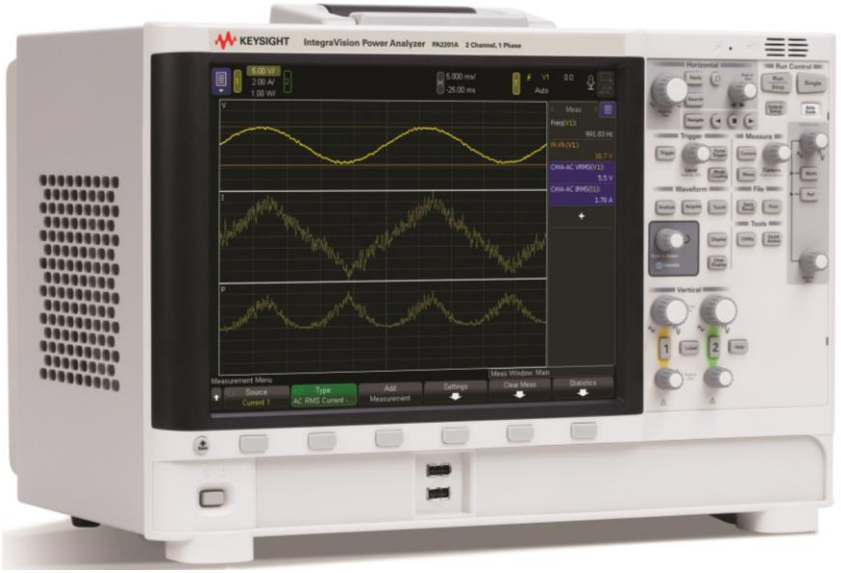
# 성공적인 AC 전원 간섭 측정

## Successfully make AC line disturbance Measurements

**Keysight**
**PA2201A**
**IntegraVision**
**Power Analyzer**

Sep 2015




KEYSIGHT TECHNOLOGIES

# Agenda

What is a power disturbance?

What is DUT power disturbance response?

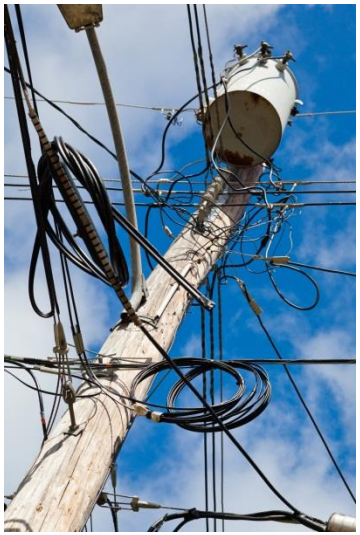
Why is DUT power disturbance response important?

How is DUT power disturbance response measured?

- Using an oscilloscope
- Using a power analyzer with dynamic measurement capability

Example: DC power supply output response

Summary



# What is a power disturbance?

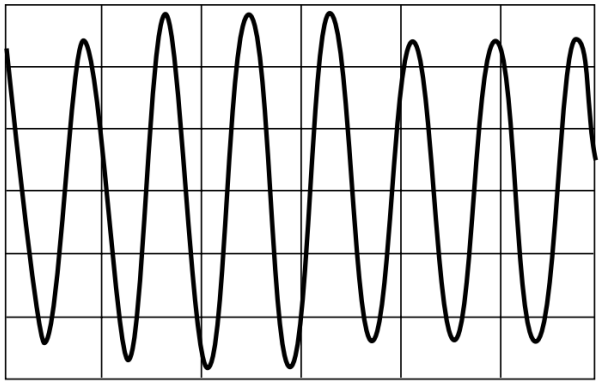
A power disturbance is any change in stimulus that affects:

- the input power of a device
- the output power of a device
- or both

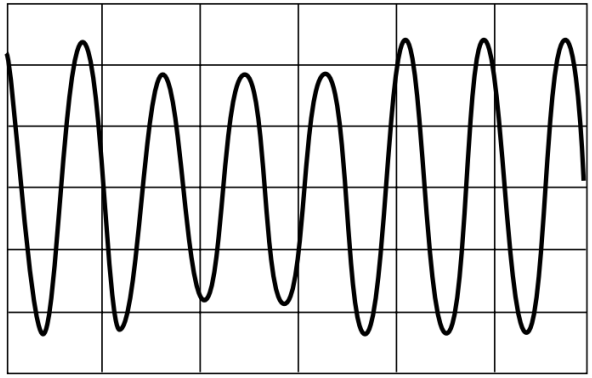
AC power grid is not perfect

- A lightning strike can cause a voltage surge
- A car accident into a utility pole can cause a brownout or blackout
- An unfortunate animal that gets into power distribution equipment can cause momentary fluctuations

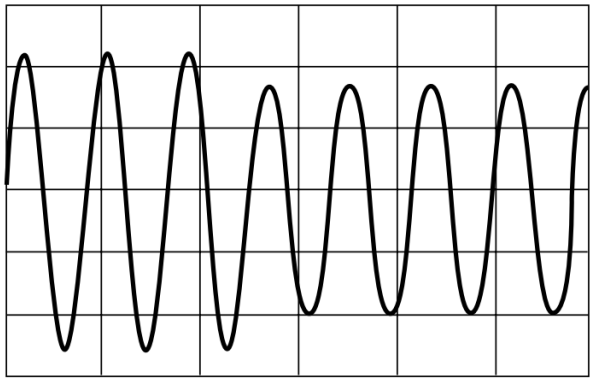
# Examples of some AC power line disturbances



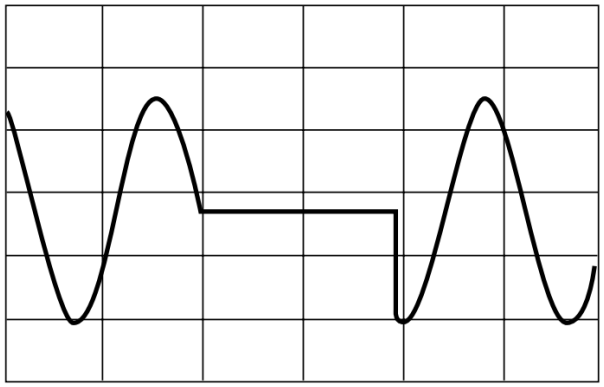
**Surge**



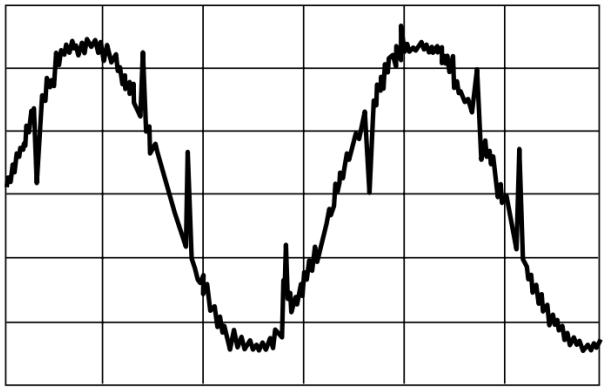
**Sag**



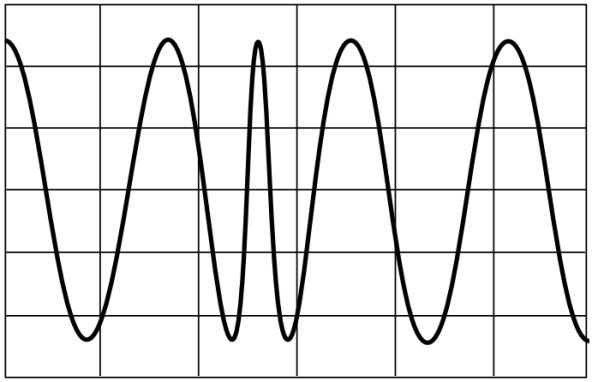
**Brownout**



**Cycle dropout**



**Noise**

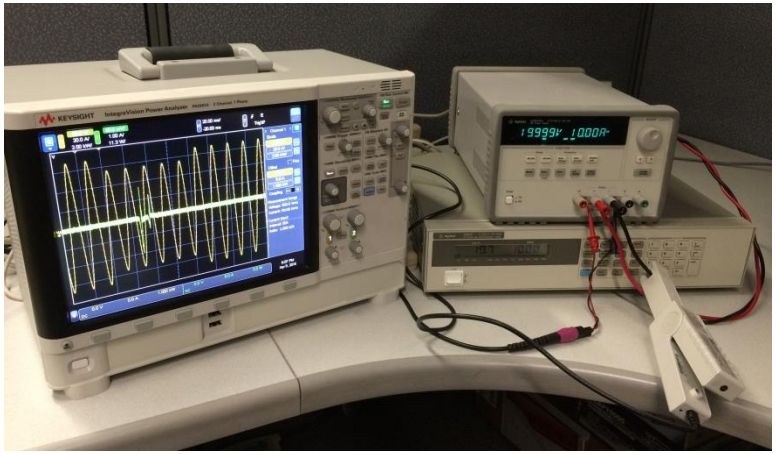


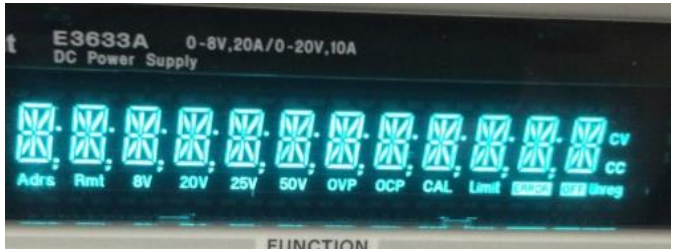
**Frequency variation**

# What is DUT power disturbance response?

What a device does as a result of the disturbance is the DUT (device under test) response to the power disturbance. For example:

- Ideally, nothing happens
- Temporary degradation of performance that ends when the disturbance ends
- Temporary loss of function that ends when the disturbance ends
- Change in functionality that can be corrected with operator intervention
- Worst case: device failure





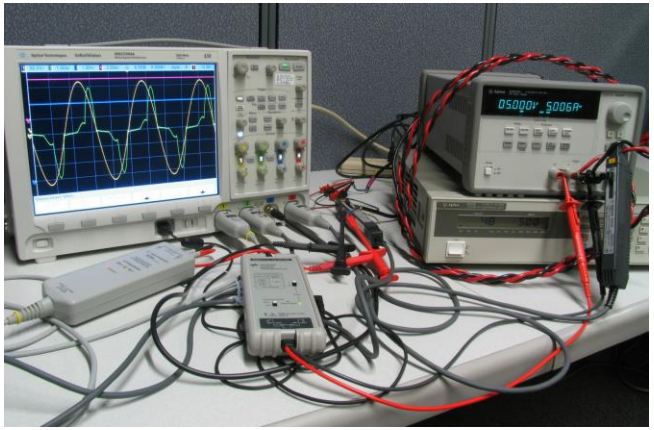

# Why is DUT power disturbance response important?

- Improve user's experience
- Increase product reliability
- Increase product quality
- Ultimately satisfy customers
- Ultimate goal: make your product as immune to power disturbances as is practical

