Selecting and Verifying the Driver Amplifier

TIPL 4402
TI Precision Labs – ADCs

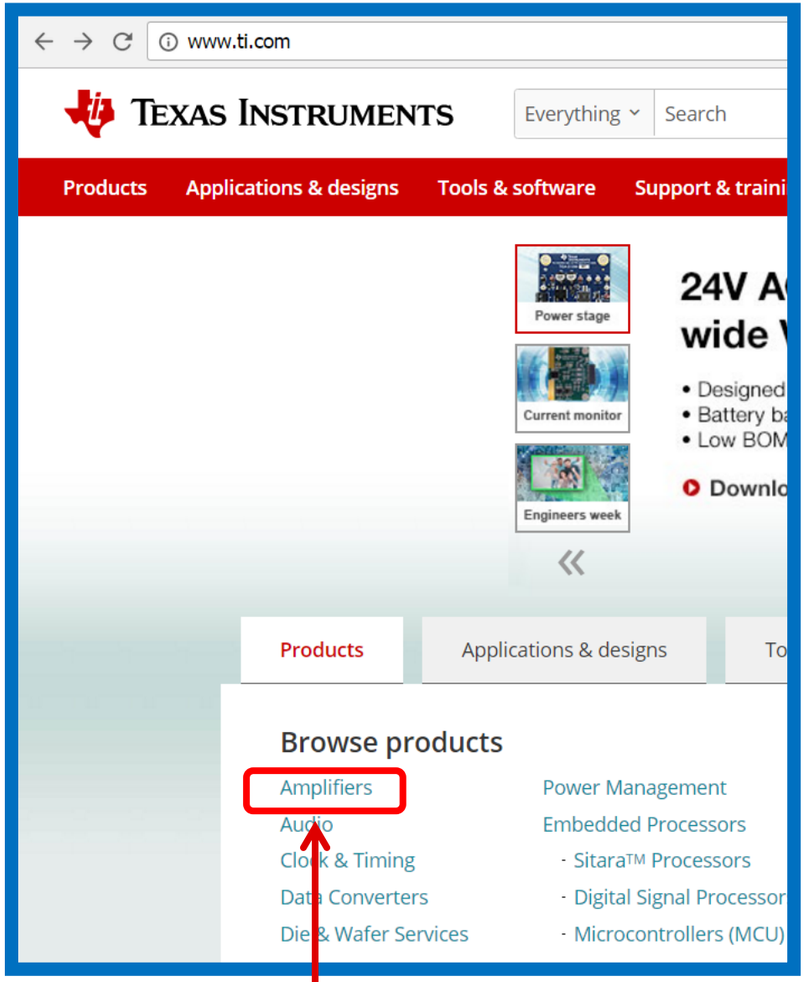
Created by Tim Green, Art Kay

Presented by Peggy Liska

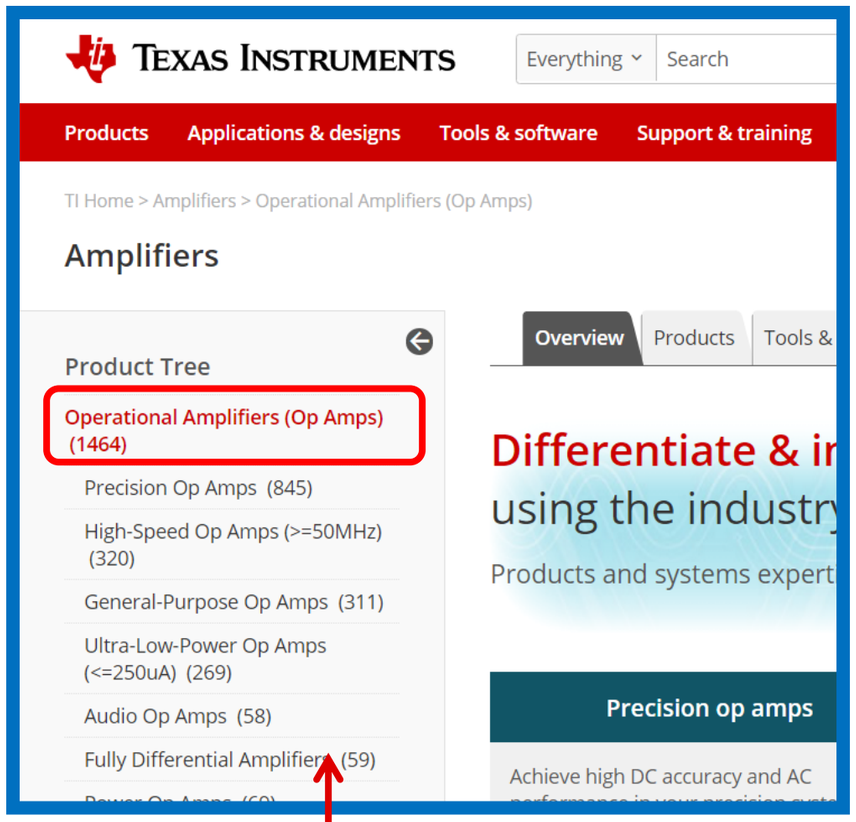
Agenda

1. SAR Operation Overview
2. Select the data converter
3. Use the Calculator to find amplifier and RC filter
4. Find the Op Amp
5. Verify the Op Amp Model
6. Building the SAR Model
7. Refine the Rfilt and Cfilt values
8. Final simulations
9. Measured Results
10. SAR Drive Calculator Algorithm

