System Function Definition
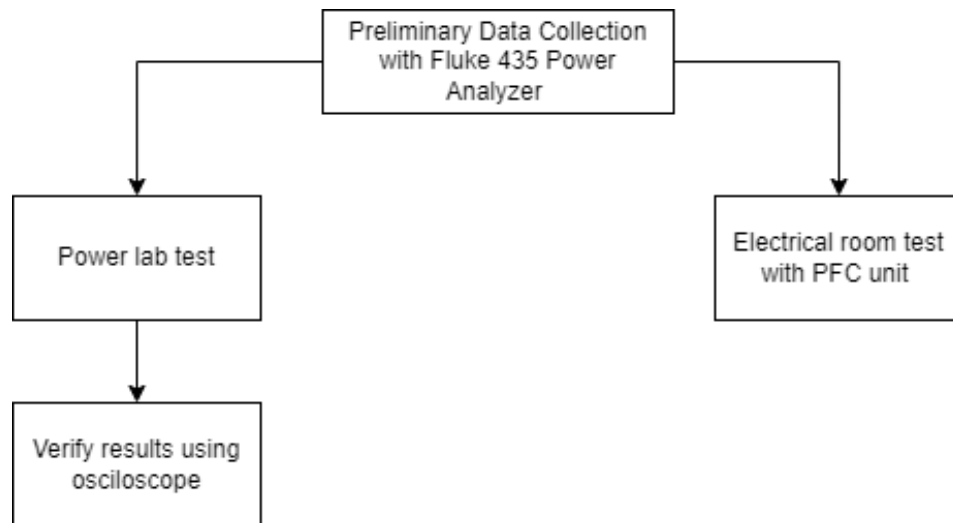
Group #4: Rupinder Arora (200398334)
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Stage 1: Preliminary Data Collection with Fluke 435 Series II Power Analyzer

Lab Test Data collection:
Performed Data Collection with both the Power Analyzer and Oscilloscope
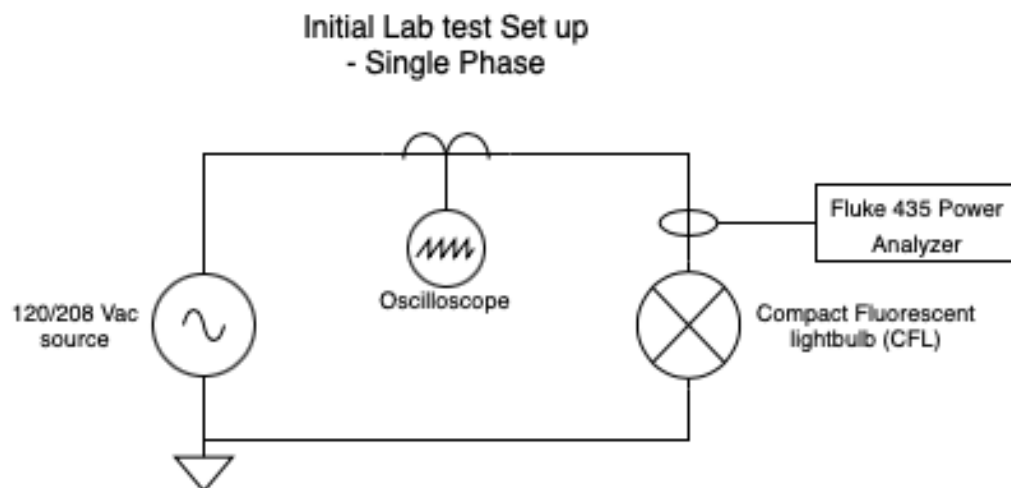Load: CFL bulb

Table 1: Device comparison

Device Settings	
Oscilloscope	Power Analyzer
FFT setting 8 min 20 sec measurement time	Harmonics setting 8 min 20 sec recorded time duration

Table 2: Total harmonic Distortion

	Total Harmonic Distortion (THD)		
Order of Harmonics	Oscilloscope (%)	Power Analyzer (%)	Difference in measurement (%)
1	reference	reference	n/a
3	87.14	73.2	14.2
5	56.60	45.9	10.7
7	40.92	34.9	6.0

The maximum difference between the devices is 14.2%. It is concluded that the oscilloscope outputs higher THD compared to the Power Analyzer. Data collected from initial testing gave an insight on the accuracy of the devices used to measure the data, as well as help define the expectation for the Harmonic Monitoring Device (final product).

