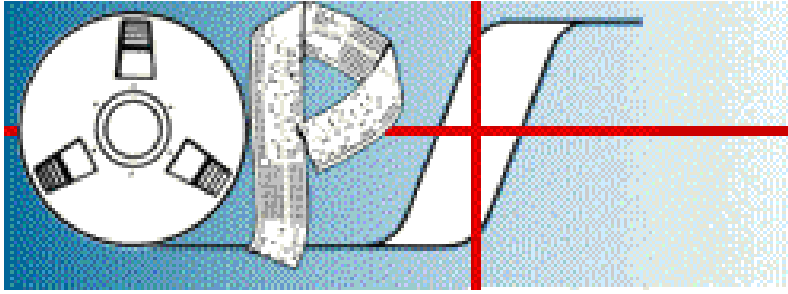


## OPTIMIZED PROGRAM SERVICE LLC.



Electro-Magnetic Design Using Advanced Computer Techniques

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# HIREAC

## PROGRAM DESCRIPTION AND OPERATING INSTRUCTIONS

### I. INTRODUCTION

**HIREAC** is a program capable of handling a wide range of high reactance transformers which use special arrangements of coils and/or magnetic shunts to achieve precise values of reactance. **HIREAC** is ideally suited to handle current-limiting transformers, ballasts and transformers where precise impedance is to be built into the design. It is intended to be used by experienced transformer designers as an extension to their engineering capabilities and relies on their background for judgement and subjective analysis of the results obtained. The computational power of **HIREAC** enables the designer to examine many alternatives and quickly provides the effects of each decision made during the design process.

**HIREAC** is an interactive program that allows the user to establish and maintain custom data files containing proprietary material, cost and labor information. This gives the user greater control over a wide range of design considerations. It enables the designer to research more efficient, and most cost effective design solutions, resulting in improved product quality, improved productivity and lower costs.

### II. FEATURES

#### **HIREAC INCLUDES THE FOLLOWING NEW FEATURES:**

**CUSTOM DATABASE** – **HIREAC** operates using a database of materials supplied by the individual user. This feature allows the designer to further control the material types and sizes to be considered. With conductor selection options, the program is limited to selecting components readily available from the user's own inventory of materials. More realistic cost information is provided since the user can submit costs into the database.

## II. FEATURES (CONTINUED)

**THERMAL MODELING – HIREAC** uses sophisticated thermal network modeling techniques to determine temperature rise. The thermal model is developed using a comprehensive nodal circuit analysis routine that considers the effects of the mechanical structure as well as the thermal characteristics of the materials used in the design. This provides more accurate results in the temperature calculations.

**ELECTRICAL ANALYSIS** – Extended analysis of a fixed design is further enhanced in **HIREAC**. Impedance characteristics expressed as %IR, %IX and %IZ and leakage inductance are provided for each winding using the **EXTENDED ANALYSIS OPTION**.

**VARIABLE DUCTING** – Many variations of ducting arrangements are available in **HIREAC**. Included are ducts of variable size, ducts on both sides of insulating barriers, and ducts with both blanketed or unblanketed cooling surfaces.

Other enhancements are continuously being made to expand capabilities and to improve the calculations of **HIREAC**.

## III. USE

**HIREAC** is a program used to design high-reactance applications that require side-by-side windings with air space or magnetic shunts between windings; concentric windings with magnetic shunts between coils; or concentric windings with a second gapped core structure.

**HIREAC** is used to design: lighting Ballasts, current limiting transformers and precise reactance transformers.

## IV. INPUT REQUIREMENTS

For entry of design information see **Page 4**.

## DISCLAIMER

This program and its documentation have been subjected to normal field testing procedures. Optimized Program Service, llc. makes no warranty, expressed or implied, as to the documentation and the performance of the program. Users are expected to make the final evaluation as to the value and correctness of the results obtained for their specific application.

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## MAIN MENU



- Select **“BEGIN/REVIEW DESIGN IN ENGLISH UNITS”** to start a design or review current design English units.
- Select **“RETRIEVE DESIGN FILE”** to run program with an existing data file.
- Select **“GENERATE DESIGN PRINTOUT FROM EXISTING DATA”** to print design from existing input data.
- Select **“MODIFY”** to modify existing input data
- Select **“TERMINATE”** to exit the program.

# GENERAL DESIGN DATA

OPS- Hi-Reactance Design Program

## GENERAL DESIGN DATA

FREQUENCY?

DESIGN TYPE?

CONFIGURATION?

% IMPEDANCE?

INPUT SHUNT?

SHUNT STACK?

SHUNT LENGTH?



MAIN CORE GAPPED DESIGN?

GAP LOCATION?

NUMBER OF GAPS?

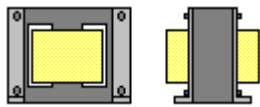
GAP THICKNESS?

NO. OF SECONDARY WINDINGS?

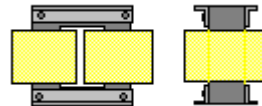



**FREQUENCY:** Frequency of input voltage in hertz.  
(See 2TRANS Manual Page 34-35 for multiple frequencies.)

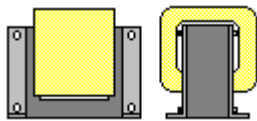
**DESIGN TYPE:**



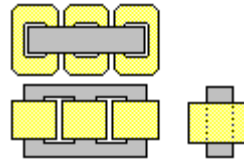
SHELL



CORE TYPE

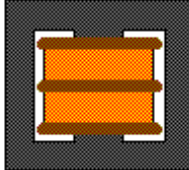


SIMPLE



THREE PHASE  
THREE-LEGGED

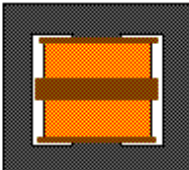
# CONFIGURATION



**TYPE 1**

Split bobbin with center-flange the **SAME THICKNESS** as outer flanges.

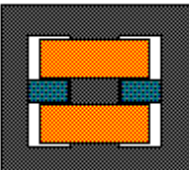
*SINGLE PHASE*



**TYPE 2**

Split bobbin with center-flange or space between coils **GREATER THAN** outer flanges or margins.

