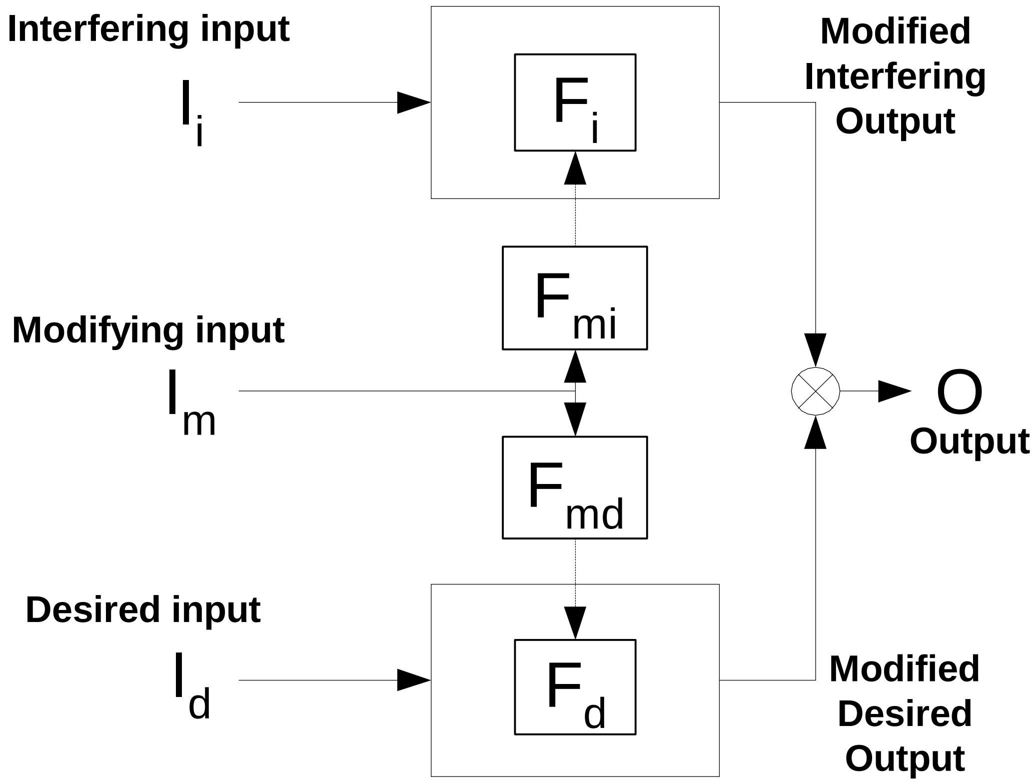
## Compensation for Interfering and Modifying Inputs

- Methods of compensation
  - Inherent insensitivity
    - eg. Shielding instrument from EMI
    - Construction of strain gauges from invar
  - High Gain feedback
  - Calculated output corrections
  - Filtering
  - Opposing inputs

