



DATE: December 29, 1993  
TO: S. Pszcolka/311.1  
FROM: K. Sahu/300.1 *KS*  
SUBJECT: Radiation Report on ISTP/SOHO/CELIAS  
Part No. M38510/665028EA (54HC165)  
Control No. 9250

PPM-93-107

cc: A. Sharma/311  
Library/300.1

A radiation evaluation was performed on 54HC165 (8-bit Shift Register) 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 cobalt-60 gamma ray source. During the radiation testing, two 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 5, 10, 15, 20, 30 and 50 krad<sup>m</sup>. The dose rate was between 0.25 and 0.35 krad/hour, depending on the total dose level (see Table II for radiation schedule). After the 50 krad irradiation, parts were annealed at 25°C for 168 hours, after which the parts were annealed at 100°C for 168 hours. After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits listed in Table III. Electrical tests included four functional tests @ 1 MHz: one at  $V_{CC} = 2.0$  V, two at  $V_{CC} = 4.5$  V and one at  $V_{CC} = 6.0$  V.

All parts passed initial electrical measurements. Both irradiated parts passed all parametric tests up to and including the 5 krad irradiation level. At the 10 krad level, both irradiated parts exceeded the maximum specification limits of 0.1  $\mu$ A for ICCH and ICCL, with maximum readings of 0.24  $\mu$ A and 0.48  $\mu$ A, respectively. Readings for these parameters continued to increase, up to 54.9  $\mu$ A and 42.1  $\mu$ A at the 30 krad level. A slight decrease was noted after 30 krad, but this was likely due to annealing for four days, necessitated by down time on the test system. At the 50 krad level, maximum readings for ICCH and ICCL were 278  $\mu$ A and 128  $\mu$ A, respectively. After annealing for 168 hours at 25°C, these readings decreased to 243  $\mu$ A and 68.5  $\mu$ A. After annealing for 168 hours at 100°C, both irradiated parts read within specification limits for ICCL. Both irradiated parts passed all other parametric and functional tests throughout all irradiation and annealing steps.

Table IV provides a summary of the functional test results, as well as the mean and standard deviation values for each parameter after different irradiation exposures and annealing steps.

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

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

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TABLE I. Part Information

Generic Part Number:	54HC165
ISTP/SOHO/CELIAS Part Number:	M38501/66502BEA
ISTP/SOHO/CELIAS Control Number:	9250
Charge Number:	C42811
Manufacturer:	Motorola
Lot Date Code:	9138A
Quantity Tested:	3
Serial Number of Control Sample:	1
Serial Numbers of Radiation Samples:	2, 3
Part Function:	8-bit Shift Register
Part Technology:	CMOS
Package Style:	16-pin DIP
Test Equipment:	S-50
Test Engineer:	T. Scherer

TABLE II. Radiation Schedule for 54HC165

EVENTS	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	11/01/93
2) 5 KRAD IRRADIATION (0.25 KRADS/HOUR) POST-5 KRAD ELECTRICAL MEASUREMENT	11/01/93 11/02/93
3) 10 KRAD IRRADIATION (0.25 KRADS/HOUR) POST-10 KRAD ELECTRICAL MEASUREMENT	11/02/93 11/03/93
4) 15 KRAD IRRADIATION (0.25 KRADS/HOUR) POST-15 KRAD ELECTRICAL MEASUREMENT	11/03/93 11/04/93
5) 20 KRAD IRRADIATION (0.25 KRADS/HOUR) POST-20 KRAD ELECTRICAL MEASUREMENT	11/04/93 11/05/93
6) 30 KRAD IRRADIATION (0.25 KRADS/HOUR) POST-30 KRAD ELECTRICAL MEASUREMENT	11/09/93 11/12/93
7) 50 KRAD IRRADIATION (0.35 KRADS/HOUR) POST-50 KRAD ELECTRICAL MEASUREMENT	11/12/93 11/15/93
8) 168-HOUR ANNEALING @25°C POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	11/15/93 11/22/93
9) 168-HOUR ANNEALING @100°C** POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	11/22/93 11/30/93

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

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\*High temperature annealing is performed to accelerate long term time dependent effects (TDE), namely, the "rebound" effect due to the growth of interface states after the radiation exposure. For more information on the need to perform this test, refer to MIL-STD-883D, Method 1019, Para. 3.10.1.

