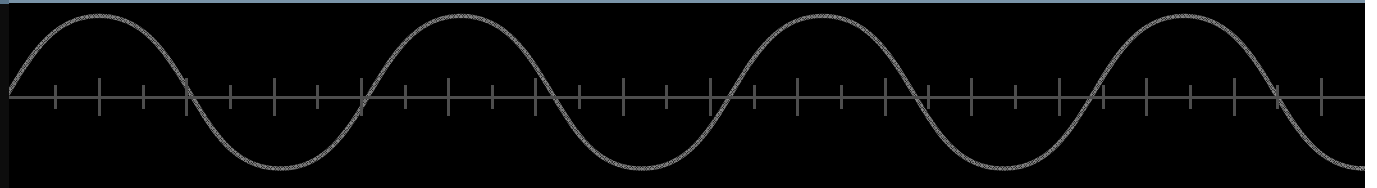
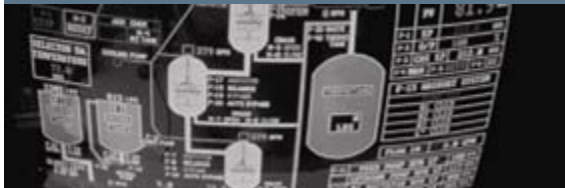


LTpowerCAD™ II

Introduction & Quick Start Guide

Rev. 2.0 07/2013



Design Tool Development Team
Power Products, Linear Technology Corp.
LTpowerCAD@Linear.com

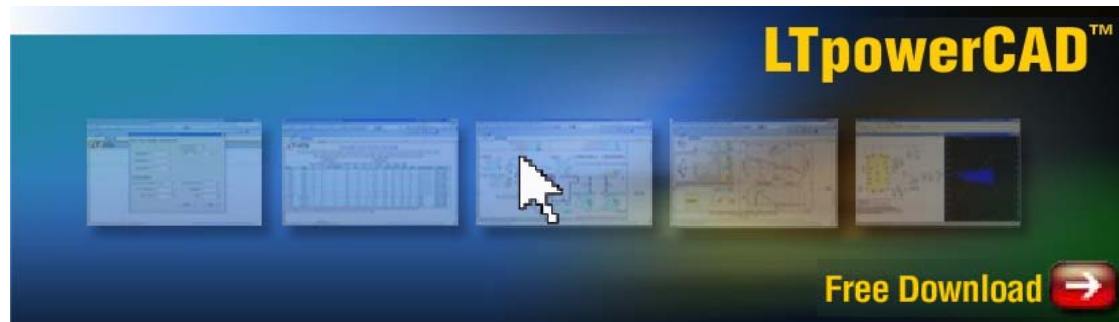
Copyright © 2013 Linear Technology. All rights reserved



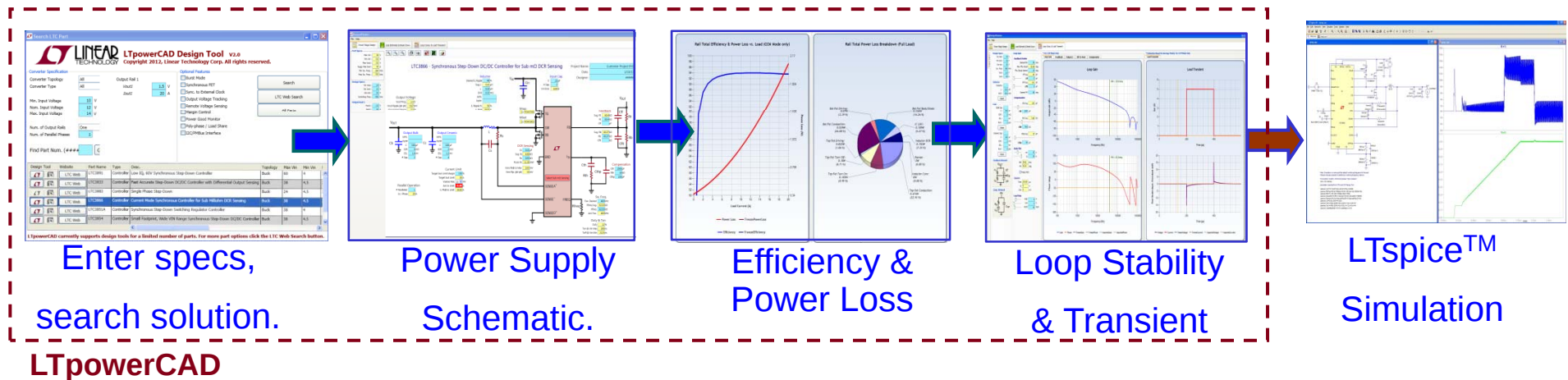
What is LTpowerCAD Design Tool

2

A Complete, Step-by-Step Power Supply Design Tool:



Step-by-Step Power Supply Design:



LTspice: A powerful circuit **simulation tool** with integrated models of most Linear Technology products.

LTpowerCAD Design Tool :

- A power supply **design tool** instead of simulation tool.
- **Searches for a solution** / LTC part for given power supply spec.
- Guides users to **select power stage components**.
- Provides detailed **power efficiency / loss** analysis.
- Provide quick **loop bode plot** stability and load transient analysis.
- Only supports **selected power products** (mostly buck & modules).
- Design file can be exported into LTspice simulation circuit.

- Go to <http://www.linear.com/LTpowerCAD>
- Download & install **LTpowerCAD II** on your Windows PC.
- See later pages for installation instruction.

Boost Converters :

Boost

Updated: 6/6/2013

Polyphase (Bold)

	Green Cell Background - Excel tool available
	Red Cell Background - LTpowerCAD Non-Excel Tool available
Bold	Bold - Polyphase single output compatible

Controller

Monolithic

μModule Regulator®

3-output	2-output	1-output
	LTC3788	LTC3787 LTC3862 LTC3786

3-output	2-output	1-output

3-output	2-output	1-output

Buck-Boost Converters :

Buck-Boost

Updated: 6/6/2013

Polyphase (Bold)

	Green Cell Background - Excel tool available
	Red Cell Background - LTpowerCAD Non-Excel Tool available
Bold	Bold - Polyphase single output compatible

Controller

Monolithic

μModule Regulator®

3-output	2-output	1-output

3-output	2-output	1-output

3-output	2-output	1-output
		LTM4605 LTM4607 LTM4609

Note:

This list was generated on 06/06/2013. **New parts** could be added to the library after that. Click **"Sync-Release"** to update LTpowerCAD library & functions.

LTpowerCAD II
Software Installation

The following system and software is required for LTpowerCAD II v2.0™

- ✓ **PC with Microsoft Windows** XP SP2 or later OS
- ✓ **Microsoft Office Excel** 2000, 2003, 2007, 2010 or 2013
- ✓ **Microsoft .NET Framework** 3.5 SP1, 4.0 or Higher

<http://www.microsoft.com/net/download>

- ✓ **Microsoft SQL Server** Compact 3.5 Service Pack 2

<http://www.microsoft.com/en-us/download/details.aspx?id=5783>

* Note : The LTpowerCAD installer is made to **automatically download and install these the Microsoft .NET and SQL Server** to your system if your system does not already have these installed. However, if for some reason they are not installed automatically, you need to install them manually from Microsoft download sites.

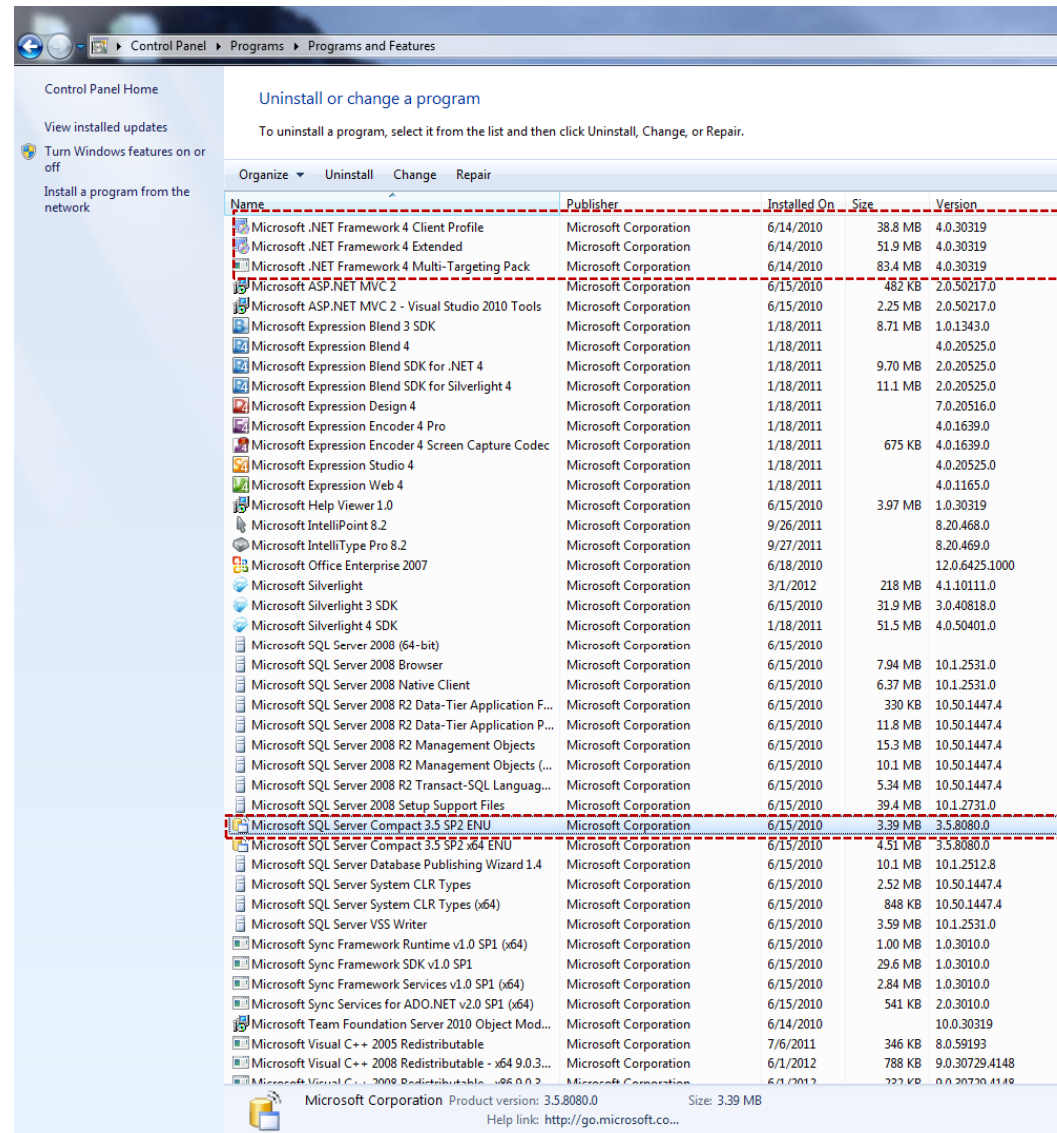
****Note:**

- Windows Vista or Windows 7, Windows 8 based PC has .NET Framework integrated.
- Some Windows XP based PC may need additional installation of the .NET Framework, which can be freely downloaded at www.microsoft.com.
- Many new computers may already have SQL Server Compact 3.5SP2 installed (check to make sure)

