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Security of Hardware Architecture, Design and Performance of Low Drop-Out Voltage Regulator LDO to Protect Power Mobile Applications

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Abstract: His paper present a new Low Drop-Out Voltage Regulator (LDO) and highlight the topologies and the advantages of the LDO for hardware security protection of Wireless Sensor Networks (WSNs), this integrated circuits are considered as an ideal solution in low power System on-chip applications (SOC) for their compact sizes and low cost. The advancement in low-power design makes it possible that ubiquitous device can be powered by low-power energy source such as ambient energy or small size batteries. In many well supplied devices the problem related to power is essentially related to cost. However for low-powered devices the problem of power is not only economics but also becomes very essential in terms of functionality. Due to the usual very small amount of energy or unstable energy available the way the engineer manages power becomes a key point in this area. Therefore, another focus of this dissertation is to try finding ways to improve the security of power management problems. Complementary metal oxide-semiconductor (CMOS) has become the predominant technology in integrated circuit design due to its high density, power savings and low manufacturing costs. The whole integrated circuit industry will still continue to benefit from the geometric downsizing that comes with every new generation of semiconductor manufacturing processes. Therefore, only several CMOS analog integrated circuit design techniques are proposed for low-powered ubiquitous device in this dissertation. This paper reviews the basics of LDO regulators and discusses the technology advances in the latest generation of LDOs that make them the preferred solution for many points of load power requirements. The paper will also introduce characteristics of CMOS LDO regulators and discuss their unique benefits in portable electronics applications. these new device offer a real advantages for the power management security of new applications mobile. Power efficiency and some practical issues for the CMOS implementation of these LDO structures are discussed.

Keywords: Security, LDO, WSNs, Low Power SOC, Integrated Circuit, CMOS Low-Power

1. Introduction

In the modern technology, the security of hardware power management has become an increasingly important design consideration for numerous products, especially those relying on battery power. Complicating the power management situation, as more features get integrated into hardware products, the number of required voltage supplies increases. between 3.6V-5.5V lithium-ion battery, a highly integrated product such as a smart phone, WSN can require more than ten different voltages such us Global positioning system, Audio Power amplifier [13-22], Memory, Baseband and DSP core, Applications (picture, music and video) processing, Low voltage wireless Sensor Networks and LAN, Display back light drivers, Photo flash charger To handle all of these voltages [23-40], one of the main contributions also is an elaborate power simulation with any level of accuracy which can still be balanced with complexity.

The simulated power consumption in System On Chip (SOC) can depend on the supply voltage, for example, for a nearly empty battery when supplying a microcontroller that operates at very low voltages. In WSN nodes, components

with different supply voltages are combined resulting in the need for LDOs [1-6] and DC/DC converters [7-12]. The Power Aware Wireless Sensor framework PAWiS allows modeling this hierarchical supply structure as well as the efficiency factor of the converters.

The PAWiS framework is based on the OMNeT++ discrete event simulator and the C++ programming language. Figure 1 depicts the structure of the framework from the users view. The model programmer mostly interacts with the framework and C++. Additionally basic knowledge of concepts of OMNeT is required to comprehend the simulation process.

The node compositions as well as the network layout are specified in configuration files. Completed models can be compiled (optionally with a GUI based on Tcl/Tk) to an executable simulator. With the optional GUI the workflow and communication of the model can be observed during the simulation. Additionally a log file with power and timing profile is generated for post-simulation analysis.

