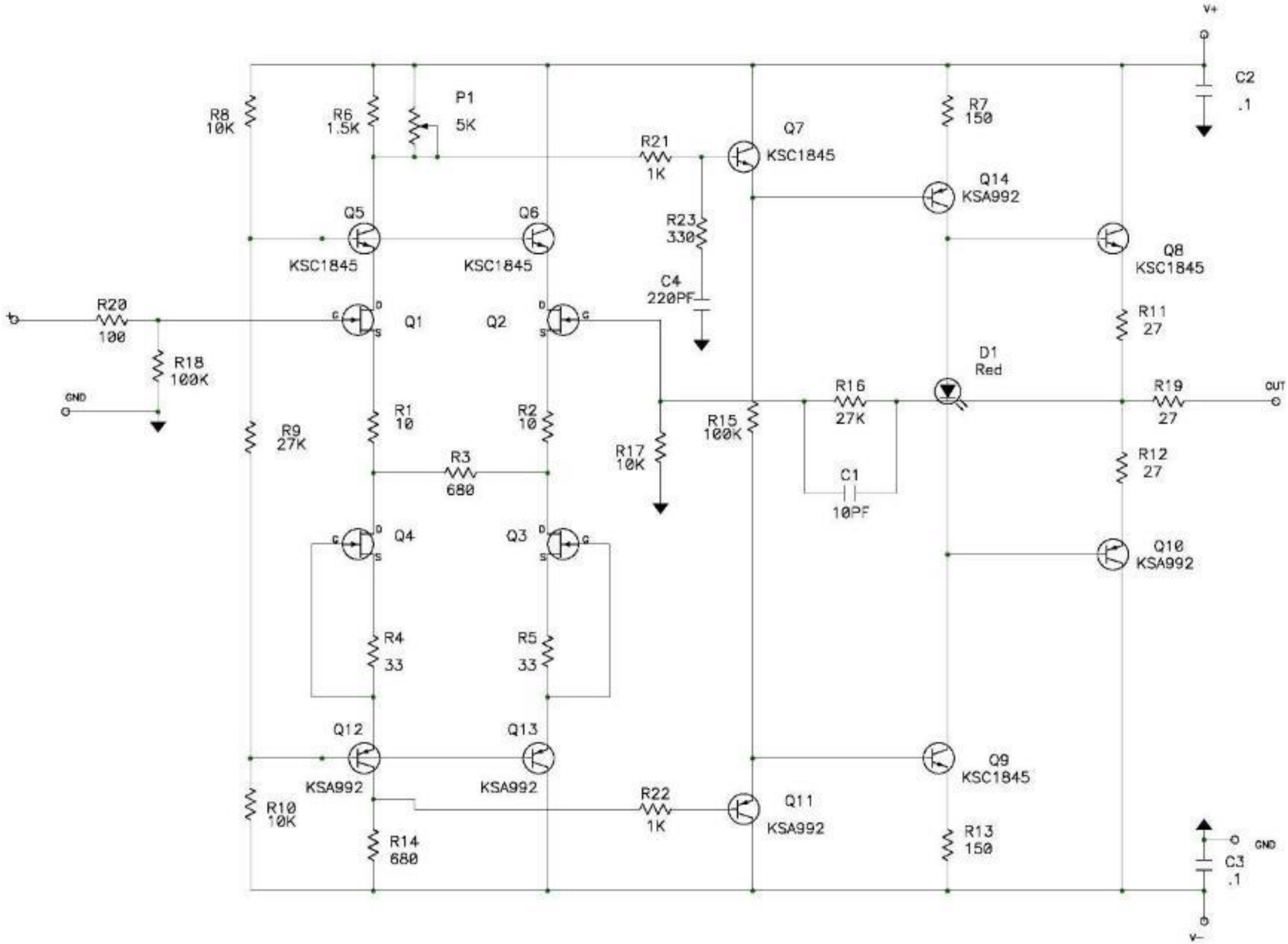
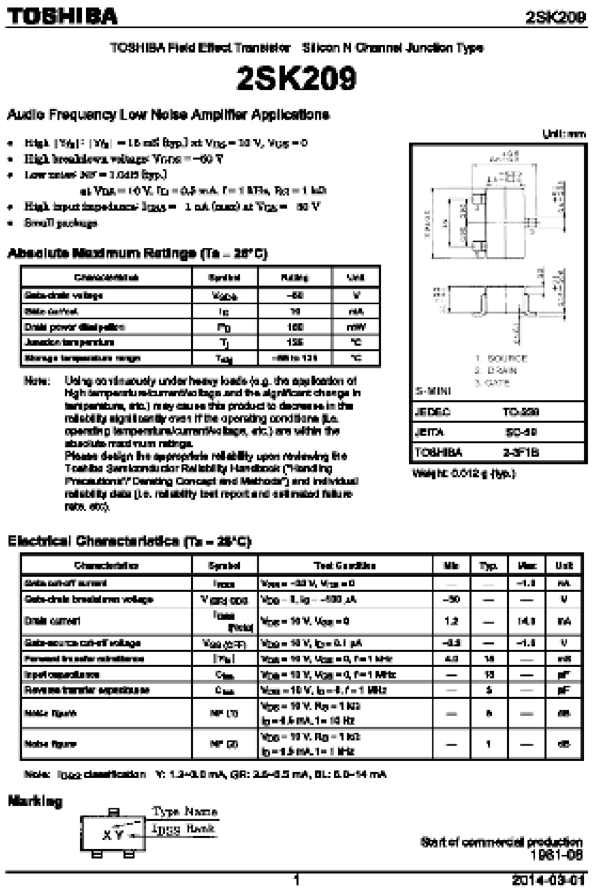


V+
C2
.1
R8
10K
R6
1.5K
P1
5K
R21
1K
Q7
KSC1845
R7
150
Q14
KSA992
Q5
Q6
R23
330
KSC1845
KSC1845
Q8
KSC1845
C4
220PF
R20
100
Q1
Q2
R11
27
R18
100K
D1
Red
GND
R16
27K
R19
27
OUT
R1
10
R2
10
R15
100K
R9
27K
R17
10K
R3
680
R12
27
C1
10PF
Q4
Q3
Q10
KSA992
R4
33
R5
33
Q12
Q13
Q9
KSC1845
KSA992
KSA992
R22
1K
Q11
KSA992
R10
10K
R14
680
R13
150
GND
C3
.1
V−



TOSHIBA 2SK209

TOSHIBA Field Effect Transistor Silicon N Channel Junction Type

2SK209

Audio Frequency Low Noise Amplifier Applications

- High |Yfs|: [illegible]
- High breakdown voltage: [illegible]
- Low noise: [illegible]
- High input impedance: [illegible]
- Small package

Absolute Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Gate-drain voltage	V_{GDS}	−50	V
Gate current	I_G	10	mA
Drain power dissipation	P_D	150	mW
Junction temperature	T_j	125	°C
Storage temperature range	T_{stg}	−55 to 125	°C

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings. Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Unit: mm

1. SOURCE
2. DRAIN
3. GATE

S-MINI

JEDEC	TO-236
JEITA	SC-59
TOSHIBA	2-3F1B

Weight: 0.012 g (typ.)

Electrical Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Gate cut-off current	I_{GSS}	[illegible]	—	—	−1.0	nA
Gate-drain breakdown voltage	$V_{(BR)GDS}$	[illegible]	−50	—	—	V
Drain current	I_{DSS} (Note)	V_{DS} = 10 V, V_{GS} = 0	1.2	—	14.0	mA
Gate-source cut-off voltage	$V_{GS(OFF)}$	V_{DS} = 10 V, I_D = 0.1 μA	−0.2	—	−1.5	V
Forward transfer admittance	$\|Y_{fs}\|$	V_{DS} = 10 V, V_{GS} = 0, f = 1 kHz	4.0	15	—	mS
Input capacitance	C_{iss}	V_{DS} = 10 V, V_{GS} = 0, f = 1 MHz	—	13	—	pF
Reverse transfer capacitance	C_{rss}	V_{DG} = 10 V, I_D = 0, f = 1 MHz	—	3	—	pF
Noise figure	NF (1)	V_{DS} = 10 V, R_G = 1 kΩ, I_D = 0.5 mA, f = 10 Hz	—	5	—	dB
Noise figure	NF (2)	V_{DS} = 10 V, R_G = 1 kΩ, I_D = 0.5 mA, f = 1 kHz	—	1	—	dB

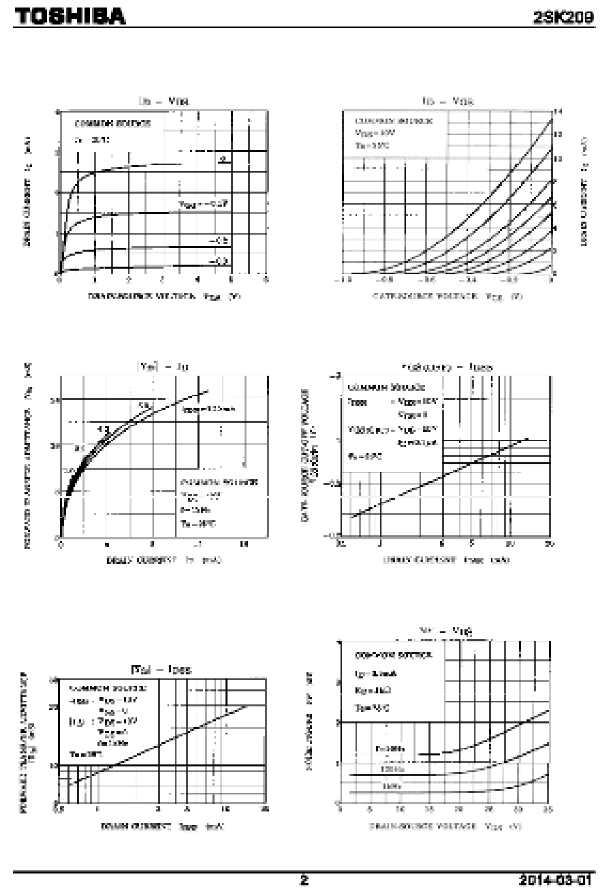
Note: I_{DSS} classification Y: 1.2~3.0 mA, GR: 2.6~6.5 mA, BL: 6.0~14 mA

