Teaching EM Measurement Techniques within an On-Line Environment

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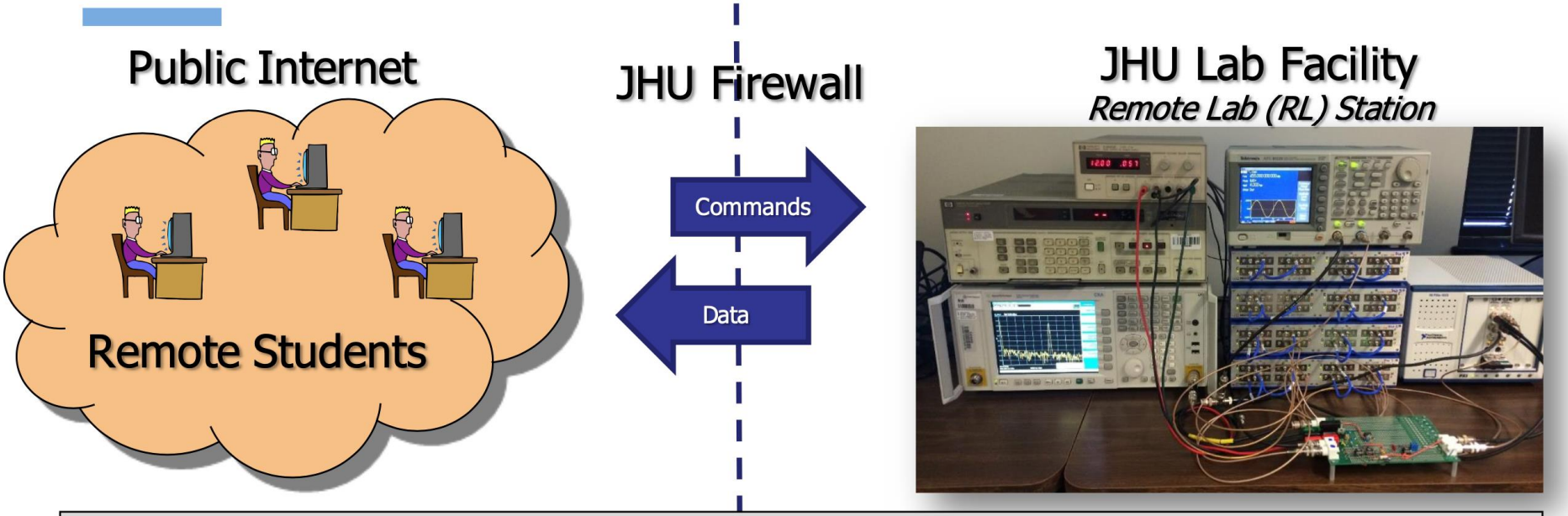
JOHNS HOPKINS
WHITING SCHOOL
of ENGINEERING

Remote Lab Concept

Laboratory Concepts for Online Courses:
Web-based access to on-campus labs

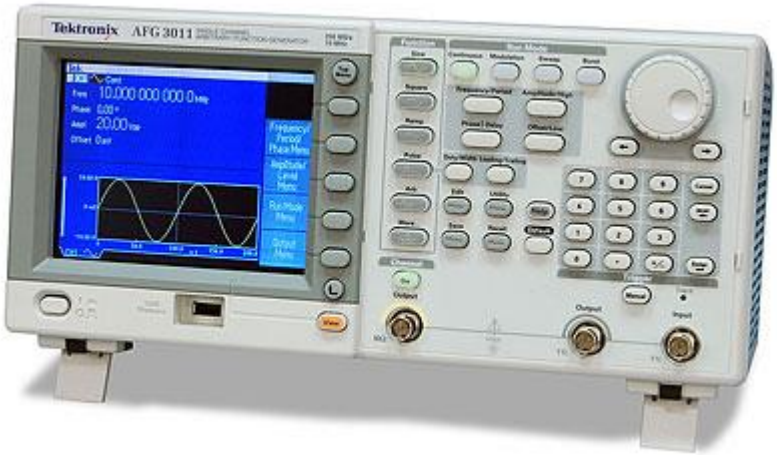


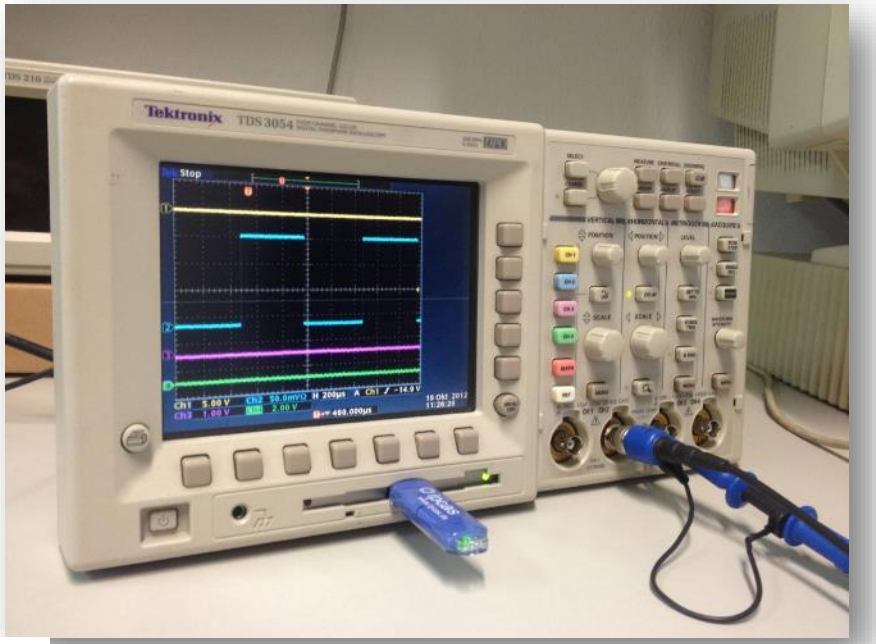
- Online students access laboratory instrumentation for measurement and characterization exercises
- One RL station currently used in 525.654 (Communication Circuits Lab)
  - Second station in development for 525.201
- Effort led by Jeff Houser and Michael Herman