Minimum Requirements (cont'd)

9

Optional: check if .NET and SQL Server are installed:



Microsoft .NET 3.5, 4 or higher is required

Required for accessing part information

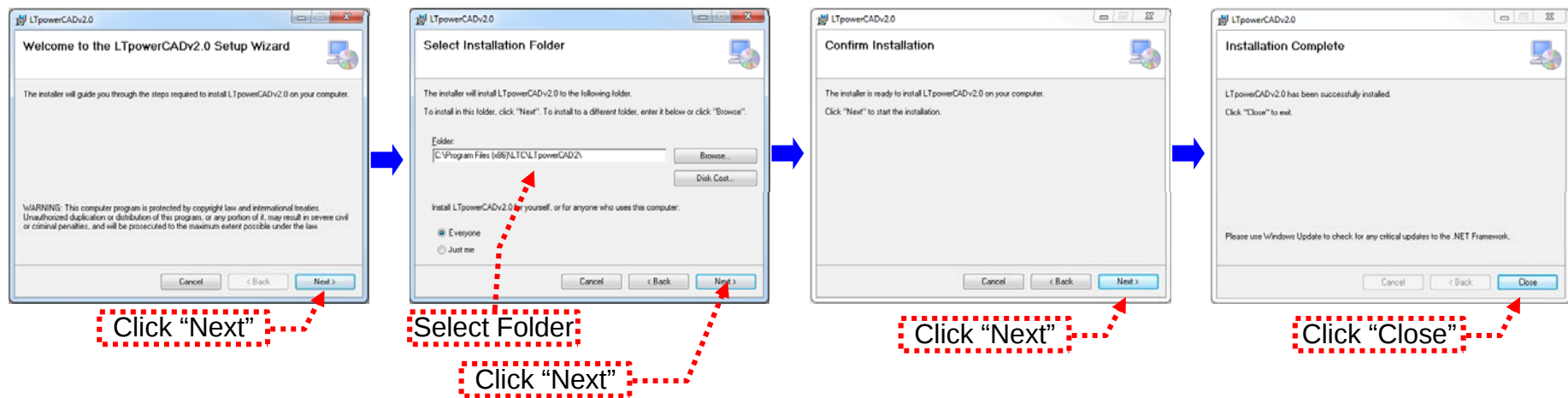
1. Double Click “**Setup.exe**” to Start LTpowerCAD II v2.0™ Design Tool Setup Wizard

Note : Do not install by double clicking the “MS.msi” file as this will prevent the installer from checking to install and installing any missing Microsoft requirements.

2. Click “**Next**”

3. Select Installation Folder and Click “**Next**”

4. Click “**Next**” to Confirm Installation and then “**Close**” to complete the Installation

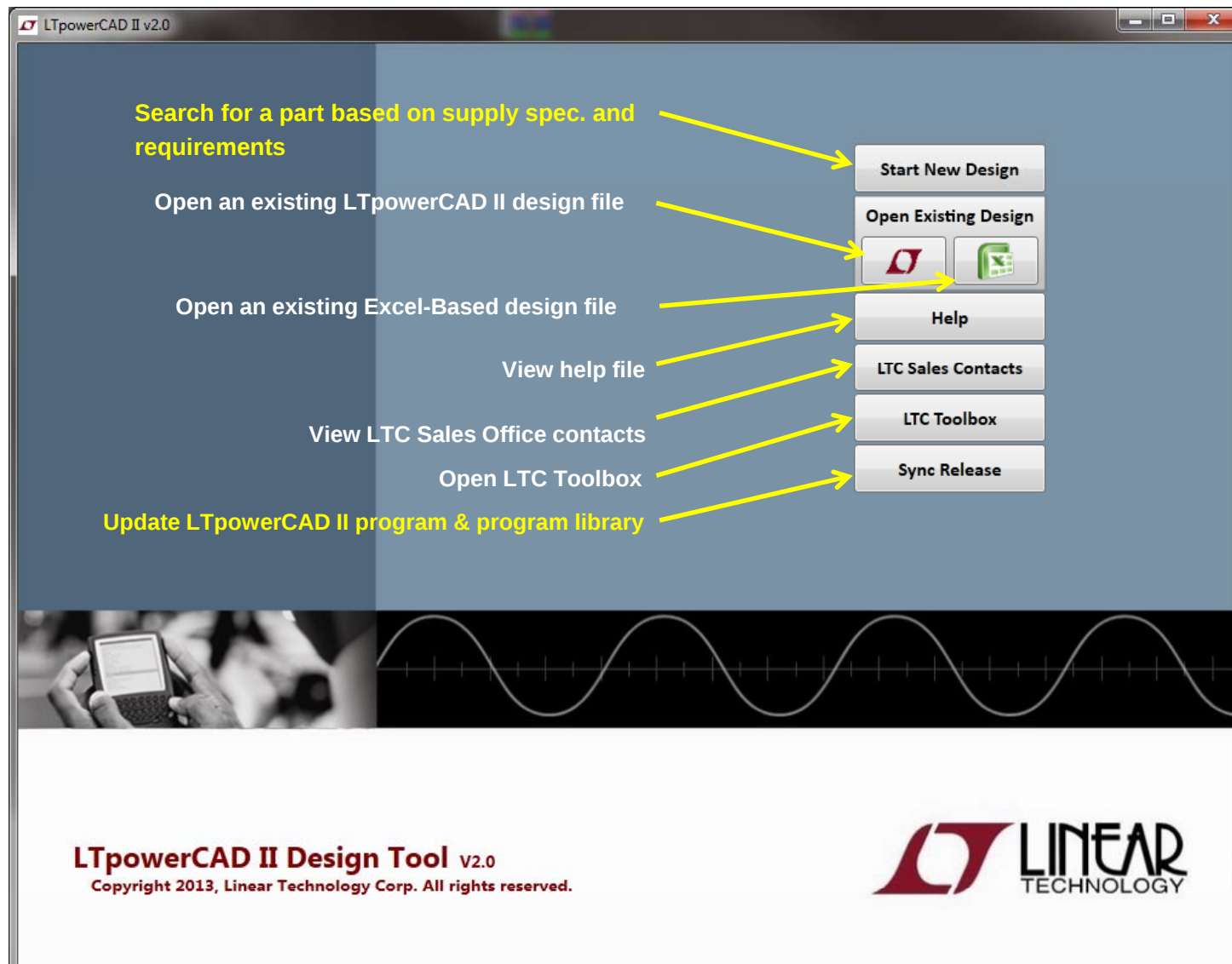


5. Check the contents of the installation folder (see next slide)

Note : The installation will place shortcuts to the LTpowerCAD II v2.0



Getting Start with LTpowerCAD II



Step 1. Enter power supply spec. and required functions.

If you know the LT part# to use, you can enter the 4-digit part# and click "go" instead of search.

Step 3. Select a Part from Search Results Table:

Click LTC icon for LTpowerCAD II tool

Click Excel icon for Excel-Based tool

Note: if the icon is in grey color, it means the design tool is not available.

Step 2. Click "Search" after the supply specs are entered to find parts.

Search LTC Part

LINEAR TECHNOLOGY **LTpowerCAD Design Tool** V2.0 Beta2 (For Intel) Copyright 2012, Linear Technology Corp. All rights reserved.

Converter Specification

Converter Topology: All

Converter Type: All

Output Rail 1

Vout1: 1.2 V

Iout1: 5 A

Min. Input Voltage: 10.8 V

Nom. Input Voltage: 12 V

Max. Input Voltage: 13.2 V

Num. of Output Rails: One

Num. of Parallel Phases: 1

Optional Features

- ☐ Burst Mode
- ☐ Synchronous FET
- ☐ Sync. to External Clock
- ☐ Output Voltage Tracking
- ☐ Remote Voltage Sensing
- ☐ Margin Control
- ☐ Power Good Monitor
- ☐ Poly-phase / Load Share
- ☐ I2C/PMBus Interface

Find Part Num. (####): Go

Search

LTC Web Search

All Parts

Design Tool	Website	Part Name	Type	Desc.	Topology	Max Vin	Min Vin	Ma
	LTC Web	LTM4612	uModule	Ultralow Noise 36VIN, 15VOUT, 5A, DC/DC μModule Regulator	Buck	36	5	5
	LTC Web	LTM4603	uModule	6A DC/DC μModule Regulator with PLL, Output Tracking and Margining	Buck	20	4.5	6
	LTC Web	LTM4602HV	uModule	6A, 28VIN High Efficiency DC/DC μModule Regulator	Buck	28	4.5	6
	LTC Web	LTM4602	uModule	6A High Efficiency DC/DC μModule Regulator	Buck	20	4.5	6
	LTC Web	LTM4618	uModule	6A DC/DC μModule Regulator with Tracking and Frequency Synchronization	Buck	26.5	4.5	6
	LTC Web	LTM4606	uModule	Ultralow EMI 28VIN, 6A DC/DC μModule Regulator	Buck	28	4.5	6
	LTC Web	LTM4603-1	uModule	6A DC/DC μModule Regulator	Buck	20	4.5	6
	LTC Web	LTM4603HV	uModule	6A, 28VIN DC/DC μModule Regulator with PLL, Output Tracking and Margining	Buck	28	4.5	6
	LTC Web	LTM4613	uModule	EN55022B Compliant 36VIN, 15VOUT, 8A, DC/DC μModule Regulator	Buck	36	5	8
	LTC Web	LTM4600HV	uModule	10A, 28VIN High Efficiency DC/DC μModule Regulator	Buck	28	4.5	10
	LTC Web	LTM4607	uModule	36VIN, 24VOUT High Efficiency Buck-Boost DC/DC μModule Regulator	Buck-Boost	36	4.5	10
	LTC Web	LTM4609	uModule	36VIN, 34VOUT High Efficiency Buck-Boost DC/DC μModule Regulator	Buck-Boost	36	4.5	10

LTpowerCAD currently supports design tools for a limited number of parts. For more part options click the LTC Web Search button.

Two possible design tool formats:

1. Non-Excel LTpowerCAD Design Tool:

If available, an active LTC button is shown:



2. Excel-Based Design Tool:

If available, an active Excel button is shown:



Note: if the icon is in grey color, it means the design tool is not available yet.

Search LTC Part

LINEAR TECHNOLOGY **LTpowerCAD Design Tool** V2.0 Beta2 (For Internal Review Only)
Copyright 2012, Linear Technology Corp. All rights reserved.

