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Designing Integrated FET Regulators Using iSim v3

Description

Intersil's iSim is a simple, highly interactive and dynamic web-based tool for selecting and simulating devices from Intersil's broad portfolio. iSim v3, the new version of iSim, takes this one step further to include new advanced capabilities for selecting, simulating and optimizing current and voltage mode controllers with integrated FETs.

Using iSim v3 is as simple as:

1. Enter design goals such as input and output specifications, as well as additional features such as SYNCH capability, Power-On Reset, Digital Control, etc.
2. Select part from among recommended devices.
3. Perform a quick AC/Transient Analysis online. Tweak compensation components and see closed-loop response change on the fly.

iSim v3 also enables the designer to look at efficiency graphs and power loss distribution across components. In addition, it provides the user actual vendor part numbers which makes creating the Bill of Materials easy and ready to order.

This Application Note describes the newly added features in iSim v3 and how they can reduce design effort and accelerate time-to-market. It takes the reader through the flexible and highly intuitive user interface which is designed to make the tool ready-to-use and multiply productivity.

Accessing iSim v3

The iSim v3 tool can be accessed from the Intersil homepage under the "Design Resources and Tools" section, as shown in Figure 1. Currently, this version of the tool is being offered only for Integrated FET products.

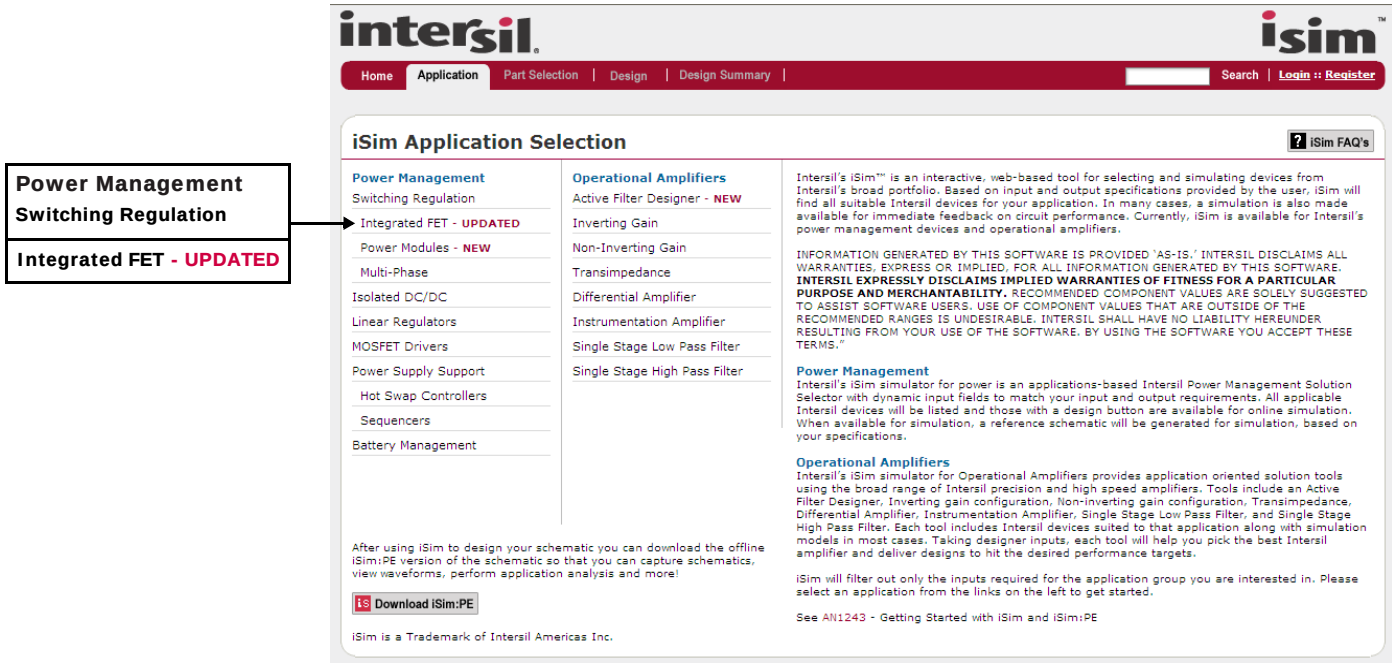

FIGURE 1. HOW TO REACH iSiM v3

iSim v3 Design Flow Overview

Figure 2 shows the design flow for the iSim v3 simulation tool with user inputs and responses from the tool.

The tool simplifies and accelerates the entire custom design by taking the user through a robust step-by-step process of selecting discrete parts by providing recommendations based on the user's design goals. iSim v3 has been designed for use with Intersil current and voltage mode controllers with Integrated FETs. The tool design flow has four main steps:

1. Requirement Specification
2. Advanced Design Section
3. Analysis and Optimization
4. Design Reports Generation

The “Requirement Specification” on page 3 describes these steps in detail.

