

2018 8

实验一 常用电子仪器的使用

1

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2

3

4

2

1 DS-5000

2 TH SG10

3 FLUKE-15B

4

3

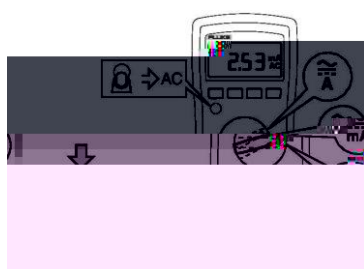
4

1

FLUKE-15B

=I G

1.1.1



1.1.1

L; HA?

L; HA?

+5V -5V +12V -12V 0~35V

2 TH-SG10



1.1.2 TH-SG10

TH-SG10

1.1.2

FSK PSK

TTL

10mHz 10MHz

+ z / +⁵Hz

2mV 20V_{P-P}

1mV 10V_{P-P} /

, V_{P-P}

+ V_{P-P} /

V_{P-P}

-

, V_{P-P}, 10KHz

1

2

+

)E

+ E

3

,

) P

, P_{P-P}

4

f=1KHz 50mV_{P-P}

3 DS-5000



$f=1\text{KHz}$ $50\text{mV}_{\text{p-p}}$

CH1

4

, , ,

$f=1\text{KHz}$ $50\text{mV}_{\text{p-p}}$

5

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5

实验二 单级放大电路

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3

A_u

R_i

R_o

4

2

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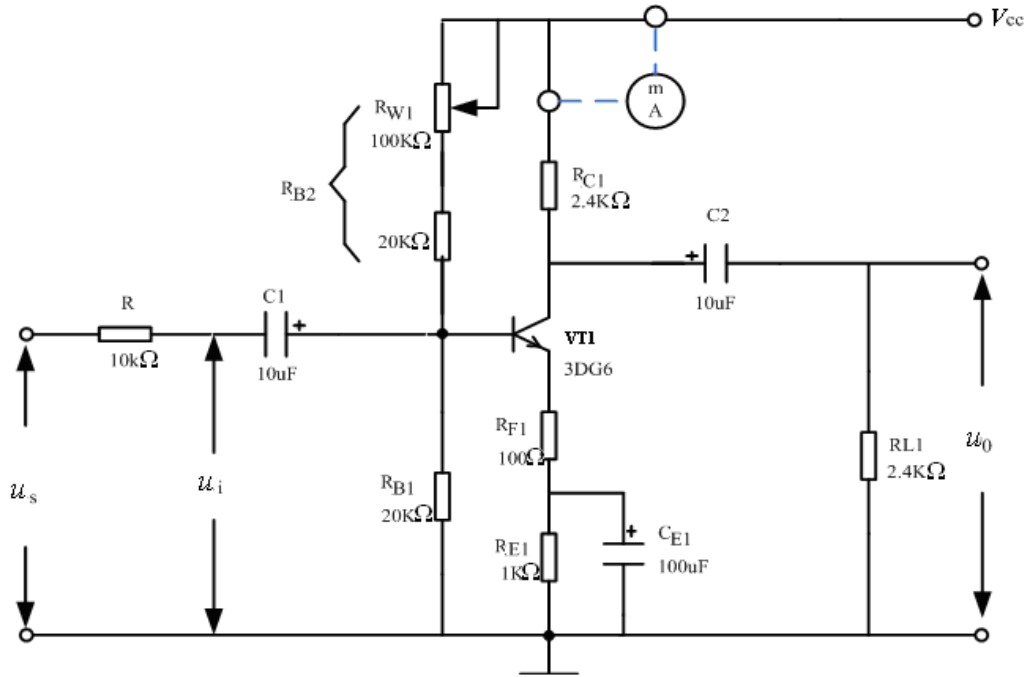
5

3DG6

3

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2
4

1.1.4



1.1.4

1
1)
2)

$+12V$ u_i u_s R_{W1} $V_E=2.2V$ U_{BEQ}
 U_{CEQ} R_{B2} 1.1.1

1.1.1

| U_{BEQ}/V | U_{CEQ}/V | R_{B2}/E |
|-------------|-------------|------------|
| | | |

3) R_{W1} $V_E=2.2V$ I_C VT_1 V_B R_{B2}
 R_{B1} 1.1.2 VT_1 I_B β

$$I_B = \frac{V_{CC} - V_B}{R_{B2}} - \frac{V_B}{R_{B1}} \quad \beta = \frac{I_C}{I_B}$$

1.1.2 I_B β

1.1.2

| I_C /mA | V_B /V | R_{B2} /k | R_{B1} /k | I_B /mA | β |
|-----------|----------|-------------|-------------|-----------|---------|
| | | | | | |

2

1 $f=1\text{KHz}$ - 50mV

u_i u_i u_o u_i u_o 1.1.3

2) u_i $f=1\text{KHz}$ u_i u_o u_o

1.1.3

1.1.3

| u_i /mV | u_o /V | A_u | A_u |
|---------------------|----------|-------|-------|
| 50mV _{P-P} | | | |
| | | | |

u_i u_o

1.1.3 - U_{P-P} U_{RMS}

3) u_i - 50mV $f=1\text{kHz}$ R_{L1} R_{L1}

1.1.4

1.1.4

| R_{C1} | R_{L1} | u_i (V)/ V_{P-P} | u_o (V)/ V_{P-P} | A_u | A_u |
|----------|----------|-------------------------|-------------------------|-------|-------|
| 2.4k | 2.4K | | | | |
| 2.4k | 10K | | | | |

4) u_i - 50mV $f=1\text{kHz}$ R_{W1} u_o

U_B U_C U_E 1.1.5

1.1.5

| R_{W1} | U_B/V | U_C/V | U_E/V | u_O |
|----------|---------|---------|---------|-------|
| | | | | |
| | | | | |
| | | | | |

U_i

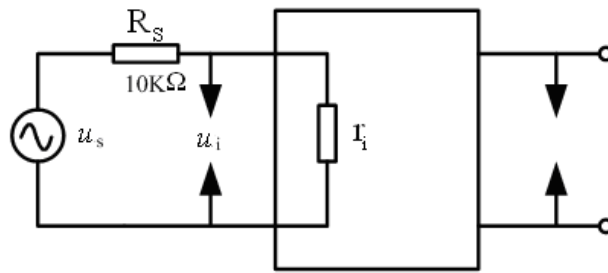
5)

