WEBENCH®
Design Center
Tools

Today's Agenda

- WEBENCH® Road Map & Vision – 10 minutes
- WEBENCH® Power Designer: Optimize Rails, Simulate, Share Designs, Coupons, & Leads – 50 minutes
- WEBENCH® Visualizer: A Great Selling Tool – 10 minutes
- WEBENCH® System Power Architect : FPGA, Processor, Hot Swap, Isolation, LDOs, Filters - 30
- WEBENCH® FET Selection & Design Optimization – 20

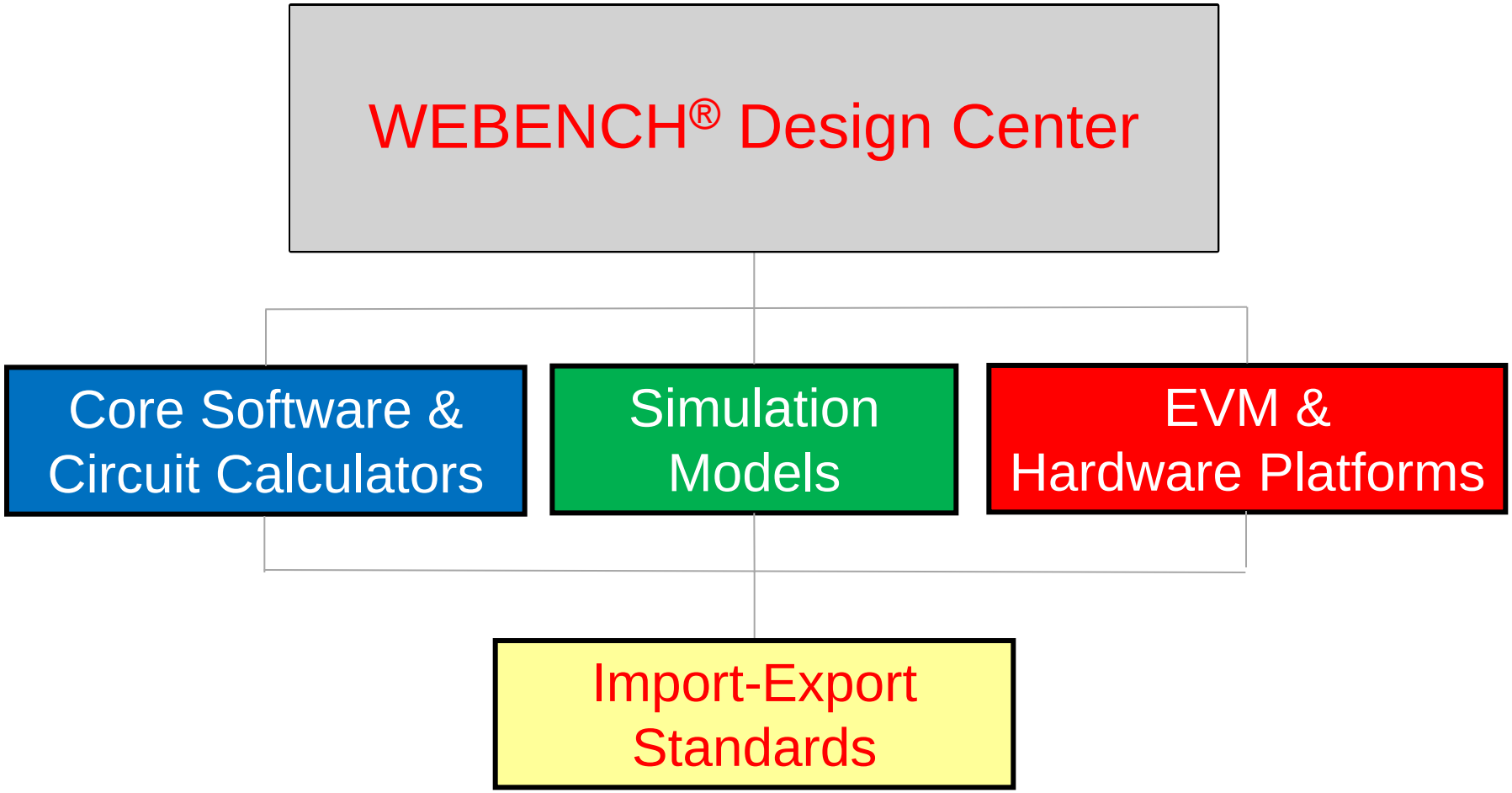
WEBENCH® Tool Industry Awards

- 2011 EDN “Innovation of the Year”
  - WEBENCH FPGA Power Architect
- 2010 Electronic Design “Year’s Best - Power”
  - WEBENCH LED Architect
- 2009 EDN “Innovation of the Year”
  - WEBENCH Power/LED Designer
- 2008 Electronic Products “Product of the Year”
  - WEBENCH Sensor Designer
- 2006 IEC “DesignVision” Award
  - WEBENCH Designer
- 2005 EDN “Innovation of the Year”
  - WEBENCH Active Filter Designer
- 2001 EDN “Innovation of the Year”
  - WEBENCH 3.0
- 2000 Electronic Products “Product of the Year”
  - WEBENCH 1.0

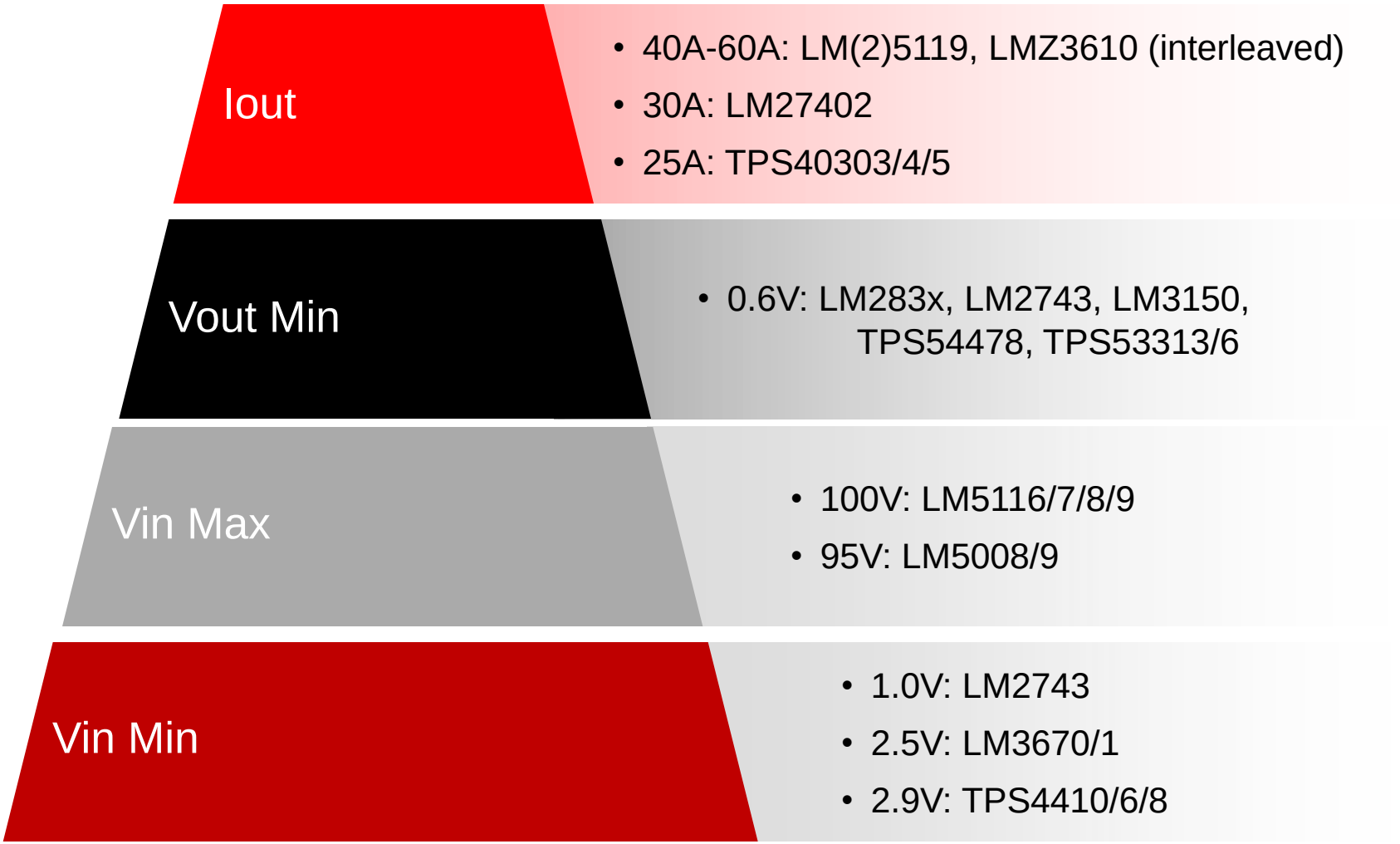
WEBENCH® Mission

Instant Ease of Use	WEBENCH® tools enable rapid comparison, selection, optimization, and prototyping for end to end analog system designs in the shortest time possible
Eco-System Accelerates Growth	Partner with industry leading component, subsystem, and supply partners to expand resources and gain share. Deliver superior performance solutions at the lowest cost in the shortest time possible
Customers Come First	Build loyal customer relationships by enabling new value in their products. Accelerate customers to market with useful design knowledge and timely advice. Grow TI Analog revenue at 2X the industry rate

WEBENCH® Development Vision



Coverage of WEBENCH Enabled Parts (Buck Switchers)



Immediate WEBENCH® Queue

Device	Vin	Vout	Iout	
TPS54062	4.7–60V	0.8–58V	0.05A	
TPS54325	4.5–18V	0.76–5.5V	3A	
TPS63020	1.8–5.5V	1.2–5.5V	3A	Buck-Boost
TPS40170	4.5–60V	0.6–50V	25A	
TLV62080/ TPS62080	2.5–5.5V	0.5–4V	1.2A	
TPS62080A	2.3–6V	0.5–4V	1.2A	
TPS62081	2.3–6V	1.8V	1.2A	
TPS62082	2.3–6V	3.3V	1.2A	
TLV62130	4–17V	0.9–5V	3A	
TLV62150	4–17V	0.9–5V	1A	
TPS51225/A/B/C	5.5–24V	3.3V & 5V	10A	
TPS54326	4.5–18V	0.76–5.5V	3A	Eco-Mode

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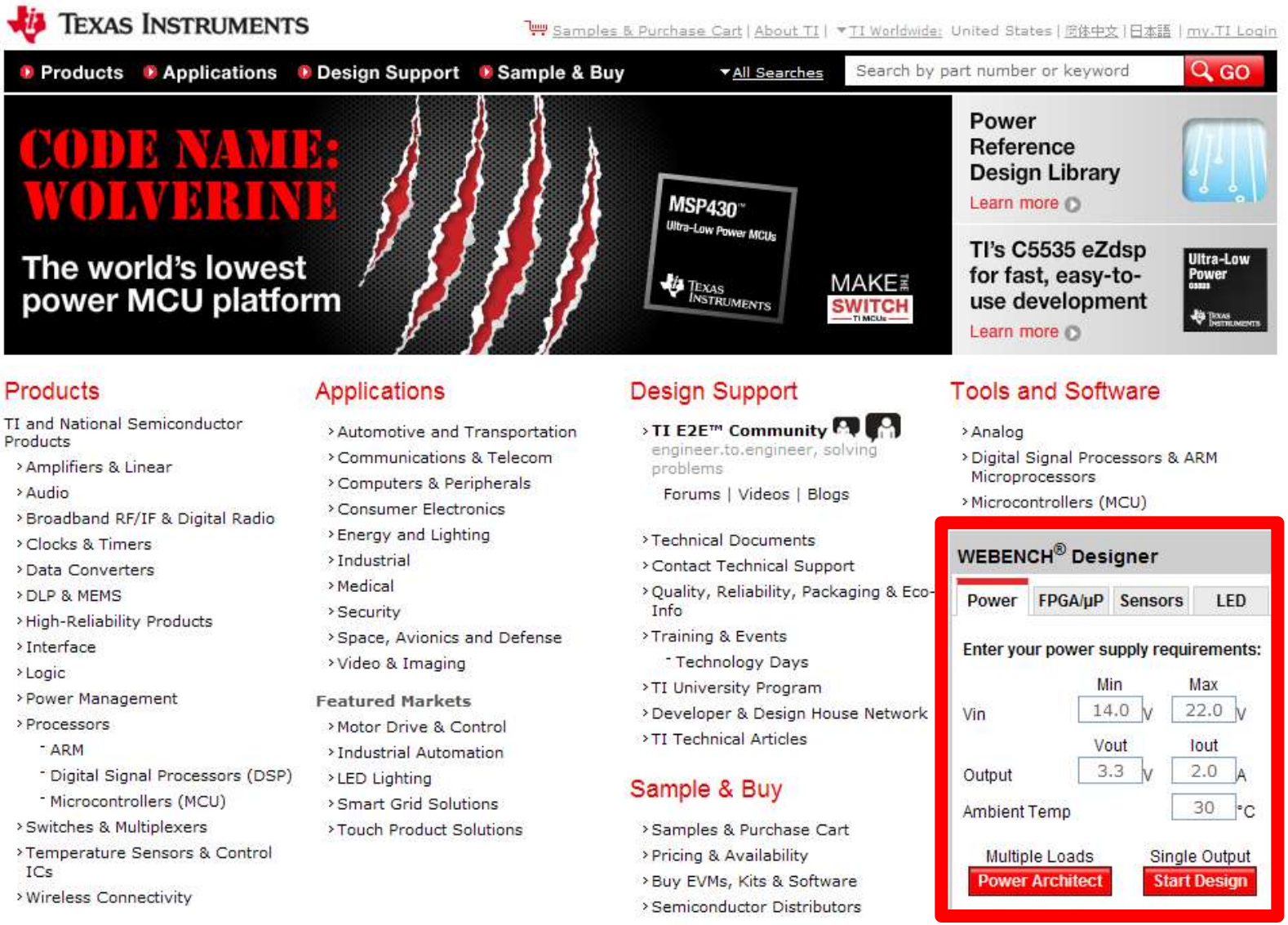
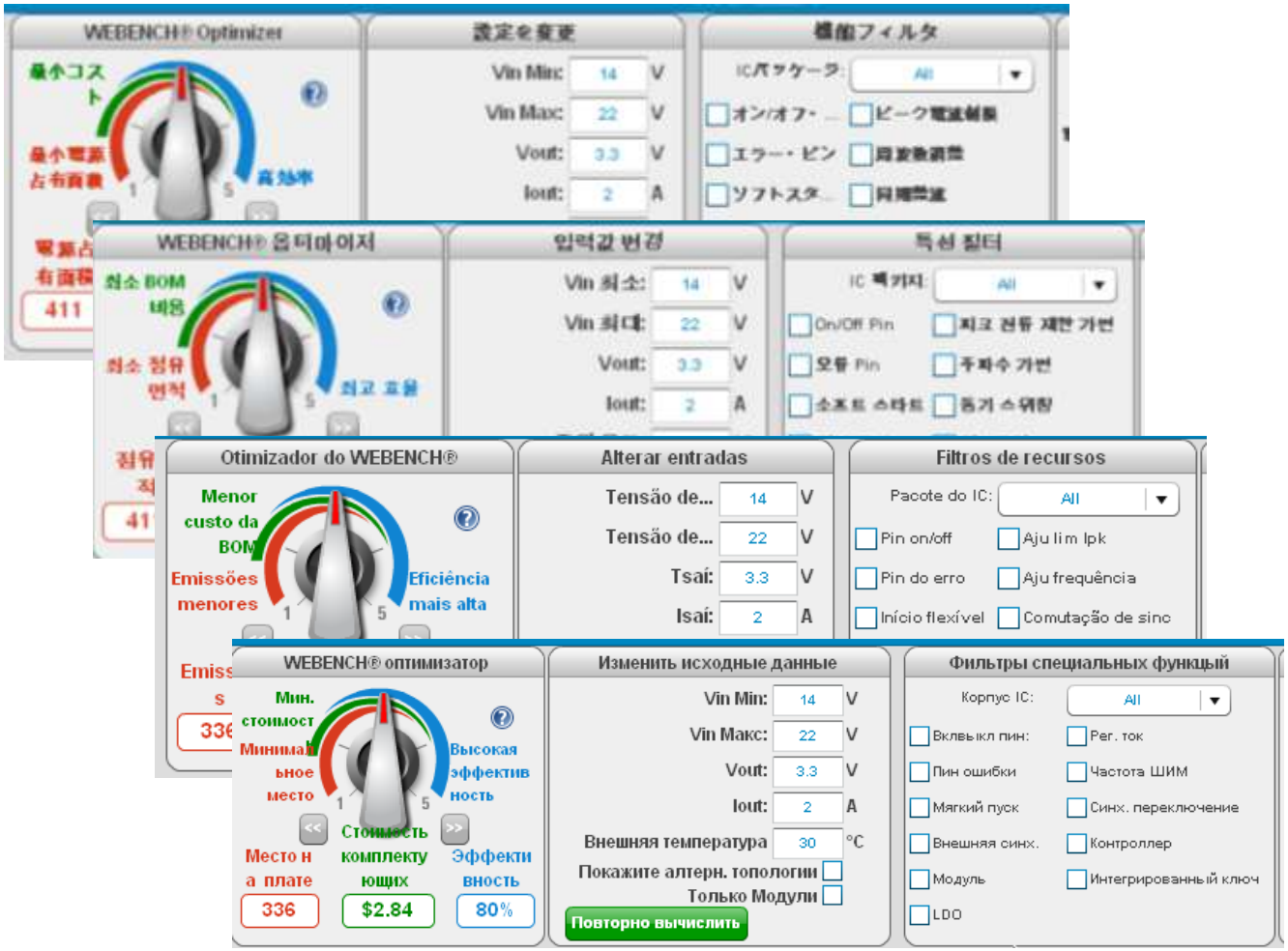
WEBENCH® Tools on TI.com