Converter Specification

Converter Topology: All
Converter Type: All

Output Rail 1
Vout1: 1.2 V
Iout1: 5 A

Min. Input Voltage: 10.8 V
Nom. Input Voltage: 12 V
Max. Input Voltage: 13.2 V

Num. of Output Rails: One
Num. of Parallel Phases: 1

Find Part Num. (####): Go

Optional Features

- ☐ Burst Mode
- ☐ Synchronous FET
- ☐ Sync. to External Clock
- ☐ Output Voltage Tracking
- ☐ Remote Voltage Sensing
- ☐ Margin Control
- ☐ Power Good Monitor
- ☐ Poly-phase / Load Share
- ☐ I2C/PMBus Interface

Search

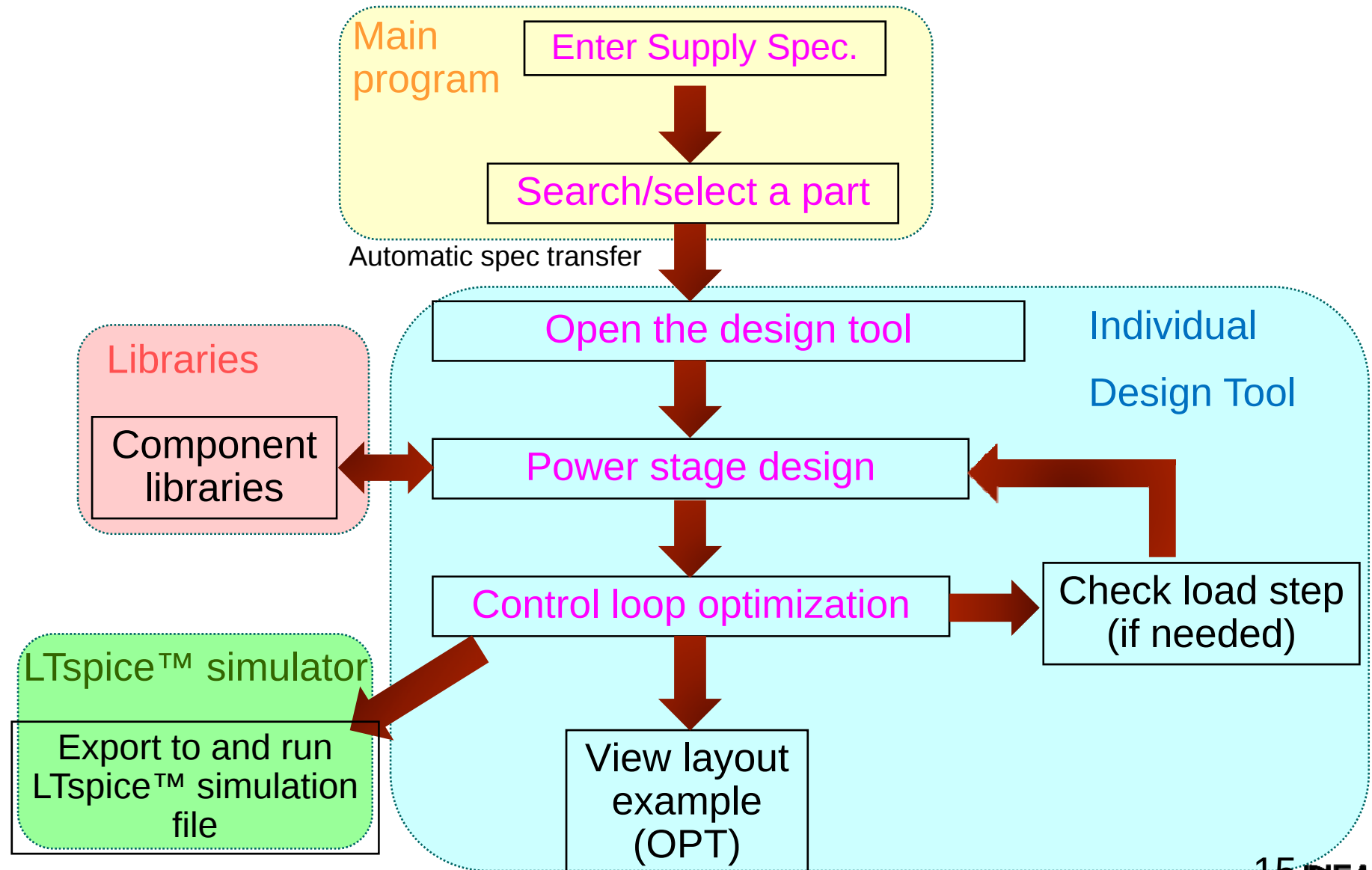
LTC Web Search

All Parts

Design Tool	Website	Part Name	Type	Desc.	Topology	Max Vin	Min Vin	Ma	
		LTC Web	LTM4612	uModule	Ultralow Noise 36VIN, 15VOUT, 5A, DC/DC μModule Regulator	Buck	36	5	5
		LTC Web	LTM4603	uModule	6A DC/DC μModule Regulator with PLL, Output Tracking and Margining	Buck	20	4.5	6
		LTC Web	LTM4602HV	uModule	6A, 28VIN High Efficiency DC/DC μModule Regulator	Buck	28	4.5	6
		LTC Web	LTM4602	uModule	6A High Efficiency DC/DC μModule Regulator	Buck	20	4.5	6
		LTC Web	LTM4618	uModule	6A DC/DC μModule Regulator with Tracking and Frequency Synchronization	Buck	26.5	4.5	6
		LTC Web	LTM4606	uModule	Ultralow EMI 28VIN, 6A DC/DC μModule Regulator	Buck	28	4.5	6
		LTC Web	LTM4603-1	uModule	6A DC/DC μModule Regulator	Buck	20	4.5	6
		LTC Web	LTM4603HV	uModule	6A, 28VIN DC/DC μModule Regulator with PLL, Output Tracking and Margining	Buck	28	4.5	6
		LTC Web	LTM4613	uModule	EN55022B Compliant 36VIN, 15VOUT, 8A, DC/DC μModule Regulator	Buck	36	5	8
		LTC Web	LTM4600HV	uModule	10A, 28VIN High Efficiency DC/DC μModule Regulator	Buck	28	4.5	10
		LTC Web	LTM4607	uModule	36VIN, 24VOUT High Efficiency Buck-Boost DC/DC μModule Regulator	Buck-Boost	36	4.5	10
		LTC Web	LTM4609	uModule	36VIN, 34VOUT High Efficiency Buck-Boost DC/DC μModule Regulator	Buck-Boost	36	4.5	10

LTpowerCAD currently supports design tools for a limited number of parts. For more part options click the LTC Web Search button.

using the LTpowerCAD™ Design Tool



Example of a non-Excel **LTpowerCAD** design Tool

Design Step 1 – Power Stage Design

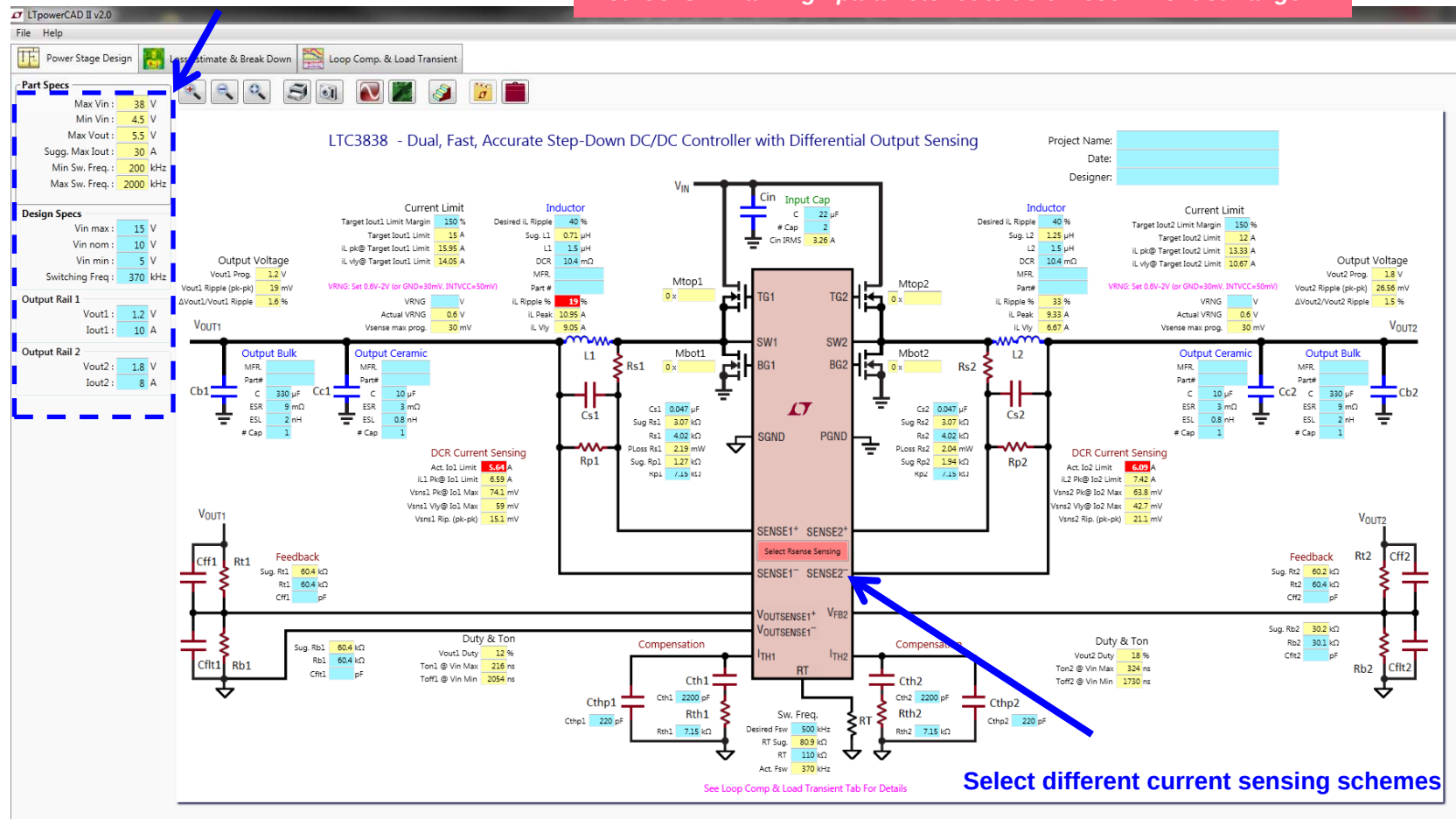
17

Yellow Cells = Suggested values or calculated parameters

Blue Cells = User's chosen values

Red Cells = Warning - parameter outside of recommended range.