10k

1.1.5

u_s u_i

1.1.6



1.1.5

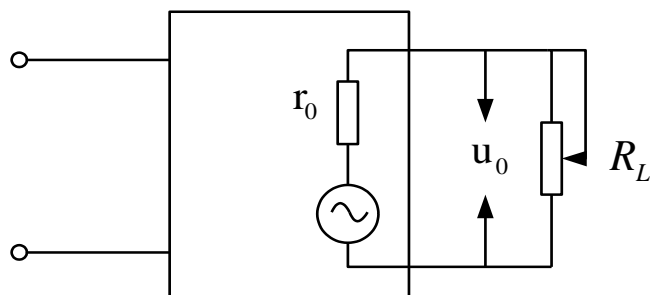
6)

1.1.6 , R_L (E

R_L

u_o

1.1.6



1.1.6

1.1.6

| U_s/mV | U_i/mV | $R_i/$ | $R_i/$ | U_o/V R_L7 | U_o/V $R_L=2.4K$ | $R_o/$ | $R_o/$ |
|----------|----------|--------|--------|-------------------|-----------------------|--------|--------|
| | | | | | | | |

5

1

2

3

实验三 射极跟随器

1

1

2

2

1

2

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4

5

6

3DG6

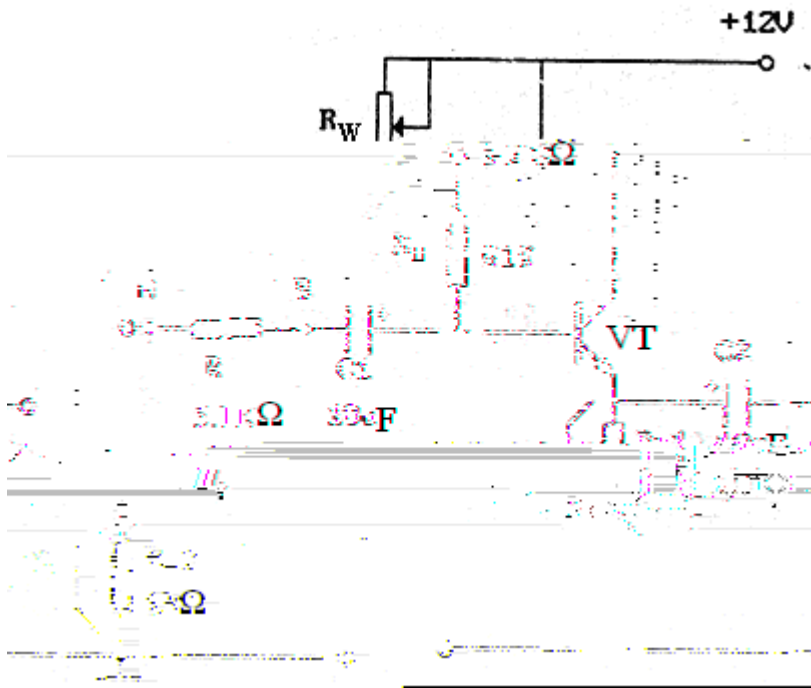
3

1

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4

1.1.7



1.1.7

1

1.1.6 +12V B f 1KHz U_i (U_i 100mV)

R_W

U_i 0

1.1.7

1.1.7

| U_E/V | U_B/V | U_C/V | $I_E = \frac{U_E}{R_E} / mA$ |
|---------|---------|---------|------------------------------|
| | | | |

R_W (I_E)

2

A_u

R_L ,E B f 1KHz U_i

U_o

U_i U_L 1.1.8

1.1.8

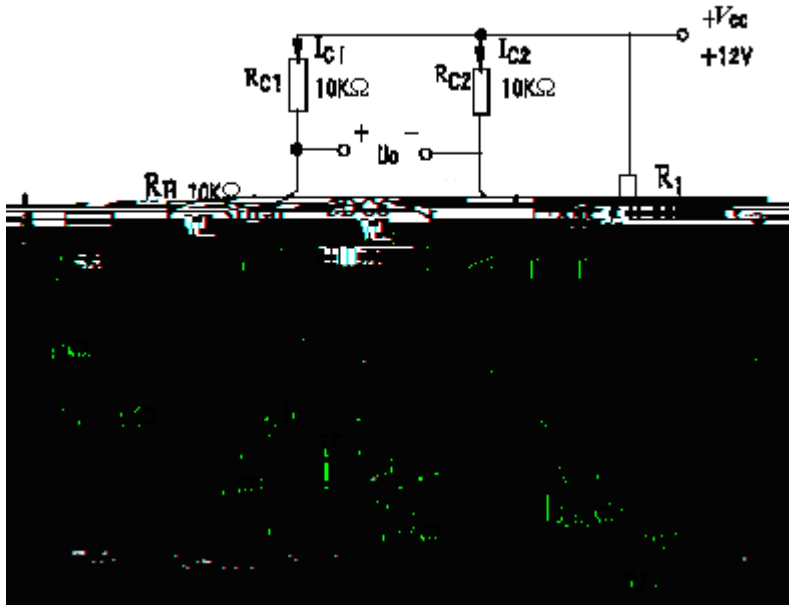
| U_i/V | U_L/V | $A_u = \frac{U_L}{U_i}$ |
|---------|---------|-------------------------|
| | | |

3

R_o

R_L B f 1KHz U_i (100mV)

1.1.8



1.1.8

1

1.1.8 K

1)

R_W U_O 0 $\pm 12V$ U_O
 VT_1 VT_2 R_E U_{RE}

1.1.11

1.1.11

| | | | | | | | |
|--|------------|------------|------------|------------|------------|------------|------------|
| | U_{C1}/V | U_{B1}/V | U_{E1}/V | U_{C2}/V | U_{R2}/V | U_{F2}/V | U_{RE}/V |
| | | | | | | | |
| | I_C/mA | | I_B/mA | | U_{CE}/V | | |
| | | | | | | | |

2)

A B (A B)
 f 1KHz 0 (C_1 C_2)
 U_i (100mV) U_i U_{c1} U_{c2}

$$A_{d1} = \frac{U_{c1}}{U_i} \quad A_{d2} = \frac{U_{c2}}{U_i} \quad A_d = \frac{|U_{c1}| + |U_{c2}|}{U_i} \quad A_{d1}$$

$$A_{d2} \quad A_d$$

3)

