



PLAC 100 Versatile Planar Transformer

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This application note is valid unless otherwise specified in the datasheet.

1. GENERAL DEFINITION

1.1 Versatile Planar Transformer

The versatile planar transformer PLAC 100 is a magnetic product specific to switching mode power supplies. It can be used as a power transformer or as an output choke inductor for many power supply topologies: forward, flyback, half-bridge, full bridge, push-pull.

The flexibility is obtained thanks to its available windings:

- 6 windings with 1 turn
- 6 windings with 3 turns

The user determines their own configuration of the windings via the PCB layout provided by PLAC 100 SOFT.

1.2 Planar Transformer

Planar transformer is a low profile transformer whose coil is made with printed circuit board.

1.3 Output Choke Inductor

An output choke inductor is used as a filter with switched mode power supplies. Its purpose is to reduce the variations of output signal. It has to operate with a DC load causing a bias magnetic field. Thus it is advisable to use gapped standard PLAC 100 (Al 100; 160; 250; 400; 630) for this application.

Custom Al are available on request.

2. ELECTRICAL DEFINITIONS

2.1 Inductance

The measurement conditions of inductance are:

Temperature: 25 °C

Frequency: 10 kHz

Voltage: 0.1 V

2.2 Al

PLAC 100 is available in 6 Al (UG; 100; 160; 250; 400; 630).

Inductance value is given by the equation:

$$L (H) = Al (nH) \times 10^{-9} \times N^2$$

N is the turn number of the coil.

2.3 Coil Resistance

Typical values of coil resistance at 25 °C:

- For 1 turn (connexion 1 to 12): $R_{DC} = 3 \text{ m}\Omega$
- For 3 turns (connexion 13 to 24): $R_{DC} = 35 \text{ m}\Omega$

The higher coil resistances at 100 °C used by the PLAC 100 SOFT are:

- For 1 turn (connexion 1 to 12): $R_{DC} = 6.6 \text{ m}\Omega$
- For 3 turns (connexion 13 to 24): $R_{DC} = 46.2 \text{ m}\Omega$

2.4 Ratio

The ratio "m" is the characteristic: $m = N_s/N_p$

N_p : Number of turns for the primary

N_s : Number of turns for the secondary

For PLAC 100, m is dependent on the configuration used.

2.5 Dielectric Test

If: Leakage Current

4 dielectric tests are defined for the PLAC 100:

- Voltage: 1000 V_{AC}

Hipot between 1 turn winding and 3 turns winding with $I_f < 100 \mu A$

- Voltage: 300 V_{AC}

Hipot between 1 turn winding with $I_f < 100 \mu A$

Hipot between 3 turns winding with $I_f < 100 \mu A$

- Voltage: 800 V_{AC}

Hipot between windings and ground with $I_f < 100 \mu A$

2.6 Insulation Resistance

4 dielectric tests are defined for the PLAC 100:

- Voltage: 1000 V_{DC}

Between 1 turn winding and 3 turns windings with $R_{DC} > 1 \text{ G}\Omega$

Between 1 turn winding with $R_{DC} > 1 \text{ G}\Omega$

Between 3 turns winding with $R_{DC} > 1 \text{ G}\Omega$

Between windings and ground with $R_{DC} > 1 \text{ G}\Omega$

3. MAGNETICAL DEFINITIONS

3.1 Saturation Flux Density

The saturation flux density B_s is the maximum intrinsic induction possible in a magnetic material. For a good usage, the working flux density should never exceed B_s . At 100 °C the PLAC 100 material has $B_s = 300 \text{ mT}$.

3.2 Effective Core Dimensions

To facilitate calculations on a non-uniform soft magnetic core, a set of effective dimensions are define to create an equivalent configuration as theoretical ring core configuration:

Effective cross-sectional area of core: $A_e = 113 \text{ mm}^2$

Effective magnetic path length: $l_e = 37.47 \text{ mm}$

Effective volume of core: $V_e = 4234 \text{ mm}^3$.

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4. INPUT AND OUTPUT TERMS

4.1 Input Data for Power Supply Definition in the PLAC 100 SOFT

4.1.1 Frequency: F

F is the operating input frequency of the power supply.

