Operational Amplifier

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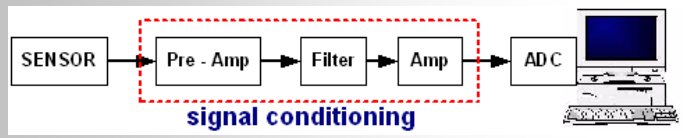
Masalah Interfacing

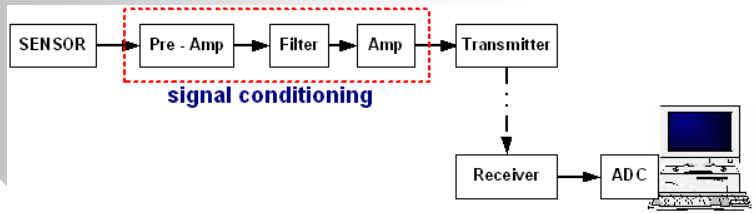
- Konversi Analog ke Digital
- Penyamaan Tegangan (voltage matching)
- Penguatan sinyal
- Linierisasi → Wheatstone Bridge
- Penghilangan Noise (Filter)

Sistem Interfacing Instrumentasi

Sistem dengan display digital

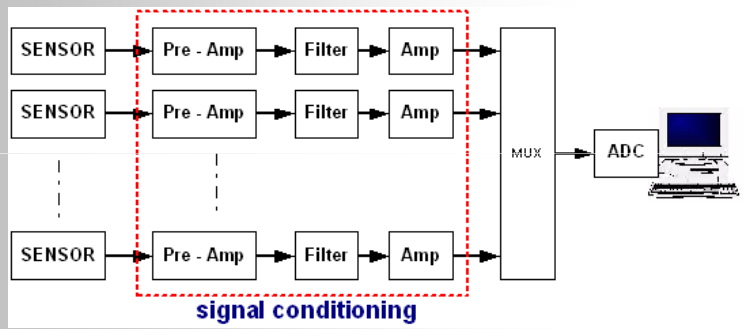


Sistem dengan transmisi data & display digital



Sistem Instrumentasi

Sistem multisensor dengan display digital



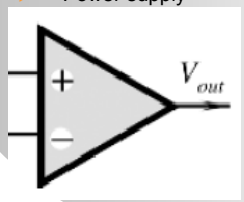
PENGKONDISI SINYAL - Amplifier

Amplifier

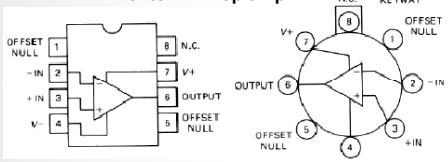
- Operational Amplifier
- Instrument Amplifier

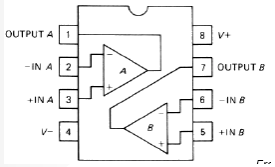
OPERATIONAL AMPLIFIER

- Primary op-amp terminal
  - Inverting input
  - Non-inverting input
  - Output
  - Power supply