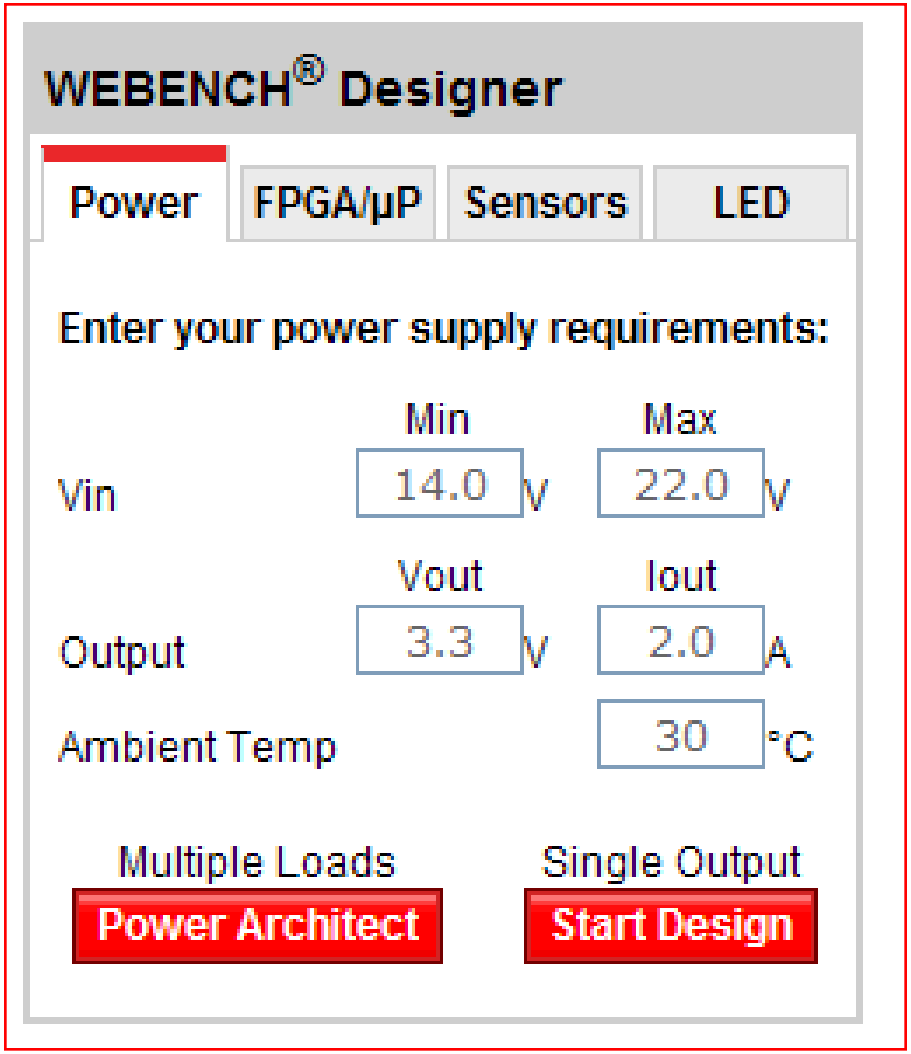


WEBENCH® Designer is Multi-Lingual

- English
- Japanese
- Simplified Chinese
- Traditional Chinese
- Korean
- Portuguese
- Russian



WEBENCH® Start Panel



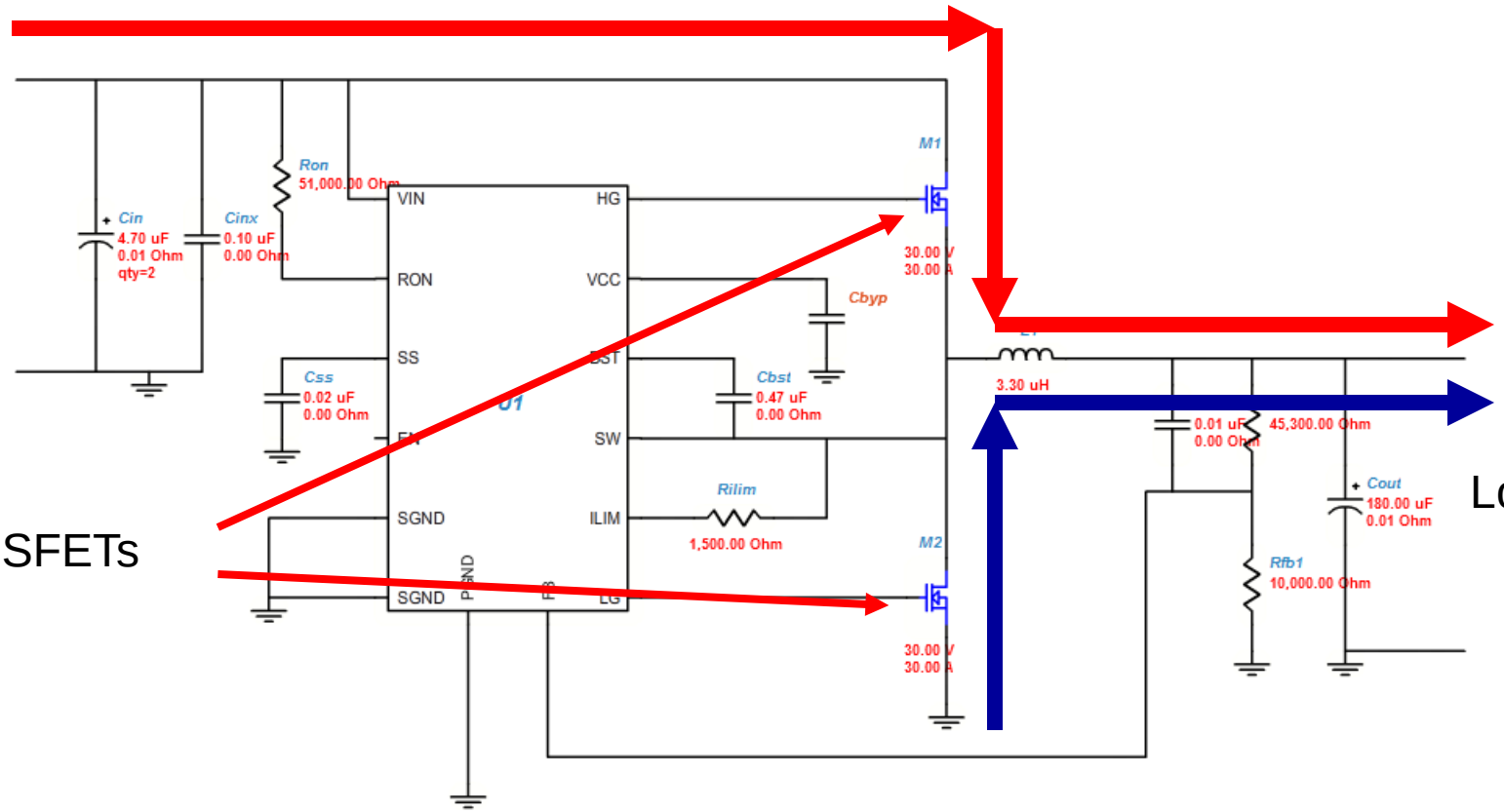
The Foundation Is Mathematics

WEBENCH® Designer Tools

Schematic – Synchronous Buck Controller

Input

Power MOSFETs

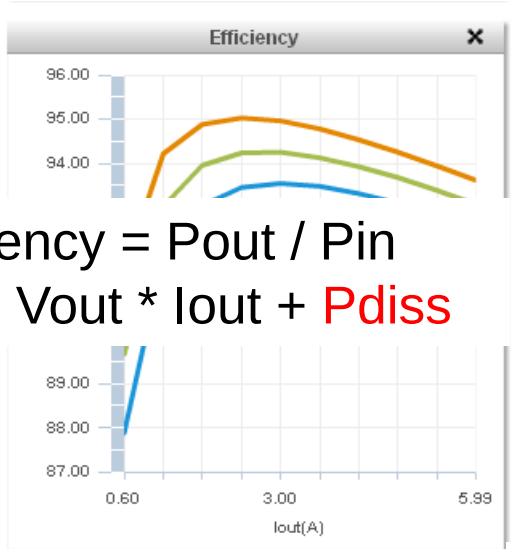


Load

Current Path with High Side Switch On

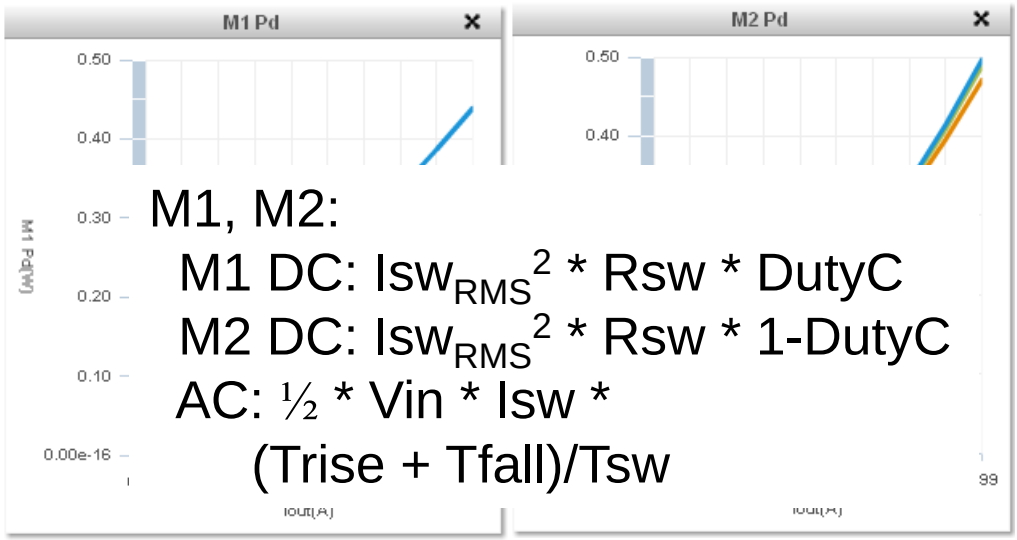
Current Path with High Side Switch Off

Visualize Behavior – Power Dissipation



Efficiency = Pout / Pin

Pin = Vout * Iout + Pdiss

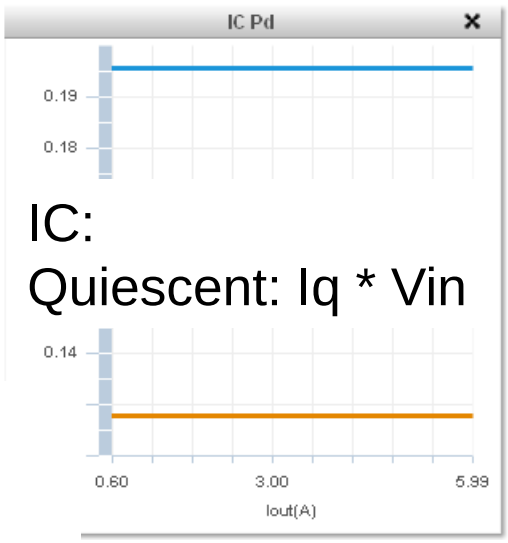


M1, M2:

M1 DC: Isw_{RMS}^2 * Rsw * DutyC

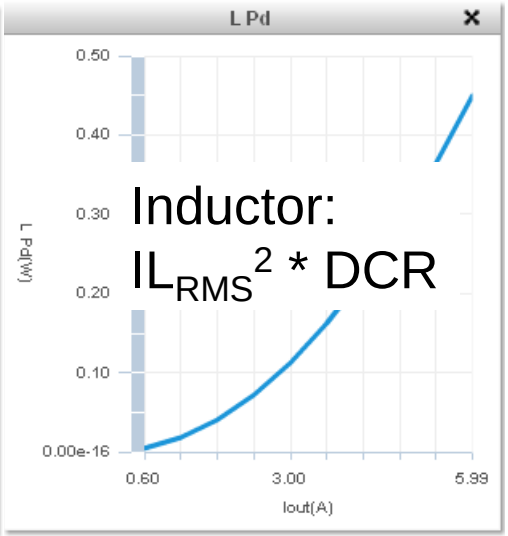
M2 DC: Isw_{RMS}^2 * Rsw * 1-DutyC

AC: ½ * Vin * Isw * (Trise + Tfall)/Tsw



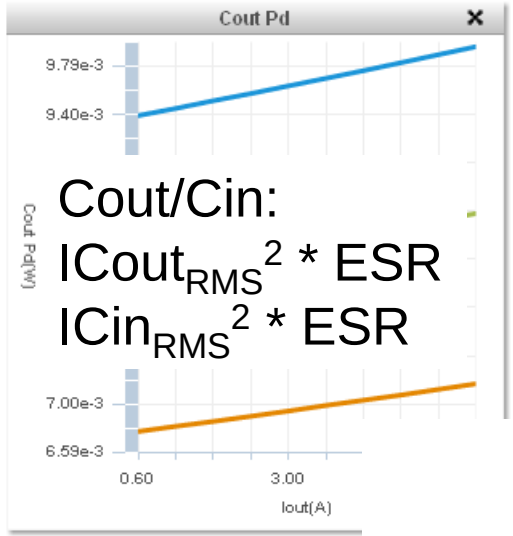
IC:

Quiescent: Iq * Vin



Inductor:

IL_{RMS}^2 * DCR



Cout/Cin:

$ICout_{RMS}^2$ * ESR

$ICin_{RMS}^2$ * ESR

WEBENCH Design Optimization

Optimization Setting	Frequency	Component Selection	Summary
1 – Smallest footprint	Highest	• Smallest footprint • Don't care about cost	Smallest size but lowest efficiency
2 – Lowest cost	High	• Lowest cost	High frequency means smaller / cheaper components
3 – Balanced	Medium	• In stock • Low cost	Balanced approach using IC's middle frequency
4 – High efficiency	Low	• Low DCR, ESR, Vf • Low cost	Higher efficiency, with low cost but larger parts
5 – Highest efficiency	Lowest	• Lowest DCR, ESR, Vf • Don't care about cost	Highest efficiency but largest parts

