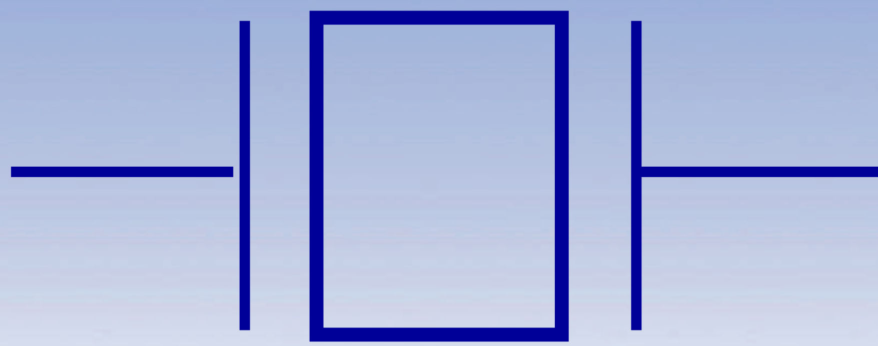
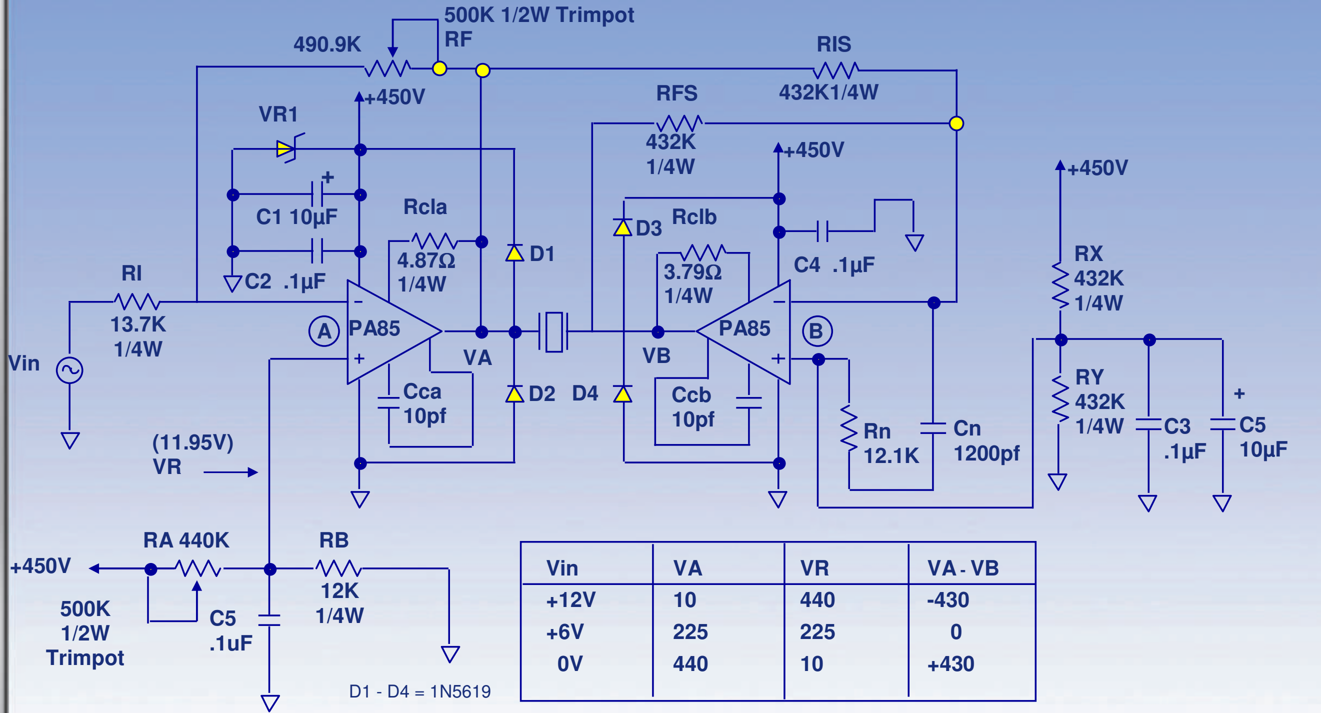
PIEZO DRIVE APPLICATIONS



860 Vpp PIEZO DRIVE SINGLE SUPPLY BRIDGE



Vin	VA	VR	VA - VB
+12V	10	440	-430
+6V	225	225	0
0V	440	10	+430

1. Vout = VA - BV

   Max Vout = Vs - V_{satA} - V_{satB}

   = 450V -10V -10V = 430V

2. Gain = $Vout_{p\text{-}p}$ / $Vin_{p\text{-}p}$ = $(VA - VB)_{p\text{-}p}$/ $Vin_{p\text{-}p}$

   $860V_{p\text{-}p}/12V_{p\text{-}p}$ = 71.67

   Gain = 2 RF/RI since we have a bridge configuration. That is the voltage gain across the load is twice that of the master amplifier, A, since +1V out of amplifier A yields -1V out of amplifier B, relative to the mid point power supply reference of +225V.