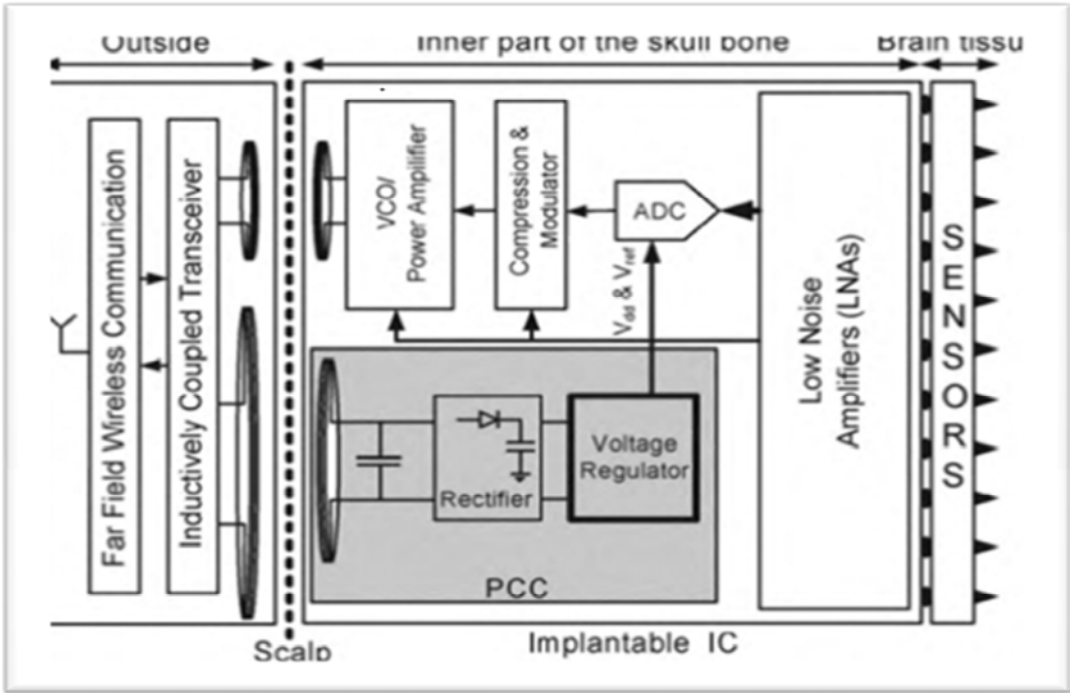

Figure 1. *Regulator integrated in the SOC.*

This paper reviews the most important element in the hardware blocs, LDO, dedicated to protect and provide a secure and stable power alimentation and discusses the technology advances in the latest generation of LDOs that make them the preferred solution for many points of load power requirements. The paper will also introduce the characteristics of CMOS LDO regulators and discuss their unique benefits in mobile electronics applications.

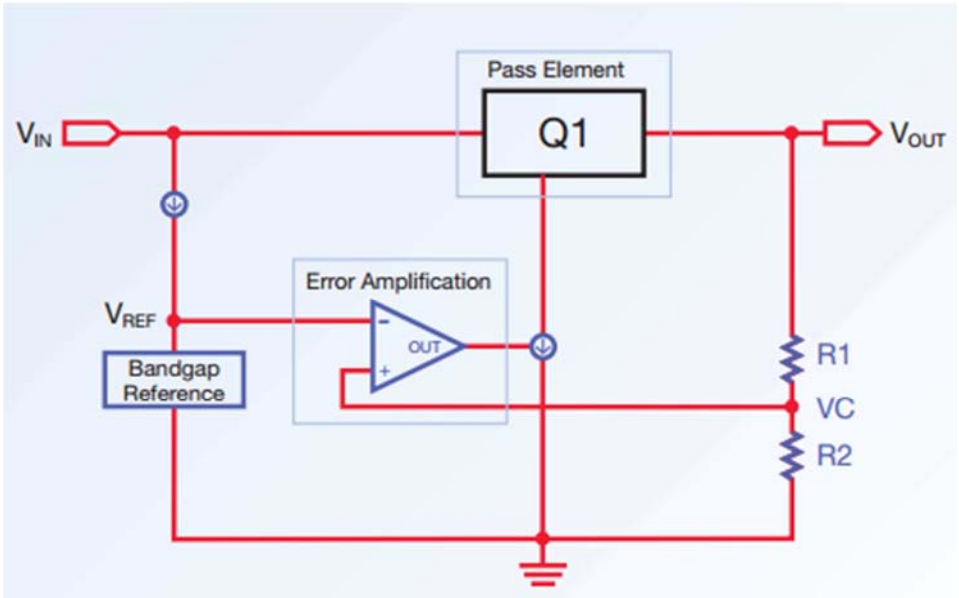

Figure 2. *The Q1 in LDO can be a Darlington pair, or an N-channel or P-channel MOSFET.*

2. Pmos-Type Regulators: Studies and Simulations

An MOS-type LDO regulator is shown in figure 2. It is composed of three main parts:

a. Power transistor (Pass Element)
b. Error amplification
c. Resistance reaction (R1, R2).