4.1.2 Input voltage: V_e ; $V_{e\max}$

The input network voltage is stabilized between minimum input voltage V_e and maximum input voltage $V_{e\max}$.

4.1.3 Output voltage: V_s

Output voltage is the voltage needed on the output load.

4.1.5 Power: $P_{\max}$

$P_{\max}$ is the maximum power used by the output load. The losses induced by diodes are ignored.

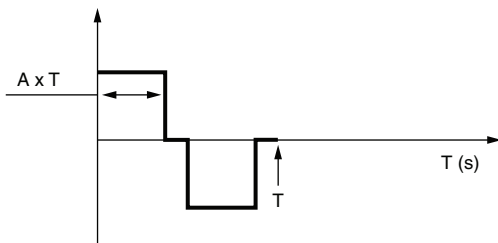
4.1.6 Loss voltage: V_p

V_p is equivalent decreased voltage caused by output choke and diodes.

4.2 Output Data for Power Supply Definition in the PLAC 100 SOFT

4.2.1 Maximum duty cycle: $A_{\max}$

The duty cycle is the ratio between conduction time of the switches and the input signal period.



$A_{\max}$ is the maximum duty cycle that provides maximum current. It corresponds to a minimum input voltage that works without saturating the magnetic material.

4.2.2 Current

The PLAC 100 SOFT provides many data about current:

- Primary current for one coil: $I_{p\text{ RMS}}$ (A)
- Secondary current for one coil: $I_{s\text{ RMS}}$ (A)
- Magnetising current: I_{mag} (A)
- Maximum current: $I_{\max}$ (A)

4.2.3 Power loss

Power loss has two origins:

- Copper loss (P_{Cu1} and P_{Cu2}) due to primary and secondary resistance coil.

- Core loss (Pf) due to hysteresis and Eddy currents

Core loss depends on frequency.

The PLAC 100 SOFT estimates core loss at 100 °C.

4.2.4 Variation of temperature

Power loss (P_{TOT}) involves increasing PLAC 100 temperature. The variation between ambient temperature (T) and PLAC 100 ($T_{\text{PLAC 100}}$) is characterized by thermal resistance ($R_{\text{TH}} = 22$). Increasing temperature is evaluated by:

$$T_{\text{PLAC 100}} - T = R_{\text{TH}} \times P_{\text{TOT}}$$

5. ENVIRONMENTAL DEFINITIONS

5.1 Climatic Category

The climatic category is defined in terms of temperature extremes (hot and cold) and number of days exposure to dampness, heat, and steady-state conditions that the component is designed to withstand.

The PLAC 100 climatic characteristics are:

- Operating range: - 55 °C to + 125 °C
- Damp heat: 10 days

5.2 Classify Materials

Plastic materials used are UL94 class V0 and PLAC 100 is RoHS-compliant.

6. STORAGE RECOMMENDATIONS

Careful attention must be paid when the components are stored. Because high and very low environmental temperature, high humidity, corrosive gases, etc. might affect the solderability of the terminals and the function of the package. Listed below are notes to be observed:

- The recommended storage conditions are in between + 10 °C and 25 °C (room temperature) at relative humidity in between 35 % and 75 %.
- Do not store them within the vicinity of any corrosive gases such as hydrogen sulphide, sulphurous acid, chlorine or ammonium. The oxidation of the metals caused by such toxic gases may affect solderability as well as the electrical performance of these products.
- Exposure to the direct sunlight and dust must be avoided
- Handle carefully to avoid deformation of terminals
- Keep parts in the original packages until just before use, and unpack only the quantity needed. Always seal any opened packages to protect them from oxidation and contaminants.

If any special storage conditions are applied (outside those recommendations), it is the user's responsibility.

7. SMD AND THROUGH HOLE COMPONENTS, SOLDER AND CLEANING RECOMMENDATION

PLAC 100 is designed to many soldering method as reflow and dual wave soldering.