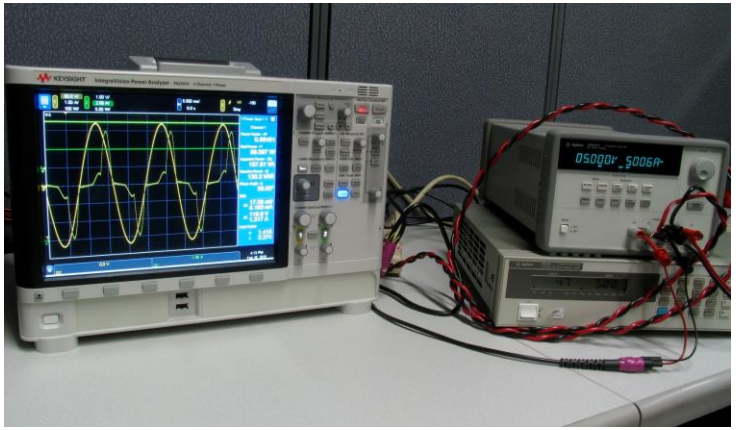

# How is DUT power disturbance response measured?

- Define power disturbances to apply to your DUT
- Define DUT pass/fail criteria
- Create the disturbance
- Verify disturbance/measure response
  - Oscilloscope
  - Power analyzer with dynamic measurement capability

Scope



Power analyzer



# Measuring DUT power disturbance response with an oscilloscope

Advantage

- Higher bandwidth (MHz to GHz)

Disadvantages

- Less accurate voltage measurement (typically 8 bits of vertical resolution)
- Earth ground-referenced inputs

  (differential probes can be used, but complicate setup)
- No direct current measurement capability

  (shunt or current probe can be used, but with drawbacks)

# Measuring DUT power disturbance response with a power analyzer with dynamic measurement capability

Advantages

- Better voltage and current accuracy

  (small differences can be accurately measured such as small affects on electrical signals as on DC power supply outputs)

- Floating inputs (for example, up to 1000 V)

- Shunt inputs to measure current directly

  (improves accuracy and simplifies setup)

Disadvantage

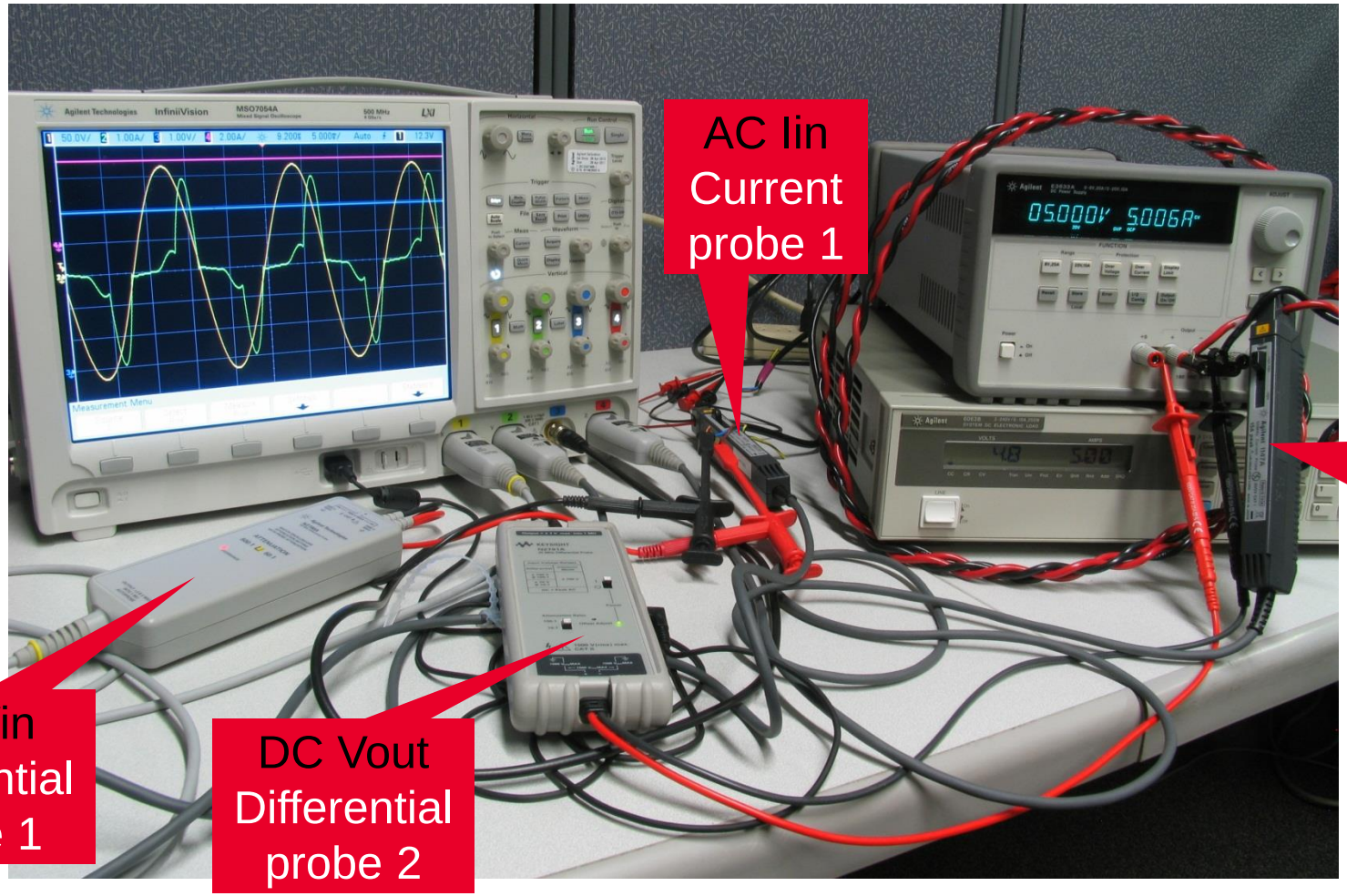
- Lower bandwidth (a few MHz)

# Measuring DUT power disturbance response

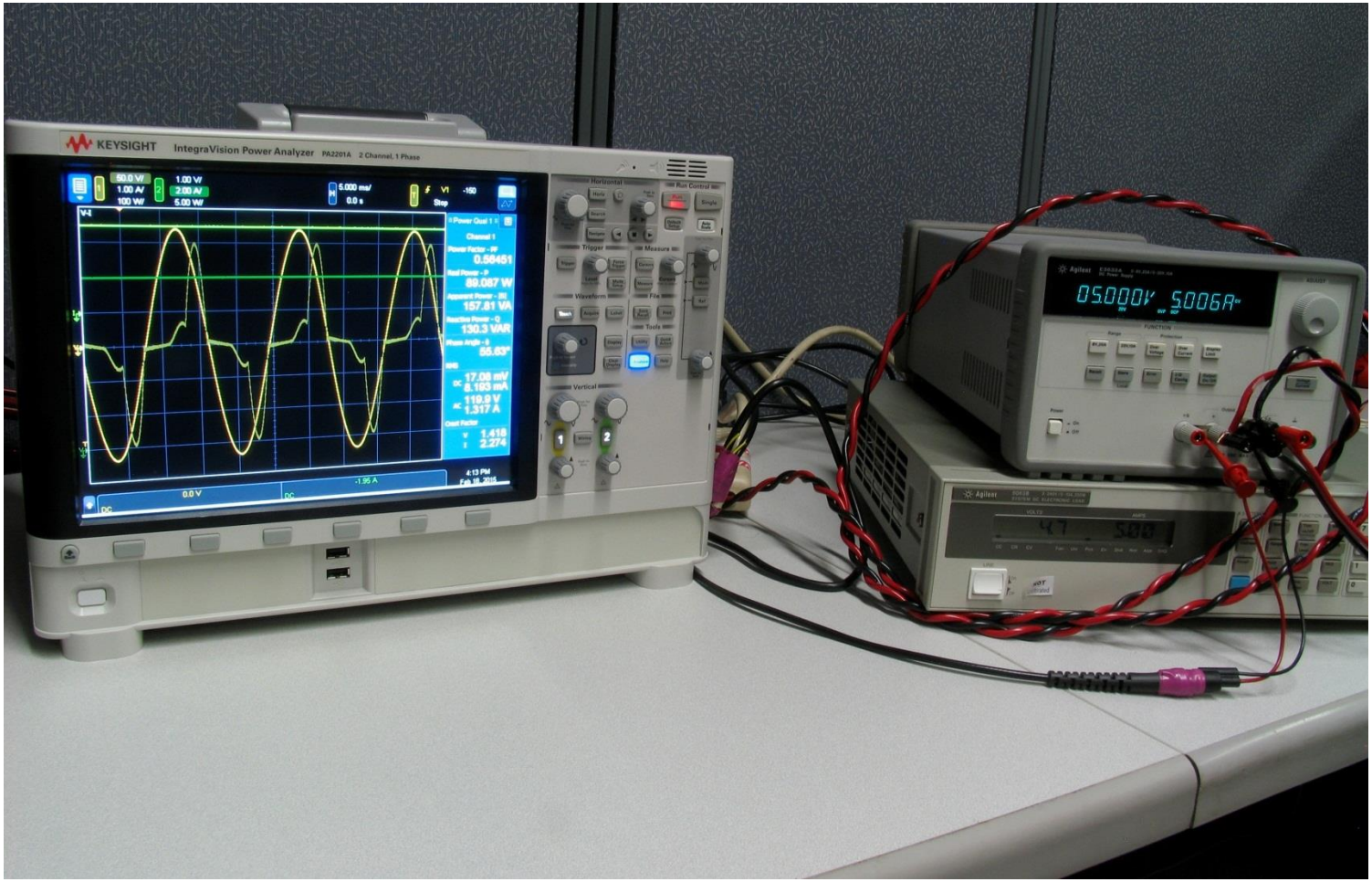
## A quick comparison of an oscilloscope to Keysight's PA2201A IntegraVision power analyzer

| | Oscilloscope | Keysight PA2201A IntegraVision Power Analyzer with dynamic measurement capability |
|---|---|---|
| Bandwidth | MHz to GHz | 2 MHz |
| Voltage accuracy | 8-bits (typical) | 16-bits |
| Isolated from earth ground | Earth referenced – need differential probes | Isolated to 1000 V |
| Current measurement | Requires external shunt or current transformer | • Built-in shunts: 2 A & 50 A<br>• Current transformer input |
| Setup complexity | Moderate | Very simple |