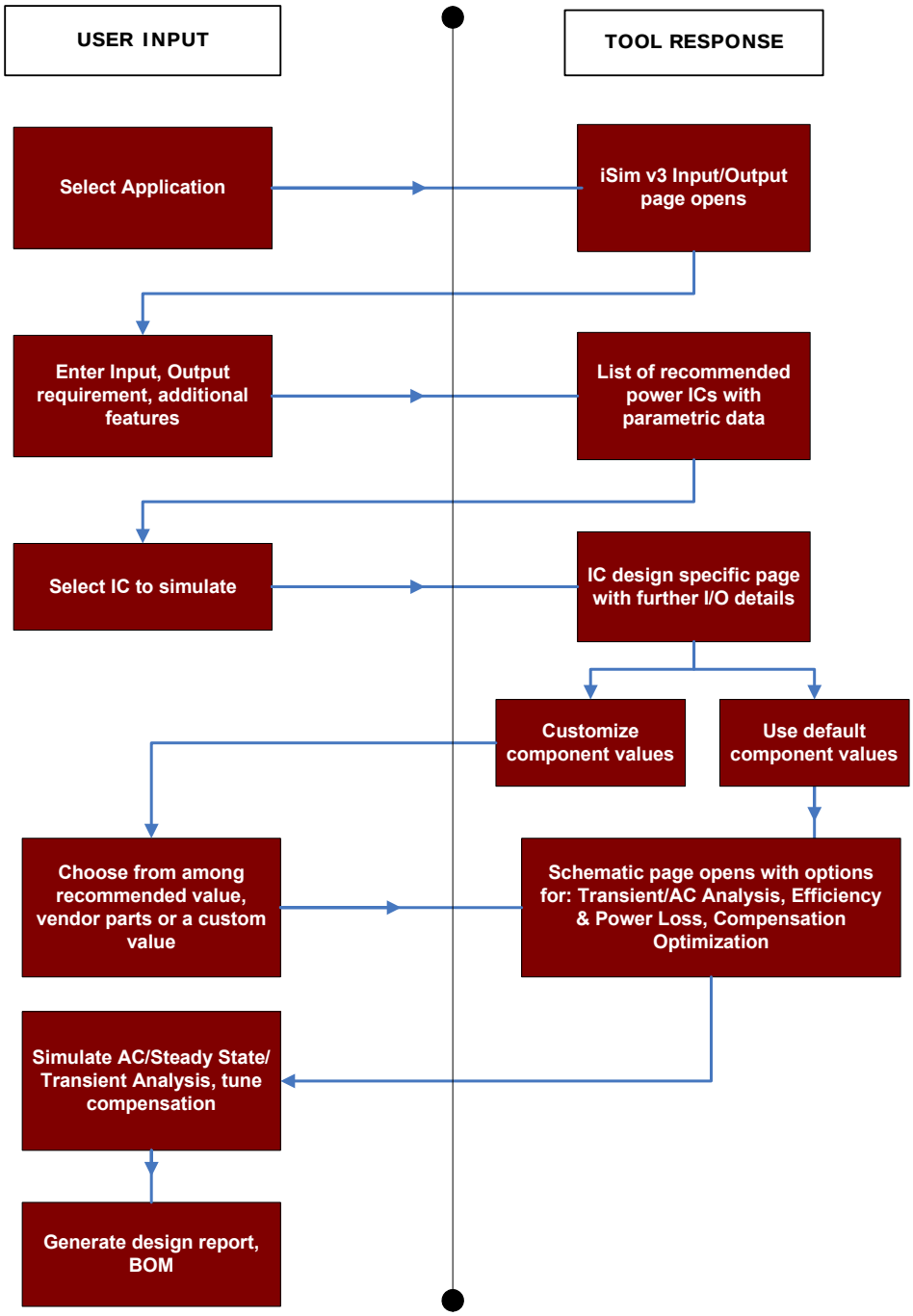

FIGURE 2. iSim v3 DESIGN FLOW

Requirement Specification

The user may enter Input and Output requirements for their design, as well as additional features they may require, such as SYNCH capability, Power-On-Reset, Digital Control, etc. The tool also provides the flexibility to enter requirements for multiple output voltages and the option to select between switching power supplies or LDOs.

Clicking the **Search** button, as shown in Figure 3, lists all Intersil Integrated FET parts that satisfy the user requirements, as well as useful parametric information.

The user may select parts from the **Device** column for further analysis and simulation. iSim models are available for those parts that are highlighted with a hyperlink. Links to the datasheet are available for all parts in the list.