Remote Lab Implementation

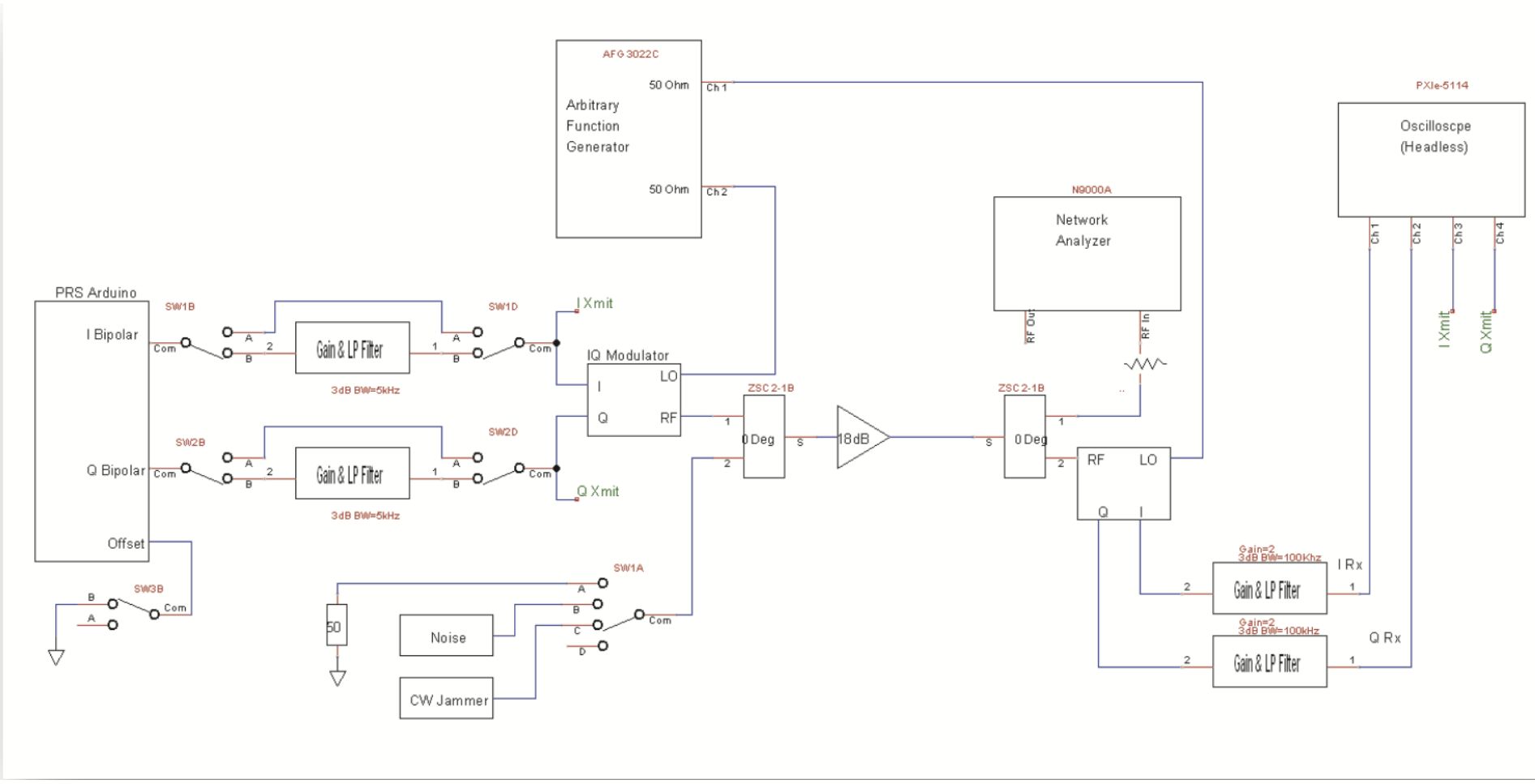
- Server software hosted on lab computer allows computer control of instruments
- Computer control via instrument data interfaces
  - USB, RS-232, HPIB, Ethernet
- Remote Instrument (RI) panel for control and display
  - User manipulates controls with keyboard & mouse
- JHU implements remote interface to allow internet access via browser sessions

