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# Impact of Different Climate of European Countries on Working and Power Dissipation of Electronics Circuits

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## Abstract

**Background/Objectives**: Environment temperature play a pivotal role in leakage power dissipation in any Electronic devices. **Methods/Statistical Analysis**: We are performing an experiment by using a FPGA system and we have taken the temperatures of capitals of different countries and corresponding power dissipation of our electronic device under test. **Findings:** When there is increase in temperature due to global warming and other conditions then more supply power is needed due to which there is a depletion in resources. In the other words, if there is increase in temperature then we need to provide more supply power because leakage power is directly proportional to ambient temperature. **Application/ Improvements:** We can think to regulate temperature of environment with cooling system in order to reduce power dissipation of any electronic device in operation.

**Keywords:** European Countries, Impact of Different Climate, Power Dissipation, Working of Electronics Circuits

## 1. Introduction

We have taken temperature of capitals of European countries and have operated our device in a control environment that have similar temperature of capital cities of European countries. The data for analysis was collected on 17 October 2015. We have used FPGA that is Artix-7 to find our results along with circuit of Rom_using_case as shown in Figures 1, 2.

In Synthesis report, Maximum combinational path delay is 0.966ns, total REAL time of Xilinx Synthesis Technology completion is 13.00 secs and total Central Processing Unit time to Xilinx Synthesis Technology completion is 12.41 secs. In power analysis in Artix-7 we can see that total and quiescent and total supply power both are 0.042 whereas dynamic power is 0. Capital of Cyprus, Nicosia has the highest temperature 28 C and needs the highest supply power 0.045 W. Capital of Sweden , Stockholm has lowest temperature 0 C and needs lowest supply power 0.03 W. There is 6.67%, 11.11% decrease in power consumption when we shift our design from Cyprus to Malta, Greece respectively in the countries with highest temperature. There is 33.3%, 31.1% decrease in power consumption when we shift our design from Sweden to Finland, Norway respectively in countries with lowest temperature.

## 2. Related Work

Change in temperature around the globe is a current main issue to be worried about and due to which many researchers and scientists have already started working upon how change in temperature can affect our lifestyle and how it will effect presence of basic needs like electricity in coming time[3,4,8]. We can see in references some examples of the works already done in this field. In 2014, using LVCMOS25 a design was published to measure power dissipation in which when Vedic multiplier design is implemented on 40 nm technology based FPGA in place of 90 nm FPGA

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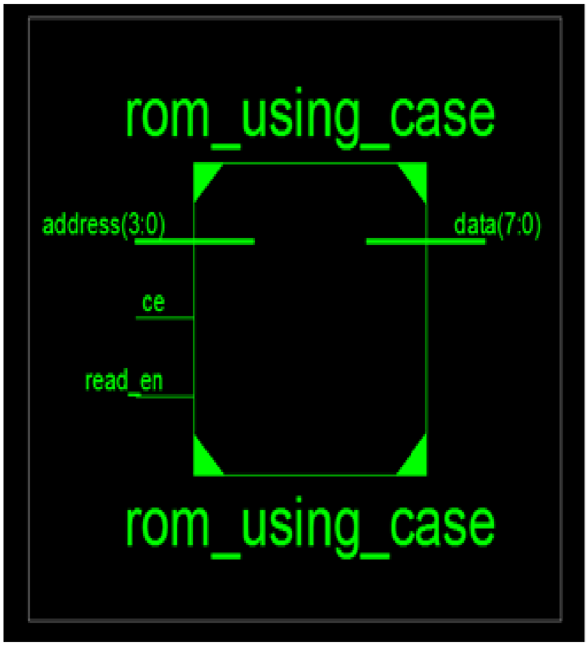


