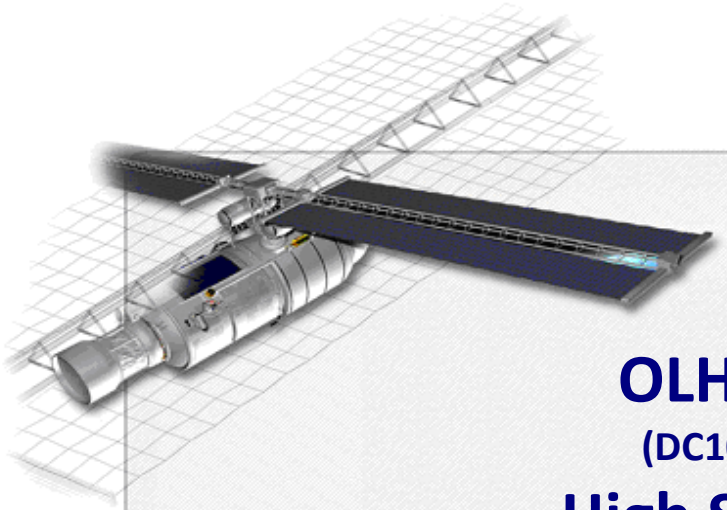
# NEUTRONS DISPLACEMENT DAMAGE TEST REPORT



## OLH400

**(DC1048)**

## High Speed Low Input-Current Optocoupler From ISOLINK

| TRAD/TN/OLH400/XXX1/ESA/YP/1104 | | Labège, May 6, 2012 |
|---|---|---|
| TRAD Tests & radiations afaq ISO 9001 Qualité AFNOR CERTIFICATION | | TRAD, Bât Gallium<br>907, Voie l'Occitane - 31670 LABEGE France<br>☏ : 05 61 00 95 60 Fax : 05 61 00 95 61<br>Email : trad@trad.fr Web Site: www.trad.fr<br><br>SIRET 397 862 038 00056 - TVA FR59397862038 |
| Written by | Verified by / Quality control | Approved by |
| **A. SAMARAS<br>04/05/2012** | **M.SAUVAGNAC/Y.PADIE<br>06/05/2012** | **C.CHATRY<br>06/05/2012** |
| Issue : 1 | | |
| To: Marc POIZAT | Project/Program: | ESA Contract N°4000102571/10/NL/AF-Radiation Characterization of Laplace RH optocouplers, sensors and detectors |

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# 1 INTRODUCTION

This report includes the test results of OLH400, a High Speed Hermetic Low Input-Current Optocoupler from ISOLINK to evaluate displacement damage effects under neutron irradiation. On November, week 45, 2011, TRAD characterized this device for neutron sensitivity at the SCK-CEN Facility, Belgium using their BR1 Neutron Irradiator.
The objectives of the test are:

- to detect and measure the degradation of device parameters as a function of neutron fluence,
- to determine if device parameters are within specified limits after exposure to final level of neutron fluence.

# 2 DOCUMENTS

## 2.1 Applicable Documents

| | | | |
|---|---|---|---|
| AD | 1. | ESA contract | N°4000102571/10/NL/AF-Radiation Characterization of Laplace RH optocouplers, sensors and detectors |
| AD | 2. | Irradiation Test Plan | ITP-TN-OLH400-ISO-ESA-1119 Issue 2 dated 28/06/2011 |

## 2.2 Reference Documents

| | | | |
|---|---|---|---|
| RD | 1. | Datasheet OLH400 | High Speed Hermetic<br>Low Input-Current Optocoupler dated 27/03/2002 |

# 3 DEVICE INFORMATION

## 3.1 Device description

The OLH400 is a High Speed Hermetic Low Input-Current Optocoupler. The OLH 400 has high current transfer ratio at very low input currents making it ideal for applications such as MOS, CMOS, and low power logic interfacing or RS232C data transmission systems. Each OLH 400 has a light emitting diode and an integrated photodiode-darlington detector IC mounted and coupled in a custom hermetic TO5 package providing 1000 Vdc electrical isolation between input and output.

| | |
|---|---|
| Type | OLH400 |
| Manufacturer | ISOLINK |
| Function | Optocoupler |
| Package | TO5 |
| Date Code | 1048 |
| Sample size | 4 parts (3 test parts + 1 control sample) |

## 3.2 Procurement information

75 parts OLH400 were delivered by ISOLINK through its French representative EUROMIP.

## 3.3 External view

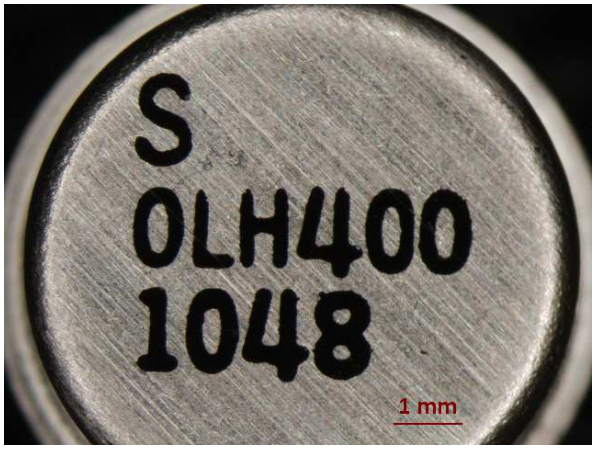



Figure 1: package marking

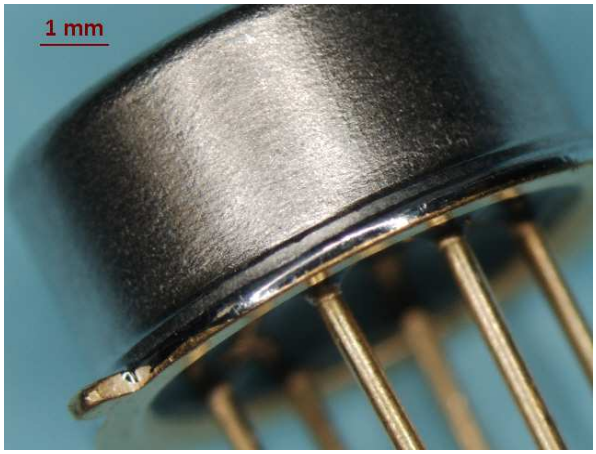



Figure 2: package view

## 3.4 Internal view

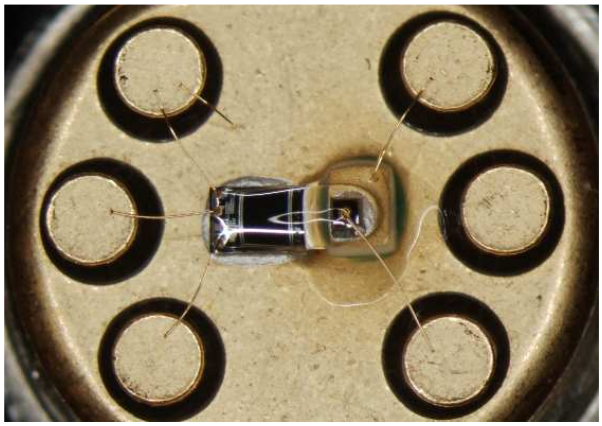
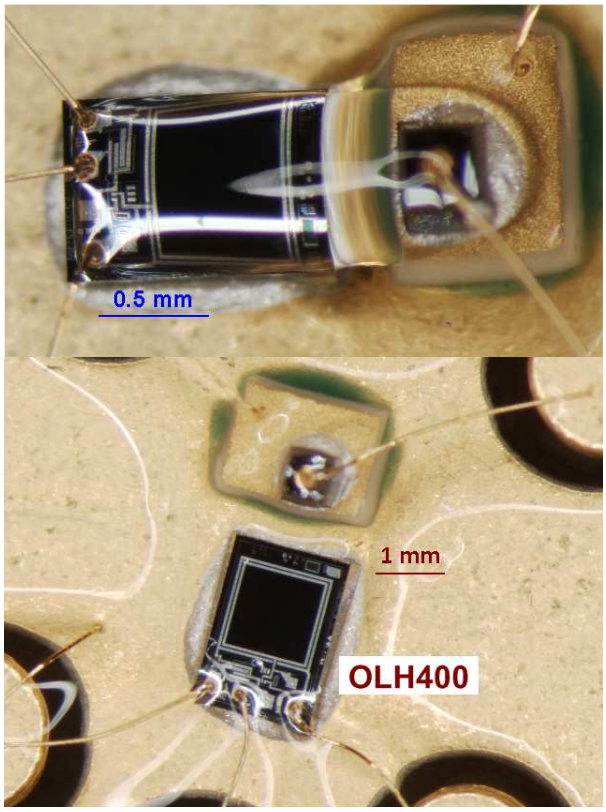


Figure 3: view of LED and integrated photodiode-darlington detector IC




## 3.5 Serialization

Each part is serialized to enable pre and post test identification and comparison.

| Serial Number | Control sample | Test samples | | |
|---|---|---|---|---|
| Serialization | 1 | 2 | 3 | 4 |

# 4 IRRADIATION MEANS AND CONDITIONS


## 4.1 BR1 irradiation facility (Belgium)

The Reactor BR1 is a versatile neutron / gamma irradiation tool.
The large cavity is used for this test. To obtain the required neutron flux, a 6cm Uranium shell is used. This spherical converter provides a 1 MeV equivalent neutron flux of 2.86E+08n/cm$^2$.s, with a low ionizing dose rate of 2,5Gy/h.
All exposures are made at 20°C ±10°C.

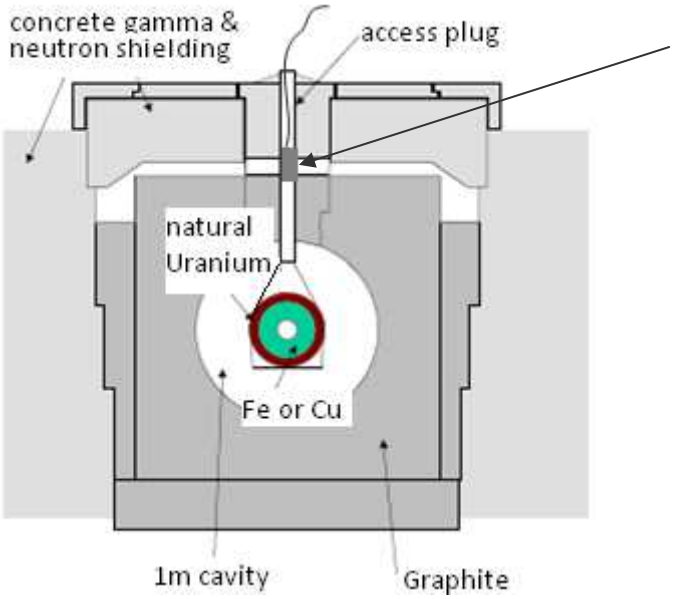



**Figure 4: schematical view of the large cavity and its spherical drivers**

The sample holder is a cylinder, dimensions of which are 3.5 cm diameter and 5.5 cm length made of high-density polyethylene.

**Figure 5: view of the sample holder**

## 4.2 Dose measurement

The SCK•CEN reactor dosimetry service is accredited by BELAC (Ministry of Economic Affairs) under the accreditation number 015-TEST. The accreditation towards norms NBN EN ISO/IEC 17025 for the Standard Practice for Determining Neutron Fluence Rate, Fluence, and Spectra by Radioactivation Techniques (ASTM261 & ASTM262) is on progress.

## 4.3 Experimental conditions

An Equivalent total fluence of 1E12 #/cm² of 10 MeV protons is required [AD2] for this TNID (Total Non Ionizing Dose) evaluation test. Considering NIEL (Non Ionizing Energy Loss) value for 1 MeV neutron (1.14E-03 MeV cm2 g$^{-1}$), it corresponds to a total fluence of 6.89E+12 #/cm² for 1 MeV neutron.
Five steps are defined to determine the component degradation under 1 MeV neutron irradiation.
The test devices have been exposed to the following neutron fluence levels:

| | Step1 | Step2 | Step3 | Step4 | Step5 |
|---|---|---|---|---|---|
| Fluence n/cm$^2$ | 5,00E+10 | 1,00E+11 | 5,00E+11 | 1,00E+12 | 7,00E+12 |
| Flux n/cm$^2$.s | 2,86E+08 | 2,86E+08 | 2,86E+08 | 2,86E+08 | 2,86E+08 |

## 4.4 Exposure set-up

The samples were exposed to neutron irradiation in an un-biased state and had all their terminal leads open.

# 5 ELECTRICAL TESTS

Electrical parameters to be measured in pre and post exposure tests are described in the following table. Electrical tests are performed on each part using the test set-up hereunder. All required data are recorded for each device. Test conditions and limits are given in the applicable irradiation test plan [AD2] and shown hereafter.

