HP 34401A MULTIMETER

Produced by

GMI Engineering & Management Institute

&

Hewlett-Packard Company

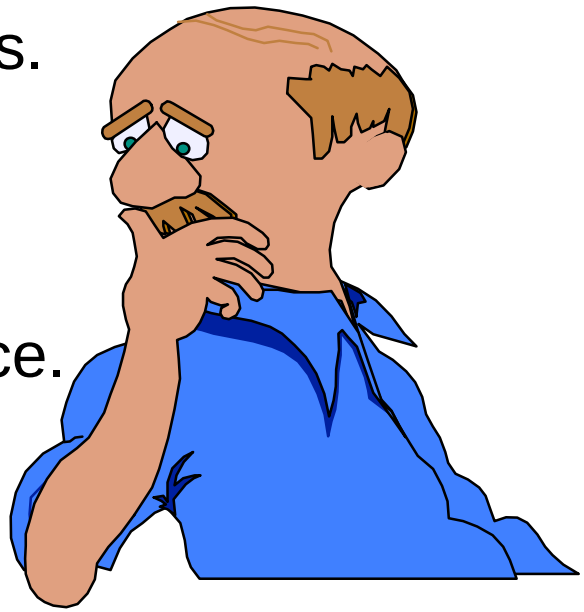
HP 34401A Multimeter

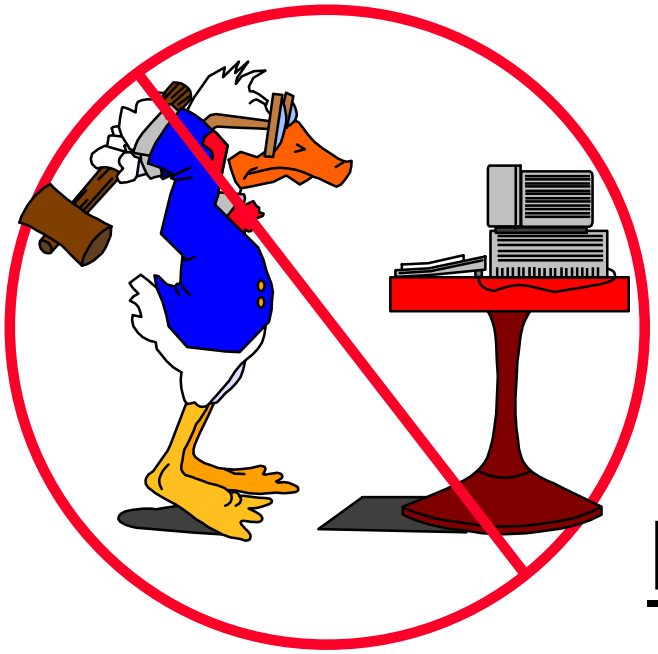
- 6 1/2 digit, high performance digital multimeter
- AC/DC voltage measurements
- AC/DC current measurements
- 2 and 4 wire resistance measurements
- Frequency and Period measurements
- Math functions

Safety Tips

Protect Yourself:
Avoid contact with Voltage or Current Source.

1) Use shrouded test leads and alligator clips.
2) Connect leads to multimeter first.
3) Do all normal connect/disconnect at source.
4) Familiarize yourself with the manual.





Safety Tips

Protect Instrument

1) Inductive Devices (e.g. transformers, chokes/inductors) induce very high transient voltages.

2) Measuring resistance: Avoid contacting probes with live circuits when in resistance modes.

3) Measuring Current: Do not connect probes across voltage source.

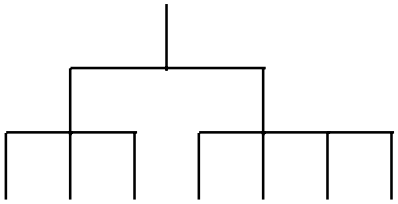
Starting Multimeter

- *To perform a complete self-test, hold down the shift key for more than five seconds as you turn on the multimeter.*
- *The display will indicate whether test passed. Error messages will be displayed if a failure occurs.*

000.002 mVDC

Menu at a Glance

Menu is organized in a top-down tree structure with 3 levels



To turn on menu Shift On/Off

To move left or right < >

To move up or down ∨ ∧

To enter command Auto / Man

A: Meas Menu → **B: Math Menu** → **C: Trig Menu** → **D: Sys Menu** → **E: I/O Menu** → **F: Cal Menu**

- A: Meas Menu
  - 1: AC Filter
  - 2:Continuity
    - 1: Min-Max
- B: Math Menu
  - 1: Read Hold
    - 1: RDGS Store
- C: Trig Menu
- D: Sys Menu
  - 1: HP-IB ADDR
    - 1: Secured
- E: I/O Menu
- F: Cal Menu

Math Functions

To make null (relative) measurement — Null

To store min/max readings — Min / Max

To make dB measurements — Shift + dB

dB = *reading in dBm - relative value in dBm*

To make dBm measurements — Shift + dBm

dBm = $10*\text{Log}_{10}$ (*reading* ^{2}*/ reference resistance/ 1mW)*

Limit testing (Access through Menu)

Triggering

Auto-trigger: Continuously takes readings at fastest rate possible for present configuration. Default.

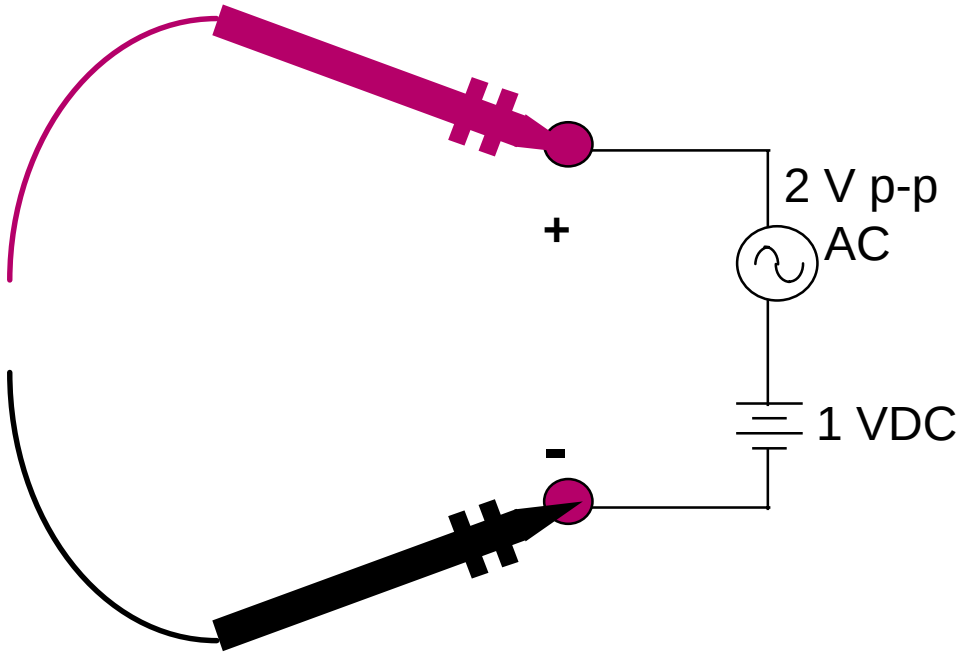
Single trigger: Manual trigger by pressing Single
One reading or specified number of readings (Sample count).