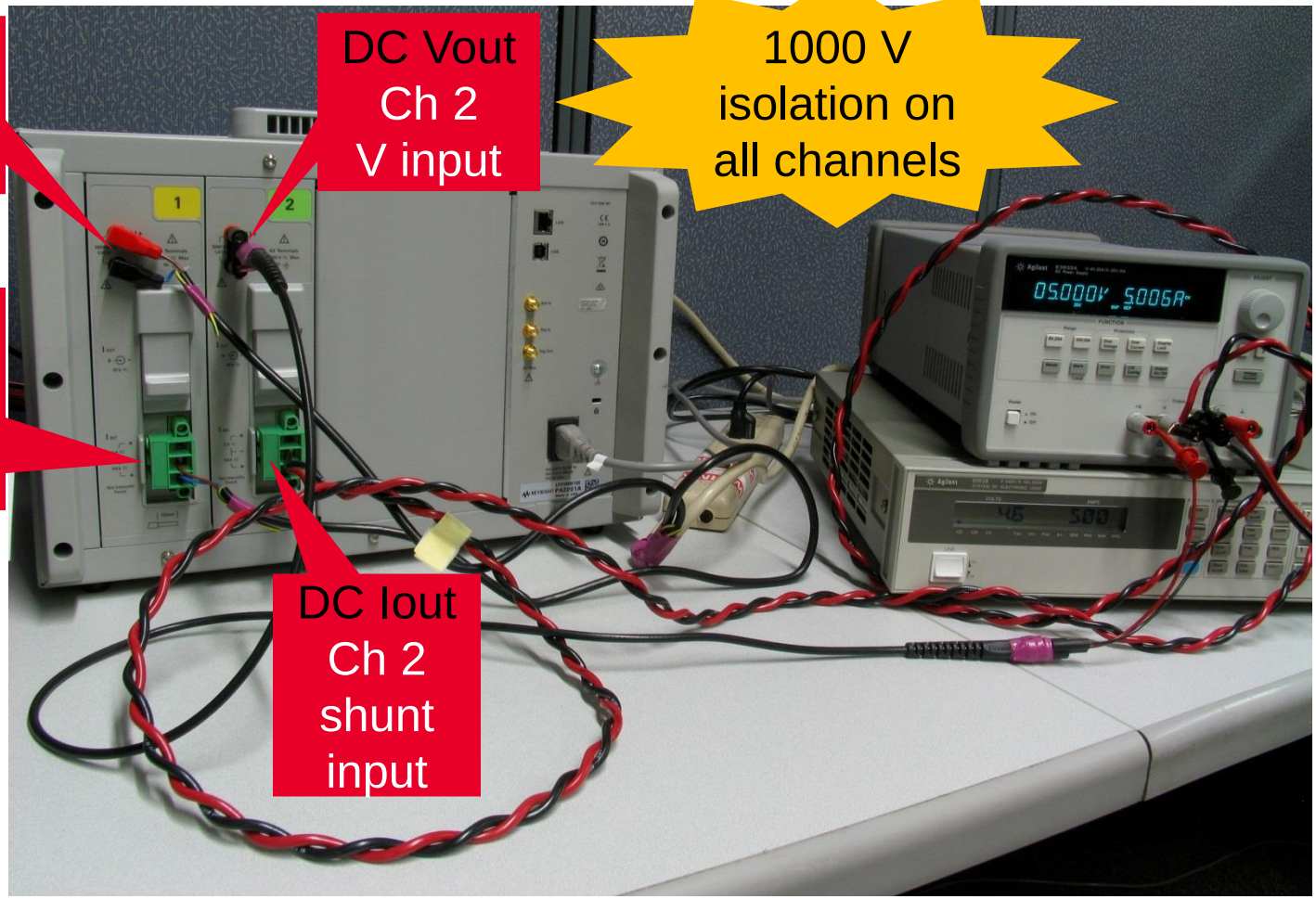
# AC input and DC output of DC power supply (V and I) measured by four channel oscilloscope



# AC in and DC out of DC power supply (V and I) measured by two channel Keysight IntegraVision power analyzer



# AC in and DC out of DC power supply (V and I) measured by two channel Keysight IntegraVision power analyzer

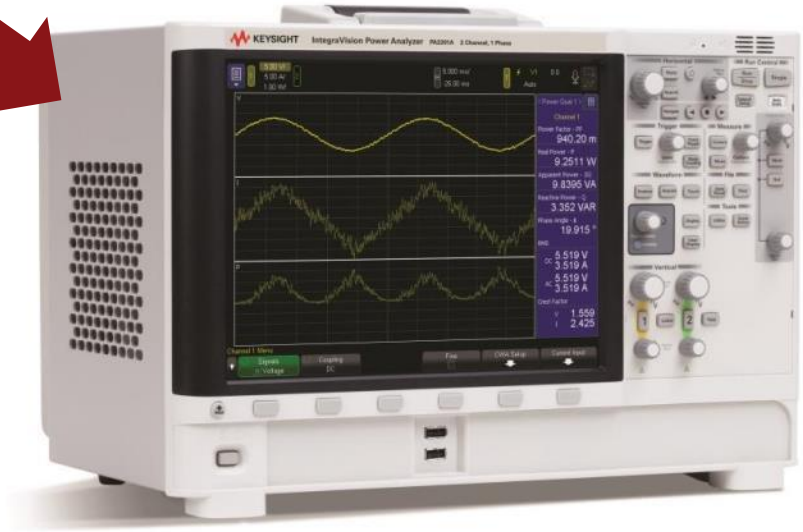


# The Keysight IntegraVision Power Analyzer

## World's First Power Analyzer with Touch-Driven Oscilloscope Visualization Capability

**Power Analyzer**

- High accuracy
- 16-bit resolution
- 1000V isolation
- Direct current measurement



