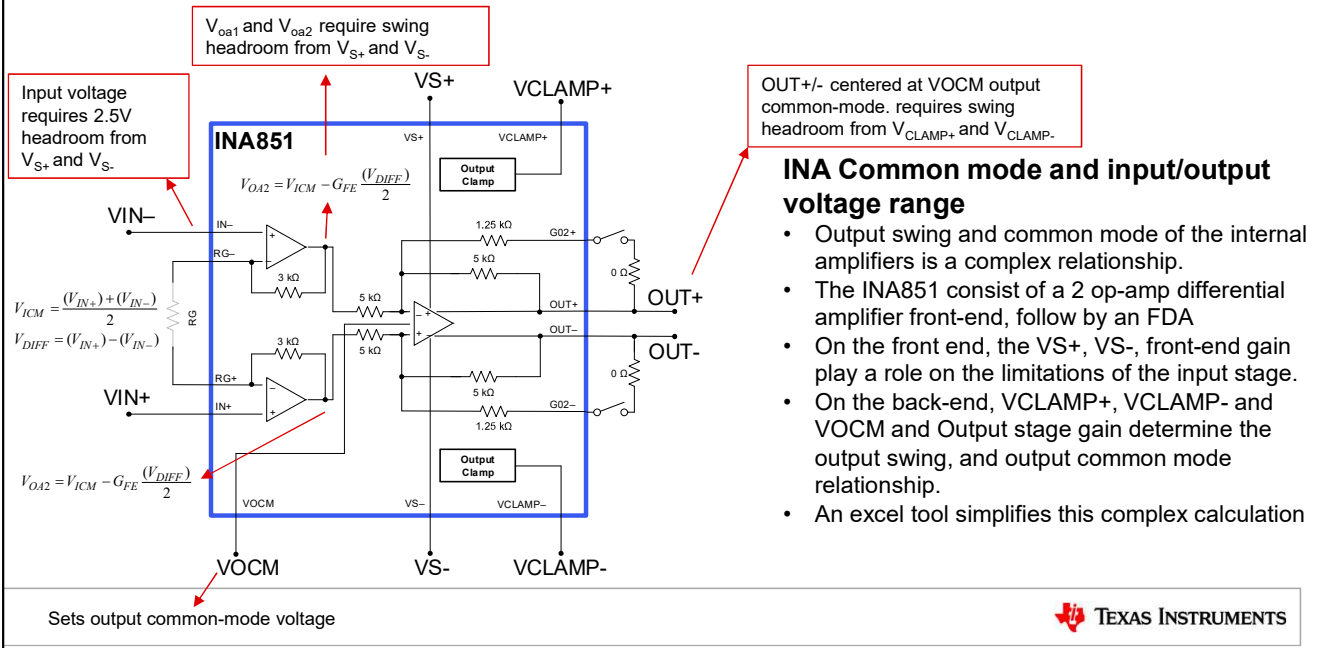


INA851

Input and Output Range Design Calculator



INA851 Input and Output Range Design Calculator



Instrumentation amplifiers are composed of multiple op amps. This figure shows the simplified INA851 configuration. Each amplifier inside the INA has its own input and output swing limitations. These limitations combine into an overall common mode versus output swing range limitation for the instrumentation amplifier.

The output swing limitation of the first stage internal amplifiers is a function of the input front-end gain, input common-mode voltage, input stage supplies (V_{S+}/V_{S-}). The output range limitations of the second stage is a function of the VOXM voltage, the gain of the output stage, the power supplies (V_{S+}/V_{S-}), and the clamp voltages (V_{CLAMP+} and V_{CLAMP-}). This relationship can be complex and generally cannot be determined with a simple equation or data sheet parameter. In some cases a data sheet diagram graphing common mode versus output swing can be used to understand this limitation.

