

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

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Select Amplifiers

TEXAS INSTRUMENTS

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TI Home > Amplifiers > Operational Amplifiers (Op Amps)

Amplifiers

Product Tree

Operational Amplifiers (Op Amps) (1464)

Precision Op Amps (845)

High-Speed Op Amps (>=50MHz) (320)

General-Purpose Op Amps (311)

Ultra-Low-Power Op Amps (<=250uA) (269)

Audio Op Amps (58)

Fully Differential Amplifiers (59)

Precision op amps

Achieve high DC accuracy and AC performance in your precision systems

Select Operational Amplifiers (Op Amps) 1464 different choices!

Amplifiers

Overview Products Tools & software Technical documents

Products for Operational Amplifier

Quick search

Channel Count

[object HTMLCollection] Single Dual

Supply Voltages (V)

Gain Bandwidth (MHz)

Slew Rates (V/μS)

Quiescent Current (mA)

Rail-to-Rail In Out In to V+ In to V-

View 22 parts

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

GBW (Typ) (MHz) ^

≥ 17.8 ≤ 50

View 11 parts

Package Group ^

- SO PowerPAD
- SOIC
- SON
- SOT
- SOT-23
- SSOP
- TQ-220

View 9 parts

Vos (Offset Voltage @ 25C) (Max) (mV) ^

≥ 0.001 ≤ 0.5

View 5 parts

Rating ^

AND ▾

- Automotive
- Catalog
- HiRel Enhanced Product
- High Temp
- Military

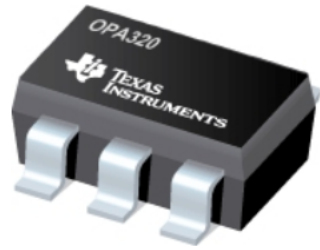
View 3 parts

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

Compare	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\$)
<input type="checkbox"/>	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
<input type="checkbox"/>	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
<input type="checkbox"/>	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

OPA320 Best offset

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 Amplifier
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.

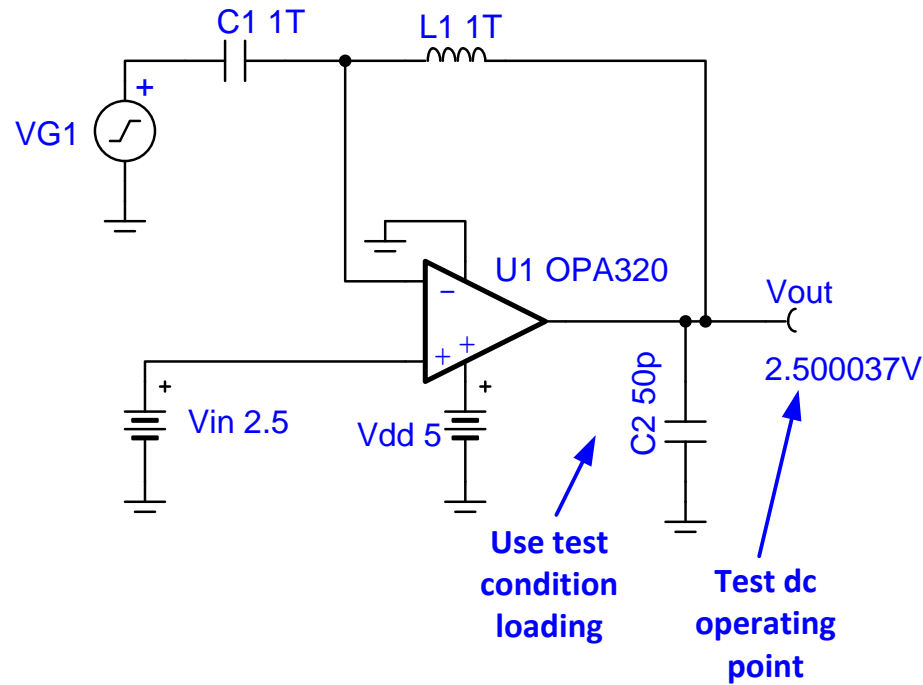
3. Press open and TINA SPICE will directly open the schematic.