Optimization Summary

- **To get high efficiency (lean toward 5)**
  - **Decrease frequency to reduce AC losses**
  - **Choose components with low resistance**
- **To get small footprint (lean toward 1)**
  - **Increase frequency to reduce inductor size**
  - **Choose components with small footprint**
- **Cost (usually 2)**
  - **Smaller components usually cheaper**

These parameters are at odds with each other and need to be balanced for a designer's needs

WEBENCH® Design And Prototyping

1. Choose a Part

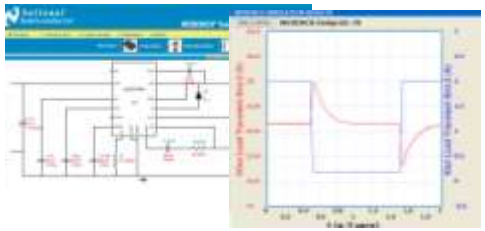
Enter Specifications

Select Part

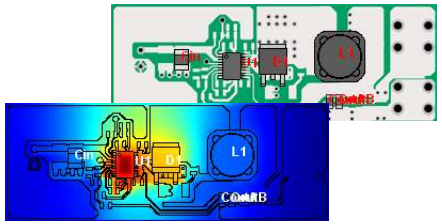
2. Create a Design

Optimize for Footprint and Efficiency, Use Graphs to Visualize Design

3. Analyze a Design



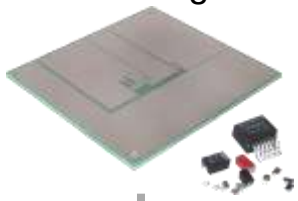
Generate Schematic/ Electrical Analysis



Generate Layout/ Thermal Analysis

4. Build It!

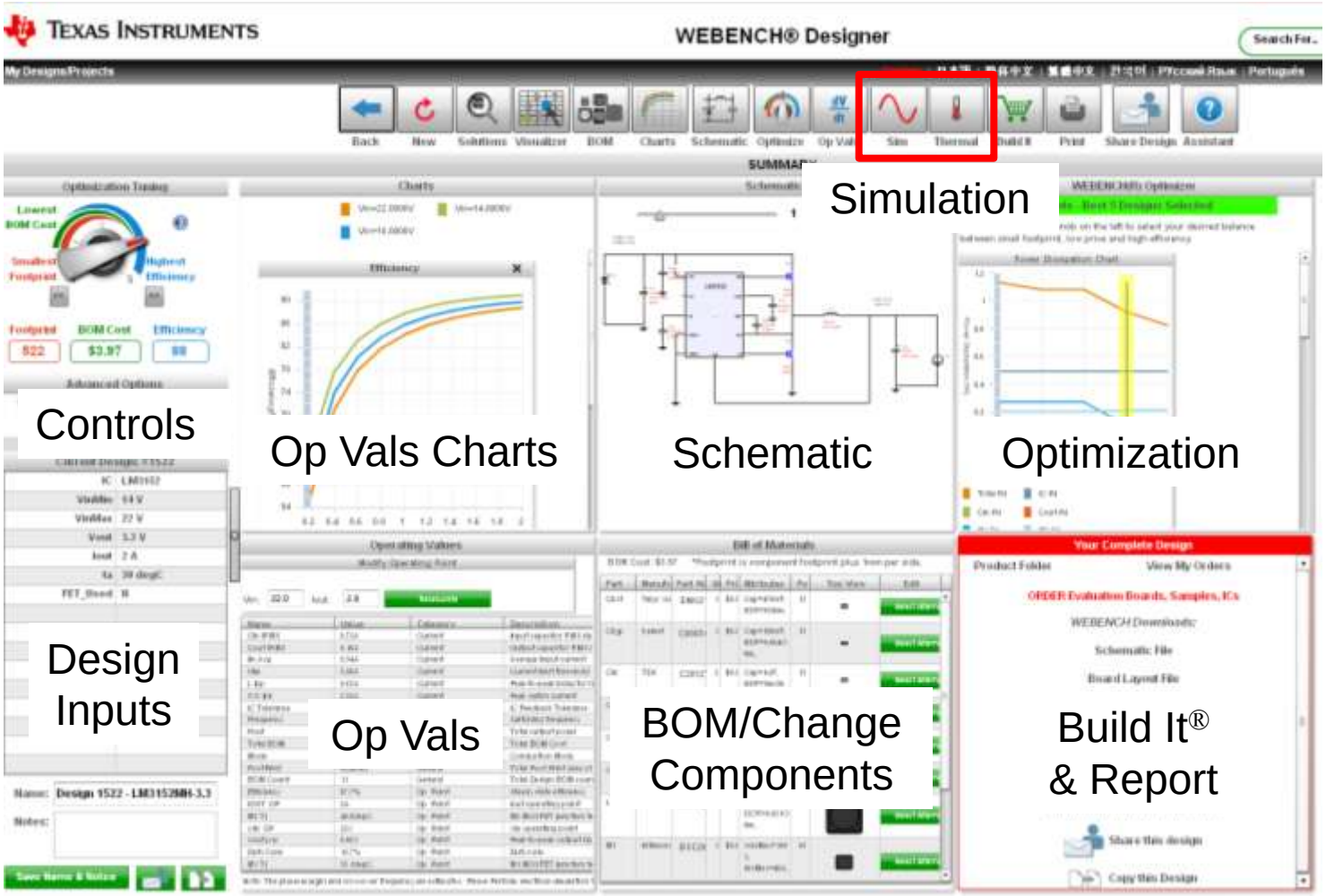
Custom Prototype Kit Overnight



Prototype

The WEBENCH® Designer Dashboard

Dashboard
1) Graphs
2) Schematic
3) Optimization
4) Operating values
5) BOM
6) Reporting
7) Electrical and Thermal Simulation