Marking

Type Name
I_{DSS} Rank

Start of commercial production 1981-08

1 2014-03-01



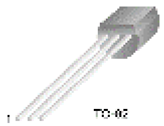
15 Cents each on a reel of 3000

FAIRCHILD
SEMICONDUCTOR®

KSA992

KSA992

Audio Frequency Low Noise Amplifier
- Complement to KSC1845



1. Emitter 2. Collector 3. Base

PNP Epitaxial Silicon Transistor

Absolute Maximum Ratings T_a=25°C unless otherwise noted

Symbol	Parameter	Ratings	Units
V_{CBO}	Collector-Base Voltage	-120	V
V_{CEO}	Collector-Emitter Voltage	-120	V
V_{EBO}	Emitter-Base Voltage	-5	V
I_C	Collector Current	-50	mA
I_B	Base Current	-10	mA
P_C	Collector Power Dissipation	500	mW
T_J	Junction Temperature	150	°C
T_{STG}	Storage Temperature	-55 ~ 150	°C

Electrical Characteristics T_a=25°C unless otherwise noted

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Units
I_{CBO}	Collector Cut-off Current	V_{CB}= -120V, I_E=0			-50	nA
I_{CEO}	Collector Cut-off Current	V_{CE}= -100V, I_B=0			-1	µA
I_{EBO}	Emitter Cut-off Current	V_{EB}= -5V, I_C=0			-50	nA
h_{FE1} h_{FE2}	DC Current Gain	V_{CE}= -5V, I_C= -0.1mA V_{CE}= -5V, I_C= -1mA	150 200	500 500	 800	
V_{BE} (on)	Base-Emitter On Voltage	V_{CE}= -5V, I_C= -1mA	-0.55	-0.61	-0.65	V
V_{CE} (sat)	Collector-Emitter Saturation Voltage	I_C= -10mA, I_B= -1mA		-0.09	-0.3	V
f_T	Current Gain Bandwidth Product	V_{CE}= -5V, I_C= -1mA	50	100		MHz
C_{ob}	Output Capacitance	V_{CB}= -30V, I_E=0, f=1MHz		2	3	pF
NV	Noise Voltage	V_{CE} = -5.0V, I_C = -1.0mA, R_G = 100kΩ, G_V = 80dB, f = 10Hz to 1.0KHz		25	40	mV

h_{FE2} Classification

Classification	F	[illegible]	E
h_{FE2}	200 ~ 400	300 ~ 600	400 ~ 800

$7.00/100
Under 3 Cents
In quantity

22 mS .9nV^hZ
$3.00 available
and 4 cost less
than a vacuum
tube

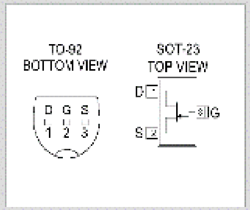
LINEAR SYSTEMS

Linear Integrated Systems

LSK170

ULTRA LOW NOISE SINGLE N-CHANNEL JFET

FEATURES	
ULTRA LOW NOISE (f = 1kHz)	e_n = 0.9nV/√Hz
HIGH BREAKDOWN VOLTAGE	BV_{GSS} = 40V max
HIGH GAIN	Y_{fs} = 22mS (typ)
HIGH INPUT IMPEDANCE	I_G = -600pA max
LOW CAPACITANCE	22pF max
IMPROVED SECOND SOURCE REPLACEMENT FOR 2SK170	
ABSOLUTE MAXIMUM RATINGS[1] @ 25 °C (unless otherwise stated)	
Maximum Temperatures	
Storage Temperature	-65 to +150 °C
Operating Junction Temperature	-55 to +135 °C
Maximum Power Dissipation	
Continuous Power Dissipation @ +125 °C	400mW
Maximum Currents	
Gate Forward Current	$I_{G(F)}$ = 10mA
Maximum Voltages	
Gate to Source	V_{GSS} = 40V
Gate to Drain	V_{GDS} = 40V

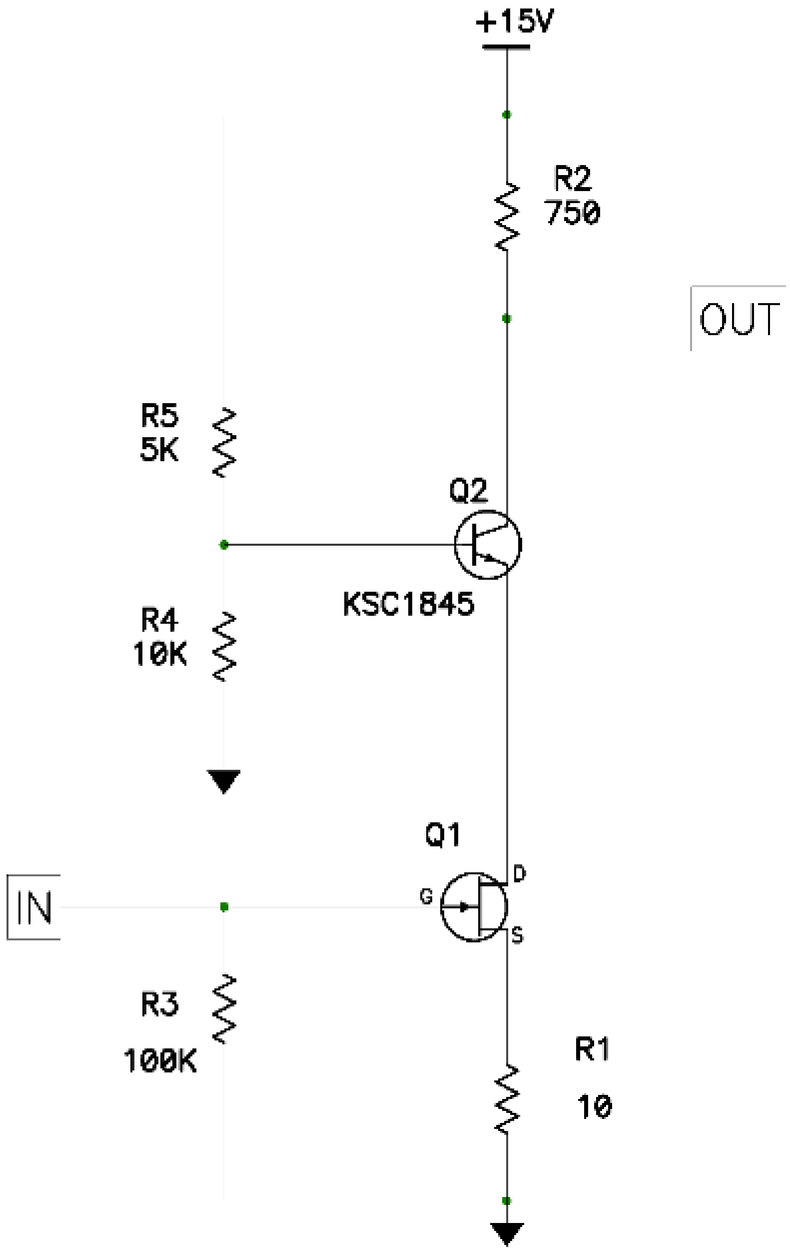


*For equivalent monolithic dual, see LSK389 family.

ELECTRICAL CHARACTERISTICS @ 25 °C (unless otherwise stated)

SYMBOL	CHARACTERISTIC		MIN	TYP	MAX	UNITS	CONDITIONS
BV_{GSS}	Gate to Source Breakdown Voltage		40			V	V_{DS} = 0, I_D = 100μA
$V_{GS(OFF)}$	Gate to Source Pinch-off Voltage		0.2		2	V	V_{DS} = 10V, I_D = 1nA
V_{GS}	Gate to Source Operating Voltage			0.5		V	V_{DS} = 10V, I_D = 1mA
I_{DSS}	Drain to Source Saturation Current	LSK170A	2.6		6.5	mA	V_{DS} = 10V, V_{GS} = 0
		LSK170B	6		12		
		LSK170C	10		20		
I_G	Gate Operating Current				0.5	nA	V_{DG} = 10V, I_D = 1mA
I_{GSS}	Gate to Source Leakage Current				1	nA	V_{GS} = 10V, V_{DS} = 0
Y_{fss}	Full Conduction Transconductance			22		mS	V_{DS} = 10V, V_{GS} = 0, f = 1kHz
Y_{fs}	Typical Conduction Transconductance			10		mS	V_{DG} = 15V, I_D = 1mA
e_n	Noise Voltage			0.9	1.9	nV/√Hz	V_{DS} = 10V, I_D = 2mA, f = 1kHz, NBW = 1Hz
e_n	Noise Voltage			2.5	4	nV/√Hz	V_{DS} = 10V, I_D = 2mA, f = 10Hz, NBW = 1Hz
C_{ISS}	Common Source Input Capacitance			20		pF	V_{DS} = 15V, I_D = 500μA
C_{RSS}	Common Source Reverse Transfer Cap.			5		pF	

[illegible]



