.69nA	1.002	.8755	1.126	14869.8
	SD	0.00A	.2509	.1245	.1264	
	95%		1.416	.6700	1.335	
ICCL	Mean	3.19mA	.7520	.6335	.5581	1.25
	SD	125.00µA	.0396	.0191	.0189	
	95%		.6867	.6020	.5269	
IOH	Mean	588.75pA	.7505	.2505	.5838	425170.0
	SD	402.18pA	.3816	.3822	.4487	
	95%		.1209	< 0	< 0	
VOL1	Mean	28.76mV	1.296	1.591	1.873	13.9
	SD	1.23mV	.0635	.0440	.0665	
	95%		1.400	1.663	1.983	
VOL2	Mean	83.75mV	1.004	1.021	1.045	4.77
	SD	1.43mV	.0070	.0074	0.121	
	95%		1.015	1.033	1.064	
VF	Mean	1.45V	1.002	1.005	1.003	1.17
	SD	7.81mV	.0057	.0046	.0034	
	95%		1.011	1.013	1.008	
VR	Mean	-16.01V	1.001	1.002	1.001	0.312
	SD	810.00mV	.0070	.0068	.0076	
	95%		1.012	1.013	1.013	
CTR1	Mean	2.91k%	.7264	.5805	.4898	0.103
	SD	177.11%	.0550	.0333	.0368	
	95%		.6356	.5255	.4291	
CTR2	Mean	*****	*****	*****	*****	-
	SD	*****	*****	*****	*****	
	95%		*****	*****	*****	
CTR3	Mean	*****	*****	*****	*****	-
	SD	*****	*****	*****	*****	
	95%		*****	*****	*****	
TPLH1	Mean	3.70µS	.3507	.2285	.1971	16.2
	SD	793.73nS	.0772	.0523	.0343	
	95%		.2233	.1422	.1404	
TPHL1	Mean	13.70µS	1.117	1.147	1.204	7.29
	SD	932.74nS	.0072	.0329	.0250	
	95%		1.129	1.201	1.246	
TPLH2	Mean	4.74µS	.8542	.7213	.6428	4.21
	SD	343.00nS	.0860	.0734	.0676	
	95%		.7122	.6003	.5313	
TPHL2	Mean	645.13nS	1.179	1.268	1.325	7.75
	SD	39.17nS	.0383	.0313	.0365	
	95%		1.242	1.319	1.386	

TABLE 35B:

6N140 DOSE RATE, DEVICES 31 TO 38

PARAMETER		PRE IRRAD	@ 15V	LIMIT RATIO
ICCH	Mean	2.61nA	1.131	15325.6
	SD	2.64nA	.4282	
	95%		1.837	
ICCL	Mean	3.17mA	.7901	1.26
	SD	172.92µA	.0174	
	95%		.7614	
IOH	Mean	542.77pA	.5133	461254.6
	SD	396.98pA	.4884	
	95%		< 0	
VOL1	Mean	28.82mV	1.263	13.87
	SD	1.60mV	.0507	
	95%		1.347	
VOL2	Mean	82.70mV	1.036	4.83
	SD	895.13µV	.0493	
	95%		1.118	
VF	Mean	1.45V	1.004	1.17
	SD	4.33mV	.0034	
	95%		1.009	
VR	Mean	15.66V	1.003	0.319
	SD	853.58mV	.0054	
	95%		1.012	
CTR1	Mean	2.94k%	.7538	0.102
	SD	248.29%	.0338	
	95%		.6980	
CTR2	Mean	1.92k%	.8694	0.156
	SD	25.00%	.0017	
	95%		.8666	
CTR3	Mean	*****	*****	-
	SD	*****	*****	
	95%		*****	
TPLH1	Mean	3.12µS	.5090	19.23
	SD	742.58nS	.1194	
	95%		.3120	
TPHL1	Mean	13.30µS	1.084	7.51
	SD	1.37µS	.0293	
	95%		1.132	
TPLH2	Mean	4.60µS	.8830	4.34
	SD	616.24nS	.0550	
	95%		.7922	
TPHL2	Mean	638.31nS	1.167	7.83
	SD	56.97nS	.0236	
	95%		1.206	

13. REFERENCES

13.1 Defence Standard 08-4 (Part 3) Issue 1: Nuclear Weapons Explosions Effects and Hardening Part 3: Nuclear Weapons Explosions: Simulation of Environments. Section 6.2.3.

13.2 Defence Standard 08-4 (Part 3) Issue 1: Nuclear Weapons Explosions Effects and Hardening Part 3: Nuclear Weapons Explosions: Simulation of Environments. Section 6.1.5.

13.3 Defence Standard 08-4 (Part 3) Issue 1: Nuclear Weapons Explosions Effects and Hardening Part 3: Nuclear Weapons Explosions: Simulation of Environments. Section 6.1.3.

13.4 BS900X Draft A, June 1986 : DCVD London.

APPENDIX A

GENRAD 1735 COMPONENT TEST SYSTEM ACCURACY

APPENDIX A

GENRAD 1735 COMPONENT TEST SYSTEM ACCURACY

MEASUREMENT	ACCURACY
INPUT DIODE	
Forward Voltage	± 25mV
Reverse Voltage	± 0.3V
Reverse Current	± 260pA
OUTPUT DETECTOR	
Breakdown Voltages	± 0.3V
Leakage Current	± 7.5nA
COUPLED	
Current Transfer Ratio	± 0.2
Collector Emitter Saturation Voltage	± 4mV
Turn On / Turn Off Times	± 0.1µS

APPENDIX B

STATISTICAL FORMULAE

APPENDIX B

STATISTICAL FORMULAE

$$\text{Mean, } \bar{X} = \frac{\sum_{i=1}^{n} Xi}{n}$$

$$\text{SD} = \sqrt{\frac{(X_1 - \bar{X})^2 + (X_2 - \bar{X})^2 \ldots\ldots + (X_n - \bar{X})^2}{n}}$$

95% confidence limit = mean ± 1.65 SD.

APPENDIX C

DEVICE PHOTOCURRENT AND OUTPUT TRANSIENT RESPONSES AT VARIOUS DOSE RATES

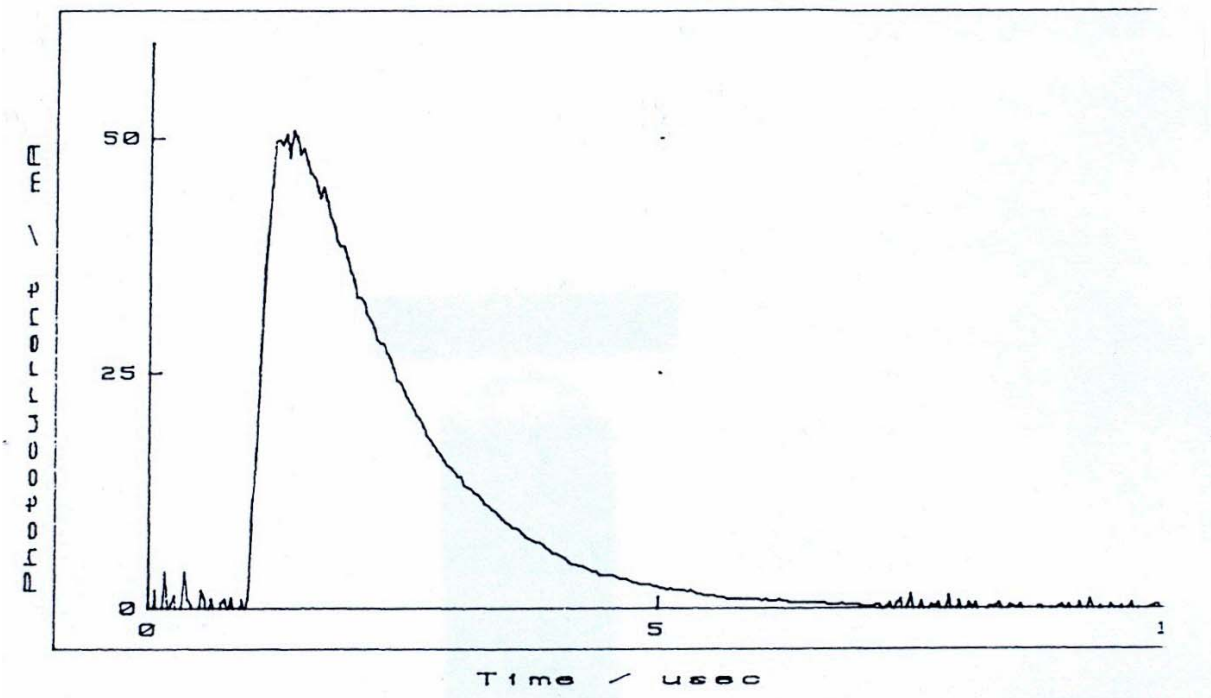

FIGURE A1. CS201 PHOTOCURRENT RESPONSE (DOSE RATE = 1E7 RADS/SEC)