   Therefore RF/RI = 71.67/2 = 35.833.

3. Offset:

   $$VA - VB = Vs\left(2\left(1 + RF/RI\right)\left(\frac{RB}{RA + RB}\right) - 1\right) - 2\,(RF/RI)\,Vin$$

   When Vin = 0 then VA - VB = +430V

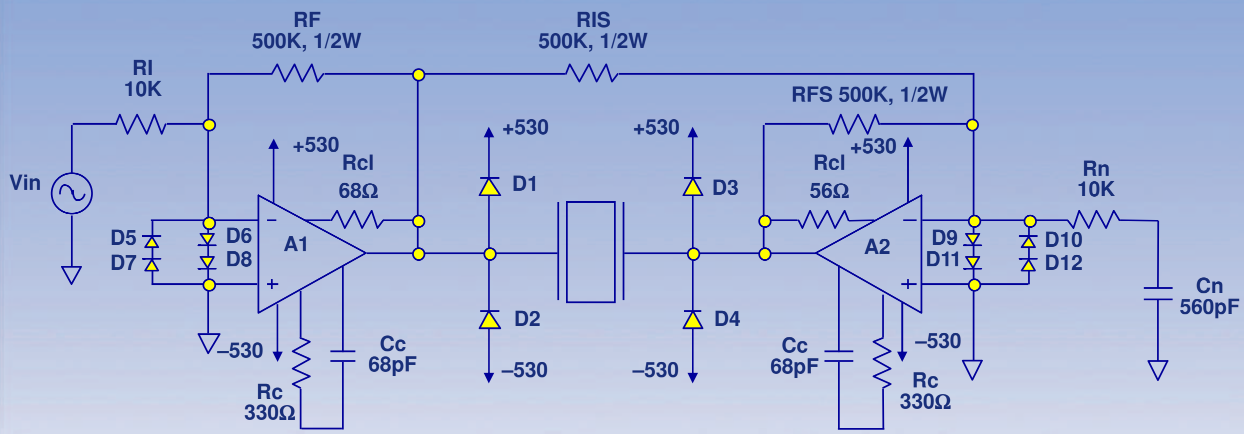
   Using RF/RI = 35.833 and solving above yields RA = 36.669RB

   Choosing RB = 12K implies RA = 440K.

4. Check for common mode voltage compliance: 11.95V > 10V; OK.

Ref. AN25

+/- 1000V PIEZO BRIDGE



A1, A2 = PA89
D1 - D4 are Semtech S20F
D5 - D12 are 1N914

Piezo users appear to never have enough voltage. As soon as it was introduced the PA89 found its way into bridge circuits to drive piezos at +/1100V and beyond.