Agenda

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5. **Verify the Op Amp Model**
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9. Measured Results
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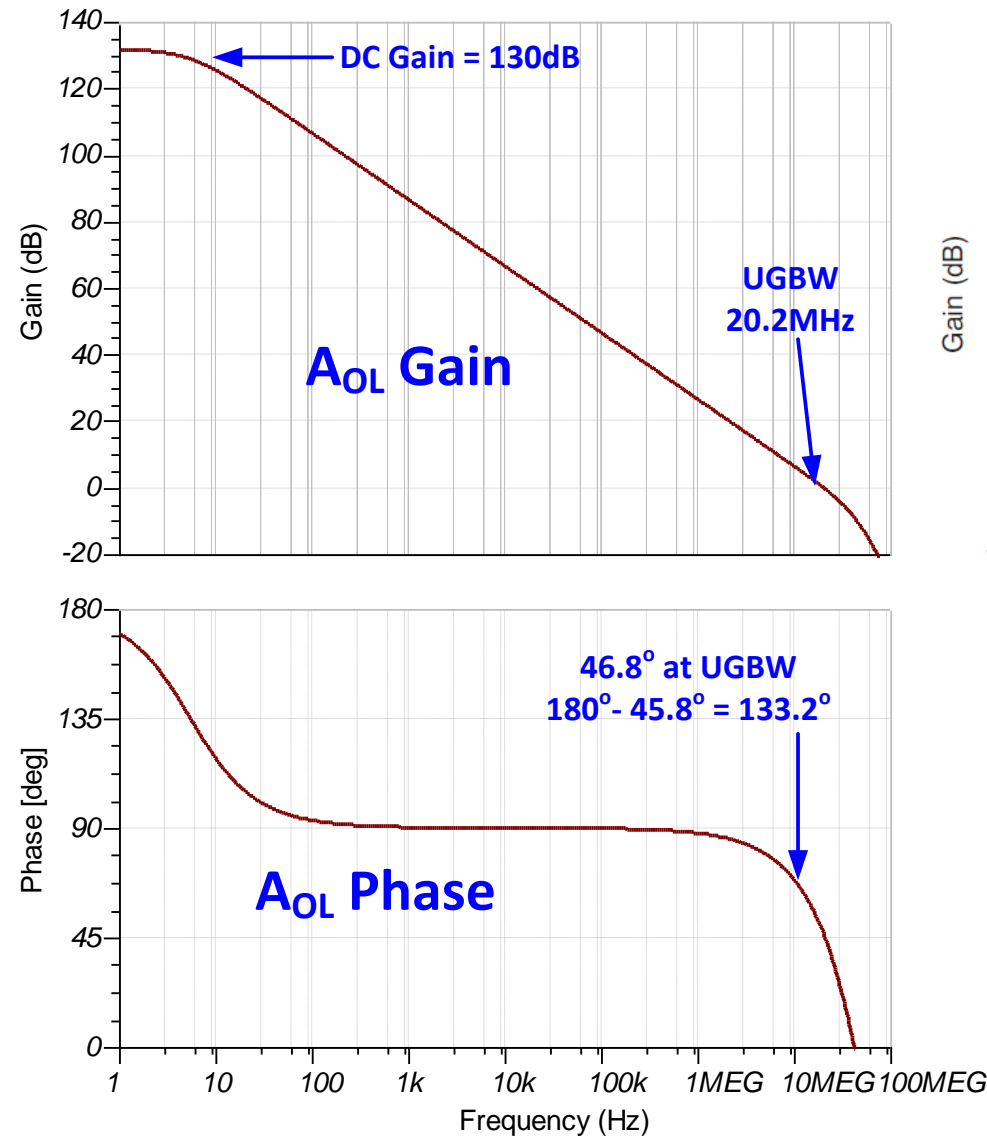
Op Amp Model: Open Loop Gain

Test Circuit for Aol

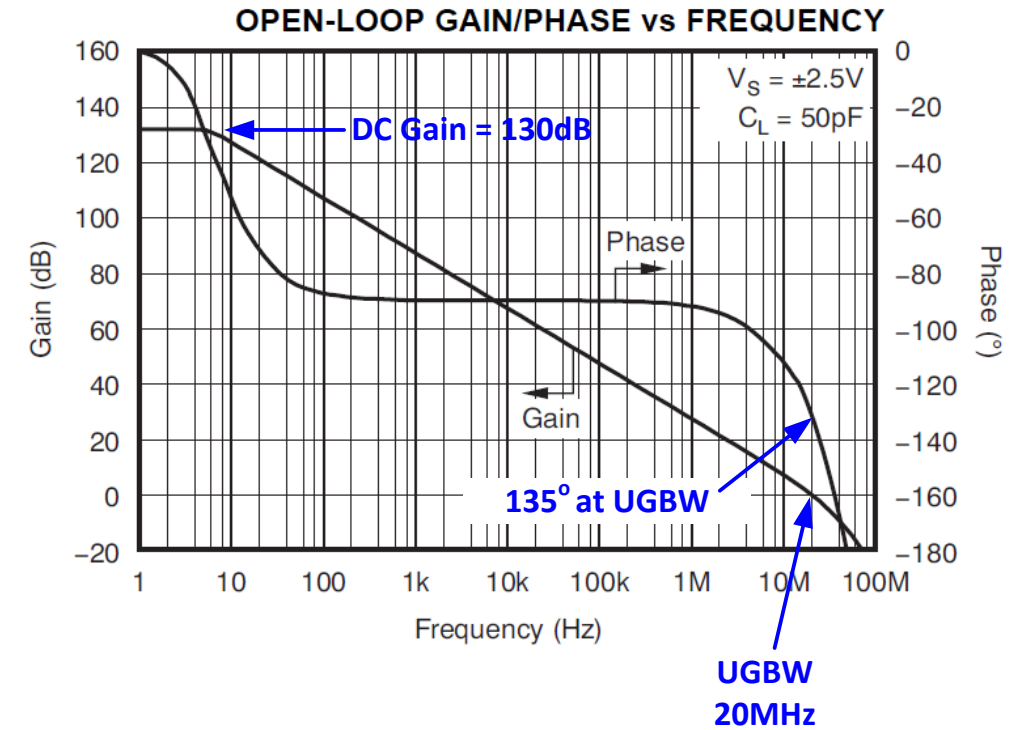


1. Test dc operating point to assure that circuit is correctly wired
 2. Run ac simulation for A_{OL} curve
- $A_{OL} = V_{out}$