Typical Local Interfaces





Typical Configuration



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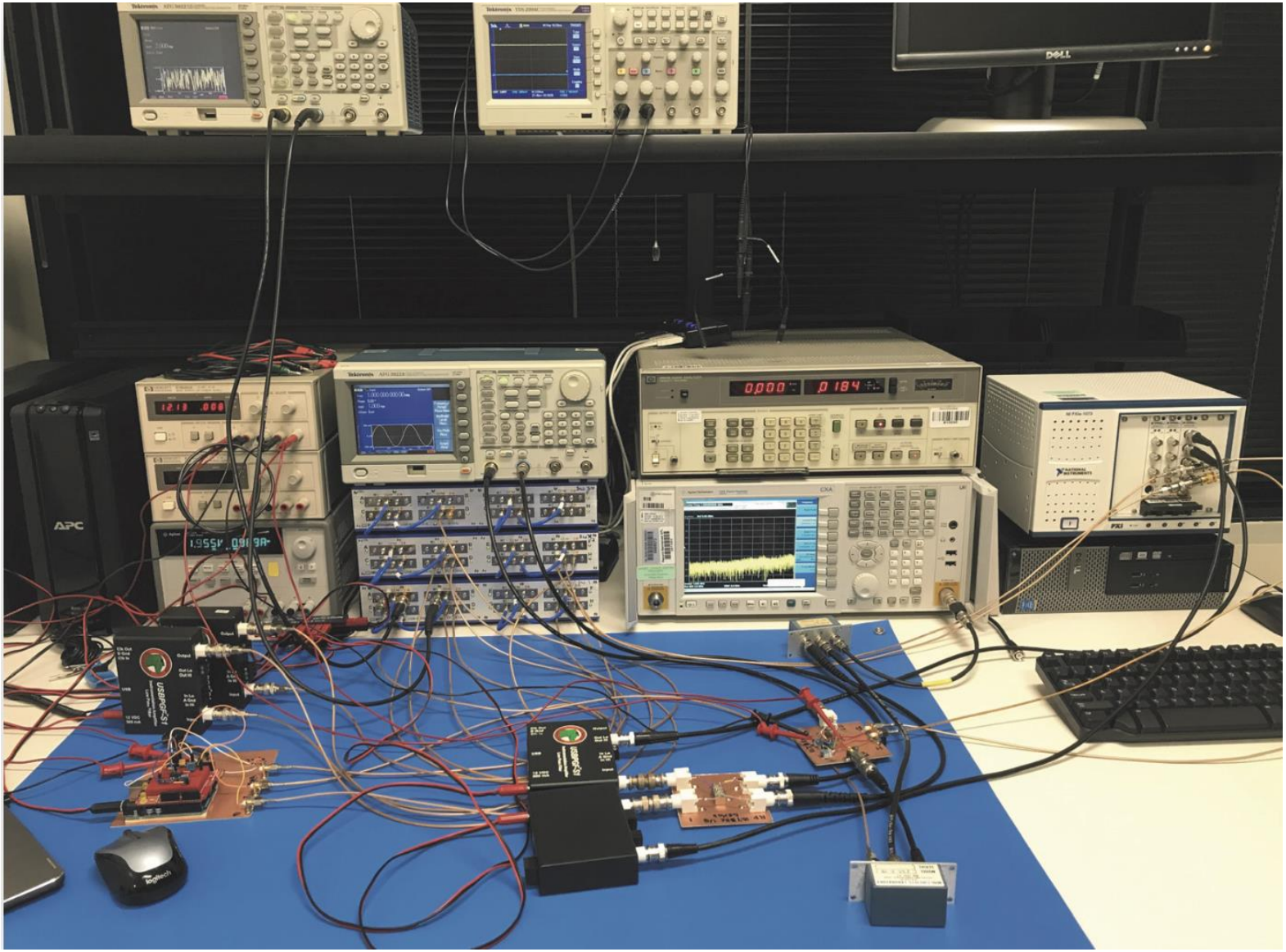
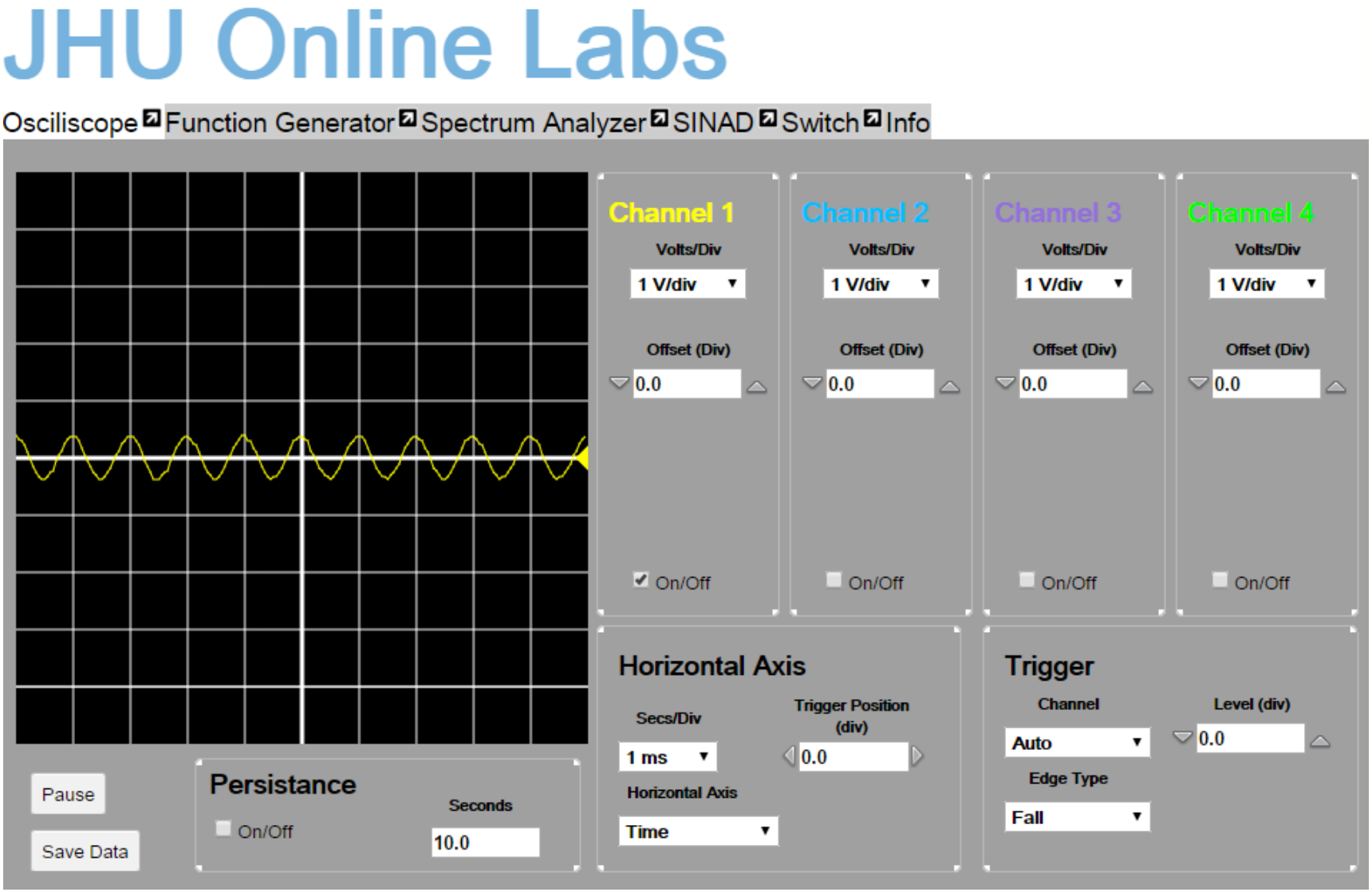


