Analog Electronic Circuits

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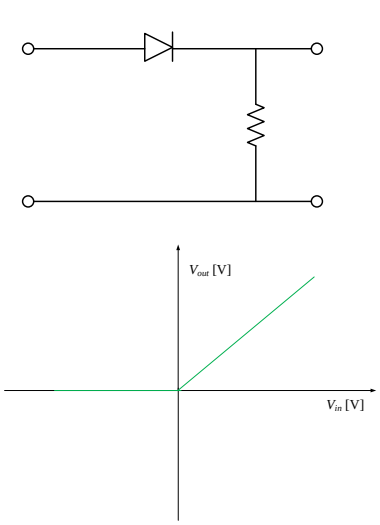
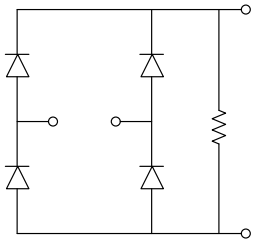
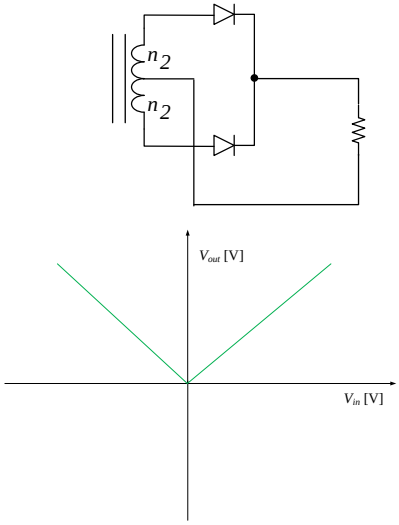
Lesson #8
Outline

- Rectifiers
  - Rectification basics
  - Precision rectifiers
  - Half-wave
  - Full-wave
- Linear regulation
  - Protection stage
- Datasheet

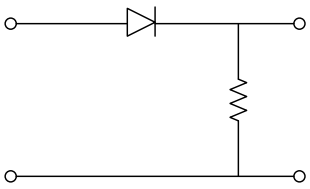
Rectification



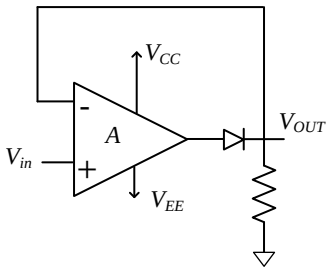




Half-wave

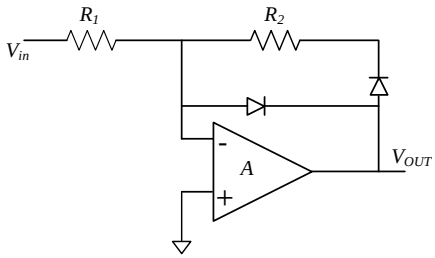


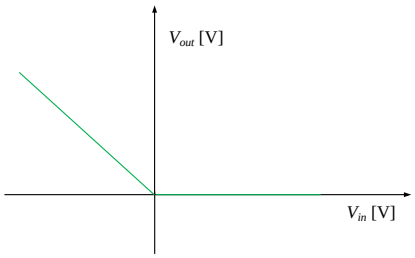
Diode voltage drop



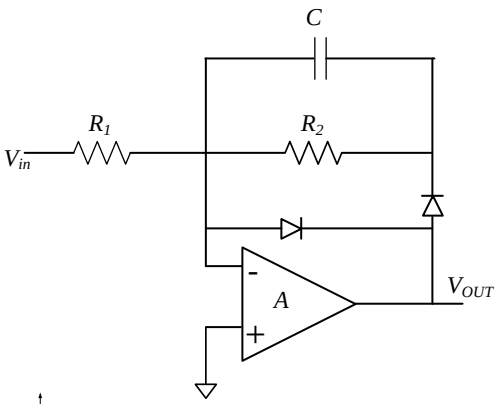
"Super-diode"