Simulated results



Data Sheet Specification



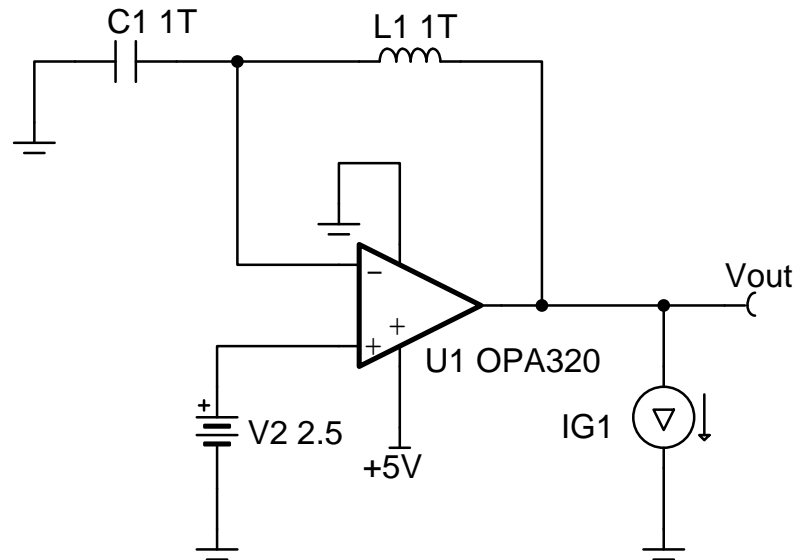
Compare key points on simulation results to data sheet curve.



Aol opa320.TSC

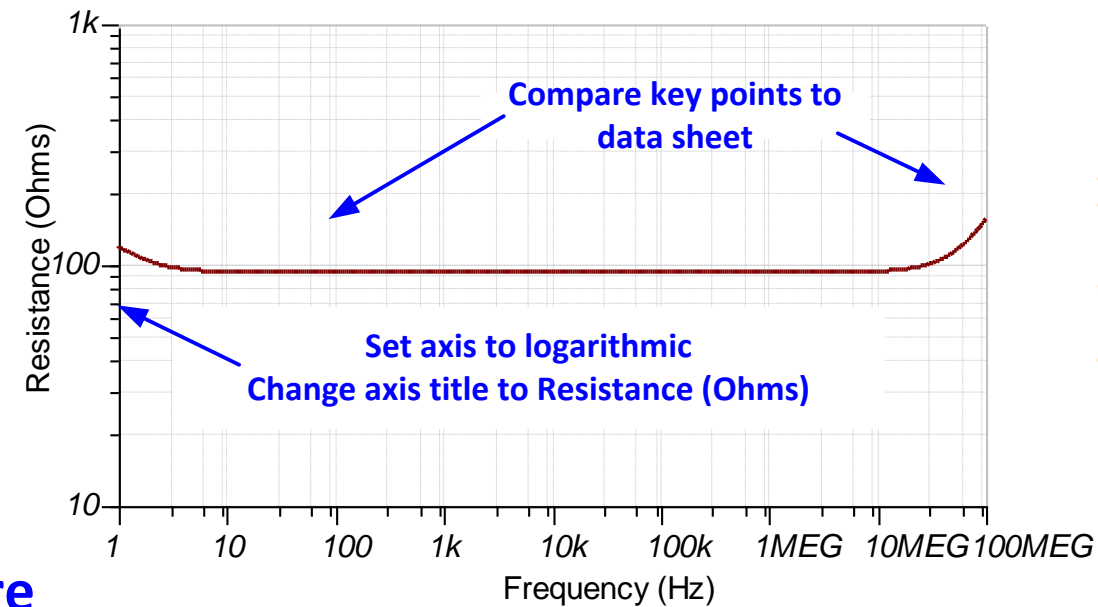
Op Amp Model: Open Loop Output Impedance

Test Circuit for Aol

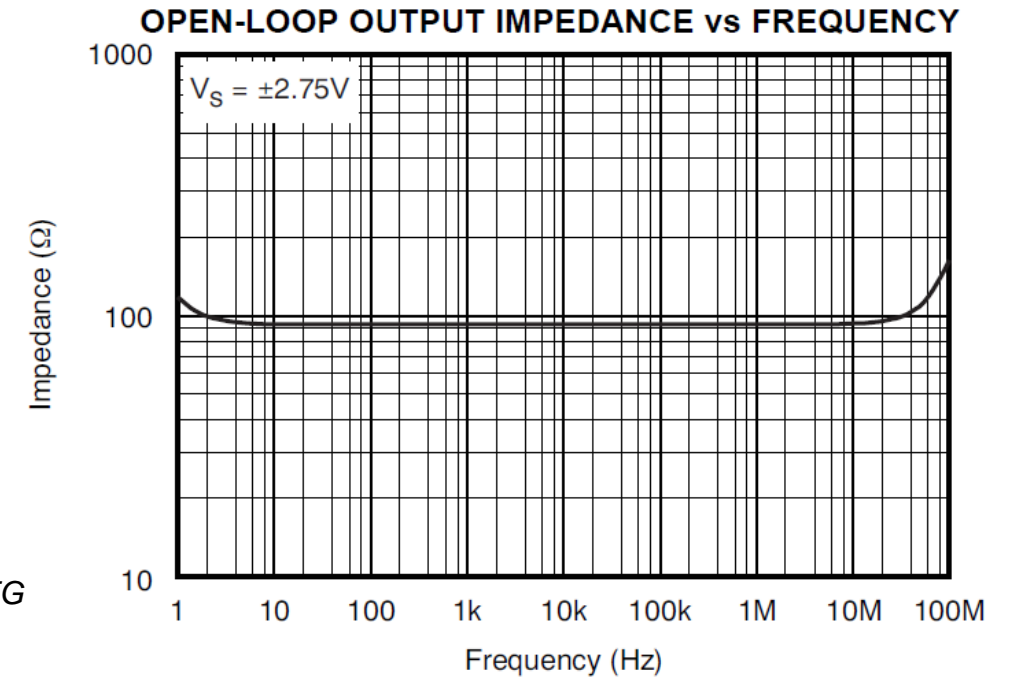


1. Test dc operating point to assure that circuit is correctly wired
2. Run ac simulation for Z_o curve.
 $Z_o = V_{out}$.

