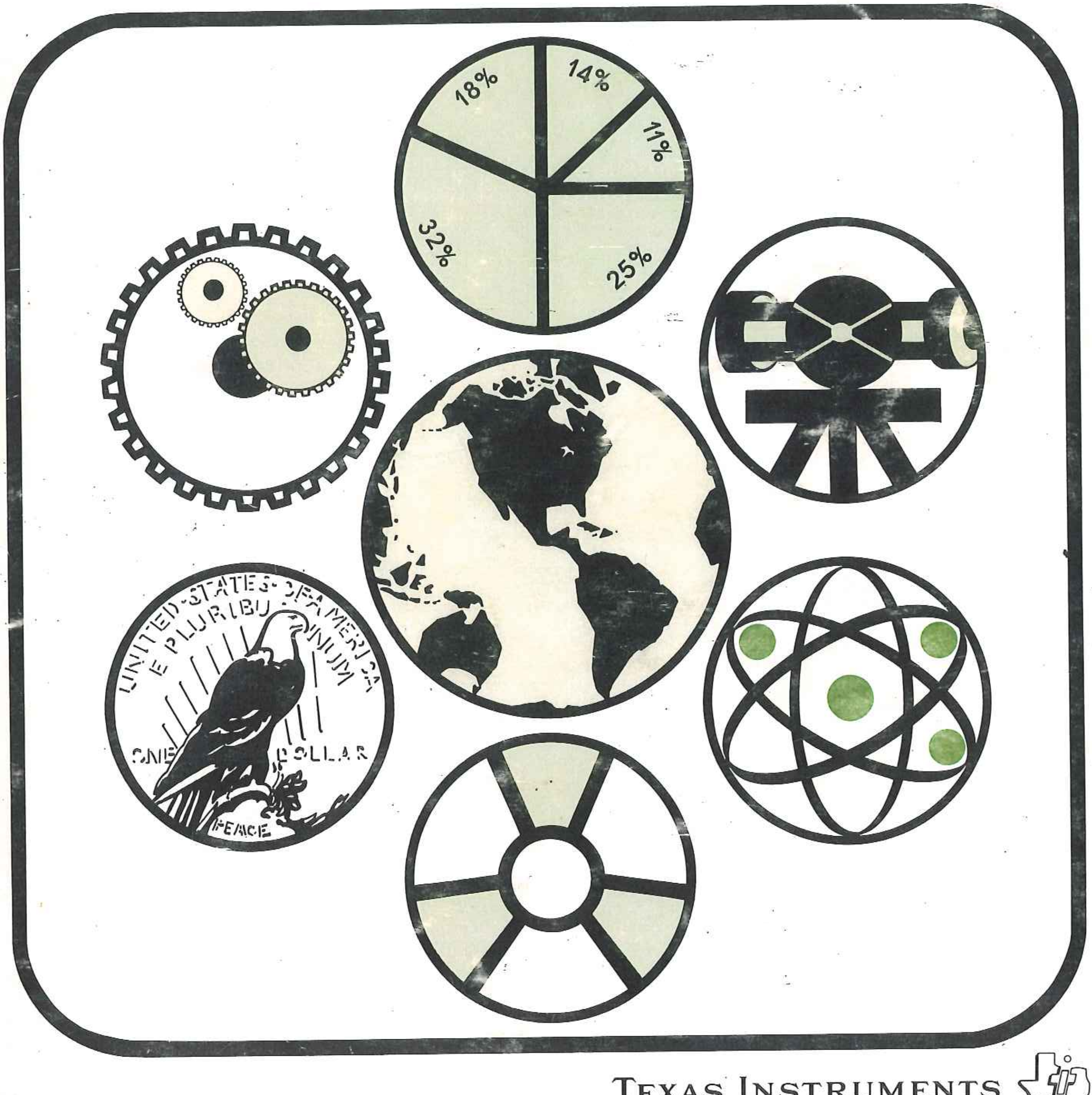
# Programmable TI 58/59 Specialty Pakettes
# Electronic Engineering



TEXAS INSTRUMENTS
INCORPORATED

# THE TI-59 PAKETTE STORY

Since the early days of handheld programmable calculators, Texas Instruments (TI) has been deeply involved in supplying not only calculators with exceptional power but also programs (software) to match. Many experts were put to work within their special fields of endeavor to design quality Software Libraries for TI calculator users. Among the Libraries produced by TI for the TI-59 are:

- Statistics
- Real Estate and Investment
- Surveying
- Navigation
- Farming
- Math/Utilities
- Aviation
- Leisure
- Business Decisions
- Securities Analysis
- Electrical Engineering
- RPN Simulator

Fully recognizing TI-59 users may require programs other than those included in TI-59 Libraries, a second program source was developed. This source, the Professional Program Exchange, gathers, compiles and redistributes programs **written by TI-59 users** who defined their own specific program needs and filled these needs by writing programs. These programs, now in Pakettes, add a new dimension to the software made available to TI-59 user. Combining some of the best TI originated programs with the most popular programs found in the Professional Program Exchange, Program Pakettes offer a true software value. Current TI Pakette offerings include:

- Securities
- Statistical Testing
- Civil Engineering
- Electronic Engineering
- Blackbody
- Oil/Gas/Energy
- Printer Utility
- Astrology
- Programming Aids
- 59 Fun
- 3-D Graphics
- Fluid Dynamics
- Mathematics
- Lab Chemistry
- Production Planning
- Marketing/Sales

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Calculator Products Division

# Submission Abstract

Program Title
CLASS "A" AMPLIFIER DESIGNED TO SPECIFIED TOLERANCES

Rev.

Abstract of Program

Biasing, load and emitter resistors are calculated for a class "A" bipolar transistor amplier. Design is constrained to a maximum allowable percent collector current variation specified by the user. Program outputs include signal power, stage minimum power gain, minimum and maximum collector currents, transistor thermal resistance, quiescent collector current, minimum and maximum junction temperatures, base-emitter voltages at Tmax and Tmin, and thevenin-Equivalent circuit values. Self-heating effects are considered and the program insures that Tmax ∠ Tjmax. An alarm is provided when the chosen transistor is unsuitable due to a small hfe min/max spread.

Original SR-52 Program by B. R. Kelso, FPO New York, N.Y.

User Benefits:

Time is saved and errors reduced by allowing the user to "plug in" transistor data sheet parameters and proceed directly to optimized design without lengthy breadboard sessions.

| | | | | |
|---|---|---|---|---|
| Category Name Electroni Eng. | Required Progs. | Prog. Steps 503 | Card Sides 3 | PC-100A Needed ☐<br>Library Module ID ☐ |

Submittal Agreement

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Submission Checklist

- ☑ Recorded Magnetic Cards
- ☑ Submission Abstract
- ☑ Program Description
- ☑ User Instructions
- ☑ Sample Problem
- ☑ Listing
- ☐
- ☐

## Program Description

Rev.

**Program Title:**
Class "A" Amplifier designed to specified tolerances

**Method, Equations, Sketches, Limitations, References, Error Recovery:**

METHOD: 1) Find the transistor's thermal resistance:

$\theta ja = (Tjmax - 25°C)/PD$

2) Find the trial minimum load resistance:

$Rli = \theta jaVcc^2/[4.4(Tjmax - Tamax)] = Rln$

3) Find the trial emitter resistance:

$R_{EI} = R_{LI} \times 10\% = R_{EN}$

4) Find the trial operating point:

$I_{CQ} = Vcc/[2(r_{LN} + R_{EN})]$

5) Find the operating point current limits:

$I_{cmax} = I_{cq} (1 + \Delta I_{cq})$ Where $\Delta I_{cq}$ = max % change

$I_{min} = I_{cq} (1 - \Delta I_{cq})$ In quiescent current

6) Find approximate maximum junction temperature:

$T_{max} = \theta_{JA} I_{cq} [Vcc - (R_{ln} + R_{en}) I_{cq}) + T_{amax}$

7) Find the actual VbeVoltage at Tmax:

$Vbex = Veelmin + \Delta Vbelog (I_{cmax}/I_1) - 0.0022 (T_{max} - 25°C)$

8) Find the minimum junction temperature:

$Tmin = \theta_{ja} I_{cmin} [Vcc - (R_{ln} + R_{en}) I_{cmin}] + T_{amin}$

9) Find the base-emitter voltage at Tmin:

$V_{ben} = V_{belmax} + \Delta V_{be} \log (I_{cmin}/I_1) - 0.0022 (Tmin - 25°C)$

10) Make a better estimate for RE:

$Re (n + 1) = [-2(V_{bex} - V_{ben})]/[I_{cmax} - I_{cmin}]$

11) Iterate beginning at Step 2 until $RE_{(n+1)} = RE_n \pm 5\%$

12) Find Thevenin - Equivalent circuit values:

$R_B = [hfe_{max} hfe_{min} [Re(n+1) (I_{cmax} - I_{cmin}) + V_{bex} - V_{ben}]/$

$[hfe_{max} I_{cmin} - hfe_{min} I_{cmax}]$

$V_{BB} = V_{ben} + I_{cmin} [R_B/hfe_{min}) + RE(n+1)]$

13) Find the biasing resistors:

$R_1 = R_B V_{CC}/V_{BB}$

☐ See Continuation Sheet

Continued From: ☑ Program Description ☐ User Instructions ☐ Stmt. of Example

Program Title: Class "A" Amplifier designed to specified tolerances - continued

Rev.

$$R_2 = R_B V_{CC} / (V_{cc} - V_{bb})$$

14) Find the stage minimum power gain:

$$A_p = [R_B R_L hfe_{min}] / [RE(R_B + hfe_{min} R_E)]$$

15) Find the stage minimum signal gain:

$$P_s = (1 - \Delta I_{CQ})^2 [V_{cc}^2 R_L / 8 (R_L + R_E)^2]$$

Limitations: This procedure regards the change in transistor base-emitter voltage as constant over a (log) decade variation in collector current. This assumption yields a very small error with careful selection of the expected operating point on the $V_{BE}/I_c$ curve; however, under very high current condition the logarithmic assumption breaks down. Also, low frequencies only.

REFERENCES: Helms, Ward J., Electronics magazine, August 8, 1974.

Terms Defined:

Icmin - Minimum collector current

Icmax - Maximum collector current

θ-ja - Transistor thermal resistance

Icq - Quiescent collector current

Tmax - Maximum junction temperature (Program insures that Tmax < Tjmax.)

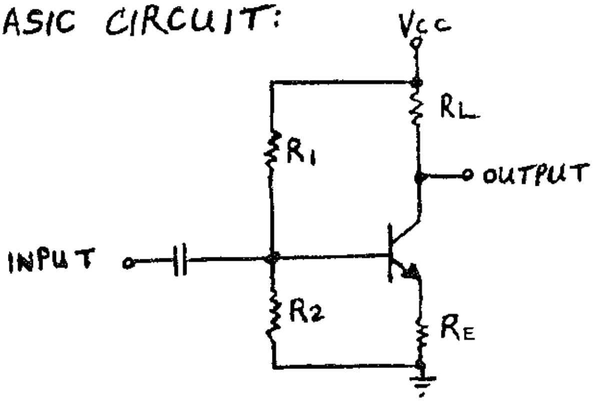
Vbex - Base-emitter voltage at Tmax

Tmin - Minimum junction temperature (With self-heating effects considered)

Vben - Base-emitter voltage at Tmin

$R_B$ and $V_{BB}$ - Thevenin-Equivalent circuit values.

BASIC CIRCUIT:



PPX-59
professional program exchange

# User Instructions

| | |
|---|---|
| **Program Title** | Class "A" Amplifier designed to Spec. Tolerances |
| Execute | |

| | | | |
|---|---|---|---|
| Partition (OP 17) | Parenthesis Levels | t Register | ☑ |
| 719 . 29 | 2 | | |
| Angular Mode (if applicable) | SBR Levels | Absolute Addresses | ☐ |
| | 0 | | |
| Library Module ID | | Disturbs Pending Operations | ☑ |

## LABELS (Op 08)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| INV | | lnx | | CE | | CLR | | x⇄t | | x² | |
| √x | | 1/x | | STO | | RCL | | SUM | | yˣ | |
| EE | | ( | | ) | | ÷ | | GTO | | X | |
| SBR | | − | | RST | | + | | R/S | | • | |
| +/− | | = | | CLR | | INV | | log | | CP | |
| tan | | Pgm | | P→R | | sin | ✓ | cos | ✓ | CMs | |
| Exc | | Prd | | \|x\| | | Eng | | Fix | | Int | |
| Deg | | Pause | | x=t | | Nop | | Op | | Rad | |
| Lbl | | x≥t | ✓ | Σ+ | ✓ | x̄ | | Grad | | St flg | |
| If flg | | D.MS | ✓ | π | ✓ | List | | Write | | Dsz | |
| Adv | | Prt | | | | | | | | | |

## USER DEFINED KEYS

A EXECUTE

| | |
|---|---|
| 0 | Ps |
| 1 | Vcc |
| 2 | Δ Icq (%) |
| 3 | Δ $V_{BE}$ |
| 4 | $V_{BEIMIN}$ |
| 5 | $V_{VBEIMAX}$ |
| 6 | $T_{JMAX}$ |
| 7 | $P_D$ at 25° C |
| 8 | $I_1$ |
| 9 | θJA |

| FLAGS 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

| STEP | PROCEDURE | ENTER | PRESS | | | OUTPUT/MODE (see legend below) |
|---|---|---|---|---|---|---|
| 1 | Enter Program Banks 1,2,3 -- Be sure to set partition to 719.29 (3 op 17) | | | | | |
| 2-13 | Choose Vcc. Regulation ≥±5%. Enter Vcc in Volts | Vcc | STO | 0 | 1 | Vcc |
| 2 | Choose the maximum allowable collector current variation, $\Delta I_{CQ}$. When $\Delta I_{CQ} \angle \pm$ 10%, power output will be poor. Enter $\Delta I_{CQ}$ in percent | $\Delta I_{CQ}(\%)$ | STO | 0 | 2 | $\Delta I_{CQ}(\%)$ |
| 4 | Using the transistors' $V_{BE}$ vs. $I_c$ curve, choose I, and 10I, such that the desired operating point is bracketed, determine $\Delta V_{BE}$ by subtracting $V_{BE}$0I, from $V_{BE}$ @10$I_1$. Enter $\Delta V_{BE}$ in volts | $\Delta V_{BE}$ | STO | 0 | 3 | $\Delta V_{BE}$ |
| 5 | From the device data sheet, determine the minimum $V_{BE}$ @ $I_1$. Enter $V_{BE\ I\ MIN}$ in Volts | $V_{BE\ I\ MIN}$ | STO | 0 | 4 | $V_{BEIMIN}$ |
| 6 | Determine the maximum $V_{BE}$ @ $I_1$. Enter $V_{BEIMAX}$ in Volts | $V_{BEI\ MAX}$ | STO | 0 | 5 | $V_{BEIMAX}$ |
| 7 | Enter $T_{JMAX}$ in °C. | $T_{JMAX}$ | STO | 0 | 6 | $T_{JMAX}$ |

## DATA REGISTERS (INV List)

| | |
|---|---|
| 10 | $R_{L1} = R_n$ |
| 11 | $R_{EI} = R_{EN}$ |
| 12 | $I_{CQ}$ |
| 13 | $I_{CMAX}$ |
| 14 | $I_{CMIN}$ |
| 15 | $T_{MAX}$ |
| 16 | $V_{BEX}$ |
| 17 | $T_{MIN}$ |
| 18 | $V_{BEN}$ |
| 19 | RE(n+1) |
| 20 | $T_{AMIN}$ |
| 21 | $T_{AMAX}$ |
| 22 | $h_{FE\ MIN}$ |
| 23 | $h_{FE\ MAX}$ |
| 24 | $R_B$ |
| 25 | $V_{BB}$ |
| 26 | $R_1$ |
| 27 | $R_2$ |
| 28 | Ap (db) |
| 9 | |

Printed only (p) Displayed Briefly ( Pause )

Continued From: ☐ Program Description ☒ User Instructions ☐ Stmt. of Example

Program Title:
Class "A" Amplifier designed to Spec. Tolerances

Rev.

| STEP | PROCEDURE | ENTER | PRESS | DISPLAY |
|---|---|---|---|---|
| | Input (Continued): | | | |
| 8 | Enter $P_D$ (at 25° C) in watts | $P_D$ | STO 07 | $P_D$ |
| 9 | Enter $I_l$ | $I_l$ | STO 08 | $I_l$ |
| 10 | Enter the design minimum ambient temperature, $T_{AMIN}$ in °C | $T_{AMIN}$ | STO 20 | $T_{AMIN}$ |
| 11 | Enter the design maximum ambient temperature, $T_{A\,MAX}$ in °C | $T_{A\,MAX}$ | STO 21 | $T_{A\,MAX}$ |
| 12 | Enter $h_{FE\,MIN}$ | $h_{FE\,MIN}$ | STO 22 | $h_{FE\,MIN}$ |
| 13 | Enter $h_{FE\,MAX}$ | $h_{FE\,MAX}$ | STO 23 | $h_{FE\,MAX}$ |

14 EXECUTE - Press A

The display will go blank, then a number (1-5) will flash (pause) followed by a value in the display. Follow instructions according to the number flashed in the display. If number is missed when it is flashed, press X≷ t to reveal number which is also put in the t register press x≷ t again and follow instructions.

| | Flashed No. | PROCEDURE | DISPLAY | ENTER | PRESS |
|---|---|---|---|---|---|
| 14a | 1 | Minimum load resistance, $R_{L\,MIN}$ is displayed. A larger number may be entered if desired. | (1) $R_{L\,MIN}$ | $R_L$ (optional) | R/S |
| 14b | 2 | Operating point for maximum output voltage swing is displayed. A different value (in amps) may be entered if desired. | (2) $I_{CQ}$ | $I_{CQ}$(optional) | R/S |
| 14c | 3 | Indicates that either the $h_{FE\,MIN/MAX}$ spread is too small or $\Delta I_{QC}$ is too small. Consider using an emitter follower for this stage or select another transistor type. | (3) flashing 9's | | CLEAR |
| 14d | 4 | Enter the standard resistor value (in ohms) nearest the displayed value | (4) R | $R_{STD}$ | R/S |
| 14e | 5 | End of execution proceed to output values | (5) 5 | Continue next step | |

Continued From: ☐ Program Description ☒ User Instructions ☐ Stmt. of Example

Program Title: CLASS "A" Amplifier Designed to Spec. Tolerances

Rev.

| STEP | PROCEDURE | ENTER | PRESS | DISPLAY |
|---|---|---|---|---|
| 15-30 | Output Values: | | | |
| 15 | Examine signal power (watts) | | RCL 00 | $P_s$ |
| 16 | Examine the stage minimum Power gain (decibels)<br>NOTE: If $A_p$ and/or $P_s$ are insufficient, add a heatsink and repeat the procedure or select a transistor with a higher $h_{FE\ MIN}$. | | RCL 28 | $A_p$ |
| 17 | Examine $R_L$ in Ohms | | RCL 10 | $R_L$ |
| 18 | Examine $R_E$ in Ohms | | RCL 19 | $R_E$ |
| 19 | Examine $R_1$ in Ohms | | RCL 26 | $R_1$ |
| 20 | Examine $R_2$ in Ohms | | RCL 27 | $R_2$ |
| 21 | Examine $I_{C\ MIN}$ (Min. Collector Current) | | RCL 14 | $I_{C\ MIN}$ |
| 22 | Examine $I_{C\ MAX}$(Max. Collector Current) | | RCL 13 | $I_{C\ MAX}$ |
| 23 | Examine $\Theta_{JA}$ (Transistor Thermal Resistance) | | RCL 09 | $\Theta_{JA}$ |
| 24 | Examine $I_{CQ}$ (Quiescent Collector Current) | | RCL 12 | $I_{CQ}$ |
| 25 | Examine $T_{MAX}$ (Max. Junction Temperature) | | RCL 15 | $T_{MAX}$ |
| 26 | Examine $V_{BEX}$ (Base-Emitter Voltage at $T_{MAX}$) | | RCL 16 | $V_{BEX}$ |
| 27 | Examine $T_{MIN}$ (min. Junction Temperature) | | RCL 17 | $T_{MIN}$ |
| 28 | Examine $V_{BEN}$ (Base-emitter Voltage at $T_{MIN}$) | | RCL 18 | $V_{BEN}$ |
| 29 | Examine $R_B$ (Thevenin equivalent) | | RCL 24 | $R_B$ |
| 30 | Examine $V_{BB}$ (Thevenin equivalent) | | RCL 25 | $V_{BB}$ |

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Calculator Products Division

## Sample Problem

**Statement of Example**

A single-stage class"A" amplifier is needed to operate from a 30-volt power supply. The maximum power output and maximum power gain must be obtained from a Texas Instruments Type TIS98 transistor over an ambient temperature range of 0°C to 70°C with a maximum quiescent-current variation of + 20%. From the transistor's data sheet, determine: $T_{max}$ = 150°C, $P_D$ = 0.36W, Δ Vbe = 0.10V from 3 to 30 MA, $V_{be1min}$ = 0.54 vat $3_{ma}$ at 25°C, $V_{ee1max}$ = 0.74 V A T 3MA at25°C, $I_1$ = 0.001A, $h_{FEEMAX}$ = 600 at 150°C at 18MA, $H_{FEMIN}$ = 100 at 80°C at 12MA.

