TWENTIETH ANNUAL

TestConX™

March 3 - 6, 2019

Hilton Phoenix / Mesa Hotel
Mesa, Arizona

Archive

COPYRIGHT NOTICE

www.testconx.org

Current measurement using non-linear passive device

Thomas Bowns

Intel Corporation Manufacturing Validation

TestConX

Mesa, Arizona • March 3 - 6, 2019

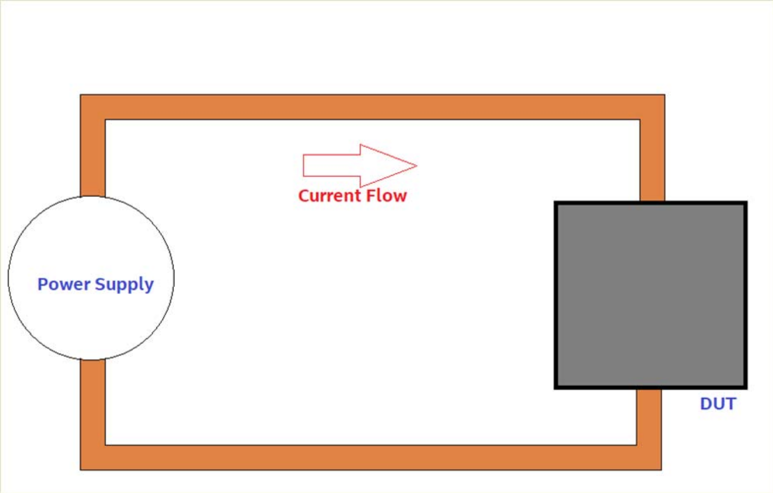
2000 - 2019 20 YEARS ANNIVERSARY

Contents

- Introduction: Measuring Power
- Linear Passive Device
- What's Wrong with Resistors?
- A Different Straight Line
- Practical Considerations
- Further Exploration

Introduction: Measuring Power

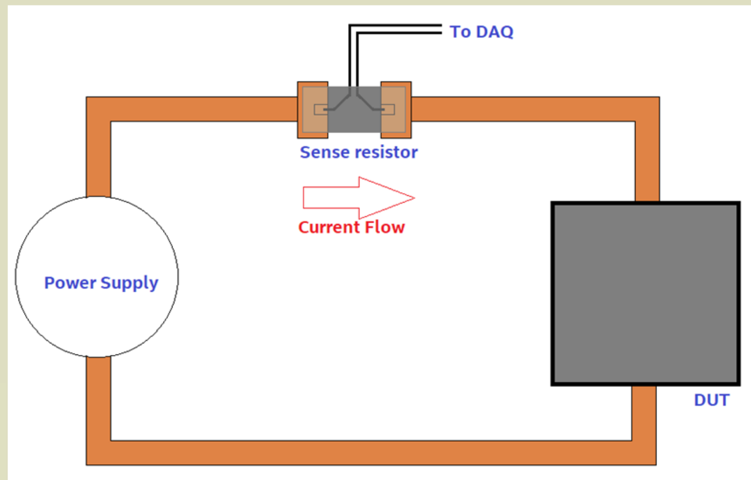
To measure system power consumption by a DUT, some means must be introduced into the circuit to sense the current flow while circuit is in operation.



Linear Passive Device

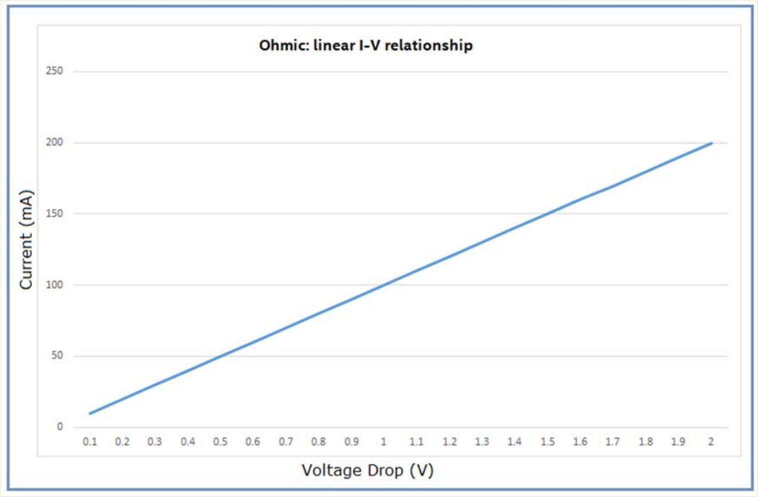
System power is typically sensed by passing current through a very low resistance shunt, and measuring the voltage drop developed.

