Methodology for tools integration in the Online assisted Platform for Computer-aided design in communications

Galia Marinova [1] and Ognyan Chikov [2]

Abstract – **The paper describes the methodology for tools integration in the Online assisted platform for computer-aided design in communications Online-CADCOM, going through tools collection, verification, classification, estimation, passport definition and interconnections. A Knowledge-base containing tutorials for multitool task solution, projects and e-learning content is developed and supported in Online-CADCOM, as well as connections to standards, protocols and specifications of communication systems, economical(cost) estimates, prototyping and optimization are supported.**

Keywords – **Online CAD tools, Integrated online platform, communication system and circuit design.**

I. Introduction

Computer-aided design and Electronic Design Automation are entering a new era where online exposition and accessibility of tools are widely spread and integration approach, from specification to prototype realization, environmental influence and cost estimation are successfully applied. Observations on that topic are presented in the EDA360 vision of Cadence [2], where design creators are seen as integrators, providing application focused platforms, instead of chips. Engineering is considered in close collaboration, in a kind of an ecosystem, together with project and business management, green economy and education. Designs are application driven and with a high percentage of software impact. Software defined radio (SDR), Cognitive radio, Software defined networks (SDN) and Smart Grids illustrate the trend of Software defined hardware in communications system design. References [3, 4, 5] also point different aspects of tools integration for system design.

The Online assisted platform for computer-aided design in communications (Online-CADCOM) is as an attempt to provide designers and student with an instrument which allows them to take advantage of these new resources and their integration in order to perform application driven design and software defined hardware design. Online-CADCOM is a part of the platform OPTIMEK which concept is described in [1]. It manages links to online tools for computer-aided design of electronic and communication circuits and systems, which are previously studied, estimated and provided with characterization passports. The paper describes the methodology for tools integration in Online-CADCOM, going through tools collection, verification, classification, estimation, passport definition and interconnections. A Knowledge-base containing tutorials for multitool task solution, projects and e-learning content, is developed and supported in Online-CADCOM, as well as connections to standards, protocols and specifications of communication systems and links to economical (cost) estimates, prototyping and optimization are supported.

First the methodology steps for tools integration in Online-CADCOM are described, then Web design and development approach for Online-CADCOM realization is presented and two design projects illustrate some advantages of Online-CADCOM.

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I. Methodology steps for tools integration in Online-CADCOM

The methodology steps for tools integration in Online-CADCOM are:

- Tools collection and estimation,
- Tools classification,
- Tools characterization passports and
- Tools integration.

These steps are considered in details further.

A. Tools collection and estimation

The first step in Online-CADCOM is a large search and study of existing online tools for computer-aided design, estimation of their reliability followed by tests of their performance. Only tools that show reliability, that possess clear algorithms and theory fundament, that show good results in verification, are selected. Up to now more than 100 online tools for CAD in communications are studied. Some of the can be found on the Portal for online tools for Telecommunications: http://mircheva.free.bg/.

B. Tools classification in Online-CADCOM

The development of the platform Online-CADCOM manages the CAD tools based on Daniel-Gajsky Y model of design levels. Two main panels are defined on the home page of Online-CADCOM, each of them combining 2 design areas from the Y model and interconnections between them:

Panel 1: Structural and Behavioral areas from the Y model and Analysis and Synthesis features as interconnections between these two areas.

Panel 2: Physical/Geometrical/Topological and Behavioral areas, covering topology design and behavioral simulation based on electromagnetic and temperature simulators, using FEM, BEM, etc. methods. Structure extraction from topology is also classified in this panel.

In these Panels CAD tools are classified in categories. Categories of online CAD tools in Panel 1 are:

- RF and microwave design (*RF/MW*);
- Antenna design (*Ant*);
- Audio design (*Aud*);
- Analog design (*A*);
- Interface circuit design of ADC,DAC, etc. (*Int*)
- Digital design (*D*);
- Power supply design (*PS*).

