

In order to make the on-line help viewable from this CD-ROM without the Rale Design System software, we have converted the text of the on-line help into an Adobe Acrobat PDF file. The image below represents the input screen from the Small Transformer Program. We have made this clickable, so that clicking on the input field that you are interested in will take you to the page in this documents that contains the text from the on-line help file.

#### PRIMARY

#### SECONDARY

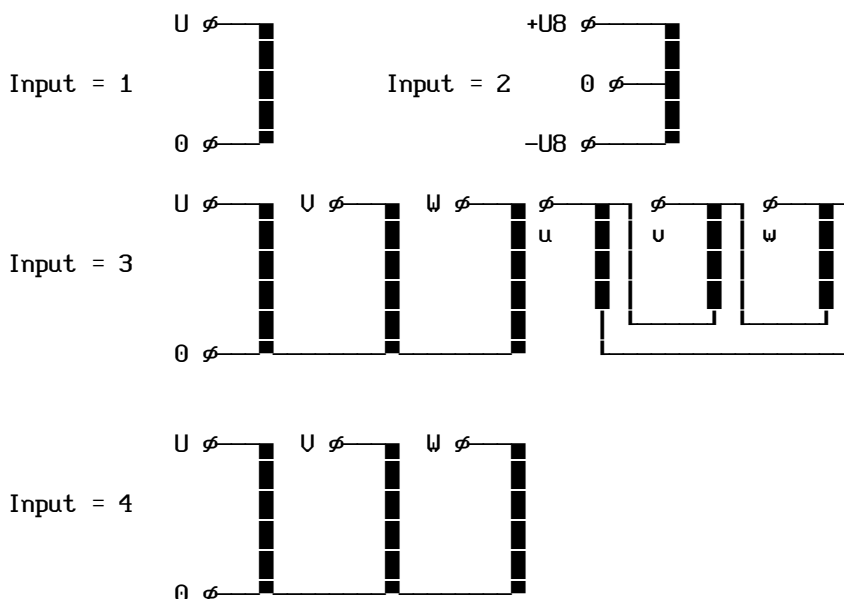
<000>Circuit	<011>Voltage	<031>Circuit
<001>Over Voltage		<041>Voltage
<002>Primary Wire		<051>Current
<003>Layer Insulation		
<004>Final Insulation		<002>Wire
<005>Form Factor		<003>Layer Insulation
<006>Frequency		<004>Final insulation
<007>dI/Io		
MASK		
<090>Regulation	<100>Steel	<110>Cooling
<091>Udiode	<101>Induction	<111>Force
<092>dUdiode	<102>Remanence	<112>Bracket
<093>Ripple	<103>W/lb	<113>Radiator
<094>Temp.Amb.	<104>UAr/lb	<114>Unused
<095>Temp.rise	<105>Gap	<115>Channel
<096>Time 1	<106>Annealed	<116>Cu-Surf.
<097>Load 1	<107>Stackfac.	<117>Rth-uarn.
<098>Time 2	<108>Hole	<118>Rth-comp.
<099>Load 2	<109>Assembly	<119>Case
		<120>Bobbin
		<121>P/S-Order
		<122>Rac/Rdc
		<123>Space fill
		<124>Vertical
		<125>Horizontal
		<126>Impregnatin
		<127>Spread
		<128>Selection
		<129>Criterion

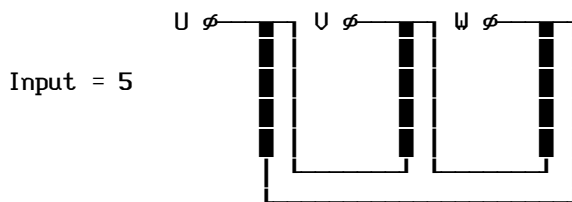
<CoFile>	<CoName>	<FeFile>	<FeName>	<Min.>	<Max.>
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000

Circuits of the Primary Winding:

Enter the type of circuit to be used on the primary winding.  
Choose from the types shown below.





001

Overvoltage of the Primary:

-----  
Enter the percent of the nominal primary voltage that is allowed.  
In other words, enter the largest input voltage allowed as a  
multiple of the nominal primary voltage.

- \* The Overvoltage plays an important part when calculating temperature rise in nominal, short-circuit and no-load operation.
- \* The nominal primary voltage is multiplied by this value during the calculations.
- \* For Example: The entered primary voltage is 230V.  
The max. primary voltage can be 244V.  
Enter the overvoltage  $244/230 = 1.06$
- \* The calculated number of turns guarantee the output voltage in warm condition, at nominal load resistance and at nominal input voltage (without influence of the overvoltage factor)

002

Wire Type:

-----  
Select the wire type to be used by entering the number of the Wire File that you wish to use. This value may be entered manually or may be changed by selecting Wires from the Material menu.

- \* All wire information is stored files. Available wire types are:
 

0 = Round	- Film Insulated
1 = Round	- Single Build
2 = Round	- Heavy Build
3 = Square	- Single Build
4 = Rectangular	- Single Build
5 = Rectangular	- Heavy Build
- \* In a wire record, all wire related data required for a calculation are stored. A wire record includes:
  - Wire type and class of insulation
  - Wire diameter (bare and insulated) for round wire
  - Wire thickness and width (bare and insulated) for flat wire
  - Wire cross-sectional area and AWG-number
- \* The program selects the best wire from the selected wire file that meets the prescribed maximum temperature or regulation. In the event, that the necessary cross-section cannot be achieved with a wire from the selected file, the program switches the wires parallel to achieve the required cross-section.

003

Thickness of the Layer Insulation:

-----

Enter the thickness of the layer insulation in mil.

- \* If the selected bobbin is without flange (Bobbon=3) and thickness of the insulation per layer not entered the program selects it by itself.
- \* The thickness of the insulation per layer can be changed by user in the test program too.
- \* The use of layer insulation:
  - Improves the winding technique.
  - Raises the thermal resistance of the coil.

004

Thickness of the Final or Intermediate Insulations:

-----

In the case of a single-section transformer enter the thickness of the intermediate insulation in mil. In a double-section transformer enter the thickness of the final insulation in mil.

- \* The final or intermediate insulations will:
  - Increase the thermal resistance of the coil.
  - Increase the space factor of the coil.

005

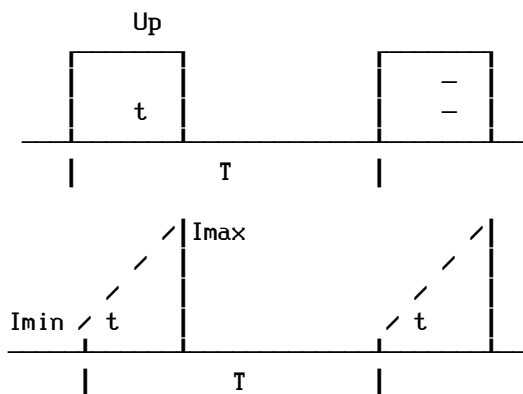
Form Factor of the Input Voltage:

-----

Enter a form factor for the input voltage.

