# Tehnici CAD
# Generator de semnal PWM
# Proiect

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Grupa 2126

## Cuprins:

# I. Specificatie enunt:

## 1) **Enuntul problemei**:

Sa se implementeze un generator de semnal PWM in programul OrCad. Dimensionarea componentelorse va face in functie de urmatoarele:

| | |
|---|---|
| fmin | 0.1 |
| fumax | 0.7 |
| Amin | 3.5 |
| Amax | 11 |
| f | 6000 |

## 2) Detalii legate de generatorul PWM:

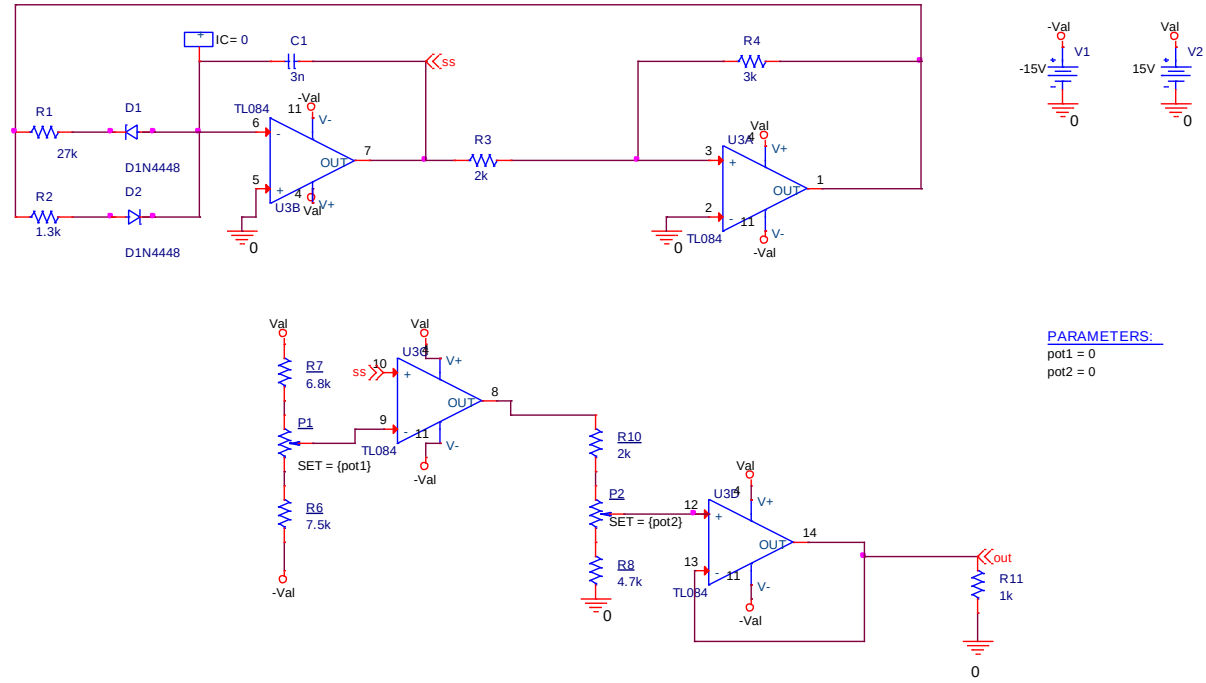
Abrevierea de la Pulse Width Modulation, PWM implica variatia in mod controlat a tensiunii date a unui dispozitiv electronic, presupunand existenta unui semnal modulat in latimea impulsurilor de comanda.

Schema electronica a unui modulator de acest tip impune existenta urmatoarelor componente:

I. Generator de semnal dinte de fierastrau cu frecventa reglabila
II. Comparator pentru reglarea factorului de umplere
III. Repetor(Buffer) pentru reglarea domeniului tensiunii de iesire

## II. Proiectarea circuitului si schema acestuia:

Schema circuitului:




### 1) Principiul de functionare:

In componenta circuitului intra 4 amplificatoare TL084, 9 rezistente, 2 diode D1N4448, 2 potentiometre si 2 surse de tensiune pentru alimentare.

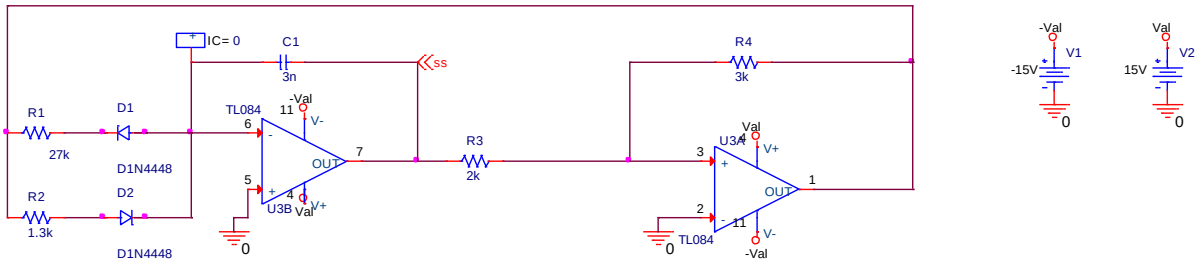
Circuitul integrator si comparatorul cu reactie pozitiva determina generarea unui semnal dinte de fierastrau care ulterior este comparat cu o tensiune de referinta variabila. Factorul de umplere poate varia intre 10% si 70%.

## 2) Semnalul dinte de fierastrau:

La realizarea circuitui am utilizat un integrator si un comparator cu reactie pozitiva, 2 diode, un condensator si 3 rezistente. Cele 2 diode au rolul de a directiona incarcarea si descarcarea condensatorului

( D1→incarca / D2→descarca). Comparatorului U3A genereaza un semnal ce permite incarcarea si descarcarea condensatorului. Generarea semnalului dinte de fierastrau se realizeaza prin descarcare brusca.