Categories of online CAD tools in Panel 2 are:

- Printed circuit board design (*PCB*);
- Elements - resistors, capacitors, inductors, transformers, crystal oscillators, heat-sinks, etc.(*Elem*);
- Electric installation design (*EI*);
- Nanotechnology design (*Nano*);
- Outcome to prototype - Development boards, PCBs, FPGA/CPLDs, USRPs, Arduino controller, etc. (*P*).

Panels1 and 2 are shown on Figure 1. Online tools selected to be connected to Online-CADCOM are classified in some of the categories from Fig. 1.

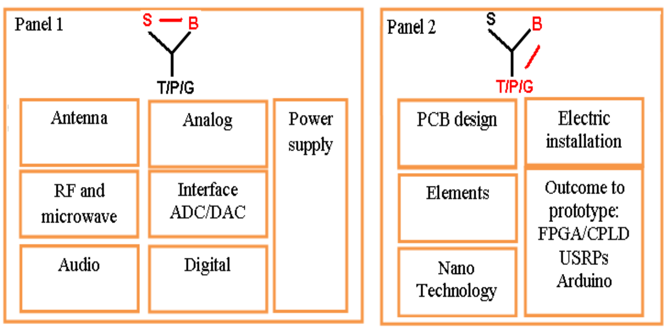


Fig.1. Panels on the home page of ONLINE-CADCOM

C. Tools characterization passports in Online-CADCOM

Each CAD tool to be considered in Online-CADCOM is characterized through 10 criteria defining a passport for each online tool as shown on Table I.

D. Tools connections in Online-CADCOM

Input/output connections of the tools considered permit to form sets of tools that solve complex design tasks in communications. Equivalence or application area overlapping, permit to enlarge multisolution synthesis in different application areas and to select optimal solution through verification tool estimates and/or cost estimates. Examples of equivalence or overlapping of application area of online tools are presented on Figures 2 and 3.

Figure 2 presents equivalence, functional area overlapping and connections of 4 online tools for filter design - 3 of the tools (Webench Filter Designer [7], Analog Filter Wizard [10] and FilterCAD [11]) perform active filter design and the forth one AADE [10] performs passive and quartz crystal filter design. Figure 3 presents Equivalence, Functional area overlapping and connections of Online tools for Switch mode power supply (SMPS) design Webench Power Designer [6] and PowerEsim [8].

III. Web design and development approach for Online-CADCOM realization

Besides the two Panels from Figure 1, Online-CADCOM develops and supports:

- Documents and links to Standards, Protocols and Specifications;
- Links to portals and platforms;
- Knowledge base containing E-learning content, Tutorials for complex task solutions in the multitool environment, Design Projects, Glossary;
- Economical estimation;
- Outcome to prototype;
- Links to Optimization tools.

These options are positioned in a separate left panel (Panel 3) on the Online-CADCOM home page.

Online-CADCOM is developed using HTML and PHP languages and MySQL for the Data base. The software architecture template MVC Framework is applied to separate Model, View and Controller parts. The Content management system permits the actualization of the platform independent of the web developer. The language CSS is used for the interface style.

IV. Project design in Online-CADCOM

Two application driven designs in Online-CADCOM are presented to illustrate its performance. The first example consists in the design of a Bandstop filter with the online tool Webench Filter Designer which is verified through simulations in Cadence ORCAD Design suit 16.6. and the second example consists in the design of SMPS for a notebook using the online tools Webench Power Designer and PowerEsim.

