



Fully Differential Amplifiers - 1

TIPL 2021

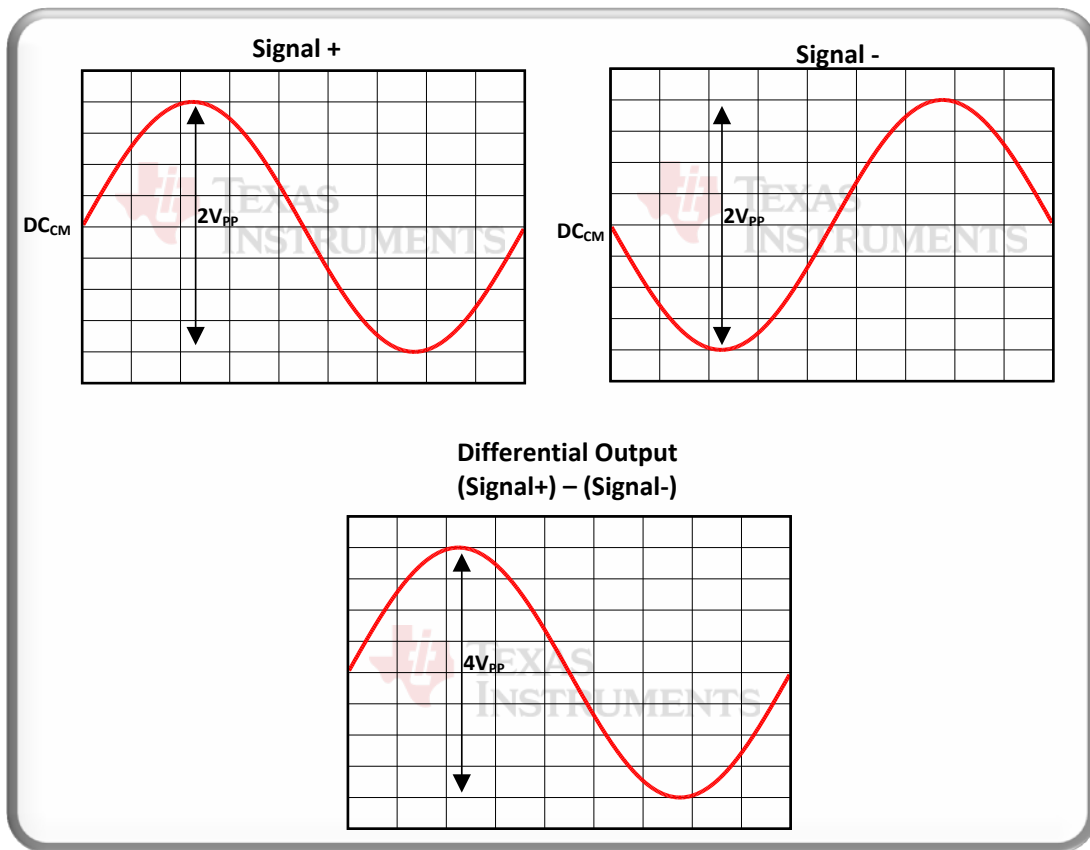
TI Precision Labs: Op Amps



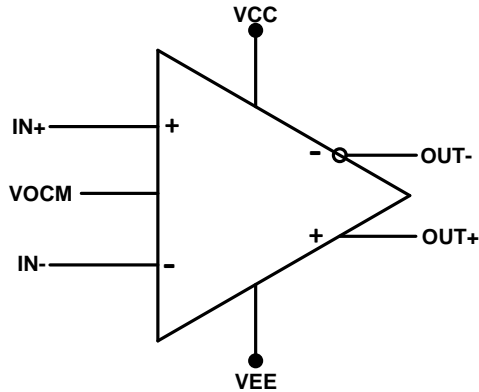
Prepared and Presented by Samir Cherian

Fully-differential Signals and Their Advantages

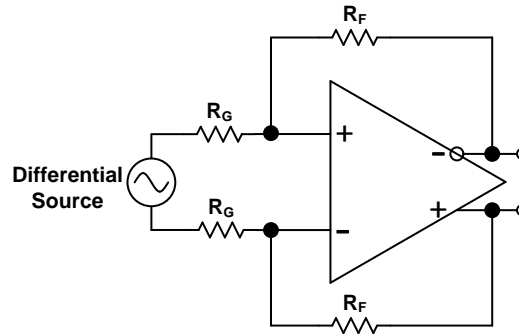
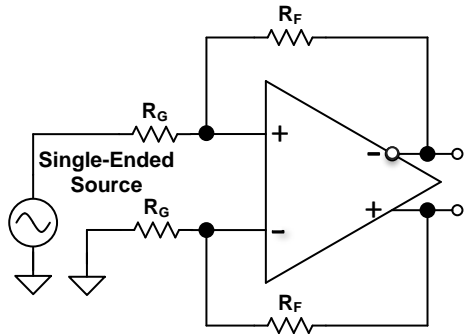
- Improved rejection of common-mode perturbations and noise.
- Improved even-order Harmonic Distortion performance.