## 5.1 Test set-up

| | |
|---|---|
| TEST BOARD | TRAD/CT1/N/OPTO/ZIP14/BR/1109 |
| TEST PROGRAM | OLH400_TN_XXX1_B1_V10.llb |

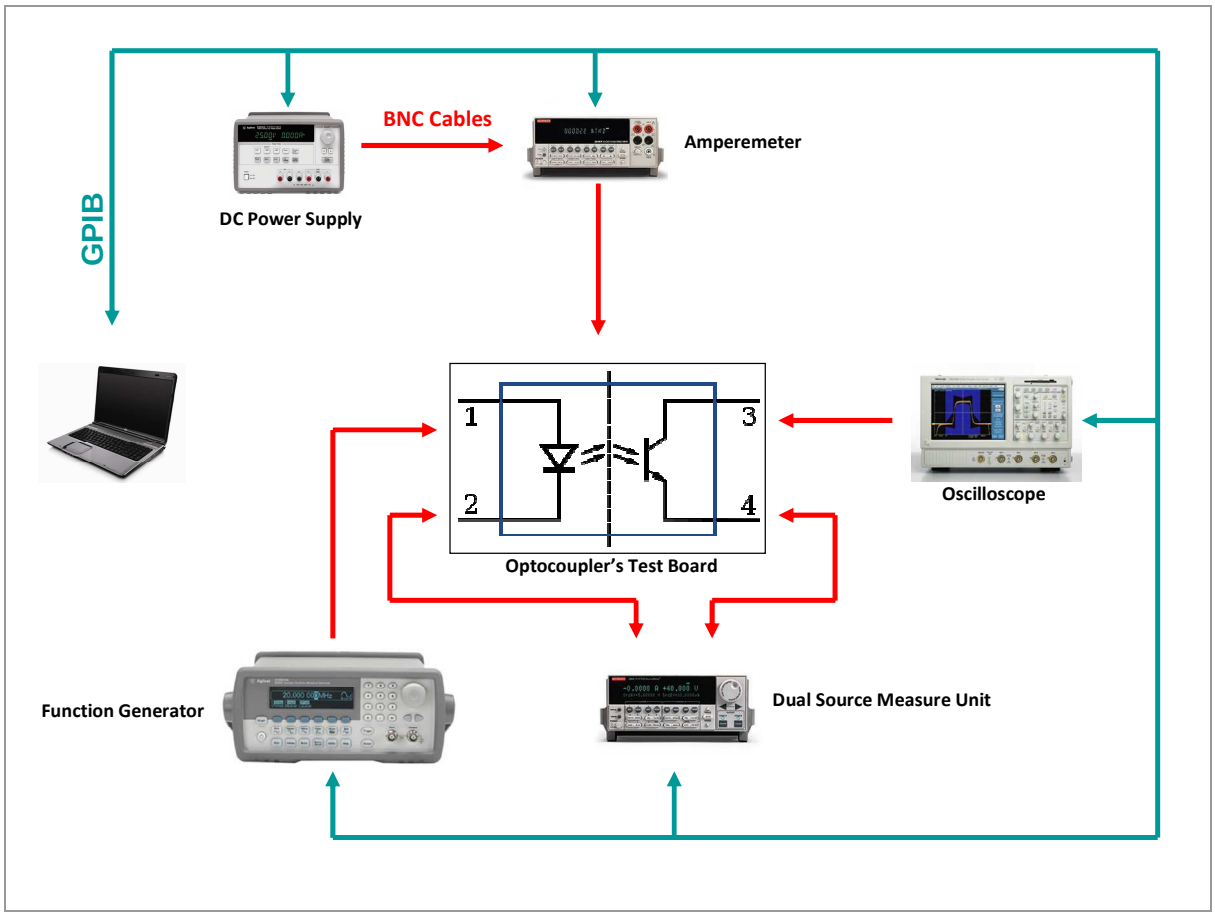



**Figure 6: test principle**

### 5.2 Electrical parameters

| PARAMETER | SYMBOL | TEST CONDITION | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| Logic Low Output Voltage | $V_{OL1}$ | $I_F$=0.5 mA,$I_{OL}$=1.5mA,$V_{CC}$=4.5V | | 0.4 | V |
| | $V_{OL2}$ | $I_F$=5 mA,$I_{OL}$=10mA,$V_{CC}$=4.5V | | 0.4 | V |
| Logic High Output Current | $I_{OH}$ | $I_F$=0mA, $V_O$=$V_{CC}$=18v | | 250 | µA |
| Logic Low Supply Current | $I_{CCL}$ | $I_F$=1.6mA, $V_{CC}$=18V | | 2 | mA |
| Logic High Supply Current | $I_{CCH}$ | $I_F$=0mA, $V_{CC}$=18V | | 40 | µA |
| Input Forward Voltage | $V_F$ | $I_F$=1.6mA | | 2 | V |
| Input Reverse Breakdown Voltage | $B_{VR}$ | $I_R$=10 µA | 3 | | V |
| Propagation Delay Time Logic High to Low | $t_{PHL1}$ | $I_F$=0.5mA, $R_L$=4.7 KΩ, $V_{CC}$=5V | | 100 | µs |
| | $t_{PHL2}$ | $I_F$=5mA, $R_L$=680 Ω, $V_{CC}$=5V | | 10 | µs |
| Propagation Delay Time Logic Low to High | $t_{PLH1}$ | $I_F$=0.5mA, $R_L$=4.7 KΩ, $V_{CC}$=5V | | 60 | µs |
| | $t_{PlH2}$ | $I_F$=5mA, $R_L$=680 Ω, $V_{CC}$=5V | | 30 | µs |
| Current Transfer Ratio | CTR1 | $I_F$=1.6 mA, $V_O$=0.4V, $V_{CC}$=4.5V | 300 | | % |
| | CTR2 | $I_F$=0.16 mA, $V_O$=0.4V, $V_{CC}$=5V | | | % |
| | CTR3 | $I_F$=0.32 mA, $V_O$=0.4V, $V_{CC}$=5V | | | % |
| | CTR4 | $I_F$=1.6 mA, $V_O$=0.4V, $V_{CC}$=5V | | | % |
| | CTR5 | $I_F$=16 mA, $V_O$=0.4V, $V_{CC}$=5V | | | % |
| | CTR6 | $I_F$=1.6 mA, $V_O$=0.4V, $V_{CC}$=20V | | | % |

Min/ Max values are those specified in the reference data-sheet [RD1].

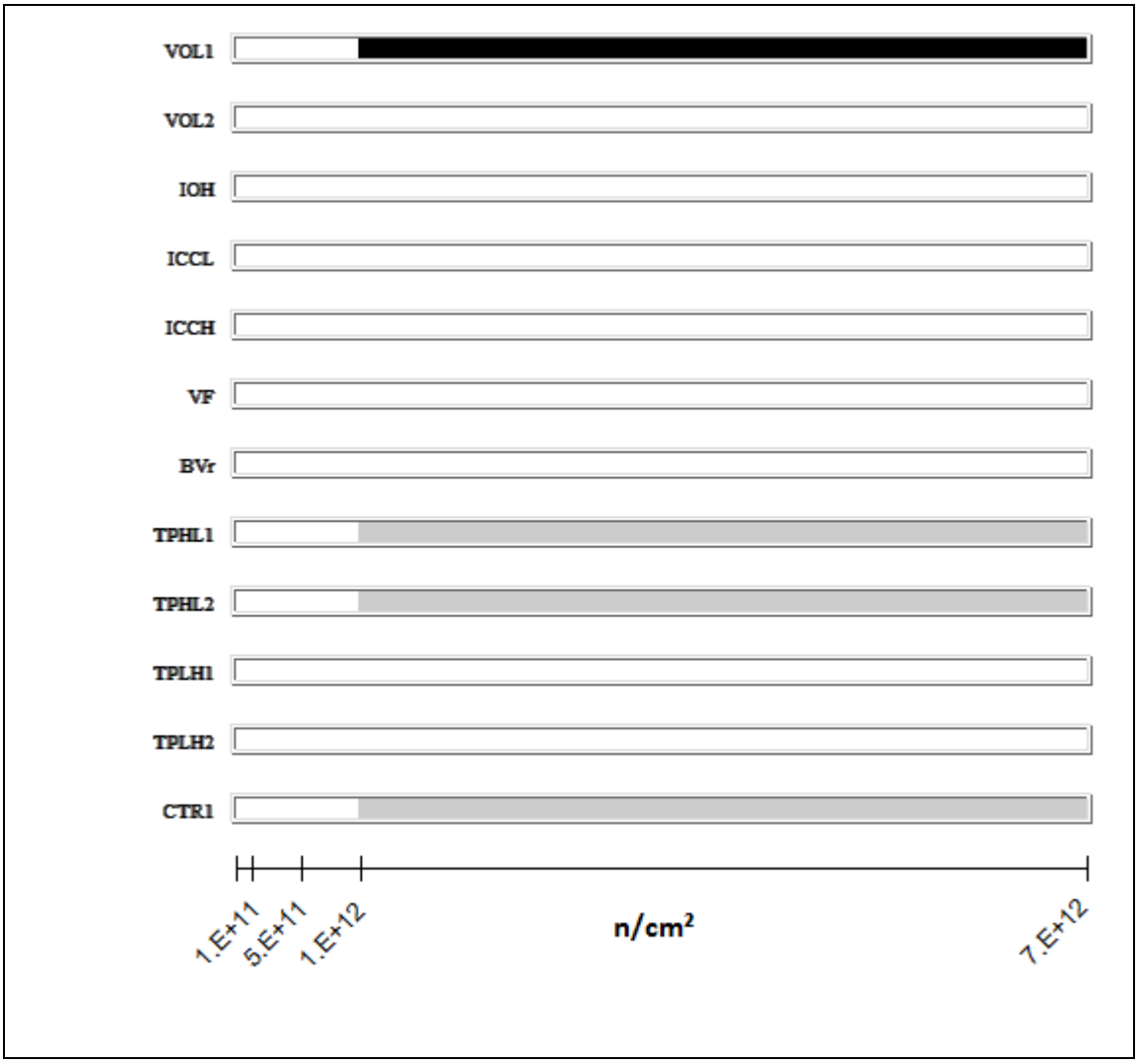
Test measurements are performed at 20°C ± 10°C.

## 6 TEST HISTORY

Test sequence and all required conditions were executed as described in the test plan.
No incident during the test was noticed.

# 7 SUMMARY RESULTS

Only parameters with applicable test limits are shown hereunder.




Within specification

Transition

Out of specification or parameter not measurable

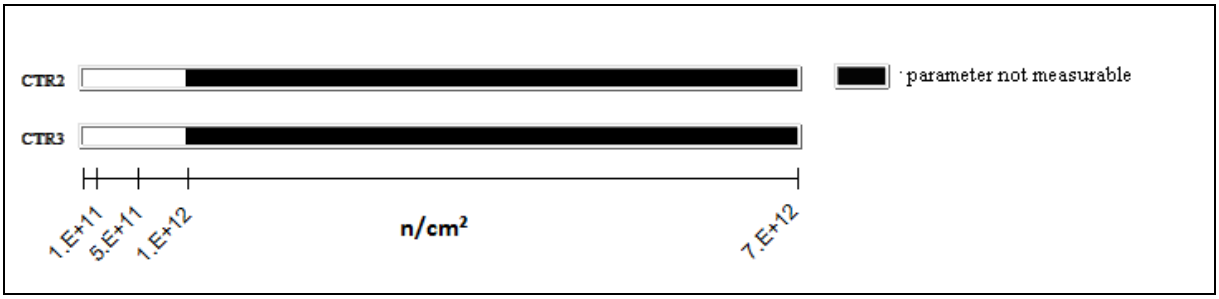
The parameter VOL1 is not measurable at step 7E12.n/cm². Indeed voltage measured at step 7 E12.n/cm² is higher than 5V (limit test condition).

- In the worst case, the parameter TPHL1 is out of specification at 1.77 E12.n/cm² by interpolation.
- In the worst case, the parameter TPHL2 is out of specification at 3.64 E12.n/cm² by interpolation.
- In the worst case, the parameter CTR1 is out of specification at 6.30 E12.n/cm² by interpolation.

Due to the important gap between the 1E12n/cm² and the 7E12n/cm² step, interpolations are given as indicative information.

Next table shows parameters results on the three components tested and which are out of specification at step 7E12n/cm².

| | Device N°2 | Device N°3 | Device N°4 | Applicable specification |
|---|---|---|---|---|
| TPHL1 (µs) at step 7E12n/cm² | 530 | 488 | 330 | MAX: 100 |
| TPHL2 (µs) at step 7E12n/cm² | 19 | 15.5 | 12.9 | MAX: 10 |
| CTR1 (%)at step 7E12n/cm² | 89.10 | 120.42 | 158.24 | MIN: 300 |




- The parameter CTR2 is not measurable at step 7E12.n/cm²
- The parameter CTR3 is not measurable at step 7E12.n/cm²

# 8 CONCLUSION

Total fluence steady-state irradiation test using neutrons has been carried out on three devices from OLH400 type, a High Speed Hermetic Low Input-Current Optocoupler from ISOLINK up to 7E12neutrons/cm², with an energy of 1 MeV.

The results indicate that:

- For the three components tested, VOL1, tPHL1, tPHL2 and CTR1 at step 7E12 n/cm² are out of specification.

| PARAMETERS | SYMBOLS | TEST CONDITIONS | Applicable specification | Worst Measurement at step 7E12 n/cm² |
|---|---|---|---|---|
| Logic Low Output Voltage | $V_{OL1}$ | $I_F$=0.5 mA, $I_{OL}$=1.5mA,$V_{CC}$=4.5V | MAX : 0.4V | >5V |
| Propagation Delay Time Logic High to Low | $t_{PHL1}$ | $I_F$=0.5mA, $R_L$=4.7 KΩ, $V_{CC}$=5V | MAX : 100 µs | 530 µs |
| | $t_{PHL2}$ | $I_F$=5mA, $R_L$=680 Ω, $V_{CC}$=5V | MAX: 10 µs | 19 µs |
| Current Transfer Ratio | CTR1 | $I_F$=1.6 mA, $V_O$=0.4V, $V_{CC}$=4.5V | MIN : 300 % | 89.10 % |

However, all devices are functional up to 1 E+12 neutrons/cm² total fluence level.

