PPM 92-282

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PARAMAX
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**Memorandum**

PPM-92-282

DATE: November 23, 1992
TO: B. Fafaul/311
FROM: K. Sahu
SUBJECT: Radiation Report on FAST/MUE
Part No. 5962-9098501MRA (54AC521)
Control No. 6115

cc: R. Kolecki/740.4
T. Miccolis
A. Sharma/311
Library/300.1
L. Cusick/740.4

A radiation evaluation was performed on 54AC521 (8-Bit Identity Comparator) 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, eight parts were irradiated under bias (see Figure 1 for bias configuration), and two parts were used as control samples. The total dose radiation steps were 5, 10, 20, 40 and 60 krads*. After 60 krads, parts were annealed at +25°C for 168 hours. The irradiation was then continued to 100 krads (cumulative). The dose rate was between 0.24 and 2.0 krads/hour, depending on the total dose level (see Table II for radiation schedule). After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits** listed in Table III. These tests included three functional tests at 1.0MHz with VCC = 3.0V, 4.5V, and 5.5V.

All ten parts passed initial (pre-rad) electrical tests. All irradiated parts passed all electrical tests up to and including the 20-krad irradiation step. After the 40-krad irradiation, three parts (SN 54, 56 and 57) exceeded the maximum specification limit of 2 uA for ICCH with readings ranging from 2.22 to3.16 uA. All other irradiated parts continued to pass at this irradiation step. After the 60-krad irradiation, four parts (SN 54, 56, 57 and 58) exceeded the maximum specification limit for ICCH, with readings ranging from 2.12 to 4.35 uA. After annealing for 168

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*The term rads, as used in this document, means rads(silicon).
**These are manufacturers' non-irradiated data specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed.

hours at 25$^{o}$C, all irradiated parts recovered to within the specification limits for ICCH. After continued irradiation to 100 krads (cumulative), seven parts (SN 53, 54, 55, 56, 57, 58 and 59) exceeded the maximum specification limits for ICCH, with readings ranging from 2.17 to 6.04 uA and four parts (SN 53, 54, 56 and 57) exceeded the maximum specification limit of 2 uA for ICCL, with readings ranging from 2.06 to 2.30 uA.

After a final annealing at 100°C, no rebound effects were observed.

All parts passed all 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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TABLE I. Part Information

| | |
|---|---|
| Generic Part Number: | 54AC521 |
| Part Number: | 5962-9098501MRA |
| FAST/MUE Control Number: | 6115 |
| Charge Number: | C23988 |
| Manufacturer: | National Semiconductor Corp. |
| Lot Date Code: | 9236A |
| Quantity Tested: | 10 |
| Serial Numbers of Radiation Samples: | 53, 54, 55, 56, 57, 58, 59, 60 |
| Serial Numbers of Control Samples: | 51, 52 |
| Part Function: | 8-Bit Identity Comparator |
| Part Technology: | CMOS |
| Package Style: | 20-pin DIP |
| Test Engineer: | J. Lander |

TABLE II. Radiation Schedule for 54AC521

| EVENTS | DATE |
| --- | --- |
| 1) Initial Electrical Measurements | 10/20/92 |
| 2) 5 KRAD IRRADIATION (0.25 krads/hour) | 10/20/92 |
| POST-5 KRAD ELECTRICAL MEASUREMENT | 10/21/92 |
| 3) 10 KRAD IRRADIATION (0.25 krads/hour) | 10/21/92 |
| POST-10 KRAD ELECTRICAL MEASUREMENT | 10/22/92 |
| 4) 20 KRAD IRRADIATION (0.50 krads/hour) | 10/22/92 |
| POST-20 KRAD ELECTRICAL MEASUREMENT | 10/23/92 |
| 5) 40 KRAD IRRADIATION (0.31 KRADS/HOUR) | 10/23/92 |
| POST-40 KRAD ELECTRICAL MEASUREMENT | 10/27/92 |
| 6) 60 KRAD IRRADIATION (1.11 KRADS/HOUR) | 10/27/92 |
| POST-60 KRAD ELECTRICAL MEASUREMENT | 10/28/92 |
| 7) 168 HOUR ANNEALING @25°C | 10/28/92 |
| POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT | 11/04/92 |
| 8) 100 KRAD IRRADIATION (2.23 KRADS/HOUR) | 11/04/92 |
| POST-100 KRAD ELECTRICAL MEASUREMENT | 11/05/92 |
| 9) 168 HOUR ANNEALING @100°C* | 11/05/92 |
| POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT | 11/13/92 |

ALL ELECTRICAL MEASUREMENTS WERE PERFORMED AT 25°C.