- \* Form Factor =  $U_{eff}/U_{dc}$   
 Where:  $U_{eff}$  - effective value of primary voltage  
         $U_{dc}$  - mean value of primary voltage within a half-cycle
- \* Typical values for form factor are:
  - Sinusoidal Input Voltage = 1.11
  - Rectangular Input Voltage = 1.00
  - Triangular Input Voltage = 0.98
- \* The form-factor plays an important role in:
  - Calculating the iron losses at non-sinusoidal primary voltage
  - Determining the number of turns in the primary
  - Calculating transformer characteristics when a rectifier circuit is specified
- \* In the case of a flyback transformer or a forward transformer the relative duty cycle ( $t/T$ ) can be "entered" through the Formfactor as follows:

$$\text{Formfactor} = T/(2*t)$$



006

Frequency of Primary Voltage:

Enter the frequency of primary voltage in Hz.

- \* The Small Transformers Program allows the frequency of the primary to be 10 - 500,000 Hz.

007

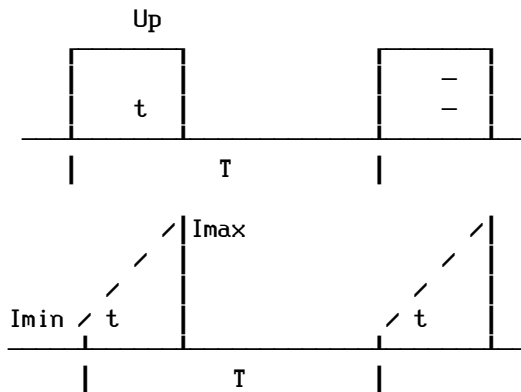
Ripple of the Input Current:

- \* Enter the ripple of the input current in %.
- \* This input is active only if you design a flyback or forward transformer.
- \* The ripple of the input current is defined as follows:

$$\text{Ripple} = 100 * (I_{\text{max}} - I_{\text{min}}) / (I_{\text{max}} + I_{\text{min}}) (\%)$$

Where:

- $I_{\text{max}}$  - Max. input current during the time  $t$ .
- $I_{\text{min}}$  - Min. input current during the time  $t$ .

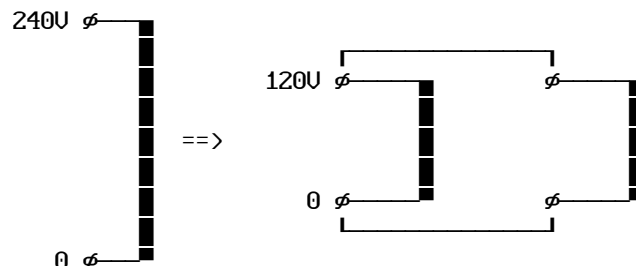


011

Primary Voltages:

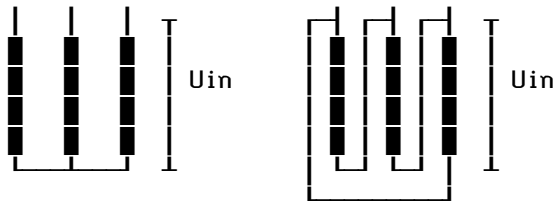
Enter the effective value of the voltage applied to the primary winding in U.

- \* A primary voltage must be entered.
- \* The maximum number of primary voltages is 8.
- \* Only 1 tapping is connected to a supply voltage.
- \* The full output capacity can be delivered over every tapping.
- \* In the case of a 2 - 120V Series/Parallel primary circuit, enter the input voltage as 240 V

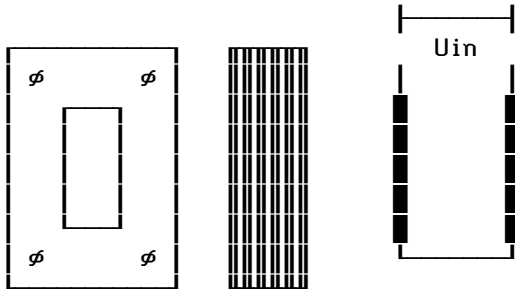


- \* The effective input voltage for a three-phase transformer

should be determined as shown below.



- \* In a single-phase transformer with 2 limbs where both windings are switched in series, enter the effective input voltage as pictured below.



021

Primary Output Current:

Enter the effective value of the output current in A in order to design the autotransformer.

- \* A primary voltage must be entered.
- \* The maximum number of output currents is 8.
- \* Only 1 tapping is connected to a supply voltage.
- \* The full output capacity can be delivered over every tapping.

Example:

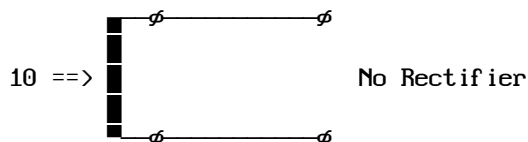
1.0A,400V <φ	Input:	U <sub>i</sub>	I <sub>o</sub>
230V >φ			
2.0A 160V <φ		120	
1.5A,140V <φ		140	1.5
120V >φ		160	2.0
		230	
0 φ		400	1.0

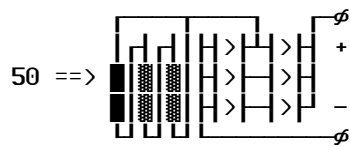
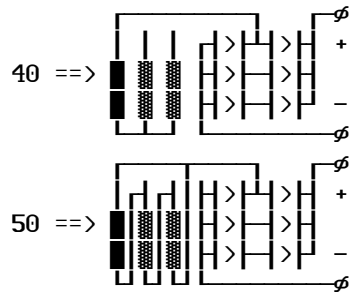
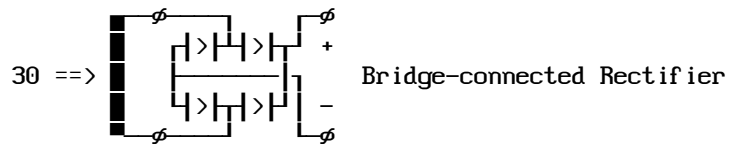
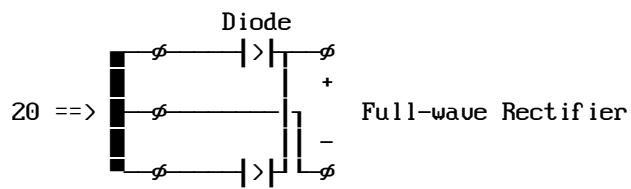
031

Circuits of the Secondary Windings

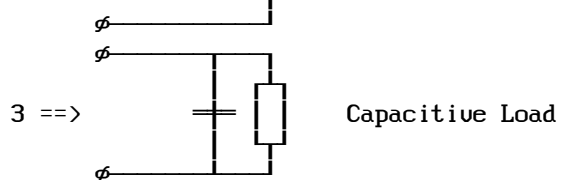
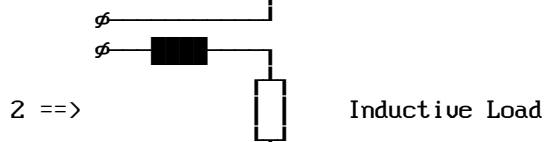
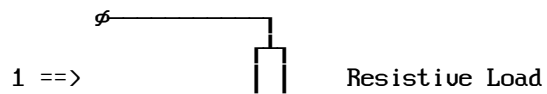
The circuits of the secondary winding are specified in this field. A two digit number is entered. The number entered is the sum of a circuit and a load valued as shown below.

