



Versatile Planar Transformer - PLAC 100 SOFT

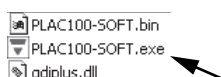
by Sebastien Marchio

This document outlines a method to design switching mode power supplies with PLAC 100 SOFT.

1. START PLAC 100 SOFT

To start PLAC100 SOFT connect the USB flash drive on the computer. PLAC100 SOFT must open automatically.

If nothing happen when you connect the USB flash drive, double-click on ".exe".



2. LANGUAGE CHOICE

2 languages are usable: French and English

Choose your language:



3. GENERAL PRESENTATION OF LEAF

Choice of supply structure

Input data

Solutions summary

Output data of selected solution

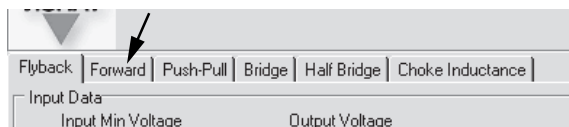
Language

PCB layout of selected solutions

Primary winding current and voltage

4. CHOICE OF SWITCHING MODE POWER SUPPLY STRUCTURE

Click on leaf to select power supply structure:

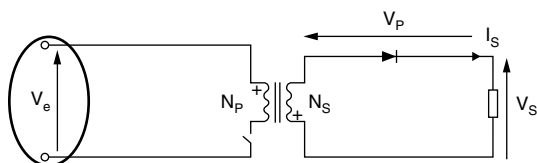


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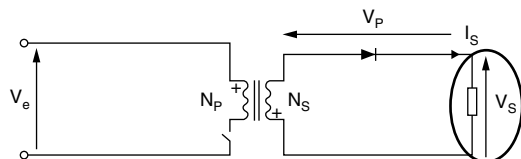
5. INPUT DATA

5.1 Flyback Converter

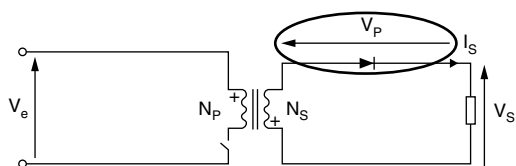
- V_e (V): Primary network minimum input voltage.
 $1 \leq V_e \leq 100$ V
- $V_{e \text{ max.}}$ (V): Primary network maximum input voltage.
 $V_e \leq V_{e \text{ max.}} \leq 100$ V



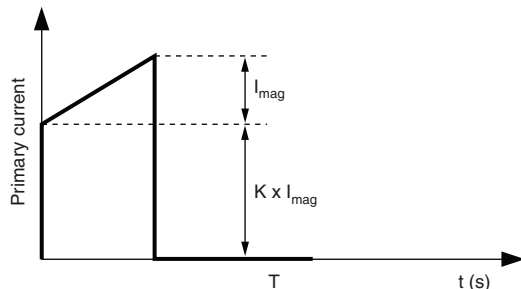
- V_S (V): Voltage needed by the load.
 $1 \leq V_S \leq 100$ V



- F (kHz): Working frequency.
 $50 \text{ kHz} \leq F \leq 400 \text{ kHz}$
- $P_{\text{max.}}$ (W): Maximum power possible for the load.
- V_P (V): Loss voltage involved by the diode.
 $0.001 \text{ V} \leq V_P \leq 100 \text{ V}$



- K definition:



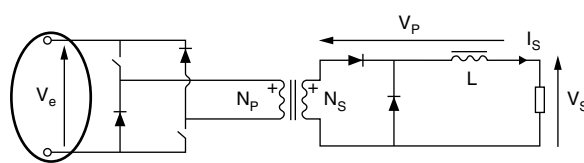
- I_{mag} (A): Magnetisation current involved by primary transformer inductance

Note

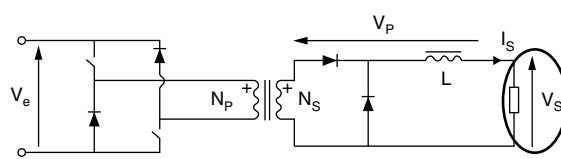
- The PLAC 100 SOFT only confirm the viability of solution at maximum power. The designer have to adapt the surrounding electronic to avoid problems of energy accumulated with minimum output power conditions.