Number of samples: Number of readings meter takes with each trigger: 1 to 50,000. Default is 1.

Reading hold: Select by pressing Shift Auto/Hold
Captures and holds a stable reading on the display.

Measuring DC Voltage

1.000000 VDC



* Note measurement indicates only DC portion of signal

Range and Resolution

Range	100 mV	1 V	10 V	100 V	1000 V (750 VAC)
Maximum Resolution	100 nV	1 μV	10 μV	100 μV	1 mV (750 μVAC)

Resolution Choices & Integration Time

	Integration Time**		Resolution Choices	
	.02	PLC	Fast 4 Digit	Fastest, Least Accurate
	.2	PLC	Fast 5 Digit	
	1	PLC	* Slow 4 Digit	
Default →	10	PLC	* Slow 5 Digit * Fast 6 Digit	
	100	PLC	Slow 6 Digit	Slowest, Most Accurate

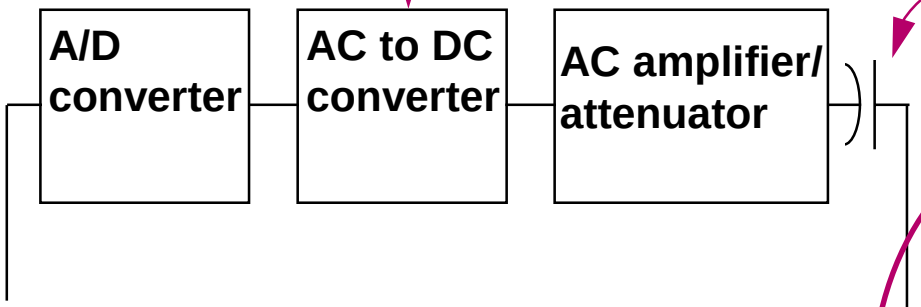
***** Equivalent to Pressing "Digits" key on front panel.
**In Power Line Cycles (PLC).

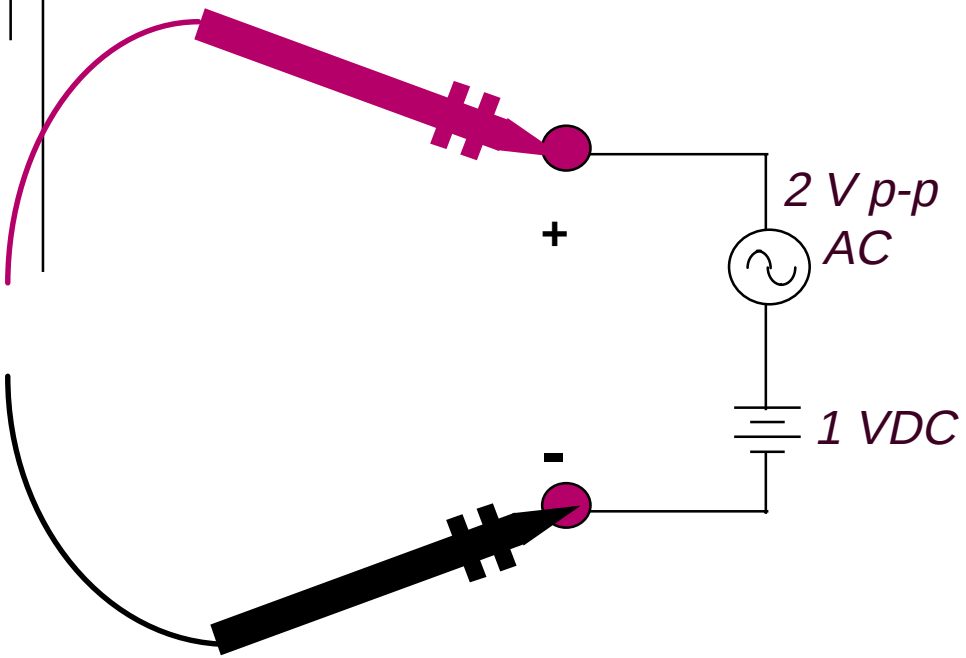
Integration times of .02 and .2 do not provide power-line noise rejection characteristics.

Measuring AC Voltage

AC to DC conversion:
DCV proportional to AC RMS

Coupling capacitor blocks DC; only lets AC signal through





707.106 mVAC

* **Note measurement indicates only the AC portion of signal**

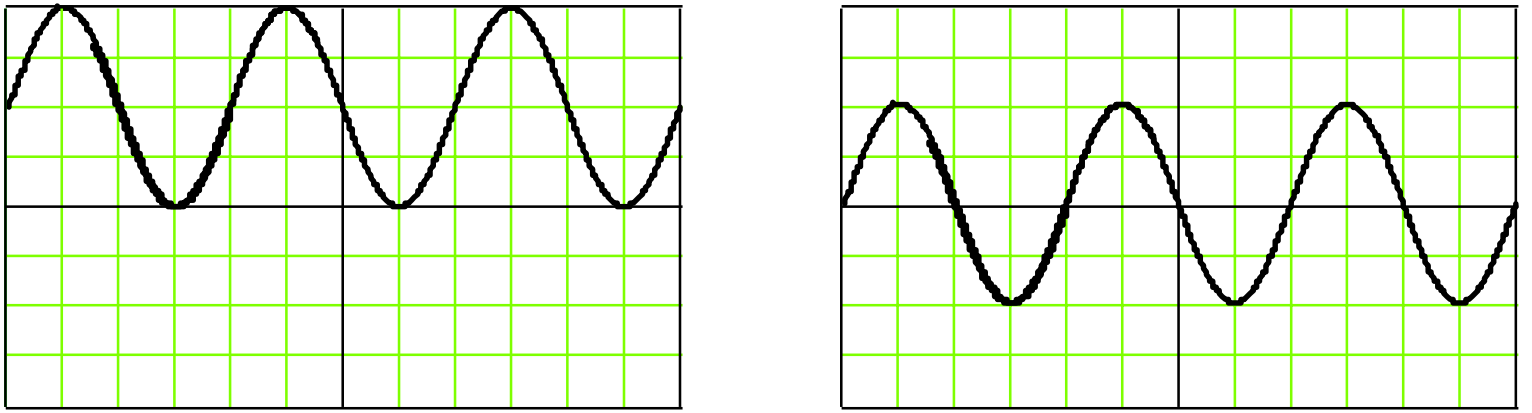
AC Filter

Frequency	Range*	Time to settle
3 Hz and above	Slow	7 sec.
20 Hz and above	Medium	1 sec.
200 Hz and above	Fast	0.1 sec.

