

Radical Audio Synthesis

Model RAS 300 Power Amplifier

Introduction

This power amplifier was born in November 2008 after the needs of two Turkish DIY audio enthusiasts Dr. Gokhan Nalbant and his friend Ersoy to construct a high power audio amplifier capable of at least 300 watt rms.

Although the basic design was done a few years ago and therefore not new or unique in any way, it has been proven by many Audio Enthusiasts as being an amplifier with outstanding audio performance.

At first glance, the amplifier seems very complex but the design is fairly simple and straight forward.

It was decided to split the amplifier in two halves, the first consisting of the input and driver section while the second half consists of all the output transistors for the purpose of mounting this assembly directly onto a heat sink.

Important Issues

This amplifier is capable of more 1000 watts peak into 4 Ohm ($\pm 70V$ supply) and it is important to note when calculating fuse, wire size and heat sink requirements.

Furthermore, this class AB amplifier dissipates a lot of heat and you need to make sure that you have adequate heat sink to dissipate this heat or even an automatically controlled fan to assist during heavy use.

The amplifier is biased in class A up to about 13 watts and it would be noted that it runs pretty hot even during idle.

The reason I decided on the high class A operation for normal use is that under normal listening levels, you would hardly ever exceed 13 watts/channel average power assuring an ample headroom of at least 23 dB.

I do not include any form of speaker protection on board and it is up to the constructor to decide what would be adequate for his/her application.

Rod Eliot has an excellent paper regarding heat sink requirements on his web site and really worth studying, please visit <http://sound.westhost.com/heatsinks.htm>

The other issue is that of power supply, reservoir capacitors and ground wiring. The better the power supply, the better the performance.

To obtain the best sonic performance it is recommended that the driver sections are powered from a separate supply exceeding the output supply voltage by about 5VDC per rail; this ensures that the output devices can be driven almost to rail voltage. Obviously a stabilized power supply for the driver section would be most beneficial to the amplifier performance.

It is highly recommended, but not essential that each power section is driven from its own power supply of around ± 60 VDC using a 600VA transformer with at least 47 000 uF capacitance per rail.

It is also better to use several parallel connected capacitors rather than a single capacitor per rail. Having several capacitors improves the ripple current capability as well as lowering the effective series resistance.

Predicted Performance

The characteristic performance of this amplifier has been acquired by means of simulation only and diagrams at the end of this paper illustrating the typical characteristics of the finished amplifier tabulated below:

<i>Output power</i>	4 Ω	372 watt rms
	8 Ω	205 watt rms
<i>THD</i>	0.00064%	1 kHz into 8 Ohms
	0.0008%	1 kHz into 4 Ohms
<i>Frequency Response</i>	2Hz to 260 kHz	(-3dB)
<i>Phase deviation</i>	14 degrees	20 Hz - 20 kHz
<i>Bias Current</i>	1.3 Amp	
<i>Operating Voltage</i>	$\pm 30 - 70$ VDC	
<i>Slew Rate</i>	20V/uS	

Note all derivatives are at a point just before the onset of clipping.

Sonically this amplifier performance is outstanding and could be placed amongst the best commercial amplifiers available, provided that care is taken when designing the power supply. This amplifier is not cheap and even in its most basic form could exceed US\$1200 which excludes the time and effort that you would put into it.

Description

The amplifier is a full complimentary symmetry design from beginning to end, this topology I have found to be the most suitable for reproducing a high standard of music.

The input is shared by two long tail pairs of opposite polarity and it is important to match them as well as one could.

I used a unique constant current source courtesy Alex Miguel. This CCS provides very stable low impedance over a wide bandwidth. Each of the long tail pairs are running at 1.2 mA.

An offset adjustment was provided by replacing the degeneration resistors of one LPT by a multi-turn potentiometer. Please ensure that the potentiometer is at its centre position before turning the amp on.

The VAS is a dual complimentary Darlington pair with a bias current set to about 11mA. A multi-turn pot is used to adjust the bias current. There is no reason that you cannot bias this amp into class A, but need to take notice that the power dissipation would increase significantly.

The power transistors are spread over a long PCB and intended to be fitted to the heat sink assembly, this makes the amplifier somewhat modular and easy to work on.

There is nothing of critical nature in this amp so built correctly it should fire up working the first time round.

Protection

Keep in mind that there is no protection of the amp or speakers in anyway. My simpler units have run for about ten years never giving a problem. If you are concerned with speaker and output protection there are many articles on the internet that you can research.

Completeness

For the sake of completeness I have attached datasheets of the semiconductors used in this design. You are at liberty to replace them with your preferred devices, but bear in mind that the 2SA970 and 2SC2240 has a different pin configuration. Also keep in mind that the amplifier was designed for lateral MOSFETs and should not be replaced as you would be faced with instant thermal runaway.

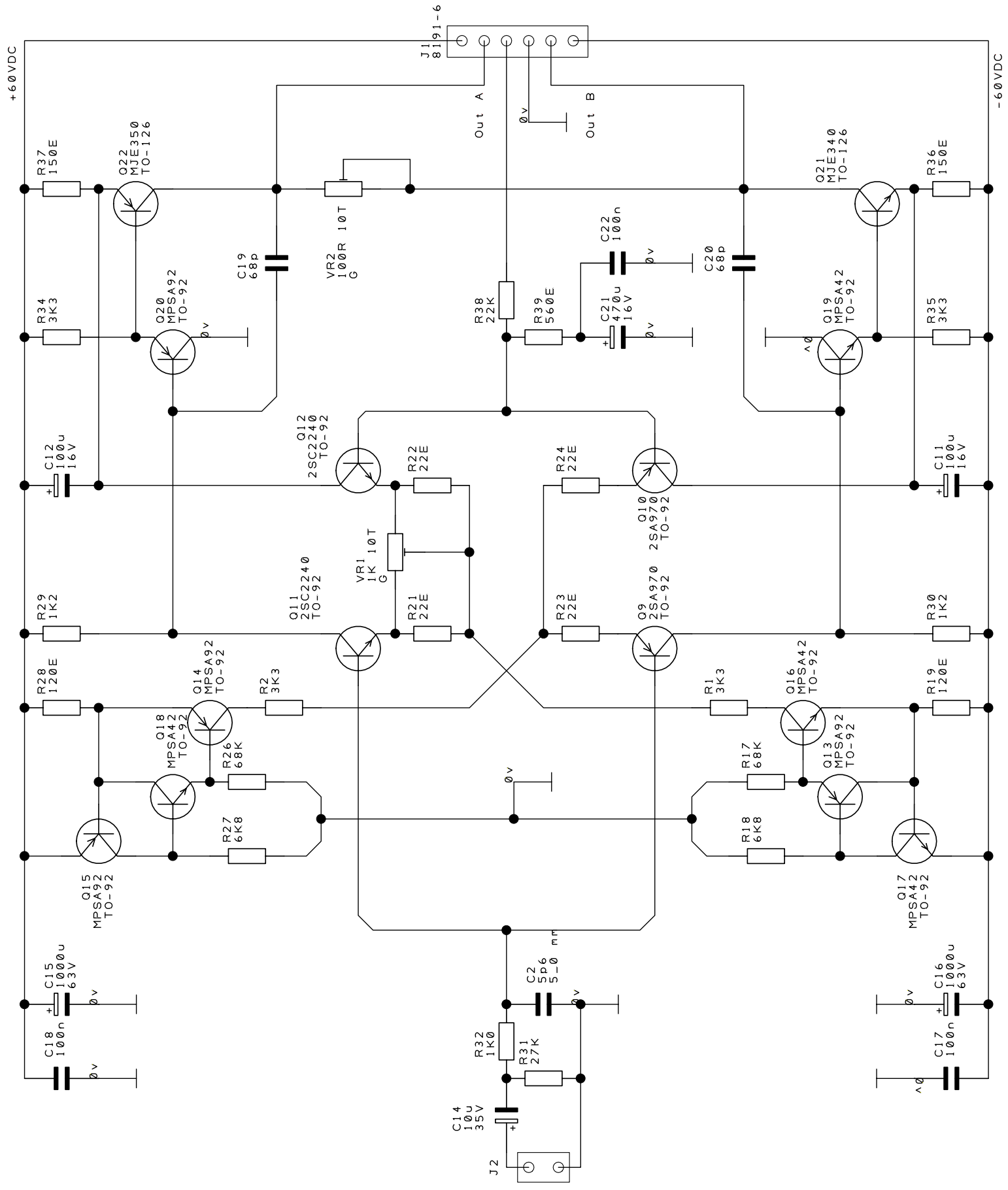
When constructing the amplifier construct each channel as a separate mono amplifier and keep the two amplifier grounds separate, this will eliminate the possibility of ground loops.

