Touch current analysis on SMPS designed for energy efficiency regulations
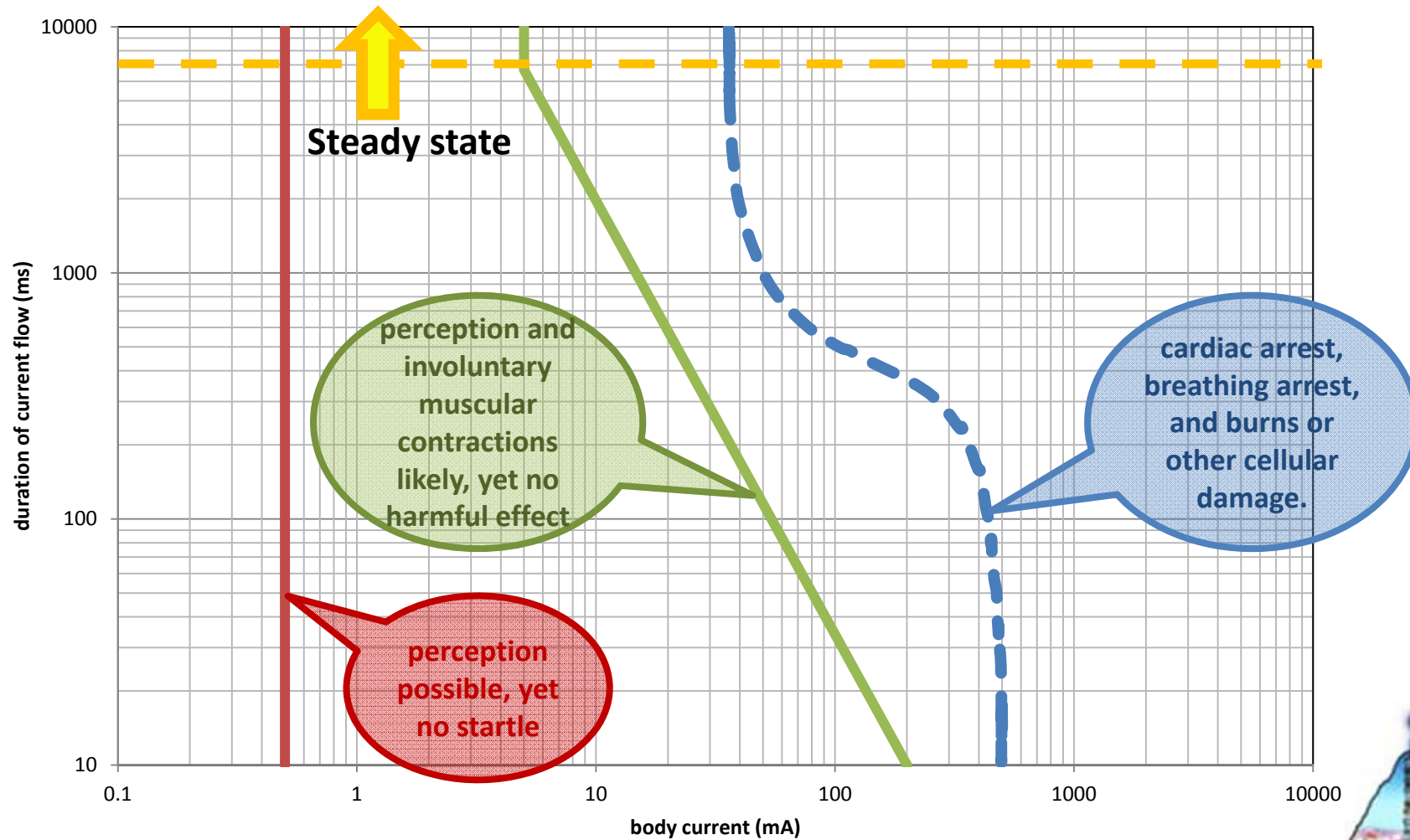
Presented by: William Meng/孟昭德