Available Circuit Values:

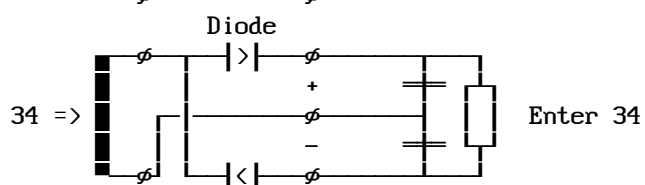
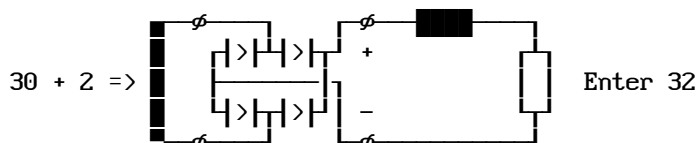
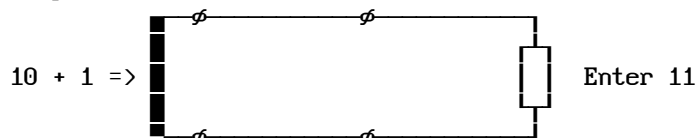


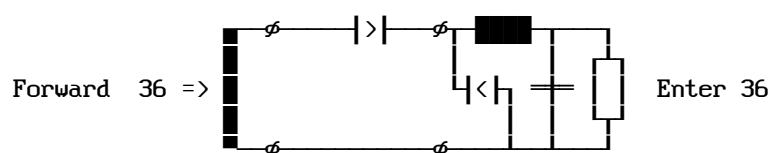
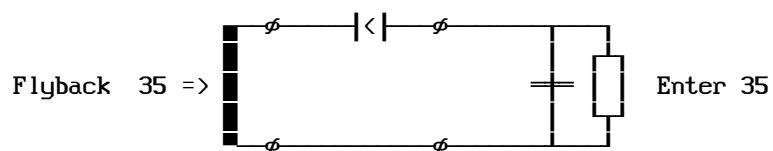


Available Load Values:



For Example:



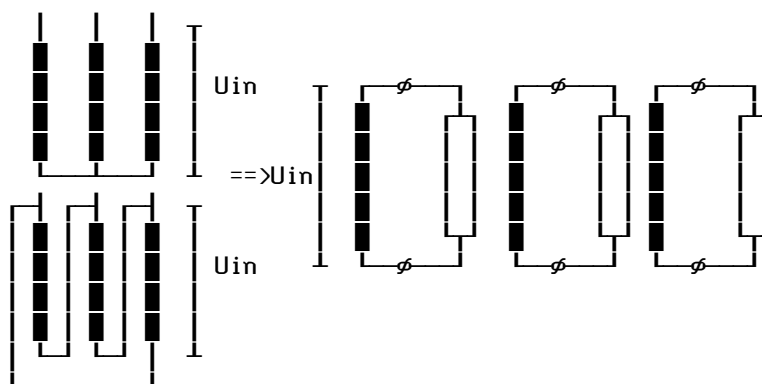


041

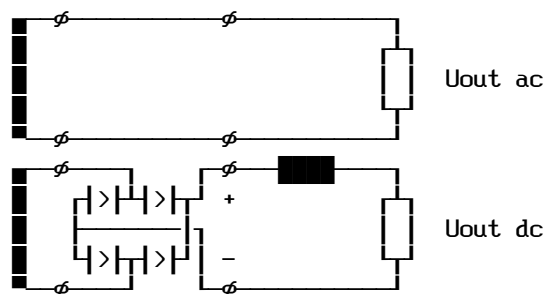
Output Voltages:

Enter the effective value of output voltage, measured on the load in U.

- \* The output voltage may be a DC or AC voltage
- \* An output voltage must be entered.
- \* The maximum number of output voltages is 8.
- \* A Three-phase load, without rectifier, is shown below.



\* Examples

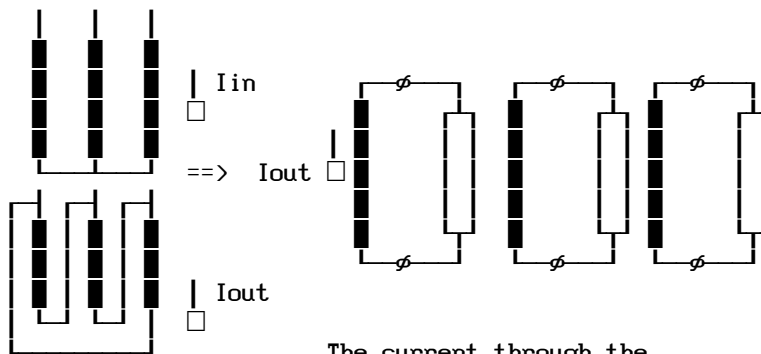


051

Output Currents:

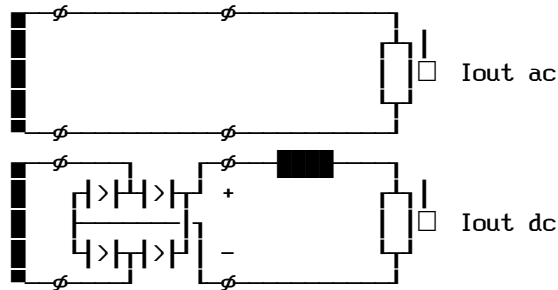
Enter the effective value of the output current, measured on the load, in A.

- \* The output current may be a DC or AC current.
- \* An output current must be entered.
- \* The maximum number of output currents is 8.
- \* The Three-phase load, without rectifier, is shown below.



The current through the winding is the "Output Current"

#### Examples



061

Wire Type:

Select the wire type to be used by entering the number of the Wire File that you wish to use. This value may be entered manually or may be changed by selecting Wires from the Material menu.

All wire information is stored files. Available wire types are:

- 0 = Round - Film Insulated
- 1 = Round - Single Build
- 2 = Round - Heavy Build
- 3 = Square - Single Build
- 4 = Rectangular - Single Build
- 5 = Rectangular - Heavy Build

- In a wire record, all wire related data required for a calculation are stored. A wire record includes:
  - Wire type and class of insulation
  - Wire diameter (bare and insulated) for round wire
  - Wire thickness and width (bare and insulated) for flat wire
  - Wire cross-sectional area and AWG-number
- The program selects the best wire from the selected wire file that meets the prescribed maximum temperature or regulation. In the event, that the necessary cross-section cannot be achieved with a wire from the selected file, the program switches the wires parallel to achieve the required cross-section.

071

Thickness of the Layer Insulation:

Enter the thickness of the layer insulation in mil.

- If the selected bobbin is without flange (Bobbin=3) and thickness of the insulation per layer not entered the



- program selects it by itself.
- The thickness of the insulation per layer can be changed by user in the test program too.
- The use of layer insulation:
  - Improves the winding technique.
  - Raises the thermal resistance of the coil.

081

Thickness of the Final or Intermediate Insulations:

-----  
 In the case of a single-section transformer enter the thickness of the intermediate insulation in mil. In a double-section transformer enter the thickness of the final insulation in mil.

- The final or intermediate insulations will:
  - Increase the thermal resistance of the coil.
  - Increase the space factor of the coil.

