Single-Supply Push-pull Class-B Power Amplifier

Introduction

In the third lab, we designed a certain kind of a power amplifier with the description and specifications below.

Design a single-supply complementary push-pull Class-B power amplifier capable of delivering at least 0.95W to a 33Ω resistive load. The supply voltage is +24V. It should operate with sinusoidal voltages with a gain equal to 20+mod(BilkentID,7) dB. The SRS DS345 signal generator provides the input *without* an offset. The −3dB bandwidth should cover 150Hz to 15KHz.

Specifications:

1. The amplifier should deliver at least 0.95W power to a 33Ω resistance ($16V_{pp}$ to a 33Ω power resistor) at 1KHz with the chosen gain value.
2. The harmonics (the highest is possibly the third harmonic) at the 0.95W output power level should be at least 40 dB lower than the fundamental signal at 1 KHz.
3. The power consumption at quiescent conditions should be less than 500mW.
4. The amplifier's efficiency (output power/total supply power) should be at least 40% at max power output (0.95W) at 1KHz.
5. The −3dB bandwidth of the amplifier should be at least 150Hz to 15KHz.

Figure 1: Description and Specification from Manual

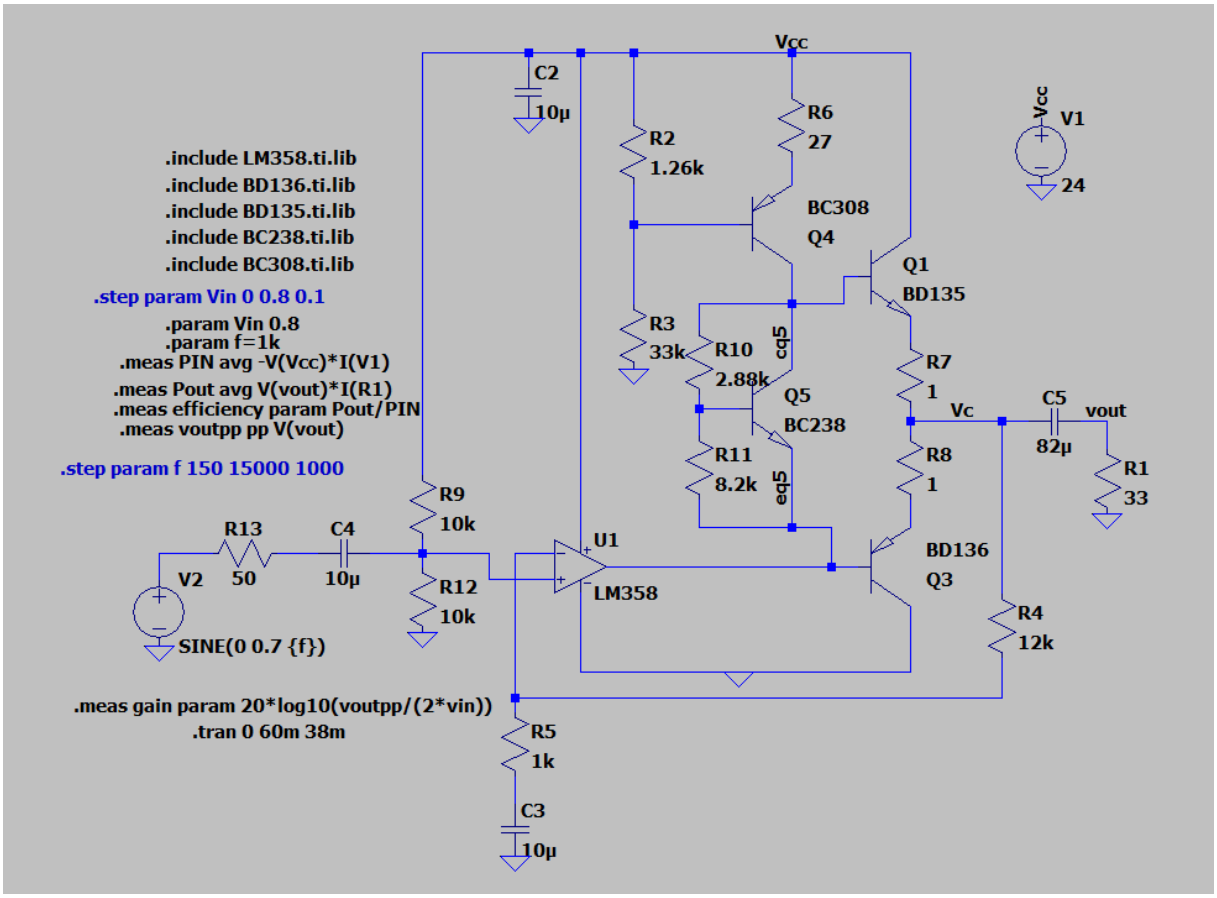


Figure 2: Overall Design

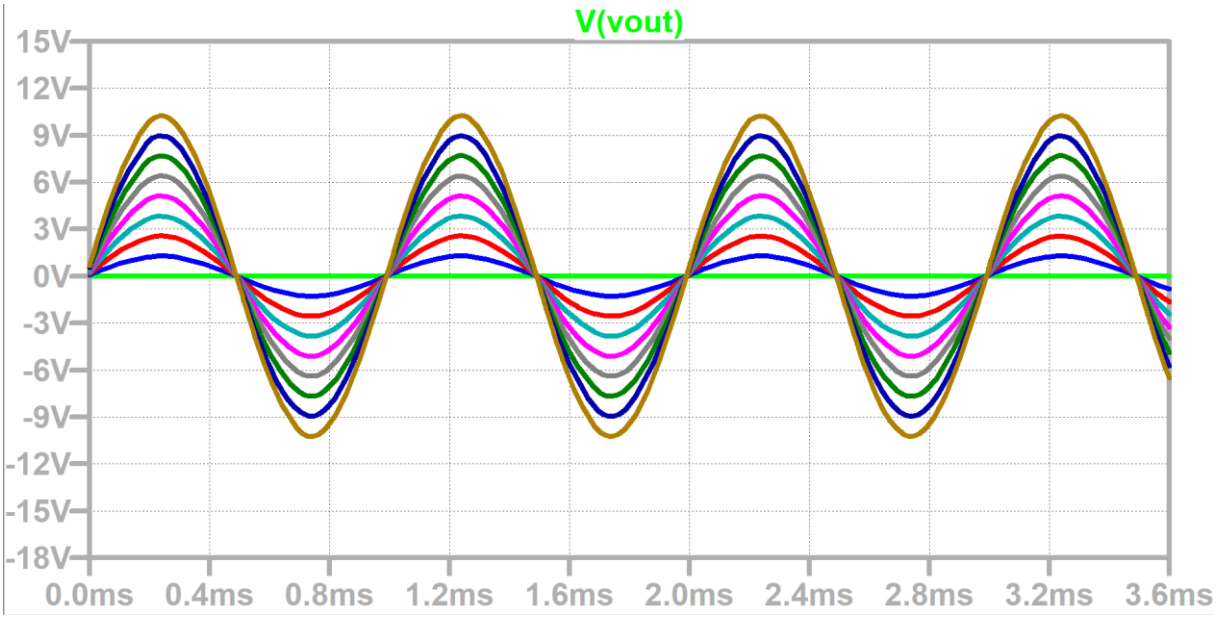


Figure 3: Vout

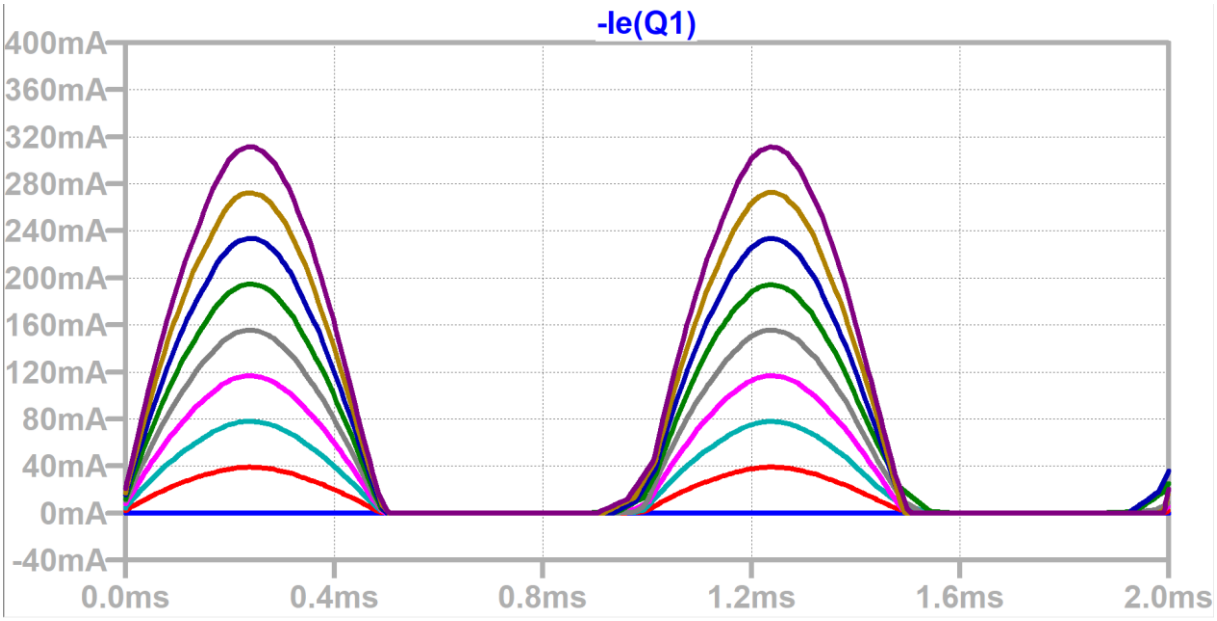


Figure 4: Ie(Q1)

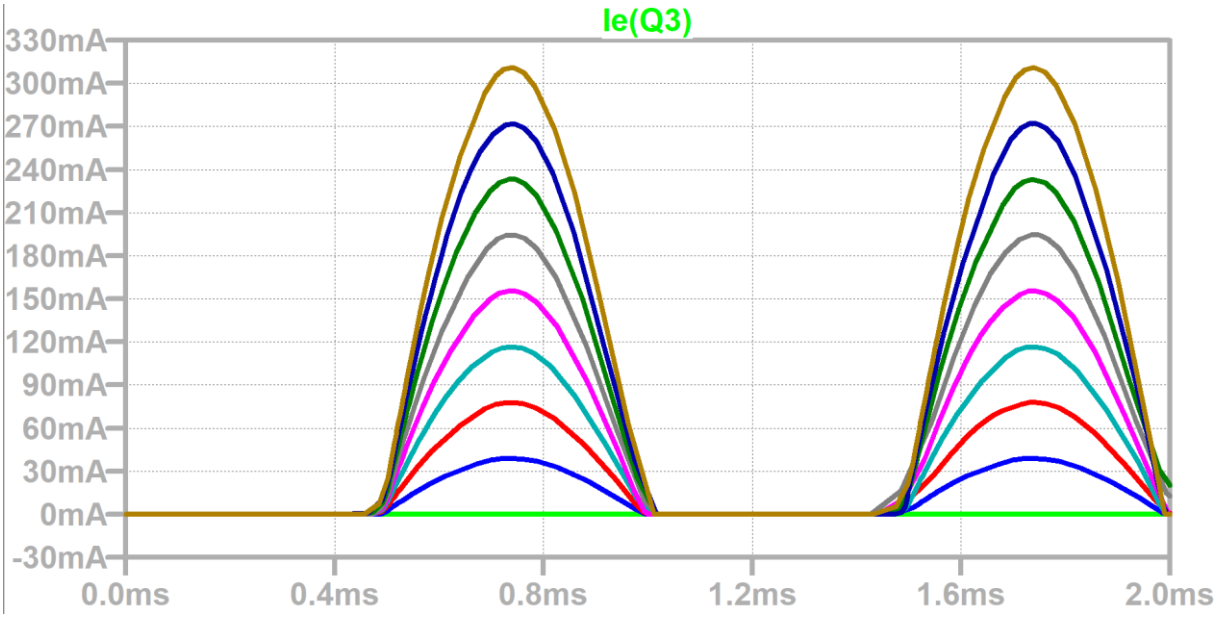


Figure 5: Ie(Q3)