Find the Op Amp

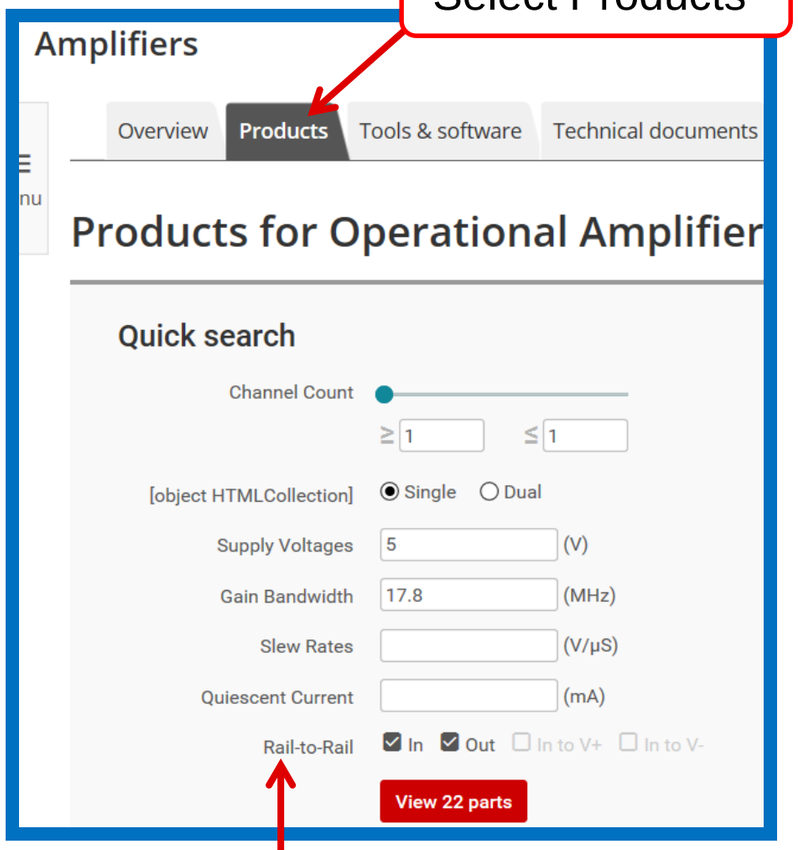


Select Amplifiers



Select
Operational Amplifiers (Op Amps)
1464 different choices!

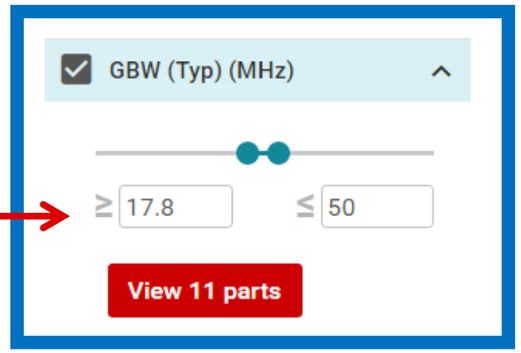
Select Products

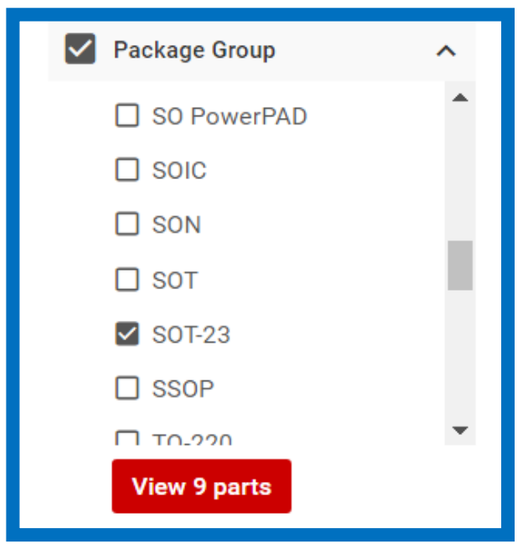


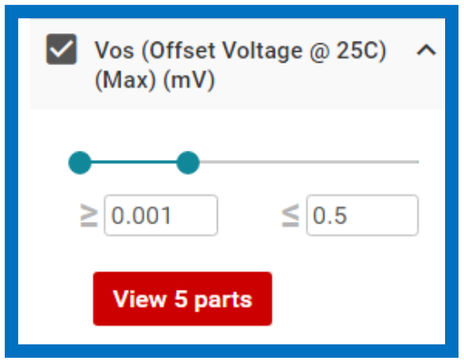
Channel Count = 1
Supply Voltage = 5V
Gain Bandwidth = 17.8MHz
22 devices left!

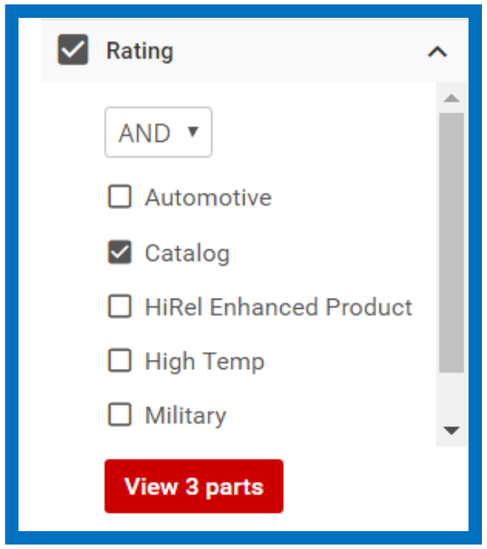
Set filters to find the best device

Use the filters to narrow options







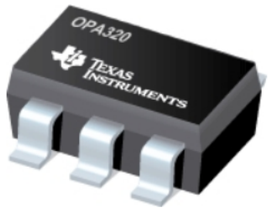


OPA320 Best offset

3 matching parts out of 1464 total parts — Email — Download to Excel

Compare	Part Number (Filter by part number)	Number of Channels (#)	Total Supply Voltage (Min) (+5V=5, +/-5V=10)	Total Supply Voltage (Max) (+5V=5, +/-5V=10)	GBW (Typ) (MHz)	Rail-to-Rail	Slew Rate (Typ) (V/us)	Vos (Offset Voltage @ 25C) (Max) (mV)	Iq per channel (Typ) (mA)	Rating	Operating Temperature Range (C)	Package Group	Approx. Price (US$)
☐	OPA320 - Precision, 20MHz, 0.9pA Ib, RRIO, CMOS Operational Amplifier	1	1.8	5.5	20	In, Out	10	0.15	1.5	Catalog	-40 to 125	SOT-23	0.80 | 1ku
☐	OPA365 - 2.2V, 50MHz, Low-Noise, Single-Supply Rail-to-Rail Operational Amplifier	1	2.2	5.5	50	In, Out	25	0.2	4.6	Catalog	-40 to 125	SOIC, SOT-23	0.65 | 1ku
☐	LMP7731 - 2.9 nV/sqrt(Hz) Low Noise, Precision , RRIO Amplifier	1	1.8	5.5	22	In, Out	2.4	0.5	2.2	Catalog	-40 to 125	SOIC, SOT-23	0.63 | 1ku

