Unisys

DATE: July 15, 1998 PPM-98-021
TO: J. Dafnis/303
FROM: K. Sahu/S. Kniffin/300.1
SUBJECT: Radiation Report on **LM117HVK (National Semi.) (LDC 9732)**
PROJECT: GOES (ITT)

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A radiation evaluation was performed on **LM117HVK 3-Terminal Adjustable Regulator (National Semi.)** to determine the total dose tolerance of these parts. The total dose testing was performed using a Co^{60} gamma ray source. During the radiation testing, eight parts were irradiated under bias (see Figure 1 for bias configuration) and two parts were used as control samples. The total dose radiation levels were 20.0, 40.0, 60.0, 80.0, 100.0, 150.0, and 200.0 kRads.[1] The dose rate was 1.200 kRads/hour (0.33 Rads/s). See Table II for the radiation schedule and effective dose rate calculation. After the 200.0 kRad irradiation, the parts were annealed under bias at 25°C and tested after 24 and 168 hours.[2] After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits[3] listed in Table III. An executive summary of the test results is provided below in bold, followed by a detailed summary of the test results after each radiation level and annealing step. For detailed information, refer to Tables I through IV and Figure 1.

All parts passed all tests up to 20kRads. After the 40-200kRad exposures, the parts showed significant degradation in Vline_3V_to_40V. Some parts also showed marginal degradation from the specification limits for Vout at Vdiff of 3V, 40V and 60V and VLd_3V_10_200mA. No significant degradation was noted in any other parameter. No significant recovery was noted in any parameter after annealing for 168 hours at 25°C.

Initial electrical measurements were made on 10 samples. Eight samples (SN's 54, 56, 58, 59, 60, 61, 62, and 64) were used as radiation samples while SN's 52 and 53 were used as control samples. All parts passed all tests during initial electrical measurements.

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After the 40.0 kRad irradiation, six parts marginally exceeded the specification limit of 1.300V for Vout_at_Vdiff_40V with readings in the range of 1.302 to 1.312V. Seven parts marginally exceeded the specification limit of 1.300V for Vout_at_Vin_60V with readings in the range of 1.302 to 1.316V. All parts exceeded the specification limit of 8.64V for Vline_3V_to_40V with readings in the range of 12.74 to 14.96V. **All parts passed all other tests.**

After the 60.0 kRad irradiation, six parts marginally exceeded the specification limit for Vout_at_Vdiff_40V with readings in the range of 1.306 to 1.323V. Seven parts marginally exceeded the specification limit for Vout_at_Vin_60V with readings in the range of 1.306 to 1.329V. All parts exceeded the specification limit of Vline_3V_to_40V with readings in the range of 19.47 to 20.48V. **All parts passed all other tests.**

After the 80.0 kRad irradiation, three parts marginally exceeded the specification limit for Vout_at_Vdiff_40V with readings in the range of 1.306 to 1.310V. Five parts marginally exceeded the specification limit for Vout_at_Vin_60V with readings in the range of 1.301 to 1.317V. All parts exceeded the specification limit of Vline_3V_to_40V with readings greater than 20.48V. **All parts passed all other tests.**

[1] The term Rads, as used in this document, means Rads (silicon). All radiation levels cited are cumulative.
[2] The temperature 25°C as used in this document implies room temperature.
[3] 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 100.0 kRad irradiation, there was a test equipment malfunction and all parts were not completely tested at this level. Two parts fell below the specification limit for Vout_at_Vdiff_40V with readings of 1.192 and 1.185V. All parts exceeded the specification limit of Vline_3V_to_40V with readings greater than 20.48V. **All parts passed all other tests.**

After the 150.0 kRad irradiation, all parts fell below the specification limit of 1.200V for Vout_at_Vdiff_3V with readings in the range of 1.096 to 1.178V. Six parts fell below the specification limit of 1.200V for Vout_at_Vdiff_40V with readings in the range of 1.175 to 1.194V. Four parts fell marginally below the specification limit for Vout_at_Vin_60V with readings in the range of 1.185 to 1.194V. All parts exceeded the specification limit of Vline_3V_to_40V with readings greater than 20.48V. Seven parts fell below the specification limit of -15mV for VLd_3V_10_to_200mA with readings in the range of -141 to -220mV. **All parts passed all other tests.**

