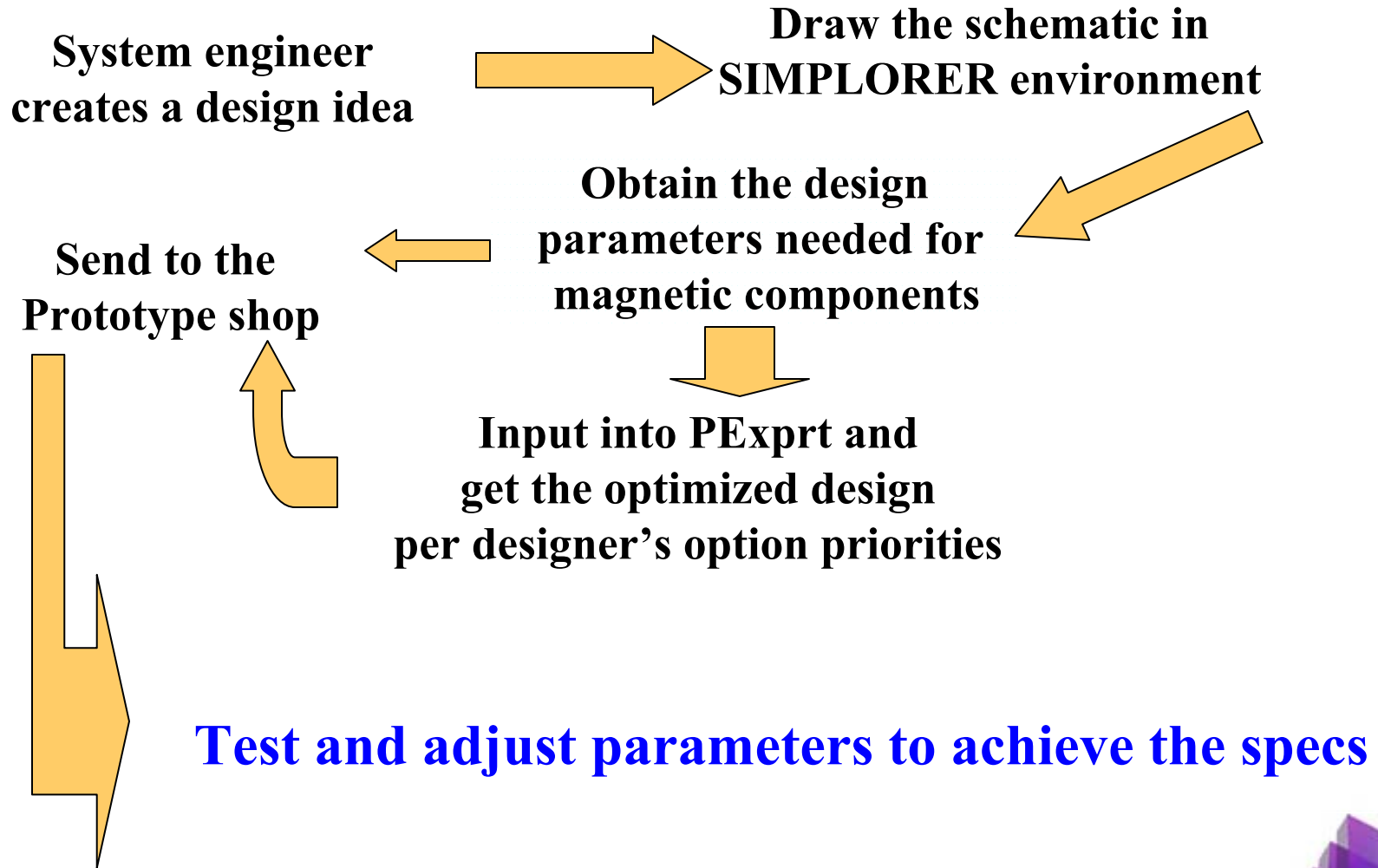


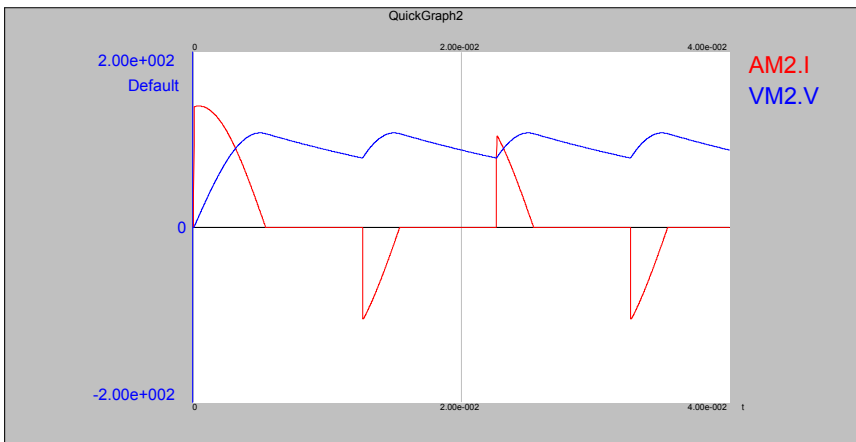
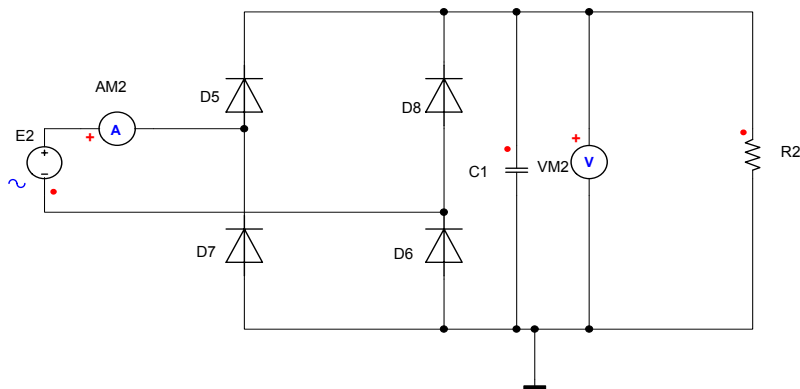
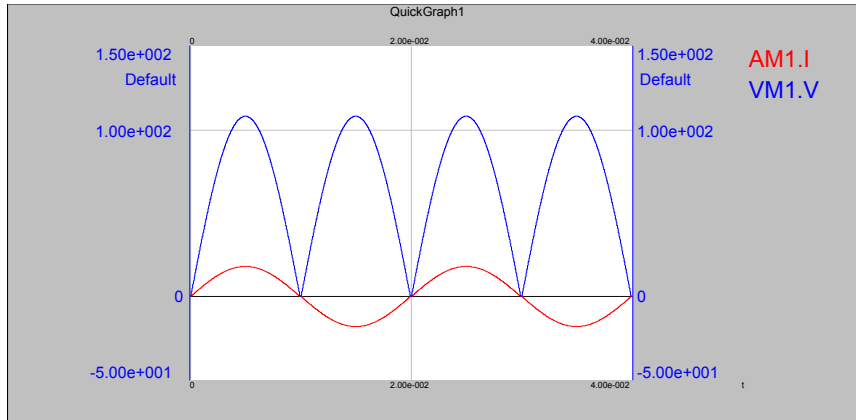
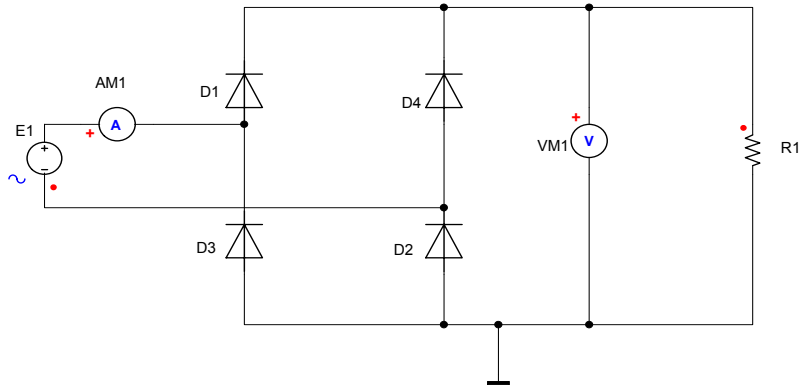
The Power Factor Correction Circuit Simulation and PFC Inductor Design with SIMPLORER[®] and PExprt[®]

Jian HUANG, PhD
Application Engineer, EM Products
Ansoft Corporation
Santa Clara, CA

The Integrated Simulation and Design Tools: SIMPLORER® and PExprt®



Currents Drawn from Power Line without Power Factor Correction



The Parameters Needed to Input into SIMPLORER

Input Data

ICA:

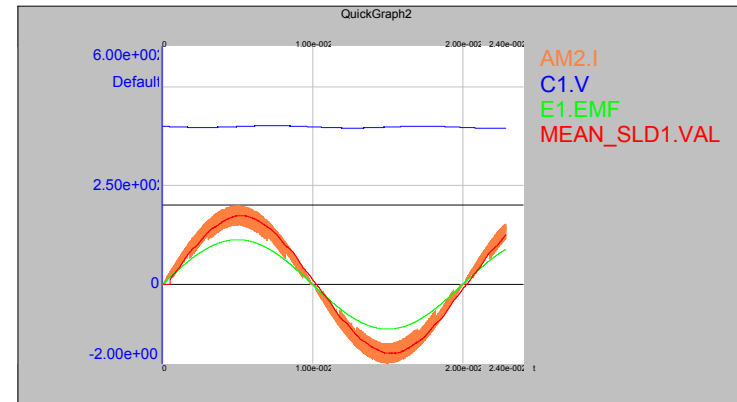
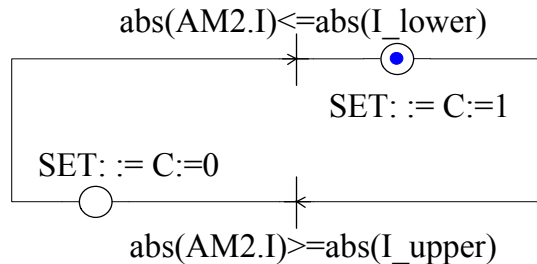
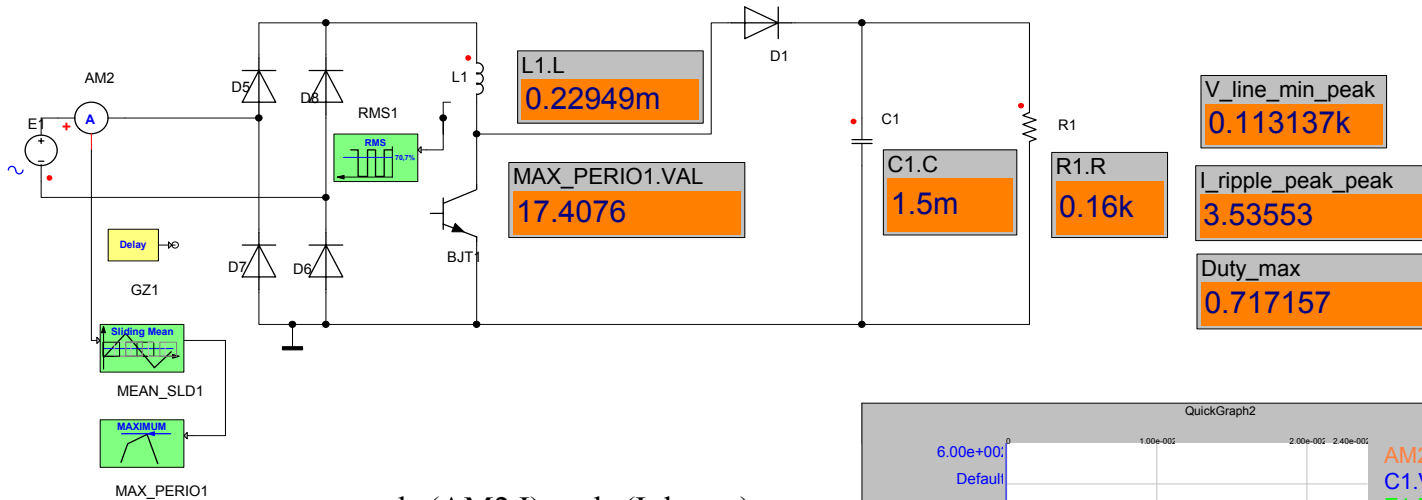
F_chopping := 100k
P_out := 1000
V_out := 400
F_line_min := 47
F_line_max := 65
V_line_min := 80
V_line_max := 270
Transient_Steady := 1
Ripple_coefficient := 0.2

Control Parameters

EQU

$I := (2 * P_out / E1.AMPL) * (E1.EMF / E1.AMPL)$
 $I_upper := 1.1 * I$
 $I_lower := 0.9 * I$
 $C_out := P_out * 1.5u$
 $I_ripple_peak_peak := Ripple_coefficient * (sqrt(2) * P_out / V_line_min)$
 $Duty_max := (V_out - sqrt(2) * V_line_min) / V_out$
 $L_pfc := Sqrt(2) * V_line_min * Duty_max / (F_chopping * I_ripple_peak_peak)$