3. Output Voltage

The power transistor is used as a current source controlled by the error amplifier. V0 at the output of the divider bridge (R1, R2) is compared with the reference voltage Vref. The output voltage is given by:

$$Vo = Vref\,(1+\frac{R1}{R2}) \tag{1}$$

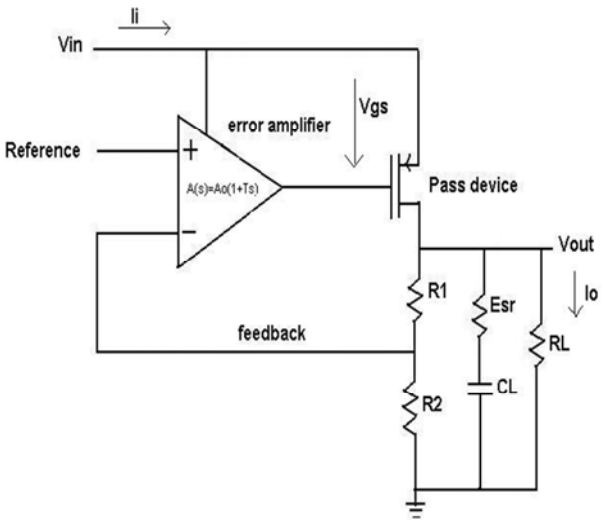

Figure 3. *Diagram of a Linear Regulator LDO.*

3. Effeciency

The efficiency of a regulator is defined by the equation:

$$Efficiency = \frac{Vo.Io}{Vi.(Io+Iq)} * 100 \tag{2}$$

Where Iq is the quiescent current of the regulator.
When Iq is negligible before equation (2) becomes:

$$Efficiency = \frac{Vo}{Vi} * 100 = \frac{Vds+Vi}{Vi} * 100 = \left(\frac{Vds}{Vi}+1\right) * 100 \tag{3}$$

Where Vds is the drain-source voltage of the power transistor. The efficiency of an LDO controller depends on the voltage across the power transistor.

4. DC Load-Regulation

The Load-Regulation DC (DC-LOR) is the difference between the maximum and the minimum of the output voltage VOUT, when ILOAD varies from 0mA to 50mA.

In other words, it defines the output impedance of the controller:

$$Zout = \frac{\Delta VOUT}{\Delta ILOAD} \tag{4}$$

The DC Load regulation represents the ability of the system to adjust the variation of the output voltage. It is given by:

$$\frac{\Delta Vo}{\Delta Io} = \frac{1}{gmp.Ao} * \frac{R1+R2}{R2} \tag{5}$$

Consequently, a small change in the output current (FIG. 6) corresponds to it a voltage variation of the power transistor MP:

$$\Delta V_{gsMP} = \frac{\Delta Io}{gmp} \tag{6}$$

Which corresponds to the variation of the input of the amplifier:

$$\Delta V_A = \frac{\Delta V_{gsMP}}{A_0} = \frac{\Delta I_0}{g_{mp}A_0} \tag{7}$$

Furthermore:

$$\Delta V_A * \frac{R1+R2}{R2} = \frac{\Delta I_0}{g_{mp}.A_0} * \frac{R1+R2}{R2} \tag{8}$$

Thus we can deduce the DC-LOR:

$$\frac{\Delta V_0}{\Delta I_0} = \frac{1}{g_{mp}.A_0} * \frac{R1+R2}{R2} \tag{9}$$

Or:

a. g_{mp} is the DC transconductance of the power transistor
b. A_o the DC gain of the error amplifier.

Note that the DC-LOR is limited by the open-loop gain.

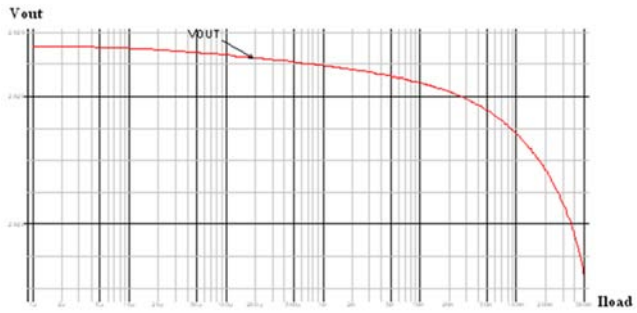

Figure 4. *Vout vs Iload.*

5. DC Line-Regulation

The DC Line-Regulation (DC-LIR) is defined as the difference between the maximum and the minimum of the output voltage VOUT, when VIN varies from 3.0V to 5.5V

The typical value of VOUT (VOUT_REG) is defined when VIN = 3.6V.