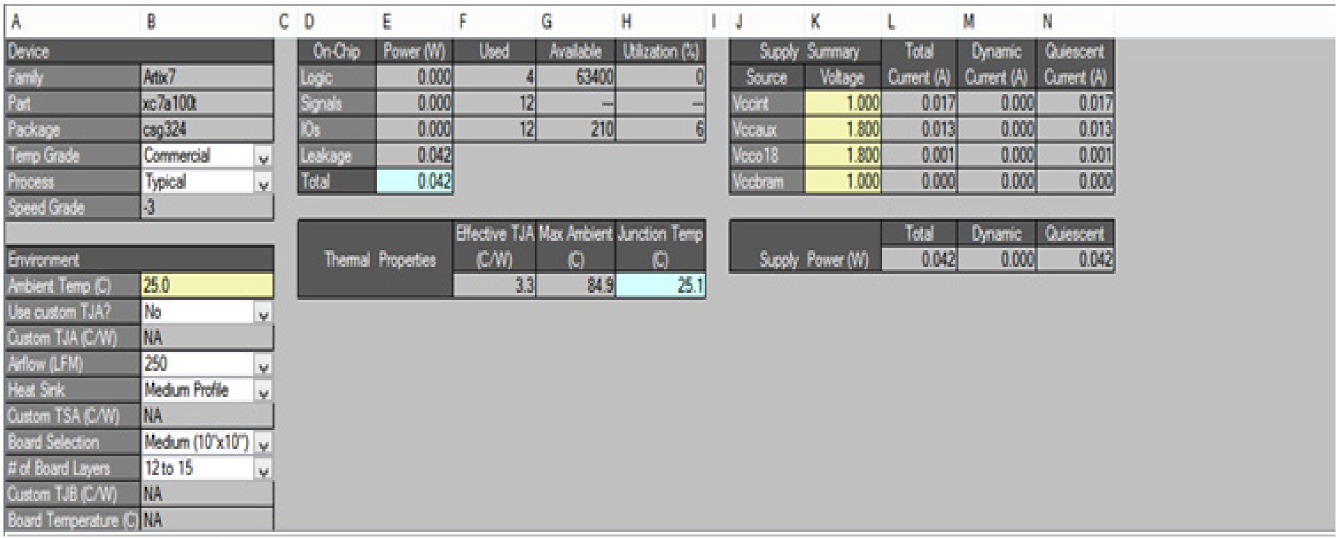
**Figure 1.** RTL schematic of FPGA.

design, there is 87.72% saving in power consumption of Vedic multiplier when temperature is constant 20°C[1] Similarly using Virtex-6 FPGA and Verilog HDL, 59.32% to 72.96% reduction is achieved when temperature varies from 288.15 K to 348.15 K and airflow is 250 LFM. LFM is a unit of airflow. It stands for Linear Feet per Minute. In similar cases, reduction is in range of 59.30% to 72.97%, when temperature varies from 288.15 K to 348.15K and airflow is 500 LFM was achieved[2]. Again LVCMOS based energy efficient UART was published, which concluded that there occurs 97.65%, 75.14%, 7.19%, 17.37% and 71.12% decrease in clock power, I/O power, leakage power, Junction Temperature (JT), total power respectively[5]. LVCMOS has been used at a higher rate in most of the already done works. There is 93.03%, 66.58%, and 33.55% decrease in JT with LVCMOS18, when they reduce ambient temperature from 348.15 K to 278.15 K, 298.15 K and 323.15 K respectively. There is 64.45%, 59.71% and 44.07% reduction in leakage power using LVCMOS25, when they scale down ambient temperature from 348.15 K to 278.15 K, 298.15 K and 323.15 K respectively[6]. Author use the HSTL family and I2C family on 45 nm technology based FPGA. Then during Leakage power analysis, they are getting 9.09% reduction with HSTL and 57.89% reduction with I2C[7]. Low power design is also possible with help of Xilinx 7.1i when target device is Spartan 3 – xc3s400 as published in research paper[9].

## 3. Results

Table 1 depicts the corresponding supply power with respect to different temperature conditions in European countries. We have only taken the temperature of capital of every country and have calculated the supply power using our device.