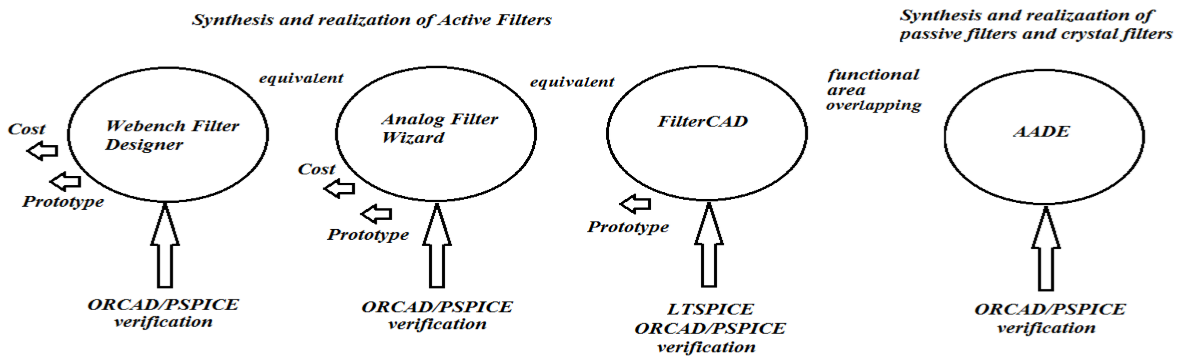


Fig.2. Equivalence, functional area overlapping and connections of online tools for filter design

TABLE I.
CHARACTERIZATION PASSPORT OF ONLINE CAD TOOLS

Type of Online CAD tool	Online calculator Online platform Module in Online Platform Free downloadable tool
Panel/ Category	Pane11 , 2 Categories from Fig.1 (Ant, Aud, RF/MW, A, Int, D, PS , PCB, Elem, EI, Nano, P)
Application area	Subcategories
Functions	Parameter calculation, Behavior, Synthesis, Analysis, Topology, Topology - Behavior Extraction
Levels of abstraction covered	Transistor, Logic, RTL, Architecture, System
Connections Input/Output	List of input and output connections to other online CAD tools
Verification tool	Simulator with high level of reliability which can verify the online tool results, ex.: ORCAD/PSpice, MATLAB, etc.
Equivalence or application area coverage	Sets of online CAD tools with application area equivalence or overlap
Qualitative Features	Theory fundament provided Friendly interface Graphical illustrations Traces and Waveforms building Animation 3D Author and Contact provided
Quantitative features	Number of parameters calculated Number of modules in a platform Number of circuits, ICs or topologies in a data base Number of models Number of elements Number of component providers

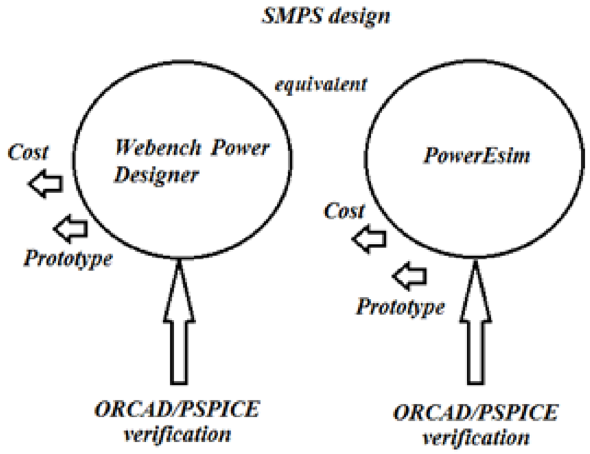


Fig.3. Equivalence, Functional area overlapping and connections of online tools for SMPS design

A. *Bandstop filter design with Webench Filter Designer with ORCAD/PSpice verification*

The specification of the filter to be designed is:
- Bandstop filter,
- Center frequency fc= 5kHz,
- Gain in the passband A=0dB,
- Minimal attenuation in the stopband ASb= -40 dB,
- Stopband bandwidth SB=100Hz,
- Passband bandwidth BWs=1000 Hz,
- Dual supply, Supply voltage ±12V.

