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Group 07

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S4-EN2111 - Electronic Circuit Design

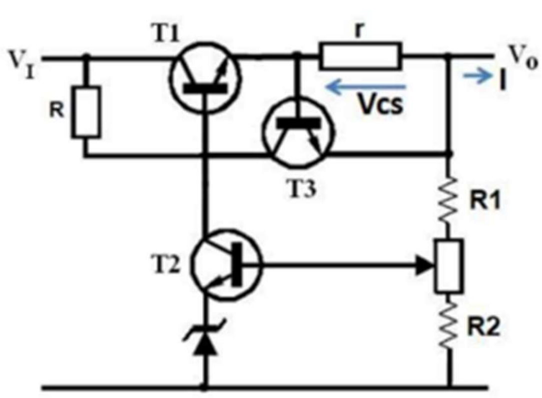
Report for linear power supply

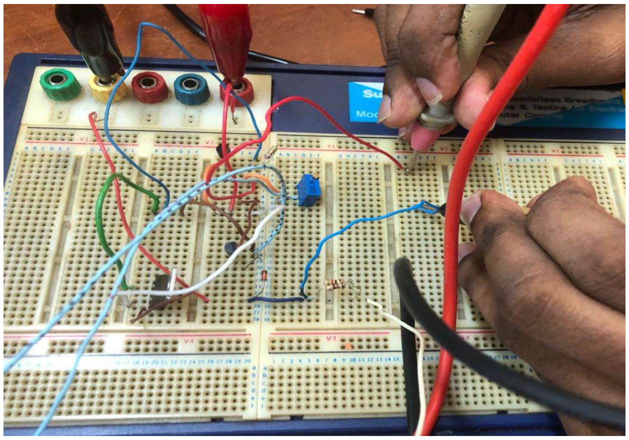
Content

Abstract

This abstract provides an overview of a report focused on component selection and calculations for a linear power supply, with a particular emphasis on measuring variable voltage range, current limiting value, and load regulation. The report explores the process of designing and implementing a linear power supply that can provide a variable output voltage while ensuring current limiting and load regulation capabilities. The report also delves into the measurement techniques used to evaluate the performance of the power supply, including measuring the variable voltage range, determining the current limiting value, and assessing load regulation. Practical examples and case studies are included to illustrate the component selection, calculations, and measurement techniques. The report concludes by highlighting the importance of accurate component selection and precise measurements in achieving a robust and reliable linear power supply design that meets the desired specifications for variable voltage range, current limiting value, and load regulation.

Introduction





Linear power supplies are widely used in various electronic applications that require a stable and reliable power source. The design and implementation of a linear power supply involve careful component selection and calculations to ensure optimal performance. This report focuses on the process of selecting components and performing calculations for a linear power supply, with specific consideration given to measuring the variable voltage range, current limiting value, and load regulation.

A linear power supply converts the incoming AC voltage into a regulated DC voltage, providing a steady and noise-free power output. The ability to vary the output voltage within a certain range is crucial in accommodating different load requirements and voltage levels for various electronic devices. Additionally, incorporating current limiting capabilities is essential to protect the power supply and the connected load from excessive current draw.

Component selection plays a critical role in designing an efficient and reliable linear power supply. Key components such as transformers, rectifier diodes, filter capacitors, voltage regulators, and current-limiting resistors need to be carefully chosen based on the desired specifications and load requirements. Calculations involving voltage ratings, current ratings, power dissipation, and thermal considerations are essential to ensure the selected components can handle the expected operating conditions.

Measurement and evaluation are crucial steps in assessing the performance of a linear power supply. Measuring the variable voltage range allows for verification of the power supply's ability to provide the desired output voltage within a specified range. Determining the current limiting value ensures that the power supply can protect the load by limiting the maximum current delivered. Load regulation measurements assess the power supply's ability to maintain a stable output voltage under varying load conditions.

By addressing the component selection, calculations, and measurement techniques for a linear power supply, this report aims to provide a comprehensive understanding of the design process. Practical examples and case studies will be included to illustrate the application of these principles in real-world scenarios. Ultimately, a well-designed linear power supply with accurate component selection and precise measurements ensures the provision of a stable and reliable power source for a wide range of electronic applications.

Constrains

Input voltage range Vi = Typical Input voltage ± 2 V where Typical input voltage = 14V + Reminder of (Group Number/5).

Current limitation = 100 mA (for all groups)

Output voltage range = Mid output voltage ± 3 V where Mid output voltage Vo = Vi - 6 + Reminder of (Group number /3).