The dropout at 100mV is the value of the voltage difference (VIN-VOUT) when VIN = VOUT_REG - 100mV, defined for ILOAD = 50mA

The DC-LIR is the ability of the system to maintain the output voltage stable. This DC-LIR is given by:

$$line\,\mathrm{Re}\,gulation = \frac{\Delta Vo}{\Delta Vi} = \frac{\Delta Vo}{\Delta Io}.\frac{\Delta Io}{\Delta Vi} \quad (10)$$

After development, we obtain:

$$line\,\mathrm{Re}\,gulation = \frac{1}{g_{mp}.Ao} * \frac{R1+R2}{R2} * \frac{1}{(Rds+R_L)} \quad (11)$$

Where Rds is the equivalent resistance of the power transistor.

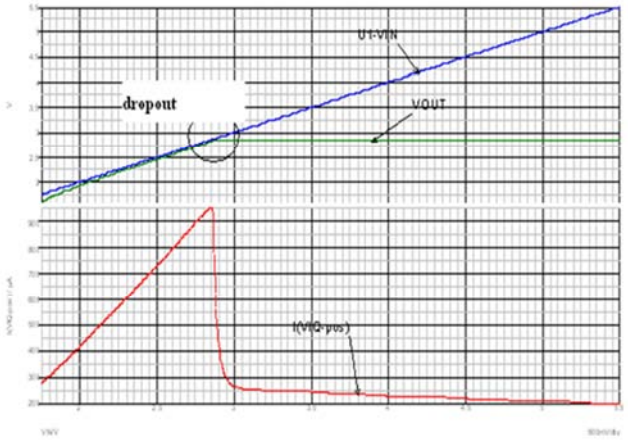

Figure 5. *Analyse DC Vout vs Vin.*

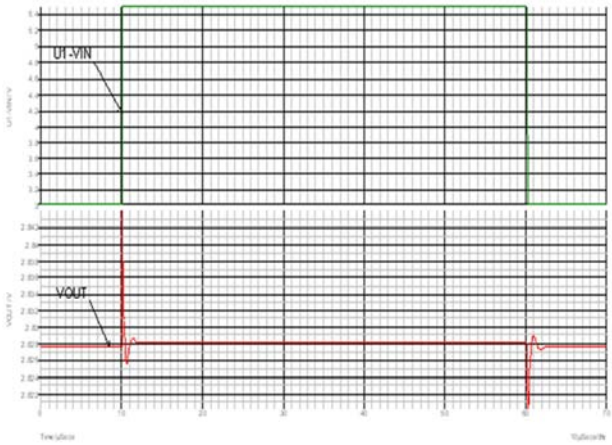

Figure 6. *Transient variation of Output voltage as a function of the input voltage.*

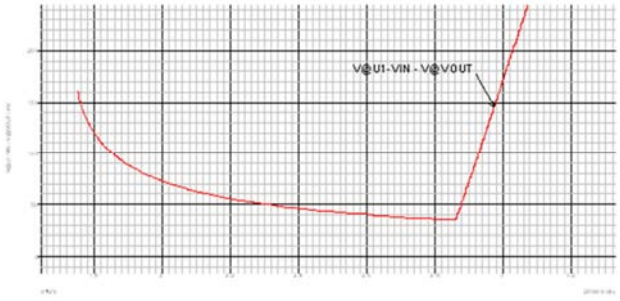

Figure 7. *Zoom of output voltage.*

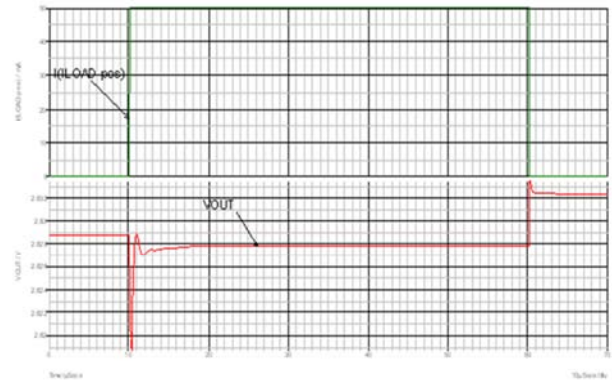

Figure 8. *Transient variation of the output voltage as a function of the load current of the LDO controller.*

6. AC Line-Regulation

This simulation consists in varying in time (transient simulation) VIN, and measuring the behavior in time of VOUT.

The AC-LIR dynamic line control is the peak-to-peak difference of Vout

The number of bounce in the curve is directly related to the stability of the ldo

7. AC Load-Regulation

The AC-load regulation AC-LOR is the peak-to-peak difference of Vout.

This simulation consists in varying in time (transient simulation) ILOAD and measuring the behavior in time of VOUT. With fixed VIN.