Webench filter designer synthesizes a 6^{th} order filter, with Linear phase 0.05° filter response, with three stages, with Bainter topology. The circuit is taken from the report file generated by Webench Filter Designer and it's presented on Fig. 4. Figure 5 presents Gain and Phase curves in frequency area, obtained in Webench Filter Designer. Then the design in verified through a project in ORCAD/Capture on Fig.6 and ORCAD/PSpice AC simulations of the Gain and the Phase, presented on Fig.7.

In Table II are shown the results for the filter parameters obtained from Webench Filter Designer simulations and from Cadence ORCAD 16.6 simulation and the difference between both estimations is calculated in percent.

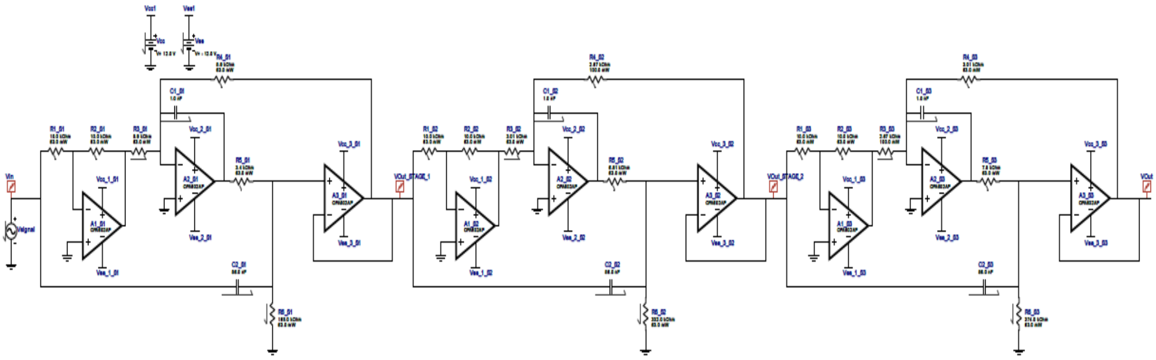


Fig.4. Bandstop filter synthesized in Webench power designer

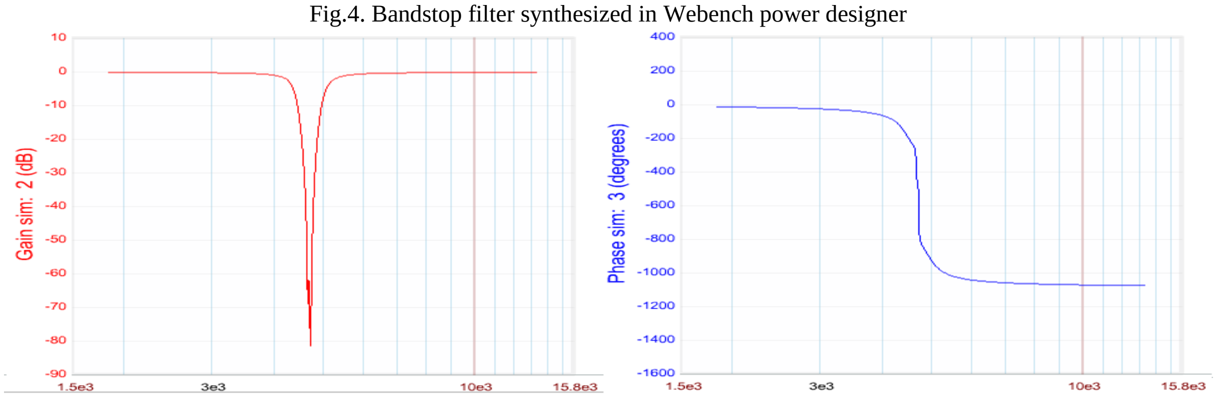


Fig.5. Gain and phase in frequency domain for the bandstop filter from Figure 4, obtained in Webench Power Designer tool