☐ See Continuation Sheet

| ENTER | PRESS | OUTPUT/MODE (see legend below) | COMMENT |
|---|---|---|---|
| 3 | OP 1 7 | 719.  29 | Partition |
| Read card banks, 1, 2 and 3 | | | |
| 30 | STO 0 1 | 30. | Vcc |
| 20 | STO 0 2 | 20. | ΔIcq (%) |
| .1 | STO 0 3 | 0.1 | ΔVbe |
| .54 | STO 0 4 | 0.54 | $Vbe_1$MIN |
| .74 | STO 0 5 | 0.74 | $Vbe_1$MAx |
| 150 | STO 0 6 | 150. | $T_j$max |
| .36 | STO 0 7 | 0.36 | Pd |
| .001 | STO 0 8 | 0.001 | $I_1$ |
| 70 | STO 2 1 | 70. | TAmax |
| 0 | STO 2 0 | 0. | Tamin |
| 600 | STO 2 3 | 600 | Hfe Max |
| 100 | STO 2 2 | 100 | Hfe Min |
| | A | | EXECUTE |
| | | (1) 887.7840909 | RL Min (not Changed) |
| | R/S | (2) 0.01536 | Icq (not changed) |
| | R/S | (2) 0.0143453655 | Icq (not changed) |
| | R/S | (2) 0.0142624571 | |
| | R/S | (4) 120.2204612 | R -- stand, R entered |
| 120 | R/S | (5) 5 | Finished execution |

Modes: (n)*—Printed only (n)—Displayed Briefly ( Pause )
n*—Printed and displayed

☐ Over

# PPX-59 Professional Program Exchange
## Sample Problem (cont'd)

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6 5 8 0 0 1
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| ENTER | PRESS | OUTPUT/MODE (see legend below) | COMMENT |
|---|---|---|---|
| | RCL 00 | 0.0606253981 | Ps |
| | RCL 28 | 22.91777965 | Ap |
| | RCL 10 | 932.1732955 | RL |
| | RCL 19 | 120. | RE |
| | RCL 26 | 46773.39562 | $R_1$ |
| | RCL 27 | 4382.853221 | $R_2$ |
| | RCL 14 | 0.0114099657 | Icmin |
| | RCL 13 | 0.0171149485 | Icmax |
| | RCL 09 | 347.2222222 | θ JA |
| | RCL 12 | 0.0142624571 | Icq |
| | RCL 15 | 144.2836306 | Tmax |
| | RCL 16 | 0.4009135723 | Vbex |
| | RCL 17 | 71.31228539 | Tmin |
| | RCL 18 | 0.7438414059 | Vben |
| | RCL 24 | 4007.348707 | RB |
| | RCL 25 | 2.570274397 | VBB |

Modes: (n)*—Printed only (n)—Displayed Briefly ( Pause )
n*—Printed and displayed

| LOC | CODE | KEY | COMMENTS |
|---|---|---|---|
| 000 | 76 | LBL | |
| 001 | 11 | A | |
| 002 | 43 | RCL | |
| 003 | 06 | 06 | |
| 004 | 75 | - | |
| 005 | 02 | 2 | |
| 006 | 05 | 5 | |
| 007 | 95 | = | |
| 008 | 55 | ÷ | |
| 009 | 43 | RCL | |
| 010 | 07 | 07 | |
| 011 | 95 | = | |
| 012 | 42 | STO | |
| 013 | 09 | 09 | |
| 014 | 65 | × | |
| 015 | 43 | RCL | |
| 016 | 01 | 01 | |
| 017 | 33 | X² | |
| 018 | 55 | ÷ | |
| 019 | 53 | ( | |
| 020 | 04 | 4 | |
| 021 | 93 | . | |
| 022 | 04 | 4 | |
| 023 | 65 | × | |
| 024 | 53 | ( | |
| 025 | 43 | RCL | |
| 026 | 06 | 06 | |
| 027 | 75 | - | |
| 028 | 43 | RCL | |
| 029 | 21 | 21 | |
| 030 | 95 | = | |
| 031 | 32 | X⇄T | |
| 032 | 01 | 1 | |
| 033 | 66 | PAU | |
| 034 | 32 | X⇄T | |
| 035 | 91 | R/S | |
| 036 | 42 | STO | |
| 037 | 10 | 10 | |
| 038 | 65 | × | |
| 039 | 93 | . | |
| 040 | 01 | 1 | |
| 041 | 95 | = | |
| 042 | 42 | STO | |
| 043 | 11 | 11 | |
| 044 | 76 | LBL | |
| 045 | 88 | DMS | |
| 046 | 43 | RCL | |
| 047 | 11 | 11 | |
| 048 | 85 | + | |
| 049 | 43 | RCL | |
| 050 | 10 | 10 | |
| 051 | 95 | = | |
| 052 | 65 | × | |
| 053 | 02 | 2 | |
| 054 | 95 | = | |
| 055 | 35 | 1/X | |
| 056 | 65 | × | |
| 057 | 43 | RCL | |
| 058 | 01 | 01 | |
| 059 | 95 | = | |
| 060 | 32 | X⇄T | |
| 061 | 02 | 2 | |
| 062 | 66 | PAU | |
| 063 | 32 | X⇄T | |
| 064 | 91 | R/S | |
| 065 | 42 | STO | |
| 066 | 12 | 12 | |
| 067 | 43 | RCL | |
| 068 | 02 | 02 | |
| 069 | 65 | × | |
| 070 | 93 | . | |
| 071 | 00 | 0 | |
| 072 | 01 | 1 | |
| 073 | 85 | + | |
| 074 | 01 | 1 | |
| 075 | 95 | = | |
| 076 | 65 | × | |
| 077 | 43 | RCL | |
| 078 | 12 | 12 | |
| 079 | 95 | = | |
| 080 | 42 | STO | |
| 081 | 13 | 13 | |
| 082 | 43 | RCL | |
| 083 | 02 | 02 | |
| 084 | 65 | × | |
| 085 | 93 | . | |
| 086 | 00 | 0 | |
| 087 | 01 | 1 | |
| 088 | 94 | +/- | |
| 089 | 85 | + | |
| 090 | 01 | 1 | |
| 091 | 95 | = | |
| 092 | 65 | × | |
| 093 | 43 | RCL | |
| 094 | 12 | 12 | |
| 095 | 95 | = | |
| 096 | 42 | STO | |
| 097 | 14 | 14 | |
| 098 | 43 | RCL | |
| 099 | 06 | 06 | |
| 100 | 32 | X⇄T | |
| 101 | 43 | RCL | |
| 102 | 09 | 09 | |
| 103 | 65 | × | |
| 104 | 43 | RCL | |
| 105 | 12 | 12 | |
| 106 | 65 | × | |
| 107 | 53 | ( | |
| 108 | 43 | RCL | |
| 109 | 01 | 01 | |
| 110 | 75 | - | |
| 111 | 53 | ( | |
| 112 | 43 | RCL | |
| 113 | 10 | 10 | |
| 114 | 85 | + | |
| 115 | 43 | RCL | |
| 116 | 11 | 11 | |
| 117 | 54 | ) | |
| 118 | 65 | × | |
| 119 | 43 | RCL | |
| 120 | 12 | 12 | |
| 121 | 54 | ) | |
| 122 | 85 | + | |
| 123 | 43 | RCL | |
| 124 | 21 | 21 | |
| 125 | 95 | = | |
| 126 | 42 | STO | |
| 127 | 15 | 15 | |
| 128 | 22 | INV | |
| 129 | 77 | GE | |
| 130 | 39 | COS | |
| 131 | 43 | RCL | |
| 132 | 10 | 10 | |
| 133 | 65 | × | |
| 134 | 01 | 1 | |
| 135 | 93 | . | |
| 136 | 00 | 0 | |
| 137 | 05 | 5 | |
| 138 | 95 | = | |
| 139 | 42 | STO | |
| 140 | 10 | 10 | |

MERGED CODES

| | | |
|---|---|---|
| 62 Pgm Ind | 72 STO Ind | 83 GTO Ind |
| 63 Exc Ind | 73 RCL Ind | 84 Op Ind |
| 64 Prd Ind | 74 SUM Ind | 92 INV SBR |

| LOC | CODE | KEY | COMMENTS |
|---|---|---|---|
| 141 | 76 | LBL | |
| 142 | 39 | COS | |
| 143 | 43 | RCL | |
| 144 | 04 | 04 | |
| 145 | 85 | + | |
| 146 | 43 | RCL | |
| 147 | 03 | 03 | |
| 148 | 65 | × | |
| 149 | 53 | ( | |
| 150 | 43 | RCL | |
| 151 | 13 | 13 | |
| 152 | 55 | ÷ | |
| 153 | 43 | RCL | |
| 154 | 08 | 08 | |
| 155 | 54 | ) | |
| 156 | 28 | LOG | |
| 157 | 95 | = | |
| 158 | 75 | - | |
| 159 | 93 | . | |
| 160 | 00 | 0 | |
| 161 | 00 | 0 | |
| 162 | 02 | 2 | |
| 163 | 02 | 2 | |
| 164 | 65 | × | |
| 165 | 53 | ( | |
| 166 | 43 | RCL | |
| 167 | 15 | 15 | |
| 168 | 75 | - | |
| 169 | 02 | 2 | |
| 170 | 05 | 5 | |
| 171 | 54 | ) | |
| 172 | 95 | = | |
| 173 | 42 | STO | |
| 174 | 16 | 16 | |
| 175 | 32 | X:T | |
| 176 | 43 | RCL | |
| 177 | 09 | 09 | |
| 178 | 65 | × | |
| 179 | 43 | RCL | |
| 180 | 14 | 14 | |
| 181 | 65 | × | |
| 182 | 53 | ( | |
| 183 | 43 | RCL | |
| 184 | 01 | 01 | |
| 185 | 75 | - | |
| 186 | 53 | ( | |
| 187 | 43 | RCL | |
| 188 | 10 | 10 | |
| 189 | 85 | + | |
| 190 | 43 | RCL | |
| 191 | 11 | 11 | |
| 192 | 54 | ) | |
| 193 | 65 | × | |
| 194 | 43 | RCL | |
| 195 | 14 | 14 | |
| 196 | 54 | ) | |
| 197 | 85 | + | |
| 198 | 43 | RCL | |
| 199 | 20 | 20 | |
| 200 | 95 | = | |
| 201 | 42 | STO | |
| 202 | 17 | 17 | |
| 203 | 43 | RCL | |
| 204 | 05 | 05 | |
| 205 | 85 | + | |
| 206 | 43 | RCL | |
| 207 | 03 | 03 | |
| 208 | 65 | × | |
| 209 | 53 | ( | |
| 210 | 43 | RCL | |
| 211 | 14 | 14 | |
| 212 | 55 | ÷ | |
| 213 | 43 | RCL | |
| 214 | 08 | 08 | |
| 215 | 54 | ) | |
| 216 | 28 | LOG | |
| 217 | 75 | - | |
| 218 | 93 | . | |
| 219 | 00 | 0 | |
| 220 | 00 | 0 | |
| 221 | 02 | 2 | |
| 222 | 02 | 2 | |
| 223 | 65 | × | |
| 224 | 53 | ( | |
| 225 | 43 | RCL | |
| 226 | 17 | 17 | |
| 227 | 75 | - | |
| 228 | 02 | 2 | |
| 229 | 05 | 5 | |
| 230 | 54 | ) | |
| 231 | 95 | = | |
| 232 | 42 | STO | |
| 233 | 18 | 18 | |
| 234 | 77 | GE | |
| 235 | 89 | π | |
| 236 | 00 | 0 | |
| 237 | 42 | STO | |
| 238 | 19 | 19 | |
| 239 | 43 | RCL | |
| 240 | 10 | 10 | |
| 241 | 65 | × | |
| 242 | 93 | . | |
| 243 | 01 | 1 | |
| 244 | 95 | = | |
| 245 | 44 | SUM | |
| 246 | 10 | 10 | |
| 247 | 00 | 0 | |
| 248 | 42 | STO | |
| 249 | 11 | 11 | |
| 250 | 61 | GTO | |
| 251 | 88 | DMS | |
| 252 | 76 | LBL | |
| 253 | 89 | π | |
| 254 | 02 | 2 | |
| 255 | 94 | +/- | |
| 256 | 65 | × | |
| 257 | 53 | ( | |
| 258 | 43 | RCL | |
| 259 | 16 | 16 | |
| 260 | 75 | - | |
| 261 | 43 | RCL | |
| 262 | 18 | 18 | |
| 263 | 54 | ) | |
| 264 | 55 | ÷ | |
| 265 | 53 | ( | |
| 266 | 43 | RCL | |
| 267 | 13 | 13 | |
| 268 | 75 | - | |
| 269 | 43 | RCL | |
| 270 | 14 | 14 | |
| 271 | 54 | ) | |
| 272 | 95 | = | |
| 273 | 42 | STO | |
| 274 | 19 | 19 | |
| 275 | 32 | X:T | |
| 276 | 43 | RCL | |
| 277 | 11 | 11 | |
| 278 | 65 | × | |
| 279 | 01 | 1 | |
| 280 | 93 | . | |
| 281 | 00 | 0 | |
| 282 | 05 | 5 | |
| 283 | 95 | = | |
| 284 | 22 | INV | |
| 285 | 77 | GE | |
| 286 | 77 | GE | |
| 287 | 43 | RCL | |
| 288 | 11 | 11 | |
| 289 | 65 | × | |
| 290 | 93 | . | |
| 291 | 09 | 9 | |
| 292 | 05 | 5 | |
| 293 | 95 | = | |
| 294 | 77 | GE | |
| 295 | 77 | GE | |

MERGED CODES

| | | |
|---|---|---|
| 62 Pgm Ind | 72 STO Ind | 83 GTO |
| 63 Exc Ind | 73 RCL Ind | 84 Op |
| 64 Prd Ind | 74 SUM Ind | 92 INV |

| LOC | CODE | KEY | COMMENTS |
|---|---|---|---|
| 296 | 43 | RCL | |
| 297 | 10 | 10 | |
| 298 | 65 | × | |
| 299 | 93 | . | |
| 300 | 09 | 9 | |
| 301 | 08 | 8 | |
| 302 | 95 | = | |
| 303 | 22 | INV | |
| 304 | 77 | GE | |
| 305 | 78 | Σ+ | |
| 306 | 43 | RCL | |
| 307 | 23 | 23 | |
| 308 | 65 | × | |
| 309 | 43 | RCL | |
| 310 | 22 | 22 | |
| 311 | 65 | × | |
| 312 | 53 | ( | |
| 313 | 43 | RCL | |
| 314 | 19 | 19 | |
| 315 | 65 | × | |
| 316 | 53 | ( | |
| 317 | 43 | RCL | |
| 318 | 13 | 13 | |
| 319 | 75 | - | |
| 320 | 43 | RCL | |
| 321 | 14 | 14 | |
| 322 | 54 | ) | |
| 323 | 85 | + | |
| 324 | 43 | RCL | |
| 325 | 16 | 16 | |
| 326 | 75 | - | |
| 327 | 43 | RCL | |
| 328 | 18 | 18 | |
| 329 | 54 | ) | |
| 330 | 55 | ÷ | |
| 331 | 53 | ( | |
| 332 | 43 | RCL | |
| 333 | 23 | 23 | |
| 334 | 65 | × | |
| 335 | 43 | RCL | |
| 336 | 14 | 14 | |
| 337 | 75 | - | |
| 338 | 43 | RCL | |
| 339 | 22 | 22 | |
| 340 | 65 | × | |
| 341 | 43 | RCL | |
| 342 | 13 | 13 | |
| 343 | 54 | ) | |
| 344 | 95 | = | |
| 345 | 42 | STO | |
| 346 | 24 | 24 | |
| 347 | 04 | 4 | |
| 348 | 66 | PAU | |
| 349 | 32 | X⇌T | |
| 350 | 91 | R/S | |
| 351 | 42 | STO | |
| 352 | 19 | 19 | |
| 353 | 43 | RCL | |
| 354 | 18 | 18 | |
| 355 | 85 | + | |
| 356 | 43 | RCL | |
| 357 | 14 | 14 | |
| 358 | 65 | × | |
| 359 | 53 | ( | |
| 360 | 53 | ( | |
| 361 | 43 | RCL | |
| 362 | 24 | 24 | |
| 363 | 55 | ÷ | |
| 364 | 43 | RCL | |
| 365 | 22 | 22 | |
| 366 | 54 | ) | |
| 367 | 85 | + | |
| 368 | 43 | RCL | |
| 369 | 19 | 19 | |
| 370 | 95 | = | |
| 371 | 42 | STO | |
| 372 | 25 | 25 | |
| 373 | 43 | RCL | |
| 374 | 23 | 23 | |
| 375 | 55 | ÷ | |
| 376 | 43 | RCL | |
| 377 | 22 | 22 | |
| 378 | 75 | - | |
| 379 | 43 | RCL | |
| 380 | 13 | 13 | |
| 381 | 55 | ÷ | |
| 382 | 43 | RCL | |
| 383 | 14 | 14 | |
| 384 | 95 | = | |
| 385 | 29 | CP | |
| 386 | 77 | GE | |
| 387 | 38 | SIN | |
| 388 | 76 | LBL | |
| 389 | 78 | Σ+ | |
| 390 | 03 | 3 | |
| 391 | 66 | PAU | |
| 392 | 32 | X⇌T | |
| 393 | 00 | 0 | |
| 394 | 23 | LNX | |
| 395 | 91 | R/S | |
| 396 | 76 | LBL | |
| 397 | 77 | GE | |
| 398 | 43 | RCL | |
| 399 | 19 | 19 | |
| 400 | 42 | STO | |
| 401 | 11 | 11 | |
| 402 | 61 | GTO | |
| 403 | 88 | DMS | |
| 404 | 76 | LBL | |
| 405 | 38 | SIN | |
| 406 | 43 | RCL | |
| 407 | 24 | 24 | |
| 408 | 65 | × | |
| 409 | 43 | RCL | |
| 410 | 01 | 01 | |
| 411 | 55 | ÷ | |
| 412 | 43 | RCL | |
| 413 | 25 | 25 | |
| 414 | 95 | = | |
| 415 | 42 | STO | |
| 416 | 26 | 26 | |
| 417 | 43 | RCL | |
| 418 | 24 | 24 | |
| 419 | 65 | × | |
| 420 | 43 | RCL | |
| 421 | 01 | 01 | |
| 422 | 55 | ÷ | |
| 423 | 53 | ( | |
| 424 | 43 | RCL | |
| 425 | 01 | 01 | |
| 426 | 75 | - | |
| 427 | 43 | RCL | |
| 428 | 25 | 25 | |
| 429 | 95 | = | |
| 430 | 42 | STO | |
| 431 | 27 | 27 | |
| 432 | 43 | RCL | |
| 433 | 24 | 24 | |
| 434 | 65 | × | |
| 435 | 43 | RCL | |
| 436 | 10 | 10 | |
| 437 | 65 | × | |
| 438 | 43 | RCL | |
| 439 | 22 | 22 | |
| 440 | 55 | ÷ | |
| 441 | 53 | ( | |
| 442 | 43 | RCL | |
| 443 | 11 | 11 | |
| 444 | 65 | × | |
| 445 | 53 | ( | |

MERGED CODES

| | | |
|---|---|---|
| 62 Pgm Ind | 72 STO Ind | 83 GTO Ind |
| 63 Exc Ind | 73 RCL Ind | 84 Op Ind |
| 64 Prd Ind | 74 SUM Ind | 92 INV SBR |

| 6, 5 | 8, 0, 0, 1 |
|---|---|

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| LOC | CODE | KEY | COMMENTS |
|---|---|---|---|
| 446 | 43 | RCL | |
| 447 | 24 | 24 | |
| 448 | 85 | + | |
| 449 | 43 | RCL | |
| 450 | 22 | 22 | |
| 451 | 65 | × | |
| 452 | 43 | RCL | |
| 453 | 11 | 11 | |
| 454 | 95 | = | |
| 455 | 28 | LOG | |
| 456 | 65 | × | |
| 457 | 01 | 1 | |
| 458 | 00 | 0 | |
| 459 | 95 | = | |
| 460 | 42 | STO | |
| 461 | 28 | 28 | |
| 462 | 53 | ( | |
| 463 | 01 | 1 | |
| 464 | 75 | - | |
| 465 | 53 | ( | |
| 466 | 43 | RCL | |
| 467 | 02 | 02 | |
| 468 | 65 | × | |
| 469 | 93 | . | |
| 470 | 00 | 0 | |
| 471 | 01 | 1 | |
| 472 | 54 | ) | |
| 473 | 54 | ) | |
| 474 | 33 | $X^2$ | |
| 475 | 65 | × | |
| 476 | 53 | ( | |
| 477 | 43 | RCL | |
| 478 | 01 | 01 | |
| 479 | 33 | $X^2$ | |
| 480 | 65 | × | |
| 481 | 43 | RCL | |
| 482 | 10 | 10 | |
| 483 | 54 | ) | |
| 484 | 55 | ÷ | |
| 485 | 53 | ( | |
| 486 | 08 | 8 | |
| 487 | 65 | × | |
| 488 | 53 | ( | |
| 489 | 43 | RCL | |
| 490 | 10 | 10 | |
| 491 | 85 | + | |
| 492 | 43 | RCL | |
| 493 | 19 | 19 | |
| 494 | 54 | ) | |
| 495 | 33 | $X^2$ | |
| 496 | 95 | = | |
| 497 | 42 | STO | |
| 498 | 00 | 00 | |
| 499 | 05 | 5 | |
| 500 | 32 | X:T | |
| 501 | 05 | 5 | |
| 502 | 91 | R/S | |

MERGED CODES

| | | |
|---|---|---|
| 62 Pgm Ind | 72 STO Ind | 83 GTO Ind |
| 63 Exc Ind | 73 RCL Ind | 84 Op Ind |
| 64 Prd Ind | 74 SUM Ind | 92 INV SBR |

**PPX-59**
professional program exchange

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6,5 8,0,0,2
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TEXAS INSTRUMENTS
Calculator Products Division

# Submission Abstract

Program Title: RF AMPLIFIER ANALYSIS

Rev.

Abstract of Program

Given the Y - parameters of a two port network, such as a transistor used as an RF Amplifier, this program calculates the input admittance, transducer gain and Linvill's C - factor for a specified load admittance assumed to be pure conductance.

Original SR-52 Program by R. B. Formeister, Phoenix, Arizona, September 1976

User Benefits:

Provides short-cut to the design of input matching networks based on loading in collector circuit, while predicting performance and alerting the designer to possible stability problems.

| | | | | |
|---|---|---|---|---|
| Category Name Electroni Eng. | Required Progs. None | Prog. Steps 307 | Card Sides 2 | PC-100A Needed ☐<br>Library Module ID ☐ |

Submittal Agreement

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Signature ______ Date ______
Name Texas Instruments ______ Tel. No. ______
Address ______
City ______ State ______ Zip ______

Submission Checklist

- ☑ Recorded Magnetic Cards
- ☑ Submission Abstract
- ☑ Program Description
- ☑ User Instructions
- ☑ Sample Problem
- ☑ Listing
- ☐ ______
- ☐ ______

Program Title: RF Amplifier Analysis

Rev.

Method, Equations, Sketches, Limitations, References, Error Recovery:

The Linvill stability factor is computed from the equation

$$C = \frac{\left| y_{12} y_{21} \right|}{2g_{11} g_{22} - R_e(y_{12} y_{21})}$$

If C is less than unity, the device is unconditionally stable. If C is > 1, the device is potentially unstable depending on source and load admittances.

The transducer gain, $G_{oo}$, is computed from the relation that:

$$G_{oo} = \frac{c}{2} \left| \frac{y_{21}}{y_{12}} \right|$$

Since an accurate input inpedance match is usually desired, a model using the y-parameters with specified load admittance and assuming resonance is forced on the output port (real load only) has been solved for $Y_{in}$, the complex input admittance. The value found for $Y_{in}$ can than be used to design the input matching network.

The effect of source impedance on output admittance is usually small when computing $Y_{in}$. These solutions have been found to be very accurate in actual application, where

$$Bin = b_{11} + Im \left[ \frac{-y_{12} y_{21}}{g_{22} + G_L} \right]$$

$$Gin = g_{11} + Re \left[ \frac{-y_{12} y_{21}}{g_{22} + G_L} \right]$$

NOTATION

Any type of notation (floating, engineering, EE, or FIX) may be used but it must be specified in program steps 8, 9, and 10. Engineering notation is recommended and is used in sample and listing.

☐ See Continuation Sheet

**PPX-59**
professional
program exchange

# User Instructions

**Program Title**
RF Amplifier Analysis

| | | | | |
|---|---|---|---|---|
| List Input | Calc/C | Bin | Gin | Goo |

Partition (OP 17) 479 . 59 *
Parenthesis Levels 1
t Register ☑
Angular Mode (if applicable) N/A
SBR Levels 2
Absolute Addresses ☐
Library Module ID N/A
* for TI-58 319.19
Disturbs Pending Operations ☑

LABELS (Op 08)

INV __ lnx __ CE __ CLR __ x:t __ x² __
√x __ 1/x __ STO __ RCL __ SUM __ y^x __
EE __ ( __ ) __ ÷ __ GTO __ × __
SBR __ − __ RST __ + __ R/S __ . __
+/− __ = __ CLR __ INV __ log __ CP __
tan __ Pgm __ P→R __ sin __ cos __ CMs __
Exc __ Prd __ |x| __ Eng __ Fix __ Int __
Deg __ Pause __ x=t __ Nop __ Op __ Rad __
Lbl __ x≥t __ Σ+ __ x̄ __ Grad __ St flg __
If flg __ D.MS __ π __ List __ Write __ Dsz __
Adv ✓ Prt __

USER DEFINED KEYS
- A Print Input
- B Calculate/Print/
- C display Bin
- D display Gin
- E Display Goo
- A'
- B'
- C'
- D'
- E'

| FLAGS 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

| STEP | PROCEDURE | ENTER | PRESS | | | OUTPUT/MODE (see legend below) |
|---|---|---|---|---|---|---|
| 1 | Enter Program | | | | | |
| 2 | Enter Y- Parameters of device to be analyzed | G11 | STO | 0 | 1 | G11 |
| | | G12 | STO | O | 2 | G12 |
| | | G21 | STO | O | 3 | G21 |
| | | G22 | STO | O | 4 | G22 |
| | | B11 | STO | O | 5 | B11 |
| | | B12 | STO | O | 6 | B12 |
| | | B21 | STO | O | 7 | B21 |
| | | B22 | STO | O | 8 | B22 |
| 3 | Enter Load Conductance | $G_L$ | STO | O | 9 | $G_L$ |
| 4 | Print input parameters to check (with PC100A Only) | | | A | | Input parameters with labels are printed |
| 5 | Calculate, print output, display stability factor | | | B | | Stability factor (C), Bin, Gin, Goo are printed. Only C is displayed. |
| 6 | DISPLAY $B_{in}$ | | | C | | $B_{in}$ |
| 7 | DISPLAY $G_{in}$ | | | D | | $G_{in}$ |
| 8 | DISPLAY $G_{oo}$ | | | E | | $G_{oo}$ |

With printer , follow steps 1, 2, 3, 4, 5
Without printer, follow steps 1, 2, 3, 5, 6, 7, 8.