8. PSRR

The PSRR is the frequency gain between Vin (f) and Vout (f). We will compute this PSRR of the regulator given in figure 9.

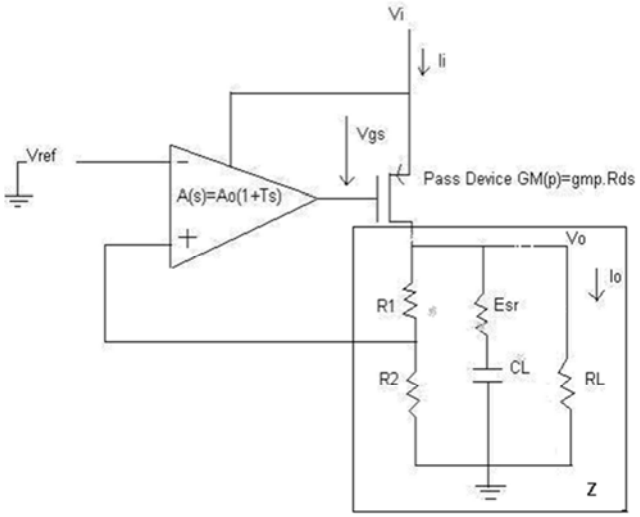

Figure 9. *Régulateur LDO.*

We have:

$$Vo(s) = -gmZVgs(s) \tag{12}$$

with

$$Z = R_L // (R1+R2) // \left(E_{SR} + \frac{1}{C_L S} \right) = \frac{Rs\left(1+E_{SR}C_L S\right)}{1+(E_{SR}+Rs)C_L S}$$

(Rs =RL//(R1+R2))

$$Vo(s) = -g_m Z \left(\frac{A(s)Vo(s)R2}{R1+R2} - V_I(s) \right) \tag{13}$$

$$PSRR(s) = \frac{Vo(s)}{V_I(s)} = \frac{g_m Z}{1+g_m Z \frac{R2}{R1+R2} A(s)} \tag{14}$$

Or A (s) and the gain of the error amplifier given by $A(s) = \frac{Ao}{1+Ts}$

Particular case:

To simplify the calculations we will take ESR = 0.

By developing equation (14) we obtain:

$$PSRR(s) = \frac{gmRS(R1+R2)(1+Ts)}{R1+R2+g_m RsR2Ao + s((R1+R2)T + RsCL(R1+R2)^{S2} RsC_L T(R1+R2)} \tag{15}$$

The equation shows that the system has a zero and two real or complex poles depending on the behavior of several parameters:

if gmRsR2Ao>> R1+R2 et RsCL>> T, equation (14) becom:

$$PSRR = \frac{gmRs(R1+R2)(1+Ts)}{g_m RsR2Ao + sRsC_L(R1+R2) +^{S2} RsC_L T(R1+R2)} \tag{16}$$

$$PSRR = \frac{(R1+R2)(1+Ts)}{R2Ao + \left(1 + s\frac{C_L(R1+R2)}{gmR2Ao} +^{S2} \frac{C_L T(R1+R2)}{gmR2Ao}\right)} \tag{17}$$

The equation 17 the forme of:

$$PSRR(s) = \frac{(R1+R2)(1+Ts)}{R2Ao} \frac{1}{1+s\frac{1}{WoQ} +^{S2} \frac{1}{Wo2}} \tag{18}$$

with:

$$Wo = \sqrt{\frac{gmR2Ao}{(R1+R2)CLT}}$$

$$Q = \sqrt{\frac{gmR2AoT}{(R1+R2)CL}}$$

The equation: $\frac{1}{1+s\frac{1}{WoQ} +^{S2} \frac{1}{Wo2}}$ Shows the existence of two real or imaginary poles:

Real Poles:

Got it!

$$Q < \frac{1}{2} \Leftrightarrow \frac{gm}{CL} < \frac{R1+R2}{R2} * \frac{1}{4AoT} \Leftrightarrow \frac{1}{T} > \frac{4AoR2}{R1+R2} \cdot \frac{gm}{CL} \tag{19}$$

In this case the PSRR become:

$$PSSR(s) = \frac{(R1+R2)(1+Ts)}{R2Ao} \bullet \frac{1}{(1+Ts)\left(1+\frac{(R1+R2)C_L}{gmR2Ao}s\right)} = \frac{R1+R2}{R2Ao} \bullet \frac{1}{1+\frac{(R1+R2)C_L}{gmR2Ao}s} \tag{20}$$