Calculations

group number = 7

Mid input voltage = 16V

Input voltage range = 14V – 18V

Mid output voltage = 9V

Output voltage range = 6V – 12V

Maximum generated power through T_1 transistor = $(V_{in(max)} – V_{o(min)}) \times I_{max}$

$= (18-6)\ V \times 100mA$

$= 12\times100\times10^{-3}\ W$

$= 1.2W$

To calculate maximum base current through T_1 transistor,

Minimum β of the transistor = 25

Maximum base current = 100mA÷25

Knee current of the Zener diode = 1mA

Then we can calculate the R value, in the worst case of the circuit.

$((V_{in(min)} – V_{o(max)} – 0.6) \div R) \geq 1mA + (100mA\div25)$

R= 280Ω

To calculate r when T_3 transistor is on and flow current of emitter of T_1= 100mA

r = 0.6 ÷ 0.1

r = 6Ω

$V_o = (1 + (R_1/R_2)) \times (Vz + 0.6)$

Zener voltage of Zener diode = 3.3V

When output voltage is maximum,

$V_{o(max)} = 12V$

$12 = (1 + (R_1/R_2)) \times (3.3+ 0.6)$

$(R_1/R_2) = 2.0769$

When output voltage is minimum,

$V_{o(min)} = 6V$

$6 = (1 + (R_1/R_2)) \times (3.3+ 0.6)$

$(R_1/R_2) = 0.5384$

Then (R_1/R_2) value varies from 0.5384 to 2.0769. We use a 10k potentiometer and two fixed resistors to get above ratio.

$(R_1/R_2)_{min} = X/Y$; when potentiometer value is zero.

$(R_1/R_2)_{max} = (X+10)/Y$; when potentiometer value is 10k.

$X=0.5384Y$

$10+0.5384Y =2.0769Y$

$Y = 10/1.5385$

$Y = 6.499k\Omega \approx 6.5\ k\Omega$

$X = 3.499k\Omega \approx 3.5\ k\Omega$

Components

T2,T3- BC109

The BC109 is a widely used NPN bipolar junction transistor (BJT) that is commonly employed in a variety of electronic circuits. It is designed for general-purpose amplification and switching applications, and it is known for its low noise and high voltage capabilities.

Here are some key specifications and features of the BC109 transistor:

- Transistor Type: NPN (Negative-Positive-Negative)
- Maximum Collector Current (Ic): 100mA (milliamperes)
- Maximum Collector-Emitter Voltage (Vce): 25V (Volts)
- Maximum Power Dissipation (Pd): 300mW (milliwatts)
- DC Current Gain (hFE): Typically ranges from 200 to 800, depending on the specific variant.

The BC109 transistor typically comes in a TO-18 metal can package, which has three leads. The pinout configuration of the BC109 is as follows:

- Pin 1 (Emitter): The emitter terminal is usually identified by a small arrow or dot on the transistor package. It is the terminal through which current flows out of the transistor.
- Pin 2 (Base): The base terminal is responsible for controlling the transistor's operation by applying a small current or voltage input.
- Pin 3 (Collector): The collector terminal is where the controlled current flows into the transistor.

Checked transistors for T1

BC 547

BC547 is a commonly used NPN bipolar junction transistor (BJT) that is widely used in electronic circuits. It is an inexpensive general-purpose transistor with a maximum current rating of 100 mA and a voltage rating of 45V.The BC547 transistor has three terminals: the base (B), the collector (C), and the emitter (E). It is designed for use in amplification and switching applications. When a small current flows into the base terminal, it controls a larger current flow between the collector and emitter terminals. The BC547 transistor is available in a TO-92 package, which is a small plastic package with three leads. The pinout configuration of BC547 is as follows:

Pin 1 (Emitter): This terminal is identified by a small arrow or dot on the transistor package. The emitter is the terminal through which current enters the transistor.

Pin 2 (Base): The base terminal is responsible for controlling the transistor's operation by applying a small current or voltage.

Pin 3 (Collector): The collector is the terminal from which the controlled current flows out of the transistor.

BD139

The BD139 is a popular NPN bipolar junction transistor (BJT) that is commonly used in a wide range of electronic circuits. It is designed for general-purpose amplifier and switching applications. The BD139 is known for its reliability and versatility.

Here are some key specifications and features of the BD139 transistor:

- Transistor Type: NPN (Negative-Positive-Negative)
- Maximum Collector Current (Ic): 1.5A (Amperes)
- Maximum Collector-Emitter Voltage (Vce): 80V (Volts)
- Maximum Power Dissipation (Pd): 8W (Watts)
- DC Current Gain (hFE): Typically ranges from 25 to 250, depending on the specific variant.

