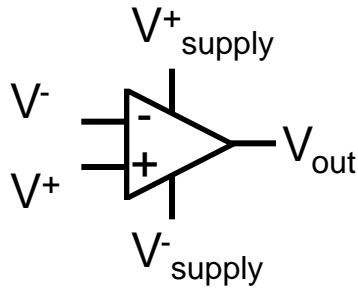


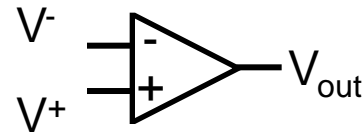
# Dagens forelesning

- Op-amp repetisjon fra tidligere kurs
- Forsterkere og signalkondisjonering  
Fraden kap 5
- Sidespor til tilbakekobling og blokkdiagram  
Kompendiet
- Skjerming for kapasitive sensorer  
Fraden avsnitt 3.2
- Sidespor til første ordens systemer

# Operasjons forsterker (opamp)



eller



$$I_{in} = \frac{(V^+ - V^-)}{Z_{in}}$$

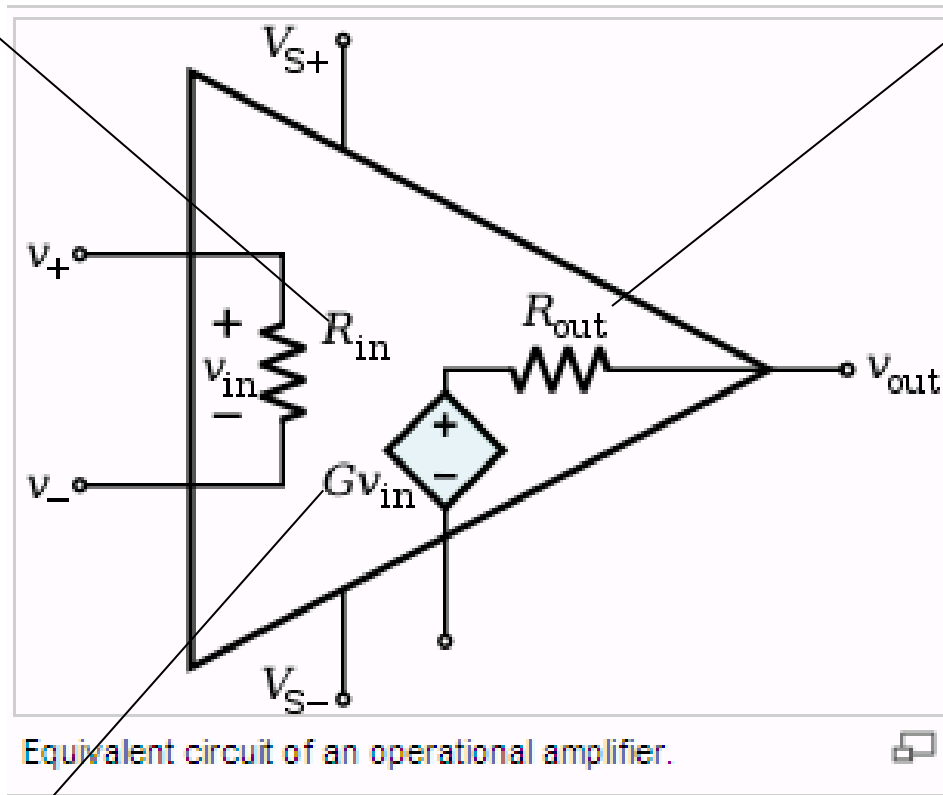
$$V_{out} = (V^+ - V^-)A_{OL} + \frac{1}{2}(V^+ + V^-)A_{CM} - I_{out}Z_{out}$$

		Typisk	Ideelt
Open loop gain:	$A_{OL}$	100 000	$\infty$
Common mode gain:	$A_{CM}$	0.001	0
Utgangsimpedans:	$Z_{out}$	100 $\Omega$	0
Inngangsimpedans:	$Z_{in}$	1M $\Omega$	$\infty$