5.2 Forward Converter

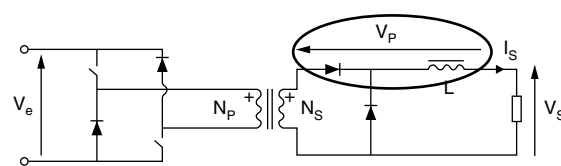
- V_e (V): Primary network minimum input voltage.
 $1 \leq V_e \leq 100$ V
- $V_{e \text{ max.}}$ (V): Primary network maximum input voltage.
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- V_S (V): Voltage needed by the load.
 $1 \leq V_S \leq 100$ V

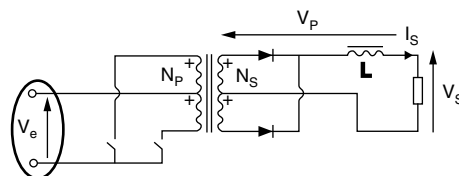


- F (kHz): Working frequency.
 $50 \text{ kHz} \leq F \leq 400 \text{ kHz}$
- $P_{\text{max.}}$ (W): Maximum power possible for the load.
- V_P (V): Loss voltage involved by the diode and choke.
 $0.001 \text{ V} \leq V_P \leq 100 \text{ V}$



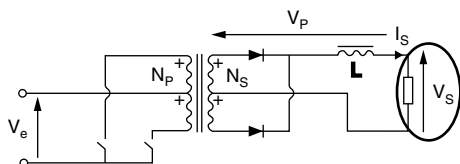
5.3 Push-Pull Converter

- V_e (V): Primary network minimum input voltage.
 $1 \leq V_e \leq 100$ V
- $V_{e \text{ max.}}$ (V): Primary network maximum input voltage.
 $V_e \leq V_{e \text{ max.}} \leq 100$ V

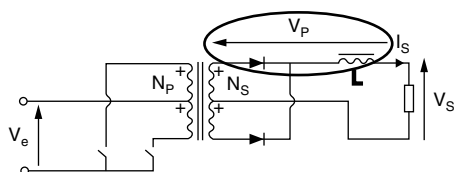


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- V_S (V): Voltage needed by the load.
 $1 \leq V_S \leq 100$ V

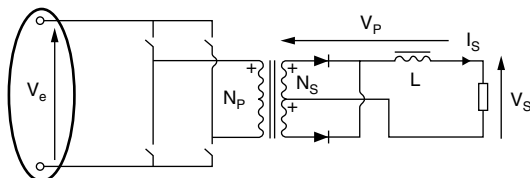


- F (kHz): Working frequency.
 $50 \text{ kHz} \leq F \leq 400 \text{ kHz}$
- P_{max} (W): Maximum power possible for the load.
- V_P (V): Loss voltage involved by the diode and choke.
 $0.001 \text{ V} \leq V_P \leq 100 \text{ V}$

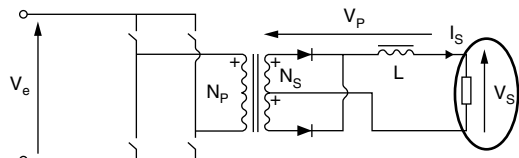


5.4 Full Bridge Converter

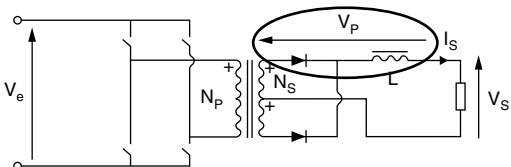
- V_e (V): Primary network minimum input voltage.
 $1 \leq V_e \leq 100$ V
- $V_{e \text{ max}}$ (V): Primary network maximum input voltage.
 $V_e \leq V_{e \text{ max}} \leq 100$ V



- V_S (V): Voltage needed by the load.
 $1 \leq V_S \leq 100$ V

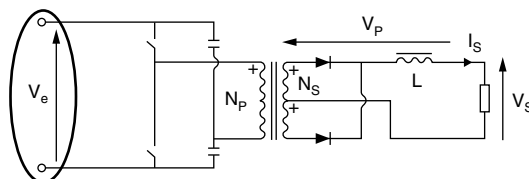


- F (kHz): Working frequency.
 $50 \text{ kHz} \leq F \leq 400 \text{ kHz}$
- P_{max} (W): Maximum power possible for the load.
- V_P (V): Loss voltage involved by the diode and choke.
 $0.001 \text{ V} \leq V_P \leq 100 \text{ V}$

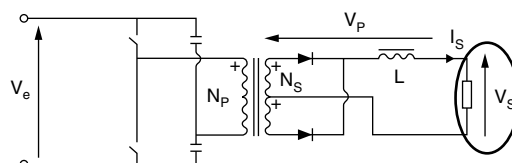


5.5 Half Bridge Converter

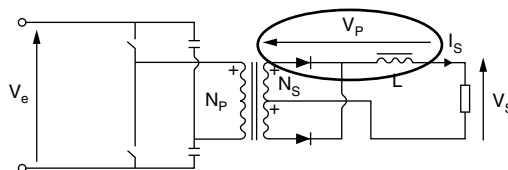
- V_e (V): Primary network minimum input voltage.
 $1 \leq V_e \leq 100$ V
- $V_{e \text{ max}}$ (V): Primary network maximum input voltage.
 $V_e \leq V_{e \text{ max}} \leq 100$ V