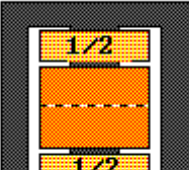
*SINGLE PHASE*



**TYPE 3**

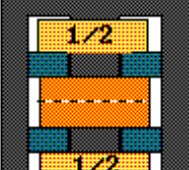
Side-by-side windings with magnetic **SHUNT** in space between coils.

*SINGLE PHASE*



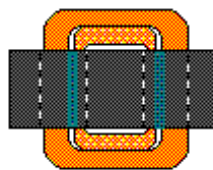
**TYPE 4**

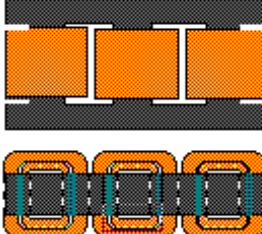
Interleaved coils where primary and secondary can be one coil or two part coils. User can select arrangement of these coils.

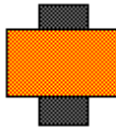


**TYPE 5**

Interleaved coils where primary and secondary can be one coil or two part coils. Magnetic **SHUNTS** in space between coils. User can select arrangement *SINGLE PHASE or THREE*

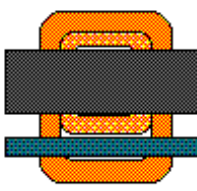


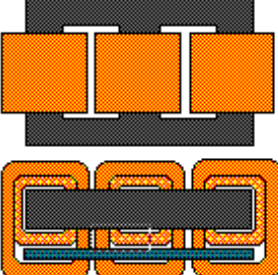


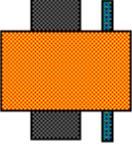


**TYPE 6**

Concentric coils with **SHUNT** placed between windings where coil passes through the **CORE WINDOW**.





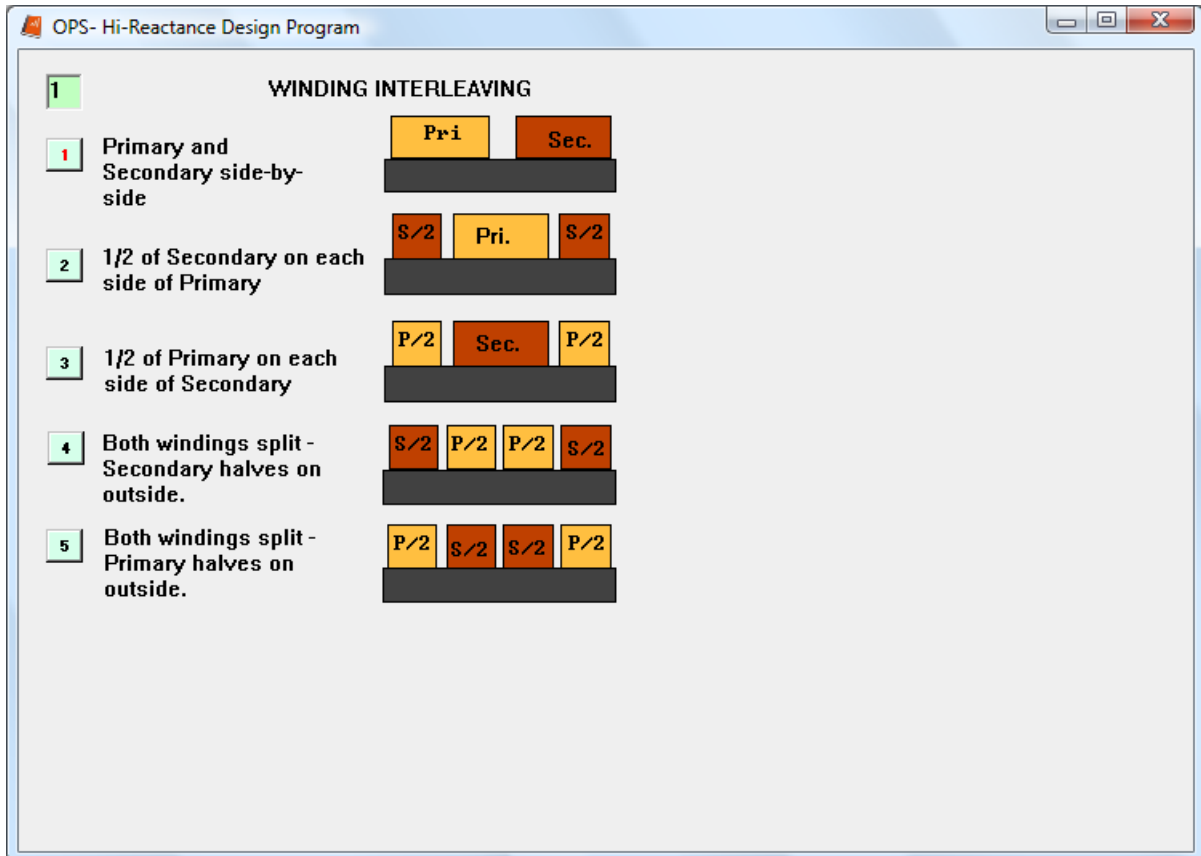


**TYPE 7**

Concentric windings with **SHUNT** as **SEPARATE CORE** with 1 or more **AIR GAPS**.