Simulated results



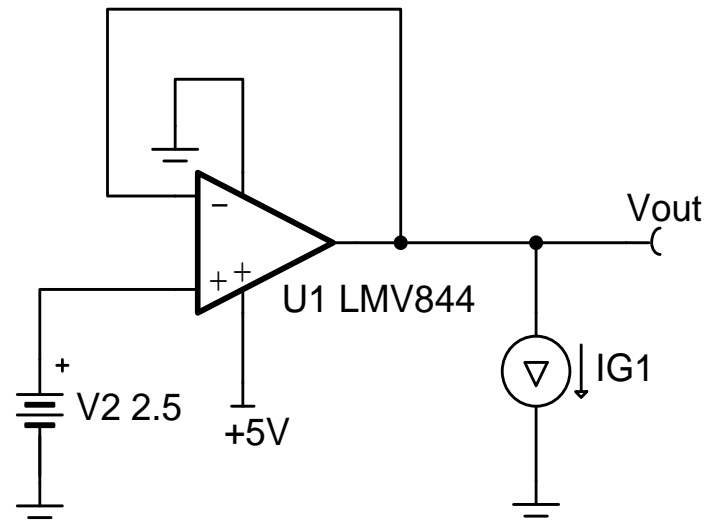
Data Sheet Specification



Zo opa320.TSC

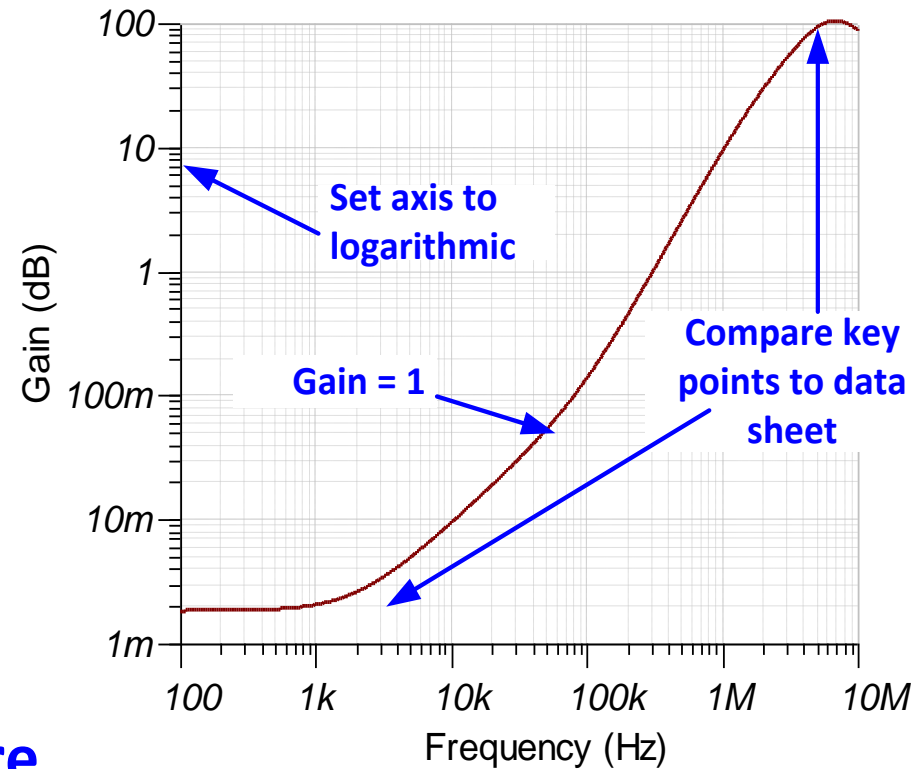
Op Amp Model: Closed loop output impedance

Test Circuit for Aol



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

Simulated results



Data Sheet Specification

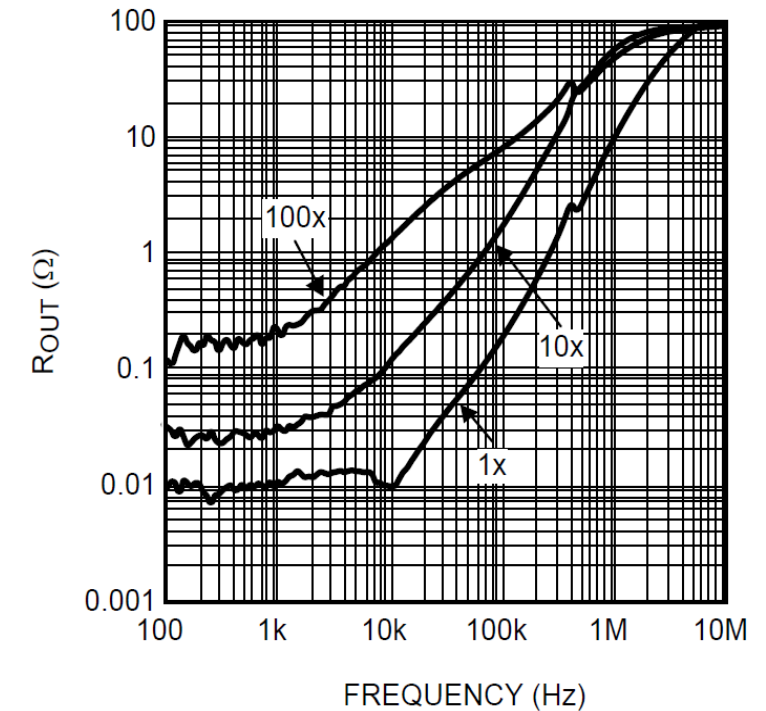


Figure 33. Closed-Loop Output Impedance vs Frequency



LMV844 Zout.TSC

Agenda – next video...