Table III. Electrical Characteristics of 54HC165

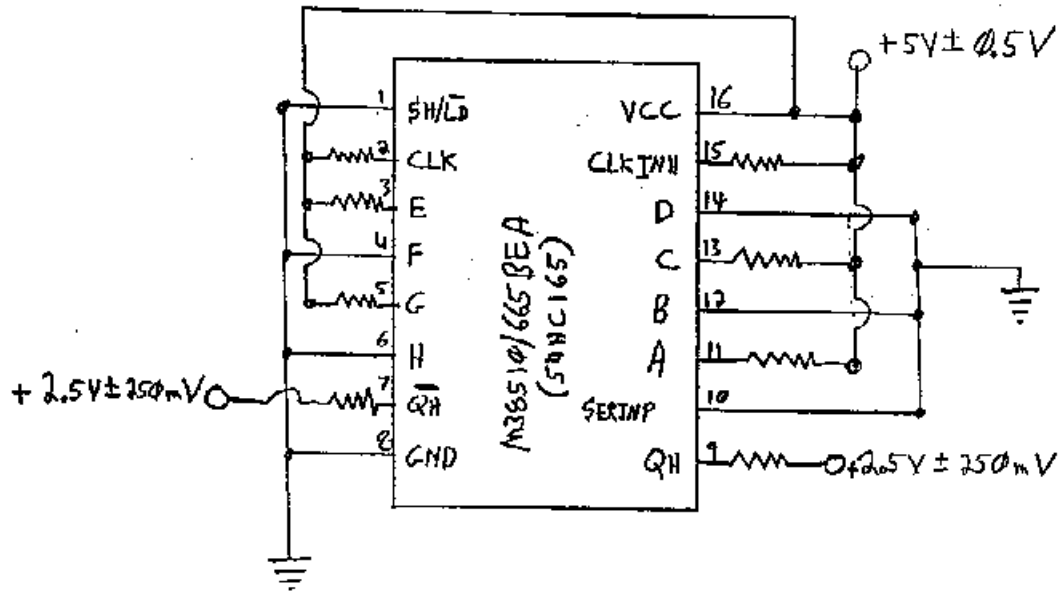
FUNCTIONAL TESTS PERFORMED						
PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT +25C ONLY
FUNCT 1	2.0V	0.0V	2.0V	FREQ=1.000MHz I <sub>OH</sub> = -20 uA I <sub>OL</sub> = 20 uA VREF = 1.0V	ALL I/O	VOL < 1.0V , VOH > 1.0V
FUNCT 2	4.5V	0.0V	4.5V	FREQ=1.000MHz I <sub>OH</sub> = -20 uA I <sub>OL</sub> = 20 uA VREF = 2.25V	ALL I/O	VOL < 2.25V , VOH > 2.25V
FUNCT 3	4.5V	0.4V	3.7V	FREQ=1.000MHz I <sub>OH</sub> = -20 uA I <sub>OL</sub> = 20 uA VREF = 2.25V	ALL I/O	VOL < 2.5V , VOH > 2.5V
FUNCT 4	6.0V	0.0V	6.0V	FREQ=1.000MHz I <sub>OH</sub> = -20 uA I <sub>OL</sub> = 20 uA VREF = 3.0V	ALL I/O	VOL < 3.0V , VOH > 3.0V
DC PARAMETRIC TESTS PERFORMED						
PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS AT +25C ONLY
VOH1	2.0V	0.30V	1.50V	LOAD = -20 uA	OUTS	>+1.95V / <+2.0V
VOH2	4.5V	0.90V	3.15V	LOAD = -20 uA	OUTS	>+4.45V / <+4.5V
VOH3	6.0V	1.20V	4.20V	LOAD = -20 uA	OUTS	>+5.95V / <+6.0V
VOH4	4.5V	0.90V	3.15V	LOAD = -4.0 mA	OUTS	>+3.98V / <+4.5V
VOH5	6.0V	1.20V	4.20V	LOAD = -5.2 mA	OUTS	>+5.48V / <+6.0V