- Improved dynamic range: 2x differential-output signal swing.



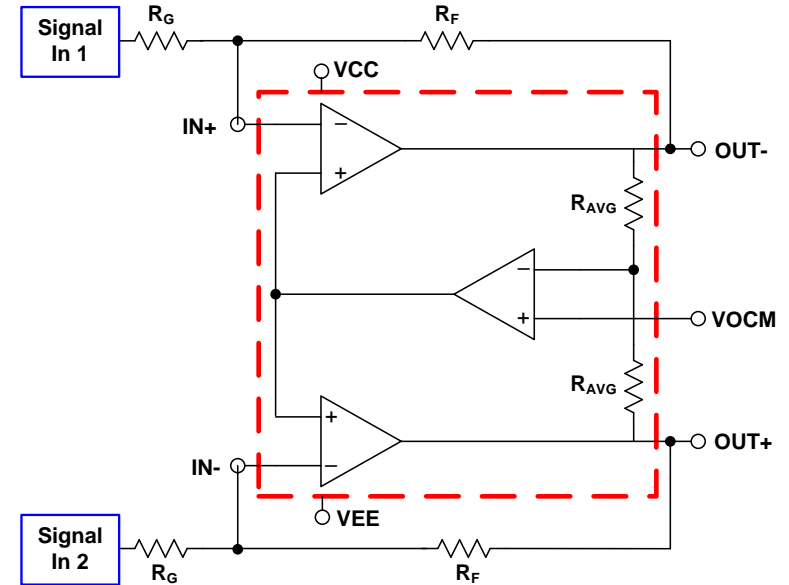
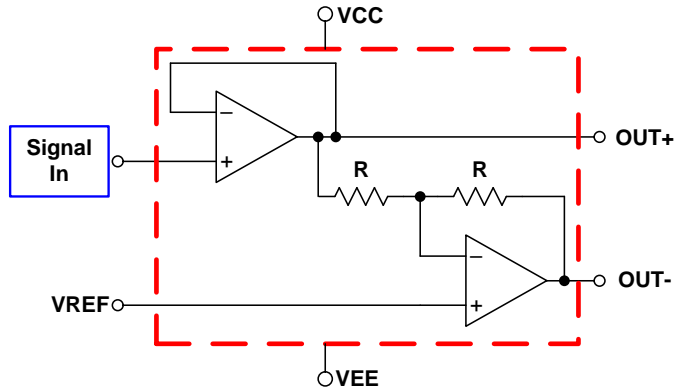
Fully-differential Amplifier (FDA): Introduction



- Converts single-ended input to differential output.
- Converts differential input to differential output.
- Independent common-mode and differential gain control allows for output common-mode level shift