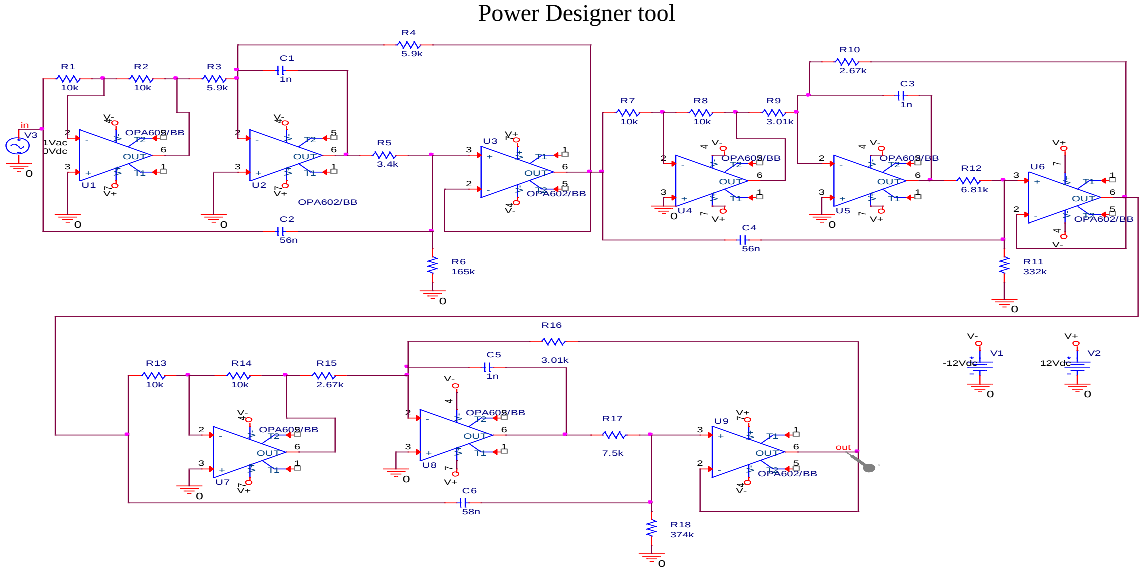


Fig.6. Electrical circuit of the Bandstop filter from Fig.4 in ORCAD Capture 16.6

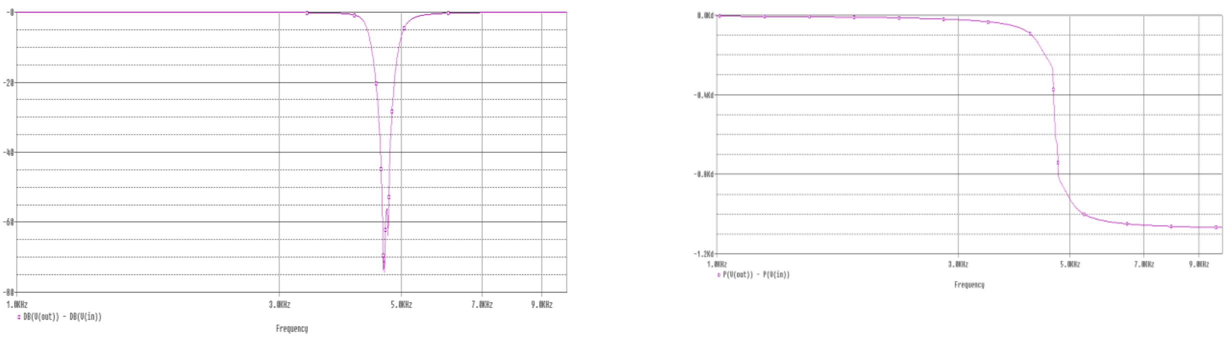


Fig.7. Gain and phase of the Filter from Fig.6, simulated in ORCAD/PSPICE 16.6

TABLE II.
COMPARISON OF PARAMETER ESTIMATIONS FOR THE FILTER FROM FIG.4 IN WEBENCH FILTER DESIGNER AND CADENCE ORCAD/PSPICE 16.6