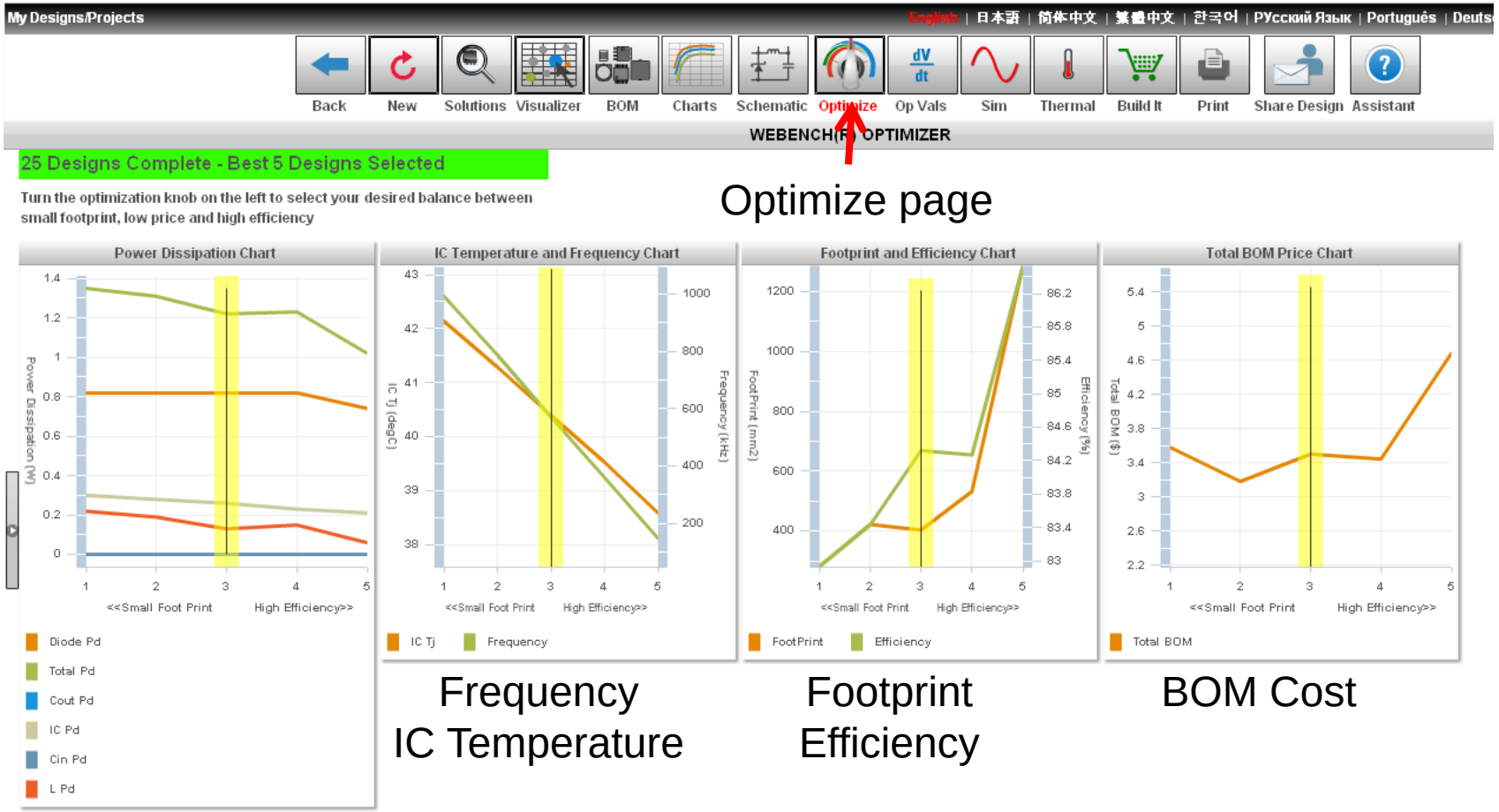


Easy Design Optimization & Tuning

WEBENCH Optimizer Knob

User entry parameters:
- Frequency
- Soft start time

Key Optimization Parameters Graphed



Optimize page

Frequency
IC Temperature

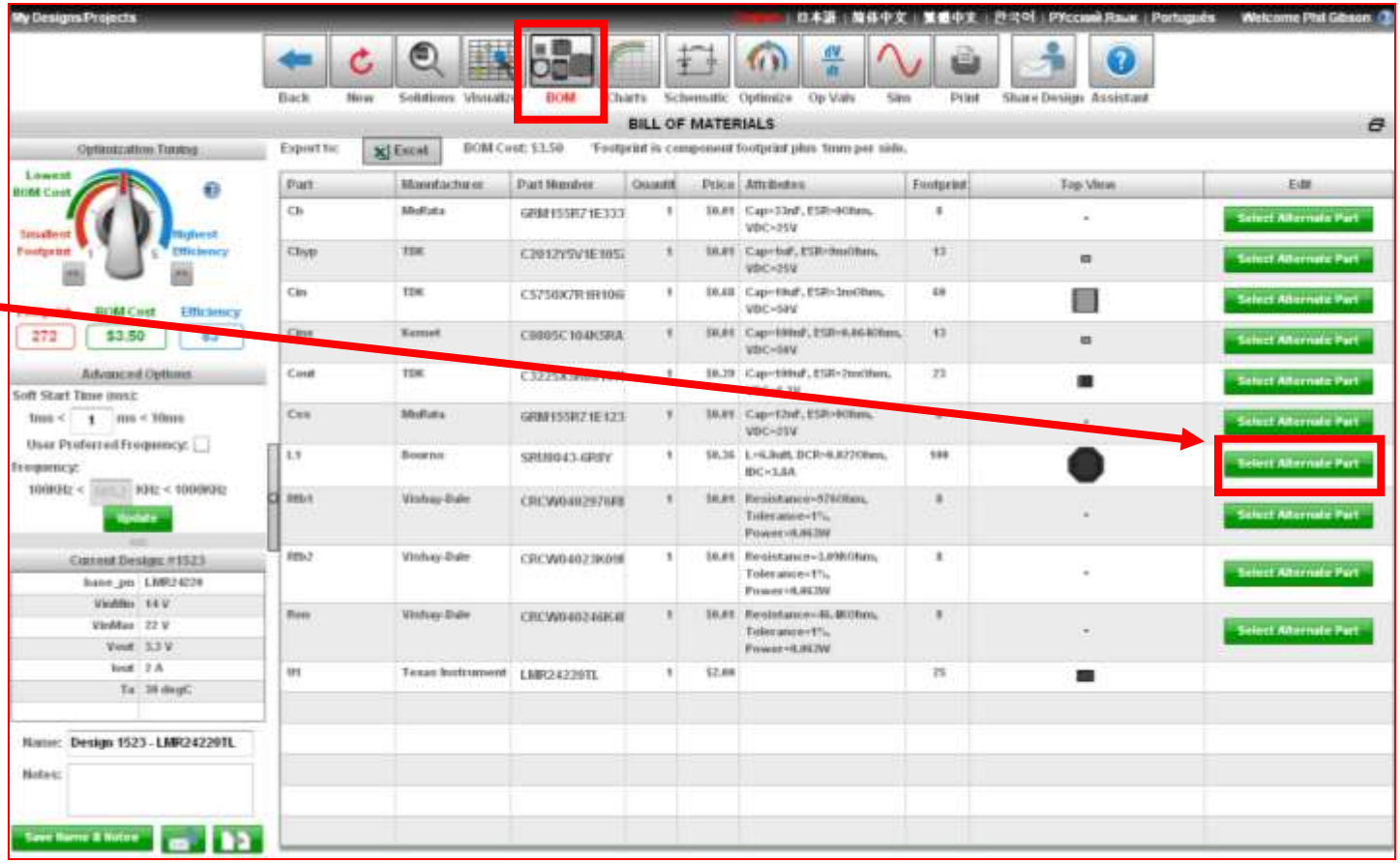
Footprint
Efficiency

BOM Cost

Power Dissipation
By Component

Continue To Improve Your Design: View and Change Your Bill Of Materials

Click Select Alternate To Change A Component

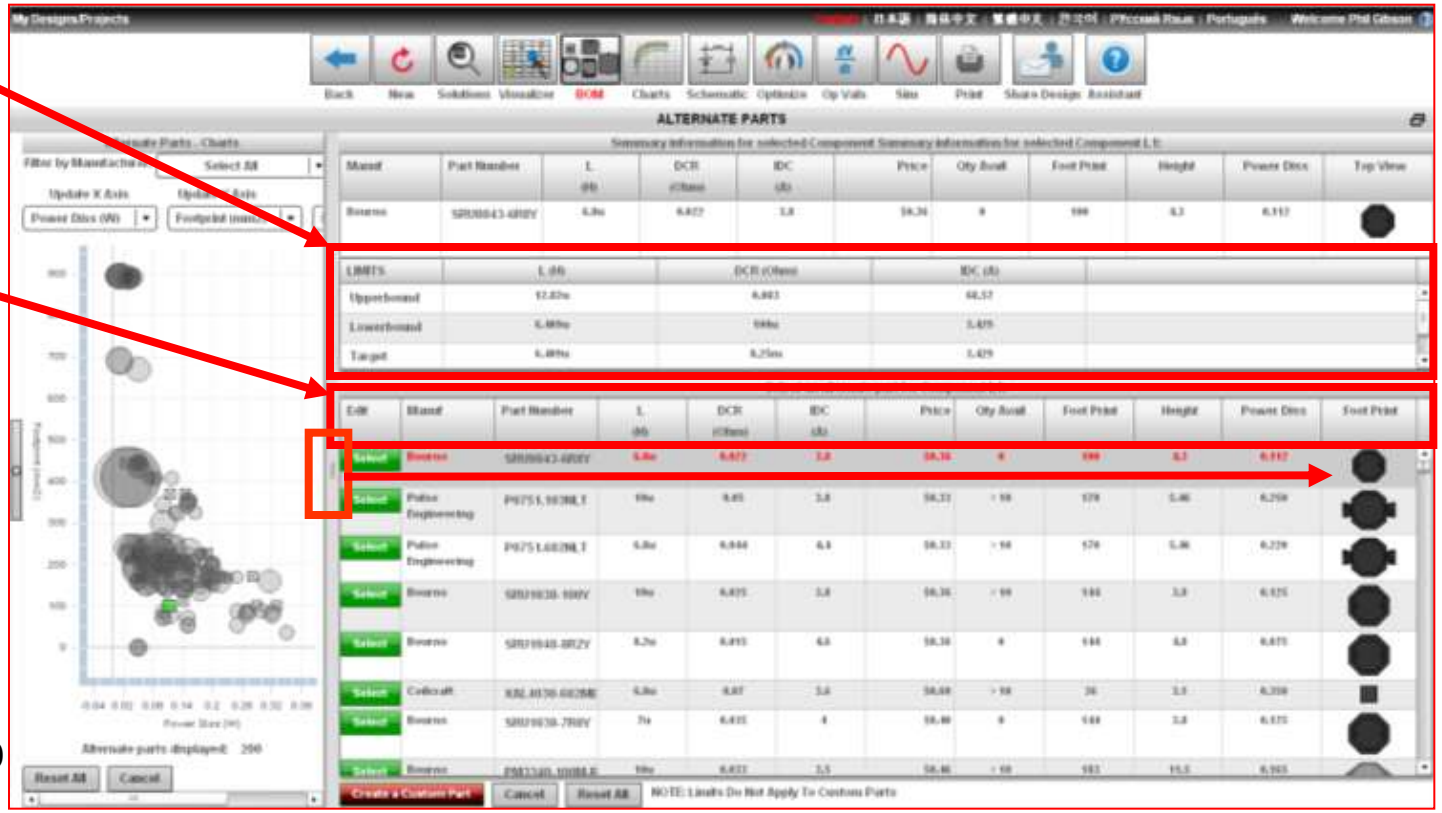


Evaluate and Select Alternate Components

Parameter Specification Limits

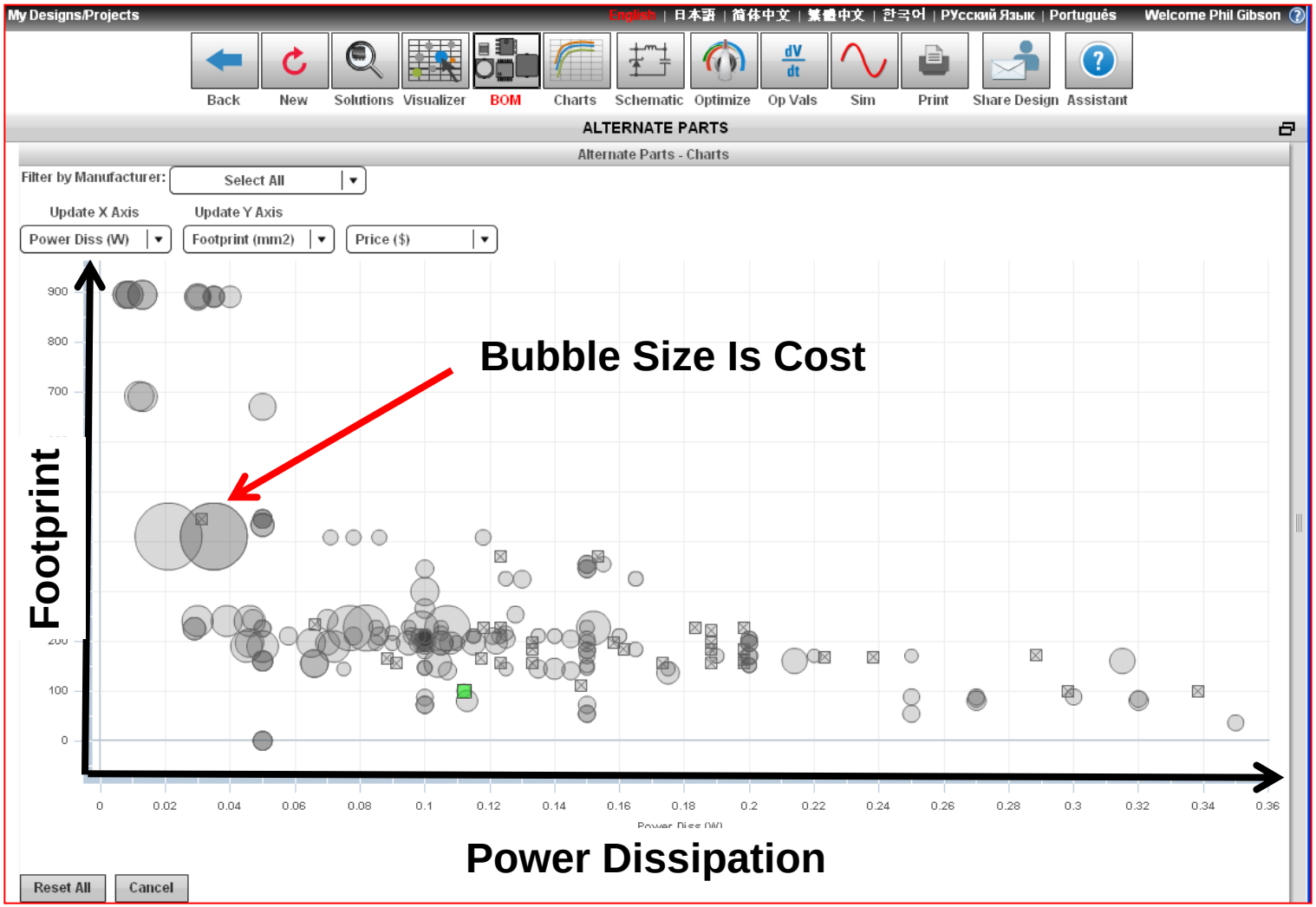
Multiple Column Sort

Component Tradeoffs:
- Footprint
- Pdiss
- Price
- Performance
  - Vout Ripple
  - Transient Resp
  - Loop Stability