*Selectable through the measurement menu

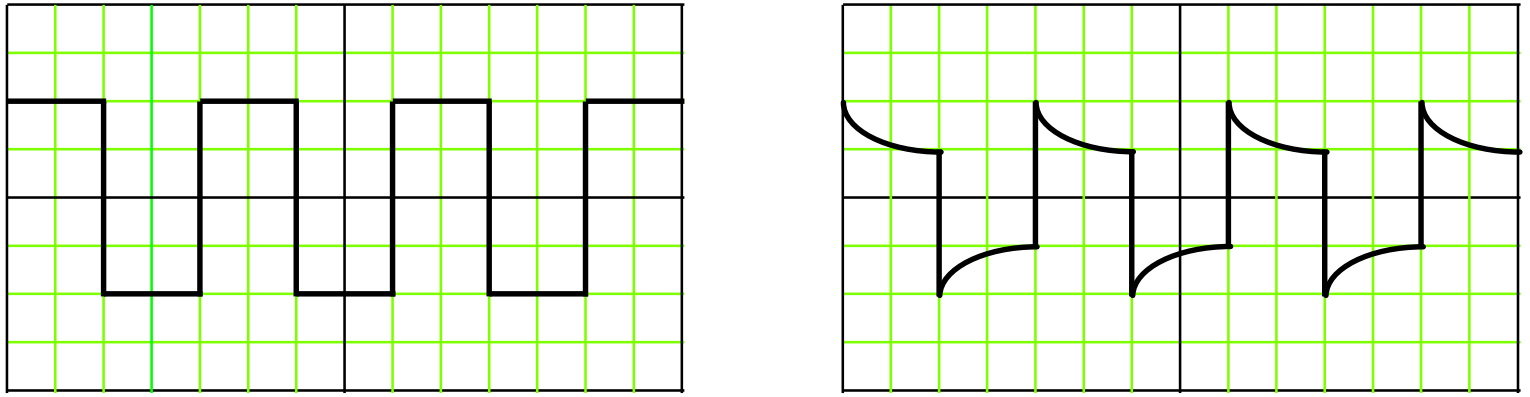
AC-Coupling vs. DC-Coupling

AC-Coupling-Advantage



*Removes DC Portion of Signal

AC-Coupling-Disadvantage



*Low Frequency waveforms can be cut-off

Vrms: Root-Mean-Square

- Instantaneous power to a resistor is: $P = \frac{v(t)^2}{R}$
- Average power to a resistor is:

$$Pavg = \frac{Vrms^2}{R} = \frac{1}{R}\left(\frac{1}{T}\int_{to}^{to+T} v(t)^2\,dt\right)$$

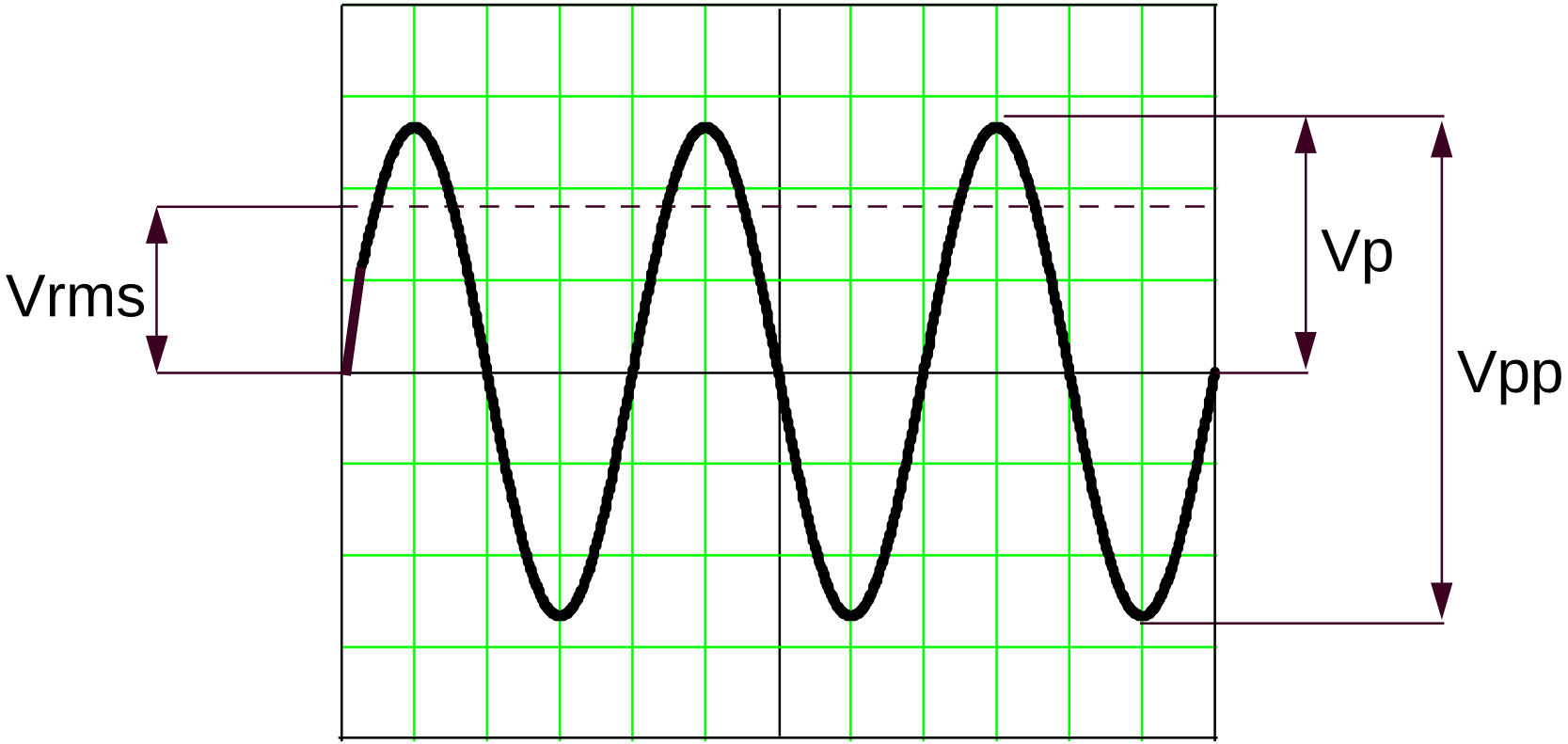
Solving for Vrms:

$$Vrms = \sqrt{\frac{1}{T}*\int_{to}^{to+T} v(t)^2\,dt}$$

- A given Vrms AC has the heating (power) effect of a VDC with the same value.

Voltage measurements

Peak to Peak

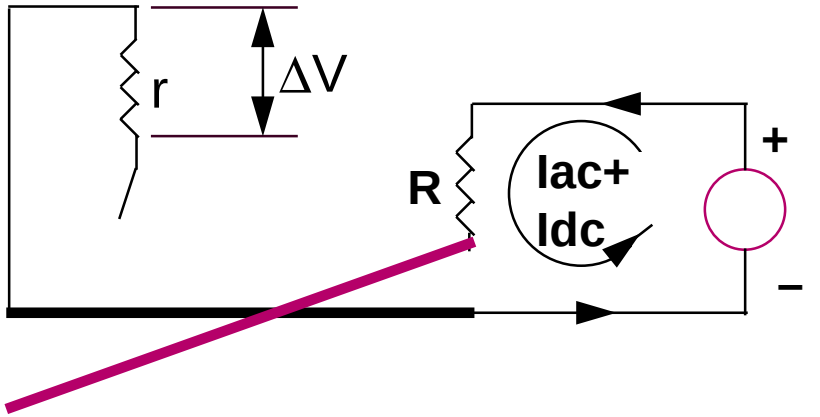


Vrms = Vp * .707 (Sine wave)

