

Unisys

DATE: July 15, 1998 PPM-98-022
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SUBJECT: Radiation Report on **SG1846 (Linfinity) (LDC 9715)**
PROJECT: GOES (ITT)

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A radiation evaluation was performed on **SG1846J (SG565706-1) Current Mode PWM Controller (Linfinity)** 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 limits³ 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 80kRads. After 100-200kRad exposures, the parts showed some degradation in Iib, Ios and Voh_swing in the Error Amplifier section only. No significant recovery was noted in any parameter after annealing for 168 hours at 25°C following the 200kRad irradiation step.

Initial electrical measurements were made on 10 samples. Eight samples (SN's 160, 161, 162, 163, 164, 165, 167, and 168) were used as radiation samples while SN's 158 and 159 were used as control samples. All parts passed all tests during initial electrical measurements.

Current Sense Amplifier, Oscillator, Shut Down Terminal, and Output Section

All parts passed all tests through 200kRads and 168 hours annealing at 25°C.

Error Amplifier Section

All parts passed all tests up to 80.0 kRads.

After the 100.0 kRad irradiation, SN 162 marginally exceeded the specification limit of 250nA for Ios with a reading of 271nA. SN 168 fell marginally below the specification limit of 4.30V for Voh_swing with a reading of 3.89V. **All parts passed all other tests.**

After the 150.0 kRad irradiation, seven parts fell below the specification limit of -1.00 μ A for non_inv_Iib and inv_Iib with readings in the range of -1.04 to -1.36 μ A for both. SN 162 exceeded the specification limit for Ios with a reading of 329nA. SNs 160 and 168 fell below the specification limit for Voh_swing with readings of 3.15 and 2.09V respectively. **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 200.0 kRad irradiation, all parts fell below the specification limit for non_inv_Iib and inv_Iib with readings in the range of -1.13 to -1.52 μ A for both. SN 162 exceeded the specification limit for Ios with a reading of 392nA. SNs 160 and 168 fell below the specification limit for Voh_swing with readings of 2.87 and 1.68V respectively. **All parts passed all other tests.**

After annealing the parts for 24 hours at 25°C, the parts showed no significant recovery in any parameter. The parts did show an increase in degradation in V_shutdown with three parts exceeding the specification limit of 400mV with readings of 428, 448 and 416mV.

After annealing the parts for 168 hours at 25°C, the parts showed some recovery in the Iib measurements with readings in the range of -1.04 to -1.50 μ A and very modest recovery in Voh_swing. Three parts continued to exceed the specification limit for V_shutdown with similar readings to those after 24 hours of annealing.

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.

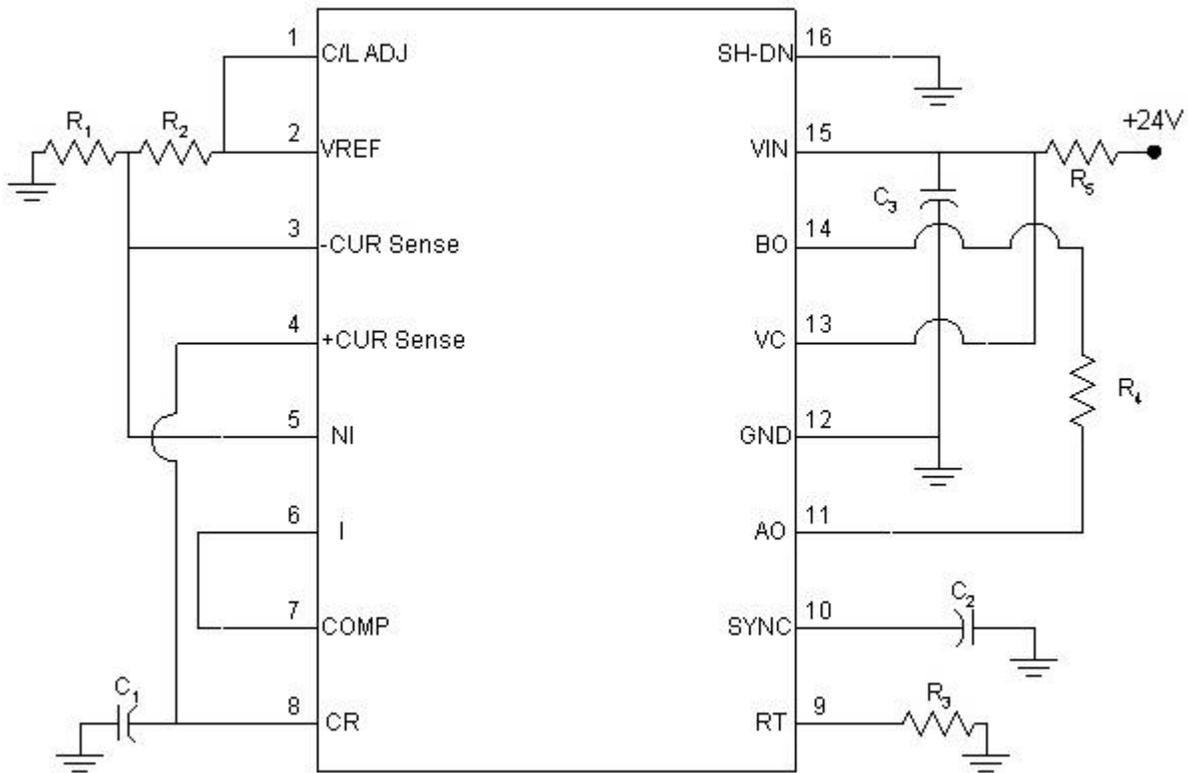
Any further details about this evaluation can be obtained upon request. If you have any questions, please call us at (301) 731-8954.