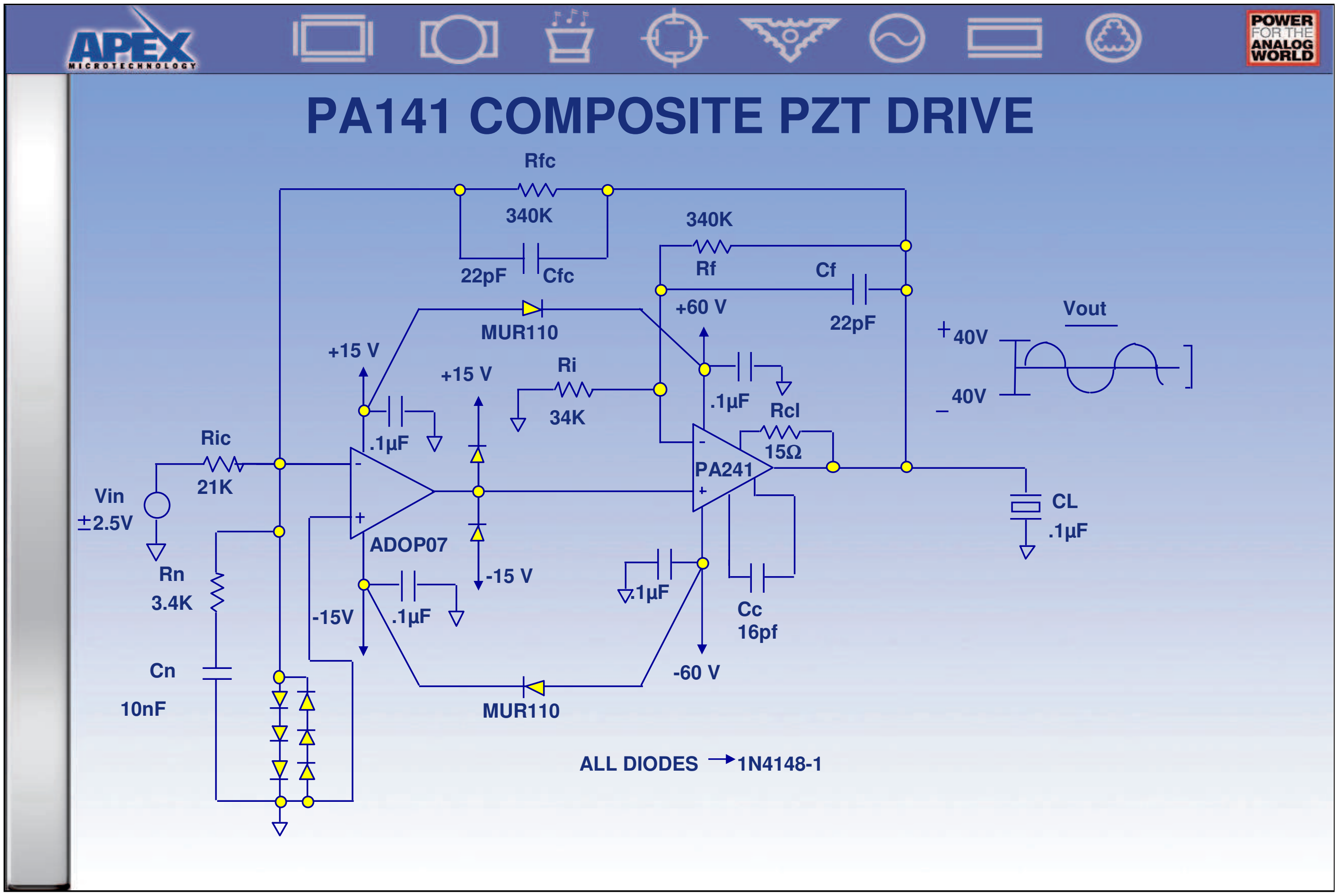
In this application we use the dual supply bridge configuration to deliver up to almost twice the supply voltage of 530V across the load. A1 operates in a gain of 50 to translate the +/–10Vinput to +/–500V out of A1. A2 then inverts this output to add an additional –/+500V across the Piezo to yield a net +/–1000V.

A2 uses noise gain compensation to allow its Vo/Vin transfer function to remain at –1, though its compensation capacitor Cc is set for a gain of 50. The noise gain will allow AC stability as well as a balanced bridge since both amplifiers are now compensated identically for the same slew rate.

Input protection diodes, output flyback diodes and proper component selection enhance reliability. Remember to select Cc capacitors with a voltage rating of at least 1100V, RI, RF, RIS, and RFS with proper power dissipation and voltage coefficient of resistance, and D1 - D4 with a PIV of at least 1100V.

As a final note remember to check the amplifiers for AC stability due to capacitive loading depending upon the capacitance of the piezo being driven.

Ref. AN25



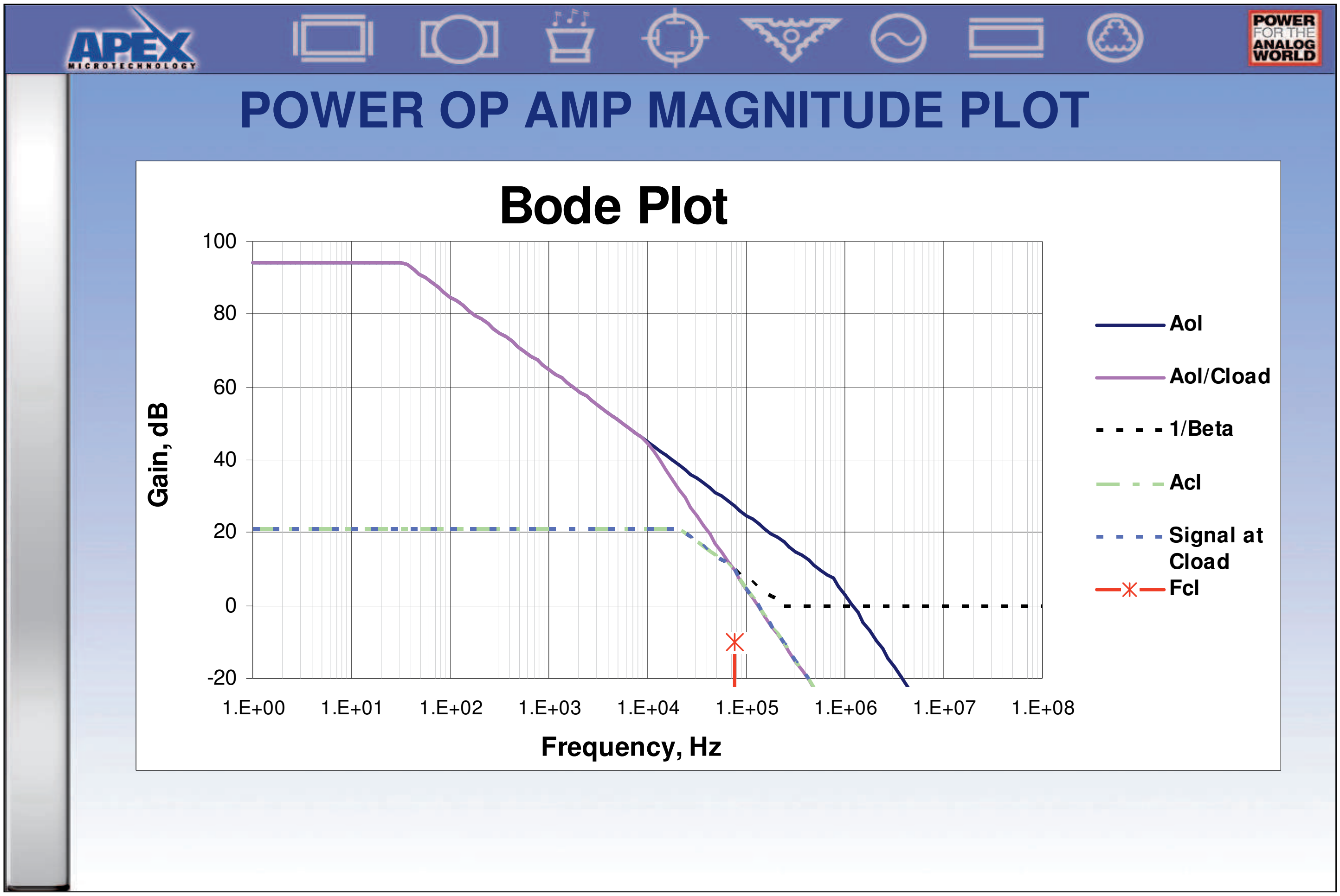
This circuit is included as an example in Power Design.xls. It is different from most power op amps in that current limit from positive side to negative side does not match well at all.