Contoh : IC op-amp 741



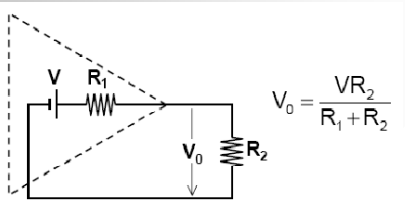


Dual op-amp 1458

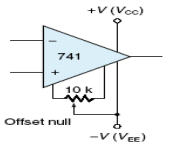
Amplifier : Op - Amp

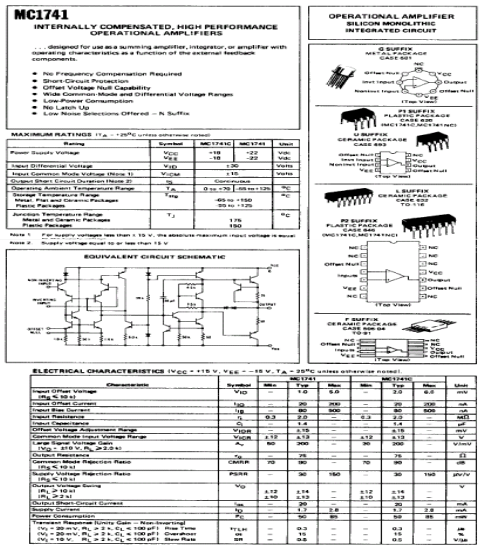
Karakteristik Op-Amp Ideal

- Infinite open loop voltage gain
  - *Open loop gain* adalah *gain* op-amp tanpa umpan balik
  - Ideal open loop gain : tidak terhingga
- Infinite input impedance
  - Arus input adalah NOL
  - Beberapa *low grade op-amp* memiliki arus input dalam orde mA
- Zero output impedance
  - Beberapa op-amp memiliki *output impedance* sekiat 100 – 200 Ω



Data sheet for the 741 general-purpose op-amp. (Copyright © Semiconductor Components Industries, LLC. Used by permission.)



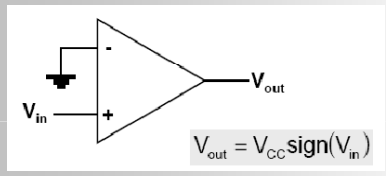


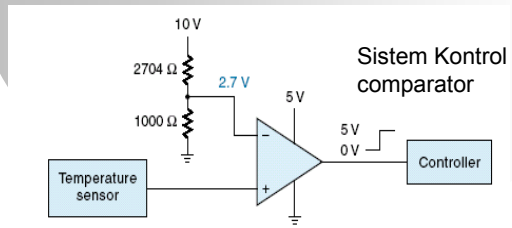
Karakteristik

Parameter	Ideal	LM741	LF347	LM318
Open-loop Gain (A_{OL})	∞	$2 . 10^5$	10^5	$2 . 10^5$
Input Resistance (R_{in})	∞ Ω	2 M Ω	10^{12} Ω	3 M Ω
Output Resistance (R_o)	0 Ω	75 Ω	75 Ω	75 Ω
Gain Bandwidth Product	∞ Hz	1 MHz	4 MHz	15 MHz
CMRR	∞	90 dB	100 dB	100 dB

Amplifier : Rangkaian Op - Amp

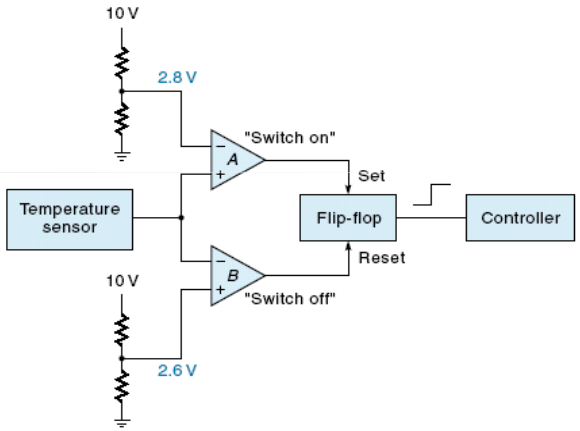
- **Voltage comparator**



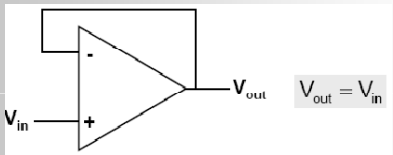


Sistem Kontrol Blower menggunakan comparator

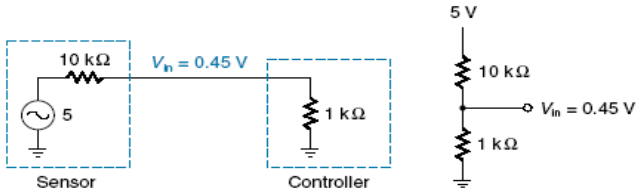
Sistem Kontrol Blower menggunakan window comparator