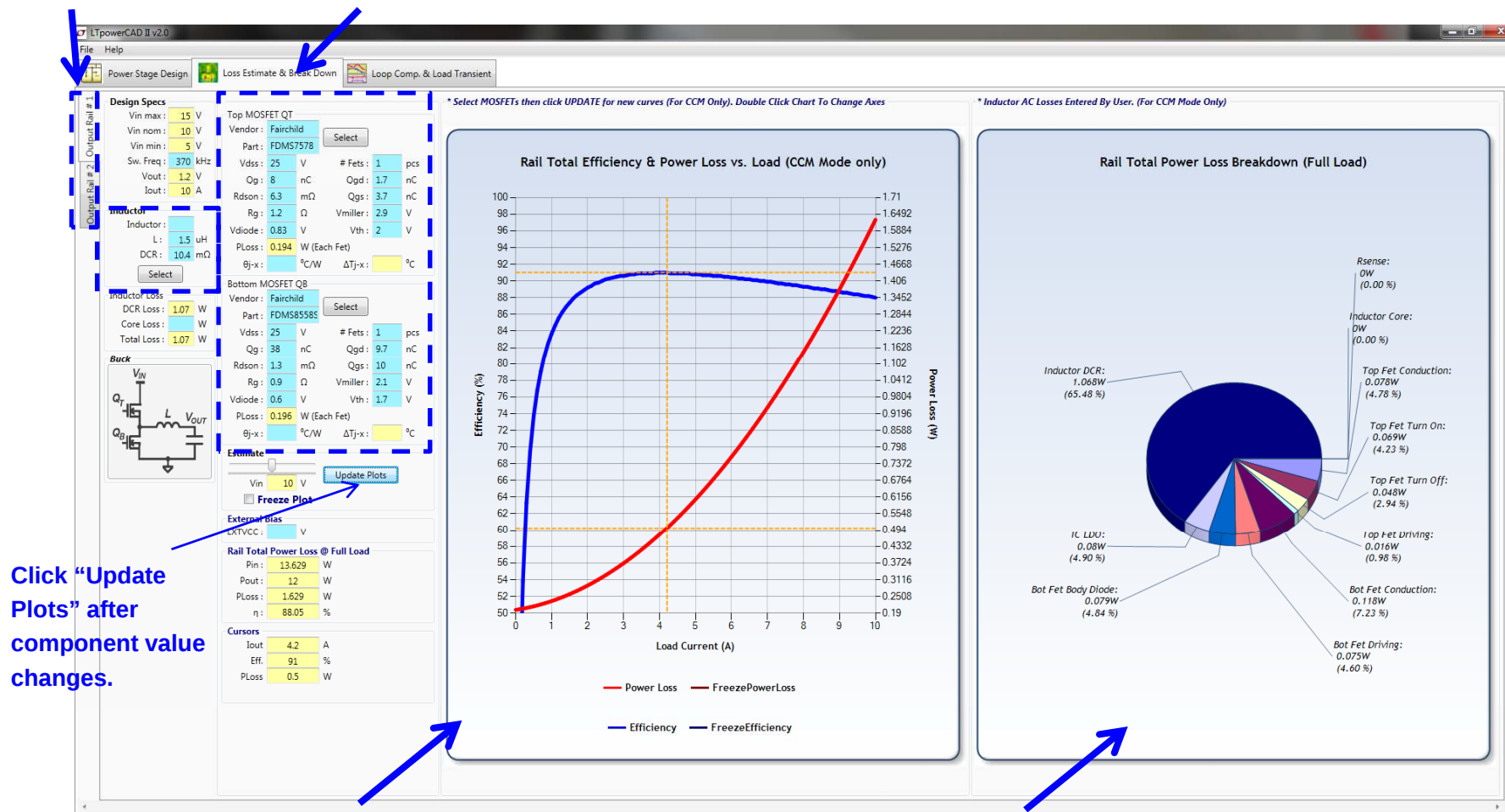
Design Requirements & Part Limits



- User can only change blue-cell values and check calculated circuit parameters in yellow and red cells.
- Red cells are for warnings. User needs to decide if following/correcting the warning or not.

View data for each rail

Enter power stage component details & Test Conditions (enter manually or select from built-in library)



LTpowerCAD II v2.0

File Help

Power Stage Design Loss Estimate & Break Down Loop Comp. & Load Transient

Design Specs

Vin max: 12 V
Vin nom: 12 V
Vin min: 12 V
Sw. Freq: 500 kHz
Vout: 1 V
Iout: 20 A

Inductor

Inductor: L: 0.3 uH
DCR: 1 mΩ

Inductor Loss

DCR Loss: W
Core Loss: W
Total Loss: W

Buck

Top MOSFET QT

Vendor: Fairchild
Part: FDM58558S

Vds: 25 V
Qg: 38 nC
Rds(on): 1.3 mΩ
Rg: 0.9 Ω
Vdiode: 0.6 V
Ploss: W (Each Fet)
θj-x: °C/W

Fets: 1 pcs
Qgd: 9.7 nC
Qgs: 10 nC
Vth: 1.7 V
ΔTj-x: °C

Bottom MOSFET QB

Vendor: Fairchild
Part: FDM58558S

Vds: 25 V
Qg: 38 nC
Rds(on): 1.3 mΩ
Rg: 0.9 Ω
Vdiode: 0.6 V
Ploss: W (Each Fet)
θj-x: °C/W

Fets: 1 pcs
Qgd: 9.7 nC
Qgs: 10 nC
Vth: 1.7 V
ΔTj-x: °C

Estimate

Vin: 12 V

Update Plots

Freeze Plot

External Bias

EXTVCC: V

Rail Total Power Loss @ Full Load

Pin: W
Pout: W
Ploss: W
η: %

Cursors

Iout: 0 A
Eff: 0 %
Ploss: 0 W

Click "Select" to open MOSFET library.

Power MOSFET Library

Built-In Parts:

Vendor	Part Name	Vds (V)	Rds(on) (mΩ)	Qg (nC)	Qgd (nC)	Qgs (nC)	Rg (Ω)	Vdiode (V)	Vmiller (V)	Vth (V)	Package	Channel Type
Renesas	RJK0301	30	3	32	7	14.5	2	0.84	3	2.5	LFPK	N
Renesas	RJK0305	30	10	8	1.5	3.6	0.6	0.85	3	2.5	LFPK	N
Infineon	BSC019N02K	20	1.6	64	11	19	1.90	0.80	1.90	1.0	PG-TDSON	N
Infineon	BSC026N02K	20	2.1	40	7	11.4	1.50	0.85	1.90	1.0	PG-TDSON	N
Infineon	BSC046N02K	20	3.5	21	4	6.5	1.90	0.90	2.10	1.0	PG-TDSON	N
Infineon	BSC010NE2L	25	1.1	31	6.8	11	0.60	0.80	2.40	1.6	PG-TDSON	N
Infineon	BSC010NE2L	25	1.1	29	6.9	10	0.60	0.56	2.40	1.6	PG-TDSON	N
Infineon	BSC014NE2L	25	1.6	18.7	4.7	6.8	0.60	0.56	2.50	1.6	PG-TDSON	N
Infineon	BSC018NE2L	25	1.8	19	4.3	7	0.80	0.85	2.50	1.6	PG-TDSON	N
Infineon	BSC0911ND	25	1.3	25	5.5	8.8	0.60	0.79	2.30	1.6	PG-TISON	N
Infineon	BSC0911ND	25	3.7	7.7	1.8	3	0.90	0.84	2.60	1.6	PG-TISON	N

Select Show N-Fets Only Show P-Fets Only

User Parts:

Vendor	Part Name	Vds (V)	Rds(on) (mΩ)	Qg (nC)	Qgd (nC)	Qgs (nC)	Rg (Ω)	Vdiode (V)	Vmiller (V)	Vth (V)	Package	Channel Type
Part: Jukl	FDM58558S	25	1.3	38	9.7	10	0.90	0.60	2.10	1.7	POWER 56	N
Fairchild	FDM57578	25	6.3	8	1.7	3.7	1.20	0.83	2.90	2.0	POWER 56	N

Select Delete Show N-Fets Only Show P-Fets Only

Add A New User Part:

Vendor	Part Name	Vds (V)	Rds(on) (mΩ)	Qg (nC)	Qgd (nC)	Qgs (nC)	Rg (Ω)	Vdiode (V)	Vmiller (V)	Vth (V)	Package	Channel Type

Add Part To Library

Cancel / Exit

Vendor Links

FAIRCHILD SEMICONDUCTOR VISHAY infineon RENESAS

Standard library

User created library

User can add new part into user library

Popular vendor weblinks

Click "Select" to open inductor library.

Standard library

User created library

User can add new part into user library

Popular vendor weblink / web-search site.

Vendor	Part Name	Inductance (μH)	L Tol. (%)	DCR (mΩ)	DCR Tol. (%)	ISat (A)	L Decrease (%)	IHeat (A)	Temp. Rise (C)	Core	L x W x H (mm)
VITEC	59P8903	0.32	10	0.17	10.00	50.00	20.00	80.00	40.00	Ferrite	14.0 x 13.0 x 7.6
VITEC	59P8904	0.44	10	0.17	10.00	35.00	20.00	80.00	40.00	Ferrite	14.0 x 13.0 x 7.6
VITEC	59P9873N	0.22	15	0.29	10.00	47.00	20.00	48.00	40.00	Ferrite	11.0 x 7.5 x 7.2
VITEC	59P9874N	0.30	15	0.29	10.00	34.00	20.00	48.00	40.00	Ferrite	11.0 x 7.5 x 7.2
VITEC	59P9875N	0.40	15	0.29	10.00	23.00	20.00	48.00	40.00	Ferrite	11.0 x 7.5 x 7.2
VITEC	59P9876N	0.51	15	0.29	10.00	17.00	20.00	48.00	40.00	Ferrite	11.0 x 7.5 x 7.2
WURTH	744 301 025	0.22	20	0.32	10.00	65.00	20.00	40.00	50.00	Ferrite	11.3 x 11.0 x 8.9
WURTH	744 301 033	0.33	20	0.32	10.00	46.00	20.00	40.00	50.00	MnZn	11.0 x 11.0 x 9.0
WURTH	744 301 047	0.47	20	0.32	10.00	35.00	20.00	40.00	50.00	MnZn	11.0 x 11.0 x 9.0
WURTH	744 304 022	0.22	20	0.17	10.00	23.00	20.00	26.00	50.00	Ferrite	11.5 x 11.8 x 3.8
WURTH	744 306 030	0.30	20	0.26	10.00	24.00	20.00	26.00	50.00	Ferrite	10.5 x 10.3 x 5.0

Vendor	Part Name	Inductance (μH)	L Tol. (%)	DCR (mΩ)	DCR Tol. (%)	ISat (A)	L Decrease (%)	IHeat (A)	Temp. Rise (C)	Core	L x W x H (mm)
COILCRAFT	SER1360-331	0.33	20	0.77	20	43	20	16.9	40	Ferrite	12.9 x 13 x 5.8