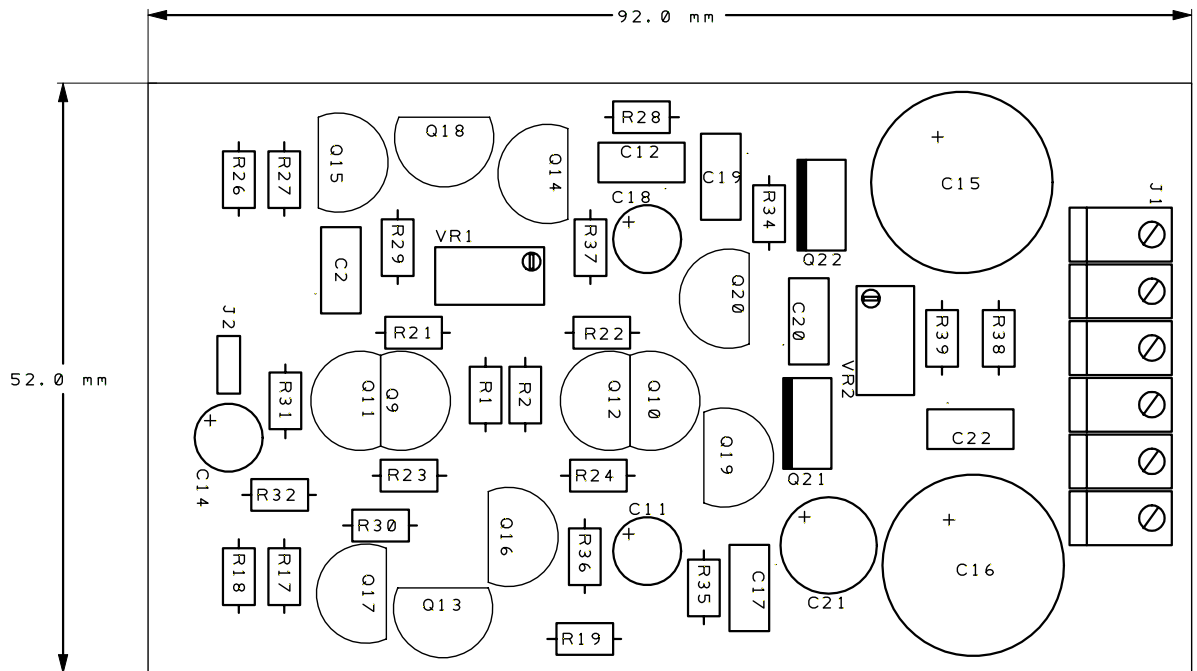
It is advisable to protect your speakers, either by underrated fuses or capacitors while fiddling and setting it up first time round as too often does one accidentally remove the input connector, touching it with your finger and the result could be a load speaker cone ripped apart.

Use adequately rated wiring and I would suggest at least 2 – 2.5 mm² wire for the output section and 1 mm² for the input section.

If you decide to use relays in your speaker line for the purpose of protection, then use relays with contacts rated at 400VAC, the reasoning behind this is that mains relays have much higher contact pressure than low voltage types and even high current automotive relays would not be recommended.

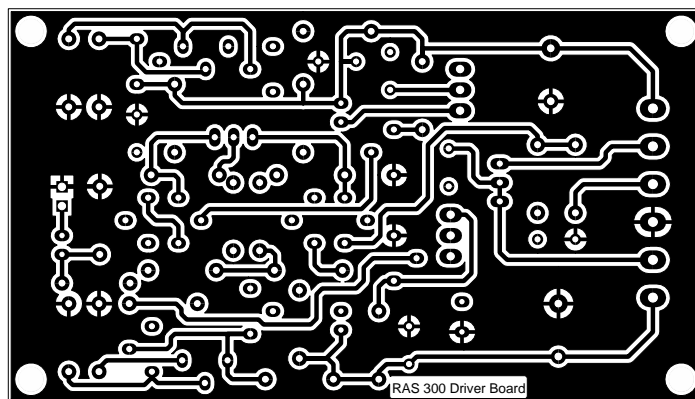
One final word, pay much attention to your power supplies, it is by far the most important part of the amplifier, if you skimp here you will get an amplifier with mediocre performance, not even nearly to the specifications. As far as power supplies go, bigger is better!