Schema circuitului semnal dinte de fierastrau:




## III. <u>Determinarea valorilor componentelor:</u>

●Consideram $R_3$=2k

$R_4$=3k

T = $\left(\frac{1}{f}\right)$ => T= $\left(\frac{1}{6}\right)$ => <u>T=166,66us</u>

Incarcare si descarcare setata la 5-95% =>

$T_1$ = $\left(\frac{95}{100}\right)$ * T => $T_1$ = $\left(\frac{95}{100}\right)$ * 166,66 => <u>$T_1$ = 158,32us</u>

●Consideram C=3n

$T_1$=2*$\left(\frac{R3}{R4}\right) * R * C1$ => $R_1$= $T_1$*$\left(\frac{1}{2}\right)\left(\frac{R4}{R3}\right)\left(\frac{1}{C1}\right)$ =>R=26,38k =><u>$R_1$=27k(val. standard)</u>

$T_2$ = $\left(\frac{5}{100}\right) * T$ => $T_2$ = $\left(\frac{5}{100}\right)$ * 166,66 => <u>$T_2$= 8.33us</u>

$R_1 = T_2 * \left(\frac{1}{2}\right)\left(\frac{R4}{R3}\right)\left(\frac{1}{C1}\right)$ => $R_2$=1.388k => <u>$R_2$=1,3k (val.standard)</u>

Folosind analiza tranzitorie am masurat tensiunile:

$V_{max}$ = 9,3 $V_{min}$= -13,1

Calculam tensiunea de referinta:

$\left(\frac{Vref-Vmin}{Vmax-Vmin}\right) = (1-D)$ ; unde D cuprins intre 10-70%

$\left(\frac{Vref+13,1}{9,3+13,1}\right) = (1-D)$ => $V_{ref}$ pentru 10% = 6,8

$V_{ref}$ pentru 70% =-6,4

Dimensionarea rezistentelor:

●Consideram $P_1$=10k

=> $V_{ref.min} = \left(\frac{R6}{P+R6+R7}\right) * 2 * V_{al} - V_{al}$

=> $V_{ref.max} = \left(\frac{R6+P}{P+R6+R7}\right) * 2 * V_{al} - V_{al}$

=>$R_6+R_7$=14,39 => <u>$R_7$= 6,8k</u>

=> $R_6$=7,25 => <u>$R_6$= 7,5k ( val. standard)</u>

●Consideram P2=10k

$A_1 = A_{min} = 3,5$ $A_2 = A_{max} = 11$

$V_{o.generator} = 11,9$

$A_1 = \left(\frac{R8}{P+R8+R10}\right) * V_{o.generator}$

$A_2 = \left(\frac{R8+P}{P+R8+R10}\right) * V_{o.generator}$

=> $R_8 + R_{10} = 6,94$

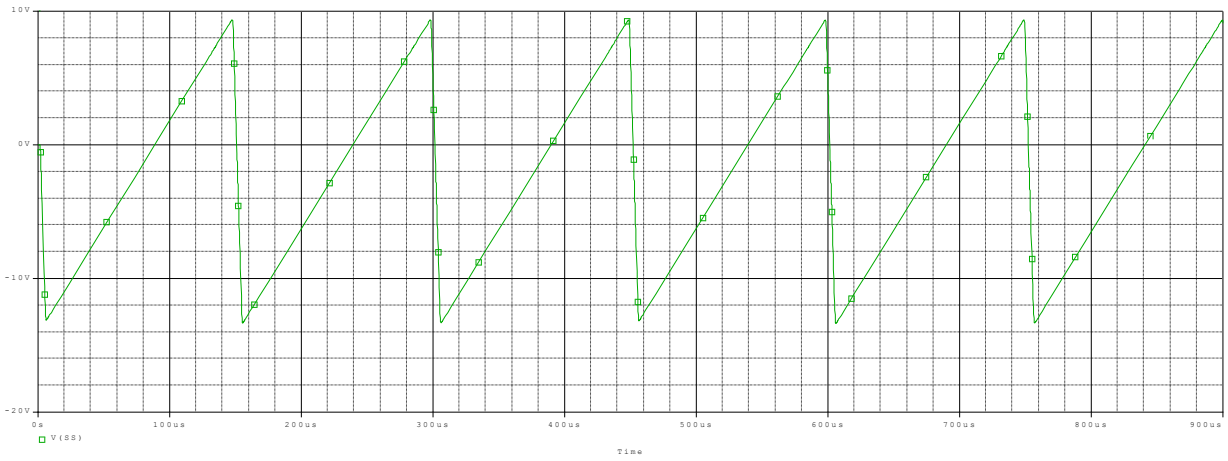
=> $R_8 = 4,86$ => <u>$R_8$ = 4,7k (val. standard)</u>

=> $R_{10} = 2,08$ => <u>$R_{10}$= 2k (val. standard)</u>

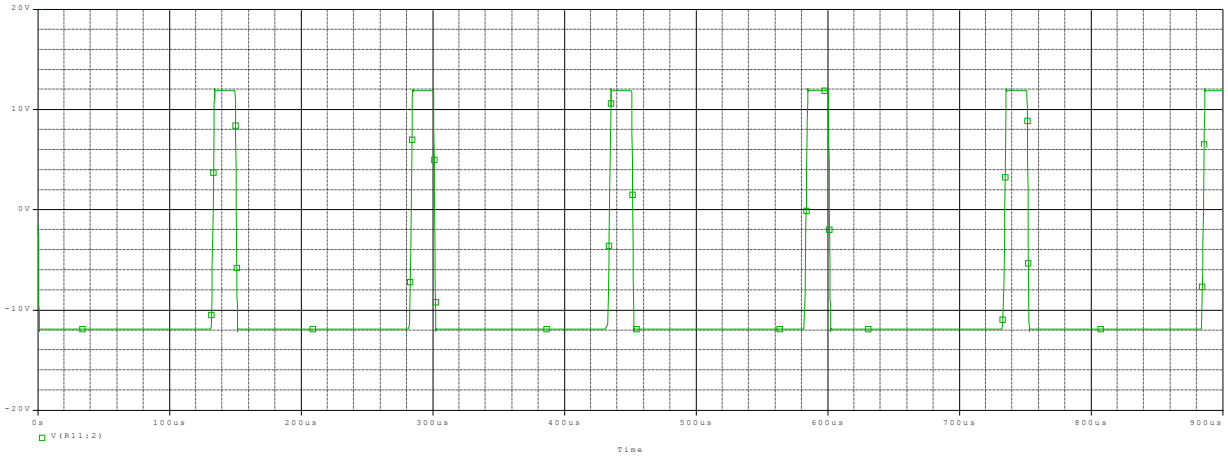
## IV. Analize efectuate si interpretarea acestora:

### 1) Realizarea analizei in timp:

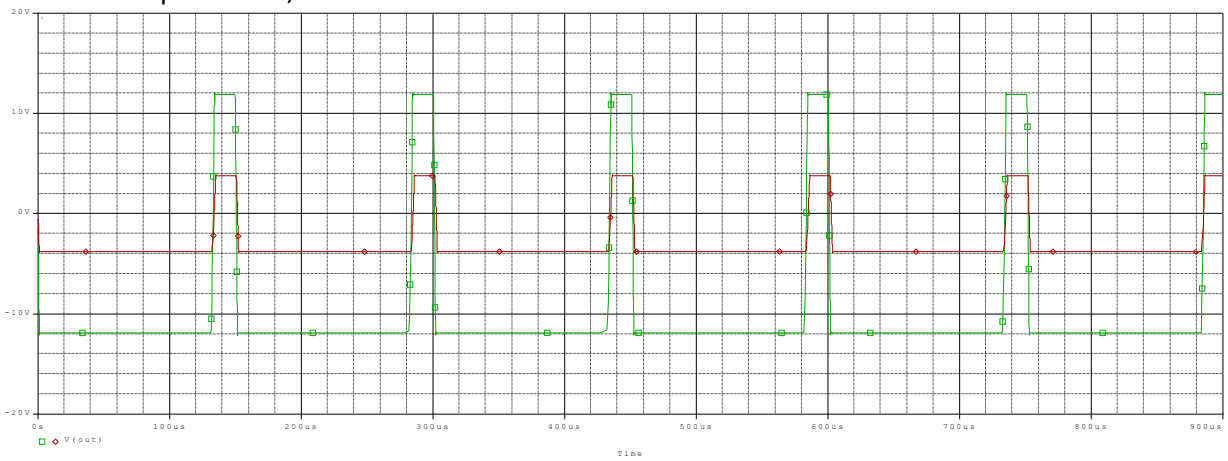
Semnal dinte de fierastrau:



Semnal PWM:




Variatia amplitudinii 3,5-11




2) **Realizarea analizei parametrice:**

Aceasta tip de analiza reliefeaza cum influenteaza potentiometrele circuitul. Ca parametri pentru potentiometrele P1, respectiv P2 au fost alesi pot1/ pot2.

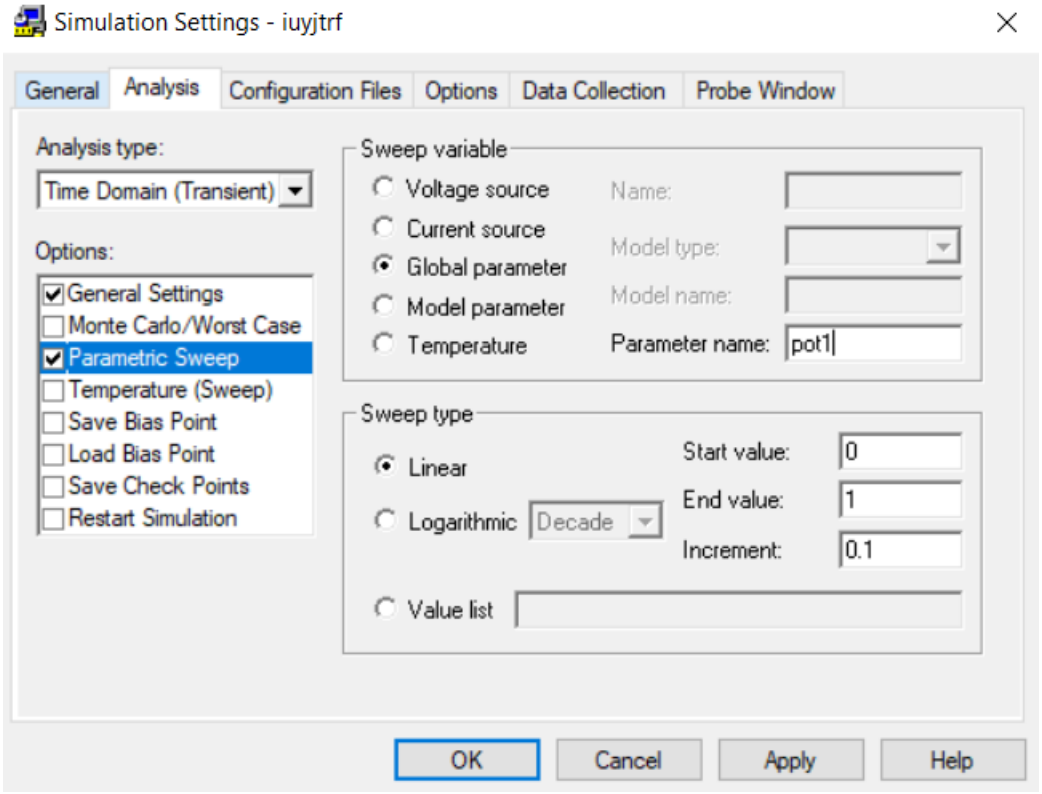
PARAMETERS:

pot1 = 0

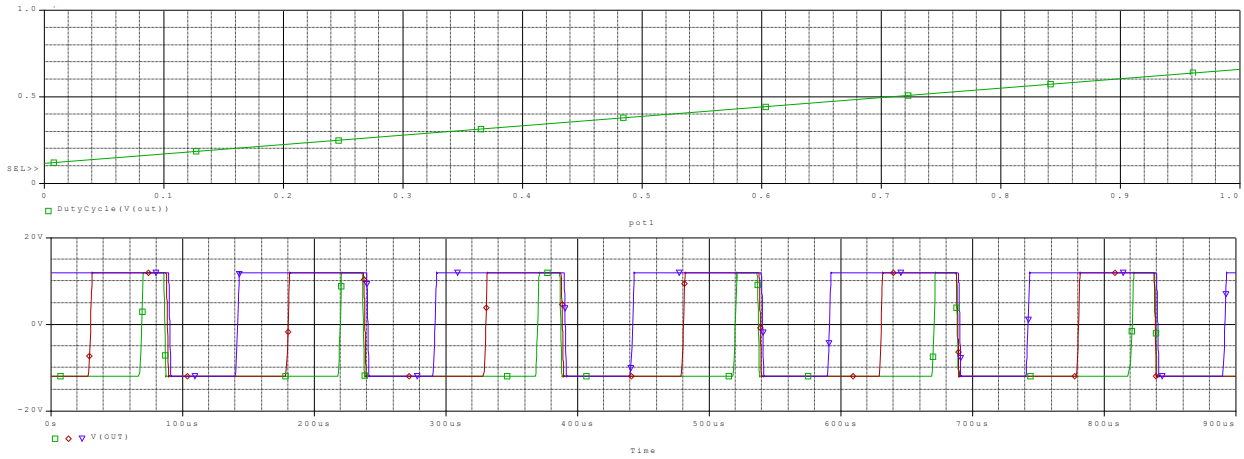
pot2 = 0

Analiza parametrica face observabila variatia potentiometrului P1, precum si limitele factorului de umplere (10-70%).

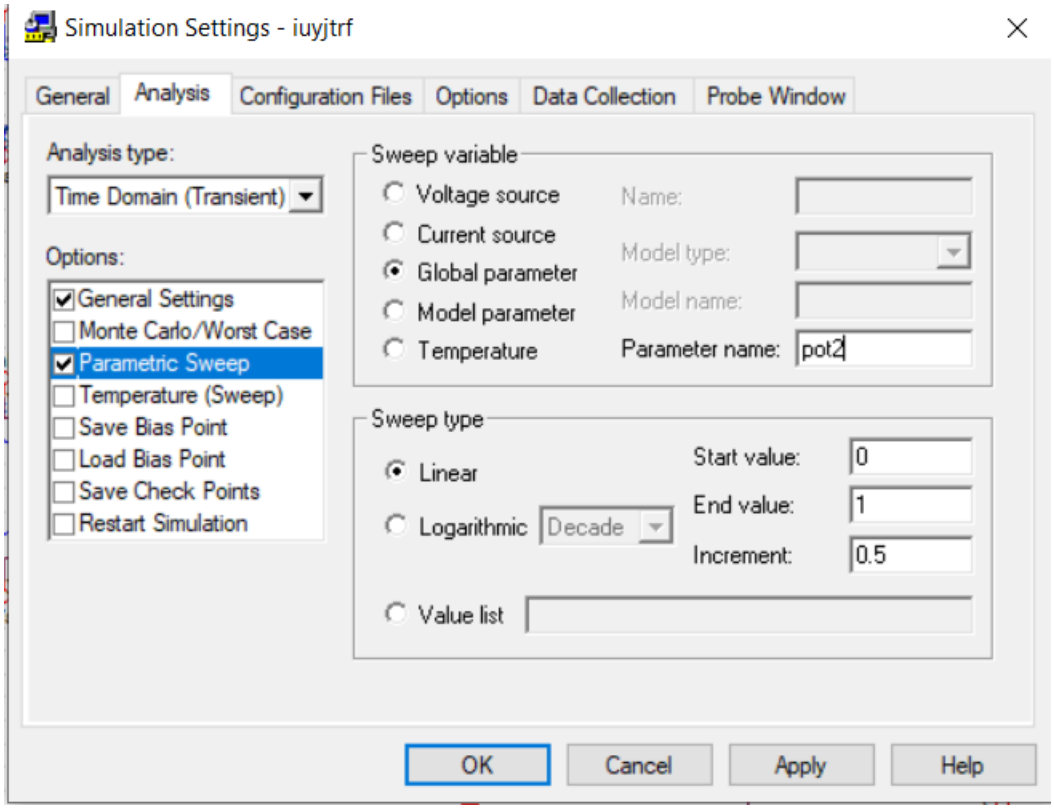
Setarile analizei parametrice pentru pot1:



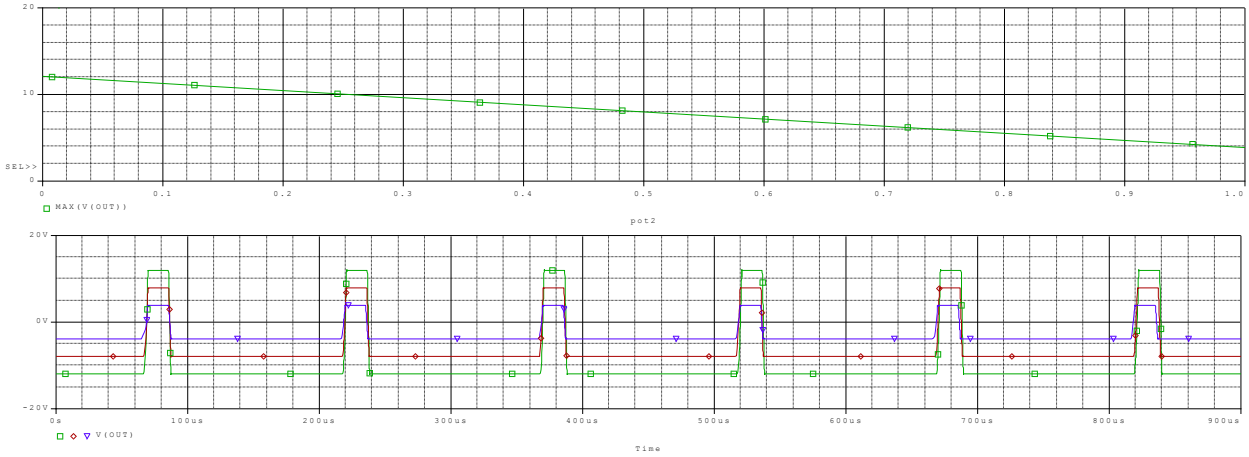
Limitele factorului de umplere: 10% - 70% (graficul de sus)/ Semnalul PWM in timp ce pot1 variaza(graficul de jos)




