ESA-RAD-290

MOTOROLA

*Motorola Semiconductors S.A.*
*Discrete & Analog Products Division*

→ J. Minnee 14/02/96

ETC -

ESA-QCA0075T-C

# TOTAL DOSE EFFECTS CHARACTERIZATION

# RESULTS FOR LM111H

ORIGINAL
EN ROUGE

Ref : MOT/RAD.0043

| DATE CODE : 9504 | DIFFUSION LOT : 1A338506<br>WAFER N° : M80T1 |
|---|---|

*Total Quality Six Sigma for Total Customer Satisfaction*

# MOTOROLA



***Motorola Semiconductors S.A.***

***Discrete & Analog Products Division***

| | TOTAL DOSE TEST PLAN No.<br>**N° MOT/RAD.0043** | ISSUE No : 0<br>DATE : 07/03/95<br>PAGE : 1/2 |
|---|---|---|
| SCC COMPONENT No<br>**9103 002 07B** | COMPONENT DESIGNATION<br>**LM111H** | IRRADIATION SPEC :<br>ISSUE : |

| SPECIFICATIONS | ACCEPTANCE | SAMPLE SIZE | PROJECT |
|---|---|---|---|
| GENERIC : **9000** ISSUE REV.<br>DETAIL ISSUE REV.<br>**9103 002** | DIFFUSION ☐<br>LOT ☐ | **10 (Sn° 1 to 10)**<br>CONTROL DEVICES<br>**1 (Sn° 11)** | |
| FAMILY<br>**LINEAR** | GROUP<br>**IC'S** | | PACKAGE **TO99** |
| MANUFACTURER NAME<br>**MOTOROLA**<br>ADDRESS :<br>AVENUE GENERAL EISENHOWER<br>31023 TOULOUSE CEDEX - FRANCE | TEST HOUSE NAME<br>**MOTOROLA**<br>ADDRESS :<br>AVENUE GENERAL EISENHOWER<br>31023 TOULOUSE CEDEX - FRANCE | | ORIGINATOR NAME<br>**ALCATEL BELL**<br>TELEPHONE : |

| FACILITY | IRRADIATION | IRRADIATION MEASUREMENT INTERVAL | | LEVEL OF INTEREST |
|---|---|---|---|---|
| FACILITY<br>SOURCE<br>**C060**<br>**DERTS**<br>AVENUE E. BELIN<br>31055 TOULOUSE CEDEX - FRANCE | SINGLE ☐<br>MULTIPLE ☒ | BIASED ☐<br>UNBIASED ☒<br>TEMP °C | CIRCUIT REF<br>SUPPLY VOLTAGE<br>DURATION | |

| SINGLE IRRADIATION | MULTIPLE IRRADIATION STEPS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| DOSE (KRAD) (Si) | DOSE KRADS (Si) | 10 | 20 | 30 | 50 | | | | |
| DOSE RATE (RAD) (Si) | DOSE RATE (KRADS) (Si) | 5,7 | 5,7 | 5,7 | 5,7 | | | | |
| EXPOSURE TIME | EXPOSURE TIME (mn) | 105' | 105' | 105' | 210' | | | | |

| IRRADIATION CONDITIONS | | | ANNEAL TEST ? YES | | |
|---|---|---|---|---|---|
| BIASED (REMOTE TEST) | ☒ | BIAS CIRCUIT REF **(SEE P 5)** | BIASED | ☒ | BIAS CIRCUIT REF **(SEE P 5)** |
| UNBIASED (REMOTE TEST) | ☐ | SUPPLY VOLTAGE **±15V** | UNBIASED | ☐ | SUPPLY VOLTAGES **±15 V** |
| IN-SITU TEST | ☐ | TEMP °C : **25** | TEMP °C : **25°** | | DURATION : **168 h** |

ELECTRICAL PARAMETERS TO BE TESTED : **TABLE 2A OF ESA / SCC DETAIL SPECIFICATION N° 9103 002**

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*Discrete & Analog Products Division*



| | TOTAL DOSE TEST PLAN No.<br>**N° MOT/RAD.0043** | ISSUE No : 0 REV :<br>DATE : 07/03/95 DATE :<br>PAGE : 2/2 |
|---|---|---|

IRRADIATION TEST SEQUENCE **(SEE PAGE 6)**

| TEST STEP | DESCRIPTION | REQUIREMENTS |
|---|---|---|
| | | |

REMARKS

*Total Quality Six Sigma for Total Customer Satisfaction*

## 1 - TOTAL DOSE EFFECTS CHARACTERIZATION SUMMARY

| NUMBER OF IRRADIATED DEVICES | 10 |
|---|---|
| IRRADIATION STEPS (KRADS [Si]) | 10 - 20 - 30 - 50 |
| 1ST PARAMETERS OUT OF SPECIFICATION | After an irradiation of 10Krads, small drifts on IIO parameter are found on several parts. The worst case value is at this level 14,4nA. (specified limit : ±10nA). |
| 2ND PARAMETER OUT OF SPECIFICATION | After an irradiation of 50Krads one part shows a weak drift on VIO parameter since the worst case value found is -2,093mV (specified limit: ±2mv). |
| LOST OF FUNCTIONALITY | All the tested devices stay functional during this radiation evaluation. |