# From wikipedia

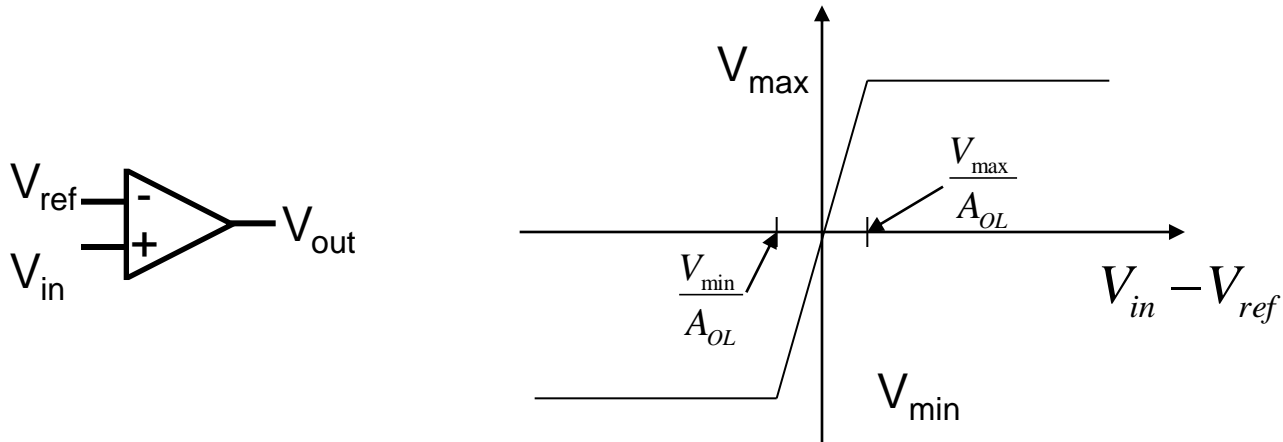
$Z_{in}$

$Z_{out}$



$A_{OL}$

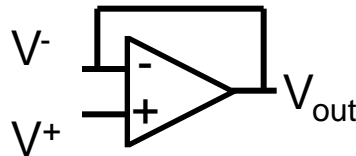
# Komparator



For en ideell opamp er

$$V_{out} = V_{max} \quad \text{for} \quad V_{in} > V_{ref}$$
$$V_{out} = V_{min} \quad \text{for} \quad V_{in} < V_{ref}$$

# Negativ tilbakekopling av opamp



$$V_{out} = A_{OL} (V^+ - V^-) = V^- \Rightarrow$$

$$V^+ = V^- \left( 1 + \frac{1}{A_{OL}} \right) \Rightarrow$$

$$V^- = V^+ \left( 1 + \frac{1}{A_{OL}} \right)^{-1} \Rightarrow$$

$$V^- \approx V^+$$

En negativ tilbakekopling tvinger negativ inngang til samme verdi som den positive inngangen

# Spenningsfølger

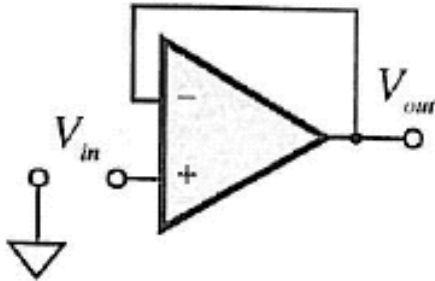
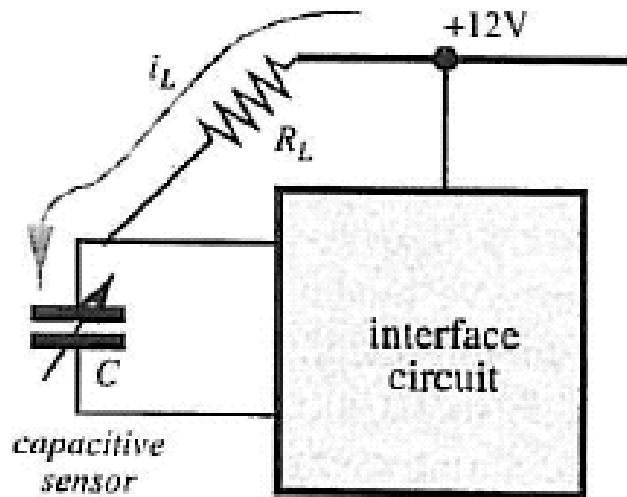


Fig. 5.7. Voltage follower with an operational amplifier.

- Konverterer "ned" utgangsimpedansen fra en sensor.