# WINDING INTERLEAVING

## WINDING ARRANGEMENTS for Types 4 and 5.



## GENERAL DESIGN DATA (CONTINUED)

OPS- Hi-Reactance Design Program

---

### GENERAL DESIGN DATA

**FREQUENCY?**    60 HZ 50 HZ 400 HZ MULTI OTHER

**DESIGN TYPE?**    SHELL CORE SIMPLE 3 PHASE


**CONFIGURATION?**    TYPE 1 TYPE 2 TYPE 3 TYPE 4 TYPE 5 TYPE 6 TYPE 7

**% IMPEDANCE?**     NONE % IX % IZ

**INPUT SHUNT?**    YES NO

**SHUNT STACK?**   

**SHUNT LENGTH?**   



**MAIN CORE GAPPED DESIGN?**    NO YES INVERTER

**GAP LOCATION?**    UNDER COIL AT EACH END ACROSS CORE

**NUMBER OF GAPS?**   

**GAP THICKNESS?**   

**NO. OF SECONDARY WINDINGS?**    1 2

OFF ON

**IMPEDANCE:** For types 4-7 only. Enter required impedance as either % IX or % IZ.

**INPUT SHUNT:** For Types 3 and 5 only. Enter YES if shunt is being entered.

**SHUNT STACK:** Enter stack dimension of the shunt.

**SHUNT LENGTH:** Enter the length of the shunt. Program will determine shunt gap.

**GAPPED DESIGN:** Air gap is to be present in the core leg.

**NO:** No gap is used.

**YES:** Enter total length of the air gap to appear across the core.

**INVERTER:** Primary voltage is alternating D.C.

**GAP LOCATION: Select one -**

**UNDER COIL:** Gap appears in center-leg under the coil,

**AT EACH END:** Gap appears at each end of center-leg

**ACROSS CORE:** Gap is across core.

**NUMBER OF GAPS:** Number of gaps to be used.

**GAP THICKNESS:** Total thickness of gap in inches.

**NO. OF SECONDARY WINDINGS:** Enter number of secondary (output) windings.

Two (2) are permitted.



# COOLING DUCTS (PAGE 1)

OPS- Hi-Reactance Design Program

## GENERAL DESIGN DATA - Cooling Ducts

COOLING DUCTS?  NO DUCTS  INTERNAL  EXTERNAL  BOTH

UNBLANKETED?  NO  YES SPACER SHAPE?  SQUARE  RECTANGULAR

INTERNAL DUCTS:

THICKNESS?  .250  .375  .500  .625  .750  1.00  OTHER

EFFECTIVENESS?

EXTERNAL DUCTS:

# OF LOCATIONS?

LOCATIONS?  1 ENTRIES

THICKNESS?  .250  .375  .500  .625  .750  1.00  OTHER

EFFECTIVENESS?

TYPE?  END  FULL

VARIABLE?  NO  YES

THICKNESSES?  1 ENTRIES

TYPES(1 or 2)?  1 ENTRIES

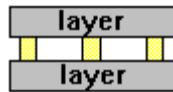
DUCT EACH SIDE OF BARRIER?  1 ENTRIES

THICKNESS - UNDER/OVER?  2 ENTRIES

**COOLING DUCTS:** Spaces in coils that permit air or oil to flow parallel to the coil axis.

**INTERNAL DUCTS:**

Ducts are placed within windings only



**EXTERNAL DUCTS:**

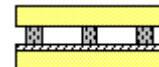
Ducts are placed between winding only



**BOTH:** Ducts both within and between windings.



UNBLANKETED



BLANKETED

**UNBLANKETED:** No insulation in ducted area.

**SPACER SHAPE:** Shape of actual duct spacer.

**SQUARE:** Both dimensions of spacer are the same.

**RECTANGULAR:** Width of spacer can be different than thickness.

**CORRUGATED DUCT SPACER SHAPE:** (METAL Spacers only).

Square wave or Sine wave -



SINE WAVE CORRUGATED DUCT.



SQUARE WAVE CORRUGATED DUCT.

**THICKNESS:** Thickness of duct opening.

**EFFECTIVENESS:** Percent of duct free from obstruction , such as leads.

## COOLING DUCTS (PAGE 2)

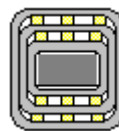
### EXTERNAL DUCT -

**# OF LOCATIONS:** Enter number of required duct locations.

**LOCATIONS:** Enter number of winding **UNDER** which duct is to be located. (2 indicates duct under second winding, etc.)

**THICKNESS:** Radial thickness of duct opening.

**EFFECTIVENESS:** Percent of duct free from obstruction.



### TYPE -

**END:** Ducts on ends of coils outside core window **END DUCTS**

**FULL DUCTS**

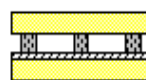
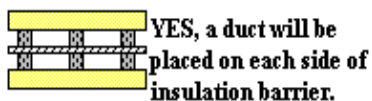
**FULL:** Duct around coil.

**VARIABLE- YES:** If all external ducts are of different size or type or if duct is to be on each side of the barrier.

**THICKNESS:** Enter thickness for each external duct.

**TYPE:** Enter (1) for End or (2) for Full for each external duct.

**DUCT EACH SIDE OF BARRIER :** Enter (1) for **YES** or (0) for **NO** for each external duct.



**No, the duct will be placed over the section insulation of the previous winding.**

**THICKNESS UNDER/OVER:** Enter thickness for duct under and over the barrier.

## SINGLE-PHASE CORE (PAGE 1)

OPS- Hi-Reactance Design Program

---

### GENERAL DESIGN DATA - Single-Phase Cores

---

**CORE TYPE?**   

**ENTER CORE?**   

**INPUT RATIOS?**         **Y/T RATIO?**     **L/T RATIO?**

**CORE MATERIAL?**   

**THICKNESS?**        **AW?**     **TW?**     **IRON DENSITY?**

**STACK FACTOR?**   

**FLUX DENSITY?**   

**DESCRIPTION?**   

**WEDGE?**   

**SPACE?**   

**WNDG FORM THK?**   

**NET END ALLOW?**   

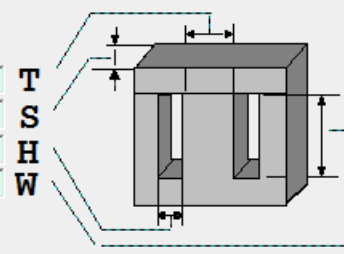
\* ENTER CORE DIMENSIONS

T

S

H

W



**CORE NAME?**

**CORE TYPE:** Type of core structure.

**C-CORE:** Wound cut cores.

**SCRAPLESS:** Tool made laminations.

**STRIP:** Core made with sheared strips.

**ENTER CORE -**

**YES:** Core dimensions must be entered on next page.

**NO:** Core will be selected by **HIREAC** for C-Core, Scrapless and Strip only.

**INPUT RATIOS -**

**NO:** Normal ratios to give uniform cross-section throughout the core structure are assumed.

Default values are:

For single phase (Shell Type)	Leg/Tongue = .5	Yoke/Tongue = .5
For three-phase (Three-Leg)	Leg/Tongue = 1	Yoke/Tongue = 1
For three-phase (Five-Leg)	Leg/Tongue = .5	Yoke/Tongue = .6