- Average drift current transfer ratio are described in next table function of the irradiation step and CTR configuration

| PARAMETERS | SYMBOL | UNIT | STEP IRRADIATION | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 0E10 n/cm² | 5E10 n/cm² | 1E11 n/cm² | 5E11 n/cm² | 1E12 n/cm² | 7E12 n/cm² |
| Average drift Current Transfer Ratio | $\overline{\Delta CTR1}$ | % | 0.00E+00 | 7.28E-06 | 7.54E-06 | 5.06E-05 | 1.23E-04 | 8.25E-03 |
| | $\overline{\Delta CTR2}$ | % | 0.00E+00 | 9.81E-06 | 2.05E-05 | 1.63E-04 | 5.21E-04 | Not measurable |
| | $\overline{\Delta CTR3}$ | % | 0.00E+00 | 7.91E-06 | 1.53E-05 | 1.04E-04 | 2.89E-04 | Not measurable |
| | $\overline{\Delta CTR4}$ | % | 0.00E+00 | 7.24E-06 | 7.44E-06 | 5.01E-05 | 1.22E-04 | 7.96E-03 |
| | $\overline{\Delta CTR5}$ | % | 0.00E+00 | 3.93E-05 | 3.49E-06 | 6.67E-05 | 1.00E-04 | 1.64E-03 |
| | $\overline{\Delta CTR6}$ | % | 0.00E+00 | 6.58E-06 | 6.13E-06 | 4.14E-05 | 1.00E-04 | 5.21E-03 |

- CTR5 configuration (IF=16 mA, VO=0.4V, VCC=5V) is the least sensitive configuration at the fluence of 7E12n/cm².
- Conversely, CRT2 (IF=0.16 mA, VO=0.4V, VCC=5V) and CTR3 (IF=0.32 mA, VO=0.4V, VCC=5V) configuration exhibits the greatest parameter degradation at the final irradiation step (not measurable).

# 9 DETAILED TESTS RESULTS

The pre and post radiation test results are shown graphically in the following pages (9-2 to 9-18). The data is displayed in the following tables and graphs.

These graphs show parameter's shifts observed during the neutron testing sequence. The Control sample results are shown on each graph (black curve).

When available in the device data-sheet/specification, the maximum/minimum/typical values are also shown (red dotted line).

The tables include drift calculation between each measurement step and the "0" neutrons/cm² step.

For CTR values, the formula used is:

$$\text{Drift} = \frac{1}{\text{measurement } (X \text{ neutrons /cm}^2)} - \frac{1}{\text{measurement } (0 \text{ neutrons /cm}^2)}$$

For other parameters, the formula used is:

Drift value= measurement (X neutrons/cm²) - measurement (0 neutrons/cm²)

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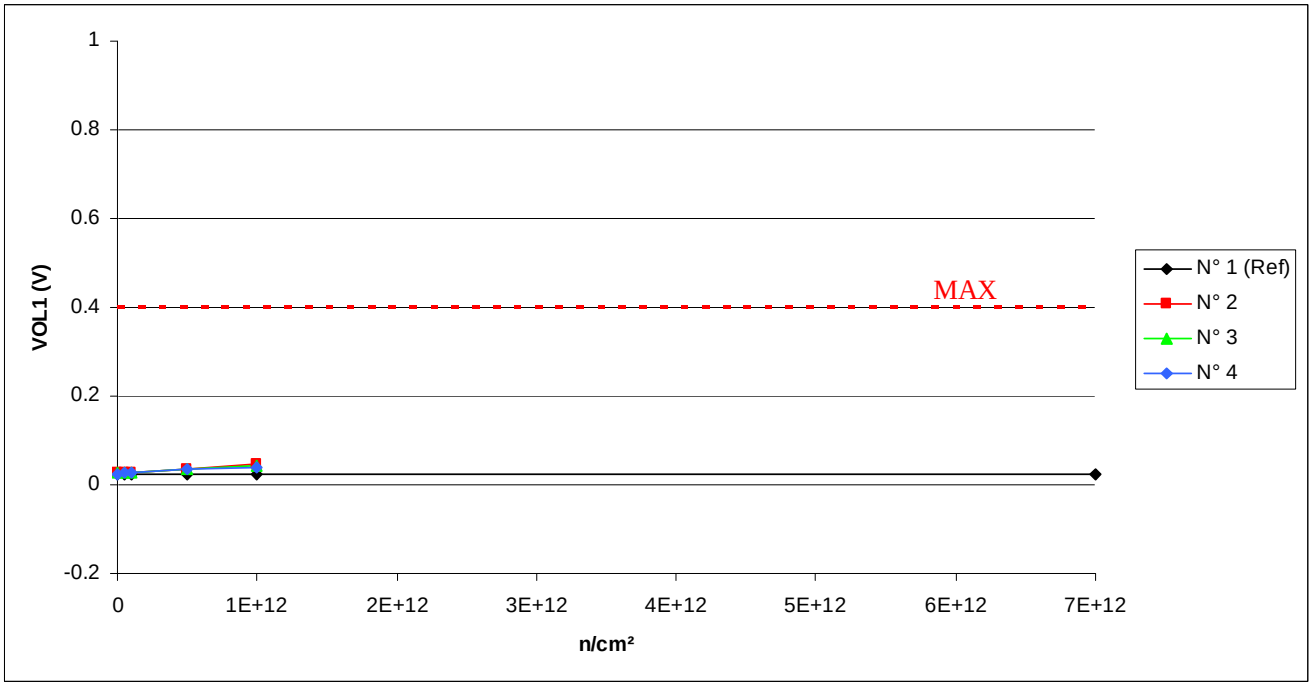
## 1. VOL1

**Ta=25°C; If=0.5mA; IOL=1.5mA; Vcc=4.5V**




**VOL1. (V)** **Max = 0.4**

| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | 0.024 | 0.024 | 0.024 | 0.025 | 0.024 | 0.025 |
| N° 2 | 0.027 | 0.028 | 0.029 | 0.036 | 0.048 | Not Measurable* |
| N° 3 | 0.026 | 0.027 | 0.027 | 0.034 | 0.045 | Not Measurable* |
| N° 4 | 0.025 | 0.026 | 0.026 | 0.034 | 0.040 | Not Measurable* |

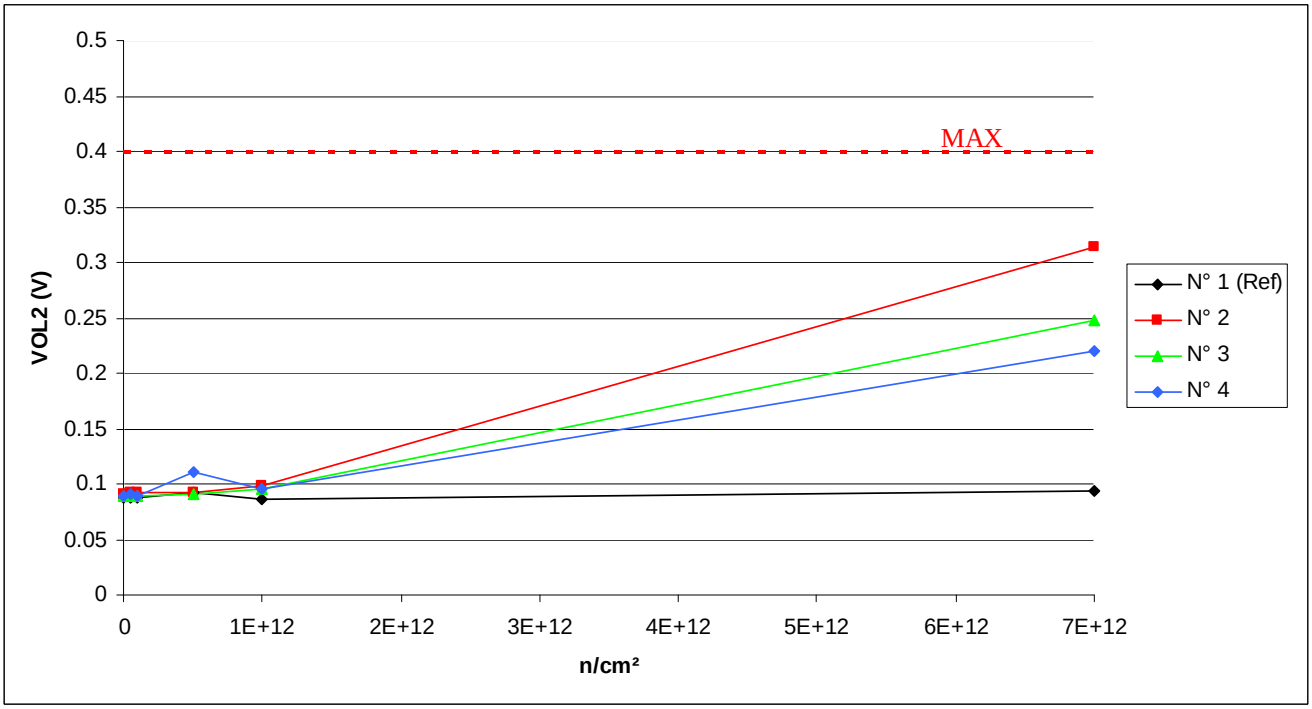
**Delta [VOL1]**

| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | --- | 2.578E-4 | 8.946E-5 | 8.726E-4 | -3.510E-6 | 1.040E-3 |
| N° 2 | --- | 9.341E-4 | 1.465E-3 | 8.358E-3 | 2.070E-2 | NaN |
| N° 3 | --- | 8.763E-4 | 1.258E-3 | 7.855E-3 | 1.887E-2 | NaN |
| N° 4 | --- | 9.207E-4 | 1.090E-3 | 8.833E-3 | 1.505E-2 | NaN |
| Average | --- | 9.104E-4 | 1.271E-3 | 8.349E-3 | 1.821E-2 | NaN |
| σ | --- | 3.023E-5 | 1.880E-4 | 4.888E-4 | 2.880E-3 | 0.000E+0 |
| Average+3σ | --- | 1.001E-3 | 1.835E-3 | 9.815E-3 | 2.684E-2 | NaN |
| Average-3σ | --- | 8.197E-4 | 7.069E-4 | 6.882E-3 | 9.567E-3 | NaN |

* Measured value is >5V (limit test condition)

## 2. VOL2

**Ta=25°C; If=5mA; IOL=10mA; Vcc=4.5V**




**VOL2. (V)** **Max = 0.4**

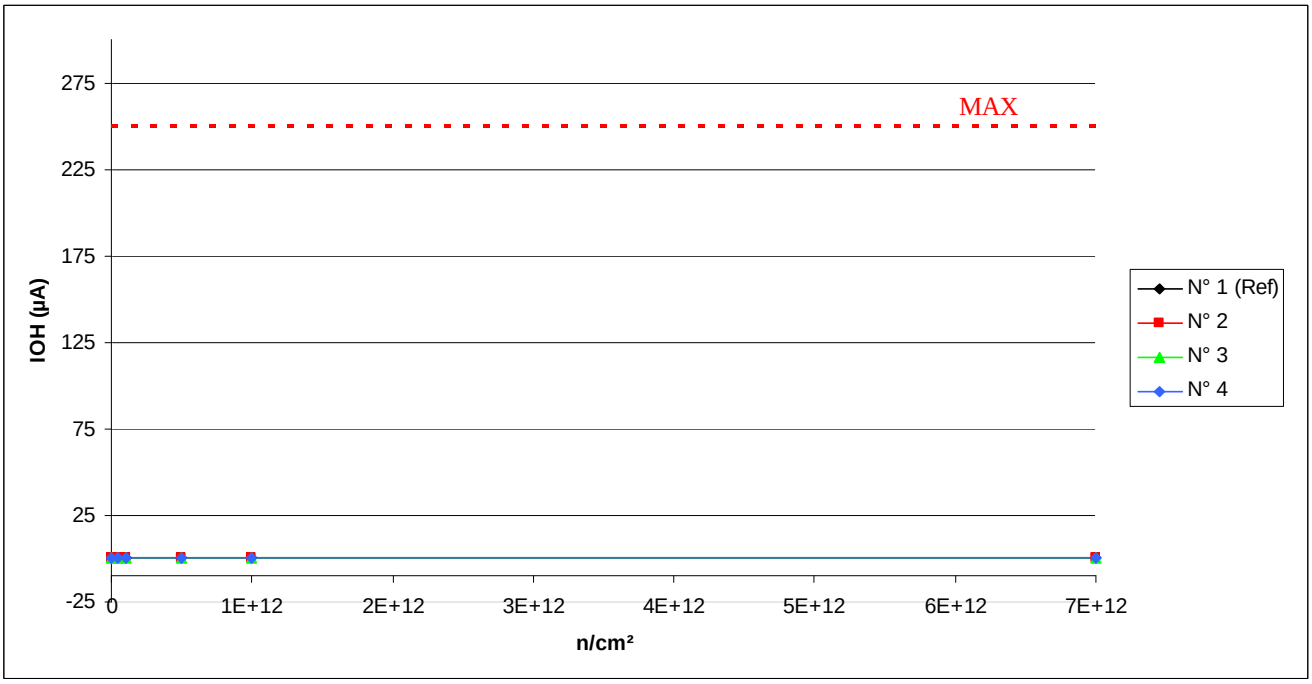
| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | 0.087 | 0.088 | 0.087 | 0.092 | 0.086 | 0.094 |
| N° 2 | 0.091 | 0.092 | 0.092 | 0.093 | 0.099 | 0.314 |
| N° 3 | 0.089 | 0.090 | 0.089 | 0.091 | 0.096 | 0.247 |
| N° 4 | 0.089 | 0.091 | 0.090 | 0.111 | 0.095 | 0.220 |

