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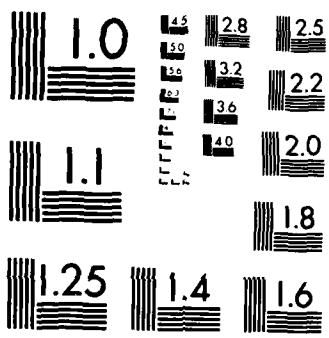

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Serial No. WWB-4-227

Air Force Office of Scientific Research
Building 410
Bolling Air Force Base, D. C. 20332

Attention: Mr. Harry Winsor, Code NE

Subject: Contract F49620-83-C-0153,
Third Quarterly Report on Study in Spurious Sensitivity
of Electronics in Space

Gentlemen:

In partial fulfillment of the requirements of Item 0002AB of Sections B and F of the subject contract, enclosed are six (6) copies of the Third Quarterly Report covering the period from April 1 to June 30, 1984.

Very truly yours,

ITT AEROSPACE/OPTICAL DIVISION

W. W. Butler
Senior Contract Administrator

WWB:rrp

Enclosures

cc: Ms. A. Sprunt, Code PKD (letter only)

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A measurement program in which a proton beam irradiates sensitive electro-optical sensors used in spacecraft systems has been prepared. The progress reported during this period includes device procurement, test setup, laboratory testing and accelerator test preparation. A second set of tests will be scheduled for July at the Harvard Cyclotron.

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Study in Spurious Sensitivity of Electronics in Space

Third Quarterly Report

Contract Number
F49620-83-C-0153

Prepared for

USAF, AFSC
Air Force Office of Scientific Research
Building 410
Bolling AFB, DC 20332

Prepared by

ITT Aerospace/Optical Division
P.O. Box 3700
Fort Wayne, IN 46801

Program Objectives

A measurement program in which an energetic proton beam irradiates sensitive electro-optical sensors used in spacecraft systems has been prepared. The testing is to be in two segments using beam time at the Indiana University Cyclotron, Harvard Cyclotron or Los Alamos Meson Physics Facility.

The initial testing will investigate sensors with high gain but which do not require cooling. Photomultiplier tubes meet these requirements and are frequently used in star trackers, imaging systems, surveillance systems, warning systems and other scientific instrumentation. Later testing will be performed on photodiodes and infrared sensors.

Procurement

During this reporting period ITT-A/OD has received three RCA Avalanche photodiode types - 30902E, 30817 and 30916E. Two infrared detector types have been procured. These are Kodak Indium Antimonide and Honeywell HgCdTe detectors.

Testing

During this reporting period all of the photodiodes have been operated in the laboratory and their characteristics are being measured. In addition to the avalanche photodiodes discussed above three PIN-10 Shottky Barrier Detectors from United Detector Technology and five photoconductive (SD-100-12-12-121) and five (SD-100-12-22-021) photodiodes from Silicon Detector Corporation are being tested.

A Dewar has been assembled for the infrared detectors. This will allow cooling of the detectors during irradiation. The detectors have been mounted so that they have a clear view through the infrared window in the Dewar. Within the next week the signal to noise ratio will be measured.

During July or early August the photodiodes and infrared detectors will be tested in the 160 MeV proton beam at the Harvard Cyclotron. The exact data of the testing is still being determined. Full information will be submitted to AFOSR prior to any commitment.

Meetings

At the request of AFOSR an abstract was submitted and a paper is to be presented at the Spacecraft Survivability Workshop which is convened in conjunction with the 1984 Chemical Systems Laboratory Scientific Conference on Obscuration and Aerosol Research. A copy of the abstract is attached.

Abstract
Study in Spurious Sensitivity of Electronics in Space

Passive electro-optical instrumentation including, vidicons, image dissectors, silicon photodiodes and various infrared sensors is being used in a variety of exoatmospheric applications. These include, among others, star sensing, tracking and surveillance systems. The operation of spaceborne electro-optical sensor system in the presence of the ambient and nuclear weapons particle environment is a recurring question. Due to the difficulties of working at a large accelerator facility, few measurements of positive ion interaction have been made. Instead effects due to positive ions are calculated or estimated from existing electron data. Such measurements are important because it is nearly impossible to sufficiently shield sensitive components from positive ions with energies greater than 50MeV. In fact shielding can actually enhance the dose by producing bremsstrahlung radiations. Shielding is especially difficult for electro-optical sensor that require a clear view of space.

ITT-A/OD has begun a measurement program to determine the transient response of electro-optical sensors. The first of these tests was performed on January 1, 1981 on an Image Dissector Camera at the Indiana University Cyclotron Facility. The purpose of these measurements was to provide quantative estimates of face plate fluorescence dynode emission and wall emission. The front of the camera was blocked so that only the dark and any particle generated currents were being observed. Various parts of the camera were irradiated with 200MeV and 40MeV protons to help identify sensitive areas and to help determine the cause of the currents. A particle flux on the order of 10^8 protons/cm^2-sec were sufficient to affect the ability of the Image Dissector to track a target. Proton intensity greater than 10^9 protons/cm^2-sec rendered the camera useless for tracking. These effects were mainly caused by face plate fluorescence and dynode emission.

The temporal response of an FW129 and FW130 photomultiplier tube and a 4012 image dissector tube manufactured by the Electro-Optics Products Division of ITT was measured in a 318MeV proton beam at the Los Alamos Meson Physics Facility. The pulse structure of the beam consisted of 200 ps pulses containin 10^7-10^8 protons separated by 4.5 μs. These were continued for a macropulse of 720 μs. The repetition rate was 8HZ. The tubes were oriented head-on to the beam and side on hitting just the electron multiplier. For all three tube types the response head-on to the beam was higher than when just the photomultiplier was exposed. For the head-on orientation the tubes only partially recovered after a micropulse before receiving another pulse. The complete pulse decay to the baseline was observed after a macropulse. After pulsing in the tubes was also a feature of these observations.

The efforts described above will be expanded to include silicon photodiodes and infrared detectors. The photodiodes will include PIN, Schottky barrier and advance types. The infrared detectors chosen are photovoltaic Indium Antimoncide and photoconductive HgCdTe. These will be tested in the 160MeV beam at the Harvard Cyclotron. This facility was chosen because of its availability and cost. Finally these data will be combined with the operational parameters and specifications of known systems to determine the transient response of these systems to energetic protons.

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