**YES:** Yoke/Tongue and Leg/Tongue must be entered.

## SINGLE-PHASE CORE (CONTINUED)

OPS- Hi-Reactance Design Program

---

### GENERAL DESIGN DATA - Single-Phase Cores

---

CORE TYPE?	<input type="button" value="C-CORE"/> <input type="button" value="SCRAPLESS"/> <input type="button" value="STRIP"/>		
ENTER CORE?	<input type="button" value="YES"/> <input type="button" value="NO"/>		
INPUT RATIOS?	<input type="button" value="NO"/> <input type="button" value="YES"/>	Y/T RATIO? .5	L/T RATIO? .5
CORE MATERIAL?	<input type="button" value="M2"/> <input type="button" value="M3"/> <input type="button" value="M4"/> <input type="button" value="M6"/> <input type="button" value="M19"/> <input type="button" value="M22"/> <input type="button" value="M27"/> <input type="button" value="SPECIAL"/>		
THICKNESS?	.025	AW? 112	TW? 113
STACK FACTOR?	.955		
FLUX DENSITY?	11		
DESCRIPTION?	special		
WEDGE?	.032		
SPACE?	.03125		
WNDG FORM THK?	.061		
NET END ALLOW?	.031		

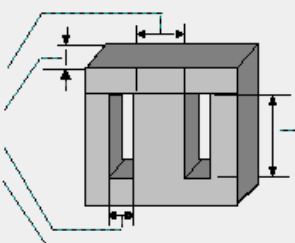
\* ENTER CORE DIMENSIONS

.875 T

1 S

.625 H

2.75 W



CORE NAME? x123

**Y/T RATIO:** Of the width of strip in core ends to the core leg strip width.

**L/T RATIO:** Of width of strip in outside core legs to width of strip in core center leg.  
For shell type core only.

### CORE MATERIAL-

**M GRADE:** ASTM material grade designation (M6, etc.)

For stamped lamination cores – 6, 15, 19, 22, 27, 36, 45, 50, 54, 55

For strip or cruciform cores – 2, 3, 4, 6, 19, 22, 27

**THICKNESS:** Thickness of individual lamination.

**STACKING FACTOR:** Proportion of core stack that is actually iron.

**FLUX DENSITY:** Induction in core (in kilo-gausses).

## SINGLE-PHASE CORE (PAGE 2)

OPS- Hi-Reactance Design Program
\_ □ ×

---

### GENERAL DESIGN DATA - Single-Phase Cores

---

**CORE TYPE?** C-CORE SCRAPLESS STRIP

**ENTER CORE?** YES NO

**INPUT RATIOS? 1** NO YES **Y/T RATIO?** .5 **L/T RATIO?** .5

**CORE MATERIAL?** M2 M3 M4 M6 M19 M22 M27 SPECIAL

**THICKNESS?** .025 **AW?** 112 **TW?** 113 **IRON DENSITY?** .276

**STACK FACTOR?** .955

**FLUX DENSITY?** 11

**DESCRIPTION?** special

**WEDGE?** .032

**SPACE?** .03125

**WNDG FORM THK?** .061

**NET END ALLOW?** .031

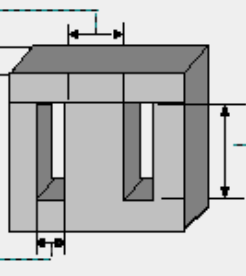
\* ENTER CORE DIMENSIONS

.875 **T**

1 **S**

.625 **H**

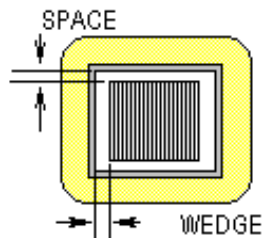
2.75 **W**



**CORE NAME?** x123

OFF
ON

←
→



**WEDGE:** Thickness allowed at each end of the core stack (S).

**SPACE:** Thickness allowed on each side of the core tongue (T).

**WNDG. FORM THK:** Total thickness of winding tube, bobbin, or insulation under the first layer of wire.

**NET END ALLOW:** Net difference between the coil length and the wide dimension (W) of the core window.

**SEC. PROPORTION:** Enter proportion of net winding space to be allocated to secondary. (Asked for Types 1 through 5).

### CORE DIMENSIONS -

**T:** Strip width of core center leg.

**S:** Stack of laminations.

**H:** Narrow dimensions of core window.

**W:** Wide dimension of core window.

## C-CORES AND DG CORES (PAGE 1)

OPS- Hi-Reactance Design Program
\_ □ ×

---

### GENERAL DESIGN DATA - Single-Phase Cores

---

**CORE TYPE?** C-CORE SCRAPLESS STRIP

**ENTER CORE?** YES NO

**CORE MATERIAL?** H Z A S SAI SPECIAL

**THICKNESS?** .004 **AW?** 3 **TW?** 1.5 **IRON DENSITY?** .276

**STACK FACTOR?** .955

**FLUX DENSITY?** 11

**DESCRIPTION?** special

**WEDGE?** .032

**SPACE?** .125

**WNDG FORM THK?** .25

**NET END ALLOW?** .25

**\* ENTER CORE DIMENSIONS**

3

2.25

2

7

D  
E  
F  
G

**CORE NAME?** x123

OFF

ON

←

→

### CORE TYPE -

**C-CORE:** Wound cut core

**SCRAPLESS:** Tool made laminations.

**STRIP:** Core made with sheared strips.

### ENTER CORE -

**YES:** Core dimensions must be entered on next page.

**NO:** Program selects core from file for C-Cores in the database.

DG core dimensions must always be entered.