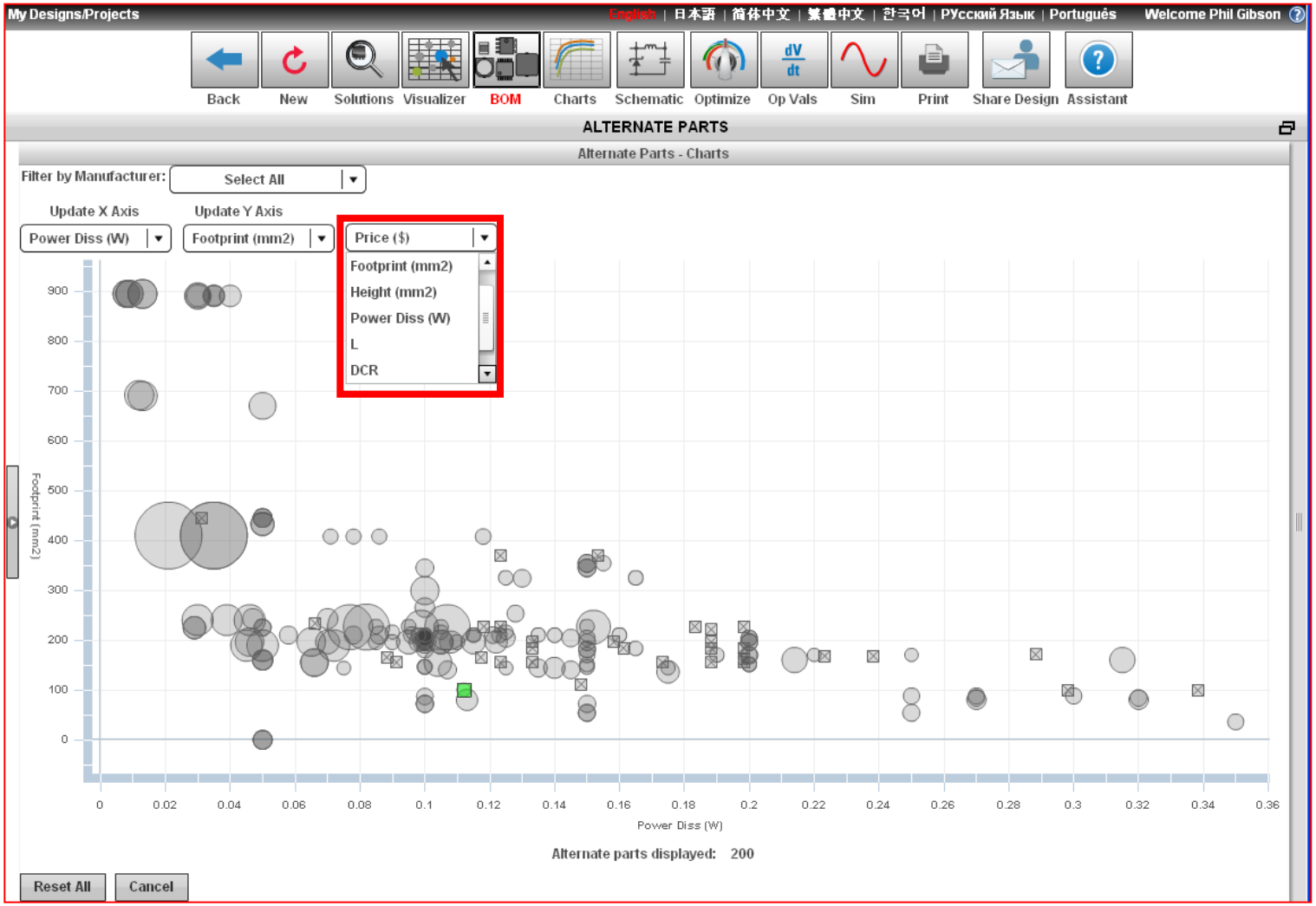


Texas Instruments

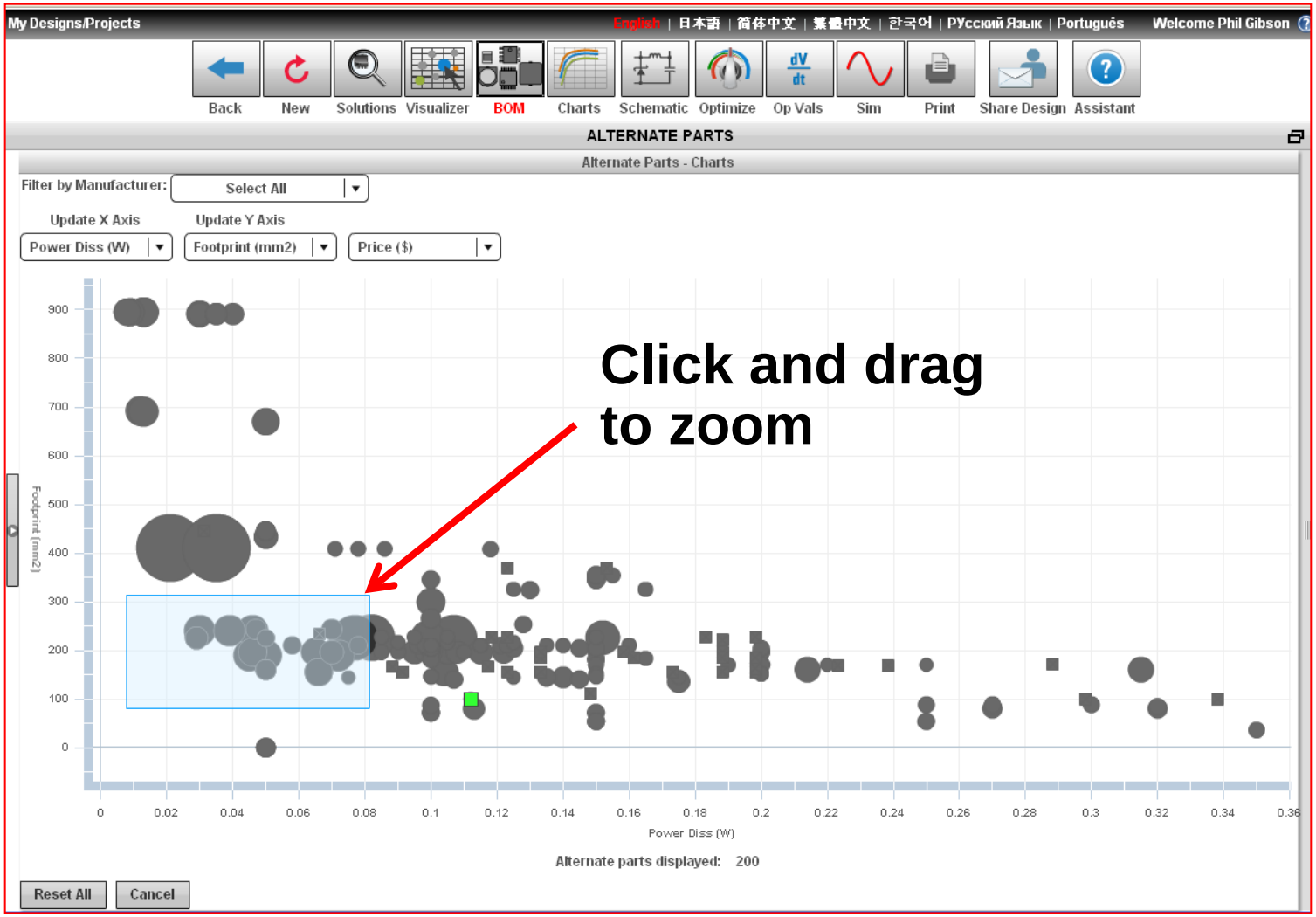
Evaluate Components - Inductor



Change Perspective - Inductor



Evaluate Components – Zoom to Highlight For More Detail

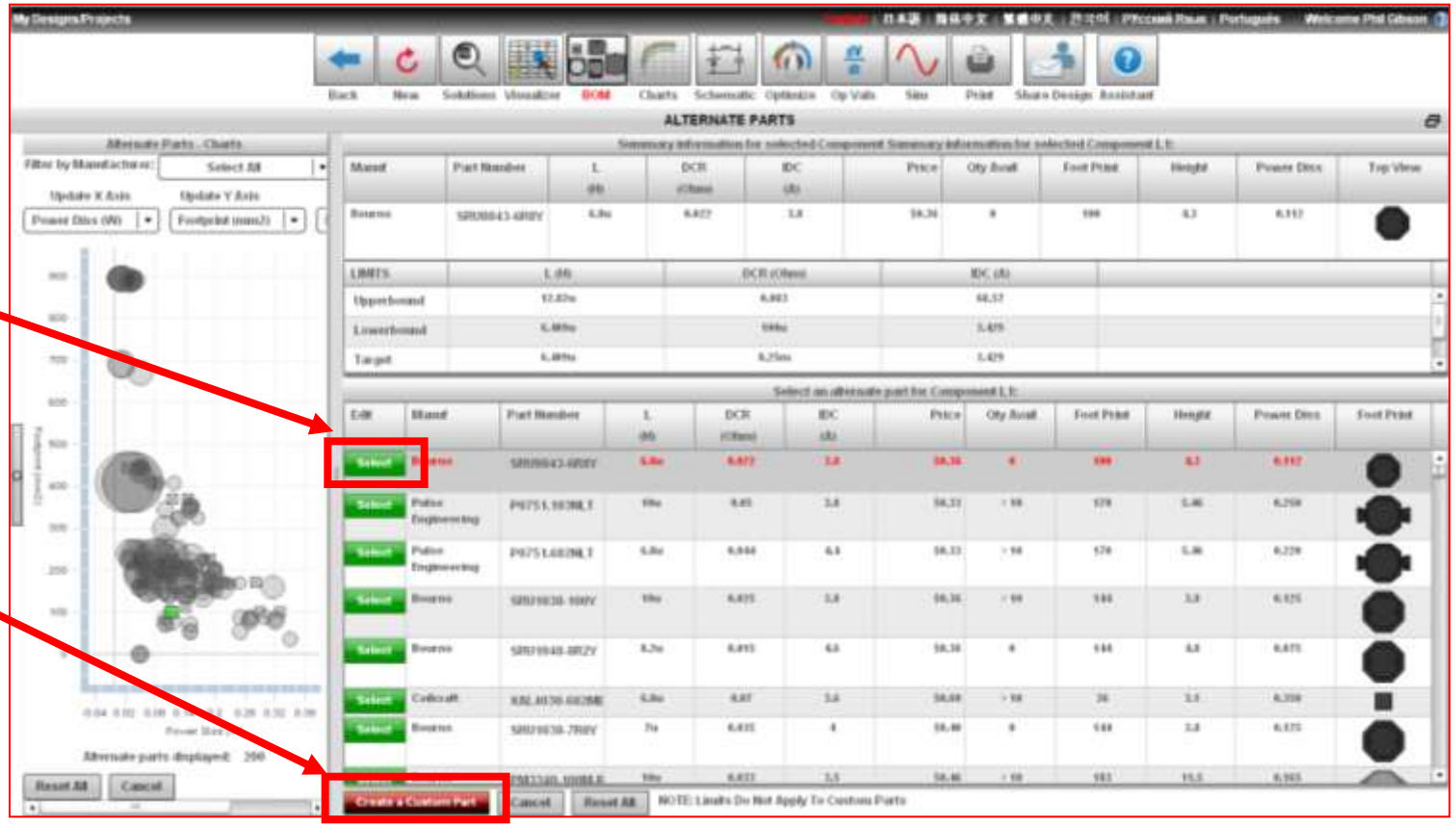


Select New Component

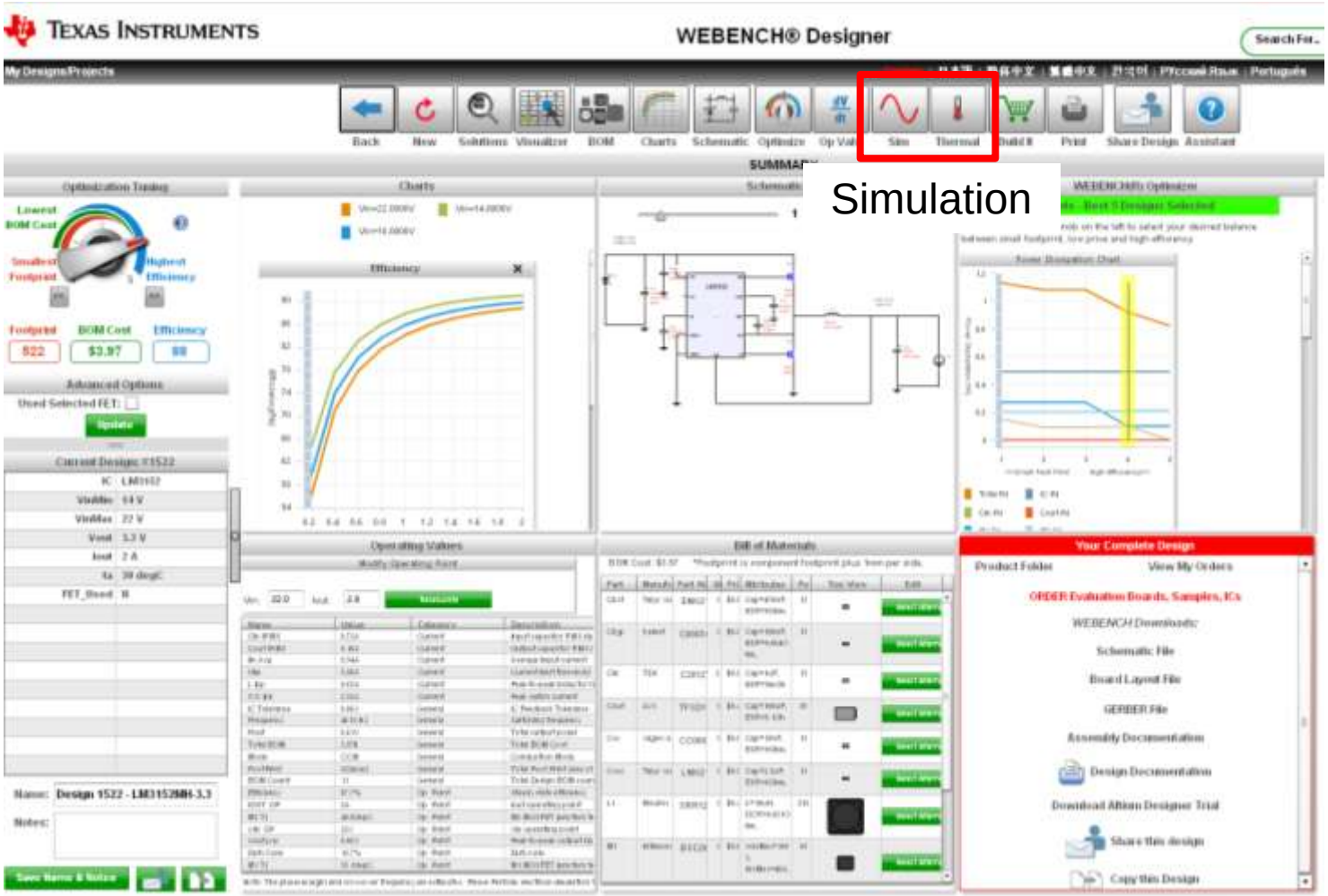
Filtered list based on zoom box

Click to select a component

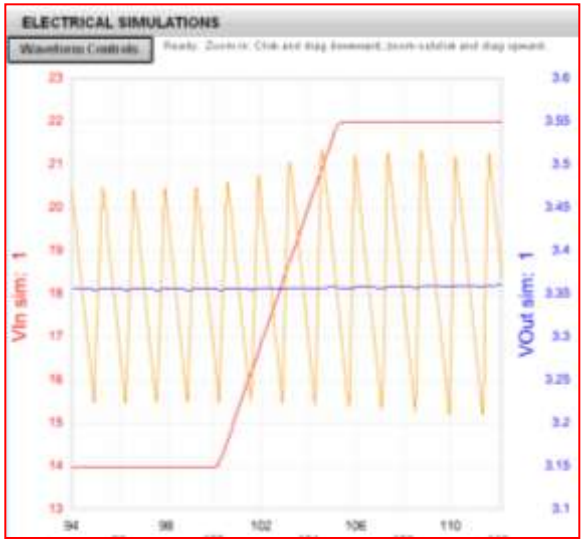
Or create a custom component

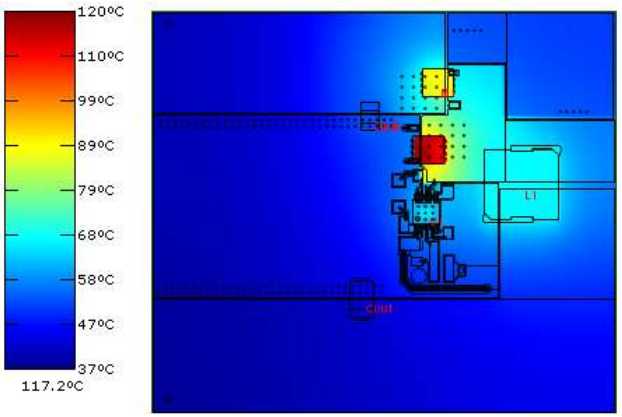


Your New BOM Is Updated And Simulation Is Only A Button Away

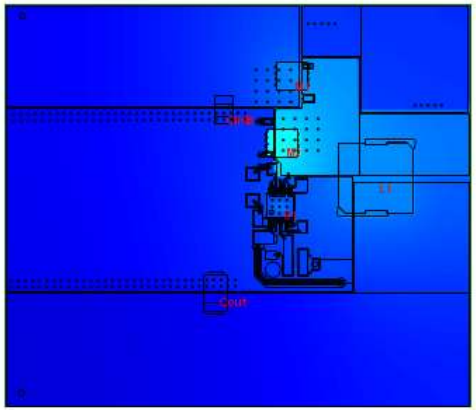


Customize and Simulate Electrically & Thermally





0.5oz copper thickness
Low side FET is 117C



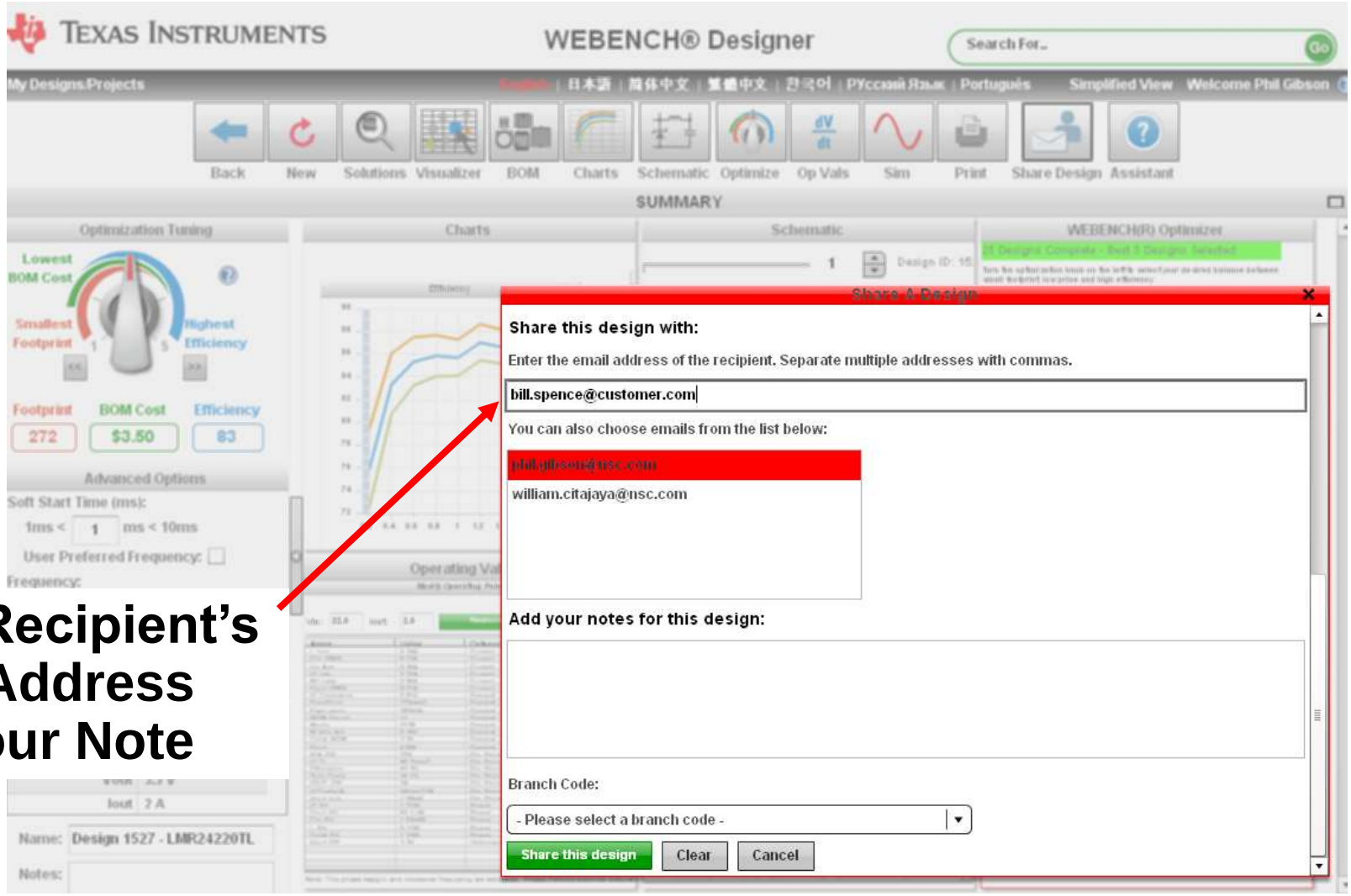
4.0oz thickness
Low side FET is 68C

Offer A Design To A Customer Easily

Click on Share Project button

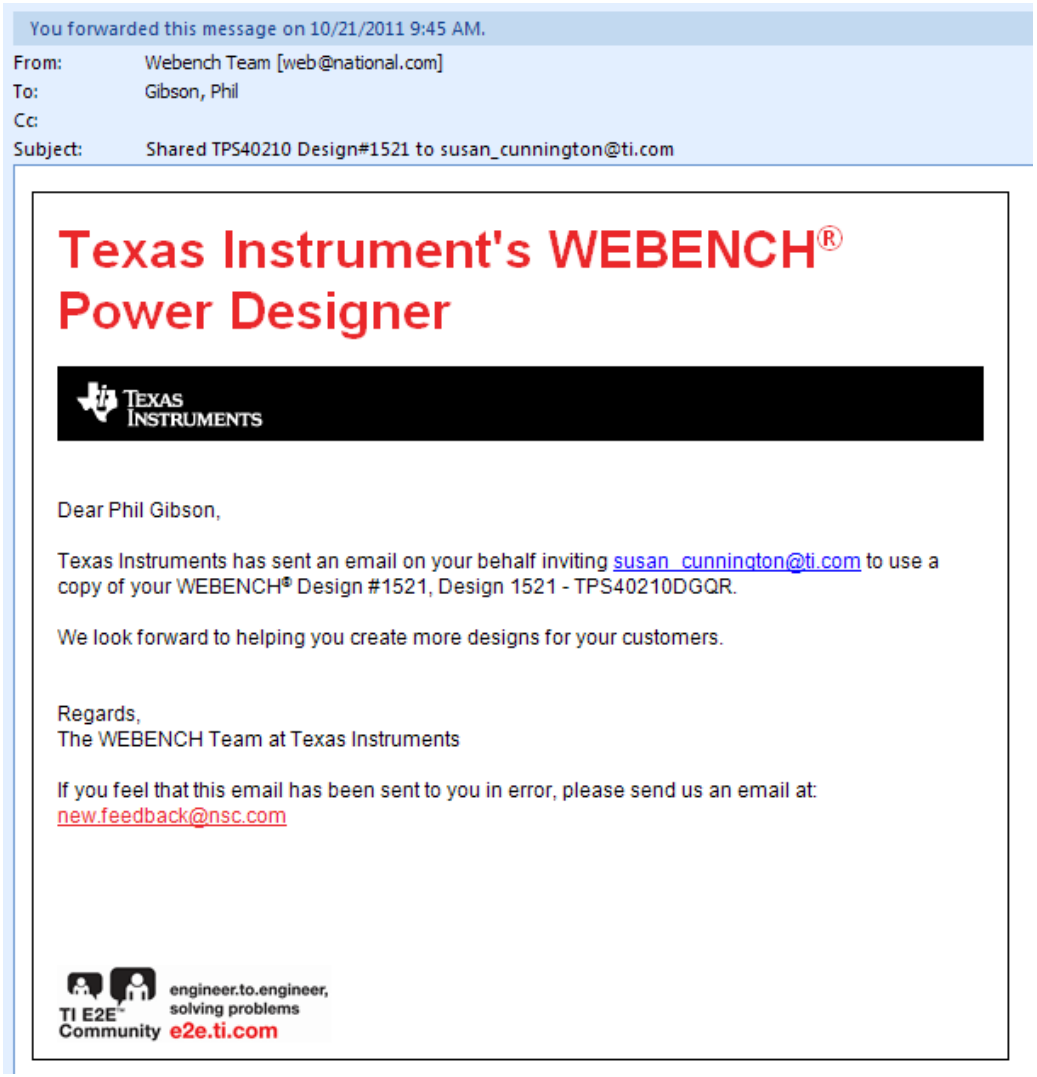
TEXAS INSTRUMENTS

Share The Design With Team Members Quickly – Start The Lead Flow



Enter Recipient's Email Address And Your Note

Invitation To Open Your Offer:



You forwarded this message on 10/21/2011 9:45 AM.

From: Webench Team [web@national.com]
To: Gibson, Phil
Cc:
Subject: Shared TPS40210 Design#1521 to susan_cunnington@ti.com

Texas Instrument's WEBENCH® Power Designer

Texas Instruments

Dear Phil Gibson,

Texas Instruments has sent an email on your behalf inviting susan_cunnington@ti.com to use a copy of your WEBENCH® Design #1521, Design 1521 - TPS40210DGQR.

We look forward to helping you create more designs for your customers.