## 2 - DEVICES IDENTIFICATION

DEVICE IDENTIFICATION NUMBER : **LM111H**

MANUFACTURER : **MOTOROLA**

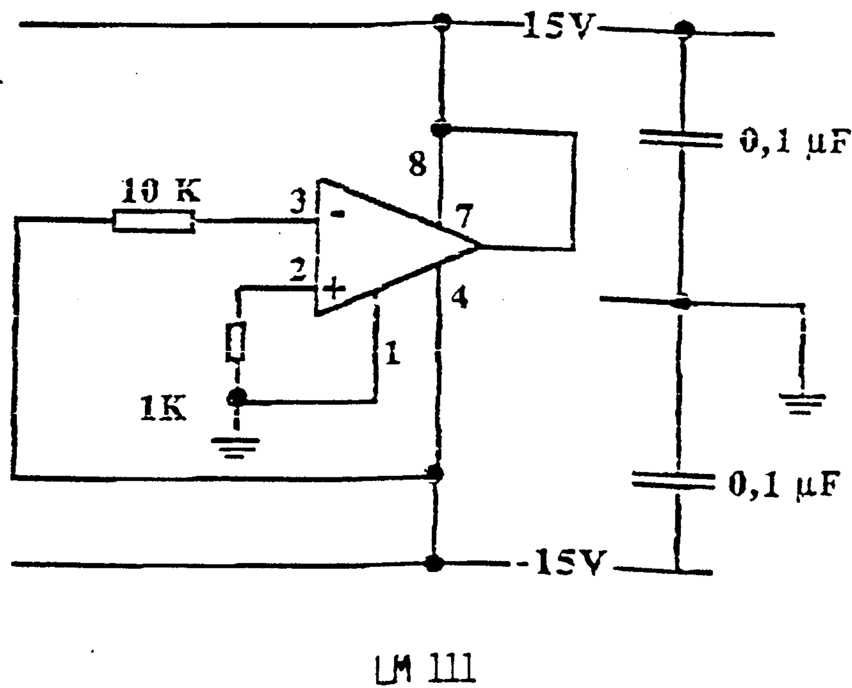
DATE CODE : **9504**

SERIAL NUMBERS : **1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10**

CORRELATION PART : **N° 11**

## 3 - IRRADIATION CONDITIONS

### 3.1) POLARIZATION CONDITIONS




LM 111

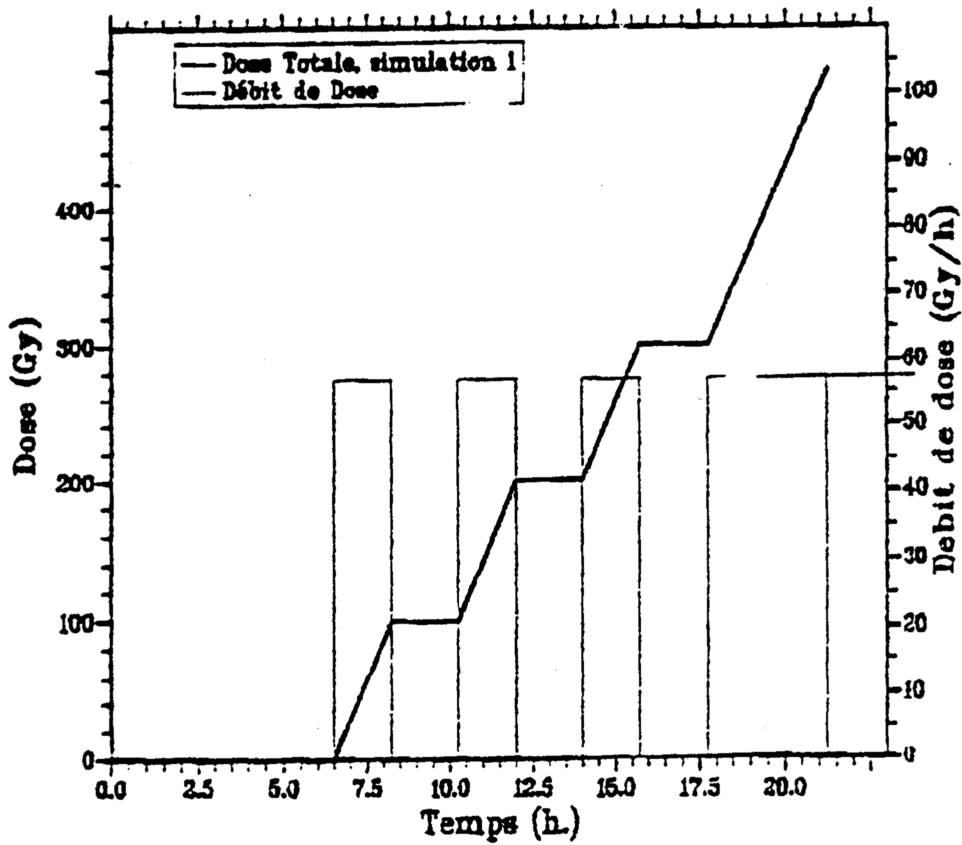
## 3.2) IRRADIATION PLAN

| DATE | TIME | TOTAL DOSE (KRADS) | DOSE RATE (KRADS / H) |
|---|---|---|---|
| 21.02.95 | 105' | 10 | 5,7 |
| 21.02.95 | 105' | 20 | 5,7 |
| 21.02.95 | 105' | 30 | 5,7 |
| 21.02.95 | 210' | 50 | 5,7 |

**NOTE**

Between two irradiation steps a read and record measurement was performed at MOTOROLA plant.
The time interval between exposure and re-exposure was 2H. The measurements were performed in a time interval of 1H after the exposure.

## 3.3) IRRADIATION PROFILE



### 3.4) IRRADIATION EQUIPMENT

Irradiations were performed with the CERT-DERT CO60 source (Gammacell 220) in TOULOUSE (31). The dose rate was 5,7 Krads / h. The exposure was done at ambient temperature

## 4 - MEASUREMENT CONDITIONS

Measurements were done according ESA / SCC 9103/002 detail specification table 2 on a LTX equipment.

# 5 - RESULTS

## 5.1) DATALOGS

ESA / SCC table 2A datalogs including measurement conditions are shown in appendix 1. Part number 11 is the correlation component.

## 5.2) DIAGRAMS

Diagrams corresponding to ESA / SCC 9103 / 002 detail specification table 4 are shown in appendix 2. Specification limits and statistical information are given.

## 5.3) TOTAL DOSE HARDNESS

The following table sums up the radiation hardness results of the 10 irradiated parts.

| TOTAL DOSE (KRADS) | 0 | 10 | 20 | 30 | 50 | annealing |
|---|---|---|---|---|---|---|
| NUMBER OF IN SPECIFICATION DEVICE | 10/10 | 2/10 | 1/10 | 1/10 | 0/10 | 1/10 |
| NUMBER OF IN SPECIFICATION PARAMETERS FOR ALL DEVICES | 21/21 | 19/21 | 18/21 | 18/21 | 17/21 | 17/21 |

**NOTE**

The 21 parameters of ESA/SCC table2A detail specification have been measured.

## 5.4) COMMENTS

### IIO parameter:

After an irradiation of 10Krads, most of parts show weak drifts on IIO parameter. The values found are around the specified limit (±10nA). However, two parts present a worst case value of 14,4nA. At the total dose level of 20Krads, the IIO worst case value reach 21nA. This value is a saturation one since IIO parameter keep it all along the remaining evaluation phases. No rebound is found during the room temperature annealing.

### VIO parameter:

After an irradiation of 50Krads, one part shows a very small drift on VIO parameter. The worst case value found is -2,093mV for a specified limit at ±2mV. No evolution of this drift is found during the annealing phase.

## 5.5) SYNTHESIS SUMMARY :

All the tested parts have been found functional during this radiation verification test. IIO parameters were found out of the ESA/SCC table 2 specification but the corresponding drifts are rather limited and reach a saturation value around 21nA. We think that this drift come from the differents IC input transistor states under irradiation due to the polarization condition applied on the LM111H devices.

# APPENDIX 1

# TABLE 2 (A) RESULTS AFTER 0 Krad, 10 Krads, 20 Krads, 30 Krads and 50 Krads AND AFTER 168 h of annealing

## ELECTRICAL MEASUREMENTS

## BEFORE RADIATION

DC AT 25 °C

**MOTOROLA**

*Motorola Semiconducteurs S.A.*

*Centre Electronique de Toulouse*

*MOTOROLA Semiconductors*

*HIGH RELIABILITY DIVISION*

*TRACEABILITY INFORMATION*

| | |
|---|---|
| PROCESS LOT NUMBER | **NTTA0111H** |
| DEVICE | **TY38356H** |
| SOURCE TYPE | **LM111H** |
| DATE CODE | **9504** |
| CUSTOMER | **VARIOUS** |
| CUSTOMER PART NUMBER | **SCC 9103 002 07B** |
| LOT SIZE | **11** |
| SERIAL NUMBER RANGE | **1-11** |
| MEASUREMENT TYPE | **25 C RADIATION TESTING** |
| DATE | **03-MAR-95** |
| COMMENTS | |

**TABLE 2A DC PARAMETERS**
**ELECTRICAL RECORDS BEFORE RADIATION TESTING**

LM111H Temperature : 25 Lot: NTTA0111H Page: 1

## *PARAMETERS TEST CONDITIONS*

| Test Nb | 1.0 | 3.0 | 4.0 | 5.0 | 6.0 | 8.0 | 13.0 | 14.0 | 15.0 | 16.0 |
|---|---|---|---|---|---|---|---|---|---|---|
| Test | VIO1 | IIO1 | IIB1+ | IIB1- | VIO3 | IIO3 | IIO2 | IIB2+ | IIB2- | VIO2 |
| VCC | 15.000 V | 15.000 V | 15.000 V | 15.000 V | 15.000 V | 15.000 V | 29.500 V | 29.500 V | 29.500 V | 2.500 V |
| VEE | -15.000 V | -15.000 V | -15.000 V | -15.000 V | -15.000 V | -15.000 V | -500.000 mV | -500.000 mV | -500.000 mV | -2.500 V |
| VIC | 0.000 V | | | | | | -14.500 V | -14.500 V | -14.500 V | 0.000 V |
| V6 | | | | | 15.000 V | 15.000 V | | | | |
| V5 | | | | | | 15.000 V | | | | |