REQUIREMENT 1

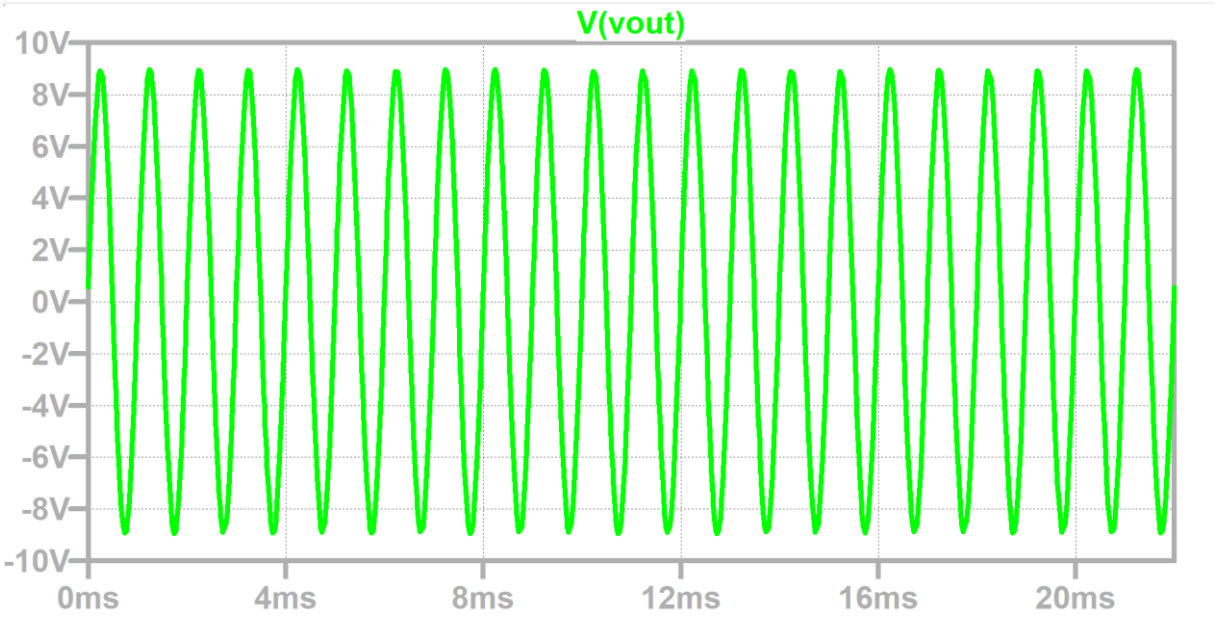


Figure 6: Vout for Conditions in Figure 2

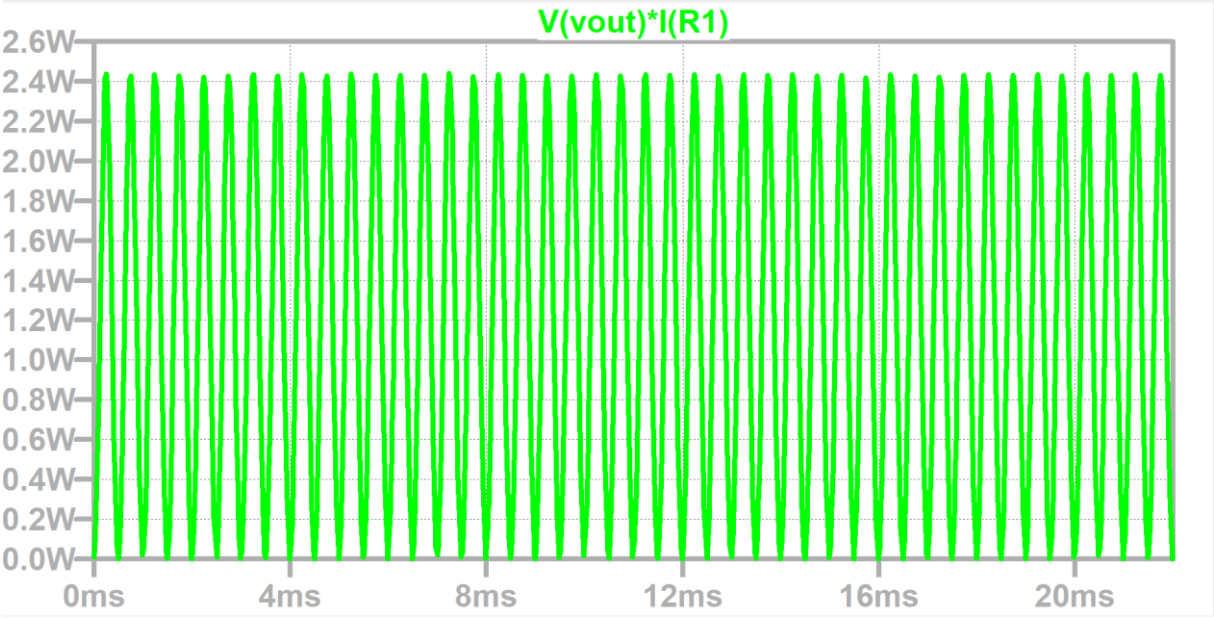


Figure 7: Power at 33k Resistor

```
pin: AVG(-v(vcc)*i(v1))=2.27884 FROM 0 TO 0.022
pout: AVG(v(vout)*i(r1))=1.18705 FROM 0 TO 0.022
efficiency: pout/pin=0.520901