Modes: (n)*—Printed only (n)—Displayed Briefly ( Pause )
n*—Printed and displayed

DATA REGISTERS (INV List)

| | |
|---|---|
| 0 | I/o Looping |
| 1 | G11 |
| 2 | G12 |
| 3 | G21 |
| 4 | G22 |
| 5 | B11 |
| 6 | B12 |
| 7 | B21 |
| 8 | B22 |
| 9 | GL |
| 0 | G12 x G21 |
| 1 | B12 x B21 |
| 2 | R10 - R11 |
| 3 | B12 x G21 |
| 4 | G12 x B21 |
| 5 | R12 - R14 |
| 6 | C |
| 7 | Bin |
| 8 | Gin |
| 9 | Goo (DB) |

## Sample Problem

Statement of Example

Calculate the performance of a transistor whose y-parameters are:

$Y_{11}$ = 3.0 + j3.8 mmho
$Y_{12}$ = .017 - j.37 mmho
$Y_{21}$ = 57 - j32 mmho
$Y_{22}$ = .54 + j1.1 mmho

Assume a collector circuit load of 470 ohms (=$G_L$)

NOTE: Watch units of measure!

☐ See Continuation Sheet

| ENTER | PRESS | OUTPUT/MODE (see legend below) | COMMENT |
|---|---|---|---|
| 3 x $10^{-3}$ | STO 01 | 3. -03 | $G_{11}$ |
| .017 x $10^{-3}$ | STO 02 | 17. - 06 | $G_{12}$ |
| 57 x $10^{-3}$ | STO 03 | 57. - 03 | $G_{21}$ |
| .54 x $10^{-3}$ | STO 04 | 540. - 06 | $G_{22}$ |
| 3.8 x $10^{-3}$ | STO 05 | 3.8 -03 | $B_{11}$ |
| -.37 x $10^{-3}$ | STO 06 | -370. -06 | $B_{12}$ |
| -32 x $10^{-3}$ | STO 07 | -32. -03 | $B_{21}$ |
| 1.1 x $10^{-3}$ | STO 08 | 1.1 -03 | $B_{22}$ |
| 470 | 1/x | 2.1276596. -03 | |
| | STO 09 | 2.1276596. -03 | $G_L$ |
| | A | 3. -03 G11<br>17. -06 G12<br>57. -03 G21<br>540. -06 G22<br>3.8 -03 B11<br>-370. -06 B12<br>-32. -03 B21<br>1.1 -03 B22 | Print input parameters with labels |
| | B | 2.1276596-03 GL<br>1.2828109 00 C<br>11.90973 -03 BIN<br>7.0751077 -03 GIN<br>20.538394 00 GOO | Calculate, Print all output, display C only |

Mo· ·ly (n)—Displayed Briefly ( Pause )
displayed

☐ Over

# PPX-59 Professional Program Exchange
# Sample Problem (cont'd)

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| ENTER | PRESS | OUTPUT/MODE (see legend below) | COMMENT |
|---|---|---|---|
| | C | 11.90973 - 03 | $B_{in}$ |
| | E | 7.0751077 -03 | $G_{in}$ |
| | D | 20.538394 00 | $G_{oo}$ |

Modes: (n)*—Printed only (n)—Displayed Briefly ( Pause )
n*—Printed and displayed

# PPX-59 Professional Program Exchange

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6 5 8 0 0 2
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| LOC | CODE | KEY | COMMENTS |
|---|---|---|---|
| 000 | 76 | LBL | |
| 001 | 98 | ADV | |
| 002 | 22 | INV | |
| 003 | 58 | FIX | |
| 004 | 22 | INV | |
| 005 | 57 | ENG | |
| 006 | 69 | OP | |
| 007 | 04 | 04 | |
| 008 | 57 | ENG | |
| 009 | 68 | NOP | |
| 010 | 68 | NOP | |
| 011 | 73 | RC* | |
| 012 | 00 | 00 | |
| 013 | 69 | OP | |
| 014 | 20 | 20 | |
| 015 | 69 | OP | |
| 016 | 06 | 06 | |
| 017 | 92 | RTN | |
| 018 | 76 | LBL | |
| 019 | 12 | B | |
| 020 | 43 | RCL | |
| 021 | 02 | 02 | |
| 022 | 65 | × | |
| 023 | 43 | RCL | |
| 024 | 03 | 03 | |
| 025 | 95 | = | |
| 026 | 42 | STO | |
| 027 | 10 | 10 | |
| 028 | 43 | RCL | |
| 029 | 06 | 06 | |
| 030 | 65 | × | |
| 031 | 43 | RCL | |
| 032 | 07 | 07 | |
| 033 | 95 | = | |
| 034 | 42 | STO | |
| 035 | 11 | 11 | |
| 036 | 94 | +/- | |
| 037 | 85 | + | |
| 038 | 43 | RCL | |
| 039 | 10 | 10 | |
| 040 | 95 | = | |
| 041 | 42 | STO | |
| 042 | 12 | 12 | |
| 043 | 43 | RCL | |
| 044 | 06 | 06 | |
| 045 | 65 | × | |
| 046 | 43 | RCL | |
| 047 | 03 | 03 | |
| 048 | 95 | = | |
| 049 | 42 | STO | |
| 050 | 13 | 13 | |
| 051 | 43 | RCL | |
| 052 | 07 | 07 | |
| 053 | 65 | × | |
| 054 | 43 | RCL | |
| 055 | 02 | 02 | |
| 056 | 95 | = | |
| 057 | 42 | STO | |
| 058 | 14 | 14 | |
| 059 | 85 | + | |
| 060 | 43 | RCL | |
| 061 | 13 | 13 | |
| 062 | 95 | = | |
| 063 | 42 | STO | |
| 064 | 15 | 15 | |
| 065 | 43 | RCL | |
| 066 | 12 | 12 | |
| 067 | 33 | X² | |
| 068 | 85 | + | |
| 069 | 43 | RCL | |
| 070 | 15 | 15 | |
| 071 | 33 | X² | |
| 072 | 95 | = | |
| 073 | 34 | ΓX | |
| 074 | 42 | STO | |
| 075 | 16 | 16 | |
| 076 | 43 | RCL | |
| 077 | 04 | 04 | |
| 078 | 85 | + | |
| 079 | 43 | RCL | |
| 080 | 09 | 09 | |
| 081 | 95 | = | |
| 082 | 65 | × | |
| 083 | 43 | RCL | |
| 084 | 01 | 01 | |
| 085 | 75 | - | |
| 086 | 43 | RCL | |
| 087 | 10 | 10 | |
| 088 | 85 | + | |
| 089 | 43 | RCL | |
| 090 | 11 | 11 | |
| 091 | 95 | = | |
| 092 | 35 | 1/X | |
| 093 | 65 | × | |
| 094 | 43 | RCL | |
| 095 | 16 | 16 | |
| 096 | 95 | = | |
| 097 | 42 | STO | |
| 098 | 16 | 16 | |
| 099 | 43 | RCL | |
| 100 | 02 | 02 | |
| 101 | 33 | X² | |
| 102 | 85 | + | |
| 103 | 43 | RCL | |
| 104 | 06 | 06 | |
| 105 | 33 | X² | |
| 106 | 95 | = | |
| 107 | 42 | STO | |
| 108 | 19 | 19 | |
| 109 | 43 | RCL | |
| 110 | 03 | 03 | |
| 111 | 33 | X² | |
| 112 | 85 | + | |
| 113 | 43 | RCL | |
| 114 | 07 | 07 | |
| 115 | 33 | X² | |
| 116 | 95 | = | |
| 117 | 55 | ÷ | |
| 118 | 43 | RCL | |
| 119 | 19 | 19 | |
| 120 | 95 | = | |
| 121 | 34 | ΓX | |
| 122 | 55 | ÷ | |
| 123 | 02 | 2 | |
| 124 | 65 | × | |
| 125 | 43 | RCL | |
| 126 | 16 | 16 | |
| 127 | 95 | = | |
| 128 | 28 | LOG | |
| 129 | 65 | × | |
| 130 | 01 | 1 | |
| 131 | 00 | 0 | |
| 132 | 95 | = | |
| 133 | 42 | STO | |
| 134 | 19 | 19 | |
| 135 | 43 | RCL | |
| 136 | 04 | 04 | |
| 137 | 85 | + | |
| 138 | 43 | RCL | |
| 139 | 09 | 09 | |
| 140 | 95 | = | |
| 141 | 35 | 1/X | |
| 142 | 65 | × | |
| 143 | 53 | ( | |
| 144 | 43 | RCL | |
| 145 | 11 | 11 | |
| 146 | 75 | - | |
| 147 | 43 | RCL | |
| 148 | 10 | 10 | |
| 149 | 54 | ) | |
| 150 | 85 | + | |
| 151 | 43 | RCL | |
| 152 | 01 | 01 | |
| 153 | 95 | = | |

MERGED CODES

62 Pgm Ind
63 Exc Ind
64 Prd Ind
72 STO Ind
73 RCL Ind
74 SUM Ind
83 GTO Ind
84 Op Ind
92 INV SBR

# PPX-59 Professional Program Exchange

| LOC | CODE | KEY | COMMENTS |
|---|---|---|---|
| 154 | 42 | STO | |
| 155 | 18 | 18 | |
| 156 | 43 | RCL | |
| 157 | 04 | 04 | |
| 158 | 85 | + | |
| 159 | 43 | RCL | |
| 160 | 09 | 09 | |
| 161 | 95 | = | |
| 162 | 35 | 1/X | |
| 163 | 65 | × | |
| 164 | 43 | RCL | |
| 165 | 15 | 15 | |
| 166 | 95 | = | |
| 167 | 94 | +/- | |
| 168 | 85 | + | |
| 169 | 43 | RCL | |
| 170 | 05 | 05 | |
| 171 | 95 | = | |
| 172 | 42 | STO | |
| 173 | 17 | 17 | |
| 174 | 01 | 1 | |
| 175 | 06 | 6 | |
| 176 | 42 | STO | |
| 177 | 00 | 00 | |
| 178 | 01 | 1 | |
| 179 | 05 | 5 | |
| 180 | 00 | 0 | |
| 181 | 00 | 0 | |
| 182 | 00 | 0 | |
| 183 | 00 | 0 | |
| 184 | 98 | ADV | |
| 185 | 71 | SBR | |
| 186 | 98 | ADV | |
| 187 | 01 | 1 | |
| 188 | 04 | 4 | |
| 189 | 02 | 2 | |
| 190 | 04 | 4 | |
| 191 | 03 | 3 | |
| 192 | 01 | 1 | |
| 193 | 71 | SBR | |
| 194 | 98 | ADV | |
| 195 | 02 | 2 | |
| 196 | 02 | 2 | |
| 197 | 02 | 2 | |
| 198 | 04 | 4 | |
| 199 | 03 | 3 | |
| 200 | 01 | 1 | |
| 201 | 71 | SBR | |
| 202 | 98 | ADV | |
| 203 | 02 | 2 | |
| 204 | 02 | 2 | |
| 205 | 00 | 0 | |
| 206 | 01 | 1 | |
| 207 | 00 | 0 | |
| 208 | 01 | 1 | |
| 209 | 71 | SBR | |
| 210 | 98 | ADV | |
| 211 | 43 | RCL | |
| 212 | 16 | 16 | |
| 213 | 92 | RTN | |
| 214 | 76 | LBL | |
| 215 | 13 | C | |
| 216 | 43 | RCL | |
| 217 | 17 | 17 | |
| 218 | 92 | RTN | |
| 219 | 76 | LBL | |
| 220 | 14 | D | |
| 221 | 43 | RCL | |
| 222 | 18 | 18 | |
| 223 | 92 | RTN | |
| 224 | 76 | LBL | |
| 225 | 15 | E | |
| 226 | 43 | RCL | |
| 227 | 19 | 19 | |
| 228 | 92 | RTN | |
| 229 | 76 | LBL | |
| 230 | 11 | A | |
| 231 | 01 | 1 | |
| 232 | 42 | STO | |
| 233 | 00 | 00 | |
| 234 | 02 | 2 | |
| 235 | 02 | 2 | |
| 236 | 00 | 0 | |
| 237 | 02 | 2 | |
| 238 | 00 | 0 | |
| 239 | 02 | 2 | |
| 240 | 71 | SBR | |
| 241 | 98 | ADV | |
| 242 | 02 | 2 | |
| 243 | 02 | 2 | |
| 244 | 00 | 0 | |
| 245 | 02 | 2 | |
| 246 | 00 | 0 | |
| 247 | 03 | 3 | |
| 248 | 71 | SBR | |
| 249 | 98 | ADV | |
| 250 | 02 | 2 | |
| 251 | 02 | 2 | |
| 252 | 00 | 0 | |
| 253 | 03 | 3 | |
| 254 | 00 | 0 | |
| 255 | 02 | 2 | |
| 256 | 71 | SBR | |
| 257 | 98 | ADV | |
| 258 | 02 | 2 | |
| 259 | 02 | 2 | |
| 260 | 00 | 0 | |
| 261 | 03 | 3 | |
| 262 | 00 | 0 | |
| 263 | 03 | 3 | |
| 264 | 71 | SBR | |
| 265 | 98 | ADV | |
| 266 | 01 | 1 | |
| 267 | 04 | 4 | |
| 268 | 00 | 0 | |
| 269 | 02 | 2 | |
| 270 | 00 | 0 | |
| 271 | 02 | 2 | |
| 272 | 71 | SBR | |
| 273 | 98 | ADV | |
| 274 | 01 | 1 | |
| 275 | 04 | 4 | |
| 276 | 00 | 0 | |
| 277 | 02 | 2 | |
| 278 | 00 | 0 | |
| 279 | 03 | 3 | |
| 280 | 71 | SBR | |
| 281 | 98 | ADV | |
| 282 | 01 | 1 | |
| 283 | 04 | 4 | |
| 284 | 00 | 0 | |
| 285 | 03 | 3 | |
| 286 | 00 | 0 | |
| 287 | 02 | 2 | |
| 288 | 71 | SBR | |
| 289 | 98 | ADV | |
| 290 | 01 | 1 | |
| 291 | 04 | 4 | |
| 292 | 00 | 0 | |
| 293 | 03 | 3 | |
| 294 | 00 | 0 | |
| 295 | 03 | 3 | |
| 296 | 71 | SBR | |
| 297 | 98 | ADV | |
| 298 | 02 | 2 | |
| 299 | 02 | 2 | |
| 300 | 02 | 2 | |
| 301 | 07 | 7 | |
| 302 | 00 | 0 | |
| 303 | 00 | 0 | |
| 304 | 71 | SBR | |
| 305 | 98 | ADV | |
| 306 | 92 | RTN | |

MERGED CODES

62 Pgm Ind
63 Exc Ind
64 Prd Ind
72 STO Ind
73 RCL Ind
74 SUM Ind
83 GTO Ind
84 Op Ind
92 INV SBR

**PPX-59**
professional
program exchange

Page 1 of 6

6 5 | 8 0 0 3
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TEXAS INSTRUMENTS
Calculator Products Division

# Submission Abstract

Program Title
BIPOLAR JUNCTION TRANSISTOR ANALYSIS

Rev.

Abstract of Program

This program calculates the emitter bypass and coupling capacitors for a B.J.T. circuit. The program is designed for a low frequency analysis. The capacitors are found using pole zero cancellation.

Original SR-52 Program by Alan Charbonneau, San Luis Obispo, California, Sept. 1976.

User Benefits:

This program allows the user to vary circuit parameters and quickly determine the effect on the biasing capacitors.

| | | | | |
|---|---|---|---|---|
| Category Name Electronic Eng. | Required Progs. None | Prog. Steps 282 | Card Sides 2 | PC-100A Needed ☐<br>Library Module ID ☐ |

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Signature ____ Date ____
Name Texas Instruments Tel. No. ____
Address ____
City ____ State ____ Zip ____

Submission Checklist

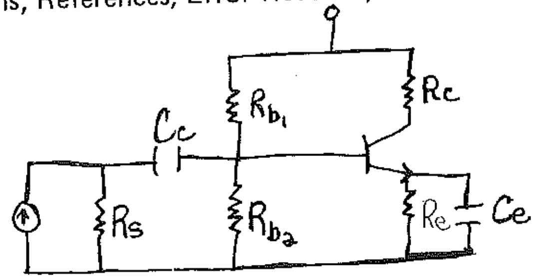
- ☑ Recorded Magnetic Cards
- ☑ Submission Abstract
- ☑ Program Description
- ☑ User Instructions
- ☑ Sample Problem
- ☑ Listing
- ☐
- ☐

## Program Description

Program Title:
Bipolar Junction Transistor Analysis

Rev.

Method, Equations, Sketches, Limitations, References, Error Recovery:



In order to solve for the values of the coupling capacitors (Cc, Ce), $R_{b1}$ $R_{b2}$, Rc, Re, Rs, $h_{ie}$, $h_{fe}$ and the lower cutoff frequency (fL) (in Hz) desired must all be known. These equations only apply for a low frequency analysis.

$$R_B = \frac{(R_{B_1})(R_{B_2})}{(R_B + R_{B_1})} \qquad Rs' = \frac{(Rs)(RB)}{(Rs + R_B)} \qquad R_\square = Rs + \frac{(R_B)(h_{ie})}{(R_B + h_{ie})}$$

$$B = \frac{R_B + h_{ie} + R_e(hfe+1)}{R_B + h_{ie}} \qquad K = \frac{R_s' + h_{ie} + R_e(h_{fe}+1)}{Rs' + h_{ie}}$$

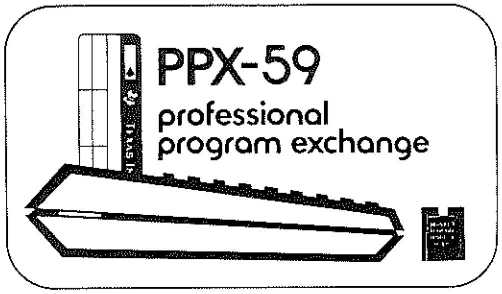
$$\frac{f_e = (B-1)f_L}{B(K-1)} \qquad f_\square = \frac{f_L}{B} = \frac{1}{R_\square C_c}$$

$$C_c = \frac{1}{2\pi f_\square R_\square} \qquad C_e \ \frac{1}{2\pi f_e R_E}$$

References: L. F. Amplifier Notes. Calif. Polytechnic St. Univ. (San Luis Obispo)

Any type of notation (Floating, Engineering, EE, or FIX) may be used but it must be specified in program steps 8, 9 and 10. Engineering notation is recommended and is used in sample and listing.

☐ See Continuation Sheet



# User Instructions

**Program Title** Bipolar Junction Transistor Analysis

| | | | | |
|---|---|---|---|---|
| $R_{B2}$ | $R_e$ | $f_L$ | $h_{fe}$ | $C_E$ |
| $R_{al}$ | $R_c$ | $R_s$ | $h_{ie}$ | $C_c$ |

Partition (OP 17) 479 , 59*

Parenthesis Levels 3

t Register ☑

Angular Mode (if applicable) n/a

SBR Levels 1

Absolute Addresses ☐

Library Module ID n/a

*for TI-58 319.19

Disturbs Pending Operations ☑

LABELS (Op 08)

| | | | | | |
|---|---|---|---|---|---|
| INV | lnx | CE | CLR | x:t | x² |
| √x | 1/x | STO | RCL | SUM | yˣ |
| EE | ( | ) | ÷ | GTO | × |
| SBR | − | RST | + | R/S | • |
| +/− | = | CLR | INV | log | CP |
| tan | Pgm | P→R | sin | cos | CMs |
| Exc | Prd | \|x\| | Eng | Fix | Int |
| Deg | Pause | x=t | Nop | Op | Rad |
| Lbl | x≥t | Σ+ | x̄ | Grad | St flg |
| If flg | D.MS | π | List | Write | Dsz |
| Adv | Prt ✓ | | | | |

USER DEFINED KEYS

| | |
|---|---|
| A | Enter $R_{Bl}$ |
| B | Enter $R_c$ |
| C | Enter $R_s$ |
| D | Enter $h_{ie}$ |
| E | Displays $C_c$ |
| A' | Enter $R_{B2}$ |
| B' | Enter $R_e$ |
| C' | Enter $f_L$ |
| D' | Enter $h_{fe}$ |
| E' | Displays $C_e$ |

| FLAGS 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

| STEP | PROCEDURE | ENTER | PRESS | OUTPUT/MODE (see legend below) |
|---|---|---|---|---|
| 1 | Enter Program | | | |
| 2 | Enter $R_{Bl}$ | $R_{Bl}$ | A | $R_{Bl}$ |
| 3 | Enter $R_{B2}$ | $R_{B2}$ | *A | $R_{B2}$ All output displayed and printed. |
| 4 | Enter $R_c$ | $R_c$ | B | $R_c$ |
| 5 | Enter $R_e$ | $R_e$ | *B | $R_e$ |
| 6 | Enter $R_s$ | $R_s$ | C | $R_s$ |
| 7 | Enter $f_L$ (Cutoff freq.) | $f_L$ | *C | $f_L$ |
| 8 | Enter $h_{ie}$ | $h_{ie}$ | D | $h_{ie}$ |
| 9 | Enter $h_{fe}$ | $h_{fe}$ | *D | $h_{fe}$ |
| 10 | Press E to solve for $C_c$ | | E | $C_c$ |
| 11 | Press *E to solve for $C_e$ | | *E | $C_e$ |

Steps 2-9 may be executed in any order desired and can be changed after the program has been run individually.
Step 11 must always follow step 10 and this must be repeated for each variable change.
If program will be used exclusively with a printer, Step 201 can be changed from GTO to SBR. It is then only necessary to press E for output. *E' will then be executed automatically after E.

Modes: (n)*—Printed only (n)—Displayed Briefly ( Pause )
n*—Printed and displayed

☐ See Continuation Sheet

DATA REGISTERS (INV List)

| | |
|---|---|
| 0 | |
| 1 | $R_{Bl}$ |
| 2 | $R_{B2}$ |
| 3 | $R_c$ |
| 4 | $R_E$ |
| 5 | $R_s$ |
| 6 | $f_L$ |
| 7 | $h_{ie}$ |
| 8 | $h_{fe}$ |
| 9 | $R_B$ |
| 10 | B |
| 11 | $R_s$ |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |

# Sample Problem

Statement of Example

Given Circuit Parameters:

$R_{B1}$ = 150k$\Omega$
$R_{B2}$ = 39k$\Omega$
$R_c$ = 5.6k$\Omega$
$R_e$ = 2.2k$\Omega$
$h_{fe}$ = 80
$h_{ie}$ = 1.3k$\Omega$
$f_L$ = 250H
$R_s$ = 4.7k$\Omega$

Each parameter may be varied by choosing the appropriate user defined key.