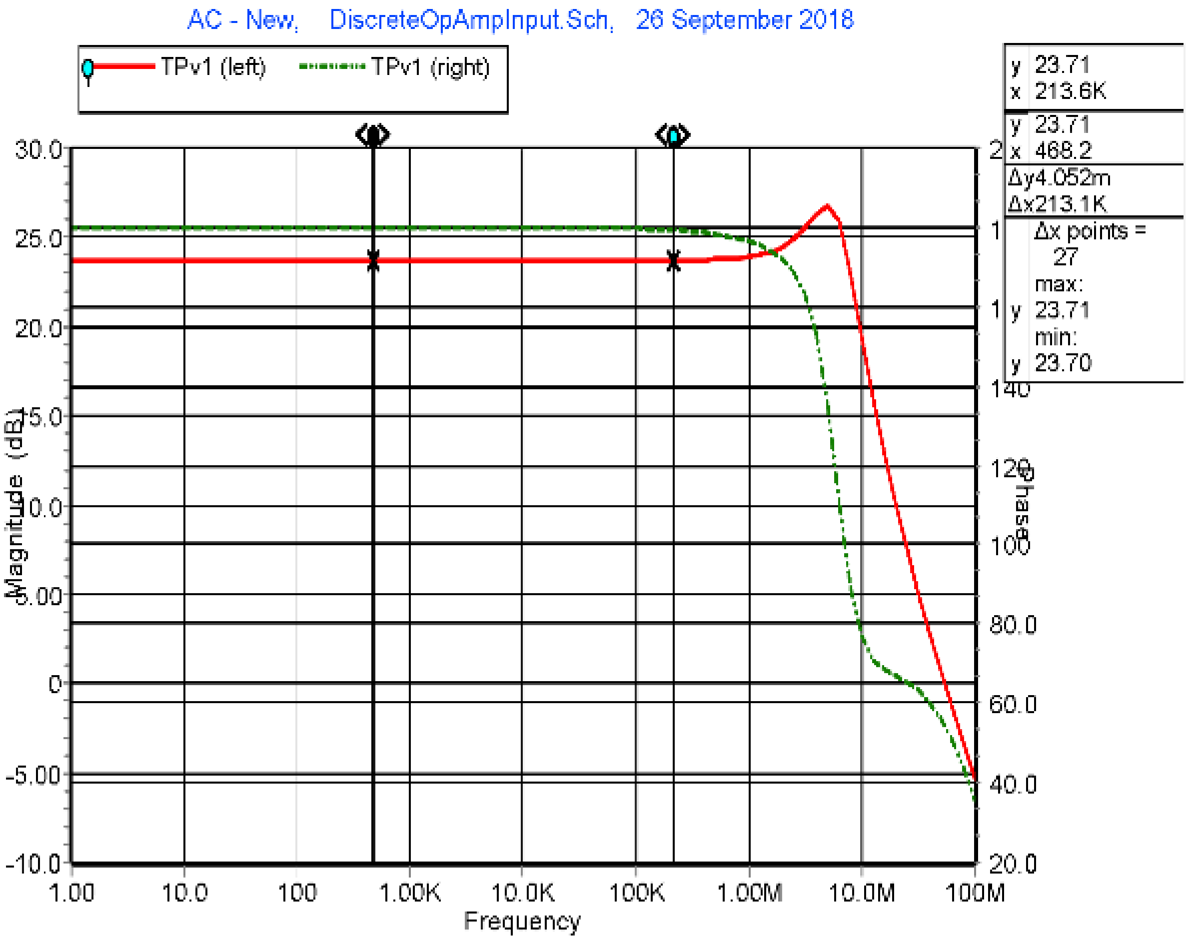
Front End

Gain = Yfs*750 Yfs 25

750/(1/Yfs + 10) =15

Q2 cascode has no gain

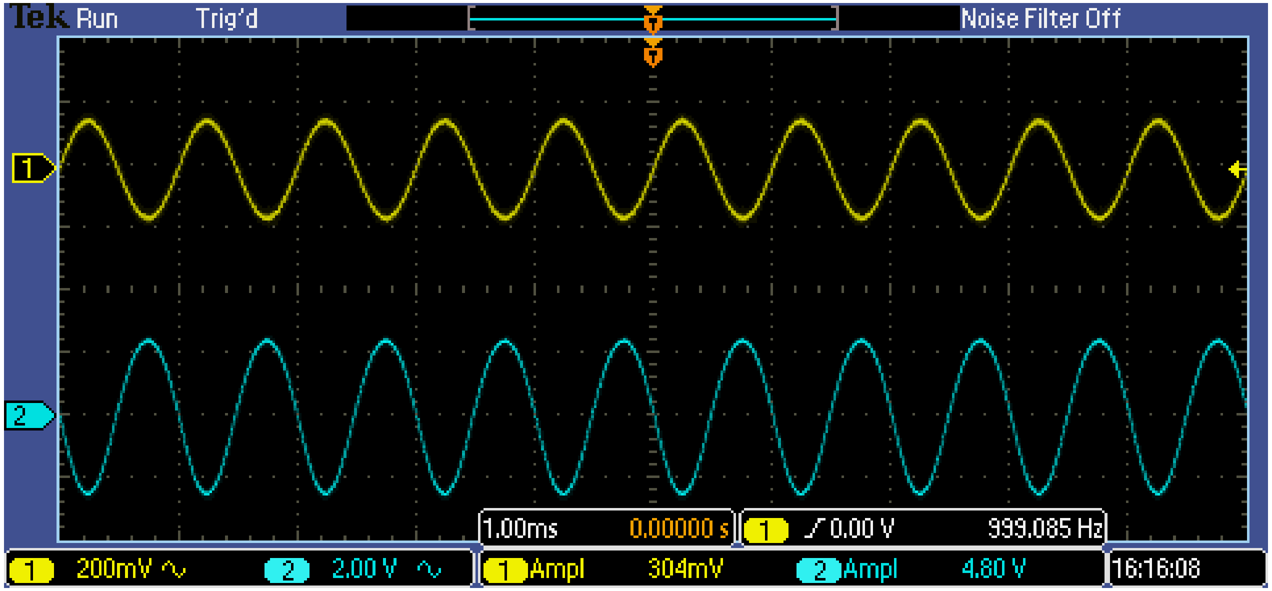
Because it shares R2 with Q1



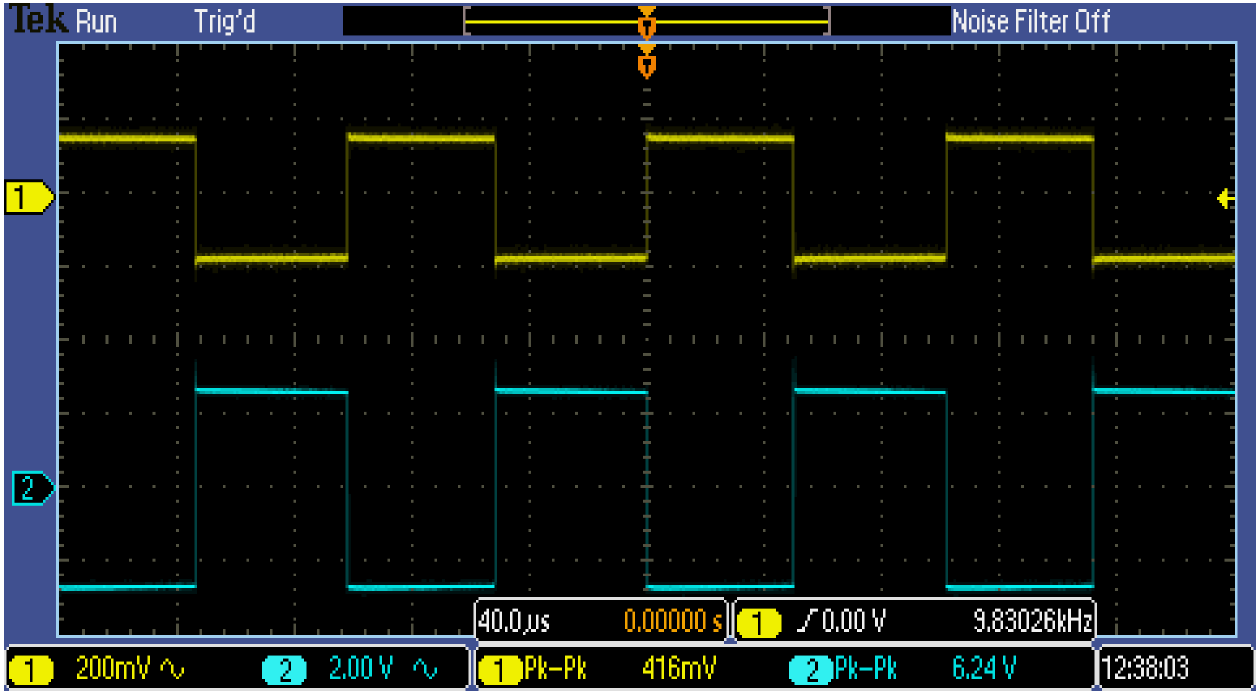
dB to

$23.5/20 = 1.175$

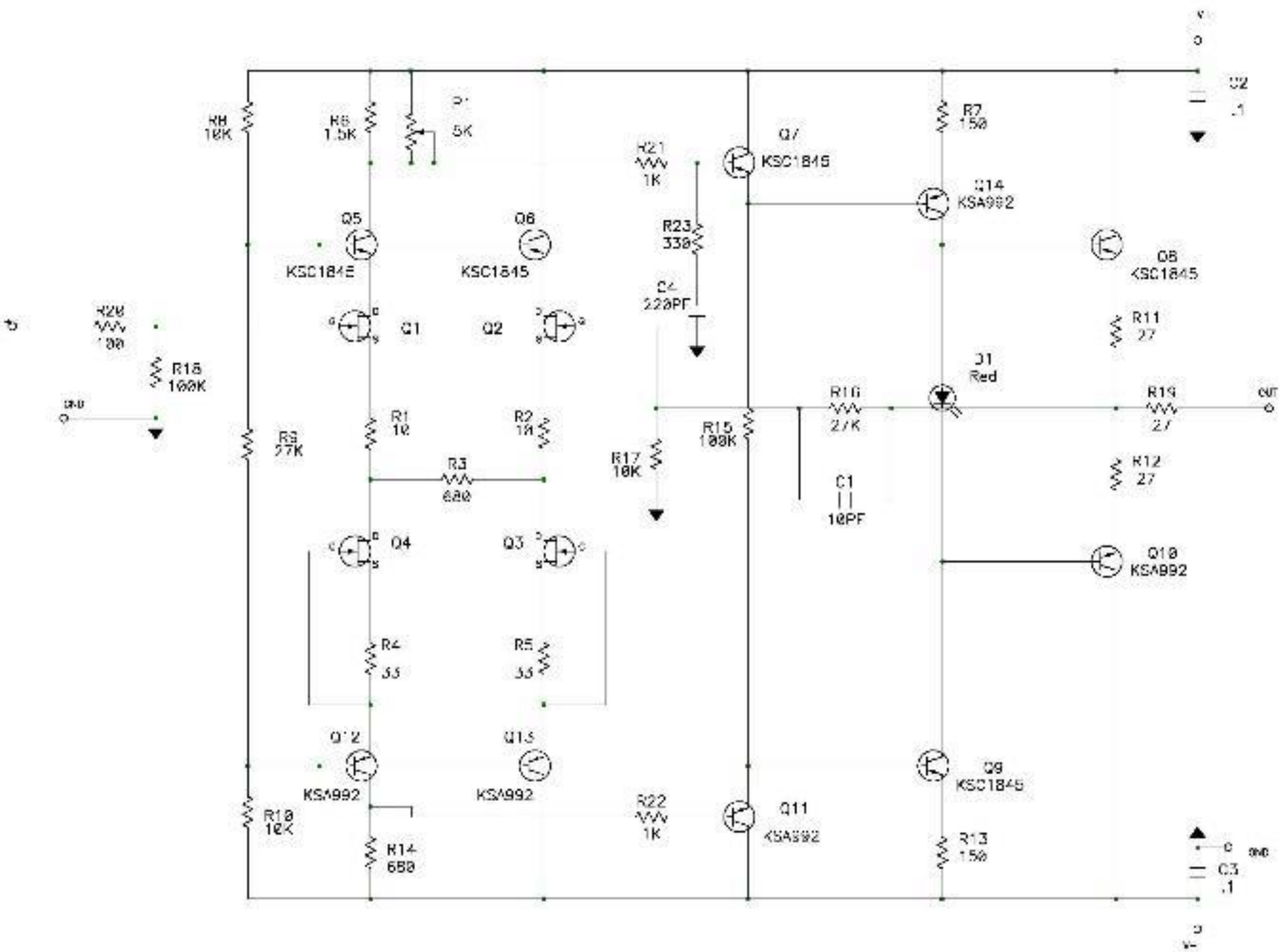
$10^{\wedge}1.175 = 15$


Tek Run
Trig'd
Noise Filter Off
1
2
1.00ms
0.00000 s
1
0.00 V
999.085 Hz
1
200mV
2
2.00 V
1 Ampl
304mV
2 Ampl
4.80 V
16:16:08

