prospective touch voltage

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Product Safety

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outline

why?

what's touch voltage?

what's "prospective" touch voltage?

how do we measure it today?

what's good/bad about that?

proposed approach and why?

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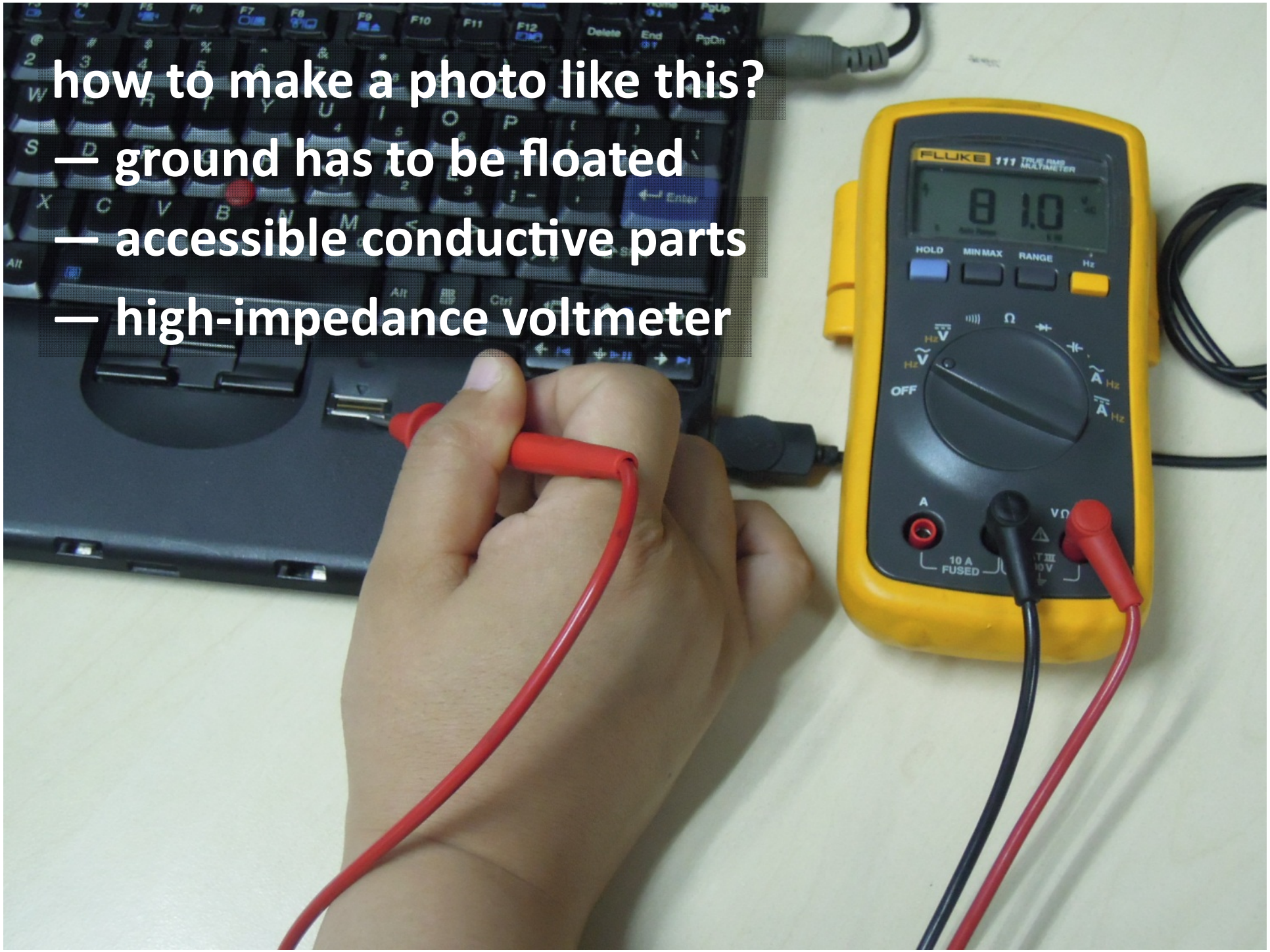
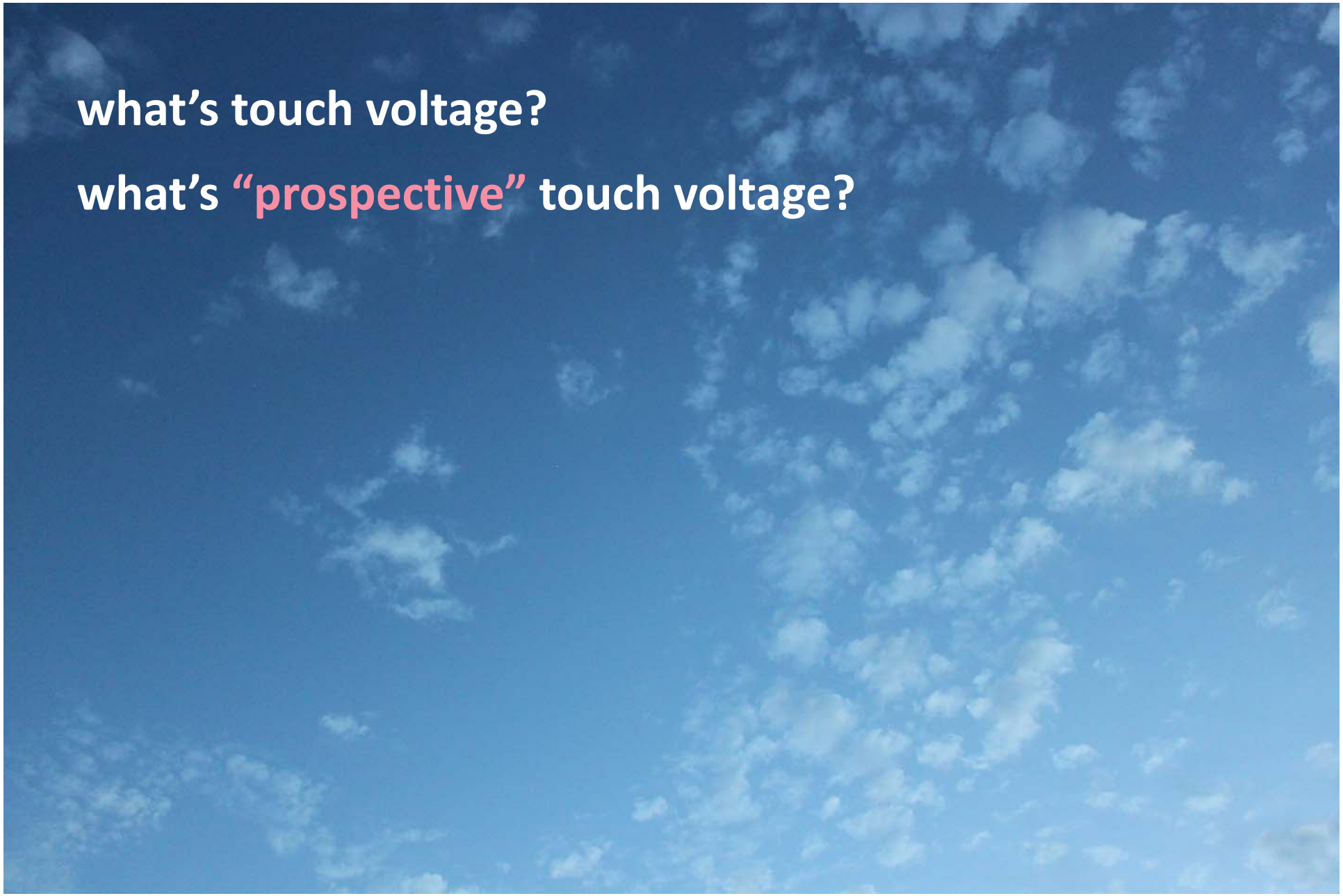
102.19VAC!?


how to make a photo like this?
— ground has to be floated
— accessible conductive parts
— high-impedance voltmeter
FLUKE 111
HOLD
MIN MAX
RANGE
OFF
10 A FUSED



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ELECTROPEDIA

(effective) touch voltage [IEV 195-05-11; 826-11-05]

- **voltage between conductive parts when touched simultaneously by a person or an animal.**
  - NOTE – The value of the effective touch voltage may be appreciably influenced by the impedance of the person or the animal in electric contact with these conductive parts.

“prospective” touch voltage [IEV 195-05-09; 826-11-03]

- **voltage between simultaneously accessible conductive parts when those conductive parts are not being touched by a person or an animal.**
  - SOURCE: 826-02-03 MOD

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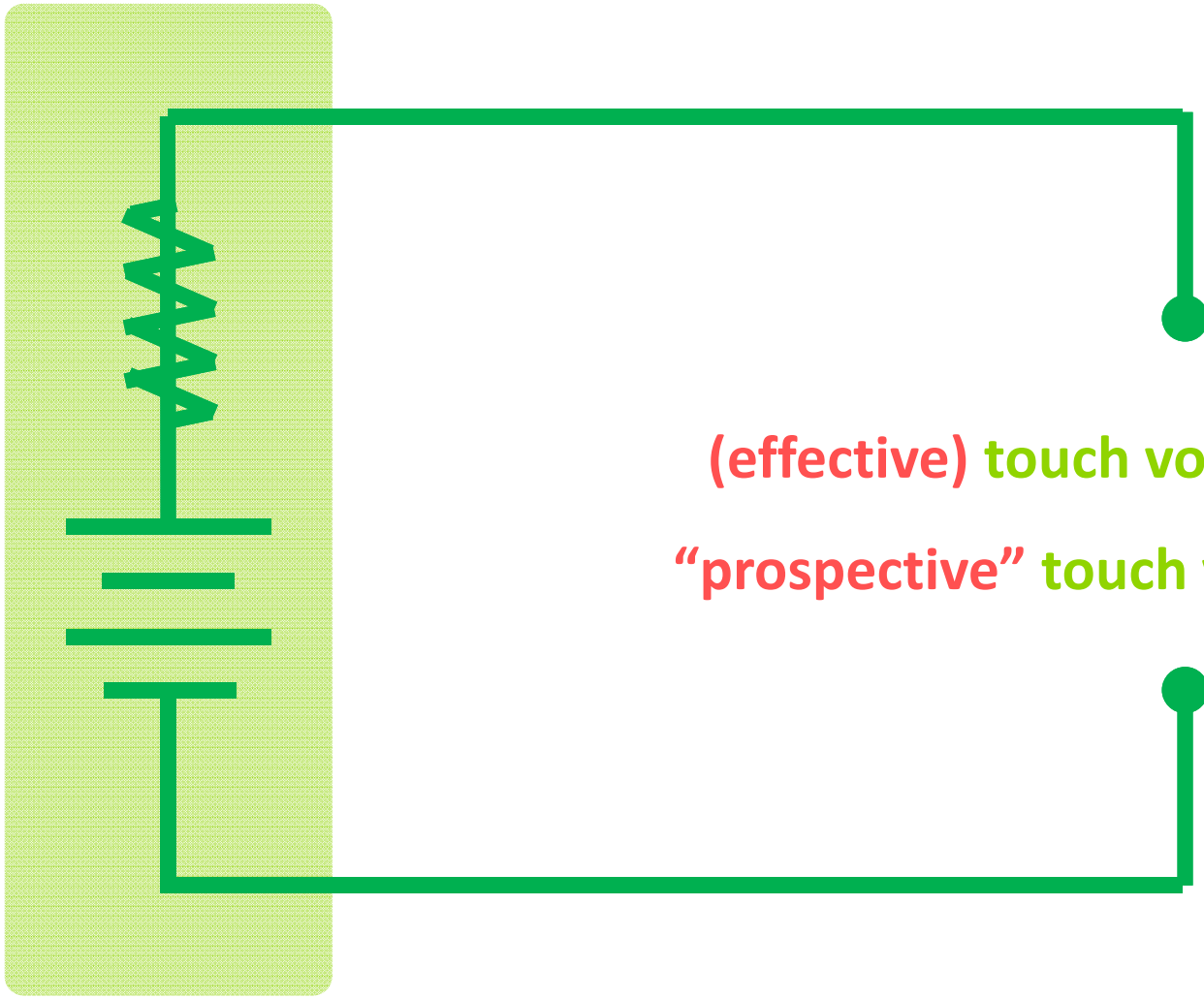

(effective) touch voltage, or

“prospective” touch voltage?

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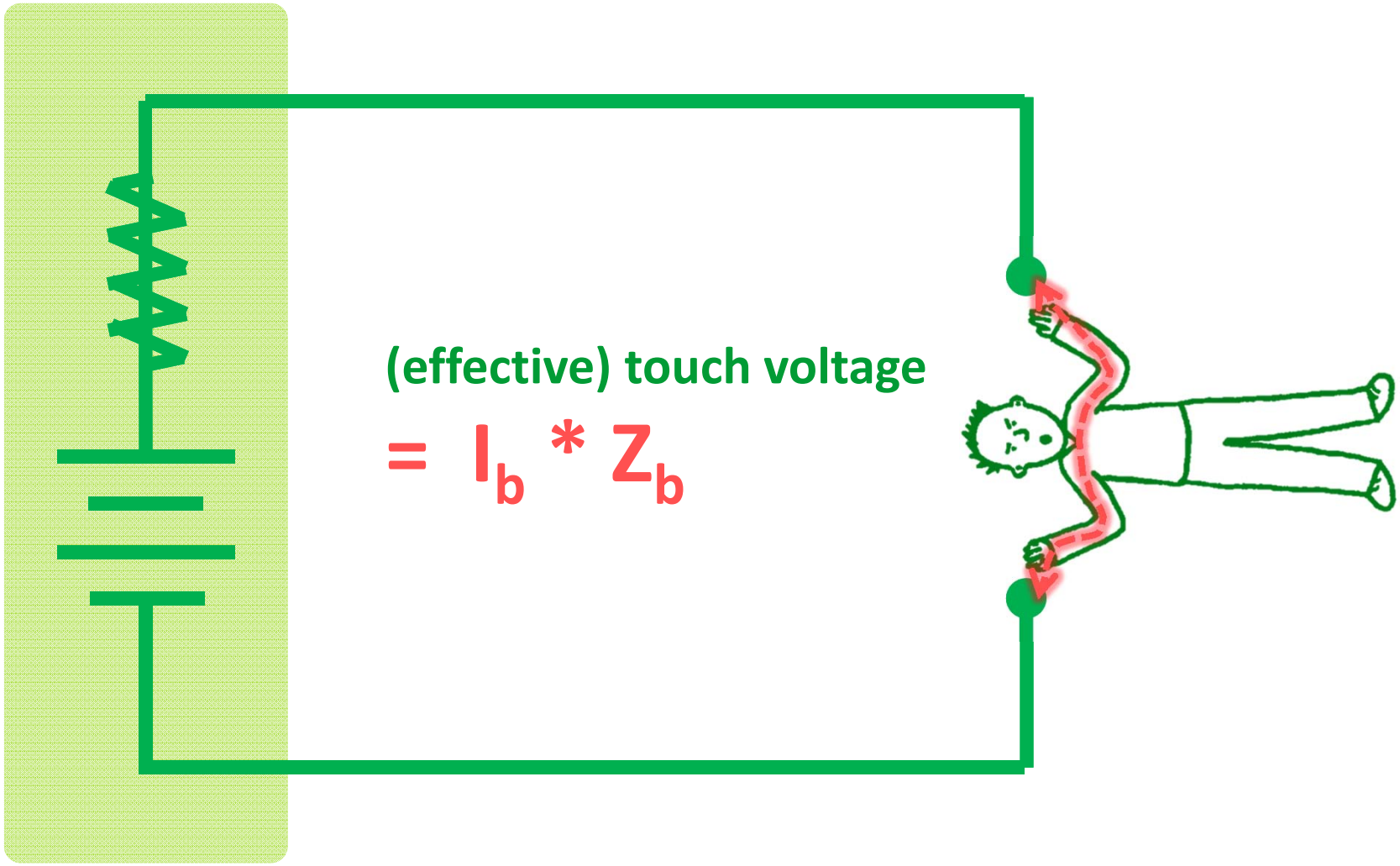

for parts that are touched simultaneously
—it's (**effective**) touch voltage;
(it could be "**prospective**" touch voltage too.)