Date: 2011/09/23

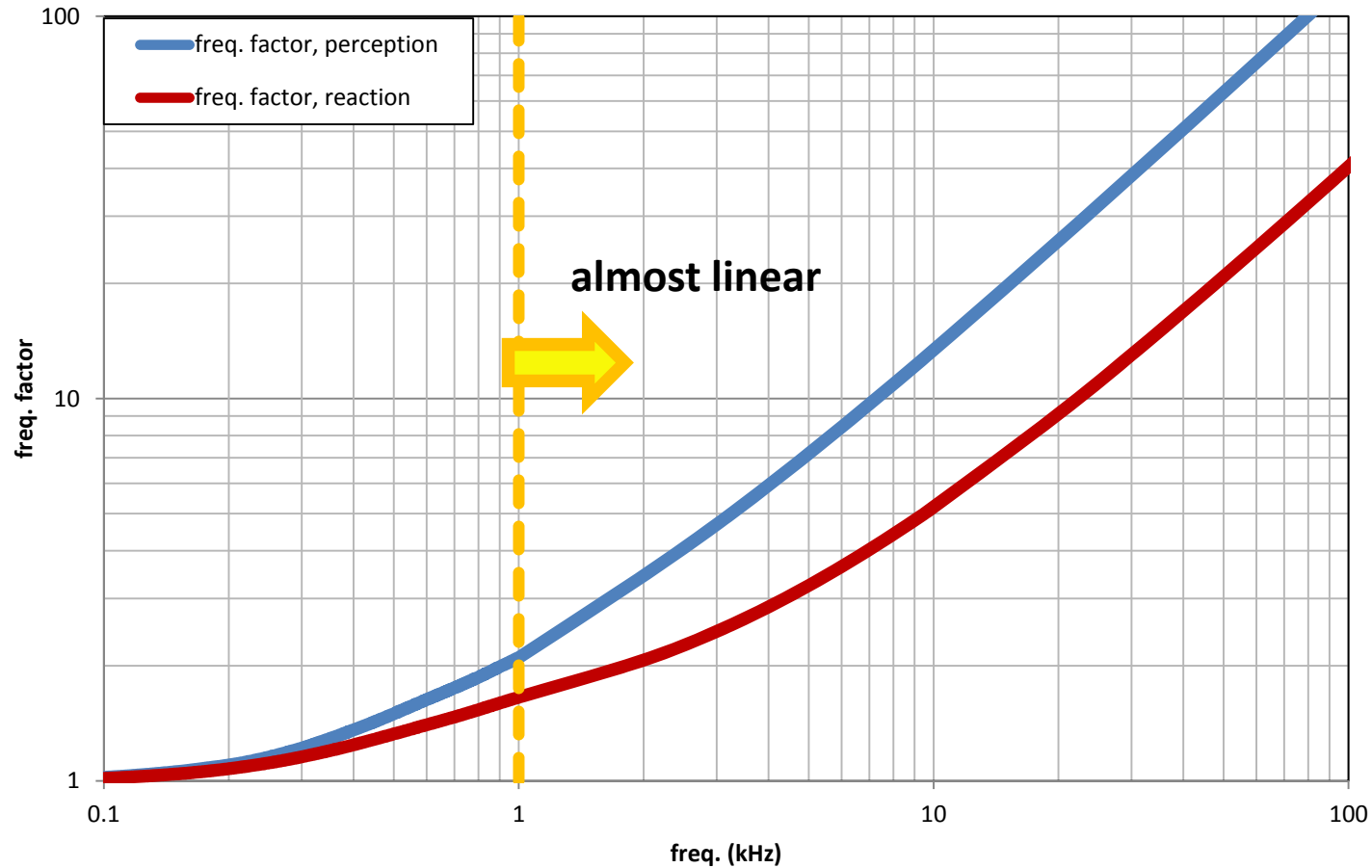how many times have you heard that "it's not the volts that'll kill you, but the amps"?
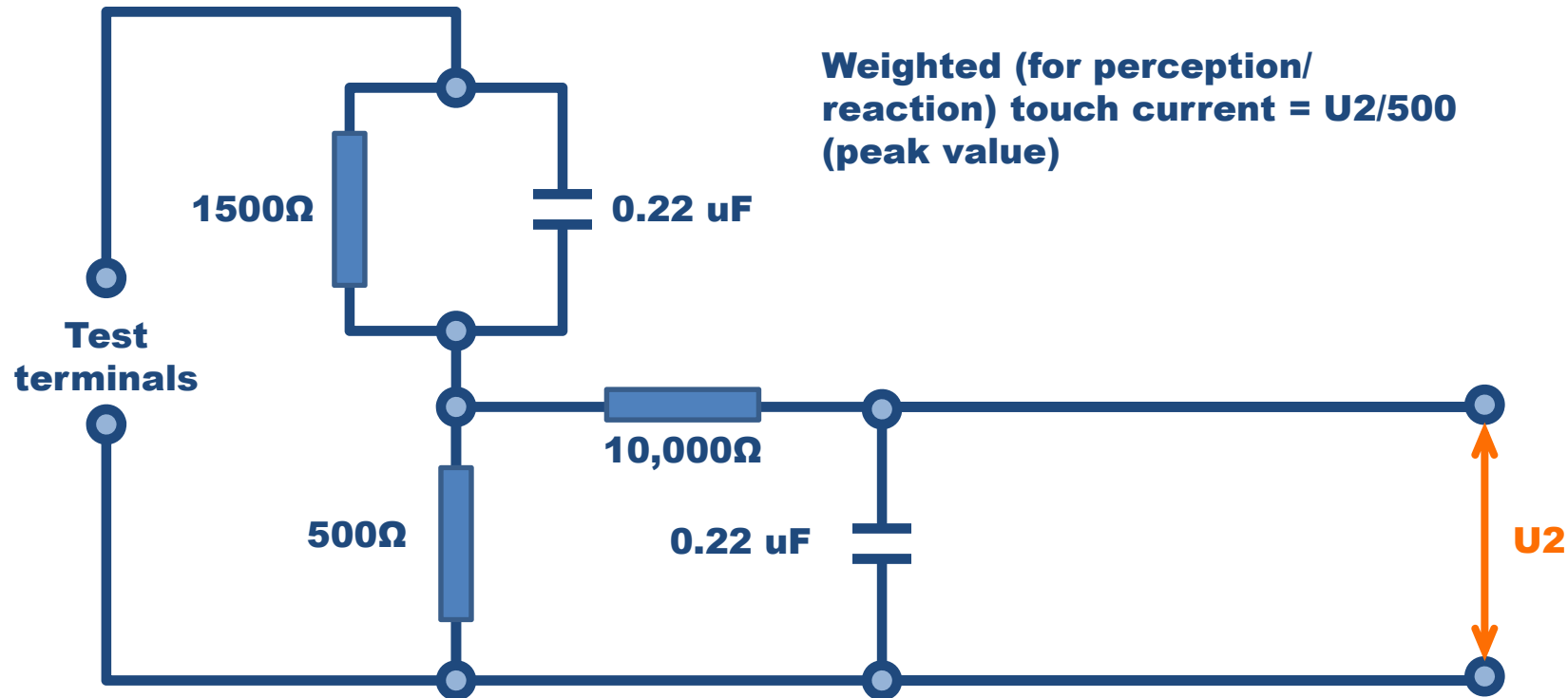
nothing but 'closed loop'
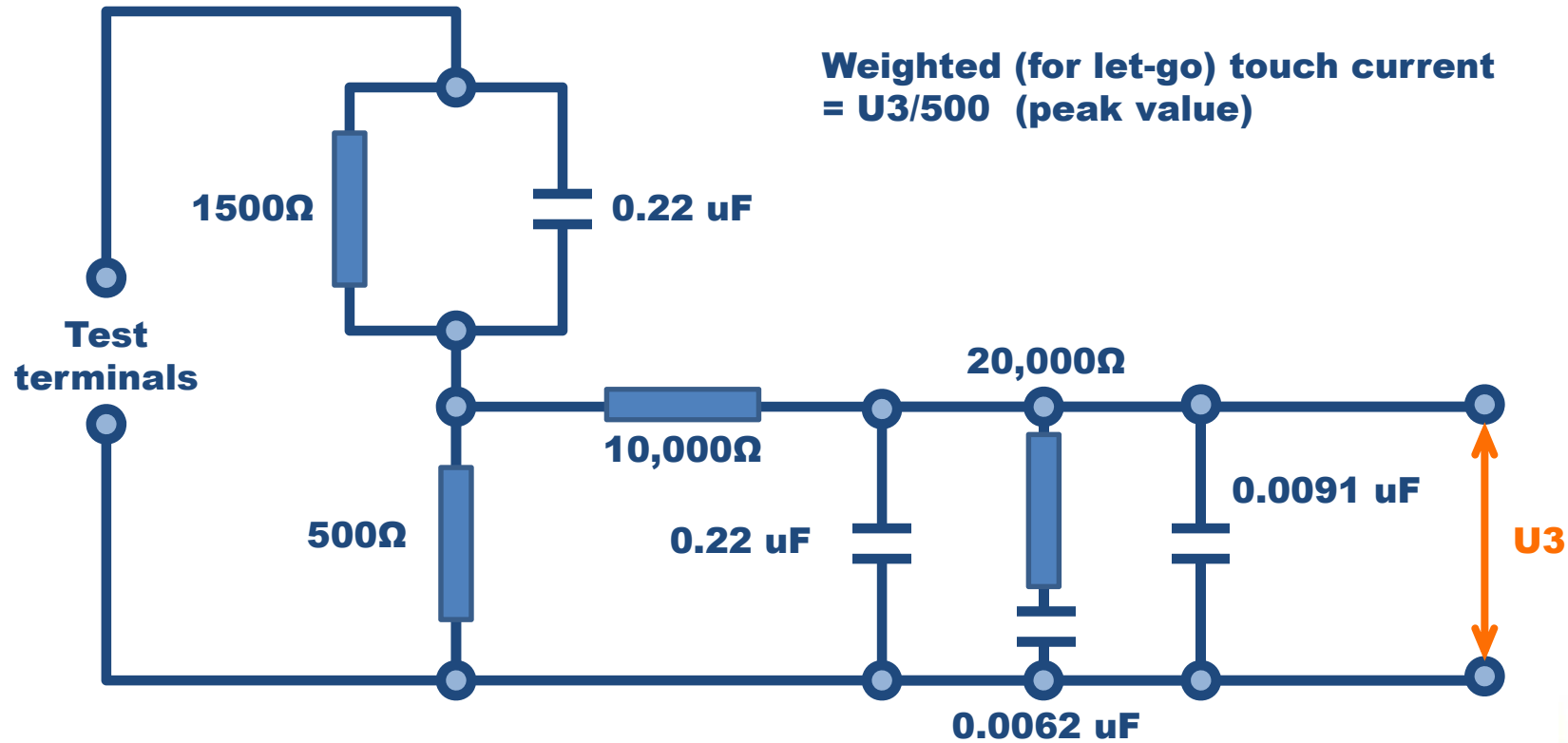
Basis of touch current: ac, iec 60479-1