4.80/.3 =16



10 KHz square wave response of front end.



Input gain 16

Vas 50 Q14,Q9

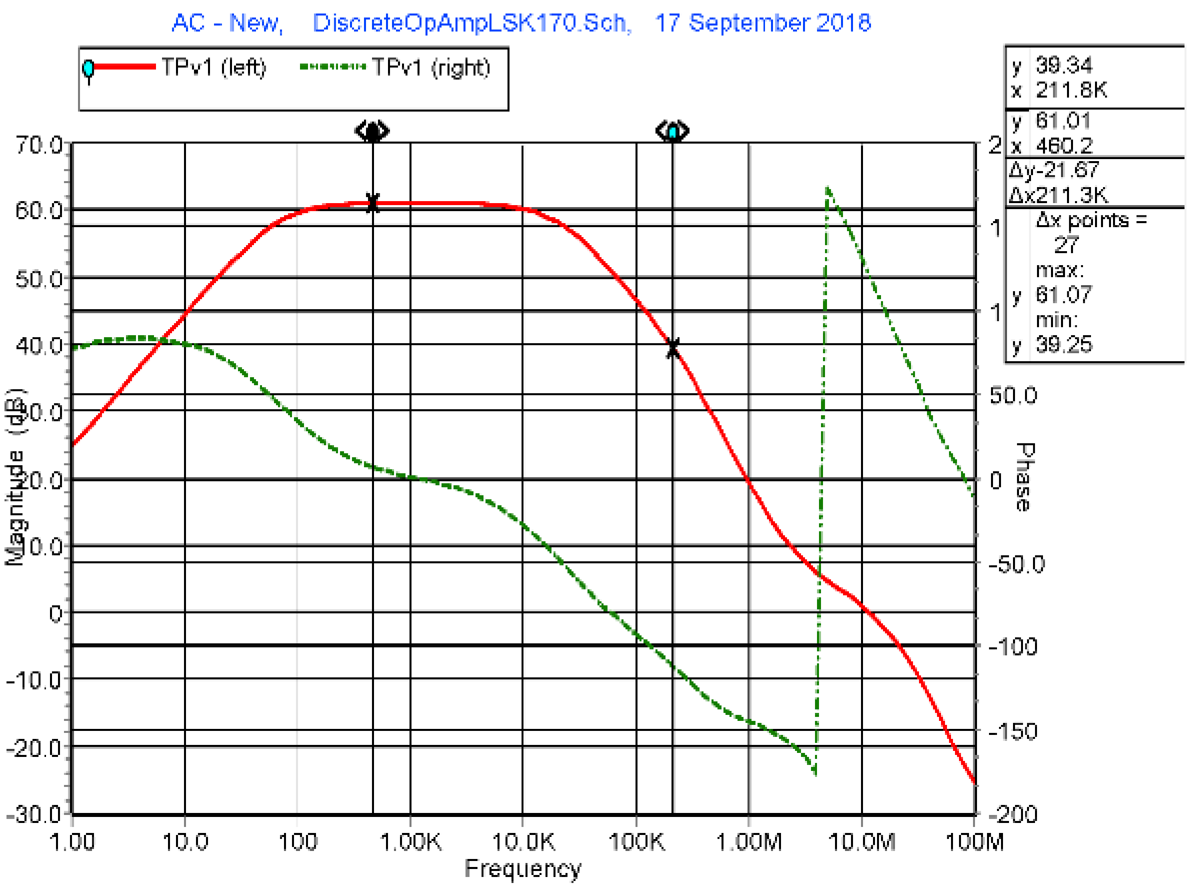
27+3 = 30*500

15000/2=7500

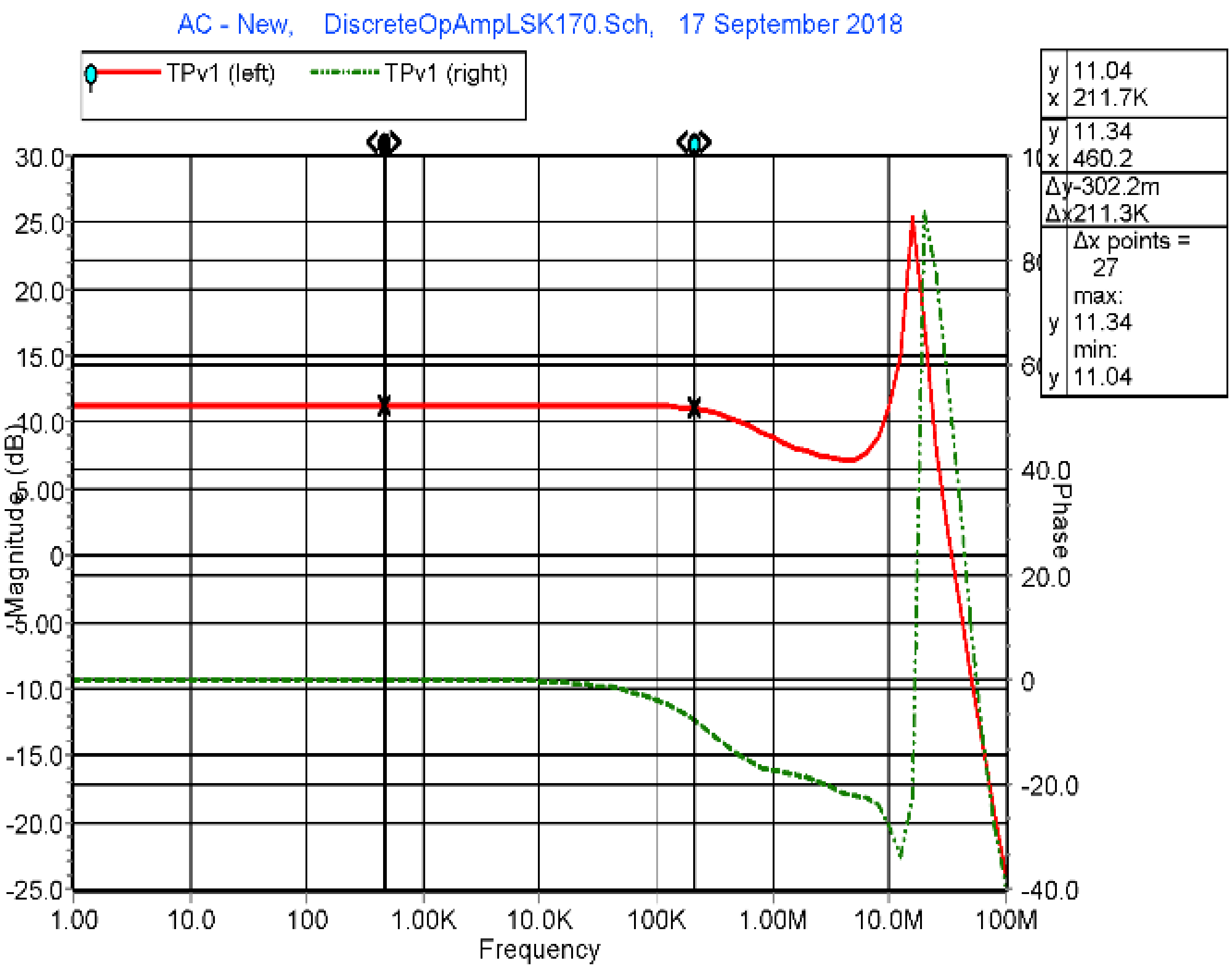
7500/150 = 50

50 * 16 = 800

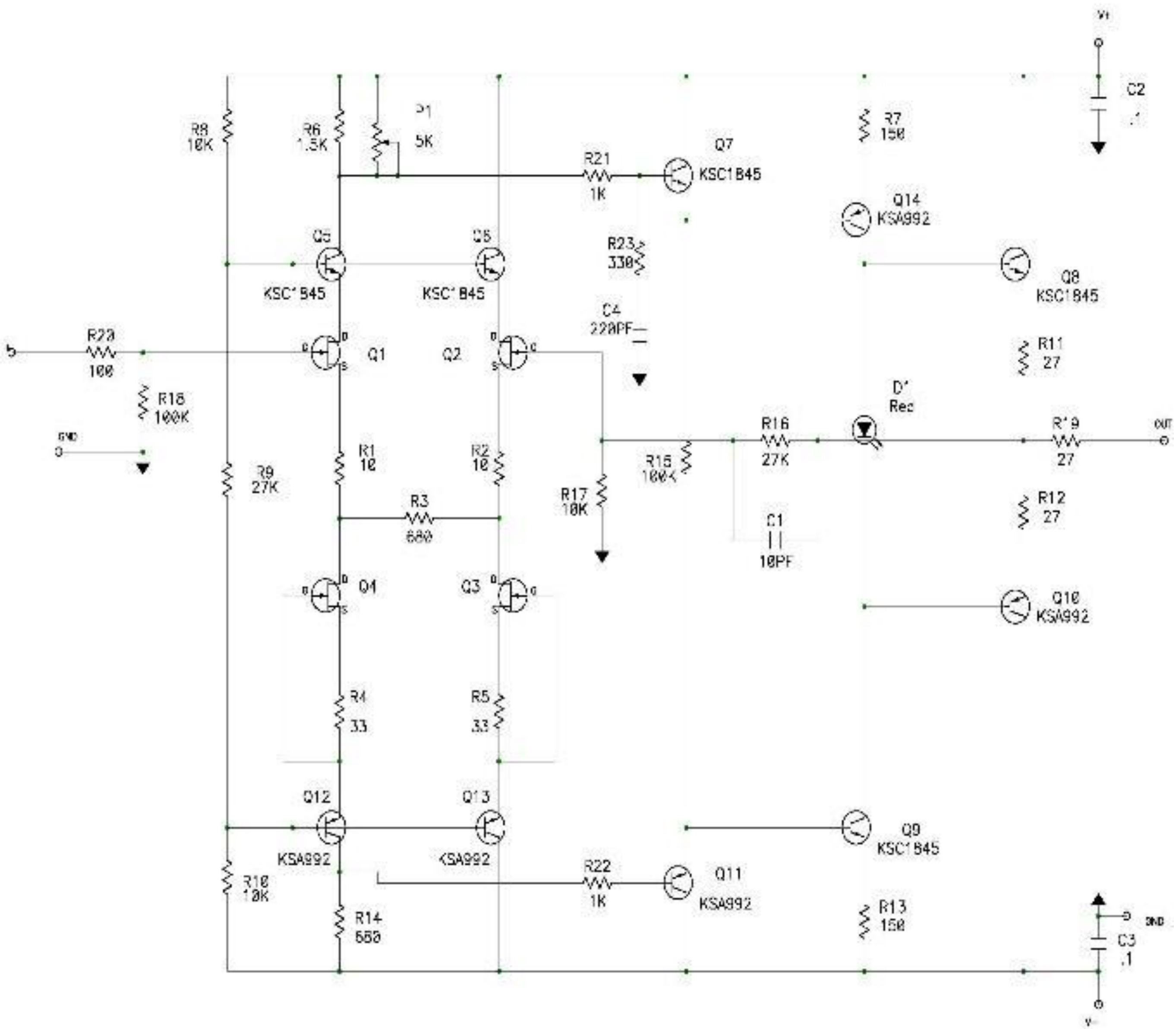
58 dB open loop

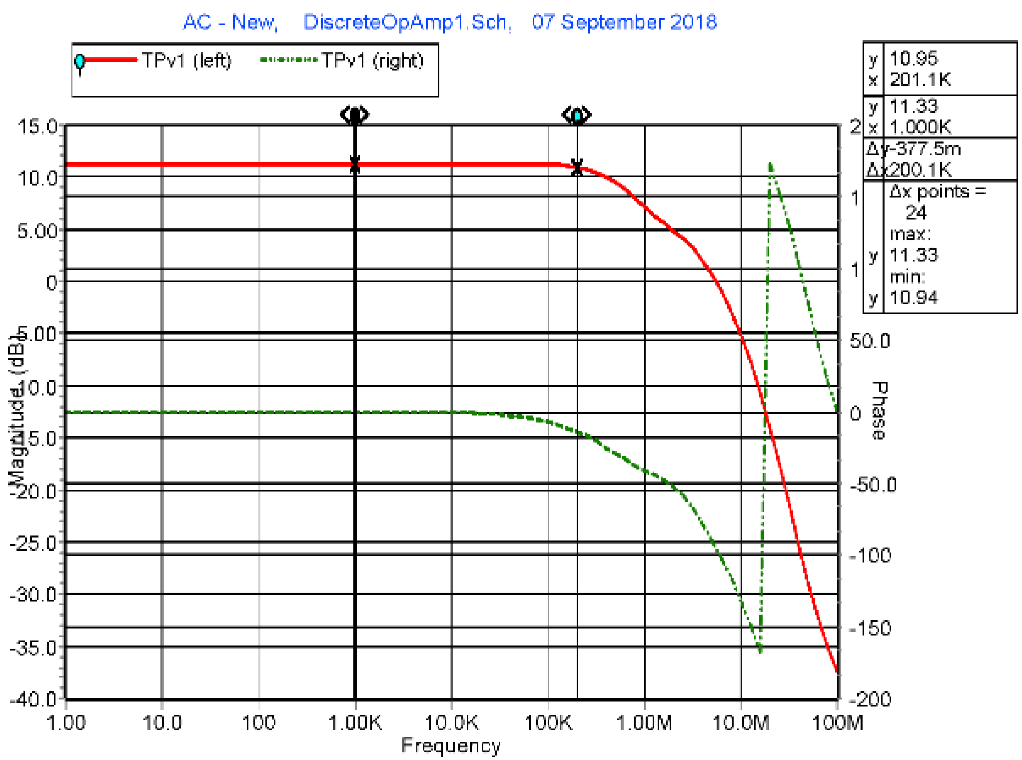


AC - New, DiscreteOpAmpLSK170.Sch, 17 September 2018
TPv1 (left)
TPv1 (right)
y 39.34
x 211.8K
y 61.01
x 460.2
Δy-21.67
Δx211.3K
Δx points = 27
max:
y 61.07
min:
y 39.25
Magnitude (dB)
Phase