Get the latest model from the web



TI Home > Semiconductors > Amplifiers > Operational Amplifiers (Op Amps) > Precision Op Amps >

OPA320 (ACTIVE)

Precision, 20MHz, 0.9pA Ib, RRIO, CMOS Operational Amplifier

OPAx320x Precision, 20-MHz, 0.9-pA, Low-Noise, RRIO, CMOS Operational Amplifie
F)

OPA320, OPA320S, OPA2320, OPA2320S EMI Immunity Performance

Description & parametrics | Online datasheet | Technical documents | **Tools & software** | Order Now | Compare | Quality &

Models | Design kits & evaluation modules | TI Designs & reference designs | Software | Development tools | TI design network

Models (6)

Title	Category	Type	Size (KB)	Date	Views
OPA320S PSpice Model (Rev. A)	PSpice Model	ZIP	4 KB	29 Aug 2013	117 views
OPA320S TINA-TI Reference Design (Rev. A)	TINA-TI Reference Design	TSC	1203 KB	29 Aug 2013	64 views
OPA320S TINA-TI Spice Model (Rev. A)	TINA-TI Spice Model	ZIP	8 KB	29 Aug 2013	50 views
OPAy320 Family PSpice Model (Rev. C)	PSpice Model	ZIP	3 KB	28 Jul 2014	132 views
OPAy320 Family TINA-TI Reference Design (Rev. C)	TINA-TI Reference Design	TSC	255 KB	29 Jul 2014	90 views
OPAy320 Family TINA-TI Spice Model (Rev. C)	TINA-TI Spice Model	ZIP	8 KB	29 Jul 2014	125 views

Do you want to open or save **sbom439c.tsc** from **ti.com**?

Open | Save | Cancel

1. The TINA model is located under tools and software.

2. Select the “reference design”. This will be a fully wired example schematic.

3. Press open and TINA SPICE will directly open the schematic.

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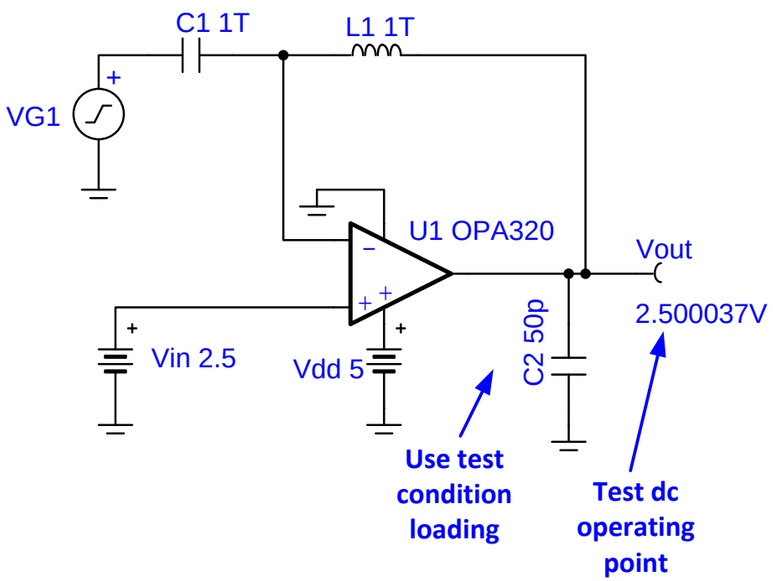
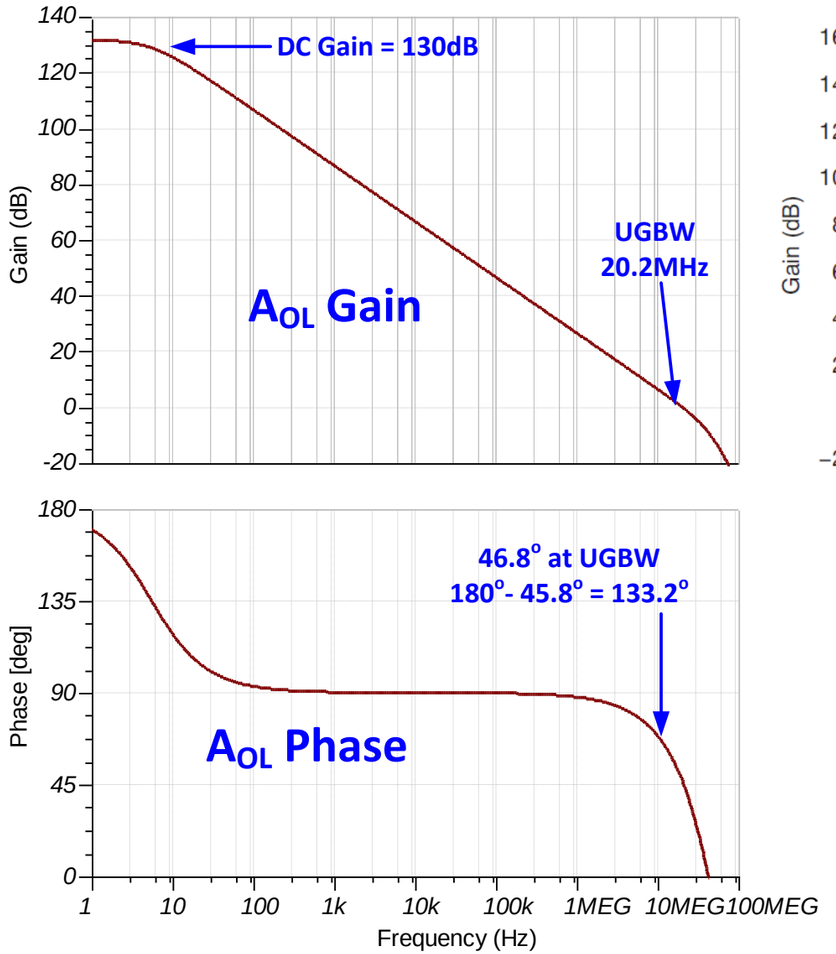
Op Amp Model: Open Loop Gain