INA851 Input and Output Range Design Calculator

Download INA851 Input and Output Range Design Calculator: (excel file)

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INA851 input and output range design calculator

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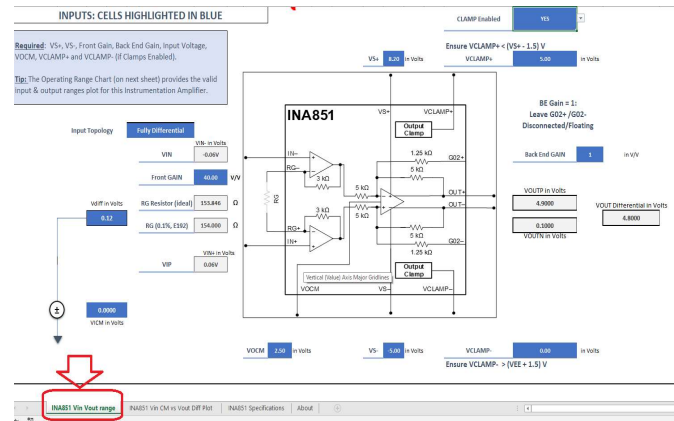
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INA851 Input and Output Range Design Calculator

The excel tool consists of two sheets:

First sheet: "INA851_Vin_Vout_tool"

- User fills the highlighted cells in blue with required voltages.
- **Required:** VS+, VS-, Front-End Gain, Back-End Gain, Input differential/input common-mode Voltage, VOCM, VCLAMP+ and VCLAMP- (if Clamps Enabled).
- Excel provides resulting VOUT+, VOUT-, and VOUT-differential voltages, and the RG resistor for a given front-end gain.
- The tool highlights in red any voltage out of range, and displays warnings in red if the device is outside of linear range.



The excel tool consists of two sheets, select the sheet at the bottom:

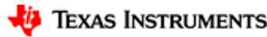
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- Excel provides resulting VOUT+, VOUT-, and VOUT-differential voltages, and the RG resistor for a given front-end gain.
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INA851 Input / Output Range Calculator

First sheet: "INA851_Vin_Vout_tool"

Input : Cells High-lighted in blue
Enter all the operating and supply voltage conditions.



Tip: The Operating Range Chart (on next sheet) provides the valid input & output ranges plot for this Instrumentation Amplifier.

Enter the input differential voltage.

Input Topology: Fully Differential

VIN: in Volts: -0.06V

Front GAIN: 40.00 V/V

RG Resistor (Ideal): 153.846 Ω

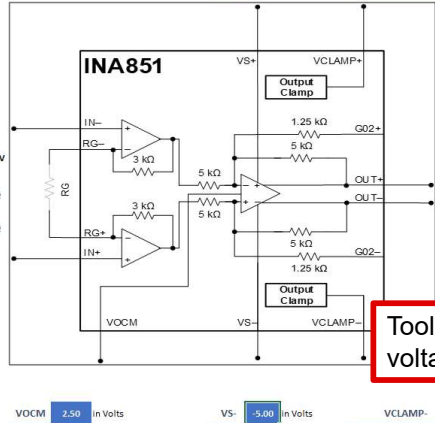
RG (0.1%, E192): 154.000 Ω

VIP: in Volts: 0.06V

Vdiff in Volts: 0.12

VOCM in Volts: 0.0000

Enter FE Gain



Enter BE Gain: 1-V/V or 0.2-V/V

CLAMP Enabled: YES

Ensure VCLAMP+ < (VS+ - 1.5) V

VCLAMP+: 5.00 in Volts

BE Gain = 1: Leave G02+ /G02- Disconnected/Floating

Back End GAIN: 1 in V/V

Tool calculates expected out+ and out- voltages

VOUTP in Volts: 4.9000

VOUTM in Volts: 0.1000

VOUT Differential in Volts: 4.8000

Enter the input common mode voltage.

Enter VS supplies, VCLAMP and V_{OCM} voltages



First sheet: "INA851_Vin_Vout_tool"

- User fills the highlighted cells in blue with required voltages.
- Required: VS+, VS-, Front-End Gain, Back-End Gain, Input differential/input common-mode Voltage, VOCM, VCLAMP+ and VCLAMP- (if Clamps Enabled).
- Excel provides resulting VOUT+, VOUT-, and VOUT-differential voltages, and the RG resistor for a given front-end gain.
- The tool highlights in red any voltage out of range, and displays warnings in red if the device is outside of linear range

INA851 Input / Output Range Calculator

First sheet: "INA851_Vin_Vout_tool"

INPUTS: CELLS HIGHLIGHTED IN BLUE

Required: VS+, VS-, Front Gain, Back End Gain, Input Voltage, VO_{CM}, VCLAMP+ and VCLAMP- (if Clamps Enabled).