### CORE MATERIAL: For C-CORES:

**H:** 4 mil oriented silicon

**Z:** 4 mil super-oriented silicon

**A:** 12 mil oriented silicon

**S:** 4 mil supermendur

**SAI:** Amorphous metal

**SPECIAL:** If none of the above, the enter the following-

**AW:** Excitation loss in VA/Pound (VA/Kilograms for SI units)

**TW:** Core loss in Watts/Pound (Watts/Kilograms for SI units)

**IRON DENSITY:** Core material weight in pounds/cubic inch. (Grams/mm<sup>3</sup> for SI units)

**DESCRIPTION:** Name of core material.

**THICKNESS:** Thickness of individual lamination.

**STACK FACTOR:** Proportion of core leg that is actually iron.

**FLUX DENSITY:** Induction in core (in kilo-gausses).

## C-CORES AND DG CORES (PAGE 2)

OPS- Hi-Reactance Design Program
\_ □ ×

---

### GENERAL DESIGN DATA - Single-Phase Cores

---

**CORE TYPE?** C-CORE SCRAPLESS STRIP

**ENTER CORE?** YES NO

**CORE MATERIAL?** H Z A S SA1 SPECIAL

**THICKNESS?** .004 **AW?** 3 **TW?** 1.5 **IRON DENSITY?** .276

**STACK FACTOR?** .955

**FLUX DENSITY?** 11

---

**DESCRIPTION?** special

**WEDGE?** .032

**SPACE?** .125

**WNDG FORM THK?** .25

**NET END ALLOW?** .25

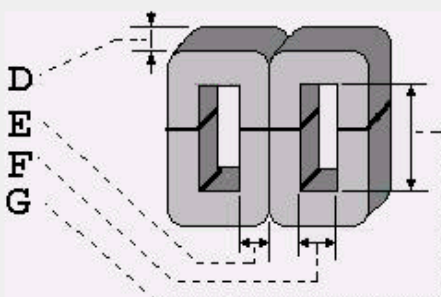
\* ENTER CORE DIMENSIONS

3 **D**

2.25 **E**

2 **F**

7 **G**



**CORE NAME?** x123

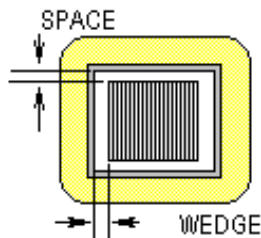
OFF ON

← →

### CORE DIMENSIONS -

- D:** Strip width of wound core.
- E:** Build-up of strip.
- F:** Narrow dimension of core window.
- G:** Wide dimension of core window.

**CORE NAME:** Core identifier when core is entered.



**WEDGE:** Clearance allowed at each side of “D” dimension.

**SPACE:** Clearance allowed at each side of “E” dimension.

**WNDG FORM THK:** Total thickness of winding tube, bobbin, or insulation under the first layer of wire.

**NET END ALLOW:** Net difference between coil length and window “G” dimension.

## PRIMARY – WINDING DATA (PAGE 1)

The screenshot shows a software window titled "OPS- Hi-Reactance Design Program" with a sub-header "PRIMARY - WINDING DATA - Page 1". The window contains the following controls:

- NO. OF PRI.?**: A row of four buttons labeled 1, 2, 3, and 4. The button '1' is highlighted with a red border.
- PRIMARY TAPS?**: A row of four buttons labeled NONE, LO-NOM-HI, END LAYER, and RANDOM. The button 'LO-NOM-HI' is highlighted with a red border.
- SAME HITAP WIRE?**: Two buttons labeled YES and NO. The button 'YES' is highlighted with a red border.
- LO VOLTS?**: A text input field containing the value 300.
- NOM VOLTS?**: A text input field containing the value 600.
- HI VOLTS?**: A text input field containing the value 600.
- DIEL. TEST(KV)?**: A text input field containing the value 1.5.
- At the bottom left, there are two buttons labeled OFF and ON.
- At the bottom right, there are two blue arrow buttons pointing left and right.

**NO. OF PRI:** Number of Primary windings.  
 Select 1 for single primary winding  
 Select 2 for two identical primaries  
 Select 3 or 4 for extended primaries (See 2TRANS Manual Page 37-43).

### THREE PHASE -

**WYE:** One end of each three-phase winding is connected to a common point. (neutral)



WYE

**DELTA:** Three-phase windings are connected in series for a closed circuit.



DELTA

### PRIMARY TAPS -

**NONE:** No Taps.

**LO –NOM – HI:** Tap below nominal and above nominal in primary only.

**END LAYER:** Up to 6 taps permitted in each winding with all taps exiting at end of layers.

**RANDOM:** Up to 6 taps permitted in each winding with taps exiting the coil wherever they occur.



## PRIMARY – WINDING DATA (CONTINUED)

The screenshot shows a software window titled "OPS- Hi-Reactance Design Program" with a sub-header "PRIMARY - WINDING DATA - Page 1". The window contains several input fields and buttons:

- NO. OF PRI.?**: A row of four buttons labeled 1, 2, 3, and 4. The button labeled "1" is highlighted with a red border.
- PRIMARY TAPS?**: A row of four buttons labeled NONE, LO-NOM-HI, END LAYER, and RANDOM. The button labeled "LO-NOM-HI" is highlighted with a red border.
- SAME HITAP WIRE?**: Two buttons labeled YES and NO. The button labeled "YES" is highlighted with a red border.
- LO VOLTS?**: A text input field containing the value "300".
- NOM VOLTS?**: A text input field containing the value "600".
- HI VOLTS?**: A text input field containing the value "600".
- DIEL. TEST(KV)?**: A text input field containing the value "1.5".
- At the bottom left, there are two buttons labeled "OFF" and "ON".
- At the bottom right, there are two blue arrow buttons pointing left and right.

### **SAME HITAP WIRE -**

**YES:** Entire primary is wound with the same wire.

**NO:** Portion of primary above the nominal is wound with a different wire.

**LO VOLTS:** Lowest voltage tap on the primary.

**NOM VOLTS:** Nominal voltage tap on the primary.

**HI VOLTS:** Highest voltage tap on the primary.

**DIEL. TEST (KV):** Test voltage in kilo-volts usually applied for 1 minute.

## PRIMARY – WINDING DATA (PAGE 2)

The screenshot shows a software window titled "OPS- Hi-Reactance Design Program" with a sub-window "PRIMARY - WINDING DATA - Page 2". The window contains several sections of controls:

- PRIMARY WIRE?**: Buttons for CU, AL, and AL 58%.
- WIRE FILM?**: Buttons for SINGLE and HEAVY.
- PRI. WIRE SHAPE?**: Buttons for PICK, RD, SQ, RG, FOIL, HRD, RDP, and MULTI.
- SKEW?**: Input field with value 0.
- AWG SIZE?**: Input field with value 33.
- NO. HIGH?**: Input field with value 1.
- NO. WIDE?**: Input field with value 1.
- SPACE FACTOR?**: Input field with value .95.
- WRAP?**: Input field with value .0007.
- DUCT LOCATION?**: Buttons for 1, 2, 3, 4, 5, 6, and OTHER.
- DUCT SIZE?**: Buttons for NONE, SPECIFY LAYERS, SPECIFY NUMBER, .250, .375, .500, .625, .750, 1.00, and OTHER.
- TYPE?**: Buttons for END and FULL.
- BULGE FACTOR?**: Input field with value 1.1.
- WINDING MARGIN?**: Input field with value .125.
- LAYER INS. THK?**: Input field with value .002 and a multiplier input with value 1.
- SECTION INS. THK?**: Input field with value .015 and a multiplier input with value 1.
- Buttons for OFF and ON.
- Navigation arrows (left and right).