The BD139 transistor typically comes in a TO-126 package, which is a medium-sized plastic package with three leads. The pinout configuration of BD139 is as follows:

- Pin 1 (Emitter): The emitter terminal is usually identified by a small arrow or dot on the transistor package. It is the terminal through which current flows out of the transistor.
- Pin 2 (Base): The base terminal is responsible for controlling the transistor's operation by applying a small current or voltage input.
- Pin 3 (Collector): The collector terminal is where the controlled current flows into the transistor.

It's worth noting that the BD139 is often used in conjunction with the complementary PNP transistor BD140, as they are commonly used in pairs for various applications.

D883

The D883 is a common designation for the 2SD883 transistor, which is an NPN bipolar junction transistor (BJT) commonly used in electronic circuits. It is designed for general-purpose amplification and switching applications.

Here are some key specifications and features of the 2SD883 transistor:

- Transistor Type: NPN (Negative-Positive-Negative)
- Maximum Collector Current (Ic): 1.5A (Amperes)
- Maximum Collector-Emitter Voltage (Vce): 60V (Volts)
- Maximum Power Dissipation (Pd): 1W (Watts)
- DC Current Gain (hFE): Typically ranges from 60 to 240, depending on the specific variant.

The 2SD883 transistor usually comes in a TO-92 package, which is a small plastic package with three leads. The pinout configuration of the 2SD883 is as follows:

- Pin 1 (Emitter): The emitter terminal is typically identified by a small arrow or dot on the transistor package. It is the terminal through which current flows out of the transistor.
- Pin 2 (Base): The base terminal is responsible for controlling the transistor's operation by applying a small current or voltage input.
- Pin 3 (Collector): The collector terminal is where the controlled current flows into the transistor.

Used transistor for the design.

The TIP31 is a widely used NPN power transistor that is commonly employed in various electronic applications, including amplification, and switching circuits. It is designed to handle higher power and current levels compared to smaller signal transistors like the BC547.

Here are some key specifications and features of the TIP31 transistor:

- Transistor Type: NPN (Negative-Positive-Negative)
- Maximum Collector Current (Ic): 3A (Amperes)
- Maximum Collector-Emitter Voltage (Vce): 40V (Volts)
- Maximum Power Dissipation (Pd): 40W (Watts)
- DC Current Gain (hFE): Typically ranges from 10 to 50, depending on the specific variant.

The TIP31 transistor comes in a TO-220 package, which can handle higher power dissipation compared to smaller packages like TO-92. It typically has three leads: the emitter (E), the base (B), and the collector (C). The pinout configuration of TIP31 is as follows:

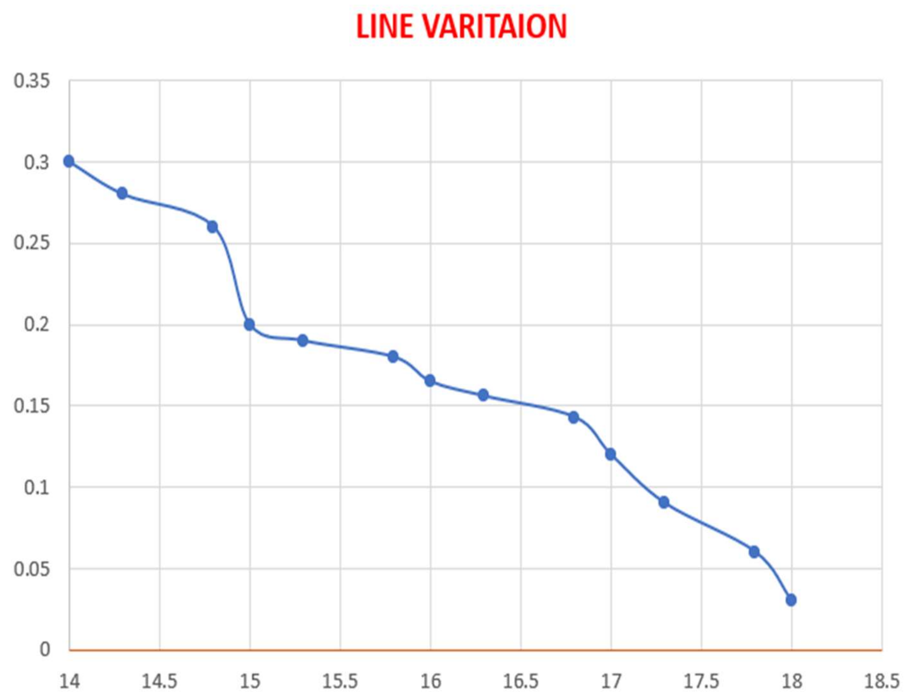
Pin 1 (Emitter): The emitter terminal is usually indicated by a small arrow or dot on the transistor package. It is the terminal through which the current flows out of the transistor.

