EE BD 324 – Microelectronics I
Lab 5 – Adjustable DC Power Supply Design
Penn State Erie, The Behrend College
Fall Semester 2006

Objective: To design an adjustable DC power supply

Relevant Textbook Sections: Sections 3.4, 3.5

Equipment: PC, OrCAD PSpice

Parts: None

PSpice Usage: Required

Reports: Design review from the group during the second lab period. Bring sufficient supporting documentation to support your work.

Preliminary Calculations: Read through the laboratory procedure

Number of Laboratory Periods: 2

Point Breakdown:

Memorandum **Circuits "R" Us** **Penn State Erie**

To: Engineering Design Team
From: The Boss
Subject: Adjustable power supply design

Our main competitor has just introduced a new DC power supply for use with consumer electronics. In order for us to maintain our advantage as a leader in the consumer electronics industry, we must design and manufacture a new power supply to compete with this product at a lower cost. We need to come up with a preliminary design as well as cost estimates. I would like to meet with the design group next week, at which time we can discuss your design further.

Here are some of the issues that need to be addressed:

- The nominal DC output voltage.
- How to select the shunt resistors.
- How to avoid burning out diodes w/ with no load attached.
- How to avoid burning out resistors.
- Cost tradeoffs.

I have included the specs this design must meet, as well as information about the available parts, manufacturing costs, and performance of our competitor's design.

Design Specifications

- Selectable output voltages: 3V, 4.5V, 6V, 7.5V, 9V.
- Output current: 50mA. This is a bit confusing. Your design must be able to deliver at least this much current. So if I connect a load that will draw 50mA your design must be able to handle it. If the load would draw more than 50mA your design would not be required to deliver that much current, although if it could that would be fine.

Do not use the transformer in PSPICE. Simply model the secondary winding of the transformer as a sinewave voltage source.

Competitor's Design

I went into the lab and measured the following characteristics for our competitor's power supply. They advertise it for $12.99 in their catalog. The ripple voltage was measured with no load connected to the power supply.

Selected Output Voltage	Measured Output Voltage	Measured Ripple Voltage (p-p)
3V	4.1V	80mV
4.5V	5.3V	100mV
6V	6.3V	120mV
7.5V	8V	140mV
9V	8.5V	160mV

Parts Costs (estimated including overhead)

- Resistors: $0.10 (0.25W), $0.25 (1W)
- Capacitors: $0.25
- Zener Diodes: $0.25
- Diodes (D1N4001): $0.25
- Bridge rectifier packages: $0.50
- Step Down Power Transformers (center tapped or with a single secondary winding)
    1. 12.6V rms, $1\frac{7}{16} x 1\frac{11}{16} x 1\frac{1}{2}$ inches, $2.50.
    2. 25.2V rms, $1\frac{11}{16} x 1\frac{15}{16} x 1\frac{3}{4}$ inches, $2.50.
- Plastic housing, including voltage selector switch: $1.00.

1N746 thru 1N759

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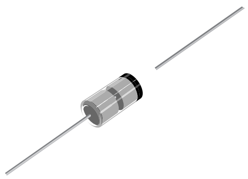
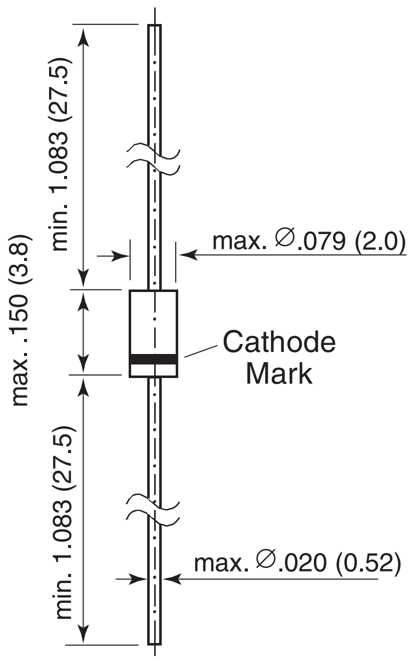


Zener Diodes

V_Z Range 3.3 to 12V
Power Dissipation 500mW

DO-204AH (DO-35 Glass)



Dimensions in inches and (millimeters)

Features

- Silicon Planar Power Zener Diodes.
- Standard Zener voltage tolerance is ±5% for “A” suffix. Other tolerances are available upon request.

Mechanical Data

Case: DO-35 Glass Case
Weight: approx. 0.13 grams
Packaging codes/options:
D7/10K per 13” reel, (52mm tape), 20K/box
D8/10K per Ammo tape (52mm tape), 20K/box

Maximum Ratings and Thermal Characteristics (T_A = 25°C unless otherwise noted)

Parameter	Symbol	Value	Unit
Zener Current (see Table “Characteristics”)			
Power Dissipation at T_L = 75°C	P_{tot}	500(1)	mW
Thermal Resistance Junction to Ambient Air	$R_{\Theta JA}$	300(2)	°C/W
Maximum Junction Temperature	T_j	175	°C
Storage Temperature Range	T_S	–65 to +175	°C

Notes:
(1) T_L is measured 3/8” from body.
(2) Valid provided that leads at a distance of 3/8” from case are kept at ambient temperature.

Electrical Characteristics (T_A = 25°C unless otherwise noted) **Maximum V_F = 1.5V at I_F = 200mA**

Type Number	Nominal Zener Voltage V_Z @ $I_{ZT}^{(3)}$ (Volts)	Test Current I_{ZT} (mA)	Maximum Zener Impedance Z_{ZT} @ $I_{ZT}^{(1)}$ (Ω)	Maximum Regulator Current $I_{ZM}^{(2)}$ (mA)	Maximum Reverse Leakage Current T_A = 25°C I_R @ V_R = 1V (µA)	Maximum Reverse Leakage Current T_A = 150°C I_R @ V_R = 1V (µA)
1N746A	3.3	20	28	110	10	30
1N747A	3.6	20	24	100	10	30
1N748A	3.9	20	23	95	10	30
1N749A	4.3	20	22	85	2	30
1N750A	4.7	20	19	75	2	30
1N751A	5.1	20	17	70	1	20
1N752A	5.6	20	11	65	1	20
1N753A	6.2	20	7	60	0.1	20
1N754A	6.8	20	5	55	0.1	20
1N755A	7.5	20	6	50	0.1	20
1N756A	8.2	20	8	45	0.1	20
1N757A	9.1	20	10	40	0.1	20
1N758A	10	20	17	35	0.1	20
1N759A	12	20	30	30	0.1	20

Notes:
(1) The Zener impedance is derived from the 1 kHz AC voltage which results when an AC current having an RMS value equal to 10% of the Zener current (I_{ZT}) is superimposed on I_{ZT}. Zener impedance is measured at two points to insure a sharp knee on the breakdown curve and to eliminate unstable units.
(2) Valid provided that leads at a distance of 3/8” from case are kept at ambient temperature.
(3) Measured with device junction in thermal equilibrium.