Parameter of the filter	Estimation in Webench Filter Designer	Estimation in Cadence ORCAD/PSPICE 16.6	Difference in estimates in [%]
Center frequency fc	4.731 kHz	4.656 kHz	1.61%
Attenuation at fc - ASb	-77.4 dB	-74 dB	4.6%
Stopband SB	135 Hz	360 Hz	62.5%
Passband BWs	968 Hz	846 Hz	14.42%

Results obtained in Webench Filter Designer are closer to the specification than those obtained in Cadence ORCAD design suit 16.6, so it seems that Webench Filter Designer gives more optimistic results. The PSpice verification is one more guarantee for the results obtained and they might occur to be more realistic.

B. Comparative design of SMPS for a notebook with Webench Power Designer and PowerEsim

The specification of the SMPS for the notebook to be designed is:

The input voltage is an AC voltage with value 220-240 V and frequency 50 Hz, which makes for the Vmin(Vin RMS)=156 V and Vmax(Vin RMS)=167 V .

The output voltage Vout is 15 V and the output current Iout is 3.75 A, the ambient temperature is 30º.

A minimal acceptable value of the SMPS efficiency coefficient is 65%.

The SMPS for the notebook is specified in PowerEsim and it proposes 5 possible solutions as shown on Fig.8. Table III presents the values of the efficiency coefficients for each of the solutions. Only 3 solutions have acceptable efficiency coefficient values, since they have values of the efficiency coefficient superior than 65% , these are the topologies - Buck PNP Buck DC-DC and Flyback AC/DC.

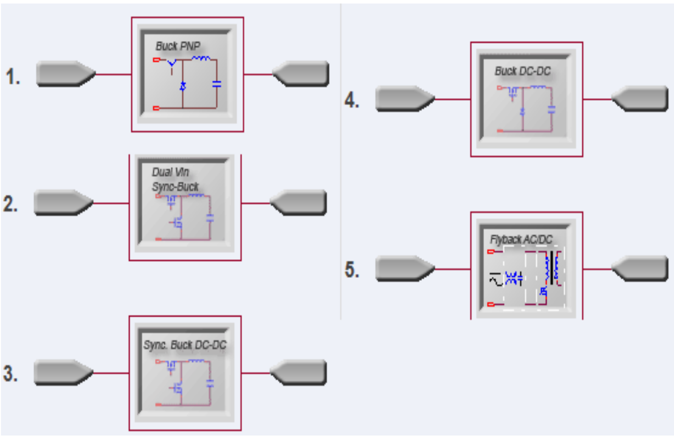


Fig. 8. SMPS designs for the notebook in PowerEsim

The topologies Dual Vin Sync Buck and Sync Buck DC-DC are rejected since their efficiency coefficients values are too low.

TABLE III.
TOPOLOGIES AND EFFICIENCY COEFFICIENTS OF THE SMPS DESIGNS IN POWERESIM.

SMPS topology in PowerEsim	Efficiency coefficient
Buck PNP	67%
Dual Vin Sync Buck	5%
Sync Buck DC-DC	33%
Buck DC-DC	87%
Flyback AC/DC	85.58%

The same specification is synthesized with the tool Webench Power Designer. An unique solution is proposed as shown on Fig.9. The efficiency coefficient obtained for the power supply designed is 86%. The circuit synthesized, which is taken from the Webench Power Designer report file is shown on Fig.10. Webench posts a message (*why other parts were not found*) that several hundreds of ICs were tested for this specification and each of them doesn't meet the current or the voltage constraints in the specification (*Current exceeds limit* or *Voltage is outside of limit*) or they *are not configured for AC/DC Conversion*.

The comparison between these two online platforms for SMPS design shows that PowerEsim proposes more numerous solutions, most probably because this tool supports ICs from multiple providers and Webench supports mostly TI ICs. This makes PowerEsim more versatile and the possibility to consider both platforms which is provided by Online-CADCOM helps to increase the number of solutions and thus gives a wider choice for designers and users.

