

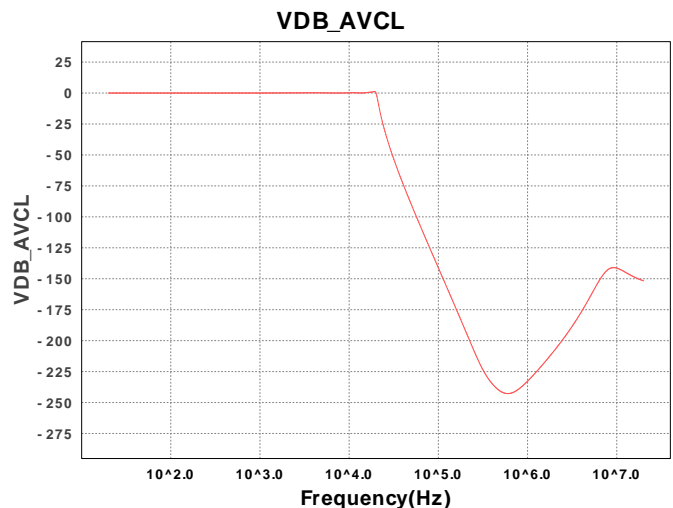
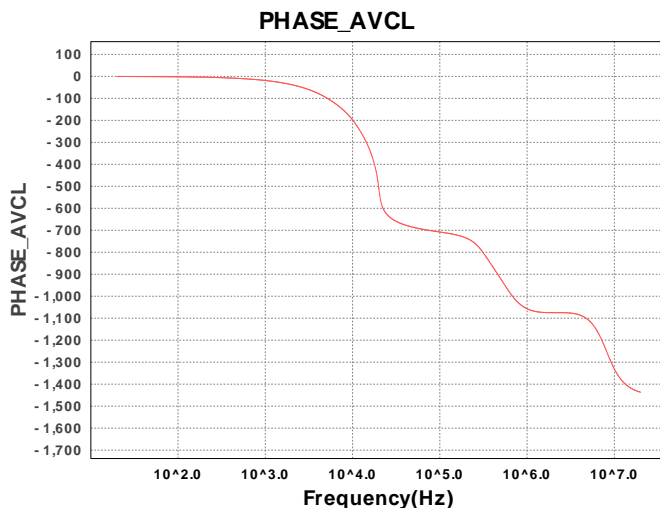
## Electrical BOM

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	A1_S1	Texas Instruments	OPA604AP	GbwTyp= 20.0 MHz VccMin= 9.0 V VccMax= 48.0 V	1	\$1.05	DIP 0 mm <sup>2</sup>
2.	A1_S2	Texas Instruments	OPA604AP	GbwTyp= 20.0 MHz VccMin= 9.0 V VccMax= 48.0 V	1	\$1.05	DIP 0 mm <sup>2</sup>
3.	A1_S3	Texas Instruments	OPA604AP	GbwTyp= 20.0 MHz VccMin= 9.0 V VccMax= 48.0 V	1	\$1.05	DIP 0 mm <sup>2</sup>
4.	A1_S4	Texas Instruments	OPA604AP	GbwTyp= 20.0 MHz VccMin= 9.0 V VccMax= 48.0 V	1	\$1.05	DIP 0 mm <sup>2</sup>
5.	C1_S1	Samsung Electro-Mechanics	CL05C102JO5NNNC Series= C0G/NP0	Cap= 1.0 nF VDC= 16.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm <sup>2</sup>
6.	C1_S2	Samsung Electro-Mechanics	CL05C102JO5NNNC Series= C0G/NP0	Cap= 1.0 nF VDC= 16.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm <sup>2</sup>
7.	C1_S3	Samsung Electro-Mechanics	CL05C102JO5NNNC Series= C0G/NP0	Cap= 1.0 nF VDC= 16.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm <sup>2</sup>
8.	C1_S4	Samsung Electro-Mechanics	CL05C102JO5NNNC Series= C0G/NP0	Cap= 1.0 nF VDC= 16.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm <sup>2</sup>
9.	C2_S1	MuRata	GRM1885C1H162JA01D Series= C0G/NP0	Cap= 1.6 nF VDC= 50.0 V IRMS= 0.0 A	1	\$0.02	0603 5 mm <sup>2</sup>
10.	C2_S2	MuRata	GRM2195C1H752JA01D Series= C0G/NP0	Cap= 7.5 nF VDC= 50.0 V IRMS= 0.0 A	1	\$0.06	0805 7 mm <sup>2</sup>
11.	C2_S3	AVX	08053A332JAT2A Series= C0G/NP0	Cap= 33.0 nF VDC= 25.0 V IRMS= 0.0 A	1	\$0.06	0805 7 mm <sup>2</sup>
12.	C2_S4	CUSTOM	CUSTOM Series= ?	Cap= 360.0 nF VDC= 0.0 V IRMS= 0.0 A	1	NA	CUSTOM 0 mm <sup>2</sup>
13.	R1_S1	Vishay-Dale	CRCW040215K0FKED Series= CRCW..e3	Res= 15.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>
14.	R1_S2	Vishay-Dale	CRCW04023K65FKED Series= CRCW..e3	Res= 3.65 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>
15.	R1_S3	Vishay-Dale	CRCW04021K24FKED Series= CRCW..e3	Res= 1.24 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
16.	R1_S4	Vishay-Dale	CRCW0603332RFKEA Series= CRCW..e3	Res= 332.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	\$0.01	0603 5 mm <sup>2</sup>
17.	R2_S1	Vishay-Dale	CRCW040222K6FKED Series= CRCW..e3	Res= 22.6 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>
18.	R2_S2	Vishay-Dale	CRCW04026K04FKED Series= CRCW..e3	Res= 6.04 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>
19.	R2_S3	Vishay-Dale	CRCW04022K00FKED Series= CRCW..e3	Res= 2.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>
20.	R2_S4	Vishay-Dale	CRCW0402511RFKED Series= CRCW..e3	Res= 511.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>

## Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Vsignal	AC DC	AC Voltage Source Amplitude AC Voltage Source DC Offset	1 V 0.0 V
2.	Vcc	V	Vcc Supply Rail Value	5.0 V
3.	Vee	V	Vee Supply Rail Value	-5.0 V



## Design Inputs

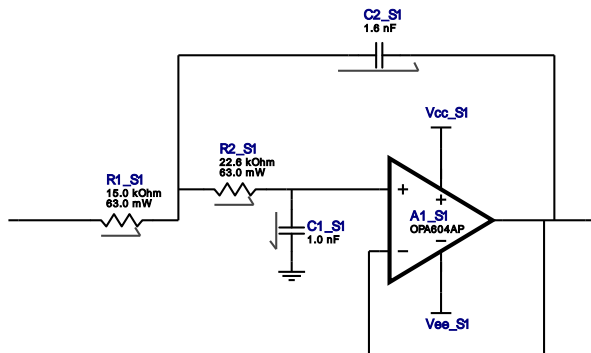
#	Name	Value	Description
1.	FilterType	Lowpass	
2.	FilterResponse	Chebyshev	
3.	FilterOrder	8.0	
4.	FilterTopology	Sallen_Key	
5.	NumberOfStages	4.0	
6.	PassbandFrequency	20.0 kHz	
7.	StopbandAttenuation	-45.0 dB	
8.	StopbandFrequency	30.0 kHz	
9.	Gain	1.0 V/V	
10.	DualSupply	+/-5.0 V	Power supply(s) to active chips
11.	ResistorTolerance	E96	Resistor series - 1% Passive resistor tolerance
12.	CapacitorTolerance	E24	Capacitor series - 5% Passive capacitance tolerance
13.	SeedCapacitance	1.0 nF	Seed Capacitance to start design of filter

## Design Assistance

1. **OPA604AP** Product Folder : <http://www.ti.com/product/OPA604> : contains the data sheet and other resources.

## Filter Stage :1

Cutoff Frequency 6.869 kHz  
 Min GBW Req'd 425.184 kHz  
 Stage Gain 1.0 V/V  
 Stage Q 619.0 m  
 Stage Topology Sallen\_Key

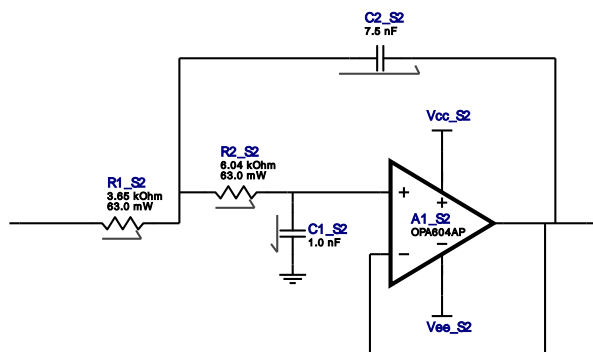


## Electrical BOM

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	A1_S1	Texas Instruments	OPA604AP	GbwTyp= 20.0 MHz VccMin= 9.0 V VccMax= 48.0 V	1	\$1.05	DIP 0 mm <sup>2</sup>
2.	C1_S1	Samsung Electro-Mechanics	CL05C102JO5NNNC Series= C0G/NP0	Cap= 1.0 nF VDC= 16.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm <sup>2</sup>
3.	C2_S1	MuRata	GRM1885C1H162JA01D Series= C0G/NP0	Cap= 1.6 nF VDC= 50.0 V IRMS= 0.0 A	1	\$0.02	0603 5 mm <sup>2</sup>
4.	R1_S1	Vishay-Dale	CRCW040215K0FKED Series= CRCW..e3	Res= 15.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>
5.	R2_S1	Vishay-Dale	CRCW040222K6FKED Series= CRCW..e3	Res= 22.6 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>