- V_S (V): Voltage needed by the load.
 $1 \leq V_S \leq 100$ V



- F (kHz): Working frequency.
 $50 \text{ kHz} \leq F \leq 400 \text{ kHz}$
- P_{max} (W): Maximum power possible for the load.
- V_P (V): Loss voltage involved by the diode and choke.
 $0.001 \text{ V} \leq V_P \leq 100 \text{ V}$

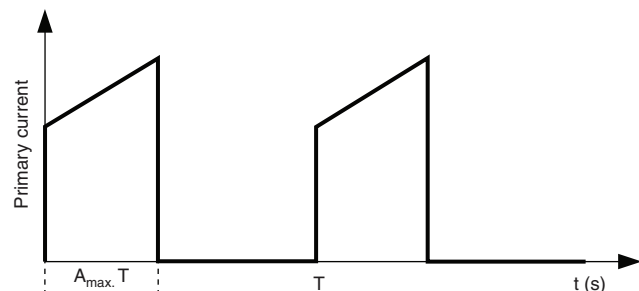


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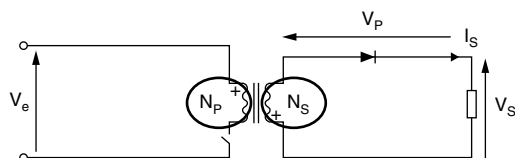
6. OUTPUT DATA

6.1 Flyback Converter

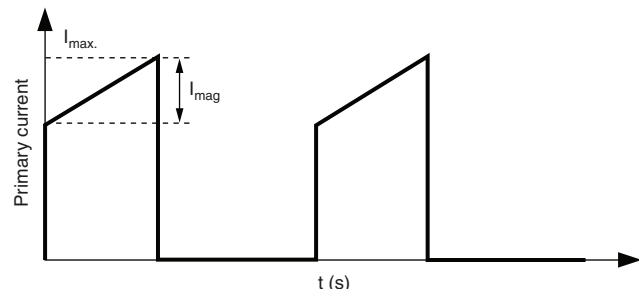
- A_{max} : Duty-cycle



- T (s): Period $T = 1/F$
- N_P : Primary winding turn number
- N_S : Secondary winding turn number

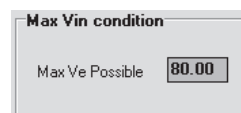


- m : Ratio $m = \frac{N_S}{N_P}$
- Al (nH): Inductance factor
- L (μH): Primary inductance
- I_c (A): Current $I_c = \frac{P_{max}}{0.98 \times A_{max} \times V_e}$
- 0.98: Hypothetical power efficiency used for the current calculation
- I_{mag} (A): Magnetisation current involved by primary transformer inductance
- I_{max} (A): Maximum current in primary winding

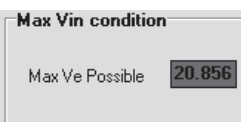


- $I_{P\ RMS}$ (A): Primary winding root mean square current
- $I_{S\ RMS}$ (A): Secondary winding root mean square current
- B_{max} (T): Maximum magnetic flux density in the core
- R_P (Ω): Primary winding resistance at 100 °C
- R_S (Ω): Secondary winding resistance at 100 °C

- P_{CuP} (W): Primary copper loss
- P_{CuS} (W): Secondary copper loss
- P_f (W): Core loss
- P_{TOT} (W): Power loss $P_{TOT} = P_f + P_{CuP} + P_{CuS}$
- T °C: Increasing temperature involved by power loss
- n : Transformer efficiency
- $V_{e\ max. possible}$ (V): $V_{e\ max. allow}$ by the solution selected: Green color, $V_{e\ max. possible}$ is upper than $V_{e\ max. input}$ data