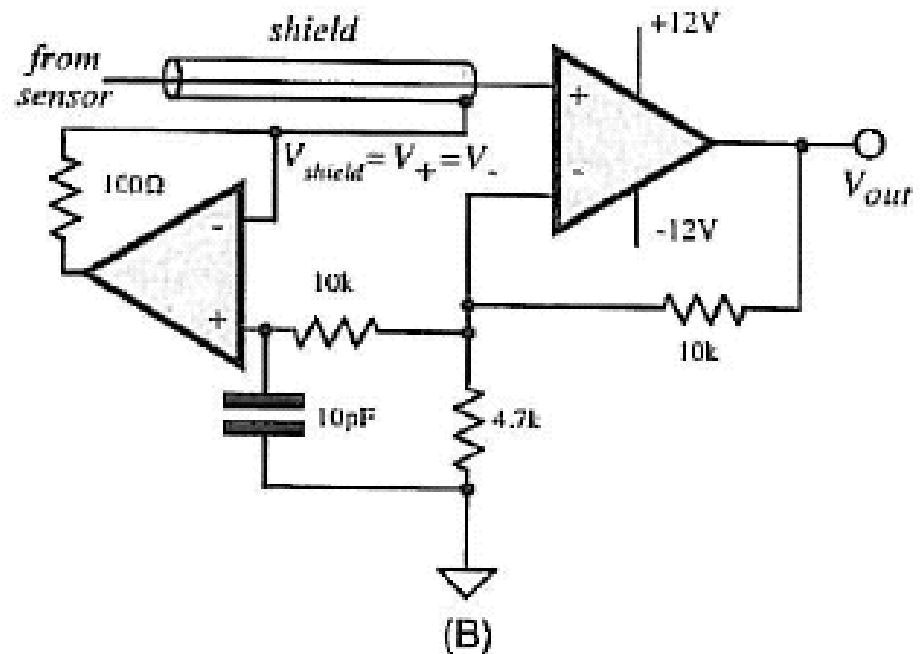
# Drevet skjerm (driven shield)

Problem:



(A)

Løsning:



(B)

Fig. 5.4. Circuit board leakage affects input stage (A); driven shield of the input stage (B).

Essensen er å holde skjermen på samme potensial som signalet for å unngå lekkasjestrømmer. For å oppnå dette bruker vi en tilbakekopling.