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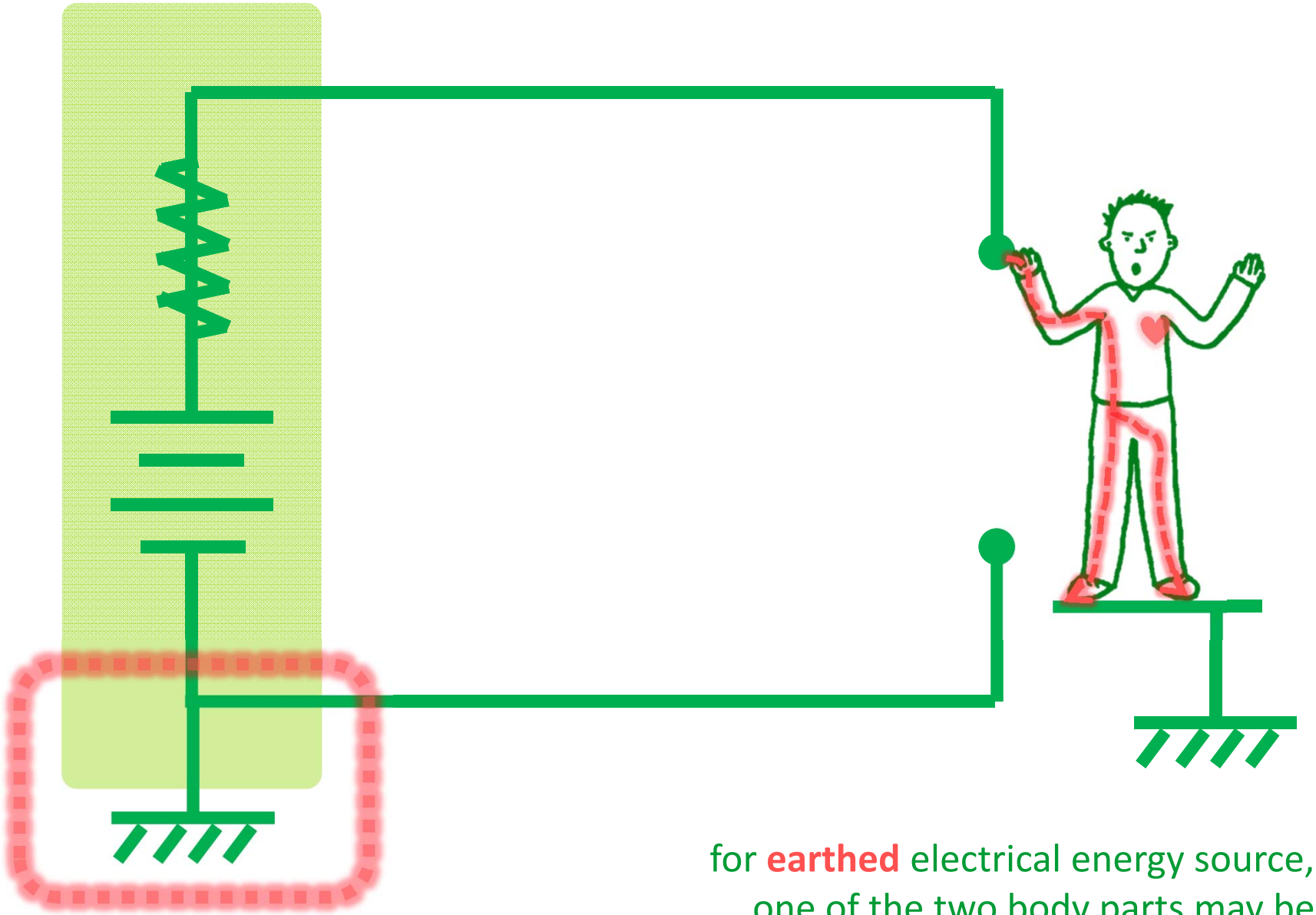

for **earthed** electrical energy source,
one of the two body parts may be
grounded on which the person stands.

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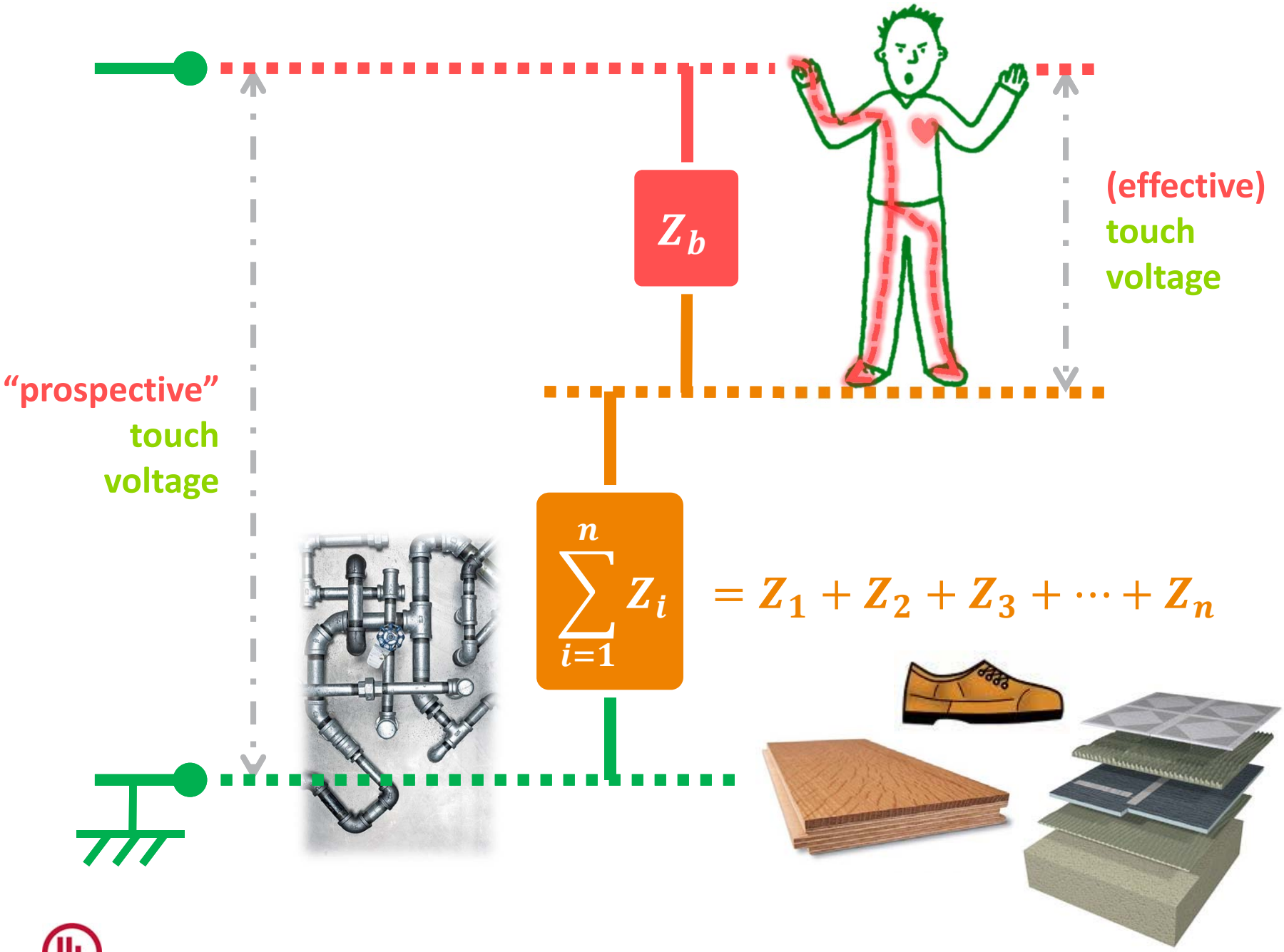

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what's good/bad about current practice?

- ✓ prospective touch voltage by voltmeter;
- ✓ touch current measurement if prospective touch voltage exceeds 60VDC/30VAC/42.4VPK;
- ✓ will be classified as hazardous live if both voltage and current limits are exceeded.

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annex W (informative) — summation of touch current

two quite different mechanisms:

- earthed, and
  - an "earthed" circuit means that the circuit is either
    a) directly earthed or
    b) in some way referenced to earth so that its potential with respect to earth is fixed.
- unearthed (floating)
  - which can exist in CLASS I EQUIPMENT and earthed circuits in CLASS II EQUIPMENT.

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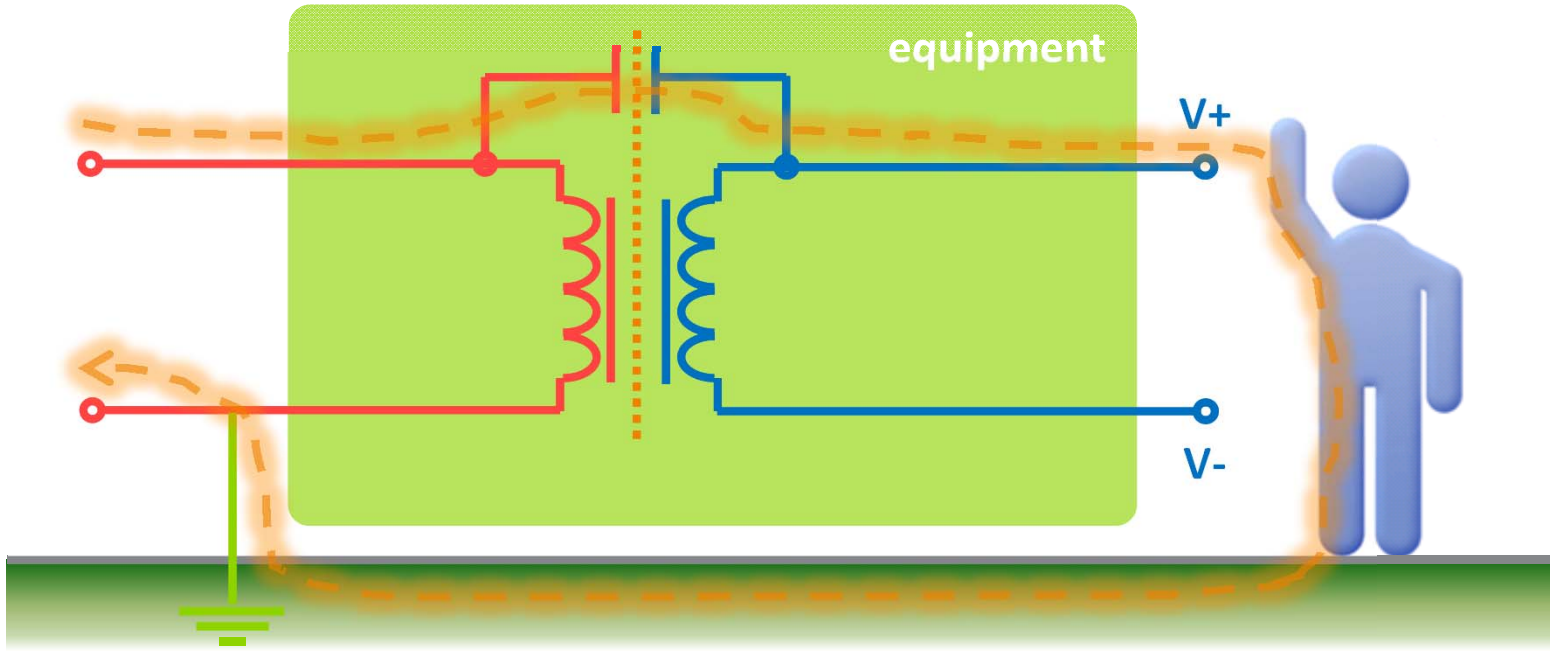
W.1—unearthed (floating) circuits

- this current comes from a relatively high voltage, high impedance source, and its value is largely unaffected by the operating voltage on the electronic circuit.



