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Electronics 1 Part 2 (Quickstudy: Academic)

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Supplemental Material
ELECTRONICS 1 PART 2
PART 2 OF FUNDAMENTALS OF ELECTRONIC DEVICES & BASIC ELECTRONIC CIRCUITS

OPERATIONAL AMPLIFIERS

DEFINITIONS

- A basic differential amplifier (see *Electronics 1 Part One*) and/or mathematical difference operation can be modified to perform addition, integration and differentiation. Hence, the differential amplifier is also designated as an **Operational Amplifier** (Op-Amp).
- An Op-Amp represents, in essence, a high-gain electronic circuit intended to amplify the difference in the signal voltages applied to its two input terminals, namely, inverting (-) and non-inverting (+) inputs (Fig. 2).
- In simple terms (Fig. 2), an Op-Amp simulates a differential amplifier made up of, for example, a pair of BJTs driven by a constant current source (ICL7660) and NMOSFETs can also be used in differential pairs.

IDEAL OP-AMP CHARACTERISTICS

- Nominal voltage gain, $A_v = \infty$
- Input impedance (or both inputs), $Z_{in} = \infty$
- Output impedance, $Z_o = 0$
- Both transistors are identical.
- $V_{CM} = V_{CM1} = V_{CM2} = V_{CM3} = V_{CM4} = V_{CM5} = V_{CM6}$
- Headroom (HWR) = ∞
- PSRR (input impedance), it may be difficult to achieve a very high input impedance.
- PSRR and PSRR(2) provide high-input impedance operation.

OP-AMP OPERATIONAL PARAMETERS

- Any device (operational amplifier) is a very complex and non-linear device (Fig. 4) made of operational characteristics.
- INPUT BIAS CURRENT:** This is the current entering the differential amplifier for active region operation of the pair of BJTs (or, MOSFETs) which comes through R_{in} to that $V_{in} = -I_{in} \times R_{in} \times A_v$ or R_{in} value. This could be large enough to saturate the output. Saturation is overcome by introducing $R_{in} = R_{in1}$ and R_{in2} and made adjustable to compensate for input offset current due to any discontinuity in the differential pair configuration (Fig. 3).
- INPUT OFFSET VOLTAGE (V_{io} or V_{os}):** It is required at the input as a constant voltage to offset the finite common-mode voltage due to unequal current flowing through the differential pair devices in the OP-AMP, so that this balancing gives zero output voltage.
- CMRR:** When the OP-AMP is ideally balanced at the input, the output voltage is 0. If $V_{in} = V_{in1} = V_{in2}$ and this circuit can reject common-mode signals due to its common-mode gain ($A_{cm}) = 0$. For differential mode signals $V_{in} = V_{in1} - V_{in2}$ (or $V_{in1} = V_{in2}$). The ratio A_{dm}/A_{cm} common-mode rejection ratio (CMRR) in practical OP-AMPS, $A_{dm} = 0$ and $A_{cm} = \infty$, so CMRR is finite and indicates the extent of balance in the OP-AMP (A figure of merit parameter).
- COMMON-MODE REJECTION:** This is the peak output swing with reference to zero at the output. It is limited by power supply voltages used in ∞ percent of power supply voltage (PSV).
- INPUT VOLTAGE SWING:** Input common-mode voltage swing, is limited by the saturation of the differential amplifier at the input, to ∞ percent of power supply voltage (PSV).

LINEAR VOLTAGE-TO-CURRENT CONVERTERS

Fig. 8 Source Circuit Fig. 9 Sink Circuit

LOGARITHMIC AMPLIFIER

Fig. 10

CHARGE AMPLIFIER

Fig. 11

PRECISION RECTIFIER & PEAK DETECTOR

Fig. 12 Precision Rectifier Fig. 13 Peak Detector

VOLTAGE FOLLOWER (UNITY GAIN AMPLIFIER)

Fig. 14

$Z_{in} = A \times (R_{in} \text{ Device})$
 $Z_{out} = (R_{out} \text{ Device}) / A$

REGULATED POWER SUPPLY

Fig. 15

NEW RATE: Maximum rate at which the output voltage can change (involves transients) in ideal OP-AMP, denoted as ω .

OTHER PARAMETERS: (1) Bandwidth, (2) Maximum output current available when the output terminal is not grounded (3) PSRR: Power supply rejection ratio. Change in input offset voltage to corresponding change in one of the power supply voltages (PSV). Ideally, PSRR = ∞ ; in practice, it is of the order of a few dBV.

FREQUENCY ROLL-OFF

It is the roll-off of the voltage gain at high frequencies. This is indicated by gain bandwidth product. Roll-off to higher frequencies is affected by frequency compensation.

INVERTING AMPLIFIER (VIRTUAL GROUND AMPLIFIER)

Fig. 2

NON-INVERTING AMPLIFIER

Fig. 4

INTEGRATOR (LOW-PASS FILTER)

Fig. 5

DIFFERENTIATOR (HIGH-PASS FILTER)

Fig. 6

LEVEL CLAMPING

Fig. 7

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Synopsis

Part 2 of the fundamentals of electronic devices and basic electronic circuits.

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Customer Reviews

Stashed this away for reference on projects if anything is forgotten or disputed. No longer need internet if its not available. The quality is good, but the amount of information is overwhelming. If you are going to actually be studying for a class, I recommend making your own study card in addition to buying this as there are many benefits to doing so.

BarCharts are a great little reference. I would not recommend them as a study aid, but as a quick reference, they are great! I have used them for Chem, Physics, Electronics and Math. They are great for what they are.

It's legible, convenient, durable, water proof, etc. It's a handy little cheat sheet. I keep in a binder with the documents for a TI NSpire Calculator. I was kinda hoping that it would cover microwave transmission parameters. Some of that is on the Circuit Theory/Analysis card. Still, there was not much on the cards concerning practical impedance matching circuits. You just can't cram everything on a couple or three cards. All the basics are there. You should be able to derive the rest.

Nice to have on hand, well constructed gives a lot of useful information.

I was hoping there would be more to it but, its still a good referance

Excellent product. I strongly recommend this item.

High quality and delivered on time.

This is part 1 of 2. It Comes before part 2, and is the first in it's series. It's also laminated, which is great for eating Taco bell near.

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