Basis of touch current: HF effect

measurement network
by iec 60990, for perception

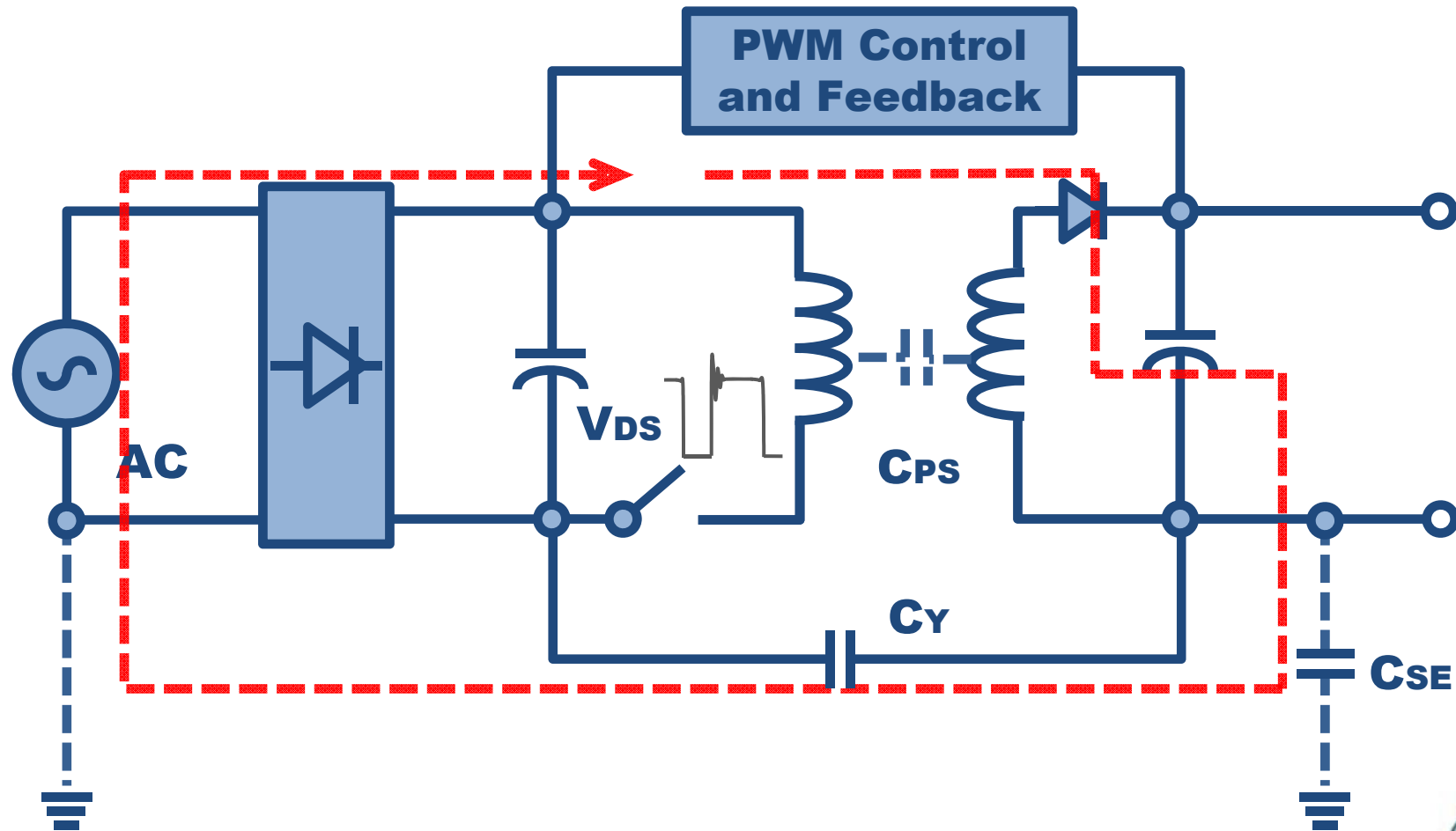Weighted (for perception/reaction) touch current = U2/500 (peak value)