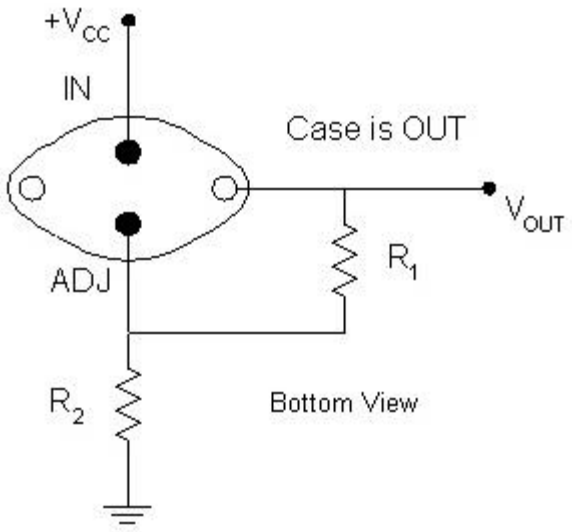
After the 200.0 kRad irradiation, all parts fell below the specification limit for Vout_at_Vdiff_3V with readings in the range of 0.907 to 1.130V. All parts fell below the specification limit for Vout_at_Vdiff_40V with readings in the range of 1.150 to 1.175V. All parts fell marginally below the specification limit for Vout_at_Vin_60V with readings in the range of 1.162 to 1.185V. All parts exceeded the specification limit of Vline_3V_to_40V with readings greater than 20.48V. All parts fell below the specification limit for VLd_3V_10_to_200mA with readings in the range of -149 to -249mV. **All parts passed all other tests.**

After annealing the parts for 24 and 168 hours at 25°C, the parts showed no significant recovery in any parameter except VLd_3V_10_to_200mA with all parts passing this test.

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 us at (301) 731-8954.

Figure 1. Radiation Bias Circuit for LM117HVK



Notes:
1. R_1 = 150Ω ±5%, ½W.
2. R_2 = 2.7kΩ ±5%, ½W.
3. V_{CC} = 50.0V ±0.5V.
4. Check $V_{OUT} \approx$ 24.0V.

TABLE I. Part Information

Generic Part Number:	LM117HVK
GOES (ITT) Part Number	LM117HVK
Charge Number:	C80709/C80825
Manufacturer:	National Semi.
Lot Date Code (LDC):	9732
Quantity Tested:	10
Serial Number of Control Samples:	52, 53
Serial Numbers of Radiation Samples:	54, 56, 58, 59, 60, 61, 62, and 64
Part Function:	3-Terminal Adjustable Regulator
Part Technology:	Bipolar
Package Style:	TO-3 Can
Test Equipment:	A540
Test Engineer:	S. Archer-Davies

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

TABLE II. Radiation Schedule for LM117HVK

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	06/08/98
2) 20.0 KRAD IRRADIATION (1.200 KRADS/HOUR)	06/15/98
POST-20.0 KRAD ELECTRICAL MEASUREMENT	06/16/98
3) 40.0 KRAD IRRADIATION (1.200 KRADS/HOUR)	06/16/98
POST-40.0 KRAD ELECTRICAL MEASUREMENT	06/17/98
4) 60.0 KRAD IRRADIATION (1.200 KRADS/HOUR)	06/17/98
POST-60.0 KRAD ELECTRICAL MEASUREMENT	06/18/98
5) 80.0 KRAD IRRADIATION (1.200 KRADS/HOUR)	06/18/98
POST-80.0 KRAD ELECTRICAL MEASUREMENT	06/19/98
6) 100.0 KRAD IRRADIATION (1.200 KRADS/HOUR)	06/22/98
POST-100.0 KRAD ELECTRICAL MEASUREMENT	06/23/98
7) 150.0 KRAD IRRADIATION (1.200 KRADS/HOUR)	06/23/98
POST-150.0 KRAD ELECTRICAL MEASUREMENT	06/25/98
8) 200.0 KRAD IRRADIATION (0.450 KRADS/HOUR) *	06/25/98
POST-200.0 KRAD ELECTRICAL MEASUREMENT	06/29/98
9) 24 HOUR ANNEALING @25°C	06/29/98
POST-24 HOUR ANNEAL ELECTRICAL MEASUREMENT	06/30/98
10) 168 HOUR ANNEALING @25°C	06/30/98
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	07/06/98

Effective Dose Rate = 200,000 RADS/14 DAYS=595.2 RADS/HOUR=0.16 RADS/SEC
The effective dose rate is lower than that of the individual radiation steps as it takes into account the weekend and the extended step.

* The step was extended due to the weekend.

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

Table III. Electrical Characteristics of LM117HVK /1

Test #	Parameter /2	Units	Test Conditions	Spec. min	Lim. max
1	IQ_3V	mA	V_{IN} -V_{OUT} = 3V	-5.0	5.0
2	IQ_40V	mA	V_{IN} -V_{OUT} = 40V	-5.0	5.0
3	IQ_60V	mA	V_{IN} -V_{OUT} = 60V	-8.2	8.2
4	IADJ_3V	mA	V_{IN} -V_{OUT} = 3V	-100	100
5	IADJ_40V	mA	V_{IN} -V_{OUT} = 40V	-100	100
6	Delta_IADJ_1	mA	10mA £ I_L £ I_{MAX}, 3V £ (V_{IN} -V_{OUT}) £ 60V	-5.0	5.0
7	Vout_at_Vdiff_3V	V	V_{DIFF} = 3V	1.200	1.300
8	Vout_at_Vdiff_40V	V	V_{DIFF} = 40V	1.200	1.300
9	Vout_at_Vin_60V	V	V_{IN} = 60V	1.200	1.300
10	VLine_3V_to_40V	mV	3V £ (V_{IN} -V_{OUT}) £ 40V, I_L = 10mA	-8.64	8.644
11	VLine_40V_to_58.8V	mV	40V £ (V_{IN} -V_{OUT}) £ 58.8V, I_L = 10mA	-25	25
12	VLd_3V_10_to_200mA	mV	V_{IN} -V_{OUT} = 3V, 10mA £ I_L £ 200mA	-15	15
13	VLd_40V_10_to_100mA	mV	V_{IN} -V_{OUT} = 40V, 10mA £ I_L £ 100mA	-15	15
14	VLd_40V_10_to_150mA	mV	V_{IN} -V_{OUT} = 40V, 10mA £ I_L £ 150mA	-15	15