## *LIMITS*

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MIN | -2.000 mV | -10.000 nA | 0.000 A | 0.000 A | -2.000 mV | -10.000 nA | -10.000 nA | 0.000 A | 0.000 A | -2.000 mV |
| MAX | 2.000 mV | 10.000 nA | 100.000 nA | 100.000 nA | 2.000 mV | 10.000 nA | 10.000 nA | 100.000 nA | 100.000 nA | 2.000 mV |

## *DATA RECORDS*

| Test Nb | 1.0 | 3.0 | 4.0 | 5.0 | 6.0 | 8.0 | 13.0 | 14.0 | 15.0 | 16.0 |
|---|---|---|---|---|---|---|---|---|---|---|
| Test | VIO1 | IIO1 | IIB1+ | IIB1- | VIO3 | IIO3 | IIO2 | IIB2+ | IIB2- | VIO2 |
| Unit | mV | nA | nA | nA | mV | nA | pA | nA | nA | mV |
| 1 | -1.373 | 0.002 | 48.902 | 48.900 | -1.193 | 3.596 | 1.000 | 59.938 | 59.937 | -1.731 |
| 2 | -1.014 | 0.112 | 37.715 | 37.604 | -1.014 | 3.596 | 18.000 | 63.562 | 63.543 | -1.553 |
| 3 | -0.467 | 0.004 | 27.005 | 27.001 | -0.469 | 0.549 | 3.000 | 45.555 | 45.552 | -1.014 |
| 4 | -1.194 | 0.003 | 52.736 | 52.733 | -0.834 | 3.601 | 12.000 | 67.146 | 67.135 | -1.552 |
| 5 | -0.649 | 0.005 | 38.249 | 38.244 | -0.649 | 3.738 | 3.000 | 45.563 | 45.560 | -1.015 |
| 6 | -0.287 | 0.166 | 34.626 | 34.460 | -0.287 | 3.611 | 9.000 | 41.814 | 41.805 | -0.833 |
| 7 | -1.014 | 0.007 | 38.267 | 38.260 | -0.834 | 0.082 | 9.000 | 56.323 | 56.313 | -1.373 |
| 8 | -1.013 | 0.003 | 49.127 | 49.124 | -0.648 | 3.714 | 2.000 | 63.541 | 63.539 | -1.373 |
| 9 | -0.835 | 0.014 | 38.253 | 38.238 | -0.649 | 0.006 | 7.000 | 56.362 | 56.355 | -1.374 |
| 10 | -0.648 | 3.757 | 34.414 | 30.657 | -0.289 | 0.526 | 12.000 | 52.755 | 52.742 | -1.014 |
| 11 | -0.469 | 0.000 | 30.875 | 30.875 | -0.290 | 0.008 | 4.000 | 38.273 | 38.268 | -0.836 |
| MEAN | -814.818uV | 370.273pA | 39.106nA | 38.736nA | -650.545uV | 2.093nA | 7.273pA | 53.712nA | 53.704nA | -1.243mV |
| SIGMA | 338.948uV | 1.125nA | 8.016nA | 8.320nA | 303.234uV | 1.789nA | 5.293pA | 9.698nA | 9.696nA | 311.657uV |
| MIN | -1.373mV | -0.000 A | 27.005nA | 27.001nA | -1.193mV | 6.000pA | 1.000pA | 38.273nA | 38.268nA | -1.731mV |
| MAX | -287.000uV | 3.757nA | 52.736nA | 52.733nA | -287.000uV | 3.738nA | 18.000pA | 67.146nA | 67.135nA | -833.000uV |
| QTY | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 |

**TOTAL PASSED DEVICES : 11**
**TOTAL FAILED DEVICES : 0**
**NO REJECTED UNITS.**

## *PARAMETERS TEST CONDITIONS*

| | |
|---|---|
| **Test Nb** | 38.0 |
| **Test** | II |
| **VCC** | 18.000 V |
| **VEE** | -18.000 V |

## *LIMITS*

| | |
|---|---|
| **MIN** | 0.000 A |
| **MAX** | 20.000 nA |

## *DATA RECORDS*

| **Test Nb** | **38.0** |
|---|---|
| **Test** | **II** |
| **Unit** | **pA** |
| **1** | 4.000 |
| **2** | 7.000 |
| **3** | 5.000 |
| **4** | 5.000 |
| **5** | 4.000 |
| **6** | 3.000 |
| **7** | 2.000 |
| **8** | 8.000 |
| **9** | 3.000 |
| **10** | 3.000 |
| **11** | 3.000 |
| **MEAN** | 4.273pA |
| **SIGMA** | 1.849pA |
| **MIN** | 2.000pA |
| **MAX** | 8.000pA |
| **QTY** | 11 |

**TOTAL PASSED DEVICES : 11**
**TOTAL FAILED DEVICES : 0**
**NO REJECTED UNITS.**

## ELECTRICAL MEASUREMENTS

## AFTER 10 KRad

DC AT 25 °C

**MOTOROLA**

*Motorola Semiconducteurs S.A.*
*Centre Electronique de Toulouse*

*MOTOROLA Semiconductors*

*HIGH RELIABILITY DIVISION*

*TRACEABILITY INFORMATION*

| | |
|---|---|
| PROCESS LOT NUMBER | **NTTA0111H** |
| DEVICE | **TY38356H** |
| SOURCE TYPE | **LM111H** |
| DATE CODE | **9504** |
| CUSTOMER | **VARIOUS** |
| CUSTOMER PART NUMBER | **SCC 9103 002 07B** |
| LOT SIZE | **11** |
| SERIAL NUMBER RANGE | **1-11** |
| MEASUREMENT TYPE | **25 C RADIATION TESTING** |
| DATE | **03-MAR-95** |

COMMENTS

**TABLE 2A DC PARAMETERS**
**ELECTRICAL RECORDS AFTER 10 Krad**

## *PARAMETERS TEST CONDITIONS*

| Test Nb | 1.0 | 3.0 | 4.0 | 5.0 | 6.0 | 8.0 | 13.0 | 14.0 | 15.0 | 16.0 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Test** | VIO1 | IIO1 | IIB1+ | IIB1- | VIO3 | IIO3 | IIO2 | IIB2+ | IIB2- | VIO2 |
| **VCC** | 15.000 V | 15.000 V | 15.000 V | 15.000 V | 15.000 V | 15.000 V | 29.500 V | 29.500 V | 29.500 V | 2.500 V |
| **VEE** | -15.000 V | -15.000 V | -15.000 V | -15.000 V | -15.000 V | -15.000 V | -500.000 mV | -500.000 mV | -500.000 mV | -2.500 V |
| **VIC** | 0.000 V | | | | | | -14.500 V | -14.500 V | -14.500 V | 0.000 V |
| **V6** | | | | | 15.000 V | 15.000 V | | | | |
| **V5** | | | | | | 15.000 V | | | | |

