Projektovanje analognih i RF integrisanih kola na FTN-u u Novom Sadu

Jelena Radić

Univerzitet u Novom Sadu,
Fakultet tehničkih nauka,
Departman za energertiku, elektroniku i telekomunikacije
URL: www.icreate.ftn.uns.ac.rs

Savetovanje ”Fabrika čipova u Srbiji - Ima li interesa i kadrova?”

28 -29 jun 2013, Petnica

Sadržaj

- Grupa “ICreate”
- Istraživanje
- Projekti
- Rezultati

Grupa “ICreate”

- Tim koji se bavi projektovanjem analonih i RF integrisanih kola
- ICreate čine:
  - dr Mirjana Videnovic-Misic, docent, vođa grupe
  - dr Laslo Nađ, vanredni profesor, savetnik
  - dipl. inž. Alena Đugova, istraživač saradnik, član
  - dipl. inž. Jelena Radić, asistent, član
  - dipl. inž. Aleksandar Pajkanović, istraživač pripravnik, član

Istraživanje

- Projektovanje analognih i RF integrisanih kola na jako visokim frekvencijama za uskopojasne i širokopojasne primene
  - Uskopojasni i širokopojasni nisko-šumni pojačavači – NŠP (eng. *low noise amplifier* - LNA)
  - Ultraširokopojasni impulsni generatori/predajnici (eng. *UWB pulse generator/transmitter)*
  - Ultraširokopojasni pojačavači snage (eng. *UWB power amplifier*)
  - Operacioni pojačavači (eng. *operational amplifier*)
  - Oscilatori (eng. *oscillator)*
- Članstvo u *Europractice* zajednici
  - Pristup najnovijim tehnologijama koje organizacija nudi
  - Mogućnost fabrikacije čipova po znatno povoljnijim cenama (small ASIC and Multi Project Wafer - MPW runs)

Istraživanje

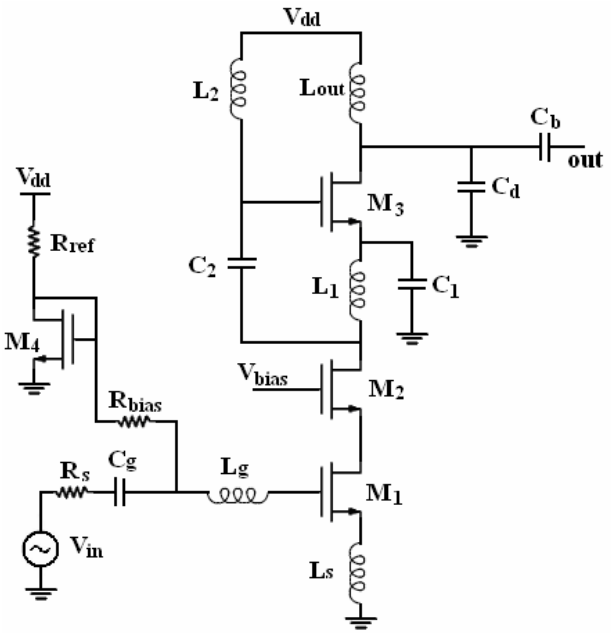
- Korišćene tehnologije
  - UMC 0,18 μm (L180E 1P6M MM/RFCMOS)
  - UMC 0,13 μm (L130E 1P8M MM/RFCMOS)
  - AMS 0,35 μm BiCMOS (C35B3, C35B4, S35D4)
- Alati za projektovanje analognih i RF integrisanih kola
  - Cadence alati
    - Virtuoso (L/XL/GXL) Schematic and Composer Symbol Editor
    - Analog Design Environment - Spectre (dc, tran, SP, PSS, Pnoise, PSS...)
    - Virtuoso (L/XL /GXL) Layout Editor
    - Diva, Assura, QRC parasitic extraction
  - Mentor Graphics alati
    - Calibre

Projekti

- Evropski FP7 Marie Curie ITN projekat – “Low-cost and energy-efficient LTCC sensor/IR-UWB transceiver solutions for sustainable healthy environment ”, SENSEIVER (www.senseiver.com)
- Evropski FP7 – REGPOT projekat – “Reinforcement of Research Potentials of the Faculty of Technical Sciences in the filed of post silicon electronics”, APOSTILLE (www.apostille.rs)
- Nacionalni projekti finansirani od strane Ministarstva prosvete, nauke i tehnološkog razvoja
  - Inovativne elektronske komponente i sistemi bazirani na neorganskim i organskim tehnologijama ugrađeni u robe i proizvode široke potrošnje – TR-32016
  - Razvoj metoda, senzora i sistema za praćenje kvaliteta vode, vazduha i zemljišta – III-43008

Rezultati

- Nisko-šumni pojačavač sa višestrukim iskorišćenjem struje polarizacije za primene na 2,4 GHz frekvenciji (*Bluetooth*)