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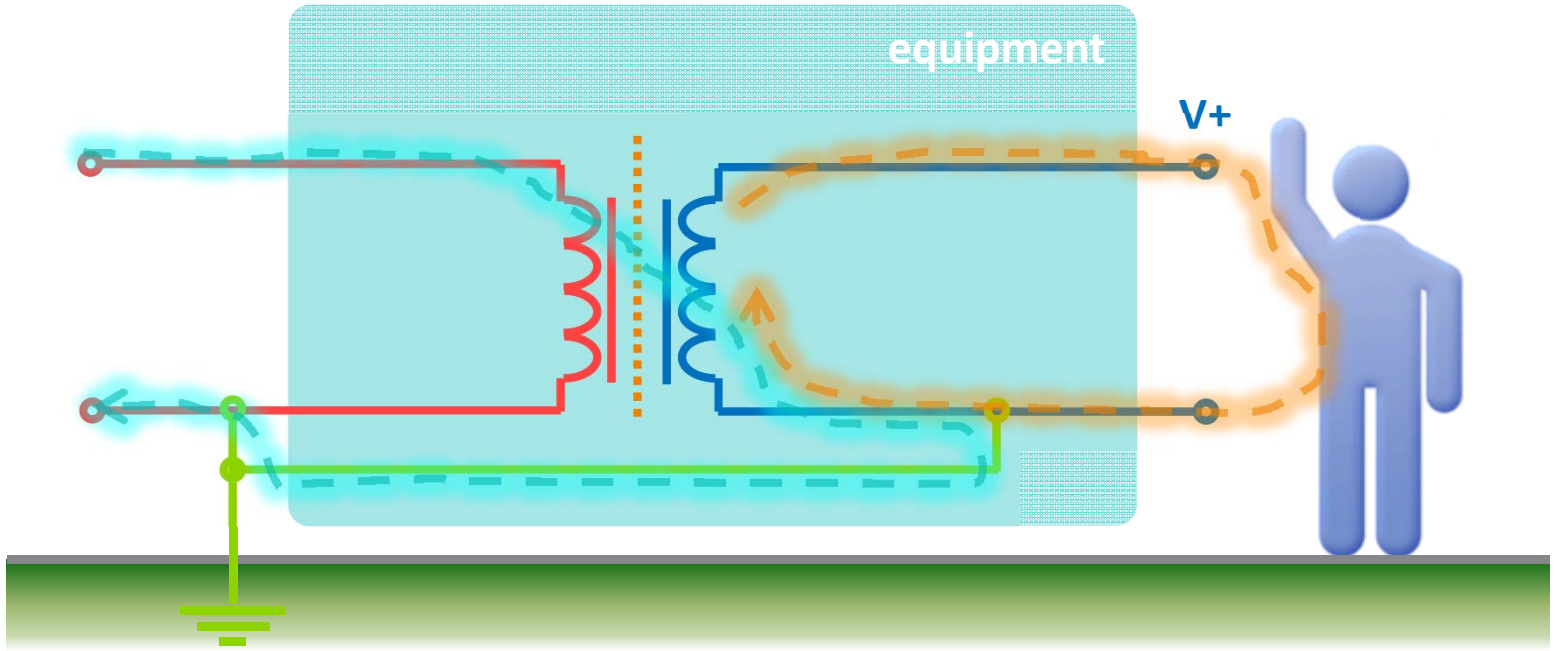
W.2—earthed circuits

- the current through the human body (Iv) is due to the operating voltage (V+) of the circuit, which is a source of low impedance compared with the body.



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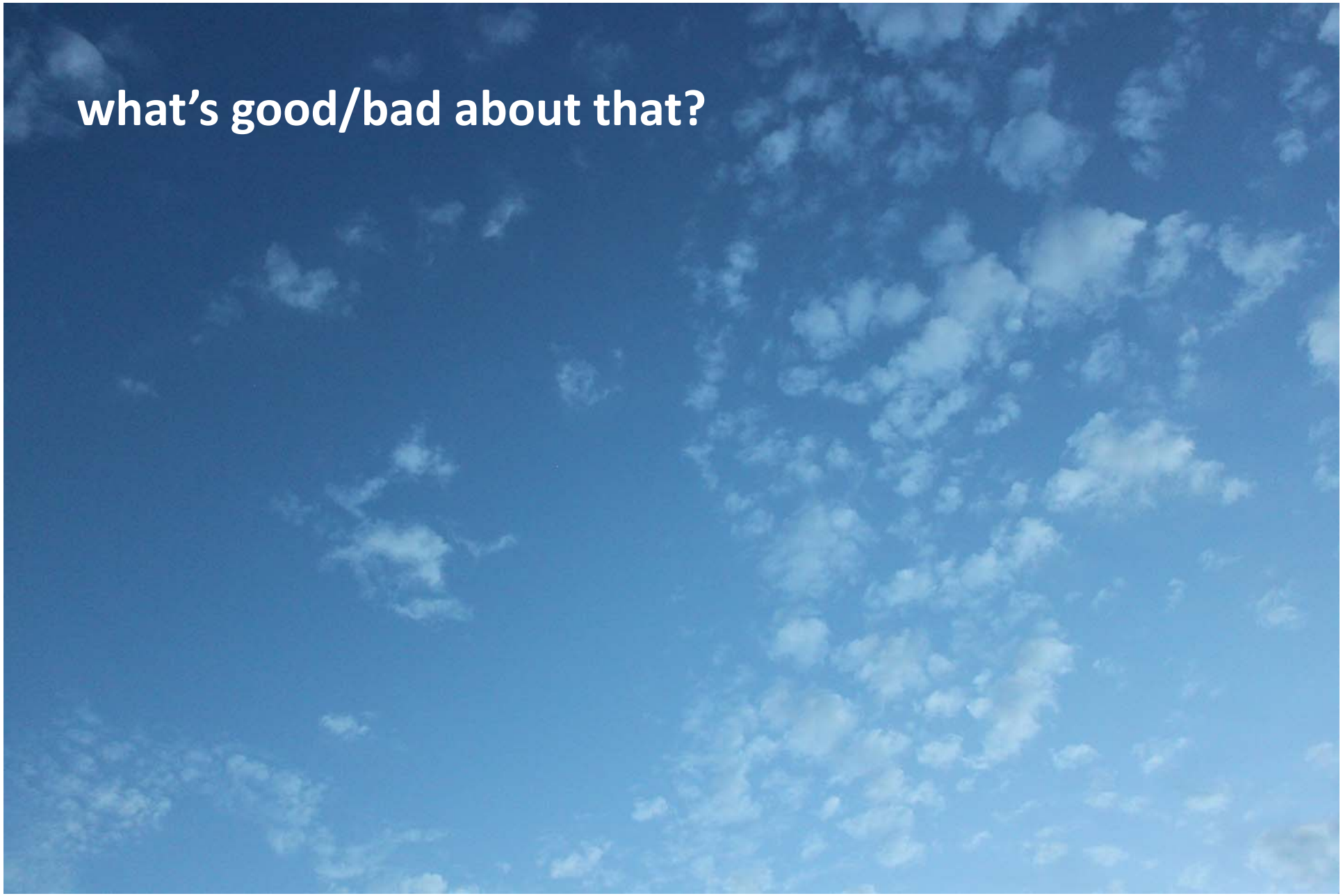
what's good/bad about that?



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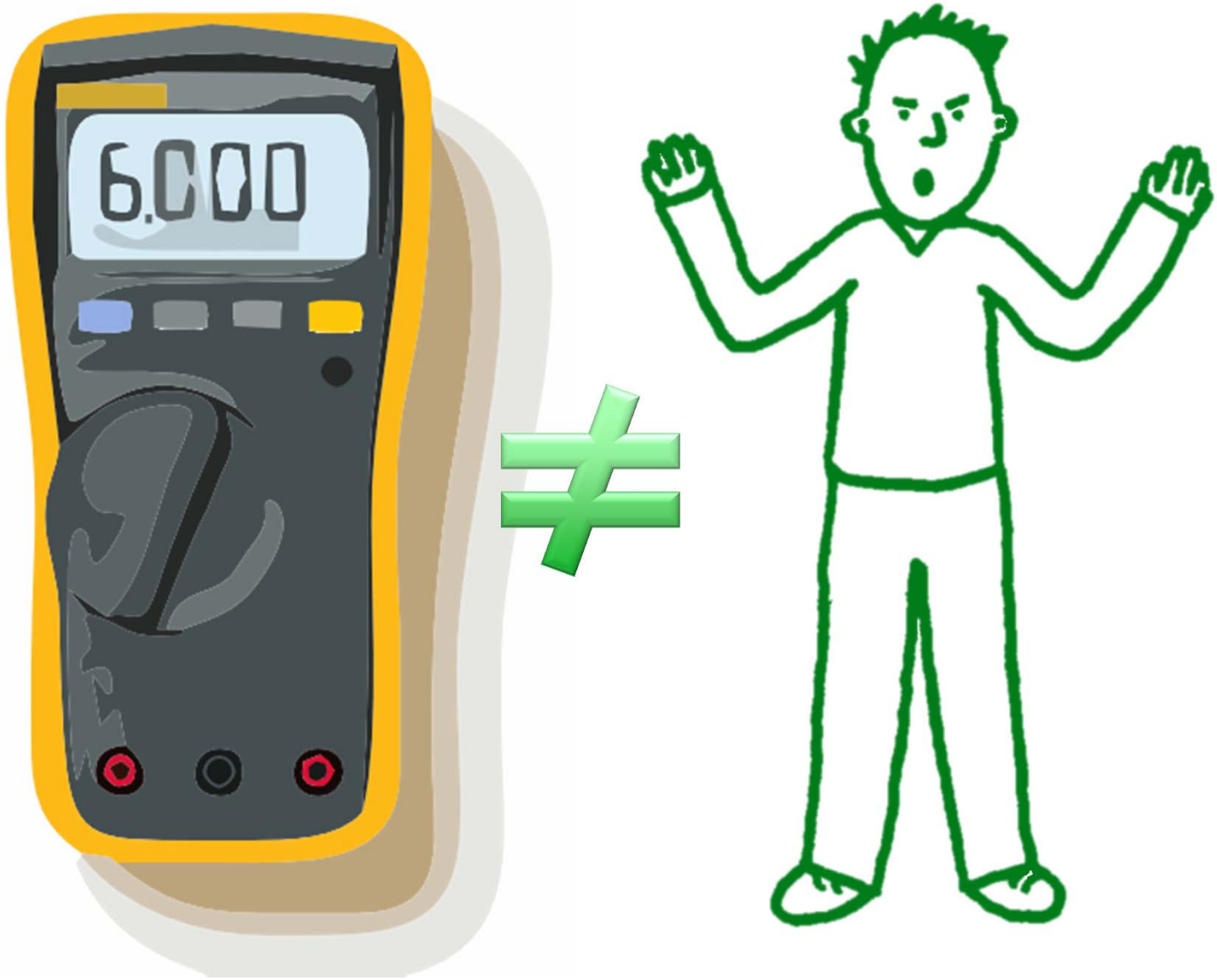

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accessible conductive parts/circuits

Z INSULATION e.g., bridging capacitors

R INSTRUMENT = 2k or 5k or ∞

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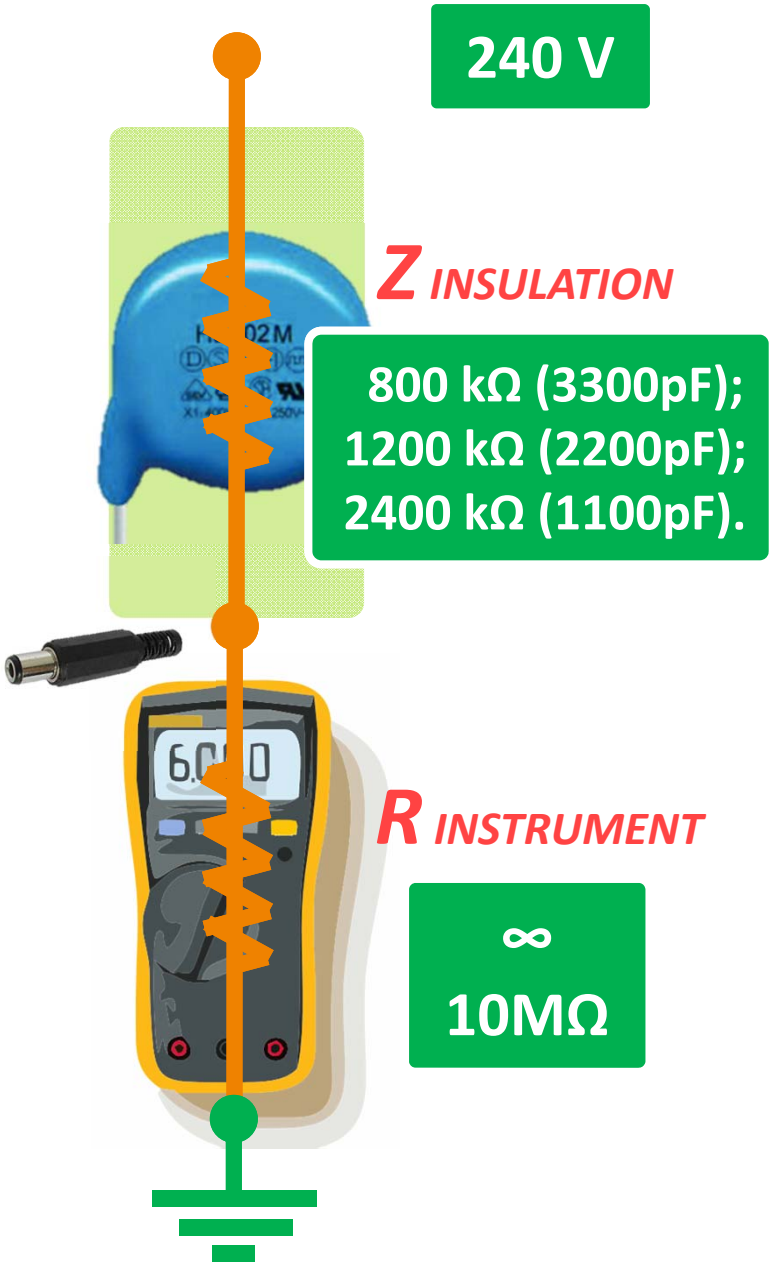
if $R_{INSULATION} << R_{INSTRUMENT}$

measured voltage =

- 240V (∞);
- 222.22V (10MΩ; 3,300pF)
- 214.29V (10MΩ; 2,200pF)
- 193.55V (10MΩ; 1,100pF)