090

Regulation of the Secondary or DC Voltage:

-----  
 The regulation of the secondary voltage or of the rectifier output voltage with the RC-load is entered in (%).  
 It is defined as follows:

$$\text{Regulation} = (-) 100 * (U_o - U_n) / U_n \quad (\%)$$

Where:  $U_o \Rightarrow$  no-load secondary voltage or no-load rectifier output voltage with the RC-load in (V)

$U_n \Rightarrow$  nominal secondary voltage or rectifier output nominal voltage with RC-load in (V)

- The regulation of the rectifier output voltage with RC-load (Secondary circuit 23,33,34,43,and 53) has to be entered with sign "-", for instance : -25 for the regulation of 25%
- The regulation of the rectifier output voltage is always larger than the value entered in this field
- The relationship of regulation of the rectifier output voltage with a RC-Load to the regulation of the secondary voltage could be approximately described as follows:

Regulation of the secondary voltage %	Regulation of the rectifier output with RC-Load %	
	1 phase	3 phase
1	8-12	5-6
2.5	12-14	7-8
5	14-17	9-10
10	20-25	13-14
15	30-33	17-18
20	37-40	20-22
30	52-54	30-32
40	64-66	41-43
50	80-82	50-53

NOTE:

The regulation of a autotransformer with more inputs and outputs can not be calculated. Because of this the "regulation" of a autotransformer is defined as follows:

$$\text{Regulation} = 100 * P_{cu}/P_{out} \quad (\%)$$

Where:  $P_{cu}$  => Cu-losses in (W)

$P_{out}$  => Output power in (W)

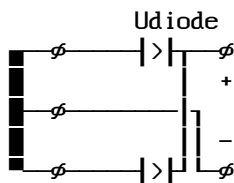
091

Diode-Threshold Voltage:

---

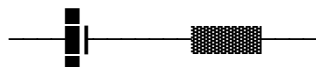
Normally the voltage drop of a diode lies between 0.4 V and 1 V. In the case of several diodes switched in series, the threshold voltage of all diodes switched in series should be entered. Enter  $U_{diode}$  in this field in V.

\* Example



\* Equivalent Circuit

$U_{diode}(V) \quad R_{diode} (\Omega)$



\* Refer to <092> $dU_{diode}$

092

Resistive Diode-Voltage-Drop:

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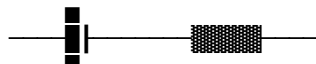
Normally the resistive diode voltage drop ( $dU_{diode}$ ) lies between 0.05 and 0.3 V. In the case of several series-connected diodes the relative diode-resistance of all series-connected diodes should be entered. Enter  $dU_{diode}$  in this field in V.

\* The program calculates the resistance of the diode as follows:

$$R_{diode} = dU_{diode} / \text{Nominal\_DC\_current}$$

\* Equivalent Circuit

$U_{diode}(V) \quad R_{diode} (\Omega)$



\* Refer to <091> $U_{diode}$

093

Ripple of the Output Voltage:

---

Enter the ripple of the output voltage in %.

\* The ripple of the output voltage is defined as follows:

$$\text{Ripple} = 100 * (U_{\text{max}} - U_{\text{min}}) / (U_{\text{max}} + U_{\text{min}}) (\%)$$

Where:

- $U_{\text{max}}$  - Max. output voltage during a periode.
- $U_{\text{min}}$  - Min. output voltage during a periode.

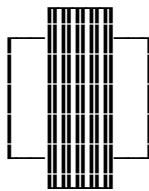
- \* The program calculates the capacitance of the smoothing capacitor in mF.

094

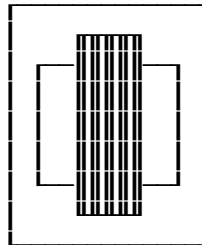
Ambient Temperature:

-----  
The ambient temperature is entered in °C

Measuring Point for  
ambient temperature



Measuring Point for  
ambient temperature



- \* Refer to <095> Excessive Temperature

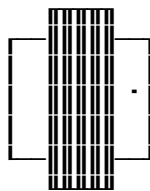
095

Temperature Rise of Winding:

-----  
The temperature rise is entered in °K.

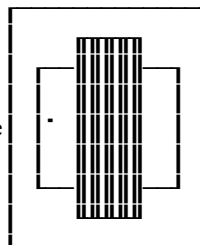
- \* The temperature rise on the winding is defined as:  
Temperature Rise = max. Temp. - Ambient Temp.

Measuring Point for  
ambient temperature



Measuring Point  
for max.temperature  
of the winding

Measuring Point for  
ambient temperature



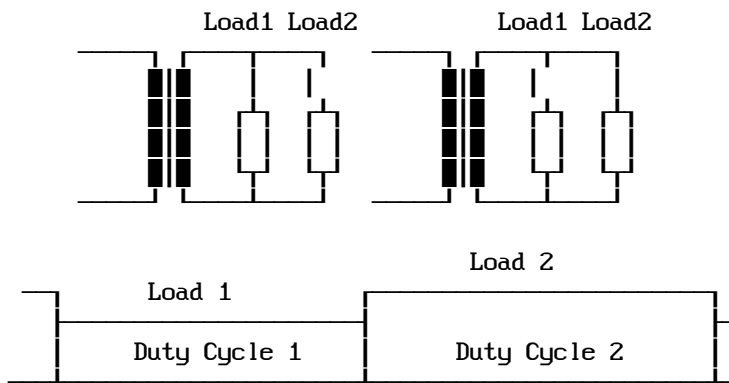
- \* Refer to <094> Ambient Temperature

096

Duty Cycle 1 :

-----  
Enter the duration of Duty Cycle 1, as shown in the figure below, in minutes.

- \* Duty Cycle 1 is used in calculating temperature rise.
- \* During Duty Cycle 1 the transformer yields Load 1.
- \* If Load 1 = 1, the output current (not power) is nominal during Duty Cycle 1.



\* Refer to <097>, <098> and <099>

097

Load during phases of the Duty Cycle 1:

Enter the load on the transformer during Duty Cycle 1, as a multiple of the current through the nominal load (resistance) at the overvoltage.

For example:

-Nominal output voltage  $U_a=12V$

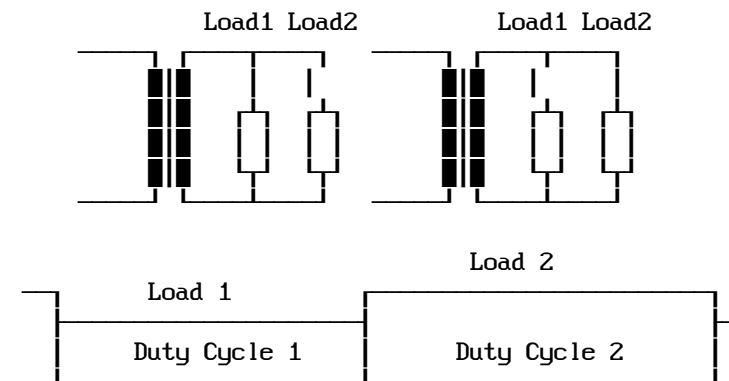
-Nominal output current  $I_a=1A$

-Nominal Load  $=U_a/I_a=12V/1A=12\ \Omega$

-Overvoltage  $=1.06\ (6\%)$

-Load 1  $= 2.1$

The temperature rise during Duty Cycle 1 will be calculated with the output current :  $1A \times 1.06 \times 2.1 = \text{ca. } 2.226A$