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Thanks for your time!
Please try the quiz.

Selecting and Verifying the Driver Amplifier

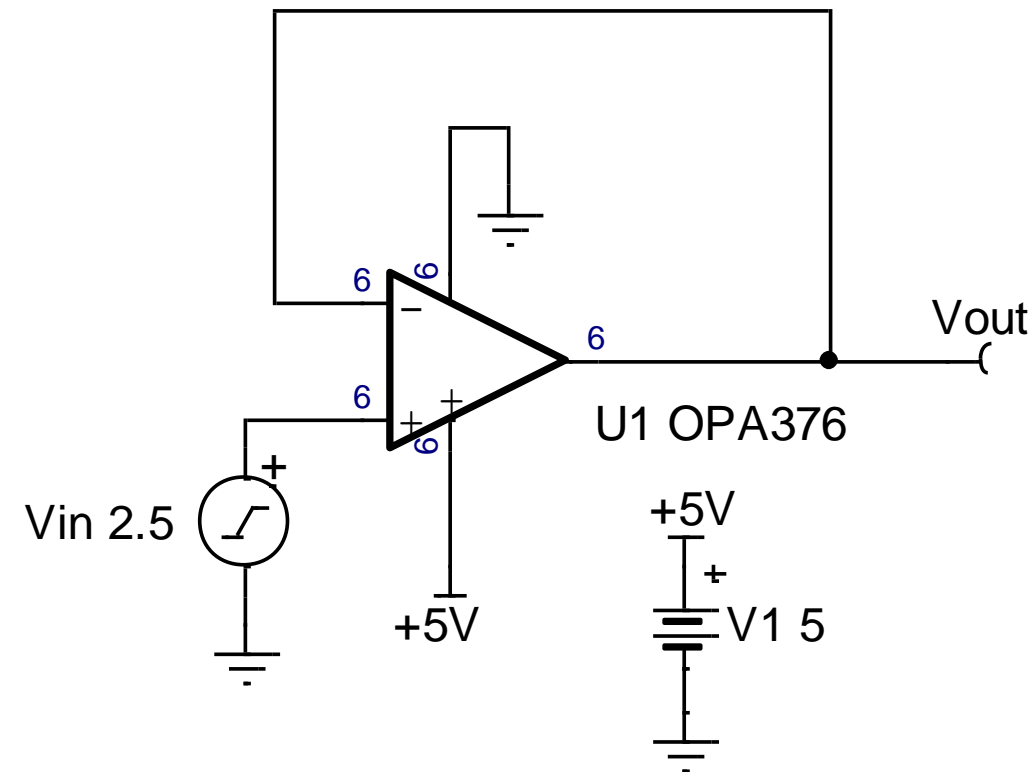
TIPL 4402

TI Precision Labs – ADCs

Created by Art Kay

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 ($V_{os} < 200\mu V$), low noise ($e_n < 10nV/\sqrt{Hz}$), 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 ($V_{os} < 200\mu V$), low noise ($e_n < 10\text{nV}/\text{rtHz}$), and small package (single channel SOT-23).

Precision Op Amps - Products

Quick search

Channel Count

Power Supply Single Dual

Supply Voltages (V+)

Gain Bandwidth (MHz)

Offset Voltage (mV)

Rail-to-Rail In Out In to V+ In to V-

[View 14 parts](#)

Vn at 1kHz (Typ) (nV/rtHz) ^

[View 14 parts](#)

CMRR (Typ) (dB) v

Range (C)

Package Group ^

SON

SOT-23

SOT-23-THIN

SOT-5X3

SSOP

TO-99

TSSOP

[View 5 parts](#)

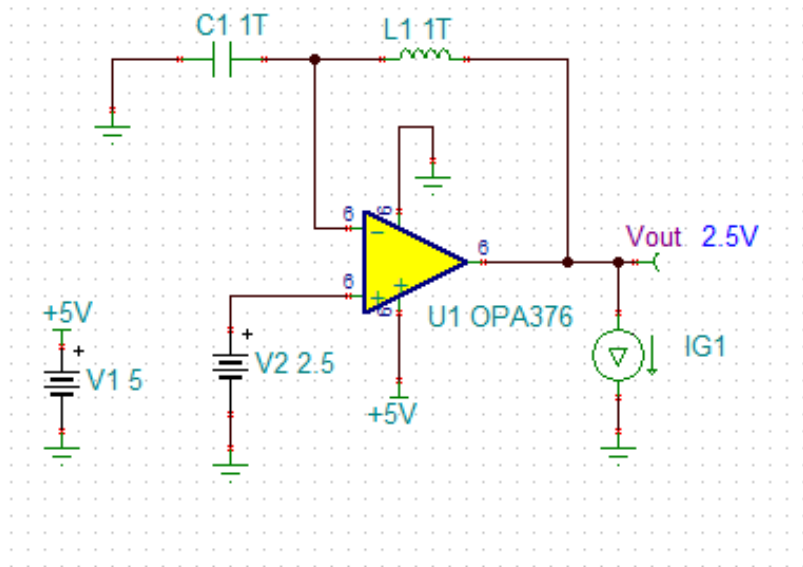
Approx. Price (US\$) v

Quiz: Introduction to SAR ADC Component Selection

Compare	Part Number Filter by part number <input type="text"/>	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\$)
<input type="checkbox"/>	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
<input type="checkbox"/>	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
<input type="checkbox"/>	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
<input type="checkbox"/>	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
<input type="checkbox"/>	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.