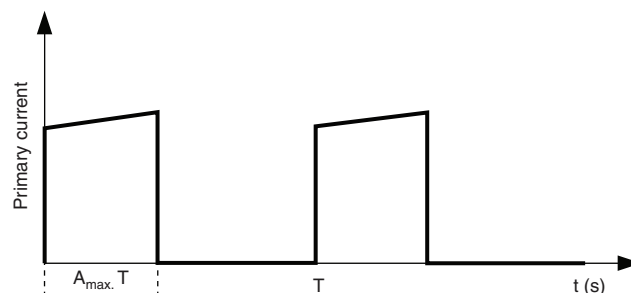


Red color, $V_{e\ max. possible}$ is lower than $V_{e\ max. input}$ data

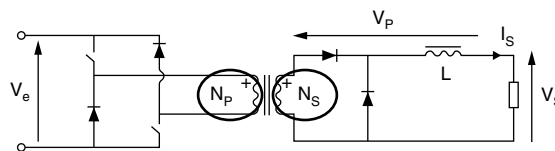


6.2 Forward Converter

- A_{max} : Duty-cycle

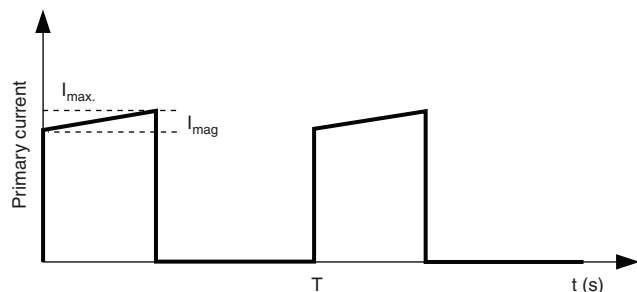


- T (s): Period $T = 1/F$
- N_P : Primary winding turn number
- N_S : Secondary winding turn number

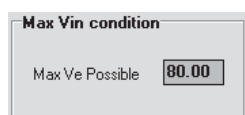


- m : Ratio $m = \frac{N_S}{N_P}$
- Al (nH): Inductance factor
- L (μH): Primary inductance
- I_c (A): Current $I_c = \frac{P_{max}}{0.98 \times A_{max} \times V_e}$
- 0.98: Hypothetical power efficiency used for the current calculation
- I_{mag} (A): Magnetisation current involved by primary transformer inductance
- I_{max} (A): Maximum current in primary winding

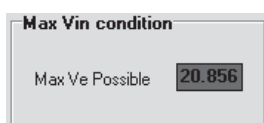
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- $I_{p\text{ RMS}}$ (A): Primary winding root mean square current
- $I_{s\text{ RMS}}$ (A): Secondary winding root mean square current
- B_{max} (T): Maximum magnetic flux density in the core
- R_p (Ω): Primary winding resistance at 100 °C
- R_s (Ω): Secondary winding resistance at 100 °C
- P_{CuP} (W): Primary copper loss
- P_{CuS} (W): Secondary copper loss
- P_f (W): Core loss
- P_{TOT} (W): Power loss $P_{\text{TOT}} = P_f + P_{\text{CuP}} + P_{\text{CuS}}$
- T °C: Increasing temperature involved by power loss
- n : Transformer efficiency
- $V_{e\text{ max. possible}}$ (V): $V_{e\text{ max.}}$ allow by the solution selected:
Green color, $V_{e\text{ max. possible}}$ is upper than $V_{e\text{ max.}}$ input data

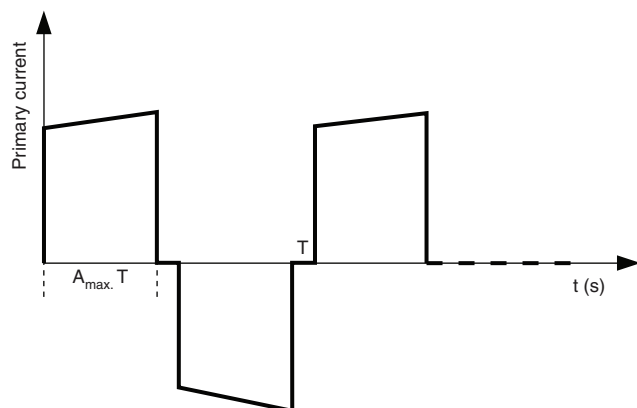


Red color, $V_{e\text{ max. possible}}$ is lower than $V_{e\text{ max.}}$ input data

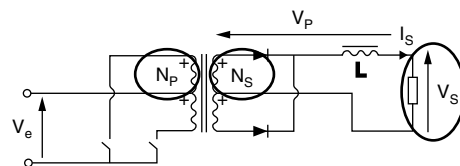


6.3 Push-Pull Converter

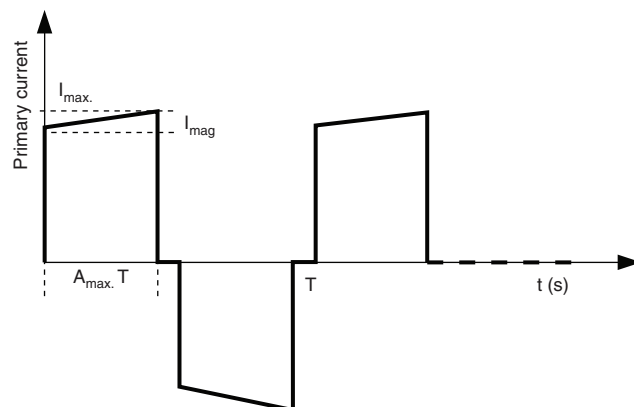
- A_{max} : Duty-cycle



- T (s): Period $T = 1/F$
- N_p : Primary winding turn number
- N_s : Secondary winding turn number