**PRIMARY WIRE:** Select Copper (CU) or Aluminum (AL).

**WIRE FILM:** Select Single Film or Heavy Film.

### PRI. WIRE SHAPE -

**PICK:** Program selects from wire file.

**RD:** Round wire: Enter as AWG wire size.

**SQ:** Square wire: Enter as AWG wire size.

**RG:** Rectangular wire: Enter as thickness and width.

**FOIL:** Foil or Strip: Enter as thickness and width.

**HRD:** Round half AWG size wire.

**RDP:** Round wire precision wound.

**MULTI:** Wire consisting of more than one size. (See 2TRANS Manual Page 36).

**SKEW:** Portion of a turn width subtracted from the winding space because of skew in the winding. A value of (1) means 1 turn width subtracted.

**AWG SIZE:** Standard American wire gauge sizes for round and square wires.

**NO HIGH:** Number of wire strands high in a multi-stranded wire.

**NO. WIDE:** Number of wire strands wide in a multi-stranded wire.

## PRIMARY – WINDING DATA (CONTINUED)

OPS- Hi-Reactance Design Program \_ □ X

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**PRIMARY - WINDING DATA - Page 2**

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PRIMARY WIRE?

WIRE FILM?

PRI. WIRE SHAPE?

SKEW?       AVG SIZE?       NO. HIGH?       NO. WIDE?

SPACE FACTOR?       WRAP?

DUCT LOCATION?

DUCT SIZE?

TYPE?

BULGE FACTOR?

WINDING MARGIN?

LAYER INS. THK?       #?

SECTION INS. THK?       #?

**SPACE FACTOR:** Proportion of space occupied by wire that is actually wire.

**WRAP:** Thickness of wrap on a conductor. If (0) the program uses designated film thickness.

**DUCT LOCATION-**

**NONE:** No ducts

**SPECIFY LAYERS:** Select number of layers desired between internal ducts in this winding.

**\*\*\*NOTE:** See 2TRANS Manual Page 55 for other entries permitted for ducting in single phase Core-Type Transformers.

**BULGE FACTOR:** Factor applied to winding build when calculating the winding mean turn. Default value is 1.1

**WINDING MARGIN:** Distance from each end of the coil from where winding is to begin. (For bobbins, enter flange thickness.)

**LAYER INS. THK:** Thickness and number of thickness between layers of wire.

**\*\*\*NOTE:** If program is to select insulation, enter voltage stress in volts/per mil. Value must be greater than 9. For SI units enter as volts/mm. Value must be greater than 356.

**SECTION INS. THK:** Enter as thickness and number of thicknesses.

## HIGH TAP – WINDING DATA

OPS- Hi-Reactance Design Program V8.5 11/2003

### PRIMARY HIGH TAP - WINDING DATA

WINDING VOLTAGE? 600

NUMBER OF TAPS? 3

VOLTS? 450,500,550

WIRE SHAPE?

SKEW? 0

THKNESS	1	WIDTH	.007	# HIGH	1	# WIDE	1
LINEAR SPACE FACTOR	1	WRAP	.00				

BULGE FACTOR? 1.1

WINDING MARGIN? .085

LAYER INS.? .0000 # OF PIECES? 1

SECTION INS.? .0000 # OF PIECES? 1

Enter taps and tap voltages to be located between NOMINAL voltage and HIGHEST voltage of this section.

**WINDING VOLTAGE:** Total voltage of the primary nominal voltage plus the high tap section.

**NUMBER OF TAPS:** Up to 6 permitted.

**TAP VOLTS:** Entered as values between the nominal primary voltage and the value shown in the winding voltage (highest voltage of the section).

## SECONDARY – WINDING DATA (PAGE 1)

OPS- Hi-Reactance Design Program \_ □ ×

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### SECONDARY 1 - WINDING DATA Page 1

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RECTIFIER TYPE? **NONE** HW FV BR FVE HVC FVC BRC FWEC

POWER FACTOR? -.766

WINDING VOLTAGE? 5800

WINDING CURRENT? .00146

DIEL. TEST (KV)? 2.5

OFF ON

### RECTIFIER TYPE -

**NONE:** Output is not rectified. For Rectified Windings See 2TRANS Manual Page 51-53.

### THREE PHASE -

**WYE:** One end of each three-phase winding is connected to a common point. (neutral)



**WYE**

**DELTA:** Three-phase windings are connected in series for a closed circuit.



**DELTA**

**POWER FACTOR:** Enter as cosine of load power factor angle or as negative (-) if leading

**WINDING VOLTAGE:** For single phase enter as winding RMS voltage. For three phase Enter as line – to –line voltage.

**WINDING CURRENT:** For single phase enter as winding RMS current for three phase Enter as line current.

**SHORT CIRCUIT CURRENT:** Current achieved when first secondary (only) is shorted.

**DIEL. TEST (KV):** Enter winding test volts in KV.

**NUMBER OF TAPS:** Up to 6 taps are permitted below the rated secondary voltage.

**TAP VOLTS:** Enter a voltage for each tap specified above.

## SECONDARY – WINDING DATA (PAGE 2)

OPS- Hi-Reactance Design Program

### SECONDARY 1 - WINDING DATA Page 2

SECONDARY WIRE?

WIRE FILM?

SEC. WIRE SHAPE?

SKEW?       AVG SIZE       # HIGH       # WIDE

LINEAR SPACE FACTOR       WRAP

DUCT LOCATION?