**Delta [VOL2]**

| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | --- | 1.070E-3 | 3.471E-4 | 5.135E-3 | -5.923E-4 | 6.738E-3 |
| N° 2 | --- | 1.162E-3 | 8.190E-4 | 2.048E-3 | 7.516E-3 | 2.227E-1 |
| N° 3 | --- | 1.210E-3 | 2.217E-4 | 1.742E-3 | 6.570E-3 | 1.579E-1 |
| N° 4 | --- | 1.506E-3 | 2.048E-4 | 2.162E-2 | 5.412E-3 | 1.304E-1 |
| Average | --- | 1.293E-3 | 4.152E-4 | 8.471E-3 | 6.500E-3 | 1.703E-1 |
| σ | --- | 1.863E-4 | 3.498E-4 | 1.139E-2 | 1.053E-3 | 4.742E-2 |
| Average+3σ | --- | 1.852E-3 | 1.465E-3 | 4.265E-2 | 9.660E-3 | 3.126E-1 |
| Average-3σ | --- | 7.341E-4 | -6.343E-4 | -2.570E-2 | 3.339E-3 | 2.809E-2 |

## 3. IOH

**Ta=25°C; If=0; Vo=Vcc=18V**




**IOH. (µA)** **Max = 250.0**

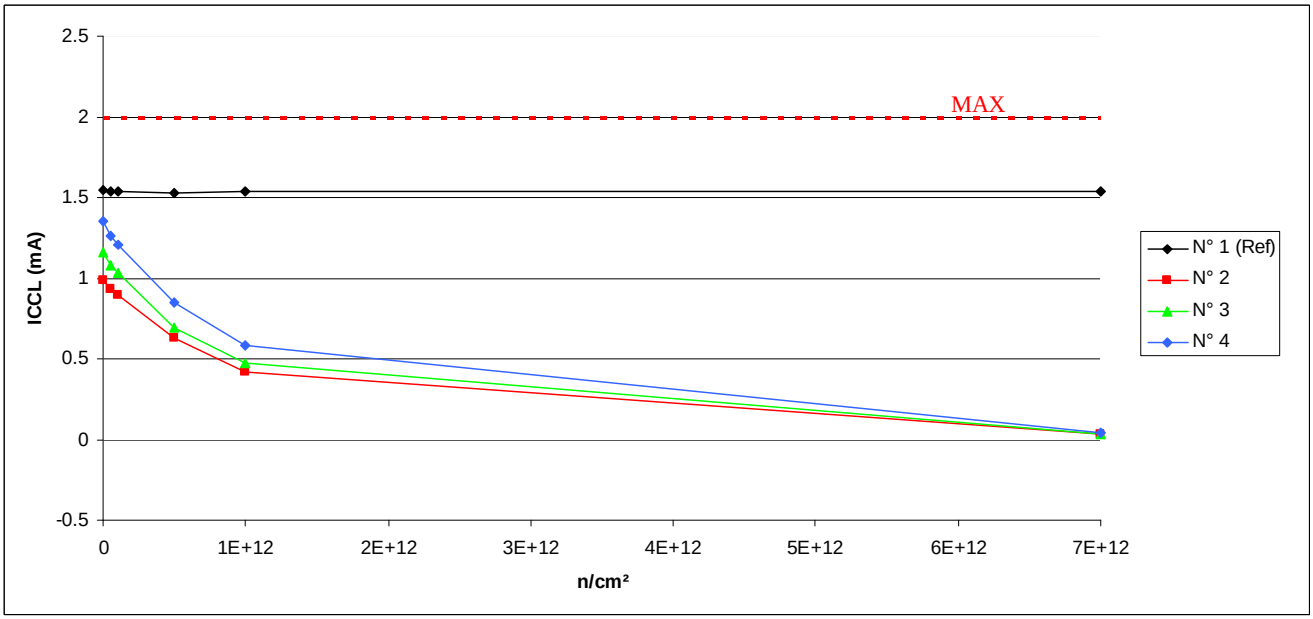
| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | 5.985E-4 | 6.812E-4 | 5.914E-4 | 7.352E-4 | 6.347E-4 | 4.673E-4 |
| N° 2 | 6.001E-4 | 5.939E-4 | 5.938E-4 | 7.654E-4 | 8.370E-4 | 7.051E-4 |
| N° 3 | 6.154E-4 | 6.373E-4 | 6.392E-4 | 8.448E-4 | 7.601E-4 | 7.004E-4 |
| N° 4 | 6.205E-4 | 6.361E-4 | 6.590E-4 | 7.083E-4 | 7.619E-4 | 7.072E-4 |

**Delta [IOH]**

| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | --- | 8.265E-5 | -7.170E-6 | 1.366E-4 | 3.616E-5 | -1.312E-4 |
| N° 2 | --- | -6.203E-6 | -6.373E-6 | 1.653E-4 | 2.369E-4 | 1.050E-4 |
| N° 3 | --- | 2.192E-5 | 2.376E-5 | 2.294E-4 | 1.448E-4 | 8.503E-5 |
| N° 4 | --- | 1.564E-5 | 3.852E-5 | 8.780E-5 | 1.415E-4 | 8.679E-5 |
| Average | --- | 1.045E-5 | 1.864E-5 | 1.608E-4 | 1.744E-4 | 9.227E-5 |
| σ | --- | 1.476E-5 | 2.288E-5 | 7.089E-5 | 5.416E-5 | 1.104E-5 |
| Average+3σ | --- | 5.474E-5 | 8.727E-5 | 3.735E-4 | 3.368E-4 | 1.254E-4 |
| Average-3σ | --- | -3.383E-5 | -5.000E-5 | -5.187E-5 | 1.191E-5 | 5.913E-5 |

## 4. ICCL

**Ta=25°C; If=1.6mA; Vcc=18V**




**ICCL. (mA)** **Max = 2.0**

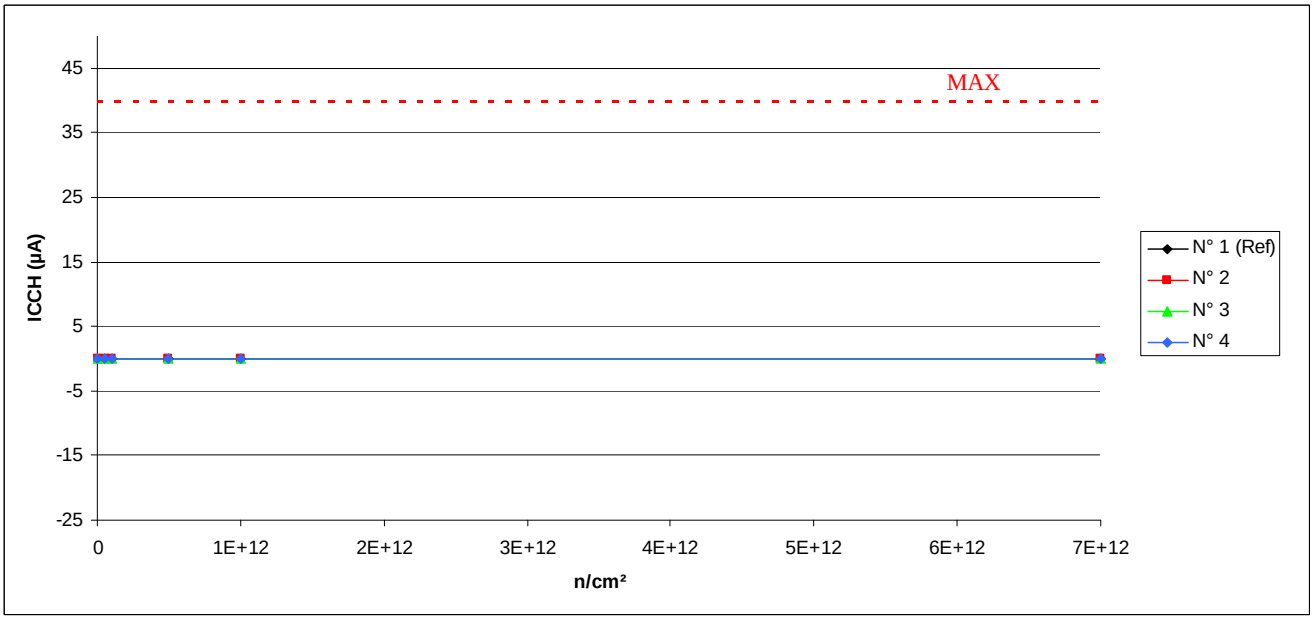
| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | 1.550 | 1.538 | 1.535 | 1.528 | 1.539 | 1.534 |
| N° 2 | 0.990 | 0.932 | 0.891 | 0.628 | 0.422 | 0.029 |
| N° 3 | 1.156 | 1.080 | 1.031 | 0.696 | 0.477 | 0.035 |
| N° 4 | 1.352 | 1.263 | 1.209 | 0.845 | 0.583 | 0.042 |

**Delta [ICCL]**

| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | --- | -1.213E-2 | -1.515E-2 | -2.210E-2 | -1.099E-2 | -1.621E-2 |
| N° 2 | --- | -5.843E-2 | -9.924E-2 | -3.624E-1 | -5.677E-1 | -9.607E-1 |
| N° 3 | --- | -7.612E-2 | -1.249E-1 | -4.593E-1 | -6.788E-1 | -1.120E+0 |
| N° 4 | --- | -8.902E-2 | -1.425E-1 | -5.064E-1 | -7.682E-1 | -1.310E+0 |
| Average | --- | -7.452E-2 | -1.222E-1 | -4.427E-1 | -6.715E-1 | -1.130E+0 |
| σ | --- | 1.536E-2 | 2.176E-2 | 7.345E-2 | 1.004E-1 | 1.748E-1 |
| Average+3σ | --- | -2.845E-2 | -5.692E-2 | -2.224E-1 | -3.703E-1 | -6.059E-1 |
| Average-3σ | --- | -1.206E-1 | -1.875E-1 | -6.631E-1 | -9.728E-1 | -1.655E+0 |

## 5. ICCH

**Ta=25°C; If=0; Vcc=18V**




**ICCH. (µA)** **Max = 40.0**

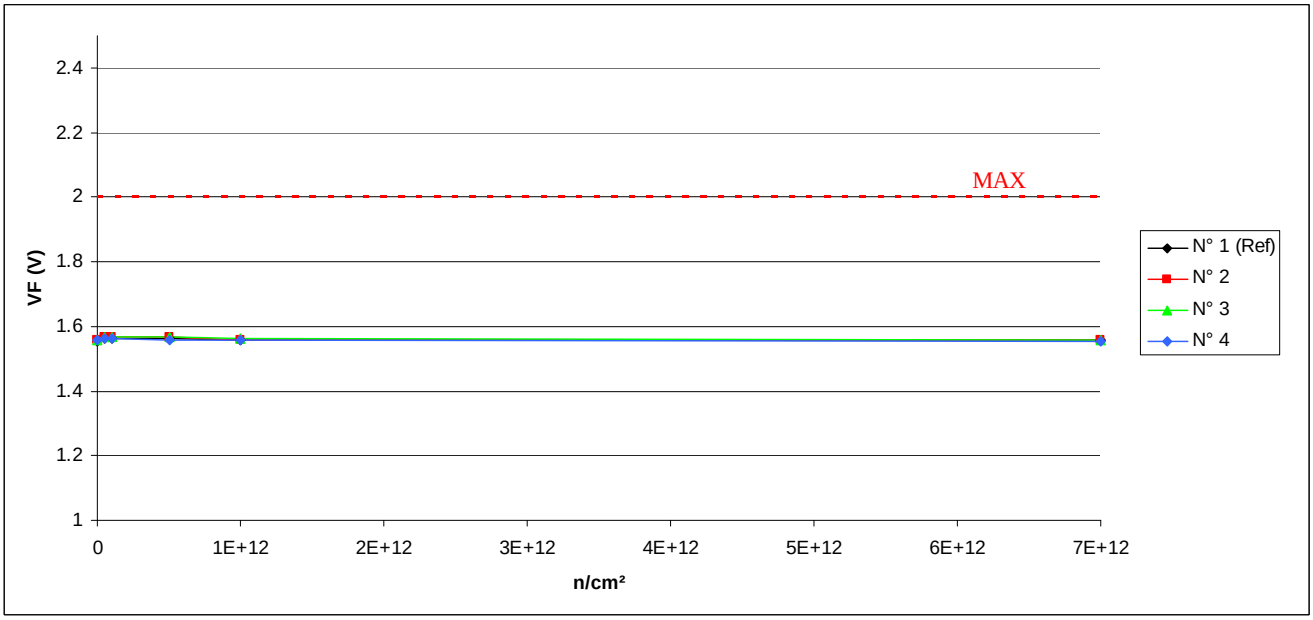
| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | 0.022 | 0.026 | 0.025 | 0.023 | 0.024 | 0.021 |
| N° 2 | 0.022 | 0.025 | 0.025 | 0.030 | 0.035 | 0.043 |
| N° 3 | 0.022 | 0.024 | 0.025 | 0.027 | 0.030 | 0.045 |
| N° 4 | 0.020 | 0.023 | 0.024 | 0.029 | 0.036 | 0.044 |