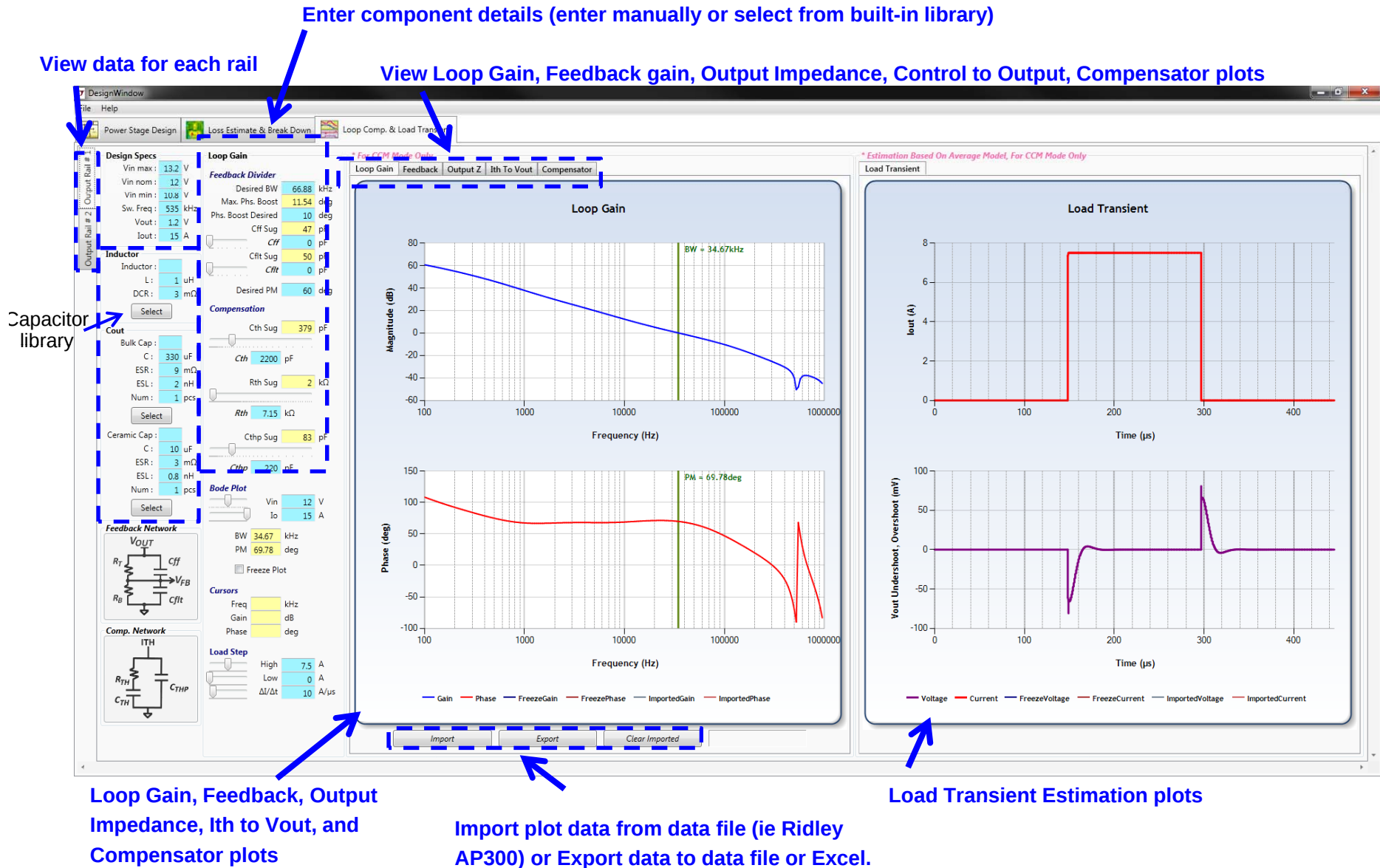
Vendor	Part Name	Inductance (μH)	L Tol. (%)	DCR (mΩ)	DCR Tol. (%)	ISat (A)	L Decrease (%)	IHeat (A)	Temp. Rise (C)	Core	L x W x H (mm)

Vendor Search Tools

Coilcraft WE VISHAY VITEC TDK muRata sunida Pulse Electronics

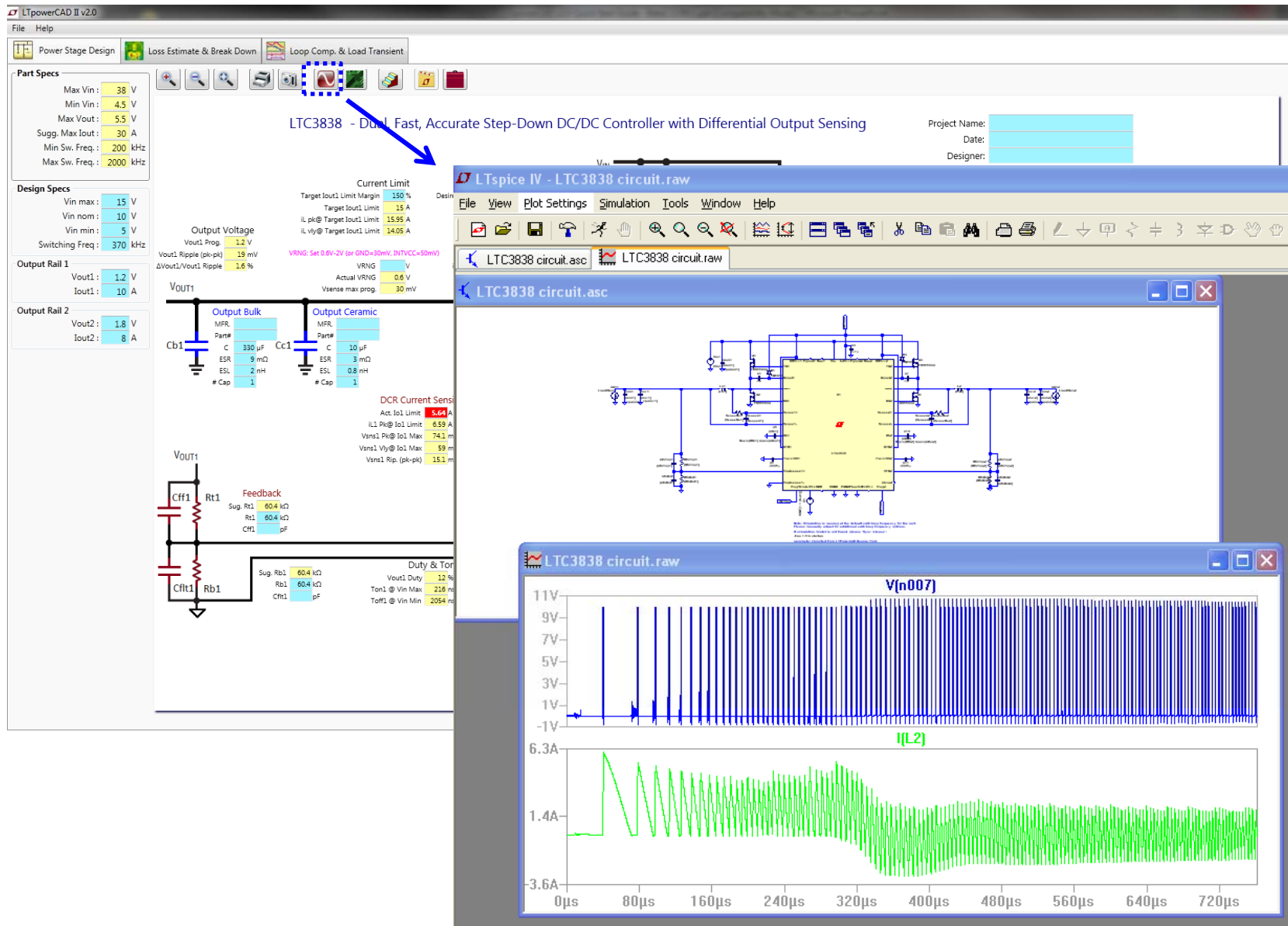
Design Step 3 – Optimize Loop Comp & Load Transient