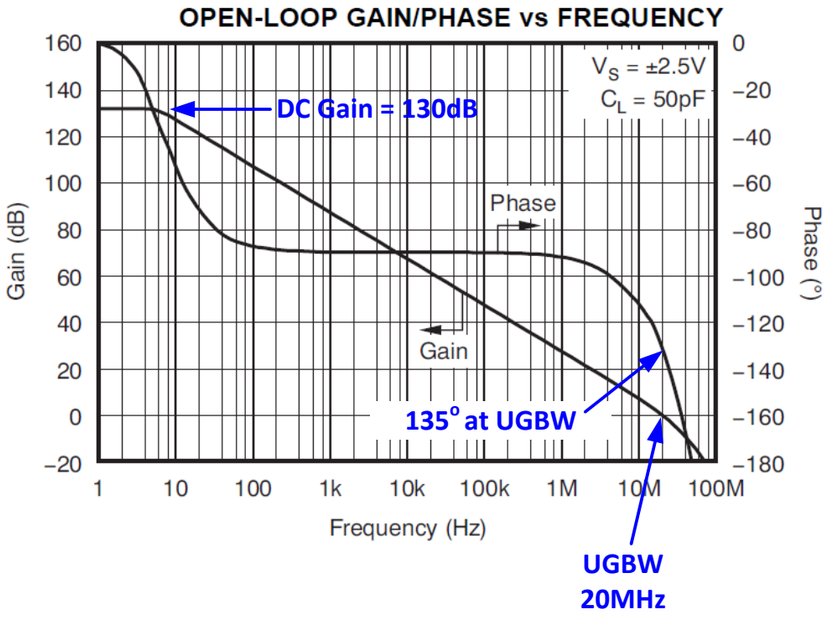
Test Circuit for Aol



Simulated results



Data Sheet Specification



1. Test dc operating point to assure that circuit is correctly wired
2. Run ac simulation for A_{OL} curve

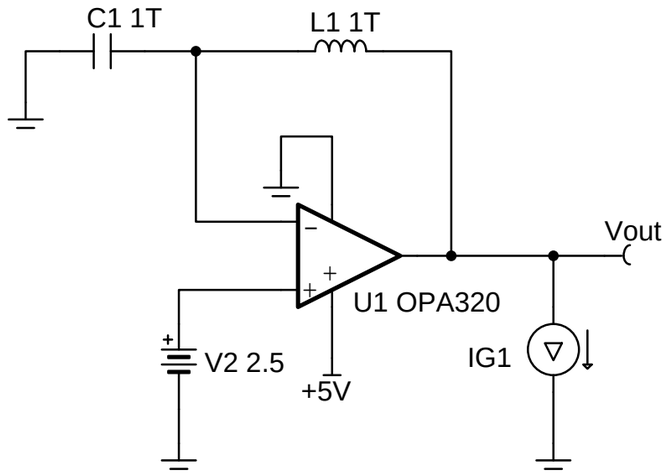
A_{OL} = Vout

Compare key points on simulation results to data sheet curve.