We will start by stabilizing the power stage, then the composite. Then we will examine current limit and frequency limitations imposed by this current limit.

1N4148 diodes on the input of the OP07 provide differential and common mode over voltage protection for transients through Cfc. Diodes on the output of the OP07 prevent over voltage transients that can occur through Cf,through the PA241 input protection diodes to the OP07 output through the PA241 internal input protection diodes.

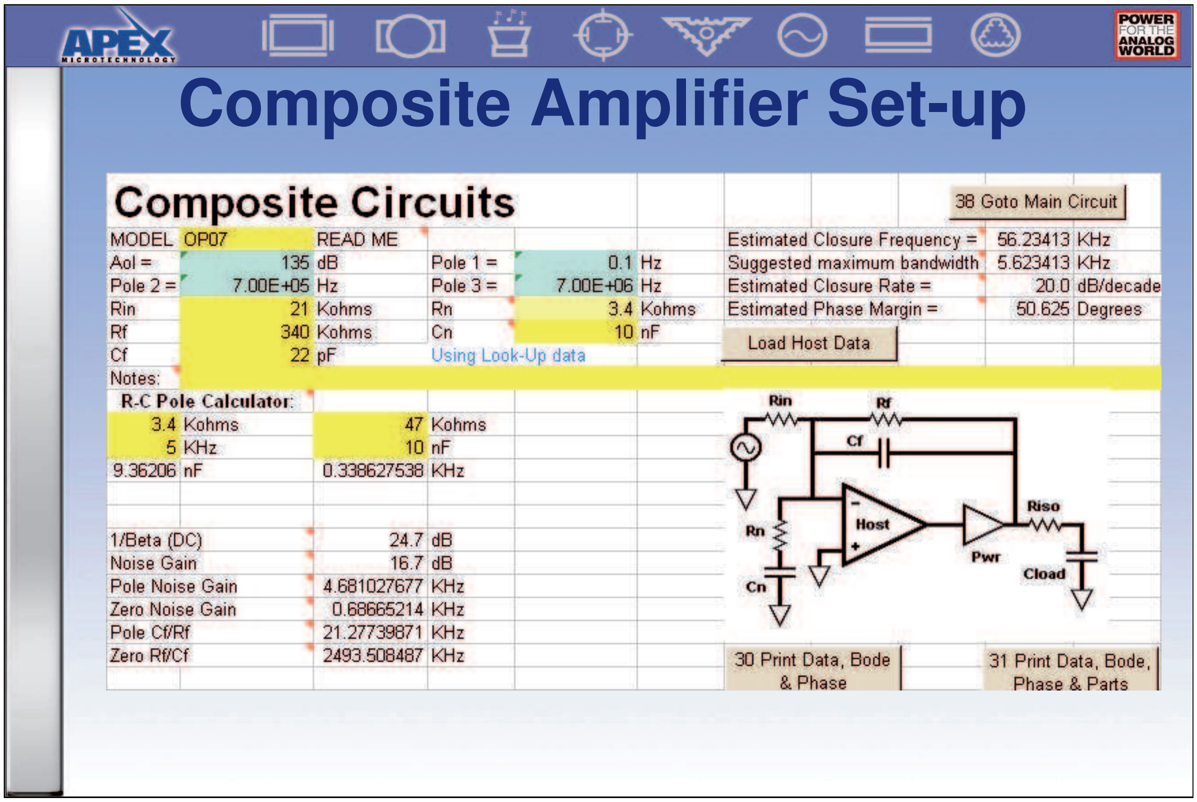
Fast recovery diodes between pairs of supplies ensure that the PA241 input stage is protected from over voltage in the event the ±15V supplies are up before the high voltage supplies.