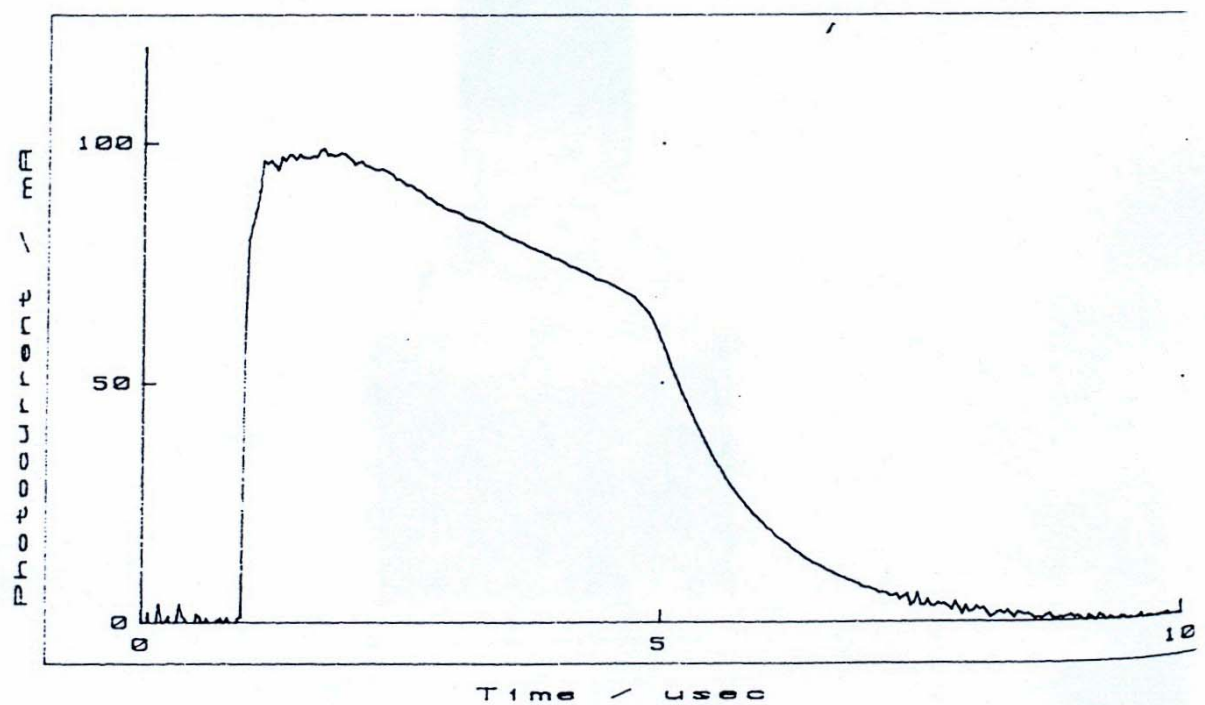

FIGURE A2. CS201 PHOTOCURRENT RESPONSE (DOSE RATE = 3E8 RADS/SEC)

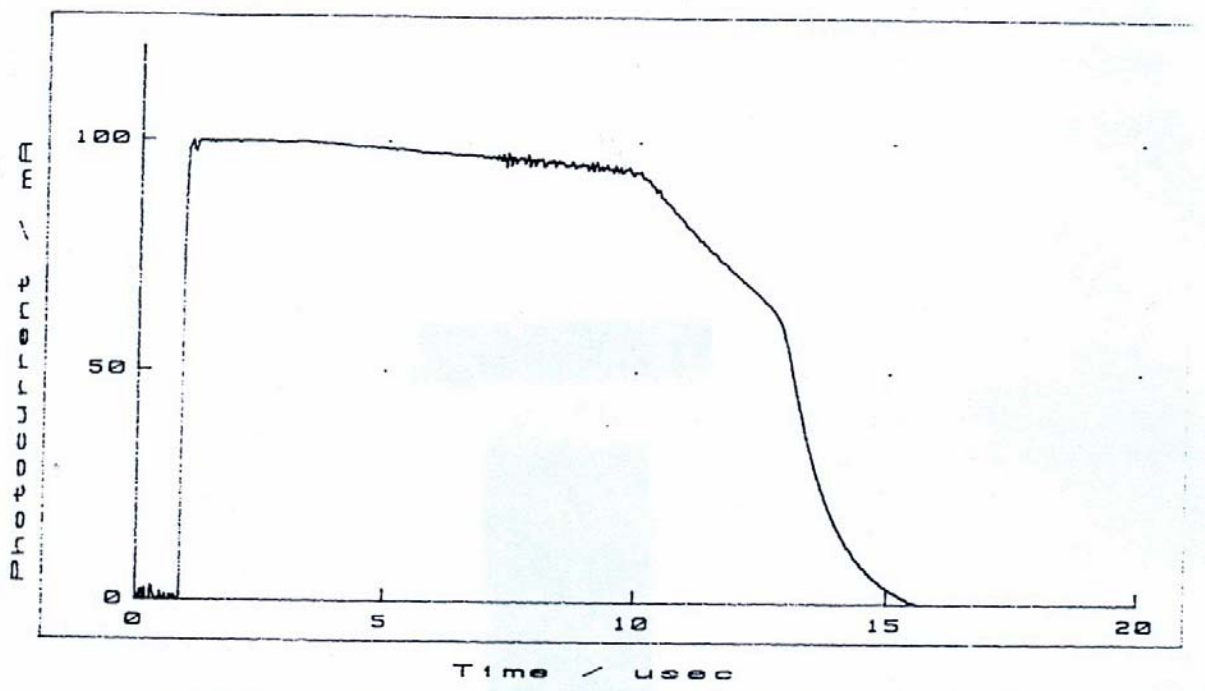

FIGURE A3. CS201 PHOTOCURRENT RESPONSE (DOSE RATE = 6E9 RADS/SEC)

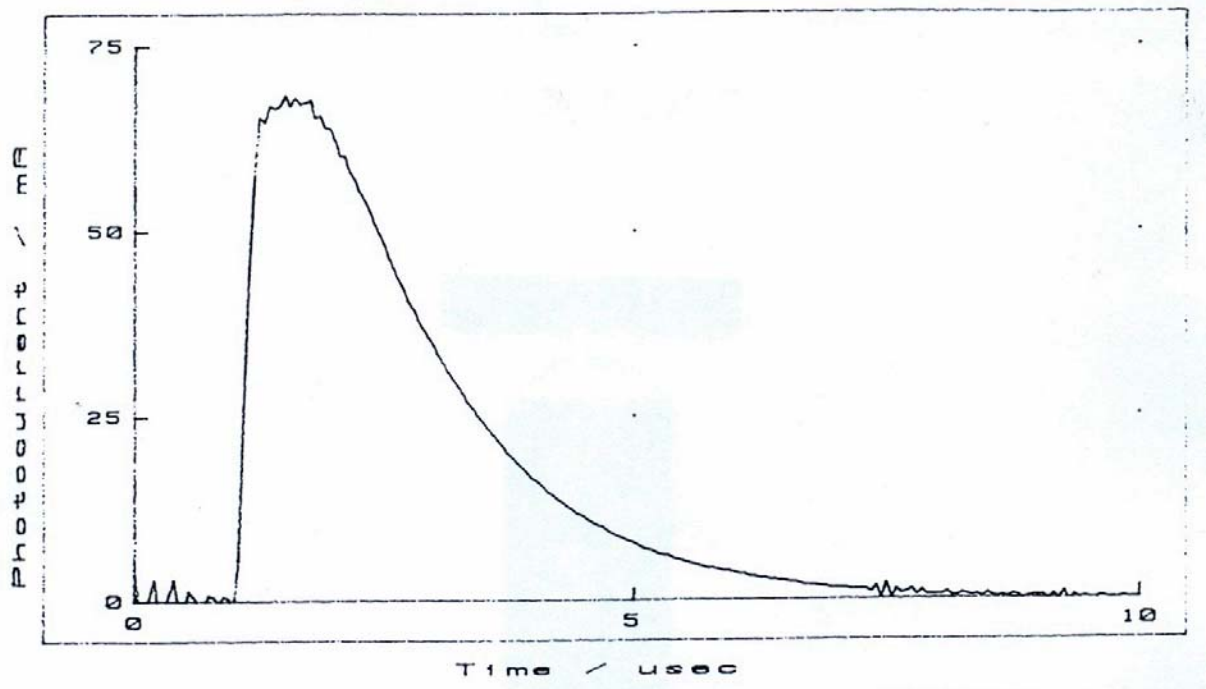

FIGURE A4. CD500 PHOTOCURRENT RESPONSE (DOSE RATE = 1E7 RADS/SEC)