☐ See Continuation Sheet

| ENTER | PRESS | OUTPUT/MODE (see legend below) | COMMENT |
|---|---|---|---|
| 150 x $10^3$ | A | 150.03 RB1 | Enter $R_{B1}$ |
| 39 x $10^3$ | 2nd A' | 39.03 RB2 | Enter $R_{B2}$ |
| 5.6 x $10^3$ | B | 5.6 03 RC | Enter $R_c$ |
| 2.2 x $10^3$ | 2nd B' | 2.2 03 RE | Enter $R_e$ |
| 4.7 x $10^3$ | C | 4.7 03 RS | Enter $R_s$ |
| 250 | 2nd C' | 250. 00 FL | Enter $F_L$ |
| 1.3 x $10^3$ | D | 1.3 03 HIE | Enter $H_{ie}$ |
| 80 | 2nd D' | 80. 00 HFE | Enter $H_{fe}$ |
|  | E | 698.44205-09 CC | $C_c$ calculated |
|  | 2nd E' | 11.318692-06 CE | $C_e$ calculated |
|  |  |  | All values printed and displayed. |

Modes: (n)*—Printed only (n)—Displayed Briefly ( Pause )
n*—Printed and displayed

☐ Over

# PPX-59 Professional Program Exchange

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6 5 8 0 0 3

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| LOC | CODE | KEY | COMMENTS |
|---|---|---|---|
| 000 | 76 | LBL | |
| 001 | 99 | PRT | |
| 002 | 22 | INV | |
| 003 | 57 | ENG | |
| 004 | 22 | INV | |
| 005 | 58 | FIX | |
| 006 | 69 | OP | |
| 007 | 04 | 04 | |
| 008 | 57 | ENG | |
| 009 | 68 | NOP | |
| 010 | 68 | NOP | |
| 011 | 32 | X:T | |
| 012 | 69 | OP | |
| 013 | 06 | 06 | |
| 014 | 92 | RTN | |
| 015 | 76 | LBL | |
| 016 | 11 | A | |
| 017 | 42 | STO | |
| 018 | 01 | 01 | |
| 019 | 32 | X:T | |
| 020 | 03 | 3 | |
| 021 | 05 | 5 | |
| 022 | 01 | 1 | |
| 023 | 04 | 4 | |
| 024 | 00 | 0 | |
| 025 | 02 | 2 | |
| 026 | 61 | GTO | |
| 027 | 99 | PRT | |
| 028 | 76 | LBL | |
| 029 | 16 | A' | |
| 030 | 42 | STO | |
| 031 | 02 | 02 | |
| 032 | 32 | X:T | |
| 033 | 03 | 3 | |
| 034 | 05 | 5 | |
| 035 | 01 | 1 | |
| 036 | 04 | 4 | |
| 037 | 00 | 0 | |
| 038 | 03 | 3 | |
| 039 | 61 | GTO | |
| 040 | 99 | PRT | |
| 041 | 76 | LBL | |
| 042 | 12 | B | |
| 043 | 42 | STO | |
| 044 | 03 | 03 | |
| 045 | 32 | X:T | |
| 046 | 03 | 3 | |
| 047 | 05 | 5 | |
| 048 | 01 | 1 | |
| 049 | 05 | 5 | |
| 050 | 00 | 0 | |
| 051 | 00 | 0 | |
| 052 | 61 | GTO | |
| 053 | 99 | PRT | |
| 054 | 76 | LBL | |
| 055 | 17 | B' | |
| 056 | 42 | STO | |
| 057 | 04 | 04 | |
| 058 | 32 | X:T | |
| 059 | 03 | 3 | |
| 060 | 05 | 5 | |
| 061 | 01 | 1 | |
| 062 | 07 | 7 | |
| 063 | 00 | 0 | |
| 064 | 00 | 0 | |
| 065 | 61 | GTO | |
| 066 | 99 | PRT | |
| 067 | 76 | LBL | |
| 068 | 13 | C | |
| 069 | 42 | STO | |
| 070 | 05 | 05 | |
| 071 | 32 | X:T | |
| 072 | 03 | 3 | |
| 073 | 05 | 5 | |
| 074 | 03 | 3 | |
| 075 | 06 | 6 | |
| 076 | 00 | 0 | |
| 077 | 00 | 0 | |
| 078 | 61 | GTO | |
| 079 | 99 | PRT | |
| 080 | 76 | LBL | |
| 081 | 18 | C' | |
| 082 | 42 | STO | |
| 083 | 06 | 06 | |
| 084 | 32 | X:T | |
| 085 | 02 | 2 | |
| 086 | 01 | 1 | |
| 087 | 02 | 2 | |
| 088 | 07 | 7 | |
| 089 | 00 | 0 | |
| 090 | 00 | 0 | |
| 091 | 61 | GTO | |
| 092 | 99 | PRT | |
| 093 | 76 | LBL | |
| 094 | 14 | D | |
| 095 | 42 | STO | |
| 096 | 07 | 07 | |
| 097 | 32 | X:T | |
| 098 | 02 | 2 | |
| 099 | 03 | 3 | |
| 100 | 02 | 2 | |
| 101 | 04 | 4 | |
| 102 | 01 | 1 | |
| 103 | 07 | 7 | |
| 104 | 61 | GTO | |
| 105 | 99 | PRT | |
| 106 | 76 | LBL | |
| 107 | 19 | D' | |
| 108 | 42 | STO | |
| 109 | 08 | 08 | |
| 110 | 32 | X:T | |
| 111 | 02 | 2 | |
| 112 | 03 | 3 | |
| 113 | 02 | 2 | |
| 114 | 01 | 1 | |
| 115 | 01 | 1 | |
| 116 | 07 | 7 | |
| 117 | 61 | GTO | |
| 118 | 99 | PRT | |
| 119 | 76 | LBL | |
| 120 | 15 | E | |
| 121 | 43 | RCL | |
| 122 | 01 | 01 | |
| 123 | 65 | × | |
| 124 | 43 | RCL | |
| 125 | 02 | 02 | |
| 126 | 55 | ÷ | |
| 127 | 53 | ( | |
| 128 | 43 | RCL | |
| 129 | 01 | 01 | |
| 130 | 85 | + | |
| 131 | 43 | RCL | |
| 132 | 02 | 02 | |
| 133 | 54 | ) | |
| 134 | 95 | = | |
| 135 | 42 | STO | |
| 136 | 09 | 09 | |
| 137 | 85 | + | |
| 138 | 43 | RCL | |
| 139 | 07 | 07 | |
| 140 | 85 | + | |
| 141 | 43 | RCL | |
| 142 | 04 | 04 | |
| 143 | 65 | × | |
| 144 | 53 | ( | |
| 145 | 43 | RCL | |
| 146 | 08 | 08 | |
| 147 | 85 | + | |
| 148 | 01 | 1 | |
| 149 | 54 | ) | |
| 150 | 95 | = | |
| 151 | 55 | ÷ | |
| 152 | 53 | ( | |
| 153 | 43 | RCL | |
| 154 | 09 | 09 | |

MERGED CODES

| | | | |
|---|---|---|---|
| 62 Pgm Ind | 72 STO Ind | 83 GTO Ind | |
| 63 Exc Ind | 73 RCL Ind | 84 Op Ind | |
| 64 Prd Ind | 74 SUM Ind | 92 INV SBR | |

| LOC | CODE | KEY | COMMENTS |
|---|---|---|---|
| 155 | 85 | + | |
| 156 | 43 | RCL | |
| 157 | 07 | 07 | |
| 158 | 54 | ) | |
| 159 | 95 | = | |
| 160 | 42 | STD | |
| 161 | 10 | 10 | |
| 162 | 55 | ÷ | |
| 163 | 53 | ( | |
| 164 | 53 | ( | |
| 165 | 53 | ( | |
| 166 | 43 | RCL | |
| 167 | 09 | 09 | |
| 168 | 65 | × | |
| 169 | 43 | RCL | |
| 170 | 07 | 07 | |
| 171 | 54 | ) | |
| 172 | 55 | ÷ | |
| 173 | 53 | ( | |
| 174 | 43 | RCL | |
| 175 | 09 | 09 | |
| 176 | 85 | + | |
| 177 | 43 | RCL | |
| 178 | 07 | 07 | |
| 179 | 54 | ) | |
| 180 | 85 | + | |
| 181 | 43 | RCL | |
| 182 | 05 | 05 | |
| 183 | 54 | ) | |
| 184 | 65 | × | |
| 185 | 02 | 2 | |
| 186 | 65 | × | |
| 187 | 89 | π | |
| 188 | 65 | × | |
| 189 | 43 | RCL | |
| 190 | 06 | 06 | |
| 191 | 54 | ) | |
| 192 | 95 | = | |
| 193 | 32 | X¦T | |
| 194 | 01 | 1 | |
| 195 | 05 | 5 | |
| 196 | 01 | 1 | |
| 197 | 05 | 5 | |
| 198 | 00 | 0 | |
| 199 | 00 | 0 | |
| 200 | 98 | ADV | |
| 201 | 61 | GTD | |
| 202 | 99 | PRT | |
| 203 | 76 | LBL | |
| 204 | 10 | E' | |
| 205 | 43 | RCL | |
| 206 | 05 | 05 | |
| 207 | 65 | × | |
| 208 | 43 | RCL | |
| 209 | 09 | 09 | |
| 210 | 55 | ÷ | |
| 211 | 53 | ( | |
| 212 | 43 | RCL | |
| 213 | 05 | 05 | |
| 214 | 85 | + | |
| 215 | 43 | RCL | |
| 216 | 09 | 09 | |
| 217 | 54 | ) | |
| 218 | 95 | = | |
| 219 | 42 | STD | |
| 220 | 11 | 11 | |
| 221 | 85 | + | |
| 222 | 43 | RCL | |
| 223 | 07 | 07 | |
| 224 | 85 | + | |
| 225 | 43 | RCL | |
| 226 | 04 | 04 | |
| 227 | 65 | × | |
| 228 | 53 | ( | |
| 229 | 43 | RCL | |
| 230 | 08 | 08 | |
| 231 | 85 | + | |
| 232 | 01 | 1 | |
| 233 | 54 | ) | |
| 234 | 95 | = | |
| 235 | 55 | ÷ | |
| 236 | 53 | ( | |
| 237 | 43 | RCL | |
| 238 | 11 | 11 | |
| 239 | 85 | + | |
| 240 | 43 | RCL | |
| 241 | 07 | 07 | |
| 242 | 54 | ) | |
| 243 | 95 | = | |
| 244 | 75 | - | |
| 245 | 01 | 1 | |
| 246 | 95 | = | |
| 247 | 65 | × | |
| 248 | 43 | RCL | |
| 249 | 10 | 10 | |
| 250 | 95 | = | |
| 251 | 55 | ÷ | |
| 252 | 53 | ( | |
| 253 | 43 | RCL | |
| 254 | 04 | 04 | |
| 255 | 65 | × | |
| 256 | 53 | ( | |
| 257 | 43 | RCL | |
| 258 | 10 | 10 | |
| 259 | 75 | - | |
| 260 | 01 | 1 | |
| 261 | 54 | ) | |
| 262 | 65 | × | |
| 263 | 43 | RCL | |
| 264 | 06 | 06 | |
| 265 | 65 | × | |
| 266 | 02 | 2 | |
| 267 | 65 | × | |
| 268 | 89 | π | |
| 269 | 54 | ) | |
| 270 | 95 | = | |
| 271 | 32 | X¦T | |
| 272 | 01 | 1 | |
| 273 | 05 | 5 | |
| 274 | 01 | 1 | |
| 275 | 07 | 7 | |
| 276 | 00 | 0 | |
| 277 | 00 | 0 | |
| 278 | 71 | SBR | |
| 279 | 99 | PRT | |
| 280 | 98 | ADV | |
| 281 | 92 | RTN | |

MERGED CODES

62 Pgm Ind
63 Exc Ind
64 Prd Ind
72 STO Ind
73 RCL Ind
74 SUM Ind
83 GTO
84 Op
92 INV

**PPX-59**
**professional program exchange**

Page 1 of 8

6,5 8,0,0,4
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TEXAS INSTRUMENTS
Calculator Products Division

# Submission Abstract

| Program Title | Rev. |
|---|---|
| POWER SUPPLY FILTER DESIGN | |

**Abstract of Program**

Calculates the value of filter capacitor, load resistance, average output voltage, minimum and maximum output voltage for both full- and half-wave rectifier circuits. User specifies line frequency, secondary voltage, rectifier voltage drop, maximum desired ripple and maximum load current.

Original SR-52 Program by B. R. Kelso, FPO New York, N.Y.

**User Benefits:**

Rapid component selection and guaranteed maximum ripple.

| | | | | |
|---|---|---|---|---|
| Category Name Electroni Eng. | Required Progs. | Prog. Steps 322 | Card Sides 2 | PC-100A Needed ☐<br>Library Module ID ☐ |

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Signature ______ Date ______
Name Texas Instruments ______ Tel. No. ______
Address ______
City ______ State ______ Zip ______

**Submission Checklist**

- ☑ Recorded Magnetic Cards
- ☑ Submission Abstract
- ☑ Program Description
- ☑ User Instructions
- ☑ Sample Problem
- ☑ Listing
- ☐ ______
- ☐ ______

Program Title: Power Supply Filter Design

Rev.

Method, Equations, Sketches, Limitations, References, Error Recovery:

This procedure makes the assumption that the transformer (fig. 1) will be operated within its design limits. First, peak secondary voltage is found based on the secondary's nominal RMS rating:

$$E_O(pk) = \sqrt{2}\, V_S$$

where $V_s$ is the secondary voltage (RMS). Next, the load resistance is calculated:

$$R_L = E_O\,(pk)/I_L$$

Where $I_L$ is the maximum load current. Next, $t_{(a\text{-}c)}$ is found (fig. 2)

$$t_{(a\text{-}c)} = (1/f_L)/2 \text{ for full-wave circuits, or}$$

$$t_{(a\text{-}c)} = 1/f_L \text{ for half-wave circuits, where } f_L$$

is the primary line frequency. Next, the ripple frequency f is found:

$$f = 1/t_{(a\text{-}c)}$$

Next, the ripple factor is calculated:

$$f_r = e_r/100$$

where $e_r$ is the maximum ripple in percent. Next, $t_{(d\text{-}b)}$ is found:

$$t_{(d\text{-}b)} = \text{arc sin } (E_O\,(pk) - f_r E_O\,(pk))/E_O\,(pk)/2\pi f_L$$

Next, $t_{(a\text{-}b)}$ is found:

$$t_{(a\text{-}b)} = (1/f_L)/4 + t_{(d\text{-}b)} \text{ for full-wave circuits, or}$$

$$t_{(a\text{-}b)} = 3((1/f_L)/4) + t_{(d\text{-}b)} \text{ for half-wave circuits.}$$

Next, the capacitor value is found:

$$C = t_{(a\text{-}b)}/R_L \ln(1/(1-f_r))$$

Next, the average output voltage is found:

$$E_O\,(avg) = (E_O\,(pk) - f_r\, E_O\,(pk) + E_O\,(pk))/2$$

Next, the minimum output voltage is found:

$$E_O\,(min) = f_r E_O\,(pk)$$

☐ See Continuation Shee

Continued From: ☒ Program Description ☐ User Instructions ☐ Stmt. of Example

Program Title: POWER SUPPLY FILTER DESIGN

Rev.

Reference: Cogburn, Onis J., "Power Supply Design Made Fast and Simple", Electronics magazine, August 30, 1973

Figure 1: Basic Circuit

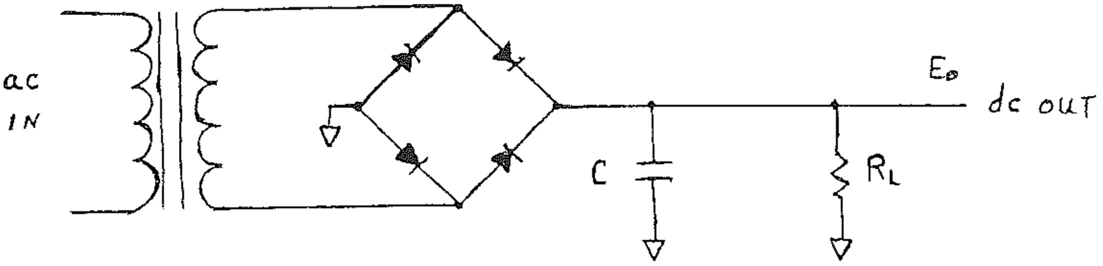
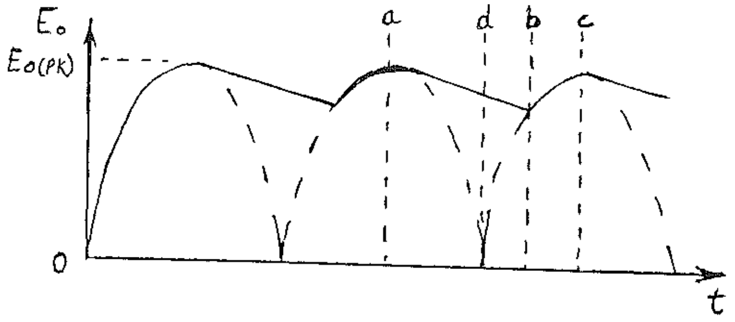


Figure 2: Output Waveform



Limitations:

1. Procedure valid only when the transformer is operated within its design limits.
2. Rectifier forward voltage drop must be doubled before entering if a full-wave bridge circuit is used.

NOTATION:

Any type of notation (floating, ENGineering, EE or FIX) may be used but it must be specified in program steps 8, 9 and 10. ENGineering notation is recommended and is used in sample and listing.

Page 4 of 8 | 6 5 | 8 0 0 4

**PPX-59**
**professional program exchange**

# User Instructions

| | | | | |
|---|---|---|---|---|
| **Program Title** Power Supply Filter Design | | | | |
| Full Wave | Half Wave | Display | | |
| $f_L$ | $V_s$ | $V_d$ | max. rip | $I_L$ |

Partition (OP 17) 479 . 59
Parenthesis Levels 1
t Register ☑
Angular Mode (if applicable) RAD
SBR Levels 1
Absolute Addresses ☐
Library Module ID N/A
Disturbs Pending Operations ☑

LABELS (Op 08)

| | | | | | |
|---|---|---|---|---|---|
| INV | lnx | CE | CLR | x⇌t | x² |
| √x | 1/x | STO | RCL | SUM | yˣ |
| EE | ( | ) | ÷ | GTO | × |
| SBR | − ✓ | RST | + ✓ | R/S | . |
| +/− | = | CLR | INV | log ✓ | CP |
| tan | Pgm | P→R | sin ✓ | cos | CMs |
| Exc | Prd | \|x\| | Eng | Fix | Int |
| Deg | Pause | x=t | Nop | Op | Rad |
| Lbl | x≥t | Σ+ | x̄ | Grad | St flg |
| If flg | D.MS | π | List | Write | Dsz |
| Adr ✓ | Prt | | | | |

USER DEFINED KEYS

- A Line Frequency
- B Secondary Voltage
- C Rectifier Drop
- D Max. Ripple (%)
- E Maximum Load
- A' Full Wave/Execute
- B' Half Wave/Execute
- C' Display Results
- D'
- E'

| FLAGS | Full Wave 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|

| STEP | PROCEDURE | ENTER | PRESS | OUTPUT/MODE (see legend below) |
|---|---|---|---|---|
| 1 | Enter Program | | | |
| 2 | Enter line frequency (Hz) | $f_L$ | A | $f_L$ |
| 3 | Enter secondary voltage (rms) | $v_s$ | B | $v_s$ |
| 4 | Enter rectifier voltage drop (volts). Double this value if a bridge is used. | $V_d$ | C | $V_d$ |
| 5 | Enter maximum desired ripple in percent. ≈ 20% gives the greatest filtering action with the smallest capacitor value. | $c_r(\%)$ | D | $e_r(\%)$ |
| 6 | Enter maximum load current | $I_L$ | E | $I_L$ |
| 7a | Execute for full wave | | 2nd A | All output is printed with labels |
| or 7b | Execute for half wave | | 2nd B | All output is printed with labels |
| | If printer unavailable - DISPLAY ROUTINE: | | | PAUSE DISPLAYED |
| 8 | Examine capacitor value (farads) | | 2nd C | (1) C |
| 9 | Examine resistor value (ohms) | | R/S | (2) $R_L$ |
| 10 | Examine average output (volts) | | R/S | (3) $E_{o(avg)}$ |
| 11 | Examine peak output (volts) | | R/S | (4) $E_{o(pk)}$ |
| 12 | Examine minimum output (volts) | | R/S | (5) $E_{o(min)}$ |
| | Steps 2-6 may be executed in any order. | | | |

DATA REGISTERS (INV List)

| | |
|---|---|
| 0 | |
| 1 | $f_L$ |
| 2 | $v_s$ |
| 3 | $V_d$ |
| 4 | $E_r$ |
| 5 | $I_L$ |
| 6 | $E_{o(pk)}$ |
| 7 | $R_L$ |
| 8 | f |
| 9 | $f_r$ |
| 0 | C |
| 1 | $E_{o(avg)}$ |
| 2 | $t_{(d-b)}$ |
| 3 | $t_{(a-b)}$ |
| 4 | $E_{o(min)}$ |
| 5 | |
| 6 | |
| 7 | |
| 8 | |

## Sample Problem

**Statement of Example**

Design an unregulated full-wave bridge power supply which will provide 3 amps current from a transformer with a 24 vac secondary. Ripple must not be greater than 15% at full load. The primary line frequency is 60 Hz and each rectifier drops 0.65v when conducting.