**Delta [ICCH]**

| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | --- | 3.510E-3 | 3.180E-3 | 1.190E-3 | 1.210E-3 | -9.200E-4 |
| N° 2 | --- | 2.450E-3 | 3.350E-3 | 7.430E-3 | 1.277E-2 | 2.079E-2 |
| N° 3 | --- | 1.780E-3 | 3.140E-3 | 5.210E-3 | 8.410E-3 | 2.308E-2 |
| N° 4 | --- | 3.680E-3 | 4.450E-3 | 9.320E-3 | 1.593E-2 | 2.436E-2 |
| Average | --- | 2.637E-3 | 3.647E-3 | 7.320E-3 | 1.237E-2 | 2.274E-2 |
| σ | --- | 9.637E-4 | 7.036E-4 | 2.057E-3 | 3.776E-3 | 1.809E-3 |
| Average+3σ | --- | 5.528E-3 | 5.757E-3 | 1.349E-2 | 2.370E-2 | 2.817E-2 |
| Average-3σ | --- | -2.543E-4 | 1.536E-3 | 1.148E-3 | 1.042E-3 | 1.732E-2 |

## 6. VF

**Ta=25°C; If=1.6mA**




**VF . (V)** **Max = 2.0**

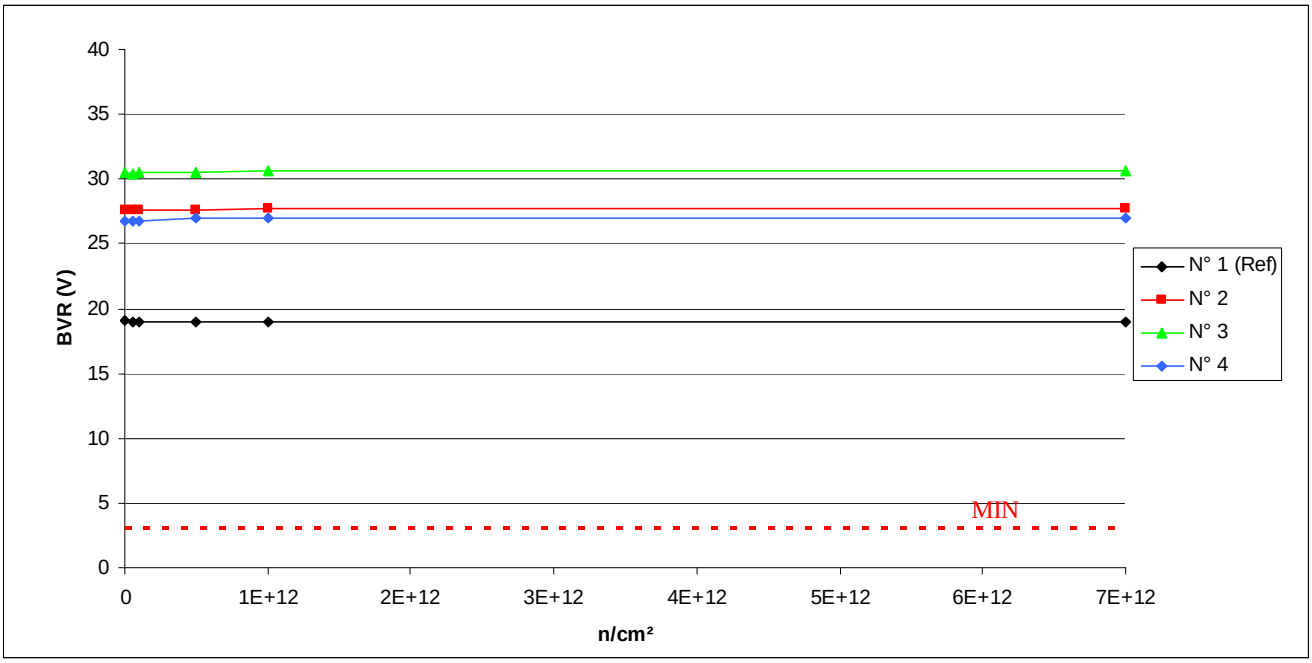
| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | 1.554 | 1.561 | 1.561 | 1.563 | 1.558 | 1.559 |
| N° 2 | 1.560 | 1.567 | 1.566 | 1.567 | 1.558 | 1.558 |
| N° 3 | 1.559 | 1.568 | 1.568 | 1.567 | 1.561 | 1.559 |
| N° 4 | 1.556 | 1.563 | 1.562 | 1.560 | 1.557 | 1.553 |

**Delta [VF]**

| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | --- | 6.826E-3 | 6.828E-3 | 8.827E-3 | 4.589E-3 | 5.651E-3 |
| N° 2 | --- | 6.837E-3 | 6.331E-3 | 7.254E-3 | -1.552E-3 | -1.715E-3 |
| N° 3 | --- | 9.591E-3 | 9.014E-3 | 8.869E-3 | 2.754E-3 | 2.190E-4 |
| N° 4 | --- | 6.635E-3 | 5.890E-3 | 3.288E-3 | 4.950E-4 | -2.732E-3 |
| Average | --- | 7.688E-3 | 7.078E-3 | 6.470E-3 | 5.657E-4 | -1.409E-3 |
| σ | --- | 1.651E-3 | 1.691E-3 | 2.872E-3 | 2.154E-3 | 1.499E-3 |
| Average+3σ | --- | 1.264E-2 | 1.215E-2 | 1.509E-2 | 7.027E-3 | 3.088E-3 |
| Average-3σ | --- | 2.733E-3 | 2.006E-3 | -2.145E-3 | -5.896E-3 | -5.907E-3 |

## 7. BVr

**Ta=25°C; Ir=10µA**




**BVr . (V)** **Min = 3.0**

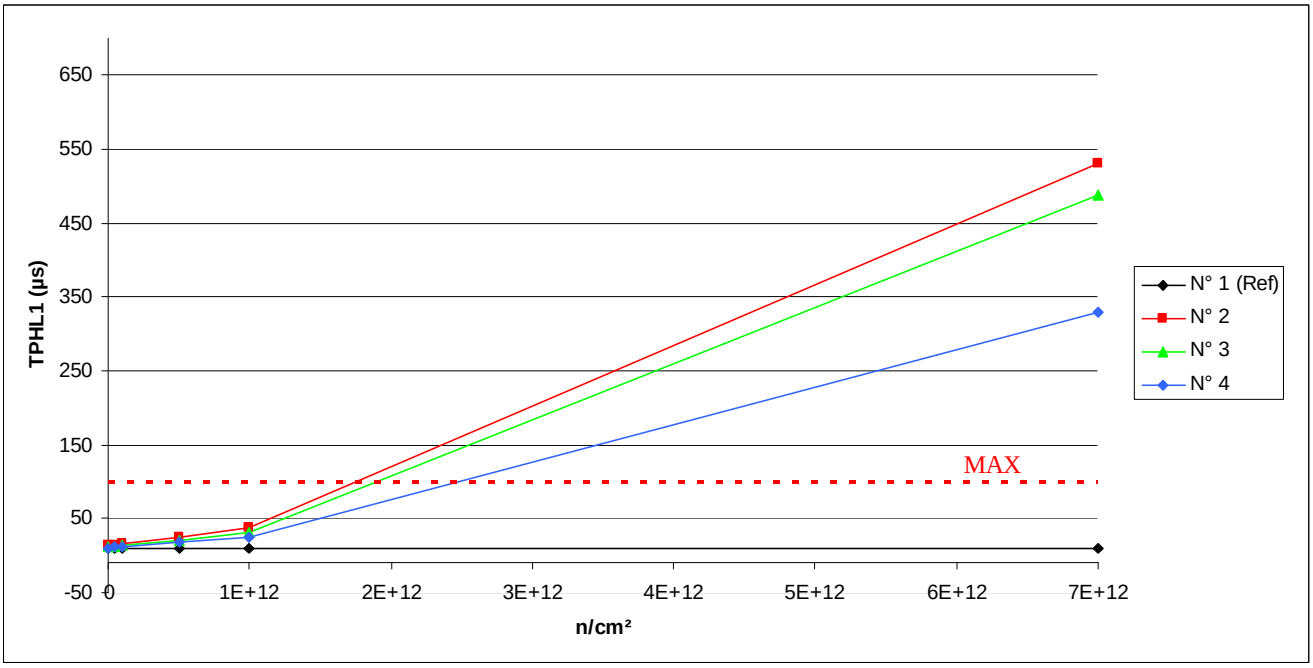
| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | 19.03 | 18.95 | 18.96 | 18.95 | 18.97 | 18.97 |
| N° 2 | 27.62 | 27.55 | 27.59 | 27.61 | 27.72 | 27.69 |
| N° 3 | 30.54 | 30.42 | 30.57 | 30.56 | 30.62 | 30.60 |
| N° 4 | 26.72 | 26.76 | 26.78 | 26.94 | 26.96 | 26.97 |

**Delta [BVr]**

| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | --- | -7.713E-2 | -7.274E-2 | -7.465E-2 | -5.448E-2 | -5.943E-2 |
| N° 2 | --- | -6.369E-2 | -2.968E-2 | -9.650E-3 | 1.010E-1 | 7.152E-2 |
| N° 3 | --- | -1.162E-1 | 3.639E-2 | 2.656E-2 | 7.852E-2 | 6.853E-2 |
| N° 4 | --- | 3.399E-2 | 5.355E-2 | 2.172E-1 | 2.344E-1 | 2.520E-1 |
| Average | --- | -4.864E-2 | 2.009E-2 | 7.802E-2 | 1.380E-1 | 1.307E-1 |
| σ | --- | 7.623E-2 | 4.394E-2 | 1.218E-1 | 8.427E-2 | 1.051E-1 |
| Average+3σ | --- | 1.800E-1 | 1.519E-1 | 4.435E-1 | 3.908E-1 | 4.459E-1 |
| Average-3σ | --- | -2.773E-1 | -1.117E-1 | -2.875E-1 | -1.148E-1 | -1.845E-1 |

## 8. TPHL1

**Ta=25°C; If=0.5mA; RL=4.7 kOhms; Vcc=5V**




**TPHL1 . (µs)** **Max = 100.0**

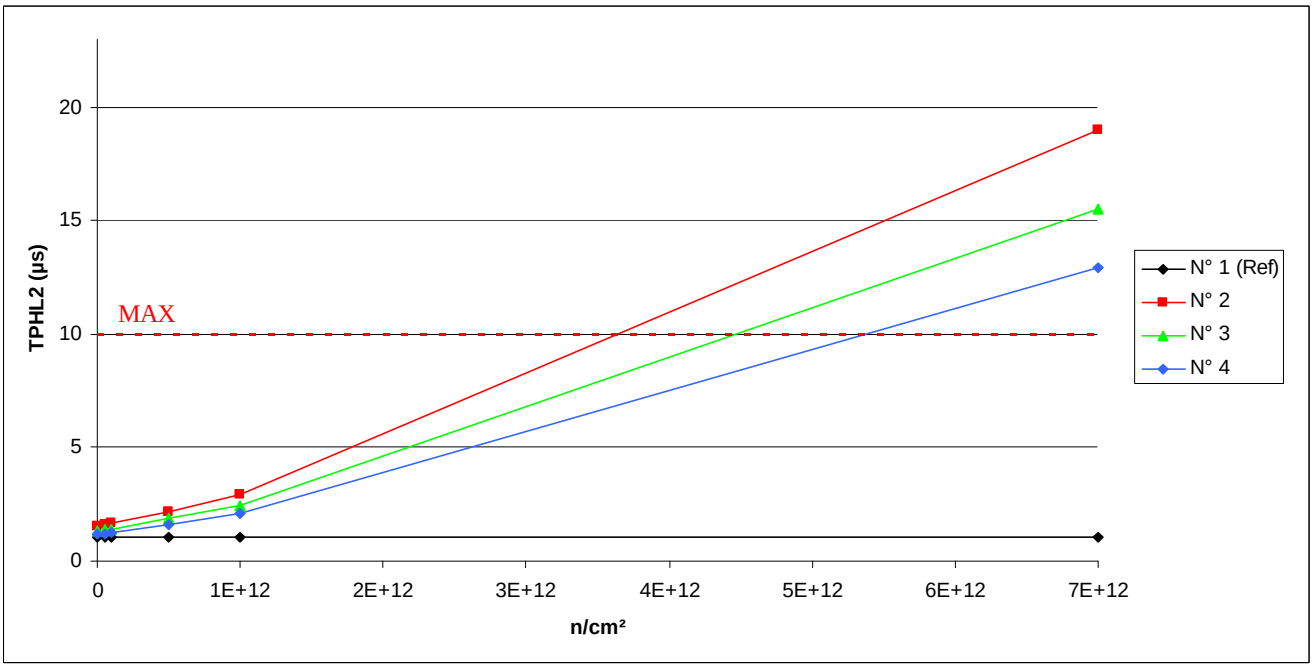
| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | 9.70 | 9.50 | 9.40 | 9.50 | 9.50 | 9.65 |
| N° 2 | 14.80 | 15.30 | 16.00 | 24.30 | 37.05 | 530.00 |
| N° 3 | 12.40 | 12.90 | 13.50 | 20.90 | 30.90 | 488.00 |
| N° 4 | 10.80 | 11.20 | 11.70 | 17.60 | 25.90 | 330.00 |