1500Ω · 0.22 uF · Test terminals · 500Ω · 10,000Ω · 0.22 uF · U2

measurement network
by iec 60990, for let-go

Weighted (for let-go) touch current = U3/500 (peak value)

Test terminals

1500Ω   0.22 uF

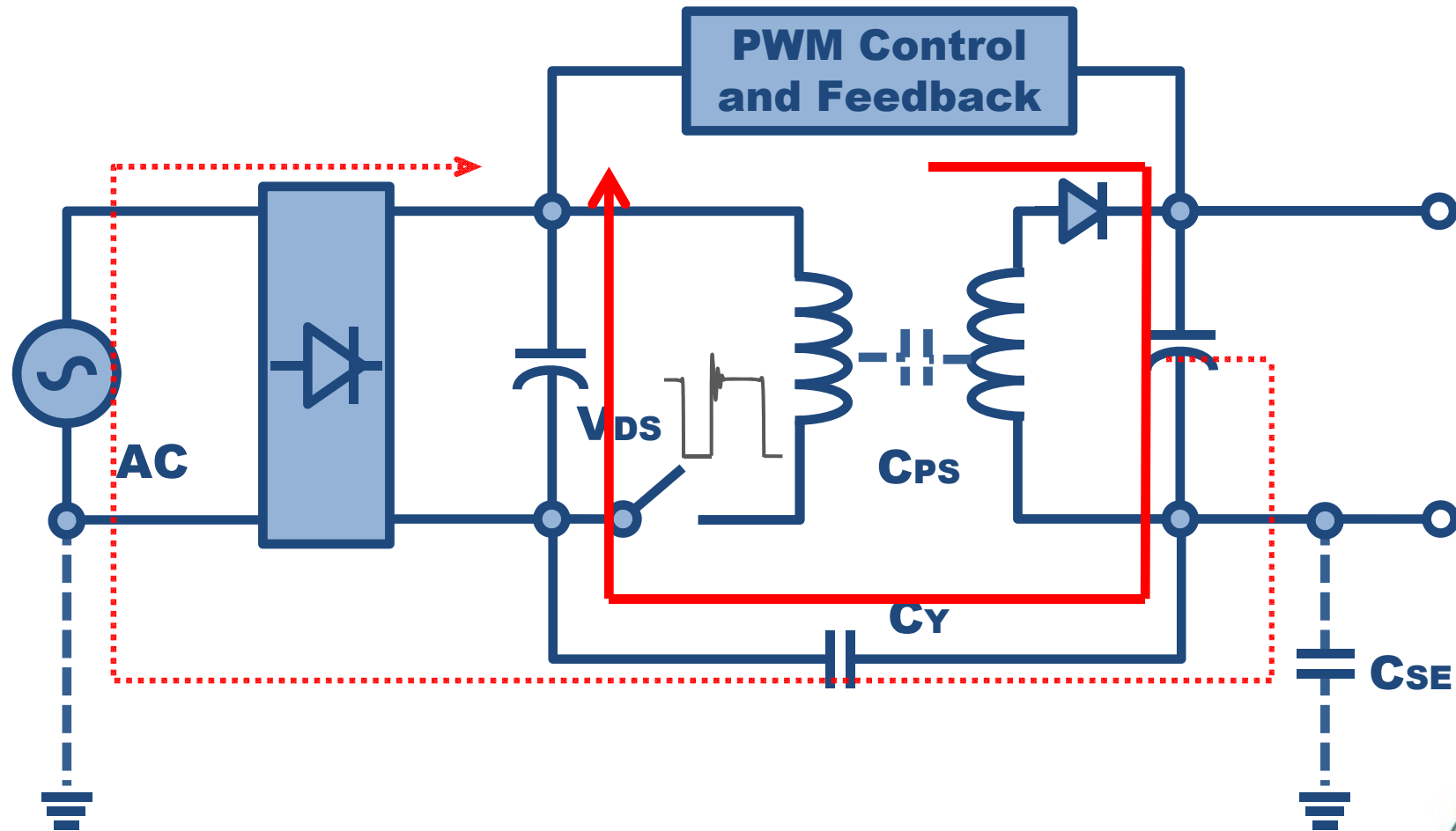500Ω   10,000Ω   0.22 uF   20,000Ω   0.0091 uF   U3