Frequency
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
-30.0
50.0
0
-50.0
-100
-150
-200
1.00
10.0
100
1.00K
10.0K
100K
1.00M
10.0M
100M

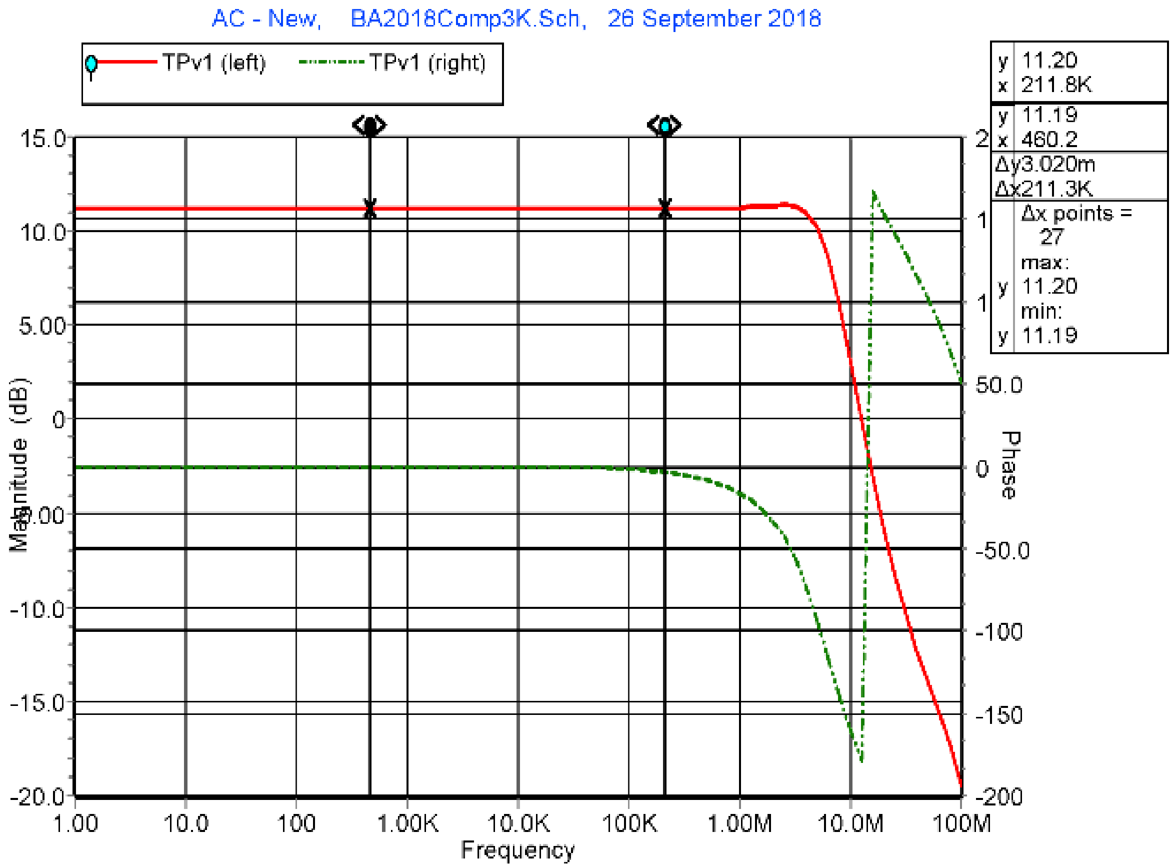


AC - New, DiscreteOpAmpLSK170.Sch, 17 September 2018
TPv1 (left)
TPv1 (right)
y 11.04
x 211.7K
y 11.34
x 460.2
Δy-302.2m
Δx211.3K
Δx points = 27
max:
y 11.34
min:
y 11.04
30.0
25.0
20.0
15.0
10.0
5.00
0
-5.00
-10.0
-15.0
-20.0
-25.0
Magnitude (dB)
40.0
20.0
0
-20.0
-40.0
Phase
1.00
10.0
100
1.00K
10.0K
100K
1.00M
10.0M
100M
Frequency