A B ()

A B

$$U_i = 1V \quad f = 1KHz$$

$$U_i \quad U_{c1} \quad U_{c2} \quad U_i \quad U_{c1} \quad U_{c2} \quad U_{RE}$$

U_i

$$A_{c1} = \frac{U_{c1}}{U_i} \quad A_{c2} = \frac{U_{c2}}{U_i} \quad A_c = \frac{|U_{c1}| - |U_{c2}|}{U_i} \quad A_{C1}$$

$$A_{C2} \quad A_C$$

2

1.1.8

K

1

5

1

1)

2)

CMRR

3)

CMRR

CMRR

2

$$U_i \quad U_{C1} \quad U_{C2}$$

实验五 负反馈放大电路

1

1

2

3

2

1

2

3

4

5 3DG6×2

3

1 ;

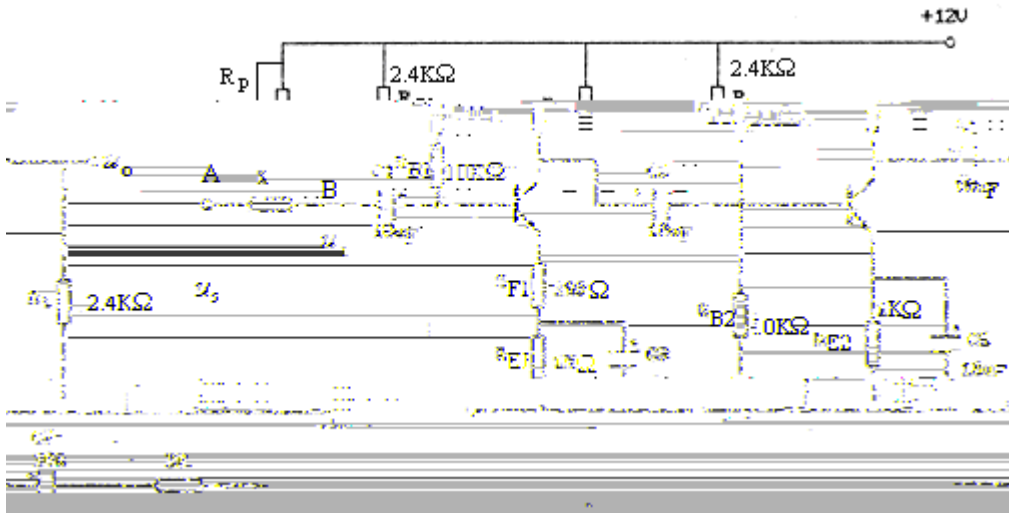
2 ($\beta_1 \beta_2 = 100$);

3 $A_{uf} = ?$? ?

4 ;

5 EWB Multisim

4



1.1.9

1.1.9

1

1

1.1.9

3DG6 R_L

U_i

0

1.1.12

1.1.12

| | U_B/V | U_E/V | U_C/V | I_C/mA |
|--|---------|---------|---------|----------|
| | | | | |
| | | | | |

2

A_u

B

1KHz

50mV

3) u_o u_o u_o

R_o $50mV$ R_L U_o

$R_o = (\frac{U_o'}{U_o} - 1)R_L$ R_o

4) R_i $R - E$ A $1KHz$

$U_{ipp} = 50mV$ A U_{Spp} $R_i = \frac{U_i}{U_s - U_i} R_s$

R_i

5) R_L B $50mV$ $1KHz$ $U_L(U_L$

) ($U_{ipp} = 50mV$) f_H f_L

$f_{BW} = f_H - f_L$

2 1

1

2 1 $R_F = 2E$ 1

A_{uf} R_{of} R_{if} f_{BW}

3 2

1

2 1 $R_F = 2E$ 1

A_{uf} R_{of} R_{if} f_{BW}

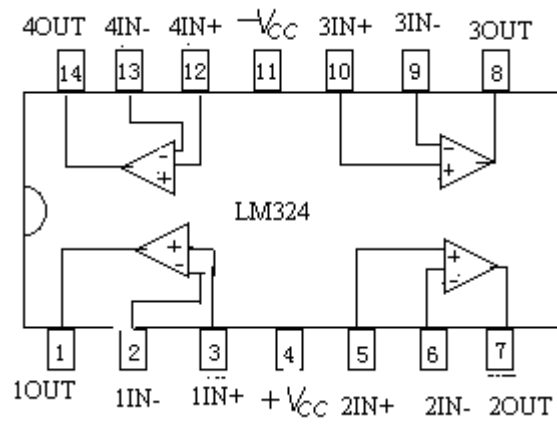
4

1) f $1KHz$

2) 1)

5.

(1)



1.1.11 LM324

1.1.13

| | | | | | |
|-------|-----|--|--|--|--|
| U_o | /mV | | | | |
| | | | | | |

2 1.1.15

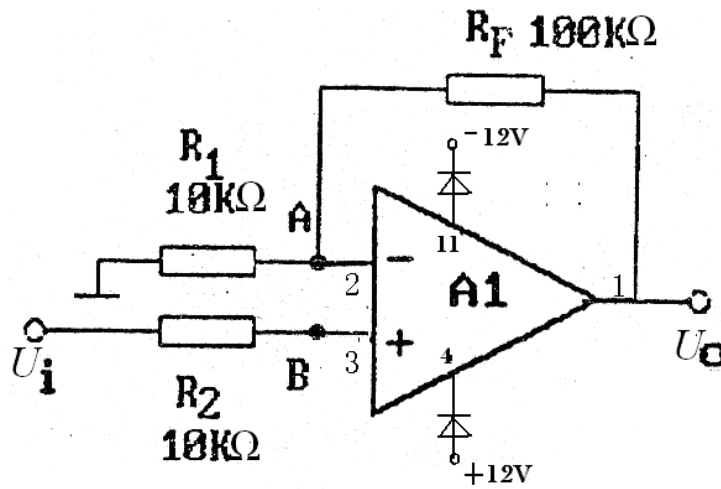
1.1.15

| | | | |
|-------------------|------------------------|--|--|
| $\Delta U_o/V$ | R_L U_i 0 800mV | | |
| $\Delta U_{AB}/V$ | | | |
| $\Delta U_{R2}/V$ | | | |
| $\Delta U_{R1}/V$ | | | |
| $\Delta U_{OL}/V$ | $U_i=800mV$ R_L / | | |