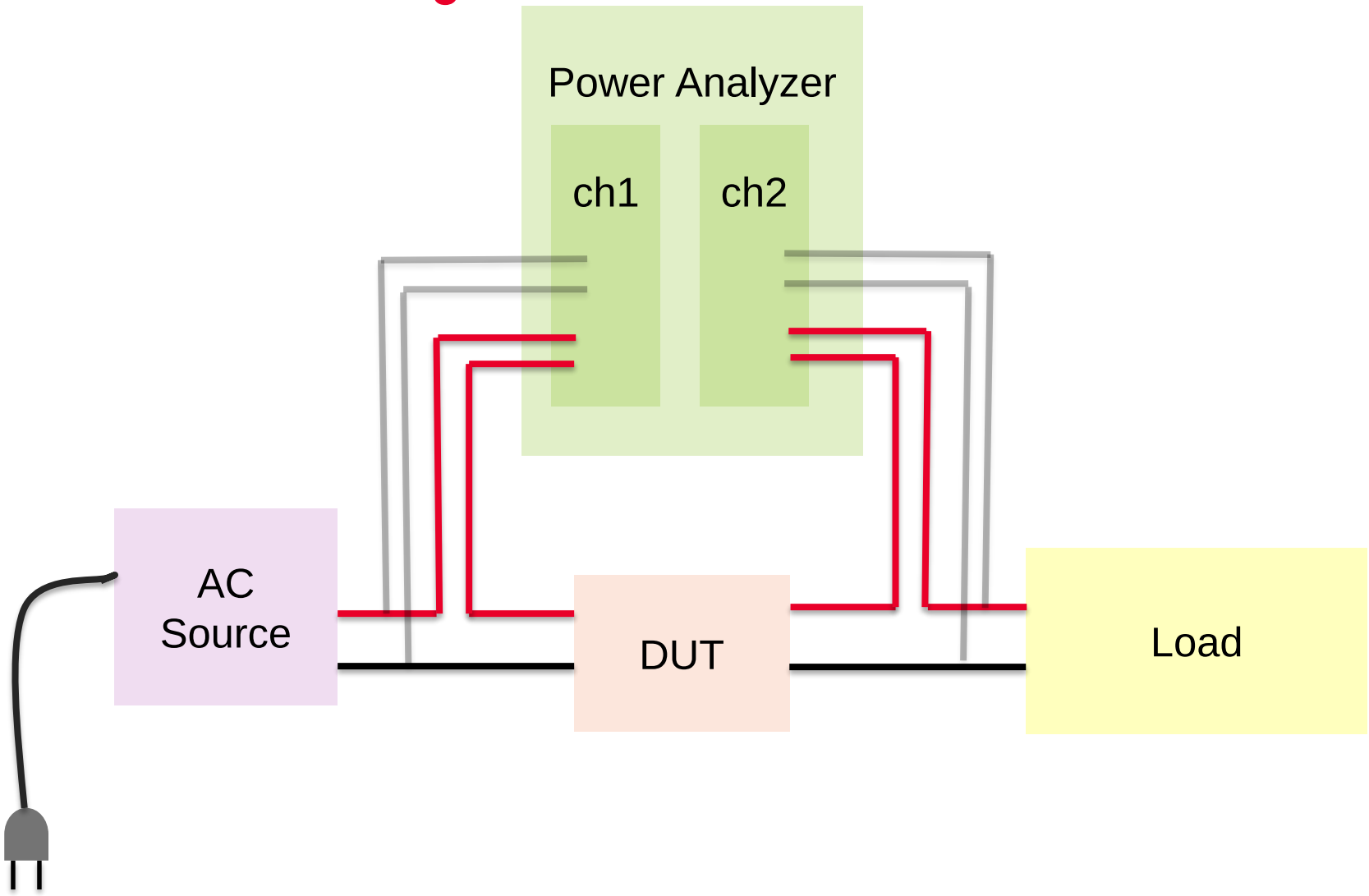

**Oscilloscope**

- Repetitive
- Single shot
- Real time waveforms
- Large touchscreen

For design, debug, and verification

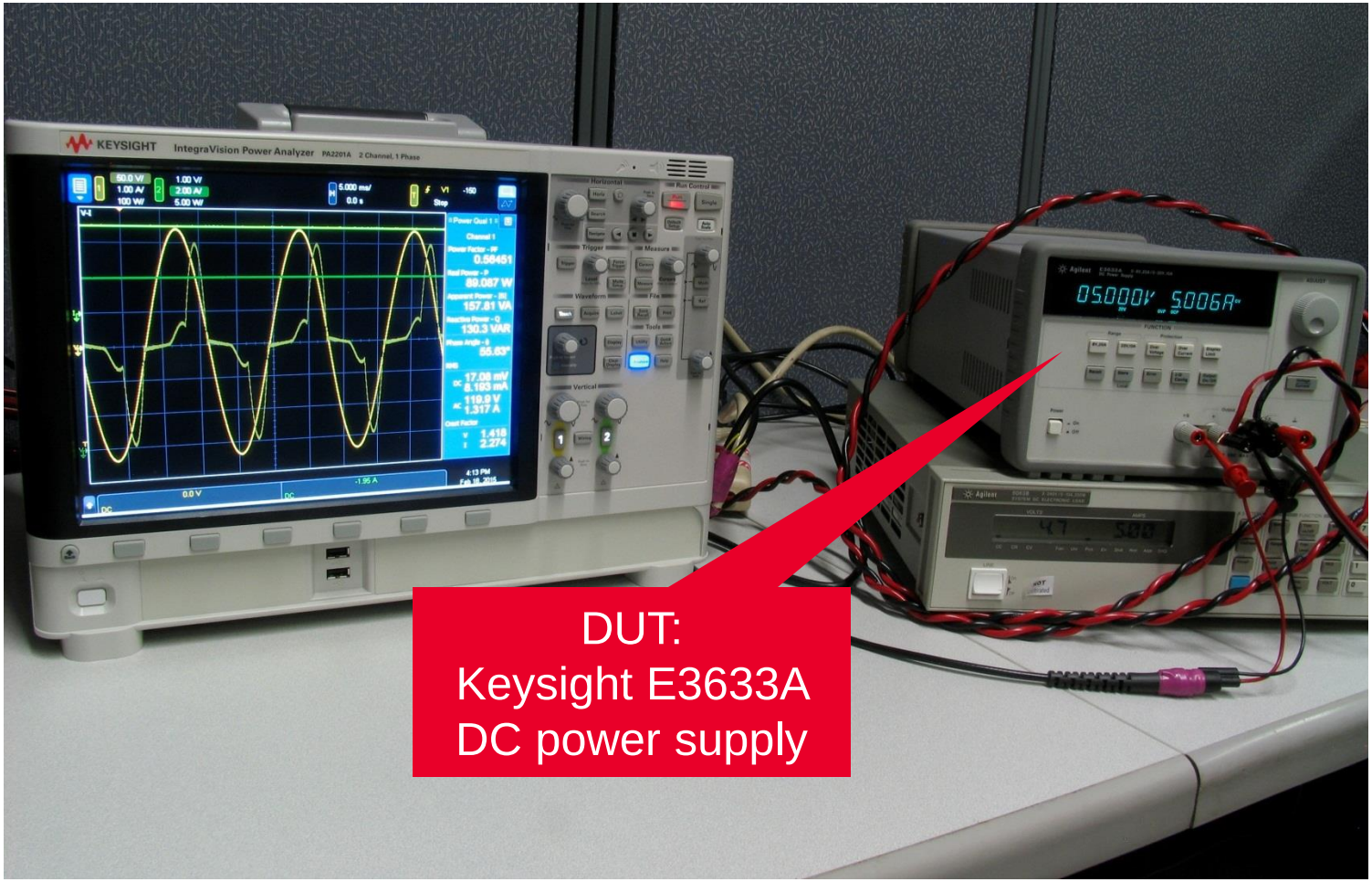
Use to easily verify power disturbance signals and measure DUT response

# Connection diagram



# DUT example: DC power supply

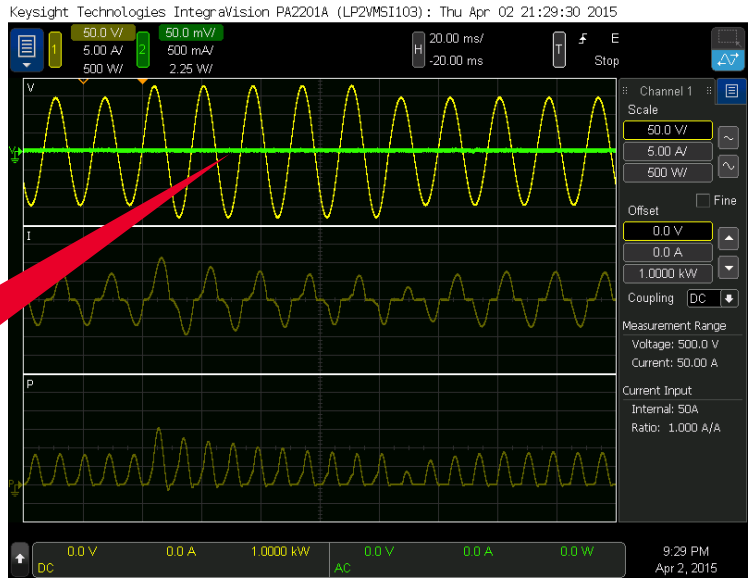
## Measure power disturbances with Keysight's IntegraVision power analyzer

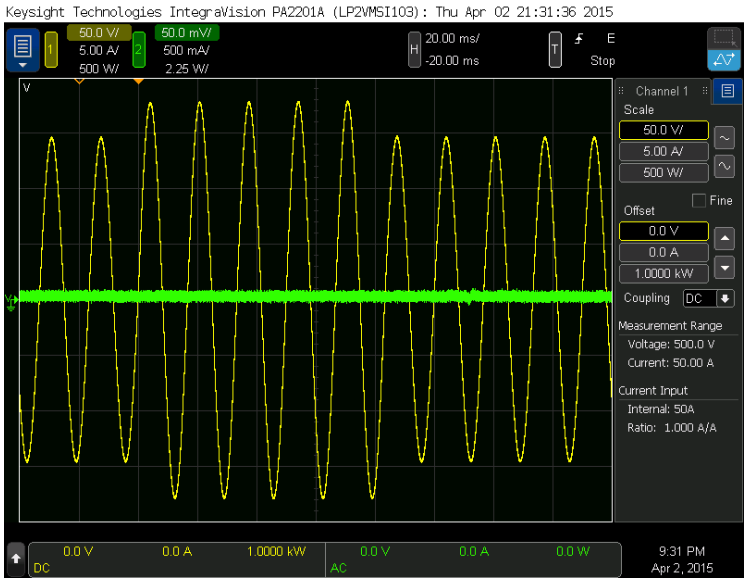


# Power disturbance measurement example

## DC power supply: AC input voltage surge (surge within specs)

DC output is not affected



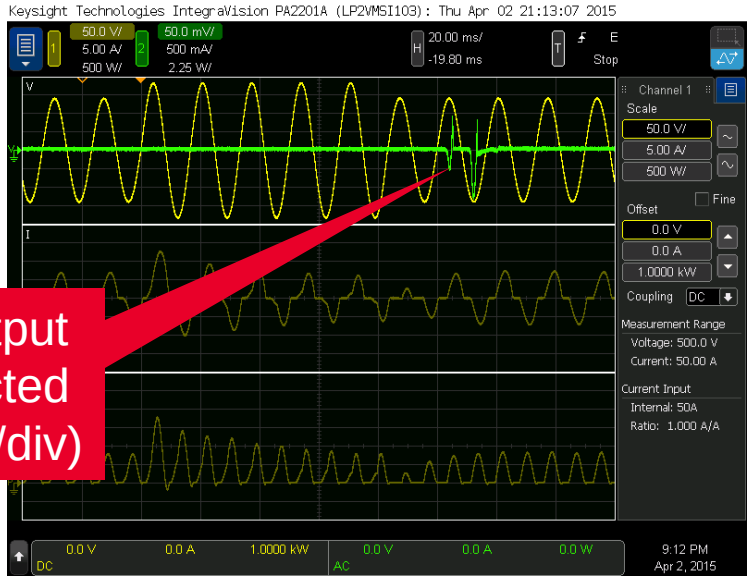




5 cycle surge
103.5 to 126.5 Vac
60 Hz

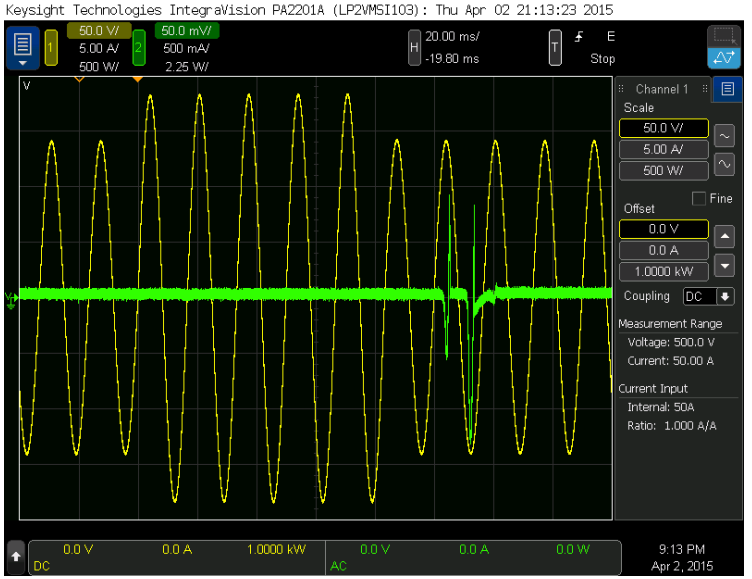
IntegraVision screenshots

# Power disturbance measurement example

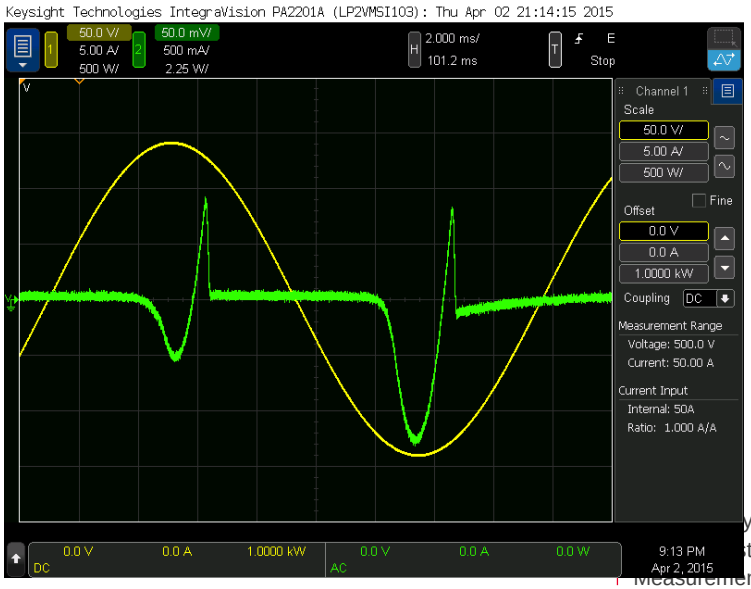
## DC power supply: AC input voltage surge (surge beyond specs)




DC output is affected (50 mV/div)