V+
C2
.1
R8
10K
R6
1.5K
P1
5K
R21
1K
Q7
KSC1845
R7
150
Q14
KSA992
Q5
KSC1845
Q6
KSC1845
R23
330
Q8
KSC1845
C4
220PF
R20
100
Q1
Q2
R11
27
R18
100K
D1
Red
GND
R16
27K
R19
27
OUT
R1
10
R2
10
R15
100K
R9
27K
R17
10K
R3
680
R12
27
C1
10PF
Q4
Q3
Q10
KSA992
R4
33
R5
33
Q12
KSA992
Q13
KSA992
Q9
KSC1845
R22
1K
Q11
KSA992
R10
10K
R14
680
R13
150
GND
C3
.1
V-

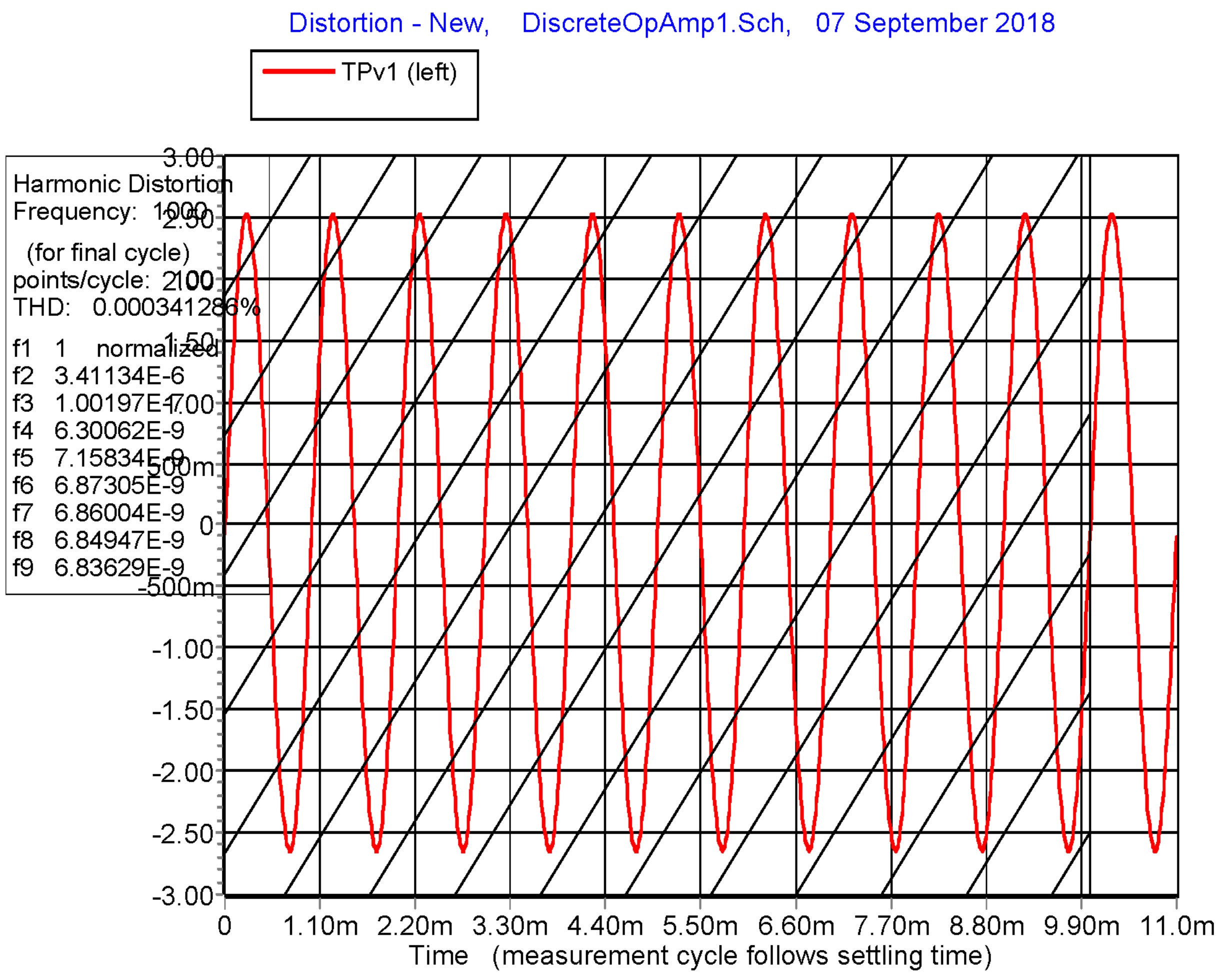


AC - New, DiscreteOpAmp1.Sch, 07 September 2018
TPv1 (left)
TPv1 (right)
y 10.95
x 201.1K
y 11.33
x 1.000K
Δy -377.5m
Δx 200.1K
Δx points = 24
max:
y 11.33
min:
y 10.94
Magnitude (dB)
15.0
10.0
5.00
0
-5.00
-10.0
-15.0
-20.0
-25.0
-30.0
-35.0
-40.0
Phase
2
1
1
50.0
0
-50.0
-100
-150
-200
1.00
10.0
100
1.00K
10.0K
100K
1.00M
10.0M
100M
Frequency

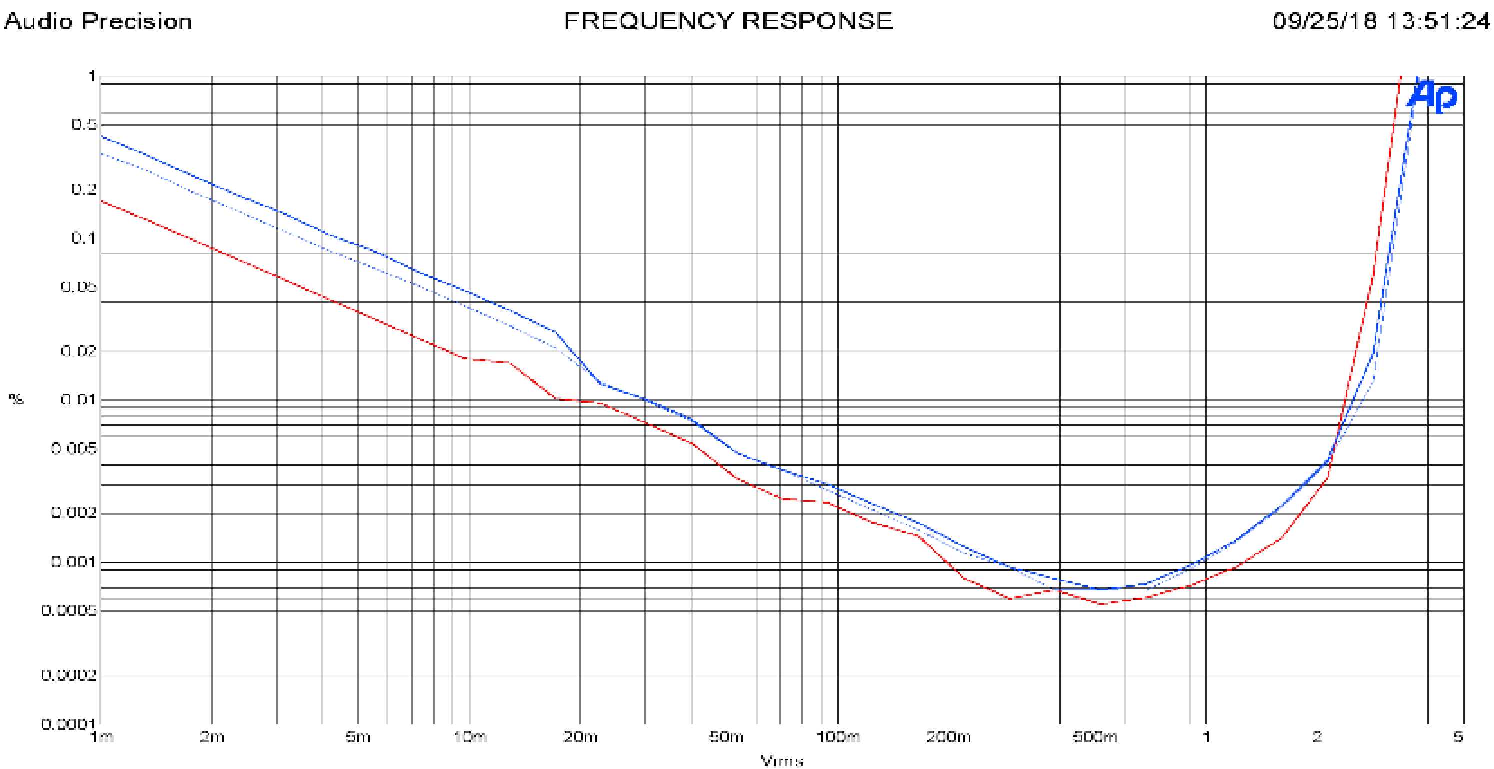


AC - New, BA2018Comp3K.Sch, 26 September 2018
TPv1 (left)
TPv1 (right)
y 11.20
x 211.8K
y 11.19
x 460.2
Δy3.020m
Δx211.3K
Δx points = 27
max:
y 11.20
min:
y 11.19
15.0
10.0
5.00
0
-5.00
-10.0
-15.0
-20.0
Magnitude (dB)
50.0
0
-50.0
-100
-150
-200
Phase
1.00
10.0
100
1.00K
10.0K
100K
1.00M
10.0M
100M
Frequency