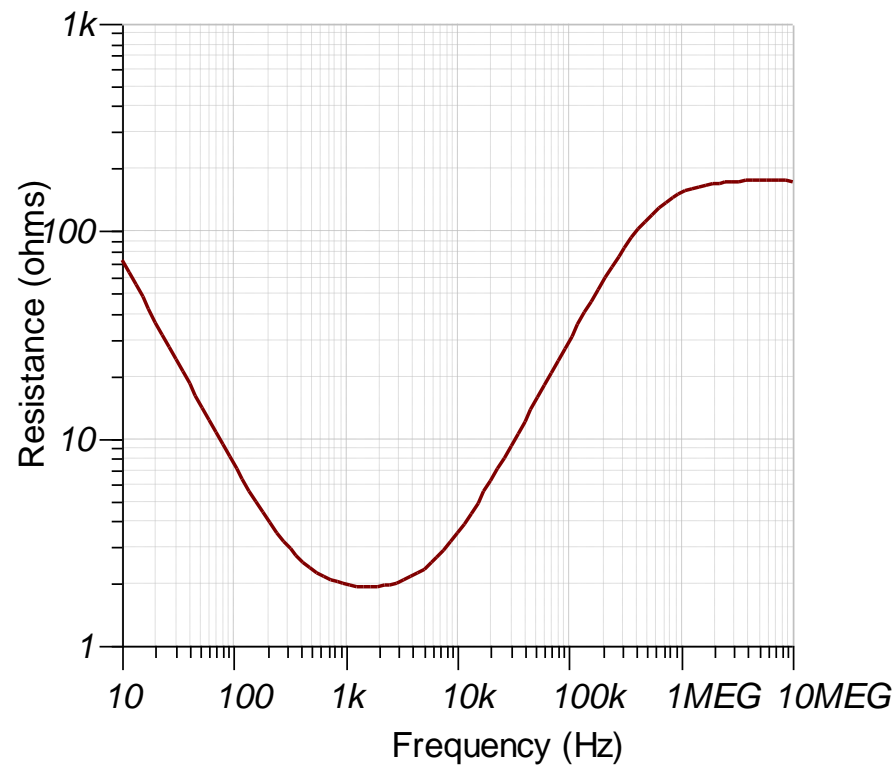


Check dc Operation



opa376 Zo.TSC

Click on icon above for TINA circuit.



Simulated Zo

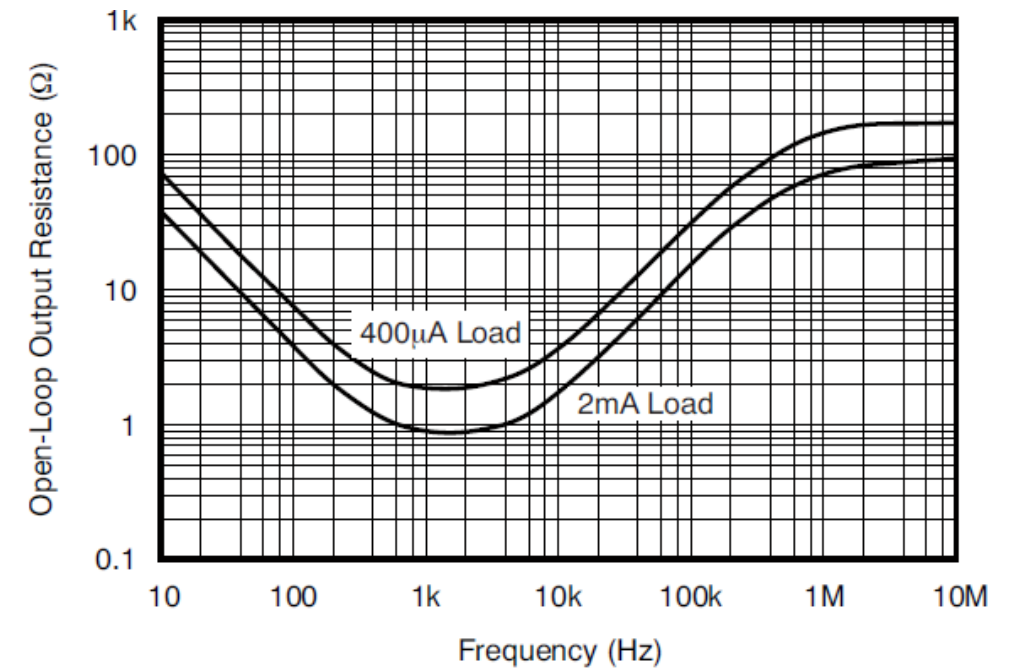
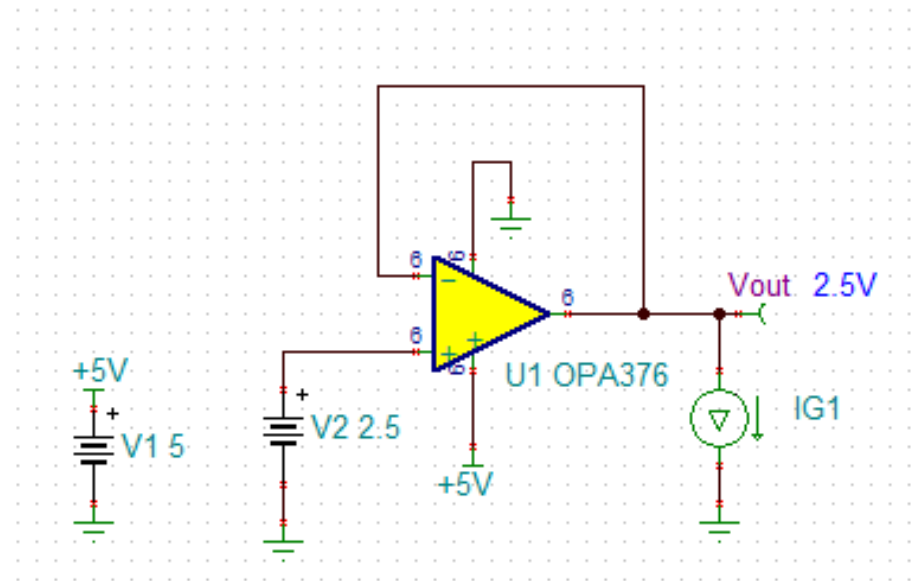