5 cycle surge
100 to 130 Vac
60 Hz

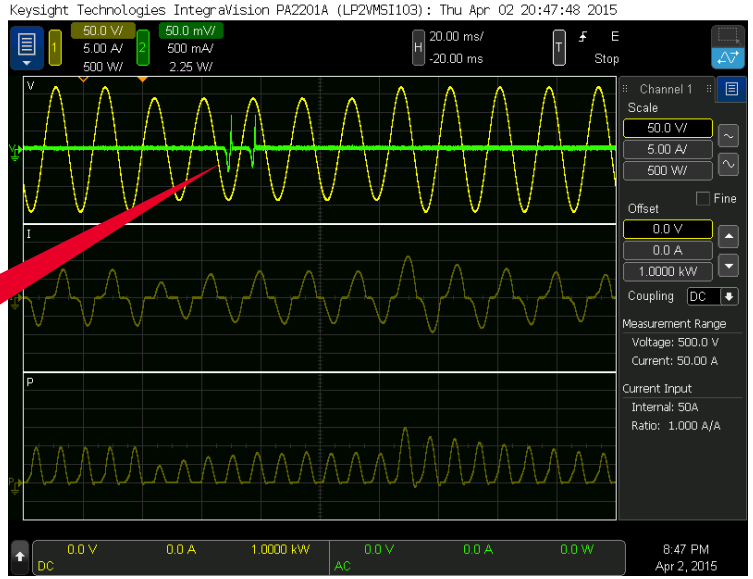


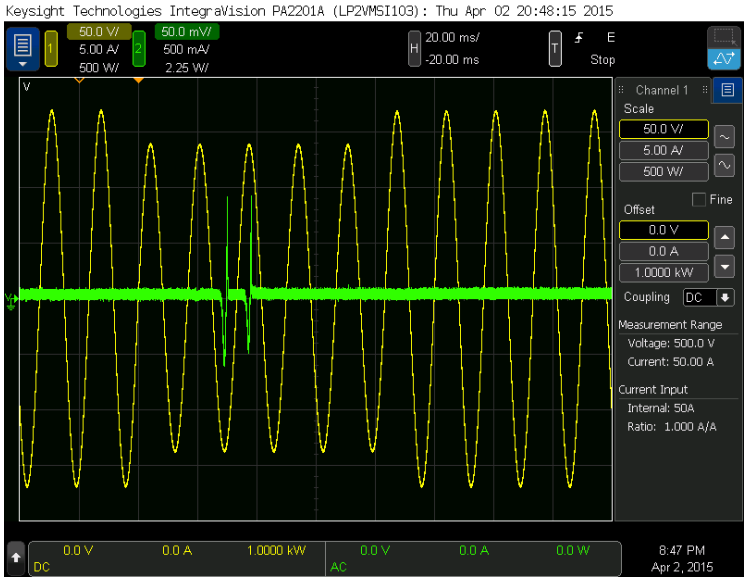

IntegraVision screenshots

# Power disturbance measurement example

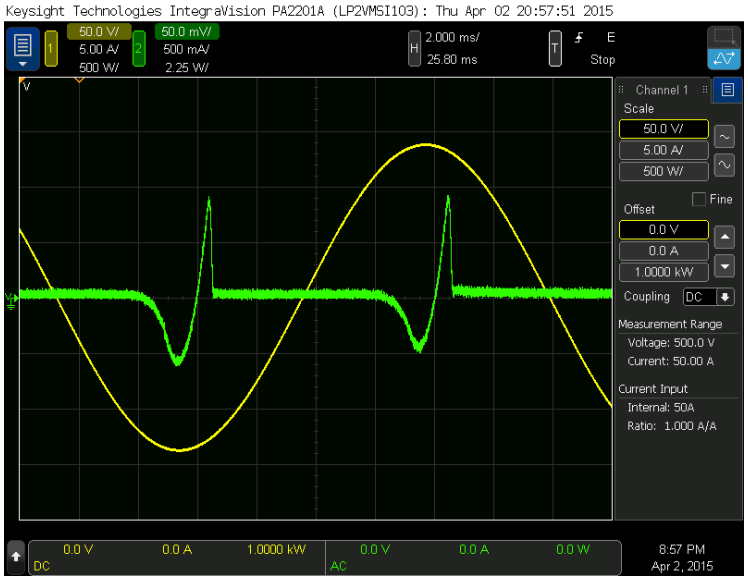
## DC power supply: AC input voltage sag

DC output is affected



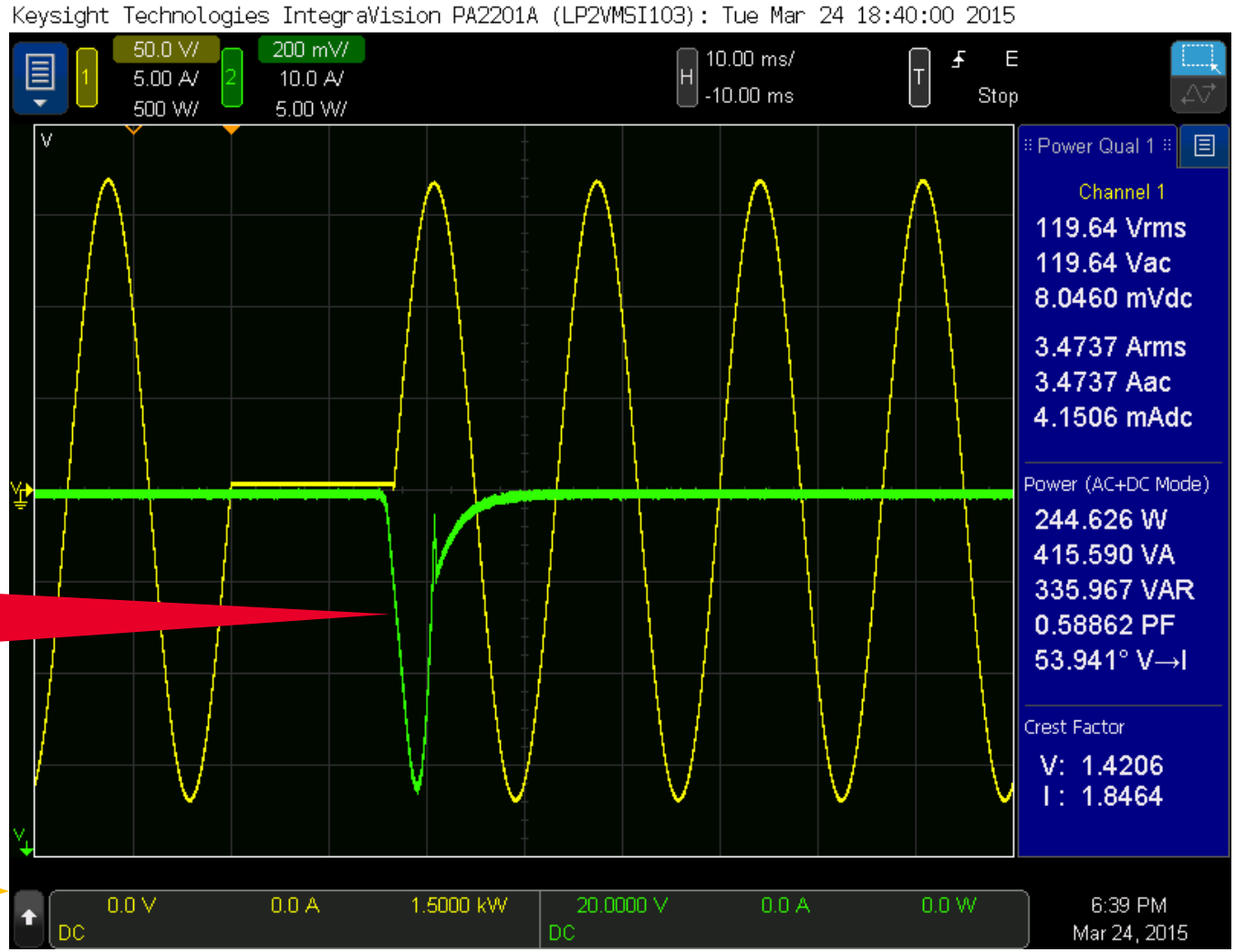

5 cycle sag
120 to 98 Vac
60 Hz




IntegraVision screenshots

# Power disturbance measurement example

## DC power supply: AC single cycle dropout with DC output loaded




DC output is affected (200 mV/div)

IntegraVision screenshot

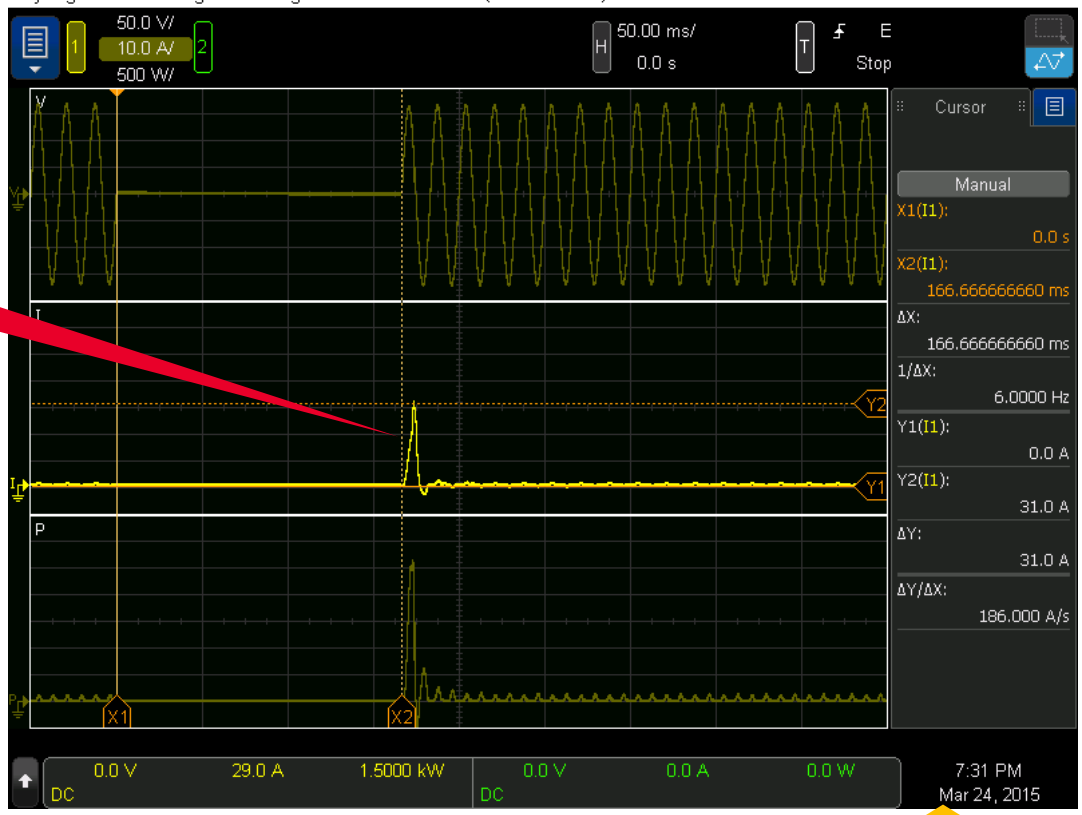
1 cycle dropout
120 to 0 Vac
60 Hz

# Power disturbance measurement example

## DC power supply: AC 10 cycle dropout with no DC load causes power supply to reset (9 cycle dropout does not reset)

Power supply resets


Keysight Technologies IntegraVision PA2201A (LP2VMSI103): Tue Mar 24 19:31:39 2015