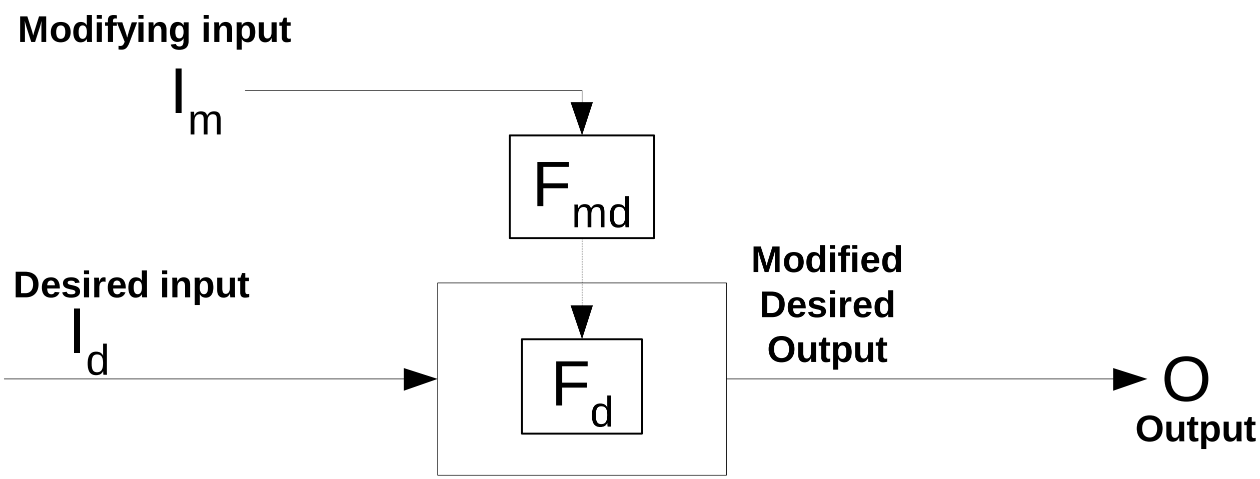
# Method of inherent insensitivity

- Minimize $F_i$, $F_{mi}$, $F_{md}$
- Selectivity - ability to of an instrument to select the input of interest and reject interference signals