0.0062 uF

Difference between Fig. 4 and Fig. 5

EMI and touch current

EMI and touch current

Touch current of an SMPS

Accessible conductive parts

I_{FY} : Leakage current through filter Y-cap

I_{BY} : Leakage current through bridging Y-cap

I_{IS} : Leakage current through insulation

I_{T} : Leakage current through winding capacitance

PWM and Feedback

Insulation

Set-up of experiment

264 V, 60 Hz

L

N

PE

EUT (SMPS)

V+

V−

Electric load

Measuring network (U2/U3)

Oscilloscope

Chroma: 63030
Prodigit: 3311F

Tektronix:
TDS3032B, DOP7104

Samples: EPS

Output (W)	Topology	PFC	Filter Y-cap (PF)	Bridging Y-cap (PF)	Efficiency level
15	Flyback	None	None	680 x 1	
90	Flyback	active	None	2200 x 1	**V**
120	Flyback	active	None	1000 x 2	
180	Resonant	active	2200 x 2	2200 x 2	

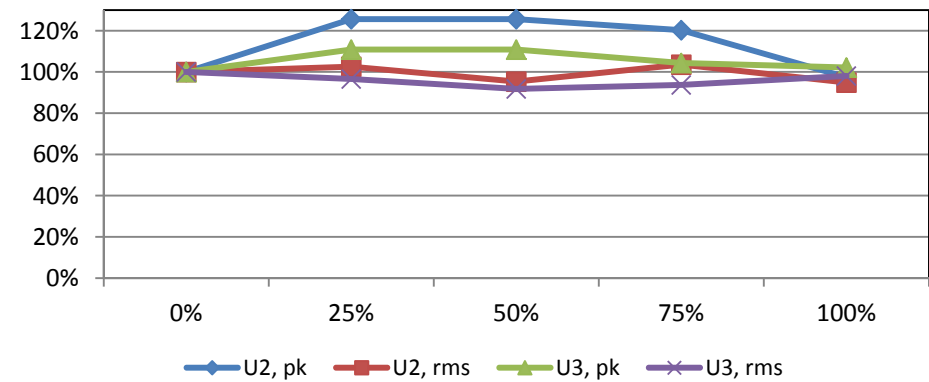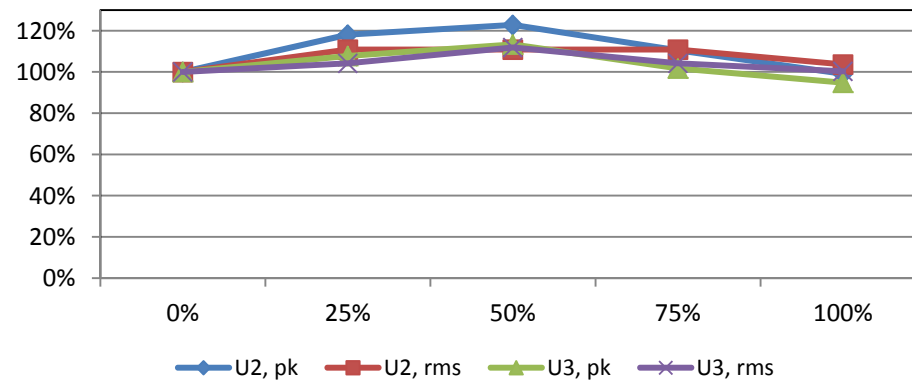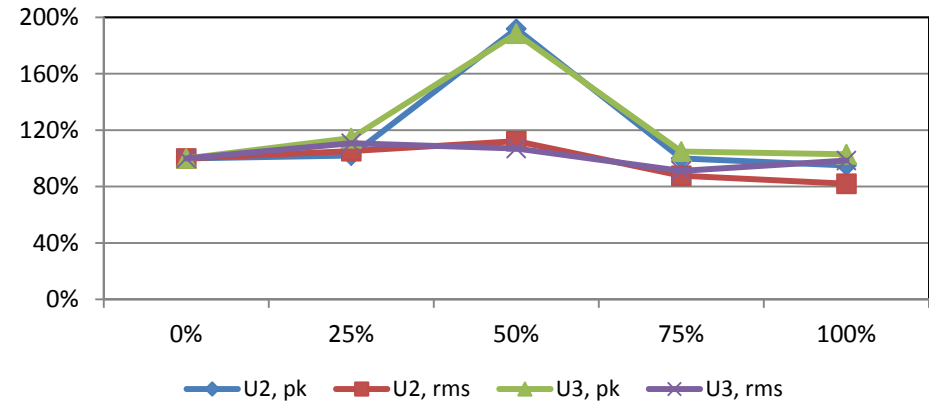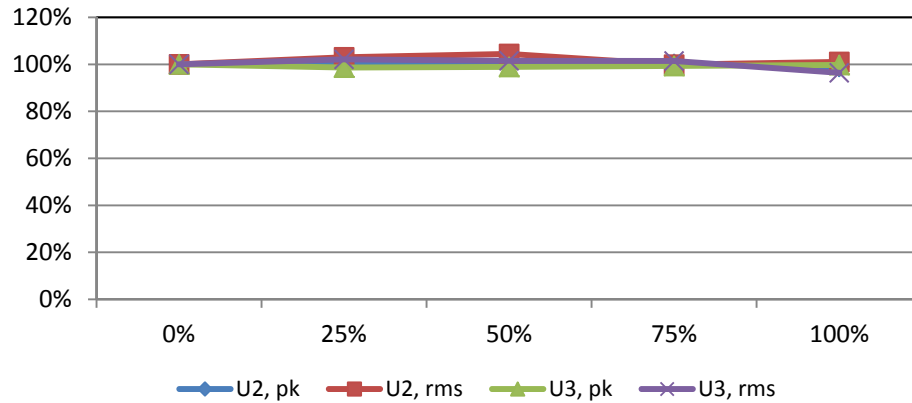*Loading conditions: 0%, 25%, 50%, 75%, 100% of max. nameplate current