# Kretser med "driver" for skjerm (AD7747)

## 24-Bit Capacitance-to-Digital Converter with Temperature Sensor

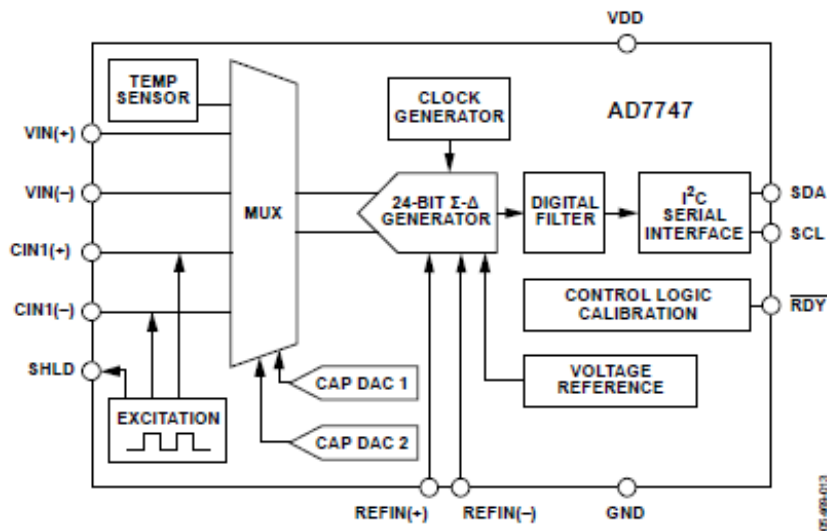


Figure 24. AD7747 Block Diagram

## ACTIVE AC SHIELD CONCEPT

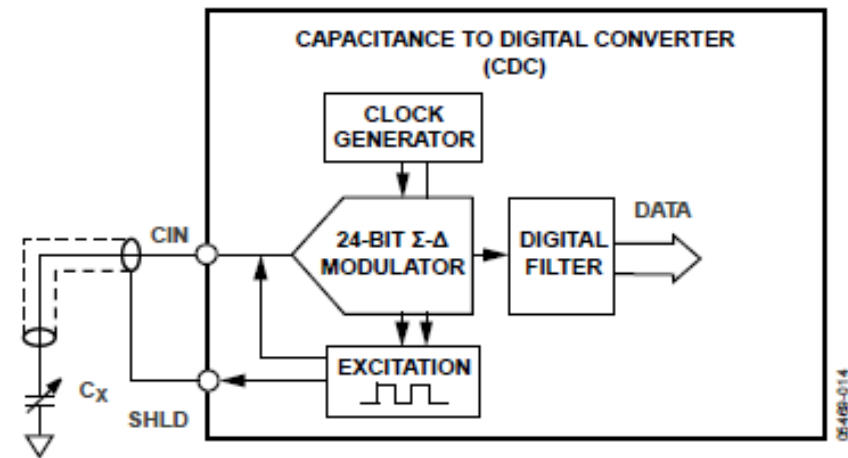


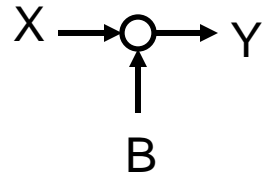
Figure 25. CDC Simplified Block Diagram

OVERVIEW

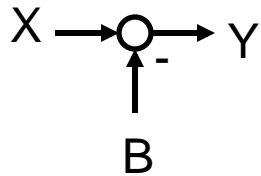


# Blokkdiagram

Sum:  $Y=X+B$



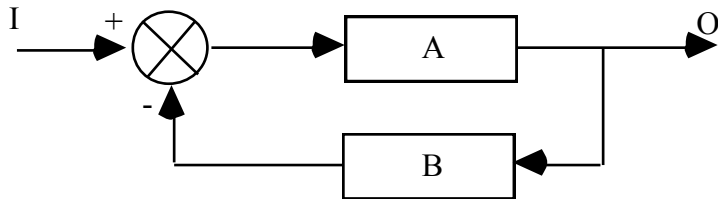
Differanse:  $Y=X-B$



Multiplikasjon:  $Y=AX$



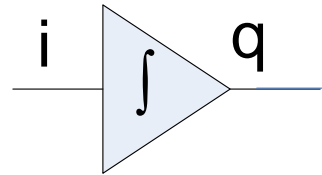
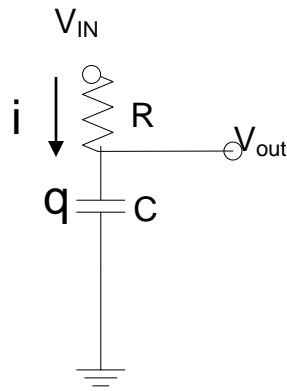
# Negativ tilbakekobling i blokkdiagram



$$O = (I - BO)A$$

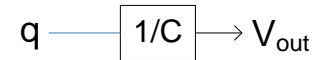
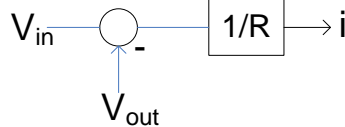
$$O = \frac{A}{1 + AB} I$$

# Sidespor: Første ordens (filter) som blokk diagram

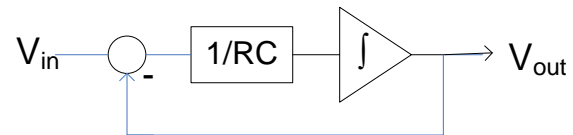
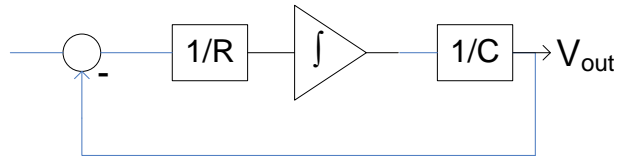
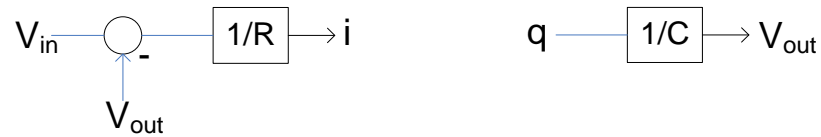
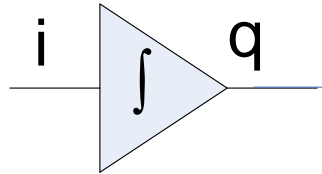