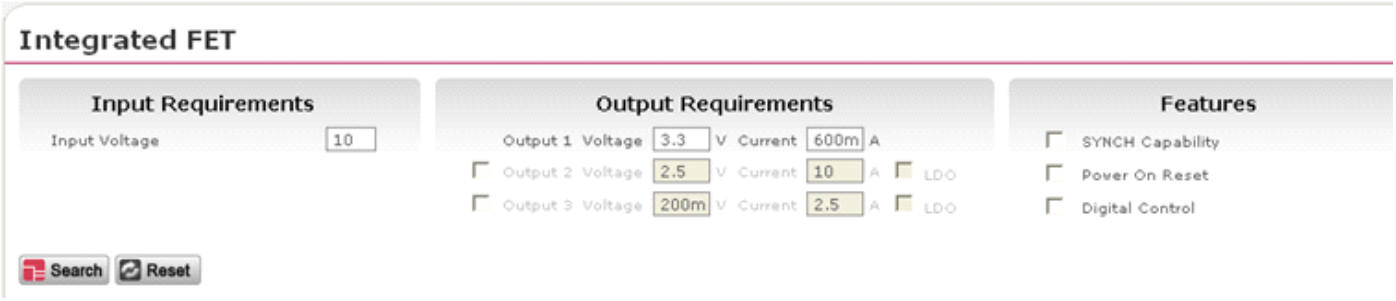

FIGURE 3. INPUT/OUTPUT REQUIREMENTS SPECIFICATION

Device	Info	Description	VIN (V) min	VIN (V) max	VOUT (V) min	VOUT (V) max	IOUT (A) max	Control Type	Switching Frequency (MHz)	Peak Efficiency (%)	BOM Footprint	Package(s)
ISL85001	DS	1A Standard Buck PWM Regulator	5.5	25	0.6	19	1	Voltage Mode	0.5	94	*	12 Ld QFN
ISL8510	DS	Dual Output Controller with 1A Standard Buck PWM and LDO	5	25	0.6	22	1	Voltage Mode	1	95	*	24 Ld QFN
ISL8501	DS	Triple Output Controller with 1A Standard Buck PWM and Dual LDOs	5	25	0.6	22	1		0.5	95	*	24 Ld QFN
ISL8500	DS	2A Standard Buck PWM Regulator	5.5	25	0.6	19	2	Voltage Mode	0.5	94	*	12 Ld QFN
ISL8502	DS	2A Synchronous Buck Regulator with Integrated MOSFETs	4.5	14	0.6	14	2	Voltage Mode		95	*	24 Ld QFN
ISL8540	DS	DC/DC Power Switching Regulator	9	40	1.21	35	2	Voltage Mode		95	*	20 Ld HTSSOP
ISL8560	DS	DC/DC Power Switching Regulator	9	60	1.21	55	2	Voltage Mode		95	*	20 Ld EPTSSOP,20 Ld QFN
ZL2105	DS	3A Integrated Digital DC-DC Converter	4.5	14	0.54	5.5	3	Digital		92	*	36 Ld QFN
ZL2106	DS	6A Digital-DC Synchronous Step-Down DC-DC Converter	4.5	14	0.54	5.5	6	Digital		87	*	36 Ld QFN

FIGURE 4. PARAMETRIC SEARCH RESULTS

Advanced Design Section

The Custom Design button brings up the advanced design section shown in Figure 5. The user can enter detailed design specifications and choose the circuit component based on the recommended value. The user can determine the output inductor, output capacitor, input capacitor or diode based on different parts. Enter design requirements such as inductor ripple and switching frequency and then choose from recommended values, vendor parts and user's own value. The recommended values are calculated based on the user's input requirements.