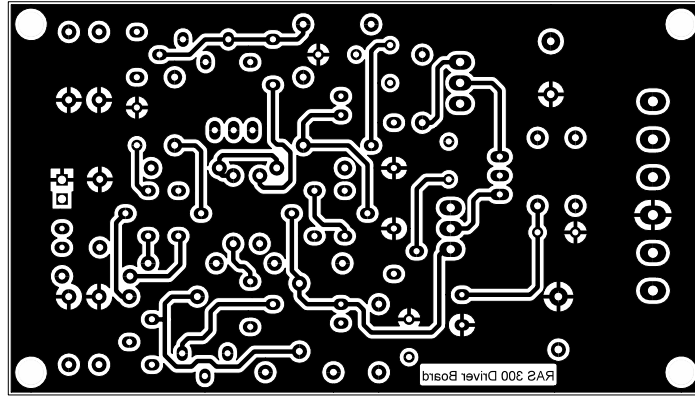


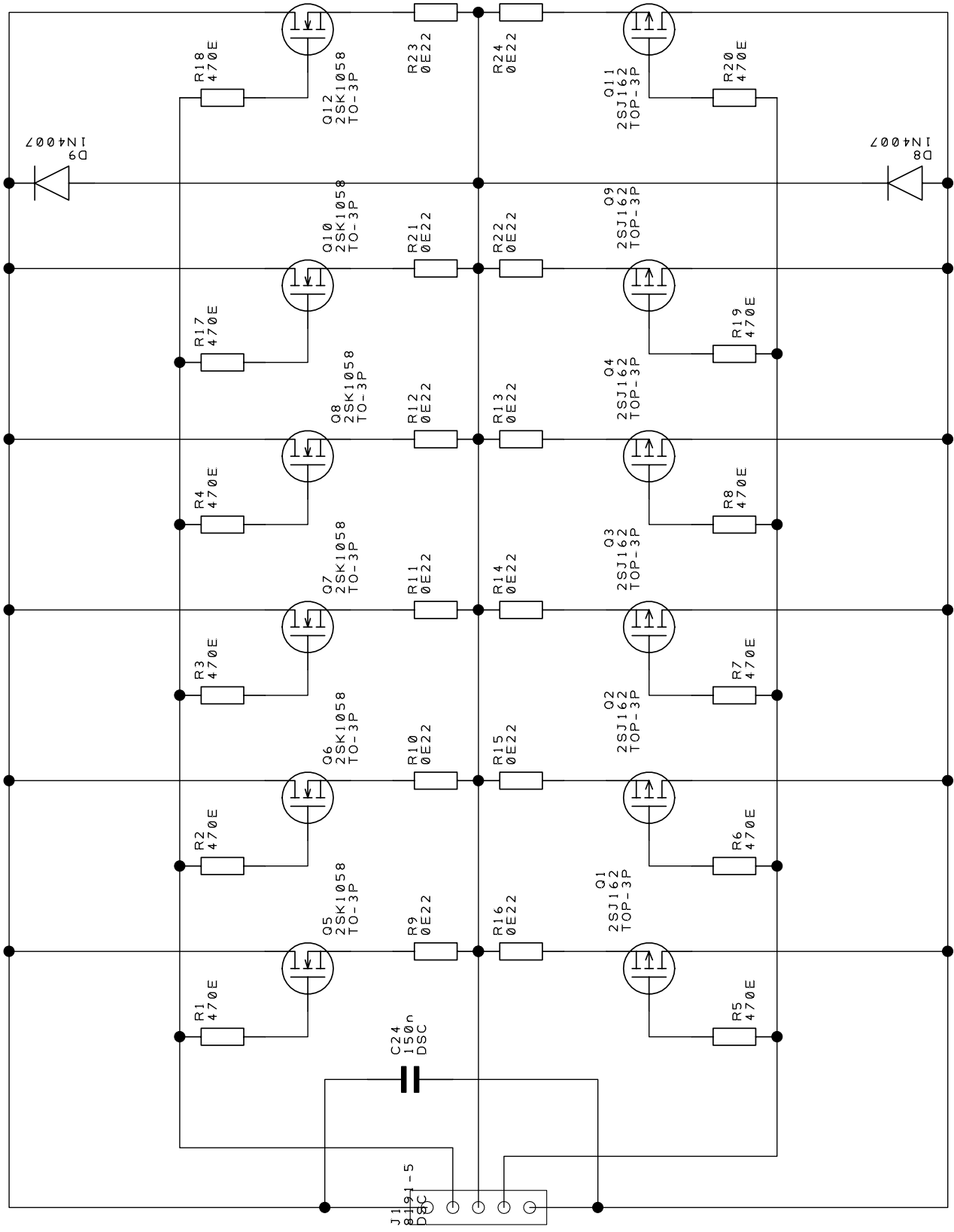


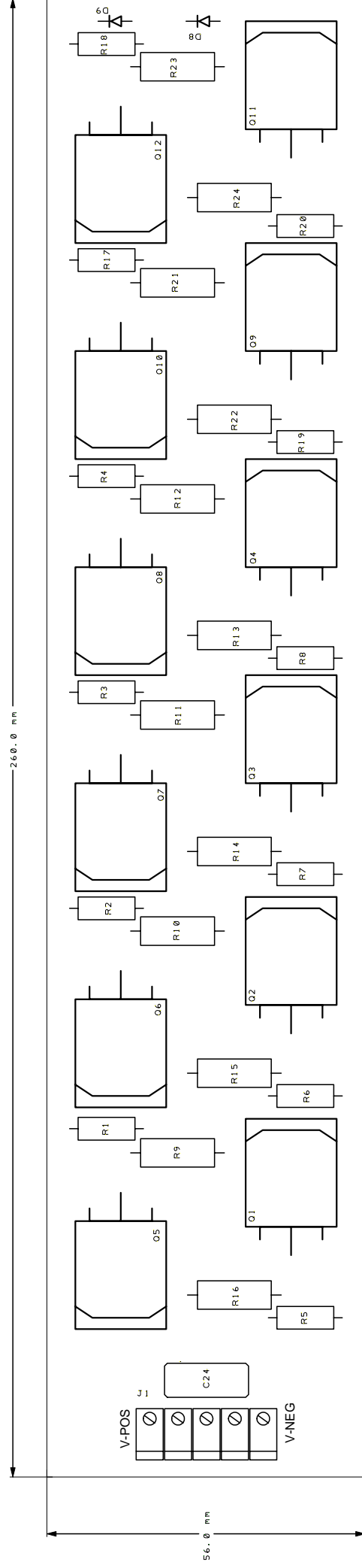
Ref	Qty	Name	300watt power amp. I sp Package
C15 C16	2	1000u	63V
C17 C18 C22	3	100n	5_0 mm
VR2	1	100R 10T	G
C11 C12	2	100u	16V
C14	1	10u	35V
R19 R28	2	120E	250mW
R36 R37	2	150E	250mW
R32	1	1K0	250mW
R29 R30	2	1K2	250mW
VR1	1	1K 10T	G
J2	1	2 Way Pi n	DSC
R21 R22 R23 R24	4	22E	250mW
R38	1	22K	250mW
R31	1	27K	250mW
Q9 Q10	2	2SA970	T0-92
Q11 Q12	2	2SC2240	T0-92
R1 R2 R34 R35	4	3K3	250mW
C21	1	470u	16V
R39	1	560E	250mW
C2	1	5p6	5_0 mm
R17 R26	2	68K	250mW
C19 C20	2	68p	5_0 mm
R18 R27	2	6K8	250mW
J1	1	8191-6	DSC