Change to Radian Mode

☐ See Continuation Sheet

| ENTER | PRESS | OUTPUT/MODE (see legend below) | | COMMENT |
|---|---|---|---|---|
| 60 | A | 60.00 | FL | Line Frequency |
| 24 | B | 24.00 | VS | Secondary volts |
| 1.3 | C | 1.300 | VD | Rectifier drop X 2 |
| 15 | D | 15.00 | %ER | Ripple (%) |
| 3 | E | 3.00 | IL | Load Current |
| | | Printed and Displayed | | |
| | 2nd A | FULL WAVE | | Full Wave Output |
| | | 3.8804387 -03 | C | Printed Only. |
| | | 10.880375 - 00 | RL | |
| | | 30.193041 00 | AVG | |
| | | 32.641125 00 | PK | |
| | | 27.744957 00 | MIN | |
| | 2nd C | (1) 3.8804387 - 03 | | C = 3880 µF |
| | R/S | (2) 10.880375 00 | | $R_L$ = 10.88 ohms |
| | R/S | (3) 30.193041 00 | | $E_o$(Avg) = 30.2 vde |
| | R/S | (4) 32.641125 00 | | $E_o$ (pk) = 32.6 v |
| | R/S | (5) 27.744957 00 | | $E_o$ (min) = 27.7 |
| | | (Pause) / Display | | |

Modes: (n)*—Printed only (n)—Displayed Briefly ( Pause )
n*—Printed and displayed

☐ Over

# PPX-59 Professional Program Exchange

65800

For TI use only

| LOC | CODE | KEY | COMMENTS |
|---|---|---|---|
| 000 | 76 | LBL | |
| 001 | 99 | PRT | |
| 002 | 22 | INV | |
| 003 | 57 | ENG | |
| 004 | 22 | INV | |
| 005 | 58 | FIX | |
| 006 | 69 | OP | |
| 007 | 04 | 04 | |
| 008 | 57 | ENG | |
| 009 | 68 | NOP | |
| 010 | 68 | NOP | |
| 011 | 32 | X:T | |
| 012 | 69 | OP | |
| 013 | 06 | 06 | |
| 014 | 92 | RTN | |
| 015 | 76 | LBL | |
| 016 | 11 | A | |
| 017 | 42 | STO | |
| 018 | 01 | 01 | |
| 019 | 32 | X:T | |
| 020 | 02 | 2 | |
| 021 | 01 | 1 | |
| 022 | 02 | 2 | |
| 023 | 07 | 7 | |
| 024 | 61 | GTO | |
| 025 | 99 | PRT | |
| 026 | 76 | LBL | |
| 027 | 12 | B | |
| 028 | 42 | STO | |
| 029 | 02 | 02 | |
| 030 | 32 | X:T | |
| 031 | 04 | 4 | |
| 032 | 02 | 2 | |
| 033 | 03 | 3 | |
| 034 | 06 | 6 | |
| 035 | 61 | GTO | |
| 036 | 99 | PRT | |
| 037 | 76 | LBL | |
| 038 | 13 | C | |
| 039 | 42 | STO | |
| 040 | 03 | 03 | |
| 041 | 32 | X:T | |
| 042 | 04 | 4 | |
| 043 | 02 | 2 | |
| 044 | 01 | 1 | |
| 045 | 06 | 6 | |
| 046 | 61 | GTO | |
| 047 | 99 | PRT | |
| 048 | 76 | LBL | |
| 049 | 14 | D | |
| 050 | 42 | STO | |
| 051 | 04 | 04 | |
| 052 | 32 | X:T | |
| 053 | 06 | 6 | |
| 054 | 01 | 1 | |
| 055 | 01 | 1 | |
| 056 | 07 | 7 | |
| 057 | 03 | 3 | |
| 058 | 05 | 5 | |
| 059 | 61 | GTO | |
| 060 | 99 | PRT | |
| 061 | 76 | LBL | |
| 062 | 15 | E | |
| 063 | 42 | STO | |
| 064 | 05 | 05 | |
| 065 | 32 | X:T | |
| 066 | 02 | 2 | |
| 067 | 04 | 4 | |
| 068 | 02 | 2 | |
| 069 | 07 | 7 | |
| 070 | 61 | GTO | |
| 071 | 99 | PRT | |
| 072 | 76 | LBL | |
| 073 | 17 | B' | |
| 074 | 22 | INV | |
| 075 | 76 | LBL | |
| 076 | 16 | A' | |
| 077 | 86 | STF | |
| 078 | 00 | 00 | |
| 079 | 70 | RAD | |
| 080 | 02 | 2 | |
| 081 | 34 | √X | |
| 082 | 65 | × | |
| 083 | 43 | RCL | |
| 084 | 02 | 02 | |
| 085 | 75 | - | |
| 086 | 43 | RCL | |
| 087 | 03 | 03 | |
| 088 | 95 | = | |
| 089 | 42 | STO | |
| 090 | 06 | 06 | |
| 091 | 42 | STO | |
| 092 | 14 | 14 | |
| 093 | 55 | ÷ | |
| 094 | 43 | RCL | |
| 095 | 05 | 05 | |
| 096 | 95 | = | |
| 097 | 42 | STO | |
| 098 | 07 | 07 | |
| 099 | 43 | RCL | |
| 100 | 01 | 01 | |
| 101 | 22 | INV | |
| 102 | 87 | IFF | |
| 103 | 00 | 00 | |
| 104 | 38 | SIN | |
| 105 | 65 | × | |
| 106 | 02 | 2 | |
| 107 | 95 | = | |
| 108 | 76 | LBL | |
| 109 | 38 | SIN | |
| 110 | 42 | STO | |
| 111 | 08 | 08 | |
| 112 | 43 | RCL | |
| 113 | 04 | 04 | |
| 114 | 55 | ÷ | |
| 115 | 01 | 1 | |
| 116 | 00 | 0 | |
| 117 | 00 | 0 | |
| 118 | 95 | = | |
| 119 | 42 | STO | |
| 120 | 09 | 09 | |
| 121 | 49 | PRD | |
| 122 | 14 | 14 | |
| 123 | 94 | +/- | |
| 124 | 85 | + | |
| 125 | 01 | 1 | |
| 126 | 95 | = | |
| 127 | 22 | INV | |
| 128 | 38 | SIN | |
| 129 | 55 | ÷ | |
| 130 | 02 | 2 | |
| 131 | 55 | ÷ | |
| 132 | 89 | π | |
| 133 | 55 | ÷ | |
| 134 | 43 | RCL | |
| 135 | 01 | 01 | |
| 136 | 95 | = | |
| 137 | 42 | STO | |
| 138 | 12 | 12 | |
| 139 | 43 | RCL | |
| 140 | 01 | 01 | |
| 141 | 35 | 1/X | |
| 142 | 55 | ÷ | |
| 143 | 04 | 4 | |
| 144 | 87 | IFF | |
| 145 | 00 | 00 | |
| 146 | 28 | LOG | |

MERGED CODES

62 Pgm Ind
63 Exc Ind
64 Prd Ind
72 STO Ind
73 RCL Ind
74 SUM Ind
83 GTO In
84 Op In
92 INV SE

| LOC | CODE | KEY | COMMENTS |
|---|---|---|---|
| 147 | 65 | × | |
| 148 | 03 | 3 | |
| 149 | 76 | LBL | |
| 150 | 28 | LOG | |
| 151 | 85 | + | |
| 152 | 43 | RCL | |
| 153 | 12 | 12 | |
| 154 | 95 | = | |
| 155 | 42 | STO | |
| 156 | 13 | 13 | |
| 157 | 55 | ÷ | |
| 158 | 43 | RCL | |
| 159 | 07 | 07 | |
| 160 | 55 | ÷ | |
| 161 | 53 | ( | |
| 162 | 01 | 1 | |
| 163 | 75 | - | |
| 164 | 43 | RCL | |
| 165 | 09 | 09 | |
| 166 | 54 | ) | |
| 167 | 35 | 1/X | |
| 168 | 23 | LNX | |
| 169 | 95 | = | |
| 170 | 42 | STO | |
| 171 | 10 | 10 | |
| 172 | 01 | 1 | |
| 173 | 94 | +/- | |
| 174 | 49 | PRD | |
| 175 | 14 | 14 | |
| 176 | 43 | RCL | |
| 177 | 06 | 06 | |
| 178 | 44 | SUM | |
| 179 | 14 | 14 | |
| 180 | 75 | - | |
| 181 | 53 | ( | |
| 182 | 24 | CE | |
| 183 | 65 | × | |
| 184 | 43 | RCL | |
| 185 | 09 | 09 | |
| 186 | 95 | = | |
| 187 | 85 | + | |
| 188 | 43 | RCL | |
| 189 | 06 | 06 | |
| 190 | 95 | = | |
| 191 | 55 | ÷ | |
| 192 | 02 | 2 | |
| 193 | 95 | = | |
| 194 | 42 | STO | |
| 195 | 11 | 11 | |
| 196 | 69 | OP | |
| 197 | 00 | 00 | |
| 198 | 22 | INV | |
| 199 | 57 | ENG | |
| 200 | 22 | INV | |
| 201 | 58 | FIX | |
| 202 | 04 | 4 | |
| 203 | 03 | 3 | |
| 204 | 01 | 1 | |
| 205 | 03 | 3 | |
| 206 | 04 | 4 | |
| 207 | 02 | 2 | |
| 208 | 01 | 1 | |
| 209 | 07 | 7 | |
| 210 | 69 | OP | |
| 211 | 03 | 03 | |
| 212 | 87 | IFF | |
| 213 | 00 | 00 | |
| 214 | 85 | + | |
| 215 | 02 | 2 | |
| 216 | 03 | 3 | |
| 217 | 01 | 1 | |
| 218 | 03 | 3 | |
| 219 | 02 | 2 | |
| 220 | 07 | 7 | |
| 221 | 02 | 2 | |
| 222 | 01 | 1 | |
| 223 | 61 | GTO | |
| 224 | 75 | - | |
| 225 | 76 | LBL | |
| 226 | 85 | + | |
| 227 | 02 | 2 | |
| 228 | 01 | 1 | |
| 229 | 04 | 4 | |
| 230 | 01 | 1 | |
| 231 | 02 | 2 | |
| 232 | 07 | 7 | |
| 233 | 02 | 2 | |
| 234 | 07 | 7 | |
| 235 | 76 | LBL | |
| 236 | 75 | - | |
| 237 | 69 | OP | |
| 238 | 02 | 02 | |
| 239 | 98 | ADV | |
| 240 | 69 | OP | |
| 241 | 05 | 05 | |
| 242 | 43 | RCL | |
| 243 | 10 | 10 | |
| 244 | 32 | X:T | |
| 245 | 01 | 1 | |
| 246 | 05 | 5 | |
| 247 | 00 | 0 | |
| 248 | 00 | 0 | |
| 249 | 71 | SBR | |
| 250 | 99 | PRT | |
| 251 | 43 | RCL | |
| 252 | 07 | 07 | |
| 253 | 32 | X:T | |
| 254 | 03 | 3 | |
| 255 | 05 | 5 | |
| 256 | 02 | 2 | |
| 257 | 07 | 7 | |
| 258 | 71 | SBR | |
| 259 | 99 | PRT | |
| 260 | 43 | RCL | |
| 261 | 11 | 11 | |
| 262 | 32 | X:T | |
| 263 | 01 | 1 | |
| 264 | 03 | 3 | |
| 265 | 04 | 4 | |
| 266 | 02 | 2 | |
| 267 | 02 | 2 | |
| 268 | 02 | 2 | |
| 269 | 71 | SBR | |
| 270 | 99 | PRT | |
| 271 | 43 | RCL | |
| 272 | 06 | 06 | |
| 273 | 32 | X:T | |
| 274 | 03 | 3 | |
| 275 | 03 | 3 | |
| 276 | 02 | 2 | |
| 277 | 06 | 6 | |
| 278 | 00 | 0 | |
| 279 | 00 | 0 | |
| 280 | 71 | SBR | |
| 281 | 99 | PRT | |
| 282 | 43 | RCL | |
| 283 | 14 | 14 | |
| 284 | 32 | X:T | |
| 285 | 03 | 3 | |
| 286 | 00 | 0 | |
| 287 | 02 | 2 | |
| 288 | 04 | 4 | |
| 289 | 03 | 3 | |
| 290 | 01 | 1 | |
| 291 | 71 | SBR | |
| 292 | 99 | PRT | |
| 293 | 98 | ADV | |
| 294 | 92 | RTN | |
| 295 | 76 | LBL | |
| 296 | 18 | C' | |
| 297 | 01 | 1 | |
| 298 | 66 | PAU | |
| 299 | 43 | RCL | |
| 300 | 10 | 10 | |
| 301 | 91 | R/S | |

MERGED CODES

| | | |
|---|---|---|
| 62 Pgm Ind | 72 STO Ind | 83 GTO Ind |
| 63 Exc Ind | 73 RCL Ind | 84 Op Ind |
| 64 Prd Ind | 74 SUM Ind | 92 INV SBR |

# PPX-59 Professional Program Exchange

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For TI use only

| LOC | CODE | KEY | COMMENTS |
|---|---|---|---|
| 302 | 02 | 2 | |
| 303 | 66 | PAU | |
| 304 | 43 | RCL | |
| 305 | 07 | 07 | |
| 306 | 91 | R/S | |
| 307 | 03 | 3 | |
| 308 | 66 | PAU | |
| 309 | 43 | RCL | |
| 310 | 11 | 11 | |
| 311 | 91 | R/S | |
| 312 | 04 | 4 | |
| 313 | 66 | PAU | |
| 314 | 43 | RCL | |
| 315 | 06 | 06 | |
| 316 | 91 | R/S | |
| 317 | 05 | 5 | |
| 318 | 66 | PAU | |
| 319 | 43 | RCL | |
| 320 | 14 | 14 | |
| 321 | 92 | RTN | |

MERGED CODES

| | | |
|---|---|---|
| 62 Pgm Ind | 72 STO Ind | 83 GTO |
| 63 Exc Ind | 73 RCL Ind | 84 Op |
| 64 Prd Ind | 74 SUM Ind | 92 INV |

**PPX-59**
professional
program exchange

Page 1 of 9

| 6 5 | 8 0 0 6 |
|---|---|

For TI use only

TEXAS INSTRUMENTS
Calculator Products Division

# Submission Abstract

Program Title: ZENER POWER SUPPLY DESIGN

Rev.

Abstract of Program

This program calculates component values and power rating pertaining to a Zener Diode regulated power supply. It can be used without a PC-100A using user defined keys or interactively with the printer prompting for input and results printed with headings.

Original SR-52 Program by B. R. Kelso, FPO New York.

User Benefits:

This program results in significant time savings to the user.

| | | | | |
|---|---|---|---|---|
| Category Name Electronic Eng. | Required Progs. | Prog. Steps 208 | Card Sides 1 | PC-100A Needed ☐<br>Library Module ID ☐ |

Submittal Agreement

Signature ______ Date ______
Name Texas Instruments Tel. No. ______
Address ______
City ______ State ______ Zip ______

Submission Checklist

- ☑ Recorded Magnetic Cards
- ☑ Submission Abstract
- ☑ Program Description
- ☑ User Instructions
- ☑ Sample Problem
- ☑ Listing
- ☐
- ☐

Program Title: ZENER POWER SUPPLY DESIGN

Rev.

Method, Equations, Sketches, Limitations, References, Error Recovery:

First, the limiting resistor current is found:

$I_{RI} = I_{ZMIN} + I_{OUTMAX}$

Where $I_{ZMIN}$ = minimum Zener Operating Current

$I_{OUTMAX}$ = maximum anticipated power supply load current

Then, the limiting resistor voltage drop is found:

$E_{RI} = Vcc - Vz$

Where Vcc is the unregulated input voltage

Vz is the rated Zener voltage

Next, the limiting resistor value is found:

$R_I = E_{RI}/I_{RI}$

Then, the limiting resistor power rating is found:

$P_{RIMAX} = I_{RI}E_{RI}^{K}$

Where K = 2 (which operates the resistor at 50% rating)

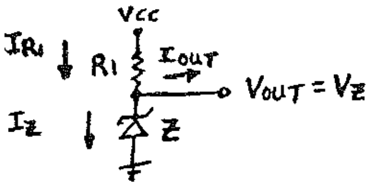
Next, the maximum power dissipated by the Zener Diode is calculated:

$P_{Emax} = I_{RI}V_Z$

Then, the safe Zener Diode Power Rating is found:

$P_Z = 2\ P_{ZMAX}$

NOTE: The resistor power rating and the Zener Diode Power Rating are twice the actual power dissipation. Basic Circuit:



SPECIAL NOTES ON PARTITIONING: The memory between steps 160 and 239 (data registers 90-99) is split between data memory and program memory to save space and to enable program to be recorded on 2 card banks. For this reason, partitioning is done under program control in the interactive version. At the end of the interactive version the memory space is repartitioned to 479.59 (6 op 17). It is suggested that the magnetic card be recorded at 479.59 (6OP 17), the initial calculator partition, so that repartitioning is not necessary prior to reading the card.

The user defined key version may be used without readingin card bank 2. If the interactive version is never to be used, it is only necessary to key in steps 120-207 and the alphanumeric data registers are unnecessary. The user-defined key version (without printer) does not partition under program control and may be used with any partition except 159.99 or 959.00.

For printer version, engineering or fix notation should not be used. Any type of notation may be used without printer.

☐ See Continuation Sheet

Continued From: ☒ Program Description ☐ User Instructions ☐ Stmt. of Example

| | |
|---|---|
| Program Title: ZENER POWER SUPPLY DESIGN | Rev. |

SPECIAL INSTRUCTIONS FOR KEYING IN AND RECORDING PROGRAM

1. Set partition to 159.99 (10 op 17)
2. Store alphanumeric data registers 60-93 only.
3. Repartition to 239.89 (9 op 17)
4. Key in steps 000-207 or program (be careful, step 208 is really part of an alphanumeric data register).
5. Repartition to 479.59 (6 op 17)
6. Record Magnetic Card Banks 1 and 2.

Page 4 of 9 | 6 5 | 8 0 0 6 |

PPX-59
professional
program exchange

## User Instructions

**Program Title** ZENER POWER SUPPLY DESIGN

| | | | | |
|---|---|---|---|---|
| $R_l$ | $P_{Rl}$ | $P_Z$ | $I_{Supply}$ | Interactive |
| $V_{cc}$ | $V_Z = V_{out}$ | $I_{ZMIN}$ | $I_{OUTMX}$ | Execute |

Partition (OP 17) 479 . 59
Parenthesis Levels 1
t Register ☑
Angular Mode (if applicable)
SBR Levels 1
Absolute Addresses ☐
Library Module ID
Disturbs Pending Operations ☐

LABELS (Op 08)

| | | | | | |
|---|---|---|---|---|---|
| INV | lnx | CE | CLR | x:t | $x^2$ |
| $\sqrt{x}$ | 1/x | STO | RCL | SUM | $y^x$ |
| EE | ( | ) | ÷ | GTO | × |
| SBR | − | RST | + | R/S | . |
| +/- | = | CLR | INV | log | CP |
| tan | Pgm | P→R | sin | cos | CMs |
| Exc | Prd | \|x\| | Eng ✓ | Fix | Int |
| Deg | Pause | x=t | Nop | Op | Rad |
| Lbl | x≥t | Σ+ | $\bar{x}$ | Grad | St flg |
| If flg | D.MS | π ✓ | Lst ✓ | Write | Dsz |
| Adv ✓ | Prt ✓ | | | | |

USER DEFINED KEYS

- A Enter Input Voltage
- B Enter Output Voltage
- C Enter Min. Zener Cur
- D Enter Output Curr
- E Execute
- A' Examine $R_l$
- B' Examine $P_{Rl}$
- C' Examine $P_Z$
- D' Examine $I_{Supply}$
- E' Start interactive

| FLAGS | Not Used 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|

| STEP | PROCEDURE | ENTER | PRESS | OUTPUT/MODE (see legend below) |
|---|---|---|---|---|
| | USING USER-DEFINED KEYS (WITHOUT A PRINTER:) | | | |
| 1 | Enter program (Only Bank 1 necessary if used without printer) | | | |
| 2 | Enter unregulated input (volts) | Vcc | A | Vcc |
| 3 | Enter desired Output (volts) | Vz=Vout | B | Vz=Vout |
| 4 | Enter desired Minimum Zener bias current (amps) | $I_{ZMIN}$ | C | $I_{ZMIN}$ |
| 5 | Enter Maximum Output Load Current (amps) | $I_{OUTMAX}$ | D | $I_{OUTMAX}$ |
| 6 | Execute | | E | Pz |
| 7 | Examine Value of $R_l$ (ohms) | | 2nd A' | $R_l$ |
| 8 | Examine Power Rating of $R_l$ (watts) | | 2nd B' | $P_{Rl}$ |
| 9 | Examine Power Rating of Zener Diode (watts) | | 2nd C' | $P_z$ |
| 10 | Examine Power Source Load Current (amps) | | 2nd D' | $I_{Supply}$ |

Modes: (n)•—Printed only (n)—Displayed Briefly ( Pause )
n•—Printed and displayed

DATA REGISTERS (INV List)

60 - 93 Alphanumeric Registers

05 Used for DSZ
06 Used for Reg. Index
07 Used for Print Reg. Index

11 $V_{cc}$
12 $V_Z = V_{out}$
13 $I_{ZMIN}$
14 $I_{OUTMAX}$
15 $R_l$
16 $P_{RlMAX}$
17 $P_{ZMAX}$
18 $I_{Rl}$
19 $E_{Rl}$

Continued From: ☐ Program Description ☒ User Instructions ☐ Stmt. of Example

Program Title: ZENER POWER SUPPLY DESIGN

Rev.

INTERACTIVE (WITH A PC-100A): (USER INSTRUCTIONS)

| Step | Procedure | Enter | Press | Printed Output |
|---|---|---|---|---|
| 1 | ENTER PROGRAM (Banks 1 and 2) | | | |
| 2 | RESET AND START PROGRAM: PRINT HEADING (Or Press 2nd E') | | RST<br>R/S | ZENER POWER SUPPLY DESIGN<br>SOURCE VOLTAGE ? |
| 3 | ENTER UNREGULATED INPUT VOLTAGE AFTER "?" Prompt. | Vcc | R/S | (SOURCE VOLTAGE) VOLT<br>ZENER VOLTAGE ? |
| 4 | ENTER DESIRED OUTPUT Voltage after "?" prompt | $V_z = V_{out}$ | R/S | (ZENER VOLTAGE) VOLT<br>MIN ZENER CURR ? |
| 5 | ENTER DESIRED MINIMUM Zener Bias Current in Amps after "?" prompt. | $I_{Z\ MIN}$ | R/S | (MIN ZENER CURR) AMPS<br>MAX OUTPUT CURR ? |
| 6 | ENTER MAXIMUM OUTPUT Load Current in Amps after "?" prompt | $I_{OUT\ MAX}$ | R/S | (MAX OUTPUT CURR) AMPS |
| 7 | SIT BACK AND WATCH. Values will be printed with appropriate headings. | | | R1 VALUE<br>(Value of R1) Ohms<br>R1 POWER<br>(R1 Power Rating) Watt<br>ZENER PWR<br>(Zener Power Rating) Watt<br>SRC CURR<br>(Source Load Current) Amps |

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**professional program exchange**

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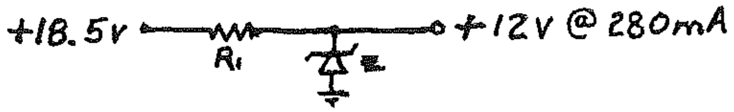
## Sample Problem

**Statement of Example**

A regulated 12 volt D.C. source is needed to supply a maximum of 0.28 amps from an 18.5 volt source. The basic circuit is shown below:



Find the value of $R_1$, the power rating of $R_1$, the power rating of the Zener Diode and the maximum current drain on the 18.5 volt source, minimum Zener Current = .02A.