3

1.1.13

1.1.16 1.1.17



1.1.13

1.1.16

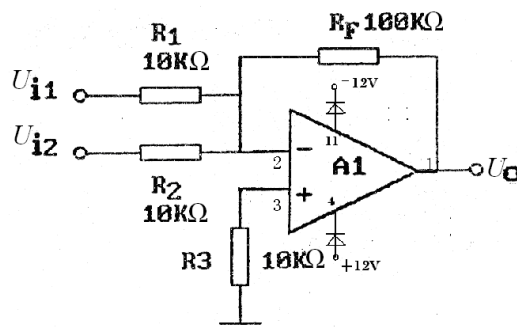
| | | | | | |
|-------|----------|-----|-----|------|------|
| | U_i/mV | 100 | 300 | 1000 | 3000 |
| U_o | /mV | | | | |
| | /mV | | | | |
| | | | | | |

1.1.17

| | | | |
|-------------------|------------------------|--|--|
| | | | |
| $\Delta U_O/V$ | R_L | | |
| $\Delta U_{AB}/V$ | U_i 0 800mV | | |
| $\Delta U_{R2}/V$ | | | |
| $\Delta U_{R1}/V$ | | | |
| $\Delta U_{OL}/V$ | $U_i=800mV$ R_L / | | |

4

1.1.14



1.1.14

1.1.18

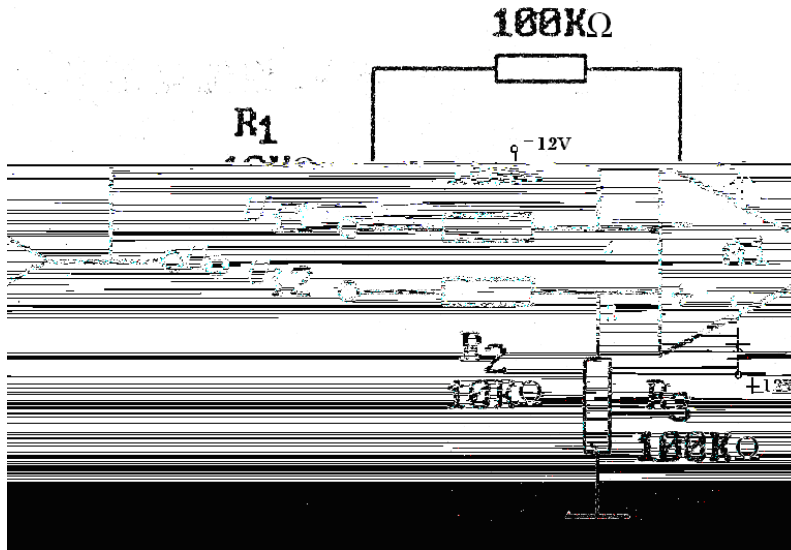
1.1.18

| | | |
|------------|-----|-----|
| U_{i1}/V | 0.3 | 0.1 |
| U_{i2}/V | 0.2 | 0.2 |
| U_O/V | | |

5

1.1.15

1.1.19



1.1.15

1.1.19

| | | |
|------------|-----|-----|
| U_{i1}/V | 0.3 | 0.1 |
| U_{i2}/V | 0.2 | 0.2 |
| U_o/V | | |

5.

(1)

(2)

实验七 信号发生与功放综合电路

1

1 OTL

2 OTL

3 RC

4

(5)

2

(1)

160Hz-20KHz

(2)

(3) +

(1) 0.1W 5W

2 $R_L 72$

3 $N > /$

4 $\eta /$

3

1 OTL

2

3

4 EWB Multisim

4

1 2

3 4

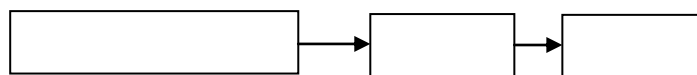
5 6 LM324

7 8

9 3DG6 (9011) 3DG12 (9013) 3CG12 (9012) IN4007 2

5.

1.1.16



(1)

RC

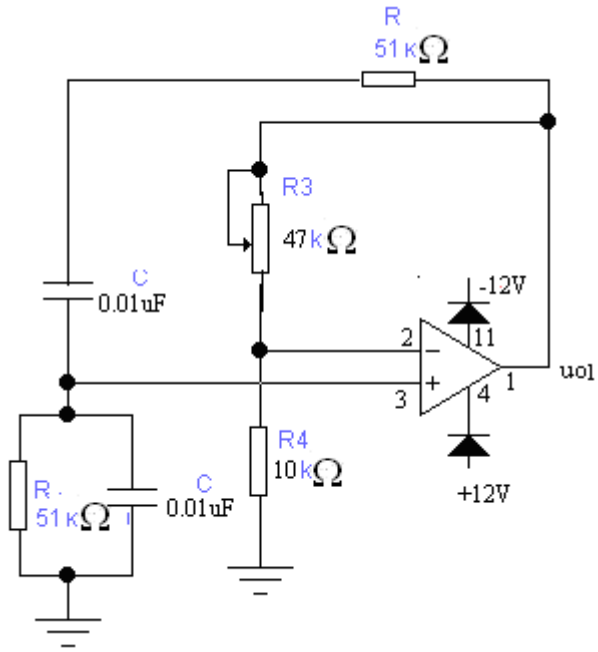


图 1.1.17 RC

RC

1.1.17

RC

Z_1

RC

Z_2

$$Z_1 = R + (1/j\omega C) \quad Z_2 = R // (1/j\omega C) = \frac{R}{1 + j\omega RC}$$