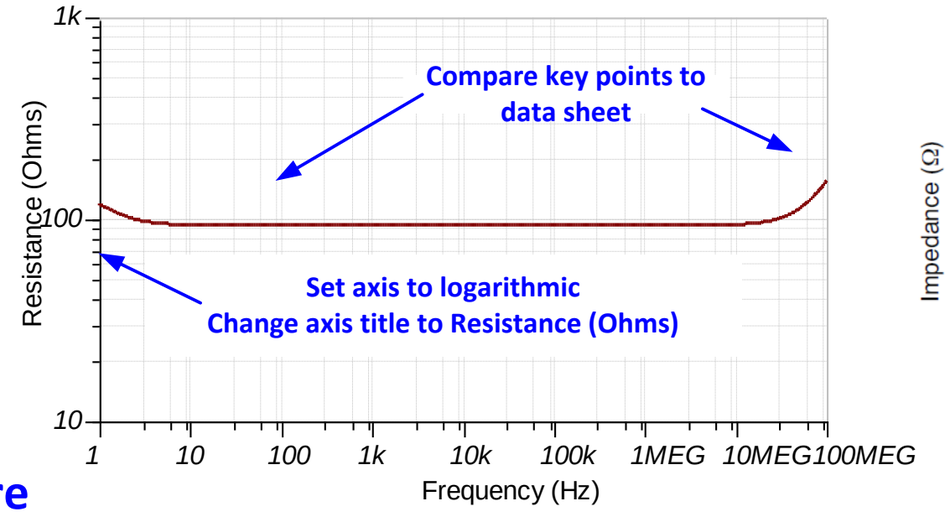
Aol opa320.TSC

Op Amp Model: Open Loop Output Impedance

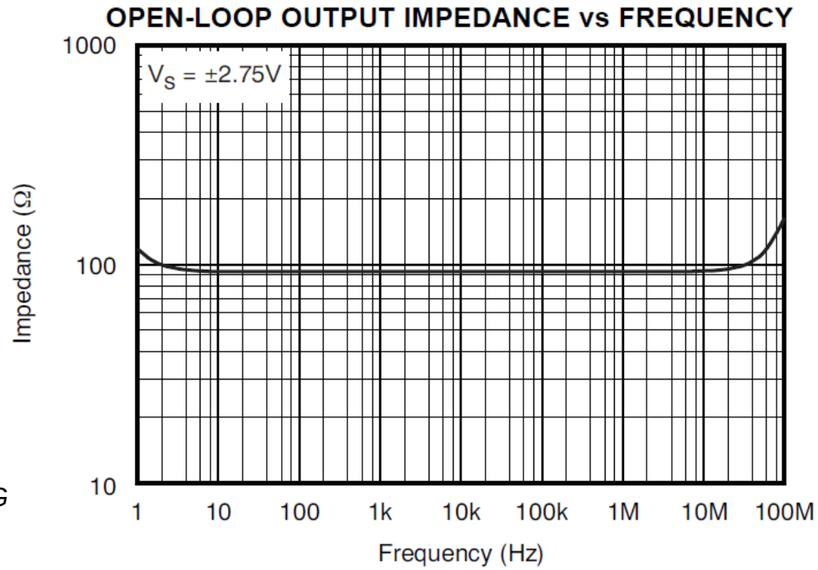
Test Circuit for Aol



Simulated results



Data Sheet Specification

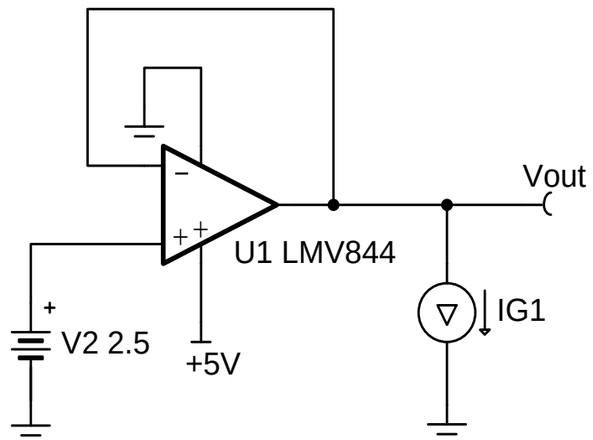


1. Test dc operating point to assure that circuit is correctly wired
2. Run ac simulation for Z_o curve. Z_o = Vout.

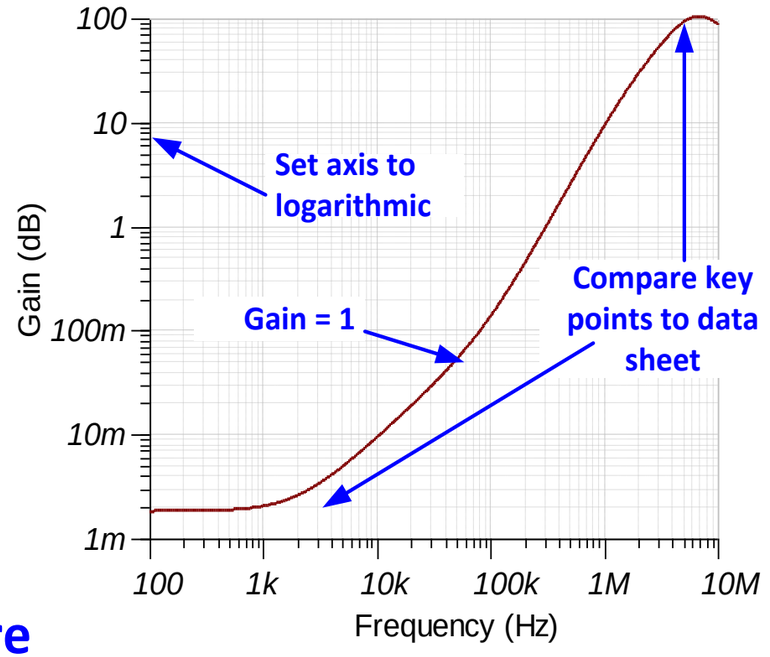
Zo opa320.TSC

Op Amp Model: Closed loop output impedance

Test Circuit for Aol



Simulated results



Data Sheet Specification

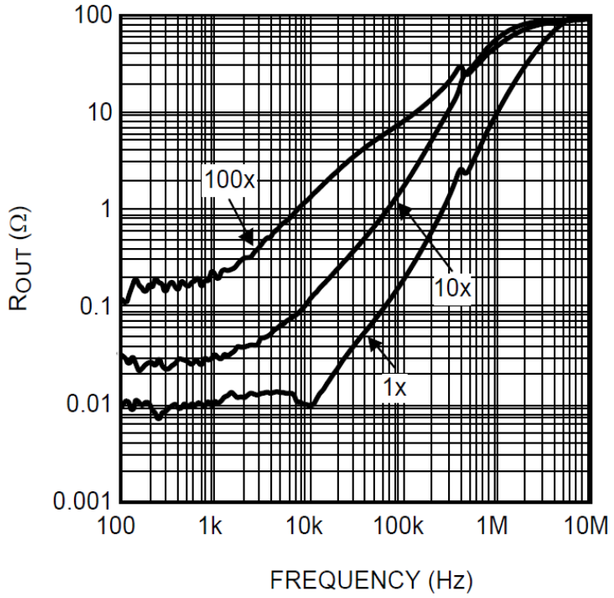


Figure 33. Closed-Loop Output Impedance vs Frequency

1. Test dc operating point to assure that circuit is correctly wired
2. Run ac simulation for Z_{out} curve. Z_{out}= Vout.

LMV844 Zout.TSC

Agenda – next video…

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Thanks for your time!
Please try the quiz.

Selecting and Verifying the Driver Amplifier

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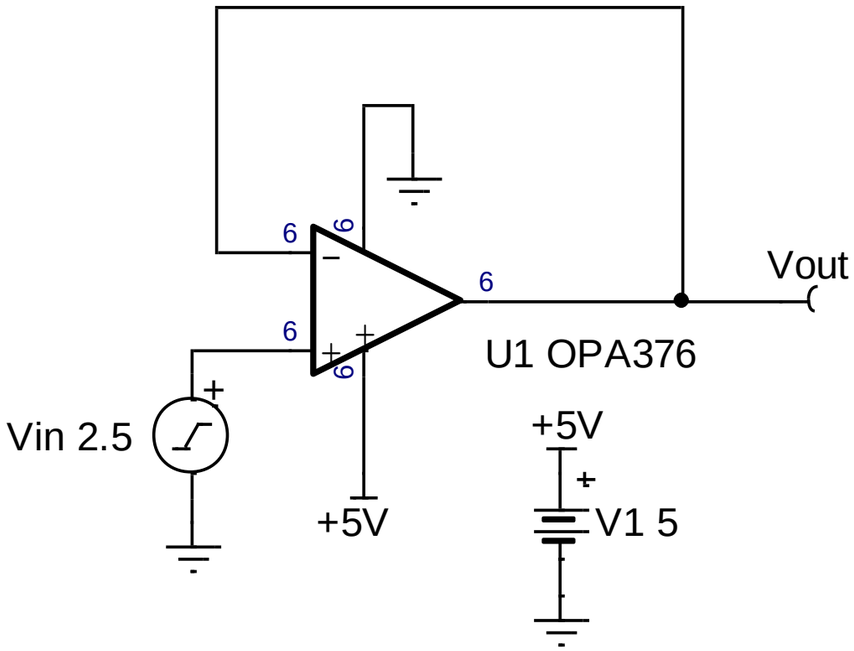
Quiz: Introduction to SAR ADC Component Selection