Samples: PC powers

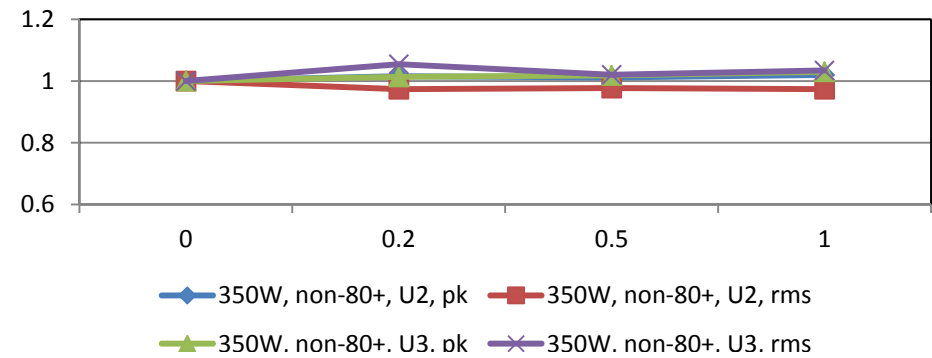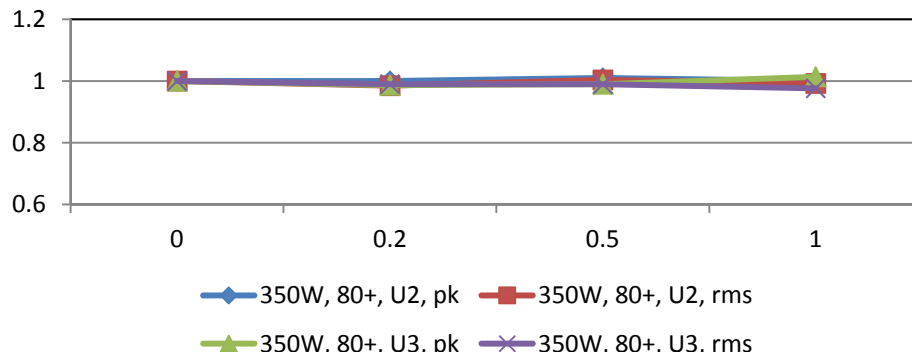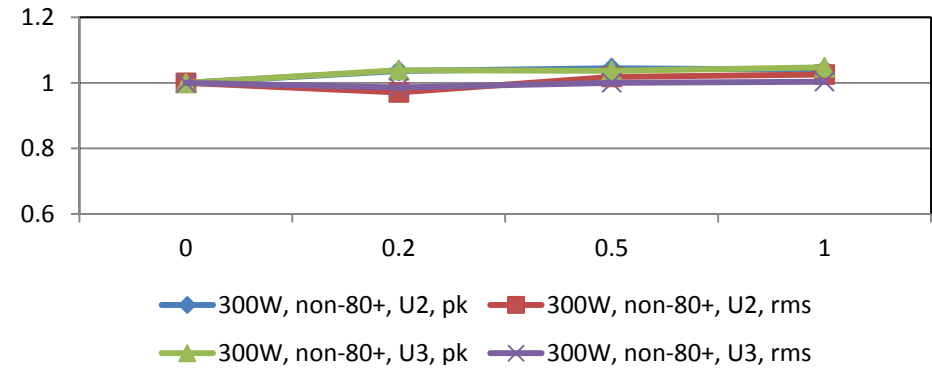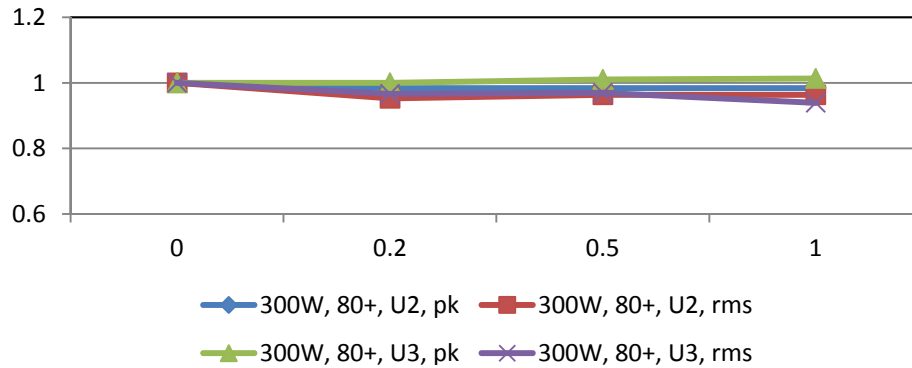| Output (W)	Topology	PFC	Filter Y-cap (PF)	Bridging Y-cap (PF)	Efficiency level
300	Dual-switch forward + flyback	active	2200 x 2 1000 x 2	2200 x 1	80 PLUS
350					
400					
300	Dual-switch forward + flyback	active	2200 x 2 1000 x 2	2200 x 1	none
350					
400					