Measuring Current

Internal current shunt
(same for ac and dc)

$$I = \frac{\Delta V}{r}$$

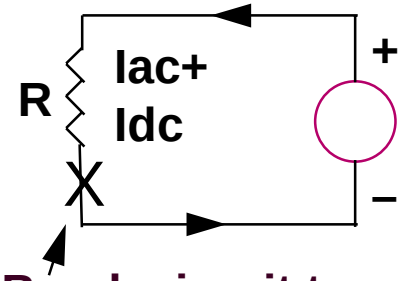


1.000000 ADC

SHIFT **DC I** **= Measure DCI**

SHIFT **AC I** **= Measure ACI**

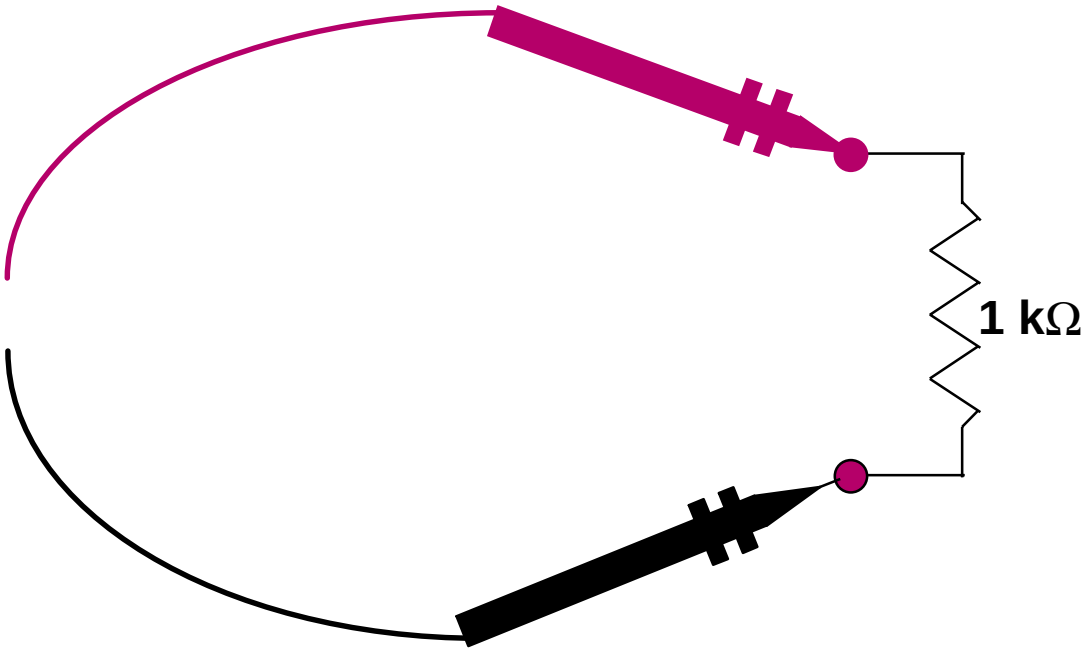
*** NEVER HOOK CURRENT LEADS DIRECTLY ACROSS A VOLTAGE SOURCE**



Break circuit to measure I

Measuring Resistance 2-wire

1.000000 kΩ

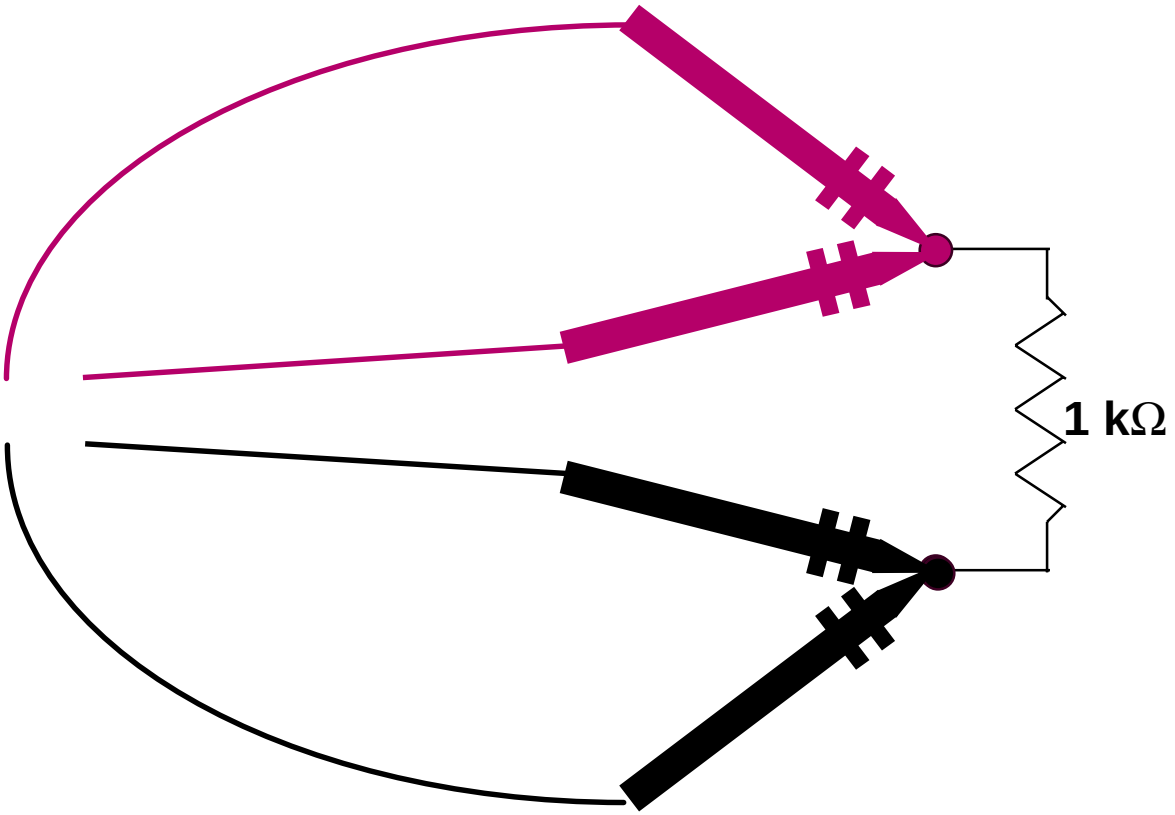


* Press **Ω 2W**
* Resistance measured includes lead resistance

*To eliminate the lead resistance:
- Short leads together
- Press **NULL**
- Lead resistance will be subtracted from reading

