

# Unisys

DATE: October 29, 1997  
TO: J. Lohr/311  
FROM: K. Sahu/300.1  
SUBJECT: Radiation Report on: TL7770-5  
Project: SMEX/LITE  
Job #: C78111  
Project part #: TL7770-5 (5962-9093201M2A)

PPM-97-044

cc: T. Miccolis/300.1  
K. LaBel/735  
A. Sharma/311  
OFA Library/300.1

A radiation evaluation was performed on TL7770-5 (5962-9093201M2A) to determine the total dose tolerance of these parts. A brief summary of the test results is provided below. For detailed information, refer to Tables I through IV and Figure 1.

The total dose testing was performed using a Co<sup>60</sup> gamma ray source. During the radiation testing, five parts were irradiated under bias (see Figure 1 for bias configuration) and one part was used as a control sample. The total dose radiation levels were 2.5, 5.0, 7.5, 10.0, 15.0, 20.0, 30.0, and 50.0 kRads.\* The dose rate was between 0.062 and 0.500 kRads/hour (0.017 to 0.139 Rads/s). See Table II for the radiation schedule and effective dose rate calculation. After the 50.0 kRad exposure, the parts were annealed for 168 hours at 25°C. After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits\*\* listed in Table III.

Initial electrical measurements were made on 6 samples. Five samples (SN's 251, 252, 253, 254, and 255) were used as radiation samples while SN 250 was used as a control sample. SN 251 exceeded the specification limits for both ICC measurements initially and those two values are not included in the data analysis. All other parts passed all tests during initial electrical measurements.

After the 2.5 kRad irradiation, SN's 252 and 253 exceeded the specification limit of -200mA for I\_SCR@3.5V with readings of -76 and -99mA respectively. **All parts passed all other tests.**

After the 5.0 kRad irradiation, all parts exceeded the specification limit for I\_SCR@3.5V with readings in the range of -84 to -80mA. **All parts passed all other tests.**

After the 7.5 kRad irradiation, all parts exceeded the specification limit for I\_SCR@3.5V with readings in the range of -90 to -84mA. **All parts passed all other tests.**

After the 10.0 kRad irradiation, all parts exceeded the specification limit for I\_SCR@3.5V with readings in the range of -87 to -84mA. **All parts passed all other tests.**

After the 15.0 kRad irradiation, SN 252 exceeded the specification limit of 5.0mA for ICC@3.5V with a reading of 6.5mA. All parts continued to exceed the specification limit for I\_SCR@3.5V with readings in the range of -81 to -78mA. All parts also exceeded the specification limit of -200mA for I\_SCR@18V with readings in the range of -103 to -92mA. **All parts passed all other tests.**

---

\* The term Rads, as used in this document, means Rads (silicon). All radiation levels cited are cumulative.

\*\* These are manufacturer's pre-irradiation data specification limits. The manufacturer provided no post-irradiation limits at the time these tests were performed.

After the 20.0 kRad irradiation, SN's 252 and 254 exceeded the specification limit of 5.0mA for ICC@3.5V and ICC@18V with readings of 6.2 and 6.3mA respectively for ICC@3.5V and 6.9mA for both for ICC@18V. All parts continued to exceed the specification limit for I\_SCR@3.5V with readings in the range of -61 to -53mA. All parts continued to exceed the specification limit for I\_SCR@18V with readings in the range of -89 to -75mA. **All parts passed all other tests.**

After the 30.0 kRad irradiation, all parts exceeded the specification limit of 5.0mA for ICC@3.5V and ICC@18V with readings in the range of 7.9 to 8.0mA for ICC@3.5V and 6.3 to 6.5mA for ICC@18V. Four parts fell below the specification limit of 16.5V for Voh\_VSO\_20mA with all parts reading 0V. All parts continued to exceed the specification limit for I\_SCR@3.5V with readings in the range of -50 to -34mA. All parts continued to exceed the specification limit for I\_SCR@18V with readings in the range of -53 to -11mA. **All parts passed all other tests.**

After the 50.0 kRad irradiation and 312-hour annealing, no recovery was noted in any parameter with all parts exceeding the specification limit of 5.0mA for ICC@3.5V and ICC@18V with readings in the range of 7.9 to 8.1mA for ICC@3.5V and 6.4 to 6.9mA for ICC@18V. All parts had readings of 0V for Voh\_VSO\_20mA (specification limit: 16.5V). All parts continued to exceed the specification limit for I\_SCR@3.5V with readings in the range of -44 to -38mA. All parts continued to exceed the specification limit for I\_SCR@18V with readings in the range of -11 to -10mA.