Q21	1	MJE340	300watt power amp. I sp TO-126
Q22	1	MJE350	TO-126
Q16	4	MPSA42	TO-92
Q17			
Q18			
Q19			
Q13	4	MPSA92	TO-92
Q14			
Q15			
Q20			



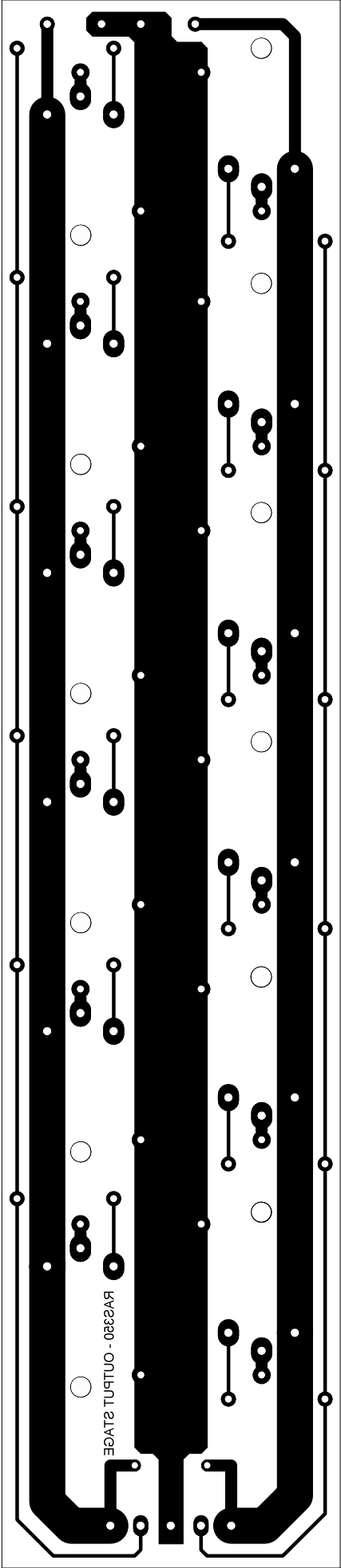




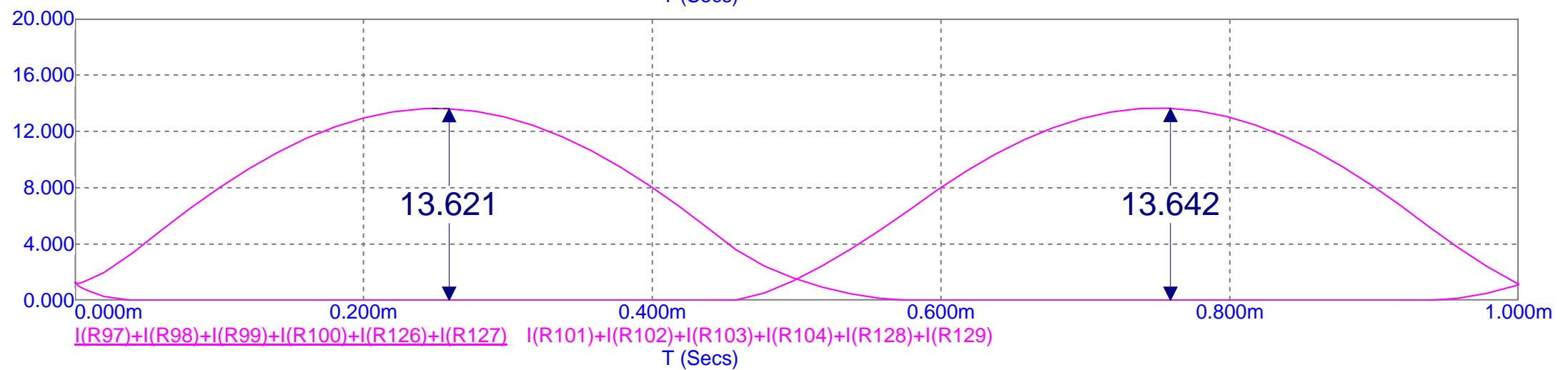
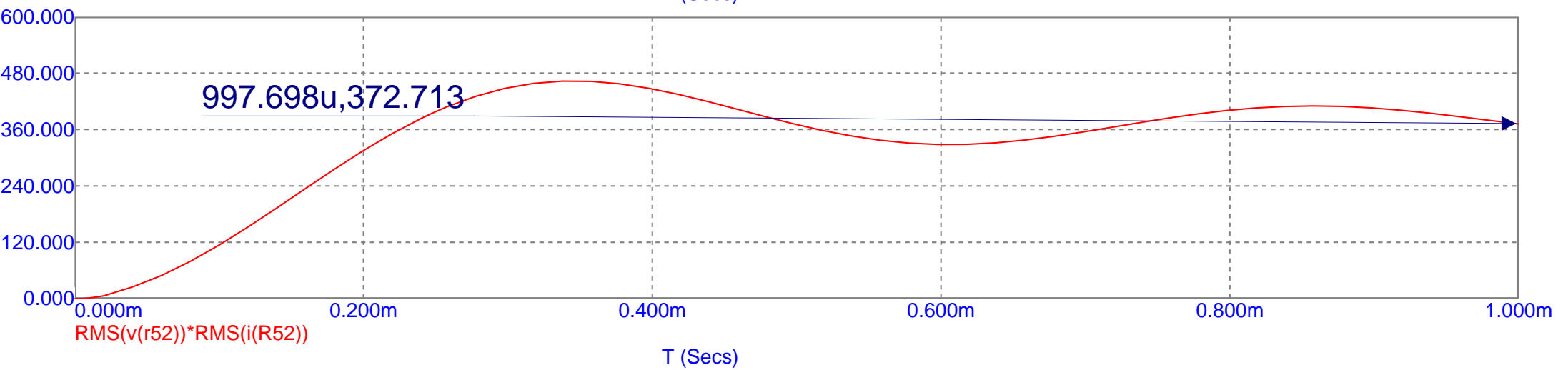
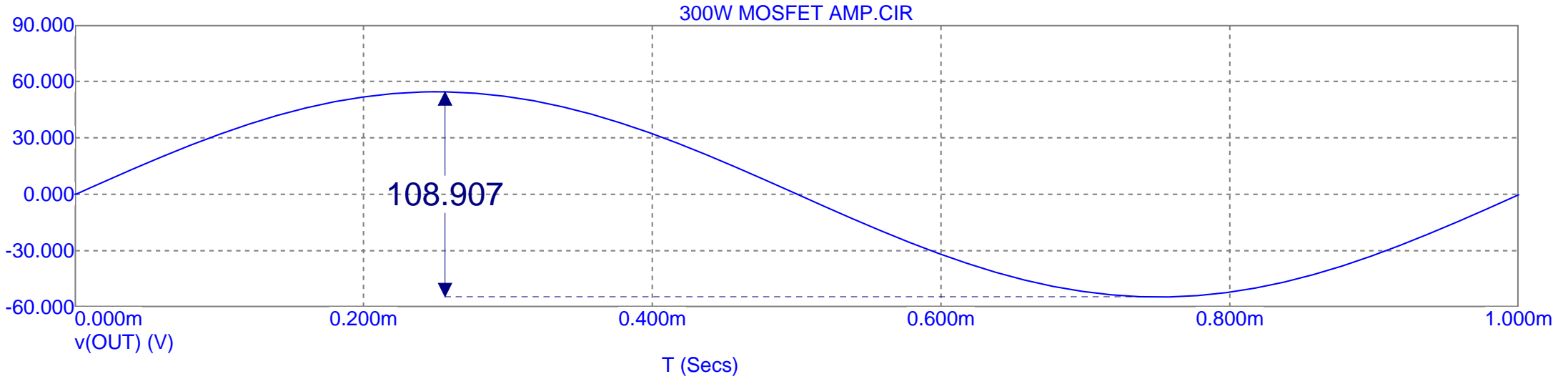