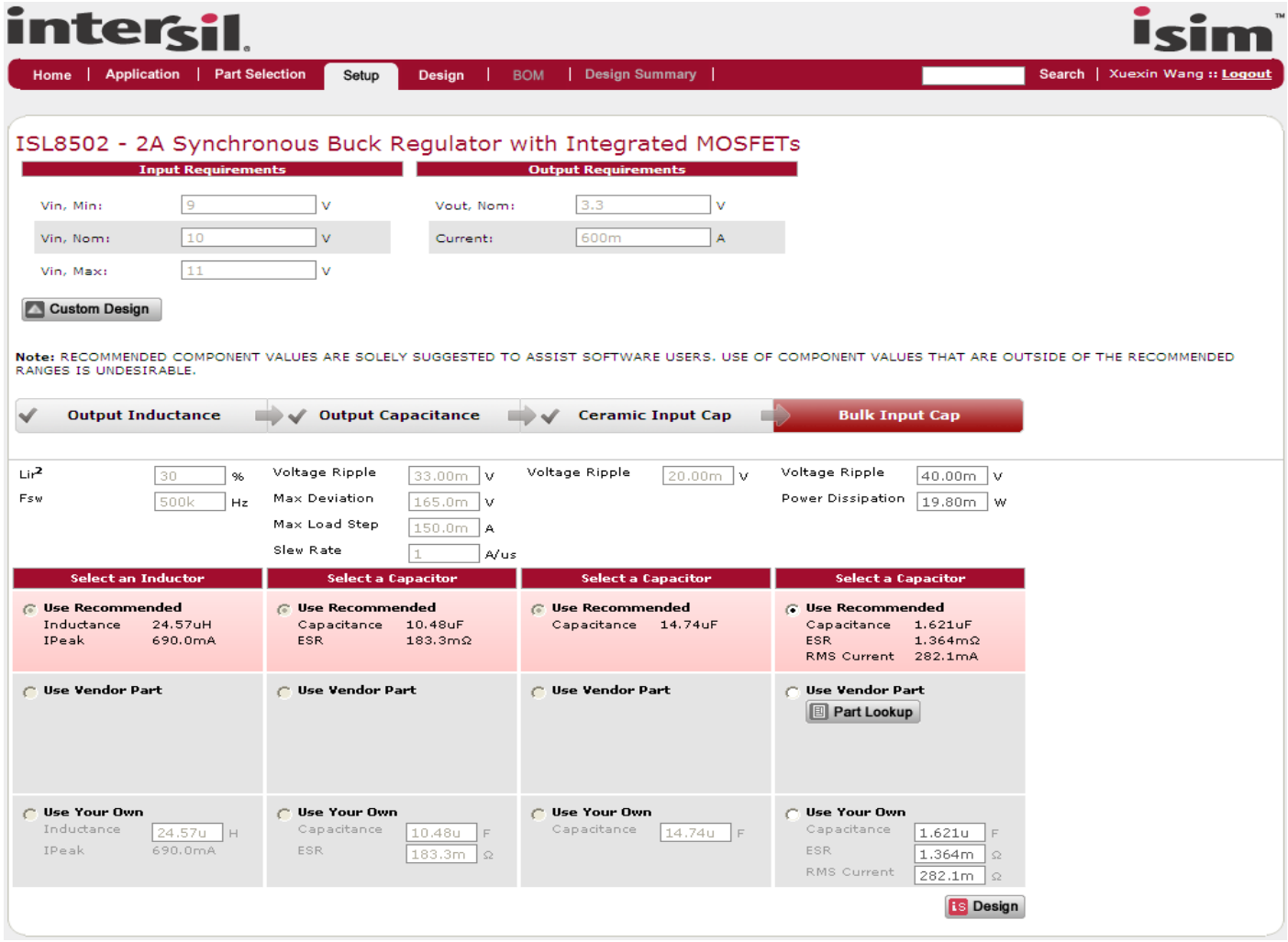

FIGURE 5. ADVANCED DESIGN SECTION

Vendor part selection is for users to look up parts from a vendor database (DigiKey in this case). The part lookup icon brings up the vendor part selection interface shown in Figure 6. The recommended values are shown on the top as reference. User can specify the limitations of the component values by tweaking the scroll bar or clicking the pencil icon on the left and entering the desired limits manually. User can also choose the manufacturer and tolerance. Click "APPLY FILTERS" and only the parts within the range will be shown in the list below. The applied limitations will be displayed (see Figure 6) by clicking "View Applied". User can also reset the limitations to default settings by clicking "Reset" or clear all limitations by clicking "Clear All".

Once the user selects the component, click "→" icon next to the DigiKey part number and the browser will be directed back to the set-up page. The part number and component parameters will be displayed under the Part Lookup icon, as shown in Figure 7.

The component value can be entered in "Use Your Own" section when the user already has the component. Once the component has been selected, click Continue and the user will be directed to next stage. After completing the setup, click Design and the tool will generate the design schematic.