## *LIMITS*

| | 1.0 | 3.0 | 4.0 | 5.0 | 6.0 | 8.0 | 13.0 | 14.0 | 15.0 | 16.0 |
|---|---|---|---|---|---|---|---|---|---|---|
| **MIN** | -2.000 mV | -10.000 nA | 0.000 A | 0.000 A | -2.000 mV | -10.000 nA | -10.000 nA | 0.000 A | 0.000 A | -2.000 mV |
| **MAX** | 2.000 mV | 10.000 nA | 100.000 nA | 100.000 nA | 2.000 mV | 10.000 nA | 10.000 nA | 100.000 nA | 100.000 nA | 2.000 mV |

## *DATA RECORDS*

| **Test Nb** | **1.0** | **3.0** | **4.0** | **5.0** | **6.0** | **8.0** | **13.0** | **14.0** | **15.0** | **16.0** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Test** | **VIO1** | **IIO1** | **IIB1+** | **IIB1-** | **VIO3** | **IIO3** | **IIO2** | **IIB2+** | **IIB2-** | **VIO2** |
| Unit | **mV** | **nA** | **nA** | **nA** | **mV** | **nA** | **nA** | **nA** | **nA** | **mV** |
| **1 F** | -1.378 | 3.603 | 56.410 | 52.807 | -1.199 | 10.931 * | 3.593 | 67.228 | 63.635 | -1.736 |
| **2 F** | -1.199 | 3.598 | 52.678 | 49.080 | -1.019 | 10.888 * | 7.326 | 67.243 | 59.917 | -1.557 |
| **3** | -0.651 | 3.596 | 45.615 | 42.020 | -0.471 | 7.194 | 7.189 | 52.807 | 45.617 | -1.017 |
| **4 F** | -1.200 | 0.026 | 56.633 | 56.607 | -0.840 | 10.928 * | 7.191 | 67.251 | 60.059 | -1.557 |
| **5 F** | -0.650 | 3.585 | 41.828 | 38.244 | -0.650 | 10.800 * | 7.176 | 56.363 | 49.186 | -1.195 |
| **6** | -0.471 | 7.200 | 41.885 | 34.685 | -0.291 | 3.580 | 3.593 | 52.791 | 49.198 | -1.016 |
| **7 F** | -1.015 | 3.595 | 49.081 | 45.486 | -0.836 | 14.486 * | 3.736 | 63.574 | 59.838 | -1.554 |
| **8 F** | -1.018 | 3.582 | 49.197 | 45.615 | -0.837 | 14.424 * | 7.325 | 67.219 | 59.894 | -1.555 |
| **9 F** | -0.838 | 0.006 | 49.108 | 49.102 | -0.652 | 10.790 * | 7.307 | 63.611 | 56.304 | -1.377 |
| **10 F** | -0.650 | 7.381 | 37.939 | 30.558 | -0.291 | 3.584 | 10.778 * | 60.015 | 49.238 | -1.016 |
| **11** | -0.291 | 3.609 | 23.936 | 20.328 | -0.290 | 3.128 | 0.005 | 45.591 | 45.586 | -0.836 |
| **MEAN** | -851.000uV | 3.616nA | 45.846nA | 42.230nA | -670.545uV | 9.158nA | 5.929nA | 60.336nA | 54.407nA | -1.311mV |
| **SIGMA** | 339.763uV | 2.301nA | 9.388nA | 10.600nA | 309.514uV | 4.161nA | 2.913nA | 7.473nA | 6.685nA | 304.000uV |
| **MIN** | -1.378mV | 6.000pA | 23.936nA | 20.328nA | -1.199mV | 3.128nA | 5.000pA | 45.591nA | 45.586nA | -1.736mV |
| **MAX** | -291.000uV | 7.381nA | 56.633nA | 56.607nA | -290.000uV | 14.486nA | 10.778nA | 67.251nA | 63.635nA | -836.000uV |
| **QTY** | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 |

**TOTAL PASSED DEVICES : 3**
**TOTAL FAILED DEVICES : 8**
**REJECTED UNITS:**

**1,2,4,5,7,8,9,10**

## *PARAMETERS TEST CONDITIONS*

| | |
|---|---|
| Test Nb | 38.0 |
| Test | II |
| VCC | 18.000 V |
| VEE | -18.000 V |

## *LIMITS*

| | |
|---|---|
| MIN | 0.000 A |
| MAX | 20.000 nA |

## *DATA RECORDS*

| Test Nb | 38.0 |
|---|---|
| Test | II |
| Unit | pA |
| 1 | 4.000 |
| 2 | 5.000 |
| 3 | 5.000 |
| 4 | 6.000 |
| 5 | 7.000 |
| 6 | 8.000 |
| 7 | 5.000 |
| 8 | 4.000 |
| 9 | 4.000 |
| 10 | 6.000 |
| 11 | 3.000 |
| MEAN | 5.182pA |
| SIGMA | 1.471pA |
| MIN | 3.000pA |
| MAX | 8.000pA |
| QTY | 11 |

TOTAL PASSED DEVICES : 11
TOTAL FAILED DEVICES : 0
NO REJECTED UNITS.

ELECTRICAL MEASUREMENTS

AFTER 20 KRad

DC AT 25 °C

**MOTOROLA**

*Motorola Semiconducteurs S.A.*

*Centre Electronique de Toulouse*

*MOTOROLA Semiconductors*

*HIGH RELIABILITY DIVISION*

*TRACEABILITY INFORMATION*

| | |
|---|---|
| PROCESS LOT NUMBER | **NTTA0111H** |
| DEVICE | **TY38356H** |
| SOURCE TYPE | **LM111H** |
| DATE CODE | **9504** |
| CUSTOMER | **VARIOUS** |
| CUSTOMER PART NUMBER | **SCC 9103 002 07B** |
| LOT SIZE | **11** |
| SERIAL NUMBER RANGE | **1-11** |
| MEASUREMENT TYPE | **25 C RADIATION TESTING** |
| DATE | **03-MAR-95** |

COMMENTS

**TABLE 2A DC PARAMETERS**
**ELECTRICAL RECORDS AFTER 20 Krad**

LM111H Temperature : 25 Lot: NTTA0111H Page: 1

## PARAMETERS TEST CONDITIONS

| Test Nb | 1.0 | 3.0 | 4.0 | 5.0 | 6.0 | 8.0 | 13.0 | 14.0 | 15.0 | 16.0 |
|---|---|---|---|---|---|---|---|---|---|---|
| Test | VIO1 | IIO1 | IIB1+ | IIB1- | VIO3 | IIO3 | IIO2 | IIB2+ | IIB2- | VIO2 |
| VCC | 15.000 V | 15.000 V | 15.000 V | 15.000 V | 15.000 V | 15.000 V | 29.500 V | 29.500 V | 29.500 V | 2.500 V |
| VEE | -15.000 V | -15.000 V | -15.000 V | -15.000 V | -15.000 V | -15.000 V | -500.000 mV | -500.000 mV | -500.000 mV | -2.500 V |
| VIC | 0.000 V | | | | | | -14.500 V | -14.500 V | -14.500 V | 0.000 V |
| V6 | | | | | 15.000 V | 15.000 V | | | | |
| V5 | | | | | | 15.000 V | | | | |