Real or complex pole:

when $Q > \frac{1}{2} \Leftrightarrow \frac{gm}{CL} > \frac{R1+R2}{R2} * \frac{1}{4AoT} \Leftrightarrow \frac{1}{T} < \frac{4AoR2}{R1+R2} \cdot \frac{gm}{CL}$

In this condition: $\frac{1}{1+s\frac{1}{WoQ} +^{S2} \frac{1}{Wo2}}$

Has a peak of amplitude at the frequency:

$$fp = \sqrt{\frac{1}{8^{\Pi 2\,T2}}\left(\frac{2Ao}{R1+R2}\right)\cdot\frac{gm}{CL}\cdot T-1} \qquad (21)$$

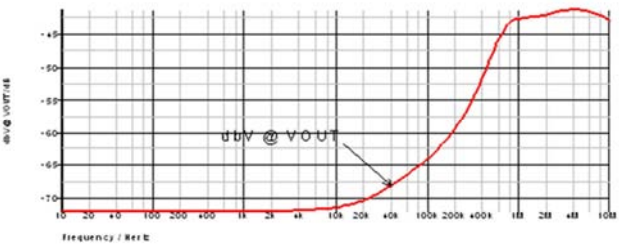

Figure 10. *Le PSRR of LDO.*

9. Conclusion and Perspectives

In this paper we proposed a new structure corresponding to a pmos type ldo. By this work, we improved the stability and security of our regulator by adding a doublet (zero, pole).

The expression relating to the different poles was elaborated. The latter have shown the dependence of the stability of the load current.

The simulations studied thus confirmed this result. in order to remedy this problem, it is necessary to try to design a new structure whose stability is independent of the load current.

References

[1] Krit Salahddine and Hassan Qjidaa "Ultra-low quiescent regulator Including precise reference and the Power-On-Reset circuit" Conference IEEE Sciences Electroniques, Technologies de l'Information et des Telecommunications (SETIT 05) Tunisia.

[2] Krit Salahddine and Hassan Qjidaa "Standard CMOS Low drop-out regulator with new dynamic Compensation" International Conf. on Modeling and Simulation, ICMS-2005 Marrakech.

[3] Krit Salahddine and Hassan Qjidaa "Low drop-out regulator with new dynamic Compensation" (WOTIC'05) Workshop sur les Technologies de l'Information et de la communication Kénitra, Maroc, 24- 25 juin 2005

[4] Krit Salahddine and Hassan Qjidaa "Standard CMOS Low-Noise High-Psrr Low Drop-out Regulator with new dynamic compensation" (ICTIS07) Information and Communication Technologies International Symposium Moroccan city of Fez in March 25-27, 2007.

[5] Krit Salah-ddine, Zared Kamal, Qjidaa Hassan and Zouak Mohcine, "A 100 mA Low Voltage Linear Regulators for Systems on Chip Applications Using 0.18 µm CMOS Technology" IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 1, No 3, January 2012.

[6] Salahddine Krit., Hassan Qjidaa., Imad El Affar, Yafrah Khadija, Ziani Messghati, and Yassir El-Ghzizal "A novel CMOS charge-pump circuit with current mode control 110 mA at 2.7 V for telecommunication systems » JOS Journal of Semiconductors Vol. 31, No. 4 April 2010.

[7] Benlafkih Abdessamad, Krit Salah-ddine and Chafik Elidrissi Mohamed " Designing a High Efficiency Pulse Width Modulation Step-Down DC/DC Converter for Mobile Phone Applications" IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 5, September 2012.

[8] Benlafkih Abdessamad, Krit Salah-ddine and Chafik Elidrissi Mohamed " A Comparative study of Analog and digital Controller On DC/DC Buck-Boost Converter Four Switch for Mobile Device Applications" IJCSI International Journal of Computer Science Issues, Vol. 10, Issue 1, January 2013.

[9] Benlafkih Abdessamad, Krit Salah-ddine and Chafik Elidrissi Mohamed " Low voltage,Comparative study of PID Controller and Analog controller on DC/DC buck Converter for mobile devices applications" International Conference on Information Systems and Technologies "ICIST'13", Tangie, Morocoo. March, 22 - 24, 2013

[10] Benlafkih Abdessamad, Krit Salah-ddine and Chafik Elidrissi Mohamed " Design and Modeling of DC/ DC Boost Converter for Mobile Device Applications "International Journal of Science and Technology Volume 2 No. 5, May, 2013.