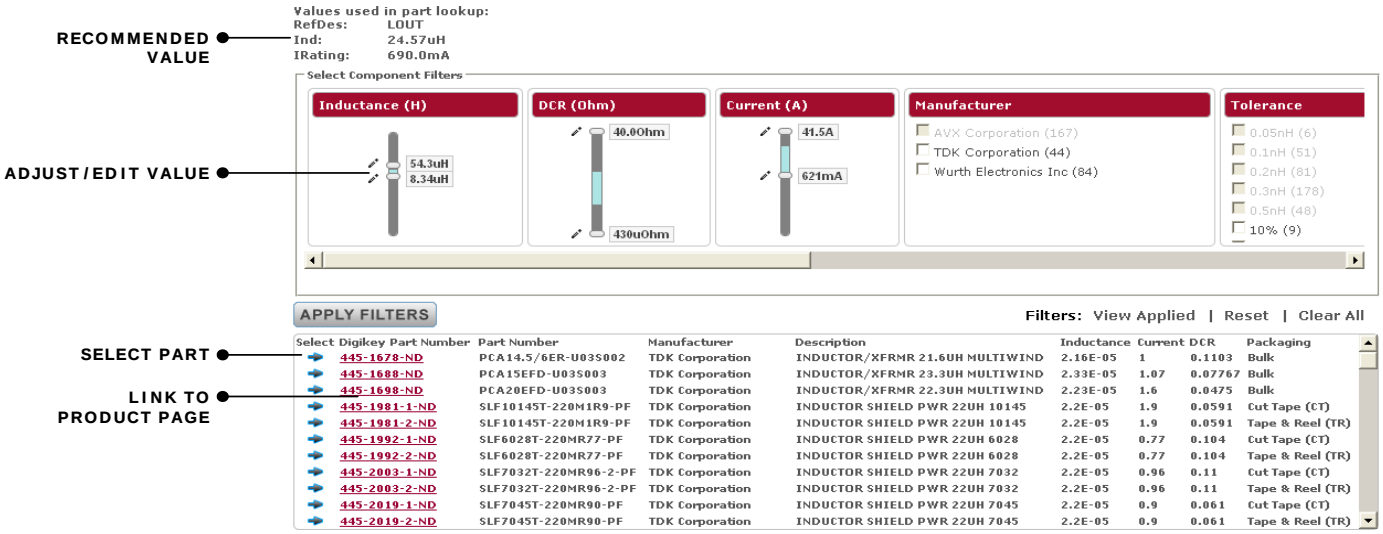

FIGURE 6. VENDOR PART SELECTION INTERFACE

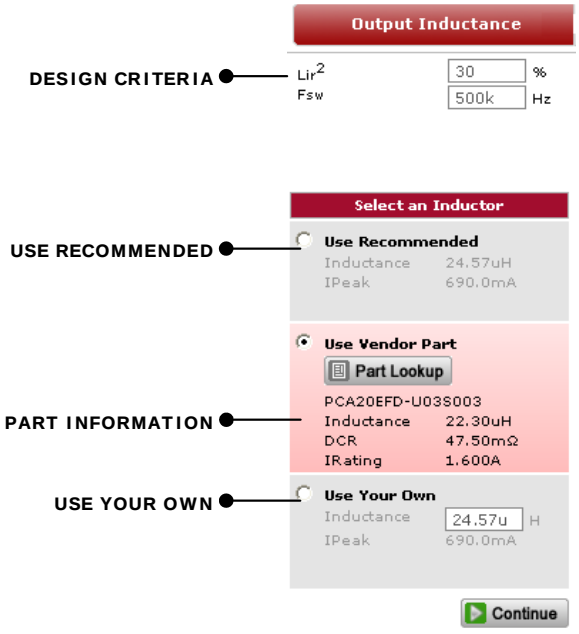

FIGURE 7. PART SELECTION INTERFACE

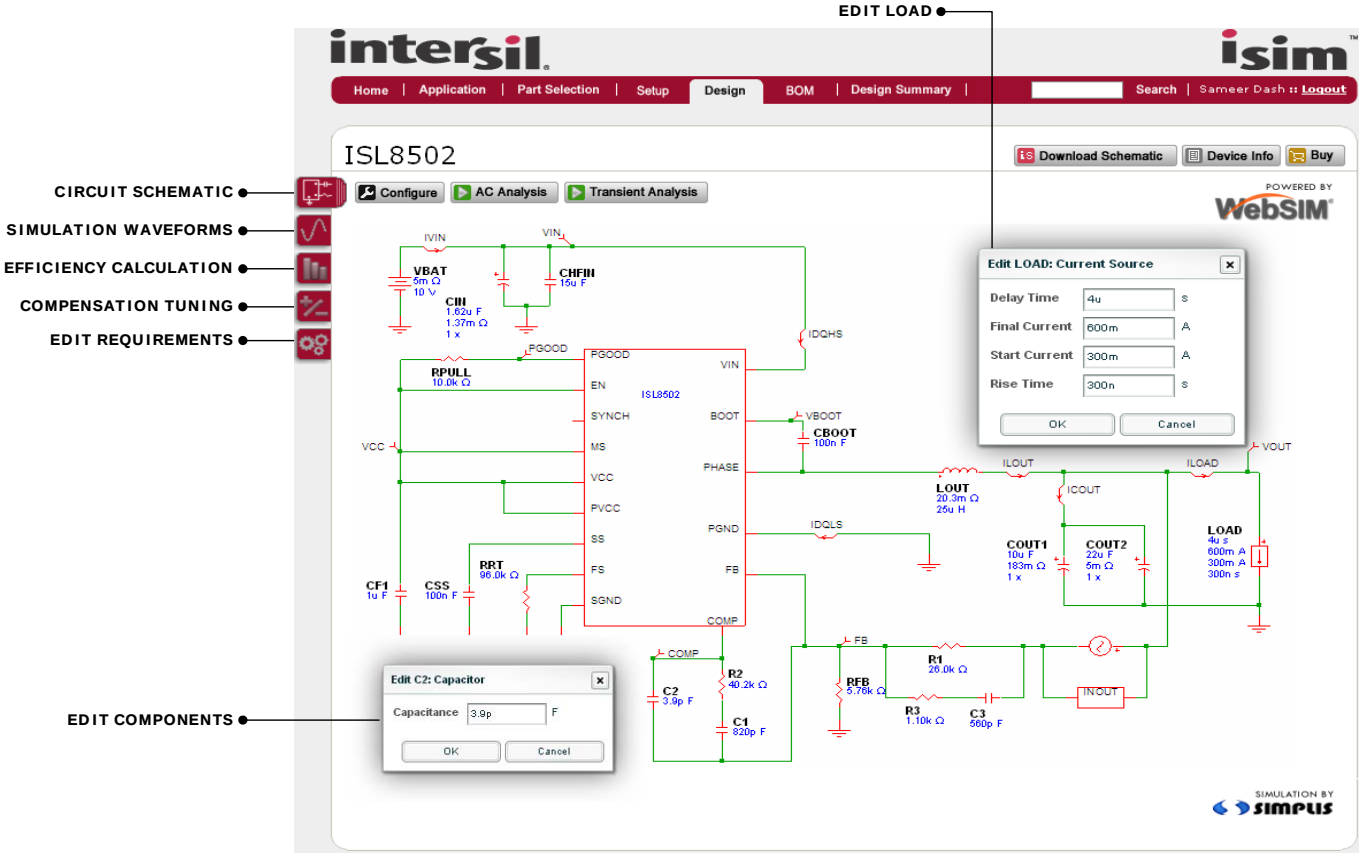

FIGURE 8. ISL8502 iSim v3 DESIGN PAGE

Analysis and Optimization

The next stage in the process is the Design Page. This includes advanced new features for editing the application schematic, performing AC and Transient Analysis, Efficiency Calculations, Compensation tuning, and editing input and output requirements - all in one simple and easy-to-use interface. Figure 8 illustrates the Design Page for the ISL8502 as an example.

Transient Analysis

The Transient Analysis can be used to analyze the circuit's behavior in response to an output load step. The Configure button is used to set the Simulation Stop Time and the LOAD can be clicked to set the Delay time, Final Current, Start Current and Rise Time of the LOAD, as shown in Figure 8.

Once the settings are configured, click the Transient Analysis button to start the simulation. Resulting waveforms can be viewed by clicking the tab on the left. Figure 9 shows the ISL8502 transient response to the 300mA load step.