R2 3.3K



Distortion - New, DiscreteOpAmp1.Sch, 07 September 2018
TPv1 (left)
Harmonic Distortion
Frequency: 1000
(for final cycle)
points/cycle: 200
THD: 0.000341286%
f1 1 normalized
f2 3.41134E-6
f3 1.00197E-7
f4 6.30062E-9
f5 7.15834E-9
f6 6.87305E-9
f7 6.86004E-9
f8 6.84947E-9
f9 6.83629E-9
3.00
2.50
2.00
1.50
1.00
500m
0
-500m
-1.00
-1.50
-2.00
-2.50
-3.00
0
1.10m
2.20m
3.30m
4.40m
5.50m
6.60m
7.70m
8.80m
9.90m
11.0m
Time (measurement cycle follows settling time)



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	5	Anlr.THD+N Ratio	Left	
2	1	Blue	Solid	5	Anlr.THD+N Ratio	Left	
3	1	Blue	Solid	1	Anlr.THD+N Ratio	Left	

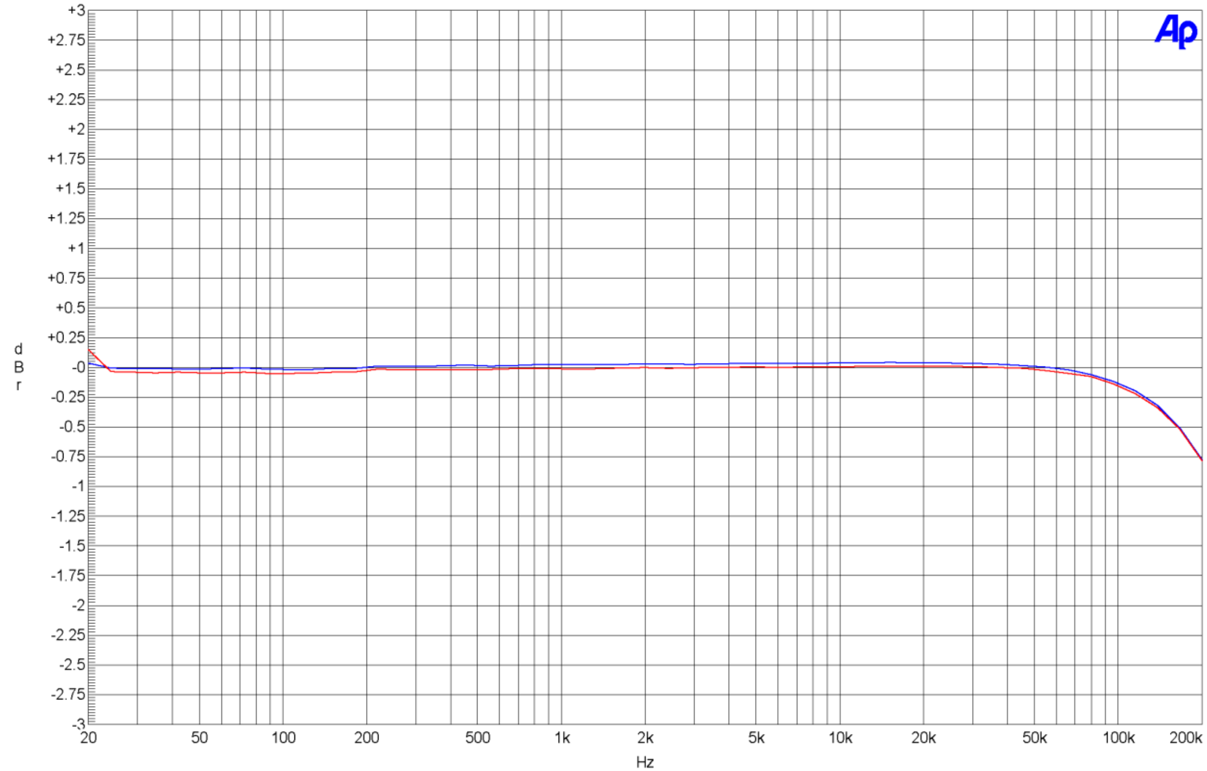
Two Channel distortion VS residual on the AP.

Dist209 TwoCH.at1

.0003% simulated

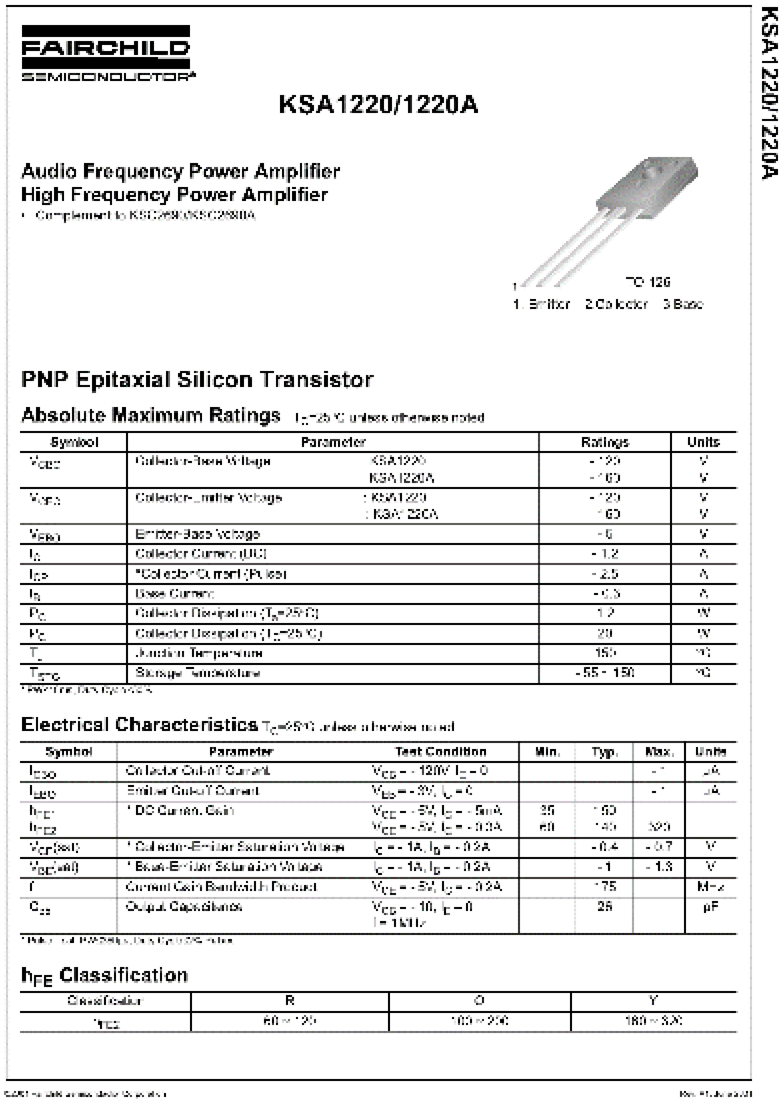
.0006% actual includes noise

Audio Precision FREQUENCY RESPONSE 09/24/18 16:26:23



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	5	Anlr.Ampl	Left	
2	1	Blue	Solid	5	Anlr.Ampl	Left	

Freq2CH.at1


FAIRCHILD SEMICONDUCTOR

KSA1220/1220A

Audio Frequency Power Amplifier
High Frequency Power Amplifier
• Complement to KSC2690/KSC2690A

TO-126
1. Emitter 2. Collector 3. Base

KSA1220/1220A

PNP Epitaxial Silicon Transistor

Absolute Maximum Ratings T_C=25°C unless otherwise noted

Symbol	Parameter	Ratings	Units
V_{CBO}	Collector-Base Voltage : KSA1220	- 120	V
	: KSA1220A	- 160	V
V_{CEO}	Collector-Emitter Voltage : KSA1220	- 120	V
	: KSA1220A	- 160	V
V_{EBO}	Emitter-Base Voltage	- 5	V
I_C	Collector Current (DC)	- 1.2	A
I_{CP}	*Collector Current (Pulse)	- 2.5	A
I_B	Base Current	- 0.3	A
P_C	Collector Dissipation (T_a=25°C)	1.2	W
P_C	Collector Dissipation (T_C=25°C)	20	W
T_J	Junction Temperature	150	°C
T_{STG}	Storage Temperature	- 55 ~ 150	°C