$$V_{out} = V \frac{R_{instrument}}{R_{insulation} + R_{instrument}}$$

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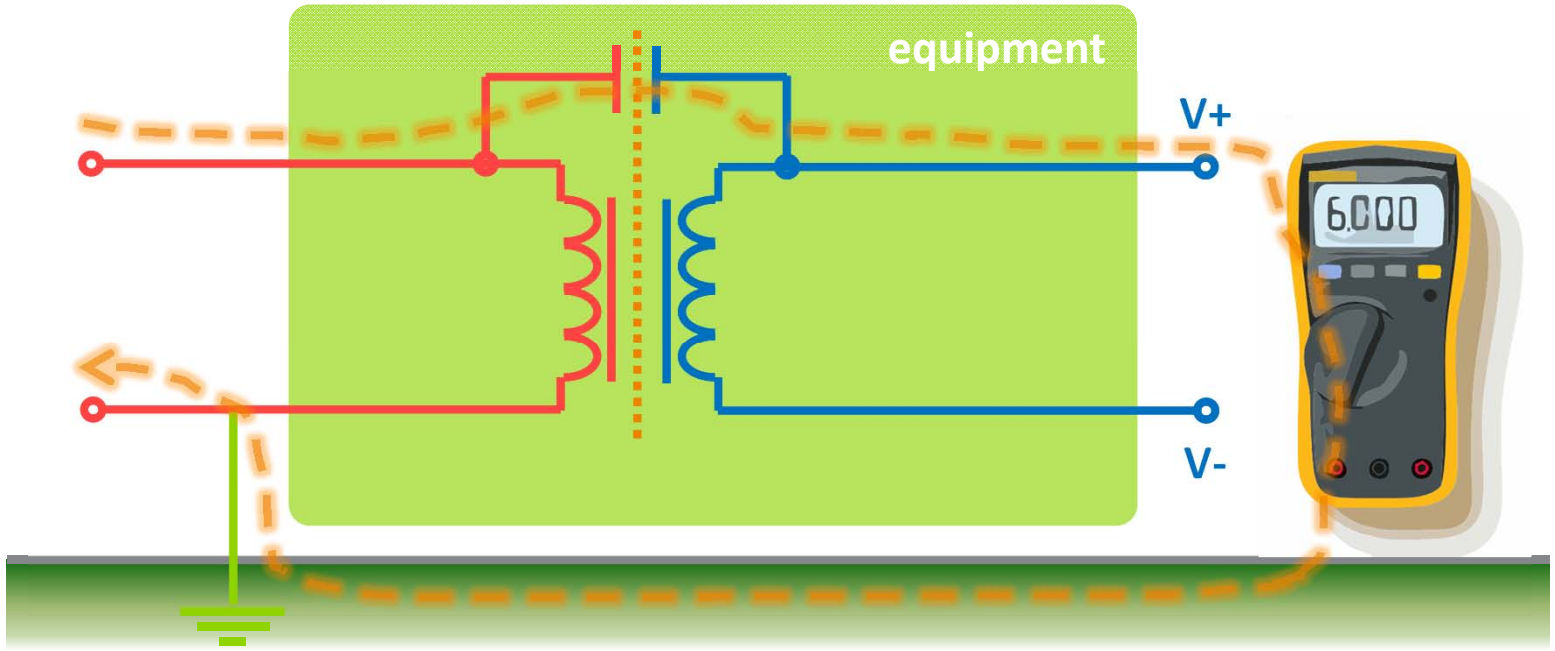
measurement of prospective touch voltage is largely useless in unearthed (floating) circuits



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if $R_{INSULATION} >> R_{INSTRUMENT}$

measured voltage =

- 0.60V (2kΩ; 3,300pF)
- 0.40V (2kΩ; 2,200pF)
- 0.20V (2kΩ; 1,100pF)
- 1.49V (5kΩ; 3,300pF)
- 1.00V (5kΩ; 2,200pF)
- 0.50V (5kΩ; 1,100pF)
- 14.12V (50kΩ; 3,300pF)
- 9.60V (50kΩ; 2,200pF)
- 4.90V (50kΩ; 1,100pF)

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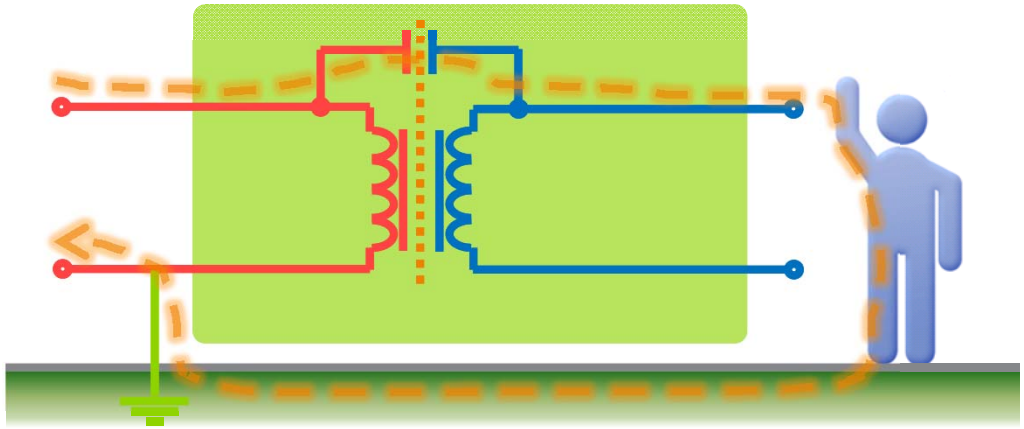
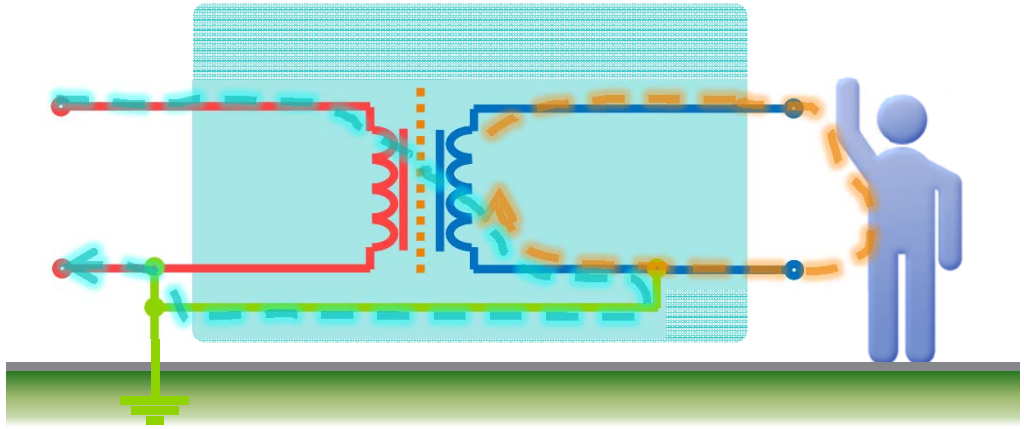


prospective touch voltage measurement is largely useless in unearthed (floating) circuits



prospective touch voltage works satisfactorily in earthed circuits

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any alternative?

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Annex A
(normative)

Test to establish whether a conductive part is a live part which may cause an electric shock

A.1 In order to determine whether a conductive part is a live part which may cause an electric shock, the lamp controlgear is operated at rated voltage and nominal supply frequency, and the following tests are conducted.

A.2 The part concerned is a live part if a current of more than 0,7 mA (peak) or 2 mA d.c. is measured.

For frequencies above 1 kHz, the limit of 0,7 mA (peak) is multiplied by the value of the frequency in kilohertz, but the result shall not exceed 70 mA (peak).

The current flowing between the part concerned and earth is measured.

Compliance is checked by measurement in accordance with Figure 4 and 7.1 of IEC 60990.

A.3 The voltage between the part concerned and any accessible part is measured, the measuring circuit having a non-inductive resistance of 50 kΩ. The part concerned is a live part if a voltage of more than 34 V (peak) is measured.

For the above test, one pole of the test supply shall be at earth potential.

touch voltage measurement in IEC 61347-1

divide $34V_{peak}$ ($24V_{rms}$)

by 50kΩ,

you get the correspondent current is

- $0.68mA_{peak}$ ($0.48mA_{rms}$) which is about:
- $0.70mA_{peak}$ ($0.50mA_{rms}$)

or rather it's rounded from 48kΩ (24V/0.5mA)

what if $42.4V_{peak}$ ($30V_{rms}$) is applied?

- 60kΩ may be used.

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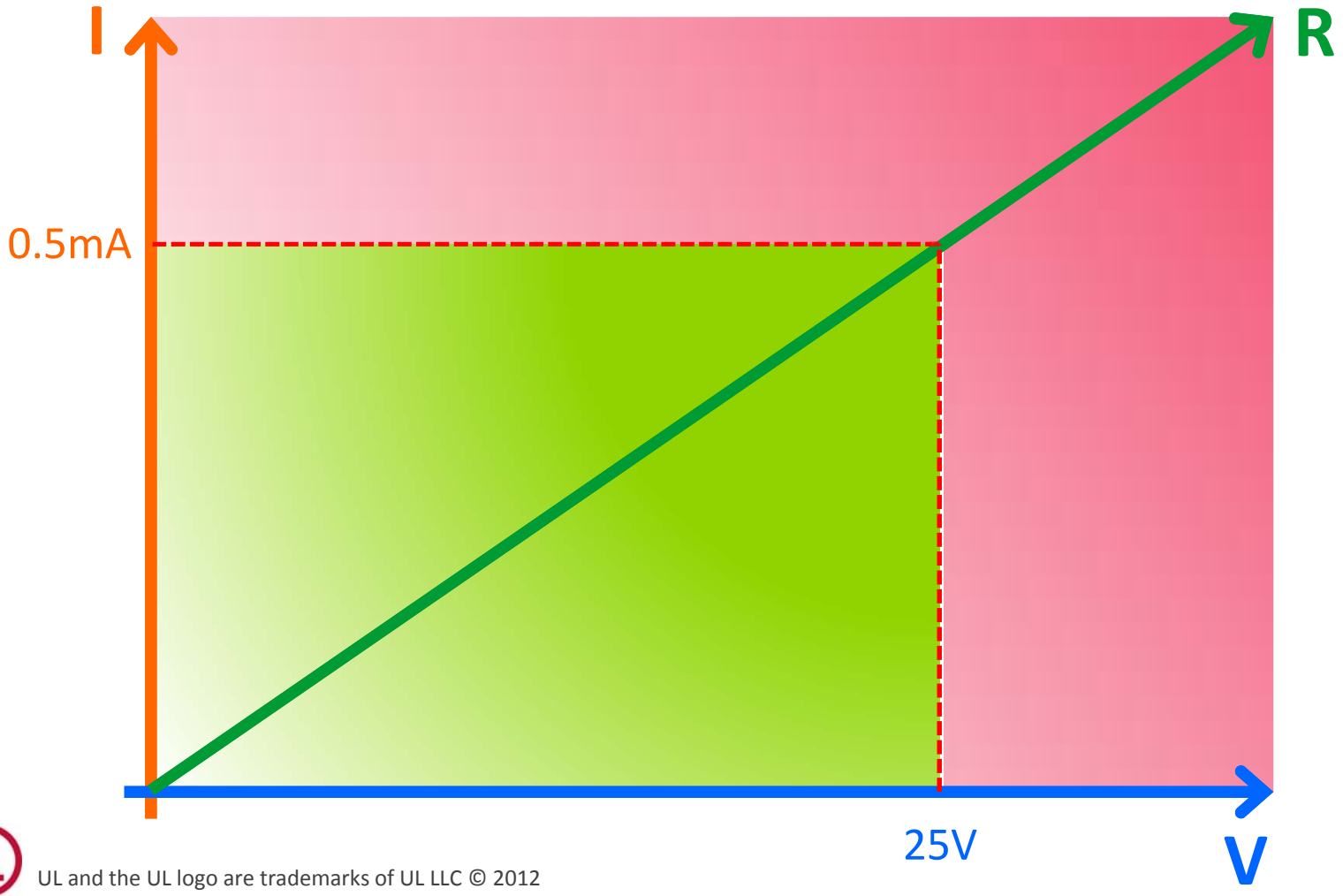
a voltage across 50kΩ not exceeding $34V_{peak}$ means the resultant electric current will not exceed $0.68mA_{peak}$ (≈$0.7mA_{peak}$)



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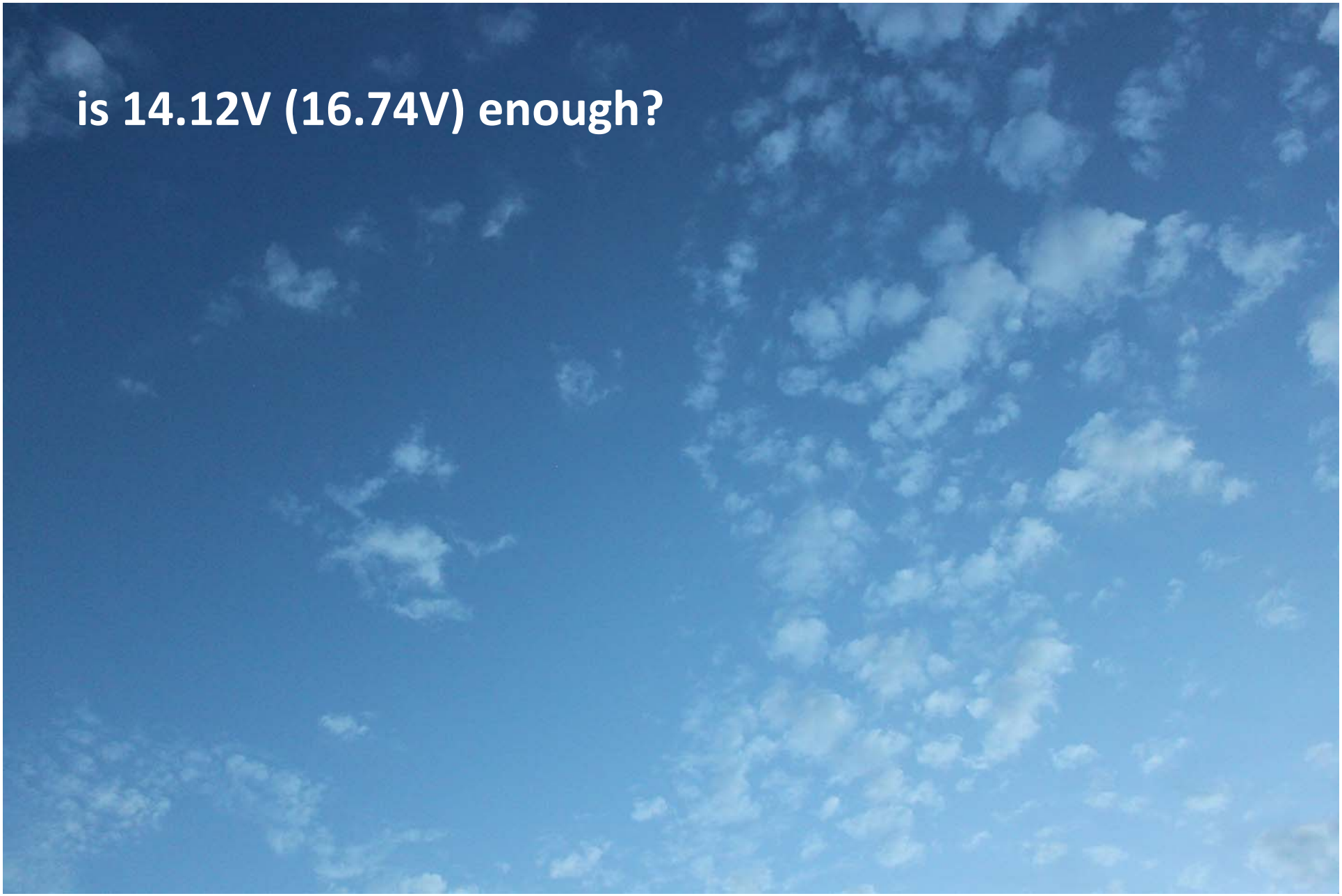
is 14.12V (16.74V) enough?