$$i = \frac{1}{R}(V_{in} - V_{out})$$

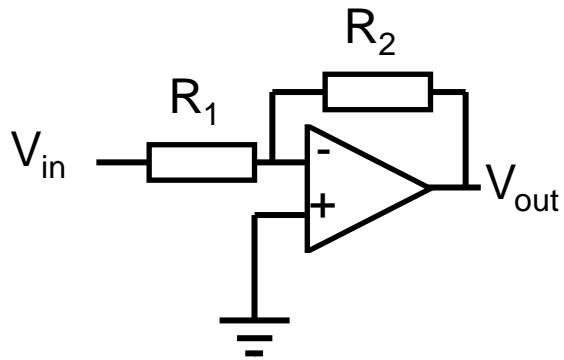
$$V_{out} = \frac{q}{C}$$



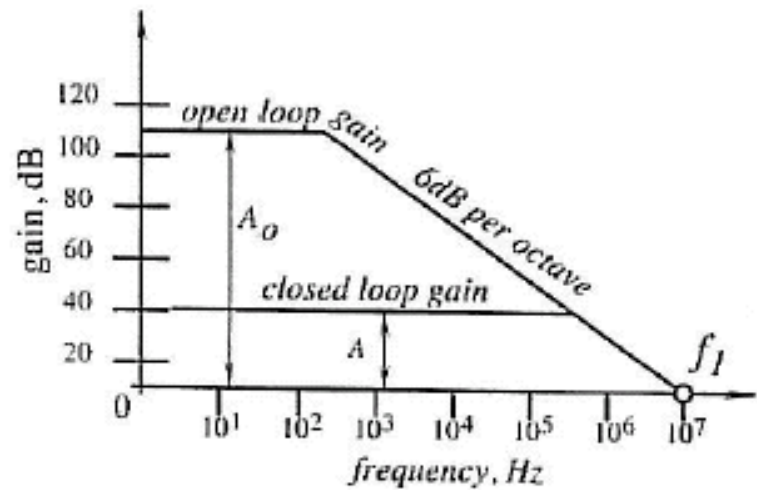
# Sammenkopling



# Inverterende forsterker

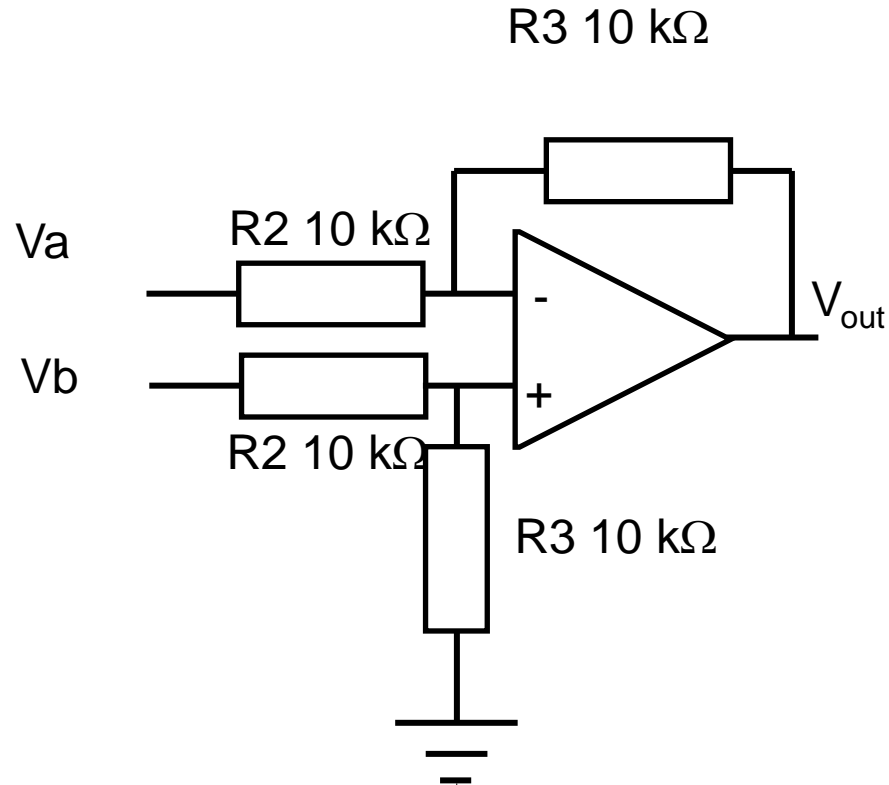


$$A_{CL} = -R_2/R_1$$



(B)