# Method of high gain feedback

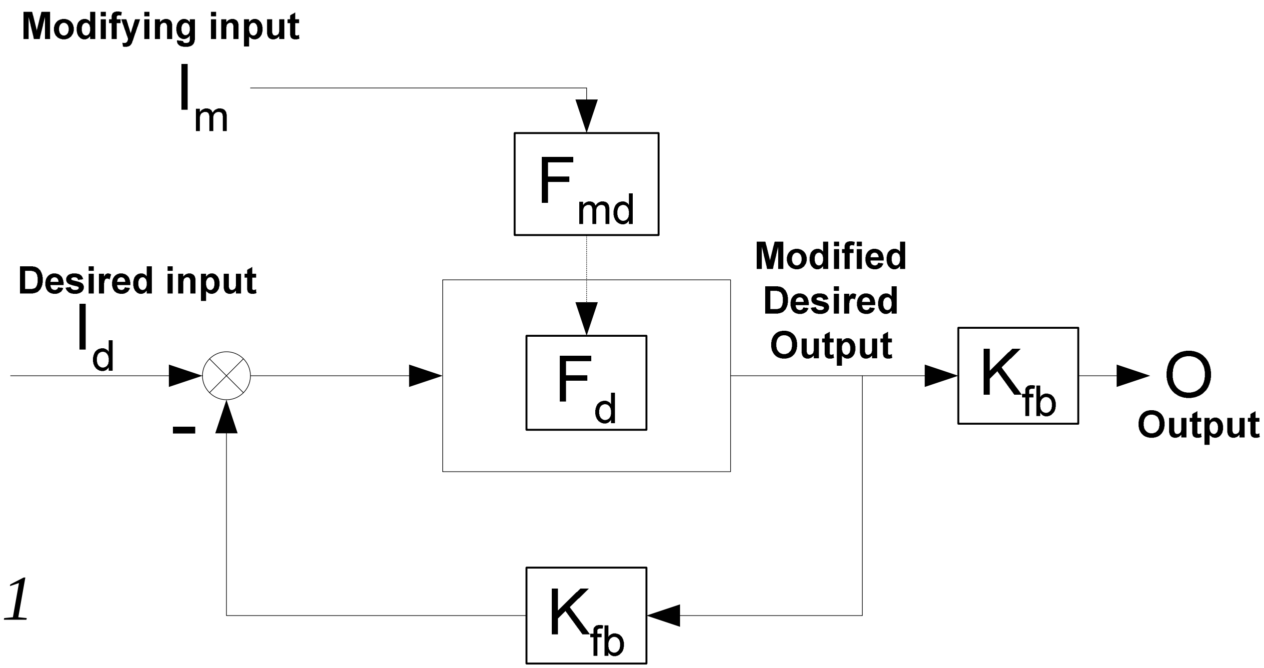
- System with modifying input




$$O = I_d F_d (I_m)$$

# Method of high gain feedback

- Feedback loop added



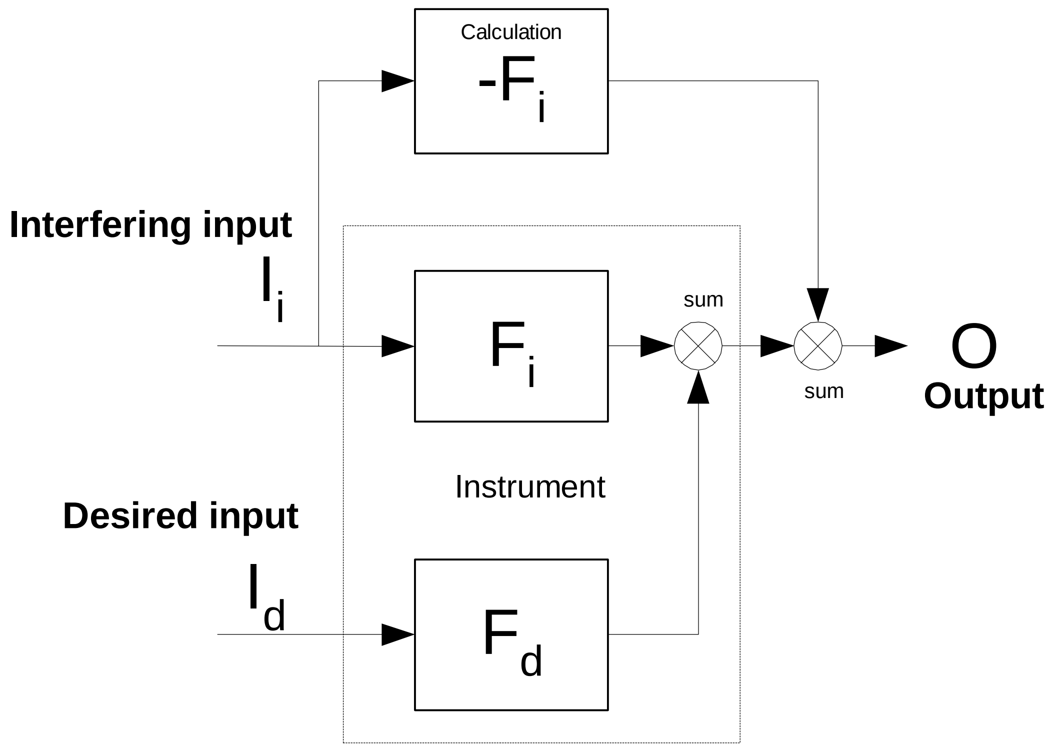

- *Kfb >>1*

$$O = \frac{I_d F_d(I_m) K_{fb}}{1 + K_{fb} F_d(I_m)} \cong \frac{I_d F_d(I_m) K_{fb}}{K_{fb} F_d(I_m)} = I_d$$