Notes:

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/ For all tests, V_{IN} -V_{OUT} = 5V, I_{OUT} = 0.1A, except where otherwise noted.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for LM117HVK /1

							Total Dose Exposure (kRads Si)														Annealing			
					Initial		20.0		40.0		60.0		80.0		100.0		150.0		200.0		24 hours @25°C		168 hours @25°C	
Test #	Parameters	Units	Spec. Lim. /2 min	Spec. Lim. /2 max	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
1	IQ_3V	mA	-5.0	5.0	0.4	0	0.4	0	0.4	0	0.4	0	0.3	0	0.3	0	0.3	0	0.3	0	0.3	0	0.3	0
2	IQ_40V	mA	-5.0	5.0	4.7	0.1	4.4	0.1	4.3	0.1	4.2	0.1	3.8	0.2	2.8	0.1	2.3	0.1	2.2	0.1	2.3	0.1	2.5	0.1
3	IQ_60V	mA	-8.2	8.2	6.6	0.2	6.0	0.2	5.9	0.1	5.7	0.1	5.4	0.2	4.4	0.2	3.8	0.2	3.7	0.1	3.8	0.1	4.0	0.1
4	IADJ_3V	?A	-100	100	-1	0.1	-1	0	-1	0.1	-1	0.1	-1	0	-1	0	-1	0.1	-1	0.1	-1	0.1	-1	0.1
5	IADJ_40V	?A	-100	100	-1	0	-1	0	-1	0	-1	0	-1	0	-1	0	-1	0	-1	0	-1	0	-1	0
6	Delta_IADJ_1	?A	-5.0	5.0	-0.1	0.1	-0.2	0	-0.1	0.1	-0.1	0.1	-0.2	0	-0.2	0	-0.2	0.1	-0.2	0.1	-0.1	0.08	-0.2	0.07
7	Vout_at_Vdiff_3V	V	1.200	1.300	1.262	0.003	1.273	0.003	1.289	0.006	1.290	0.011	1.265	0.018	1.206	0.013	1.110	0.057	1.023	0.095	1.111	0.032	1.155	0.006
8	Vout_at_Vdiff_40V	V	1.200	1.300	1.265	0.003	1.231	0.003	1.303	0.005	1.310	0.010	1.293	0.017	1.243	0.007	1.192	0.016	1.161	0.009	3/		1.189	0.006
9	Vout_at_Vin_60V	V	1.200	1.300	1.267	0.003	1.284	0.003	1.308	0.005	1.316	0.010	1.300	0.016	1.251	0.007	1.202	0.015	1.172	0.008	3/		1.197	0.005
10	VLine_3V_to_40V /4	mV	-8.64	8.64	2.96	0.05	7.68	0.45	13.56	0.73	20.14	0.53	>20.48		>20.48		>20.48		>20.48		3/		>20.48	
11	VLine_40V_to_58.8V	mV	-25	25	2	0	3	0.1	4	0.1	6	0.2	7	0.3	3/		10	0.5	10	0.5	3/		8	0.4
12	VLd_3V_10_to_200mA	mV	-15	15	0	0	0	0	-1	0.4	-2	0.6	-2	0.1	3/		-165	63	-199	33	3/		-3	0.4
13	VLd_40V_10_to_100mA	mV	-15	15	1	0	1	0.1	0	0.2	-1	0.2	-1	0.1	3/		-1	0.1	-1	0.1	3/		-1	0.1
14	VLd_40V_10_to_150mA	mV	-15	15	0	0	0	0.1	-1	0.2	-2	0.2	-2	0.2	3/		-2	0.1	-2	0.1	3/		-1	0.1

Notes:

1/ The mean and standard deviation values were calculated over the eight 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/ No reliable data was able to be acquired for this test at this level.

4/ Due to limitations in the automatic test equipment, readings above 20.5mV can not be made for this parameter.

Radiation sensitive parameters: Vout_at_Vdiff_3V, Vout_at_Vdiff_40V, Vout_at_Vin_60V, VLine_3V_to_40V, VLd_3V_10_to_200mA.