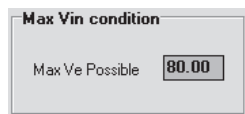
- m : Ratio $m = \frac{N_s}{N_p}$
- Al (nH): Inductance factor
- L (μ H): Primary inductance
- I_c (A): Current $I_c = \frac{P_{\text{max}}}{0.98 \times 2 \times A_{\text{max}} \times V_e}$
- 0.98: Hypothetical power efficiency used for the current calculation
- I_{mag} (A): Magnetisation current involved by primary transformer inductance
- I_{max} (A): Maximum current in primary winding



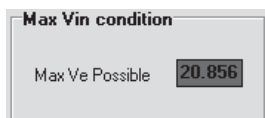
- $I_{p\text{ RMS}}$ (A): Primary winding root mean square current
- $I_{s\text{ RMS}}$ (A): Secondary winding root mean square current
- B_{max} (T): Maximum magnetic flux density in the core
- R_p (Ω): Primary winding resistance at 100 °C
- R_s (Ω): Secondary winding resistance at 100 °C
- P_{CuP} (W): Primary copper loss (for 1 winding)
- P_{CuS} (W): Secondary copper loss (for 1 winding)
- P_f (W): Core loss
- P_{TOT} (W): Power loss $P_{\text{TOT}} = P_f + 2P_{\text{CuP}} + 2P_{\text{CuS}}$
- T °C: Increasing temperature involved by power loss
- n : Transformer efficiency
- $V_{e\text{ max. possible}}$ (V): $V_{e\text{ max.}}$ allow by the solution selected:

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Green color, $V_{e \max.}$ possible is upper than $V_{e \max.}$ input data

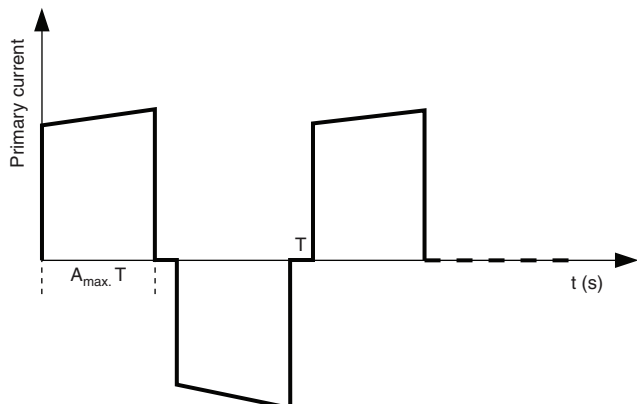


Red color, $V_{e \max.}$ possible is lower than $V_{e \max.}$ input data

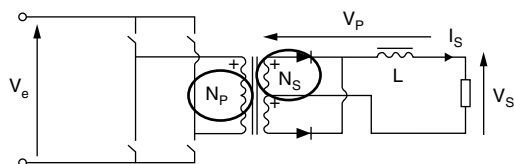


6.4 Full Bridge Converter

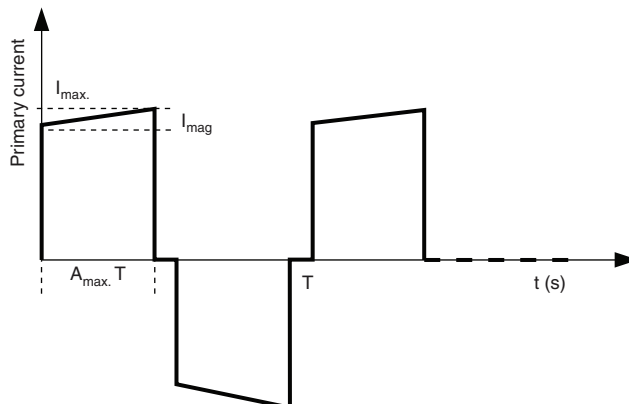
- $A_{\max.}$: Duty-cycle



- T (s): Period $T = 1/f$
- N_p : Primary winding turn number
- N_s : Secondary winding turn number

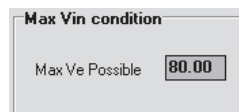


- m : Ratio $m = \frac{N_s}{N_p}$
- Al (nH): Inductance factor
- L (μH): Primary inductance
- I_c (A): Current $I_c = \frac{P_{\max}}{0.98 \times 2 \times A_{\max} \times V_e}$
- 0.98: Hypothetical power efficiency used for the current calculation
- I_{mag} (A): Magnetisation current involved by primary transformer inductance
- $I_{\max.}$ (A): Maximum current in primary winding