Ref. AN19,AN25

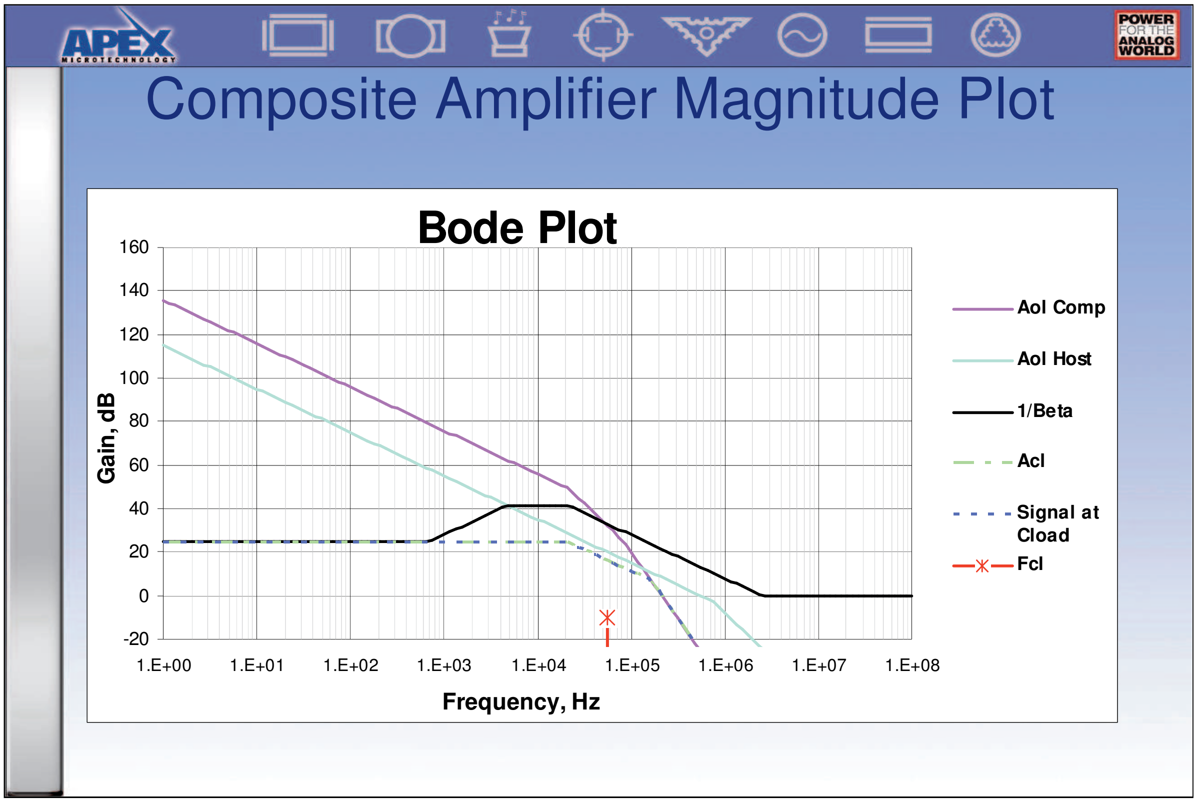


In any composite amplifier, make sure the power output stage is stable first. Any of the techniques we learned earlier can be used.