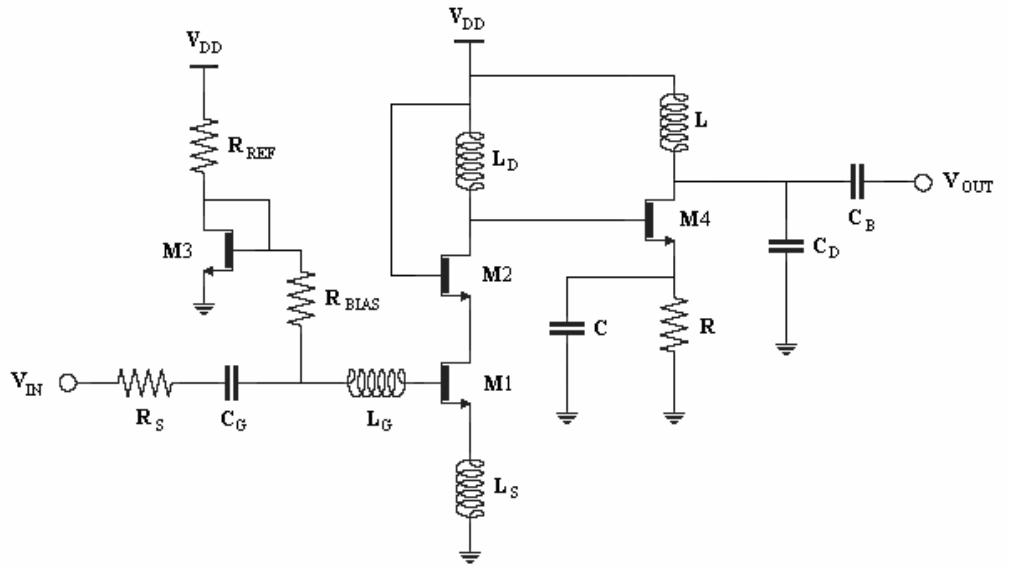


Rezultati simulacija	
f_0 [GHz]	2,4
S_{11} [dB]	– 21,18
S_{22} [dB]	– 15,93
S_{21} [dB]	23,54
NF [dB]	2,7
potrošnja	5 mA @ 3,3 V
tehnologija	AMS 0,35 μm

1. J. Radic, A. Djugova, M. Videnovic–Misic, “A 2.4 GHz high–gain Low Noise Amplifier”, *IEEE International Symposium on Signals, Circuits & Systems − ISSCS*, 9 − 10 July, 2009, Iasi, Vol. 1, pp. 85 − 88.
2. J. Radic, A. Djugova, M. Videnovic–Misic, “Influence of Current Reuse LNA Circuit Parameters on its Noise Figure”, *Serbian Journal of Electrical Engineering*, Volume 6, No. 3, стр 439 − 449, decembar 2009.
3. J. Radić, A. Đugova, M. Videnović-Mišić, “Influence of Current Reuse LNA Circuit Parameters on its Performance”, *Journal of Electrical and Control Engineering – JECE*, Volume 2, No. 3, pp. 7 − 14, June 2012.
4. J. Radic, A. Djugova, M. Videnovic–Misic, “Linearity issue in 2.4 GHz 0.35μm BiCMOS LNA”, *IEEE International Conference on Telecommunication in Modern Satellite, Cable and Broadcasting Services − TELSIKS*, 7 − 9 October, 2009, Niš, Vol.1, pp. 32 – 35.
5. J. Radic, M. Videnovic–Misic, “Dependence of S11 on current reuse LNA circuit parameters”, *1st ReCIMICo Workshop "Design and Characterization of Integrated Microsystems and Components"*, 29 − 30 September, 2008, Novi Sad, pp. 79 − 83.

Rezultati

- Dvostepeni nisko-šumni pojačavač na 1,575 GHz frekvenciji

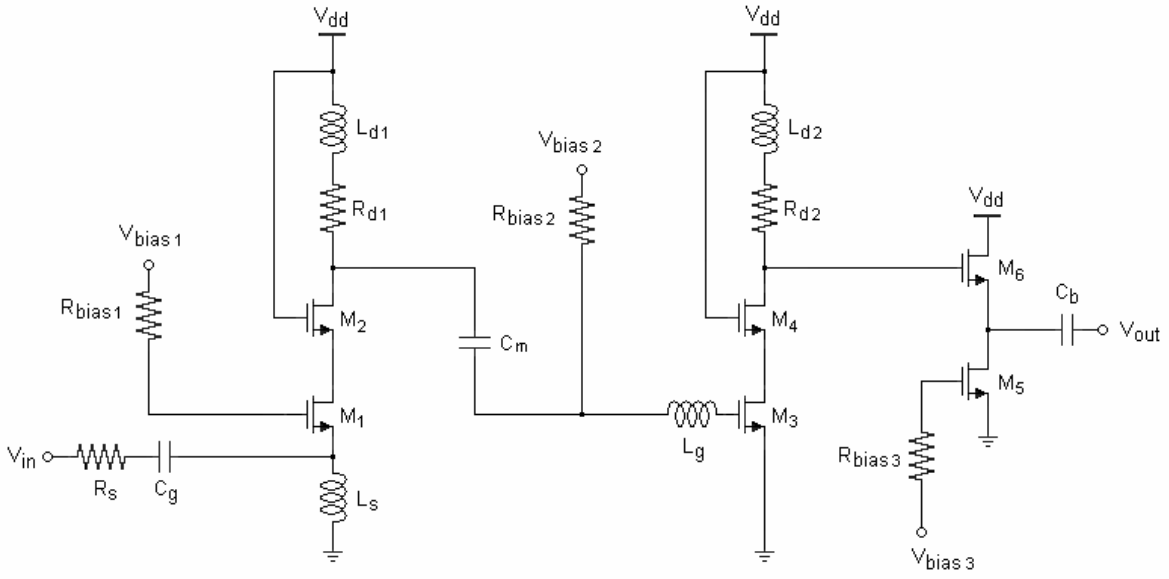


Rezultati simulacija	
f_0 [GHz]	1,575
S_{11} [dB]	– 12,01
S_{22} [dB]	– 10,61
S_{21} [dB]	22,83
NF [dB]	2,035
K_f	2,558
B_{1f}	0,953
potrošnja	9,9 mA @ 3,3 V
tehnologija	AMS 0,35 µm

1. A. Djugova, J. Radic, M. Videnovic–Misic, “Circuit and Process Parameters Issue for 1.57542GHz Low Noise Amplifier in 0.35µm BiCMOS technology”, *IEEE International Symposium on Signals, Circuits & Systems − ISSCS*, 9 − 10 July, 2009, Iasi, Vol. 1, pp. 89 − 92.
2. A. Djugova, M. Videnovic–Misic, “S-parameters and noise figure of a two-stage LNA in SiGe BiCMOS 0.35µm technology”, *1st ReCIMICo Workshop “Design and Characterization of Integrated Microsystems and Components”*, 29 − 30 September, 2008, Novi Sad, pp. 73 − 78.