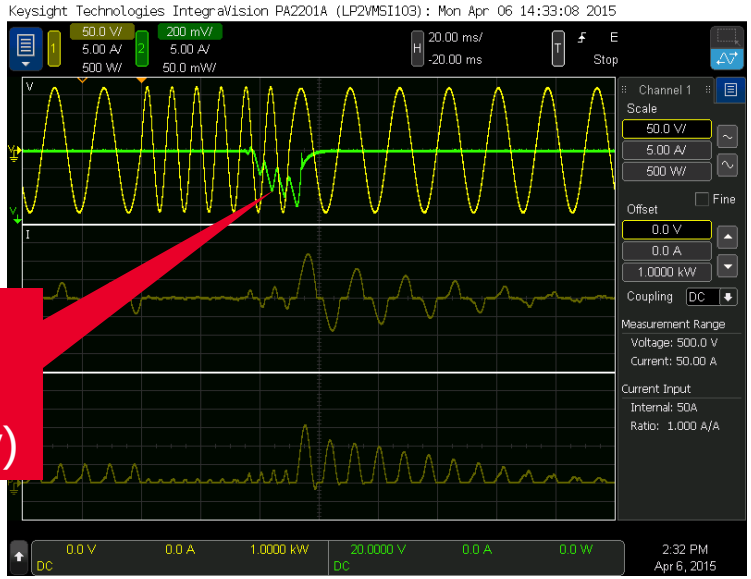



10 cycle dropout
120 to 0 Vac
60 Hz

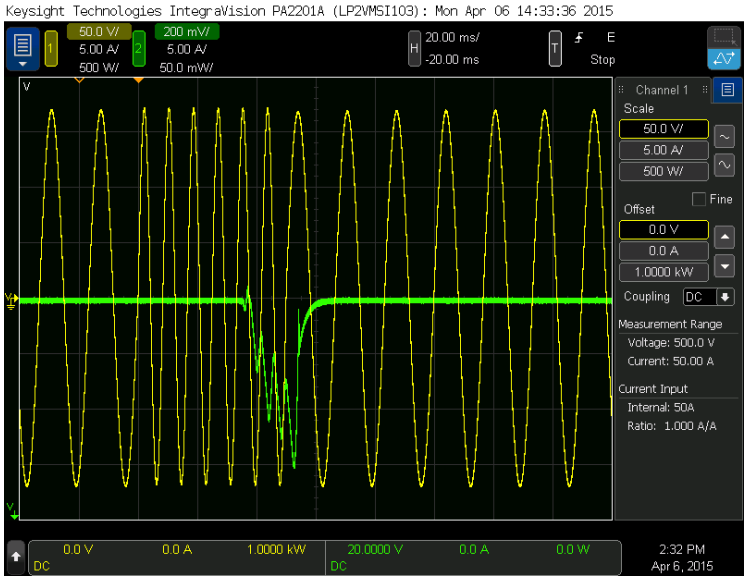
IntegraVision screenshot

# Power disturbance measurement example

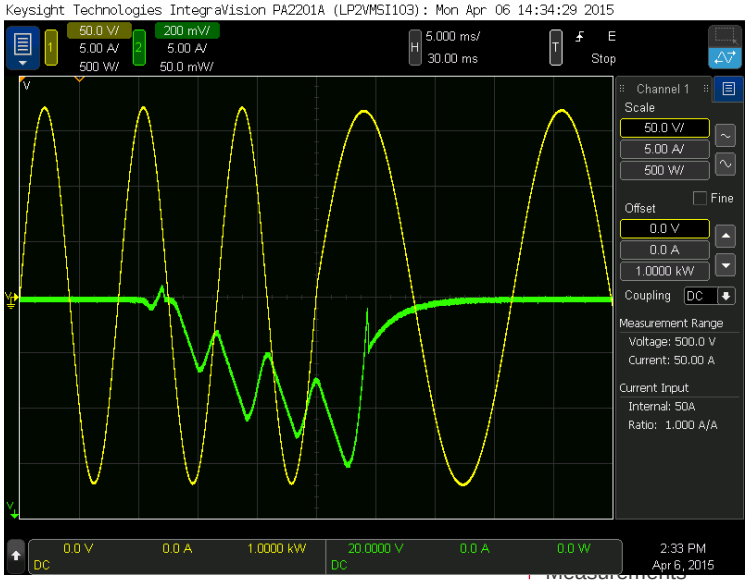
## DC power supply: AC input frequency variation




DC output is affected (200 mV/div)