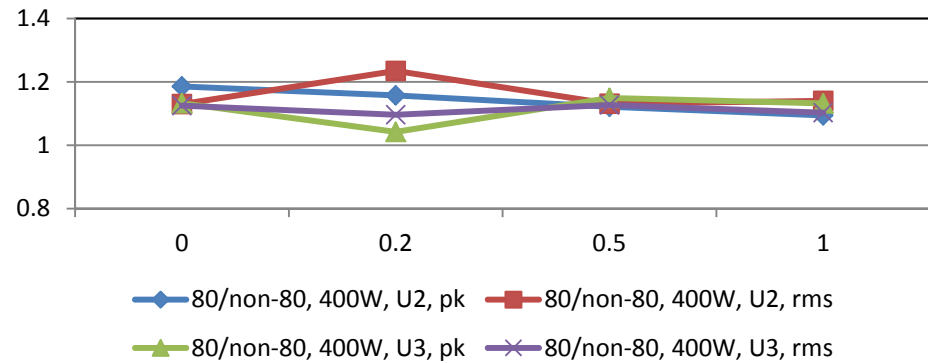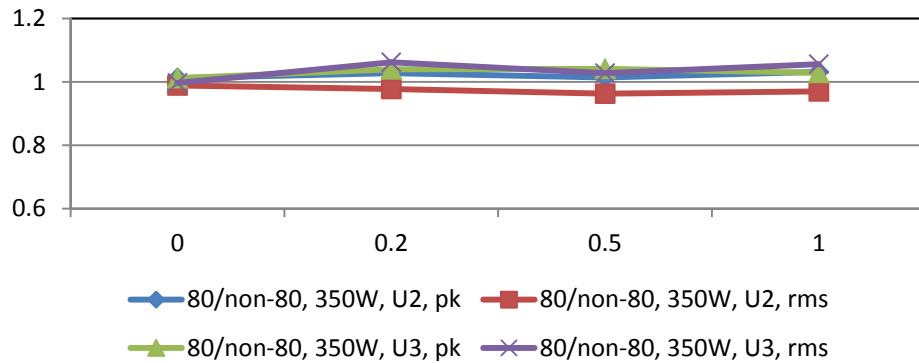Loading conditions: 0%, 25%, 50%, 75%, 100% of max. nameplate current
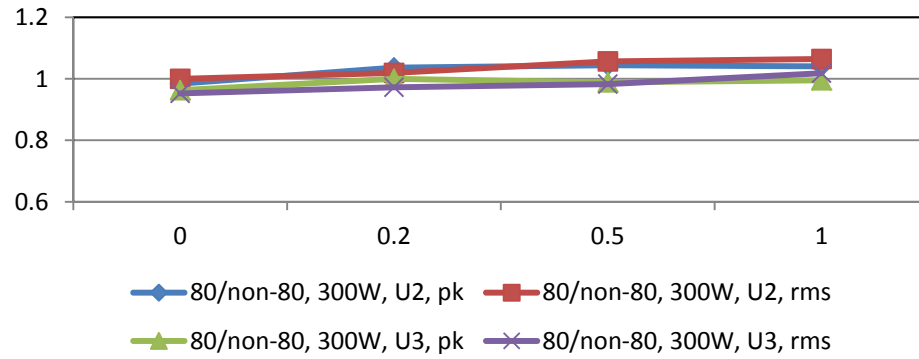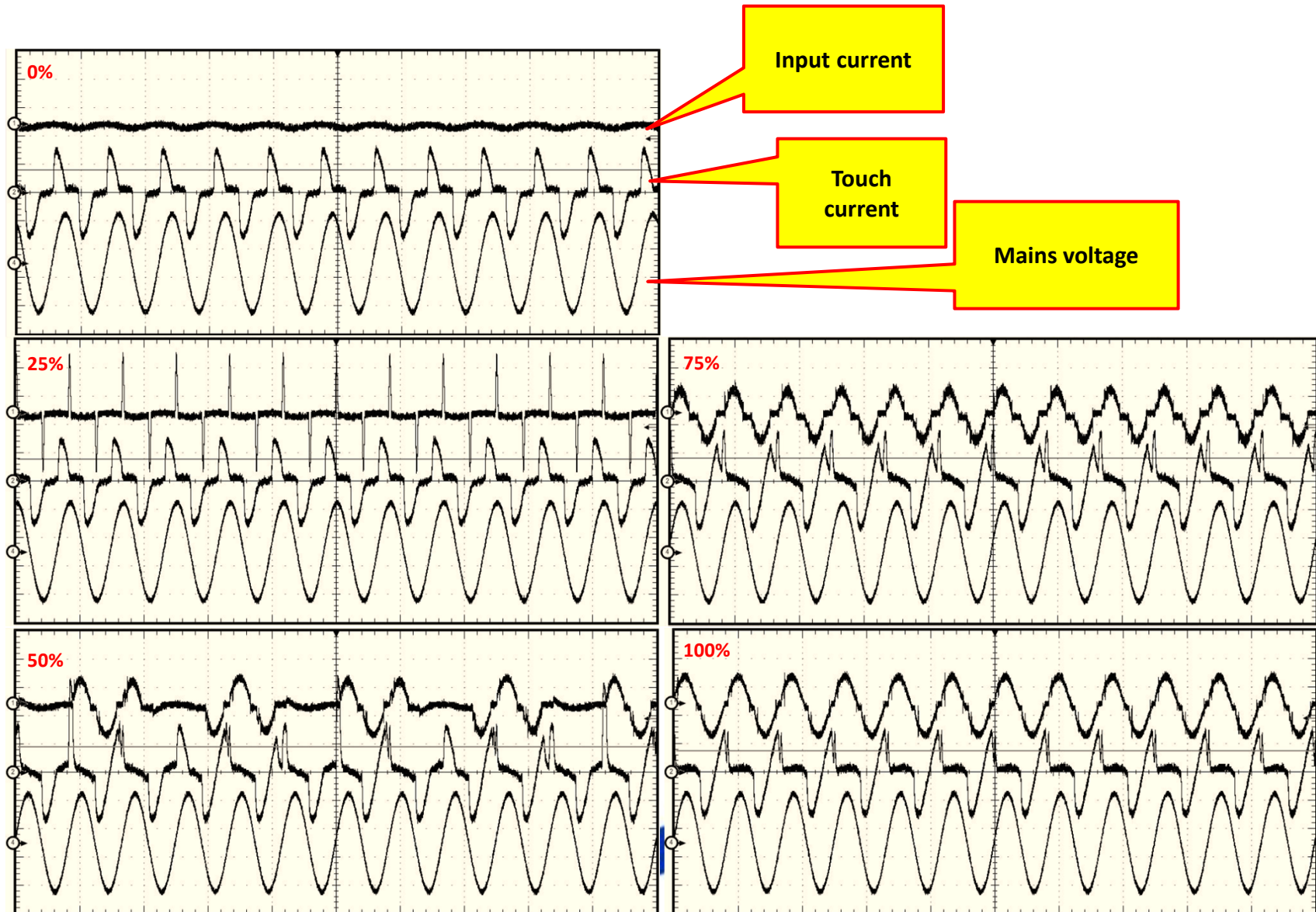Flyback: transformer for standby power (+5Vsb)