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

*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 54AC521

PART NO. : 5962-90985 01MRA | PART DESCRIPTION : 8-BIT IDENTITY COMPARATOR. | PCN : SI10584A
GENERIC : 54AC521DMQB

| LOCATION | TEST SPECIFICATIONS |
|---|---|
| DISK LABEL : LIB 25<br>DIRECTORY : DQAT:LPROGRAMS.5843 | DESC # 5962-90985 DATE : 02/13/92<br>MFG : NATIONAL SEMICONDUCTOR |

FUNCTIONAL TESTS

| PARAMETER | VCC | VIL | VIH | CONDITIONS | PINS | LIMITS AT +25C ONLY |
|---|---|---|---|---|---|---|
| FUNCT:1 | 3.00V | 0.00V | 3.00V | FREQ=1.00MHz | I/O | VOL<1.5V , VOH>1.5V |
| FUNCT:2 | 4.50V | 0.00V | 4.50V | FREQ=1.00MHz | I/O | VOL<1.5V , VOH>1.5V |
| FUNCT:3 | 5.50V | 0.00V | 5.50V | FREQ=1.00MHz | I/O | VOL<1.5V , VOH>1.5V |

DC PARAMETRIC TESTS

| PARAMETER | VCC | VIL | VIH | CONDITIONS | PINS | LIMITS AT +25C ONLY |
|---|---|---|---|---|---|---|
| VOH1 | 3.00V | 0.90V | 2.10V | LOAD=-50uA | OUTS | >+2.90V , <+3.00V |
| VOH2 | 4.50V | 1.35V | 3.15V | LOAD=-50uA | OUTS | >+4.40V , <+4.50V |
| VOH3 | 5.50V | 1.65V | 3.85V | LOAD=-50uA | OUTS | >+5.40V , <+5.50V |
| VOH4 | 3.00V | 0.90V | 2.10V | LOAD= -4mA | OUTS | >+2.40V , <+3.00V |
| VOH5 | 4.50V | 1.35V | 3.15V | LOAD=-24mA | OUTS | >+3.70V , <+4.50V |
| VFIx | [illegible] | [illegible] | [illegible] | [illegible] | PV*T | [illegible] |
| VOH7 | 5.50V | 1.65V | 3.85V | LOAD=-50mA | OUTS | >+3.85V , <+5.50V |

| PARAMETER | VCC | VIL | VIH | CONDITIONS | PINS | LIMITS AT +25C ONLY |
|---|---|---|---|---|---|---|
| VOL1 | 3.00V | 0.90V | 2.10V | LOAD=+50uA | OUTS | >+0.00V , <+0.10V |
| VOL2 | 4.50V | 1.35V | 3.15V | LOAD=+50uA | OUTS | >+0.00V , <+0.10V |
| VOL3 | 5.50V | 1.65V | 3.85V | LOAD=+50uA | OUTS | >+0.00V , <+0.10V |
| VOL4 | 3.00V | 0.90V | 2.10V | LOAD=+12mA | OUTS | >+0.00V , <+0.40V |
| VOL5 | 4.50V | 1.35V | 3.15V | LOAD=+24mA | OUTS | >+0.00V , <+0.40V |
| VOL6 | 5.50V | 1.65V | 3.85V | LOAD=+24mA | OUTS | >+0.00V , <+0.40V |
| VOL7 | 5.50V | 1.65V | 3.85V | LOAD=+50mA | OUTS | >+0.00V , <+1.65V |

| PARAMETER | VCC | VIL | VIH | CONDITIONS | PINS | LIMITS AT +25C ONLY |
|---|---|---|---|---|---|---|
| VIC- | OPEN | N/A | N/A | IIN = -3mA | INS | >-1.5V , <-0.4V |
| IIH | 5.50V | 0.00V | 5.50V | VIN = 5.5V | INS | >+0.0uA , <+0.1uA |
| IIL | 5.50V | 0.00V | 5.50V | VIN = 0.0V | INS | >-0.1uA , <+0.0uA |
| ICCH | 5.50V | 0.00V | 5.50V | VIN = 5.5V | VCC | >+0.0uA , <+2.0uA |
| ICCL | 5.50V | 0.00V | 5.50V | VIN = 0.0V | VCC | >+0.0uA , <+2.0uA |