Ref. AN19,AN25



Ref. AN19,AN25,AN38



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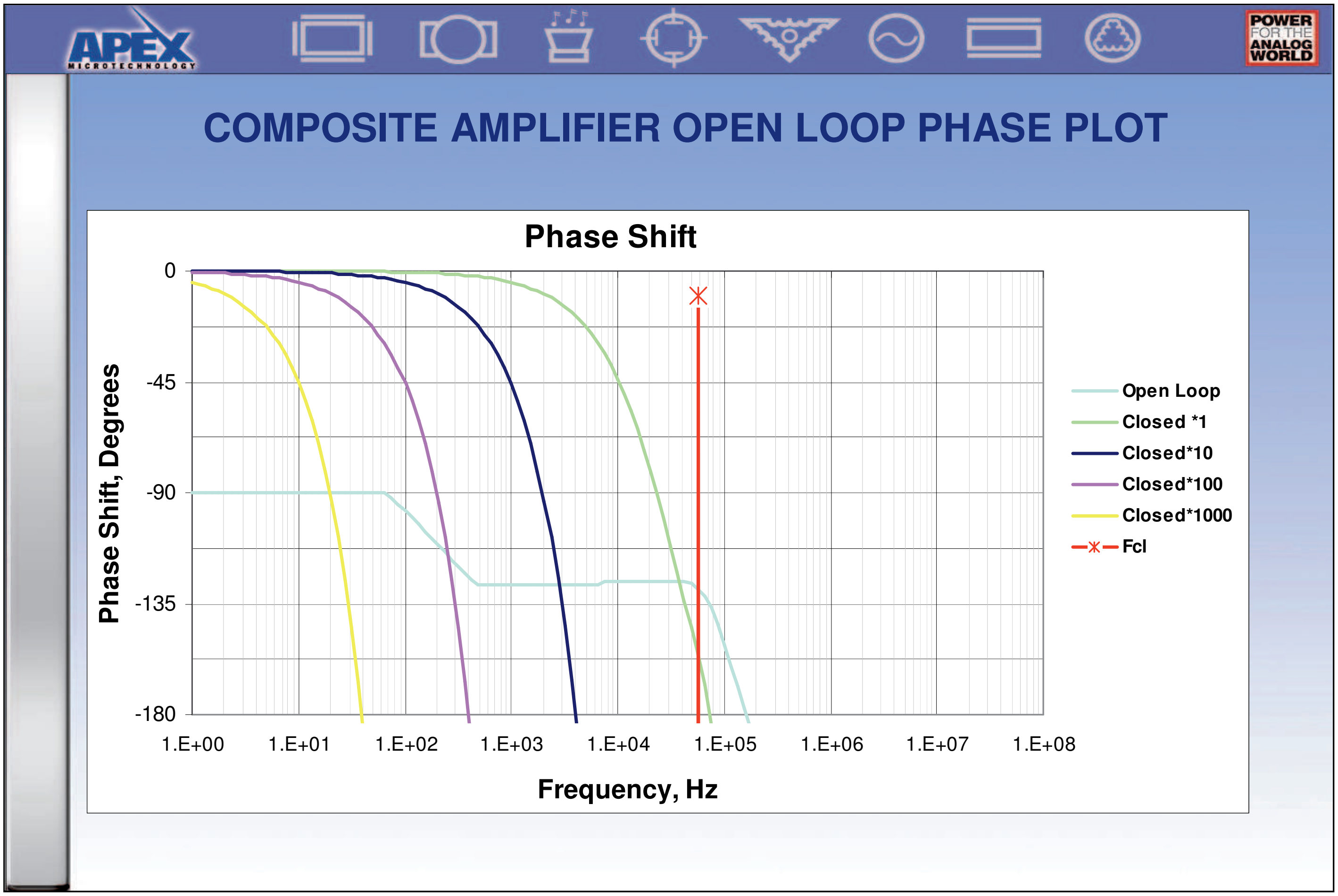