7.1 Adhesive Application (for SMD only)

When an assembly has to be wave soldered, an adhesive is essential to bond the SMDs to the substrate. Under normal conditions reflow, soldered substances do not need adhesive to maintain PLAC 100 orientation, since the solder past does it. The amount of adhesive, the curing time and temperature to use should be in accordance with adhesive manufacturer's recommendations. Otherwise, the adhesive polymerization time and temperature have to also respect PLAC 100 soldering recommendations. (§ 7-3).

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Caution: The height and the volume of adhesive dots applied are critical for two reasons: the must be high enough to reach the SMD, and there must not be any excess adhesive, since this can pollute the solder land and prevent the formation of a good soldered joint.

7.2 Flux and Solder Recommendations

SMD and through hole PLAC 100 can be used with R and RA (Rosin and Rosin Activated) type flux to OA (Organic Acid). It is always advisable not to use a flux of an activity level greater than necessary to achieve optimum yields for solder wetting. Fluxes of RA or OA activity levels are corrosive and therefore must be removed. It is advisable that all types of fluxes be removed by cleaning due to the possibility of corrosion.

- Tin lead solder:
 - Lead (Pb)-free solder:
- Typical solder paste print thickness would be 0.8 mm to 1 mm thick

7.3 Soldering Recommendations

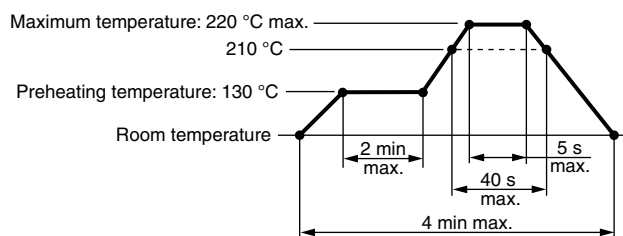
Normal preheating is required to activate flux and minimize thermal shock to components. The maximum recommended temperature for flow and reflow soldering profiles are specified below. It is important to note temperature of those profiles corresponds to parts temperature (and not PCB temperature). The use of leaded solder process or lead (Pb)-free solder process is specified under each series of SMD or through hole PLAC 100.

General Caution: User must always test and verify pre-heating and soldering processes as well as other production line assembly before final production.

LEADED SOLDER PROCESS

for SMD only

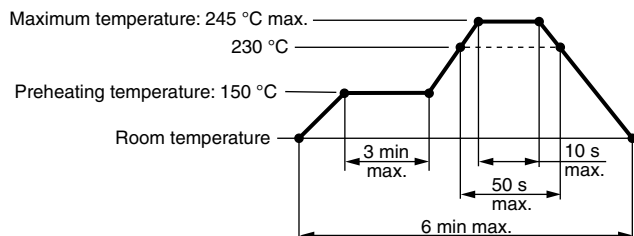
Infrared or hot air reflow soldering (2 times max.)



LEAD (Pb)-FREE SOLDER PROCESS

for SMD only

Infrared or hot air reflow soldering (2 times max.)



Soldering iron temperature:

Use the appropriate soldering iron size, shape and heat capacity for soldering PLAC 100. Not exceed the maximum time and temperature parameters specified: 3 s at 350 °C.

Wave and bath soldering temperature, for leaded versions only:

Not exceed the maximum time and temperature parameters specified: 10 s at 260 °C in accordance with IEC CEI 68-2-20.



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7.4 Washing Recommendations

Cooling down time after soldering and before exposure to defluxing solvents is required. The component body temperature when exposed to cleaning should not exceed 60 °C. Cleaning spray rinse is recommended with pressures of not greater than 60 psi (5.5 kg-cm²) for a period not to exceed 15 s to 20 s.

Appropriate defluxing solvent/aqueous:

- Aqueous detergent solutions
- Terpene based semi-aqueous
- Ester/ether based solvents
- Methanol

Caution:

- Avoid using cleaning US-Vigon solvents
- Avoid using cleaning solvents such as trichloroethane or freon which endanger the environment
- Ultrasonic may cause component damage or failure

7.5 Reworking Recommendations

- General:
Excessive and/or repeated high temperature heat exposure may affect component performance and reliability
- Recommended:
Hot air reflow technique is the safest method for SMD component
- Caution:
Avoid use of a soldering iron or wave soldering as rework technique