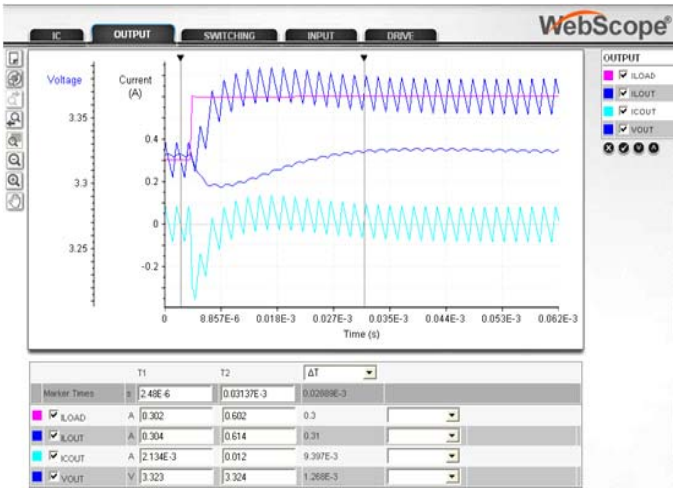

FIGURE 9. TRANSIENT ANALYSIS RESULTS

AC Analysis

The AC Analysis can be used to view the bode plot of the small signal response of the circuit in the frequency domain. The Configure button can be used to set the start and stop frequency of the AC Analysis.

Once the settings are configured, click the AC Analysis button to start the simulation. Similar to Transient Analysis, the resulting waveforms can be viewed by clicking the tab on the left.

Figure 10 shows the ISL8502 AC response and also indicates the Phase Margin and Crossover Frequency.

Efficiency / Power Loss Distribution

iSim v3 enables the user to estimate the efficiency of their design. The user may click on the tab on the left to view the efficiency calculation worksheet, as shown in Figure 11.

The tool also enables the user to study Power Loss across the primary components of the circuit and also displays conduction losses and power losses separately. In addition, the user also has the flexibility to modify circuit parameters such as switching frequency, output inductor and capacitor, and view the change in efficiency and power loss graphs.