Power Factor Correct Circuit Simulation and Magnetic Design Parameters Obtained



8-5-2002-20-a.ssh

sim  **plorer**[®]
system simulation

ANSOFT CORPORATION

Input the Parameters into PExprt

The screenshot displays the PExprt software interface for a simulation. The window title is "PExprt - [ContinuePFC-02.wif]". The menu bar includes File, Libraries, Calculations, Modeler, Reports, Options, View, Window, and Help. The toolbar contains icons for file operations and simulation. The main workspace is divided into several sections:

- Property Table:** A table with two columns: "Property" and "Value".
- Design Inputs:** A panel with the following settings:
 - Voltage Waveform:** Square (selected), Sinusoidal.
 - Frequency:** 100 kHz.
 - Conduction Mode:** Continuous (selected), Discontinuous.
 - Current:** Average: 17 A, Ripple: 3.5000 A.
 - Inductance:** 231.4 uH.
 - Voltage value:** Vpositive: 113 V, Vnegative: 286.29 V.
 - Duty Cycle:** 0.717.
- Stock Libraries:** A tree view showing libraries such as AVX, Epcos, Ferroxcube, Magnetics, Micrometals, Steward, TDK, and Design Libraries.
- Waveforms:** Two plots are shown:
 - Voltage (V):** A square wave plot with a peak of 113.00 V and a trough of -286.29 V. The period is 10.0 uS, with a pulse width of 7.2 uS.
 - Current (A):** A ripple current plot with a peak of 17.00 A and a trough of 15.25 A. The period is 10.0 uS, with a pulse width of 7.2 uS.

PExprt Internal Development Version 1.0.28. Copyright 1999-2002. Universidad Politecnica de Madrid (UPM) and Ansoft Corporation

Specify the Optimize Priority for the Design Option List

The screenshot displays the PExprt software interface for a project named [ContinuePFC-02.wif]. The main window is divided into several sections:

- Property Table:** A table with columns for Property and Value.
- Design Inputs / Modeling Options:** A panel containing:
 - Winding Losses Calculation:** Radio buttons for DC, DC + Skin (selected), and DC + Skin + Proximity (Dowell).
 - Number of harmonics:** A field for Number (32) and Relative Influence (%) (10).
 - Optimize number of turns for minimum losses:** Radio buttons for No Optimization and Apply Optimization (selected).
 - Optimization Modes:** Radio buttons for Mode 1 and Mode 2 (selected).
 - List of results:** Radio buttons for Show all solutions and Selection (selected), with a Select Solutions button.
 - Selection of elements from the Design Library:** Radio buttons for Apply Restrictions (with a Configure button) and No Restrictions (all possible configurations) (selected).
- Stock Libraries:** A tree view showing libraries like AVX, Epcos, Ferroxcube, Magnetics, Micrometals, Steward, TDK, and Micrometals_Design.
- Graphs:** Two plots are visible: a voltage plot [V] on the left and a current plot [uS] on the right. The current plot shows a peak value of 17.00.

An **Optimization Criteria** dialog box is open in the foreground, showing the following settings:

- Design Criteria:** Radio buttons for Minimum Losses, Minimum Temperature Rise (selected), Minimum Volume, Minimum Height, and Minimum Footprint.
- Number of solutions to be shown:** A field for Show the 10 best solutions.