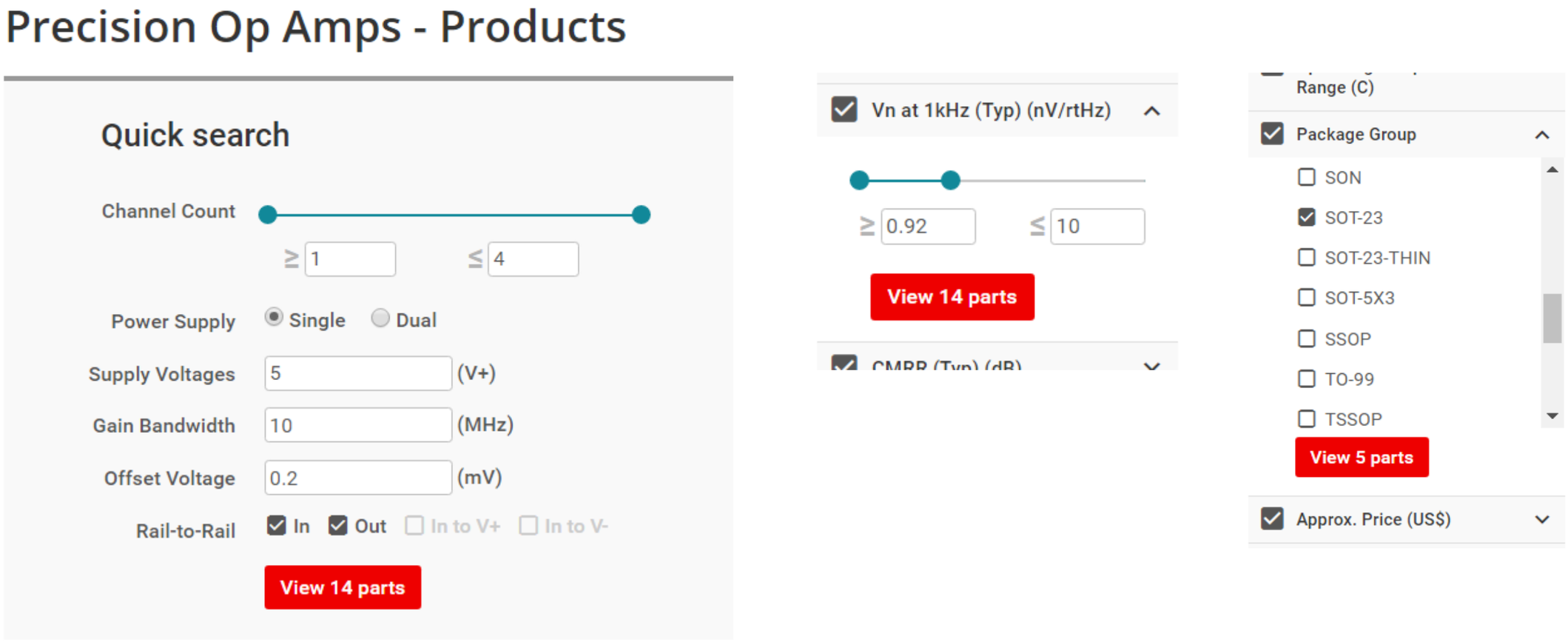
1. Use parametric search to find an amplifier with the following specifications: wide bandwidth (BW > 10MHz), single supply 5V, rail-to-rail in/out, zero input crossover distortion, low offset (Vos < 200uV), low noise (e_n < 10nV/rtHz), and small package (single channel SOT-23).
2. For the circuit below, graph the open loop output impedance, closed loop output impedance, and open loop gain.



Solutions

Quiz: Introduction to SAR ADC Component Selection

1. Use parametric search to find an amplifier with the following specifications: wide bandwidth (BW > 10MHz), single supply 5V, rail-to-rail in/out, zero input crossover distortion, low offset (Vos < 200uV), low noise (e_n < 10nV/rtHz), and small package (single channel SOT-23).

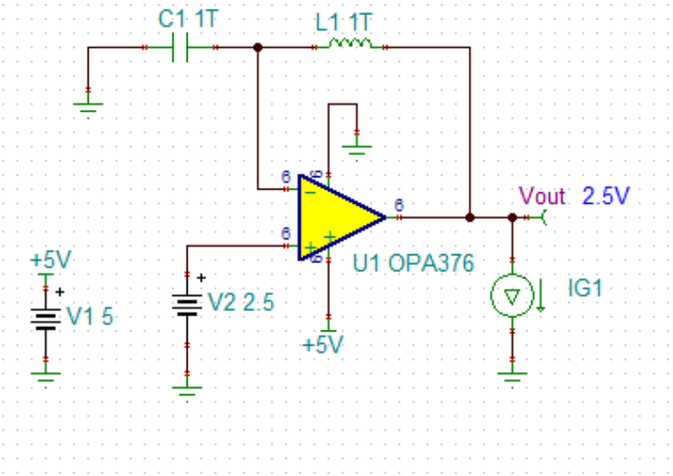


Quiz: Introduction to SAR ADC Component Selection

Compare	Part Number Filter by part number	Number of Channels (#)	Total Supply Voltage (Min) (+5V=5, +/-5V=10)	Total Supply Voltage (Max) (+5V=5, +/-5V=10)	GBW (Typ) (MHz)	Rail-to-Rail	Vos (Offset Voltage @ 25C) (Max) (mV)	Slew Rate (Typ) (V/us)	Offset Drift (Typ) (uV/C)	Iq per channel (Typ) (mA)	Vn at 1kHz (Typ) (nV/rtHz)	CMRR (Typ) (dB)	Rating	Operating Temperature Range (C)	Package Group	Approx. Price (US$)
☐	OPA320-Q1 - Automotive Qualified Precision, Zero-Crossover, 20MHz, 0.9pA Ib, RRIO, CMOS Operational Amplifier	1	1.8	5.5	120	In, Out	0.15	10	1.5	1.5	8.5	114	Automotive	-40 to 125	SOT-23	0.94 | 1ku
☐	OPA388 - 10MHz, CMOS, Zero-Drift, Zero-Crossover, True RRIO Precision Operational Amplifier	1	2.5	5.5	10	In, Out	0.005	5	0.005	1.7	7	138	Catalog	-40 to 125	SOIC, SOT-23, VSSOP	0.98 | 1ku
☐	OPA192 - High-Voltage, Rail-to-Rail Input/Output, 5µV, 0.2µV/˚C, Precision Operational Amplifier	1	4.5	36	10	In, Out	0.025	20	0.15	1	5.5	120	Catalog	-40 to 125	SOIC, SOT-23, VSSOP	1.15 | 1ku
☐	OPA320 - Precision, Zero-Crossover, 20MHz, 0.9pA Ib, RRIO, CMOS Operational Amplifier	1	1.8	5.5	20	In, Out	0.15	10	1.5	1.5	8.5	114	Catalog	-40 to 125	SOT-23	0.80 | 1ku
☐	LMP7707 - Precision, CMOS Input, RRIO, Wide Supply Range Decompensated Amplifier	1	2.7	12	14	In, Out	0.2	5.6	1	0.715	9	130	Catalog	-40 to 125	SOIC, SOT-23	1.07 | 1ku