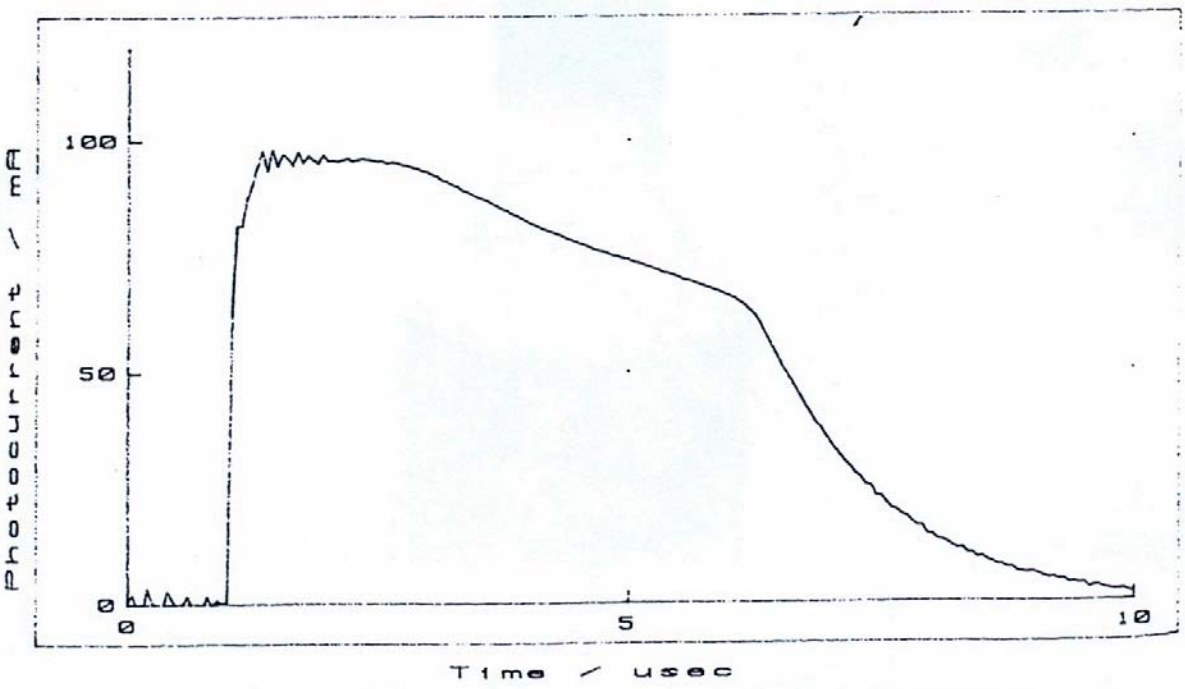

FIGURE A5. CD500 PHOTOCURRENT RESPONSE (DOSE RATE = 3E8 RADS/SEC)

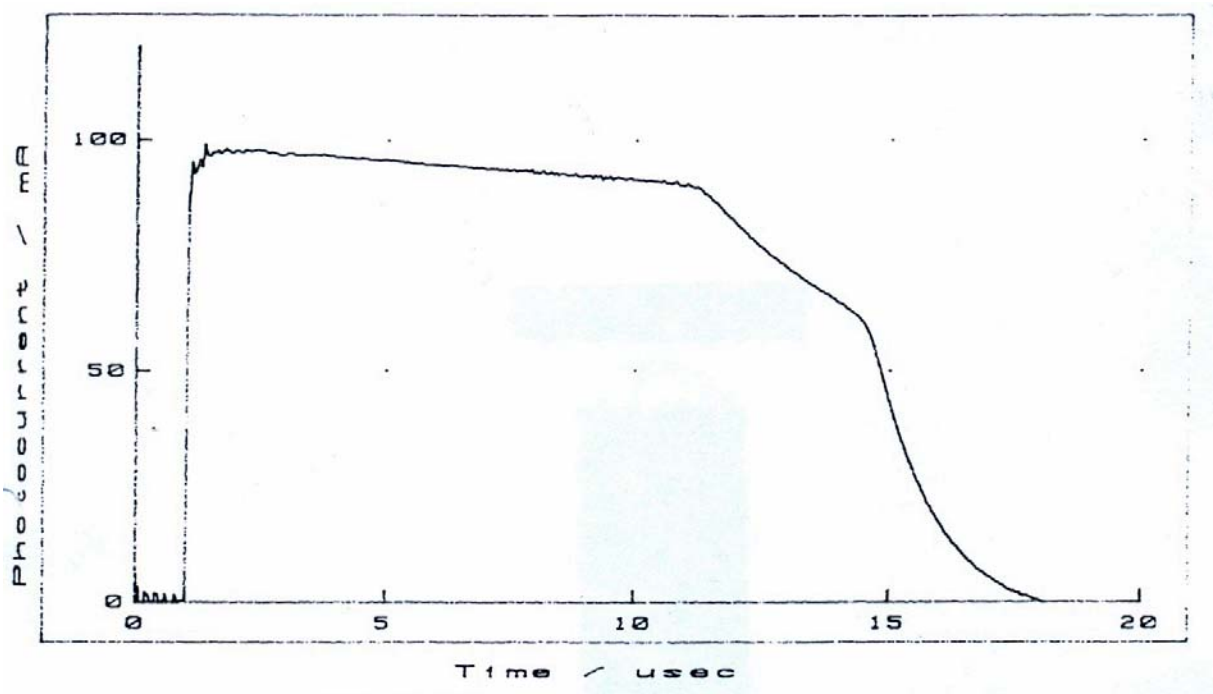

FIGURE A6. CD500 PHOTOCURRENT RESPONSE (DOSE RATE = 6E9 RADS/SEC)

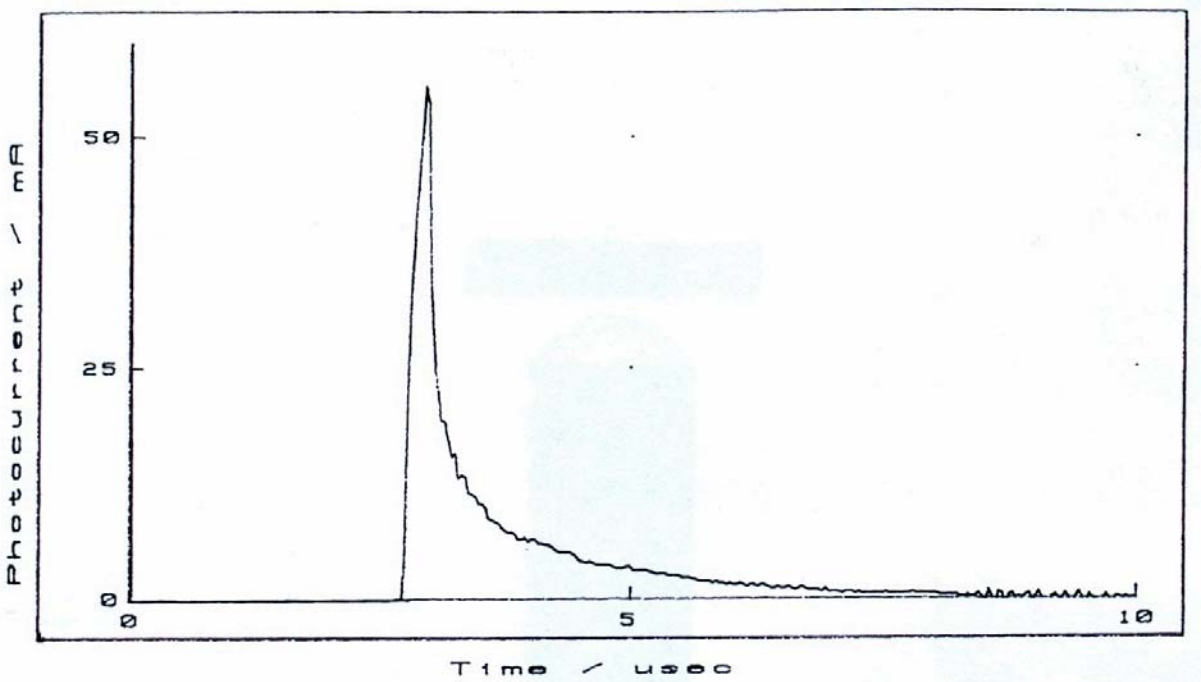

FIGURE A7(a). 4N55 PHOTOCURRENT RESPONSE IN CT1 (DOSE RATE = 3E8 RADS/SEC)

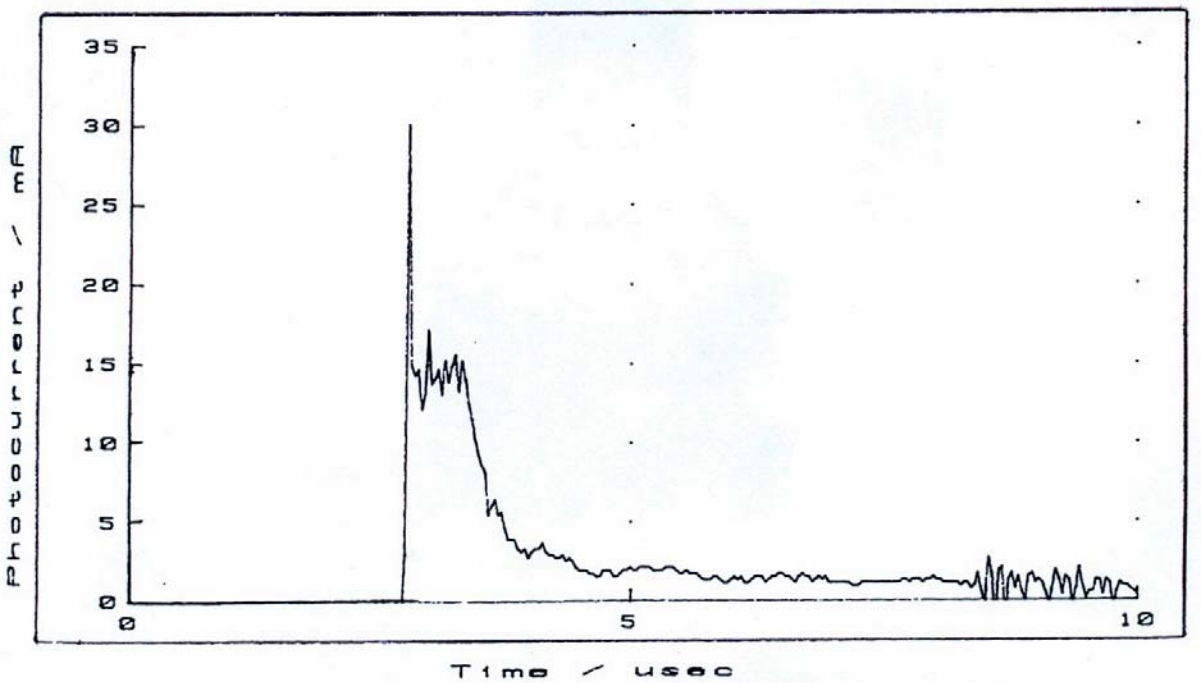

FIGURE A7(b). 4N55 PHOTOCURRENT RESPONSE IN CT2 (DOSE RATE = 3E8 RADS/SEC)