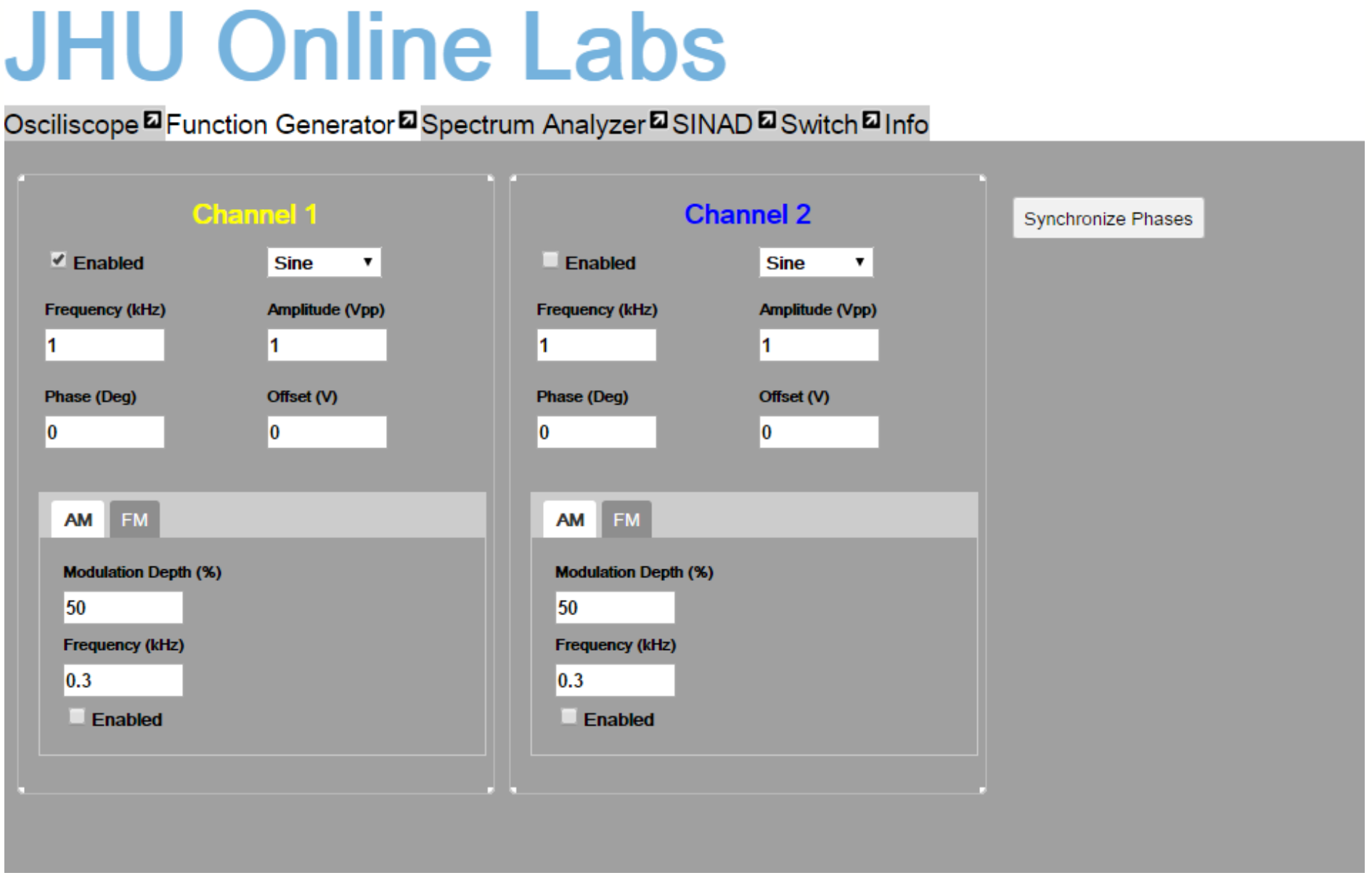
Typical Remote Interfaces

Oscilloscope



Typical Remote Interfaces (cont)

Signal Generator

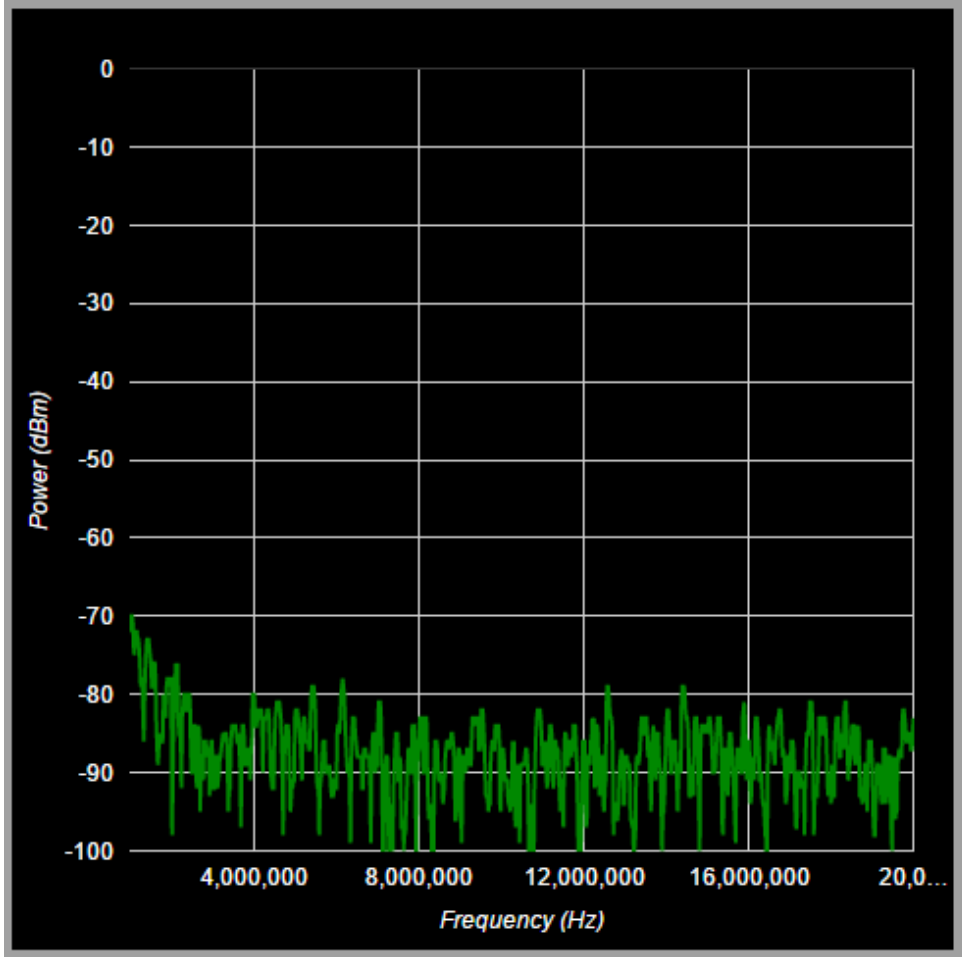


Typical Remote Interfaces (cont)

Spectrum Analyzer

JHU Online Labs

Osciliscope | Function Generator | Spectrum Analyzer | SINAD | Switch | Info



Start Freq (MHz)

1

End Freq (MHz)

20

Reference Level (dB)

0

Max Hold

Save Data

Pause

Characteristics of RIs

- RIs don’t look like actual instrument panel
- RIs are programmed; Programmer determines
  - Which features exposed
  - How features are organized
  - How controls are implemented (e.g. knob or slider)
- RIs typically expose fewer features than actual instrument
- Displays typically update slower
  - Data used to create traces must be transferred over network
  - Typically get one trace vs. continuous stream of traces

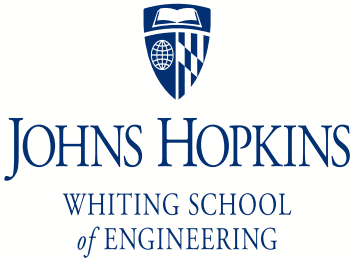
Lab Operations

- One lab per week
- Each lab set up locally; requires down time
- Lab open Wed-Sun each week
- Students conduct labs independently
- Students reserve lab time with schedule tool
  - Everyone permitted one session
  - Extra sessions can then be scheduled
- Data can be downloaded to your local machine
  - For post-lab analysis and reporting
- Read lab procedure prior to conducting lab