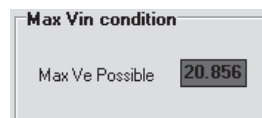


- $I_{p \text{ RMS}}$ (A): Primary winding root mean square current
- $I_{s \text{ RMS}}$ (A): Secondary winding root mean square current
- $B_{\max.}$ (T): Maximum magnetic flux density in the core
- R_p (Ω): Primary winding resistance at 100 °C
- R_s (Ω): Secondary winding resistance at 100 °C
- P_{CUp} (W): Primary copper loss
- P_{CUs} (W): Secondary copper loss (for 1 winding)
- P_f (W): Core loss
- P_{TOT} (W): Power loss $P_{\text{TOT}} = P_f + P_{\text{CUp}} + 2P_{\text{CUs}}$
- T °C: Increasing temperature involved by power loss
- n : Transformer efficiency
- $V_{e \max.}$ possible (V): $V_{e \max.}$ allow by the solution selected:

Green color, $V_{e \max.}$ possible is upper than $V_{e \max.}$ input data



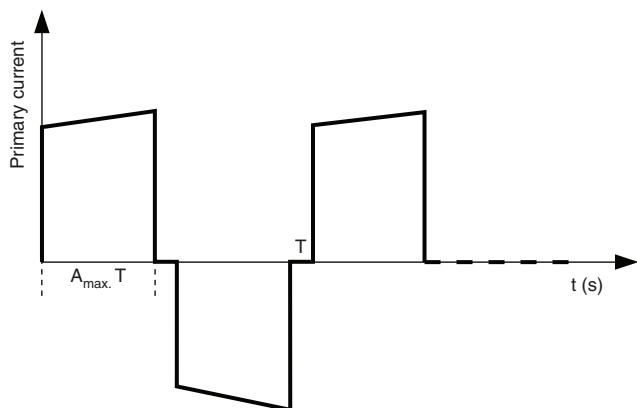
Red color, $V_{e \max.}$ possible is lower than $V_{e \max.}$ input data



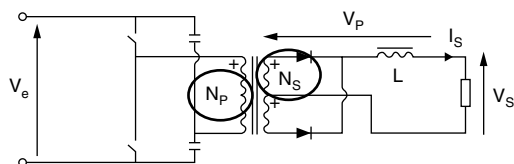
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6.5 Half Bridge Converter

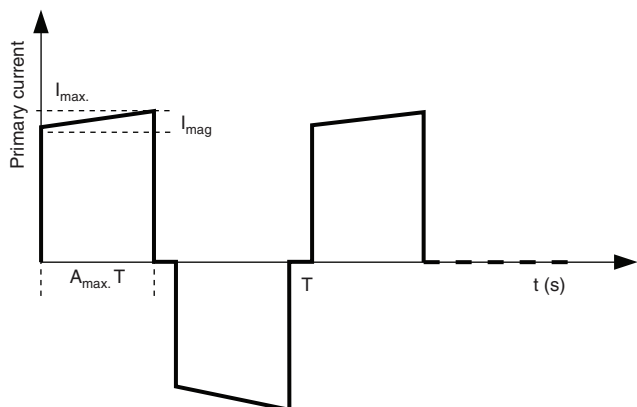
- $A_{max.}$: Duty-cycle



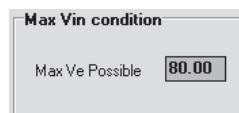
- T (s): Period $T = 1/F$
- N_p : Primary winding turn number
- N_s : Secondary winding turn number



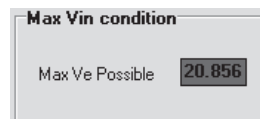
- m : Ratio $m = \frac{N_s}{N_p}$
- Al (nH): Inductance factor
- L (μH): Primary inductance
- I_c (A): Current $I_c = \frac{P_{max}}{0.98 \times A_{max} \times V_e}$
- 0.98: Hypothetical power efficiency used for the current calculation
- I_{mag} (A): Magnetisation current involved by primary transformer inductance
- $I_{max.}$ (A): Maximum current in primary winding



- $I_{p\ RMS}$ (A): Primary winding root mean square current
- $I_{s\ RMS}$ (A): Secondary winding root mean square current
- $B_{max.}$ (T): Maximum magnetic flux density in the core
- R_p (Ω): Primary winding resistance at 100 °C
- R_s (Ω): Secondary winding resistance at 100 °C
- P_{CuP} (W): Primary copper loss
- P_{CuS} (W): Secondary copper loss (for 1 winding)
- P_f (W): Core loss
- P_{TOT} (W): Power loss $P_{TOT} = P_f + P_{CuP} + 2P_{CuS}$
- T °C: Increasing temperature involved by power loss
- n : Transformer efficiency
- $V_{e\ max.}$ possible (V): $V_{e\ max.}$ allow by the solution selected: Green color, $V_{e\ max.}$ possible is upper than $V_{e\ max.}$ input data