Tip: The Operating Range Chart (on next sheet) provides the valid input & output ranges plot for this Instrumentation Amplifier.

Inputs out of common-mode, highlighted in red

Enter the input differential voltage.

Enter the input common mode voltage.

Enter VS supplies, VCLAMP and V_{OCM} voltages

In this example, the INA851 input is outside input common-mode range. The device has also excessive gain, where both internal front-end outputs are out of range. Calculator highlights in red inputs outside of range, and provides warning. Output is also highlighted red since the output stage is out of range limited by VCLAMP pins

Input stage out of range (int. out being 2.5V negative)

Front-end stage shows out of range warning due to both excessive gain and input common-mode to close negative supply

Output stage out of range limited by VCLAMP pin limits

Leave G02+ /G02- Disconnected/Floating

Back End GAIN 1 in V/V

VOUTP in Volts 5.1000

VOUT Differential in Volts 0.1000

VOUTN in Volts 0.1000

Output in Clamp limit

Output stage out of range limited by VCLAMP pin limits

VO_{CM} 2.50 in Volts

VS+ 8.20 in Volts

VS- -2.00 in Volts

VCLAMP- 0.00 in Volts

Ensure VCLAMP- > (V_{EE} + 1.5) V

First sheet: "INA851_Vin_Vout_tool"

- User fills the highlighted cells in blue with required voltages.
- **Required:** VS+, VS-, Front-End Gain, Back-End Gain, Input differential/input common-mode Voltage, VO_{CM}, VCLAMP+ and VCLAMP- (if Clamps Enabled).
- Excel provides resulting VOUT+, VOUT-, and VOUT-differential voltages, and the RG resistor for a given front-end gain.
- The tool highlights in red any voltage out of range, and displays warnings in red if the device is outside of linear range

INA851 Input and Output Range Design Calculator

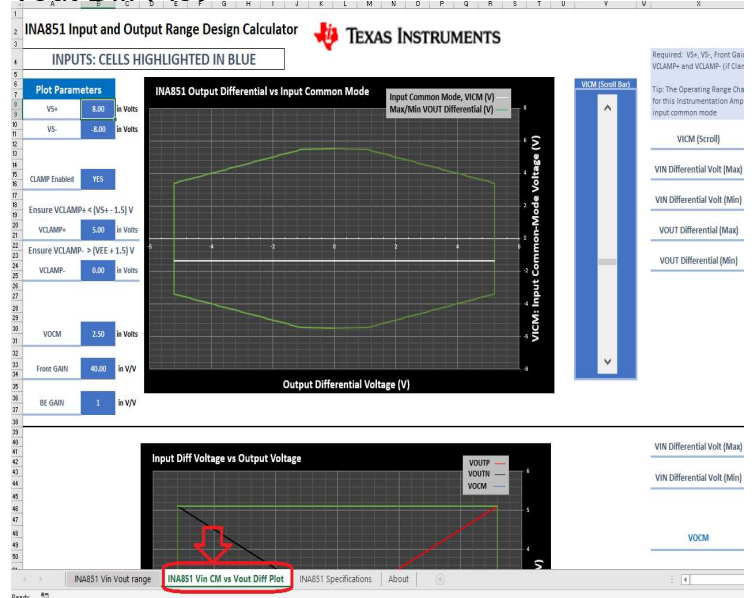
Second sheet: "INA851 Vin CM vs Vout Diff Plot"

The excel tool consists of two sheets:

Second sheet:

"INA851_Vin CM vs Vout Diff Plot"

- User fills the highlighted cells in blue.
- **Required:** VS+, VS-, Front Gain, Back End Gain, Input Voltage, VOICM, VCLAMP+ and VCLAMP-(if Clamps Enabled).
- The Operating Range Chart provides the valid input & output ranges for this Instrumentation Amplifier. Use VICM to scroll bar to adjust the input common mode.