RAS350 OUTPUT STAGE

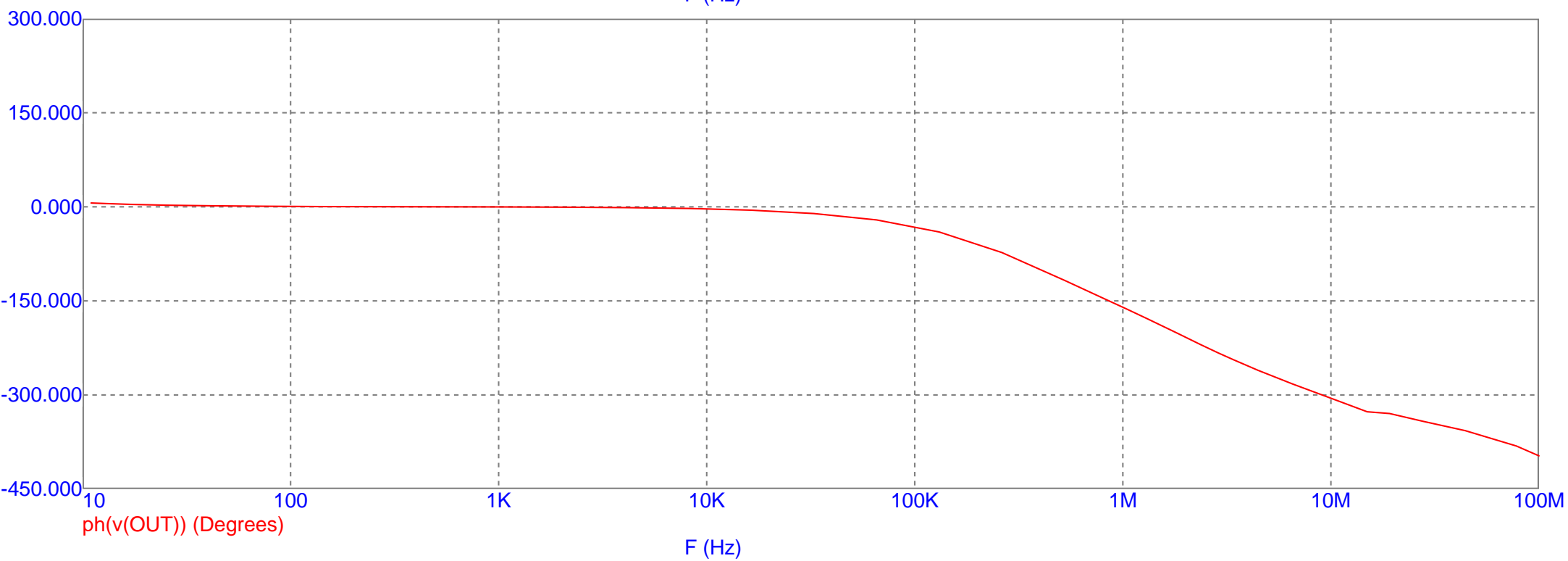
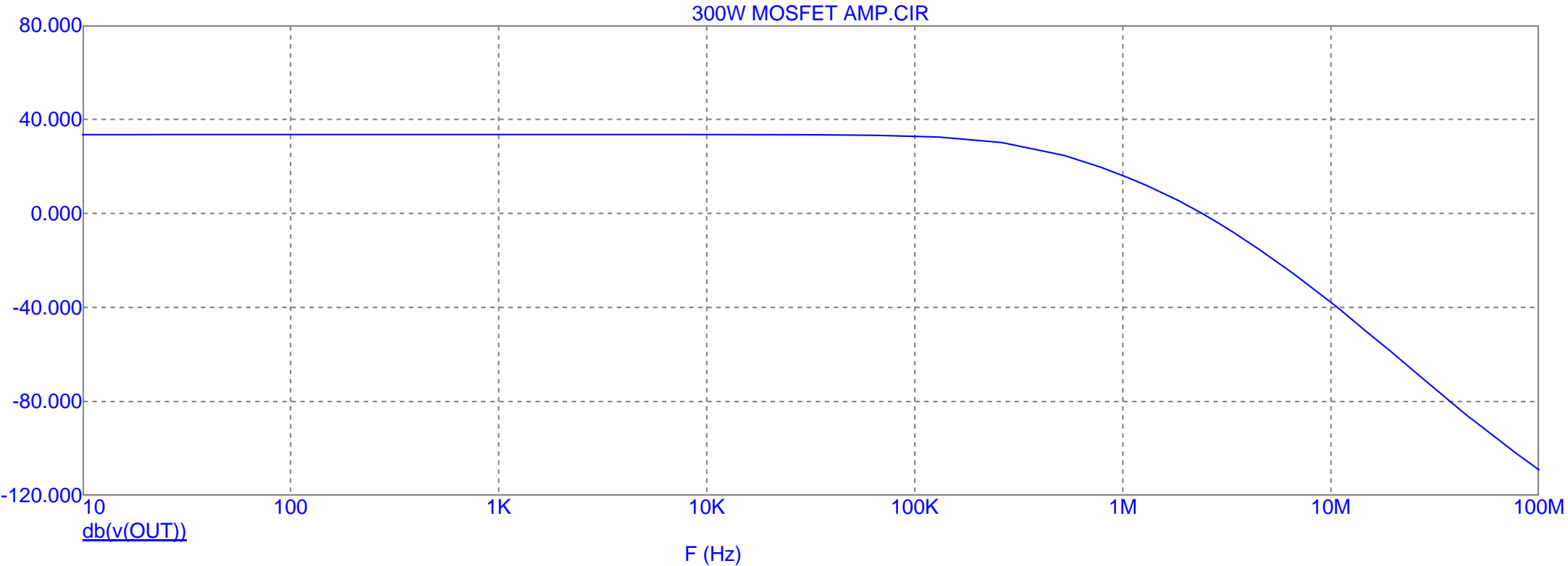
Ref	Qty	Name	300watt power amp 0-P.I sp Package
R9	12	0E22	2 Watt
R10			
R11			
R12			
R13			
R14			
R15			
R16			
R21			
R22			
R23			
R24			
C24	1	150n	DSC
D8	2	1N4007	DSC
D9			
Q1	6	2SJ162	TOP-3P
Q2			
Q3			
Q4			
Q9			
Q11			
Q5	6	2SK1058	TO-3P
Q6			
Q7			
Q8			
Q10			
Q12			
R1	12	470E	500mW
R2			
R3			
R4			
R5			
R6			
R7			
R8			
R17			
R18			
R19			
R20			
J1	1	8191-5	DSC