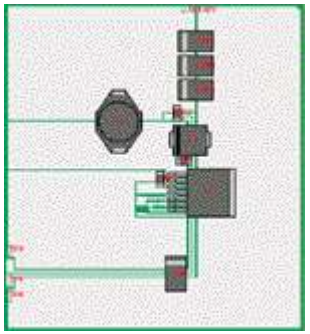
Regards,
The WEBENCH Team at Texas Instruments

If you feel that this email has been sent to you in error, please send us an email at:
new.feedback@nsc.com

TI E2E™ Community engineer.to.engineer, solving problems e2e.ti.com

WEBENCH® Build It Kit Support

Use WEBENCH Designer To Create Your Design



Order The Build It Kit For Your Design: PC board & Parts

Assemble The Kit and Test To Your Specifications For An Immediate Prototype

Part	Create	WEBENCH Tools	Schematic	BOM Images
LM22676-ADJ	Open Design			441mm²

Build It Kit Enabled Design

Why Do Electrical Simulation?

Identify Problems

- Design has been configured for stable operation BUT
- May want to verify under dynamic conditions

Try Solutions

- Improve line/load transient response
- Minimize output voltage ripple
- Modify control loop

Visualize Results

- Interactive waveform viewer allows detailed analysis of results

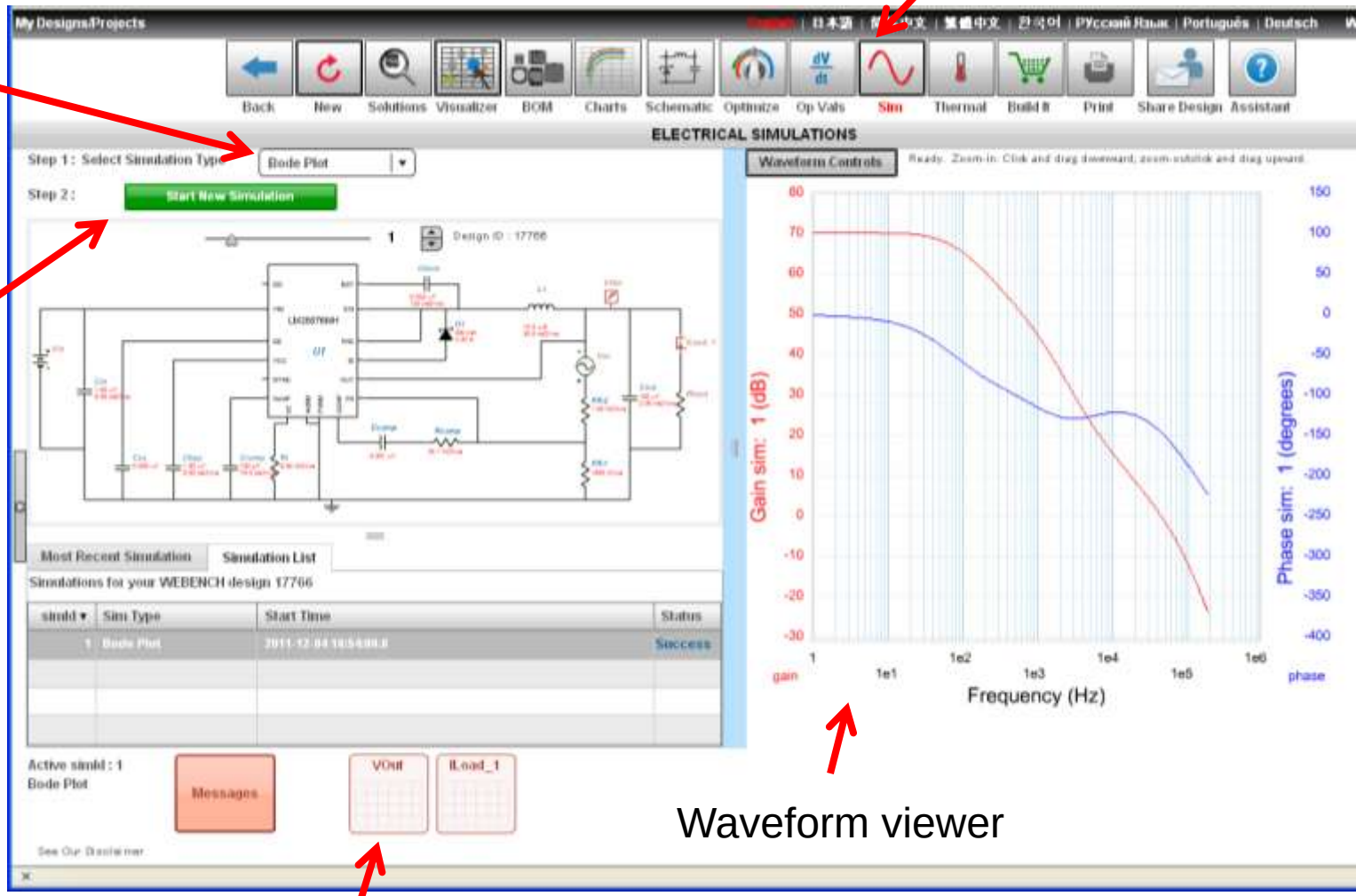
Electrical Simulation

eSim page

Specify sim type

Click start to initiate sim

- Bode Plot
- Line Transient
- Load Transient
- Startup
- Steady State



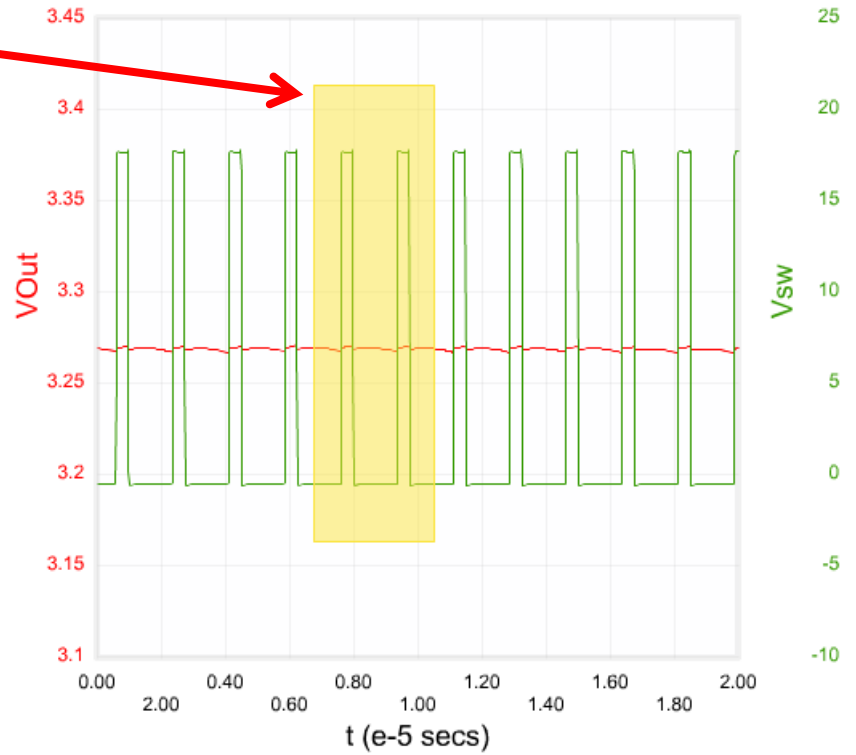
Waveform viewer

Click to view waveforms

Waveform Viewer

Click and drag down and to the right to zoom in

Click and drag up and to the left to zoom out



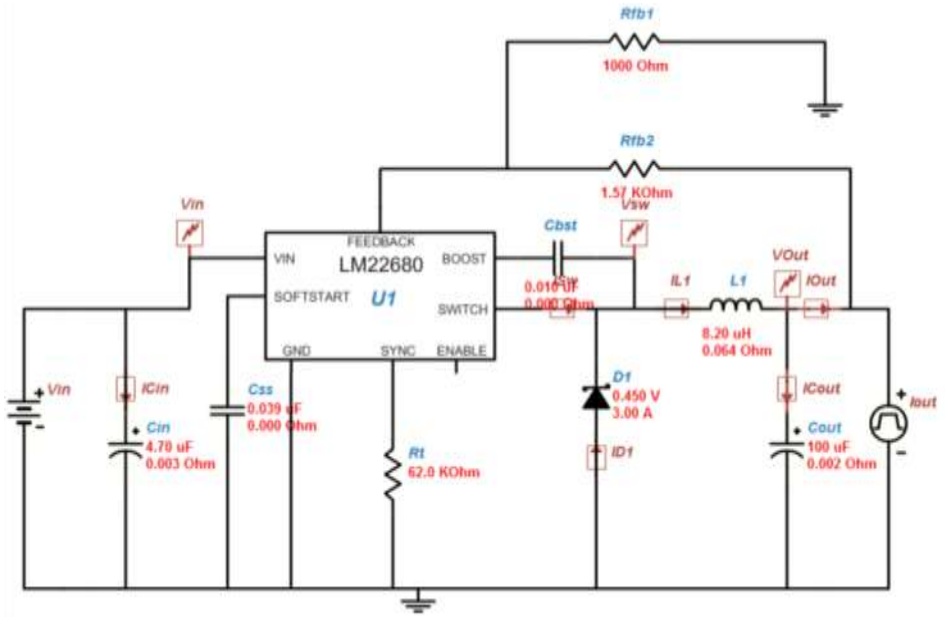
Click on a tile to add a waveform

Evaluate Transient Response

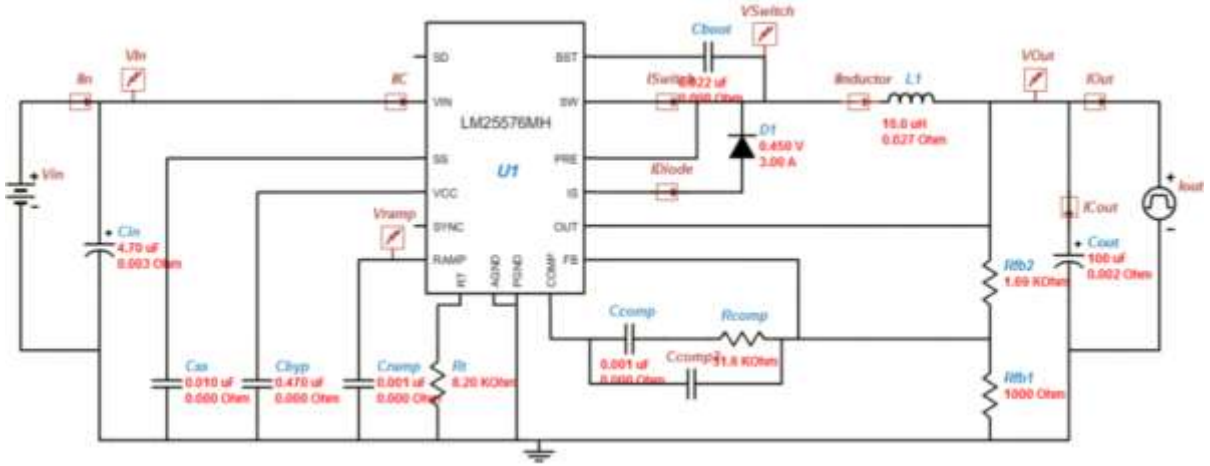
- LM22680
  - Voltage mode pulse width modulation control scheme (PWM)
  - Lower part count – SIMPLE SWITCHER®
- LM25576
  - Emulated current mode (ECM)
  - Fast transient response
- Will evaluate:
  - How does ECM compare with PWM
  - Vin: 14-22V, Vout: 3.3V, Iout: 2A

Buck Schematics

LM22680 PWM

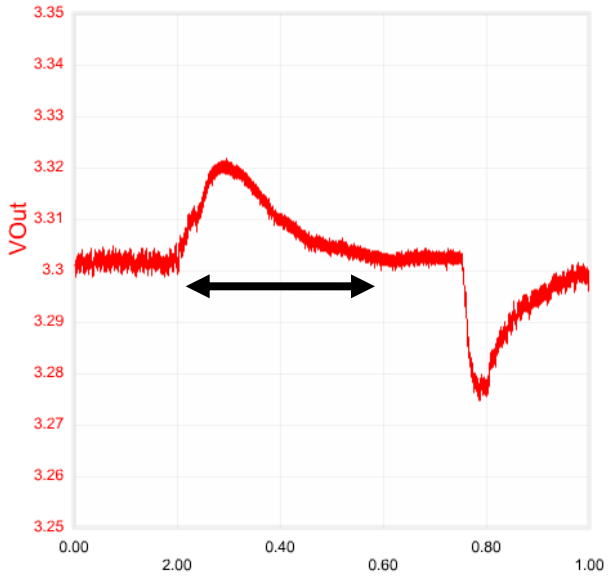


LM25576 ECM

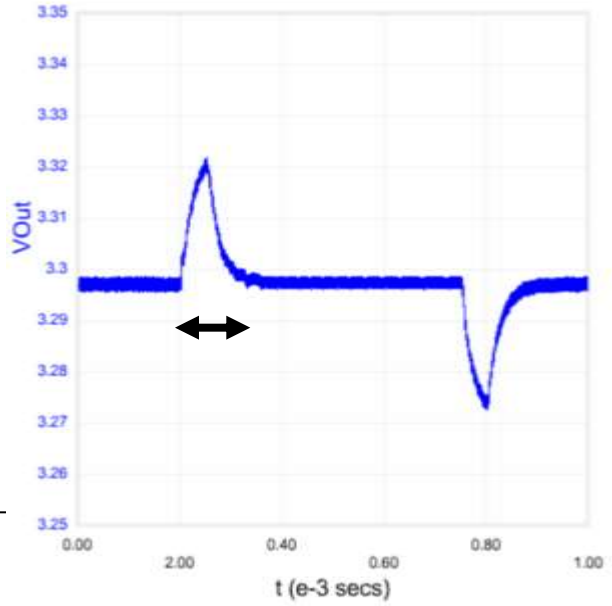


LM22680 vs LM25576
Vout for Load Transient

- LM22680 (Pulse Width Modulated)



- LM25576 (Emulated Current Mode) has faster transient response recovery time



Load Transient:
.2 – 2A
50usec rise/fall time

Why Do Thermal Simulation?