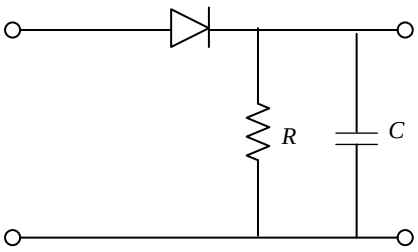
Half-wave

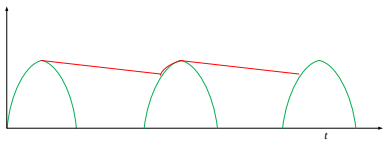




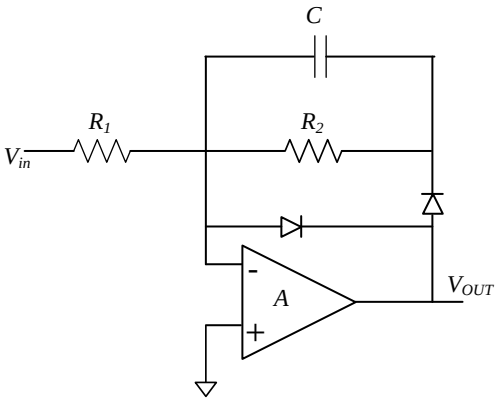
Half-wave







Half-wave

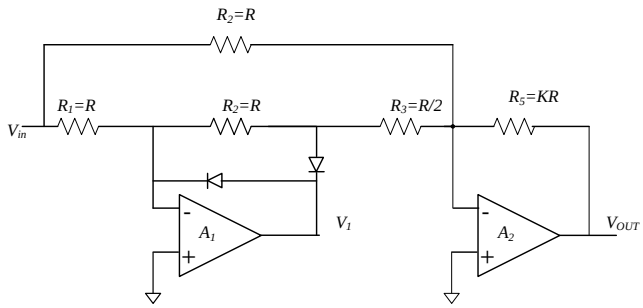


$$I_{av} = \frac{V_{in\_pk}}{R_1}\frac{1}{\pi}$$

$$V_{out} = I_{av}R_2 = \frac{V_{in\_pk}}{R_1}\frac{1}{\pi}R_2$$

$$\Delta V_{out} = \frac{V_{in\_pk}}{R_1}\frac{1}{2\pi f C}$$

Full-wave



Linear regulation

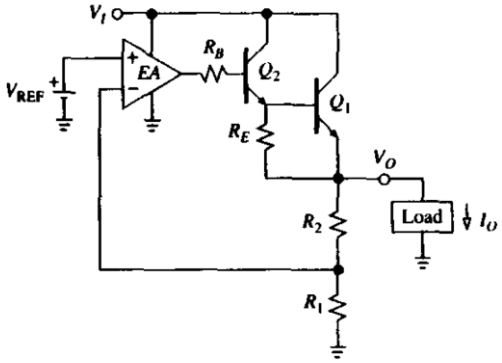


FIGURE 11.19
Basic series voltage regulator.

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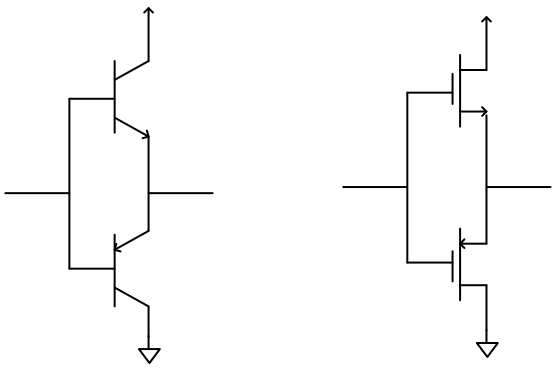
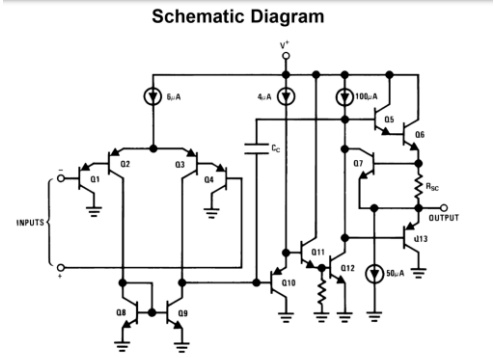
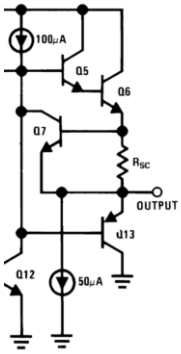
Output stage



Push-pull

Protection – sourcing current





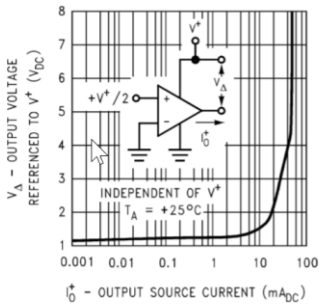
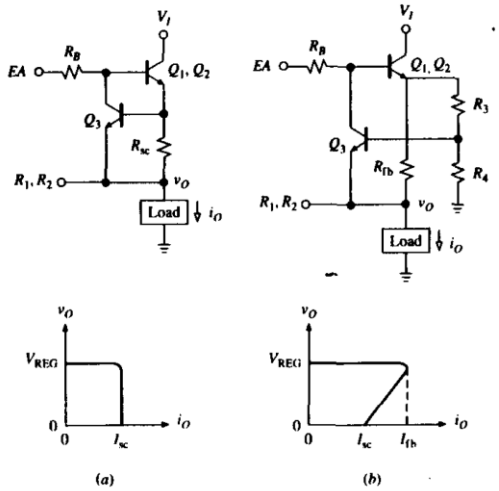


Figure 10. Output Characteristics Current Sourcing

LM324

Protection – sourcing current



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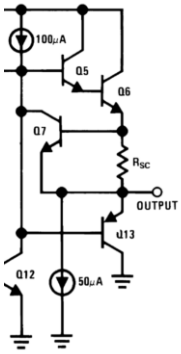
Protection – sinking current