- **Voltage follower (Buffer)**

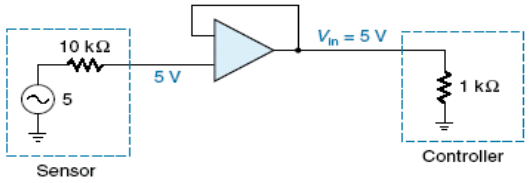


Pemasangan voltage follower untuk mencegah tegangan drop



(a) Signal experiences voltage drop

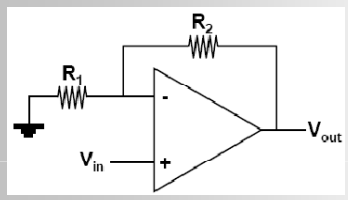
(b) Equivalent circuit



(c) No signal voltage drop

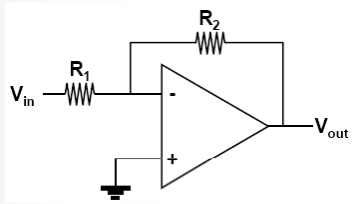
Amplifier : Rangkaian Op - Amp

- **Non-inverting amplifier**



$$V_{out} = \left(1 + \frac{R_2}{R_1}\right) V_{in}$$

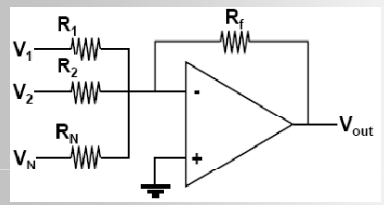
- **Inverting amplifier**



$$V_{out} = -\frac{R_2}{R_1} V_{in}$$

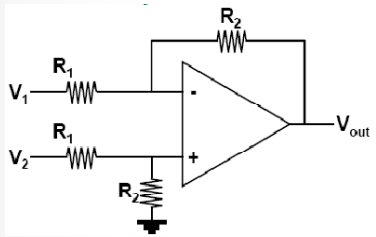
Amplifier : Rangkaian Op - Amp

- **Summing amplifier**



$$V_{out} = -\left(V_1 \frac{R_f}{R_1} + V_2 \frac{R_f}{R_2} + \cdots + V_N \frac{R_f}{R_N}\right)$$