Identify Problems

- Thermal simulation will show focus of hot spots under typical operation
- May want to review environmental influences on operating points

Try Solutions

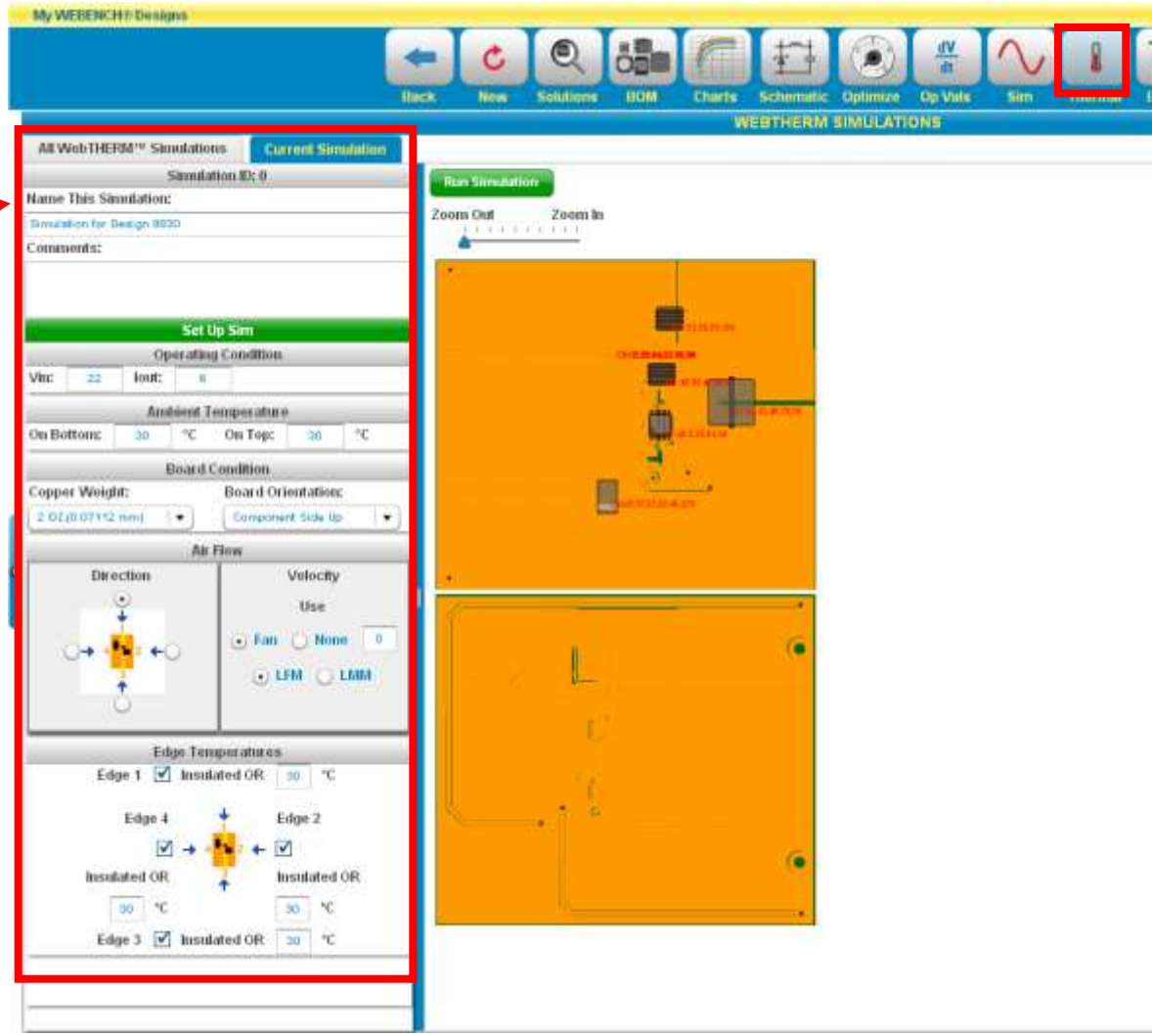
- Add different copper weighting for dissipation
- Add fan or convection of adjoining components
- Add heat sinks

Visualize Results

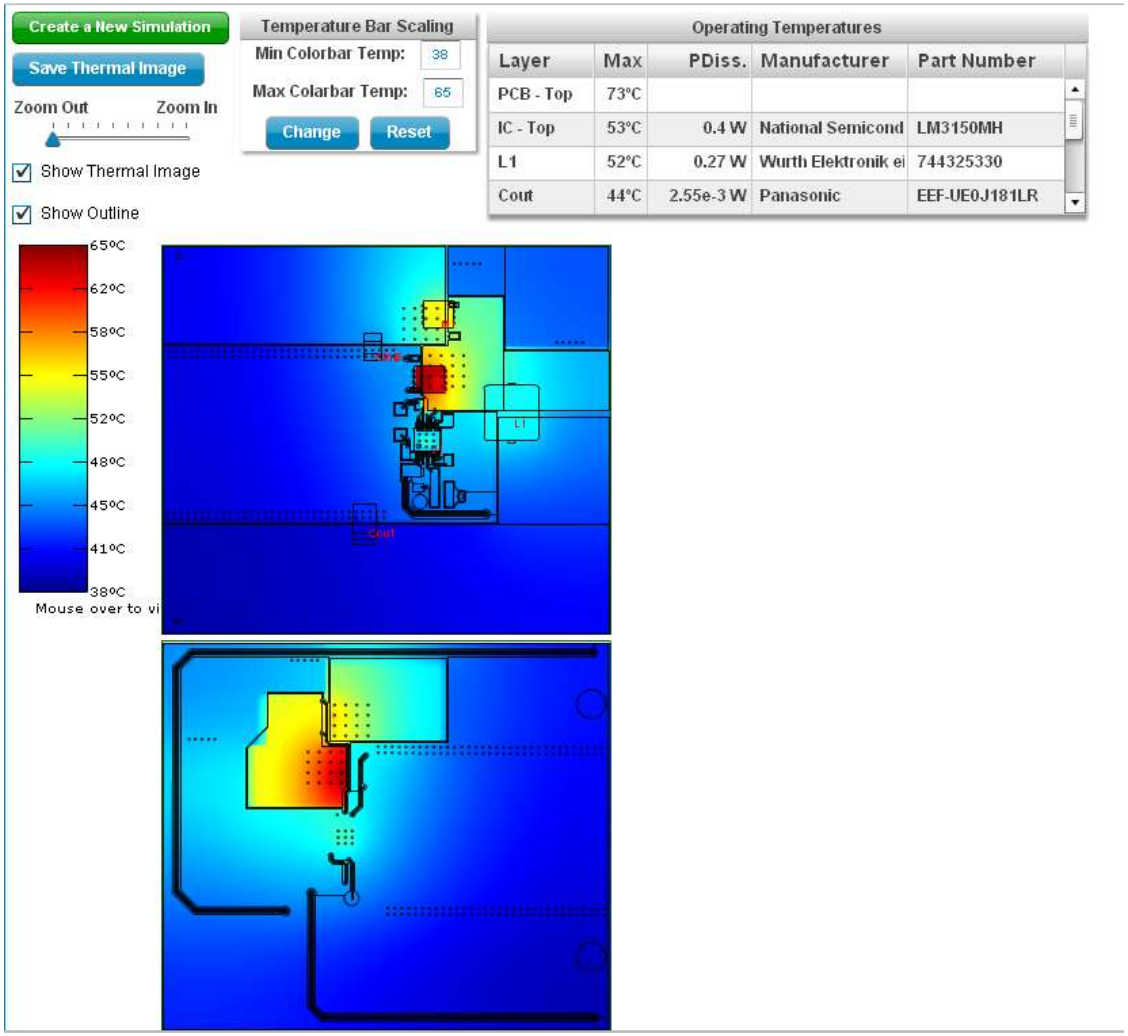
- Change environment and review thermal interactions

WebTHERM® – Board Layout

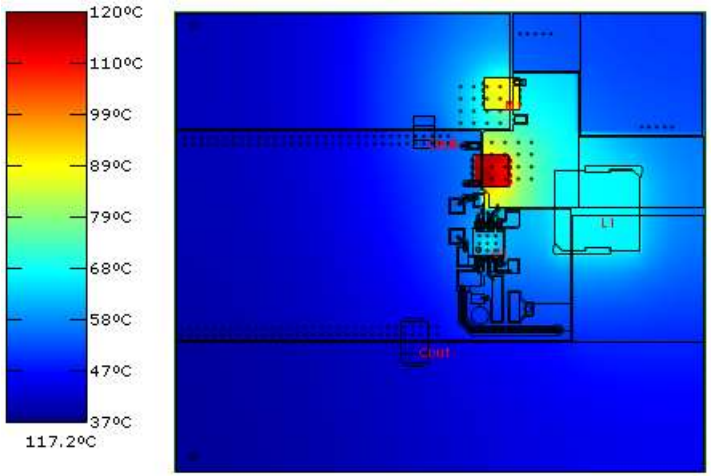
Inputs:
Copper thickness
Airflow
Board orientation

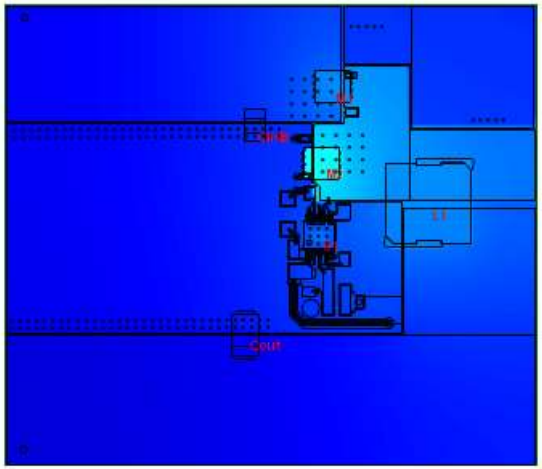


WebTHERM® Thermal Image Results



Example Trade-Offs LM3150 Controller



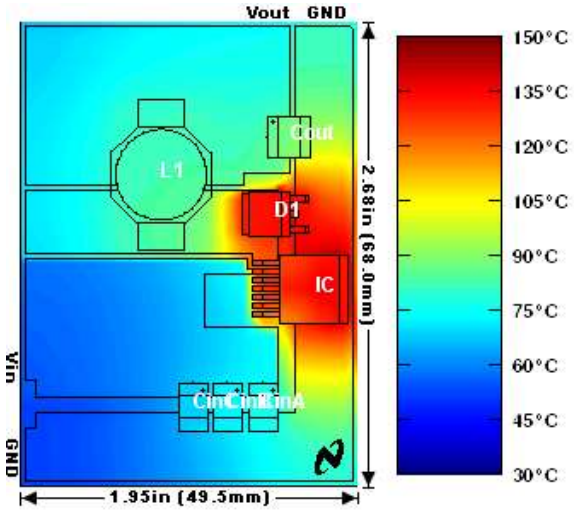


.5oz copper thickness
Low side FET is 117C

4oz copper thickness
Low side FET is 68C

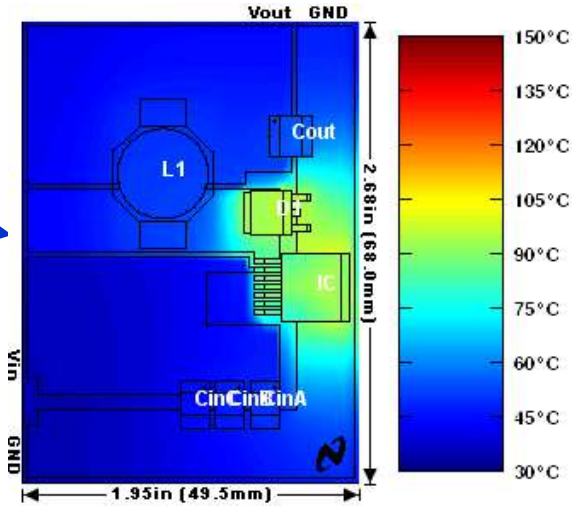
Vin: 14-22V
Vout: 3.3V
Iout: 6A

WebTHERM™ Solutions



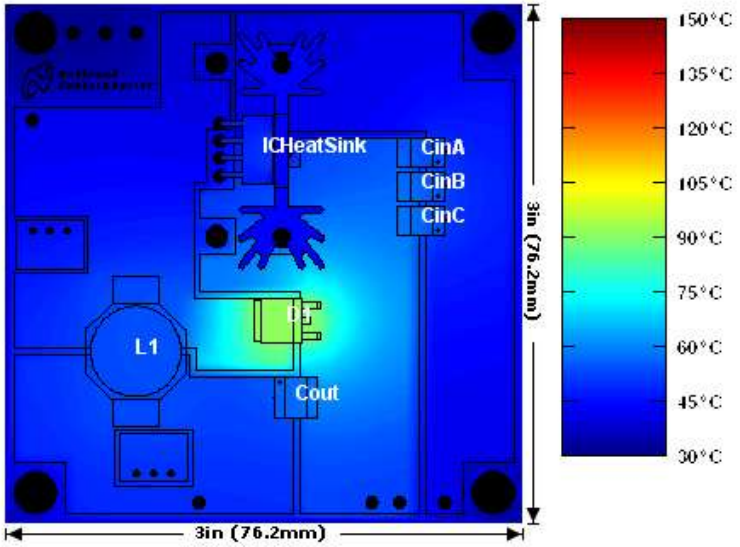
- No airflow
- Diode: 134C
- IC: 146C

Use a Fan



- 500 LFM airflow
- Diode: 95C
- IC: 106C

Or add a Heat Sink



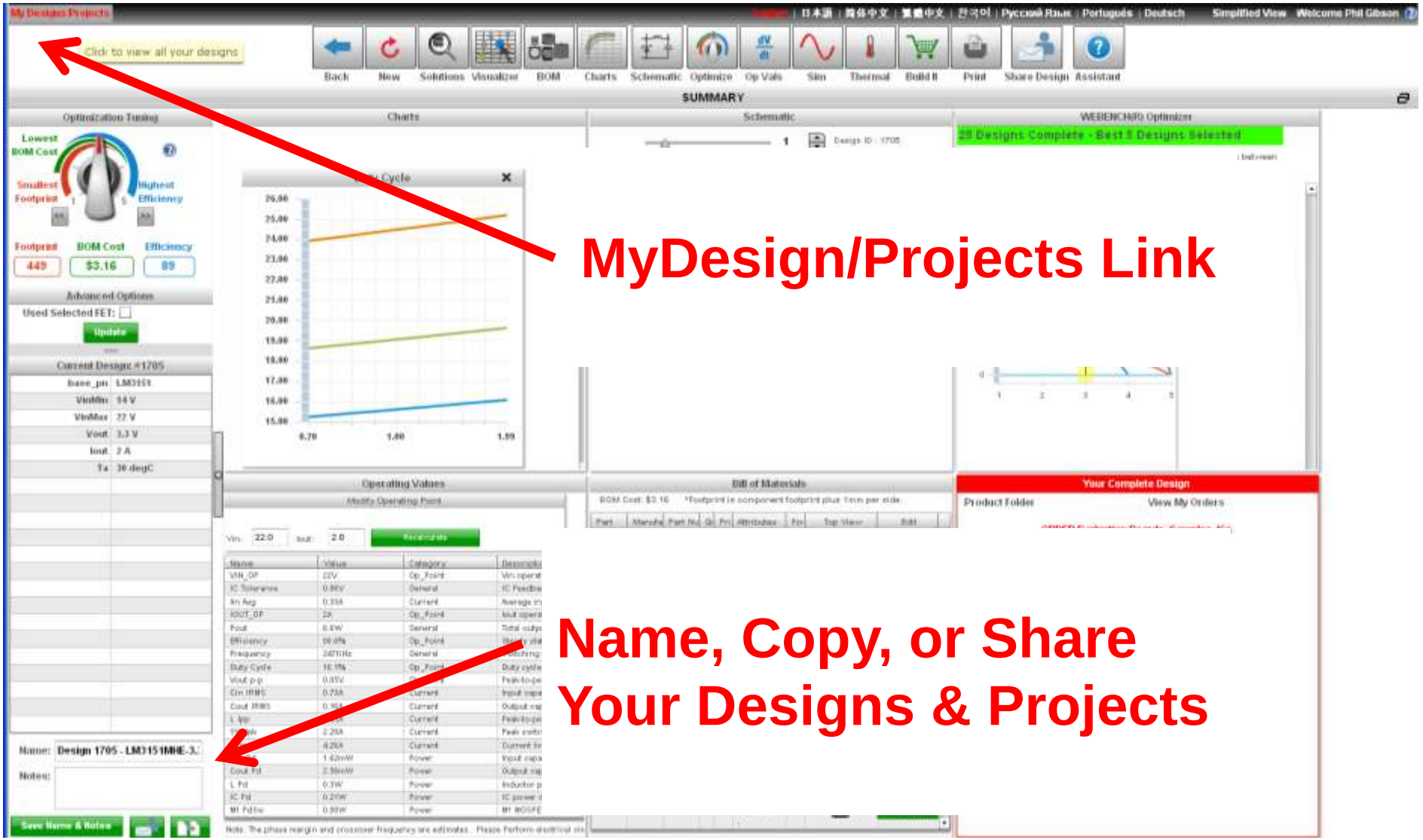
- No airflow
- Heat sink
- Diode: 91C
- IC: 52C