Figure 21. Open-Loop Output Resistance vs Frequency

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.

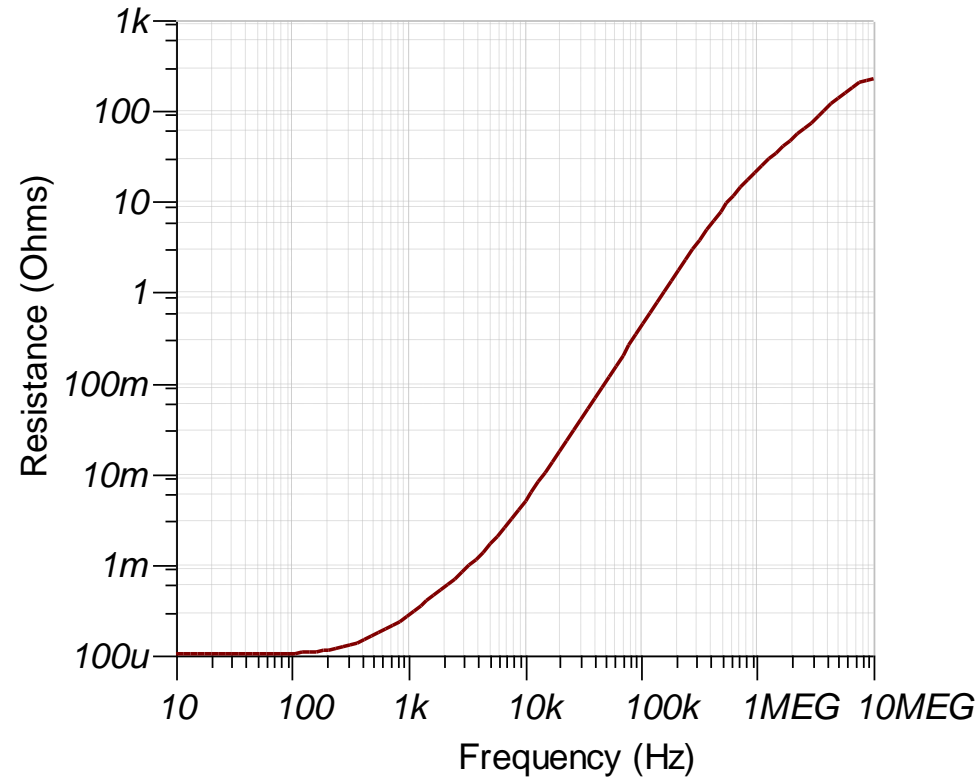


Check dc Operation



opa376 Zout.TSC

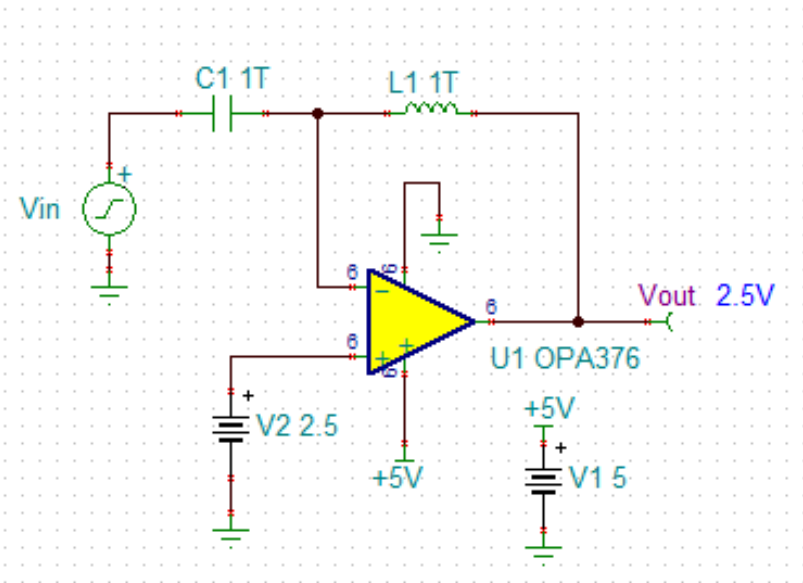
**Click on icon above
for TINA circuit.**