## Filter Stage :2

Cutoff Frequency	12.467 kHz
Min GBW Req'd	1.653 MHz
Stage Gain	1.0 V/V
Stage Q	1.326
Stage Topology	Sallen_Key

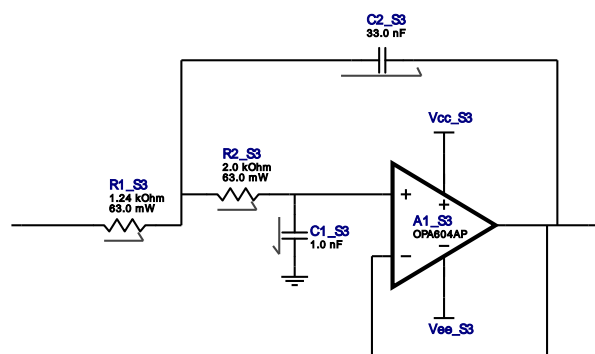


### Electrical BOM

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	A1_S2	Texas Instruments	OPA604AP	GbwTyp= 20.0 MHz VccMin= 9.0 V VccMax= 48.0 V	1	\$1.05	DIP 0 mm <sup>2</sup>
2.	C1_S2	Samsung Electro-Mechanics	CL05C102JO5NNNC Series= C0G/NP0	Cap= 1.0 nF VDC= 16.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm <sup>2</sup>
3.	C2_S2	MuRata	GRM2195C1H752JA01D Series= C0G/NP0	Cap= 7.5 nF VDC= 50.0 V IRMS= 0.0 A	1	\$0.06	0805 7 mm <sup>2</sup>
4.	R1_S2	Vishay-Dale	CRCW04023K65FKED Series= CRCW..e3	Res= 3.65 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>
5.	R2_S2	Vishay-Dale	CRCW04026K04FKED Series= CRCW..e3	Res= 6.04 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>

## Filter Stage :3

Cutoff Frequency 17.564 kHz  
 Min GBW Req'd 4.911 MHz  
 Stage Gain 1.0 V/V  
 Stage Q 2.796  
 Stage Topology Sallen\_Key

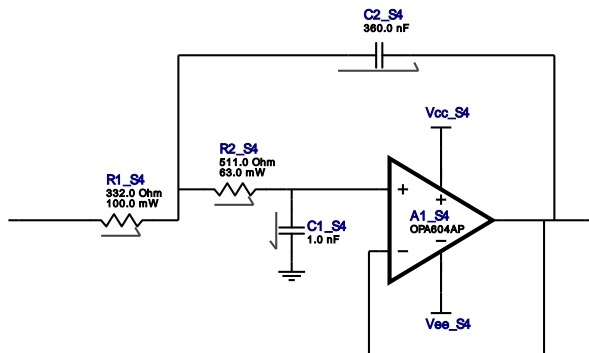


## Electrical BOM

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	A1_S3	Texas Instruments	OPA604AP	GbwTyp= 20.0 MHz VccMin= 9.0 V VccMax= 48.0 V	1	\$1.05	DIP 0 mm <sup>2</sup>
2.	C1_S3	Samsung Electro-Mechanics	CL05C102JO5NNNC Series= C0G/NP0	Cap= 1.0 nF VDC= 16.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm <sup>2</sup>
3.	C2_S3	AVX	08053A332JAT2A Series= C0G/NP0	Cap= 33.0 nF VDC= 25.0 V IRMS= 0.0 A	1	\$0.06	0805 7 mm <sup>2</sup>
4.	R1_S3	Vishay-Dale	CRCW04021K24FKED Series= CRCW..e3	Res= 1.24 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>
5.	R2_S3	Vishay-Dale	CRCW04022K00FKED Series= CRCW..e3	Res= 2.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>

## Filter Stage :4

Cutoff Frequency	20.414 kHz
Min GBW Req'd	18.893 MHz
Stage Gain	1.0 V/V
Stage Q	9.255
Stage Topology	Sallen_Key



## Electrical BOM

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	A1_S4	Texas Instruments	OPA604AP	GbwTyp= 20.0 MHz VccMin= 9.0 V VccMax= 48.0 V	1	\$1.05	DIP 0 mm <sup>2</sup>
2.	C1_S4	Samsung Electro-Mechanics	CL05C102JO5NNNC Series= C0G/NP0	Cap= 1.0 nF VDC= 16.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm <sup>2</sup>
3.	C2_S4	CUSTOM	CUSTOM Series= ?	Cap= 360.0 nF VDC= 0.0 V IRMS= 0.0 A	1	NA	CUSTOM 0 mm <sup>2</sup>
4.	R1_S4	Vishay-Dale	CRCW0603332RFKEA Series= CRCW..e3	Res= 332.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	\$0.01	0603 5 mm <sup>2</sup>
5.	R2_S4	Vishay-Dale	CRCW0402511RFKED Series= CRCW..e3	Res= 511.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>

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