Rezultati

- NŠP sa pojačavačem sa zajedničkim gejtom kao ulaznim stepenom i “inductive peaking” tehnikom

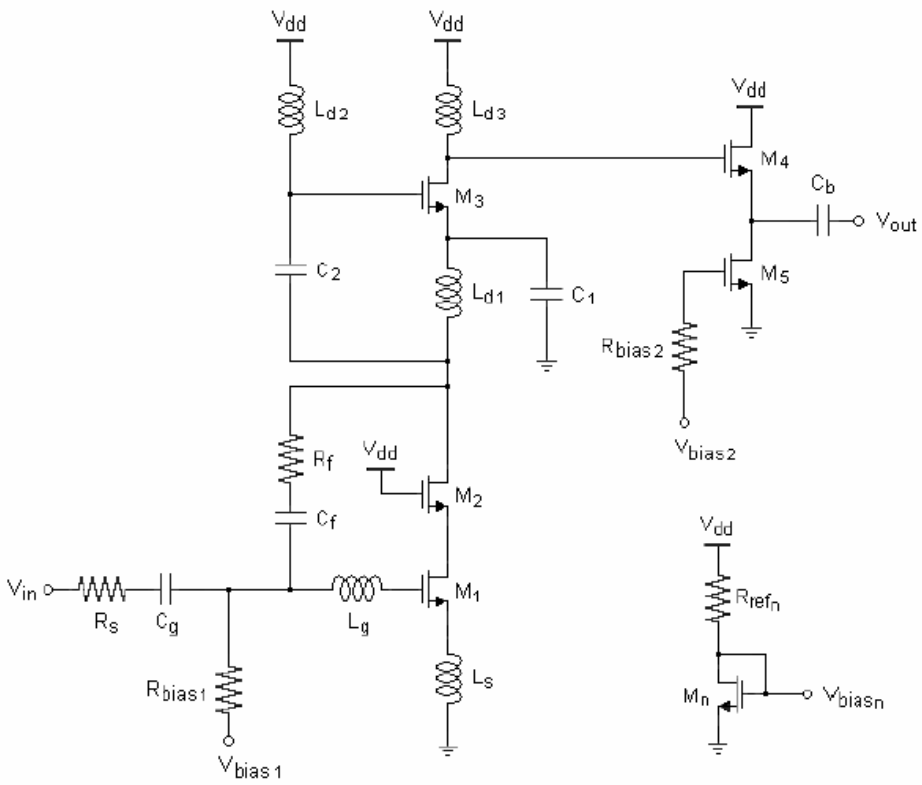


Rezultati simulacija	
BW [GHz]	3,0 – 5,0
S_{11} [dB]	< – 10,91
S_{22} [dB]	< – 11,81
S_{21} [dB]	21,25
NF [dB]	< 3,98
potrošnja [mW]	6,65
tehnologija	UMC 0,13 µm

1. A. Đugova, J. Radić, M. Videnović–Mišić, C. Duarte, V. Grade Tavares, “An UWB 3–5 GHz Common–Gate Low Noise Amplifier Designed in 0.13µm Technology”, *TELFOR 2010*, 23 − 25 November, 2010, Belgrade, pp. 786 − 789.

Rezultati

- NŠP sa višestrukim iskorišćenjem struje polarizacije, induktivnom degeneracijom sorsa i povratnom spregom

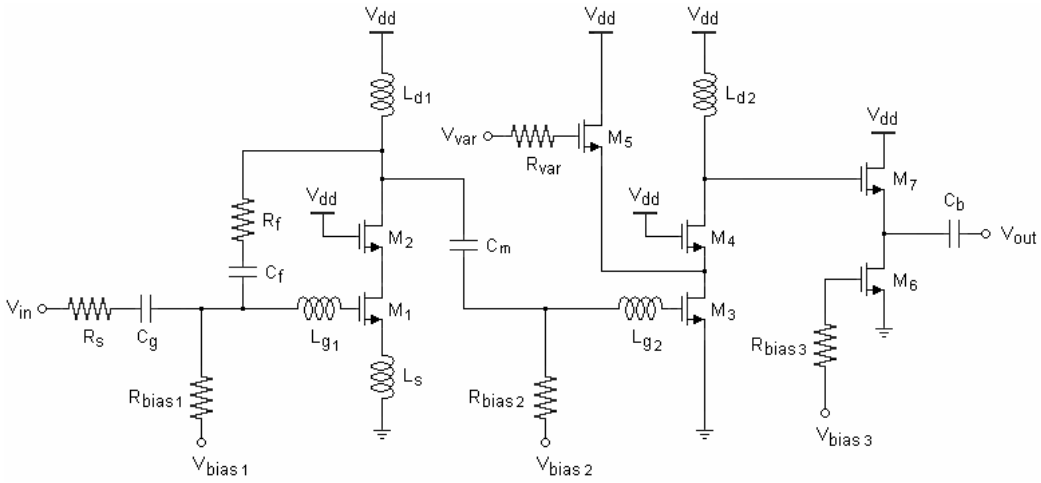


Rezultati simulacija	
BW [GHz]	6,0 – 8,5
S_{11} [dB]	< – 10
S_{22} [dB]	< – 14,9
S_{21} [dB]	14,3
NF [dB]	< 6,81
potrošnja [mW]	5,26
tehnologija	UMC 0,18 μm

1. A. Djugova, J. Radic, M. Videnovic–Misic, "A Variable Gain Low Noise Amplifier for UWB 6–10 GHz Applications", *19th Austrian Workshop on Microelectronics − Austrochip*, 26th September, 2011, Vienna, pp. 7 − 10.