Simulated Zout

Quiz: Introduction to SAR ADC Component Selection

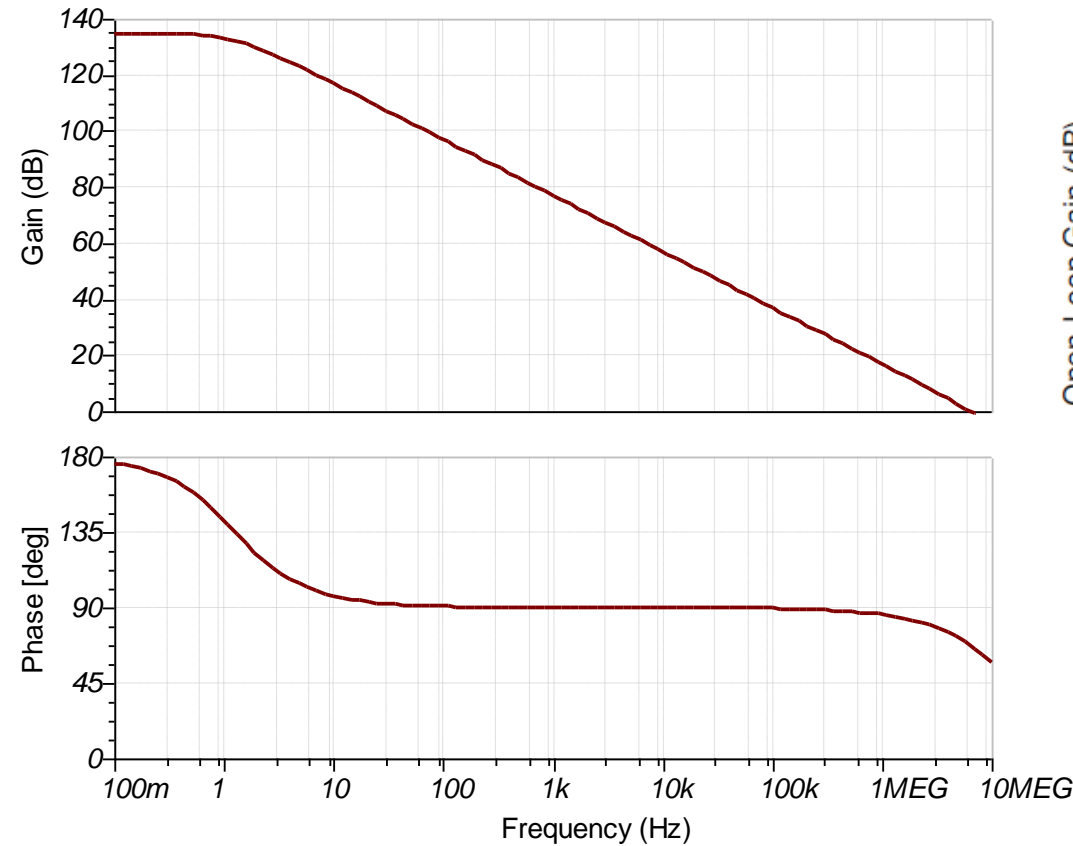
2. For the circuit below, graph the open loop output impedance, closed loop output impedance, and open loop gain.



Check dc Operation



opa376 Aol.TSC



Simulated Aol

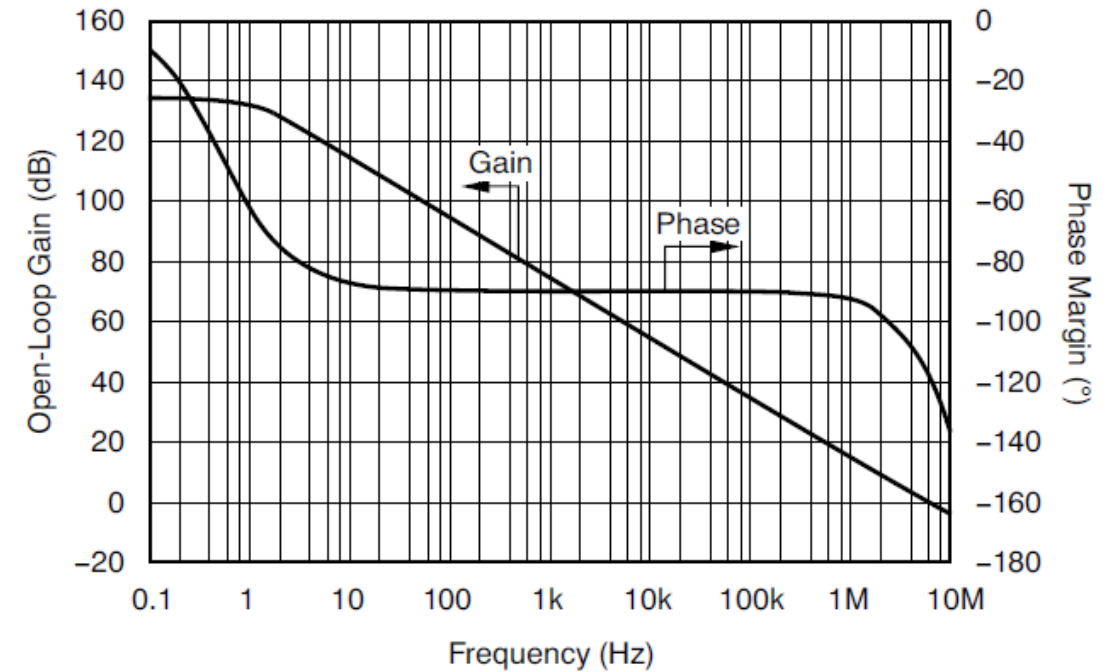


Figure 1. Open-Loop Gain and Phase vs Frequency

Data Sheet Aol

**Click on icon above
for TINA circuit.**