DUCT SIZE?

TYPE?

BULGE FACTOR?

WINDING MARGIN?

LAYER INS. ?       # OF PIECES?

SECTION INS. ?       # OF PIECES?

\*\*\*\*NOTE: Definitions for all items above are shown on Primary Page 18.

## CONSTRUCTION (PAGE 1)

OPS- Hi-Reactance Design Program

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### CONSTRUCTION

WINDING ORDER?  4 Entries req'd

SHIELDS?

COMPENSATION?

AMBIENT TEMP?  TEMP. RISE?  % DUTY CYCLE?

CONSTRUCTION?

OPEN	FORCED-AIR	ENCAPSULATED	SPECIAL
COMPOUND-FILL	SAND-RESIN	OIL-FILLED	

NO. OF WINDINGS:

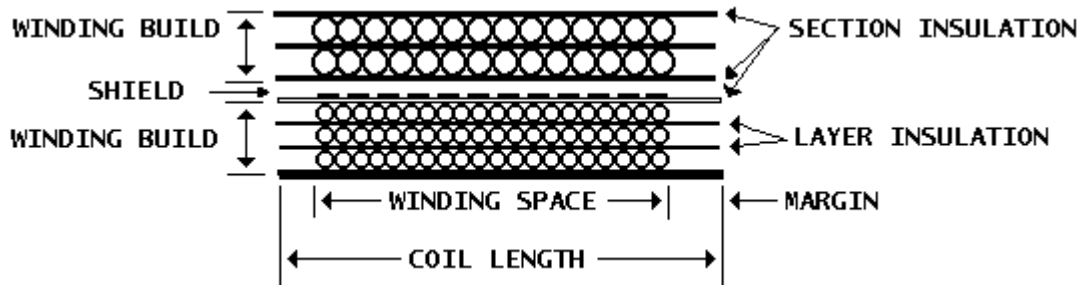
PRIMARIES: 1

HTAPS: 1

SECONDARIES: 2

TOTAL: 4

**WINDING ORDER:** Data for windings has been entered in the order of P1, P2, S1, S2, etc.  
Enter a number for each winding indicating the order it is to be wound.



**SHIELDS -**

- YES:** Transformer is to have electro-static shields between some windings.
- NO:** No shields are to be used.

**NUMBER OF SHIELDS:** Enter total number of shields.

**POSITION:** Enter number of the winding under which a shield is to be located. Quantity of entries must correspond to the number of shields.

## CONSTRUCTION (CONTINUED)

OPS- Hi-Reactance Design Program

### CONSTRUCTION

WINDING ORDER? 1,2,3,4 NO. OF WINDINGS:  
SHIELDS? YES NO 4 Entries req'd PRIMARIES: 1  
HTAPS: 1  
SECONDARIES: 2  
TOTAL: 4

COMPENSATION? YES NO

AMBIENT TEMP? 40 TEMP. RISE? 50 % DUTY CYCLE? 100

CONSTRUCTION? OPEN FORCED-AIR ENCAPSULATED SPECIAL  
COMPOUND-FILL SAND-RESIN OIL-FILLED

OFF ON

← →

### SHIELD TYPE -

**WIRE:** A layer of wire corresponding to the smallest wire in the windings adjacent to the shield will be used.

**FOIL:** A foil will be used for the shield. Enter the thickness of the foil.

**INSULATION:** Enter the thickness of insulation to be wound over the shield.

### COMPENSATION -

**YES:** Secondary turns will be adjusted to achieve the voltage entered at full load and at operating temperature.

**NO:** Secondary turns will be determined from the primary/secondary voltage ratio and will not be adjusted for voltage drops.

**% REGULATION:** Enter output voltage change from no load to full load, as a percentage of full load output volts

**% BUILD:** Percentage of the core narrow window dimension actually filled by wire, full ducts, insulation, winding form thickness, and clearance (space).

**AMBIENT TEMP:** Temperature in degrees C of surrounding air in which the transformer is operating.

**TEMP. RISE:** Temperature rise permitted in the hottest winding, above the ambient temperature.

**% DUTY CYCLE:** Percent of on-time where a full rated load is present in a repetitive on-off cycle. (Full load continuous is 100%.)



## CONSTRUCTION (PAGE 2)

OPS- Hi-Reactance Design Program

### CONSTRUCTION

WINDING ORDER? 1,2,3,4      NO. OF WINDINGS:  
SHIELDS? YES NO      4 Entries req'd      PRIMARIES: 1  
HTAPS: 1  
SECONDARIES: 2  
TOTAL: 4

COMPENSATION? YES NO

AMBIENT TEMP? 40      TEMP. RISE? 50      % DUTY CYCLE? 100

CONSTRUCTION? OPEN FORCED-AIR ENCAPSULATED SPECIAL  
COMPOUND-FILL SAND-RESIN OIL-FILLED

OFF ON      ← →

### CONSTRUCTION -

**OPEN:** Open core-coil

**FORCED AIR:** Open core-coil with blower driven air.

**ENCAPSULATED:** Transformer covered with conformal coating.

**COMPOUND FILLED:** Transformer embedded in material filling an enclosure.

**SAND RESIN:** Transformer embedded in a mixture of sand and resin in an enclosure.

**OIL FILLED:** Liquid filled enclosure using oil as an insulator and as a cooling medium.

**SPECIAL:** Special thermal routines. (See 2TRANS Manual Page 30-31).

## THERMAL CONSIDERATIONS

OPS- Hi-Reactance Design Program

### THERMAL CONSIDERATIONS

STANDARD THERMAL PARAMETERS?

AIR FLOW RATE (LINEAR FT/MIN)? 600

MAX. ALTITUDE (THOUSANDS OF FT)? 3

RELATIVE SURFACE EMISSIVITY? .93

INSUL.THERMAL CONDUCTIVITY? .005

AVERAGE COATING THICKNESS? 2

COMP.THERMAL CONDUCTIVITY? .031

SPECIAL ENTRIES?