**Delta [TPHL1]**

| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | --- | -2.000E-1 | -3.000E-1 | -2.000E-1 | -2.000E-1 | -5.000E-2 |
| N° 2 | --- | 5.000E-1 | 1.200E+0 | 9.500E+0 | 2.225E+1 | 5.152E+2 |
| N° 3 | --- | 5.000E-1 | 1.100E+0 | 8.500E+0 | 1.850E+1 | 4.756E+2 |
| N° 4 | --- | 4.000E-1 | 9.000E-1 | 6.800E+0 | 1.510E+1 | 3.192E+2 |
| Average | --- | 4.667E-1 | 1.067E+0 | 8.267E+0 | 1.862E+1 | 4.367E+2 |
| σ | --- | 5.774E-2 | 1.528E-1 | 1.365E+0 | 3.576E+0 | 1.036E+2 |
| Average+3σ | --- | 6.399E-1 | 1.525E+0 | 1.236E+1 | 2.935E+1 | 7.476E+2 |
| Average-3σ | --- | 2.935E-1 | 6.084E-1 | 4.172E+0 | 7.887E+0 | 1.258E+2 |

## 9. TPHL2

**Ta=25°C; If=5mA; RL=680 Ohms; Vcc=5V**




**TPHL2 . (µs)** **Max = 10.0**

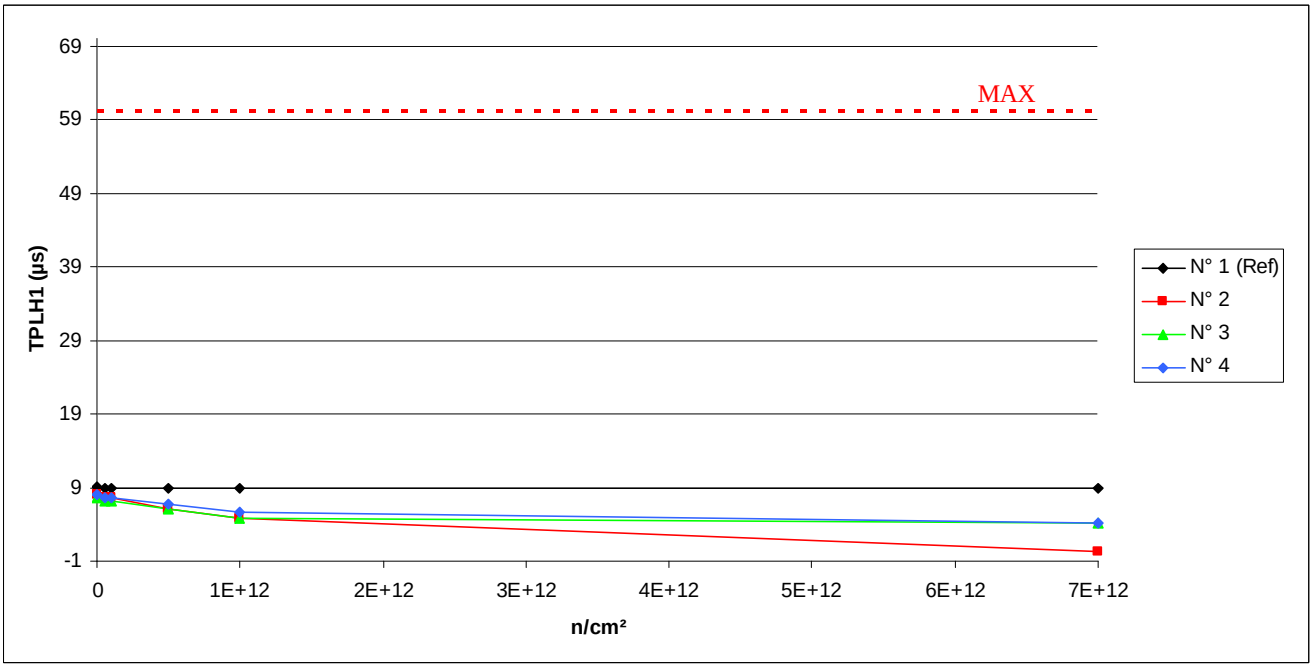
| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | 1.07 | 1.07 | 1.08 | 1.08 | 1.07 | 1.08 |
| N° 2 | 1.56 | 1.62 | 1.67 | 2.18 | 2.92 | 19.00 |
| N° 3 | 1.33 | 1.38 | 1.42 | 1.87 | 2.48 | 15.50 |
| N° 4 | 1.16 | 1.20 | 1.24 | 1.60 | 2.12 | 12.90 |

**Delta [TPHL2]**

| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | --- | 0.000E+0 | 1.000E-2 | 1.000E-2 | 0.000E+0 | 1.000E-2 |
| N° 2 | --- | 6.000E-2 | 1.100E-1 | 6.200E-1 | 1.360E+0 | 1.744E+1 |
| N° 3 | --- | 5.000E-2 | 9.000E-2 | 5.400E-1 | 1.150E+0 | 1.417E+1 |
| N° 4 | --- | 4.000E-2 | 8.000E-2 | 4.400E-1 | 9.600E-1 | 1.174E+1 |
| Average | --- | 5.000E-2 | 9.333E-2 | 5.333E-1 | 1.157E+0 | 1.445E+1 |
| σ | --- | 1.000E-2 | 1.528E-2 | 9.018E-2 | 2.001E-1 | 2.860E+0 |
| Average+3σ | --- | 8.000E-2 | 1.392E-1 | 8.039E-1 | 1.757E+0 | 2.303E+1 |
| Average-3σ | --- | 2.000E-2 | 4.751E-2 | 2.628E-1 | 5.564E-1 | 5.869E+0 |

## 10.TPLH1

**Ta=25°C; If=0.5mA; RL=4.7 kOhms; Vcc=5V**




**TPLH1 . (µs)** **Max = 60.0**

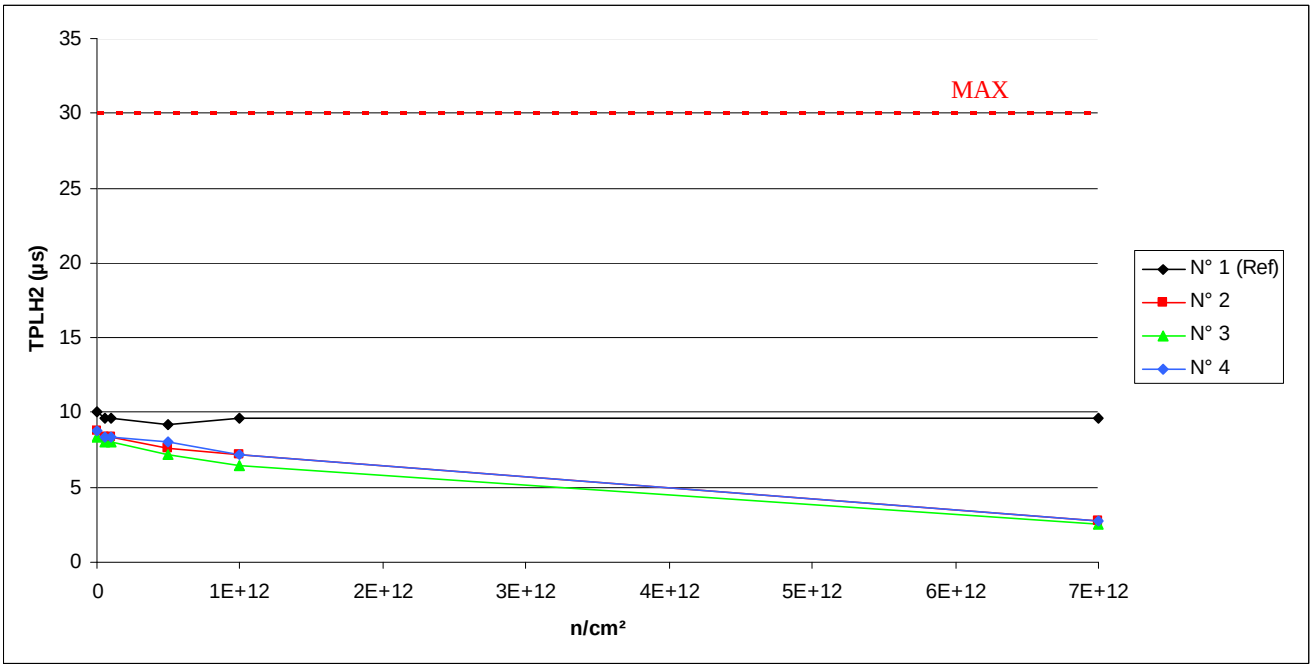
| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | 9.2 | 8.8 | 8.8 | 8.8 | 8.8 | 9.0 |
| N° 2 | 8.0 | 7.6 | 7.6 | 6.0 | 4.8 | 0.2 |
| N° 3 | 7.6 | 7.2 | 7.2 | 6.0 | 4.8 | 4.2 |
| N° 4 | 8.0 | 7.6 | 7.6 | 6.8 | 5.6 | 4.2 |

**Delta [TPLH1]**

| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | --- | -4.000E-1 | -4.000E-1 | -4.000E-1 | -4.000E-1 | -2.000E-1 |
| N° 2 | --- | -4.000E-1 | -4.000E-1 | -2.000E+0 | -3.200E+0 | -7.800E+0 |
| N° 3 | --- | -4.000E-1 | -4.000E-1 | -1.600E+0 | -2.800E+0 | -3.400E+0 |
| N° 4 | --- | -4.000E-1 | -4.000E-1 | -1.200E+0 | -2.400E+0 | -3.800E+0 |
| Average | --- | -4.000E-1 | -4.000E-1 | -1.600E+0 | -2.800E+0 | -5.000E+0 |
| σ | --- | 5.133E-16 | 5.133E-16 | 4.000E-1 | 4.000E-1 | 2.433E+0 |
| Average+3σ | --- | -4.000E-1 | -4.000E-1 | -4.000E-1 | -1.600E+0 | 2.299E+0 |
| Average-3σ | --- | -4.000E-1 | -4.000E-1 | -2.800E+0 | -4.000E+0 | -1.230E+1 |

## 11.TPLH2

**Ta=25°C; If=5mA; RL=680 Ohms; Vcc=5V**




**TPLH2 . (µs)** **Max = 30.0**

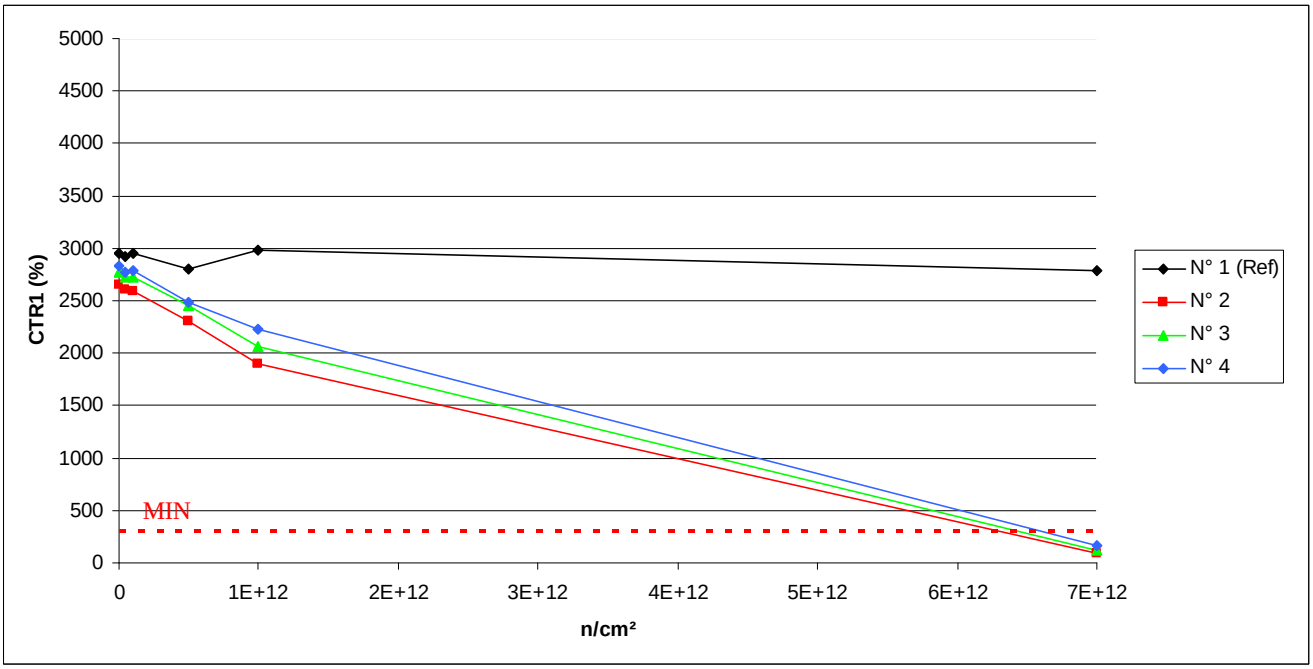
| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | 10.00 | 9.60 | 9.60 | 9.20 | 9.60 | 9.60 |
| N° 2 | 8.80 | 8.40 | 8.40 | 7.60 | 7.20 | 2.70 |
| N° 3 | 8.40 | 8.00 | 8.00 | 7.20 | 6.40 | 2.55 |
| N° 4 | 8.80 | 8.40 | 8.40 | 8.00 | 7.20 | 2.70 |