Using Ohm's law: voltage measured across the shunt divided by the resistance of the shunt gives the current through the shunt.



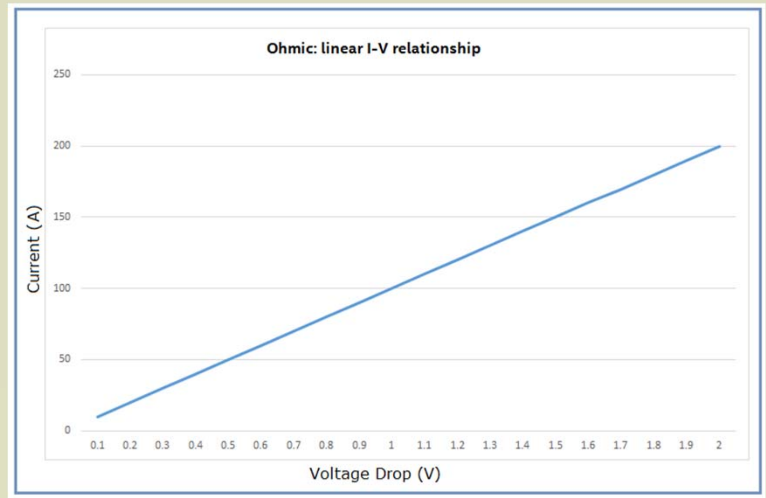
Linear Passive Device

- Effective range of a 10 ohm shunt resistor circuit: 10 to 200 mA.



What's Wrong with Resistors?

- Effective range of a 10 mOhm shunt resistor circuit: 10 to 200 A.
- Range is narrow in either case; must swap resistors out depending upon whether measuring high currents or low currents.



An idea!

courtesy: FreePNGImg.com

I mean… a really crazy idea!

courtesy: gleeza.blogspot.com

Current Measurement Using Non-Linear Passive Device

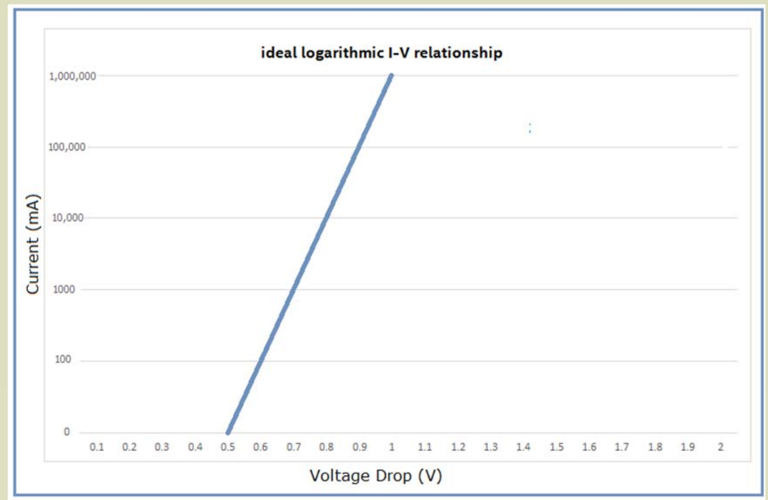
8

What if…

The sense device V/I relationship ***wasn't*** linear!