☐ See Continuation Sheet

| ENTER | PRESS | OUTPUT/MODE (see legend below) | COMMENT |
|---|---|---|---|
| WITHOUT A PRINTER --- USING USER DEFINED KEYS: | | | |
| 18.5 | A | 18.5 | Source Voltage |
| 12 | B | 12. | Zener Voltage |
| .02 | C | 0.02 | min. Zener Current |
| .28 | D | 0.28 | max. Output Current |
| | E | 7.2 | Execute |
| | 2nd A' | 21.66666667 | Value of $R_1$ ($\Omega$) |
| | 2nd B' | 3.9 | $R_1$ Power Rating (w) |
| | 2nd C' | 7.2 | Zener Power Rating (w) |
| | 2nd D' | 0.3 | Source Current (A) |
| INTERACTIVE (WITH A PC-100A) | | | |
| | E' | ZENER POWER SUPPLY DESIGN | |
| | | Source Voltage ? | |
| 18.5 | R/S | 18.5 VOLT | Enter source voltage after question mark |
| | | Zener Voltage ? | |
| 12 | R/S | 12. VOLT | Enter Zener Voltage after question mark |
| | | Min. Zener Curr ? | |
| .02 | R/S | 0.02 Amps | Enter Minimum Zener Current after question mark |
| | | Max. Output Curr ? | |
| .28 | R/S | 0.28 Amps | Enter Maximum Output current after ? results appear shortly. |

Modes: (n)*—Printed only (n)—Displayed Briefly ( Pause )
n*—Printed and displayed

Over

| ENTER | PRESS | OUTPUT/MODE (see legend below) | COMMENT |
|---|---|---|---|
| | | R1 VALUE | |
| | | 21.66666667 OHMS | |
| | | R1 POWER<br>3.9 WATT | |
| | | ZENER PWR<br>7.2 WATT | |
| | | SRC CURR<br>0.3 AMPS | |

Modes: (n)*—Printed only (n)—Displayed Briefly ( Pause )
n*--Printed and displayed

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| LOC | CODE | KEY | COMMENTS |
|---|---|---|---|
| 000 | 76 | LBL | |
| 001 | 10 | E' | |
| 002 | 22 | INV | |
| 003 | 58 | FIX | |
| 004 | 22 | INV | |
| 005 | 57 | ENG | |
| 006 | 25 | CLR | |
| 007 | 01 | 1 | |
| 008 | 00 | 0 | |
| 009 | 69 | OP | |
| 010 | 17 | 17 | |
| 011 | 08 | 8 | |
| 012 | 08 | 8 | |
| 013 | 42 | STO | |
| 014 | 07 | 07 | |
| 015 | 69 | OP | |
| 016 | 00 | 00 | |
| 017 | 71 | SBR | |
| 018 | 99 | PRT | |
| 019 | 71 | SBR | |
| 020 | 99 | PRT | |
| 021 | 09 | 9 | |
| 022 | 69 | OP | |
| 023 | 17 | 17 | |
| 024 | 06 | 6 | |
| 025 | 00 | 0 | |
| 026 | 42 | STO | |
| 027 | 07 | 07 | |
| 028 | 01 | 1 | |
| 029 | 01 | 1 | |
| 030 | 42 | STO | |
| 031 | 06 | 06 | |
| 032 | 04 | 4 | |
| 033 | 42 | STO | |
| 034 | 05 | 05 | |
| 035 | 76 | LBL | |
| 036 | 89 | π | |
| 037 | 98 | ADV | |
| 038 | 07 | 7 | |
| 039 | 01 | 1 | |
| 040 | 69 | OP | |
| 041 | 04 | 04 | |
| 042 | 71 | SBR | |
| 043 | 99 | PRT | |
| 044 | 00 | 0 | |
| 045 | 91 | R/S | |
| 046 | 72 | ST* | |
| 047 | 06 | 06 | |
| 048 | 71 | SBR | |
| 049 | 90 | LST | |
| 050 | 69 | OP | |
| 051 | 26 | 26 | |
| 052 | 97 | DSZ | |
| 053 | 05 | 05 | |
| 054 | 89 | π | |
| 055 | 15 | E | |
| 056 | 98 | ADV | |
| 057 | 04 | 4 | |
| 058 | 42 | STO | |
| 059 | 05 | 05 | |
| 060 | 76 | LBL | |
| 061 | 57 | ENG | |
| 062 | 98 | ADV | |
| 063 | 69 | OP | |
| 064 | 00 | 00 | |
| 065 | 71 | SBR | |
| 066 | 98 | ADV | |
| 067 | 73 | RC* | |
| 068 | 06 | 06 | |
| 069 | 71 | SBR | |
| 070 | 90 | LST | |
| 071 | 69 | OP | |
| 072 | 26 | 26 | |
| 073 | 97 | DSZ | |
| 074 | 05 | 05 | |
| 075 | 57 | ENG | |
| 076 | 06 | 6 | |
| 077 | 69 | OP | |
| 078 | 17 | 17 | |
| 079 | 00 | 0 | |
| 080 | 92 | RTN | |
| 081 | 76 | LBL | |
| 082 | 99 | PRT | |
| 083 | 73 | RC* | |
| 084 | 07 | 07 | |
| 085 | 69 | OP | |
| 086 | 01 | 01 | |
| 087 | 69 | OP | |
| 088 | 27 | 27 | |
| 089 | 76 | LBL | |
| 090 | 98 | ADV | |
| 091 | 73 | RC* | |
| 092 | 07 | 07 | |
| 093 | 69 | OP | |
| 094 | 02 | 02 | |
| 095 | 69 | OP | |
| 096 | 27 | 27 | |
| 097 | 73 | RC* | |
| 098 | 07 | 07 | |
| 099 | 69 | OP | |
| 100 | 03 | 03 | |
| 101 | 69 | OP | |
| 102 | 27 | 27 | |
| 103 | 69 | OP | |
| 104 | 05 | 05 | |
| 105 | 92 | RTN | |
| 106 | 76 | LBL | |
| 107 | 90 | LST | |
| 108 | 32 | X:T | |
| 109 | 25 | CLR | |
| 110 | 73 | RC* | |
| 111 | 07 | 07 | |
| 112 | 69 | OP | |
| 113 | 04 | 04 | |
| 114 | 32 | X:T | |
| 115 | 69 | OP | |
| 116 | 27 | 27 | |
| 117 | 69 | OP | |
| 118 | 06 | 06 | |
| 119 | 92 | RTN | |
| 120 | 76 | LBL | |
| 121 | 15 | E | |
| 122 | 53 | ( | |
| 123 | 43 | RCL | |
| 124 | 13 | 13 | |
| 125 | 85 | + | |
| 126 | 43 | RCL | |
| 127 | 14 | 14 | |
| 128 | 54 | ) | |
| 129 | 42 | STO | |
| 130 | 18 | 18 | |
| 131 | 32 | X:T | |
| 132 | 53 | ( | |
| 133 | 43 | RCL | |
| 134 | 11 | 11 | |
| 135 | 75 | - | |
| 136 | 43 | RCL | |
| 137 | 12 | 12 | |
| 138 | 54 | ) | |
| 139 | 53 | ( | |
| 140 | 42 | STO | |
| 141 | 19 | 19 | |
| 142 | 55 | ÷ | |
| 143 | 32 | X:T | |
| 144 | 54 | ) | |
| 145 | 42 | STO | |
| 146 | 15 | 15 | |
| 147 | 53 | ( | |
| 148 | 43 | RCL | |
| 149 | 18 | 18 | |
| 150 | 65 | × | |
| 151 | 32 | X:T | |
| 152 | 65 | × | |
| 153 | 02 | 2 | |
| 154 | 54 | ) | |
| 155 | 42 | STO | |
| 156 | 16 | 16 | |
| 157 | 53 | ( | |
| 158 | 32 | X:T | |
| 159 | 65 | × | |
| 160 | 43 | RCL | |

MERGED CODES

| | | |
|---|---|---|
| 62 Pgm Ind | 72 STO Ind | 83 GTO Ind |
| 63 Exc Ind | 73 RCL Ind | 84 Op Ind |
| 64 Prd Ind | 74 SUM Ind | 92 INV SBR |