Measuring Resistance 4-wire

1.000000 kΩ

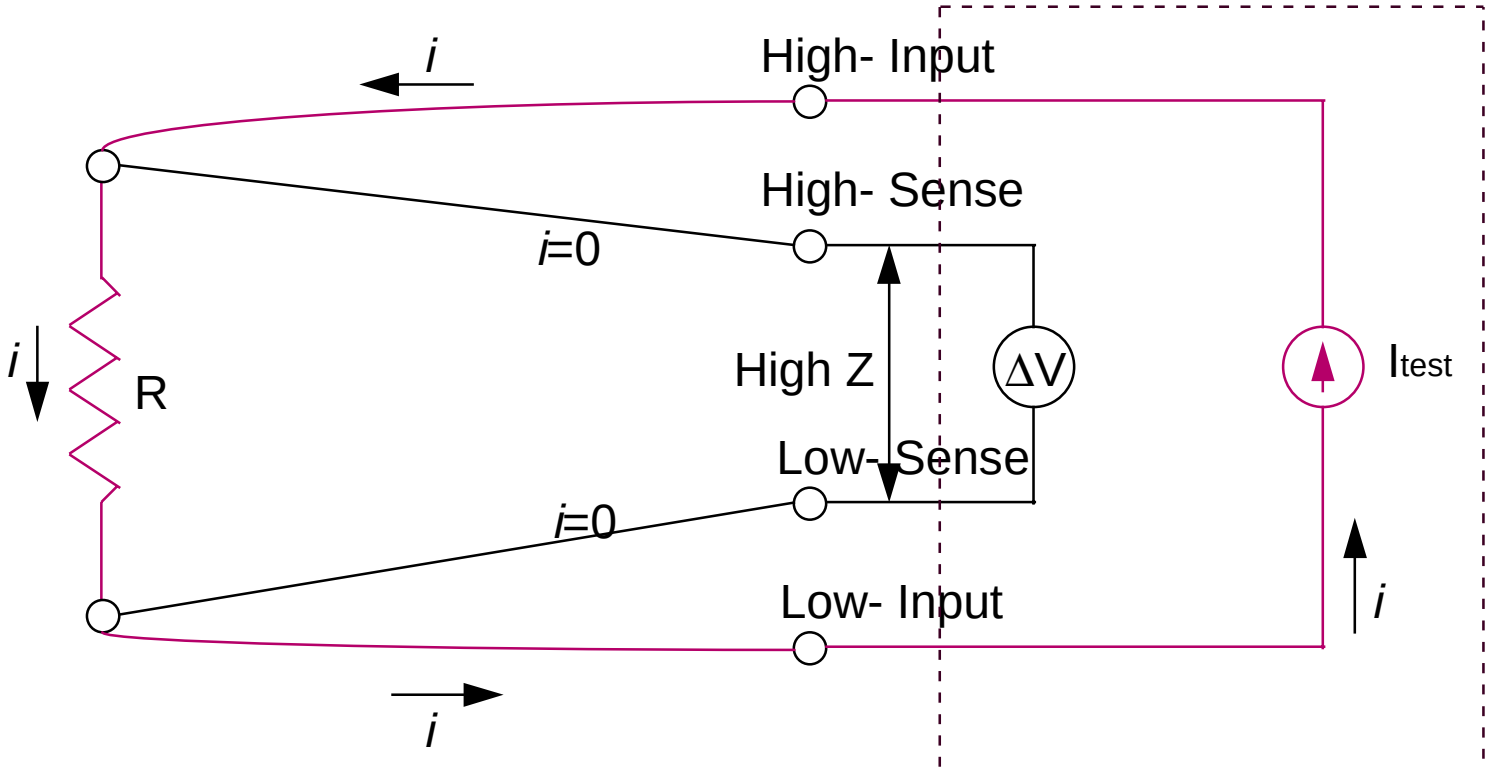


* Turn off “Null”

* Press SHIFT Ω4W

* No error due to lead resistance

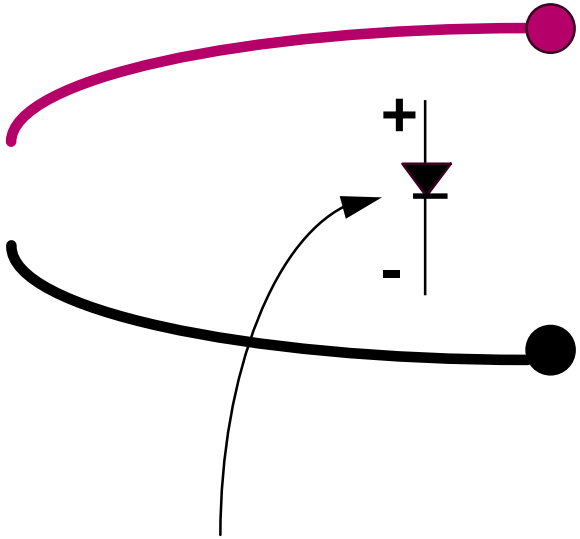
4-Wire Resistor Measurement



$\Delta V = I_{test} * R$

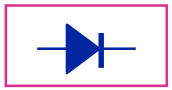
$$R = \frac{\Delta V}{I_{test}}$$

Continuity Test
& Diode Check



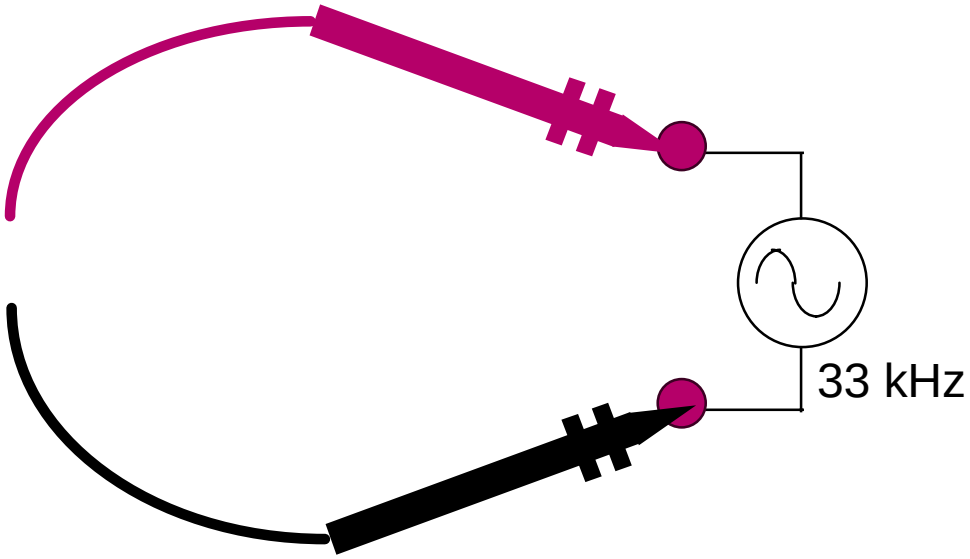
Open or Closed Circuit.