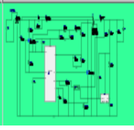
Part	Create	WEBENCH® Tools	Schematic	BOM Images	Design Considerations	BOM Footprint (mm2)	BOM Cost (1ku)	Eff (%)	BOM Count	Freq (kHz)	Vout p-p (mV)	Xover Freq (kHz)	Phase Margin (deg)	Topology	LDO	Temp (deg)	Iout Max (A)
LM5023	Open Design			 1778mm²	AC-DC QR Current Mode PWM Controller	1778	NA	86%	44	67	67.72	NA	NA	Flyback	N	32°C	5.00

Fig. 9. Unique design solution for the SMPS for a notebook in Webench Power Designer

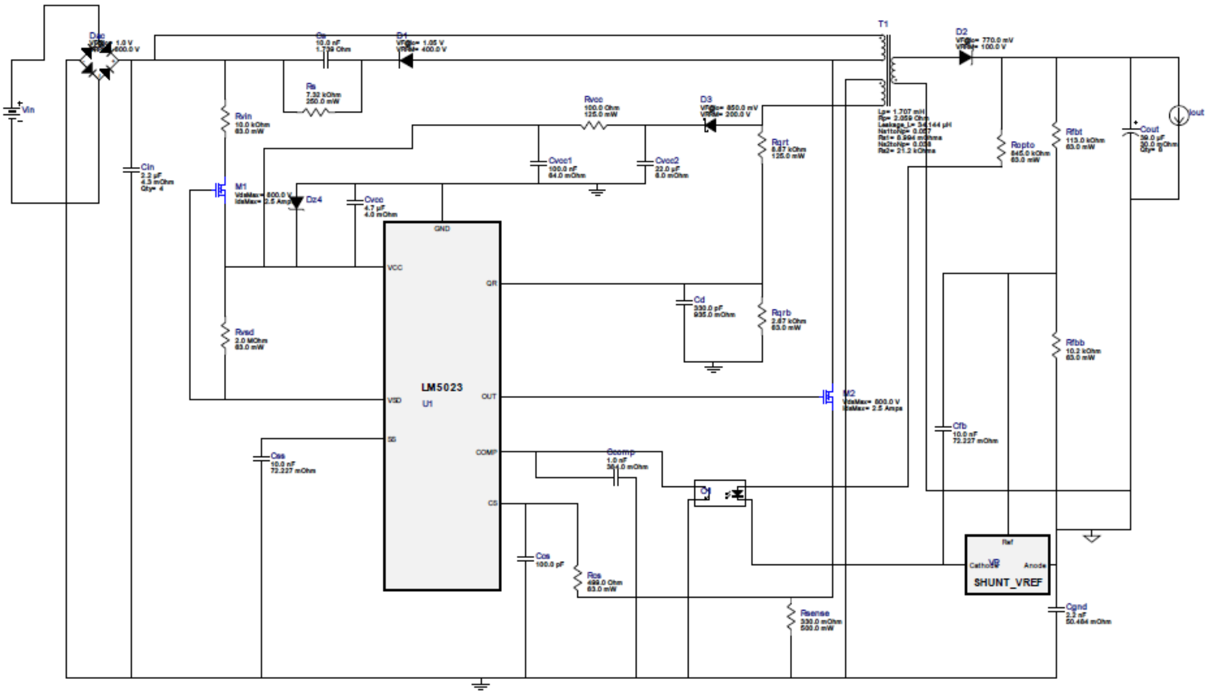


Fig. 10. Power supply circuit for the notebook generated in Webench Power Designer tool

V. Conclusion

The paper defines the main steps of the methodology for tools integration in the Online assisted Platform for Computer-aided design in communications and it illustrates some advantages for designers when using Online-CADCOM for developing high quality designs with reduces time cycle and outcome to prototype. Further results for Online-CADCOM structure and content, as well additional projects developed, will be presented in future works.

Acknowledgement

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