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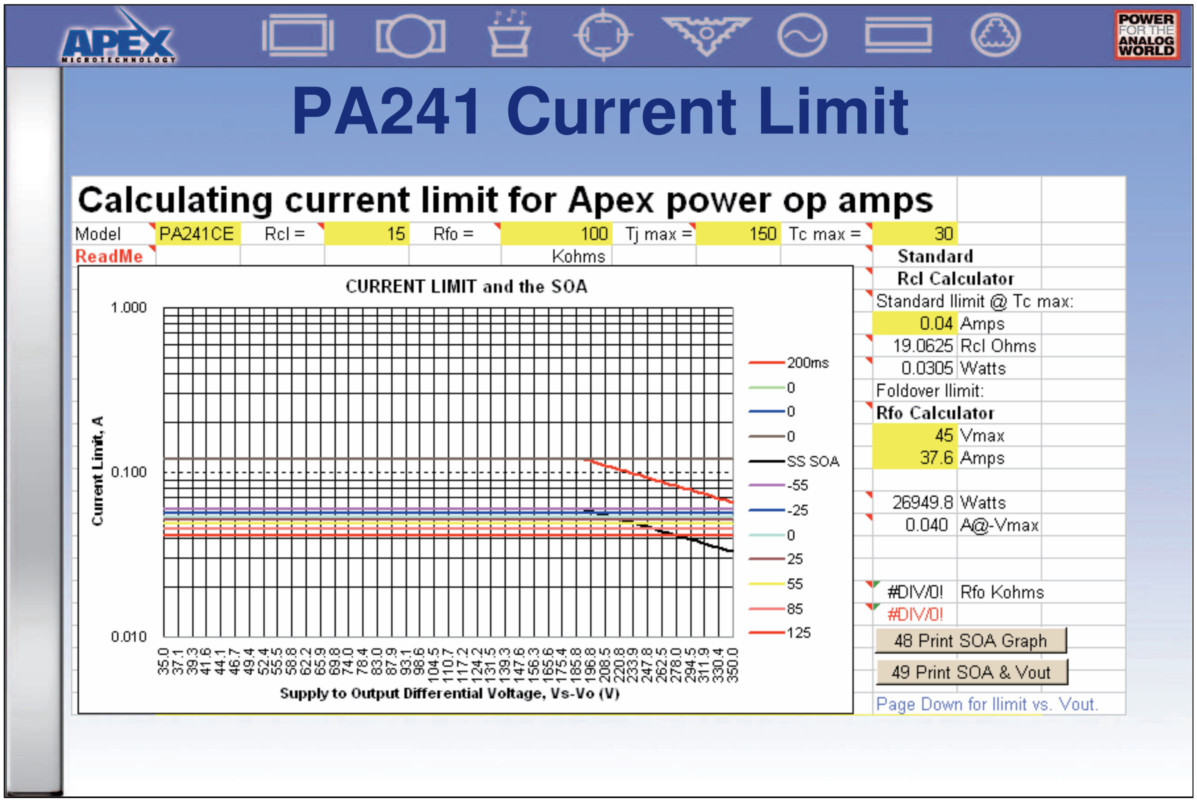
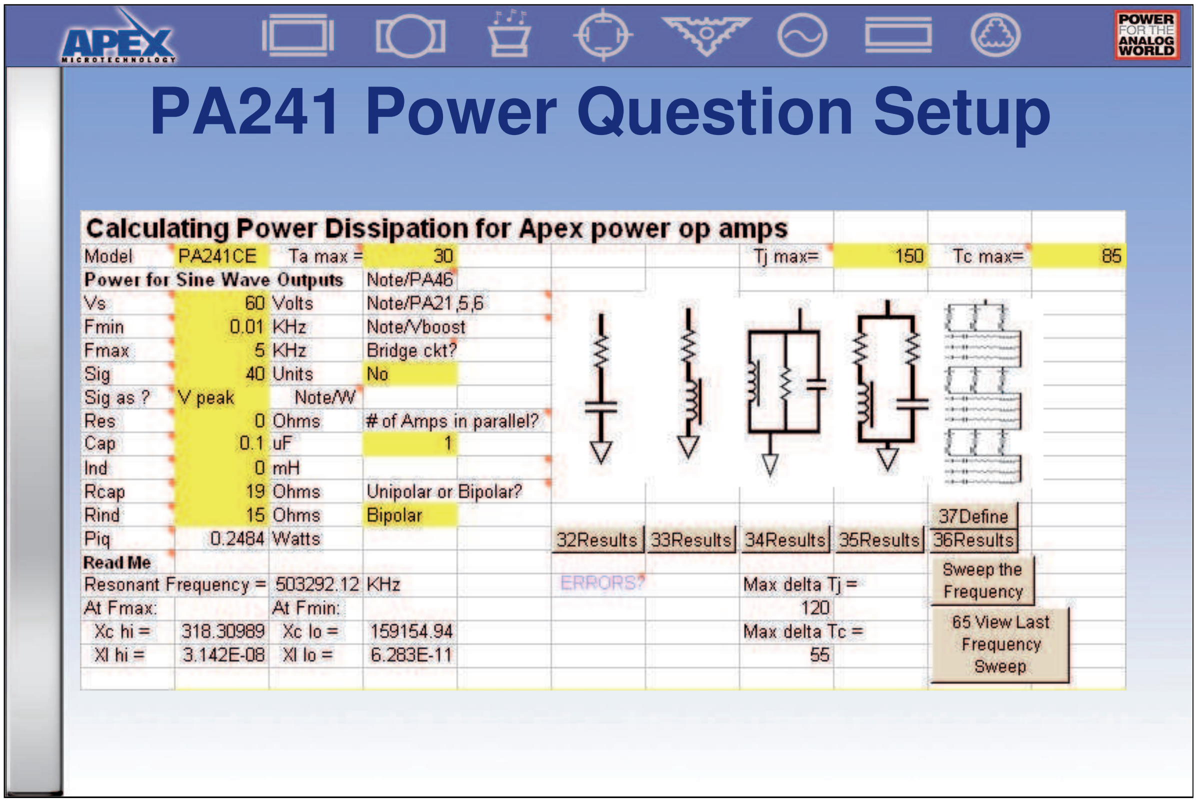


The amplifier selection, load and voltages have all been given. The only frequency that matters is the maximum (no current into a C load at DC). Our stability analysis suggested a maximum of about 10KHz (the Rf-Cf pole frequency).