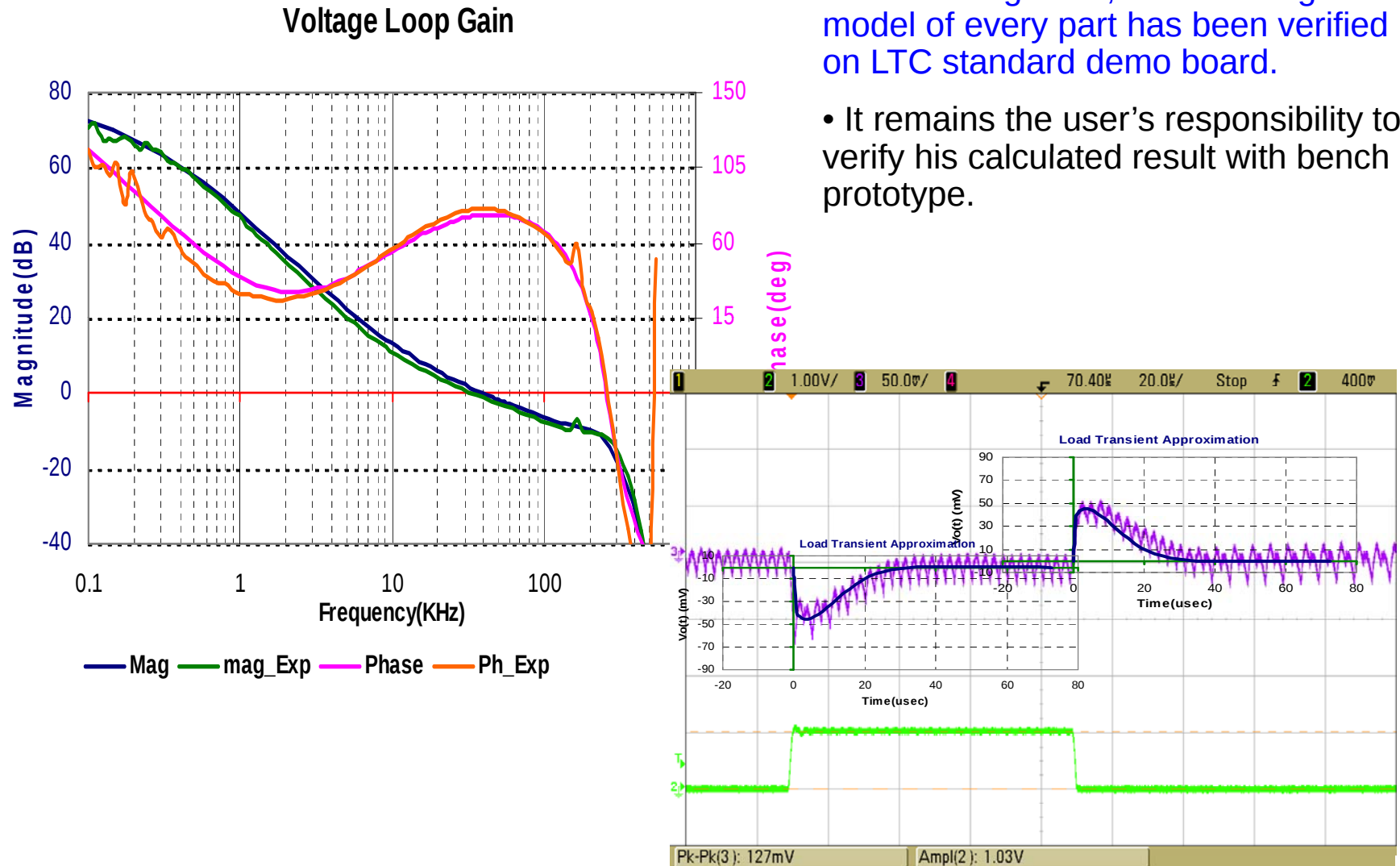
21



(Optional) Design Step 4 – Export to LTspice for Simulation

22



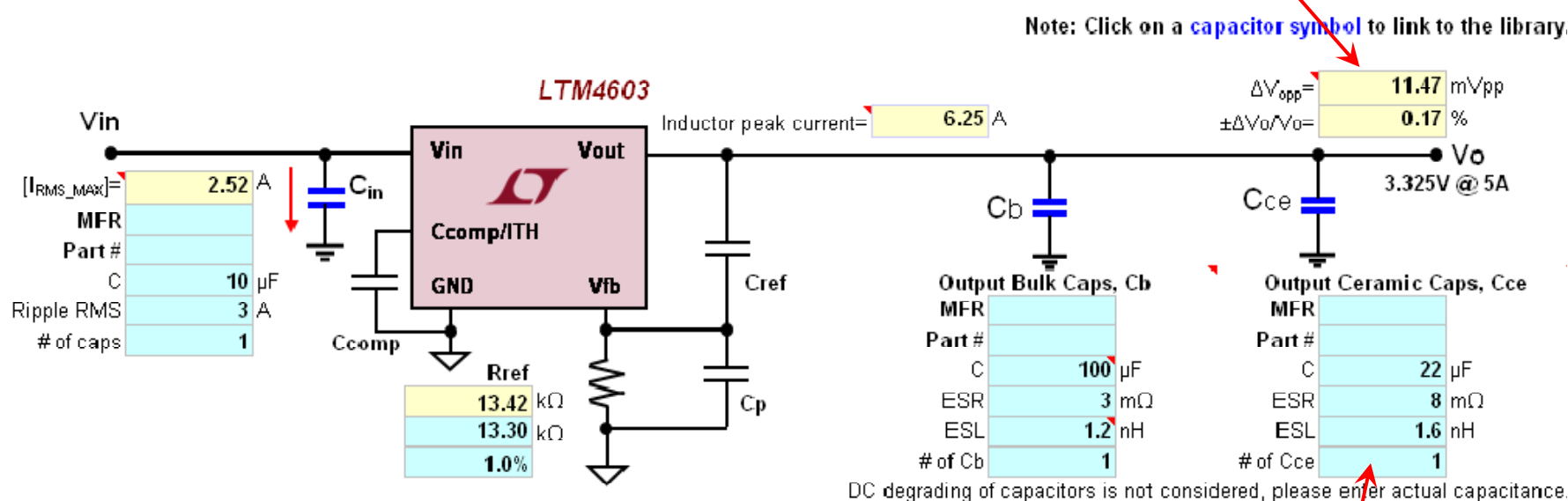


- In the design tool, the small signal model of every part has been verified on LTC standard demo board.
- It remains the user's responsibility to verify his calculated result with bench prototype.

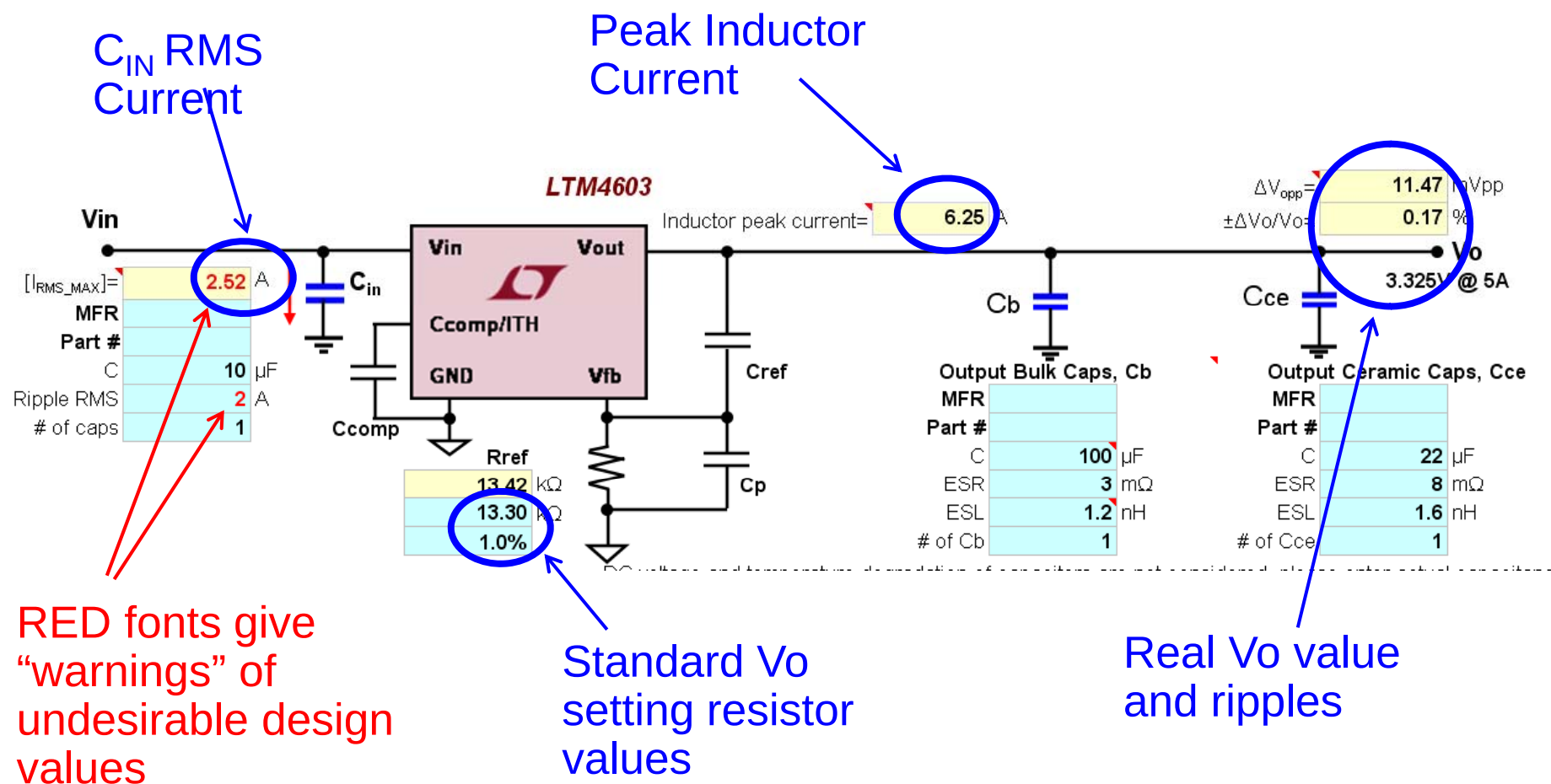
Example of a **Excel-Based** design Tool

In the design spreadsheet, power components design is guided with schematic interface:

Values in yellow cells are calculated / recommended by design tool.



Values in blue cells are selected / entered by user.



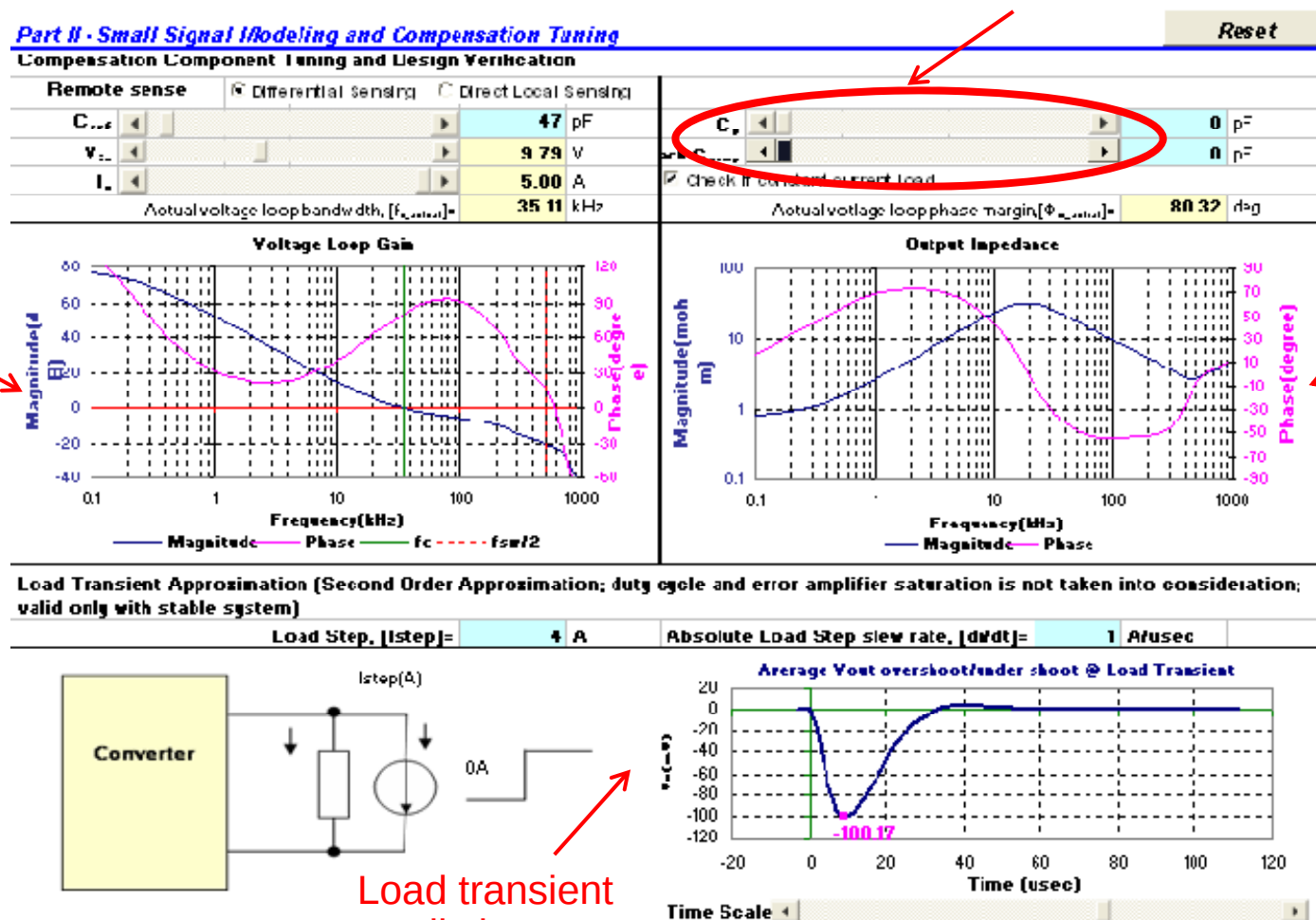
Step 2: Control Loop Optimization

27

In the design spreadsheet, control loop design can be fine tuned:

Sliding bar for compensation adjustment.