The excel tool consists of two sheets, select the sheet at the bottom:


Second sheet:

"INA851_VinCM_vs_VoutDiff_Plot"

- User fills the highlighted cells in blue.
- **Required:** VS+, VS-, Front Gain, Back End Gain, Input Voltage, VOICM, VCLAMP+ and VCLAMP-(if Clamps Enabled).
- The Operating Range Chart provides the valid input & output ranges for this Instrumentation Amplifier. Use VICM to scroll bar to adjust the input common mode.

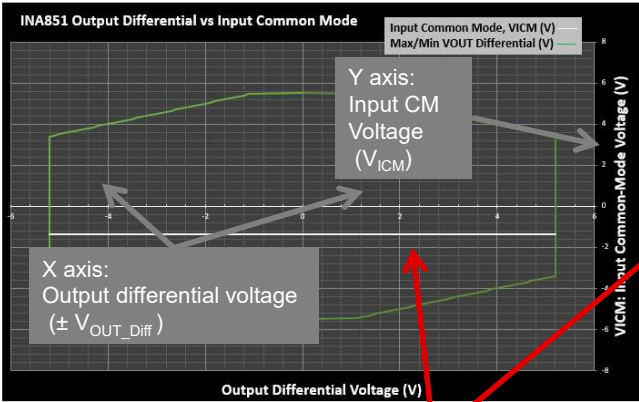
INA851 Input and Output Range Design Calculator

Second sheet: "INA851 Vin CM vs Vout Diff Plot"

INA851 Input and Output Range Design Calculator  TEXAS INSTRUMENTS

INPUTS: CELLS HIGHLIGHTED IN BLUE

Plot Parameters	
VS+	8.00 in Volts
VS-	-8.00 in Volts
CLAMP Enabled	YES
Ensure VCLAMP+ < (VS+ - 1.5) V	
VCLAMP+	5.00 in Volts
Ensure VCLAMP- > (VEE + 1.5) V	
VCLAMP-	0.00 in Volts
VOCM	2.50 in Volts
Front GAIN	40.00 in V/V
BE GAIN	1 in V/V



VICM (Scroll Bar)

Required: VS+, VS-, Front Gain, Back End Gain, Input Volt, VCLAMP+ and VCLAMP- (if Clamps Enabled).
Tip: The Operating Range Chart provides the valid input & output ranges for this Instrumentation Amplifier. Use VICM to scroll bar input common mode.

VICM (Scroll)	-1.3500 in Volts
VIN Differential Volt (Max)	0.1300 in Volts
VIN Differential Volt (Min)	-0.1300 in Volts
VOUT Differential (Max)	5.2000 in Volts
VOUT Differential (Min)	-5.2000 in Volts

Enter the supplies, clamp voltages, FE gain, BE gain and V_{OCM} voltage.

Scroll to the desired input common mode voltage. White line represents V_{ICM} level

Check input / output voltage range

 TEXAS INSTRUMENTS

"INA851_VinCM_vs_VoutDiff_Plot": User fills the highlighted cells in blue.

Required: VS+, VS-, Front Gain, Back End Gain, Input Voltage, VOCM, VCLAMP+ and VCLAMP- (if Clamps Enabled).

The Operating Range Chart provides the valid input & output ranges for this Instrumentation Amplifier. Use VICM to scroll bar to adjust the input common mode.

Here we show a calculator that allow you to confirm that the instrumentation amplifier will have a linear output swing for your configuration. Enter the supplies, front-end gain, back-end gain, VOCM voltage and VCLAMPs (if clamps enabled). Enter/Scroll the common mode voltage using VICM scroll voltage. Notice that the graph has common mode voltage on the vertical axis and Vout differential on the horizontal axis. The selected common mode voltage shows up as a white horizontal line. The output swing limitation are the points where the white line intersects with the green plot. The excel also displays the maximum differential input and max differential output on the right side of the screen.

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