AC PARAMETRIC TESTS

| PARAMETER | VCC | VIL | VIH | CONDITIONS | PINS | LIMITS AT +25C |
|---|---|---|---|---|---|---|
| TPLH1_A | 3.0V | 0.0V | 3.0V | F=1MHz,VCMP=1.50V | OUTPUTS | > 1.0ns , < 12.5ns |
| TPHL1_A | 3.0V | 0.0V | 3.0V | F=1MHz,VCMP=1.50V | OUTPUTS | > 1.0ns , < 12.5ns |
| TPLH1_B | 3.0V | 0.0V | 3.0V | F=1MHz,VCMP=1.50V | OUTPUTS | > 1.0ns , < 12.5ns |
| TPHL1_B | 3.0V | 0.0V | 3.0V | F=1MHz,VCMP=1.50V | OUTPUTS | > 1.0ns , < 12.5ns |
| TPLH1_I | 3.0V | 0.0V | 3.0V | F=1MHz,VCMP=1.50V | OUTPUTS | > 1.0ns , < 9.0ns |
| TPHL1_I | 3.0V | 0.0V | 3.0V | F=1MHz,VCMP=1.50V | OUTPUTS | > 1.0ns , < 9.0ns |

| PARAMETER | VCC | VIL | VIH | CONDITIONS | PINS | LIMITS AT +25C |
|---|---|---|---|---|---|---|
| TPLH2_A | 4.5V | 0.0V | 4.5V | F=1MHz,VCMP=2.25V | OUTPUTS | > 1.0ns , < 9.0ns |
| TPHL2_A | 4.5V | 0.0V | 4.5V | F=1MHz,VCMP=2.25V | OUTPUTS | > 1.0ns , < 9.0ns |
| TPLH2_B | 4.5V | 0.0V | 4.5V | F=1MHz,VCMP=2.25V | OUTPUTS | > 1.0ns , < 9.0ns |
| TPHL2_B | 4.5V | 0.0V | 4.5V | F=1MHz,VCMP=2.25V | OUTPUTS | > 1.0ns , < 9.0ns |
| TPLH2_I | 4.5V | 0.0V | 4.5V | F=1MHz,VCMP=2.25V | OUTPUTS | > 1.0ns , < 6.5ns |
| TPHL2_I | 4.5V | 0.0V | 4.5V | F=1MHz,VCMP=2.25V | OUTPUTS | > 1.0ns , < 6.5ns |

COMMENTS / EXCEPTIONS

(1) VIL & VIH were tested during VOL & VOH tests as Go/NoGo.
(2) VIC Positive is not performed because S-50 cannot hook up VCC to GND and open GND dynamically.

| HARDWARE REQUIREMENTS | TEMPERATURE TESTING CAPABILITY |
|---|---|
| DEVICE CONFIGURATION : 20-PIN DIP<br>LOAD BOARD # 2 OR 17 : JUMP/SWITCH GND TO PIN # 10 | +25 DEG. C. \|x\| Only |
| ATE PROGRAMMER : JUAN R. LANDER | DATE : 20 OCT 92 |

# TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing for 54AC521 1/

| | | Spec. Lim./2 | | Total Dose Exposure (TDE) (krads) | | | | | | | | | | | | Anneal | | TDE | | Anneal | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Initial | | 5 | | 10 | | 20 | | 40 | | 60 | | 168 hrs @25°C | | 100 krads | | 168 hrs @100°C | |
| Parameters | | min | max | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd | mean | sd |
| FUNC1, 1 MHz, 3.0 V | | | | PASS | | PASS | | PASS | | PASS | | PASS | | PASS | | PASS | | PASS | | PASS | |
| FUNC2, 1 MHz, 4.5 V | | | | PASS | | PASS | | PASS | | PASS | | PASS | | PASS | | PASS | | PASS | | PASS | |
| FUNC3, 1 MHz, 5.5 V | | | | PASS | | PASS | | PASS | | PASS | | PASS | | PASS | | PASS | | PASS | | PASS | |
| VOH1 | V | 2.9 | 3.0 | 2.99 | 0 | 2.99 | 0 | 2.99 | 0 | 2.99 | 0 | 2.99 | 0 | 2.99 | 0 | 2.99 | 0 | 2.99 | 0 | 2.99 | 0 |
| VOH3 | V | 5.4 | 5.5 | 5.49 | 0 | 5.49 | 0 | 5.49 | 0 | 5.49 | 0 | 5.49 | 0 | 5.49 | 0 | 5.49 | .01 | 5.49 | 0 | 5.49 | 0 |
| VOH5 | V | 3.7 | 4.5 | 4.20 | 0 | 4.20 | 0 | 4.20 | 0 | 4.20 | 0 | 4.20 | 0 | 4.20 | 0 | 4.19 | .01 | 4.19 | 0 | 4.19 | .01 |
| VOH7 | V | 3.85 | 5.5 | 4.95 | .01 | 4.94 | 0 | 4.94 | 0 | 4.94 | 0 | 4.94 | .01 | 4.94 | .01 | 4.91 | .03 | 4.93 | .01 | 4.91 | .02 |
| VOL1/3 | mV | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| VOL7 | mV | 0 | 1650 | 379 | 3.9 | 378 | 3.7 | 379 | 3.8 | 377 | 2.9 | 379 | 4.5 | 378 | 3.8 | 392 | 12 | 382 | 2.8 | 395 | 8.2 |
| VIC- | mV | -1500 | -400 | -730 | 1.5 | -731 | 1.7 | -731 | 1.8 | -731 | 1.8 | -733 | 1.7 | -738 | 1.8 | -736 | 2.0 | -737 | 1.6 | -729 | 2.1 |
| IIH | nA | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| IIL | nA | -100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ICCH | uA | 0 | 2.0 | 0.02 | .04 | 0.02 | .05 | 0.23 | 0.1 | 0.99 | 0.4 | 1.66 | .77 | 2.28 | 1.1 | 0.55 | .26 | 3.30 | 1.4 | 0.09 | .04 |
| ICCL | uA | 0 | 2.0 | 0.01 | .02 | 0.01 | .02 | 0.08 | .02 | 0.37 | 0.1 | 0.70 | .22 | 1.05 | .31 | 0.33 | .08 | 1.81 | 0.4 | 0.01 | .01 |
| TPLH1_A | ns | 1.0 | 12.5 | 8.46 | 0.1 | 8.44 | .05 | 8.50 | .06 | 8.81 | .06 | 8.84 | .04 | 8.81 | 0.1 | 8.02 | .06 | 8.07 | .06 | 8.60 | .07 |
| TPHL1_A | ns | 1.0 | 12.5 | 9.48 | .07 | 9.52 | .08 | 9.52 | .08 | 9.58 | .08 | 9.65 | .09 | 9.57 | 0.1 | 10.1 | .08 | 10.2 | .08 | 10.5 | .08 |
| TPLH1_B | ns | 1.0 | 12.5 | 8.26 | 0.1 | 8.28 | .04 | 8.30 | .05 | 8.23 | .04 | 8.27 | .05 | 8.18 | .02 | 7.85 | .08 | 7.92 | .05 | 8.38 | .06 |
| TPHL1_B | ns | 1.0 | 12.5 | 9.24 | .07 | 9.29 | .07 | 9.28 | .07 | 9.65 | .11 | 9.74 | .10 | 9.67 | 0.1 | 9.79 | .08 | 9.90 | .08 | 10.2 | .08 |
| TPLH1_I | ns | 1.0 | 9.0 | 6.37 | .04 | 6.32 | .05 | 6.33 | .06 | 6.75 | .05 | 6.71 | .05 | 6.65 | .04 | 6.45 | .02 | 6.41 | .04 | 7.03 | .07 |
| TPHL1_I | ns | 1.0 | 9.0 | 6.67 | .07 | 6.67 | .08 | 6.67 | .07 | 6.71 | .06 | 6.69 | .08 | 6.67 | .05 | 6.47 | .07 | 6.59 | 0.1 | 6.60 | .06 |
| TPLH2_A | ns | 1.0 | 9.0 | 7.24 | .03 | 7.24 | .03 | 7.27 | .03 | 7.62 | .03 | 7.65 | .01 | 7.62 | .04 | 6.76 | .02 | 6.82 | .04 | 7.02 | .05 |
| TPHL2_A | ns | 1.0 | 9.0 | 7.81 | .05 | 7.82 | .05 | 7.82 | .05 | 7.73 | .03 | 7.78 | .05 | 7.71 | .04 | 8.28 | .06 | 8.33 | .05 | 8.46 | .04 |
| TPLH2_B | ns | 1.0 | 9.0 | 7.10 | .04 | 7.14 | .03 | 7.16 | .03 | 7.11 | .05 | 7.15 | .05 | 7.04 | .02 | 6.64 | .05 | 6.71 | .03 | 6.84 | .04 |
| TPHL2_B | ns | 1.0 | 9.0 | 7.65 | .04 | 7.69 | .05 | 7.67 | .04 | 8.05 | .06 | 8.10 | .06 | 8.00 | .06 | 8.09 | .03 | 8.11 | .03 | 8.27 | .05 |
| TPLH2_I | ns | 1.0 | 6.5 | 5.84 | .03 | 5.77 | .03 | 5.77 | .03 | 6.24 | .07 | 6.04 | .02 | 5.98 | .06 | 5.86 | .03 | 5.79 | .03 | 6.17 | .03 |
| TPHL2_I | ns | 1.0 | 6.5 | 5.89 | .04 | 5.88 | .05 | 5.87 | .05 | 5.84 | .04 | 5.82 | .05 | 5.77 | .03 | 5.64 | .06 | 5.75 | .04 | 5.67 | .05 |