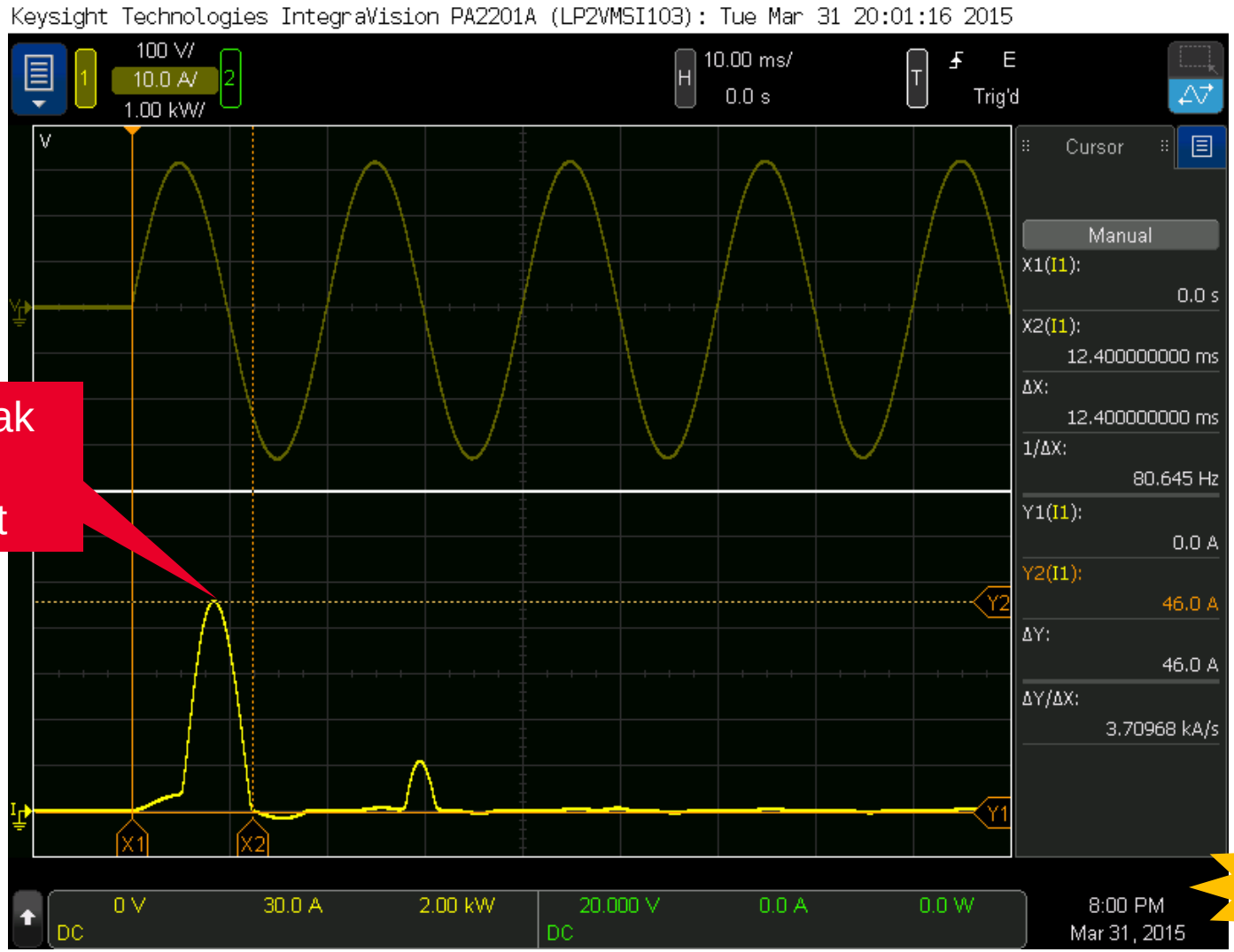

50 ms variation
60 to 120 Hz
120 Vac




IntegraVision screenshots

# Power disturbance measurement example

## DC power supply AC inrush current: AC on at 0° phase



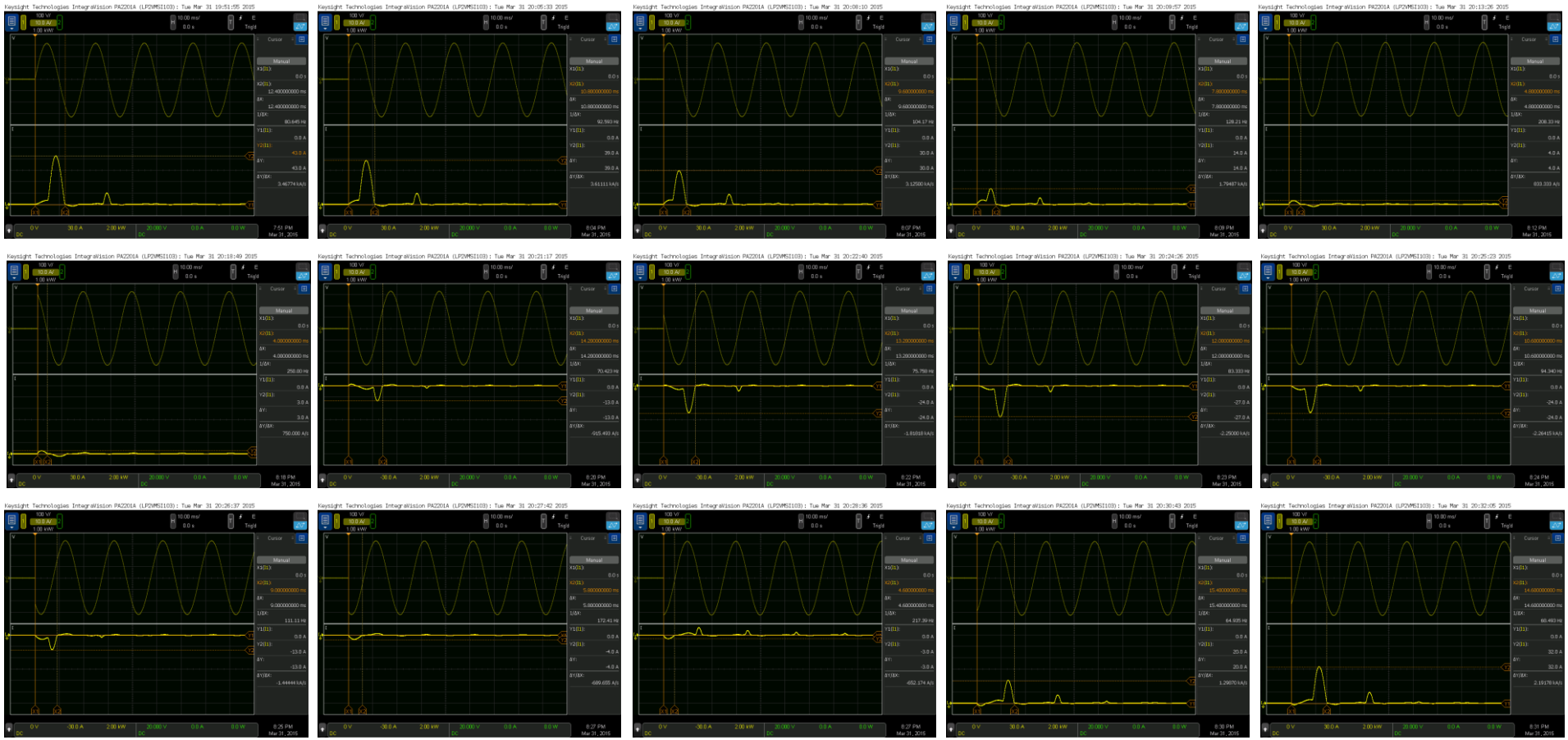

46 A peak inrush current

Inrush current
0 to 230 Vac
50 Hz

IntegraVision screenshot

# Power disturbance measurement example

## DC power supply AC inrush current: AC on at 0° to 360° phase



Inrush current
0 to 230 Vac
50 Hz

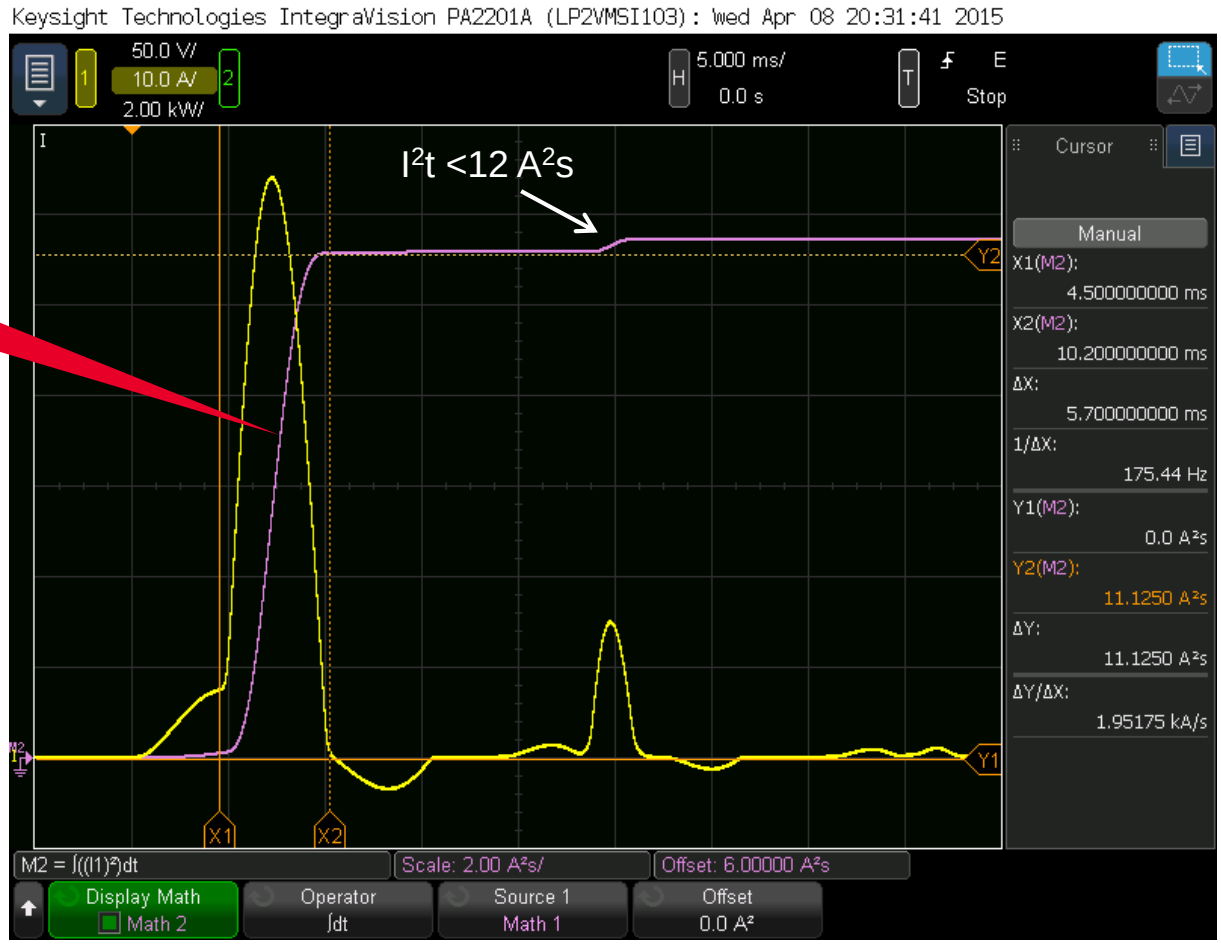
IntegraVision screenshots

# Power disturbance measurement example

## DC power supply AC inrush current: math function calculates $I^2t$

Math function shows $I^2t$ for input fuse selection

$I^2t$ measures <12 $A^2s$
Fuse specification is 38 $A^2s$
No risk of fuse blowing



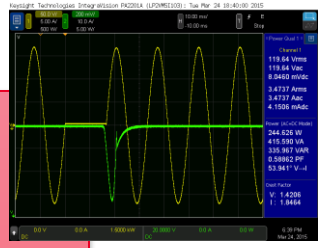

Inrush $I^2t$ measurement
0 to 120 Vac
60 Hz

IntegraVision screenshot

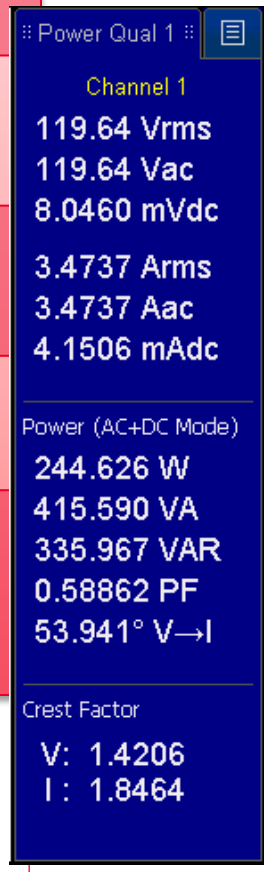
KEYSIGHT TECHNOLOGIES

# Keysight IntegraVision Power Analyzer

## Many built-in measurements beyond power disturbances



| | |
|---|---|
| Classic Scope Measurements (marker based) | Delta-T, Delta-V, Delta-I, Delta-W, RMS, P-P, Frequency, Duty Cycle, Rise/fall-time, etc. |
| Power Analysis Measurements | DC-RMS, AC-RMS, W, VA, VAR, Power Factor, Phase Angle, Crest Factor |
| Specialized Measurements | Efficiency, Inrush Current |
| Harmonics | FFT, THD,<br>Harmonics to 100$^{th}$ with no limit on fundamental |
| Integrated Energy Measurements | Amp-Hours, Watt-Hours<br>Integrate up to 10 days showing A-H, W-H plus peak value, average value for W, A, VA |




Use like a scope, measure like a power analyzer

# Summary: Power disturbance measurements

## Oscilloscopes or power analyzers with dynamic measurement capability can be used for power disturbance measurements

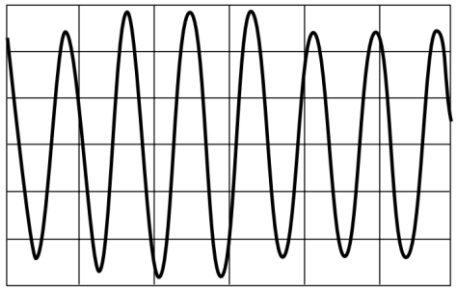
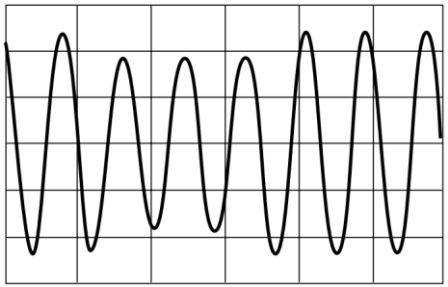
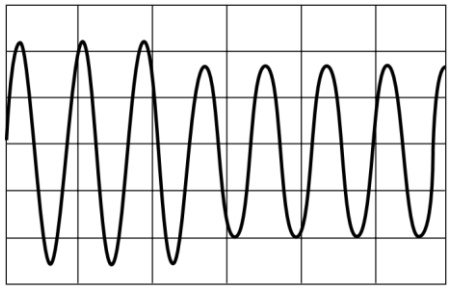
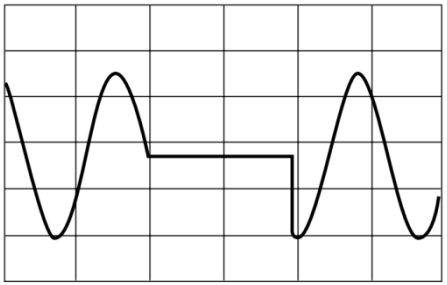
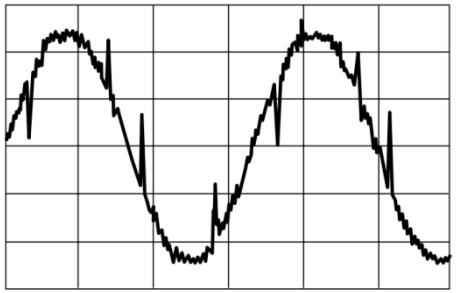
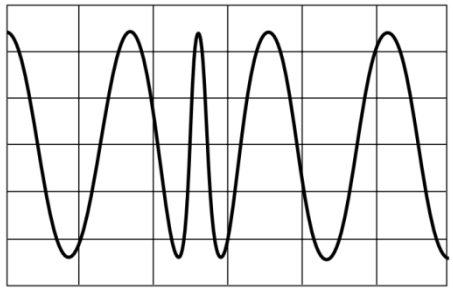
| | | |
|---|---|---|
| **Keysight Scopes**<br>  | **General purpose**<br><br>Broader set of power and non-power measurements with wider bandwidth, but at lower accuracy. | • **> 500 MHz BW**<br>• **1-2% accuracy**<br>• **8-10 bit resolution**<br><br>• Not floating<br>• Requires probes for differential voltage and current measurement<br>• Adds setup complexity |
| **Keysight IntegraVision**<br>  | **Purpose built**<br><br>Highly accurate measurements on power converter input and output. | • **0.05% accuracy**<br>• **16 bit resolution**<br>• **Low BW (2 MHz)**<br><br>• Floating inputs<br>• Direct current measurement<br>• Easy setup |