We have taken the temperature and power conditions of top 10 hottest regions so that we can see graphically that how power changes with respect to temperature as shown in Table 2.



| Device | |
|---|---|
| Family | Artix7 |
| Part | xc7a100t |
| Package | csg324 |
| Temp Grade | Commercial |
| Process | Typical |
| Speed Grade | -3 |

| Environment | |
|---|---|
| Ambient Temp (C) | 25.0 |
| Use custom TJA? | No |
| Custom TJA (C/W) | NA |
| Airflow (LFM) | 250 |
| Heat Sink | Medium Profile |
| Custom TSA (C/W) | NA |
| Board Selection | Medium (10"x10") |
| # of Board Layers | 12 to 15 |
| Custom TJB (C/W) | NA |
| Board Temperature (C) | NA |

| On-Chip | Power (W) | Used | Available | Utilization (%) |
|---|---|---|---|---|
| Logic | 0.000 | 4 | 63400 | 0 |
| Signals | 0.000 | 12 | -- | -- |
| IOs | 0.000 | 12 | 210 | 6 |
| Leakage | 0.042 | | | |
| Total | 0.042 | | | |

| Thermal Properties | Effective TJA (C/W) | Max Ambient (C) | Junction Temp (C) |
|---|---|---|---|
| | 3.3 | 84.9 | 25.1 |

| Supply Summary | | Total | Dynamic | Quiescent |
|---|---|---|---|---|
| Source | Voltage | Current (A) | Current (A) | Current (A) |
| Vccint | 1.000 | 0.017 | 0.000 | 0.017 |
| Vccaux | 1.800 | 0.013 | 0.000 | 0.013 |
| Vcco18 | 1.800 | 0.001 | 0.000 | 0.001 |
| Vccbram | 1.000 | 0.000 | 0.000 | 0.000 |

| | Total | Dynamic | Quiescent |
|---|---|---|---|
| Supply Power (W) | 0.042 | 0.000 | 0.042 |

**Figure 2.** Power analysis.

**Table 1.** Complete power and thermal analysis

| Europe | | | |
|---|---|---|---|
| **Countries** | **Capital** | **Temperature** | **Supply Power** |
| Albania | Tirana | 18 C | 0.038 |
| Andorra | Andorra La Vella | 10 C | 0.034 |
| Armenia | Yerevan | 16 C | 0.037 |
| Austria | Vienna | 8 C | 0.033 |
| Azerbaijan | Baku | 13 C | 0.035 |
| Belarus | Minsk | 7 C | 0.033 |
| Belgium | Brussels | 7 C | 0.033 |
| Bosnia and Herzegovina | Sarajevo | 9 C | 0.034 |
| Bulgaria | Sofia | 14 C | 0.036 |
| Croatia | Zagreb | 9 C | 0.034 |
| Cyprus | Nicosia | 28 C | 0.045 |
| Czech Republic | Prague | 8C | 0.033 |
| Denmark | Copenhagen | 10 C | 0.034 |
| Estonia | Tallinn | 2 C | 0.031 |
| Finland | Helsinki | 0 C | 0.03 |
| France | Paris | 9 C | 0.034 |
| Georgia | Tbilisi | 11 C | 0.034 |
| Germany | Berlin | 8 C | 0.033 |
| Greece | Athens | 21 C | 0.04 |
| Hungary | Budapest | 12 C | 0.035 |
| Iceland | Reykjavik | 8 C | 0.033 |
| Ireland | Dublin | 10 C | 0.034 |
| Italy | Rome | 15 C | 0.036 |
| Kazakhstan | Astana | 8 C | 0.033 |
| Kosovo | Pristina | 14 C | 0.036 |
| Latvia | Riga | 7 C | 0.033 |
| Liechtenstein | Vaduz | 6 C | 0.032 |
| Lithuania | Vilnius | 7 C | 0.033 |
| Luxembourg | Luxembourg | 5 C | 0.032 |
| Macedonia | Skopje | 14 C | 0.036 |
| Malta | Valletta | 24 C | 0.042 |
| Moldova | Chisinau | 7 C | 0.033 |
| Monaco | Monaco | 12 C | 0.035 |
| Montenegro | Podgorica | 17 C | 0.037 |
| Netherlands | Amsterdam | 9 C | 0.034 |
| Norway | Oslo | 1 C | 0.031 |
| Poland | Warsaw | 9 C | 0.034 |
| Portugal | Lisbon | 20 C | 0.039 |
| Romania | Bucharest | 13 C | 0.035 |
| Russia | Moscow | 4 C | 0.032 |
| San Marino | San Marino | 14 C | 0.036 |
| Serbia | Belgrade | 15 C | 0.036 |
| Slovakia | Bratislava | 9 C | 0.034 |
| Slovenia | Ljubljana | 5 C | 0.032 |
| Spain | Madrid | 13 C | 0.035 |
| Sweden | Stockholm | 0 C | 0.030 |
| Switzerland | Bern | 5 C | 0.032 |
| Turkey | Ankara | 17 C | 0.037 |
| Ukraine | Kyiv | 8 C | 0.033 |
| United Kingdom | London | 11 C | 0.034 |
| Vatican City (Holy See) | Vatican City | 15 C | 0.036 |