Setarile analizei parametrice pentru pot2:

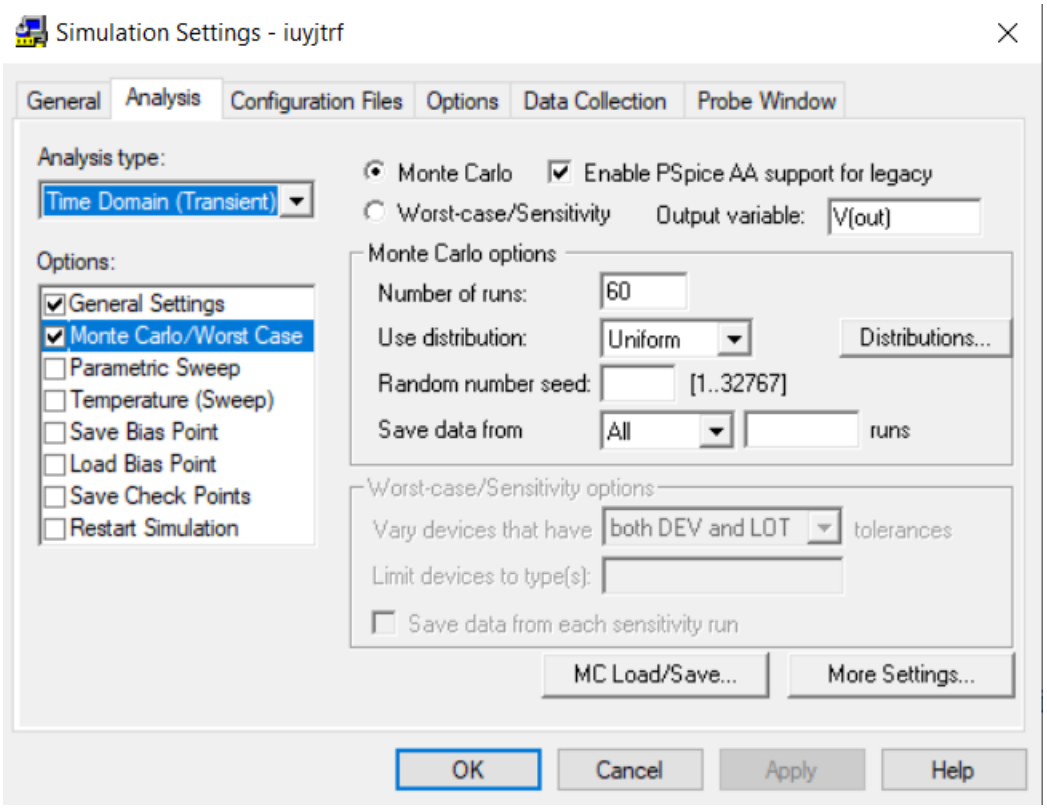


Limitele amplitudinii: 3.5-11 (graficul de sus)/ Semnalul PWM in timp ce pot2 variaza(graficul de jos)

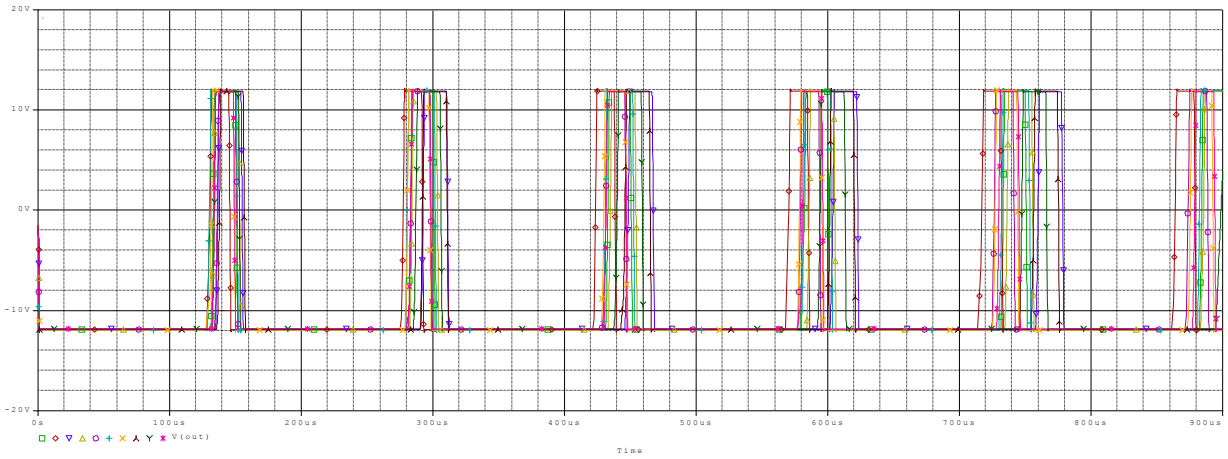


## 3) **Realizarea analizei Monte Carlo:**

Setarile analizei Monte Carlo:

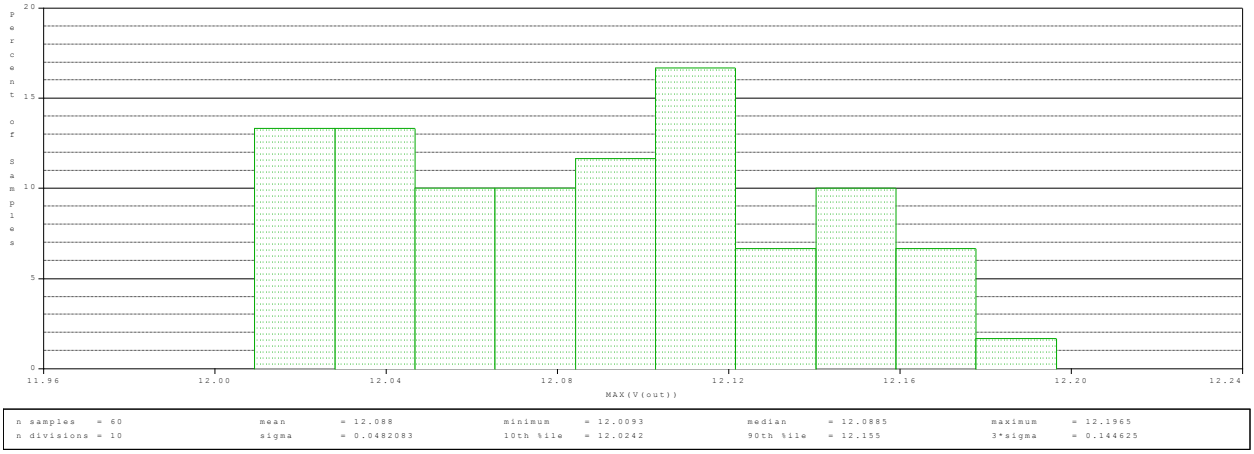


Modul in care formele de unda ale rezistentelor variaza cu toleranta de 5%:

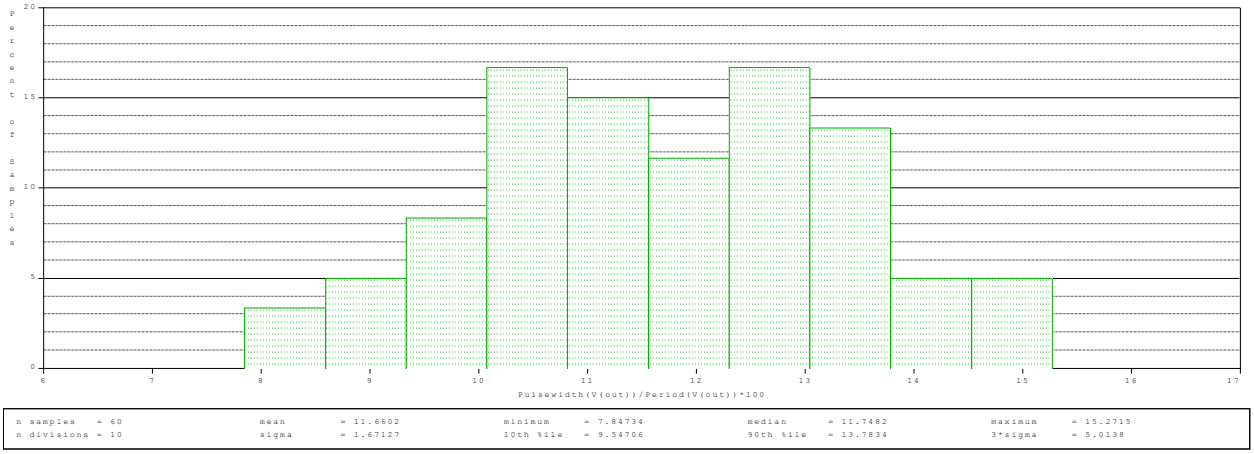



Histograma atesta procentul in care amplitudinea si factorul de umplere se schimba in functie de componentele circuitului (rezistentele cu toleranta 5% si condensatorul cu toleranta 10%) iau anumite valori:

Histograma amplitudinii:

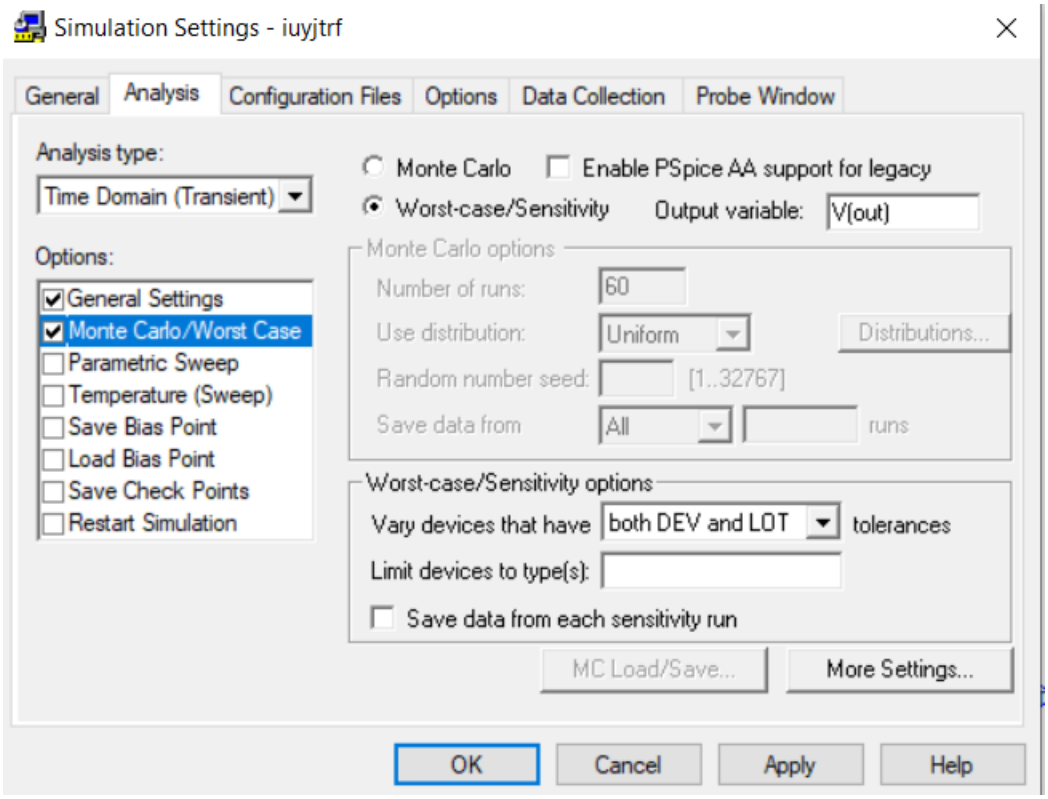



Histograma factorului de umplere:



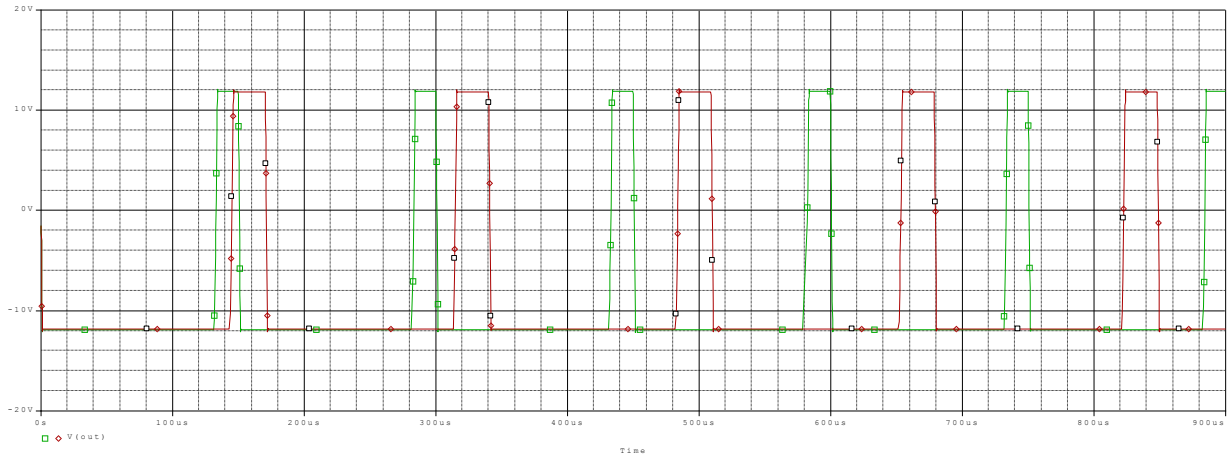
## 4) **Realizarea analizei Worst-case:**

Setarile analizei Worst-case:




Graficul surprinde modul in care circuitul se comporta atat pentru valori standard ale rezistentelor(verde) cat si in caz defavorabil(rosu) fiind influentate de tolerante.

Graficul in cazul Worst-case:



## v. Prezentarea foilor de catalog:

### 1) Foile de catalog:

# TL084
# TL084A - TL084B

## GENERAL PURPOSEJ-FET QUAD OPERATIONAL AMPLIFIERS

- WIDE COMMON-MODE (UP TO $V_{CC}^+$) AND DIFFERENTIAL VOLTAGE RANGE
- LOW INPUT BIAS AND OFFSET CURRENT
- OUTPUT SHORT-CIRCUIT PROTECTION
- HIGH INPUT IMPEDANCE J-FET INPUT STAGE
- INTERNAL FREQUENCY COMPENSATION
- LATCH UP FREE OPERATION
- HIGH SLEW RATE : 16V/µs (typ)

**N**
**DIP14**
(Plastic Package)

**D**
**SO14**
(Plastic Micropackage)

**P**
**TSSOP14**
(Thin Shrink Small Outline Package)

### DESCRIPTION

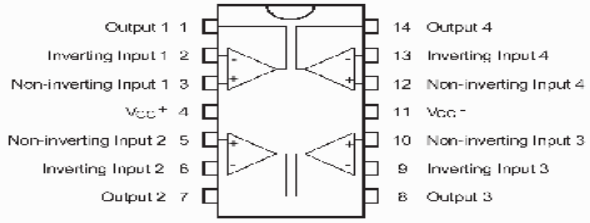
The TL084, TL084A and TL084B are high speed J-FET input quad operational amplifiers incorporating well matched, high voltage J-FET and bipolar transistors in a monolithic integrated circuit.
The devices feature high slew rates, low input bias and offset currents, and low offset voltage temperature coefficient.

### ORDER CODES

| Part Number | Temperature Range | Package | | |
|---|---|---|---|---|
| | | N | D | P |
| TL084M/AM/BM | –55°C, +125°C | • | • | • |
| TL084I/AI/BI | –40°C, +105°C | • | • | • |
| TL084C/AC/BC | 0°C, +70°C | • | • | • |

**Examples :** TL084CN, TL084CD

### PIN CONNECTIONS (top view)

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**LIMITING VALUES**

In accordance with the Absolute Maximum Rating System (IEC 60134).

| SYMBOL | PARAMETER | CONDITIONS | MIN. | MAX. | UNIT |
|---|---|---|---|---|---|
| $V_{RRM}$ | repetitive peak reverse voltage | | – | 100 | V |
| $V_R$ | continuous reverse voltage | | – | 100 | V |
| $I_F$ | continuous forward current | see Fig.2; note 1 | – | 200 | mA |
| $I_{FRM}$ | repetitive peak forward current | | – | 450 | mA |
| $I_{FSM}$ | non-repetitive peak forward current | square wave; $T_j$ = 25 °C prior to surge; see Fig.4 | | | |
| | | t = 1 μs | – | 4 | A |
| | | t = 1 ms | – | 1 | A |
| | | t = 1 s | – | 0.5 | A |
| $P_{tot}$ | total power dissipation | $T_{amb}$ = 25 °C; note 1 | – | 500 | mW |
| $T_{stg}$ | storage temperature | | –65 | +200 | °C |
| $T_j$ | junction temperature | | – | 200 | °C |