Johns Hopkins Engineering

Advanced Analog Electronic Circuit Design

Laboratory Equipment Overview
At home experiments



Lab Equipment Overview

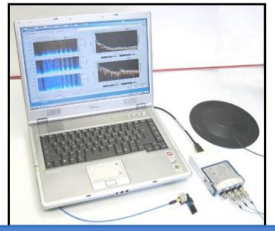
Remote Laboratories for Online Courses: Mailed Hardware

Laboratory Kits

Kits mailed to students at the beginning of the semester

Courses to date:

- 525.615: Embedded Microprocessor Systems
- 525.612: Computer Architecture
- 525.642: FPGA Design Using VHDL
- 525.661: UAV Systems and Control
- 525.732: Advanced Analog Electronic Circuit Design



Low-cost USB instrumentation

Lab Equipment Overview

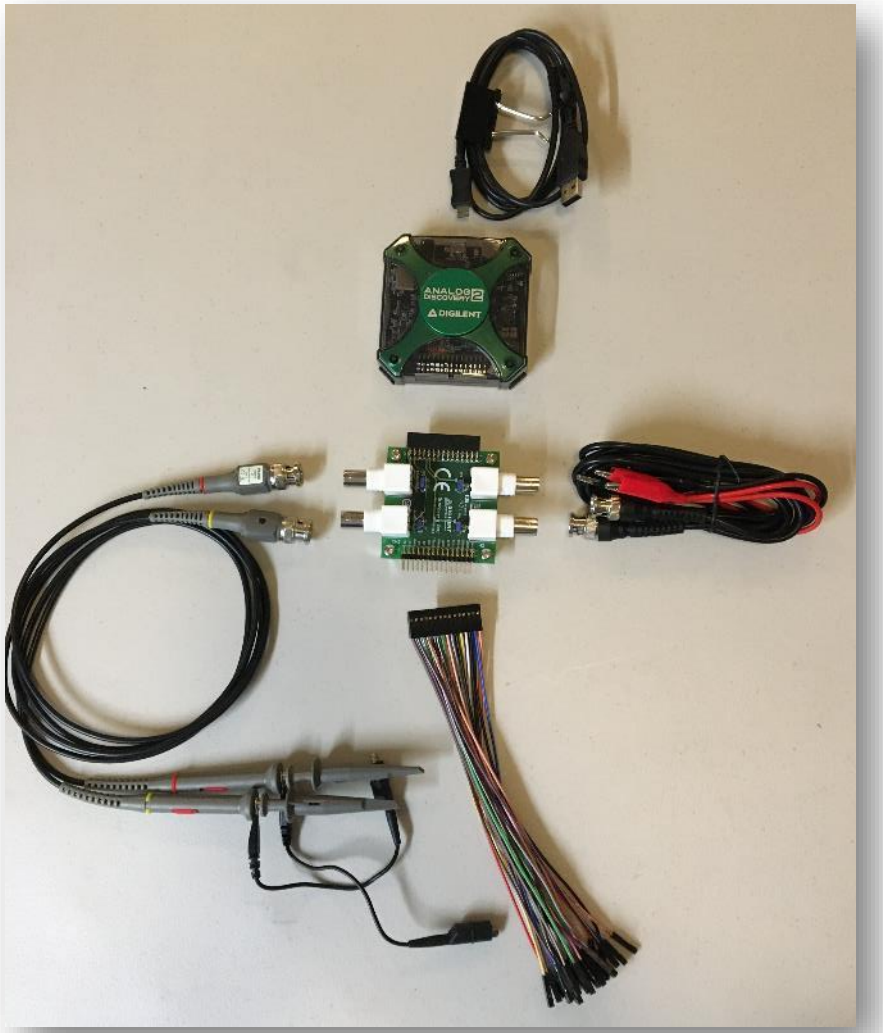
- Test Equipment Provided to you
  - (which you will return)
- Consumable Material Provided to you
  - (which you will keep)
- Material You will provide
  - (because you’re an engineer)

Test Equipment Provided to You

- Analog Discovery II
  - Oscilloscope
  - Spectrum Analyzer
  - Network Analyzer
  - Arbitrary Function Generator
  - Impedance Analyzer
  - Lots of other features we won't use
  - Programmable Power Supplies