**Delta [TPLH2]**

| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | --- | -4.000E-1 | -4.000E-1 | -8.000E-1 | -4.000E-1 | -4.000E-1 |
| N° 2 | --- | -4.000E-1 | -4.000E-1 | -1.200E+0 | -1.600E+0 | -6.100E+0 |
| N° 3 | --- | -4.000E-1 | -4.000E-1 | -1.200E+0 | -2.000E+0 | -5.850E+0 |
| N° 4 | --- | -4.000E-1 | -4.000E-1 | -8.000E-1 | -1.600E+0 | -6.100E+0 |
| Average | --- | -4.000E-1 | -4.000E-1 | -1.067E+0 | -1.733E+0 | -6.017E+0 |
| σ | --- | 0.000E+0 | 0.000E+0 | 2.309E-1 | 2.309E-1 | 1.443E-1 |
| Average+3σ | --- | -4.000E-1 | -4.000E-1 | -3.738E-1 | -1.041E+0 | -5.584E+0 |
| Average-3σ | --- | -4.000E-1 | -4.000E-1 | -1.759E+0 | -2.426E+0 | -6.450E+0 |

## 12.CTR1

**Ta=25°C; If=1.6mA; Vo=0.4V; Vcc=4.5V**




**CTR1 . (%)** **Min = 300.0**

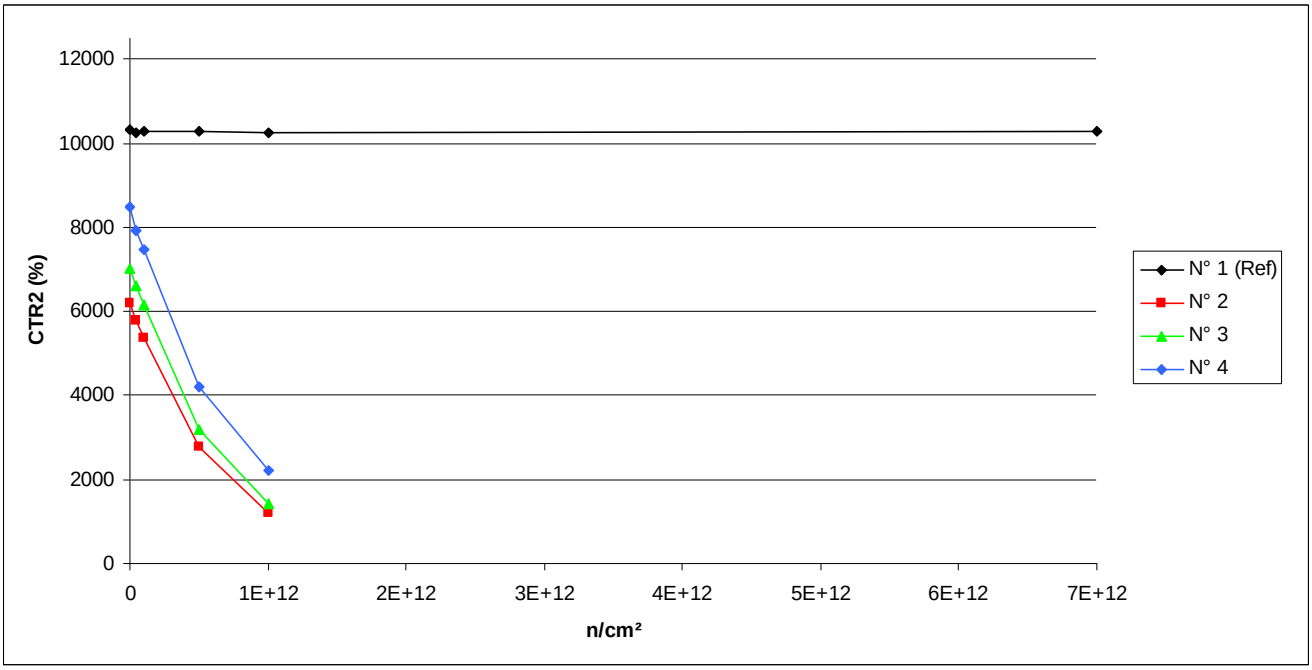
| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | 2956.298 | 2928.147 | 2948.794 | 2798.266 | 2974.934 | 2790.724 |
| N° 2 | 2656.795 | 2607.732 | 2588.479 | 2310.881 | 1903.549 | 89.101 |
| N° 3 | 2777.963 | 2724.021 | 2725.073 | 2455.830 | 2060.392 | 120.425 |
| N° 4 | 2828.825 | 2769.043 | 2784.003 | 2489.896 | 2234.604 | 158.247 |

**1/Delta [CTR1]**

| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | --- | 3.252E-6 | 8.608E-7 | 1.910E-5 | -2.119E-6 | 2.007E-5 |
| N° 2 | --- | 7.082E-6 | 9.934E-6 | 5.634E-5 | 1.489E-4 | 1.085E-2 |
| N° 3 | --- | 7.128E-6 | 6.987E-6 | 4.722E-5 | 1.254E-4 | 7.944E-3 |
| N° 4 | --- | 7.632E-6 | 5.691E-6 | 4.812E-5 | 9.400E-5 | 5.966E-3 |
| Average | --- | 7.281E-6 | 7.537E-6 | 5.056E-5 | 1.228E-4 | 8.252E-3 |
| σ | --- | 3.051E-7 | 2.174E-6 | 5.028E-6 | 2.756E-5 | 2.455E-3 |
| Average+3σ | --- | 8.196E-6 | 1.406E-5 | 6.564E-5 | 2.055E-4 | 1.562E-2 |
| Average-3σ | --- | 6.365E-6 | 1.015E-6 | 3.548E-5 | 4.009E-5 | 8.869E-4 |

## 13.CTR2

**Ta=25°C; If=0.16mA; Vo=0.4V; Vcc=5V**




**CTR2 . (%)**

| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | 10310.290 | 10251.520 | 10293.290 | 10285.250 | 10234.640 | 10284.730 |
| N° 2 | 6203.608 | 5775.991 | 5381.743 | 2790.532 | 1197.842 | Not Measurable* |
| N° 3 | 7019.056 | 6611.587 | 6137.604 | 3185.676 | 1436.956 | Not Measurable* |
| N° 4 | 8500.706 | 7913.781 | 7453.619 | 4197.863 | 2204.603 | Not Measurable* |

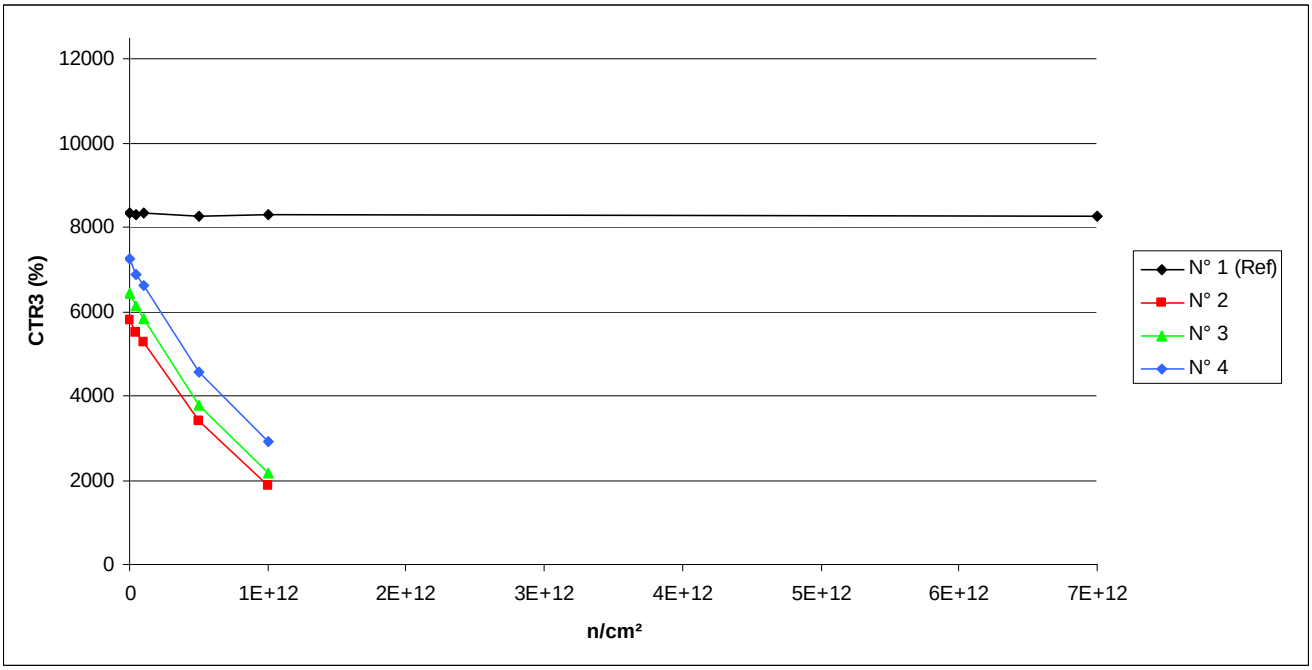
**1/Delta [CTR2]**

| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | --- | 5.560E-7 | 1.602E-7 | 2.361E-7 | 7.169E-7 | 2.410E-7 |
| N° 2 | --- | 1.193E-5 | 2.462E-5 | 1.972E-4 | 6.736E-4 | NaN |
| N° 3 | --- | 8.780E-6 | 2.046E-5 | 1.714E-4 | 5.534E-4 | NaN |
| N° 4 | --- | 8.725E-6 | 1.653E-5 | 1.206E-4 | 3.360E-4 | NaN |
| Average | --- | 9.813E-6 | 2.053E-5 | 1.631E-4 | 5.210E-4 | NaN |
| σ | --- | 1.837E-6 | 4.046E-6 | 3.897E-5 | 1.712E-4 | 0.000E+0 |
| Average+3σ | --- | 1.532E-5 | 3.267E-5 | 2.800E-4 | 1.034E-3 | NaN |
| Average-3σ | --- | 4.302E-6 | 8.396E-6 | 4.615E-5 | 7.535E-6 | NaN |

* The parameter is not measurable with this test condition

## 14.CTR3

**Ta=25°C; If=0.32mA; Vo=0.4V; Vcc=5V**




**CTR3 . (%)**

| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | 8364.4810 | 8318.0280 | 8339.1530 | 8255.1840 | 8322.2500 | 8272.1810 |
| N° 2 | 5796.2690 | 5516.2660 | 5265.0030 | 3393.2660 | 1883.6480 | Not Measurable* |
| N° 3 | 6423.0120 | 6125.1250 | 5839.2030 | 3775.0160 | 2173.9690 | Not Measurable* |
| N° 4 | 7250.6310 | 6880.9660 | 6624.6630 | 4561.7560 | 2928.2480 | Not Measurable* |