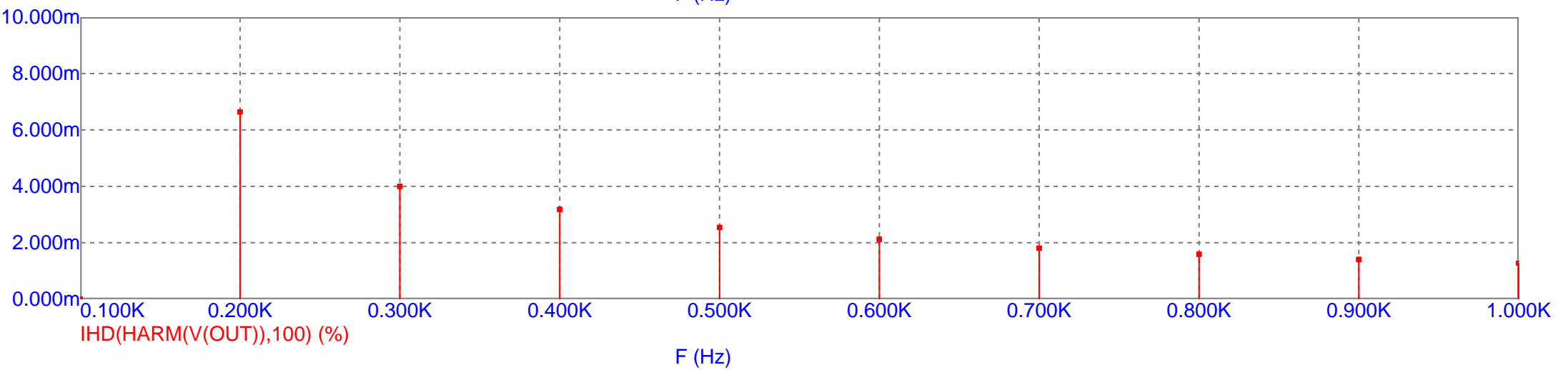
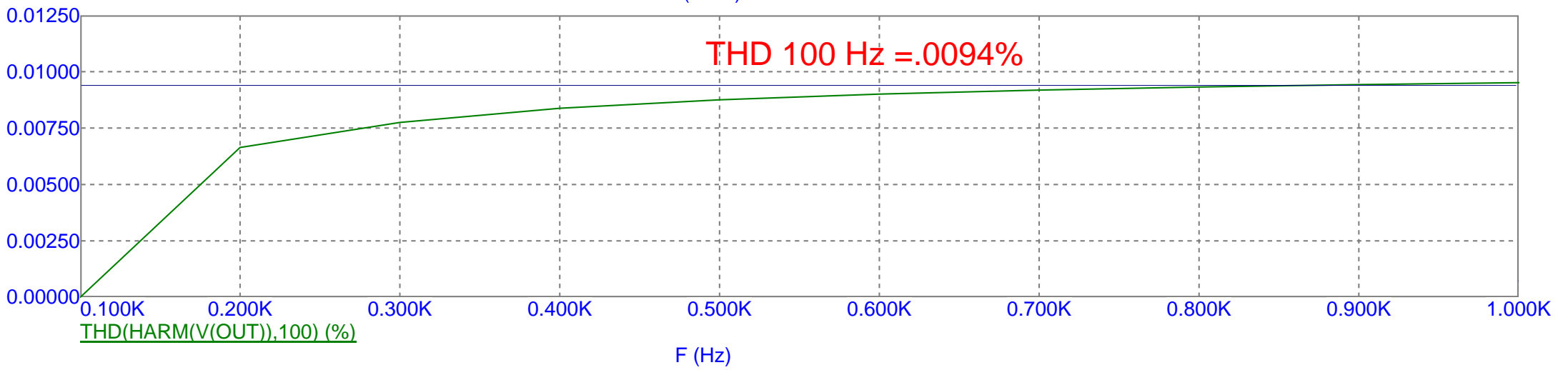
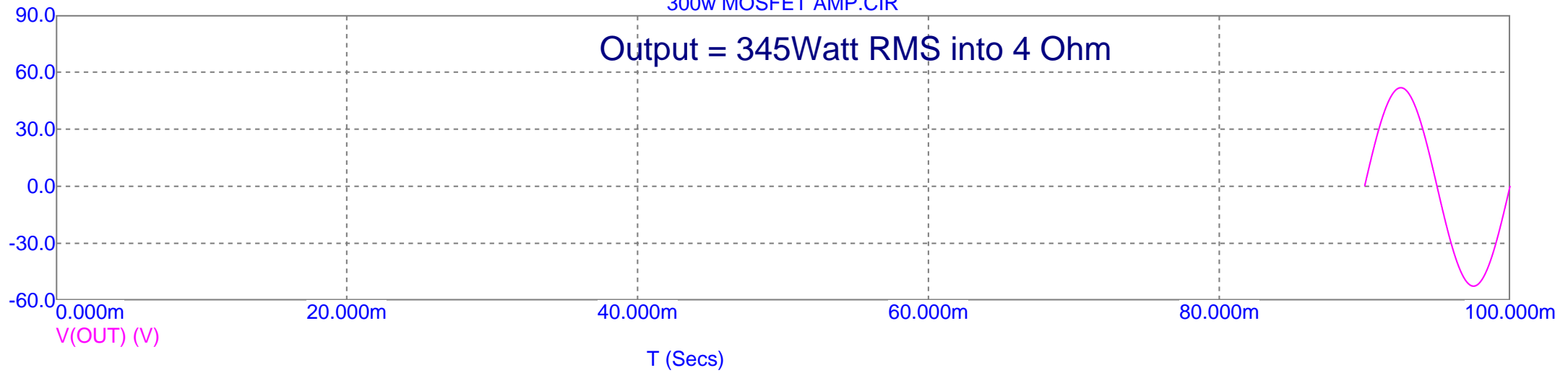
300W MOSFET AMP.CIR