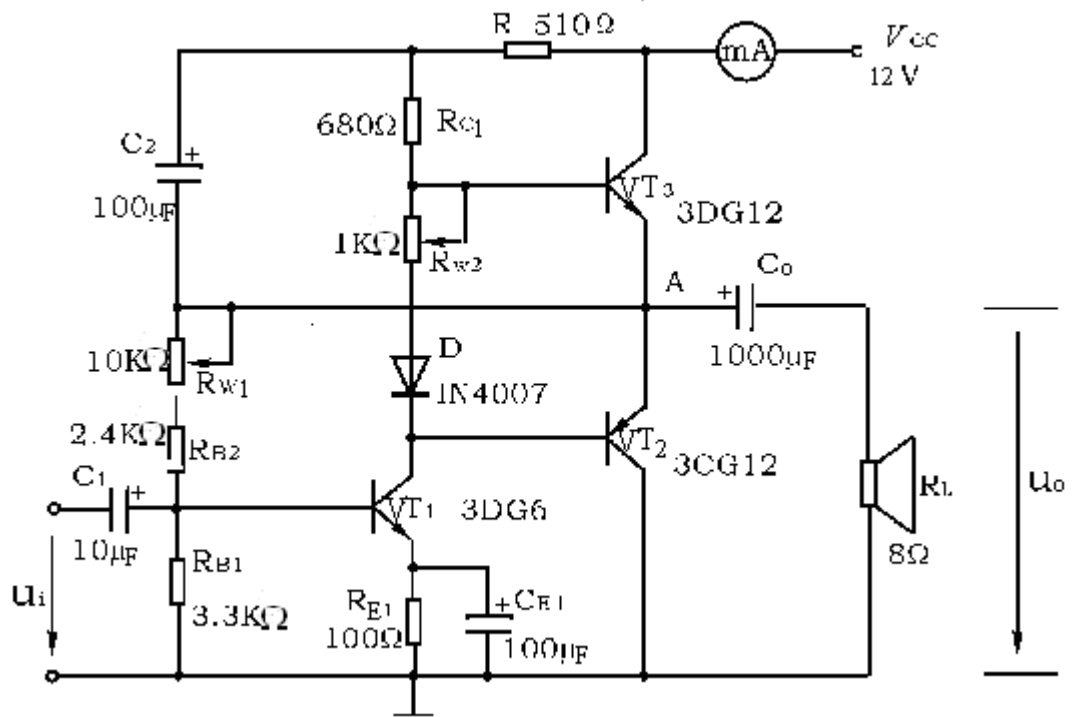
$$\dot{F} = \frac{Z_2}{Z_1 + Z_2} = \frac{1}{3 + j(\omega RC - \frac{1}{\omega RC})}$$

$$f_0 = \frac{1}{2\pi RC} \quad \left| \dot{F} \right|_{\max} = \frac{1}{3}$$

$$|\dot{A}\dot{F}| > 1 \quad A_f > 3 \quad R_3 R_4$$

$$A_f = 1 + \frac{R_3}{R_4} > 3$$

(2)OTL



1.1.18 OTL

OTL
 VT₃
 VT₁ () VT₂
 NPN PNP
 OTL
 VT₁

I_{C1}

$$\eta = \frac{P_{om}}{P_E} 100\%$$

$$\eta_{\max} = 78.5\%$$

$$I_{dc}$$

$$P_E = V_{cc} I_{dc}$$

6

1

1

R_{W2}

;

R_{W2}

2) P_{0m} η

a. P_{om}

f 1KHz

u_i

u_0

u_i

u_O

R_L

U_{om}

1.1.21

1.1.

a b

4

$(u_i = 0)$

U_N U_N 15mV

(2) ()

1) 1.1.17 LM324 1.1.19 $\pm 12V$

R_3 u_O

R_3 R_3 1.1.23

1.3.6

1.1.23

| R_3 | U_0/V | u_0 | |
|-------|---------|-------|--|
| | | | |
| | | | |
| | | | |

2) R_3 u_0 U_O

U_+ U_-

f_0 R

1.1.20

1.1.24

1.1.24

| R/k | $C/\mu F$ | f_0/Hz | f_0/Hz |
|-------|-----------|----------|----------|
| | | | |
| | | | |
| | | | |

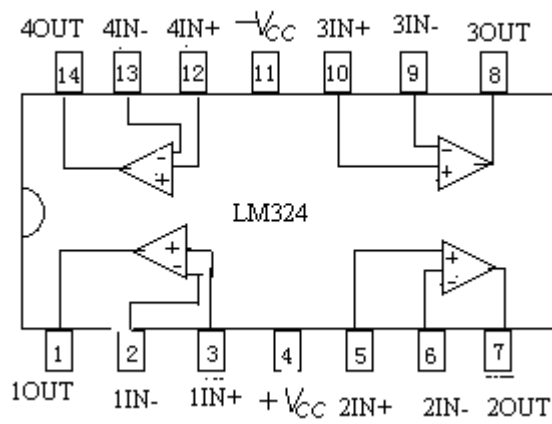
3) 1.1.21 u_{02}

R_3 1.1.

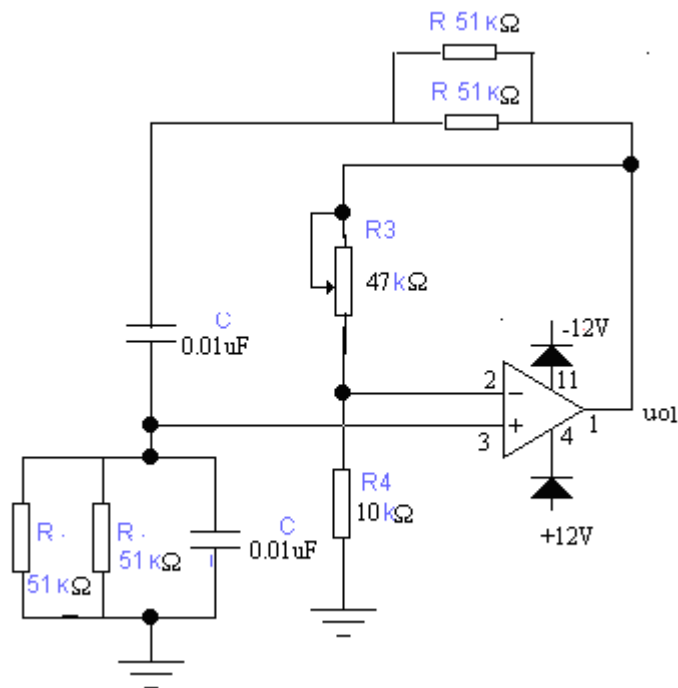
1.1.25

| $R_3/$ | u_{o2} | /Hz | u_{o2} | /V |
|--------|----------|-----|----------|----|
| | | | | |
| | | | | |
| | | | | |