Rezultati

- Dvostepeni NŠP sa induktivnom degeneracijom sorsa i povratnom spregom

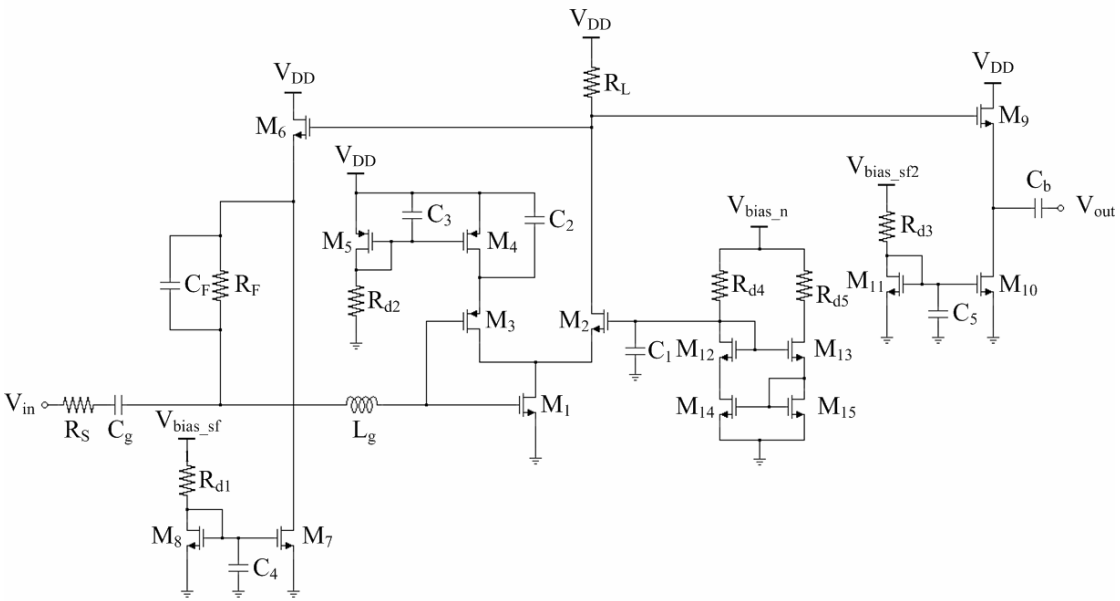


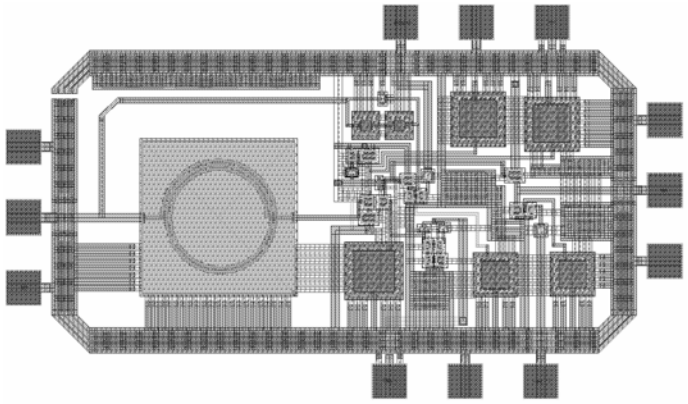
Rezultati simulacija		
FOM	Mod sa velikim pojačanjem	Mod sa malim pojačanjem
BW [GHz]	6,0 – 10,0	6,0 – 10,0
S_{11} [dB]	< – 13,37	< – 13,44
S_{22} [dB]	< – 13,97	< – 14,03
S_{21} [dB]	16,82	14,09
NF [dB]	< 7,65	< 8,20
potrošnja [mW]	12,45	12,60
tehnologija	UMC 0,18 µm	UMC 0,18 µm

1. A. Djugova, J. Radic, M. Videnovic–Misic, “A 0.18µm CMOS Low Power LNA for 6–8.5 GHz UWB Receiver”, *IEEE International Semiconductor Conference − CAS*, 17 − 19 October, 2011, Sinaia, Vol. 1, pp. 215 – 218.

Rezultati

- NŠP sa tehnikom povećenja g_m isprojektovan za niži frekvencijski opseg

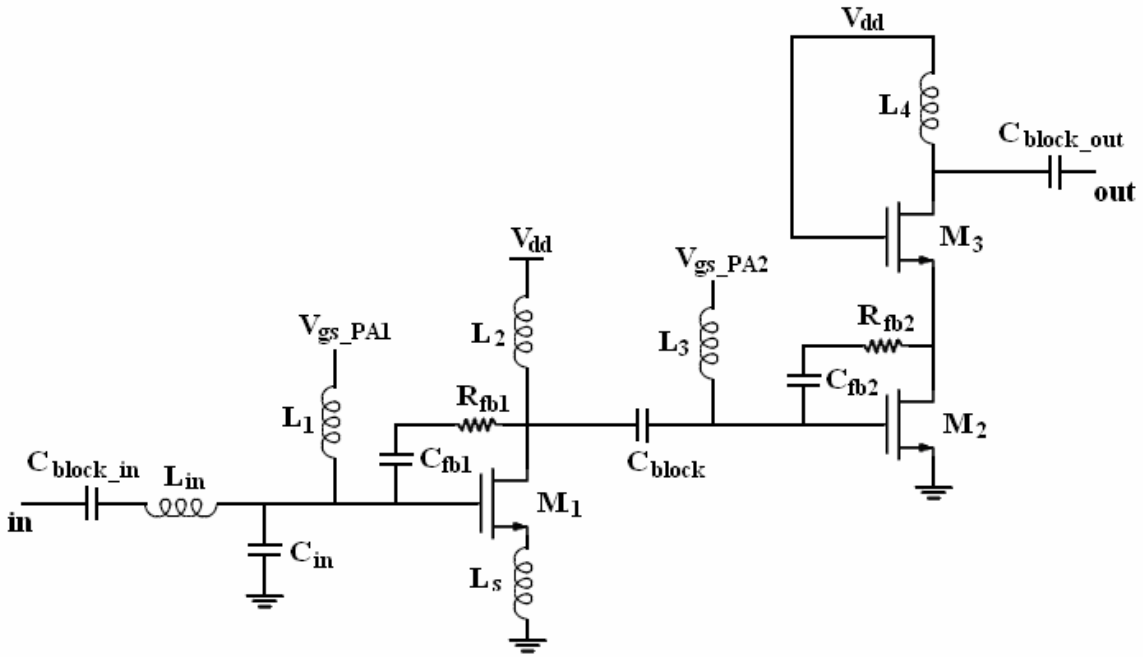




Rezultati poslejaut simulacija	
BW [GHz]	3,1 – 5,0
S_{11} [dB]	< – 10,0
S_{22} [dB]	< – 10,0
S_{12} [dB]	< – 32,0
S_{21} [dB]	9,91 ± 0,91
NF [dB]	< 4,45
potrošnja [mW]	10,18
površina čipa [mm^2]	0,91
tehnologija	UMC 0,18 μm