Electrical Characteristics T_C=25°C unless otherwise noted

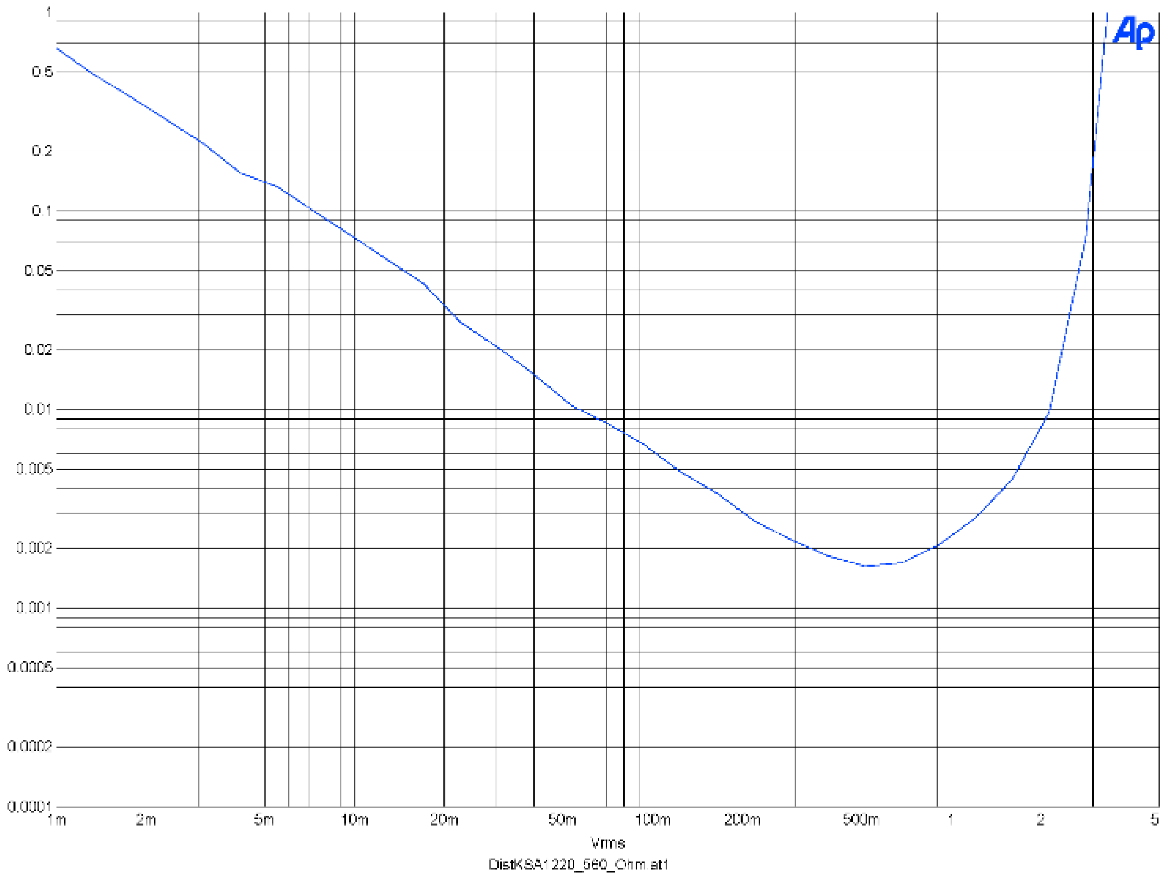
Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Units
I_{CBO}	Collector Cut-off Current	V_{CB} = - 120V, I_E = 0			- 1	μA
I_{EBO}	Emitter Cut-off Current	V_{EB} = - 3V, I_C = 0			- 1	μA
h_{FE1}	* DC Current Gain	V_{CE} = - 5V, I_C = - 5mA	35	150		
h_{FE2}		V_{CE} = - 5V, I_C = - 0.2A	60	140	320	
V_{CE}(sat)	* Collector-Emitter Saturation Voltage	I_C = - 1A, I_B = - 0.2A		- 0.4	- 0.7	V
V_{BE}(sat)	* Base-Emitter Saturation Voltage	I_C = - 1A, I_B = - 0.2A		- 1	- 1.3	V
f_T	Current Gain Bandwidth Product	V_{CE} = - 5V, I_C = - 0.2A		175		MHz
C_{ob}	Output Capacitance	V_{CB} = - 10, I_E = 0, f = 1MHz		25		pF

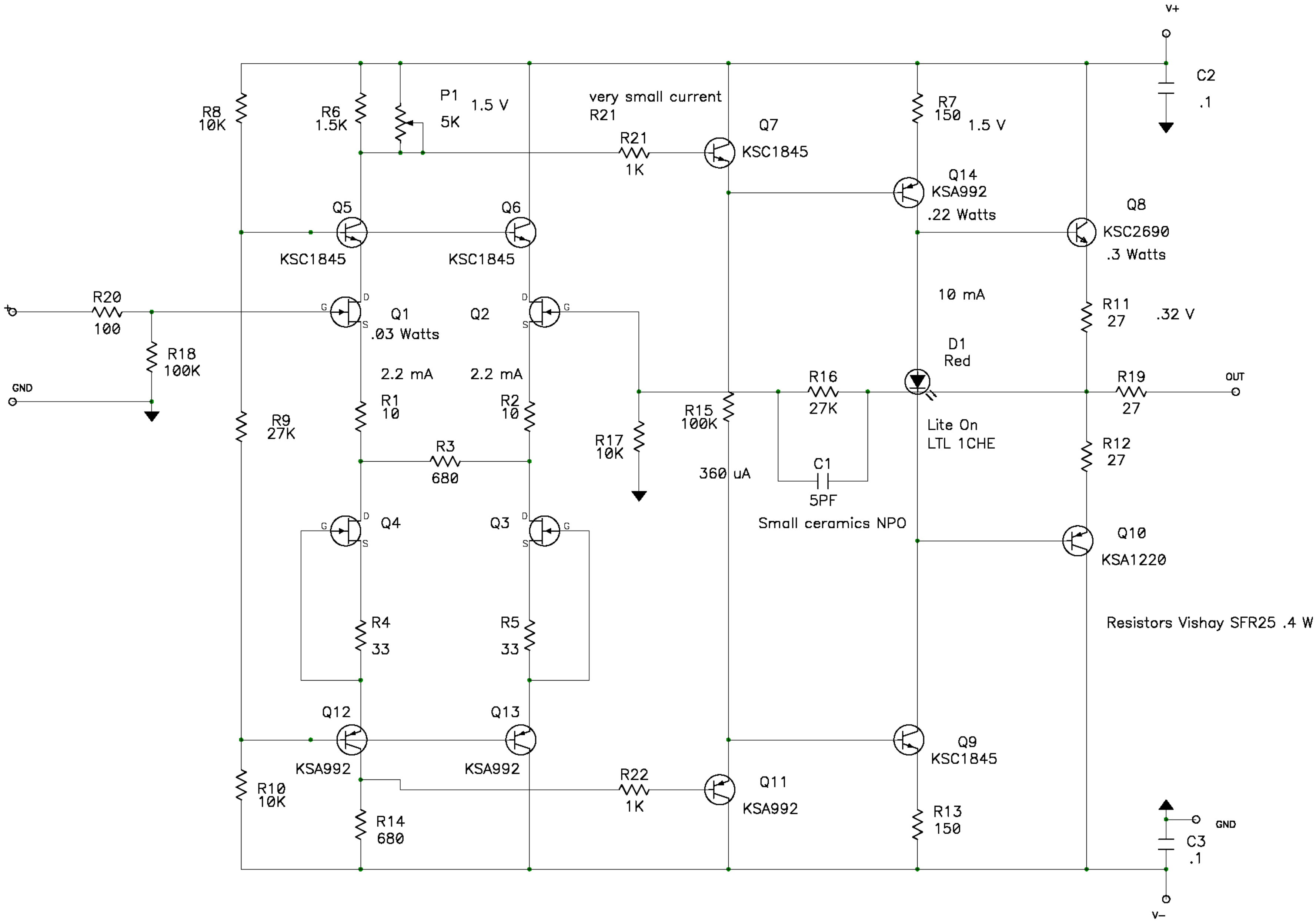
h_{FE} Classification

Classification	R	O	Y
h_{FE2}	60 ~ 120	100 ~ 200	160 ~ 320

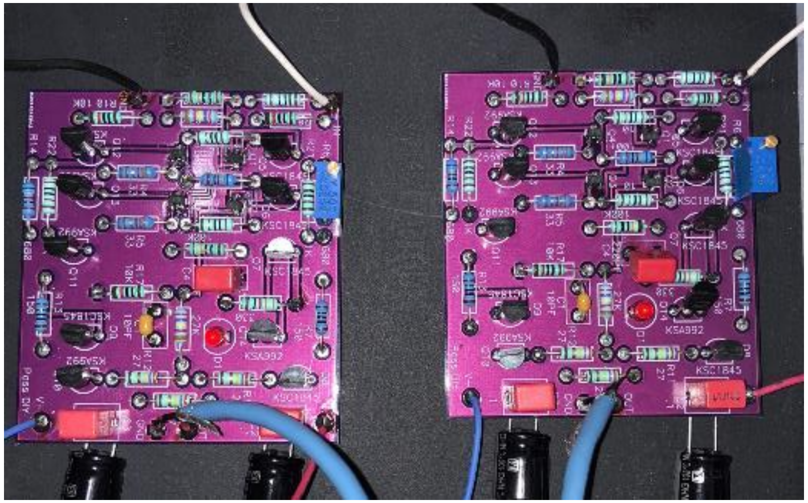
Pin configuration drops in
To use as an output transistor
To drive heavier loads.
Emitter resistors can be smaller
For higher bias.
Be careful on direction of pinout.

Audio Precision FREQUENCY RESPONSE 09/20/18 15:23:54





V+
C2
.1
R8
10K
R6
1.5K
P1
5K
1.5 V
very small current
R21
R21
1K
Q7
KSC1845
R7
150
1.5 V
Q14
KSA992
.22 Watts
Q8
KSC2690
.3 Watts
Q5
KSC1845
Q6
KSC1845
R20
100
R18
100K
GND
Q1
.03 Watts
Q2
2.2 mA
2.2 mA
R1
10
R2
10
R3
680
R9
27K
R17
10K
R15
100K
360 uA
10 mA
R11
27
.32 V
D1
Red
R16
27K
C1
5PF
Small ceramics NPO
Lite On
LTL 1CHE
R19
27
OUT
R12
27
Q4
Q3
Q10
KSA1220
R4
33
R5
33
Resistors Vishay SFR25 .4 W
Q12
KSA992
Q13
KSA992
Q9
KSC1845
R22
1K
Q11
KSA992
R10
10K
R14
680
R13
150
GND
C3
.1
V-


KSC1845
KSA992