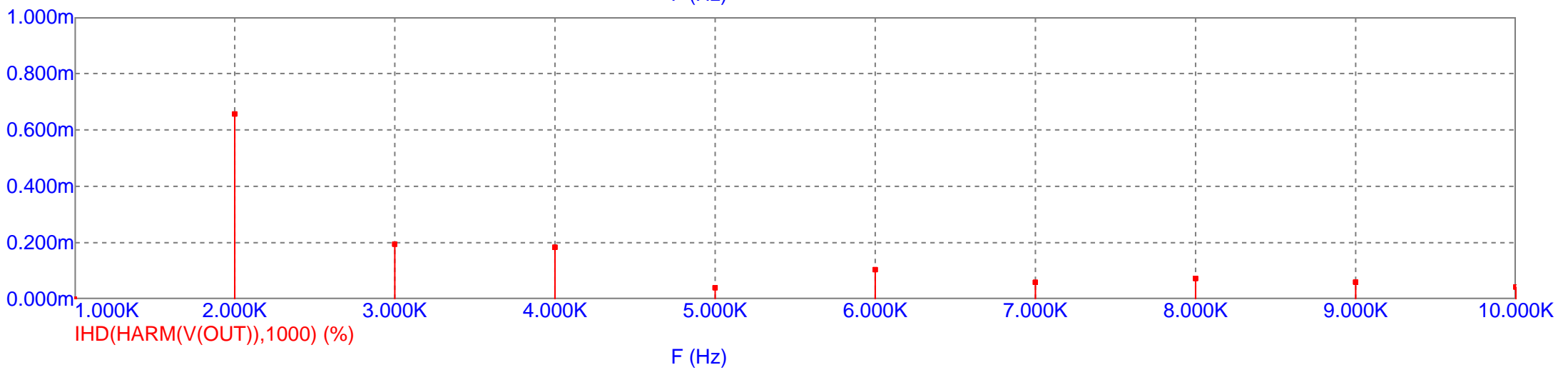
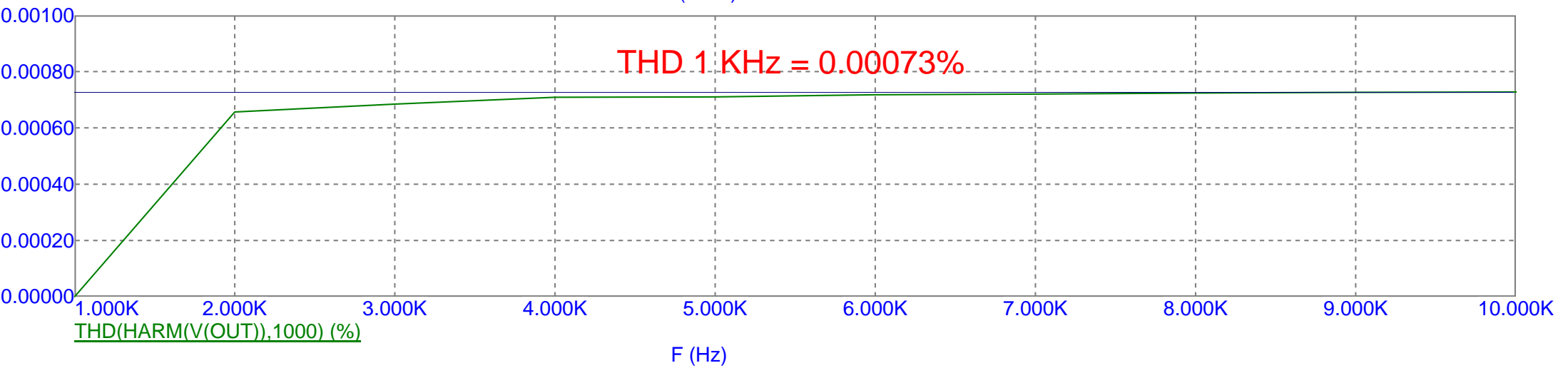
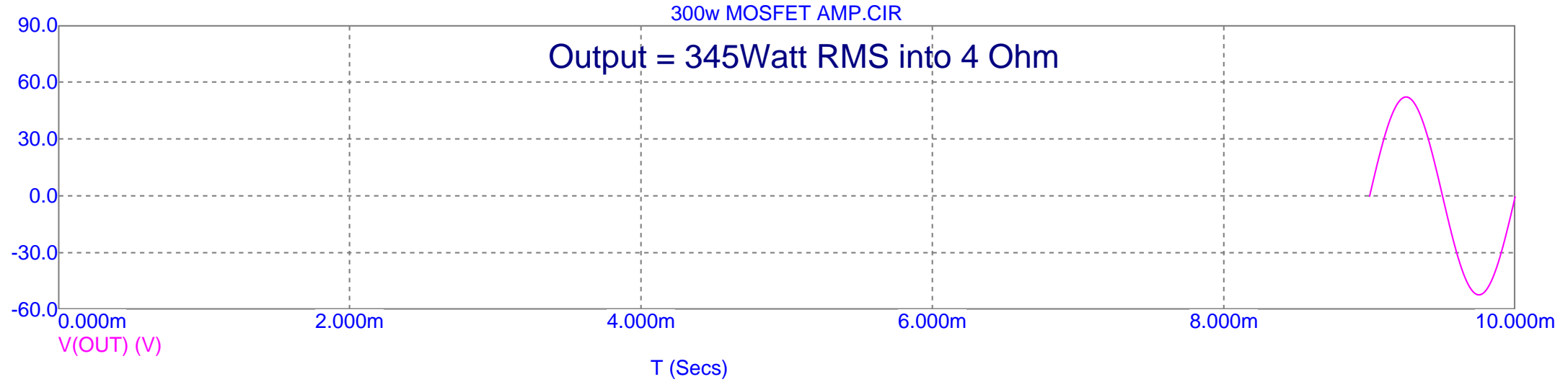
300W MOSFET AMP.CIR