YOUR DESIGN IDENTIFIER? DEMO

### STANDARD THERMAL PARAMETERS -

**YES:** HIREAC uses default values for altitude, surface emissivity, and thermal conductivity.

**NO:** User enters values.

**AIR FLOW RATE:** For forced air designs enter air flow rate in linear feet per minute.

**MAX. ALTITUDE:** Enter altitude in thousands of feet. Default value is 3.3.

**RELATIVE SURFACE EMISSIVITY:** A relative measure of surface emissivity used in calculation of radiation coefficient. Default is 0.93.

**INSULATION THERMAL CONDUCTIVITY:** Average conductivity of layer and section insulation in watt-inches per inch per degree celsius. Default value is .005.

**COMP. THERMAL CONDUCTIVITY:** Conductivity of material surrounding core-coil.

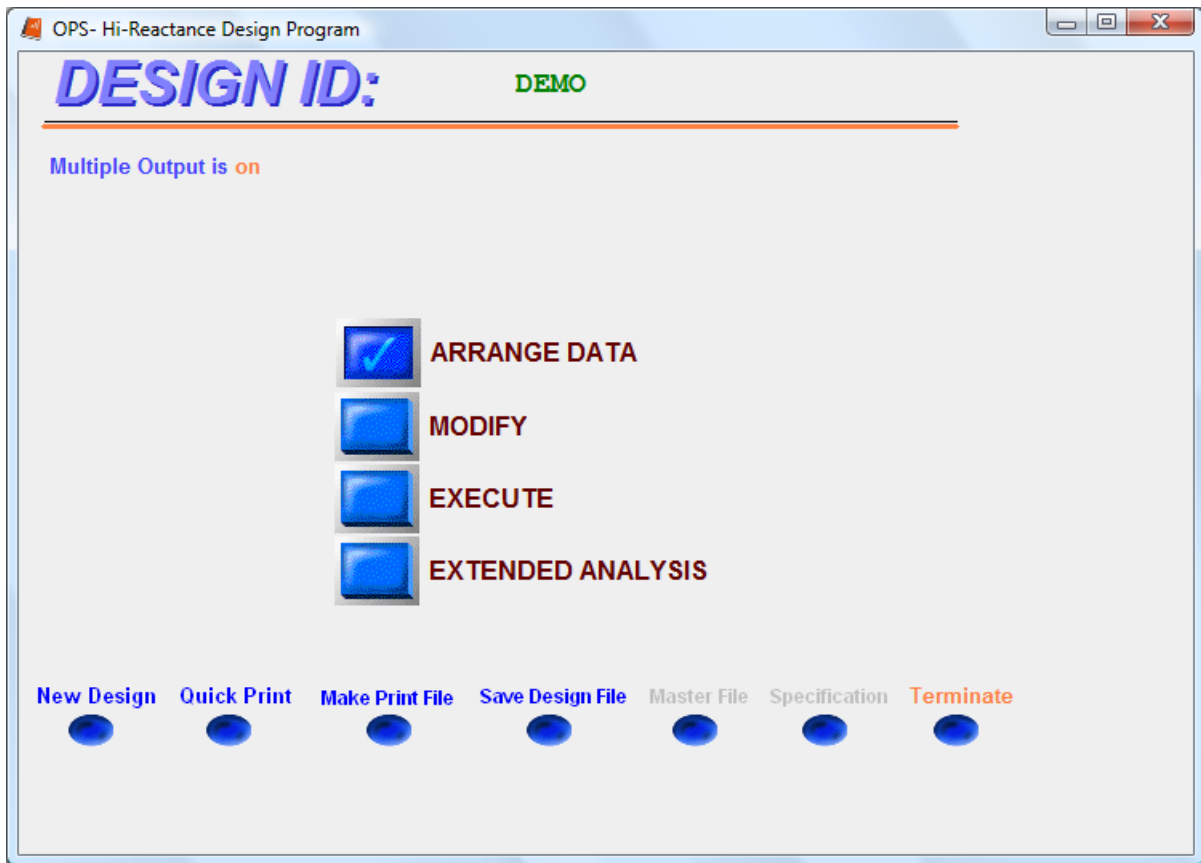
**AVERAGE COATING THICKNESS:** Average thickness of encapsulating material, compound, or sand-resin embedment.

### SPECIAL ENTRIES -

**YES:** A group of special entry options appears. (See Page 28).

**NO:** No special entries are used.

**YOUR DESIGN IDENTIFIER:** Used to identify the print-out. Enter any combinations of letters and numbers up to 16 characters.



- Select “**ARRANGE DATA**” to read input data into the program.
- Select “**MODIFY**” to modify input data.
- Select “**EXECUTE**” to run the design.
- Select “**EXTENDED ANALYSIS**” to run Extended Analysis Program  
(Only accessible after running a design.)

Navigational Buttons:

**New Design**- returns to Main Menu page.

**Quick Print** - writes current design output to notepad

**Make Print File** - saves print data to text file

**Save Design File** – creates input data file for current design

**Terminate** – exits program

## SPECIAL ENTRIES

The screenshot shows a window titled "OPS- Hi-Reactance Design Program" with a sub-header "THERMAL CONSIDERATIONS". The main content area contains the following elements:

- A question "STANDARD THERMAL PARAMETERS?" with "YES" and "NO" buttons.
- A question "SPECIAL ENTRIES?" with "YES" and "NO" buttons.
- A text input field for "YOUR DESIGN IDENTIFIER?" containing the text "DEMO".
- A "SPECIAL ENTRIES" dialog box (highlighted with an orange border) containing:
  - Two unchecked checkboxes: "WINDOW CLEARANCE" and "BUSSBAR ALLOWANCE".
  - "YES" and "NO" buttons.
  - The text "ADDITIONAL ENTRIES".
- At the bottom left, "OFF" and "ON" buttons.
- At the bottom right, two blue arrow buttons pointing left and right.

**YES** Allows user to select special entries.

**WINDOW CLEARANCE** - Program will prompt for additional clearance in the core window which will be disregarded in the build calculation.

**BUSSBAR ALLOWANCE** – Program will prompt for additional space in each winding for bussbar or leads.

## Appendix

**Type3:** side-by-side windings with magnetic shunt in space between

$CL_{S1} = (\text{Window width} - \text{ShuntLength}) \times \text{sec. proportion} - \text{net end allow}$

$CL_{P1} = (\text{Window width} - \text{ShuntLength}) \times (1 - \text{sec. proportion}) - \text{net end allow}$