Table IV provides a summary of the test results with the mean and standard deviation values for each parameter after each irradiation exposure and annealing step.

Any further details about this evaluation can be obtained upon request. If you have any questions, please call me at (301) 731-8954.

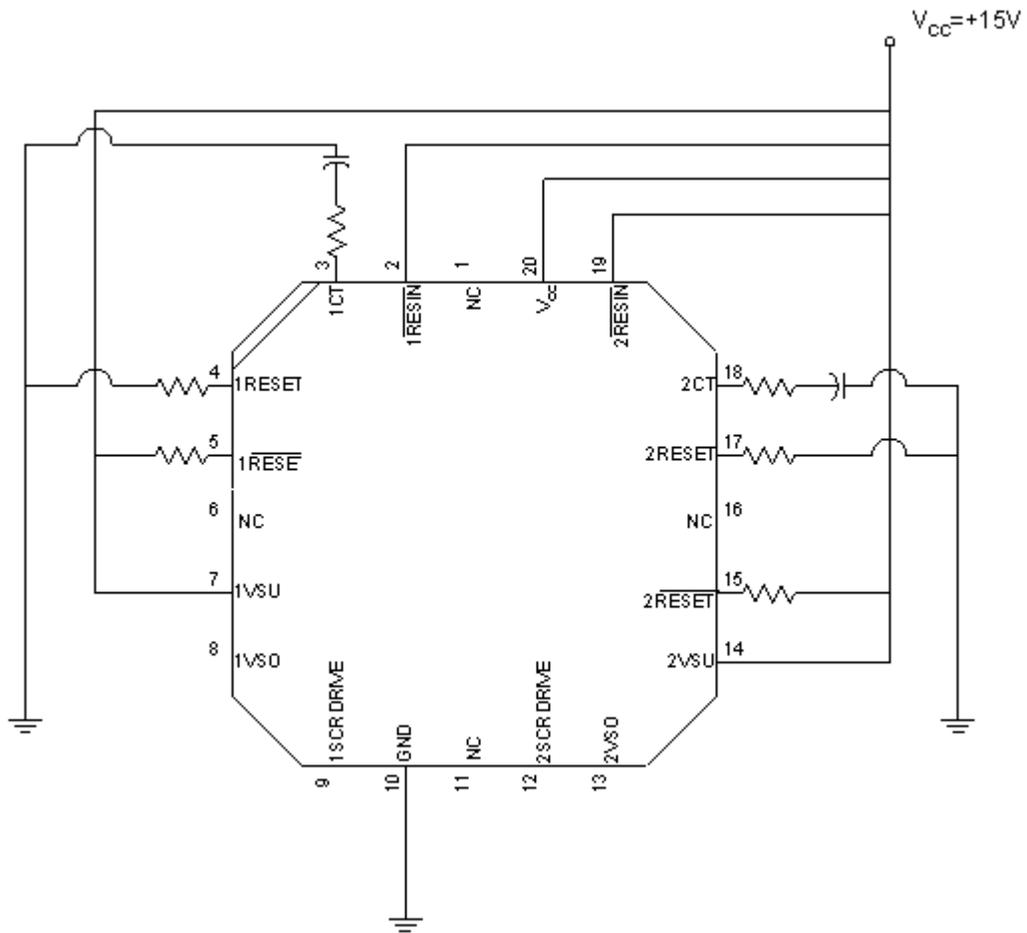
---

#### ADVISORY ON THE USE OF THIS DOCUMENT

The information contained in this document has been developed solely for the purpose of providing general guidance to employees of the Goddard Space Flight Center (GSFC). This document may be distributed outside GSFC only as a courtesy to other government agencies and contractors. Any distribution of this document, or application or use of the information contained herein, is expressly conditional upon, and is subject to, the following understandings and limitations:

- (a) The information was developed for general guidance only and is subject to change at any time;
- (b) The information was developed under unique GSFC laboratory conditions that may differ substantially from outside conditions;
- (c) GSFC does not warrant the accuracy of the information when applied or used under other than unique GSFC laboratory conditions;
- (d) The information should not be construed as a representation of product performance by either GSFC or the manufacturer;
- (e) Neither the United States government nor any person acting on behalf of the United States government assumes any liability resulting from the application or use of the information.