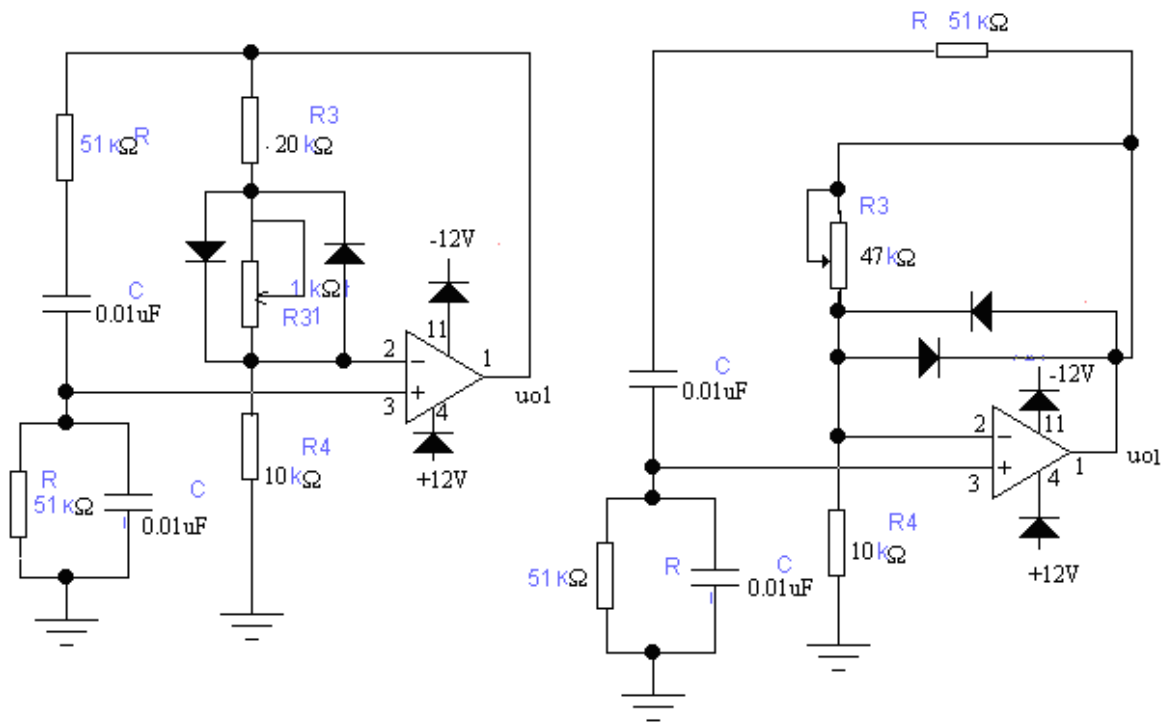
4) u_{o2} 100mV R_3



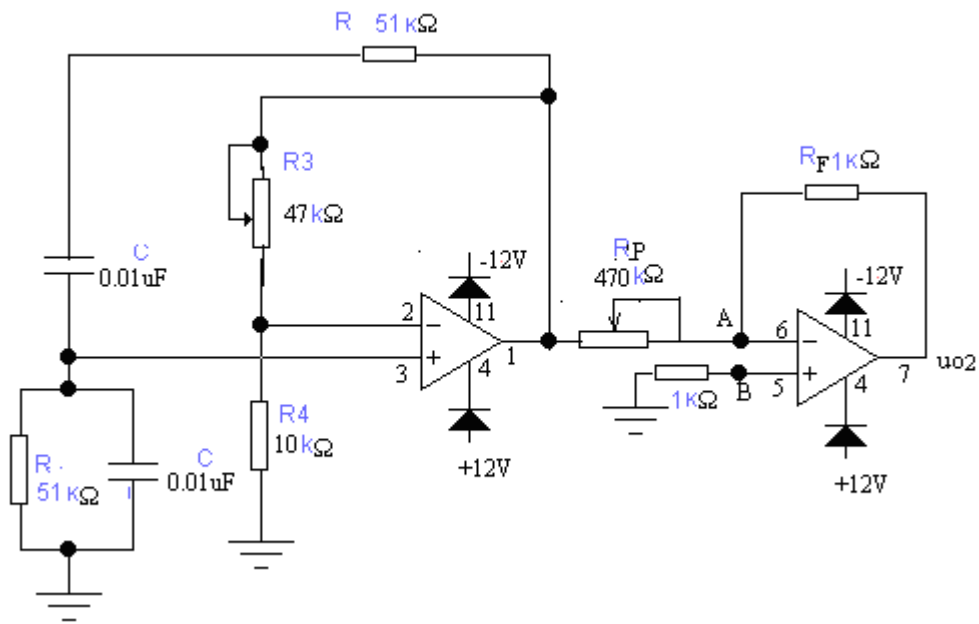
1.1.19 LM324



1.1.20



1.1.21



1.1.22

(3) u_o

1.1.23 1.1.24 1.1.25

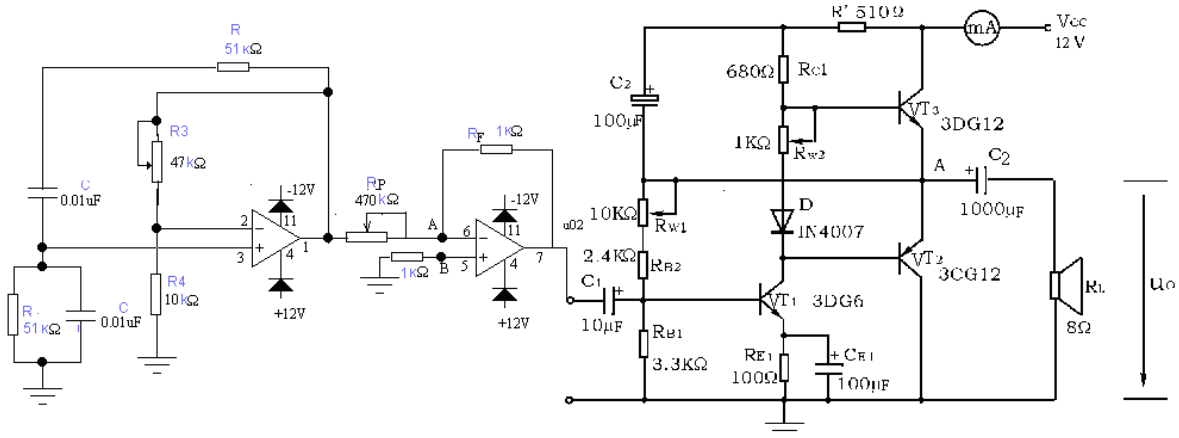


图 1.1.23

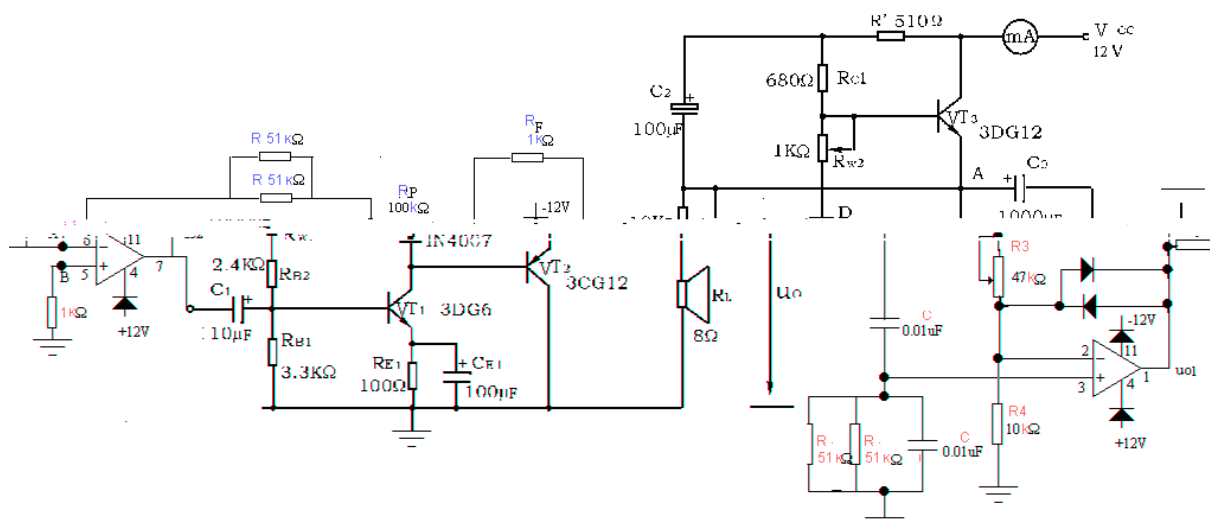


图 1.1.24