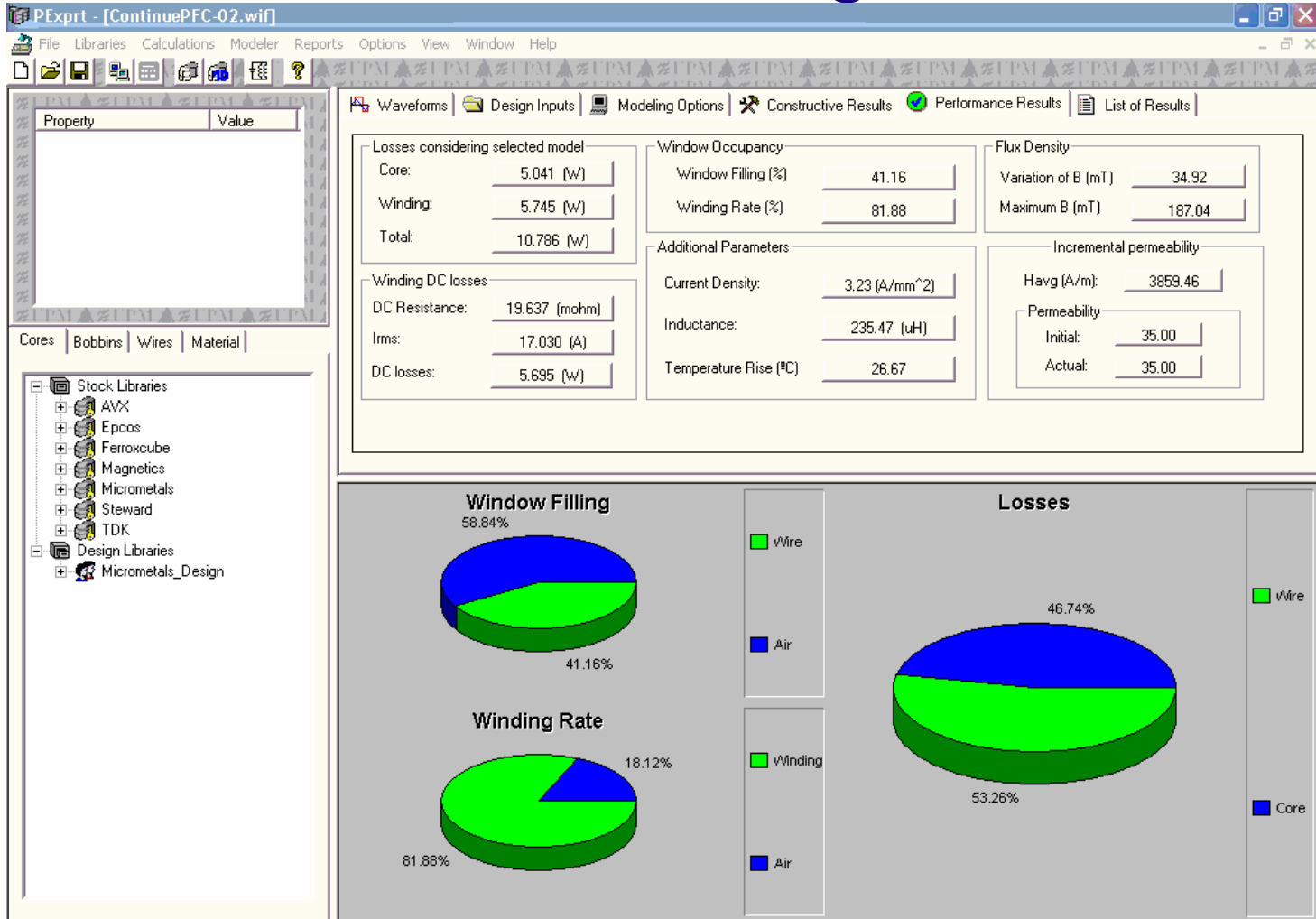
Buttons for OK, Cancel, and Apply are at the bottom of the dialog box.

Design List per System Engineer's Design Priorities

Waveforms | Design Inputs | Modeling Options | Constructive Results | Performance Results | List of Results

Core [Name]	Wire [Name]	Volume [mm ³]	Temperature ...	Gap [mm]	Parallel Turns [n]	Power Losses ...	Window Filling...
E305	AWG10	103970.00	26.67	0.0000	1	10.7861	41.16
E305	AWG11	103970.00	29.62	0.0000	1	11.9315	32.88
E305	AWG10	103970.00	32.70	0.0000	1	13.4710	33.32
E305	AWG12	103970.00	33.49	0.0000	1	13.4329	26.25
E305	AWG11	103970.00	34.97	0.0000	1	14.3500	26.62
E305	AWG13	103970.00	38.03	0.0000	1	15.1963	21.00
E305	AWG12	103970.00	38.08	0.0000	1	15.5596	21.25
E305	AWG13	103970.00	41.92	0.0000	1	17.0467	17.00
E305	AWG14	103970.00	43.99	0.0000	1	17.5077	16.72
E305	AWG14	103970.00	46.80	0.0000	1	18.9397	13.54

Magnetic Component Performance for a Selected Design



Conclusions

- ▶ Help the system engineer to verify the system design idea promptly.
- ▶ Get the magnetic optimized design without magnetic design experience requirement.
- ▶ Speed up the process to obtain the total system performance.
- ▶ Save the time and money

Thanks for your attention!

Any question?