Design Specs:
Vin: 20-22V
Vout: 5V
Iout: 5A

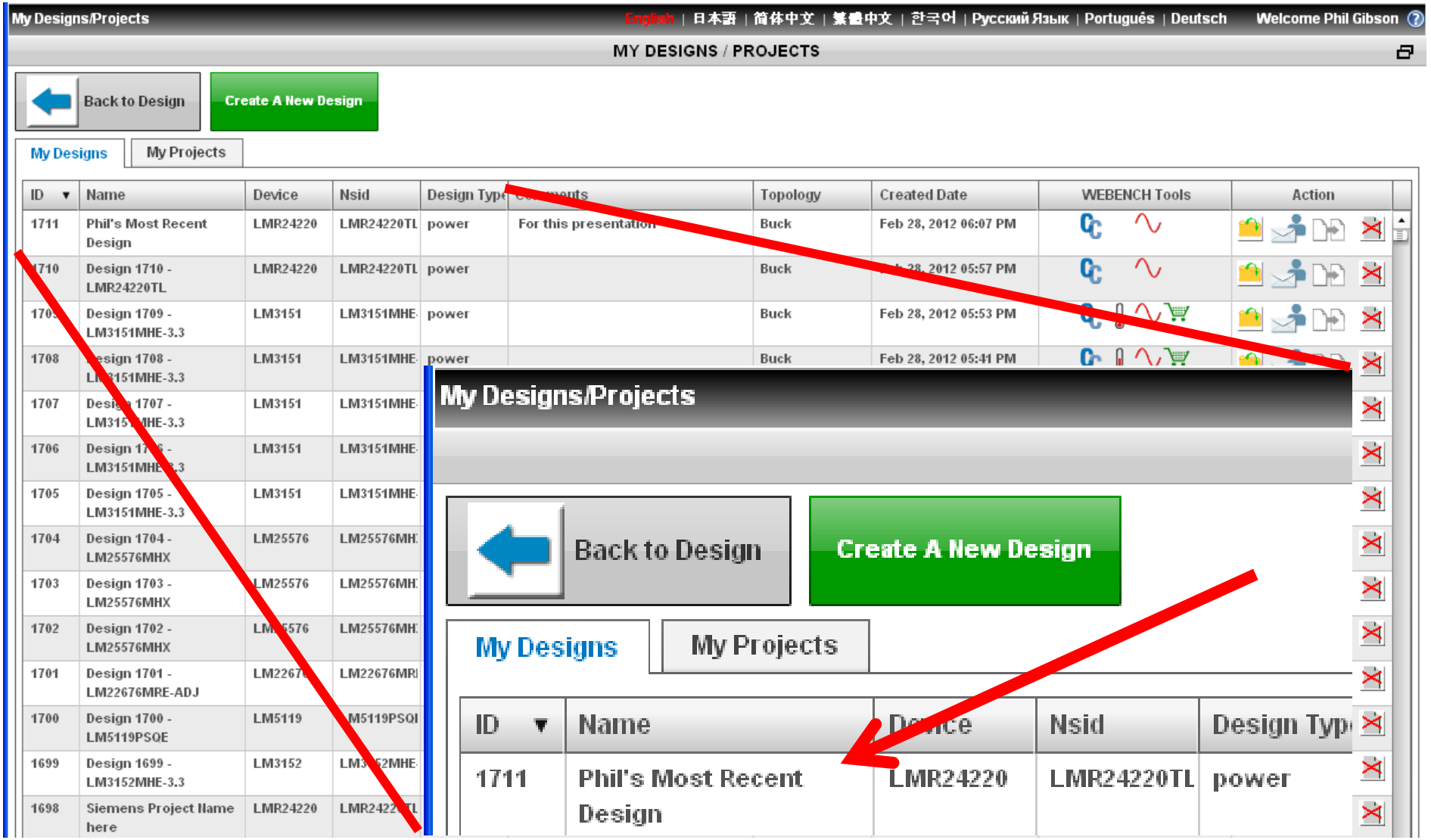
Note: heat sinks not yet enabled in new WEBENCH

Other Helpful Tips, Tricks, & Leads!

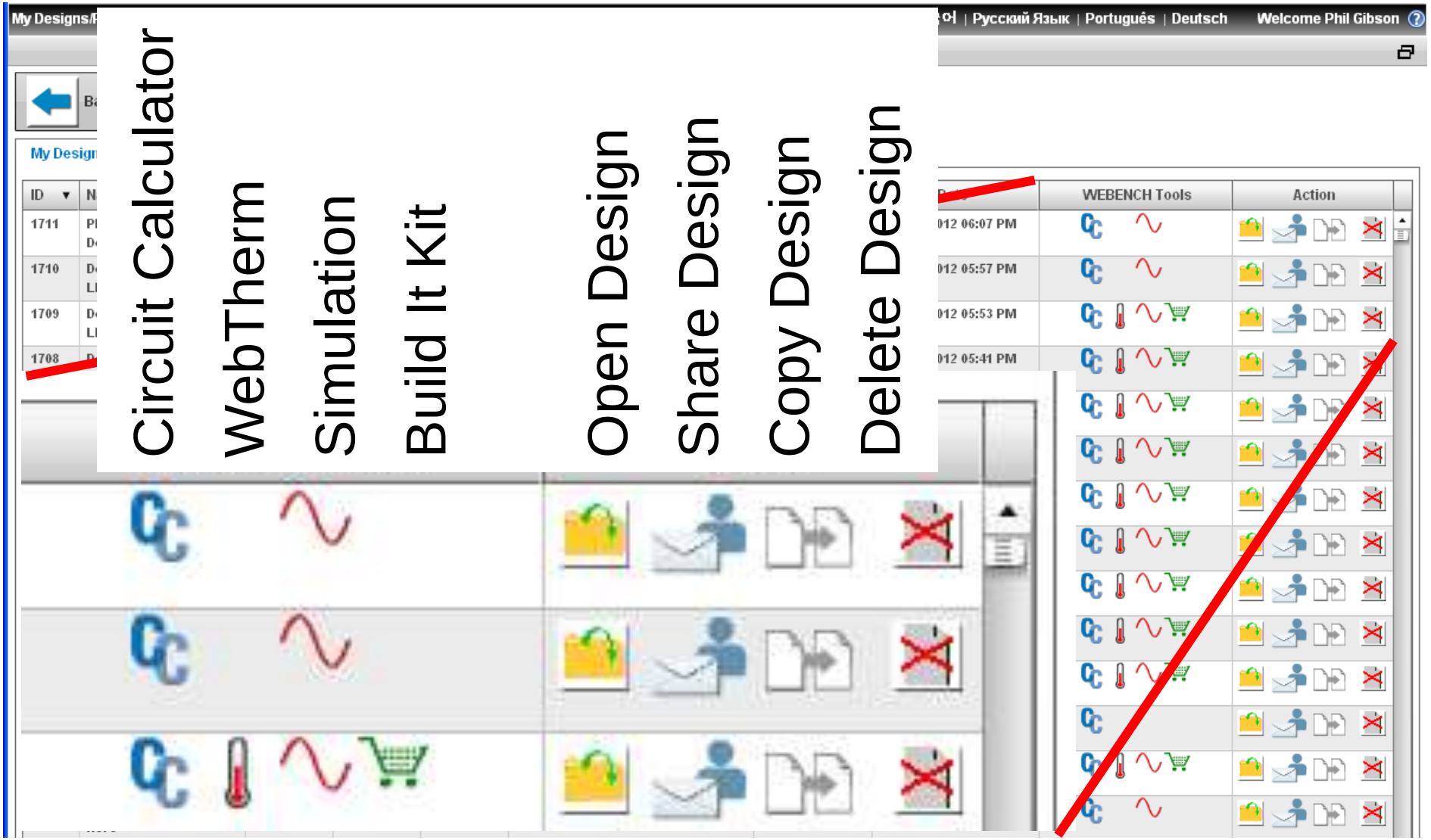
MyDesigns or MyProjects



MyProjects MyDesigns Display

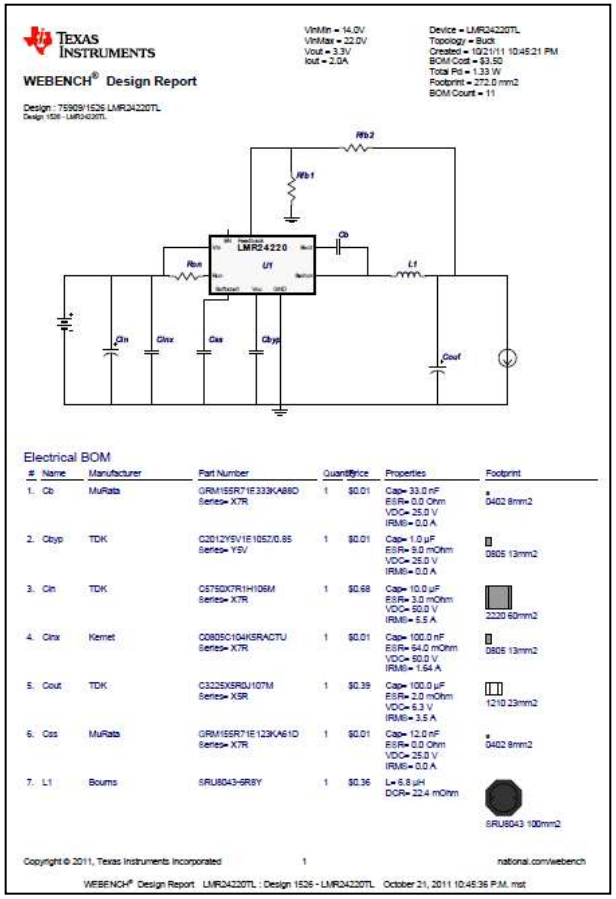


MyProjects MyDesigns Display



Your Complete Power Supply Design – Automatic Report Generation

Your Design From The Top: Input, Supply, Schematic, BOM



TEXAS INSTRUMENTS

WEBENCH® Design Report

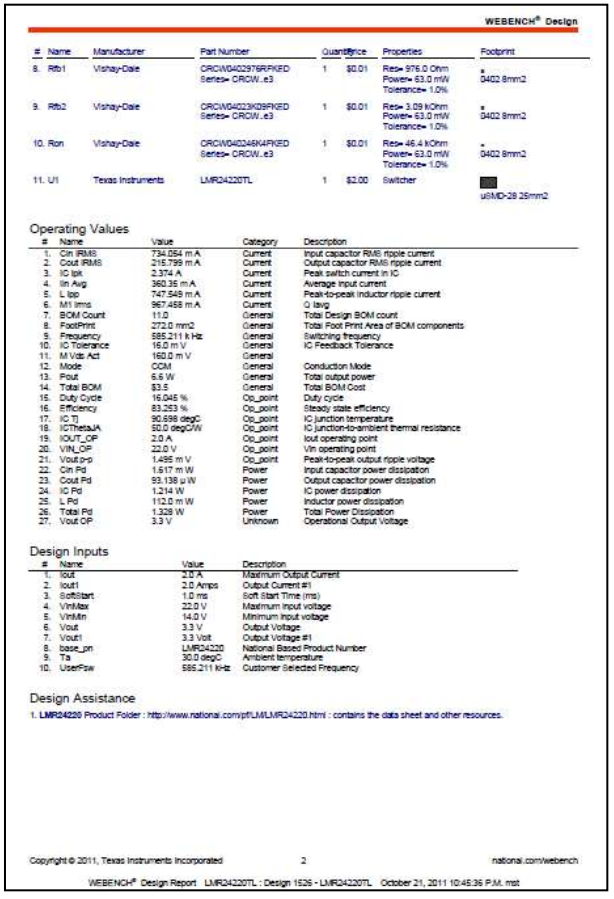
VinMin = 14.0V
VinMax = 22.0V
Vout = 3.3V
Iout = 2.0A

Device = LMR24220TL
Topology = Buck
Created = 10/21/11 10:45:21 PM
BOM Cost = $3.50
Total Pd = 1.33 W
Footprint = 272.0 mm2
BOM Count = 11

Design : 75909/1526 LMR24220TL
Design 1526 - LMR24220TL

Electrical BOM

#	Name	Manufacturer	Part Number	Quantity	Price	Properties	Footprint
1.	Cb	MuRata	GRM155R71E333KA88D Series= X7R	1	$0.01	Cap= 33.0 nF ESR= 0.0 Ohm VDC= 25.0 V IRMS= 0.0 A	0402 8mm2
2.	Cbyp	TDK	C2012Y5V1E105Z/0.85 Series= Y5V	1	$0.01	Cap= 1.0 µF ESR= 9.0 mOhm VDC= 25.0 V IRMS= 0.0 A	0805 13mm2
3.	Cin	TDK	C5750X7R1H106M Series= X7R	1	$0.68	Cap= 10.0 µF ESR= 3.0 mOhm VDC= 50.0 V IRMS= 5.5 A	2220 60mm2
4.	Cinx	Kemet	C0805C104K5RACTU Series= X7R	1	$0.01	Cap= 100.0 nF ESR= 54.0 mOhm VDC= 50.0 V IRMS= 1.64 A	0805 13mm2
5.	Cout	TDK	C3225X5R0J107M Series= X5R	1	$0.39	Cap= 100.0 µF ESR= 2.0 mOhm VDC= 6.3 V IRMS= 3.5 A	1210 23mm2
6.	Css	MuRata	GRM155R71E123KA61D Series= X7R	1	$0.01	Cap= 12.0 nF ESR= 0.0 Ohm VDC= 25.0 V IRMS= 0.0 A	0402 8mm2
7.	L1	Bourns	SRU8043-6R8Y	1	$0.36	L= 6.8 µH DCR= 22.4 mOhm	SRU8043 100mm2



#	Name	Manufacturer	Part Number	Quantity	Price	Properties	Footprint
8.	Rfb1	Vishay-Dale	CRCW0402976RFKED Series= CRCW..e3	1	$0.01	Res= 976.0 Ohm Power= 63.0 mW Tolerance= 1.0%	0402 8mm2
9.	Rfb2	Vishay-Dale	CRCW04023K09FKED Series= CRCW..e3	1	$0.01	Res= 3.09 kOhm Power= 63.0 mW Tolerance= 1.0%	0402 8mm2
10.	Ron	Vishay-Dale	CRCW0402464KFKED Series= CRCW..e3	1	$0.01	Res= 464 kOhm Power= 63.0 mW Tolerance= 1.0%	0402 8mm2
11.	U1	Texas Instruments	LMR24220TL	1	$2.00	Switcher	uSMD-28 25mm2

Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	734.054 mA	Current	Input capacitor RMS ripple current
2.	Cout IRMS	215.799 mA	Current	Output capacitor RMS ripple current
3.	IC Ipk	2.374 A	Current	Peak switch current in IC
4.	In Avg	360.36 mA	Current	Average input current
5.	L Ipp	747.548 mA	Current	Peak-to-peak inductor ripple current
6.	M1 Irms	967.458 mA	Current	Q Iavg
7.	BOM Count	11.0	General	Total Design BOM count
8.	FootPrint	272.0 mm2	General	Total Foot Print Area of BOM components
9.	Frequency	585.211 kHz	General	Switching frequency
10.	IC Tolerance	16.0 mV	General	IC Feedback Tolerance
11.	M Vds Act	160.0 mV	General	
12.	Mode	CCM	General	Conduction Mode
13.	Pout	6.6 W	General	Total output power
14.	Total BOM	$3.5	General	Total BOM Cost
15.	Duty Cycle	16.045 %	Op_point	Duty cycle
16.	Efficiency	83.253 %	Op_point	Steady state efficiency
17.	IC Tj	90.698 degC	Op_point	IC junction temperature
18.	ICThetaJA	50.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
19.	IOUT_OP	2.0 A	Op_point	Iout operating point
20.	VIN_OP	22.0 V	Op_point	Vin operating point
21.	Vout p-p	1.495 m V	Op_point	Peak-to-peak output ripple voltage
22.	Cin Pd	1.617 m W	Power	Input capacitor power dissipation
23.	Cout Pd	93.138 µ W	Power	Output capacitor power dissipation
24.	IC Pd	1.214 W	Power	IC power dissipation
25.	L Pd	112.0 m W	Power	Inductor power dissipation
26.	Total Pd	1.328 W	Power	Total Power Dissipation
27.	Vout OP	3.3 V	Unknown	Operational Output Voltage

Design Inputs

#	Name	Value	Description
1.	Iout	2.0 A	Maximum Output Current
2.	Iout1	2.0 Amps	Output Current #1
3.	SoftStart	1.0 ms	Soft Start Time (ms)
4.	VinMax	22.0 V	Maximum input voltage
5.	VinMin	14.0 V	Minimum input voltage
6.	Vout	3.3 V	Output Voltage
7.	Vout1	3.3 Volt	Output Voltage #1
8.	base_pn	LMR24220	National Based Product Number
9.	Ta	30.0 degC	Ambient temperature
10.	UserFsw	585.211 kHz	Customer Selected Frequency

Design Assistance

1. **LMR24220** Product Folder : http://www.national.com/pf/LM/LMR24220.html : contains the data sheet and other resources.

TEXAS INSTRUMENTS

Thank You!