## LIMITS

| | 1.0 | 3.0 | 4.0 | 5.0 | 6.0 | 8.0 | 13.0 | 14.0 | 15.0 | 16.0 |
|---|---|---|---|---|---|---|---|---|---|---|
| MIN | -2.000 mV | -10.000 nA | 0.000 A | 0.000 A | -2.000 mV | -10.000 nA | -10.000 nA | 0.000 A | 0.000 A | -2.000 mV |
| MAX | 2.000 mV | 10.000 nA | 100.000 nA | 100.000 nA | 2.000 mV | 10.000 nA | 10.000 nA | 100.000 nA | 100.000 nA | 2.000 mV |

## DATA RECORDS

| **Test Nb** | **1.0** | **3.0** | **4.0** | **5.0** | **6.0** | **8.0** | **13.0** | **14.0** | **15.0** | **16.0** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Test** | **VIO1** | **IIO1** | **IIB1+** | **IIB1-** | **VIO3** | **IIO3** | **IIO2** | **IIB2+** | **IIB2-** | **VIO2** |
| **Unit** | **mV** | **nA** | **nA** | **nA** | **mV** | **nA** | **nA** | **nA** | **nA** | **mV** |
| **1 F** | -1.378 | 7.195 | 56.418 | 49.223 | -1.199 | 21.697 * | 7.185 | 63.625 | 56.440 | -1.916 |
| **2 F** | -1.199 | 7.204 | 56.419 | 49.215 | -1.018 | 18.090 * | 10.910 * | 63.625 | 52.715 | -1.556 |
| **3 F** | -0.653 | 10.751 * | 41.941 | 31.190 | -0.472 | 7.171 | 7.169 | 60.050 | 52.881 | -1.198 |
| **4 F** | -1.378 | 11.166 * | 56.273 | 45.107 | -0.839 | 14.507 * | 7.199 | 70.781 | 63.582 | -1.736 |
| **5 F** | -0.837 | 11.050 * | 41.793 | 30.743 | -0.651 | 10.781 * | 10.775 * | 52.820 | 42.045 | -1.196 |
| **6** | -0.472 | 7.195 | 41.795 | 34.601 | -0.291 | 3.578 | 3.602 | 49.195 | 45.593 | -1.017 |
| **7 F** | -1.018 | 7.331 | 56.424 | 49.094 | -0.840 | 14.513 * | 10.906 * | 67.241 | 56.335 | -1.557 |
| **8 F** | -1.197 | 7.185 | 56.402 | 49.218 | -0.652 | 10.775 * | 14.541 * | 67.216 | 52.675 | -1.555 |
| **9 F** | -1.017 | 7.322 | 45.565 | 38.243 | -0.650 | 10.778 * | 14.517 * | 52.804 | 38.287 | -1.554 |
| **10 F** | -0.652 | 7.202 | 37.881 | 30.680 | -0.292 | 3.583 | 10.783 * | 56.411 | 45.628 | -1.198 |
| **11** | -0.290 | 0.090 | 31.101 | 31.012 | -0.292 | 0.002 | 0.011 | 34.700 | 34.689 | -0.838 |
| **MEAN** | -0.917mV | 7.608nA | 47.456nA | 39.848nA | -654.182uV | 10.498nA | 8.873nA | 58.043nA | 49.170nA | -1.393mV |
| **SIGMA** | 366.148uV | 3.032nA | 9.253nA | 8.524nA | 304.196uV | 6.576nA | 4.409nA | 10.382nA | 8.688nA | 325.740uV |
| **MIN** | -1.378mV | 90.000pA | 31.101nA | 30.680nA | -1.199mV | 2.000pA | 11.000pA | 34.700nA | 34.689nA | -1.916mV |
| **MAX** | -290.000uV | 11.166nA | 56.424nA | 49.223nA | -291.000uV | 21.697nA | 14.541nA | 70.781nA | 63.582nA | -838.000uV |
| **QTY** | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 |

**TOTAL PASSED DEVICES : 2**
**TOTAL FAILED DEVICES : 9**
**REJECTED UNITS:**

**1,2,3,4,5,7,8,9,10**

## *PARAMETERS TEST CONDITIONS*

| | |
|---|---|
| Test Nb | 38.0 |
| Test | II |
| VCC | 18.000 V |
| VEE | -18.000 V |

## *LIMITS*

| | |
|---|---|
| MIN | 0.000 A |
| MAX | 20.000 nA |

## *DATA RECORDS*

| Test Nb | 38.0 |
|---|---|
| Test | II |
| Unit | pA |
| 1 | 2.000 |
| 2 | 5.000 |
| 3 | 7.000 |
| 4 | 8.000 |
| 5 | 7.000 |
| 6 | 7.000 |
| 7 | 6.000 |
| 8 | 5.000 |
| 9 | 3.000 |
| 10 | 6.000 |
| 11 | 5.000 |
| MEAN | 5.545pA |
| SIGMA | 1.809pA |
| MIN | 2.000pA |
| MAX | 8.000pA |
| QTY | 11 |

**TOTAL PASSED DEVICES : 11**
**TOTAL FAILED DEVICES : 0**
**NO REJECTED UNITS.**

ELECTRICAL MEASUREMENTS

AFTER 30 KRad

DC AT 25 °C

**MOTOROLA**

*Motorola Semiconducteurs S.A.*
*Centre Electronique de Toulouse*

*MOTOROLA Semiconductors*

*HIGH RELIABILITY DIVISION*

*TRACEABILITY INFORMATION*

| | |
|---|---|
| PROCESS LOT NUMBER | **NTTA0111H** |
| DEVICE | **TY38356H** |
| SOURCE TYPE | **LM111H** |
| DATE CODE | **9504** |
| CUSTOMER | **VARIOUS** |
| CUSTOMER PART NUMBER | **SCC 9103 002 07B** |
| LOT SIZE | **11** |
| SERIAL NUMBER RANGE | **1-11** |
| MEASUREMENT TYPE | **25 C RADIATION TESTING** |
| DATE | **03-MAR-95** |

COMMENTS

**TABLE 2A DC PARAMETERS**
**ELECTRICAL RECORDS AFTER 30 Krad**

LM111H Temperature : 25 Lot: NTTA0111H Page: 1

## *PARAMETERS TEST CONDITIONS*

| Test Nb | 1.0 | 3.0 | 4.0 | 5.0 | 6.0 | 8.0 | 13.0 | 14.0 | 15.0 | 16.0 |
|---|---|---|---|---|---|---|---|---|---|---|
| Test | VIO1 | IIO1 | IIB1+ | IIB1- | VIO3 | IIO3 | IIO2 | IIB2+ | IIB2- | VIO2 |
| VCC | 15.000 V | 15.000 V | 15.000 V | 15.000 V | 15.000 V | 15.000 V | 29.500 V | 29.500 V | 29.500 V | 2.500 V |
| VEE | -15.000 V | -15.000 V | -15.000 V | -15.000 V | -15.000 V | -15.000 V | -500.000 mV | -500.000 mV | -500.000 mV | -2.500 V |
| VIC | 0.000 V | | | | | | -14.500 V | -14.500 V | -14.500 V | 0.000 V |
| V6 | | | | | 15.000 V | 15.000 V | | | | |
| V5 | | | | | | 15.000 V | | | | |

## *LIMITS*

| | 1.0 | 3.0 | 4.0 | 5.0 | 6.0 | 8.0 | 13.0 | 14.0 | 15.0 | 16.0 |
|---|---|---|---|---|---|---|---|---|---|---|
| MIN | -2.000 mV | -10.000 nA | 0.000 A | 0.000 A | -2.000 mV | -10.000 nA | -10.000 nA | 0.000 A | 0.000 A | -2.000 mV |
| MAX | 2.000 mV | 10.000 nA | 100.000 nA | 100.000 nA | 2.000 mV | 10.000 nA | 10.000 nA | 100.000 nA | 100.000 nA | 2.000 mV |