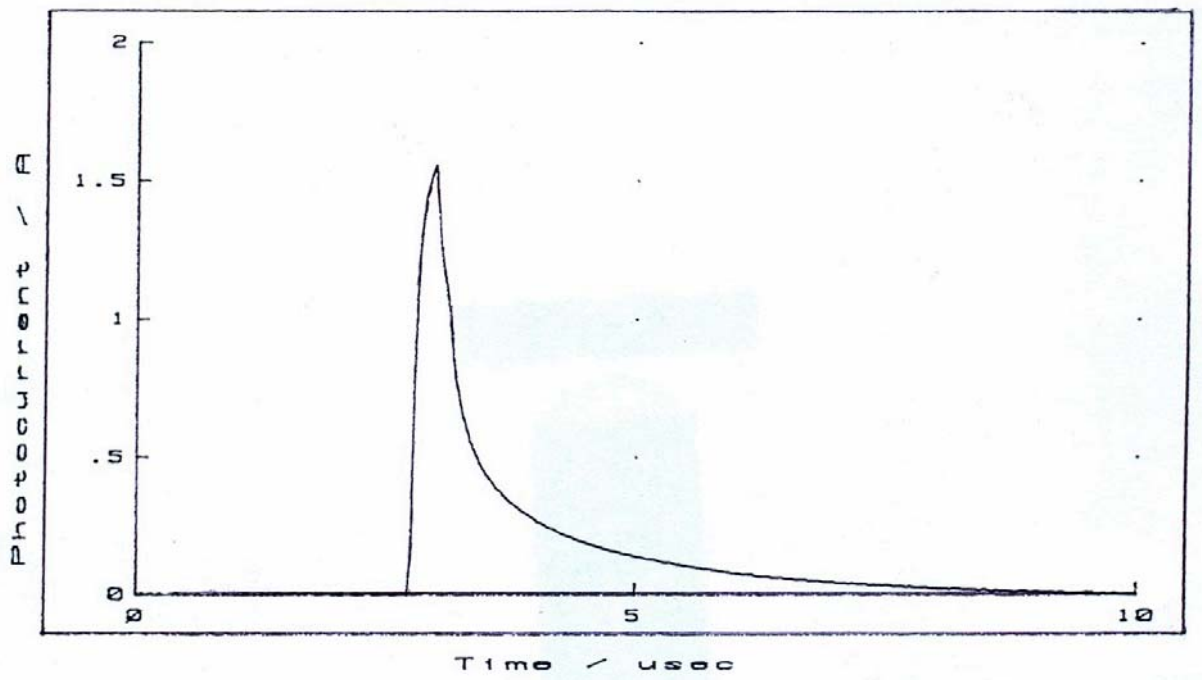

FIGURE A8(a). 4N55 PHOTOCURRENT RESPONSE IN CT1 (DOSE RATE = 6E9 RADS/SEC)

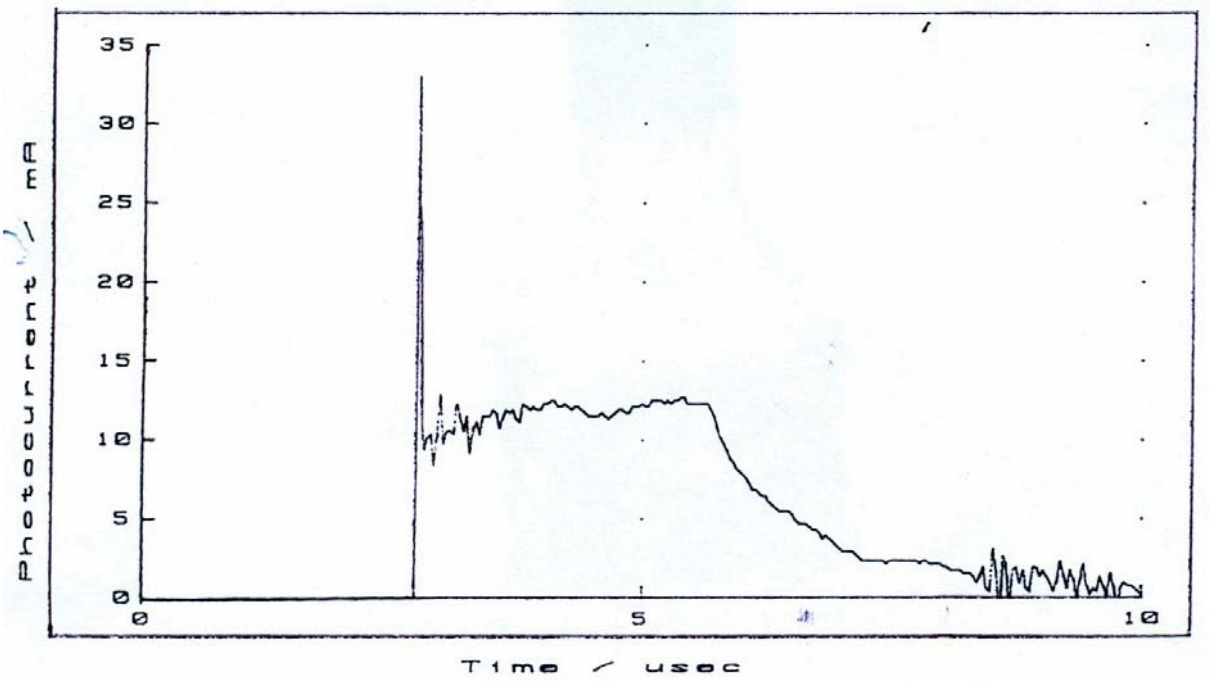

FIGURE A8(b). 4N55 PHOTOCURRENT RESPONSE IN CT2 (DOSE RATE = 6E9 RADS/SEC)

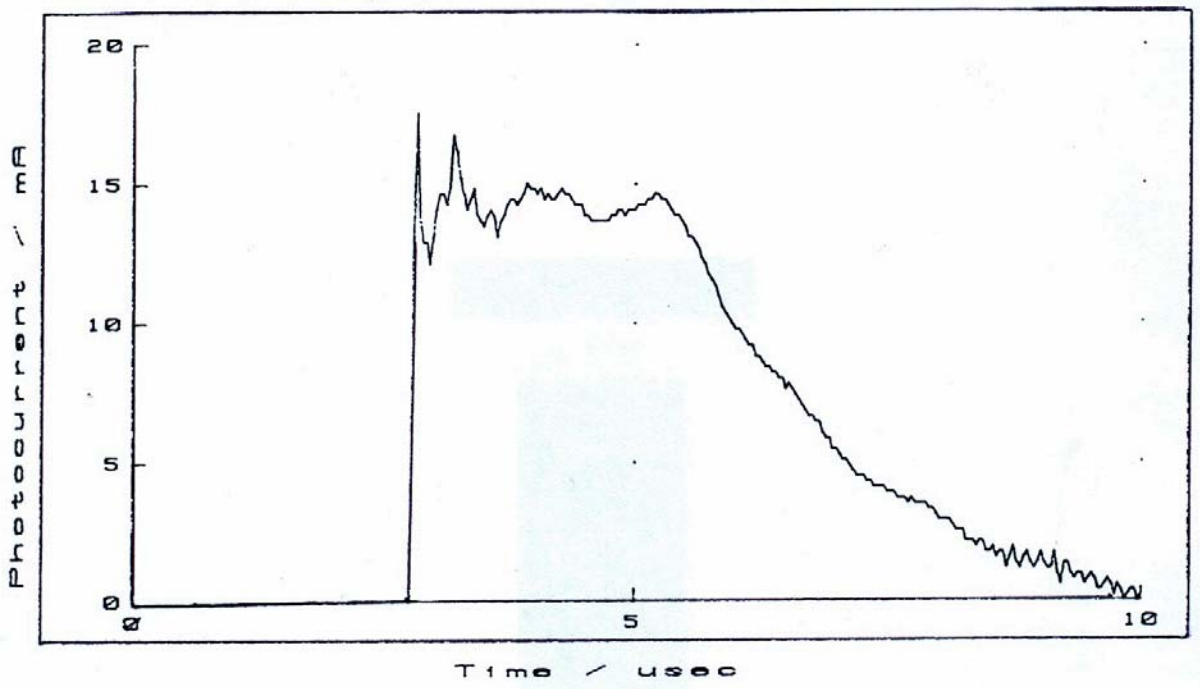

FIGURE A8(c). 4N55 PHOTOCURRENT RESPONSE IN CT3 (DOSE RATE = 6E9 RADS/SEC)