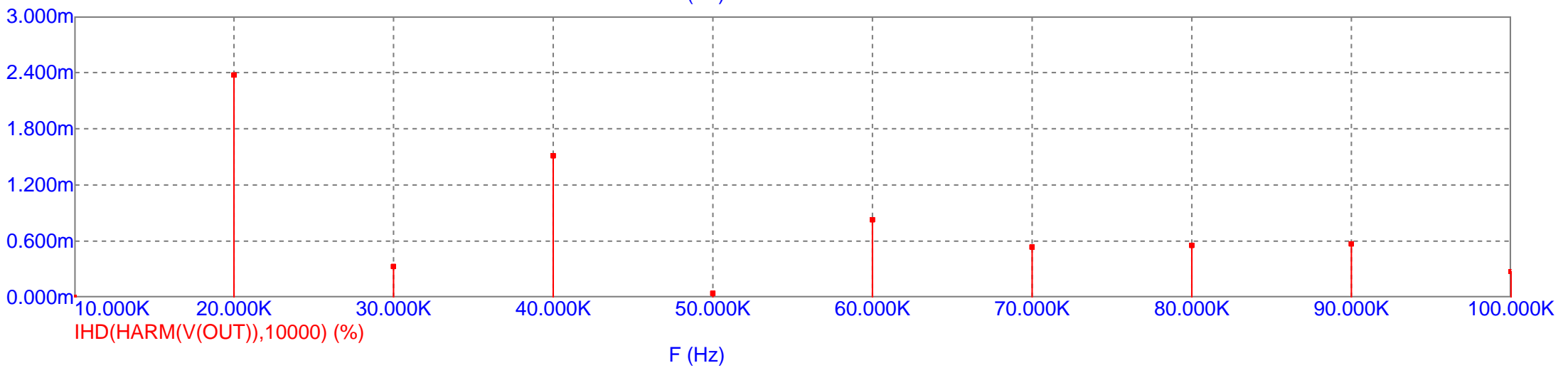
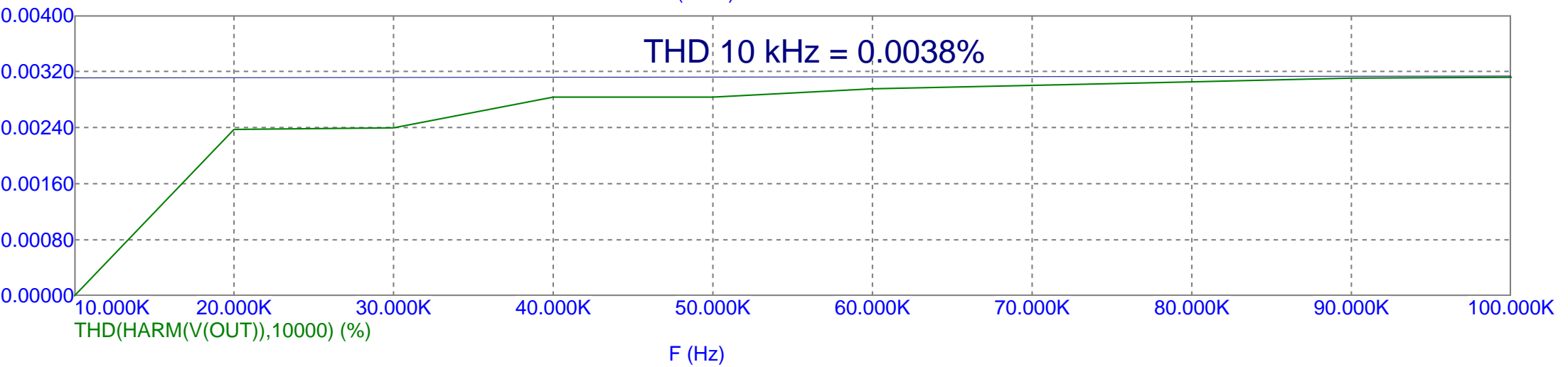
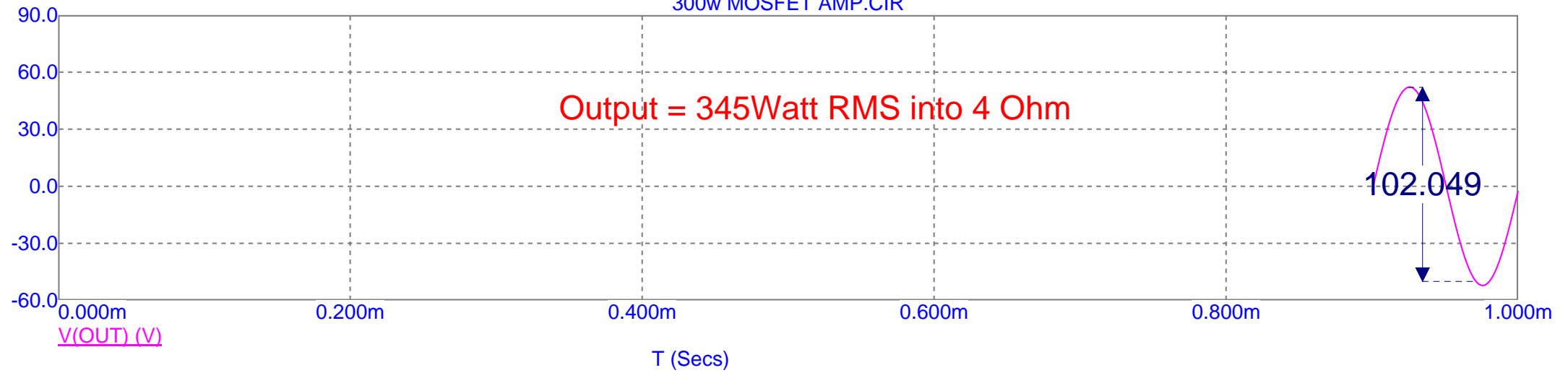
Output = 345Watt RMS into 4 Ohm



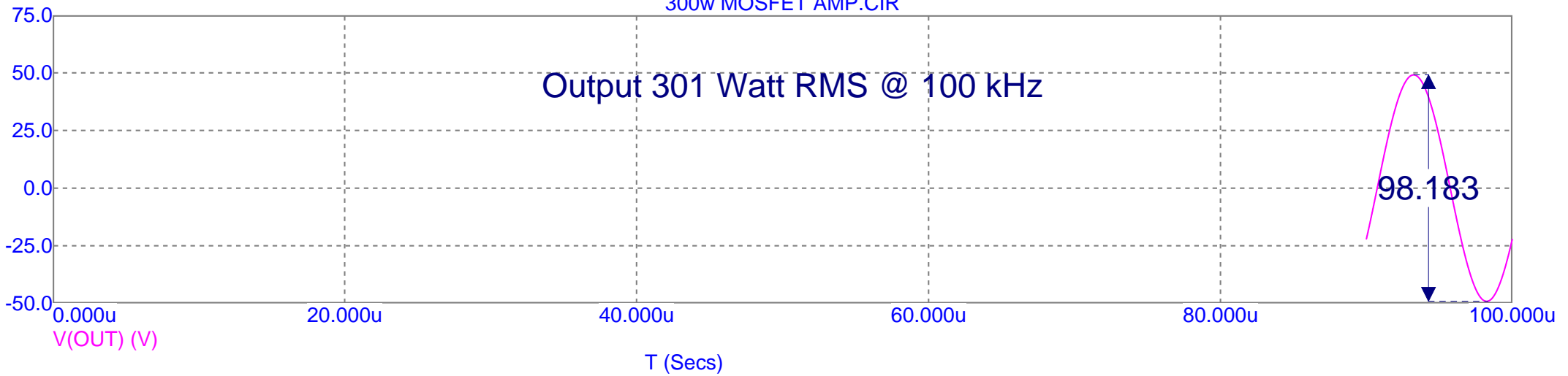
Output = 345Watt RMS into 4 Ohm



300w MOSFET AMP.CIR



Output 301 Watt RMS @ 100 kHz



THD 100 KHz = 0.075%