## *DATA RECORDS*

| Test Nb | 1.0 | 3.0 | 4.0 | 5.0 | 6.0 | 8.0 | 13.0 | 14.0 | 15.0 | 16.0 |
|---|---|---|---|---|---|---|---|---|---|---|
| Test | VIO1 | IIO1 | IIB1+ | IIB1- | VIO3 | IIO3 | IIO2 | IIB2+ | IIB2- | VIO2 |
| Unit | mV | nA | nA | nA | mV | A | nA | nA | nA | mV |
| 1 F | -1.378 | 10.874 * | 60.040 | 49.166 | -1.198 | 21.698n* | 18.102 * | 60.023 | 41.921 | -1.916 |
| 2 F | -1.198 | 10.919 * | 63.631 | 52.712 | -1.017 | 18.095n* | 18.094 * | 70.767 | 52.672 | -1.735 |
| 3 F | -0.652 | 10.785 * | 45.582 | 34.797 | -0.472 | 7.196n | 7.200 | 52.809 | 45.609 | -1.197 |
| 4 F | -1.377 | 10.805 * | 59.243 | 48.438 | -0.838 | 14.505n* | 14.508 * | 74.421 | 59.913 | -1.736 |
| 5 F | -0.836 | 14.684 * | 41.872 | 27.188 | -0.650 | 10.793n* | 10.782 * | 60.000 | 49.218 | -1.375 |
| 6 | -0.472 | 7.186 | 41.687 | 34.501 | -0.292 | 3.592n | 3.589 | 56.411 | 52.822 | -1.018 |
| 7 F | -1.195 | 10.901 * | 56.038 | 45.137 | -0.836 | 14.517n* | 14.496 * | 67.051 | 52.556 | -1.555 |
| 8 F | -1.196 | 10.921 * | 59.993 | 49.072 | -0.650 | 10.782n* | 14.537 * | 74.505 | 59.968 | -1.734 |
| 9 F | -1.017 | 10.907 * | 56.398 | 45.491 | -0.651 | 10.803n* | 14.517 * | 63.585 | 49.069 | -1.556 |
| 10 F | -0.837 | 14.762 * | 52.803 | 38.041 | -0.291 | 3.572n | 10.790 * | 59.899 | 49.109 | -1.197 |
| 11 | -0.291 | 3.614 | 30.754 | 27.140 | -0.291 | 1.000p | 0.005 | 41.888 | 41.883 | -0.837 |
| MEAN | -0.950mV | 10.578nA | 51.640nA | 41.062nA | -653.273uV | 10.505nA | 11.511nA | 61.942nA | 50.431nA | -1.441mV |
| SIGMA | 364.607uV | 3.082nA | 10.260nA | 9.132nA | 303.715uV | 6.576nA | 5.811nA | 9.737nA | 6.082nA | 343.268uV |
| MIN | -1.378mV | -3.614nA | 30.754nA | 27.140nA | -1.198mV | 1.000pA | 5.000pA | 41.888nA | 41.883nA | -1.916mV |
| MAX | -291.000uV | 14.762nA | 63.631nA | 52.712nA | -291.000uV | 21.698nA | 18.102nA | 74.505nA | 59.968nA | -837.000uV |
| QTY | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 |

**TOTAL PASSED DEVICES : 2**
**TOTAL FAILED DEVICES : 9**
**REJECTED UNITS:**

**1,2,3,4,5,7,8,9,10**

## *PARAMETERS TEST CONDITIONS*

| | |
|---|---|
| **Test Nb** | 38.0 |
| **Test** | II |
| **VCC** | 18.000 V |
| **VEE** | -18.000 V |

## *LIMITS*

| | |
|---|---|
| **MIN** | 0.000 A |
| **MAX** | 20.000 nA |

## *DATA RECORDS*

| | |
|---|---|
| **Test Nb** | **38.0** |
| **Test** | **II** |
| Unit | **pA** |
| **1** | 3.000 |
| **2** | 6.000 |
| **3** | 6.000 |
| **4** | 4.000 |
| **5** | 7.000 |
| **6** | 6.000 |
| **7** | 6.000 |
| **8** | 4.000 |
| **9** | 4.000 |
| **10** | 6.000 |
| **11** | 5.000 |
| **MEAN** | 5.182pA |
| **SIGMA** | 1.250pA |
| **MIN** | 3.000pA |
| **MAX** | 7.000pA |
| **QTY** | 11 |

**TOTAL PASSED DEVICES : 11**
**TOTAL FAILED DEVICES : 0**
**NO REJECTED UNITS.**

ELECTRICAL MEASUREMENTS

AFTER 50 KRad

DC AT 25 °C

**MOTOROLA**

*Motorola Semiconducteurs S.A.*
*Centre Electronique de Toulouse*

*MOTOROLA Semiconductors*

*HIGH RELIABILITY DIVISION*

*TRACEABILITY INFORMATION*

| | |
|---|---|
| PROCESS LOT NUMBER | **NTTA0111H** |
| DEVICE | **TY38356H** |
| SOURCE TYPE | **LM111H** |
| DATE CODE | **9504** |
| CUSTOMER | **VARIOUS** |
| CUSTOMER PART NUMBER | **SCC 9103 002 07B** |
| LOT SIZE | **11** |
| SERIAL NUMBER RANGE | **1-11** |
| MEASUREMENT TYPE | **25 C RADIATION TESTING** |
| DATE | **03-MAR-95** |

COMMENTS

**TABLE 2A DC PARAMETERS**
**ELECTRICAL RECORDS AFTER 50 Krad**

## *PARAMETERS TEST CONDITIONS*

| Test Nb | 1.0 | 3.0 | 4.0 | 5.0 | 6.0 | 8.0 | 13.0 | 14.0 | 15.0 | 16.0 |
|---|---|---|---|---|---|---|---|---|---|---|
| Test | VIO1 | IIO1 | IIB1+ | IIB1- | VIO3 | IIO3 | IIO2 | IIB2+ | IIB2- | VIO2 |
| VCC | 15.000 V | 15.000 V | 15.000 V | 15.000 V | 15.000 V | 15.000 V | 29.500 V | 29.500 V | 29.500 V | 2.500 V |
| VEE | -15.000 V | -15.000 V | -15.000 V | -15.000 V | -15.000 V | -15.000 V | -500.000 mV | -500.000 mV | -500.000 mV | -2.500 V |
| VIC | 0.000 V | | | | | | -14.500 V | -14.500 V | -14.500 V | 0.000 V |
| V6 | | | | | 15.000 V | 15.000 V | | | | |
| V5 | | | | | | 15.000 V | | | | |

## *LIMITS*

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MIN | -2.000 mV | -10.000 nA | 0.000 A | 0.000 A | -2.000 mV | -10.000 nA | -10.000 nA | 0.000 A | 0.000 A | -2.000 mV |
| MAX | 2.000 mV | 10.000 nA | 100.000 nA | 100.000 nA | 2.000 mV | 10.000 nA | 10.000 nA | 100.000 nA | 100.000 nA | 2.000 mV |