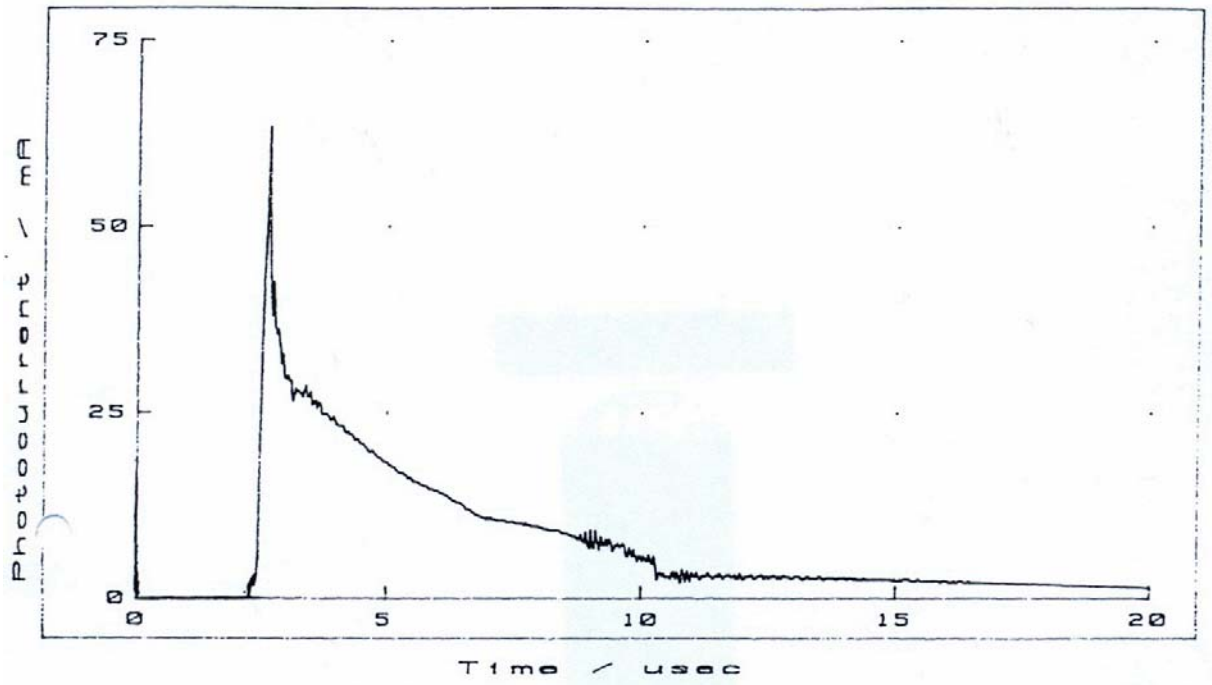

FIGURE A9(a). 6N134 PHOTOCURRENT RESPONSE (DOSE RATE = 3E8 RADS/SEC)

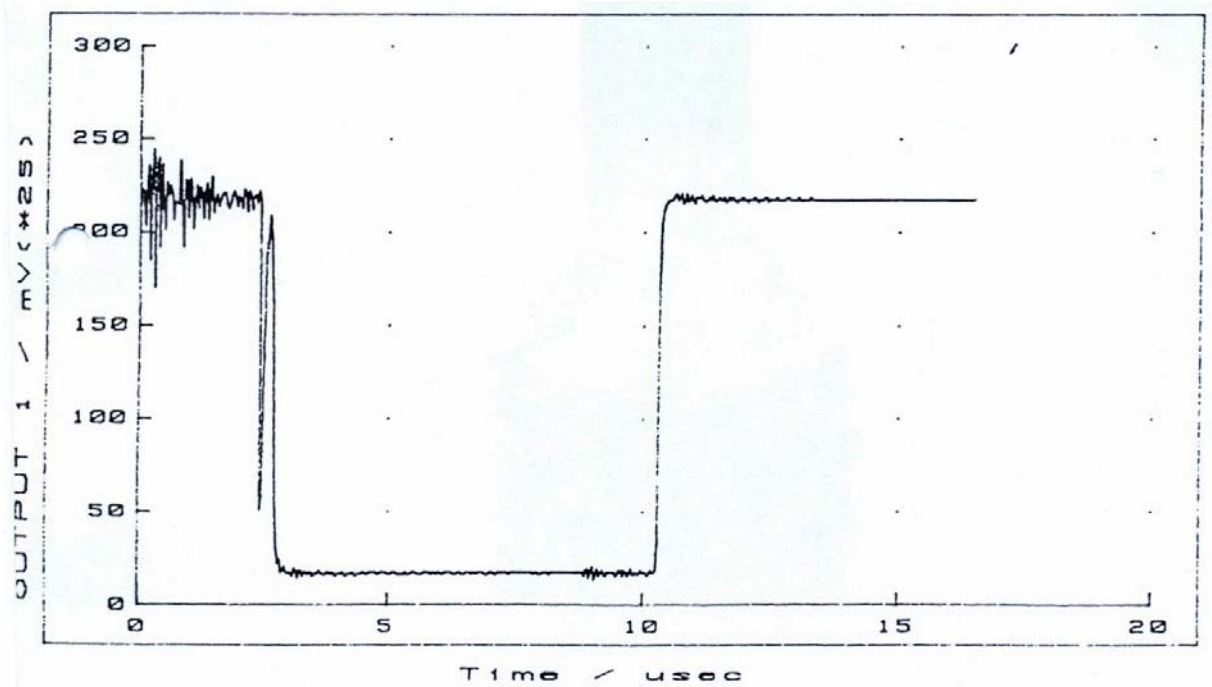

FIGURE A9(b). 6N134 OUTPUT (No.1) RESPONSE (DOSE RATE = 3E8 RADS/SEC)

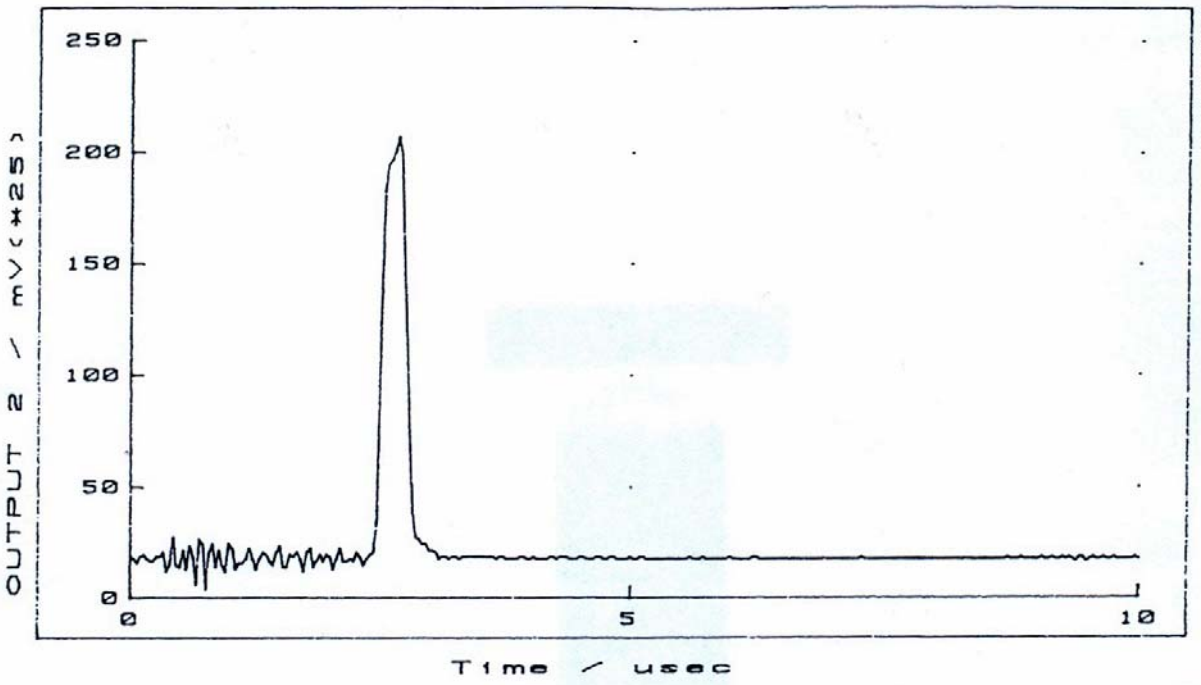

FIGURE A9(c). 6N134 OUTPUT (No.2) RESPONSE (DOSE RATE = 3E8 RADS/SEC)