[11] Kaoutar Bendaoud, Salah-ddine Krit, Jalal Laassiri, Lahoucine El maimouni "Design and simulation DC-DC Power Converters Buck and Boost for Mobile Applications using Matlab/Simulink" InternationalConference on Engineering & Mis 2016 (ICEMIS2016 submission 48), 22-24September, Agadir 2016, Morocco.

[12] Salah-ddine Krit, Jalal Laassiri, Kaoutar Bendaoud, Lahoucine El maimouni "Designing and Simulation of High Efficiency "DC-DC Buck Converter Using the Tools SIMetrix and Cadence" The 24th World Congress onEngineering (WCE 2016_pp273-277) ICEEE_78, ISBN: 978-988-19253-0-5, London, U.K., 29 June - 1 July, 2016.

[13] Krit Salahddine and Hassan Qjidaa "Class D Audio Amplifier Design Theory and Design Implementation for Portable Applications" (ISCIII'07) 3rd International Symposium on Computational Intelligence and Intelligent Informatics March 28–30, 2007, pp. 239-245. Agadir Morocco.

[14] Krit Salahddine and Hassan Qjidaa "Class D Audio Amplifier Design Theory and Design implementation for portable applications" (ICICIC'07) The Second International Conference on Innovative Computing, Information and Control September 5-7, 2007 / Kumamoto City International Center, Kumamoto, Japan

[15] Krit Salahddine and Hassan Qjidaa "Class D Audio Amplifier with trim-able Ramp Generator Design Theory and Design implementation for portable applications" presented at Design and technology of Integrated Systems, (DTIS 2007). The 2007 IEEE International Symposium on DTIS Rabat Morocco, pp 208-212.

[16] Krit Salahddine and Hassan Qjidaa "Class D Audio Amplifier With Trim-able Ramp Generator Design Theory and Design Implementation For Portable Applications" International Meeting on Materials for Electronic Applications (IMMEA-2007) April 30th to Mai 2nd 2007 at Marrakech

[17] Krit Salahddine and Hassan Qjidaa "Audio Power Amplifier Solutions for New Wireless Phones" IJCSNS International Journal of Computer Science and Network Security, VOL.9 No.1, January 2009

[18] Krit Salahddine and Hassan Qjidaa "Design and Analysis of a Class D Amplifier with high-efficiency and low-distortion" MJCM Moroccan Journal of Condensed Matter, VOL.9 No.1, ref. C22-05-08 April 2009.

[19] Salah-ddine Krit, Jalal Laassiri and Said El Hajji “Comparison and Realization of Audio Amplifiers Using CMOS Technology (Class-A, Class-B, Class-AB and Class-D)” The 2nd International Conference on Multimedia Computing and Systems (ICMCS'11) April 7-9 2011, Ouarzazate, Morocco.

[20] Salah-ddine Krit, Jalal Laassiri and Said El Hajji, “Design and Analysis of a Class D Amplifier with high-efficiency and low-distortion” The 2010 International Conference of Wireless Networks,London, U.K., 30 June - 2 July, (WCE 2010).

[21] Salah-ddine Krit, Jalal Laassiri and Said El Hajji “Comparison and Realization of Audio Amplifiers Using CMOS Technology (Class-A, Class-B, Class-AB and Class-D)” The 2nd International Conference on Multimedia Computing and Systems (ICMCS'11) April 7-9 2011, Ouarzazate, Morocco.

[22] Krit Salah-ddine, Jalal Laassiri and El Hajji Said, «Design a New Architecure of Audio Amplifiers Class-D for a Hardware Mobile Systems”, International Journal of Computer Science and Application. Volume 1, Issue 1, August 2012 PP. 6-11.

[23] Salah-ddine Krit, Jalal Laassiri and Said El Hajji “Modeling and Simulation Methodology Techniques for Advanced Low Power Communication Circuits and Systems of Wireless Sensor Networks” SIMUTools2011 4th International ICST Conference on Simulation Tools and Techniques Barcelona, Spain - March 21-25 2011.

[24] Salah-ddine Krit, Jalal Laassiri and Said El Hajji “Design and implementation of wireless technology to create wireless sensor network using OMNET++” 1er Congrès international:Informatique et Sciences de l’Ingénieur ISI’11, 1-5 March 2011 Erachidiya Morocco.

[25] Salah-ddine Krit, Jalal Laassiri, and Said El Hajji, "Modeling and Simulation Methodology Techniques for Advanced Low Power Communication Circuits", Proceedings of The World Congress on Engineering (WCE 2011), pp2313-2318, London, U.K., 6-8-July, 2011.