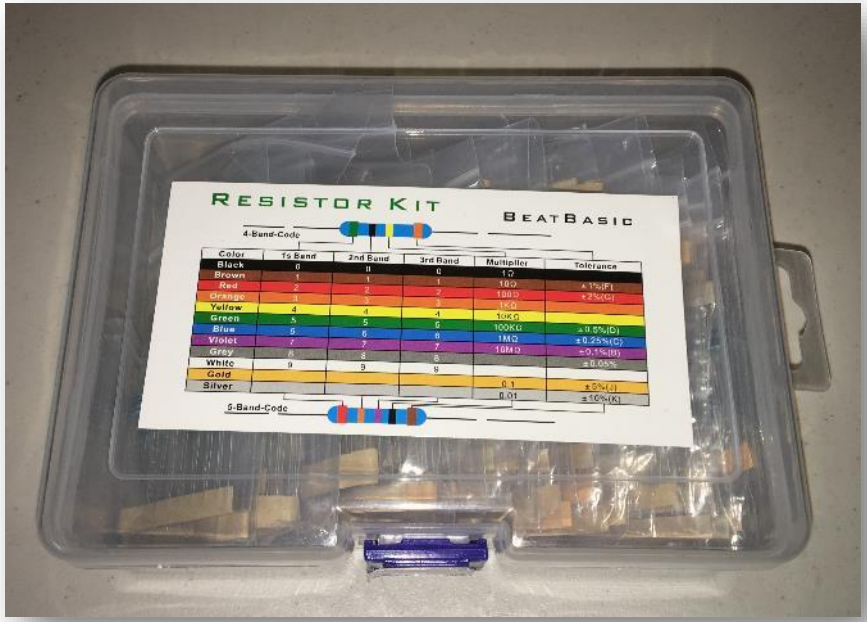
We'll use as reference voltages

- Adapters
  - Scope probes
  - Header to BNC adapter
  - 2x15 pin cable assembly
  - BNC cables with alligator clips



Consumables Provided: Resistor Kit

- Engineering kit (not full E96)
- 1% Metal Film
- Reasonable Selection
- Exact kit varies



Consumables: Capacitor Kit

- Engineering Kit
- Tolerance Unknown
  - (but not great)
- Cost/Availability trade is a challenge - sorry

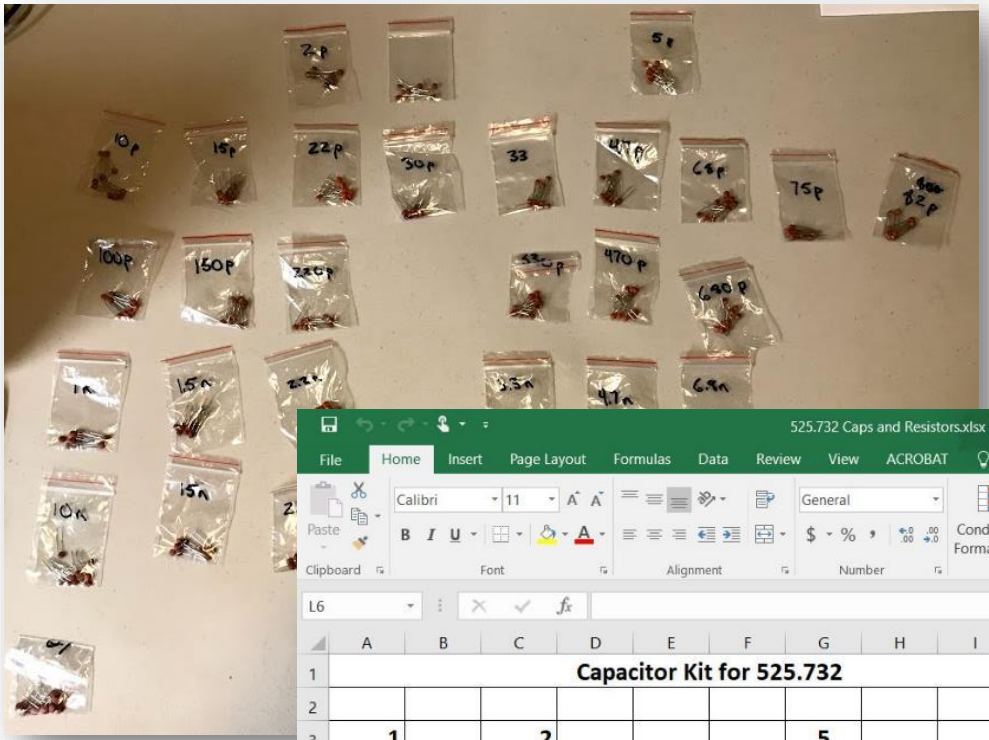
Recommend You Take Inventory

- Decode Values
  - $473 = 47x10^3 pF$
    $= 47nF$
    $= 0.047\mu F$

- Label bags

- Lay them out
  - Resistors too

- Create a table



525.732 Caps and Resistors.xlsx - Excel

	A	B	C	D	E	F	G	H	I	J
1	Capacitor Kit for 525.732									
2										
3	1		2				5			
4	10	15	22	30	33	47		68	75	82
5	100	150	220		330	470		680		
6	1000	1500	2200		3300	4700		6800		
7	0.01	0.015	0.022			0.047		0.068		
8	0.1									
9										
10	Resistor Kit									
11	10			22				47		
12	100	150	200	220	270		330	470	510	680
13	1k		2k	2.2k			3.3k	4.7k	5.1k	6.8k
14	10k		20k					47k	51k	68k
15	100k			220k		300k		470k		680k
16										
17										

Consumables: Engineering Kit

- Looks something like…
  - Integrated Circuits
  - Semiconductors
  - Passives

    Bulk Capacitance
  - Interconnect
  - Proto board
- Augmented with loose items

Consumables: Misc.