voutpp: PP(v(vout))=17.9415 FROM 0 TO 0.022
gain: 20*log10(voutpp/(2*vin))=20.9948
```

Figure 8: Results for Requirement 1

As can be seen in Fig. 5, the delivered power is 1.18W (larger than 0.95W).

REQUIREMENT 2

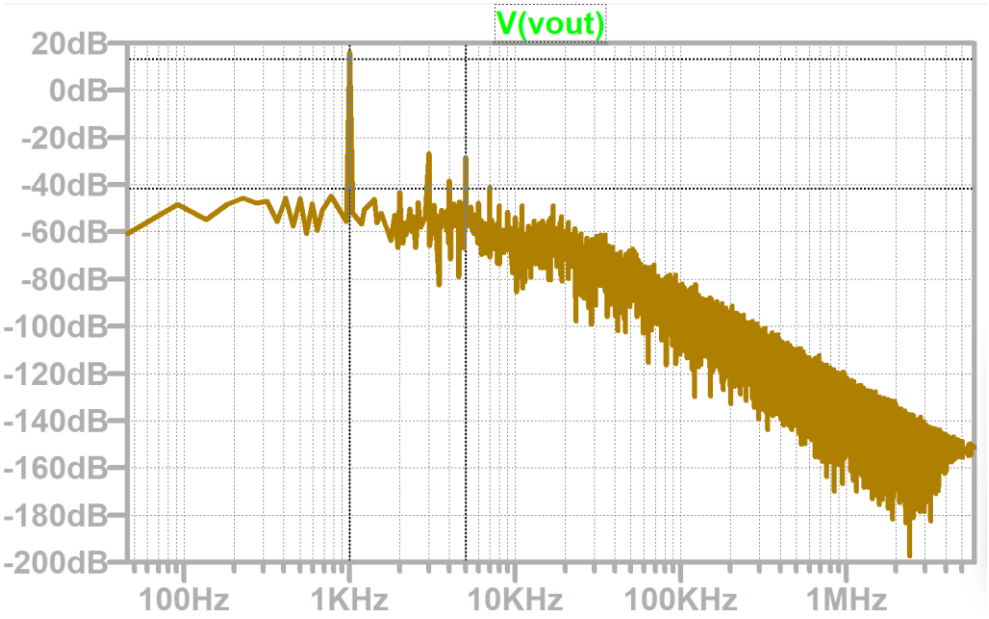
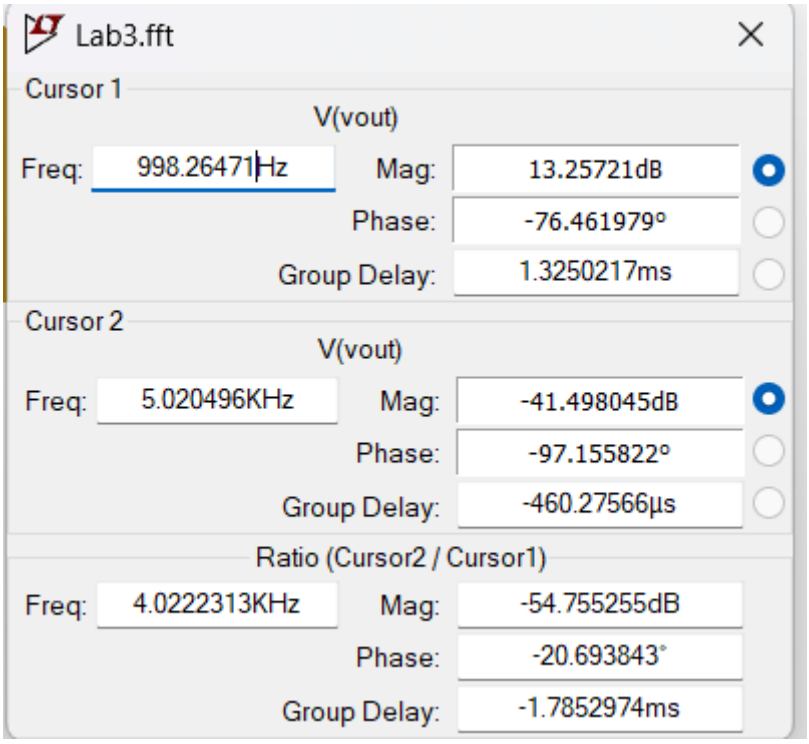


