FINAL DESIGN PROJECT

THE GEORGE WASHINGTON UNIVERSITY
SCHOOL OF ENGINEERING AND APPLIED SCIENCE
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

By Seungryul Lee (Tommy)
Professor: Zhenyu Guo
Teaching Assistant: Faisal Mohd Yasin
MAY 3, 20001
SPECIFICATION

• The power supply: 120 Vrms at 60Hz
• Two channel inputs (Line and Microphone)
  - Channel 2: 10kohm input impedance, 25uVrms for 1Vrms output
  - Channel 1: 47kohm input impedance, 100mVrms for 1Vrms
• The load is a 8 Ohm speaker
• Frequency response:
  - Line: 20 Hz to 20kHz (with distortion < ± 1 dB)
  - Mic: 20 Hz to 15kHz (with distortion < ± 1 dB)
• Three-band graphic equalizer:
  - Center frequencies of 250Hz, 4kHz, and 16kHz
• One master volume control: -20 to +20 dB
• One crossfader
POWER SOURCE
(Voltage Regulator)

V1
FREQ = 60
VAMPL = 169.7
VOFF = 0

TX1
D1N4002
D5

TX2
D1N4002
D6

U4
LM7912C
IN
GND
OUT

U5
LM7812C
IN
GND
OUT

R2
1

C1
0.1u

C2
4700u

C3
330u

R4
500

C4
0.1u

C5
4700u

C6
330u

C10
0.1u

R3
500
CIRCUIT SCHEMATIC
(Cross-fader)

U1, U2, U12, U17: LM741

V1: FREQ = 5k, VAMPL = 100mV, VOFF = 0
V2: FREQ = 5k, VAMPL = 100mV, VOFF = 0

R1, R2, R3, R4, R5, R6, R7, R8, R9: Resistors
C1: Capacitor 470uF

12Vdc Power Supplies
CIRCUIT SCHEMATIC (Crossfader)

C1 Pk–Pk 232mV
C4 Pk–Pk 220mV
CIRCUIT SCHEMATIC
(Common Emitter)
CIRCUIT SCHEMATIC (Common Emitter)

- Input: 100mV, Output: 3.32V
CIRCUIT SCHEMATIC
(Graphic Equalizer)
CIRCUIT SCHEMATIC
(Common Collector)

- **V9**: 12Vdc
- **C9**: 4700uF
- **R22**: 8Ω
- **Q2**: TIP31A
- **Q3**: TIP32A
- **D1**: D1N4002
- **D2**: D1N4002
- **C6**: 4700uF
- **R18**: 1kΩ
- **R19**: 1kΩ
- **V10**: 12Vdc
- **VOFF**: 0
- **VAMPL**: 1
- **FREQ**: 5k

Connections and components as per the schematic diagram.
CIRCUIT SCHEMATIC
(Common Collector)

- Input: 1V, Output: 904mV
## PART LIST

<table>
<thead>
<tr>
<th>PART</th>
<th>MODEL</th>
<th>AMOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformer</td>
<td>12.6V Center Tapped</td>
<td>1</td>
</tr>
<tr>
<td>Voltage Regulator</td>
<td>LM7812, LM7912</td>
<td>1 Each</td>
</tr>
<tr>
<td>Diodes</td>
<td>D1N4002</td>
<td>4</td>
</tr>
<tr>
<td>Op amps</td>
<td>LM741CN</td>
<td>19</td>
</tr>
<tr>
<td>NPN Transistor</td>
<td>2N3904</td>
<td>1</td>
</tr>
<tr>
<td>NPN Silicon Power Transistor</td>
<td>TIP31, TIP32</td>
<td>1 Each</td>
</tr>
<tr>
<td>LED</td>
<td>Red, Yellow, Green</td>
<td>3 Each</td>
</tr>
<tr>
<td>Capacitors</td>
<td>2.2n, 3.3n, 68u, 330u, 470u, 4700u…</td>
<td>23</td>
</tr>
<tr>
<td>Potentiometers</td>
<td>1k, 10k, 50k, 100k, 500k</td>
<td>6</td>
</tr>
<tr>
<td>Resistors</td>
<td>1, 8, 400, 500, 1k, 8.1k, 20k…</td>
<td>53</td>
</tr>
<tr>
<td>Wires</td>
<td>Various colors</td>
<td>10</td>
</tr>
<tr>
<td>Speaker</td>
<td>BOSE (8ohm)</td>
<td>1</td>
</tr>
<tr>
<td>Microphone</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Oscilloscope</td>
<td>Tektronix TDX 460A</td>
<td>1</td>
</tr>
<tr>
<td>Power Supply</td>
<td>LAMBDA</td>
<td>1</td>
</tr>
<tr>
<td>Multimeter</td>
<td>KEITHLEY</td>
<td>1</td>
</tr>
<tr>
<td>CD Player</td>
<td>Computer</td>
<td>1</td>
</tr>
</tbody>
</table>
TESTING PROCEDURE

- Plug in the power supply
- Turn on CD player
- Volume control (Gain)
- Crossfader control
  - Line 1: Music
  - Line 2: Microphone
- Low frequency control (Bass)
- Central frequency control (Voice)
- High frequency control (Treble)
- Plug off the power supply
PROBLEMS

- Noise: Power supply, Graphic equalizer, Common collector

- TIP31 & TIP32 are too hot because of large current
IMPROVEMENTS

• Noise reduction
  - Power supply: Reduce the ripple voltage
    (Connect capacitors between out-point of regulators and ground)
      o Positive output (2V => 800mV)
      o Negative output (7V => 800mV)
  - Graphic equalizer:
    Connect capacitor between 12V and ground
  - Common collector: Change capacitor to smaller
  - Connect 7.5 ohm resistor between output of common emitter and ground

• TIP31, TIP32: Suppose to use heat sink
Questions?