In Figure 3, Temperature is given in degree Celsius. We can see there is not much difference in temperature of top ten capitals of different countries in Europe. Graph is in descending order.

With change in temperature there is a slight change in power dissipation. Graph is in descending order of temperature as shown in Figure 4. In Table 3, we can see that as temperature increases supply power also increases.

Temperature is given in degree celsius and temperature graph is in ascending order. And we can see that there is a difference in temperature in top ten coldest countries in Europe as shown in Figure 5.

We can see that with increase in temperature power dissipation increases. And the graph is in ascending order as shown in Figure 6.

**Table 2.** Top 10 hottest regions of Europe

| Europe | | | |
|---|---|---|---|
| **Countries** | **Capitals** | **Temp** | **Supply Power** |
| Cyprus | Nicosia | 28 C | 0.045 |
| Malta | Valletta | 24 C | 0.042 |
| Greece | Athens | 21 C | 0.04 |
| Portugal | Lisbon | 20 C | 0.039 |
| Albania | Tirana | 18 C | 0.038 |
| Turkey | Ankara | 17 C | 0.037 |
| Montenegro | Podgorica | 17 C | 0.037 |
| Armenia | Yerevan | 16 C | 0.037 |
| Serbia | Belgrade | 15 C | 0.036 |
| Vatican City (Holy See) | Vatican City | 15 C | 0.036 |

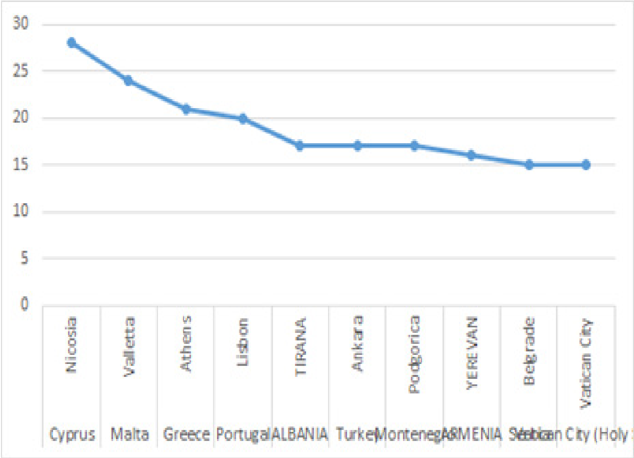


**Figure 3.** Temperature graph (for top 10 hottest regions).

## 4. Conclusion

We can see in the above given table that with increase in temperature supply power needed increases. And these are the adverse effects that we have already started facing due to environmental issues like ozone layer depletion due to global warming .With more power needed there will be more consumption of energy and hence our sources will start depleting at a higher rate. There is 21% reduction in power dissipation if we shift our device from hottest region of Europe to the coldest region of Europe.