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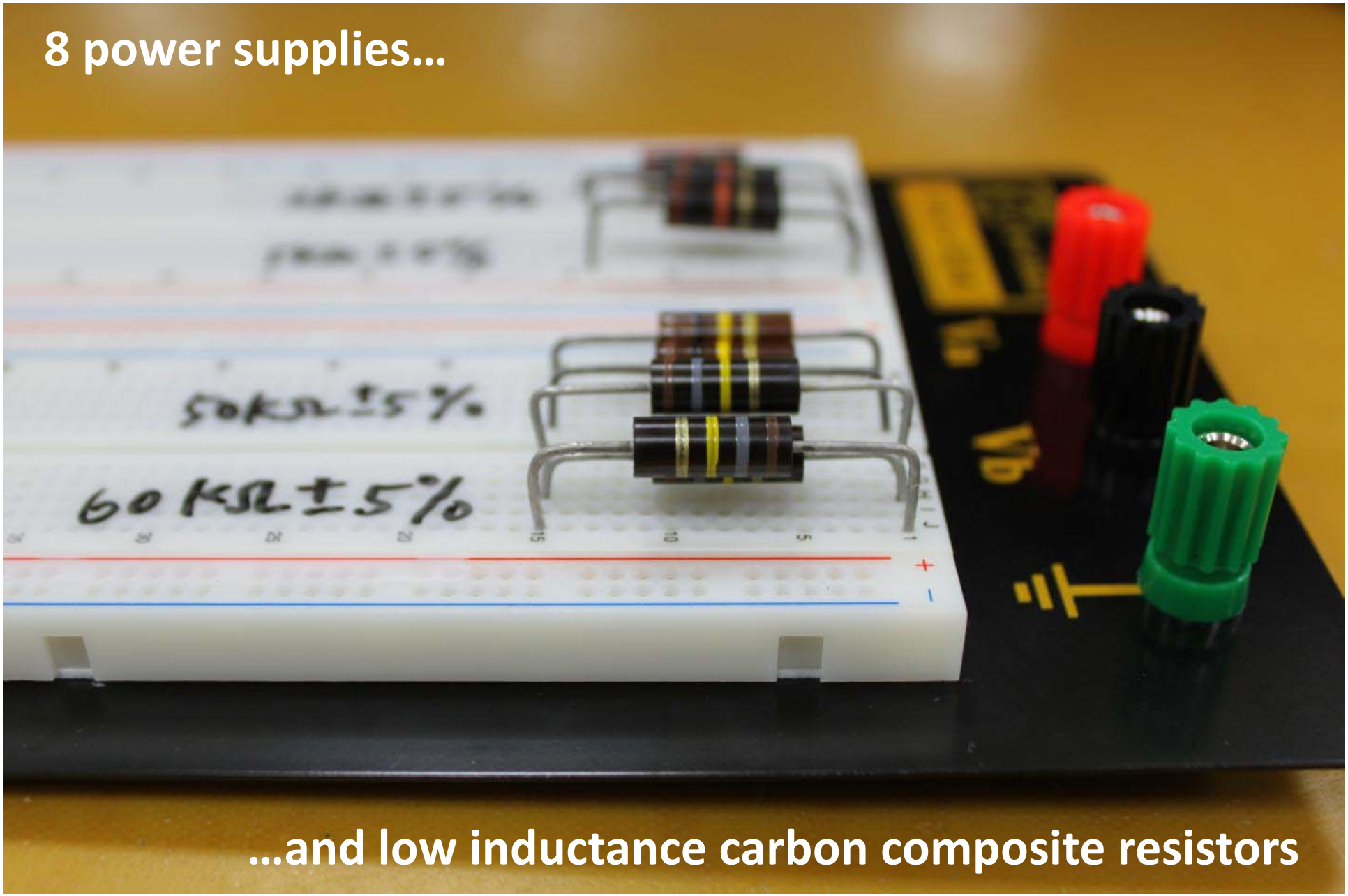
8 power supplies…



…and low inductance carbon composite resistors

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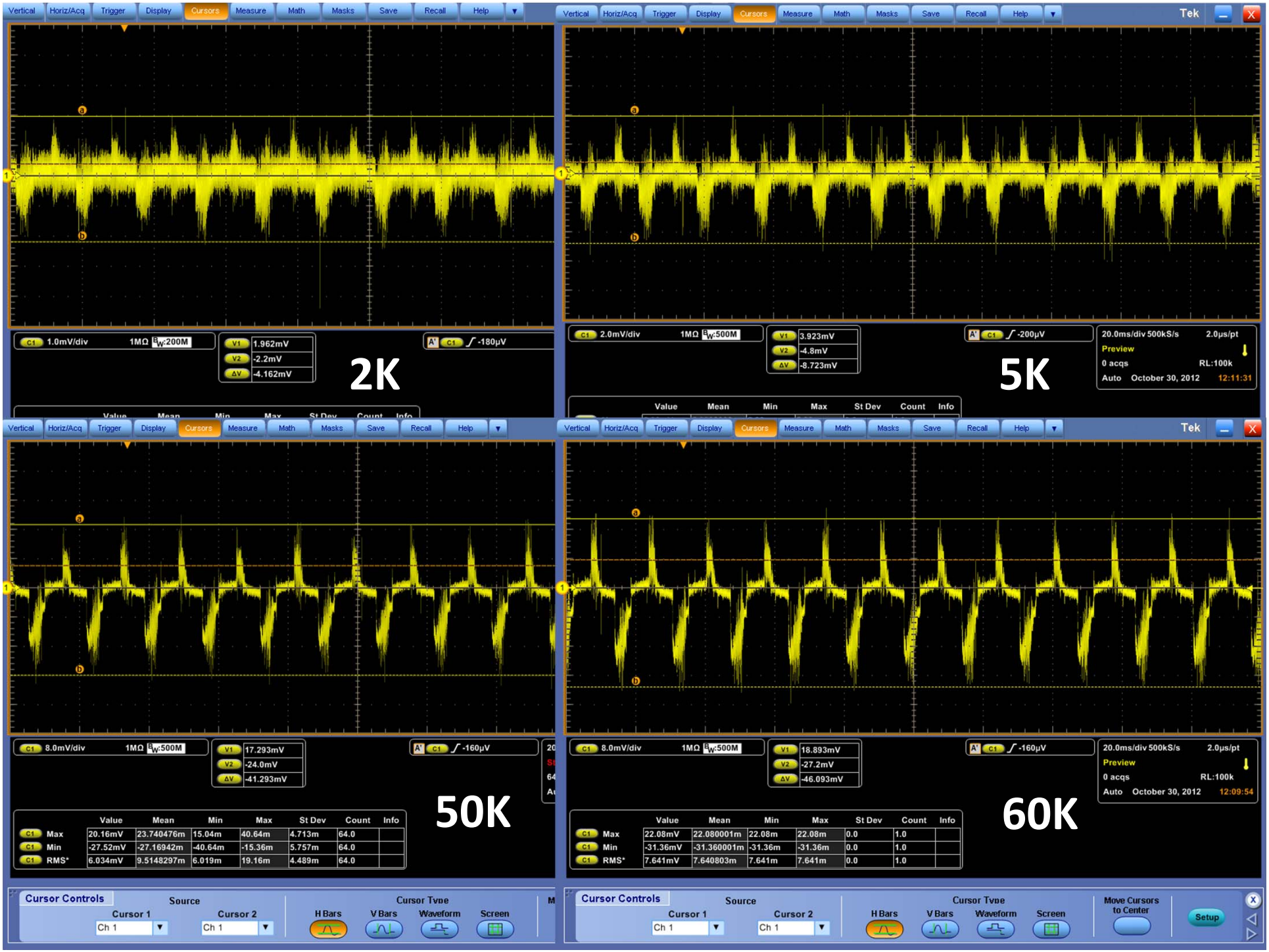
Vertical Horiz/Acq Trigger Display Cursors Measure Math Masks Save Recall Help
C1 4.0mV/div 1MΩ BW:500M
V1 13.046mV
V2 -13.44mV
ΔV -26.486mV
C1 2.64mV
20.0ms/div 500kS/s
Preview
0 acqs
Auto October 30, 20
Value Mean Min Max St Dev Count Info
C1 Max 16.64mV 16.640001m 16.64m 16.64m 0.0 1.0
C1 Min -13.76mV -13.760001m -13.76m -13.76m 0.0 1.0
C1 RMS* 4.768mV 4.7682039m 4.768m 4.768m 0.0 1.0
2K
Tek
C1 8.0mV/div 1MΩ BW:500M
V1 26.093mV
V2 -25.28mV
ΔV -51.373mV
C1 2.56mV
20.0ms/div 500kS/s 2.0µs/pt
Preview
0 acqs RL:100k
Auto October 30, 2012 11:57:16
Value Mean Min Max St Dev Count Info
C1 Max 32.64mV 32.640002m 32.64m 32.64m 0.0 1.0
C1 Min -28.48mV -28.480001m -28.48m -28.48m 0.0 1.0
C1 RMS* 12.14mV 12.141188m 12.14m 12.14m 0.0 1.0
5K
C1 80.0mV/div 1MΩ BW:500M
V1 228.928mV
V2 -220.8mV
ΔV -449.7mV
C1 3.2mV
20.0ms/div 500kS/s
Stopped
17 acqs
Auto October 30, 2012
Value Mean Min Max St Dev Count Info
C1 Max 240.0mV 239.81176m 236.8m 243.2m 2.392m 17.0
C1 Min -220.8mV -220.42352m -220.8m -217.6m 1.063m 17.0
C1 RMS* 119.9mV 119.69052m 119.5m 119.9m 126.8µ 17.0
50K
C1 80.0mV/div 1MΩ BW:500M
V1 292.928mV
V2 -268.8mV
ΔV -561.728mV
C1 3.2mV
20.0ms/div 500kS/s 2.0µs/pt
Stopped
72 acqs RL:100k
Auto October 30, 2012 12:00:14
Value Mean Min Max St Dev Count Info
C1 Max 294.4mV 202.70869m 25.6m 300.8m 111.9m 72.0
C1 Min -268.8mV -185.49769m -275.2m -19.2m 103.3m 72.0
C1 RMS* 151.4mV 100.04623m 9.313m 151.8m 57.13m 72.0
60K
Cursor Controls
Source
Cursor 1 Ch 1
Cursor 2 Ch 1
Cursor Type
H Bars V Bars Waveform Screen
Move Cursors to Center
Setup