## *DATA RECORDS*

| Test Nb | 1.0 | 3.0 | 4.0 | 5.0 | 6.0 | 8.0 | 13.0 | 14.0 | 15.0 | 16.0 |
|---|---|---|---|---|---|---|---|---|---|---|
| Test | VIO1 | IIO1 | IIB1+ | IIB1- | VIO3 | IIO3 | IIO2 | IIB2+ | IIB2- | VIO2 |
| Unit | mV | nA | nA | nA | mV | nA | nA | nA | nA | mV |
| 1 F | -1.554 | 14.326 * | 66.809 | 52.483 | -1.197 | 21.693 * | 18.109 * | 78.004 | 59.895 | -2.093 * |
| 2 F | -1.377 | 18.212 * | 67.230 | 49.019 | -1.017 | 18.095 * | 21.695 * | 74.514 | 52.819 | -1.915 |
| 3 F | -0.838 | 14.507 * | 49.046 | 34.540 | -0.472 | 7.201 | 10.786 * | 70.807 | 60.021 | -1.376 |
| 4 F | -1.378 | 18.479 * | 67.044 | 48.565 | -0.839 | 14.502 * | 21.717 * | 77.952 | 56.235 | -1.916 |
| 5 F | -0.837 | 14.494 * | 56.398 | 41.904 | -0.651 | 10.783 * | 14.510 * | 63.595 | 49.084 | -1.377 |
| 6 F | -0.650 | 10.781 * | 52.798 | 42.017 | -0.291 | 3.589 | 7.196 | 63.612 | 56.417 | -1.197 |
| 7 F | -1.196 | 14.506 * | 67.204 | 52.698 | -0.838 | 14.492 * | 21.715 * | 78.063 | 56.348 | -1.735 |
| 8 F | -1.376 | 14.505 * | 59.834 | 45.328 | -0.837 | 14.499 * | 21.691 * | 78.096 | 56.406 | -1.914 |
| 9 F | -1.196 | 21.739 * | 56.154 | 34.415 | -0.651 | 10.798 * | 14.502 * | 70.747 | 56.244 | -1.735 |
| 10 F | -0.838 | 14.510 * | 56.302 | 41.792 | -0.292 | 3.585 | 10.774 * | 74.552 | 63.778 | -1.378 |
| 11 | -0.291 | 0.366 | 30.819 | 30.454 | -0.290 | 3.323 | 0.010 | 45.604 | 45.594 | -0.837 |
| MEAN | -1.048mV | 14.220nA | 57.240nA | 43.020nA | -670.455uV | 11.142nA | 14.791nA | 70.504nA | 55.713nA | -1.588mV |
| SIGMA | 385.842uV | 5.429nA | 10.868nA | 7.503nA | 308.814uV | 6.201nA | 7.146nA | 9.871nA | 5.077nA | [illegible]83.338uV |
| MIN | -1.554mV | 366.000pA | 30.819nA | 30.454nA | -1.197mV | 3.323nA | 10.000pA | 45.604nA | 45.594nA | -2.093mV |
| MAX | -291.000uV | 21.739nA | 67.230nA | 52.698nA | -290.000uV | 21.693nA | 21.717nA | 78.096nA | 63.778nA | -837.000uV |
| QTY | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 |

**TOTAL PASSED DEVICES : 1**
**TOTAL FAILED DEVICES : 10**
**REJECTED UNITS:**

**1,2,3,4,5,6,7,8,9,10**

## PARAMETERS TEST CONDITIONS

| | | |
|---|---|---|
| **Test Nb** | 38.0 | |
| **Test** | II | |
| **VCC** | 18.000 | V |
| **VEE** | -18.000 | V |

## LIMITS

| | | |
|---|---|---|
| **MIN** | 0.000 | A |
| **MAX** | 20.000 | nA |

## DATA RECORDS

| **Test Nb** | **38.0** |
|---|---|
| **Test** | **II** |
| Unit | **pA** |
| **1** | 7.000 |
| **2** | 7.000 |
| **3** | 5.000 |
| **4** | 5.000 |
| **5** | 8.000 |
| **6** | 5.000 |
| **7** | 4.000 |
| **8** | 4.000 |
| **9** | 3.000 |
| **10** | 6.000 |
| **11** | 5.000 |
| **MEAN** | 5.364pA |
| **SIGMA** | 1.502pA |
| **MIN** | 3.000pA |
| **MAX** | 8.000pA |
| **QTY** | 11 |