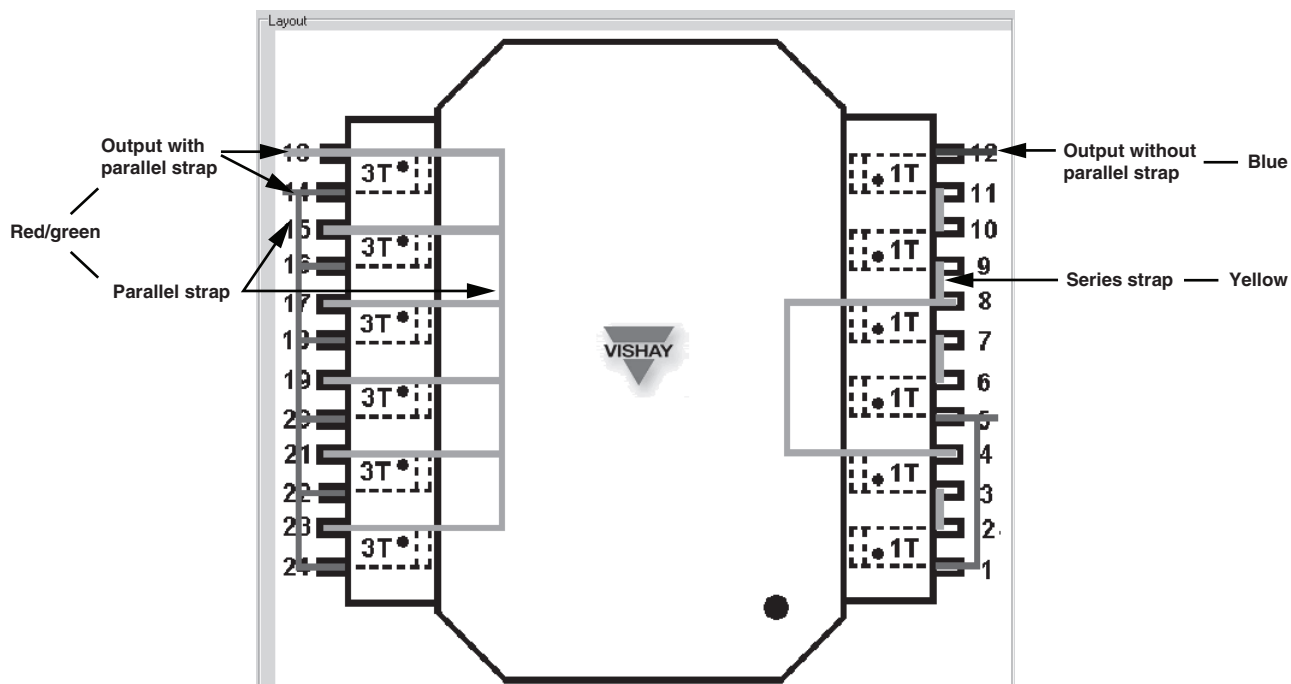
Red color, $V_{e\ max.}$ possible is lower than $V_{e\ max.}$ input data



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6.6 General Information

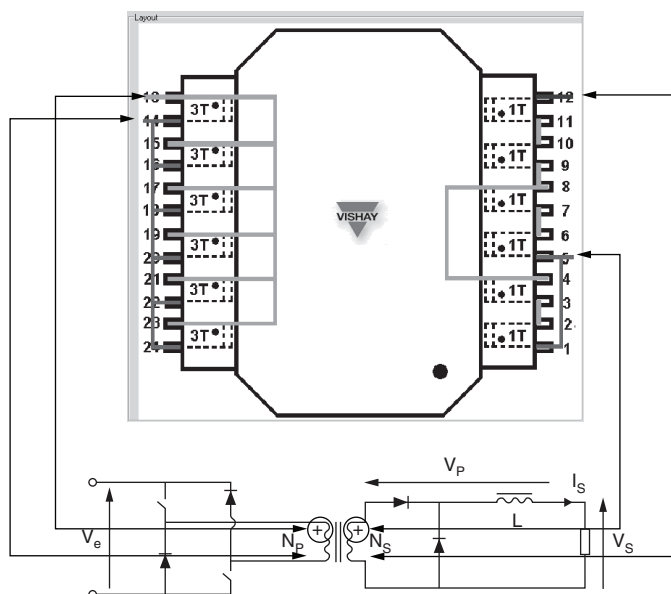
- Layout color



Green and red color with parallel straps allow to identify in the same winding the points in phases.