**Note**

1. Device mounted on an FR4 printed-circuit board; lead length 10 mm.

**ELECTRICAL CHARACTERISTICS**

$T_j$ = 25 °C unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | MAX. | UNIT |
|---|---|---|---|---|---|
| $V_F$ | forward voltage | see Fig.3 | | | |
| | 1N4148 | $I_F$ = 10 mA | – | 1 | V |
| | 1N4448 | $I_F$ = 5 mA | 0.62 | 0.72 | V |
| | | $I_F$ = 100 mA | – | 1 | V |
| $I_R$ | reverse current | $V_R$ = 20 V; see Fig.5 | | 25 | nA |
| | | $V_R$ = 20 V; $T_j$ = 150 °C; see Fig.5 | – | 50 | μA |
| $I_R$ | reverse current; 1N4448 | $V_R$ = 20 V; $T_j$ = 100 °C; see Fig.5 | – | 3 | μA |
| $C_d$ | diode capacitance | f = 1 MHz; $V_R$ = 0 V; see Fig.6 | – | 4 | pF |
| $t_{rr}$ | reverse recovery time | when switched from $I_F$ = 10 mA to $I_R$ = 60 mA; $R_L$ = 100 Ω; measured at $I_R$ = 1 mA; see Fig.7 | – | 4 | ns |
| $V_{fr}$ | forward recovery voltage | when switched from $I_F$ = 50 mA; $t_r$ = 20 ns; see Fig.8 | – | 2.5 | V |

## 2) Lista valorilor standard:

Componente folosite:

R1=27k;
R2=1.3k;
R3=2k;
R4=3k;
R6=7,5k;
R7=6,8k;
R8=4,7k;
R10=2k;
R11=1k;
C=3n;
TL084

| Standard Resistor Values (±5%) | | | | | | |
|---|---|---|---|---|---|---|
| 1.0 | 10 | 100 | 1.0K | 10K | 100K | 1.0M |
| 1.1 | 11 | 110 | 1.1K | 11K | 110K | 1.1M |
| 1.2 | 12 | 120 | 1.2K | 12K | 120K | 1.2M |
| 1.3 | 13 | 130 | 1.3K | 13K | 130K | 1.3M |
| 1.5 | 15 | 150 | 1.5K | 15K | 150K | 1.5M |
| 1.6 | 16 | 160 | 1.6K | 16K | 160K | 1.6M |
| 1.8 | 18 | 180 | 1.8K | 18K | 180K | 1.8M |
| 2.0 | 20 | 200 | 2.0K | 20K | 200K | 2.0M |
| 2.2 | 22 | 220 | 2.2K | 22K | 220K | 2.2M |
| 2.4 | 24 | 240 | 2.4K | 24K | 240K | 2.4M |
| 2.7 | 27 | 270 | 2.7K | 27K | 270K | 2.7M |
| 3.0 | 30 | 300 | 3.0K | 30K | 300K | 3.0M |
| 3.3 | 33 | 330 | 3.3K | 33K | 330K | 3.3M |
| 3.6 | 36 | 360 | 3.6K | 36K | 360K | 3.6M |
| 3.9 | 39 | 390 | 3.9K | 39K | 390K | 3.9M |
| 4.3 | 43 | 430 | 4.3K | 43K | 430K | 4.3M |
| 4.7 | 47 | 470 | 4.7K | 47K | 470K | 4.7M |
| 5.1 | 51 | 510 | 5.1K | 51K | 510K | 5.1M |
| 5.6 | 56 | 560 | 5.6K | 56K | 560K | 5.6M |
| 6.2 | 62 | 620 | 6.2K | 62K | 620K | 6.2M |
| 6.8 | 68 | 680 | 6.8K | 68K | 680K | 6.8M |
| 7.5 | 75 | 750 | 7.5K | 75K | 750K | 7.5M |
| 8.2 | 82 | 820 | 8.2K | 82K | 820K | 8.2M |
| 9.1 | 91 | 910 | 9.1K | 91K | 910K | 9.1M |

| Standard Capacitor Values (±10%) | | | | | | |
|---|---|---|---|---|---|---|
| 10pF | 100pF | 1000pF | .010µF | .10µF | 1.0µF | 10µF |
| 12pF | 120pF | 1200pF | .012µF | .12µF | 1.2µF | |
| 15pF | 150pF | 1500pF | .015µF | .15µF | 1.5µF | |
| 18pF | 180pF | 1800pF | .018µF | .18µF | 1.8µF | |
| 22pF | 220pF | 2200pF | .022µF | .22µF | 2.2µF | 22µF |
| 27pF | 270pF | 2700pF | .027µF | .27µF | 2.7µF | |
| 33pF | 330pF | 3300pF | .033µF | .33µF | 3.3µF | 33µF |
| 39pF | 390pF | 3900pF | .039µF | .39µF | 3.9µF | |
| 47pF | 470pF | 4700pF | .047µF | .47µF | 4.7µF | 47uF |
| 56pF | 560pF | 5600pF | .056µF | .56µF | 5.6µF | |
| 68pF | 680pF | 6800pF | .068µF | .68µF | 6.8µF | |
| 82pF | 820pF | 8200pF | .082µF | .82µF | 8.2µF | |

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# TL084A - TL084B

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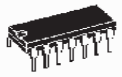

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Examples : TL084CN, TL084CD

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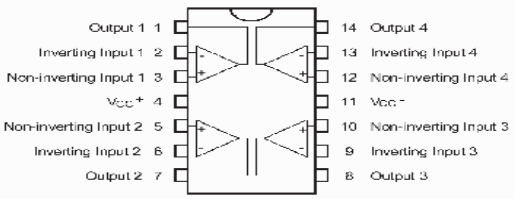


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## VI. Bibliografia:


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- http://www.bel.utcluj.ro/dce/didactic/de/de.htm
- Indrumator Proiectare Asistata de Calculator – Ovidiu Pop, Raul Fizesan, Gabriel Chindris
- https://www.youtube.com/user/FlowCAD