VOL1	2.0V	0.30V	1.50V	LOAD = +20 uA	OUTS	>+0.0V / <+0.05V
VOL2	4.5V	0.90V	3.15V	LOAD = +20 uA	OUTS	>+0.0V / <+0.05V
VOL3	6.0V	1.20V	4.20V	LOAD = +20 uA	OUTS	>+0.0V / <+0.05V
VOL4	4.5V	0.90V	3.15V	LOAD = +4.0 mA	OUTS	>+0.0V / <+0.26V
VOL5	6.0V	1.20V	4.20V	LOAD = +5.2 mA	OUTS	>+0.0V / <+0.26V
VIC+	GND			IIN = +1 mA	INS	>+0.4V / <+1.5V
VIC-	OPEN			IIN = -1 mA	INS	>-1.5V / <0.0V
IIL	6.0V	0.0V	6.0V	VIN = 0.0V	INS	>-0.05 uA / <+0.0 uA
IIH	6.0V	0.0V	6.0V	VIN = 6.0V	INS	>0.0 uA / <+0.05 uA
ICCH	6.0V	0.0V	6.0V	VIN = 6.0V	VCC	>+0.0A / <+0.1 uA
ICCL	6.0V	0.0V	6.0V	VIN = 0.0V	VCC	>+0.0A / <+0.1 uA
IOS1	2.0V	0.0V	2.0V	VOUT = GND	BUTS	>-50 mA / <-2 mA
IOS2	4.5V	0.0V	4.5V	VOUT = GND	BUTS	>-150 mA / <-15 mA
IOS3	6.0V	0.0V	6.0V	VOUT = GND	BUTS	>-180 mA / <-25 mA
IOS4	4.0V	0.0V	4.0V	VOUT = GND	OUTS	>-120 mA / <-10 mA
TPLH1	4.5V	0.0V	4.5V	CLOCK TO Q		>4NS / <3NS
TPLH1	4.5V	0.0V	4.5V	CLOCK TO Q*		>4NS / <3NS
TPHL1	4.5V	0.0V	4.5V	CLOCK TO Q		>4NS / <3NS
TPHL1	4.5V	0.0V	4.5V	CLOCK TO Q*		>4NS / <3NS
TPLH3	4.5V	0.0V	4.5V	H TO Q		>5NS / <4NS
TPHL3	4.5V	0.0V	4.5V	H TO Q		>5NS / <4NS
TPLH5	4.5V	0.0V	4.5V	SH/LO* TO Q*		>4NS / <3NS
TPHL5	4.5V	0.0V	4.5V	SH/LO* TO Q		>4NS / <3NS