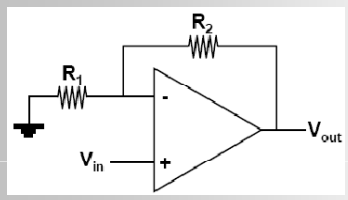
- **Differential amplifier**



$$V_{out} = \frac{R_2}{R_1}(V_2 - V_1)$$

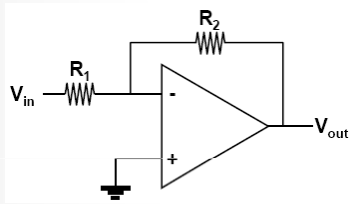
Amplifier : Rangkaian Op - Amp

- **Non-inverting amplifier**



$$V_{out} = \left(1 + \frac{R_2}{R_1}\right) V_{in}$$

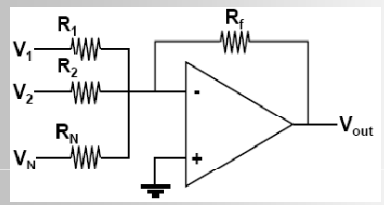
- **Inverting amplifier**



$$V_{out} = -\frac{R_2}{R_1} V_{in}$$

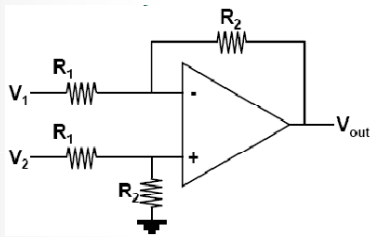
Amplifier : Rangkaian Op - Amp

- **Summing amplifier**



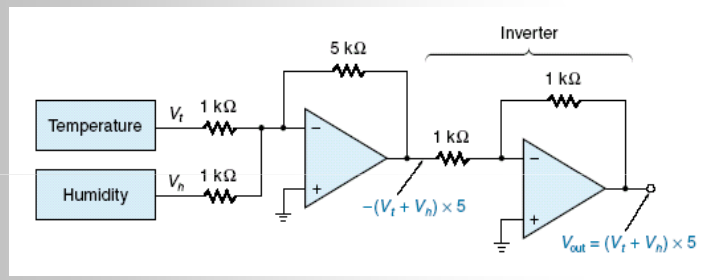
$$V_{out} = -\left(V_1 \frac{R_f}{R_1} + V_2 \frac{R_f}{R_2} + \cdots + V_N \frac{R_f}{R_N}\right)$$

- **Differential amplifier**



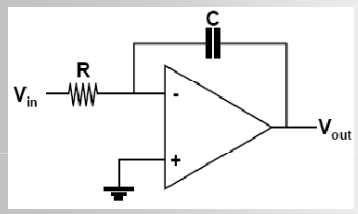
$$V_{out} = \frac{R_2}{R_1}(V_2 - V_1)$$

Penyalaan Air conditioning (AC) dengan bantuan summing amplifier dan penguat inverting



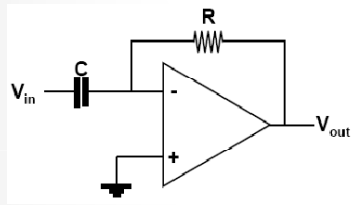
Amplifier : Rangkaian Op - Amp

- **Integrating amplifier**



$$V_{out} = -\frac{1}{j\omega CR} V_{in} = -\frac{1}{RC} \int V_{in} dt$$

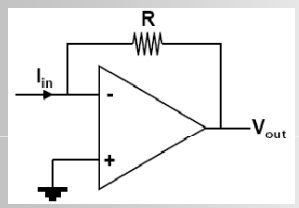
- **Differentiating amplifier**



$$V_{out} = -\frac{R}{\frac{1}{j\omega C}} V_{in} = -RC \frac{dV_{in}}{dt}$$

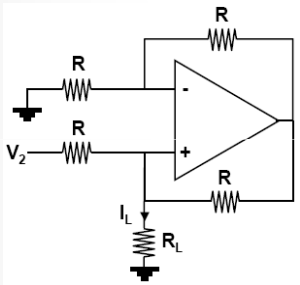
Amplifier : Rangkaian Op - Amp

- **Current to Voltage converter**



$$V_{out} = -I_{in} R$$

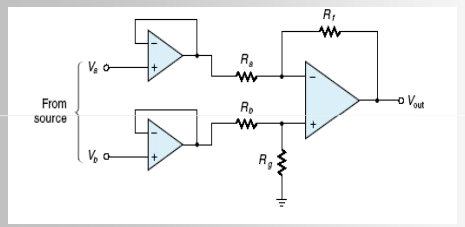
- **Voltage to Current converter**

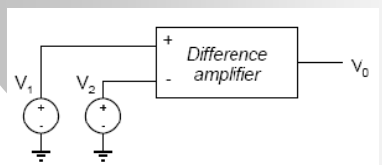


$$I_L = \frac{V_{in}}{R}$$

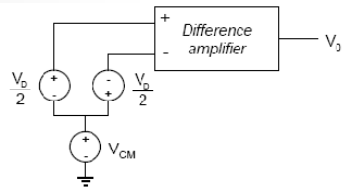
Amplifier : Instrumentation Amplifier

- Differential Amplifier





- Tegangan COMMON MODE & DIFFERENCE MODE



$$V_{CM} = \frac{V_2 + V_1}{2}$$

$$V_D = V_2 - V_1$$

Data sheet for the PGA204 instrumentation amplifier. (Courtesy of Burr-Brown Corp.)