Figure 1. Radiation Bias Circuit for TL7770-5



Notes:

1. Capacitor is 0.1 $\mu$ f, 20V DC.
2. Resistors are 10k $\Omega$   $\pm$  5%, 1/4 W.
3. V<sub>CC</sub> = 15.0V  $\pm$  0.5V DC

TABLE I. Part Information

Generic Part Number:	TL7770-5
SMEX/LITE Part Number	TL7770-5 (5962-9093201M2A)
Charge Number:	C78111
Manufacturer:	Texas Instruments
Lot Date Code (LDC):	9537A
Quantity Tested:	6
Serial Number of Control Sample:	250
Serial Numbers of Radiation Samples:	251, 252, 253, 254, and 255
Part Function:	Dual Power Supply Supervisor
Part Technology:	Bipolar
Package Style:	20Pin LCC
Test Equipment:	A540
Test Engineer:	D. Davis

- The manufacturer for this part guaranteed no radiation tolerance/hardness.

TABLE II. Radiation Schedule for TL7770-5

EVENT.....	DATE
1) INITIAL ELECTRICAL MEASUREMENTS .....	09/04/97
2) 2.5 KRAD IRRADIATION (0.125 KRADS/HOUR) .....	09/19/97
POST-2.5 KRAD ELECTRICAL MEASUREMENT .....	09/22/97
3) 5.0 KRAD IRRADIATION (0.125 KRADS/HOUR) .....	09/22/97
POST-5.0 KRAD ELECTRICAL MEASUREMENT .....	09/24/97
4) 7.5 KRAD IRRADIATION (0.125 KRADS/HOUR) .....	09/24/97
POST-7.5 KRAD ELECTRICAL MEASUREMENT .....	09/26/97
5) 10.0 KRAD IRRADIATION (0.125 KRADS/HOUR) .....	09/26/97
POST-10.0 KRAD ELECTRICAL MEASUREMENT .....	09/29/97
6) 15.0 KRAD IRRADIATION (0.125 KRADS/HOUR) .....	09/29/97
POST-15.0 KRAD ELECTRICAL MEASUREMENT .....	10/01/97
7) 20.0 KRAD IRRADIATION (0.125 KRADS/HOUR) .....	10/02/97
POST-20.0 KRAD ELECTRICAL MEASUREMENT .....	10/04/97
8) 30.0 KRAD IRRADIATION (0.125 KRADS/HOUR) .....	10/04/97
POST-30.0 KRAD ELECTRICAL MEASUREMENT .....	10/07/97
9) 50.0 KRAD IRRADIATION (0.125 KRADS/HOUR) + 312 HOUR ANNEALING @25°C .....	10/07/97
POST-50.0 KRAD + 312 HOUR ANNEAL ELECTRICAL MEASUREMENT .....	10/22/97

Effective Dose Rate = 50,000 RADS/33 DAYS=63.1 RADS/HOUR=0.018 RADS/SEC

The effective dose rate is lower than that of the individual radiation steps as it takes into account the transit and testing time.

The annealing after the 50 kRad step was the result of test equipment repair.

PARTS WERE IRRADIATED AND ANNEALED UNDER BIAS, SEE FIGURE 1.

Table III. Electrical Characteristics of TL7770-5 /1

Test #	Parameter	Units	Test Conditions /2	Spec. min	Lim. max
1	ICC@3.5V	mA	1VSU = 18V, 2VSU = 2V,	0.0	5.0
2	ICC@18V	mA	1RESIN & 2RESIN @ V <sub>CC</sub> , 1VSO & 2VSO @ 0V	0.0	5.0
3&7	IOL 3.5V	mA	V <sub>O</sub> = 0V	-50	
4&8	IOL 18V	mA	V <sub>O</sub> = 0V	-50	
5,6&9,10	Voh 15mA	V	I <sub>OH</sub> = -15mA	2.0	
11&15	Ioh 3.5V	mA	V <sub>O</sub> = 3.5V		50
12&16	Ioh 18V	mA	V <sub>O</sub> = 18V		50
13,14&17,18	Vol 15mA	V	I <sub>OL</sub> = 15mA		0.4
19&21	Voh VSO 20mA	V	I <sub>OH</sub> = -20mA	2.0	
20&22	Voh VSO 20mA	V	I <sub>OH</sub> = -20mA	16.5	
23&25	Voh RST 15mA	V	I <sub>OH</sub> = -15mA	2.0	
24&26	Vol RST 15mA	V	I <sub>OL</sub> = 15mA		0.4
27&29	I_SCR@3.5V	mA	Duration = 1ms		-200
28&30	I_SCR@18V	mA	Duration = 1ms		-200
31,32,35,36, 39,40,41,42	I_RES	mA	V <sub>I</sub> = 5.5V or 0.4V	-10.0	
33,34&37,38	I_VSO	mA	V <sub>I</sub> = 2.4V		2.0

Note:

1/ These are the manufacturer's non-irradiated data sheet specification limits. The manufacturer provided no post-irradiation limits at the time the tests were performed.