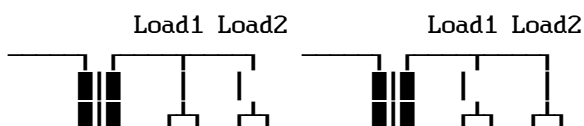
\* Refer to <096>, <098> and <099>

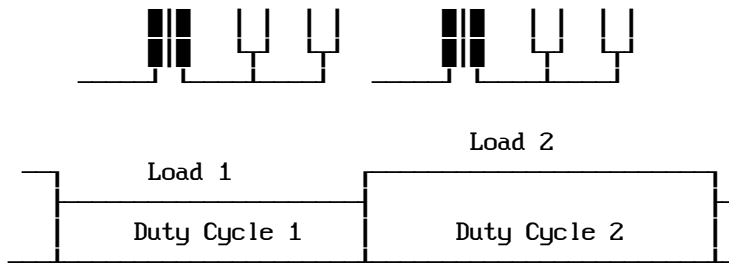
098

Duty Cycle 2 :

Enter the duration of Duty Cycle 2, as shown in the figure below, in minutes.

- \* Duty Cycle 2 is used in calculating temperature rise.
- \* During Duty Cycle 2 the transformer yields Load 2.





\* Refer to <096>, <097> and <099>

099

Load during phases of the Duty Cycle 2:

-----  
Enter the load on the transformer during Duty Cycle 2,  
as a multiple of the current through the nominal load  
(resistance) at the overvoltage.

For example:

-Nominal output voltage  $U_a=12V$

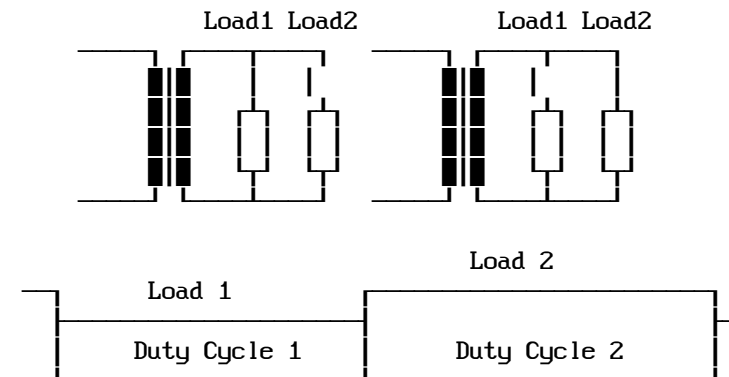
-Nominal output current  $I_a=1A$

-Nominal Load  $=U_a/I_a=12V/1A=12\ \Omega$

-Overvoltage  $=1.06\ (6\%)$

-Load 1 = 2.1

The temperature rise during Duty Cycle 2 will be calculated with  
the output current :  $1A \times 1.06 \times 2.1 = \text{ca. } 2.226A$



\* Refer to <096>, <097> and <098>

100

Steel:

-----  
Steel grades are stored in files. The names of these files  
are assigned according to the name of the rolling mill, or  
the name of the stamping company.

\* The program distinguishes between 4 groups of steel grades.

These are:

- cold-rolled, non-oriented steel
- cold-rolled, grain-oriented steel
- Ni-Fe steel
- Ferrites

\* In a steel record, the data required for the design  
calculations are stored. This information includes:

- Name

- mechanical data: e.g., space factor, specific gravity
- electrical data: e.g., active and reactive losses in relation to frequency, induction and grain direction, temperature etc.

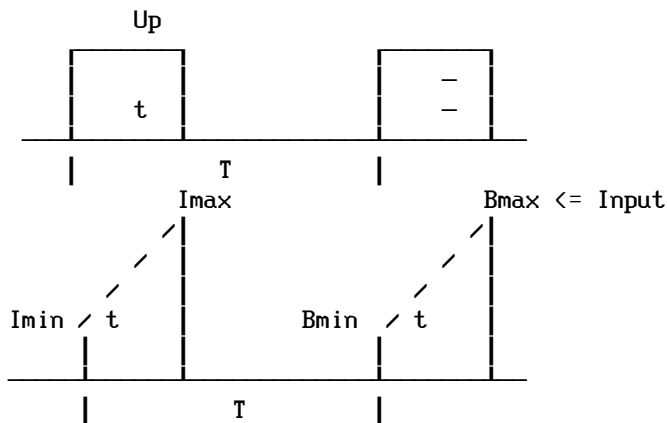
\* Fields 3 and 4 of the status line show the selected Fe-file and the selected steel grade

101

Induction:

-----  
Enter the peak value of induction in T.

- \* The range of input values lies between 1% and 90% of the saturation induction of the selected steel grade. The standard value is 70% saturation induction.
- \* The induction under nominal load should be entered. The no-load induction is higher.
- \* The optimal induction must be established by the user with respect to price, weight, no-load current, inrush current, etc.
- \* The program automatically optimizes the induction when the core-losses are non-economically high in relation to the copper-losses. This could happen in applications where a high frequency, or a steel grade with very high active losses is used.
- \* In the case of a flyback transformer or a forward transformer enter the peak value  $B_{max}$  of the induction. The ac-component of the induction  $0.5 \cdot (B_{max} - B_{min})$  is dependent on the ripple of the primary-current and on the remanence.



\* Refer to <102>Remanence, <311> <312>Induction

102

Factor of Remanence Induction:

-----

$$\text{Remanence} = \pm Br/Bn$$

Where:  $Br$  = Remanence induction in T  
 $Bn$  = Nominal induction in T

- \* The remanence induction is very important in the calculation of the inrush current and typically falls between 0.25 - 0.60.

- \* In the case of a forward transformers enter the negative value for the remanence, if the core is premagnetized during the turn-off time.
- \* For the reduction of the remanence enter:  
   Assembly=2           => Core assembly as a choke  
   Gap=2-4            => Gap 2-4 mils  
   Remanence=<0.1     => No remanence
- \* The alternate stacked core has the remanence-factor 0.35-0.60.
- \* The remanence induction is largely dependent on:
  - Steel grade
  - Core type
  - Core design
  - Type and size of airgap

103

Correction of the calculated, active Steel-Losses:

---

The active steel-losses are multiplied by this value. This field would be changed if the steel to be used is not in the program's database, and a similar steel was selected.

104

Correction of the calculated reactive Steel-Losses:

---

The reactive steel-losses are multiplied by this value. This field would be changed if the steel to be used is not in the program's database, and a similar steel was selected.

105

Airgap:

---

The standard airgap size per lamination junction point (1 mil), as stored in the core files, is multiplied by this value.

- \* The program differentiates between 2 types of airgaps:
  - airgap in an alternately stacked core
  - airgap in a welded core comprised of core stacks or ferrite cores
- \* The airgap and core type influence:
  - no-load current
  - inrush current
  - remanence
- \* With alternately stacked laminations the no-load current is smaller, but the inrush current or remanence may be larger.

106

Heat-Treatment of Laminations after Stamping:

---

This field specifies if the laminations were heat-treated after stamping. Enter:

  1 = heat-treated (annealed)  
   0 = not heat-treated

- \* Ferrites and C-Cores are always heat-treated.

107

Correction of the Fe-Stacking Factor:

---

The stacking factor stored in the steel file of the selected steel grade is multiplied by the value entered here.