# Summary: Improve your DUT's response to power disturbances

Increase your DUT's **immunity** to power disturbances

- Surge
- Sag
- Brownout
- Cycle dropout
- Noise
- Frequency variation

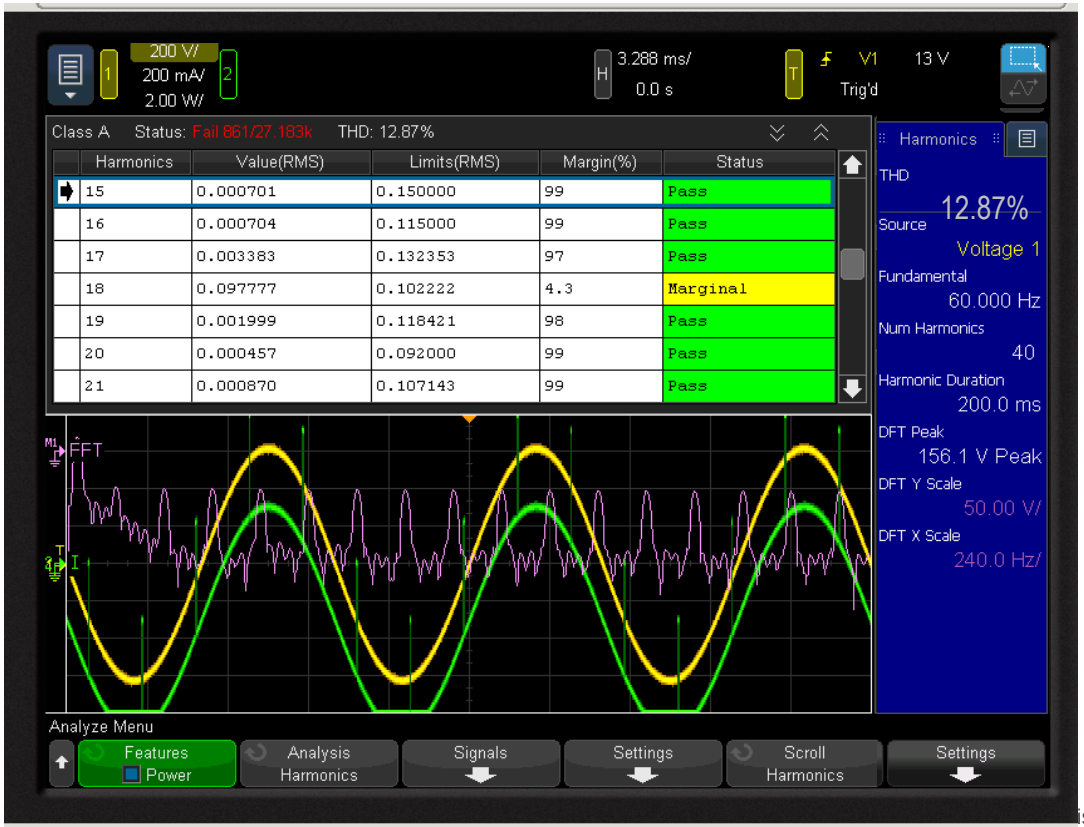

Better **satisfy** your customers

# Expanded Feature Set

## IEC 61000-3-2 Pre-compliance


Effortlessly test to pre-compliance standard of IEC61000-3-2 (Class A, B, C, or D).



# Expanded Feature Set

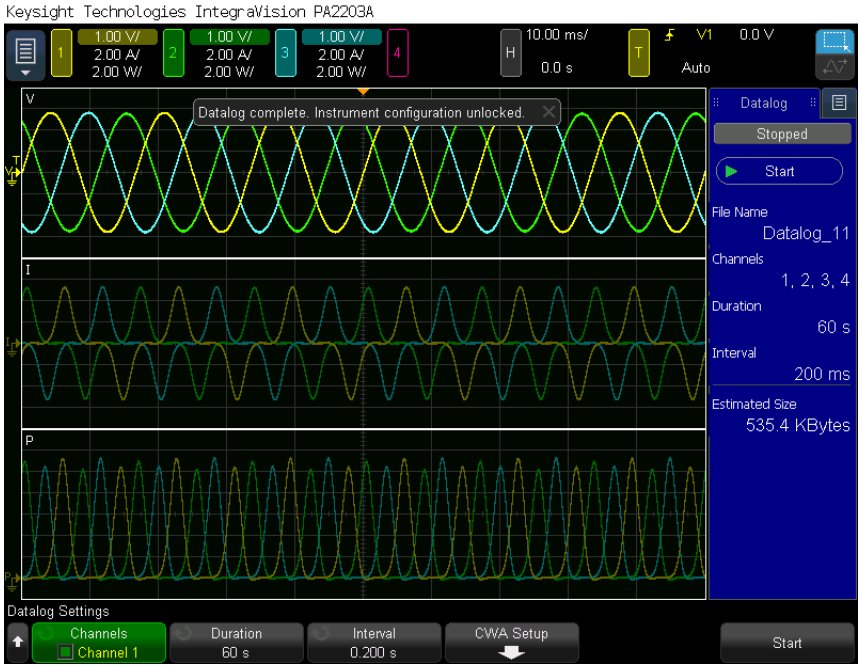
## Integrated Datalogging


### Capture data for an extended time

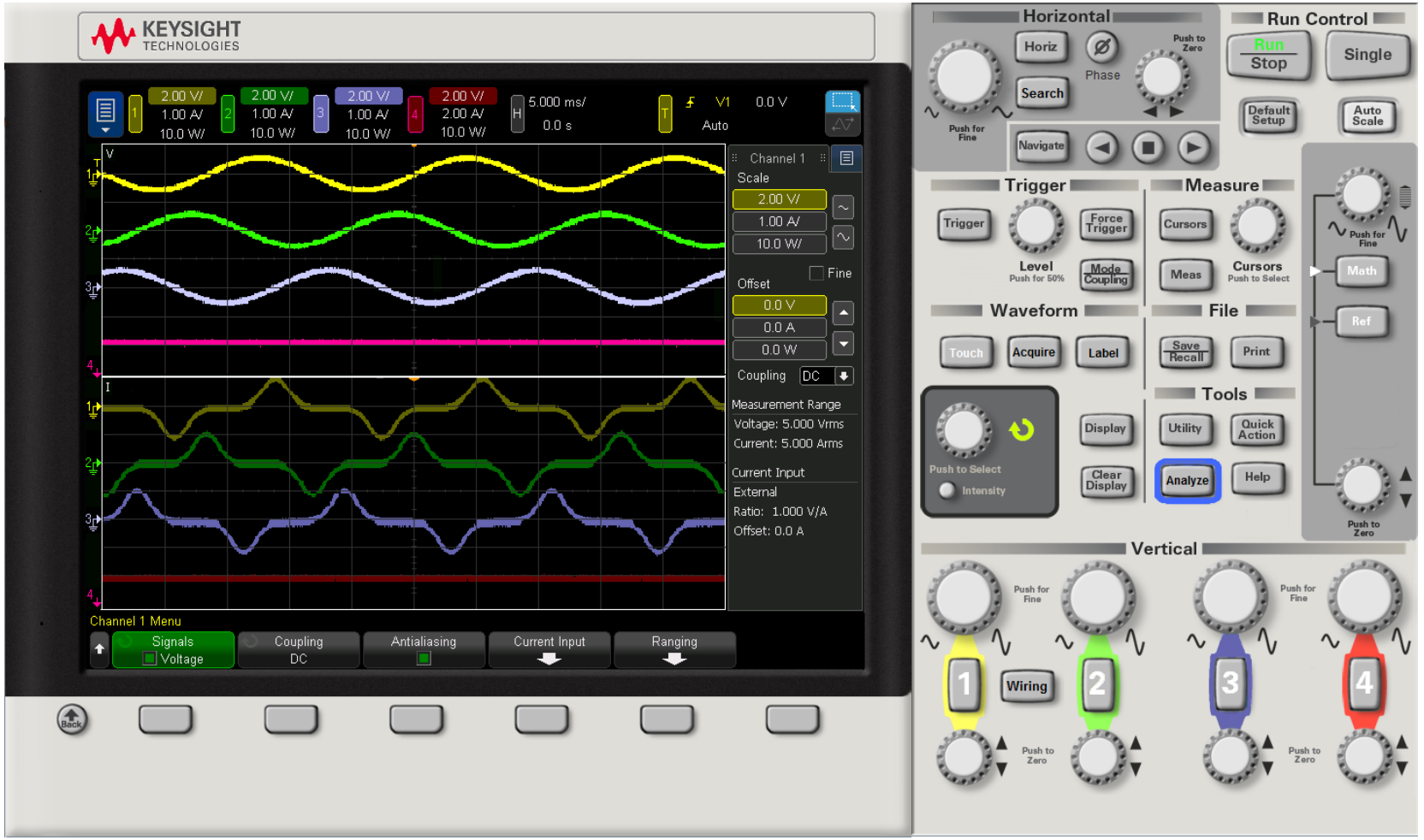
- Enables off-line analysis
- Archive test data

### Fully configurable via touch screen

- Set DURATION from 1s to 1 year
- Set INTERVAL from 50ms to 1 day
- Save data file to USB for easy transfer, archive, and analysis



# Inbox Preview of the PA2203A: 4 channels (3-Phase)



# *Thank You!*

Questions?