Vertical Horiz/Acq Trigger Display Cursors Measure Math Masks Save Recall Help
C1 1.0mV/div 1MΩ BW:200M
V1 1.962mV
V2 -2.2mV
ΔV -4.162mV
A' C1 -180µV
2K
Vertical Horiz/Acq Trigger Display Cursors Measure Math Masks Save Recall Help Tek
C1 2.0mV/div 1MΩ BW:500M
V1 3.923mV
V2 -4.8mV
ΔV -8.723mV
A' C1 -200µV
20.0ms/div 500kS/s 2.0µs/pt
Preview
0 acqs RL:100k
Auto October 30, 2012 12:11:31
5K
Value Mean Min Max St Dev Count Info
Vertical Horiz/Acq Trigger Display Cursors Measure Math Masks Save Recall Help
C1 8.0mV/div 1MΩ BW:500M
V1 17.293mV
V2 -24.0mV
ΔV -41.293mV
A' C1 -160µV
50K
Value Mean Min Max St Dev Count Info
C1 Max 20.16mV 23.740476m 15.04m 40.64m 4.713m 64.0
C1 Min -27.52mV -27.16942m -40.64m -15.36m 5.757m 64.0
C1 RMS* 6.034mV 9.5148297m 6.019m 19.16m 4.489m 64.0
Vertical Horiz/Acq Trigger Display Cursors Measure Math Masks Save Recall Help Tek
C1 8.0mV/div 1MΩ BW:500M
V1 18.893mV
V2 -27.2mV
ΔV -46.093mV
A' C1 -160µV
20.0ms/div 500kS/s 2.0µs/pt
Preview
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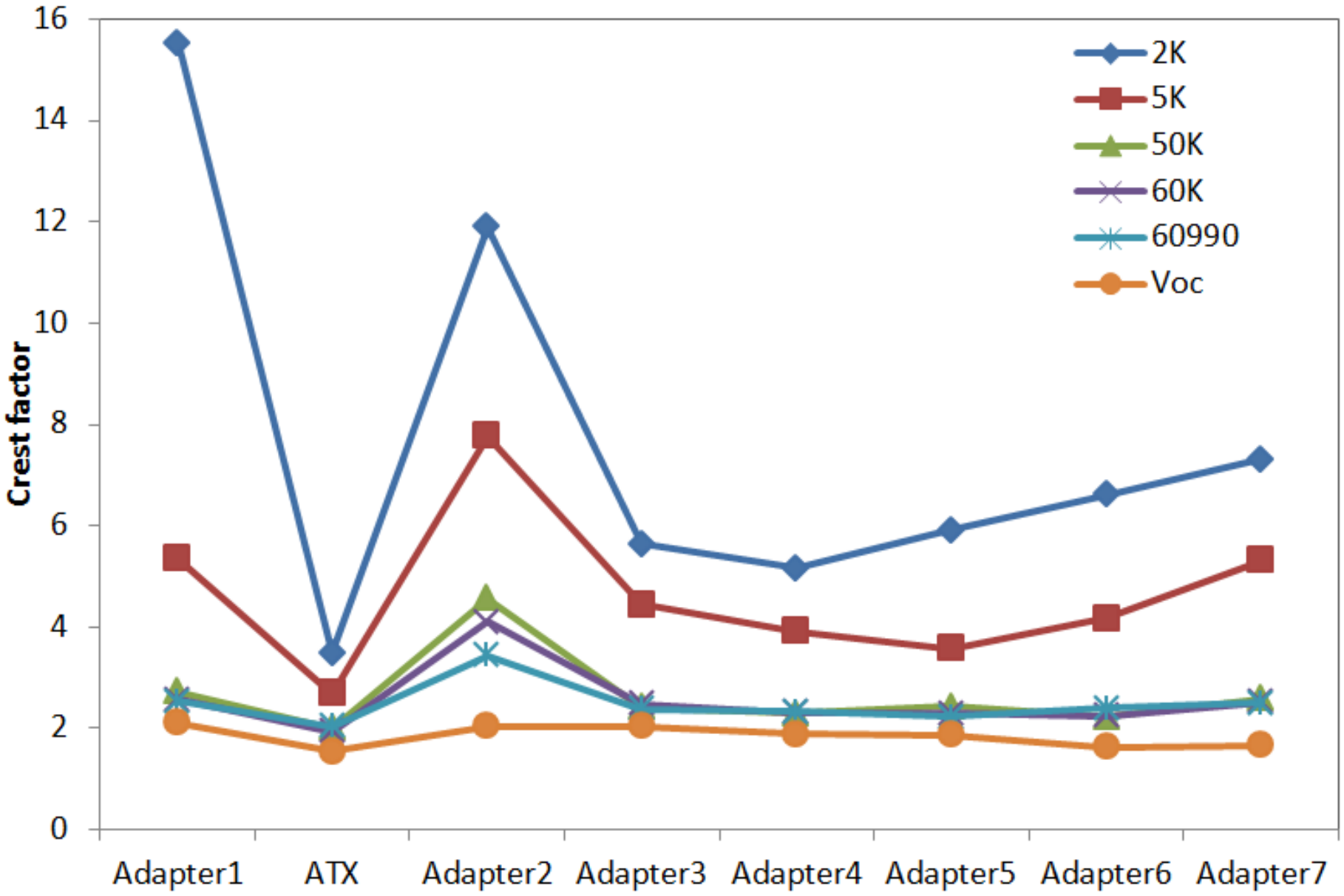
60K
Value Mean Min Max St Dev Count Info
C1 Max 22.08mV 22.080001m 22.08m 22.08m 0.0 1.0
C1 Min -31.36mV -31.360001m -31.36m -31.36m 0.0 1.0
C1 RMS* 7.641mV 7.640803m 7.641m 7.641m 0.0 1.0
Cursor Controls
Source
Cursor 1 Ch 1
Cursor 2 Ch 1
Cursor Type
H Bars V Bars Waveform Screen
Move Cursors to Center
Setup



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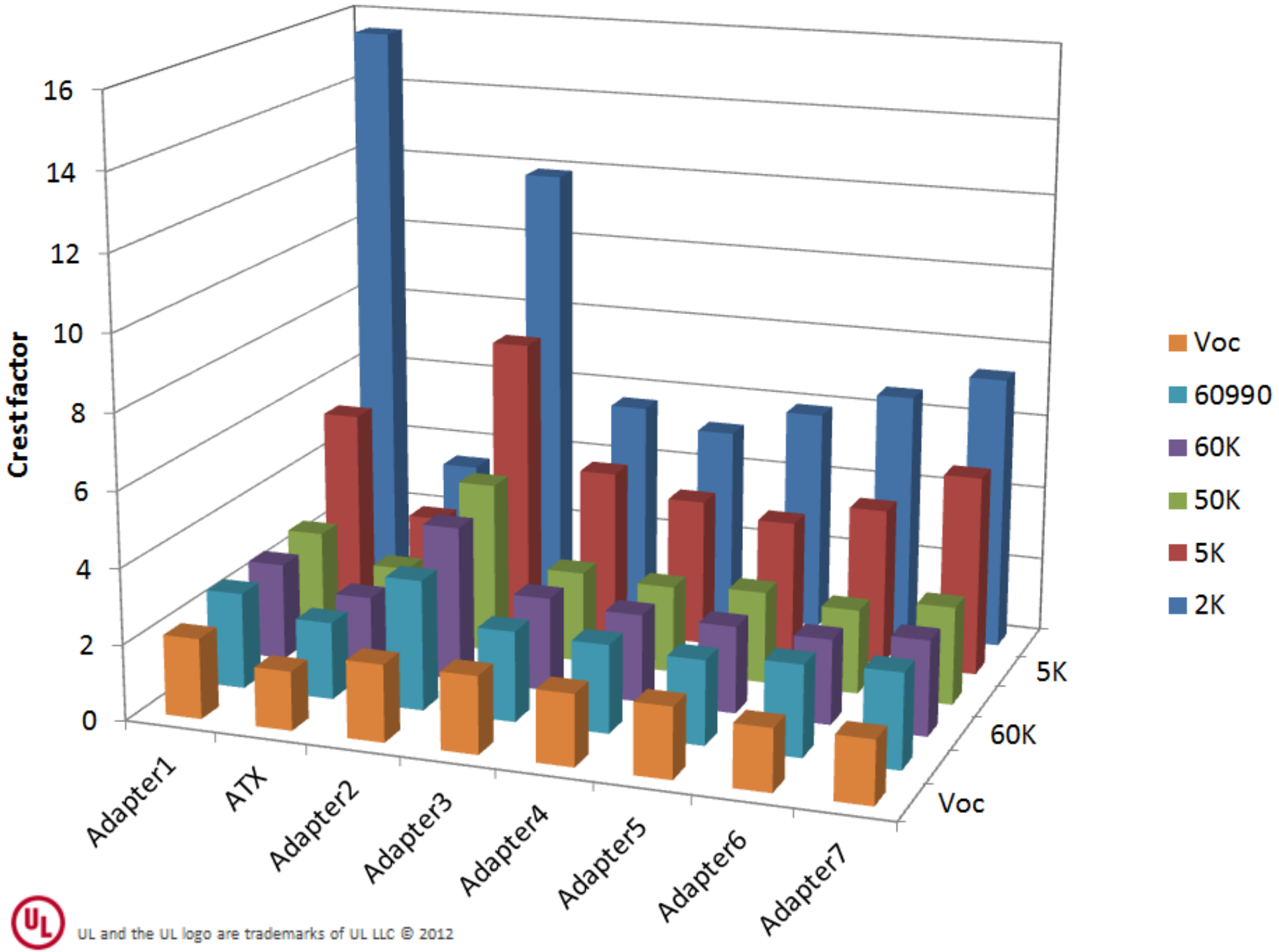

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240 V

Z INSULATION

800 kΩ (3300pF);
1200 kΩ (2200pF);
2400 kΩ (1100pF).

60 Hz

800 ~~k~~Ω (3300pF);
1200 ~~k~~Ω (2200pF);
2400 ~~k~~Ω (1100pF).

60 kHz

R INSTRUMENT

2kΩ
5kΩ
50kΩ

∞
10MΩ

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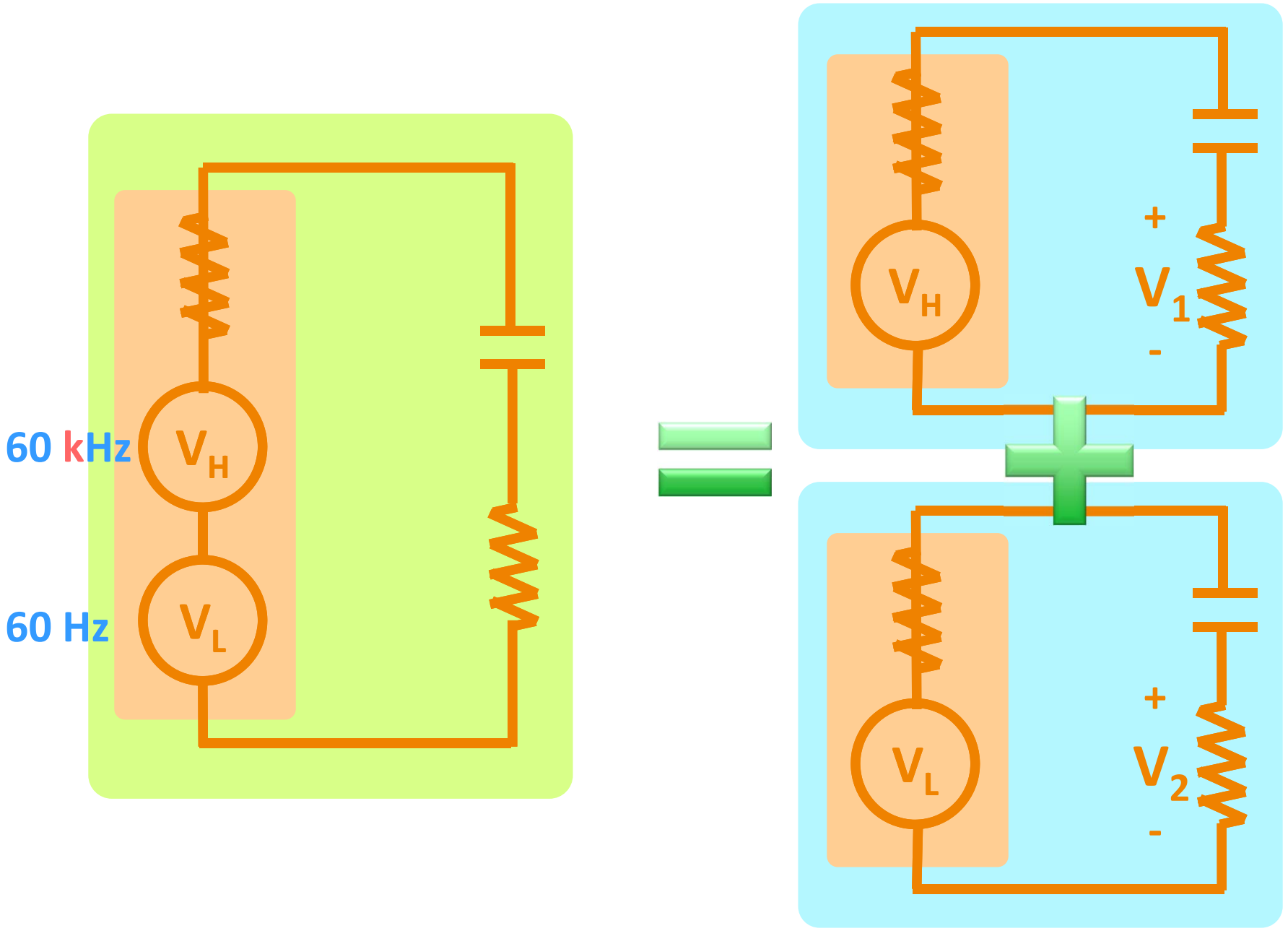

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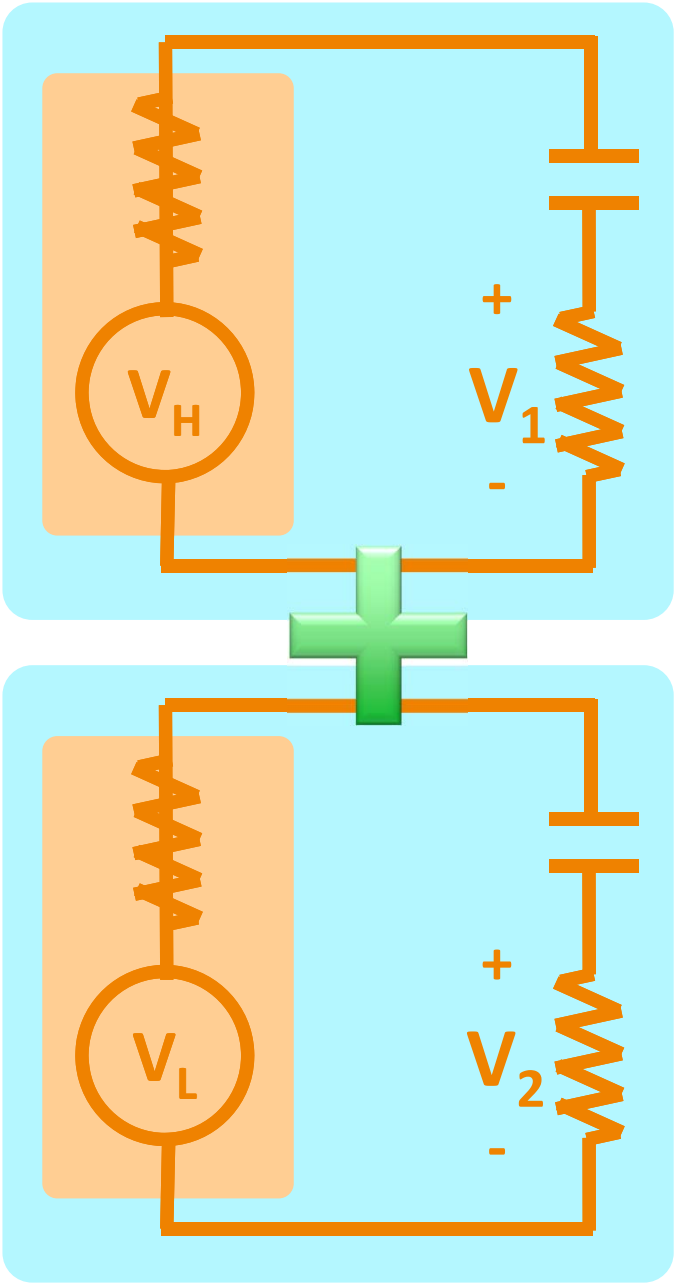
$$V_1 = V_H \frac{R_{meas.}}{R_{Y-cap} + R_{meas.}}$$

= **V_H * 0.714** (2k; 3300pF)
= **V_H * 0.862** (5k; 3300pF)
= **V_H * 0.984** (50k; 3300pF)
= **V_H * 0.987** (60k; 3300pF)
= **V_H * 0.999** (10M; 3300pF)

$$V_2 = V_L \frac{R_{meas.}}{R_{Y-cap} + R_{meas.}}$$

= **V_L * 0.003** (2k; 3300pF)
= **V_L * 0.006** (5k; 3300pF)
= **V_L * 0.059** (50k; 3300pF)
= **V_L * 0.070** (60k; 3300pF)
= **V_L * 0.926** (10M; 3300pF)