# PPX-59 Professional Program Exchange

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```
LOC CODE  KEY   COMMENTS
161  12    12
162  65    X
163  02    2
164  54    )
165  42   STO
166  17    17
167  92   RTN
168  76   LBL
169  11    A
170  42   STO
171  11    11
172  92   RTN
173  76   LBL
174  12    B
175  42   STO
176  12    12
177  92   RTN
178  76   LBL
179  13    C
180  42   STO
181  13    13
182  92   RTN
183  76   LBL
184  14    D
185  42   STO
186  14    14
187  92   RTN
188  76   LBL
189  16   A'
190  43   RCL
191  15    15
192  92   RTN
193  76   LBL
194  17   B'
195  43   RCL
196  16    16
197  92   RTN
198  76   LBL
199  18   C'
200  43   RCL
201  17    17
202  92   RTN
203  76   LBL
204  19   D'
205  43   RCL
206  18    18
207  92   RTN
```

See Note on entering Program in "Program Description"

Alphanumeric Data Registers

| Contents | Reg. |
|---|---|
| 3632413515. | 60 |
| 1700423227. | 61 |
| 3713221700. | 62 |
| 42322737. | 63 |
| 4617311735. | 64 |
| 42322737. | 65 |
| 1322170000. | 66 |
| 42322737. | 67 |
| 3024310046. | 68 |
| 1731173500. | 69 |
| 1541353500. | 70 |
| 13303336. | 71 |
| 3013440032. | 72 |
| 4137334137. | 73 |
| 15413535. | 74 |
| 13303336. | 75 |
| 3502004213. | 76 |
| 2741170000. | 77 |
| 32233036. | 78 |
| 3502003332. | 79 |
| 4317350000. | 80 |
| 43133737. | 81 |
| 4617311735. | 82 |
| 33433500. | 83 |
| 43133737. | 84 |
| 3635150015. | 85 |
| 4135350000. | 86 |
| 13303336. | 87 |
| 461731. | 88 |
| 1735003332. | 89 |
| 4317350000. | 90 |
| 36413333. | 91 |
| 2745001617. | 92 |
| 3624223100. | 93 |

Labels and Locations

| | | |
|---|---|---|
| 001 | 10 | E' |
| 036 | 89 | π |
| 061 | 57 | ENG |
| 082 | 99 | PRT |
| 090 | 98 | ADV |
| 107 | 90 | LST |
| 121 | 15 | E |
| 169 | 11 | A |
| 174 | 12 | B |
| 179 | 13 | C |
| 184 | 14 | D |
| 189 | 16 | A' |
| 194 | 17 | B' |
| 199 | 18 | C' |
| 204 | 19 | D' |

MERGED CODES

| | | |
|---|---|---|
| 62 Pgm Ind | 72 STO Ind | 83 GTO Ind |
| 63 Exc Ind | 73 RCL Ind | 84 Op Ind |
| 64 Prd Ind | 74 SUM Ind | 92 INV SBR |

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**professional program exchange**

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Calculator Products Division

# Submission Abstract

Program Title
RESISTIVE VOLTAGE DIVIDER

Rev.

Abstract of Program

This program was assembled to provide the user with a method to quickly design (empirically) resistive voltage divider networks often encountered in basic designs; and to evaluate the various parameters of intermediate and completed network designs.

Original SR-52 Program by Clarence R. Carpenter, Pittsburgh, PA., September, 1976.

User Benefits:

Saves engineering time and provides complete engineering data (i.e. voltage levels, resistance values and power dissipated by the divider resistors, and all currents.

Category Name Electroni Eng.
Required Progs.
Prog. Steps 155
Card Sides 1
PC-100A Needed ☐
Library Module ID ☐

Submittal Agreement

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Signature Date
Name Texas Instruments Tel. No.
Address
City State Zip

Submission Checklist

- ☑ Recorded Magnetic Cards
- ☑ Submission Abstract
- ☑ Program Description
- ☑ User Instructions
- ☑ Sample Problem
- ☑ Listing
- ☐
- ☐

Program Title: Resistive Voltage Divider

Rev.

Method, Equations, Sketches, Limitations, References, Error Recovery:

Given three (of eleven) parameters describing a resistive voltage divider network, as inputs, the program will compute the values of the remaining eight. The program is divided into two separate sections and will accept two different sets of input parameters.

(1) $E_i$, $E_o$ & $R_t$ (2) $E_i$, $R_1$, $R_2$

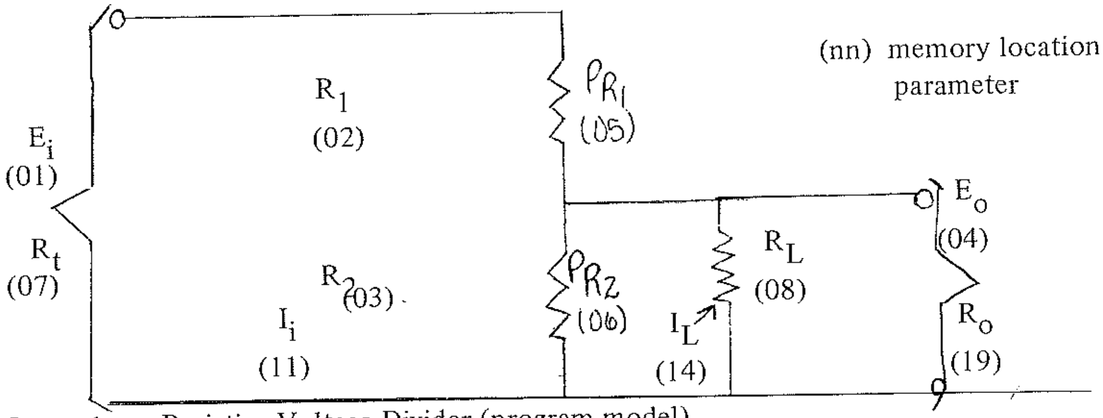

Figure 1. Resistive Voltage Divider (program model).

Table 1. Parameter Description and Derivation.

| symbol | description | derivation |
|---|---|---|
| $E_i$ | input voltage | keyboard input (ki) |
| $E_o$ | output voltage | $I_i \times R_o$ or (ki) |
| $R_1$ | divider resistor | $E_i - E_o \div I_i$ or (ki) |
| $R_2$ | divider resistor | $R_o \times R_L \div R_L - R_o$ or (ki) |
| $R_o$ | output (net) resistance | $R_2 \times R_L \div R_L + R_2$ |
| $R_t$ | total (input) resistance | $R_o + R_1$ or (ki) |

☒ See Continuation Sheet

Continued From: ☒ Program Description ☐ User Instructions ☐ Stmt. of Example

Program Title: RESISTIVE VOLTAGE DIVIDER

Rev.

TABLE 1 - (Continued) Parameter Description and Derivation

| | | |
|---|---|---|
| $I_i$ | input (source) current | $E_i \div R_t$ |
| $I_{RL}$ | load current | $E_o \div R_L$ |
| $P_{R1}$ | power disipated by $R_1$ | $I_i^2 \times R_1$ |
| $P_{R2}$ | power disipated by $R_2$ | $E_o^2 \div R_2$ |
| $R_L$ | load resistor | programed or (ki) |

Procedure.

The intended procedure for the development of a resistive voltage divider network utilizes the first program section to determine initialvalues for $R_1$ and $R_2$ and to check other variables for reasonable values (or levels)

Standard values for $R_1$ and $R_2$ are then chosen (See Table 2) and the second section of the program is run to recompute all parameter values.

Note 1.

In both sections of the program the input variables may be entered in any order and only changed input variables need to be entered for subsequent calculations; that is, previous input values, which are still valid, need not be reentered.

Note 2.

For convenience $R_L = 1$ megohm has been incorporated in the program, however, any value ($>$ zero) for $R_L$ may be substituted in the program by keying in the following sequence:

| enter | press | display |
|---|---|---|
| desired value of $R_L$ ($> 0$) | STO 0 8 | $R_L$ |

TABLE 2. One decade of STANDARD VALUE (5%) RESISTORS.

| | | | | | |
|---|---|---|---|---|---|
| 1.1 | 1.6 | 2.4 | 3.6 | 5.1 | 7.5 |
| 1.2 | 1.8 | 2.7 | 3.9 | 5.6 | 8.2 |
| 1.3 | 2.0 | 3.0 | 4.3 | 6.2 | 9.1 |
| 1.5 | 2.2 | 3.3 | 4.7 | 6.8 | 10.0 |

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## User Instructions

**Program Title** RESISTIVE VOLTAGE DIVIDER

| run-1 | Eo-out | $R_1$-out | $R_2$-out | run-2 |
|---|---|---|---|---|
| $E_i$-in | Eo-in | $R_1$-in | $R_2$-in | $R_t$-in |

Partition (OP 17) 479 , 59 *
Parenthesis Levels
t Register ☐
Angular Mode (if applicable) N/A
SBR Levels 1
Absolute Addresses ☐
Library Module ID N/A
* for TI-58 239.29
Disturbs Pending Operations ☐

LABELS (Op 08)

INV _ lnx _ CE _ CLR _ x:t _ x² _
√x _ 1/x _ STO _ RCL _ SUM _ yˣ _
EE _ ( _ ) _ ÷ _ GTO _ × _
SBR _ − _ RST _ + _ R/S _ . _
+/- _ = _ CLR _ INV _ log _ CP _
tan _ Pgm _ P→R _ sin _ cos _ CMs _
Exc _ Prd _ |x| _ Eng _ Fix _ Int _
Deg _ Pause _ x=t _ Nop _ Op _ Rad _
Lbl _ x≥t _ Σ+ _ x̄ _ Grad _ St flg _
If flg _ D.MS _ π _ List _ Write _ Dsz _
Adv _ Prt _

USER DEFINED KEYS

- A Enter $E_i$
- B Enter $E_o$
- C Enter $R_1$
- D Enter $R_2$
- E Enter $R_t$
- A' run program-1
- B' Display $E_o$
- C' Display $R_1$
- D' Display $R_2$
- E' run program-2

| FLAGS 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

| STEP | PROCEDURE | ENTER | PRESS | | | OUTPUT/MODE (see legend below) |
|---|---|---|---|---|---|---|
| | Enter Program | | | | | |
| 1 | Given: $E_i$, $E_o$, & $R_t$ - Find: $R_1$, $R_2$, $I_i$, $I_{RL}$, $P_{R1}$ & $P_{R2}$ | | | | | |
| a. | Enter known parameters (any order) | $E_i$ | | A | | $E_i$ |
| | | $E_o$ | | B | | $E_o$ |
| | | $R_t$ | | E | | $R_t$ |
| | (if $R_L \neq 10^6$ ohms) | $R_L$ | STO | 0 | 8 | $R_L$ |
| | (else press R/S after E) | | | | | |
| b. | Run program | | 2nd | A' | | $I_{RL}$ |
| | --to display all parameters, go to step 3. | | | | | |
| 2. | Given: $E_i$, $R_1$, & $R_2$ - Find: $E_o$, $R_t$, $I_i$, $I_{RL}$, $P_{R1}$ & $P_{R2}$ | | | | | |
| a. | Enter known parameters (any order) | $E_i$ | | A | | $E_i$ |
| | | $R_1$ | | C | | $R_1$ |
| | | $R_2$ | | D | | $R_2$ |
| | (if $R_L \neq 10^6$ ohms) | $R_L$ | STO | 0 | 8 | $R_L$ |
| | (else press R/S after E) | | 2nd | E' | | $I_{RL}$ |
| b. | Run program - 2 -- to display all parameters, go to step 3. | | | | | |
| 3 | To display desired parameters after running either program -- | | | | | |
| | | $E_i$ | RCL | 0 | 1 | $E_i$ |
| | | $E_o$ | 2nd | B' | | $E_o$ |

DATA REGISTERS (INV List)

| | |
|---|---|
| 0 | |
| 1 | $E_i$ |
| 2 | $R_1$ |
| 3 | $R_2$ |
| 4 | $E_o$ |
| 5 | $P_{R1}$ |
| 6 | $P_{R2}$ |
| 7 | $R_t$ |
| 8 | $R_L$ |
| 9 | |
| 0 | |
| 11 | $I_i$ |
| 12 | |
| 13 | |
| 14 | $I_{RL}$ |
| 15 | |
| 16 | |
| 17 | |
| 18 | |
| 19 | $R_o$ |

Modes: (n)•—Printed only (n)—Displayed Briefly ( Pause )

Continued From: ☐ Program Description ☒ User Instructions ☐ Stmt. of Example

Program Title: RESISTIVE VOLTAGE DIVIDER

Rev.

| | | | |
|---|---|---|---|
| $R_1$ | 2nd | C' | $R_1$ |
| $R_2$ | 2nd | D' | $R_2$ |
| $R_t$ | RCL | 0 7 | $R_t$ |
| $I_i$ | RCL | 1 1 | $I_i$ |
| $I_{RL}$ | RCL | 1 4 | $I_{RL}$ |
| $P_{R1}$ | RCL | 0 5 | $P_{R1}$ |
| $P_{R2}$ | RCL | 0 6 | $P_{R2}$ |

## Sample Problem

Statement of Example

Design a resistive voltage divider network which will provide an output voltage of 5.5 volts 0.25 volts with an input voltage of 7.15 volts. The network will be presented with a load resistance of 10,000 ohms. The input current (source loading) shall be between 0.9 and 1.1 ma. Determine the standard (5%) resistance values for $R_1$ and $R_2$, also the minimum (standard) power rating of both resistors which will allow at least 200% safety margin.

☐ See Continuation Sheet

| ENTER | PRESS | OUTPUT/MODE (see legend below) | COMMENT |
|---|---|---|---|
| Enter program | | | |
| The total resistance ($R_t$) is determined by $E_i$ $I_i$ and in this case is 7150 ohms The following sequence will enter the initial values and compute the precise values for $R_1$ and $R_2$. | | | |
| ($R_t$) 7150 | E | 7150 | |
| ($E_i$) 7.15 | A | 7.15 | |
| ($E_o$) 5.5 | B | 5.5 | |
| ($R_L$) 10000 | STO 0 8 | 10000 | |
| run program 1 | 2nd A' | 0.00055 | load current ($I_{R_L}$) |
| display R1 | 2nd C' | 1650 | ohms (R1) |
| Display R2 | 2nd D' | 1222.22222 | ohms (R2) |
| Select standard values for R1 and R2 (from table 2) as inputs to program 2. (Ei) need not be reentered - see note 1). | | | |
| (R1) 1600 | C | 1600 | |
| (R2) 12000 | D | 12000 | |
| run program | 2 2nd E' | .0005528351 | load current (IRL) |
| display Eo | 2nd B' | 5.528350515 | volts (Eo) |
| display Ii | RCL 1 1 | .0010135309 | amps (Ii) |

Modes: (n)*—Printed only (n)—Displayed Briefly ( Pause )
n*—Printed and displayed

☐ Over

# PPX-59 Professional Program Exchange
# Sample Problem (cont'd)

These values for R1 and R2 meet the tolerances set in the original problem, however other values could (and should) be tried.

Enter 1800 ohms for R1 and recompute.

| ENTER | PRESS | OUTPUT/MODE (see legend below) | COMMENT |
|---|---|---|---|
| (R1) 1800 | C | 1800 | |
| run program | 2 2nd E' | 0.000537594 | amps ($I_{R_L}$) |
| display Eo | 2nd B' | 5.37593985 | volts |

Although still within tolerance, the error in output voltage is greater than the first run. Try a new standard value for R2 (15 Kohms).

| ENTER | PRESS | OUTPUT/MODE (see legend below) | COMMENT |
|---|---|---|---|
| (R2) 15 000 | D | 15000 | |
| run program | 2 2nd E' | 0.00055 | amps ($I_{R_L}$) |
| display Eo | 2nd B' | 5.5 | volts |
| display Ii | RCL 1 1 | .0009166667 | amps |
| display PR1 | RCL 0 5 | 0.0015125 | watts |
| display PR2 | RCL 0 6 | 0.0020166667 | watts |

These computed values are within the tolerances required - Eo being exact.

Standard 1/10 watt resistors would be suitable for both R1 and R2.

(Total design time including loading the program - less than 5 minutes.)

Modes: (n)*—Printed only (n)—Displayed Briefly ( Pause )
n*—Printed and displayed

# PPX-59 Professional Program Exchange

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6 5 | 8 0 0 7
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| LOC | CODE | KEY | COMMENTS |
|---|---|---|---|
| 000 | 76 | LBL | |
| 001 | 16 | A' | |
| 002 | 43 | RCL | |
| 003 | 01 | 01 | |
| 004 | 55 | ÷ | |
| 005 | 43 | RCL | |
| 006 | 07 | 07 | |
| 007 | 95 | = | |
| 008 | 42 | STO | |
| 009 | 11 | 11 | |
| 010 | 43 | RCL | |
| 011 | 01 | 01 | |
| 012 | 75 | - | |
| 013 | 43 | RCL | |
| 014 | 04 | 04 | |
| 015 | 95 | = | |
| 016 | 55 | ÷ | |
| 017 | 43 | RCL | |
| 018 | 11 | 11 | |
| 019 | 95 | = | |
| 020 | 42 | STO | |
| 021 | 02 | 02 | |
| 022 | 94 | +/- | |
| 023 | 85 | + | |
| 024 | 43 | RCL | |
| 025 | 07 | 07 | |
| 026 | 95 | = | |
| 027 | 42 | STO | |
| 028 | 19 | 19 | |
| 029 | 65 | × | |
| 030 | 43 | RCL | |
| 031 | 08 | 08 | |
| 032 | 55 | ÷ | |
| 033 | 53 | ( | |
| 034 | 43 | RCL | |
| 035 | 08 | 08 | |
| 036 | 75 | - | |
| 037 | 43 | RCL | |
| 038 | 19 | 19 | |
| 039 | 95 | = | |
| 040 | 42 | STO | |
| 041 | 03 | 03 | |
| 042 | 61 | GTO | |
| 043 | 48 | EXC | |
| 044 | 76 | LBL | |
| 045 | 10 | E' | |
| 046 | 43 | RCL | |
| 047 | 03 | 03 | |
| 048 | 65 | × | |
| 049 | 43 | RCL | |
| 050 | 08 | 08 | |
| 051 | 55 | ÷ | |
| 052 | 53 | ( | |
| 053 | 43 | RCL | |
| 054 | 08 | 08 | |
| 055 | 85 | + | |
| 056 | 43 | RCL | |
| 057 | 03 | 03 | |
| 058 | 95 | = | |
| 059 | 42 | STO | |
| 060 | 19 | 19 | |
| 061 | 85 | + | |
| 062 | 43 | RCL | |
| 063 | 02 | 02 | |
| 064 | 95 | = | |
| 065 | 42 | STO | |
| 066 | 07 | 07 | |
| 067 | 35 | 1/X | |
| 068 | 65 | × | |
| 069 | 43 | RCL | |
| 070 | 01 | 01 | |
| 071 | 95 | = | |
| 072 | 42 | STO | |
| 073 | 11 | 11 | |
| 074 | 65 | × | |
| 075 | 43 | RCL | |
| 076 | 19 | 19 | |
| 077 | 95 | = | |
| 078 | 42 | STO | |
| 079 | 04 | 04 | |
| 080 | 76 | LBL | |
| 081 | 48 | EXC | |
| 082 | 43 | RCL | |
| 083 | 11 | 11 | |
| 084 | 33 | X² | |
| 085 | 65 | × | |
| 086 | 43 | RCL | |
| 087 | 02 | 02 | |
| 088 | 95 | = | |
| 089 | 42 | STO | |
| 090 | 05 | 05 | |
| 091 | 43 | RCL | |
| 092 | 04 | 04 | |
| 093 | 33 | X² | |
| 094 | 55 | ÷ | |
| 095 | 43 | RCL | |
| 096 | 03 | 03 | |
| 097 | 95 | = | |
| 098 | 42 | STO | |
| 099 | 06 | 06 | |
| 100 | 43 | RCL | |
| 101 | 04 | 04 | |
| 102 | 55 | ÷ | |
| 103 | 43 | RCL | |
| 104 | 08 | 08 | |
| 105 | 95 | = | |
| 106 | 42 | STO | |
| 107 | 14 | 14 | |
| 108 | 92 | RTN | |
| 109 | 76 | LBL | |
| 110 | 17 | B' | |
| 111 | 43 | RCL | |
| 112 | 04 | 04 | |
| 113 | 92 | RTN | |
| 114 | 76 | LBL | |
| 115 | 18 | C' | |
| 116 | 43 | RCL | |
| 117 | 02 | 02 | |
| 118 | 92 | RTN | |
| 119 | 76 | LBL | |
| 120 | 19 | D' | |
| 121 | 43 | RCL | |
| 122 | 03 | 03 | |
| 123 | 92 | RTN | |
| 124 | 76 | LBL | |
| 125 | 11 | A | |
| 126 | 42 | STO | |
| 127 | 01 | 01 | |
| 128 | 92 | RTN | |
| 129 | 76 | LBL | |
| 130 | 12 | B | |
| 131 | 42 | STO | |
| 132 | 04 | 04 | |
| 133 | 92 | RTN | |
| 134 | 76 | LBL | |
| 135 | 13 | C | |
| 136 | 42 | STO | |
| 137 | 02 | 02 | |
| 138 | 92 | RTN | |
| 139 | 76 | LBL | |
| 140 | 14 | D | |
| 141 | 42 | STO | |
| 142 | 03 | 03 | |
| 143 | 92 | RTN | |
| 144 | 76 | LBL | |
| 145 | 15 | E | |
| 146 | 42 | STO | |
| 147 | 07 | 07 | |
| 148 | 91 | R/S | |
| 149 | 01 | 1 | |
| 150 | 52 | EE | |
| 151 | 06 | 6 | |
| 152 | 42 | STO | |
| 153 | 08 | 08 | |
| 154 | 92 | RTN | |

MERGED CODES

| | | |
|---|---|---|
| 62 Pgm Ind | 72 STO Ind | 83 GTO Ind |
| 63 Exc Ind | 73 RCL Ind | 84 Op Ind |
| 64 Prd Ind | 74 SUM Ind | 92 INV SBR |

**PPX-59**
professional
program exchange

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658008
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TEXAS INSTRUMENTS
Calculator Products Division

# Submission Abstract

| | |
|---|---|
| Program Title<br>FIELD EFFECT TRANSISTOR ANALYSIS | Rev. |

Abstract of Program

This program calculates the source bypass and coupling capacitors for a F.E.T. circuit. The method used is pole zero cancellation. The program is designed for a low frequency analysis. Engineering notation is used.

Original SR-52 Program by Alan Charbonneau, San Luis Obispo, Calif., Sept. 1976

User Benefits:

This program allows the user to vary circuit parameters and quickly determine the effect on the circuit capacitances.

| | | | | |
|---|---|---|---|---|
| Category Name Electroni Eng. | Required Progs. | Prog. Steps 328 | Card Sides 2 | PC-100A Needed ☐<br>Library Module ID ☐ |

Submittal Agreement

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Address ______
City ______ State ______ Zip ______

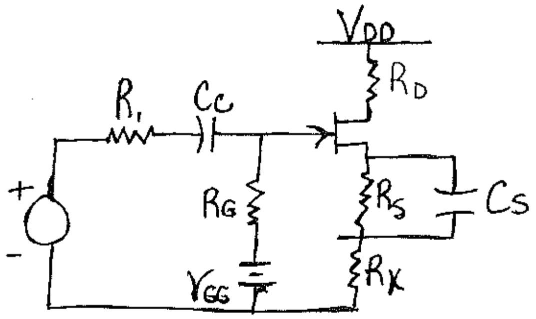
Submission Checklist

- ☑ Recorded Magnetic Cards
- ☑ Submission Abstract
- ☑ Program Description
- ☑ User Instructions
- ☑ Sample Problem
- ☑ Listing
- ☐ ______
- ☐ ______

Program Title:
Field Effect Transistor Analysis

Rev.

Method, Equations, Sketches, Limitations, References, Error Recovery:



The solution for the values of the coupling capacitors ($C_c$, $C_s$) requires that values are known for $R_1$, $R_s$, $R_G$, $R_x$, $g_m$ (mutual conductance) and the lower cut off frequency. ($f_L$ in Hz)

$$Ks = \frac{1 + g_m(Rx + Rs)}{1 + gmRx}$$

$R = R_1 + R_G$
$W = W_s$
$f_s = f_o \qquad f_s = \frac{fL}{Ks}$

$$C_s = \frac{1}{2\pi f_s R_s} \qquad C_c = \frac{1}{2\pi f_o R_o}$$

These equations only apply for a low frequency analysis.

References: L. F. Amplifier Notes
Calif. Polytechnic St. University (San Luis Obispo)

NOTE: Engineering Notation is used throughout the program. Fixed notation may be used with engineering notation only when used without a printer; the alphanumeric routines do not work in fixed notation.

☐ See Continuation Sheet

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## User Instructions

**Program Title** Field Effect Transistor Analysis

| | | | | |
|---|---|---|---|---|
| $R_G$ | $R_x$ | $f_L$ | Show $C_s$ | Pt $C_c$, $C_s$ |
| $R_1$ | $R_s$ | $g_m$ | find $C_c$ | Print All |

Partition (OP 17) 479 . 59 * Parenthesis Levels 3

t Register ☑

Angular Mode (if applicable) N/A

SBR Levels 2

Absolute Addresses ☐

Library Module ID No

* for TI-58 399.09

Disturbs Pending Operations ☐

LABELS (Op 08)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| INV | | lnx | | CE | | CLR | | x⇌t | | $x^2$ | |
| √x | | 1/x | | STO | | RCL | ✓ | SUM | | $y^x$ | |
| EE | | ( | | ) | | ÷ | | GTO | | × | |
| SBR | | − | | RST | | + | | R/S | | . | |
| +/− | | = | | CLR | | INV | | log | | CP | |
| tan | ✓ | Pgm | | P→R | | sin | | cos | | CMs | |
| Exc | ✓ | Prd | | \|x\| | | Eng | | Fix | | Int | |
| Deg | | Pause | | x=t | | Nop | | Op | | Rad | |
| Lbl | | x≥t | | Σ+ | | x̄ | | Grad | | St flg | |
| If flg | | D.MS | | π | | List | | Write | | Dsz | ✓ |
| Adv | | Prt | ✓ | | | | | | | | |

USER DEFINED KEYS

| | |
|---|---|
| A | Enter $R_1$ |
| B | Enter $R_s$ |
| C | Enter $g_m$ |
| D | Calculate $C_c$ |
| E | Print input and output |
| A' | Enter $R_c$ |
| B' | Enter $R_x$ |
| C' | Enter $f_L$ |
| D' | Recall $C_s$ |
| E' | Print only $C_c$, $C_s$ |

| FLAGS | Not Used 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|

| STEP | PROCEDURE | ENTER | PRESS | | OUTPUT/MODE (see legend below) |
|---|---|---|---|---|---|
| 1 | Enter Program Banks 1 and 2 (w/o printer bank 1 only) | | | | |
| 2 | Enter $R_1$ | $R_1$ | | A | $R_1$* |
| 3 | Enter $R_G$ | $R_G$ | 2nd | *A' | $R_G$* |
| 4 | Enter $R_s$ | $R_s$ | | B | $R_s$* |
| 5 | Enter $R_x$ | $R_x$ | 2nd | *B' | $R_x$* |
| 6 | Enter $g_m$ | $g_m$ | | C | $g_m$* |
| 7 | Enter $f_L$ | $f_L$ | 2nd | *C' | $f_L$* |
| | WITHOUT PRINTER | | | | |
| 8 | Calculate $C_c$ and $C_s$ and display $C_c$ | | | D | $C_c$ |
| 9 | Recall value of $C_s$ calculated in step 8 | | 2nd | *D' | $C_s$ |

Modes: (n)*—Printed only (n)—Displayed Briefly ( Pause )
n*—Printed and displayed

DATA REGISTERS (INV List)

| | |
|---|---|
| 0 | Looping |
| 1 | $R_1$ |
| 2 | $R_G$ |
| 3 | $R_s$ |
| 4 | $R_x$ |
| 5 | $g_m$ |
| 6 | $f_L$ |
| 7 | $f_s$ |
| 8 | $C_c$ |
| 9 | $C_s$ |
| 0 | |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |

☒ See Continuation Sheet

Continued From: ☐ Program Description ☒ User Instructions ☐ Stmt. of Example

Program Title: FIELD EFFECT TRANSISTOR ANALYSIS

Rev.

| STEP | PROCEDURE | PRESS | PRINTED OUTPUT | |
|---|---|---|---|---|
| | WITH PRINTER: | | | |
| 10 | Calculate $C_c$ and $C_s$ and print input and output | E | FET ANALYSIS | |
| | | | INPUT | |
| | | | $(R_l)$ | R1 |
| | | | $(R_9)$ | RG |
| | | | $(R_s)$ | RS |
| | | | $(R_x)$ | RX |
| | | | $(g_m)$ | GM |
| | | | $(f_L)$ | FL |
| | | | OUTPUT | |
| | | | $(C_c)$ | CC |
| | | | $(C_s)$ | CS |
| 11 | Calculate $C_c$ and $C_s$ and print output only | 2nd E | FET ANALYSIS | |
| | | | OUTPUT | |
| | | | $(C_c)$ | CC |
| | | | $(C_s)$ | CS |

NOTES:

Steps 2-7 may be executed in any order desired and can be changed individually before or after output is printed or displayed. Keys D, E and *E' will calculate both values. Key *D' will only recall the previously calculated value of $C_s$.
*CMs can be used to clear all inputted values.

## Sample Problem

Statement of Example

Given circuit parameters:
$R_l$ = 100 kΩ
$R_G$ = 2.2 MΩ
$R_c$ = 6.8 KΩ
$R_x$ = .33 KΩ
$g_m$ = 2.0 mV
$f_L$ = 8 Hz

Each parameter may be varied by choosing the appropriate user defined key.

☐ See Continuation Sheet

| ENTER | PRESS | OUTPUT/MODE (see legend below) | COMMENT |
|---|---|---|---|
| 100 EE 3 | A | 100. 03* | Enter $R_l$ |
| 2.2 EE 6 | 2nd A' | 2.2 06* | Enter $R_G$ |
| 6.8 EE 3 | B | 6.8 03* | Enter $R_s$ |
| 330 | 2nd B' | 330 00* | Enter $R_x$ |
| 2 EE 3± | C | 2. -03* | Enter $g_m$ |
| 8 | 2nd C' | 8. 00* | Enter $f_L$ |
| WITHOUT PRINTER: | | | |
| | D | 79.514943 -09 | $C_c$ and $C_s$ calculated<br>$C_c$ Displayed |
| | 2nd D | 26.89476 -06 | $C_s$ Displayed |

Modes: (n)*—Printed only (n)—Displayed Briefly ( Pause )
n*—Printed and displayed

☒ Over