Pin 2 (Base): The base terminal is responsible for controlling the transistor's operation by applying a small current or voltage input.

Pin 3 (Collector): The collector terminal is where the controlled current flows into the transistor.

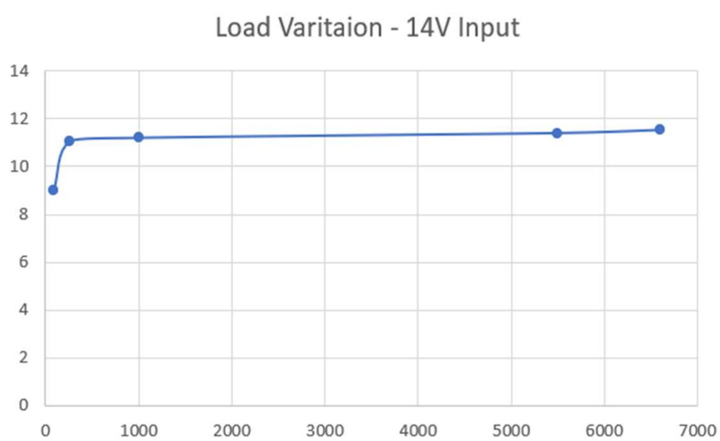
Line Variation Diagram

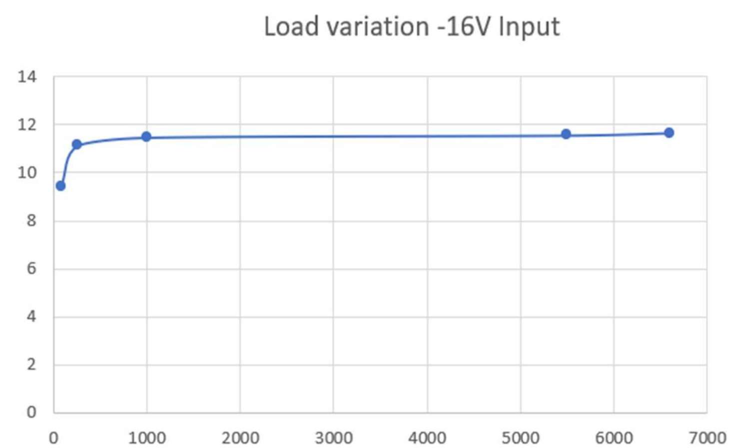
INPUT VOLTAGE(V) X axis	VARIATION OF THE OUTPUT(V) Y axis
14	0.3
14.3	0.28
14.8	0.26
15	0.2
15.3	0.19
15.8	0.18
16	0.165
16.3	0.156
16.8	0.143
17	0.12
17.3	0.09
17.8	0.06
18	0.03