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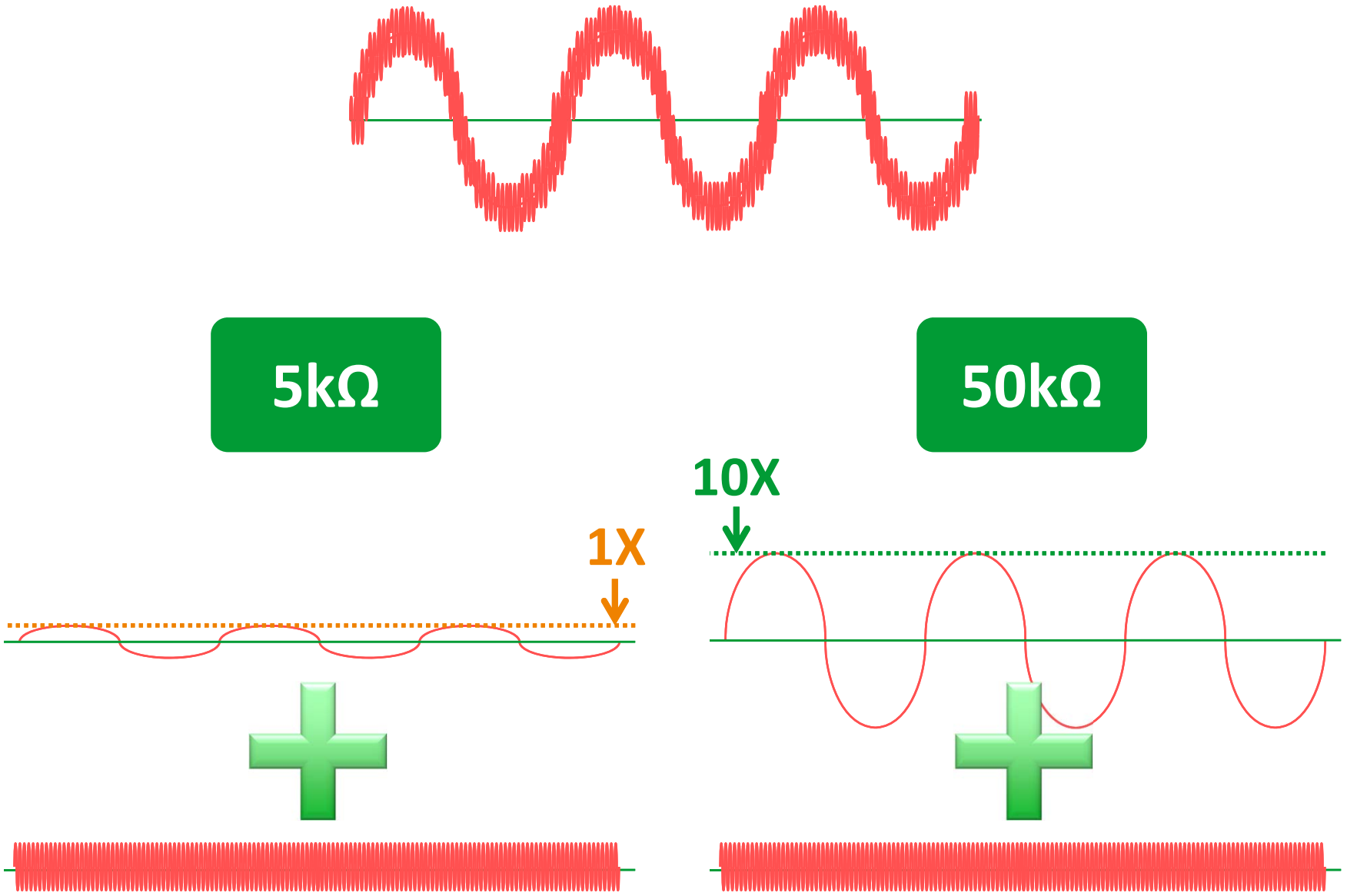

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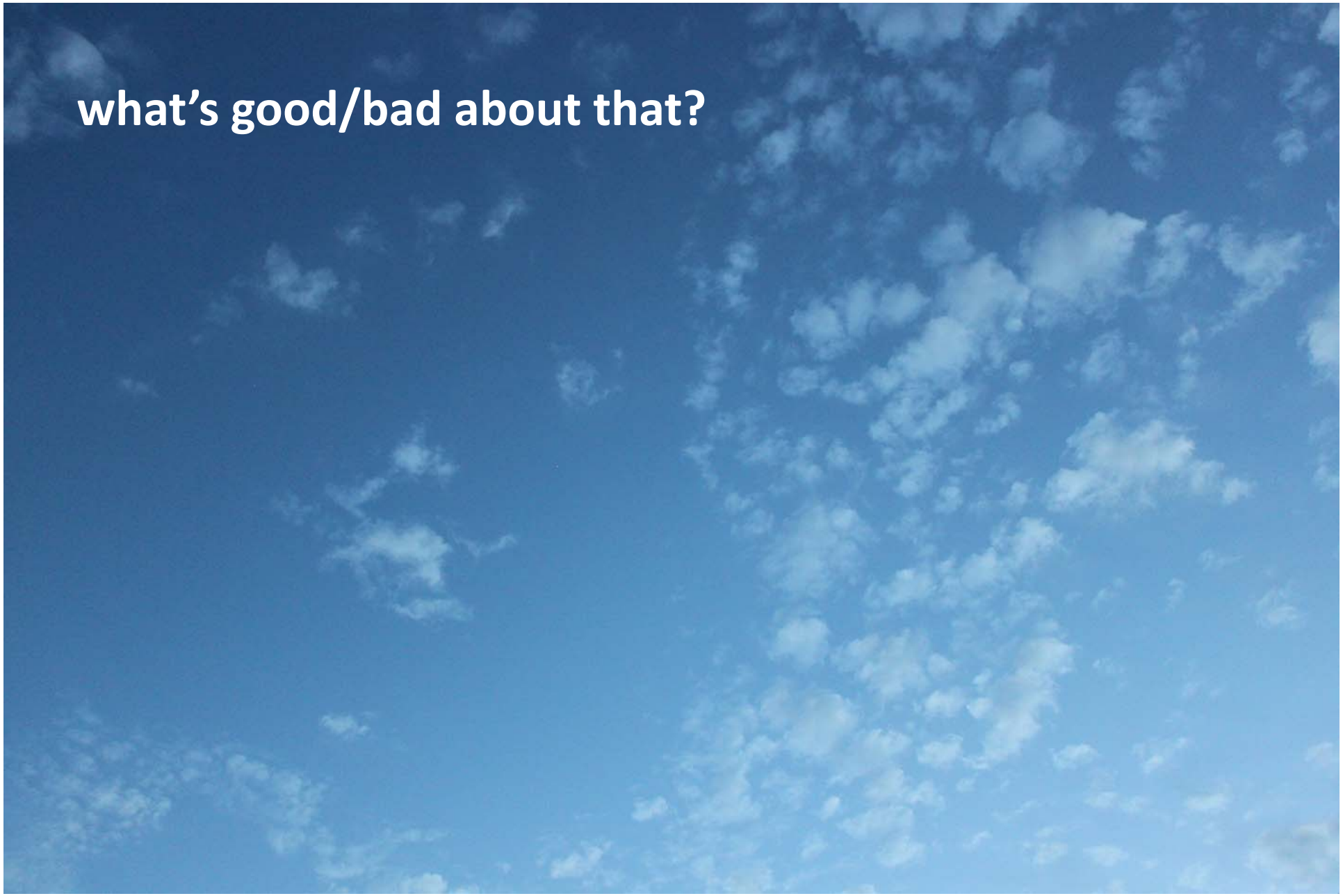
what's good/bad about that?



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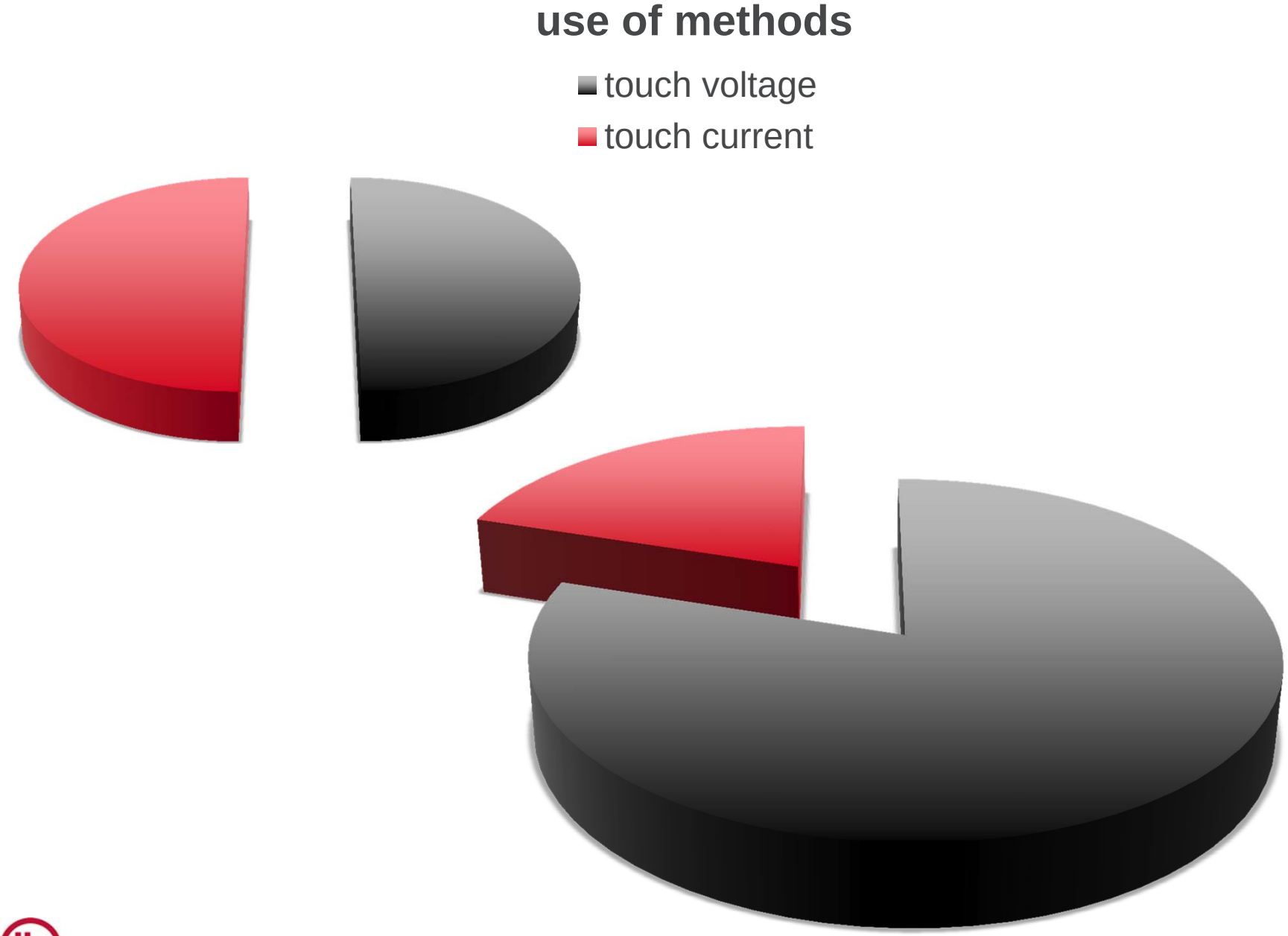

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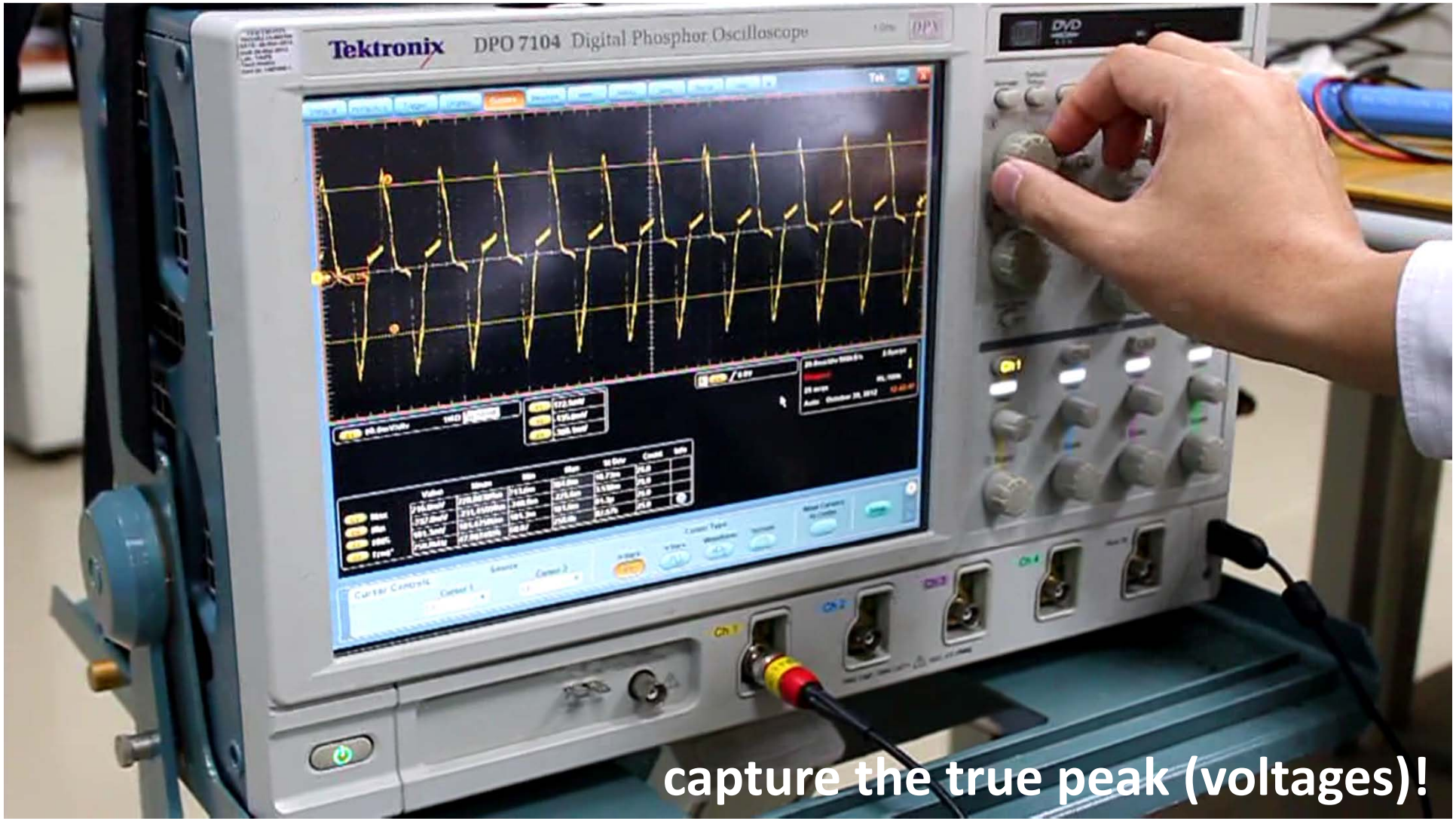