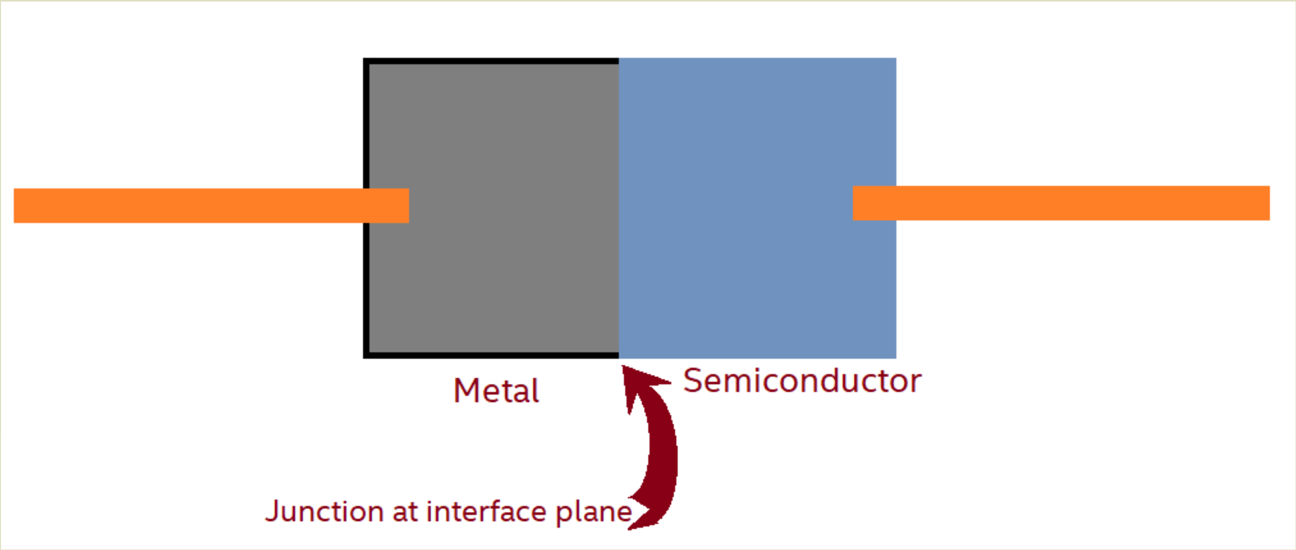
How about a *different* straight line!

- Theoretical passive device presents a logarithmic forward current to voltage drop ratio.
- Voltage drop range limited and measurable regardless of forward current: higher rate of change at low current, smaller rate of change at high current.



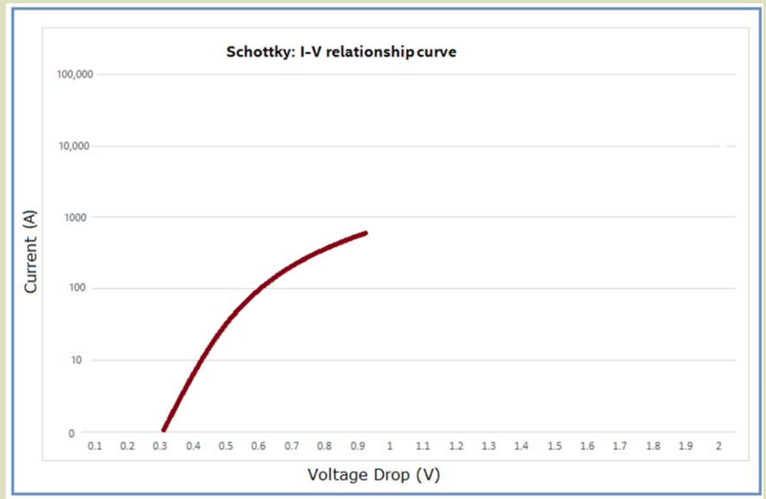
Current Measurement Using Non-Linear Passive Device 10

Presenting: the Schottky Junction



The Schottky Junction

- Metal-semiconductor junction typically used in high speed switching.
- Benefit of relatively low forward voltage drop.
- Schottky junction exhibits a transfer function that is close to logarithmic.



Some theoretical results

Current (A)	Measured voltage drop (V)
0.1	0.26
0.5	0.27
1	0.3
5	0.34
10	0.38
50	0.47
100	0.52
250	0.7

TestConX

Current Measurement Using Non-Linear Passive Device 13

2000-2019 20 YEARS ANNIVERSARY

Practical Considerations and Ideas

- Schottky Junctions typically exhibit a significant thermal response. At higher junction temperatures, forward voltage drop is reduced quite a bit; as much as 200%.
- This would require additional compensation circuitry, including an adjacent temperature sensor and derating factor logic within the data acquisition unit (DAQ).
- Forward voltage drop, though fairly low, is still significant in typical SOC circuits: 0.3 V to 0.6 V would be unacceptable in measuring 0.95 V circuit without remote sense.

Further Exploration

There are a number of factors that comprise the Schottky junction: including metal type, semiconductor material, doping level and spread, junction interface material, and wire bond method.

Each of these factors contributes to forward voltage drop, current capacity, rectification and thermal reactivity.

Further exploration into use of the Schottky junction will lead to more practical applications beyond high speed rectification and switching, including applications leveraging its characteristic current to voltage curve.