- DC-DC Converter
  - Somewhat fragile package

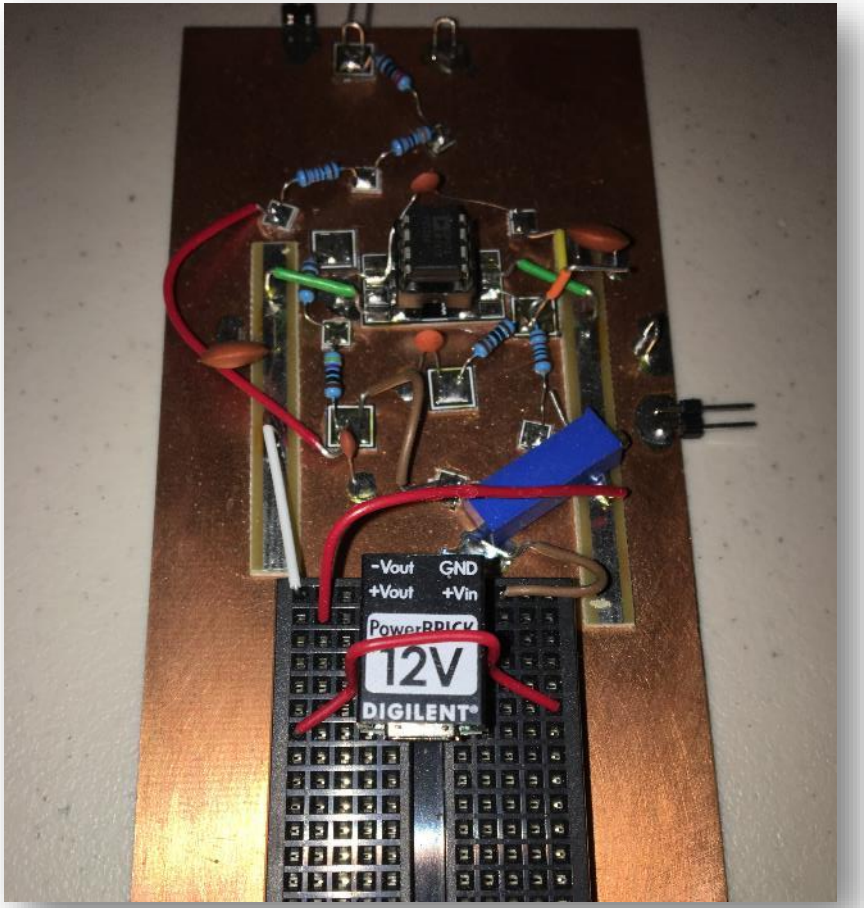
    Strap it down?

    Leave the uUSB side connected
  - Use bypass capacitors

    Bulk electrolytic
    - Voltage Rating & Polarity!!

    0.1uF

    Both supplies !



Software for Headless USB Instrument

- Conduct internet search:
  - Digilent Analog Discovery II
- Download Control Software
  - Called “Waveforms”

Multi-platform

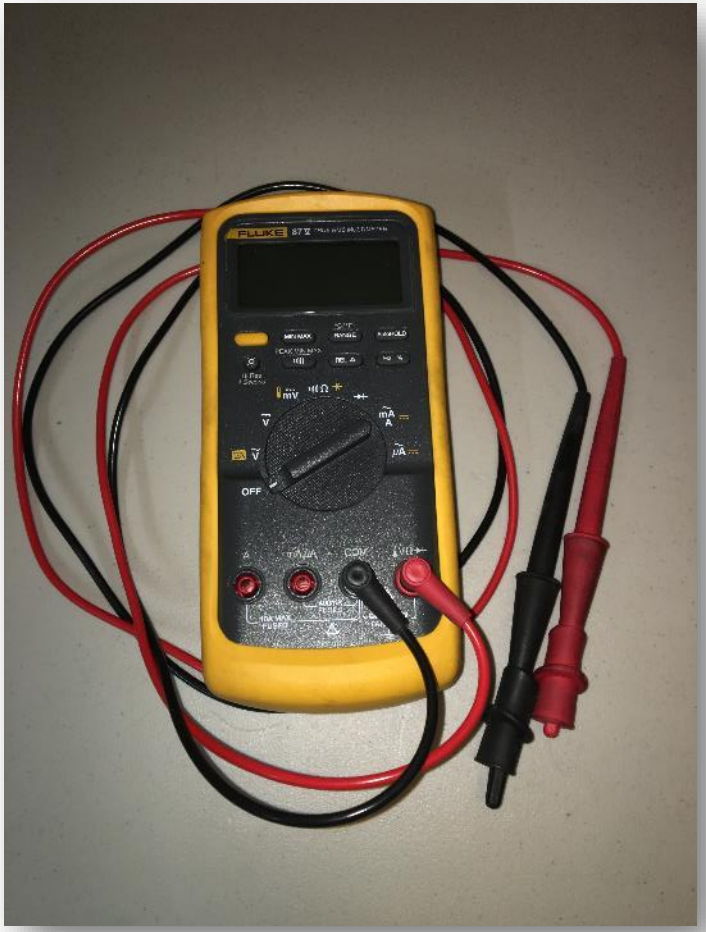
- Mac, Linux, Windows, Arm

Runs in demo mode if no hardware detected

Things Students Need to Bring

- Multi-meter
  - Doesn't need to be $$$$
  - If you don't already own one

  Need to hand in your 'Engineer Card'
- Jumper Wires
  - More robust connections
  - Less time chasing loose connection problems



Basic Hand Tools

- Needle Nose Plyers
- Side cutters
- Small screw drivers
- Flux Capacitor Adjuster

End – Thank You!