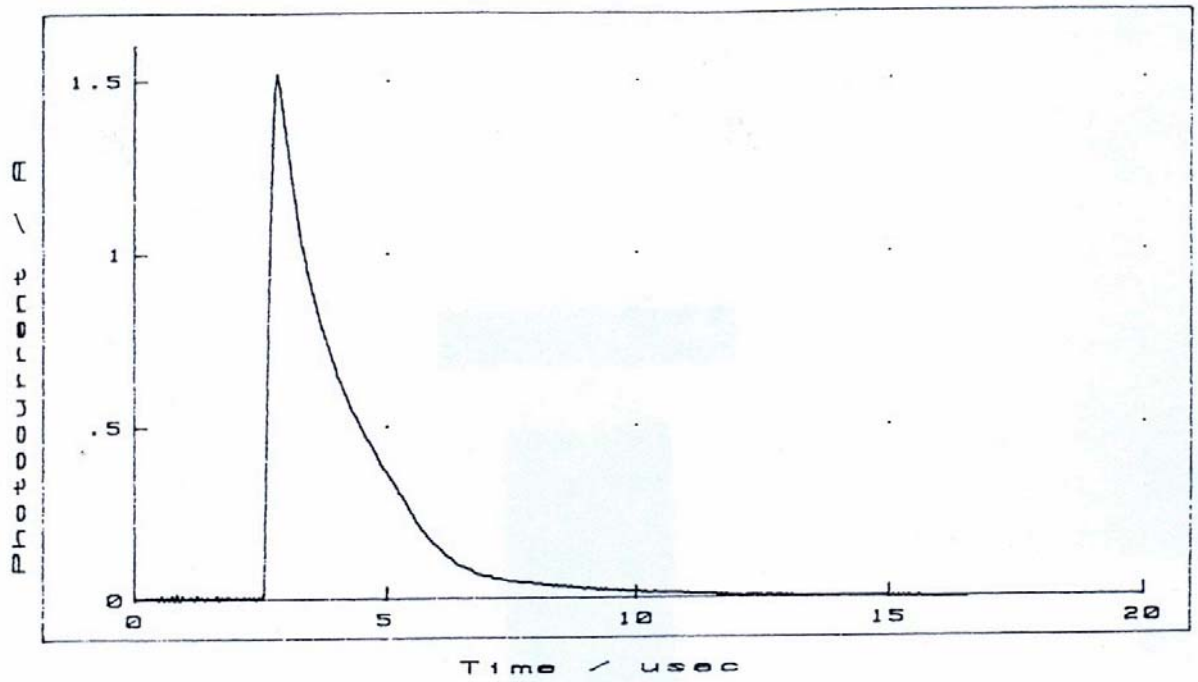

FIGURE A10(a). 6N134 PHOTOCURRENT RESPONSE (DOSE RATE = 6E9 RADS/SEC)

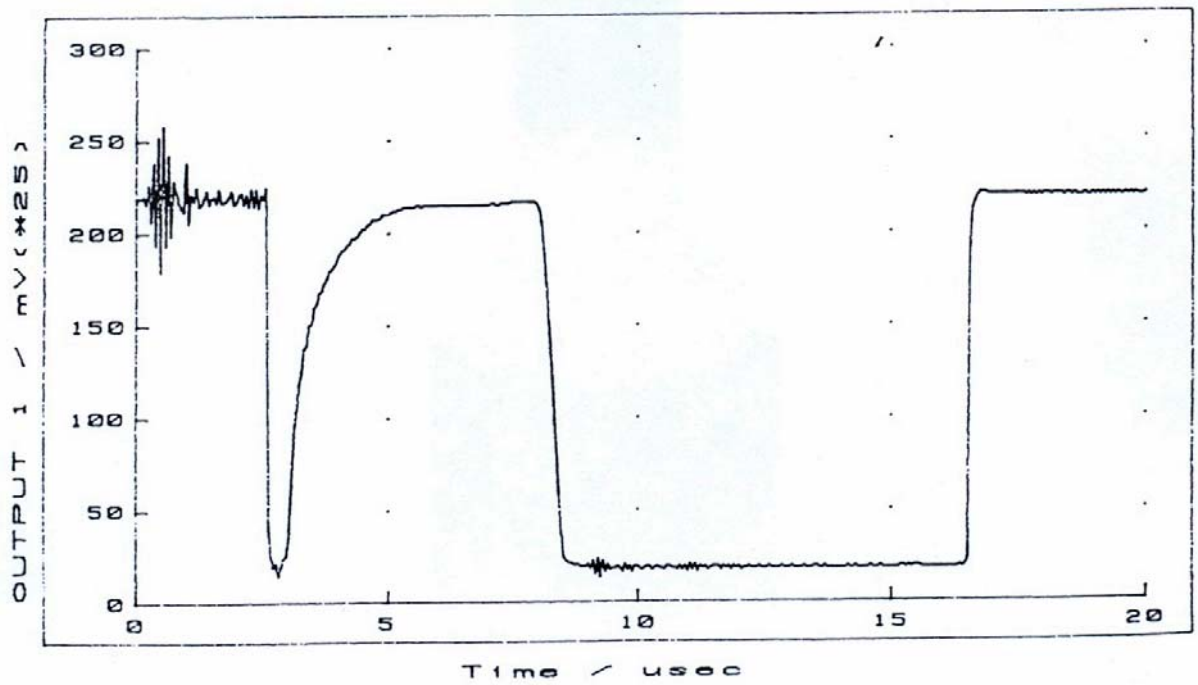

FIGURE A10(b). 6N134 OUTPUT (No.1) RESPONSE (DOSE RATE = 6E9 RADS/SEC)

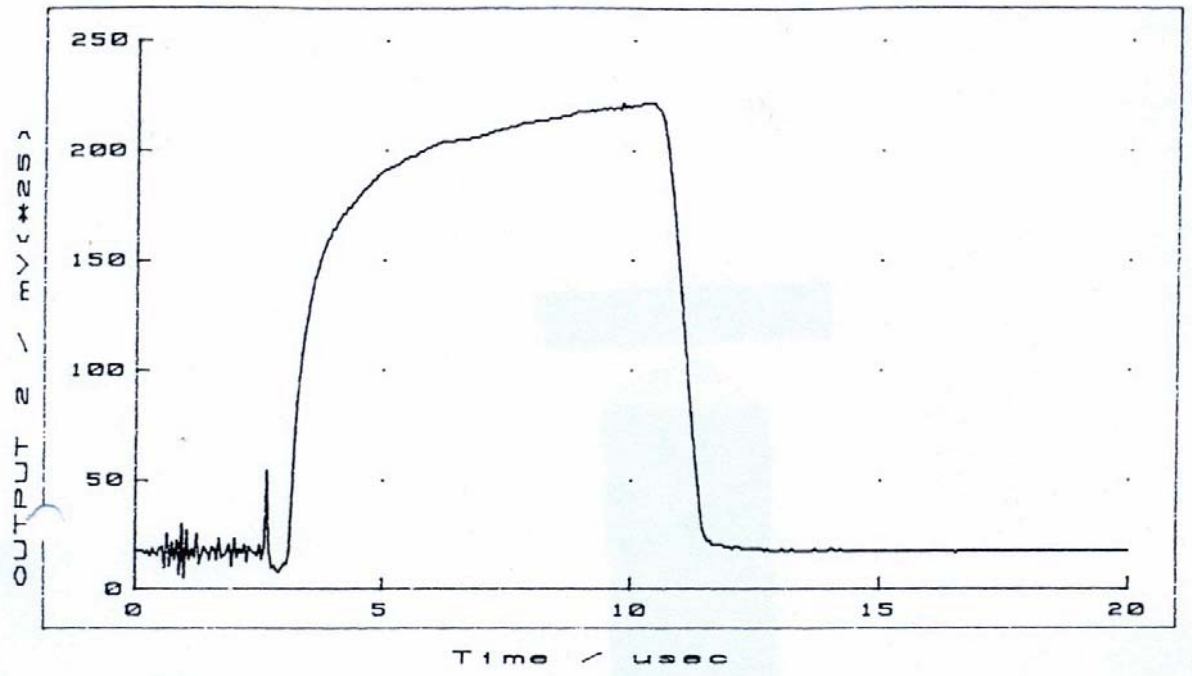

FIGURE A10(c). 6N134 OUTPUT (No.2) RESPONSE (DOSE RATE = 6E9 RADS/SEC)