Figure 9: Requirement 2



The difference is 54 dB, satisfying the condition.

REQUIREMENT 3

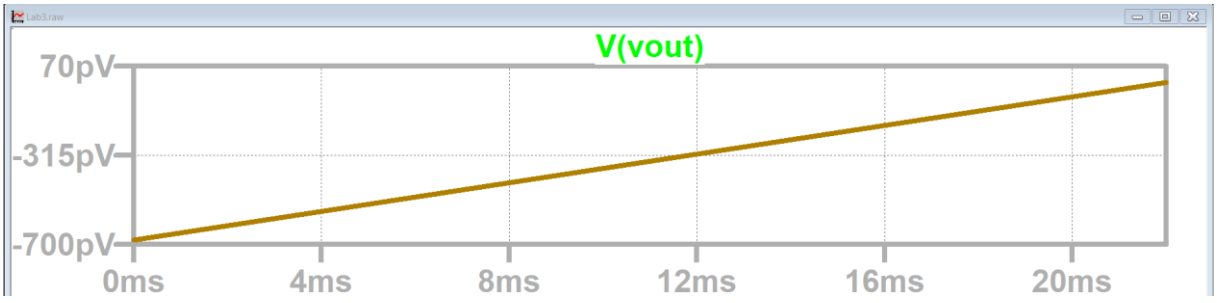


Figure 10: Vout Graph for 3rd Requirement

SPICE Output Log: C:\Users\emira\Documents_Labs\313\Lab3.log

```
.step vin=0.7
tnom = 27
temp = 27
method = modified trap
.step vin=0.8

Measurement: pin
  step      AVG(-v(vcc)*i(v1))      FROM  TO
     1      0.225014    0     0.022
     2      0.225014    0     0.022
     3      0.225014    0     0.022
     4      0.225014    0     0.022
     5      0.225014    0     0.022
     6      0.225014    0     0.022
     7      0.225014    0     0.022
     8      0.225014    0     0.022
     9      0.225014    0     0.022

Measurement: pout
  step      AVG(v(vout)*i(r1))      FROM  TO
     1      4.66988e-21 0     0.022
     2      4.66988e-21 0     0.022
     3      4.66988e-21 0     0.022
     4      4.66988e-21 0     0.022
     5      4.66988e-21 0     0.022
     6      4.66988e-21 0     0.022
```

Figure 11: LTSpice Measurements for Requirement 3

'Pin' is 0.225 for all steps, satisfying the requirement.

REQUIREMENT 4

```
Measurement: efficiency
  step            pout/pin
     1            0.520901
     2            0.520901
     3            0.520901
     4            0.520901
     5            0.520901
     6            0.520901
     7            0.520901
     8            0.520901
     9            0.520901
```

Figure 12: Efficiency Measurements

Efficiency is 0.520901 for all steps, satisfying the requirement.

REQUIREMENT 5

```
Measurement: gain
  step       20*log10(voutpp/(2*vin))
     1       20.3527
     2       21.0093
     3       21.0156
     4       21.0181
     5       21.0146
     6       21.0121
     7       21.0128
     8       21.0033
     9       21.0066
    10       21.0009
    11       20.9923
    12       20.9881
    13       20.9327
    14       20.8084
    15       20.5612
    16       20.283
```

Figure 13: Gain Measurements

The gain is not beyond 19dB (22-3) as desired.