**Table 3.** (Top ten coldest regions of Europe)

| Europe | | | |
|---|---|---|---|
| **Countries** | **Capitals** | **Temp** | **Supply Power** |
| Sweden | Stockholm | 0 C | 0.03 |
| Finland | Helsinki | 0 C | 0.03 |
| Norway | Oslo | 1 C | 0.031 |
| Estonia | Tallinn | 2 C | 0.031 |
| Russia | Moscow | 4 C | 0.032 |
| Luxembourg | Luxembourg | 5 C | 0.032 |
| Slovenia | Ljubljana | 5 C | 0.032 |
| Switzerland | Bern | 5 C | 0.032 |
| Liechtenstein | Vaduz | 6 C | 0.032 |
| Latvia | Riga | 7 C | 0.033 |

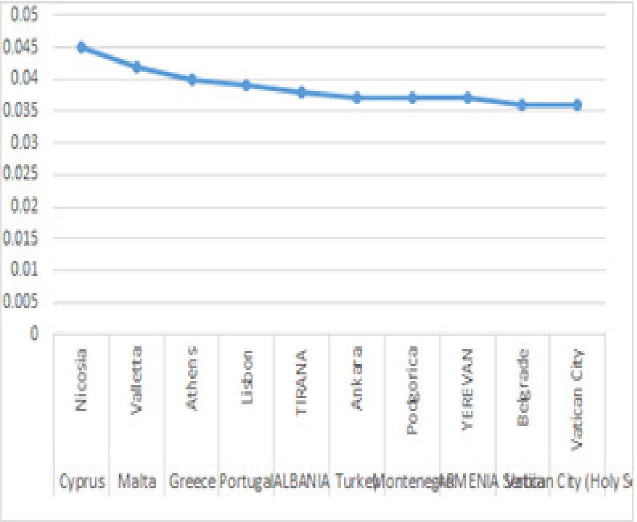


**Figure 4.** Power graph (for Top 10 hottest regions).

## 5. Future Work

This was the analysis of European countries and their capitals. There is a less variation as temperature is less but next we will use this device in Asian countries which have a very high temperature and will see the difference.

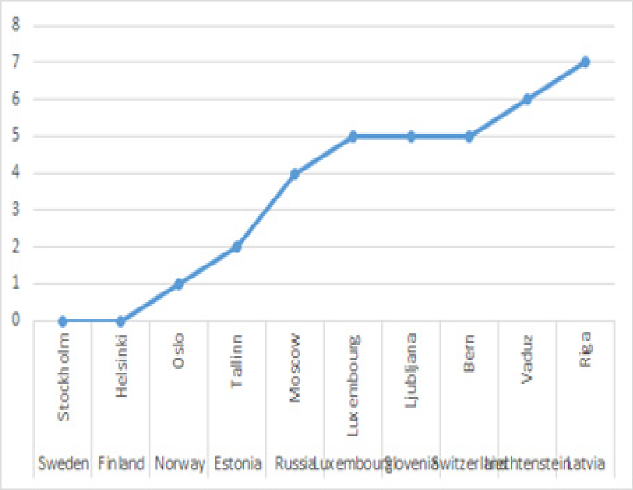


**Figure 5.** Temperature graph (top 10 coldest regions).

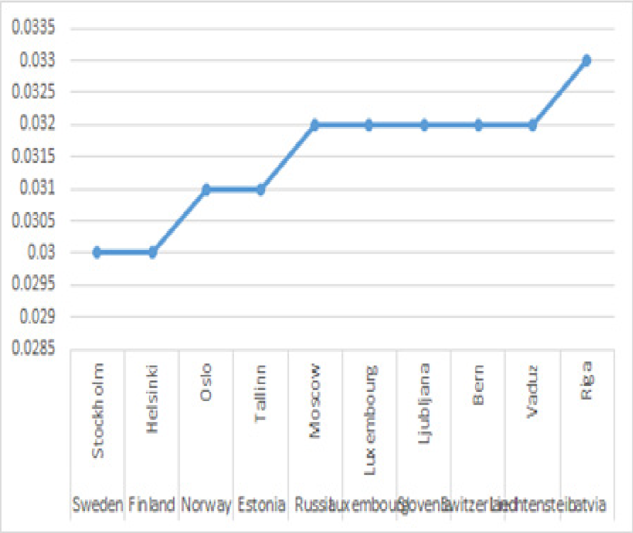


**Figure 6.** Power graph (top 10 coldest regions).

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