Cont = Continuity test

Shift  = Diode check

Measuring Frequency & Period

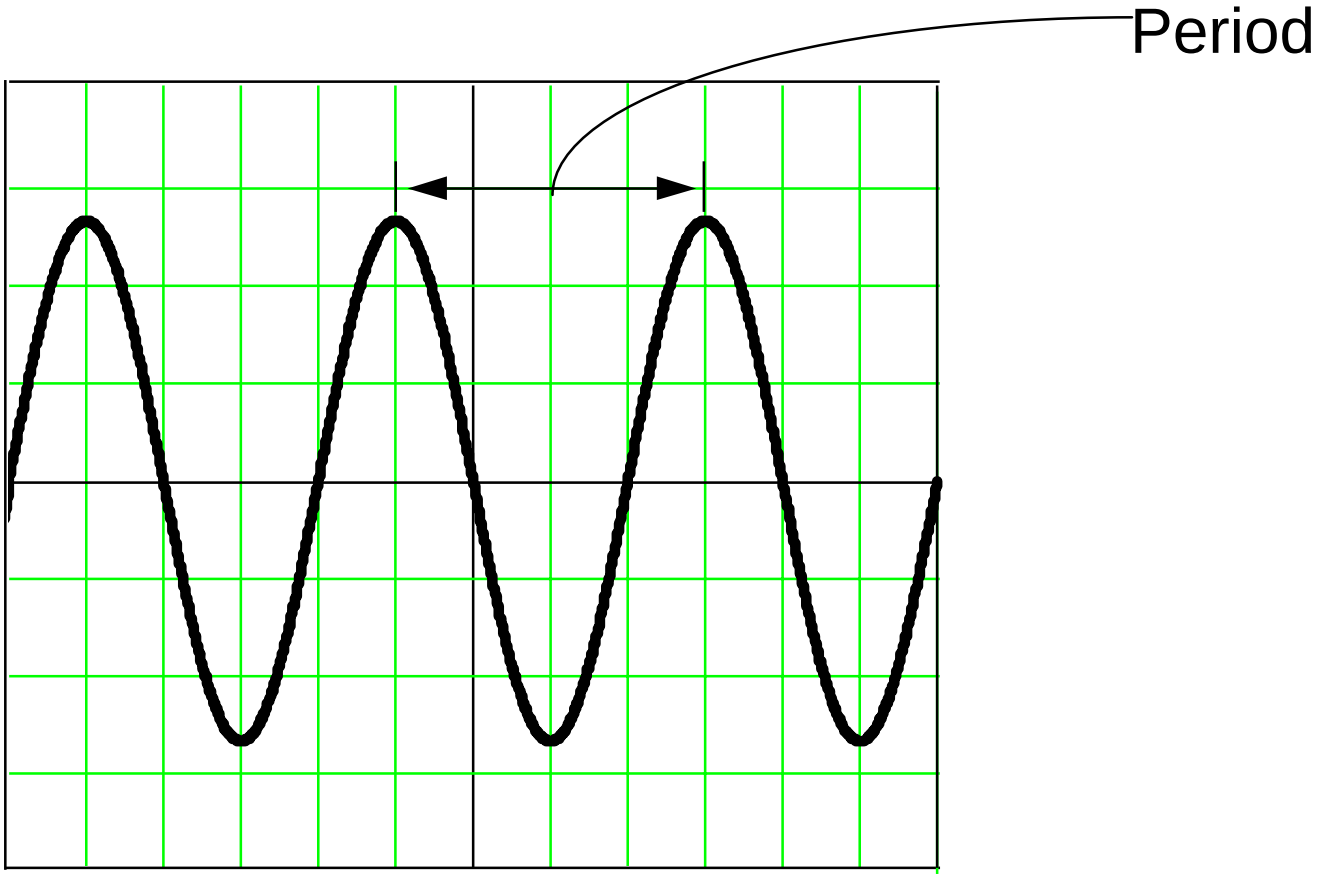
33.000,0 kHz



Freq = Measure Frequency

Shift Period = Measure Period

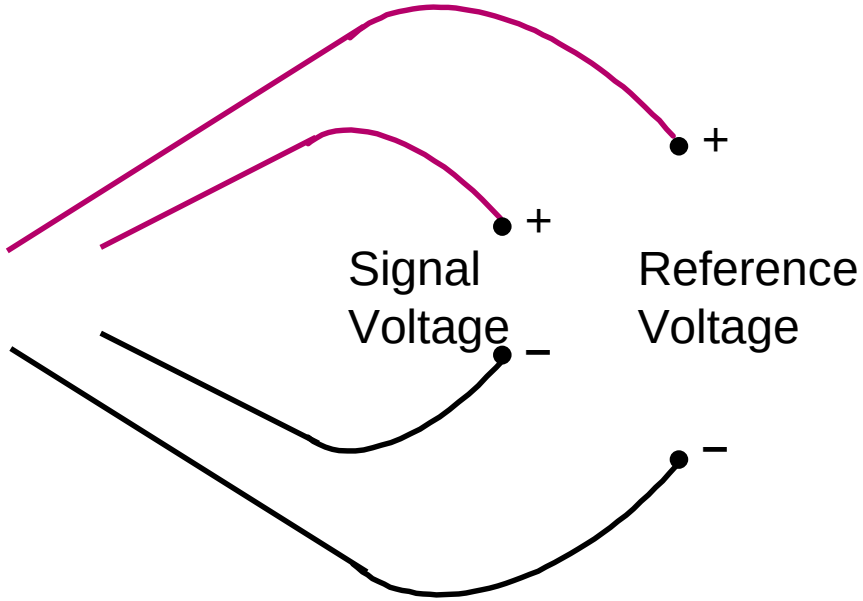
Frequency and Period



Frequency = 1/Period

Ratio Measurements

DCV : DCV



$$\text{Ratio} = \frac{\textit{dc signal voltage}}{\textit{dc reference voltage}}$$

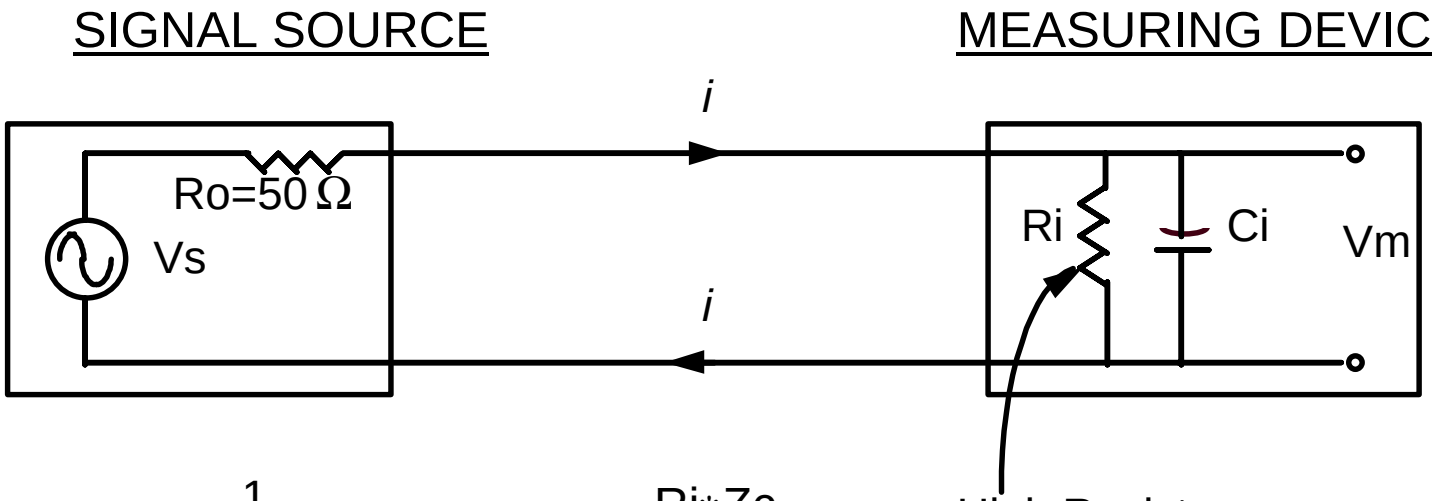
*To enable ratio measurements, use the MEAS menu.