Rezultati

- Pojačavač snage sa LC prilagodnom mrežom i rednom povratnom spregom za “1-3” grupu MB-OFDM UWB primene

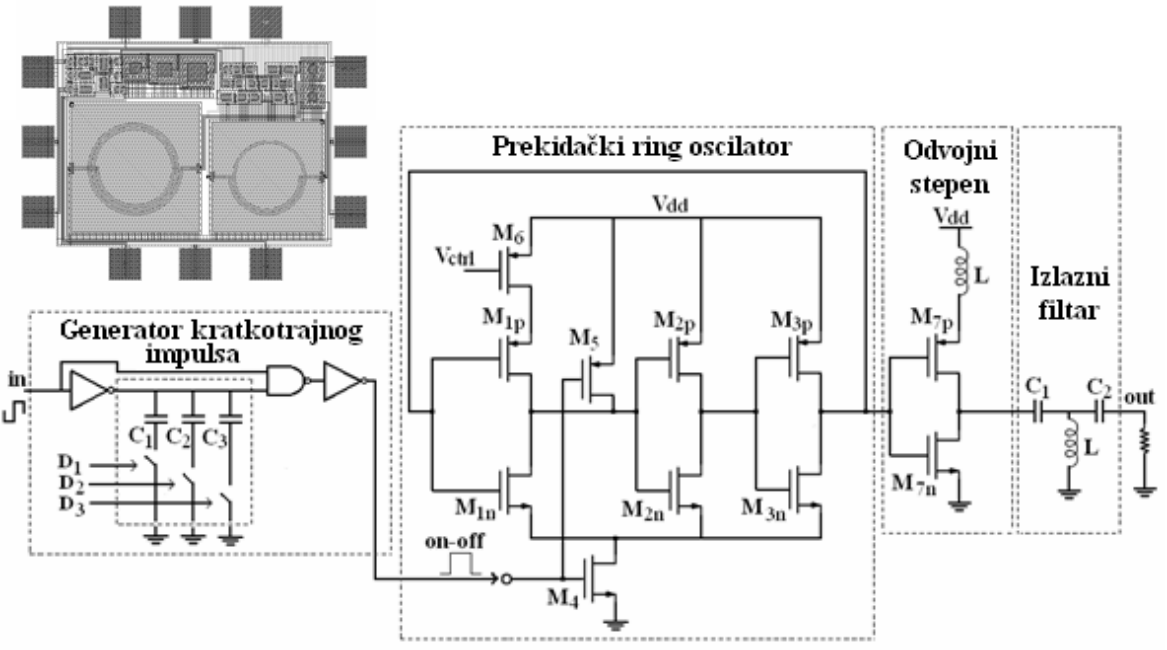


Rezultati simulacija	
BW [GHz]	3,1 − 7,5
S_{11} [dB]	< – 5,0
S_{22} [dB]	< – 7,0
pojačanje [dB]	18,0
S_{21max} [dB]	20,0
$OP_{1\text{-}dB}$ [dBm]	3,6
PAE [%]	30,0
potrošnja [mW]	15,0
tehnologija	UMC 0,13 μm

1. J. Radic, A. Djugova, M. Videnovic–Misic, “A Low–Power and High Linearity CMOS UWB Power Amplifier for Group 1~3 MB–OFDM Application”, *18th Austrian Workshop on Microelectronics − Austrochip*, 6th October, 2010, Villach, pp. 33 − 36.
2. J. Radić, A. Đugova, M. Videnović–Mišić, C. Duarte, V. Grade Tavares, “A Low–Power and High Gain CMOS UWB Power Amplifier for Group 1~3 MB–OFDM Application”, *TELFOR 2010*, 23 − 25 November, 2010, Belgrade, pp. 783 − 786.
3. J. Radic, A. Djugova, M. Videnovic–Misic, L. Nađ, “Pojačavač snage za MB−OFDM UWB primene isprojektovan u 0.13um CMOS tehnologiji”, *ETRAN 2010*, 07 – 11. juna, 2010, Donji Milanovac, EЛ2.1-1-4.

Rezultati

- IR-UWB impulsni generator zasnovan na ring oscilatoru za primene u višem UWB opsegu