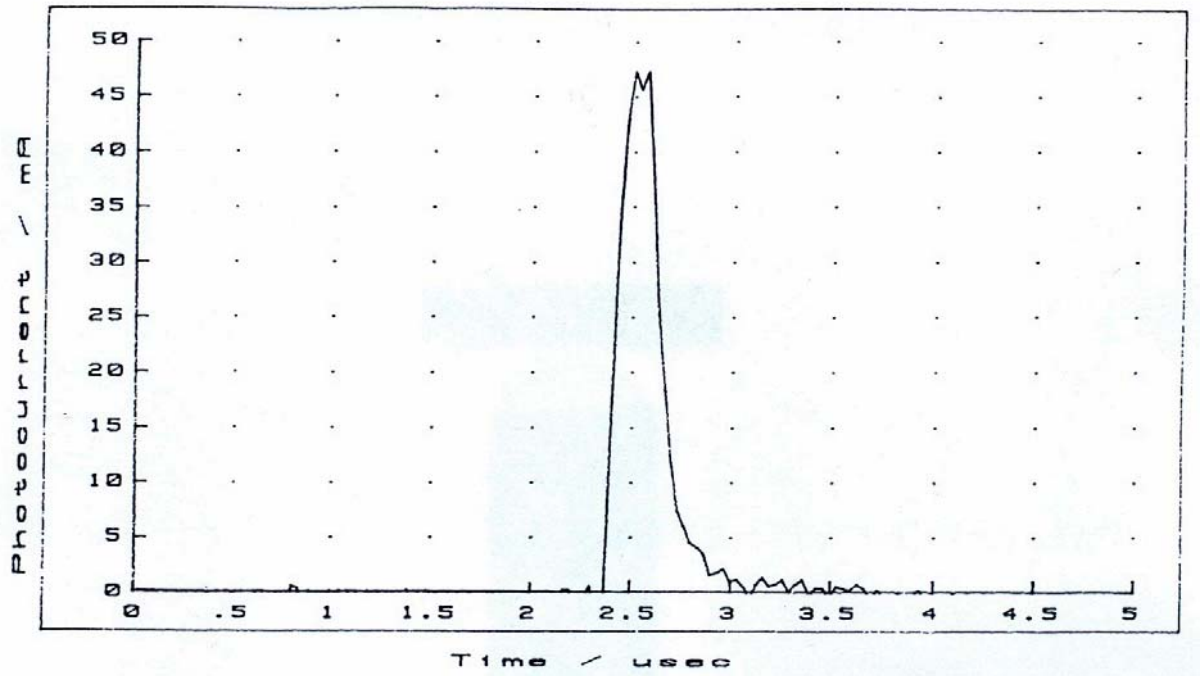

FIGURE A11(a). 6N140 PHOTOCURRENT RESPONSE (DOSE RATE = 1E7 RADS/SEC)

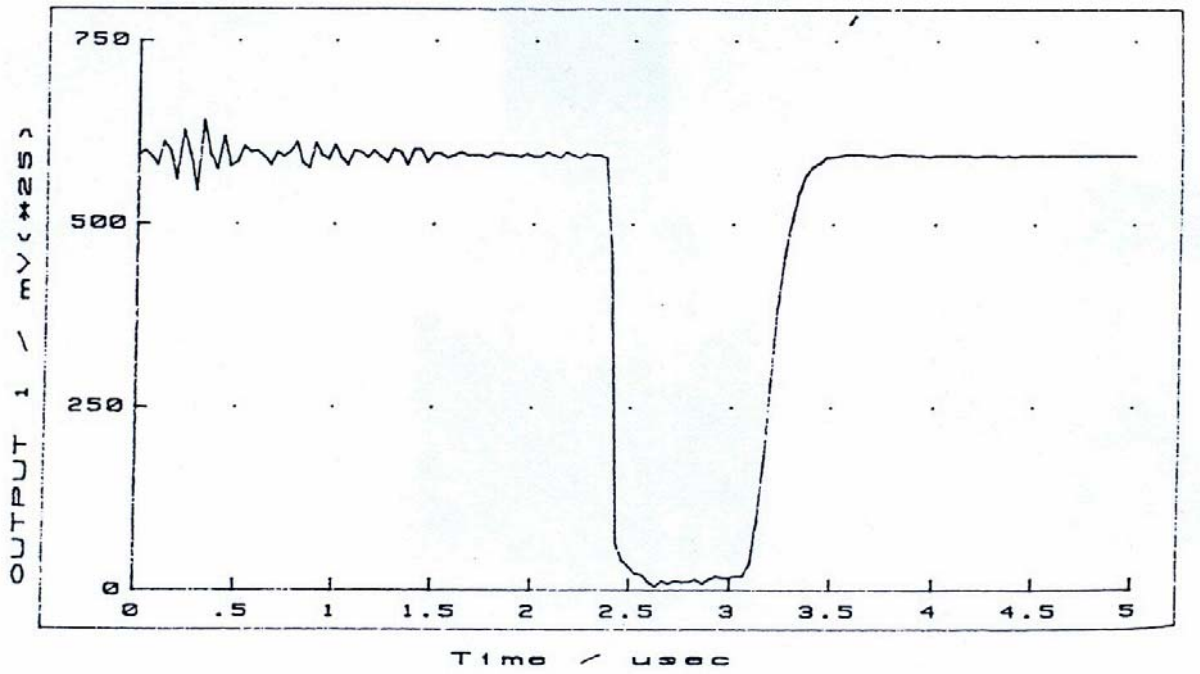

FIGURE A11(b). 6N140 OUTPUT (No.1) RESPONSE (DOSE RATE = 1E7 RADS/SEC)

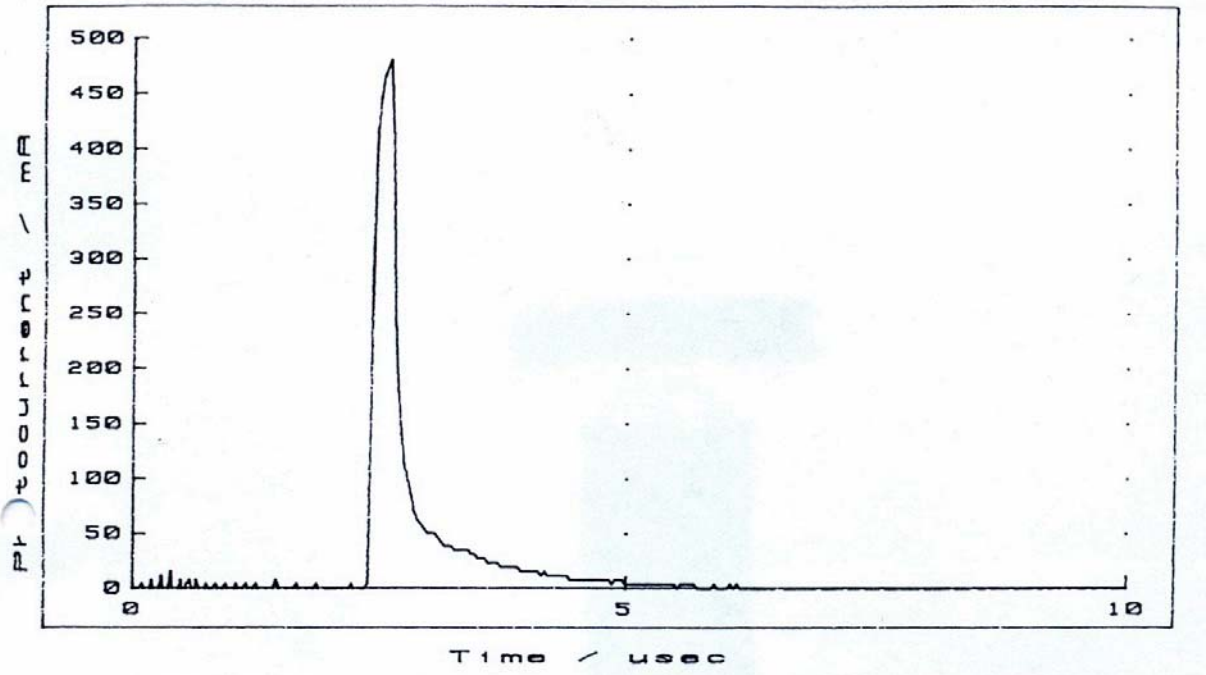

FIGURE A12(a). 6N140 PHOTOCURRENT RESPONSE (DOSE RATE = 3E8 RADS/SEC)

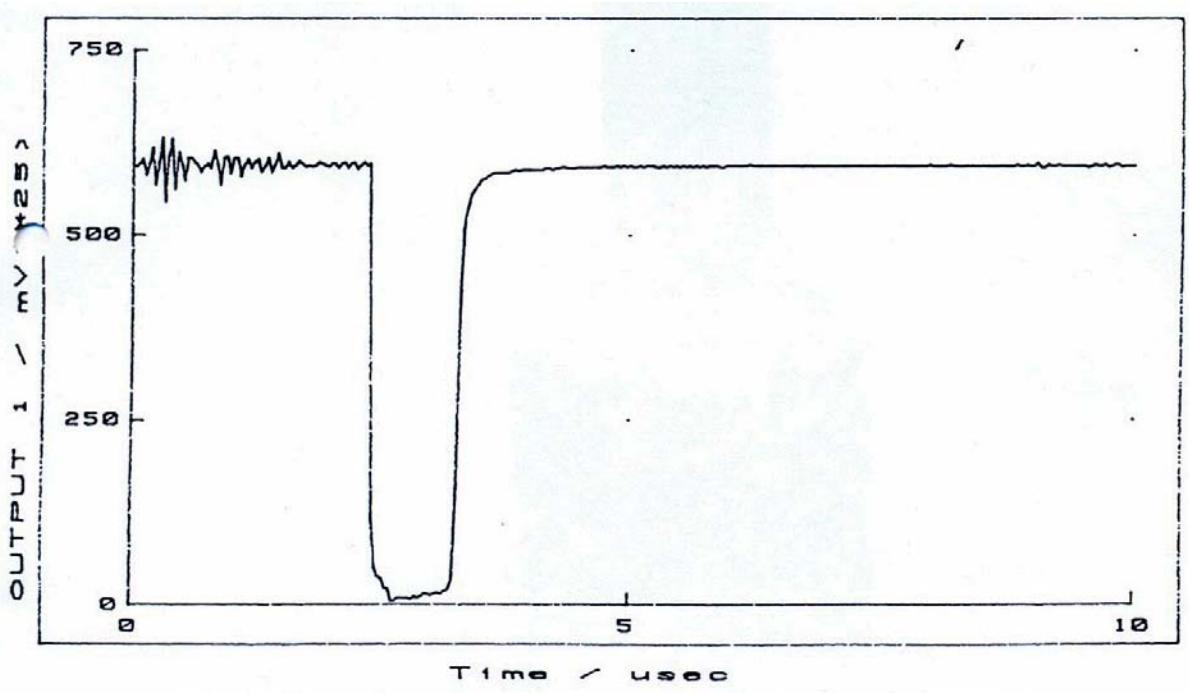

FIGURE A12(b). 6N140 OUTPUT (No.1) RESPONSE (DOSE RATE = 3E8 RADS/SEC)