Voltage
RMS vs. Peak

Waveform	Vrms	Vp
sine	1.0	1.414
triangle	1.0	1.733
square	1.0	1.0
DC	1.0	1.0

* Peak voltage = 1/2 of Peak to Peak voltage

High Z Termination



$$Zc = \frac{1}{j\ 2\pi f\ C}$$

$$Zin = \frac{Ri * Zc}{Ri + Zc}$$

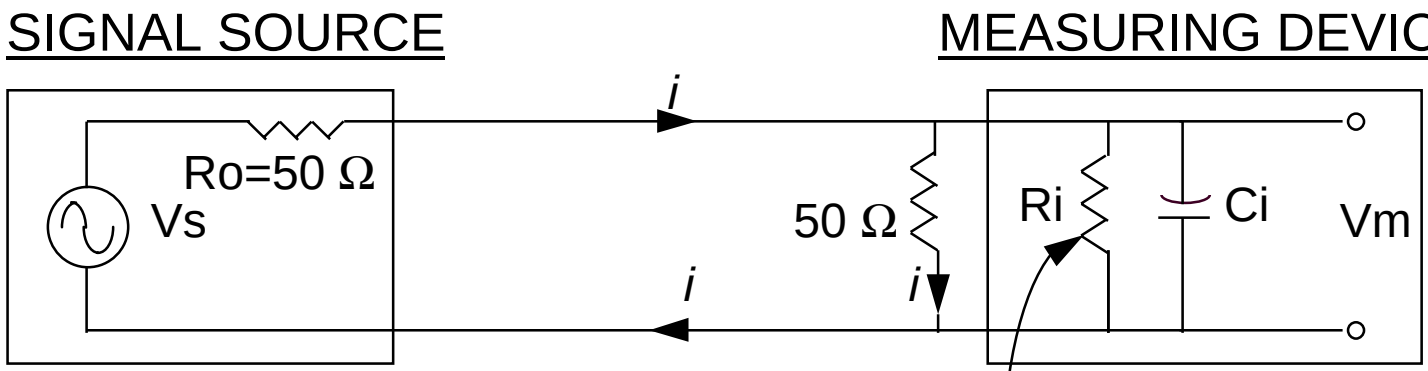
$$Vs = \left(1 + \frac{Ro}{Zin}\right) * Vm$$

. . . . for very large Zin, Vs $\cong$ Vm

As frequency increases, Zin decreases

For less than 1% error Zin $\geq$ 100 Ro

50 Ω Termination



$$Vs = \left(1 + \frac{50\Omega}{50\Omega}\right) * Vm$$

$$Vs = 2 * Vm$$

$$Vm = \left(\frac{1}{2}\right) * Vs$$

*Vm will not equal Vs, if Zin = Ro, but the ratio between them is 2:1.

Remote Interface

HP-IB (IEEE-488) Address:

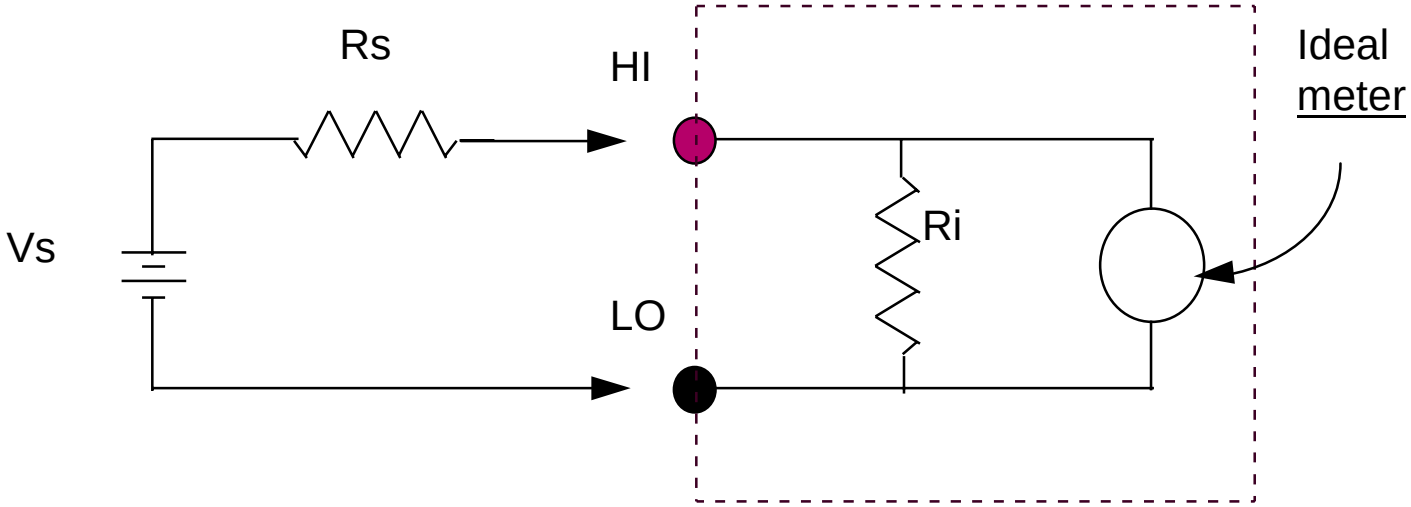
Can be any value between 0 - 31. Factory set at 21.
Address 31 is talk only mode.
Adjustable only through the I/O menu.

RS-232 Interface:

Baud rate must be selected (I/O menu): 300, 600, 1200, 2400, 4800, or 9600.
Parity selection (I/O menu): Even or Odd

Programming Languages	HP-IB	RS-232
SCPI Language	✓	✓
HP 3478A Language	✓	Not allowed
Fluke 8840A Language	✓	Not allowed

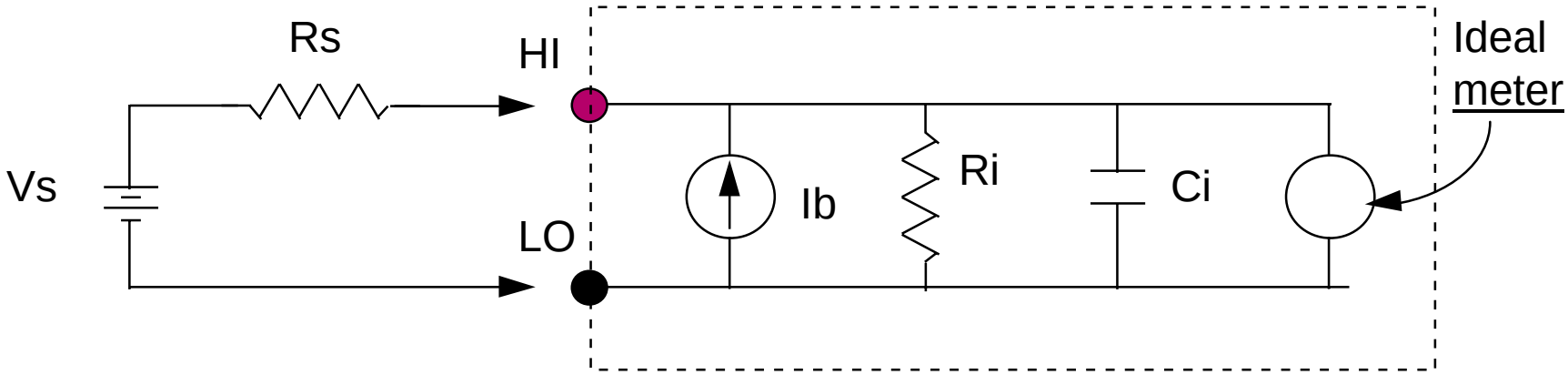
Loading Errors (DC volts)