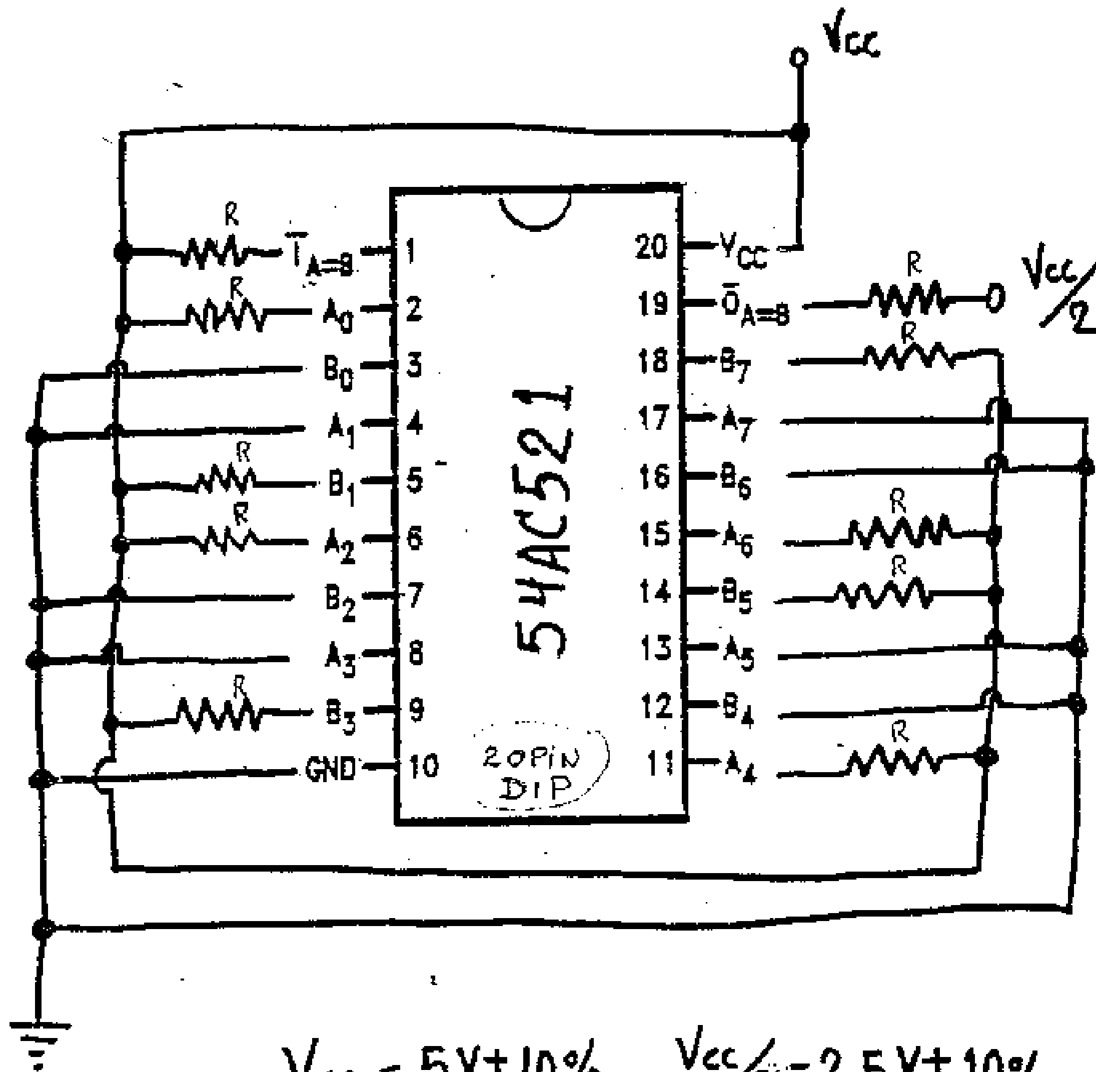
Notes:

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

2/These are manufacturers' non-irradiated data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were performed.

3/No significant variation was observed in VOL1 - VOL7 during irradiation and annealing. Additional data on VOL2 - VOL6 are available on request.

Figure 1. Radiation Bias Circuit for 54AC161




$V_{cc} = 5V \pm 10\%$ , $V_{cc}/2 = 2.5V \pm 10\%$

$R = 1K_{OHM} \pm 5\%$ , 1/4 W

$T_A = +25^{\circ C}$.