Ref. AN37



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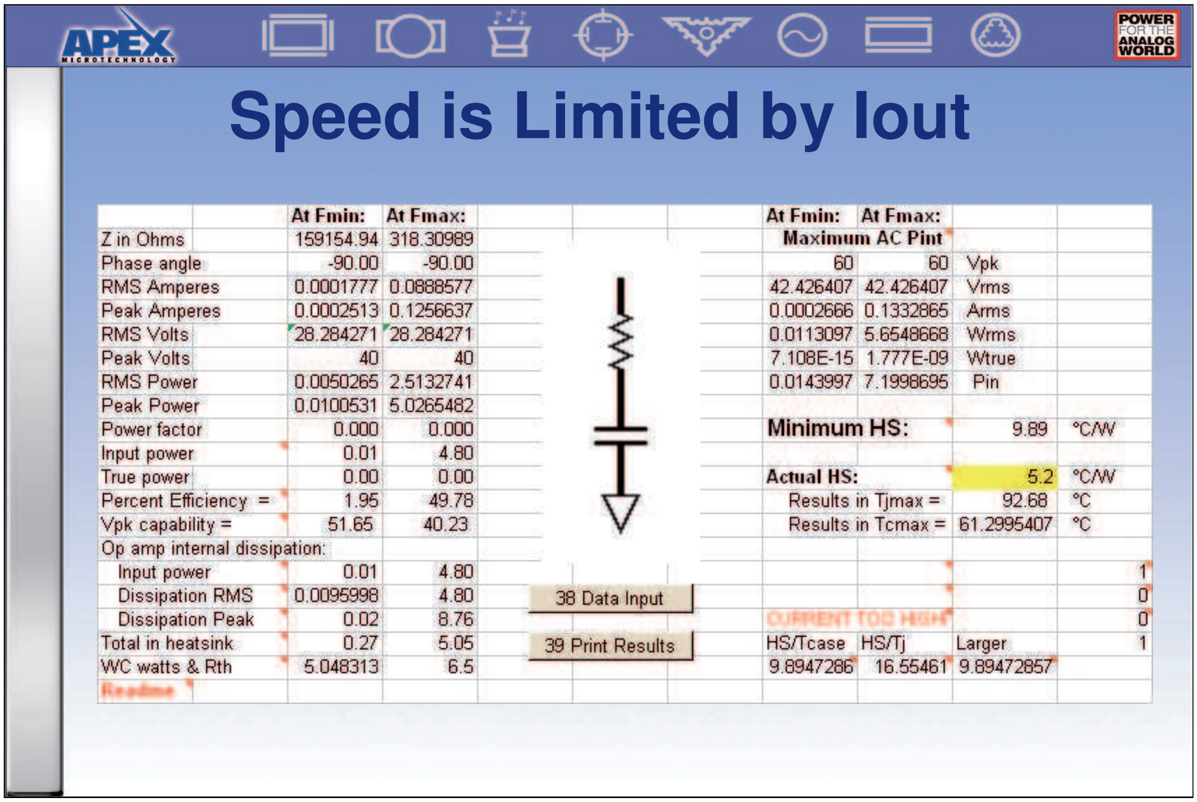

	At Fmin:	At Fmax:
Z in Ohms	159154.94	318.30989
Phase angle	-90.00	-90.00
RMS Amperes	0.0001777	0.0888577
Peak Amperes	0.0002513	0.1256637
RMS Volts	28.284271	28.284271
Peak Volts	40	40
RMS Power	0.0050265	2.5132741
Peak Power	0.0100531	5.0265482
Power factor	0.000	0.000
Input power	0.01	4.80
True power	0.00	0.00
Percent Efficiency =	1.95	49.78
Vpk capability =	51.65	40.23
Op amp internal dissipation:		
Input power	0.01	4.80
Dissipation RMS	0.0095998	4.80
Dissipation Peak	0.02	8.76
Total in heatsink	0.27	5.05
WC watts & Rth	5.048313	6.5
Readme		

At Fmin:	At Fmax:		
Maximum AC Pint			
60	60	Vpk	
42.426407	42.426407	Vrms	
0.0002666	0.1332865	Arms	
0.0113097	5.6548668	Wrms	
7.108E-15	1.777E-09	Wtrue	
0.0143997	7.1998695	Pin	
Minimum HS:		9.89	°C/W
Actual HS:		5.2	°C/W
Results in Tjmax =		92.68	°C
Results in Tcmax =		61.2995407	°C
			1
			0
CURRENT TOO HIGH!			0
HS/Tcase	HS/Tj	Larger	1
9.8947286	16.55461	9.89472857	

255mA would be required to drive the .1µF load at 10Kz! Notice the “CURRENT TOO HIGH!” flag at the lower right. This is based on data sheet maximum, not the current limit resistor used. Since this is 10x our capability, 1KHz will be the limit with a 75Ω current limit resistor. When this is plugged in, we will find normal operation with no heatsink is possible. To analyze fault conditions, find the lowest impedance to be encountered, assume the current limit (47mA in this case) is driven into the load and calculate the output voltage. Subtract this from the supply voltage, compare to the SOA of the amplifier and calculate a larger heatsink as required.

Ref. AN37