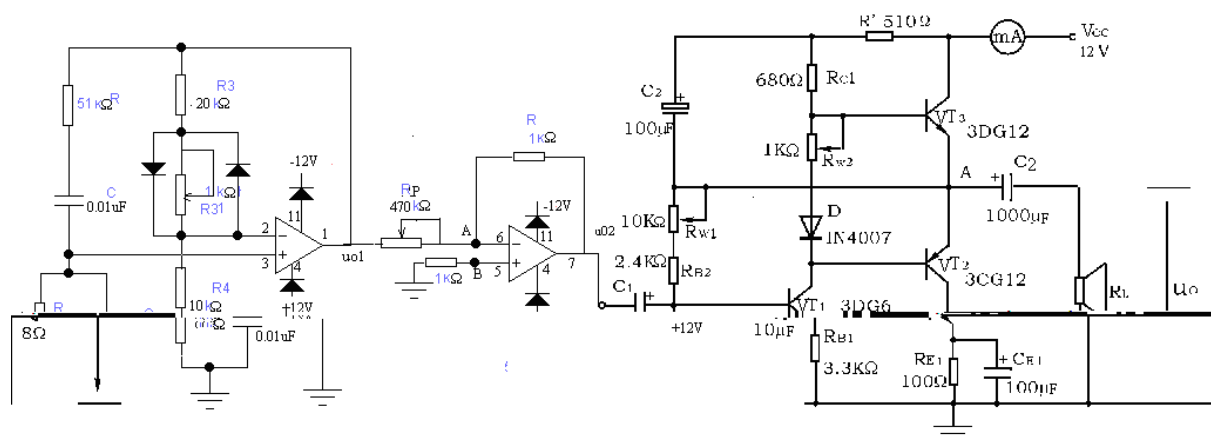


图 1.1.25

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2

3

4 EWB Multisim

5

()

6

7

实验八 直流稳压电源

1

1

2

3

2

1

2

3

4

U_o U_o 9V VT₁ VT₂

U_{CE1S} Φ

5

EWB Multisim

3

1

2

3

4

5

6

7

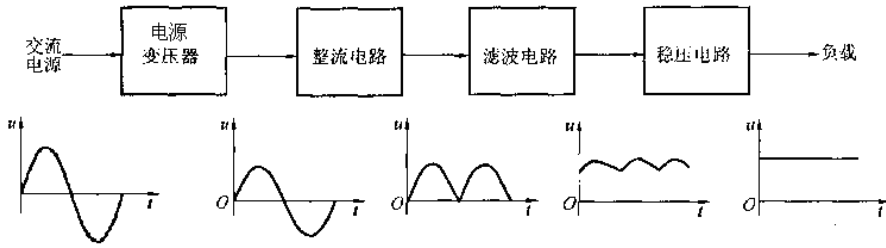
8

3DG6 3DG12 (9013)