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Figure 1. Radiation Bias Circuit for SG1846



Notes:

1. $V_{IN} = 24.0V \pm 0.5V$.
2. $R_1 = R_2 = 5.1k\Omega \pm 5\%$, $\frac{1}{2}W$.
3. $R_3 = 6.2k\Omega \pm 1\%$, $\frac{1}{2}W$.
4. $R_4 = 10k\Omega \pm 1\%$, $\frac{1}{2}W$.
5. $R_5 = 100\Omega \pm 5\%$, $\frac{1}{2}W$.
6. $C_1 = 0.01\mu F \pm 5\%$.
7. $C_2 = 100pF \pm 10\%$.
8. $C_3 = 1\mu F \pm 10\%$. As close to D.U.T. as possible.
9. Capacitors are 50V rated for 125°C.

TABLE I. Part Information

Generic Part Number:	SG1846J
GOES (ITT) Part Number	SG565706-1
Charge Number:	C80709/C80825
Manufacturer:	Linfinity
Lot Date Code (LDC):	9715
Quantity Tested:	10
Serial Number of Control Samples:	158, 159
Serial Numbers of Radiation Samples:	160, 161, 162, 163, 164, 165, 167, and 168
Part Function:	Current Mode PWM Controller
Part Technology:	Bipolar
Package Style:	16 Pin DIP
Test Equipment:	A540
Test Engineer:	S. Norris

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

TABLE II. Radiation Schedule for SG1846

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 annealing step was included due to the weekend.

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

Table III. Electrical Characteristics of SG1846 /1

Test #	Parameter	Units	Test Conditions /2	Spec. min	Lim. max
Error Amplifier Section					
1	V _{os}	mV			5.0
2	non_inv_iib	mA		-1.0	1.0
3	inv_iib	mA		-1.0	1.0
4	I _{os}	nA			250
5	PSRR	dB	V _{IN} = 8V to 40V	60	
6	CMRR	dB	V _{CM} = 1V to 12V	60	
7	V _{oh_swing}	V	R _L = 15k Ω	4.30	
8	V _{ol_swing}	V	R _L = 15k Ω		1.00
9	Gain	dB	V _O = 1.2V to 3V, V _{CM} = 2V	80	
Current Sense Amplifier, Oscillator, Shut Down Terminal, and Output Section					
1	I _{cc}	mA			21.0
2	Init_Freq	kHz	R _T = 10k Ω , C _T = 4.7nF	39	47
3	+iib	mA	V _{PIN 1} = 0.5V, Pin 7 Open	-10.0	10.0
4	-iib	mA	V _{PIN 1} = 0.5V, Pin 7 Open	-10.0	10.0
5	I _{os}	mA	V _{PIN 1} = 0.5V, Pin 7 Open	-1.00	1.00
6	I _{sync}	mA	Sync Voltage = 5.25V, Pin 8 = 0V		1.50
7	V _{shutdown}	mV		250	400
8	I _{latch_max}	mA	Current into Pin 1 guaranteed not to latch circuit in shutdown state.		0.80
9	I _{latch_min}	mA	Current into Pin 1 guaranteed to latch circuit in shutdown state.	3.0	
10	coll_leak	mA	V _C = 40V		200
11	V _{oh_20mA_a}	V	I _{SOURCE} = 20mA	12.0	
12	V _{oh_100mA_a}	V	I _{SOURCE} = 100mA	13.0	
13	V _{ol_20mA_b}	V	I _{SINK} = 20mA		0.40
14	V _{ol_100mA_b}	V	I _{SINK} = 100mA		2.10
15	V _{oh_20mA_b}	V	I _{SOURCE} = 20mA	12.0	
16	V _{oh_100mA_b}	V	I _{SOURCE} = 100mA	13.0	
17	V _{ol_20mA_a}	V	I _{SINK} = 20mA		0.40
18	V _{ol_100mA_a}	V	I _{SINK} = 100mA		2.10

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} = 15V, except where otherwise noted.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for SG1846 /1