# Subtraksjonskrets



# Instrumenteringsforsterker

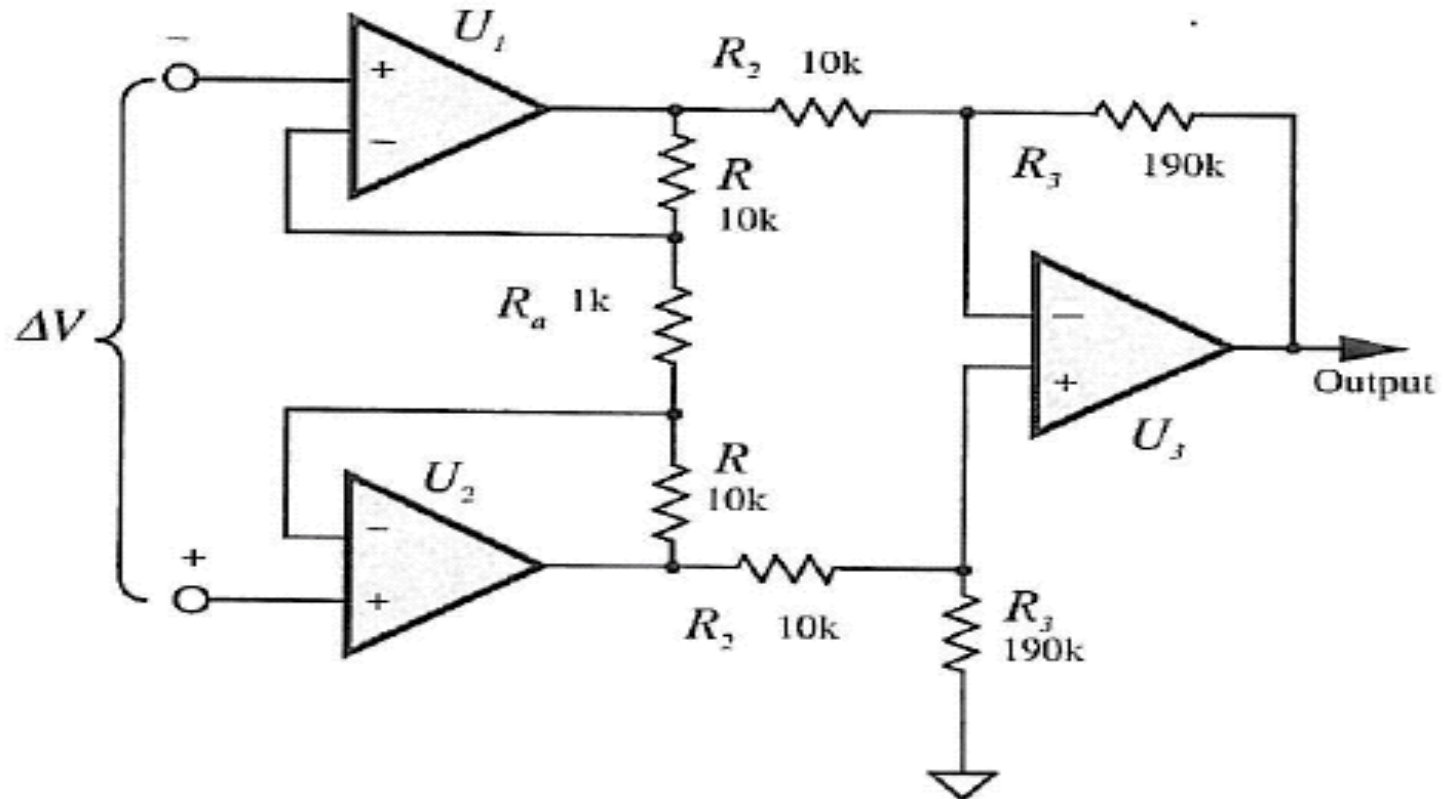


Fig. 5.8. Instrumentation amplifier with three operational amplifiers and matched resistors.