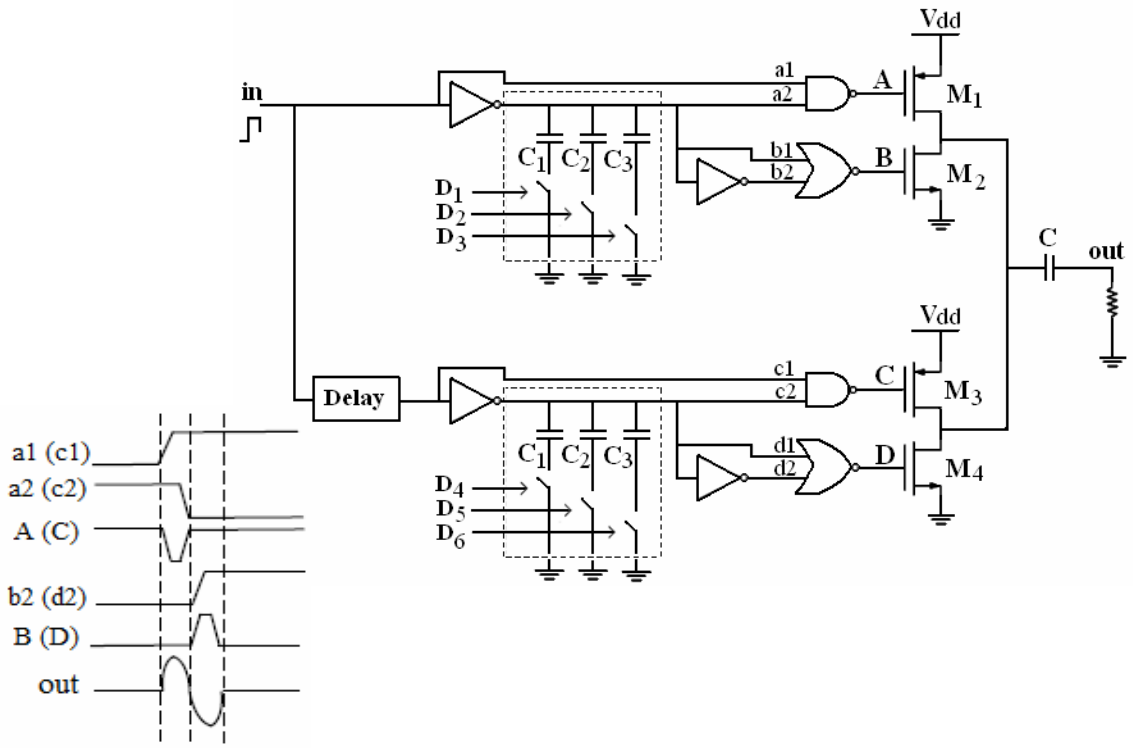


Rezultati postlejaut simulacija	
BW [GHz]	4,9 − 10,6
potrošnja [mW]	1,64
PRF [MHz]	200
V_{pp} amplituda [mV]	180
dužina impulsa [ns]	0,6
PSD_{max} [dBm/MHz]	– 42,92 (@ 7,60 GHz)
površina čipa [mm^2]	0,39
tehnologija	UMC 0,18 µm

1. J. Radic, A. Djugova, Mirjana Videnovic–Misic, “Low Power IR-UWB Pulse Generator in 0.18µm CMOS Technology”, *IEEE International Conference on Telecommunication in Modern Satellite, Cable and Broadcasting Services − TELSIKS*, 5 − 8 October, 2011, Niš, Vol. 2, pp. 761 – 764.
2. J. Radic, A. Djugova, M. Videnovic–Misic, “Low Power IR-UWB Pulse Generator in 0,13um CMOS Technology”, *International Scientific Conference on Information, Communication and Energy Systems and Technologies − ICEST*, 29 June − 1 July, 2011, Niš, Vol. 1, pp. 179 − 182.

Rezultati

- Podešljivi generator 5-og izvoda Gausovog impulsa za ceo UWB opseg

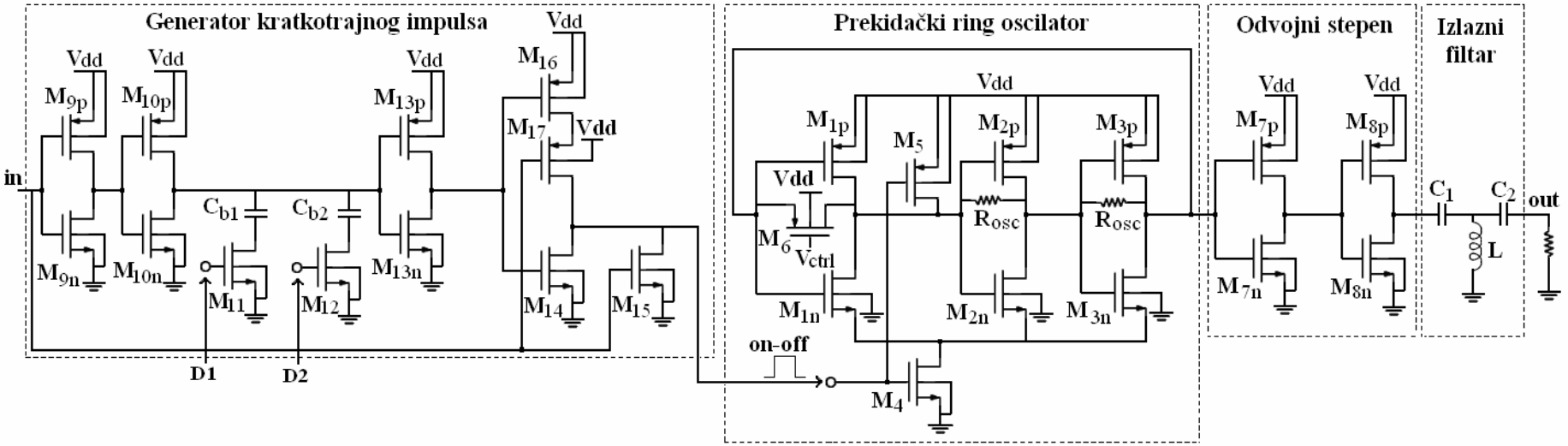


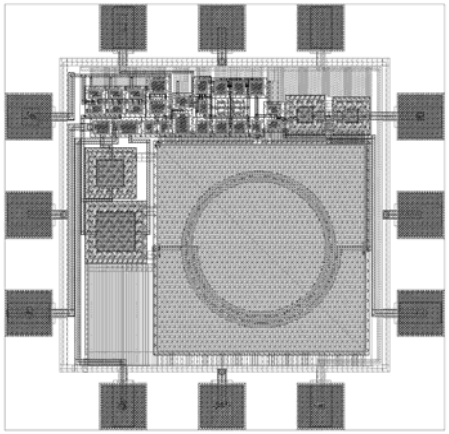
Rezultati simulacija	
BW [GHz]	3,1 − 10,6
potrošnja [mW]	0,99
PRF [MHz]	100
V_{pp} amplituda [mV]	320
maksimalana V_{pp}[mV]	560
dužina impulsa [ns]	0,4
PSD_{max} [dBm/MHz]	– 44,8 (@ 5,6 GHz)
tehnologija	UMC 0,18 µm

J. Radic, A. Djugova, M. Videnovic–Misic, "A 3.1-10.6 GHz Impulse-Radio UWB Pulse Generator in 0.18 um", *IEEE International Symposium on Intelligent Systems and Informatics − SISY*, 8 − 10 September, 2011, Subotica, pp. 335 − 338.