- \* Normally, this correction factor is used with C-Cores

(0.85-0.95).

- With ferrite cores this correction factor is always 1.

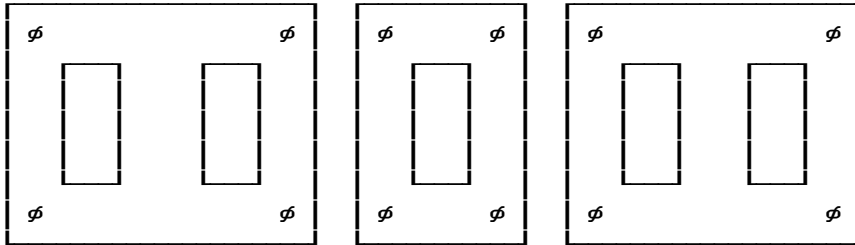
108

#### Holes in the Corners of the Core:

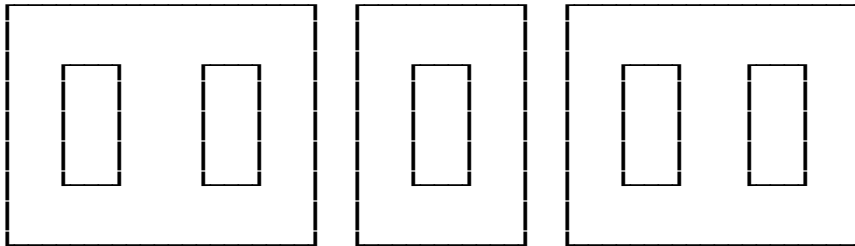
Specify if the core has holes in the corners.

- The hole size is stored in the core files.
- When using a core without holes in the corners, the no-load current is smaller. This is of particular importance in small cores where the holes would be relatively large in comparison to the width of the yokes.
- Enter:

With holes in the corners = 1



Without holes in the corners = 0

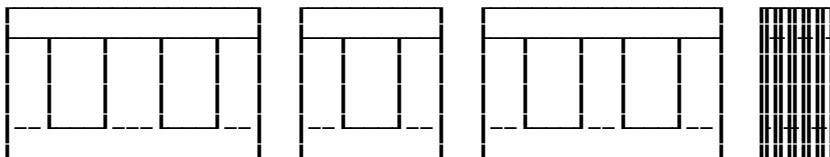


109

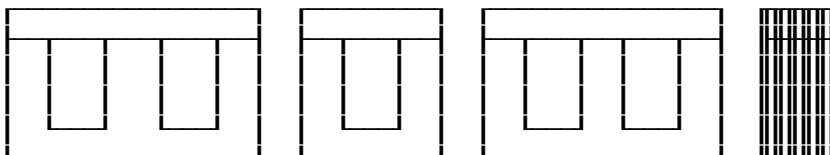
#### Core Assembly:

Enter which of the core assemblies, shown below, should be used in the calculations.

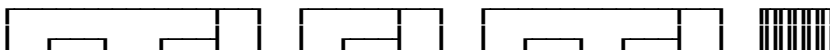
1 => alternately stacked EI or UI laminations



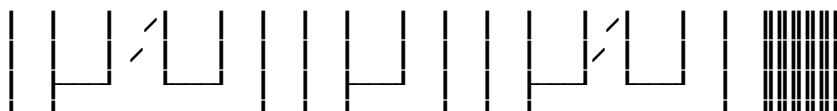
2 => welded EI or UI laminations



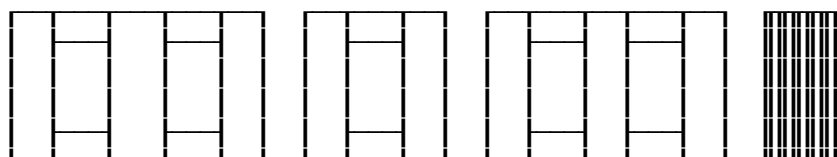
3 => Ready Core



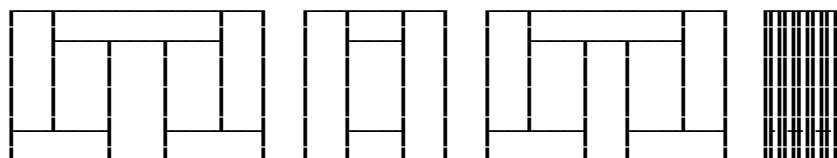




4 => Modulus Core consisting of individual core stacks



5 => Alternately stacked strip laminations



\* C and Ferrite Cores only have 1 assembly type. Selecting a core type for C and Ferrite cores will not affect the calculations.

110

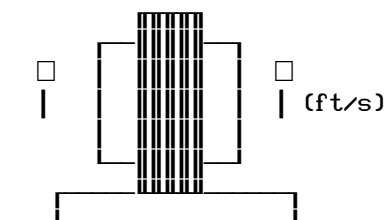
Cooling Factor:

-----  
The cooling factor for emission and convection calculated by the program is multiplied by the value entered in this field. The program assumes that the transformer is mounting is detached, and on a thermally insulated ground. The transformer is assumed to have a factor of emission of 0.9.

111

Ventilation:

-----  
Enter the airspeed past the transformer in ft/s.

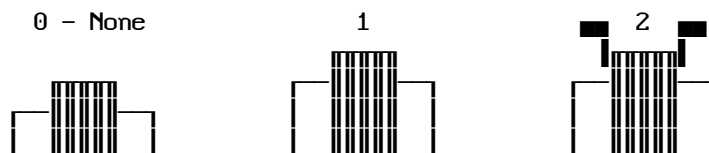


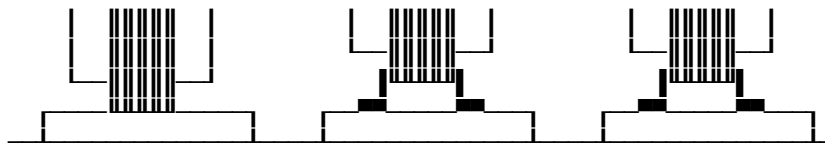
\* Airspeed = 0 corresponds to "natural cooling".

112

Mounting Brackets:

-----  
Enter the type of mounting brackets, as shown below, to be used.



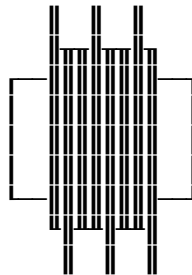


\* Mounting brackets increase the core cooling area.

113

Radiator:

-----  
The "radiator" is created by special assembly of the core with alternate laminations extended to increase the cooling area. A "radiator" can be easily created with EI and UI laminations. The I-laminations, which form the radiator rib, are two times wider than normal I-laminations. As seen in the figure below, the core must be alternately stacked. The program calculates the width of the cooling channel between the "radiator" ribs.