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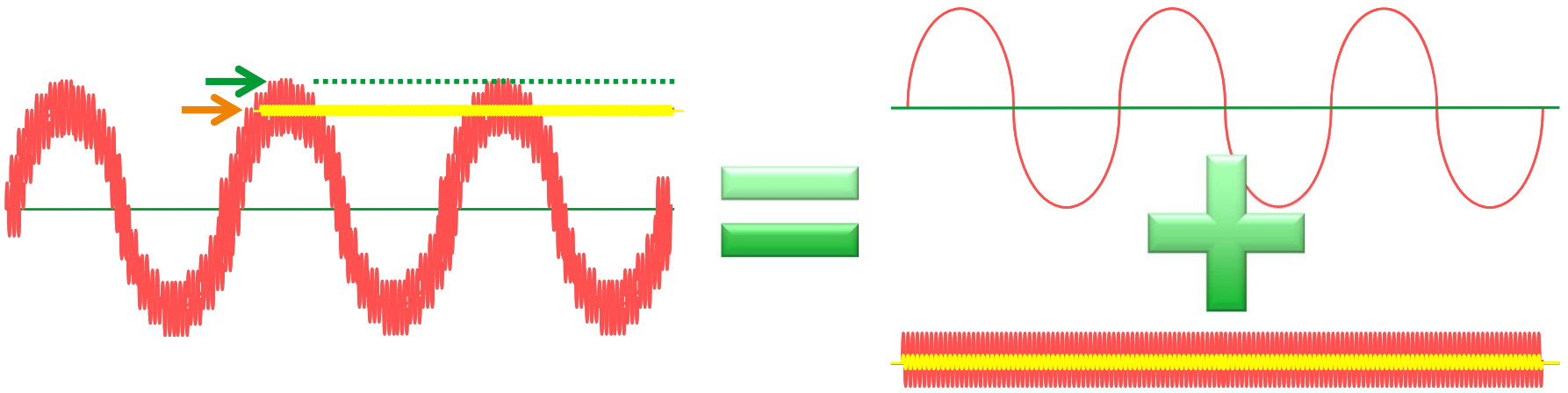

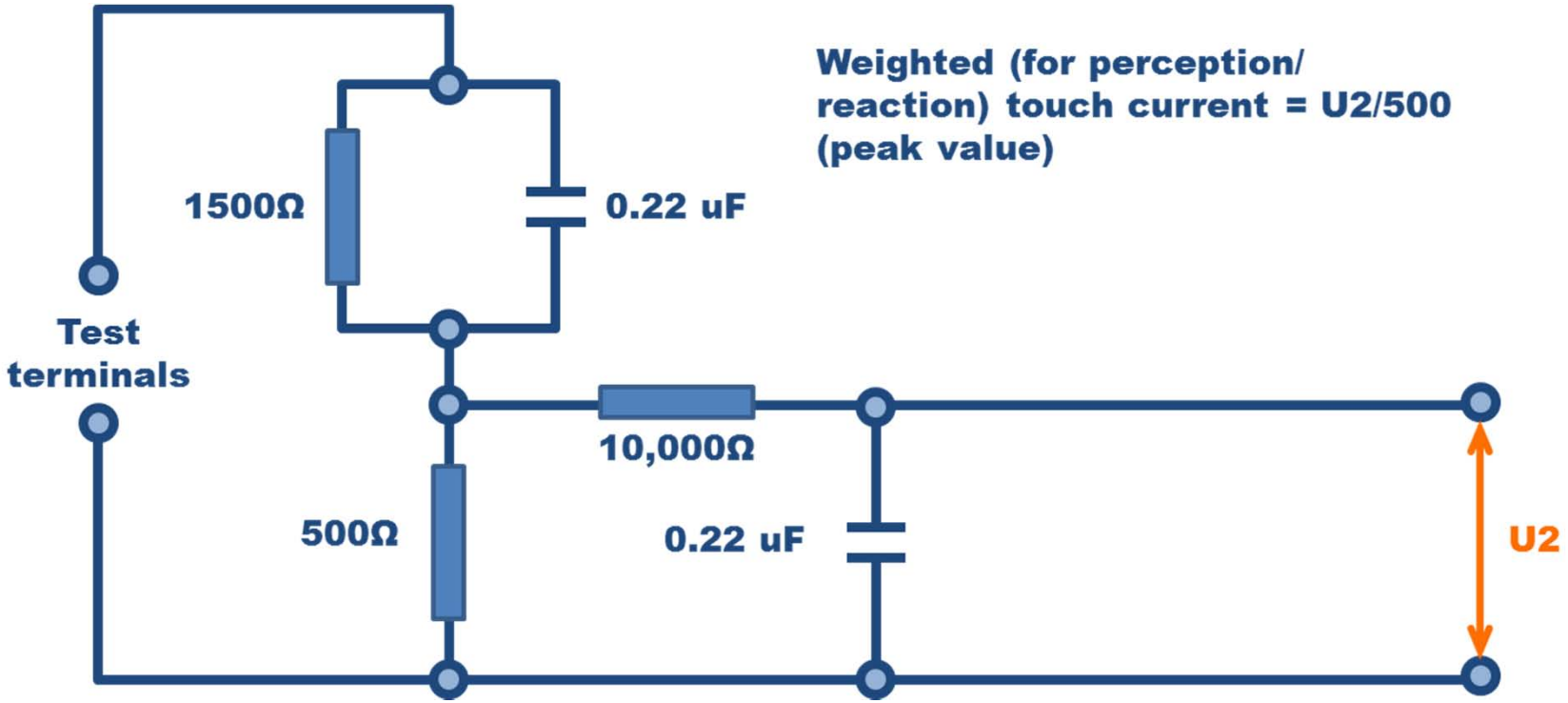

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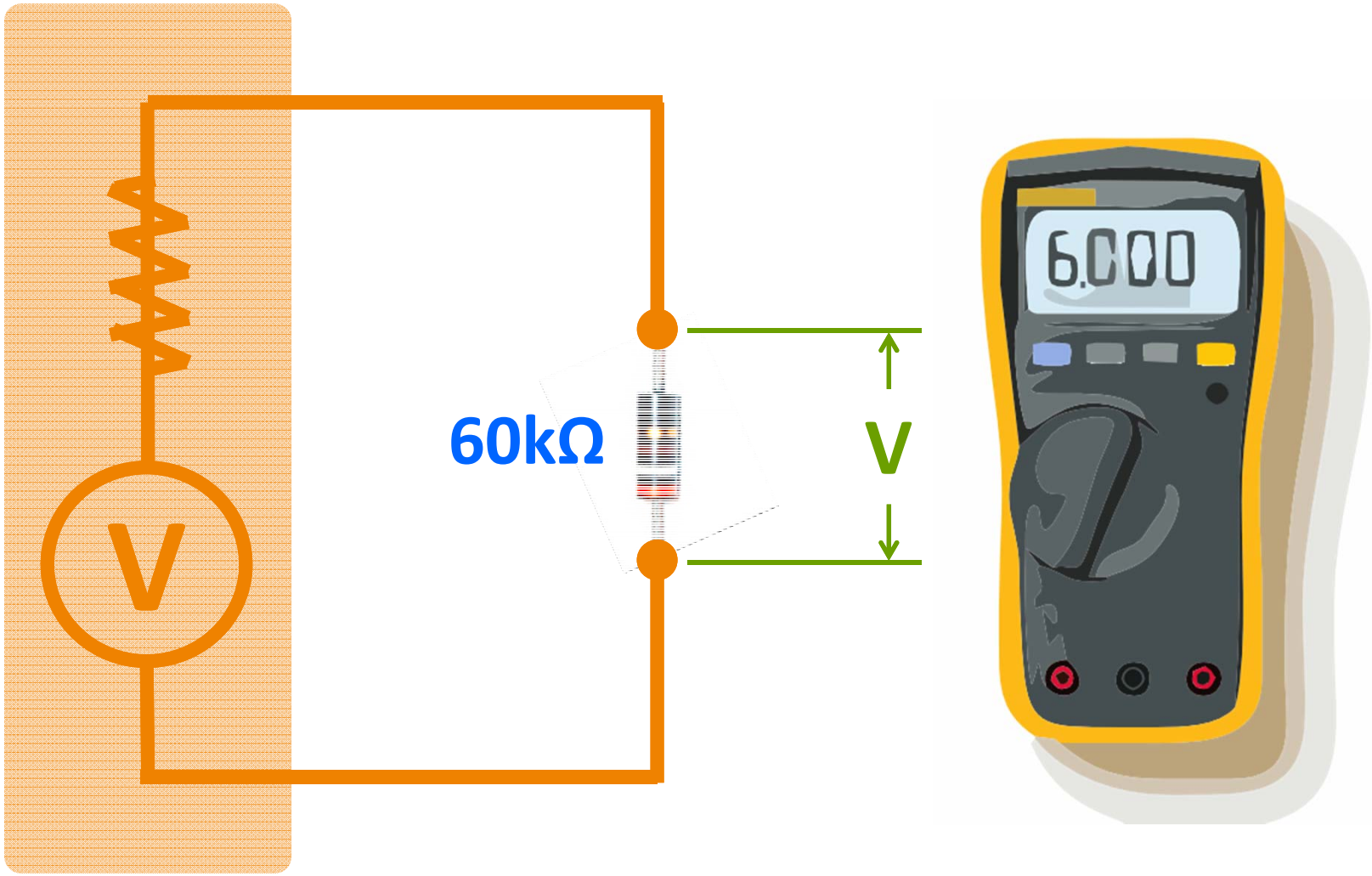

V ≤ 60VDC/30VAC/42.4VPK,

...or otherwise,

touch current measurement is needed.

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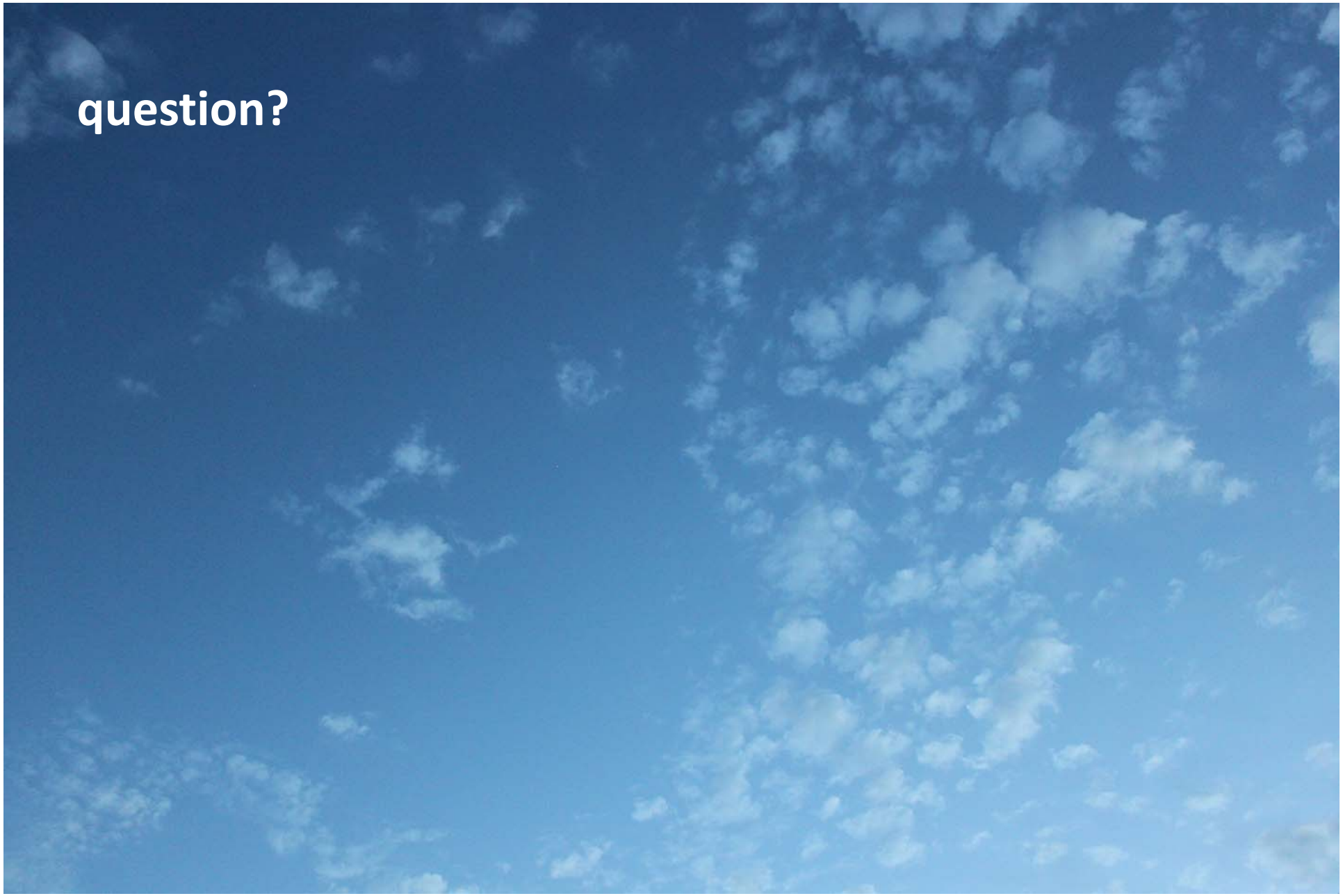
question?



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