2/  $-41.25V < V_{IN} < -4.25V$  unless otherwise noted.

**TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for TL7770-5 /1**

Test #	Parameters	Units	Spec. Lim. /2		Total Dose Exposure (kRads)																			
					Initial		2.5		5.0		7.5		10.0		15.0		20.0		30.0		50.0 + 312 hour Anneal @25°C			
					mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
1	ICC@3.5V	mA	0.0	5.0	3.0	0.04	3.0	0.04	2.9	0.04	2.8	0.04	2.8	0.04	3.7	1.6	4.5	1.8	8.0	0	8.0	0.1		
2	ICC@18V	mA	0.0	5.0	3.4	0.05	3.3	0.05	3.2	0.04	3.2	0.04	3.2	0.05	3.2	0.2	5.0	1.9	6.4	0.1	6.4	0.1		
3&7	IOL 3.5V	mA	-50		-0.01	0	-0.01	0	-0.01	0	-0.01	0	-0.01	0	-0.01	0	-5.0	0	-5.0	0	-5.0	0		
4&8	IOL 18V	mA	-50		-0.01	0	-0.01	0	-0.01	0	-0.01	0	-0.01	0	-0.01	0	-0.01	0	-0.01	0	-0.01	0		
5&9	Voh 15mA	mA	2.0		2.5	0	2.5	0	2.5	0	2.5	0	2.5	0	2.5	0	2.5	0	2.5	0	2.5	0		
6&10	Voh 15mA	mA	16.5		17.0	0.07	17.0	0	17.0	0	17.0	0	17.0	0	17.0	0	17.0	0	17.0	0	17.0	0		
11&15	Ioh 3.5V	mA		50	-0.01	0	-0.01	0	-0.01	0	0.0	0.008	0.0	0.004	0.0	0	0.0	0	5.0	0	4.2	1.9		
12&16	Ioh 18V	V		50	0.02	0	0.02	0	0.02	0	0.03	0	0.03	0	0.03	0	0.04	0	0.04	0.004	0.02	0		
13,14&17,18	Vol 15mA	V		0.4	0.170	0.003	0.170	0.004	0.171	0.004	0.172	0.004	0.174	0.003	0.175	0.004	0.177	0.004	0.178	0.004	0.176	0.005		
19&21	Voh VSO 20mA	V	2.0		2.7	0	2.7	0	2.7	0	2.7	0	2.7	0	2.7	0	2.4	0.5	2.6	0	2.5	0		
20&22	Voh VSO 20mA	V	16.5		17.2	0	17.2	0	17.2	0	17.2	0	17.2	0	17.2	0	17.2	0.01	1P/4F		F			
23&25	Voh RST 15mA	mV	2.0		2.5	0	2.5	0	2.5	0	2.5	0	2.5	0	2.5	0	2.5	0	2.5	0	2.5	0		
24&26	Vol RST 15mA	mV		0.4	0.16	0	0.16	0.01	0.17	0.01	0.17	0.01	0.17	0.01	0.17	0.01	0.18	0.01	0.16	0.01	0.16	0.01		
27&29	I_SCR@3.5V	V		-200	-220	0	-166	64	-82	1.4	-87	2.6	-85	1.1	-80	1.5	-58	3.0	-43	5.6	-40	2.2		
28&30	I_SCR@18V			-200	-216	0	-215	0	-214	0	-214	0.4	-213	0	-97	4.0	-84	4.8	-19	16.1	-10	0.4		
A /4	I_RES			-10.0	-0.12	0.005	-0.28	0.02	-0.45	0.04	-0.58	0.07	-1.07	0.17	-1.76	0.25	-2.32	0.29	-3.18	0.32	-3.43	0.32		
33,34&37,38	I_VSO	V		2.0	0.004	0	0.005	0.0006	0.006	0.0008	0.006	0.0008	0.007	0.0008	0.008	0.0008	0.008	0.0008	0.42	0.008	0.47	0.017		

- Notes:
- 1/ The mean and standard deviation values were calculated over the five parts irradiated in this testing. The control samples remained constant throughout testing and are not included in this table.
  - 2/ These are manufacturer's pre-irradiation data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were performed.
  - 3/ "P" ("F") indicates that all parts passed (failed) this test at this irradiation level or annealing step. "nPmF" means that n parts passed and m parts failed this test at this irradiation level or annealing step. The failing parts had degraded so much that no measurements could be made for these parameters.
  - 4/ "A" includes test numbers 31, 32, 35, 36, 39, 40, 41, and 42.

**Radiation sensitive parameters: ICC@3.5V, ICC@18V, Voh VSO 20mA (16.6V), I\_SCR@3.5V, I\_SCR@18V.**