# PPX-59 Professional Program Exchange Sample Problem (cont'd)

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6 5 8 0 0 8
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| ENTER | PRESS | OUTPUT/MODE (see legend below) | COMMENT |
|---|---|---|---|
| | WITH | PRINTER: | |
| | E | FET ANALYSIS | |
| | | INPUT | |
| | | 100. 03 R1 | |
| | | 2.2 06 RG | |
| | | 6.8 03 RS | |
| | | 330. 00 RX | |
| | | 2. -03 GM | |
| | | 8. 00 FL | |
| | | OUTPUT | |
| | | 79.514943-09 CC | |
| | | 26.89476-06 CS | |
| | 2nd E | FET ANALYSIS | |
| | | OUTPUT | |
| | | 79.514943-09 CC | |
| | | 26.89476-06 CS | |

Modes: (n)*—Printed only (n)—Displayed Briefly ( Pause )
n*—Printed and displayed

# PPX-59 Professional Program Exchange

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6 5 8 0 0 8

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| LOC | CODE | KEY | COMMENTS |
|---|---|---|---|
| 000 | 76 | LBL | |
| 001 | 43 | RCL | |
| 002 | 22 | INV | |
| 003 | 57 | ENG | |
| 004 | 69 | OP | |
| 005 | 04 | 04 | |
| 006 | 57 | ENG | |
| 007 | 73 | RC* | |
| 008 | 00 | 00 | |
| 009 | 69 | OP | |
| 010 | 06 | 06 | |
| 011 | 69 | OP | |
| 012 | 20 | 20 | |
| 013 | 92 | RTN | |
| 014 | 76 | LBL | |
| 015 | 97 | DSZ | |
| 016 | 22 | INV | |
| 017 | 57 | ENG | |
| 018 | 69 | OP | |
| 019 | 04 | 04 | |
| 020 | 57 | ENG | |
| 021 | 32 | X:T | |
| 022 | 69 | OP | |
| 023 | 06 | 06 | |
| 024 | 92 | RTN | |
| 025 | 76 | LBL | |
| 026 | 11 | A | |
| 027 | 42 | STO | |
| 028 | 01 | 01 | |
| 029 | 32 | X:T | |
| 030 | 03 | 3 | |
| 031 | 05 | 5 | |
| 032 | 00 | 0 | |
| 033 | 02 | 2 | |
| 034 | 61 | GTO | |
| 035 | 97 | DSZ | |
| 036 | 76 | LBL | |
| 037 | 16 | A' | |
| 038 | 42 | STO | |
| 039 | 02 | 02 | |
| 040 | 32 | X:T | |
| 041 | 03 | 3 | |
| 042 | 05 | 5 | |
| 043 | 02 | 2 | |
| 044 | 02 | 2 | |
| 045 | 61 | GTO | |
| 046 | 97 | DSZ | |
| 047 | 76 | LBL | |
| 048 | 12 | B | |
| 049 | 42 | STO | |
| 050 | 03 | 03 | |
| 051 | 32 | X:T | |
| 052 | 03 | 3 | |
| 053 | 05 | 5 | |
| 054 | 03 | 3 | |
| 055 | 06 | 6 | |
| 056 | 61 | GTO | |
| 057 | 97 | DSZ | |
| 058 | 76 | LBL | |
| 059 | 17 | B' | |
| 060 | 42 | STO | |
| 061 | 04 | 04 | |
| 062 | 32 | X:T | |
| 063 | 03 | 3 | |
| 064 | 05 | 5 | |
| 065 | 04 | 4 | |
| 066 | 04 | 4 | |
| 067 | 61 | GTO | |
| 068 | 97 | DSZ | |
| 069 | 76 | LBL | |
| 070 | 13 | C | |
| 071 | 42 | STO | |
| 072 | 05 | 05 | |
| 073 | 32 | X:T | |
| 074 | 02 | 2 | |
| 075 | 02 | 2 | |
| 076 | 03 | 3 | |
| 077 | 00 | 0 | |
| 078 | 61 | GTO | |
| 079 | 97 | DSZ | |
| 080 | 76 | LBL | |
| 081 | 18 | C' | |
| 082 | 42 | STO | |
| 083 | 06 | 06 | |
| 084 | 32 | X:T | |
| 085 | 02 | 2 | |
| 086 | 01 | 1 | |
| 087 | 02 | 2 | |
| 088 | 07 | 7 | |
| 089 | 61 | GTO | |
| 090 | 97 | DSZ | |
| 091 | 76 | LBL | |
| 092 | 14 | D | |
| 093 | 71 | SBR | |
| 094 | 30 | TAN | |
| 095 | 43 | RCL | |
| 096 | 08 | 08 | |
| 097 | 92 | RTN | |
| 098 | 76 | LBL | |
| 099 | 19 | D' | |
| 100 | 43 | RCL | |
| 101 | 09 | 09 | |
| 102 | 92 | RTN | |
| 103 | 76 | LBL | |
| 104 | 30 | TAN | |
| 105 | 53 | ( | |
| 106 | 43 | RCL | |
| 107 | 06 | 06 | |
| 108 | 65 | × | |
| 109 | 53 | ( | |
| 110 | 43 | RCL | |
| 111 | 05 | 05 | |
| 112 | 65 | × | |
| 113 | 43 | RCL | |
| 114 | 04 | 04 | |
| 115 | 85 | + | |
| 116 | 01 | 1 | |
| 117 | 54 | ) | |
| 118 | 55 | ÷ | |
| 119 | 53 | ( | |
| 120 | 53 | ( | |
| 121 | 43 | RCL | |
| 122 | 04 | 04 | |
| 123 | 85 | + | |
| 124 | 43 | RCL | |
| 125 | 03 | 03 | |
| 126 | 54 | ) | |
| 127 | 65 | × | |
| 128 | 43 | RCL | |
| 129 | 05 | 05 | |
| 130 | 85 | + | |
| 131 | 01 | 1 | |
| 132 | 54 | ) | |
| 133 | 54 | ) | |
| 134 | 53 | ( | |
| 135 | 42 | STO | |
| 136 | 07 | 07 | |
| 137 | 65 | × | |
| 138 | 02 | 2 | |
| 139 | 65 | × | |
| 140 | 89 | π | |
| 141 | 65 | × | |
| 142 | 53 | ( | |
| 143 | 43 | RCL | |
| 144 | 01 | 01 | |
| 145 | 85 | + | |
| 146 | 43 | RCL | |
| 147 | 02 | 02 | |
| 148 | 54 | ) | |
| 149 | 54 | ) | |
| 150 | 35 | 1/X | |
| 151 | 42 | STO | |
| 152 | 08 | 08 | |

MERGED CODES

| | | |
|---|---|---|
| 62 Pgm Ind | 72 STO Ind | 83 GTO Ind |
| 63 Exc Ind | 73 RCL Ind | 84 Op Ind |
| 64 Prd Ind | 74 SUM Ind | 92 INV SBR |

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6,5 8,0,0,8
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| LOC | CODE | KEY | COMMENTS |
|---|---|---|---|
| 153 | 53 | ( | |
| 154 | 02 | 2 | |
| 155 | 65 | × | |
| 156 | 89 | π | |
| 157 | 65 | × | |
| 158 | 43 | RCL | |
| 159 | 07 | 07 | |
| 160 | 65 | × | |
| 161 | 43 | RCL | |
| 162 | 03 | 03 | |
| 163 | 54 | ) | |
| 164 | 35 | 1/X | |
| 165 | 42 | STO | |
| 166 | 09 | 09 | |
| 167 | 92 | RTN | |
| 168 | 76 | LBL | |
| 169 | 15 | E | |
| 170 | 22 | INV | |
| 171 | 57 | ENG | |
| 172 | 71 | SBR | |
| 173 | 30 | TAN | |
| 174 | 71 | SBR | |
| 175 | 99 | PRT | |
| 176 | 01 | 1 | |
| 177 | 42 | STO | |
| 178 | 00 | 00 | |
| 179 | 69 | OP | |
| 180 | 00 | 00 | |
| 181 | 02 | 2 | |
| 182 | 04 | 4 | |
| 183 | 03 | 3 | |
| 184 | 01 | 1 | |
| 185 | 03 | 3 | |
| 186 | 03 | 3 | |
| 187 | 04 | 4 | |
| 188 | 01 | 1 | |
| 189 | 03 | 3 | |
| 190 | 07 | 7 | |
| 191 | 69 | OP | |
| 192 | 03 | 03 | |
| 193 | 69 | OP | |
| 194 | 05 | 05 | |
| 195 | 03 | 3 | |
| 196 | 05 | 5 | |
| 197 | 00 | 0 | |
| 198 | 02 | 2 | |
| 199 | 71 | SBR | |
| 200 | 43 | RCL | |
| 201 | 03 | 3 | |
| 202 | 05 | 5 | |
| 203 | 02 | 2 | |
| 204 | 02 | 2 | |
| 205 | 71 | SBR | |
| 206 | 43 | RCL | |
| 207 | 03 | 3 | |
| 208 | 05 | 5 | |
| 209 | 03 | 3 | |
| 210 | 06 | 6 | |
| 211 | 71 | SBR | |
| 212 | 43 | RCL | |
| 213 | 03 | 3 | |
| 214 | 05 | 5 | |
| 215 | 04 | 4 | |
| 216 | 04 | 4 | |
| 217 | 71 | SBR | |
| 218 | 43 | RCL | |
| 219 | 02 | 2 | |
| 220 | 02 | 2 | |
| 221 | 03 | 3 | |
| 222 | 00 | 0 | |
| 223 | 71 | SBR | |
| 224 | 43 | RCL | |
| 225 | 02 | 2 | |
| 226 | 01 | 1 | |
| 227 | 02 | 2 | |
| 228 | 07 | 7 | |
| 229 | 71 | SBR | |
| 230 | 43 | RCL | |
| 231 | 98 | ADV | |
| 232 | 76 | LBL | |
| 233 | 48 | EXC | |
| 234 | 08 | 8 | |
| 235 | 42 | STO | |
| 236 | 00 | 00 | |
| 237 | 69 | OP | |
| 238 | 00 | 00 | |
| 239 | 22 | INV | |
| 240 | 57 | ENG | |
| 241 | 03 | 3 | |
| 242 | 02 | 2 | |
| 243 | 69 | OP | |
| 244 | 02 | 02 | |
| 245 | 04 | 4 | |
| 246 | 01 | 1 | |
| 247 | 03 | 3 | |
| 248 | 07 | 7 | |
| 249 | 03 | 3 | |
| 250 | 03 | 3 | |
| 251 | 04 | 4 | |
| 252 | 01 | 1 | |
| 253 | 03 | 3 | |
| 254 | 07 | 7 | |
| 255 | 69 | OP | |
| 256 | 03 | 03 | |
| 257 | 69 | OP | |
| 258 | 05 | 05 | |
| 259 | 01 | 1 | |
| 260 | 05 | 5 | |
| 261 | 01 | 1 | |
| 262 | 05 | 5 | |
| 263 | 71 | SBR | |
| 264 | 43 | RCL | |
| 265 | 01 | 1 | |
| 266 | 05 | 5 | |
| 267 | 03 | 3 | |
| 268 | 06 | 6 | |
| 269 | 71 | SBR | |
| 270 | 43 | RCL | |
| 271 | 98 | ADV | |
| 272 | 98 | ADV | |
| 273 | 98 | ADV | |
| 274 | 92 | RTN | |
| 275 | 76 | LBL | |
| 276 | 99 | PRT | |
| 277 | 22 | INV | |
| 278 | 57 | ENG | |
| 279 | 69 | OP | |
| 280 | 00 | 00 | |
| 281 | 02 | 2 | |
| 282 | 01 | 1 | |
| 283 | 00 | 0 | |
| 284 | 00 | 0 | |
| 285 | 01 | 1 | |
| 286 | 07 | 7 | |
| 287 | 00 | 0 | |
| 288 | 00 | 0 | |
| 289 | 03 | 3 | |
| 290 | 07 | 7 | |
| 291 | 69 | OP | |
| 292 | 02 | 02 | |
| 293 | 01 | 1 | |
| 294 | 03 | 3 | |
| 295 | 03 | 3 | |
| 296 | 01 | 1 | |
| 297 | 01 | 1 | |
| 298 | 03 | 3 | |
| 299 | 69 | OP | |
| 300 | 03 | 03 | |

MERGED CODES

| | | |
|---|---|---|
| 62 Pgm Ind | 72 STO Ind | 83 GTO Ind |
| 63 Exc Ind | 73 RCL Ind | 84 Op Ind |
| 64 Prd Ind | 74 SUM Ind | 92 INV SBR |

# PPX-59 Professional Program Exchange

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| LOC | CODE | KEY | COMMENTS | LOC | CODE | KEY | COMMENTS | LOC | CODE | KEY | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 322 | 30 | TAN | | | | | | | | | |
| 323 | 71 | SBR | | | | | | | | | |
| 324 | 99 | PRT | | | | | | | | | |
| 325 | 71 | SBR | | | | | | | | | |
| 326 | 48 | EXC | | | | | | | | | |
| 327 | 92 | RTN | | | | | | | | | |
| 328 | 00 | 0 | | | | | | | | | |
| 329 | 00 | 0 | | | | | | | | | |
| 330 | 00 | 0 | | | | | | | | | |

MERGED CODES

62 Pgm Ind
63 Exc Ind
64 Prd Ind
72 STO Ind
73 RCL Ind
74 SUM Ind
83 GTO Ind
84 Op Ind
92 INV SBR

PPX-59
professional
program exchange

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TEXAS INSTRUMENTS
Calculator Products Division

# Submission Abstract

| | |
|---|---|
| Program Title SOLUTION OF RESISTIVE NETWORKS | Rev. |

**Abstract of Program**

This program solves for the total resistance of both simple and complicated D.C. networks.

Original SR-52 Program by Craig Byrd of Chula Vista, California

**User Benefits:**

Assists in solving resistive networks. Also can be used to solve capacitive and inductive circuits.

| | | | | |
|---|---|---|---|---|
| Category Name Electroni Eng. | Required Progs. | Prog. Steps 170 | Card Sides 1 | PC-100A Needed ☐<br>Library Module ID ☐ |

**Submittal Agreement**

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Signature ____________ Date ____________

Name Texas Instruments Tel. No. ____________

Address ____________

City ____________ State ____________ Zip ____________

**Submission Checklist**

- ☑ Recorded Magnetic Cards
- ☑ Submission Abstract
- ☑ Program Description
- ☑ User Instructions
- ☑ Sample Problem
- ☑ Listing
- ☐ ____________
- ☐ ____________

**IMPORTANT**

Program Title: SOLUTION OF RESISTIVE NETWORKS

Rev.

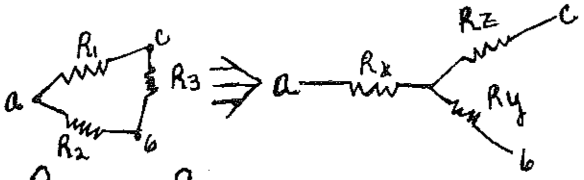
Method, Equations, Sketches, Limitations, References, Error Recovery:

This program uses network simplification to solve for the $\Delta$to y and y to $\Delta$networks. It also sums series resistors and sums the reciprocals of parallel resistors to solve for the total resistance.

Eqs.

$$R_T\text{ (series)} = R_1 + R_2 + R_3 \;.... + R_n \qquad R_T\text{ (parallel)} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \;... + \frac{1}{R_n}$$

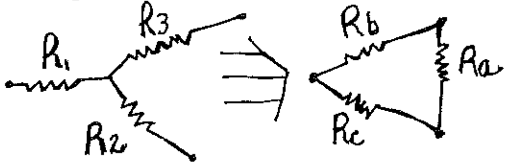
$R_\Delta$ to $R_y$



$$Rx = \frac{R_1 \cdot R_2}{(R_1+R_2+R_3)} \qquad Rz = \frac{R_1 \cdot R_3}{(R_1+R_2+R_3)}$$

$$Ry = \frac{R_2 \cdot R_3}{(R_1+R_2+R_3)}$$

$R_y$ to $R_\Delta$



$$Ra = \frac{R_1R_2+R_2R_3+R_3R_1}{R_1}$$

$$Rb = \frac{R_1R_2+R_2R_3+R_3R_1}{R_2}$$

$$Rc = \frac{R_1R_2+R_2R_3+R_3R_1}{R_3}$$

*Solve $\Delta$to y ckts
first and then sum the series and
parallel legs to find the total resistance.

PPX-59 professional program exchange

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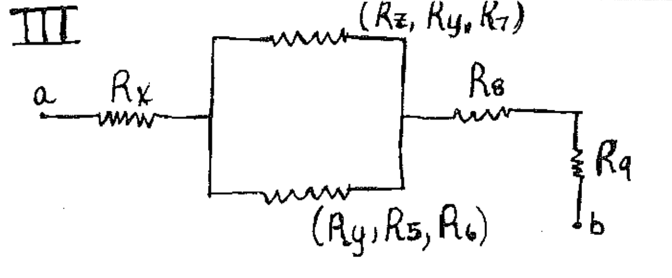
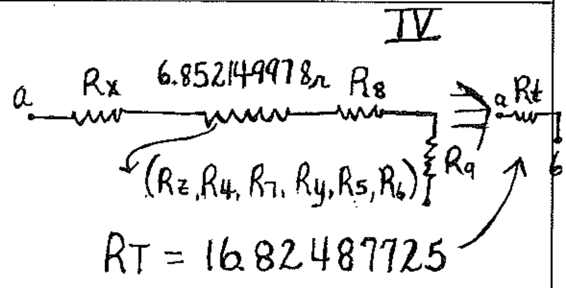
TEXAS INSTRUMENTS
Calculator Products Division

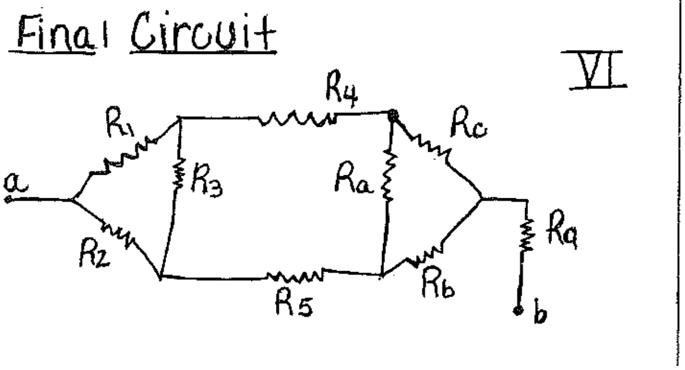
Continued From: ☒ Program Description ☐ User Instructions ☐ Stmt. of Example

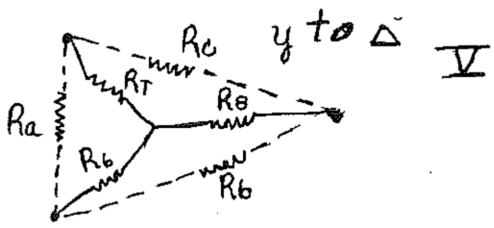
Program Title: SOLUTION OF RESISTIVE NETWORKS

Rev.



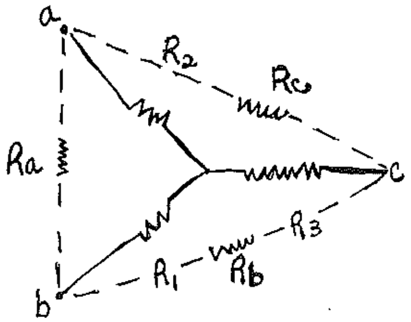






*Procedure for Solving Circuitry:
Solve Δ to y transformations first
In transforming from Δ to y networks, if the R values are entered clockwise, the Rx, Ry and Rz values are shown in their respective clockwise positions. If the Δ resistors are entered counter clockwise, the y resistors value are shown in their counter clockwise position.

In transforming a Y circuit to a Δ circuit the Δ value resistor are shown opposite the y value entry.



Example: If Y entered 3-2-1 the Δ values are 3.67Ω (Ra) Opposite $R_3$, 5.5Ω (Rb) Opposite $R_2$ and the 1Ω (Rc) Opposite $R_1$.

In using the Δ to Y or Y to Δ methods you must press E to initialize the program

Page 4 of 8     6 5 8 0 0 9

**PPX-59**
professional
program exchange

# User Instructions

Program Title SOLUTION OF RESISTIVE NETWORKS

|  |  |  |  |  |
|---|---|---|---|---|
|  | Recall | Recall |  |  |
| Δ - Y | Series | Parallel | Y - Δ | Init. |

Partition (OP 17) 479 , 59 *
Parenthesis Levels 1
t Register ☐
Angular Mode (if applicable)
SBR Levels 1
Absolute Addresses ☑
Library Module ID
* for TI-58 239.29
Disturbs Pending Operations ☐

LABELS (Op 08)

|  |  |  |  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|
| INV |  | lnx |  | CE |  | CLR |  | x⇌t |  | $x^2$ |  |
| √x |  | 1/x |  | STO | ✓ | RCL | ✓ | SUM | ✓ | $y^x$ | ✓ |
| EE | ✓ | ( |  | ) |  | ÷ | ✓ | GTO |  | × |  |
| SBR |  | − | ✓ | RST |  | + | ✓ | R/S |  | . |  |
| +/− |  | = |  | CLR |  | INV |  | log |  | CP |  |
| tan | ✓ | Pgm |  | P→R |  | sin | ✓ | cos | ✓ | CMs |  |
| Exc |  | Prd |  | \|x\| |  | Eng |  | Fix |  | Int |  |
| Deg |  | Pause |  | x=t |  | Nop |  | Op |  | Rad |  |
| Lbl |  | x≥t |  | Σ+ |  | $\bar{x}$ |  | Grad |  | St flg |  |
| If flg |  | D.MS |  | π |  | list |  | Write |  | Dsz |  |
| Adv |  | Prt |  |  |  |  |  |  |  |  |  |

USER DEFINED KEYS

| | |
|---|---|
| A | Δ to Y |
| B | Series |
| C | Parallel |
| D | Y to Δ |
| E | Initialize |
| A' | |
| B' | Series Total |
| C' | Parallel Total |
| D' | |
| E' | |

| FLAGS 0 | Branch Cont. 1 | Branch Cont. 2 | Branch Cont. 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|

| STEP | PROCEDURE | ENTER | PRESS | OUTPUT/MODE (see legend below) |
|---|---|---|---|---|
| 1 | Enter Program | | | |
| 2 | Initialize | | E | 0 |
| 3 | ΔR Values (If any) | $R_1$, $R_2$ & $R_3$ | A (3 tms) | 0 |
| | ΔR Solutions | | R/S (3 tms) | Rx, Ry, Rz |
| 5 | Initialize | | E | 0 |
| 6 | YR Values (If Any) | $R_1$, $R_2$ & $R_3$ | D (3 tms) | $R_1$, $R_2$, 0 |
| 7 | Press Run 5 times | | R/S | 0, 0, Ra, Rb, Rc |
| 8 | Series Networks ($R_1$-$R_N$) | (Series Values) | B | 0 |
| 9 | Series Sum ($R_1$ - $R_N$) | | B' | Series Sum |
| 10 | Parallel Networks ( $\frac{1}{R_1} - \frac{1}{R_N}$ ) | (Parl. Values) | C | 0 |
| 11 | Parallel Sum ( $\frac{1}{R_1} - \frac{1}{R_N}$ ) | | C' | Parallel Sum |

DATA REGISTERS (INV list)

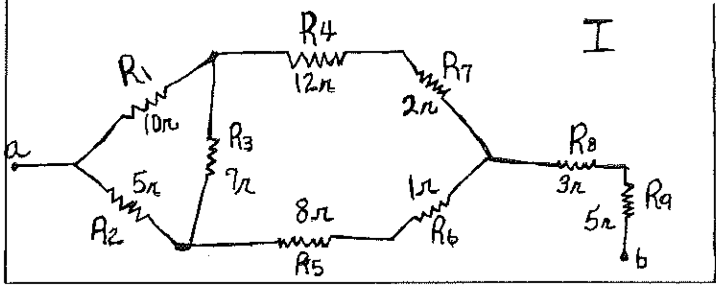
0 Pointer
1 Δ or Y Values
2 Δ or Y Values
3 Δ or Y Values
4 Sum of Δ Values
5 Series Sums
6 Parallel Sums
7 Sum of Y Values
8
9
0
1
2
3
4
5
6
7
8
9

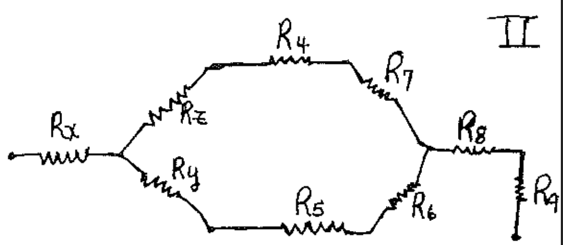
Modes: (n)*—Printed only (n)—Displayed Briefly ( Pause )

## Sample Problem

Statement of Example

Solve the following resistive network for the total resistance and then transform the Y network ($R_8$, $R_7$ & $R_6$) into a ⊿ network (Ra, Rb, & Rc)





☐ See Continuation Sheet

| ENTER | PRESS | OUTPUT/MODE (see legend below) | COMMENT |
|---|---|---|---|
| | E | 0 | Initialize |
| 10 | A | 10 | $R_1$ Δ to Y |
| 5 | A | 5 | $R_2$ |
| 7 | A | 0 | $R_3$ |
| | R/S | 2.272727273 | Rx |
| | R/S | 1.590909091 | Ry |
| | R/S | 3.181818182 | Rz |
| | B | 0 | Series Leg (Rz) |
| 12 | B | 0 | ($R_4$) |
| 2 | B | 0 | ($R_7$) |
| | B' | 17.18181818 | Series Leg Total |
| | C | 0 | 1st Parallel Leg |
| 1.590909091 | B | 0 | Series Leg (Ry) |
| 8 | B | 0 | ($R_5$) |
| 1 | B | 0 | ($R_6$) |
| | B' | 10.59090909 | Series Leg Total |
| | C | 0 | 2nd Parallel Leg |
| | C' | 6.552149978 | Parallel Total |
| | B | 0 | Parallel Total |
| 2.272727273 | B | 0 | Rx |
| 3 | B | 0 | R8 |
| 5 | B | 0 | R9 |
| | B' | 16.82487725 | CKT R Total |

Modes: (n)*—Printed only (n)—Displayed Briefly ( Pause )
n* --Printed and displayed

☐ Over

# PPX-59 Professional Program Exchange
# Sample Problem (cont'd)

| ENTER | PRESS | OUTPUT/MODE (see legend below) | COMMENT |
|---|---|---|---|
| | E | 0 | Initialize |
| 3 | D | 3 | $R_8$ Y |
| 2 | D | 2 | $R_7$ to |
| 1 | D | 0 | $R_6$ Δ |
| | R/S | 0 | |
| | R/S | 0 | |
| | R/S | 3.666666667 | |
| | R/S | 5.5 | |
| | R/S | 11 | |

Modes: (n)* —Printed only (n)—Displayed Briefly ( Pause )
n* —Printed and displayed

# PPX-59 Professional Program Exchange

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| LOC | CODE | KEY | COMMENTS |
|---|---|---|---|
| 000 | 76 | LBL | |
| 001 | 16 | A' | |
| 002 | 03 | 3 | |
| 003 | 42 | STO | |
| 004 | 00 | 00 | |
| 005 | 87 | IFF | |
| 006 | 02 | 02 | |
| 007 | 44 | SUM | |
| 008 | 25 | CLR | |
| 009 | 91 | R/S | |
| 010 | 92 | RTN | |
| 011 | 76 | LBL | |
| 012 | 11 | A | |
| 013 | 72 | ST* | |
| 014 | 00 | 00 | |
| 015 | 44 | SUM | |
| 016 | 04 | 04 | |
| 017 | 97 | DSZ | |
| 018 | 00 | 00 | |
| 019 | 91 | R/S | |
| 020 | 16 | A' | |
| 021 | 76 | LBL | |
| 022 | 39 | COS | |
| 023 | 73 | RC* | |
| 024 | 00 | 00 | |
| 025 | 97 | DSZ | |
| 026 | 00 | 00 | |
| 027 | 43 | RCL | |
| 028 | 86 | STF | |
| 029 | 01 | 01 | |
| 030 | 86 | STF | |
| 031 | 02 | 02 | |
| 032 | 03 | 3 | |
| 033 | 42 | STO | |
| 034 | 00 | 00 | |
| 035 | 61 | GTO | |
| 036 | 39 | COS | |
| 037 | 76 | LBL | |
| 038 | 43 | RCL | |
| 039 | 87 | IFF | |
| 040 | 01 | 01 | |
| 041 | 38 | SIN | |
| 042 | 76 | LBL | |
| 043 | 30 | TAN | |
| 044 | 65 | × | |
| 045 | 73 | RC* | |
| 046 | 00 | 00 | |
| 047 | 55 | ÷ | |
| 048 | 43 | RCL | |
| 049 | 04 | 04 | |
| 050 | 95 | = | |
| 051 | 91 | R/S | |
| 052 | 87 | IFF | |
| 053 | 02 | 02 | |
| 054 | 16 | A' | |
| 055 | 61 | GTO | |
| 056 | 39 | COS | |
| 057 | 76 | LBL | |
| 058 | 38 | SIN | |
| 059 | 97 | DSZ | |
| 060 | 00 | 00 | |
| 061 | 30 | TAN | |
| 062 | 76 | LBL | |
| 063 | 91 | R/S | |
| 064 | 91 | R/S | |
| 065 | 76 | LBL | |
| 066 | 44 | SUM | |
| 067 | 22 | INV | |
| 068 | 86 | STF | |
| 069 | 02 | 02 | |
| 070 | 22 | INV | |
| 071 | 86 | STF | |
| 072 | 01 | 01 | |
| 073 | 61 | GTO | |
| 074 | 39 | COS | |
| 075 | 76 | LBL | |
| 076 | 12 | B | |
| 077 | 44 | SUM | |
| 078 | 05 | 05 | |
| 079 | 25 | CLR | |
| 080 | 91 | R/S | |
| 081 | 76 | LBL | |
| 082 | 17 | B' | |
| 083 | 48 | EXC | |
| 084 | 05 | 05 | |
| 085 | 91 | R/S | |
| 086 | 76 | LBL | |
| 087 | 13 | C | |
| 088 | 35 | 1/X | |
| 089 | 44 | SUM | |
| 090 | 06 | 06 | |
| 091 | 25 | CLR | |
| 092 | 91 | R/S | |
| 093 | 76 | LBL | |
| 094 | 18 | C' | |
| 095 | 48 | EXC | |
| 096 | 06 | 06 | |
| 097 | 35 | 1/X | |
| 098 | 91 | R/S | |
| 099 | 76 | LBL | |
| 100 | 52 | EE | |
| 101 | 73 | RC* | |
| 102 | 00 | 00 | |
| 103 | 97 | DSZ | |
| 104 | 00 | 00 | |
| 105 | 42 | STO | |
| 106 | 16 | A' | |
| 107 | 86 | STF | |
| 108 | 03 | 03 | |
| 109 | 61 | GTO | |
| 110 | 52 | EE | |
| 111 | 76 | LBL | |
| 112 | 55 | ÷ | |
| 113 | 43 | RCL | |
| 114 | 07 | 07 | |
| 115 | 55 | ÷ | |
| 116 | 73 | RC* | |
| 117 | 00 | 00 | |
| 118 | 95 | = | |
| 119 | 91 | R/S | |
| 120 | 97 | DSZ | |
| 121 | 00 | 00 | |
| 122 | 55 | ÷ | |
| 123 | 61 | GTO | |
| 124 | 85 | + | |
| 125 | 76 | LBL | |
| 126 | 42 | STO | |
| 127 | 87 | IFF | |
| 128 | 03 | 03 | |
| 129 | 45 | YX | |
| 130 | 76 | LBL | |
| 131 | 75 | - | |
| 132 | 65 | × | |
| 133 | 73 | RC* | |
| 134 | 00 | 00 | |
| 135 | 54 | ) | |
| 136 | 44 | SUM | |
| 137 | 07 | 07 | |
| 138 | 87 | IFF | |
| 139 | 03 | 03 | |
| 140 | 85 | + | |
| 141 | 61 | GTO | |
| 142 | 52 | EE | |
| 143 | 76 | LBL | |
| 144 | 85 | + | |
| 145 | 22 | INV | |
| 146 | 86 | STF | |
| 147 | 03 | 03 | |
| 148 | 16 | A' | |
| 149 | 61 | GTO | |
| 150 | 55 | ÷ | |
| 151 | 76 | LBL | |
| 152 | 14 | D | |
| 153 | 72 | ST* | |
| 154 | 00 | 00 | |
| 155 | 97 | DSZ | |
| 156 | 00 | 00 | |
| 157 | 91 | R/S | |
| 158 | 16 | A' | |
| 159 | 61 | GTO | |

MERGED CODES

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 62 | Pgm | Ind | 72 | STO | Ind | 83 | GTO | Ind |
| 63 | Exc | Ind | 73 | RCL | Ind | 84 | Op | Ind |
| 64 | Prd | Ind | 74 | SUM | Ind | 92 | INV | SBR |

# PPX-59 Professional Program Exchange

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6 5 | 8 0 0 9

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| LOC | CODE | KEY | COMMENTS | LOC | CODE | KEY | COMMENTS | LOC | CODE | KEY | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 160 | 52 | EE | | | | | | | | | |
| 161 | 76 | LBL | | | | | | | | | |
| 162 | 15 | E | | | | | | | | | |
| 163 | 47 | CMS | | | | | | | | | |
| 164 | 81 | RST | | | | | | | | | |
| 165 | 76 | LBL | | | | | | | | | |
| 166 | 45 | $Y^x$ | | | | | | | | | |
| 167 | 97 | DSZ | | | | | | | | | |
| 168 | 00 | 00 | | | | | | | | | |
| 169 | 75 | - | | | | | | | | | |

MERGED CODES

| | | |
|---|---|---|
| 62 Pgm Ind | 72 STO Ind | 83 GTO Ind |
| 63 Exc Ind | 73 RCL Ind | 84 Op Ind |
| 64 Prd Ind | 74 SUM Ind | 92 INV SBR |

# ELECTRONIC ENGINEERING

- **CLASS "A" AMPLIFIER DESIGNED TO SPECIFIED TOLERANCES**
  Biasing, load and emitter resistors are calculated for a class "A" bipolar transistor amplifier. Design is constrained to a maximum allowable percent collector current variation specified by the user.
  **TI-59 only.**

- **RF AMPLIFIER ANALYSIS**
  Calculates the input admittance, transducer gain, and Linvill's C-factor for a specified load admittance assumed to be pure conductance when given the Y-parameters of a two part network, such as a transistor used as an RF Amplifier.
  **TI-58 or TI-59.**

- **BIPOLAR JUNCTION TRANSISTOR ANALYSIS**
  Calculates the emitter bypass and coupling capacitors for a B.J.T. circuit. The program is designed for a low frequency analysis.
  **TI-58 or TI-59.**

- **POWER SUPPLY FILTER DESIGN**
  Load resistance, filter capacitor value, and the minimum, maximum, and average output voltages for both the full- and half-wave rectifier circuits are calculated.
  **TI-59 only.**

- **ZENER POWER SUPPLY DESIGN**
  Calculates component values and power rating pertaining to a Zener diode regulated power supply.
  **TI-59 only.**

- **RESISTIVE VOLTAGE DIVIDER**
  Provides a method to empirically design and evaluate resistive voltage divider networks often encountered in basic designs.
  **TI-58 or TI-59.**

- **FIELD EFFECT TRANSISTOR ANALYSIS**
  Calculates the source bypass and coupling capacitors for a F.E.T. circuit using the pole zero cancellation method.
  **TI-58 or TI-59.**

- **SOLUTION OF RESISTIVE NETWORKS**
  Solves for the total resistance of both simple and complicated D.C. networks.
  **TI-58 or TI-59.**

*PREPROGRAMMED MAGNETIC CARDS ARE NOT INCLUDED.*
*(The program Code Lists must be keyed into blank magnetic cards.)*

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