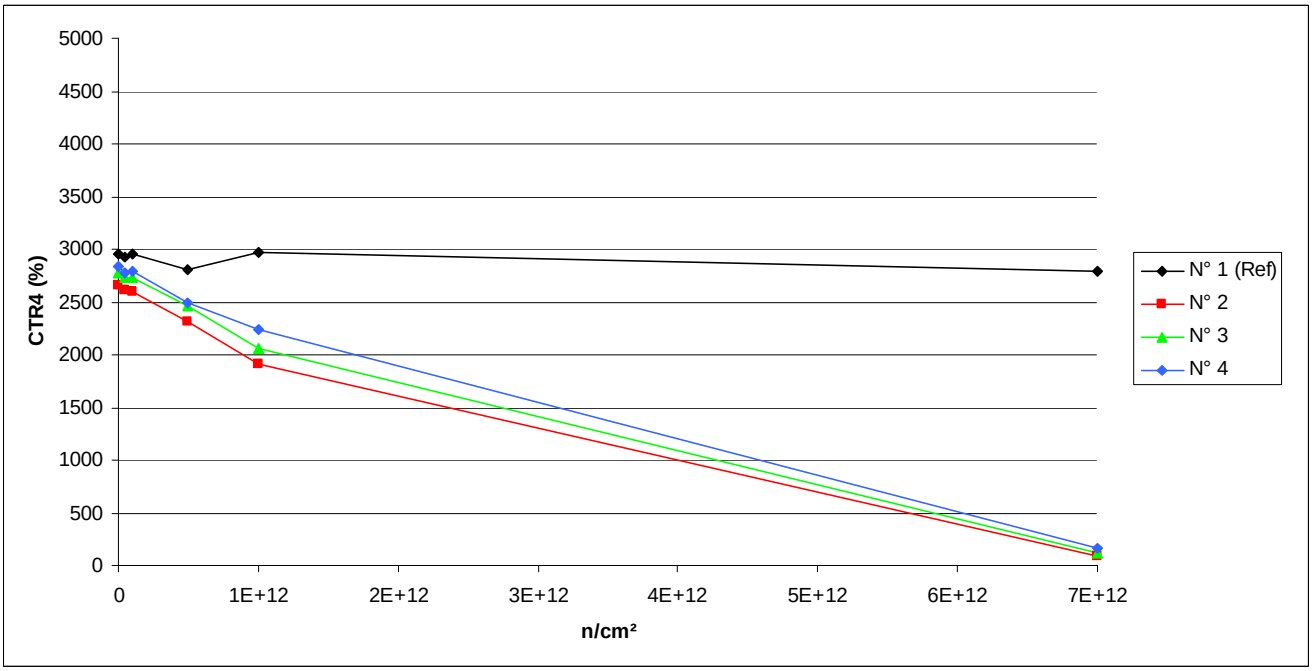
**1/Delta [CTR3]**

| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | --- | 6.677E-7 | 3.631E-7 | 1.583E-6 | 6.067E-7 | 1.334E-6 |
| N° 2 | --- | 8.757E-6 | 1.741E-5 | 1.222E-4 | 3.584E-4 | NaN |
| N° 3 | --- | 7.572E-6 | 1.557E-5 | 1.092E-4 | 3.043E-4 | NaN |
| N° 4 | --- | 7.409E-6 | 1.303E-5 | 8.129E-5 | 2.036E-4 | NaN |
| Average | --- | 7.913E-6 | 1.534E-5 | 1.042E-4 | 2.887E-4 | NaN |
| σ | --- | 7.358E-7 | 2.197E-6 | 2.089E-5 | 7.855E-5 | 0.000E+0 |
| Average+3σ | --- | 1.012E-5 | 2.193E-5 | 1.669E-4 | 5.244E-4 | NaN |
| Average-3σ | --- | 5.705E-6 | 8.743E-6 | 4.155E-5 | 5.309E-5 | NaN |

* The parameter is not measurable with this test condition

## 15.CTR4

**Ta=25°C; If=1.6mA; Vo=0.4V; Vcc=5V**




**CTR4 . (%)**

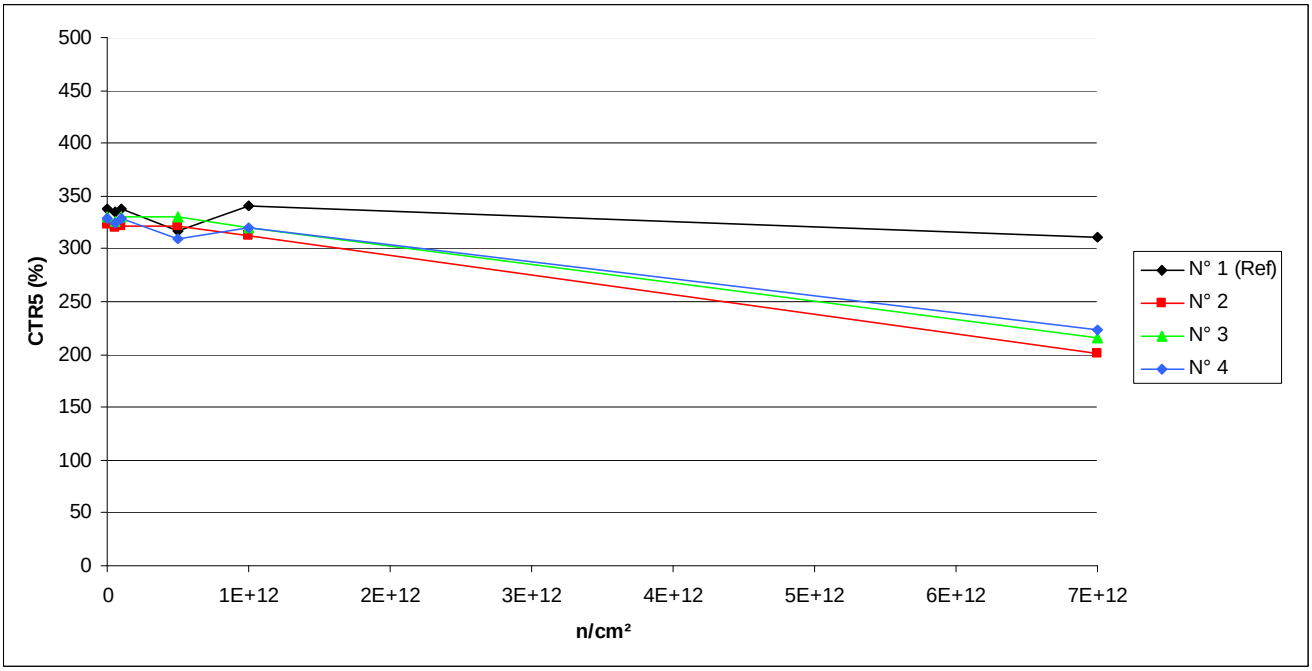
| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | 2957.517 | 2930.407 | 2950.151 | 2799.434 | 2976.405 | 2787.351 |
| N° 2 | 2658.967 | 2609.854 | 2591.062 | 2316.428 | 1909.668 | 92.566 |
| N° 3 | 2779.902 | 2726.323 | 2727.744 | 2460.629 | 2066.381 | 124.331 |
| N° 4 | 2830.221 | 2770.843 | 2786.273 | 2491.270 | 2240.804 | 163.387 |

**1/Delta [CTR4]**

| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | --- | 3.128E-6 | 8.442E-7 | 1.909E-5 | -2.146E-6 | 2.064E-5 |
| N° 2 | --- | 7.077E-6 | 9.856E-6 | 5.561E-5 | 1.476E-4 | 1.043E-2 |
| N° 3 | --- | 7.069E-6 | 6.878E-6 | 4.668E-5 | 1.242E-4 | 7.683E-3 |
| N° 4 | --- | 7.572E-6 | 5.573E-6 | 4.807E-5 | 9.294E-5 | 5.767E-3 |
| Average | --- | 7.239E-6 | 7.436E-6 | 5.012E-5 | 1.216E-4 | 7.959E-3 |
| σ | --- | 2.877E-7 | 2.195E-6 | 4.808E-6 | 2.741E-5 | 2.342E-3 |
| Average+3σ | --- | 8.103E-6 | 1.402E-5 | 6.454E-5 | 2.038E-4 | 1.499E-2 |
| Average-3σ | --- | 6.376E-6 | 8.499E-7 | 3.570E-5 | 3.935E-5 | 9.327E-4 |

## 16.CTR5

**Ta=25°C; If=16mA; Vo=0.4V; Vcc=5V**




**CTR5 . (%)**

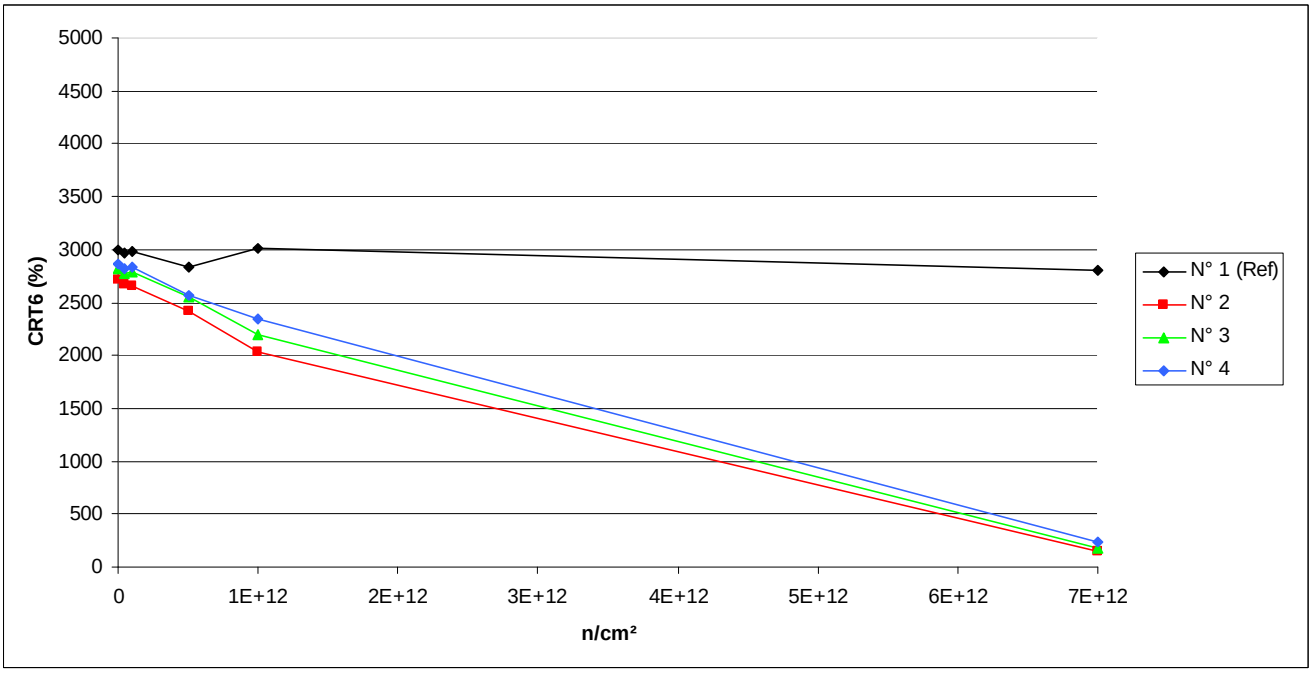
| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | 338.122 | 334.361 | 337.252 | 316.879 | 341.076 | 310.921 |
| N° 2 | 322.818 | 319.581 | 321.090 | 321.957 | 311.926 | 201.032 |
| N° 3 | 330.634 | 326.599 | 330.941 | 330.123 | 320.081 | 216.237 |
| N° 4 | 329.245 | 323.988 | 329.612 | 310.133 | 319.520 | 223.494 |

**1/Delta [CTR5]**

| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | --- | 3.327E-5 | 7.625E-6 | 1.983E-4 | -2.561E-5 | 2.587E-4 |
| N° 2 | --- | 3.137E-5 | 1.667E-5 | 8.281E-6 | 1.082E-4 | 1.877E-3 |
| N° 3 | --- | 3.736E-5 | -2.808E-6 | 4.676E-6 | 9.971E-5 | 1.600E-3 |
| N° 4 | --- | 4.928E-5 | -3.380E-6 | 1.872E-4 | 9.245E-5 | 1.437E-3 |
| Average | --- | 3.934E-5 | 3.493E-6 | 6.671E-5 | 1.001E-4 | 1.638E-3 |
| σ | --- | 9.117E-6 | 1.141E-5 | 1.043E-4 | 7.866E-6 | 2.222E-4 |
| Average+3σ | --- | 6.669E-5 | 3.773E-5 | 3.797E-4 | 1.237E-4 | 2.304E-3 |
| Average-3σ | --- | 1.199E-5 | -3.075E-5 | -2.463E-4 | 7.651E-5 | 9.715E-4 |

## 17.CTR6

**Ta=25°C; If=1.6mA; Vo=0.4V; Vcc=20V**




**CTR6 . (%)**

| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | 2992.349 | 2965.489 | 2986.054 | 2830.450 | 3013.261 | 2809.956 |
| N° 2 | 2710.926 | 2665.528 | 2650.716 | 2417.198 | 2038.976 | 143.349 |
| N° 3 | 2825.770 | 2775.625 | 2782.406 | 2554.515 | 2192.443 | 182.293 |
| N° 4 | 2868.613 | 2811.642 | 2832.061 | 2561.685 | 2349.300 | 236.688 |

**1/Delta [CTR6]**

| | 0.n/cm² | 5E10.n/cm² | 1E11.n/cm² | 5E11.n/cm² | 1E12.n/cm² | 7E12.n/cm² |
|---|---|---|---|---|---|---|
| N° 1 (Ref) | --- | 3.027E-6 | 7.045E-7 | 1.912E-5 | -2.319E-6 | 2.169E-5 |
| N° 2 | --- | 6.283E-6 | 8.379E-6 | 4.482E-5 | 1.216E-4 | 6.607E-3 |
| N° 3 | --- | 6.393E-6 | 5.515E-6 | 3.758E-5 | 1.022E-4 | 5.132E-3 |
| N° 4 | --- | 7.064E-6 | 4.499E-6 | 4.177E-5 | 7.706E-5 | 3.876E-3 |
| Average | --- | 6.580E-6 | 6.131E-6 | 4.139E-5 | 1.003E-4 | 5.205E-3 |
| σ | --- | 4.226E-7 | 2.012E-6 | 3.638E-6 | 2.232E-5 | 1.367E-3 |
| Average+3σ | --- | 7.847E-6 | 1.217E-5 | 5.230E-5 | 1.672E-4 | 9.306E-3 |
| Average-3σ | --- | 5.312E-6 | 9.568E-8 | 3.048E-5 | 3.333E-5 | 1.105E-3 |