Test #	Parameters	Units	Spec. Lim. /2 min max		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			
					mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
Error Amplifier Tests Section																										
1	Vos	mV		5.0	0.3	0	0.3	0	0.3	0	0.3	0	0.3	0	0.3	0	0.3	0	0.3	0	0.3	0	0.3	0	0.3	0
2	non_inv_lib	?A	-1.0	1.0	-0.2	0	-0.3	0	-0.4	0	-0.6	0	-0.7	0.1	-0.9	0.1	-1.1	0.1	-1.2	0.1	-1.2	0.1	-1.1	0.1	-1.1	0.1
3	inv_lib	?A	-1.0	1.0	-0.2	0	-0.3	0	-0.4	0	-0.5	0	-0.7	0	-0.8	0	-1.1	0.1	-1.2	0.1	-1.2	0.1	-1.1	0		
4	Ios	nA		250	2	2	2	2	8	20	18	45	49	92	62	119	43	108	52	137	54	140	53	148		
5	PSRR	dB	60		137	7	133	6	140	8	139	9	135	7	140	9	132	9	137	8	133	7	133	8		
6	CMRR	dB	60		105	5	103	6	100	3	107	7	108	7	111	5	106	10	112	9	106	9	106	10		
7	Voh_swing	V	4.30		4.74	0.03	4.74	0.03	4.73	0.05	4.69	0.13	4.70	0.15	4.66	0.29	4.23	0.97	4.14	1.20	4.16	1.16	4.28	1.01		
8	Vol_swing	V		1.00	0.67	0.004	0.67	0.004	0.67	0.004	0.67	0.004	0.68	0.01	0.68	0.01	0.68	0.01	0.67	0	0.68	0	0.67	0		
9	Gain	dB	80		107	0.1	107	0.1	107	0.1	107	0.1	107	0.1	107	0.1	107	0.1	107	0.2	107	0.1	107	0.1		
Current Sense Amplifier, Oscillator, Shutdown Terminal, and Output Tests Section																										
1	Icc	mA		21.0	17.0	0.3	16.8	0.4	16.7	0.3	16.5	0.3	16.7	0.3	16.5	0.2	16.4	0.3	16.2	0.7	16.3	0.6	16.3	0.3		
2	Init_Freq	kHz	39	47	43	1.4	44	1.1	45	1.1	44	1.2	44	1.6	44	1.1	44	1.4	45	1.8	45	1.2	45	1.5		
3	+lib	?A	-10.0	10.0	0.4	0.2	1.5	0.8	0.8	0.8	0.5	0.4	1.0	0.9	1.4	0.8	0.8	0.4	1.0	1.0	0.9	0.6	2.0	0.4		
4	-lib	?A	-10.0	10.0	0.2	0.1	1.0	0.9	0.4	0.4	0.2	0.1	0.4	0.4	0.9	0.6	0.5	0.6	0.5	0.6	0.6	0.6	0.8	0.7		
5	Ios	?A	-1.00	1.00	0.33	0.22	0.19	0.07	0.12	0.04	0.16	0.03	0.21	0.14	0.65	0.34	0.44	0.27	0.59	0.61	0.82	0.58	0.43	0.35		
6	I_sync	mA		1.50	1.28	0.01	1.28	0.01	1.29	0.01	1.29	0.01	1.29	0.01	1.29	0.01	1.29	0.01	1.29	0.01	1.29	0.01	1.29	0.01		
7	V_shutdown	mV	250	400	345	7	348	8	350	7	354	10	363	16	362	16	374	14	413	46	399	31	400	34		
8	I_latch_max	mA		0.80	0	0	0	0	0	0	0	0	0	0	0	0	-0.1	0.01	0	0	0	0	0	0		
9	I_latch_min	mA	3.0		3.5	0.1	3.4	0	3.4	0	3.4	0	3.4	0	3.4	0	3.3	0	3.3	0	3.3	0	3.3	0		
10	coll_leak	?A		200	-13	8	-6	12	-4	13	-13	0	-13	0	-9	13	-9	13	-9	9	-12	10	0	13		
11	Voh_20mA_a	V	12.0		13.5	0	13.5	0	13.5	0	13.5	0	13.5	0	13.5	0	13.5	0	13.5	0	13.5	0	13.5	0		
12	Voh_100mA_a	V	13.0		13.3	0	13.3	0	13.3	0	13.3	0	13.3	0	13.3	0	13.2	0	13.2	0	13.2	0	13.2	0		
13	Vol_20mA_b	V		0.40	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0		
14	Vol_100mA_b	V		2.10	0.7	0	0.7	0	0.7	0.1	0.7	0.1	0.7	0.1	0.7	0.1	0.7	0.1	0.7	0.1	0.7	0.1	0.7	0.1		
15	Voh_20mA_b	V	12.0		13.5	0	13.5	0	13.5	0	13.5	0	13.5	0	13.5	0	13.5	0	13.5	0	13.5	0	13.5	0		
16	Voh_100mA_b	V	13.0		13.3	0	13.3	0	13.3	0	13.2	0	13.2	0	13.2	0	13.2	0	13.2	0	13.2	0	13.2	0		
17	Vol_20mA_a	V		0.40	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0		
18	Vol_100mA_a	V		2.10	0.7	0.1	0.7	0.1	0.7	0.1	0.7	0.1	0.7	0.1	0.7	0.1	0.7	0.1	0.7	0.1	0.7	0.1	0.7	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.

Radiation sensitive parameters: non_inv_lib, inv_lib, Ios, Voh_swing.