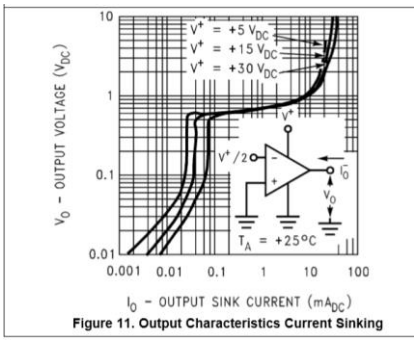


Figure 11. Output Characteristics Current Sinking

LM324

Datasheet

Product Folder | Sample & Buy | Technical Documents | Tools & Software | Support & Community

TEXAS INSTRUMENTS
LM124-N, LM224-N
LM2902-N, LM324-N
SNOSC16D – MARCH 2000 – REVISED JANUARY 2015

LMx24-N, LM2902-N Low-Power, Quad-Operational Amplifiers

1 Features

- Internally Frequency Compensated for Unity Gain
- Large DC Voltage Gain 100 dB
- Wide Bandwidth (Unity Gain) 1 MHz (Temperature Compensated)
- Wide Power Supply Range:
  - Single Supply 3 V to 32 V
  - or Dual Supplies ±1.5 V to ±16 V
- Very Low Supply Current Drain (700 μA) —Essentially Independent of Supply Voltage
- Low Input Biasing Current 45 nA (Temperature Compensated)
- Low Input Offset Voltage 2 mV and Offset Current: 5 nA
- Input Common-Mode Voltage Range Includes Ground
- Differential Input Voltage Range Equal to the Power Supply Voltage
- Large Output Voltage Swing 0 V to V+ − 1.5 V
- **Advantages:**
  - Eliminates Need for Dual Supplies
  - Four Internally Compensated Op Amps in a Single Package
  - Allows Direct Sensing Near GND and V_{OUT} also Goes to GND
  - Compatible With All Forms of Logic
  - Power Drain Suitable for Battery Operation
  - In the Linear Mode the Input Common-Mode, Voltage Range Includes Ground and the Output Voltage
  - Can Swing to Ground, Even Though Operated from Only a Single Power Supply Voltage
  - Unity Gain Cross Frequency is Temperature Compensated
  - Input Bias Current is Also Temperature Compensated

2 Applications

- Transducer Amplifiers
- DC Gain Blocks
- Conventional Op Amp Circuits

3 Description

The LM124-N series consists of four independent, high-gain, internally frequency compensated operational amplifiers designed to operate from a single power supply over a wide range of voltages. Operation from split-power supplies is also possible and the low-power supply current drain is independent of the magnitude of the power supply voltage.

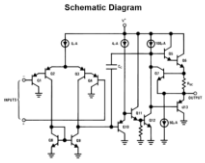
Application areas include transducer amplifiers, DC gain blocks and all the conventional op amp circuits which now can be more easily implemented in single power supply systems. For example, the LM124-N series can directly operate off of the standard 5-V power supply voltage which is used in digital systems and easily provides the required interface electronics without requiring the additional ±15 V power supplies.

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
LM124-N	CDIP (14)	19.56 mm × 6.67 mm
LM224-N		
LM324-N	CDIP (14)	19.56 mm × 6.67 mm
	PDIP (14)	19.177 mm × 6.35 mm
	SOIC (14)	8.65 mm × 3.91 mm
	TSSOP (14)	5.00 mm × 4.40 mm
LM2902-N	PDIP (14)	19.177 mm × 6.35 mm
	SOIC (14)	8.65 mm × 3.91 mm
	TSSOP (14)	5.00 mm × 4.40 mm

(1) For all available packages, see the orderable addendum at the end of the datasheet.

Schematic Diagram

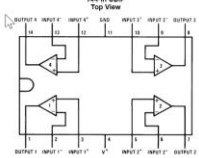


LM324

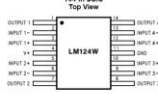
TEXAS INSTRUMENTS
www.ti.com
LM124-N, LM224-N
LM2902-N, LM324-N
SNOSC16D – MARCH 2000 – REVISED JANUARY 2015

5 Pin Configuration and Functions

J Package
14-Pin CDIP
Top View



D Package
14-Pin SOIC
Top View



Pin Functions

PIN NAME	PIN NO.	TYPE	DESCRIPTION
OUTPUT1	1	O	Output, Channel 1
INPUT1-	2	I	Inverting Input, Channel 1
INPUT1+	3	I	Noninverting Input, Channel 1
V+	4	P	Positive Supply Voltage
INPUT2+	5	I	Noninverting Input, Channel 2
INPUT2-	6	I	Inverting Input, Channel 2
OUTPUT2	7	O	Output, Channel 2
OUTPUT3	8	O	Output, Channel 3
INPUT3-	9	I	Inverting Input, Channel 3
INPUT3+	10	I	Noninverting Input, Channel 3
GND	11	P	Ground or Negative Supply Voltage
INPUT4+	12	I	Noninverting Input, Channel 4
INPUT4-	13	I	Inverting Input, Channel 4
OUTPUT4	14	O	Output, Channel 4