Quiz: Introduction to SAR ADC Component Selection

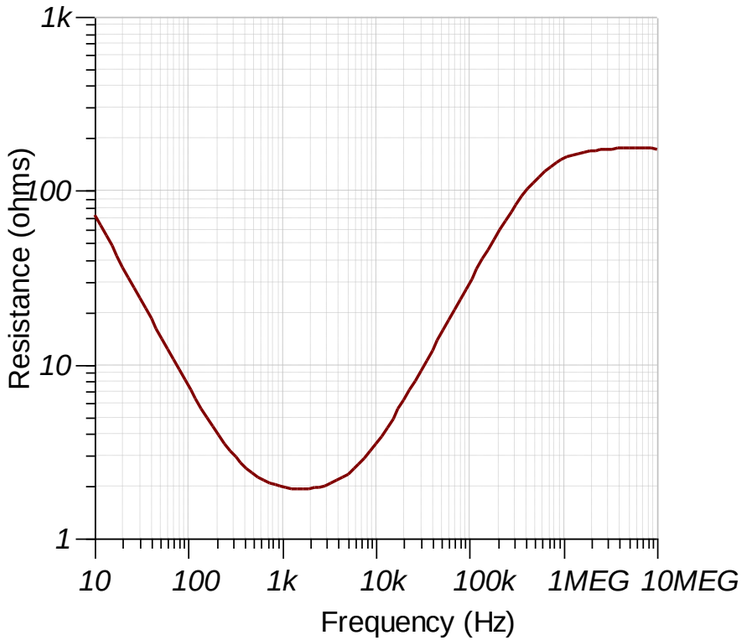
2. For the circuit below, graph the open loop output impedance, closed loop output impedance, and open loop gain.



Check dc Operation

opa376 Zo.TSC

Click on icon above for TINA circuit.



Simulated Zo

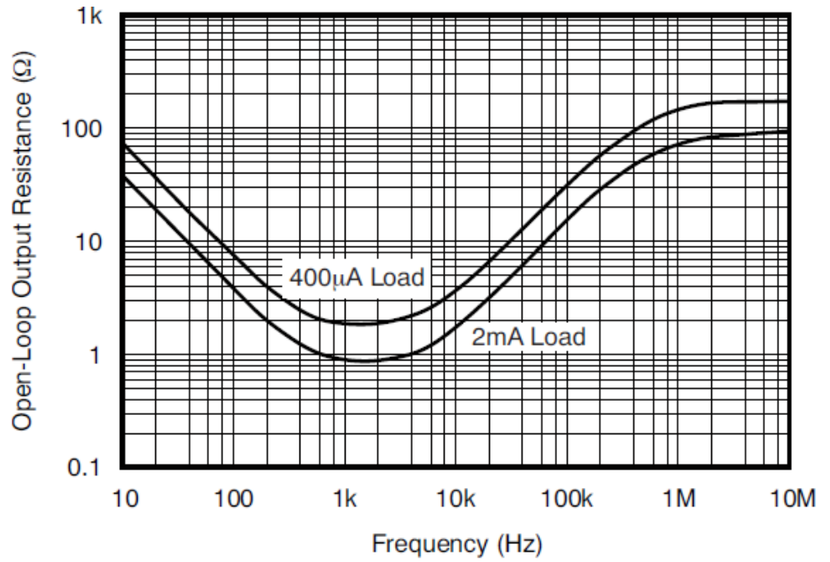
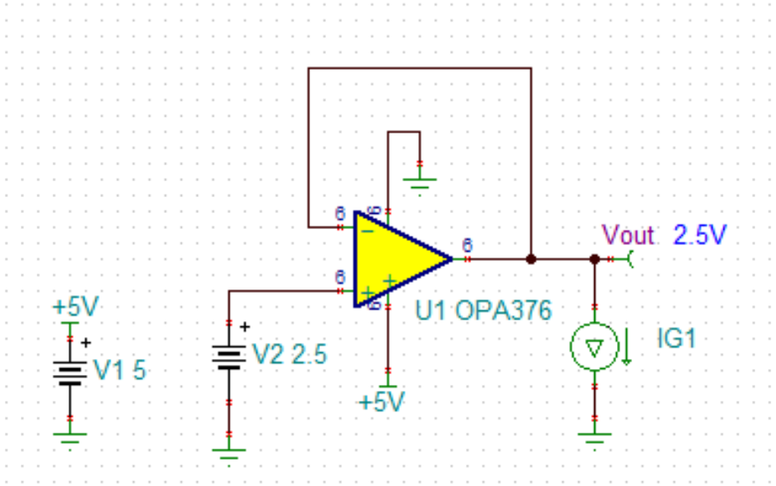