BURR-BROWN®

PGA204
PGA205

Programmable Gain INSTRUMENTATION AMPLIFIER

FEATURES

- DIGITALLY PROGRAMMABLE GAIN:
  PGA204: G=1, 10, 100, 1000V/V
  PGA205: G=1, 2, 4, 8V/V
- LOW OFFSET VOLTAGE: 50μV max
- LOW OFFSET VOLTAGE DRIFT: 0.25μV/°C
- LOW INPUT BIAS CURRENT: 2nA max
- LOW QUIESCENT CURRENT: 5.2mA typ
- NO LOGIC SUPPLY REQUIRED
- 16-PIN PLASTIC DIP, SOL-16 PACKAGES

APPLICATIONS

- DATA ACQUISITION SYSTEM
- GENERAL PURPOSE ANALOG BOARDS
- MEDICAL INSTRUMENTATION

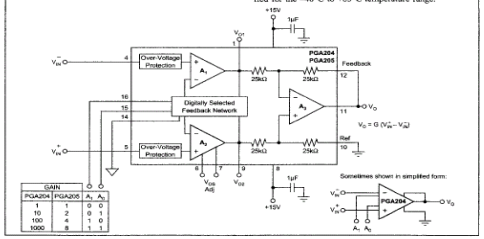
DESCRIPTION

The PGA204 and PGA205 are low cost, general purpose programmable-gain instrumentation amplifiers offering excellent accuracy. Gains are digitally selected: PGA204—1, 10, 100, 1000, and PGA205—1, 2, 4, 8V/V. The precision and versatility, and low cost of the PGA204 and PGA205 make them ideal for a wide range of applications.

Gain is selected by two TTL or CMOS-compatible address lines, A_0 and A_1. Internal input protection can withstand up to ±40V on the analog inputs without damage.

The PGA204 and PGA205 are laser trimmed for very low offset voltage (50μV), drift (0.25μV/°C) and high common-mode rejection (115dB at G=1000). They operate with power supplies as low as ±4.5V, allowing use in battery operated systems. Quiescent current is 5mA.

The PGA204 and PGA205 are available in 16-pin plastic DIP, and SOL-16 surface-mount packages, specified for the –40°C to +85°C temperature range.



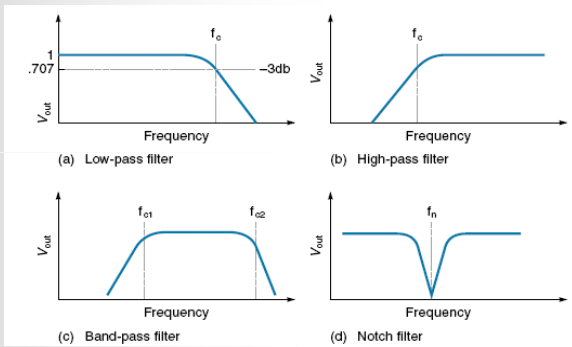
Filter

- Filter digunakan untuk membuang sinyal dengan frekuensi yang tidak diinginkan
- Klasifikasi filter berdasarkan implementasi
  - **Filter aktif** (termasuk rangkaian RC dan op-amp)
  - **Filter pasif**
    - Terdiri atas rangkain RLC
  - **Filter digital**

Filter

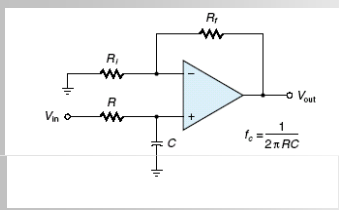
Klasifikasi Filter berdasarkan respon frekuensi

- Low pass filter
- High pass filter
- Bandpass filter
- Band Stop (notch)

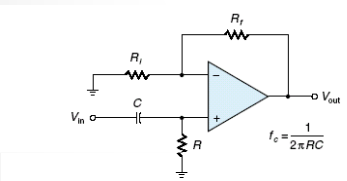


Filter

- Low pass filter



- High pass filter



- Notch filter