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for 54HC165 /1

Parameters	min	max	Total Dose Exposure (krads)														Annealing				
			Initials		5		10		15		20		30		50		168 hrs @25°C		168 hrs @100°C		
			mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	
VOH1	v	1.95	2	1.99	-	1.99	-	1.99	-	1.99	-	1.99	-	1.99	-	1.99	-	1.99	-	1.99	-
VOH2	v	4.45	4.5	4.49	-	4.49	-	4.49	-	4.49	-	4.49	-	4.49	-	4.49	-	4.49	0	4.49	0
VOH3	v	5.95	6	5.99	0	5.99	0	5.99	0	5.99	0	5.99	0	5.99	.01	5.99	.01	5.99	.01	5.99	0
VOH4	v	3.95	4.5	4.35	0	4.35	0	4.35	.01	4.35	.01	4.35	.01	4.34	.01	4.34	.01	4.34	.01	4.34	.01
VOH5	v	5.45	6	5.84	-	5.84	0	5.84	0	5.83	0	5.83	0	5.84	.01	5.83	.01	5.83	.01	5.83	0
VOL1	mV	0	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VOL2	mV	0	50	2.5	2.6	4.75	4.9	4.75	5.1	3.3	3.5	3.75	3.8	4.25	4.4	-	-	-	8	3.7	-
VOL3	mV	0	50	11.8	6.3	21.8	9.2	22	9.1	17.5	5.5	20	5.5	22.5	7	2	2	7.75	2.2	29.5	9.3
VOL4	mV	0	260	107	3.6	115	5.4	115	5.5	112	4.6	113	4.4	114	4.2	95.5	2.8	101	2.6	118	8.6
VOL5	mV	0	260	120	6.6	137	9.8	126	11	135	7.5	133	7.6	136	8.4	102	3.8	112	4.4	145	15
VICP	v	0.4	1.6	1.02	0	1.02	0	1.02	0	1.02	0	1.02	0	1.02	0	1.01	0	1.02	0	1.02	0
VICN	v	-1.6	0	-0.94	0	-0.94	0	-0.94	0	-0.94	0	-0.94	0	-0.94	0	-0.94	0	-0.94	0	-0.95	0
III	mA	-50	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IIH	mA	0	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ICCH	mA	0	100	-	-	-	200	55	250	50	1100	52535	2365	43155	3355	2.735	7700	2.435	7550	93700	4400
ICCL	mA	0	100	-	-	-	450	35	1495	315	41505	545	17060	170	1.335	650	68700	200	39	1	1
IOS1	mA	-50	-2	-11.2	0.2	-10.8	.36	-10.5	.46	-10.1	.62	-9.85	.75	-9.71	.82	-8.39	1.2	-8.65	1.2	-8.39	1.2
IOS2	mA	-150	-15	-107	1.5	-106	1.6	-105	1.5	-103	2.4	-102	2.8	-102	3	-97.4	4.5	-98.4	4.6	-98.2	4.6
IOS3	mA	-180	-25	-170	2.1	-169	2.1	-168	2.2	-156	2.7	-165	3.2	-165	3.5	-152	5.1	-161	5.1	-161	5
IOS4	mA	-120	-10	-45.7	.69	-44.9	.93	-44.5	.89	-43.6	1.2	-43.2	1.4	-43.1	1.5	-40.9	2.2	-41.3	2.3	-41.2	2.2
TPH1	ns	4	33	21.2	1.4	21.2	1.5	21.1	1.4	21.1	1.3	21.2	1.3	21.9	1.3	21.9	1.1	21.7	1.2	21.9	1.2
TPHL1	ns	4	33	20.9	.77	20.9	.79	20.8	.78	20.7	.85	22.0	.94	21.6	.69	21.6	.57	21.4	.73	21.7	.53
TPH3	ns	5	32	15.8	.17	15.9	.17	15.9	.13	17	.17	19.2	.16	17.9	0.2	20.3	0.2	20	.18	20	.23
TPHL3	ns	5	32	15.7	0.2	18.8	0.2	16.7	.17	18.7	.21	20.6	0.2	21.8	0.2	22.1	0.2	21.7	0.2	22.2	.27
TPH5	ns	4	35	20.6	.26	20.8	.27	20.6	.23	20.9	.26	22.0	.27	21.5	.26	23.5	.29	23.4	.24	23.5	.27
TPHL5	ns	4	35	15.3	.22	15.4	.22	18.3	0.2	18.5	.21	20.3	0.2	21.4	.22	21.9	.21	21.4	0.2	21.9	.23
FUNC1	1MHz	2.0V	VIH=2.0V	PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC2	1MHz	4.5V	VIH=4.5V	PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC3	1MHz	4.5V	VIH=3.7V	PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	
FUNC4	1MHz	6.0V	VIH=6.0V	PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS		PASS	

1/ The mean and standard deviation values were calculated over the two parts irradiated in this testing. The control sample remained constant throughout the testing and is not included in this table.

Figure 1. Radiation Bias Circuit for 54HC165



Note: All resistors are 2kΩ, 10%, 1/4W.