- $O$ is no longer a function of $F_d(I_m)$

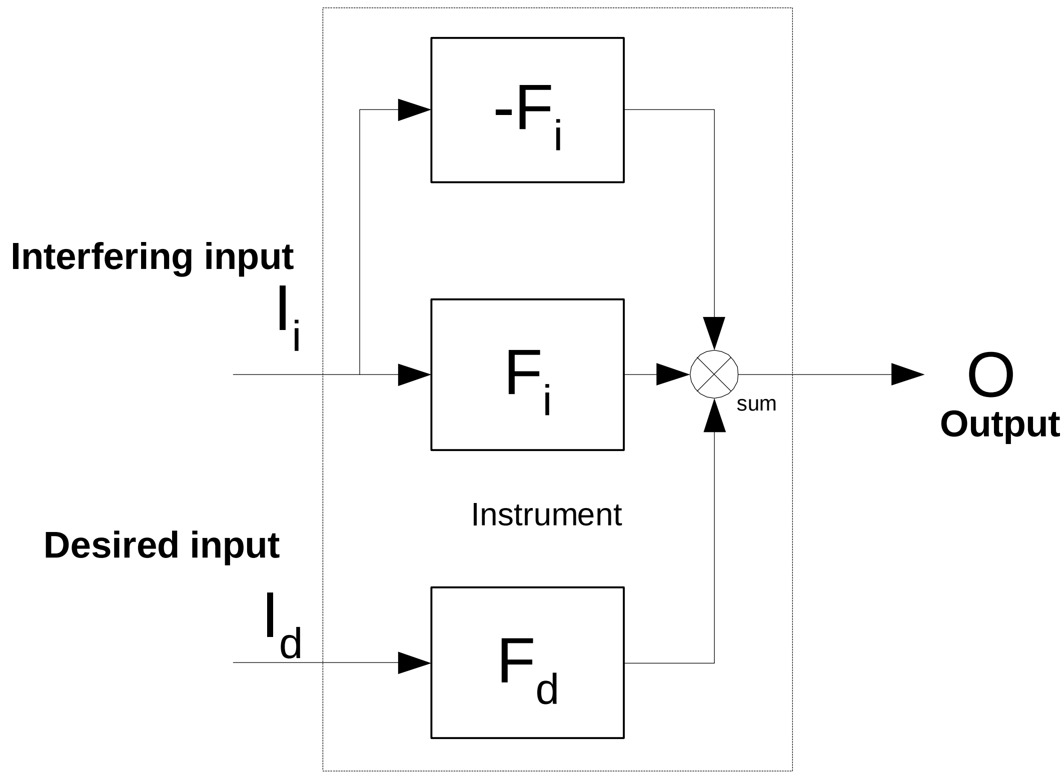
# Method of calculated output correction

- Computer based systems allow correction to be made easily
- Requires that $I_i$ be measured also