Result: EPS

Result: PC powers

Result: PC powers (cont.)

Top chart legend:
- 80/non-80, 300W, U2, pk
- 80/non-80, 300W, U2, rms
- 80/non-80, 300W, U3, pk
- 80/non-80, 300W, U3, rms

Bottom-left chart legend:
- 80/non-80, 350W, U2, pk
- 80/non-80, 350W, U2, rms
- 80/non-80, 350W, U3, pk
- 80/non-80, 350W, U3, rms

Bottom-right chart legend:
- 80/non-80, 400W, U2, pk
- 80/non-80, 400W, U2, rms
- 80/non-80, 400W, U3, pk
- 80/non-80, 400W, U3, rms
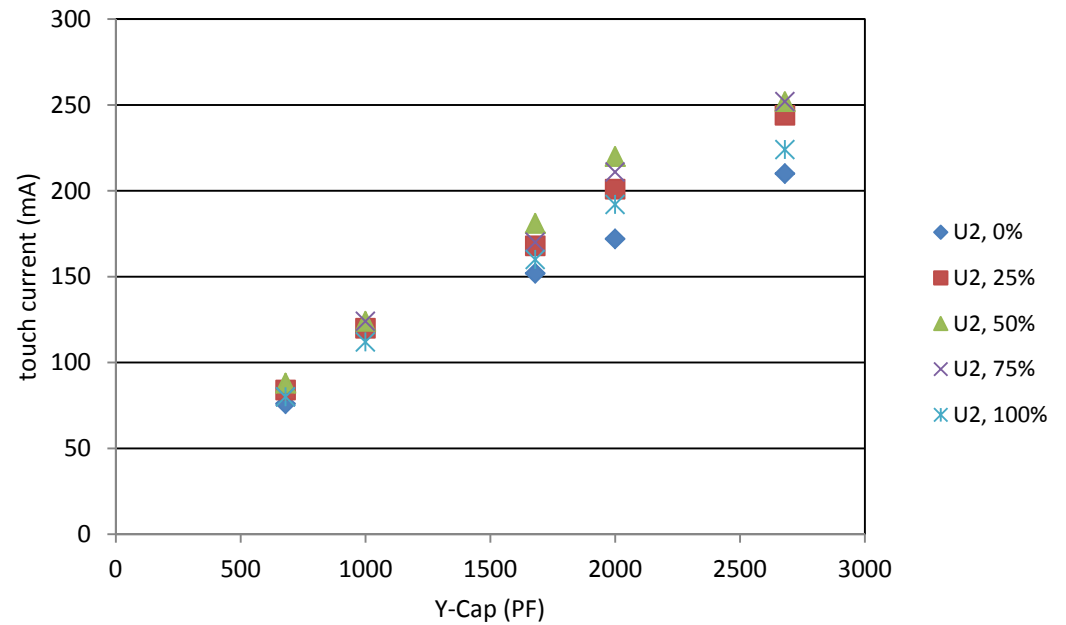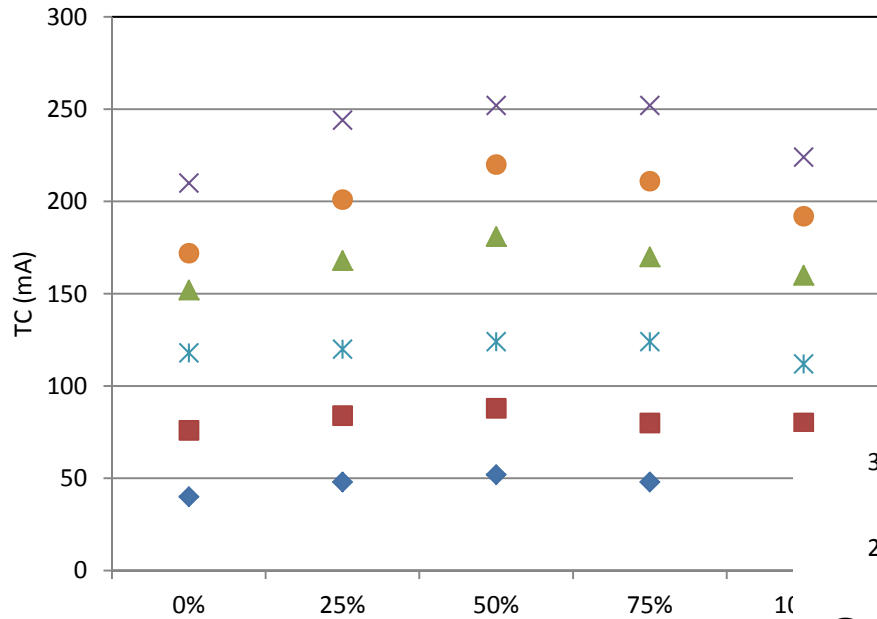
Observation: EPS, 90W

Hypothesis: only bridging Y is influenced by loading

Recommendation

- Touch current shall be measured with the EuT loaded

- Peak measurement is more appropriate than rms measurement

- Keep the EuT completed!!