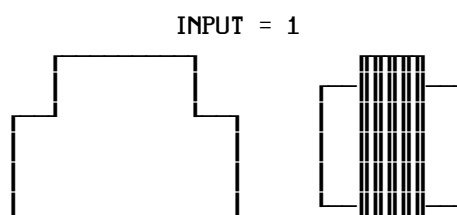
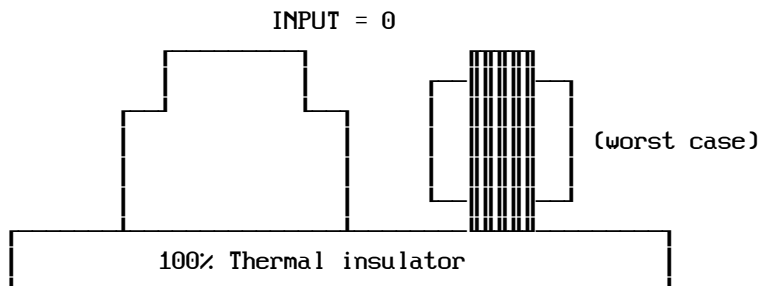
\* Enter: 0 = No Radiator  
1 = With Radiator

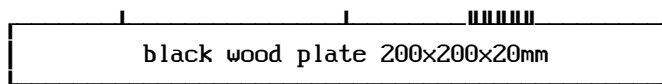
\* The cooling channel of the radiator must stand in a vertical position.

114

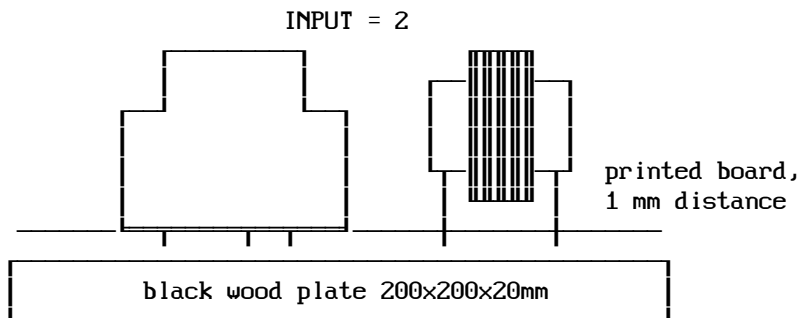
Chassis:

-----  
Enter the chassis, as shown below, that best identifies the operating environment of the transformer.

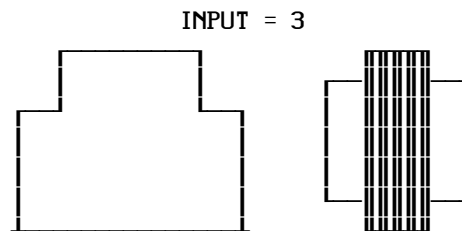




If the core has brackets and the transformers is not in the case then there is a distance between the core and the chassis of 40 mils



If the transformer is potted in a case then there is a distance between the case and the chassis of 40 mils



There is no thermal contact of the transformer or of the case with the chassis.

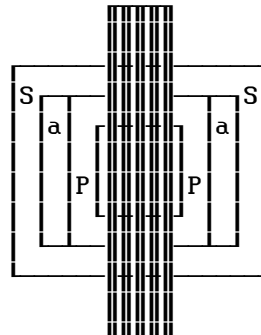
115

Cooling Channel:

In single section coil transformers, a front-sided cooling channel can be provided between the primary and secondary windings. Enter the width of the channel "a" in in.

Transformer seen from top

Cooling channel front-sided  
between primary and  
secondary (width "a")



Legend: P = primary  
S = secondary

\* The cooling channel must stand in vertical position.

116

Additional Cooling Area of the Winding:

-----  
The calculated cooling area of the coil is multiplied by the value entered here. A value may be entered in this field if the cooling area of the coil can be increased. For example, if large connectors increase the effective cooling area of the coil, a value greater than 1 would be entered.

117

Correction Factor of the Thermal  
Conductivity of the Varnish:

-----  
This position is only active when a impregnation is specified (Impregnation 1,2,5 or 6). The program assumes that the varnish has a thermal conductivity of 0.01 W/°K/in. To change the thermal conductivity of the varnish, enter a^correction factor based on the calculation:

$$\text{Factor} = 0.004 / (\text{thermal conductivity of your varnish in W/°K/cm})$$

\* For Example:

Thermal Conductivity of your varnish	Enter
0.004 W/°K/cm	1
0.003 W/°K/cm	1.33
0.002 W/°K/cm	2
0.001 W/°K/cm	4

118

Correction Factor of the Thermal  
Conductivity of the Potting Compound:

-----  
This position is only active when a potted transformer is specified. The program assumes that the potting compound has a thermal conductivity of 0.02 W/K/in. To change the thermal conductivity of the potting compound, enter a correction factor based on the calculation:

$$\text{Factor} = 0.008 / (\text{thermal conductivity of your potting compound in W/°K/cm})$$

\* For Example:

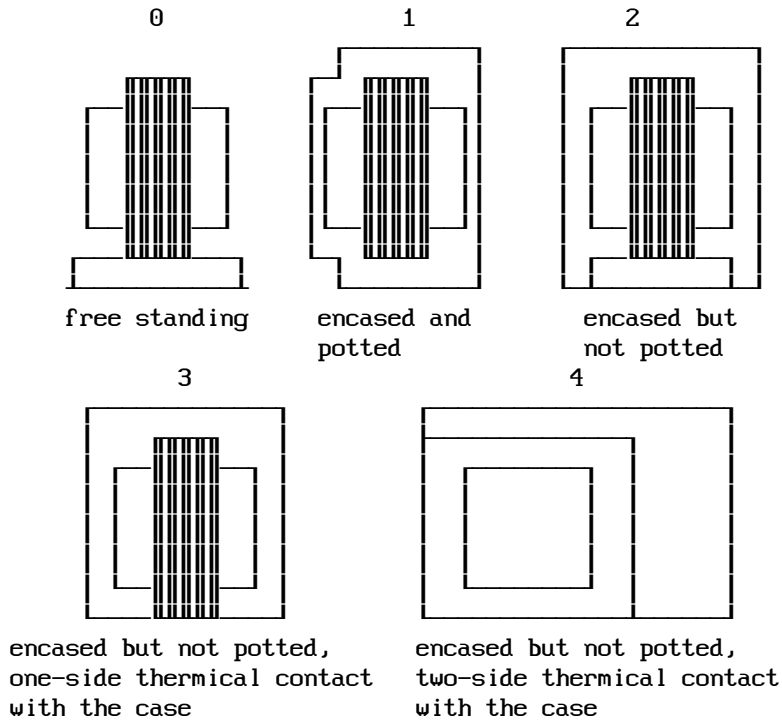
Thermal Conductivity of your potting compound	Enter
0.008 W/°K/cm	1
0.006 W/°K/cm	1.33
0.004 W/°K/cm	2
0.002 W/°K/cm	4

119

Transformer Environment:

-----  
Enter the environment type, as shown below, that best

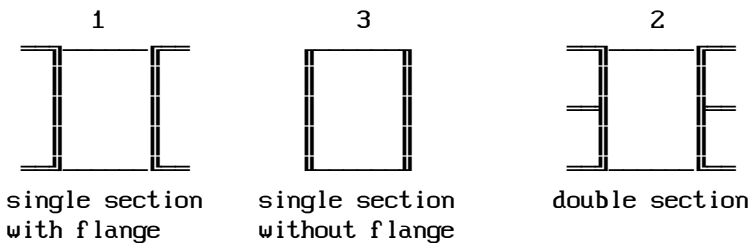
identifies the operating environment of the transformer.