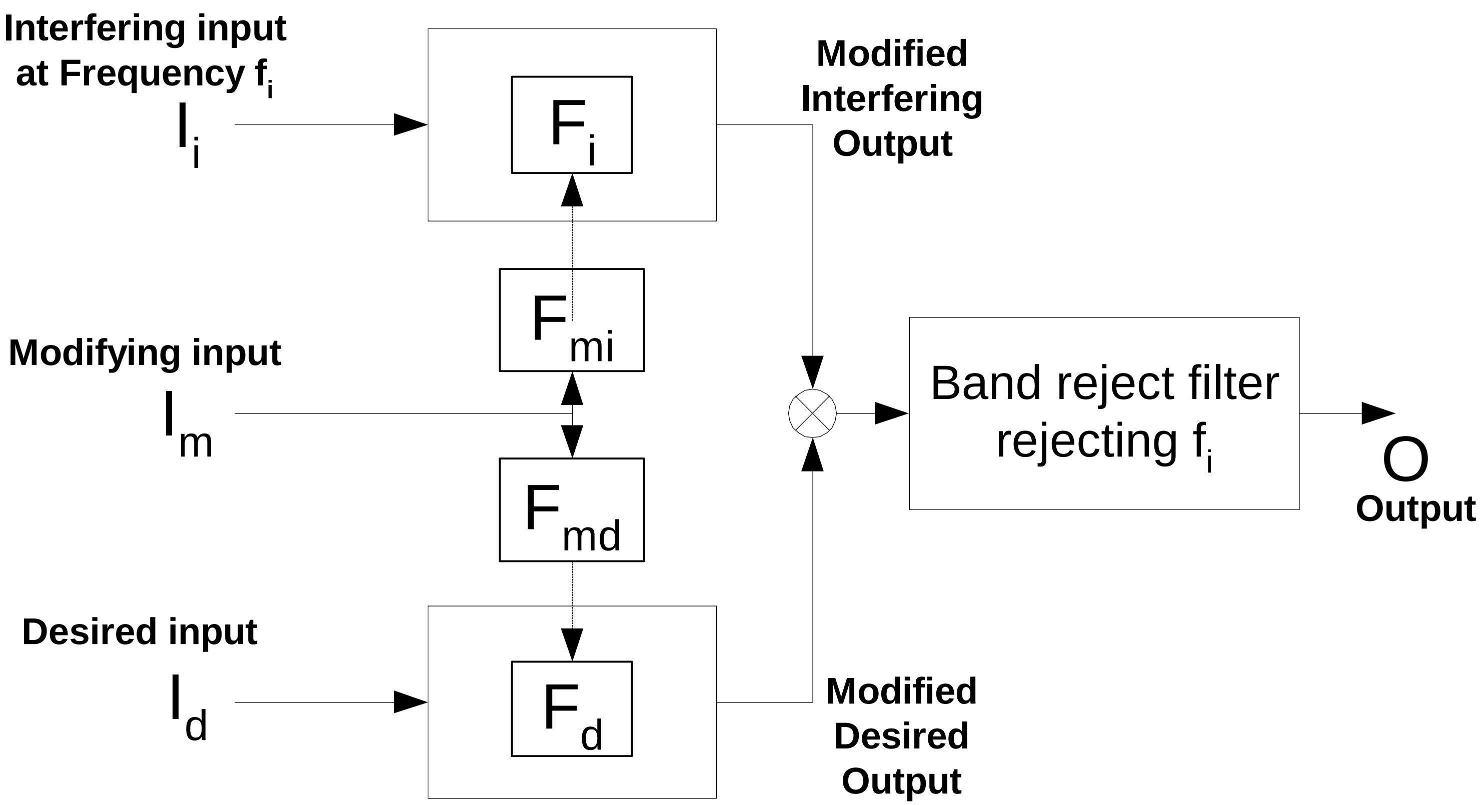
# Method of Opposing Inputs

- Input information is used in some manner to form a correcting signal within the instrument



# Method of filtering

- Removes interfering signal
  - Frequency of desired signal must be different from frequency of interference



# Reporting Instrument Error

- NIST 1297
  - Standardizes the reporting of uncertainty
  - Coordinated with CIPM/ISO
  - Based on representing each component of uncertainty ($u_i$) in a measurement by an estimated standard deviation associated with that component. $u_i$ = <u>standard uncertainty</u>
  - Divides types of uncertainty into two categories
    - Type A - can be evaluated directly as a standard deviation
    - Type B - must be estimated in non-statistical fashion, but is expressed as a standard deviation
  - Assumes a correction factor is applied to remove systematic error (bias is removed by calibration)
  - Defines <u>combined uncertainty</u> ($u_c$) as the RMS of the component uncertainties:

$$u_c = \sqrt{\sum_i (u_i)^2}$$

# NIST 1297 -cont-

– Note: $$u_i = \frac{\partial u}{\partial x_i} x_i$$

and $$u_c = \sqrt{\sum_i \left( \frac{\partial u_i}{\partial x_i} x_i \right)^2}$$

–

– Defines <u>expanded uncertainty</u>, U, as the range within which the "value of the measurand"(Y) can confidently be expected to lie. And expanded uncertainty can be calculated as a product of coverage factor (k), and combined uncertainty ($u_c$)

$$U = ku_c$$

$$Y = y \pm U = y \pm ku_c$$

– Y- measurand, y - measurement result

# NIST 1297 -cont-

- Recommends use of a coverage factor of 2 (This is equivalent to ±2 standard deviations or 95% if normal) or an explanation why.

# Traceability of measurand and uncertainty

- A traceable measurand is not needed for determination of uncertainty.
  - Correction of systematic error or bias is assumed
  - Standard deviation of y given a single Y allows u(y) to be determined