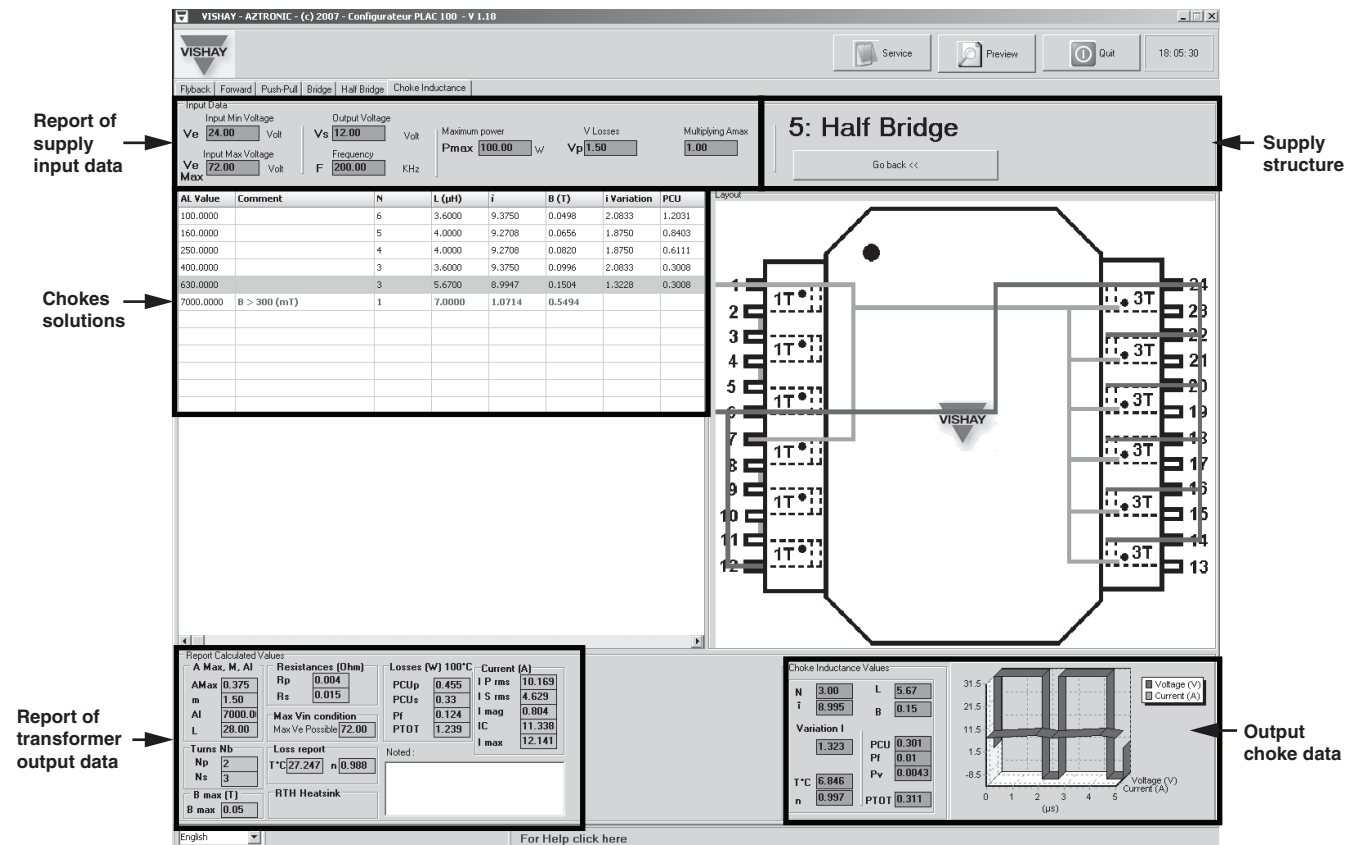
- Identification of direction of coupling

For each elementary winding the direction of coupling is identify by a spot. For transformer, the direction of coupling is deduced with this spots:



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7.3 Output Data



- N: Winding turn number
- L (μH): Inductance value
- $\hat{I}$ (A): Maximum current

8. PRINT SOLUTION

To print or to save a selected solution:

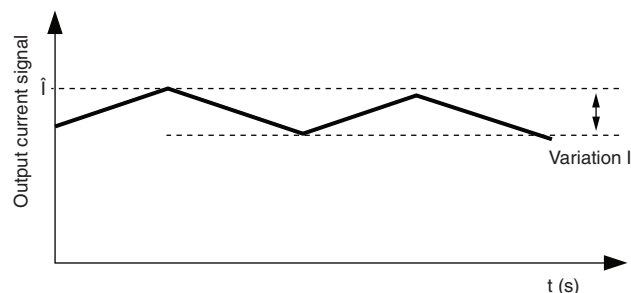
- Click on “Preview”, a new window appear.



- Click on “Print”, a new window appear.



- Choose “Landscape”.
- Choose your printer to print or “Pdf Creator” to save the selected solution.



- B (T): Maximum magnetic flux density in the core
- P_{CU} (W): Copper loss
- P_f (W): Core loss
- P_{TOT} (W): Power loss $P_{TOT} = P_f + P_{CU}$
- T °C: Increasing temperature involved by power loss
- n: Choke efficiency