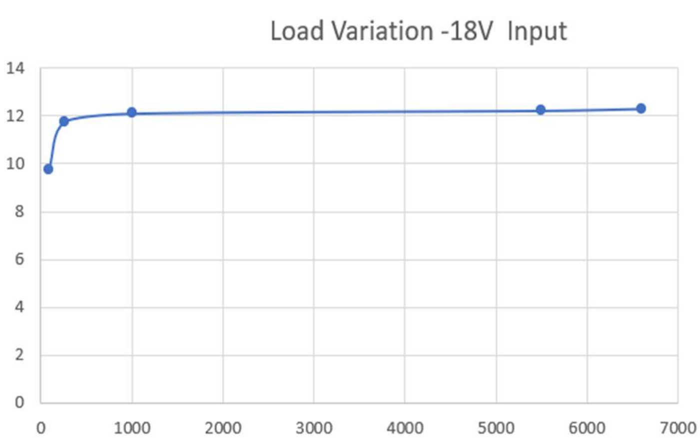


Load Variation Diagram

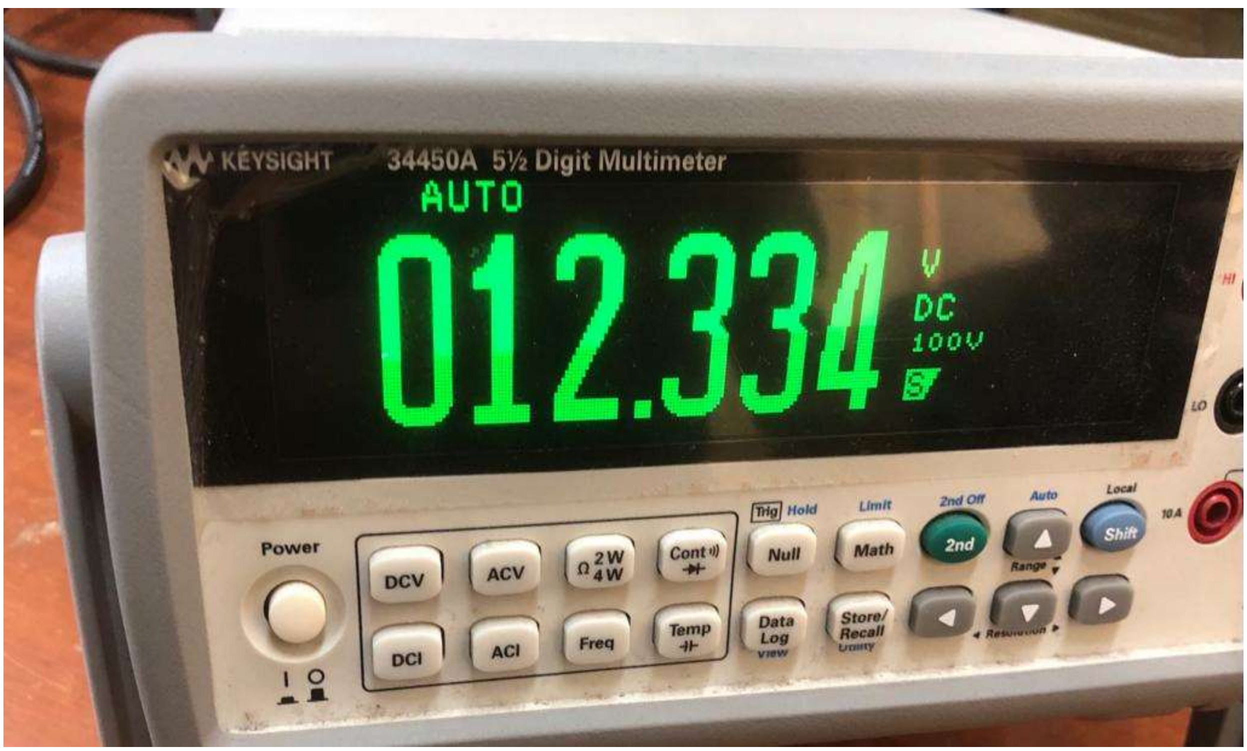
Load resistance (Ohm)-X axis	Input Voltage(V)	Output Voltage(V)-Y axis
82	14	8.99
	16	9.45
	18	9.75
260	14	11.05
	16	11.14
	18	11.77
1000	14	11.2
	16	11.48
	18	12.11
5500	14	11.4
	16	11.57
	18	12.23
6600	14	11.53
	16	11.67
	18	12.31







Measurement including variable voltage range, current limiting value, load regulation.



Conclusion

Designing a linear power supply involves meticulous component selection, calculations, and precise measurements to ensure optimal performance and meet the desired specifications. This report has provided an overview of the process involved in component selection and calculations for a linear power supply, with a specific focus on measuring the variable voltage range, current limiting value, and load regulation.

By carefully selecting components such as transformers, rectifier diodes, filter capacitors, voltage regulators, and current-limiting resistors, designers can ensure the power supply can handle the expected operating conditions while delivering stable and reliable power output. Calculations involving voltage ratings, current ratings, power dissipation, and thermal considerations play a vital role in determining the suitability of the selected components.

Accurate measurements of the variable voltage range, current limiting value, and load regulation are crucial in assessing the performance of the linear power supply. These measurements validate the power supply's ability to provide the desired output voltage within the specified range, protect the load from excessive current draw, and maintain a stable output voltage under varying load conditions. A well-designed linear power supply with precise component selection and careful calculations ensures the provision of a stable and low-noise power source for a wide range of electronic applications. This, in turn, contributes to the reliable operation and longevity of electronic devices.

While this report has provided a general overview of the component selection and calculations for a linear power supply, it is important to note that further research and analysis may be necessary depending on the specific requirements and constraints of the intended application. Consulting additional references and manufacturers' datasheets will provide more detailed information and guidelines for specific component selection and calculations.

References

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