FIGURE 10. AC ANALYSIS RESULTS

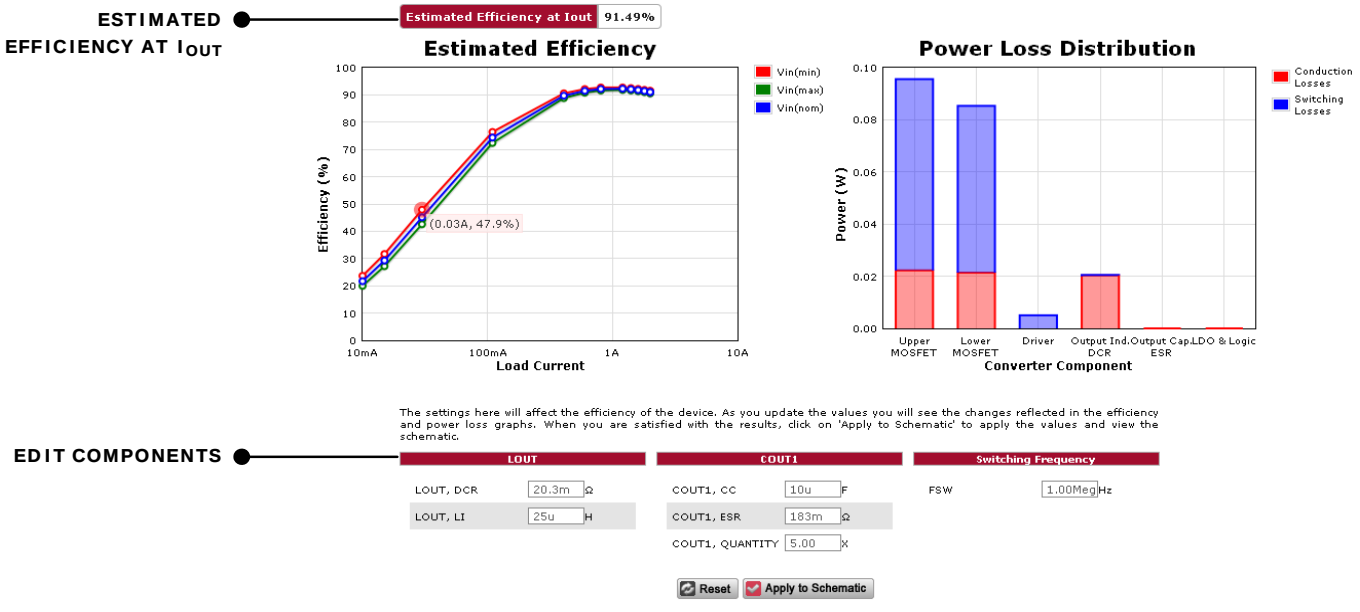

FIGURE 11. EFFICIENCY CALCULATION WORKSHEET

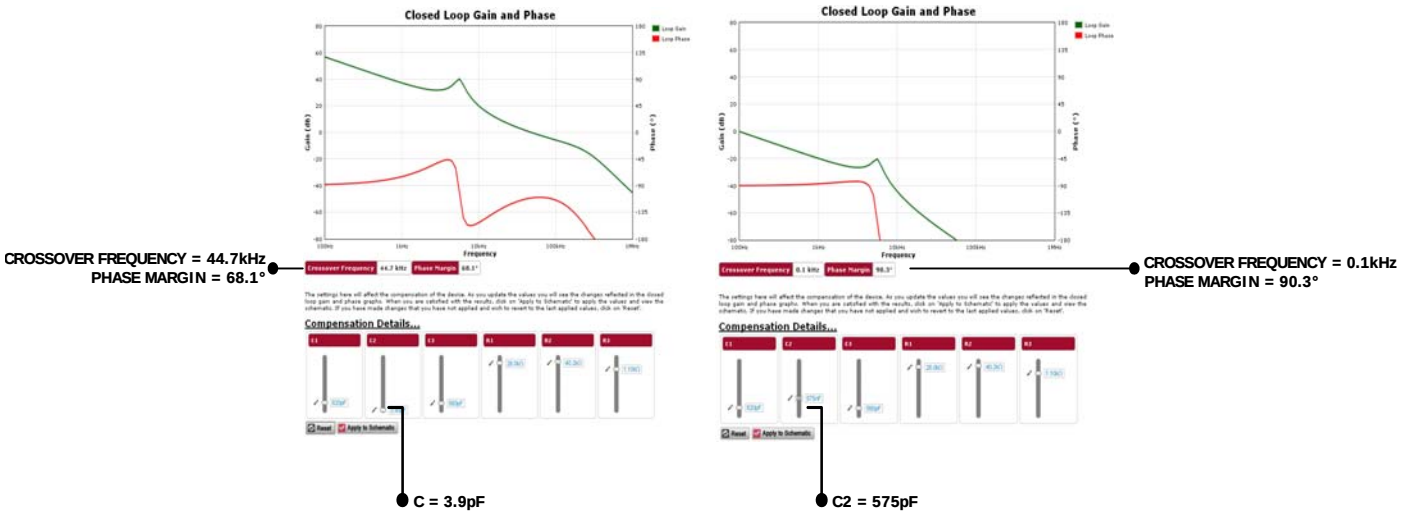

FIGURE 12. COMPENSATION TUNING EXAMPLE

Compensation Tuning

The compensation tuning feature on iSim v3 allows the user to change the values of compensation components and also view the change in the bode plot to achieve the desired gain and bandwidth for the system. To tune the compensation components, click on the tab on the left.

The slide bars allow the user to intuitively change the values of the components and then apply them to the schematic using the Apply to Schematic button.

Figure 12 illustrates how a change in the value of a compensation component (C2 in this case) results in a change in bandwidth and phase margin.

Editing Input, Output Requirements

If the user wishes to change the input and output requirements for voltage and current, this can be done using the tab on the left, as shown in Figure 13. Clicking Design button re-starts the design with the new requirement specifications.