Figure 21. Open-Loop Output Resistance vs Frequency

Data Sheet Zo

Quiz: Introduction to SAR ADC Component Selection

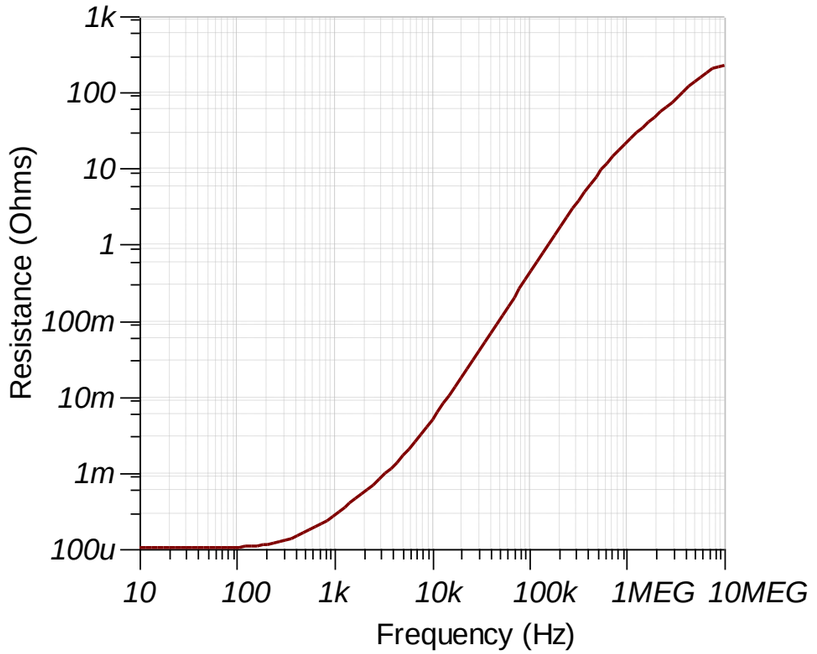
2. For the circuit below, graph the open loop output impedance, closed loop output impedance, and open loop gain.



Check dc Operation

opa376 Zout.TSC

Click on icon above for TINA circuit.



Simulated Zout

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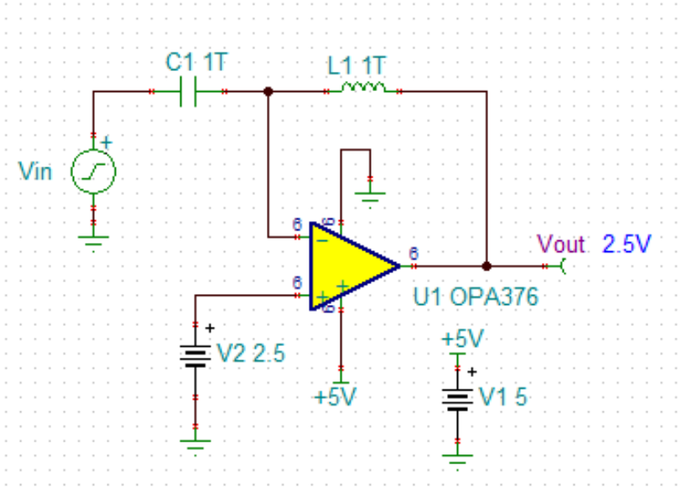
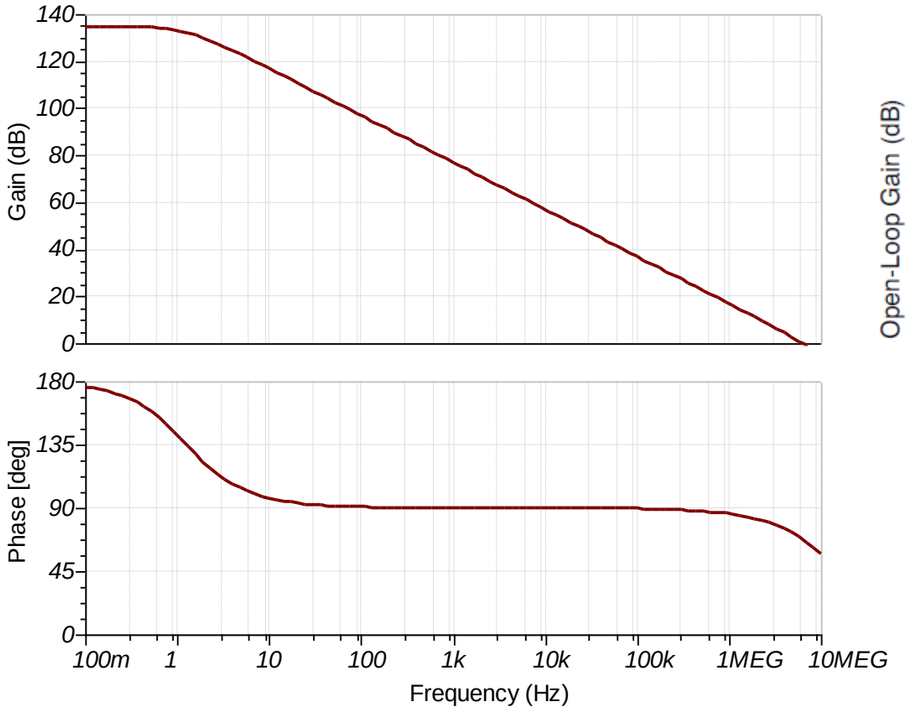


Check dc Operation

opa376 Aol.TSC

Click on icon above for TINA circuit.



Simulated Aol

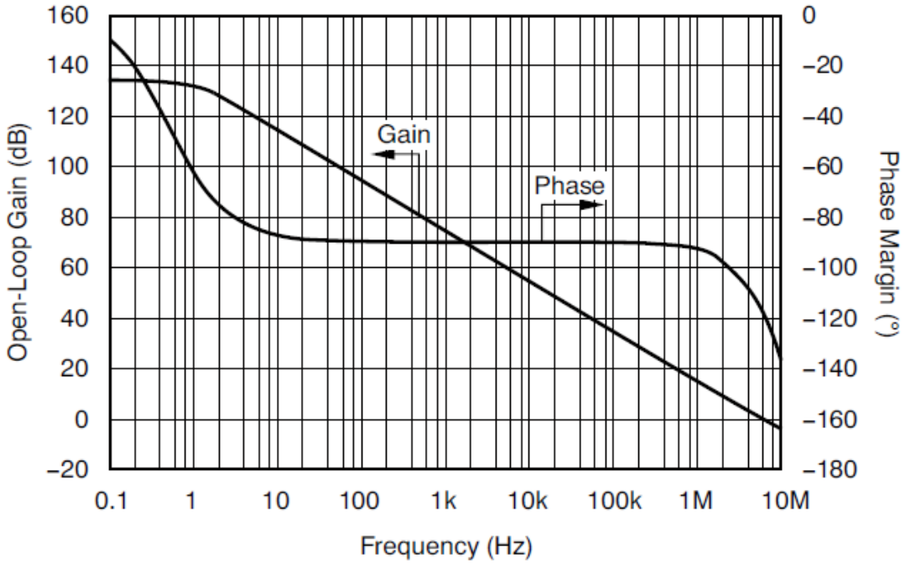


Figure 1. Open-Loop Gain and Phase vs Frequency

Data Sheet Aol