[26] Krit Salah-ddine, Jalal Laassiri and El Hajji Said, "Specification and Verification of Uplink Framework for Application of Software Engineering using RM-ODP", IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 5, No 1, September 2011.

[27] Krit Salah-ddine, Jalal Laassiri and El Hajji Said, " Power Aware Simulation Framework for Spice Compatible Battery Model of Wireless Sensor Networks", Journal Of Computing, Volume 4, Issue 4, April 2012.

[28] Krit Salah-ddine, Jalal Laassiri and El Hajji Said, " Design Methodology of Energy Consumption for Wireless Sensor Networks using Energy Renewable", Journal Of Computing, Volume 4, Issue 5, Mai 2012.

[29] Wafaa Ibrihich, Krit Salah-ddine, Jalal Laassiri, and Said El Hajji, "Review On The Attacks And Security Protocols for Wireless Sensor Networks" European Journal of Scientific Research, Volume 101 No 2 May, 2013

[30] Wafaa Ibrihich, Krit Salah-ddine, Jalal Laassiri, and Said El Hajji, "Comparative Analysis of secure routing in WSN " The 2014 International Conference of Wireless Networks, ICWN_58, London, U.K., 2-4 July 2014.

[31] Wafaa Ibrihich, Krit Salah-ddine, Jalal Laassiri, and Said El Hajji, "Study and Simulation of Protocols of WSN Using NS2" Transactions on Engineering Technologies, pp 467-480, 2015.

[32] Wafaa Ibrihich, Krit Salah-ddine, Jalal Laassiri, and Said El Hajji, " The Comparison Study of Hierarchical Routing Protocols for Ad-Hoc and Wireless Sensor Networks: A Literature Survey " The International Conference on Engineering&MIS 2015, Istanbul, Turkey — September 24 - 26, 2015

[33] Wafaa Ibrihich, Krit Salah-ddine, Jalal Laassiri, and Said El Hajji, "Study and Simulation of Protocols of WSN Using NS2" Transactions on Engineering Technologies, pp 467-480, 2015. Science+Business Media Dordrecht, Chapter, Springer.

[34] Mustapha Kabrane, Salah-ddine Krit, Lahoucine El maimouni, alal Laassiri, "Control of Urban Traffic Using Low-Cost and Energy-Saving for Wireless Sensor Network: Study and Simulation" InternationalJournal of Engineering Research And Management (IJERM),Volume-03, Issue-04, 91-96, April 2016

[35] Wafaa Ibrihich, Krit Salah-ddine, Jalal Laassiri, and Said El Hajji, "Recent Advances of Hierarchical Routing Protocols for Ad-Hoc and Wireless Sensor Networks: A Literature Survey*" International Journal Of Informatics Technologies-Ijit, Vol.:9, issue: 2, May 2016.

[36] Mustapha Kabrane, Salah-ddine Krit, Jalal Laassiri, Lahoucine El maimouni “Urban Mobility in Smart Cities Using Low-Cost and Energy-Saving Wireless Sensor Networ” InternationalConference on Engineering & Mis 2016 (ICEMIS2016 submission 29), 22-24September, Agadir 2016, Morocco.

[37] Hassan Oudani, Salah-ddine Krit, Jalal Laassiri, Lahoucine El maimouni “ Comparative Study and Simulation of Flat and Hierarchical Routing Protocols for Wireless Sensor Network” InternationalConference on Engineering & Mis 2016 (ICEMIS2016 submission 33), 22-24September, Agadir 2016, Morocco.

[38] Salah-ddine Krit, Elbachir Haimoud “Review On The IT Security: Attack And Defense” International Conference on Engineering& Mis 2016 (ICEMIS2016 submission 74), 22-24 September, Agadir 2016, Morocco.

[39] Wafaa Ibrihich, Esghir Mustapha, Krit Salah-ddine, Jalal Laassiri, and Said El Hajji, "An Advanced Analysis on Secure HierarchicalRouting Protocols in Wireless Sensor Network" International Conference on Engineering & Mis 2016 (ICEMIS2016 submission 72), 22-24 September, Agadir 2016, Morocco.

[40] Krit Salah-ddine, Mohamed Benaddy, Brahim El habil, "Reliability of Transport Data and Energy Efficient in Wireless Sensor Networks: A Literature Survey" International Conference on Engineering & Mis 2016 (ICEMIS2016 submission 50), 22-24 September, Agadir 2016, Morocco.