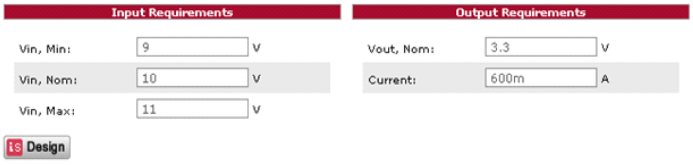

FIGURE 13. RE-DESIGN OPTION

Design Reports Generation

Once the user has completed the design, iSim v3 offers the convenient option to download the following items:

1. **BOM:** The tool allows the user to view a Bill of Materials reflecting the design schematic developed by the user, with actual Manufacturer and Vendor Part Numbers from Digikey as shown in Figure 14. It also provides pricing information and the option to order these parts using the CHECKOUT button. The Bill of Materials can be viewed using the BOM tab on the top. The user may download the BOM in Microsoft Excel format using the BOM button under the Design Summary tab on the top.
2. **Design Summary:** The user may also download a summary of the entire design including Input, Output requirements, Schematic and Bill of Materials using the PDF Download button under the Design Summary tab on the top.
3. **Schematic for iSim PE:** After using iSim to design the schematic, the user can download the offline iSim:PE version of the schematic, using the Download Schematic button, to edit schematics, add or delete components, view waveforms and perform application analysis on their desktop. iSim:PE is a complete offline tool and is powered by the Simplis/Simetrix simulator.

Conclusion

iSim v3 is the new version of Intersil's iSim tool and is designed specifically for Integrated FET parts. The tool implements several new features to help designers quickly select the best components and then simulate and optimize their design. New features in iSim v3 include efficiency graphs, power loss distribution, bill of material generation, and dynamic tuning for compensating closed loop response. The application note illustrates these features using examples to serve as a quick manual for designers and prepare them to quickly evaluate and generate an actual credible design based on the customer's requirements.

BOM Powered By Digi-Key

CHECKOUT x 100 Boards

Price Break: 100

Ref	Qty	Digi-Key Part Number	Manufacturer Part Number	Manufacturer	Description	#	$
U1	1	ISL8502IRZ-TCT-ND	ISL8502	Intersil	IC REG SYNC BUCK 2.5A 24QFN	#	5.37000
C1	1	04023C821KAT2A-ND	04023C821KAT2A	AVX Corporation	CAP CER 820PF 25V X7R 0402	DK #	0.57800
C2	1	0201ZA4R7CAQ2A-ND	0201ZA4R7CAQ2A	AVX Corporation	CAP CER 4.7PF 10V NP0 0201	DK #	0.07900
C3	1	04025C561JAT2A-ND	04025C561JAT2A	AVX Corporation	CAP CER 560PF 50V X7R 0402	DK #	0.06700
CBOOT	1	0306ZD104KAT2A-ND	0306ZD104KAT2A	AVX Corporation	CAP CER .10UF 10V X5R 0306	DK #	0.42875
CF1	1	0508ZC105MAT9A-ND	0508ZC105MAT9A	AVX Corporation	CAP CER 1.0UF 10V X7R 0508	DK #	0.71750
CHFIN	1	490-1945-1-ND	GRM55ER71E156KA01L	Murata Electronics North America	CAP CER 15UF 25V 10% X7R 2220	DK #	5.38200
CIN	1	478-1658-1-ND	TAJA155K020RNJ	AVX Corporation	CAP TANTALUM 1.5UF 20V 10% SMD	DK #	0.35000
COUT1	1	478-1762-1-ND	TPSC106K025R0500	AVX Corporation	CAP TANT LOWESR 10UF 25V 10% SMD	DK #	0.88000
COUT2	1	12106Z226KAT2A-ND	12106Z226KAT2A	AVX Corporation	CAP CER 22UF 6.3V 10% X7S 1210	DK #	0.80500
CSS	1	02014D104KAT2A-ND	02014D104KAT2A	AVX Corporation	CAP CER .10UF 4V 10% X5R 0201	DK #	0.10500
LOUT	1	445-1028-1-ND	MLF1608C180K	TDK Corporation	INDUCTOR MULTILAYER 18UH 1608	DK #	0.41000
R1	1	14.3KXTR-ND	MFR-25FRF-14K3	Yageo	RES 14.3KOHM 1/4W 1% METLFLM T/R	DK #	0.02138
R2	1	311-35.7KCRTR-ND	RC0805FR-0735K7L	Yageo	RES 35.7K OHM 1/8W 1% 0805 SMD	DK #	0.00420
R3	1	2312 396 71152-ND	MCA12060D1151BP500	Vishay/BC Components	RES 1.15K OHM 1/8W .1% SMD 1206	DK #	0.34800
RFB	1	311-5.76KFRDKR-ND	RC1206FR-075K76L	Yageo	RES 5.76K OHM 1/4W 1% 1206 SMD	DK #	0.08200
RPULL	1	10.0KAVTB-ND	FMP300FTF73-10K	Yageo	RES MET FILM 10K OHM 3W 1% AX	DK #	0.07400
RRT	1	100K8FTB-ND	HHV-50JT-52-100K	Yageo	RES MET FILM 100K OHM 1/2W 5% AX	DK #	0.11300

FIGURE 14. BILL OF MATERIALS PAGE

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