Vs = ideal DUT voltage
Rs = DUT source resistance
Ri = multimeter input resistance
(10 MΩ or > 10 GΩ)

$$\text{Error}(\%) = \frac{100 * Rs}{Rs + Ri}$$

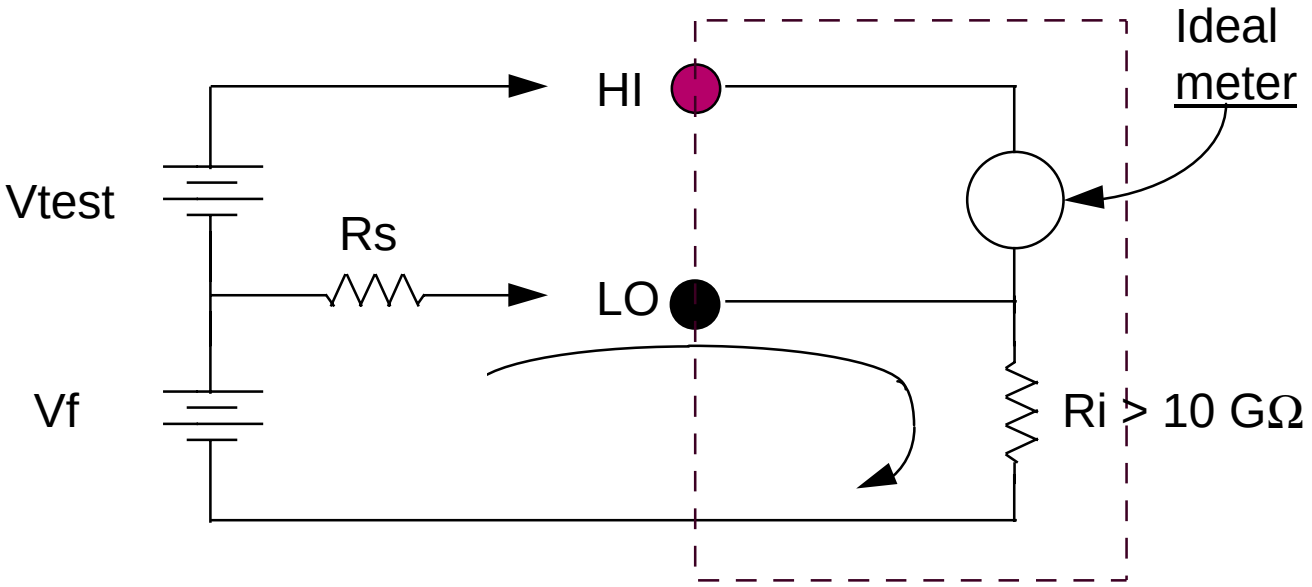
Leakage Current Errors



Ib = multimeter bias current
Rs = DUT source resistance
Ci = multimeter input capacitace

Error(v) $\cong$ Ib $*$ Rs

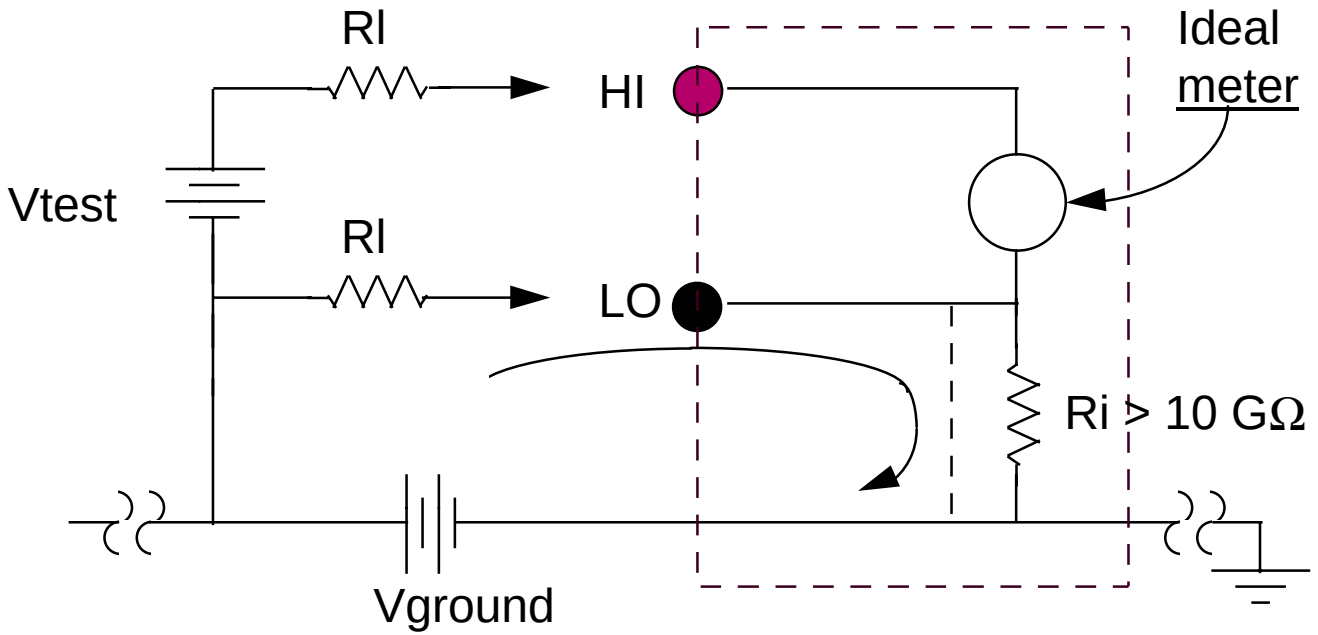
Common Mode Rejection (CMR)



Vf = float voltage
Rs = DUT source resistance imbalance
Ri = multimeter isolation resistance

$$\text{Error(v)} = \frac{Vf * Rs}{Rs + Ri}$$

Noise caused by Ground Loops



Rl = lead resistance
Ri = multimeter isolation resistance
Vground = voltage drop on ground bus

The DIGITAL MULTIMETER

Hints for Accurate Measurements:

- Measure as near full scale as possible
- Use a Ratio measurement whenever possible.
- Before measuring, short the test leads together to check for offsets. (Exception: RMS AC measurements)

Where to get more information

- HP 34401A User's Guide
- HP 34401A Service Guide
- For on-line technical information call HP Direct at 1-800-452-4844