IN4007

IN4735

4



1.1.26

$u_1(220V, 50Hz)$

u_2

1.1.27

IN4007

VT₁

VT₂ R₇

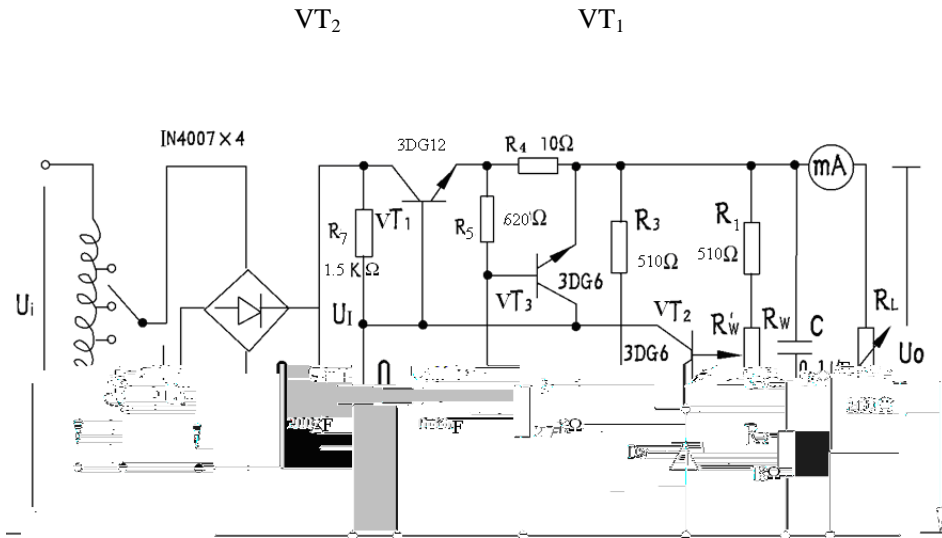
R₁ R₂ R_w

R₃ D_w

VT₃

R₄ R₅

R₆



1.1.27

1.3.18

VT₃ R₄ R₅ R₆

(1) U_o

$$U_o = \frac{R_1 + R_w + R_2}{R_2 + R_w} U_z U_{BE2}$$

$$R_w = U_o$$

(2) R_o

$$R_o = U_1$$

$$R_o = \frac{\Delta U_o}{\Delta U_1} \Big|_{U_1=}$$

(3) S

$$S = \frac{\Delta U_o / U_o}{\Delta U_1 / U_1} \Big|_{R_L=}$$

(3)

5

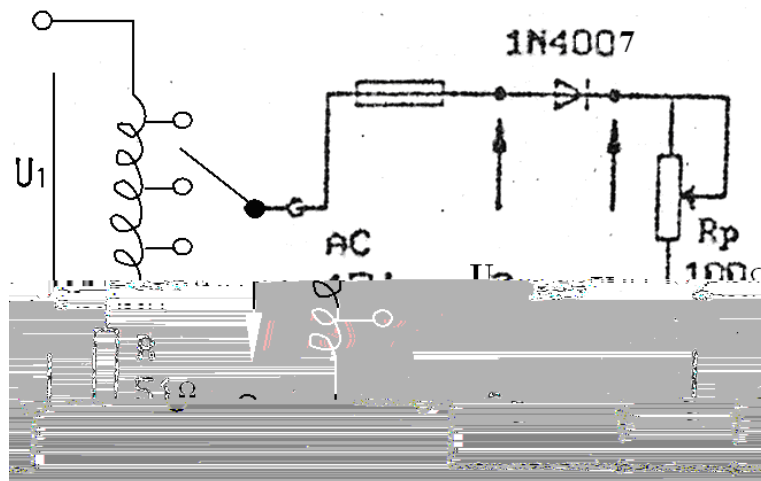
(1)

1.1.28 1.1.29

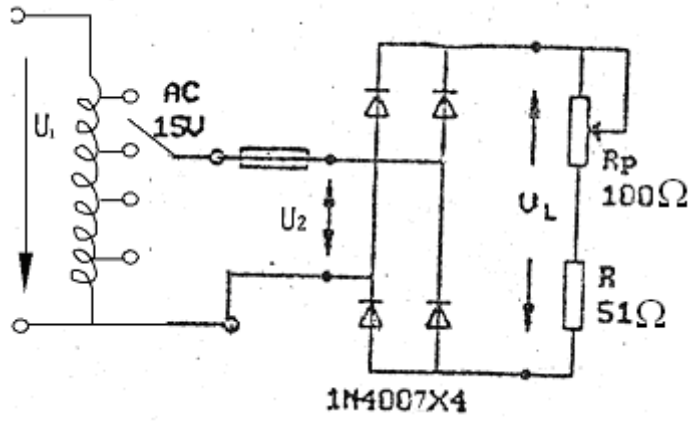
$U_2 U_L$

$U_2 U_L$

1.1.26



1.1.28

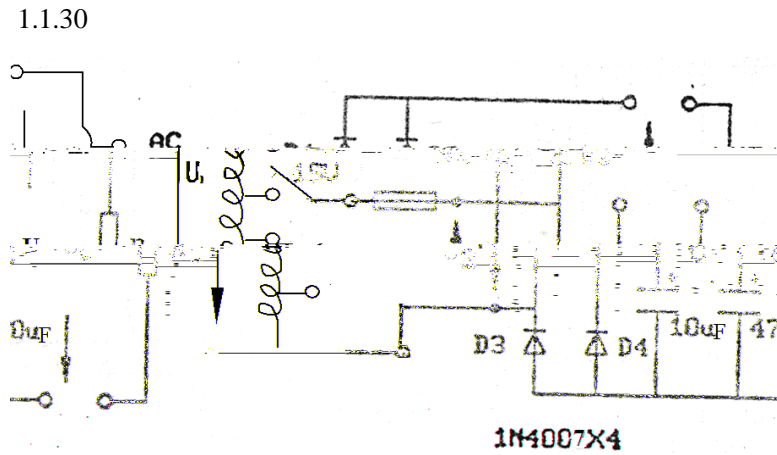


1.1.29

1.1.26

| | | |
|-------|--------|--------|
| | 1.3.19 | 1.3.20 |
| U_2 | | |
| U_L | | |
| U_2 | | |
| U_L | | |

(2)



1.1.30

1 R_L U_L 1.3.9

2 R_L $R_L + E$ 1.1.27

1.1.27

| | | |
|--|-------|-------|
| | U_L | U_L |
|--|-------|-------|

| | | | |
|-----------|-------|--|--|
| R_L7 | 10uF | | |
| | 470uF | | |
| $R_L7 +E$ | 10uF | | |
| | 470uF | | |

(3)

1 9-15V

2 $I_o = 100mA$

3 $S_r < 0.5\%$

1 16V

U_1 U_O R_W U_O

R_W

U_Z U_1 U_O

U_{BE} U_{CE}

2

R_W U_{omin} U_{omax}

3 S

I_O 100mA 1.3.11 U_2

U_1 U_O 1.1.29

1.1.29 I_O 100mA $U_2=16V$

U_2/V U_1/V U_O/V

4 R_O

$U_2=16V$ I_O 50mA 100mA U_O 1.1.30

1.1.30 $U_2=16V$

5

U_2 16V U_O 9V I_O 100mA \bar{U}_O

6)

a. R_W R_L $U_O=9V$ $I_O=100mA$

VT_3

b. R_L I_O 120mA U_O VT_3

R_4

c.

6

1

2 U_O 9V U_{Imin}

U_{2min}

3 U_O R_W

4

5 S R_O

7

1

2

3 EWB Multisim

5

6