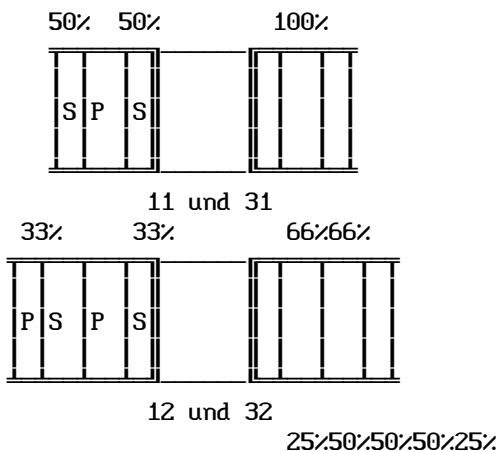
120

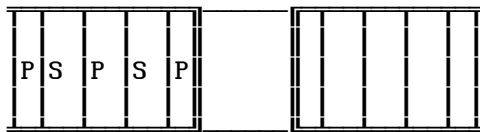
Type of Bobbin:

Enter the type of bobbin, as shown below, that best identifies the bobbin to be used in the transformer.



Bei Einkammer-Ausführung unterscheidet man noch 3 Möglichkeiten. Diese Ausführungen werden bei Übertragern angewendet.





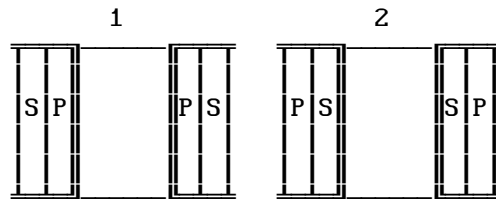
13 und 33

121

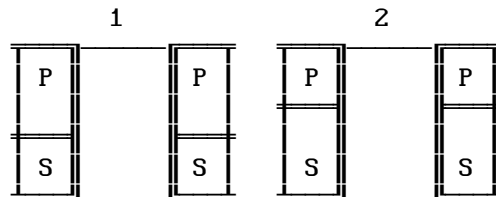
Arrangement of the Windings:

Enter the arrangement of the windings, as shown below, that best identifies the arrangement of the windings for the transformer being designed.

- single-section bobbin with and without flange



- double-section bobbin



Legend : P = primary  
S = secondary

122

Limiting the Supplemental Winding Losses:

Here the program is told, how high the supplementary losses due to current displacement and Eddy-current may be. Enter a factor based on the formula:

$$\text{Factor} = 1 + (P_e + P_s) / P_{dc}$$

Where:  $P_s$  = Skin-Effect Losses

$P_e$  = Eddy-Current Losses

$P_{dc}$  = purely (resistive) Ohmic Losses (warm  $R \cdot I^2$ )

- \* Regulation of supplementary losses is achieved by switching the wires in parallel.
- \* The supplementary losses may, in high-frequency or high-current applications, exceed the prescribed values and force the program to switch the wires in parallel.

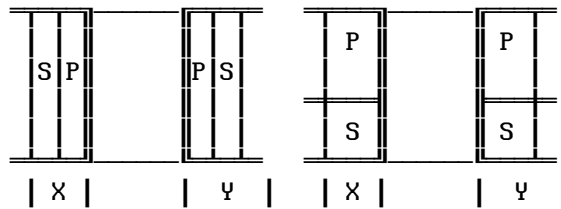
123

Limiting the Utilization of the Winding Space Fill:

Enter the winding fill factor as defined below. When selecting

a core, the program selects a core large enough that the prescribed winding space will not be surpassed. The winding space limitation is defined as follows:

$$\text{Factor} = X/Y$$



124

"Bulge" in the Winding:

-----  
Enter whether the winding will be "hammered", wound with sufficient tension, or will have a bulge.

Enter: 0 = hammered or pressed winding  
1 = wound with sufficient tension  
2 = not hammered winding has a "Bulge".

125

Winding Technique:

-----  
The program distinguishes between 2 winding techniques.

Enter: 1 = normal winding technique  
2 = random winding

\* When using a layer insulation, the program automatically uses an improved "normal" winding technique.

126

Impregnation:

-----  
Enter: 1 = impregnation with a double-component varnish (no air in the winding)  
2 = impregnation with a single-component varnish ( 50% air - 50% varnish in the winding)  
3 = dry (no varnish in the winding)  
4 = only bobbin encased and potted (no air in the winding)  
5 = impregnation with a double-component varnish (no air in the winding) only bobbin encased (but not potted), typical UDE  
6 = impregnation with a single-component varnish ( 50% air - 50% varnish in the winding) only bobbin encased (but not potted), typical UDE  
7 = dry (no varnish in the winding) only bobbin encased (but not potted), typical UDE

127

Spread:

-----  
Here can be limited the supplemental winding losses.

$$\text{Spread} = 100 * d/D \quad (\%)$$

d = Distance between two insulated wires in the same layer.  
D = Diameter of the insulated wire.

- \* This position is only active when the insulation per layer is specified.

128

#### Selection of the Core:

-----  
The program offers three options for selecting a core:

Enter: 0 = Automatic Selection

-----  
The user can mark a core file only under Menu "Material/Cores.." The program then starts its search for a properly sized core at the marked core. If no file have been marked, the starts automatic selection with a standard core file and the first core in that file.

1 = Core selection from the core file

-----  
The user marks a core file and a core under the Menu "Material/Cores..", sets the input position Selektion=1. The program calculates the transformer with the marked core, if the selected core is large enough.

2 = Core selection out of the input file

-----  
The input file is loaded out of the library. The program calculates the transformer with the loaded core, if the loaded core is large enough.

3 = Manual input of the core

-----  
The user must enter all dimensions of a core and the bobbin under the Menu "Material/Cores.." into the clipboard, set the input position Selektion=3. The program calculates the transformer with the entered core, if the manually defined core is large enough.

- \* Refer to <CoFile>,<CoName>

129

#### Criteria of Calculation:

- - \* The transformer is calculated to 2 criteria:

##### Regulation or Temperature Rise

- 0 => The program decides completely automatically, to which criteria the transformer shall be calculated.
- 1 => The calculation criteria is Regulation.
- 2 => The calculation criteria is Temperature Rise.

- \* The transformer with a rectifier and a RC-load will be always



calculated with criteria Regulation.

CoFile

Name of Core File:

- \* The name of the core family selected is shown here.
- \* The content of a core file can be displayed with the Menu "Material/Cores"

Refer to <CoName>,<128> Selection of the Core

CoName

Name of the Selected Core:

- \* Here the name of the selected core is shown. By selecting the core, all relevant mechanical data of core and bobbin have been chosen.

FeFile

Name of the Fe-File:

- \* Here the name of the selected Fe-File is shown.
- \* The content of an Fe-File can be displayed with the Menu "Material/Steel"

FeName

Name of Selected Steel:

- \* Here the name of the steel is shown. By selecting the steel grade, all relevant data has been given to the program for calculating the Fe-Losses, the No-load Current, etc.

Min.

Minimum Value:

- \* The minimum permissible value of the current input field is shown.
- \* The marking in the title of the input field has the following meaning:
  - \* => Value or multiplications factor
  - => Code or Integral Number

Max.

Maximum Value:

- \* The maximum permissible value of the current input field is shown.
- \* The marking in the title of the input field has the following meaning:
  - \* => Value or multiplication factor
  - => Code or Integral Number