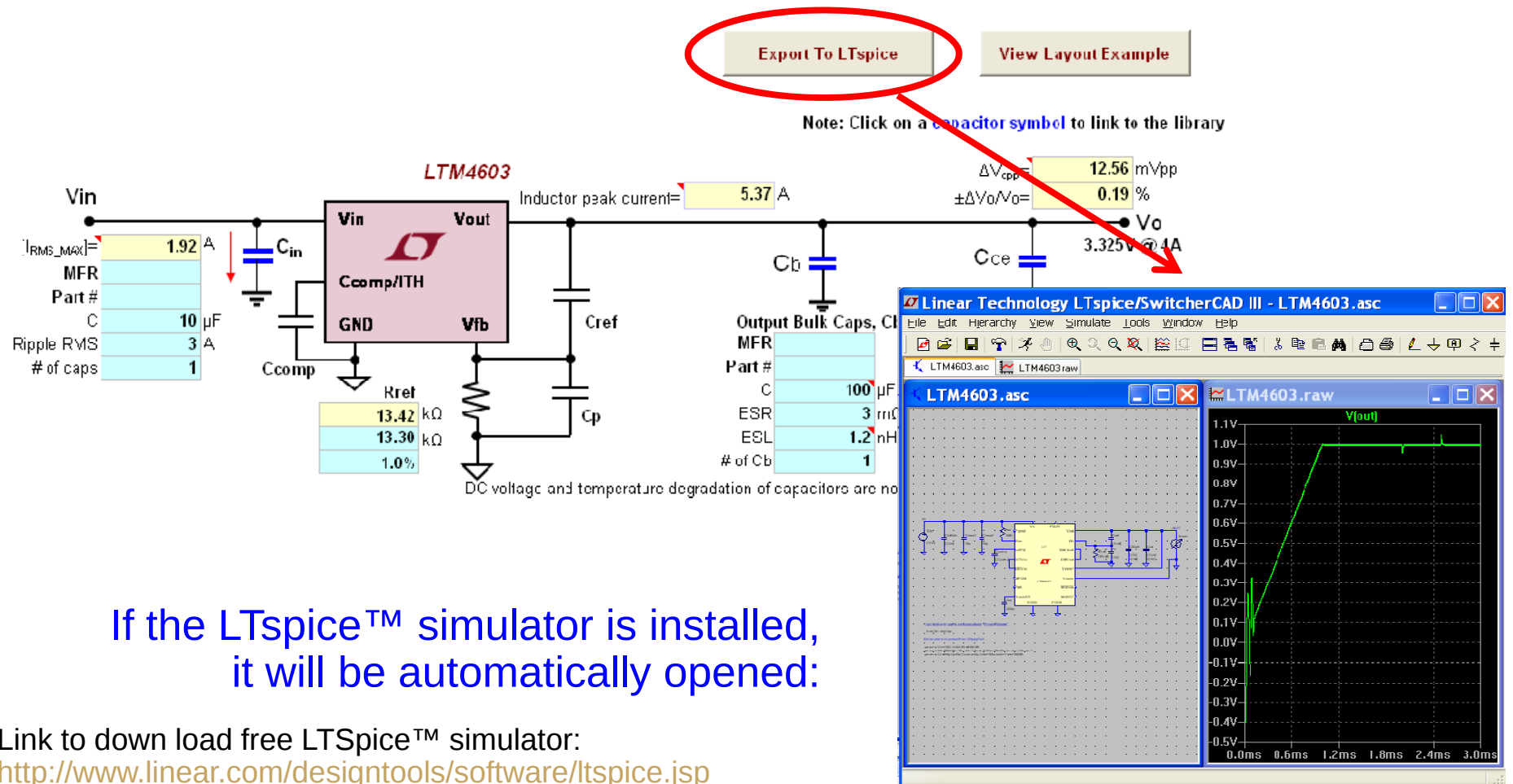
Loop gain prediction



Output Impedance

Export to & Run LTspice™ Simulation

In the design spreadsheet, click the “Export To LTspice” button:



If the LTspice™ simulator is installed, it will be automatically opened:

Link to down load free LTSpice™ simulator:

<http://www.linear.com/designtools/software/ltspice.jsp>

Additional Feature (2):

29

Summary of design: BOM, size, cost and stress

In the design spreadsheet, click the “Summary” sheet:

Summary of Design

Bill of Material of Power Components									
			Unit	⌀ inch	⌀ mm				
Component	Part #	# of parts	Value	Package	L	W	H	Unit Price	Total Price
Cin (bulk)	0	1	100 μF	1210	0.098	0.126	N/A		\$0.00
Cin (ceramic)			μF	1206	0.063	0.126	N/A		\$0.00
Cout (bulk)	2R5TPE220MC	0	220 μF	0805	0.049	0.079	N/A		\$0.00
Cout (ceramic)	0.00	1	72 μF	1210	0.098	0.126	N/A		\$0.00
MicroModule	LTM4603	1		LGA (15 X 15 X2.8)	0.591	0.591	0.110		\$0.00
Power Component Summary:									
					Foot print clearance factor= 1.5				
Total footprint are W/O output Bulk Capacitors					0.560		inch^2		
Total footprint					0.560		inch^2		
Total BOM cost W/O input and output Bulk Capacitors					\$0.00				
Total BOM cost					\$0.00				
Design Analysis									
Parameters	Condition	Minimum	Typical	Maximum	Units				
Input Voltage		7.000	12.000	14.000	V				
Output Voltage		0.984	0.999	1.014	V				
Inductor peak-to-peak Ripple			0.909	0.921	A				
Frequency			1004.016		KHz				
Crossover freq.	Vin=8.09V		119.891		kHz				
Phase Margin	Vin=8.09V		39.159		Deg.				
It remains the customer's responsibility to verify proper and reliable operation in the actual application.									

Power components summary

Stress analyses

Any feedback comments on the program or issues encountered are welcome!

Please forward your comments to the addresses below.

LTpowerCAD@Linear.com

LTpowerCAD II v2.0™

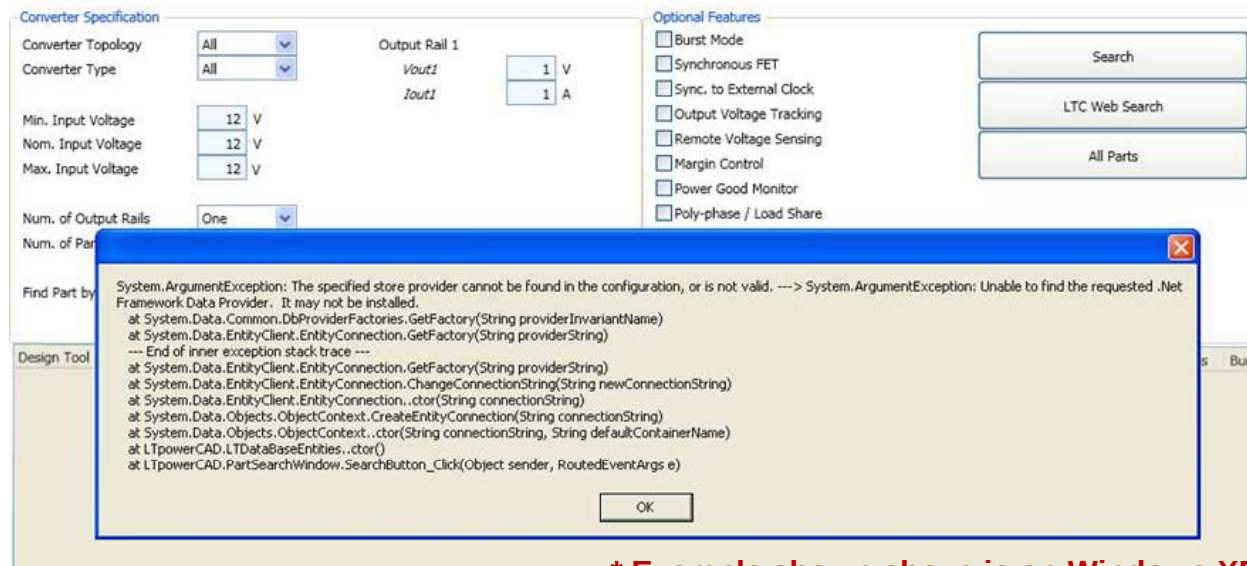
Installation

Troubleshooting

I. Microsoft SQL Server Compact 3.5 SP2 ENU requirement :

1) Possible issue: Microsoft SQL Server Compact 3.5 SP2 is requirement missing

LTpowerCAD II v2.0 requires Microsoft SQL Server Compact 3.5 SP2 to access the internal parts database. If this is not installed, the program may have issues accessing information for parts included in the program. An example screenshot is shown below where this type of error has occurred. *If this is confirmed to be installed on your system, make sure it was installed correctly which may require a repair of the installation or new installation of this requirement.*



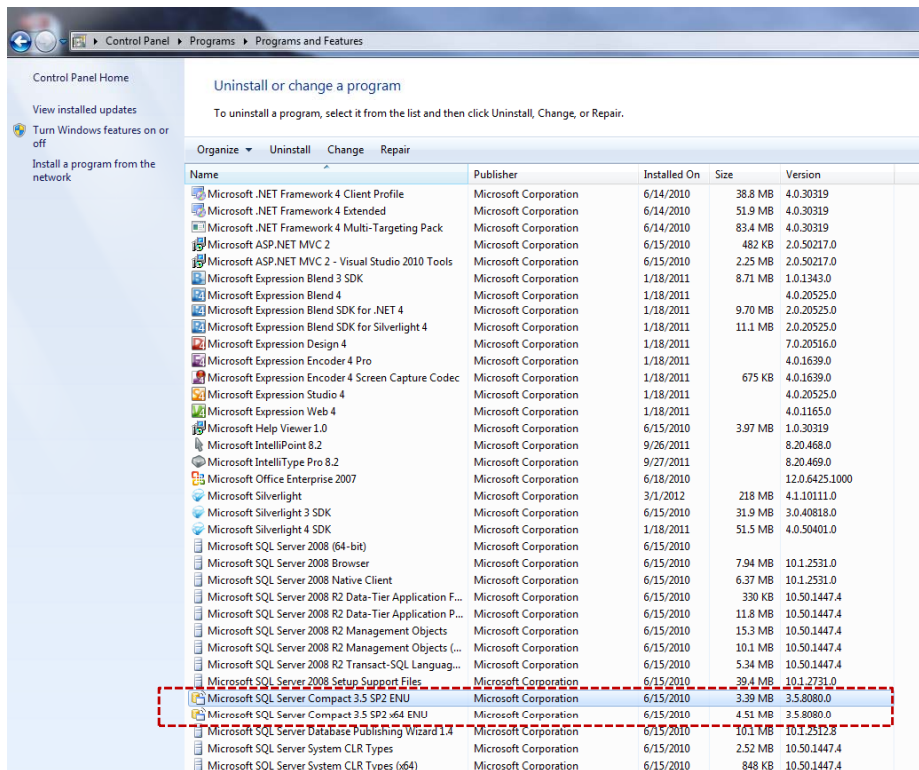
*** Example shown above is on Windows XP**