Rezultati

- Digitalno-kontrolisani impulsni generator za niži UWB opseg





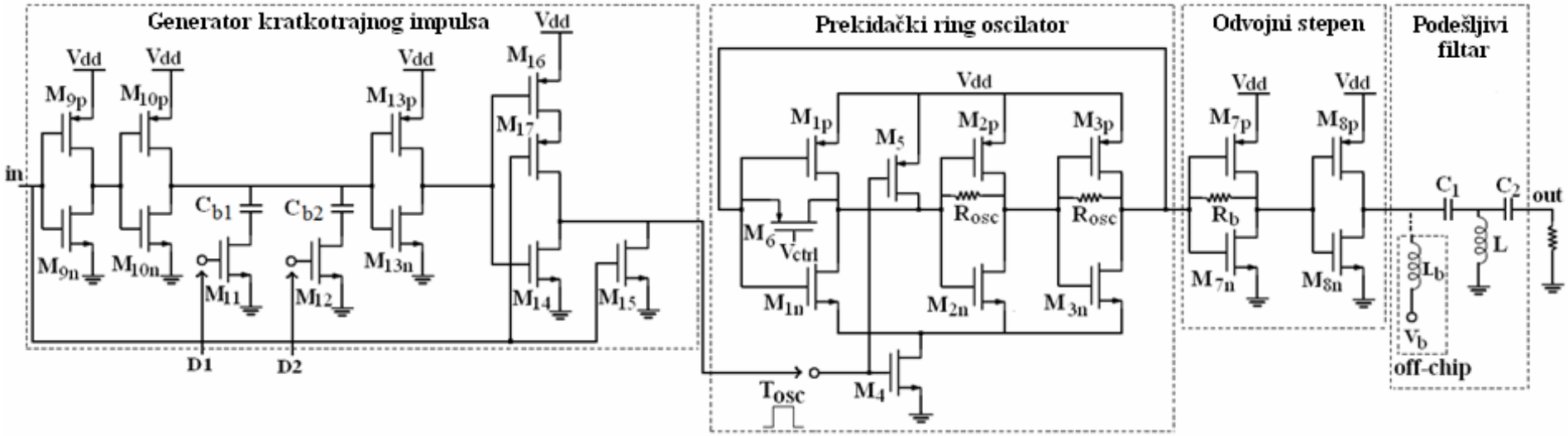
Rezultati

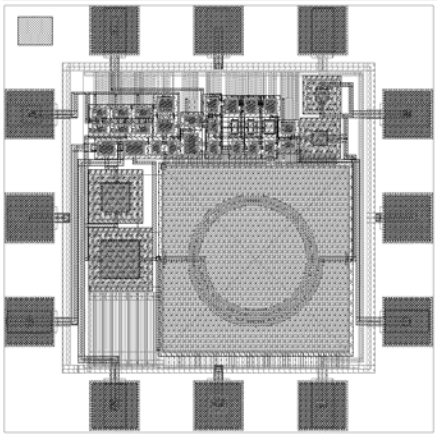
Rezultati postlejaut simulacija		
FOM	Bez induktora L_b	Sa induktorom L_b
BW [GHz]	3,10 − 7,50	3,10 − 6,65
potrošnja [mW]	0,70	0,93
PRF [MHz]	100	80
V_{pp} amplituda [mV]	261	295
dužina impulsa [ns]	0,7	1,5
PSD_{max} [dBm/MHz]	– 44,2 (@ 4,70 GHz)	– 41,3 (@ 3,96 GHz)
površina čipa [mm^2]	0,35	0,35
tehnologija	UMC 0,18 µm	UMC 0,18 µm

1. J. Radic, A. Djugova, L. Nagy, M. Videnovic–Misic, “A Low Power 3.1-7.5 GHz Tunable Pulse Generator for Impulse Radio UWB”, *IEEE International Symposium on Intelligent Systems and Informatics − SISY*, 20 – 22 September, 2012, Subotica, pp. 425 –428.
2. J. Radic, A. Djugova, L. Nadj, M. Videnovic–Misic, “Feedback Influence on Performance of Ring Oscillator for IR-UWB Pulse Generator in 0.18µm CMOS technology”, *IEEE 28th International Conference on Microelectronics − MIEL*, 13 − 16 May, 2012, Niš, pp. 357 – 360.
3. J. Radic, A. Djugova, L. Nagy, M. Videnovic–Misic, “Body Effect Influence on 0.18µm CMOS Ring Oscillator Performance for IR-UWB Pulse Generator Applications”, *IEEE Mediterranean Conference on Embedded Computing − MECO*, 19 − 21 June, 2012, Bar, pp. 170 – 173.

Rezultati

- Podešljivi impulsni generator sa mogućnošću potiskivanja WLAN opsega





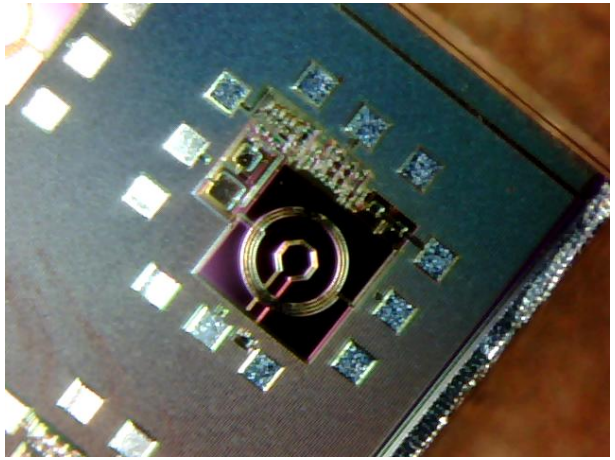
Rezultati

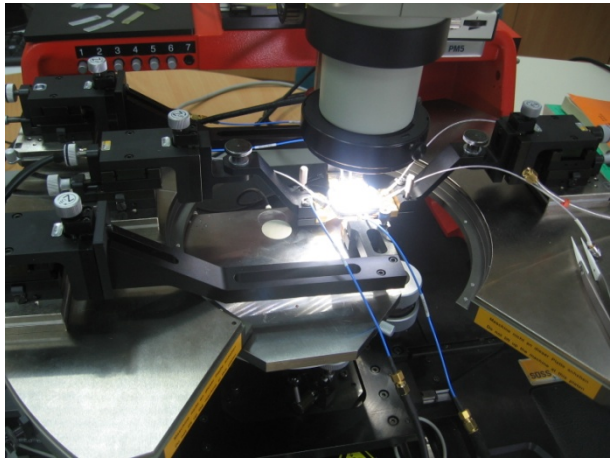
Post-layout simulation results	
BW [GHz]	3,1 − 10,6
potrošnja [mW]	0,89 − 2,0
PRF [MHz]	80 − 200
V_{pp} amplituda [mV]	211 − 250
dužina impulsa [ns]	0,5 0 − 0,75
površina čipa [mm^2]	0,31
tehnologija	UMC 0,18 µm