FDA: Discrete-amplifier Realization

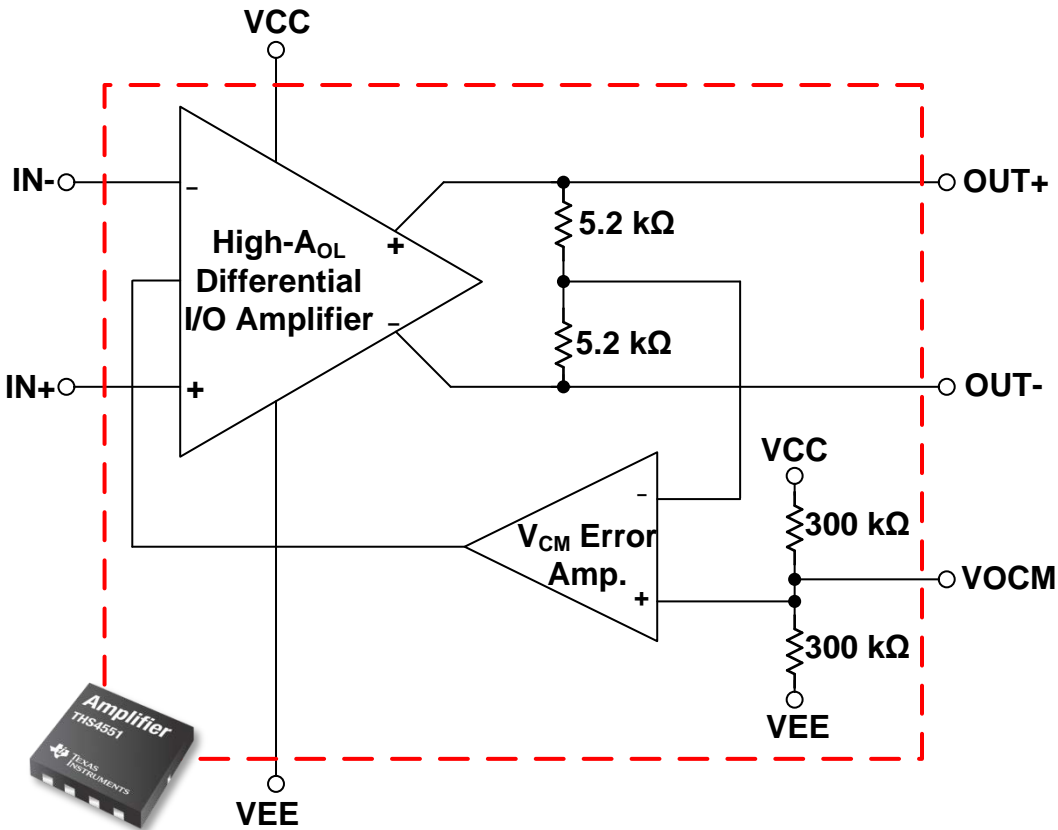


- High input impedance.
- Phase difference between inverting and noninverting outputs results in balance error.

$$E_{n_Out} = \sqrt{E_{n_Amp1}^2 + 4 \times E_{n_Amp2}^2}$$

- Integrated solution can offer lower noise for same power consumption and better matching for reduced balance error.