Important : Make sure you installed using “setup.exe” file (not the MS.msi file)

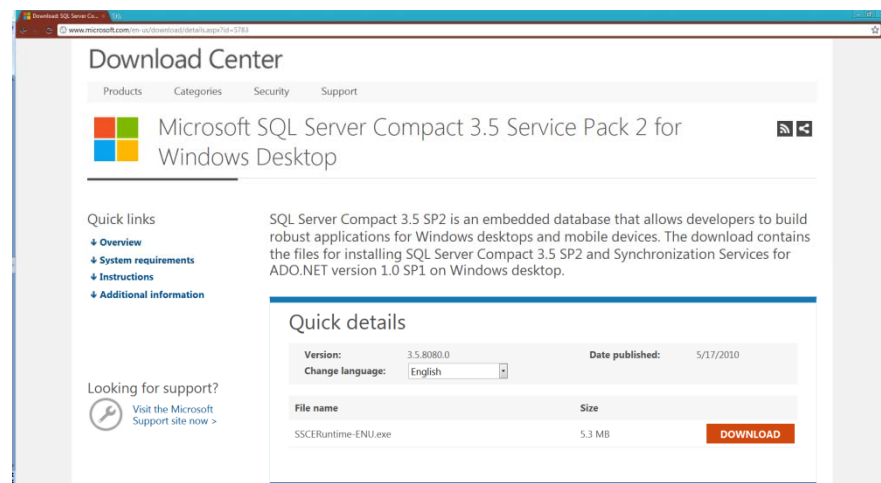
Possible issue solution:

Check the programs you have currently installed on your system to see if Microsoft SQL Server Compact 3.5 SP2 requirement is missing or not. The LTpowerCAD II v2.0 installer automatically checks if you have this requirement, if not it will download and install it automatically. This can also be freely downloaded at Microsoft at <http://www.microsoft.com/en-us/download/details.aspx?id=5783> If this is confirmed to be installed on your system, make sure it was installed correctly which may require a repair of the installation or new installation of this requirement.

Step 1) Check the list of programs you have currently installed on your system by going to Start Menu → Control Panel → Uninstall a program



Step 2) If this is not installed, this can be downloaded from <http://www.microsoft.com/en-us/download/details.aspx?id=5783> . Please download and install this package, then try to un-install / re-install LTpowerCAD II v2.0.



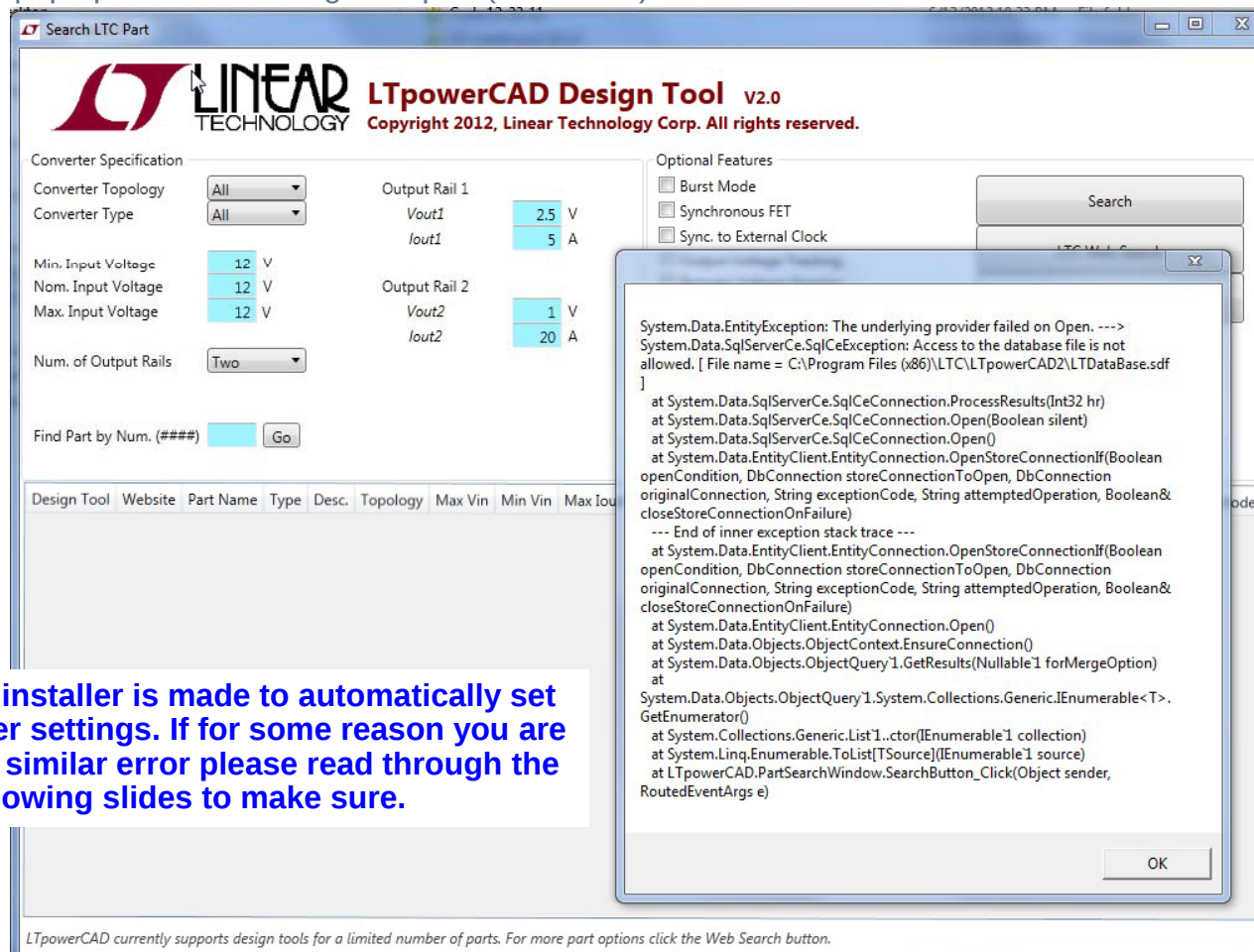
**** Note : The installer is made to automatically download and install these software requirements to your system if your system does not already have these installed.**

Important : Make sure you installed using “setup.exe” file (not the MS.msi file)

II. Microsoft Security Settings :

2) Possible issue: Microsoft Security Settings

Security default settings may prevent access of LTpowerCAD II v2.0 from its database causing an error message to pop up when searching for a part (see below).



**** Note :** The installer is made to automatically set up these folder settings. If for some reason you are still getting a similar error please read through the following slides to make sure.

Important : Make sure you installed using "setup.exe" file (not the MS.msi file)

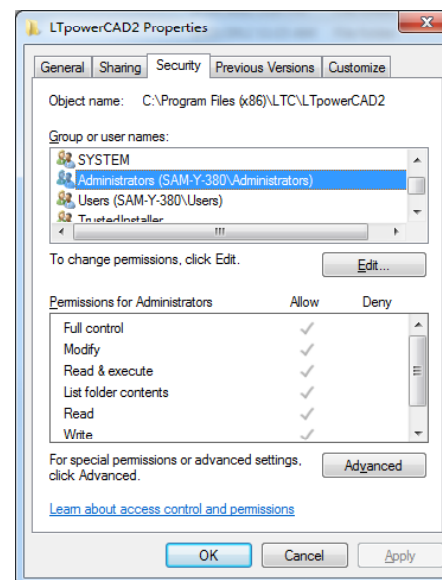
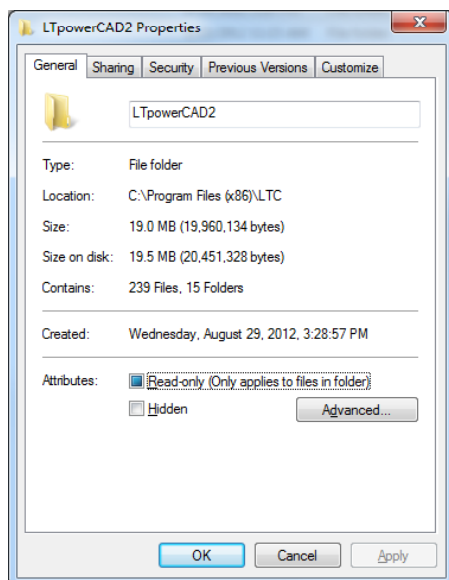
Possible issue solution:

Run the program with an Administrator account , or try to modify your system's Users account security settings for now (see below).

Step 1) Go to the LTC folder location: (ie C:\Program Files (x86)\LTC)

Step 2) Right click on the LTpowerCAD 2 program folder → **Properties**

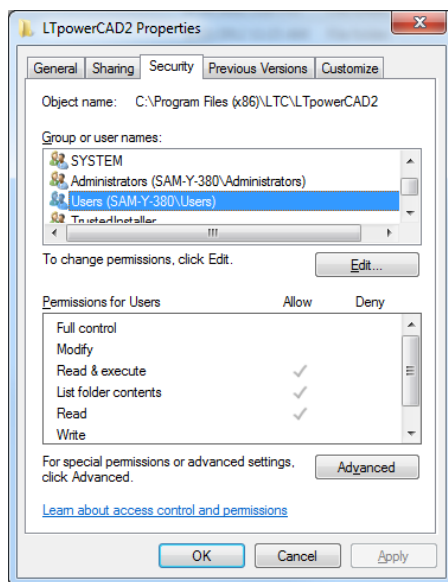
Step 3) Click on the **Security** tab. Click on your **Administrators** account and see that the permissions should show Allow for all options (except for Special permissions). The **SYSTEM** account should also have the same settings.



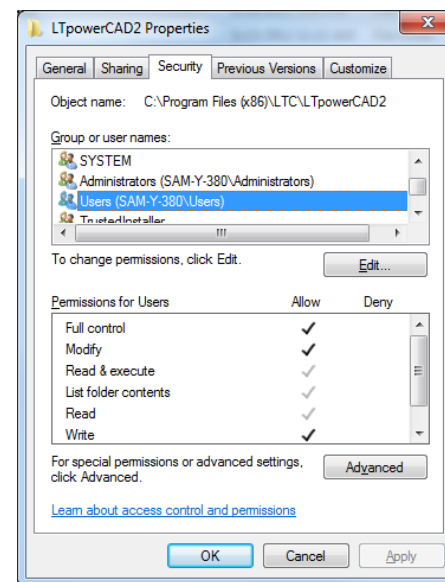
Important : Make sure you installed using “setup.exe” file (not the MS.msi file)

Possible issue solution (cont'd):

Step 4) Click on your **Users** account to see the user settings. Your user account may not have the permissions set (like shown below) that are needed. You can change these in the next step.



Step5) Click on the **Edit** button and click on your **Users** account again and click the check boxes on the **Allow** column for **Full control, Modify, Write**. Click **OK**. The settings should now be the same as you saw for the **Administrators** account.



Important : Make sure you installed using “setup.exe” file (not the MS.msi file)