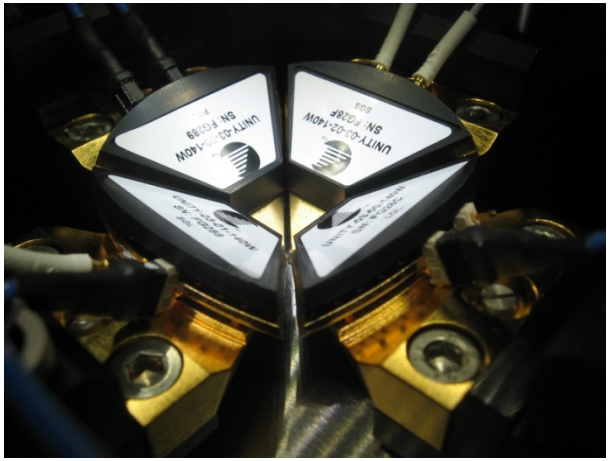
1. L. Nagy, J. Radic, A. Djugova, M. Videnovic-Misic, "Ultra Low-Power Low-Complexity Tunable 3-10 GHz IR-UWB Pulse Generator", *Journal of Microelectronics, Electronic Components and Materials – MIDEM*, Volume 42, No. 3, pp. 185 – 191, 2012.
2. J. Radic, A. Djugova, L. Nagy, M. Videnovic–Misic, "Body Bias Influence on Ring Oscillator Performance for IR-UWB Pulse Generator in 0.18µm CMOS technology", *International Scientific Conference on Information, Communication and Energy Systems and Technologies – ICEST*, 29 – 30 June, 2012, Veliko Tarnovo, Volume 1, pp. 59 – 62.
3. J. Radic, A. Djugova, L. Nagy, M. Videnovic-Misic and L. Zivanov, "Comparison of Feedback Influence on Ring Oscillator Performance for IR-UWB Pulse Generator in 0.13µm and 0.18µm CMOS technologies", *4th IFIP WG 5.5/SOCOLNET Doctoral Conference on Computing, Electrical and Industrial Systems – DoCEIS'13*, 15 – 17 April, 2013, Costa de Caparica, Lisbon, pp. 603 – 610.
4. Jelena Radic, Alena Djugova, Laszlo Nagy, Kalman Babkovic, Mirjana Videnovic–Misic, "Feedback Influence on Ring Oscillator Performance for IR-UWB Pulse Generator in 0.13µm CMOS technology", *IEEE International Symposium – ELMAR-2012*, 12 – 14 September, 2012, Zadar, pp. 101 – 104.

Rezultati

- Merenje prvog fabrikovanog čipa

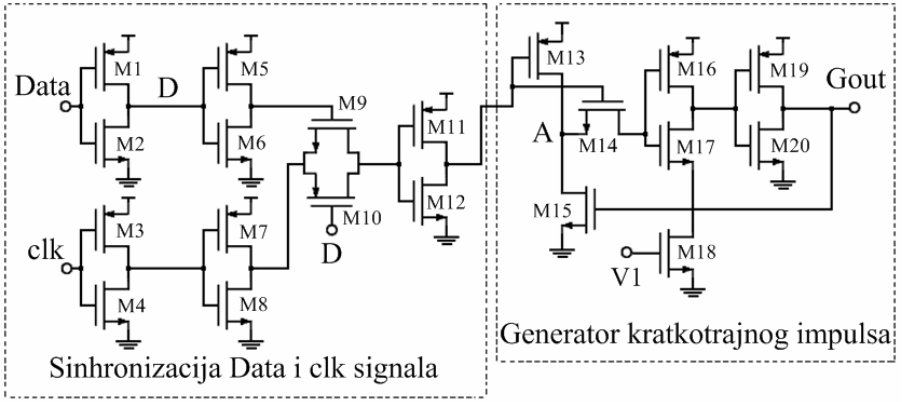


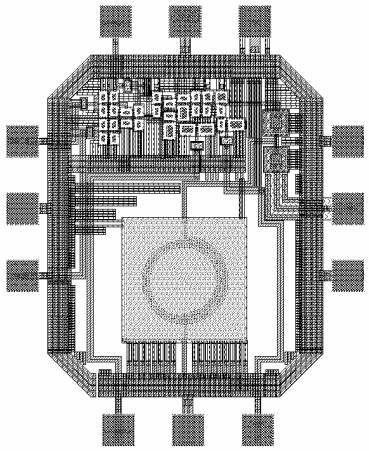


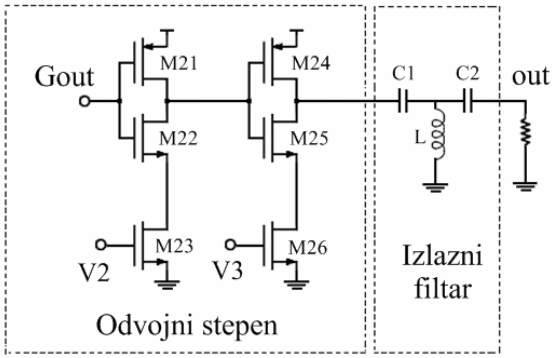


Rezultati

- Podešljivi impulsni generator zasnovan na uobličavanju kratkotrajnog impulsa







Post-layout simulation results	
BW [GHz]	3,0 − 7,8
potrošnja [mW]	1,3
PRF [MHz]	100
V_{pp} amplituda [mV]	403
dužina impulsa [ns]	0,60
površina čipa [mm^2]	0,63
tehnologija	UMC 0,18 μm

Hvala Vam na pažnji!!!

Jelena Radić

E-mail: jelenar_@uns.ac.rs,
jelena.radicmg@gmail.com

URL: www.icreate.ftn.uns.ac.rs