**TOTAL PASSED DEVICES : 11**
**TOTAL FAILED DEVICES : 0**
**NO REJECTED UNITS.**

ELECTRICAL MEASUREMENTS

AFTER 168 H ANNEALING

DC AT 25 °C

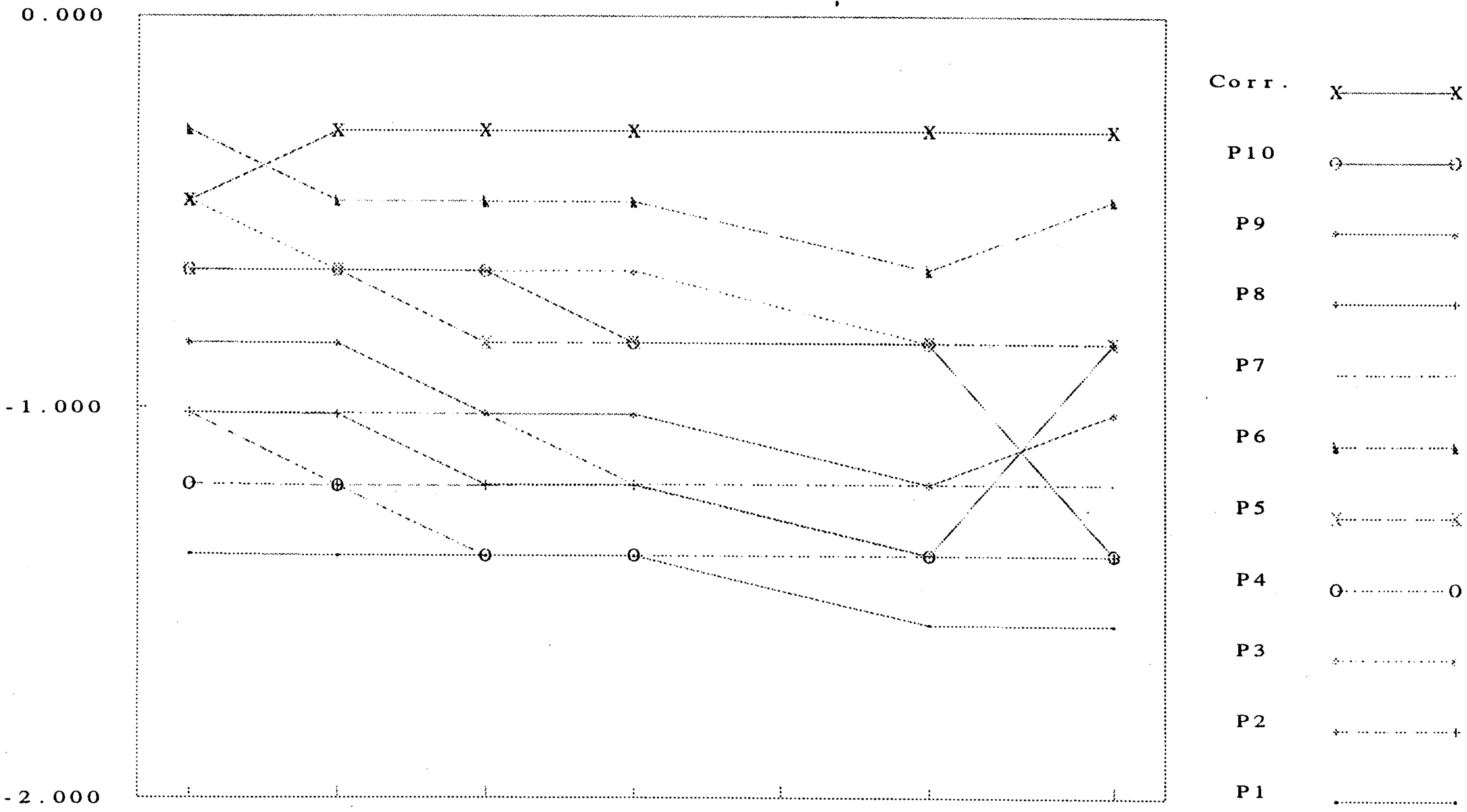
MOTOROLA

*Motorola Semiconducteurs S.A.*
*Centre Electronique de Toulouse*

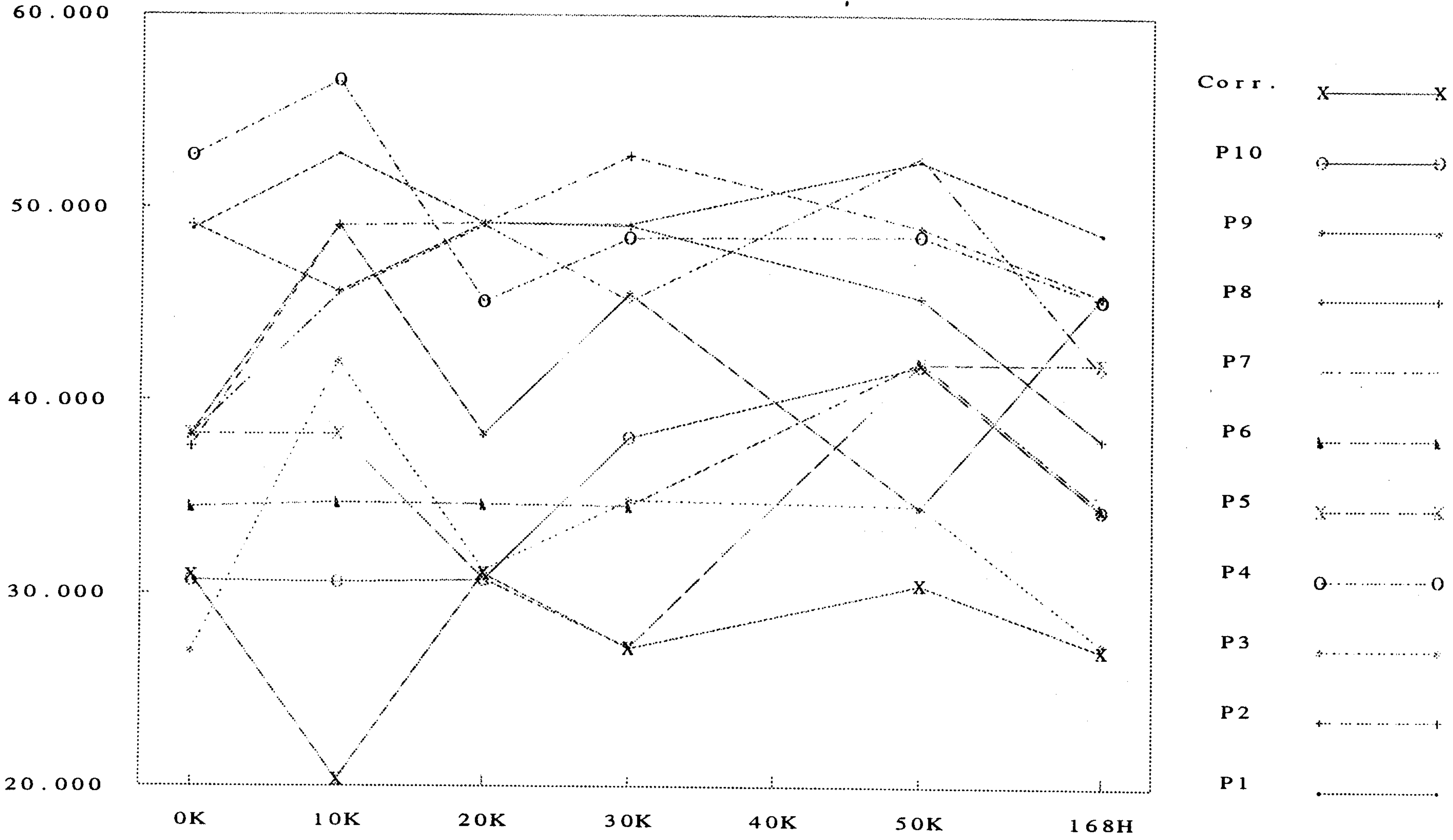
TOTAL DOSE RADIATION TESTING
MOTOROLA FRANCE

Source:LM111H Lot:NTTA0111H Date Code:9504 Date:03-MAR-95

Test Nb=1.0 Test =VIO1 VCC =15.000 V
VEE =-15.000 V VIC =0.000 V




Limit min: -2.000 mV Limit max: 2.000 mV



TOTAL DOSE RADIATION TESTING
MOTOROLA FRANCE
Source:LM111H
Lot:NTTA0111H
Date Code:9504
Date:03-MAR-95
Test Nb=5.0
Test =IIB1-
VCC =15.000 V
VEE =-15.000 V
Test5.0 IIB1-(nA)
60.000
50.000
40.000
30.000
20.000
0K
10K
20K
30K
40K
50K
168H
Corr.
P10
P9
P8
P7
P6
P5
P4
P3
P2
P1
Limit min: 0.000 nA
Limit max: 100.000 nA

## Devices Measurements

### Test4.0 IIB1+(nA)

| | 0K | 10K | 20K | 30K | 50K | 168H |
|---|---|---|---|---|---|---|
| Correl. | 30.875 | 23.936 | 31.101 | 30.754 | 30.819 | 27.237 |
| P1 | 48.902 | 56.410 | 56.418 | 60.040 | 66.809 | 63.263 |
| P2 | 37.715 | 52.678 | 56.419 | 63.631 | 67.230 | 63.625 |
| P3 | 27.005 | 45.615 | 41.941 | 45.582 | 49.046 | 41.914 |
| P4 | 52.736 | 56.633 | 56.273 | 59.243 | 67.044 | 63.574 |
| P5 | 38.249 | 41.828 | 41.793 | 41.872 | 56.398 | 56.410 |
| P6 | 34.626 | 41.885 | 41.795 | 41.687 | 52.798 | 41.682 |
| P7 | 38.267 | 49.081 | 56.424 | 56.038 | 67.204 | 59.781 |
| P8 | 49.127 | 49.197 | 56.402 | 59.993 | 59.834 | 52.503 |
| P9 | 38.253 | 49.108 | 45.565 | 56.398 | 56.154 | 60.033 |
| P10 | 34.414 | 37.939 | 37.881 | 52.803 | 56.302 | 56.195 |
| MEAN | 39.929nA | 48.037nA | 49.091nA | 53.729nA | 59.882nA | 55.898nA |
| SIGMA | 7.944nA | 6.266nA | 7.901nA | 7.978nA | 6.777nA | 8.264nA |
| MIN | 27.005nA | 37.939nA | 37.881nA | 41.687nA | 49.046nA | 41.682nA |
| MAX | 52.736nA | 56.633nA | 56.424nA | 63.631nA | 67.230nA | 63.625nA |
| CP | 2.09795 | 2.6599 | 2.10931 | 2.08914 | 2.45933 | 2.0169 |
| CPK | 1.6754 | 2.55549 | 2.07097 | 1.93334 | 1.97327 | 1.77899 |