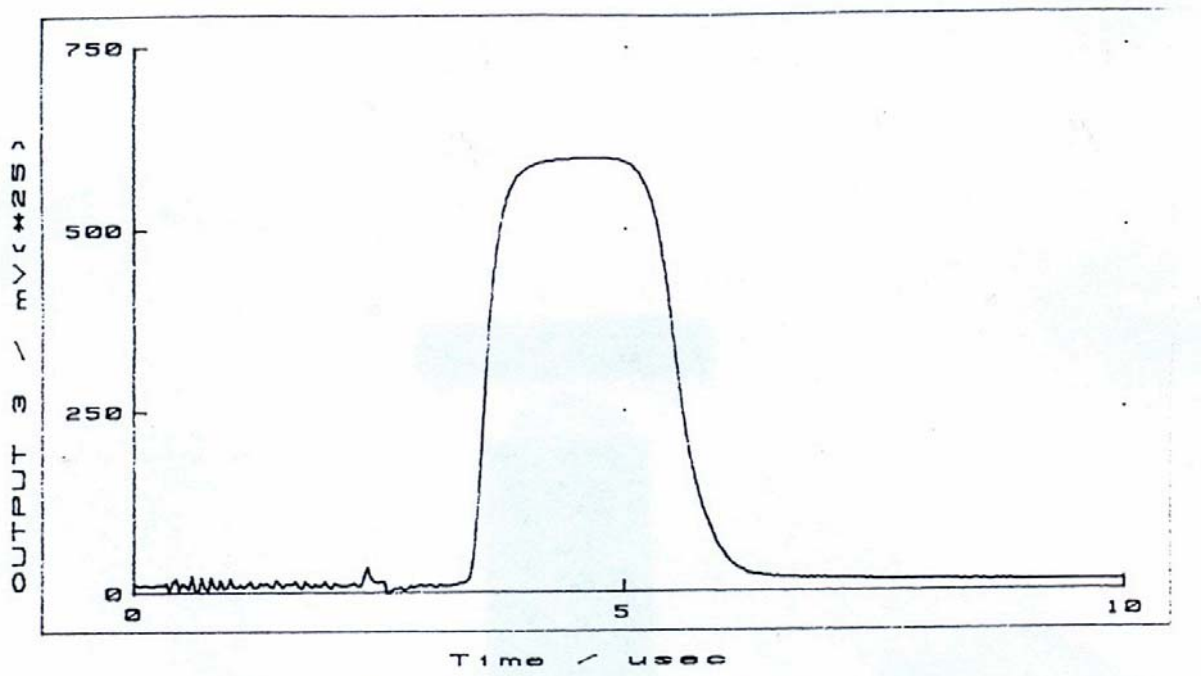

FIGURE A12(c). 6N140 OUTPUT (No.3) RESPONSE (DOSE RATE = 3E8 RADS/SEC)

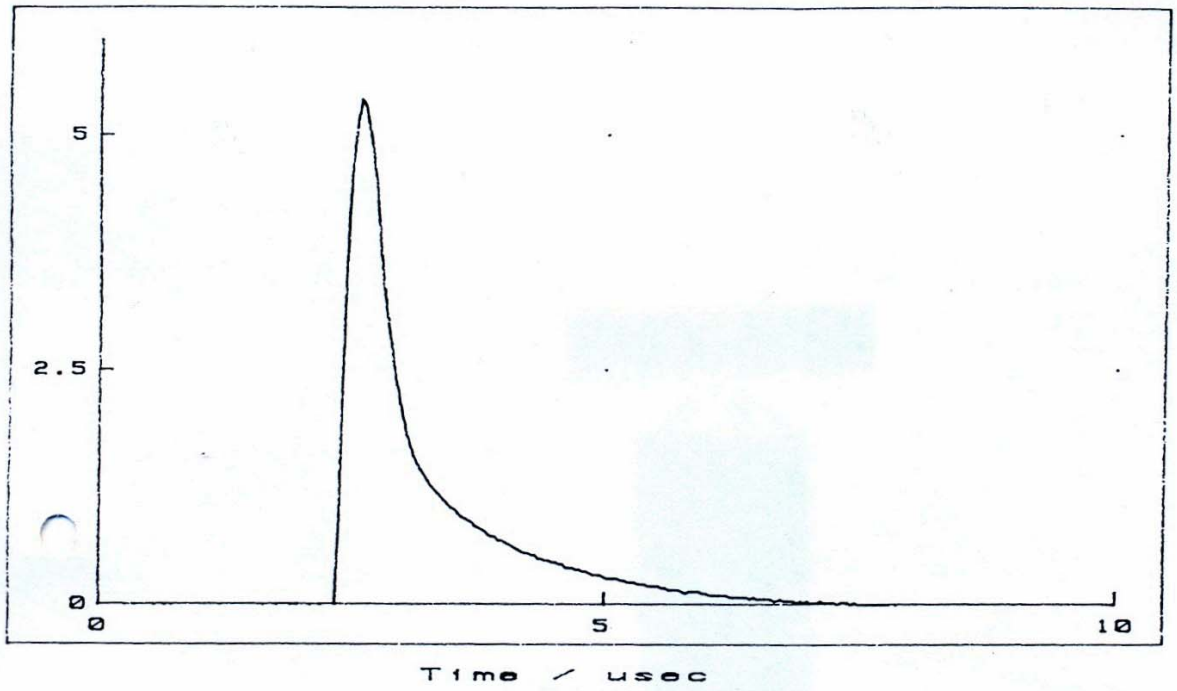

FIGURE A13(a). 6N140 PHOTOCURRENT RESPONSE (DOSE RATE = 6E9 RADS/SEC)

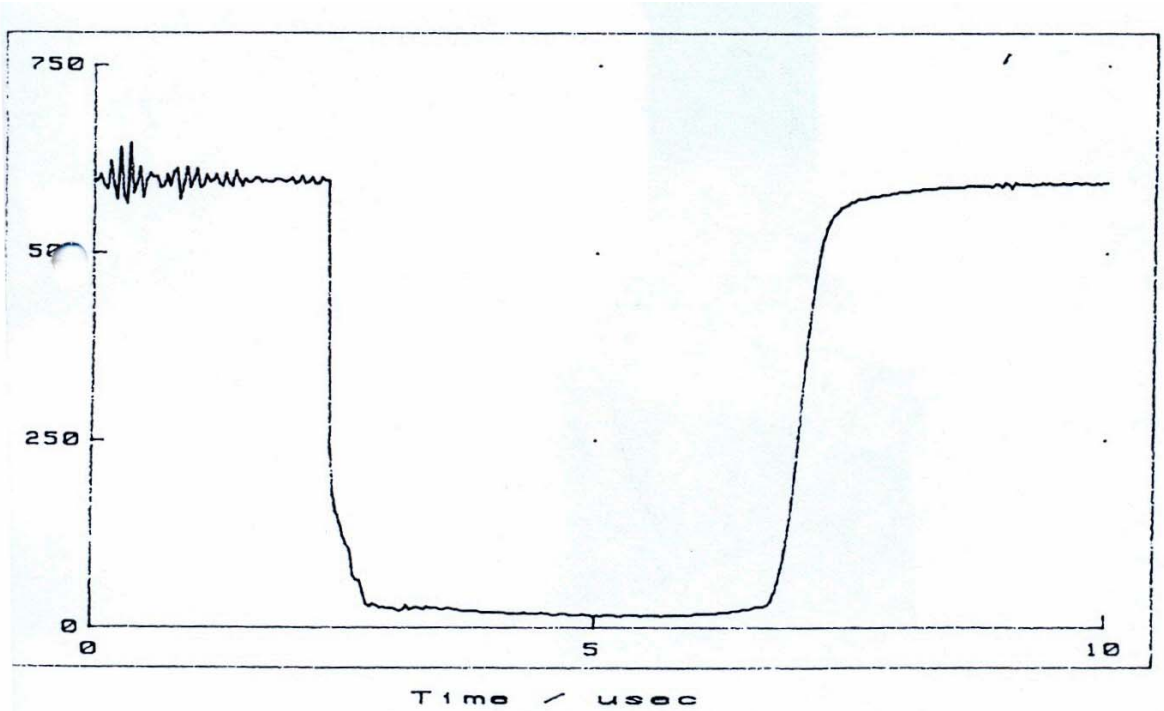

FIGURE A13(b). 6N140 OUTPUT (No.1) RESPONSE (DOSE RATE = 6E9 RADS/SEC)