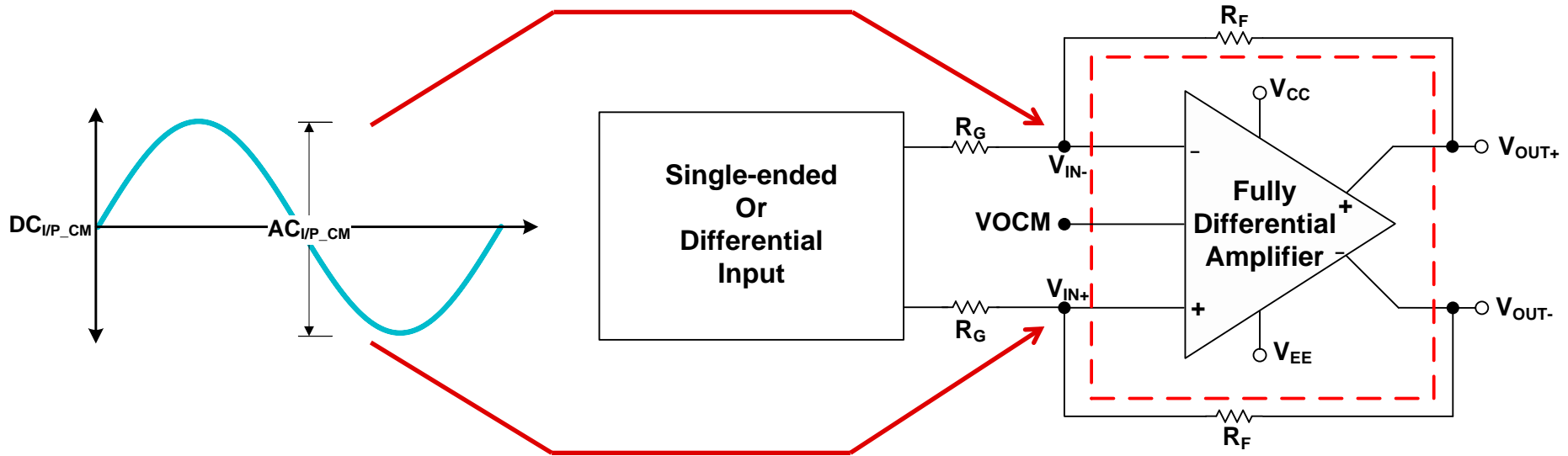
Integrated FDA: THS4551 Block Diagram



- Integrated fully-differential, high- A_{OL} amplifier.
- Integrated wide-bandwidth, common-mode feedback, error amplifier.
- Integrated resistors to detect the average output common-mode voltage.
- Integrated mid-supply, common-mode set resistors.

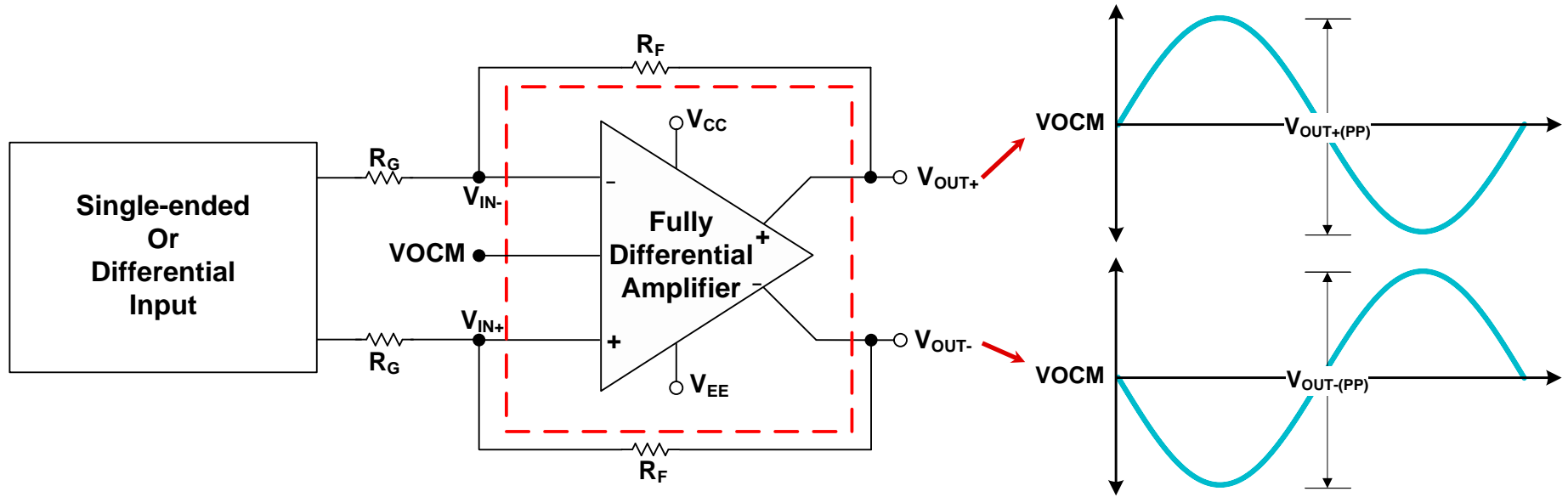
How an FDA Works: Rule 1 of 3

There are Three Golden Rules that determine how an FDA works



- 1 The voltage (DC and AC) at the inputs track each other exactly, similar to an op-amp's virtual short across its inputs.

How an FDA Works: Rules 2 and 3



2 The two outputs are 180° out of phase, AND

3 The two outputs have the same DC offset voltage equal to $VOCM$.

$$V_{OUT+}(t) - V_{OCM} = -(V_{OUT-}(t) - V_{OCM})$$
$$V_{OCM} = \frac{V_{OUT+}(t) + V_{OUT-}(t)}{2}$$



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