Electrical Room (ED 188) Data Collection:
Utilizing the Fluke 435 Power Analyzer to perform Data Collection on the Power Factor Correction (PFC) Unit
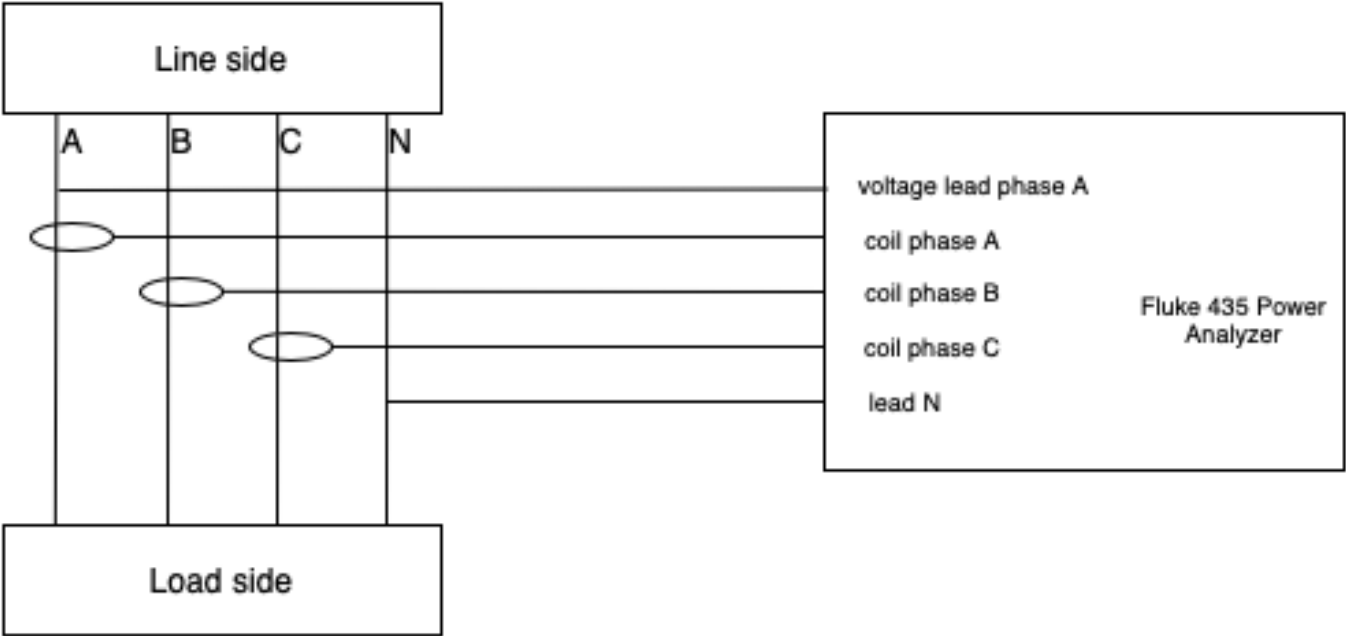
PFC Unit measurement Set-up

Table 3: Device settings

Fluke 435 Settings (error setting)

Measurement topology: Three phase with neutral mode
Application mode: Harmonics
Duration: 2 weeks
 	
User Setup
Date (Initial): November 9, 2022
Config: 3φ Wye
Freq: 60 Hz
Vnom: 120V
Limits: EN 50160*
 	
Logger
Measurement name: MEAS 25
Start time: 1:30 pm Nov.9.2022
Interval: 30s
Duration: 30d
Readings: Vrms (wye)
       Vrms (delta)
       A-rms
       Hz

```
Volt THD
Amp THD
Amp H1
Amp H3
Amp H5
Amp H7

***Vnom must be 277V. PF Unit fed from 480V
```

**Previous setting data will be analyzed November 14, 2022. Correct settings will be applied once the old setting is analyzed.

```
Fluke 435 Settings (correct setting)

Measurement topology: Three phase with neutral mode
Application mode: Harmonics
Duration: 2 weeks

User Setup
Date: November 14, 2022?
Config: 3φ Wye
Freq: 60 Hz
Vnom: 277V
Limits: EN 50160*

Logger
Measurement name: MEAS 26
Start time: XX
Interval: 30s
Duration: 30d
Readings: Vrms (wye)
         Vrms (delta)
         A-rms
         Hz
         Volt THD
         Amp THD
         Amp H1
         Amp H3
         Amp H5
         Amp H7
```

Data Collection must include the following:
- Harmonic level (THD %)
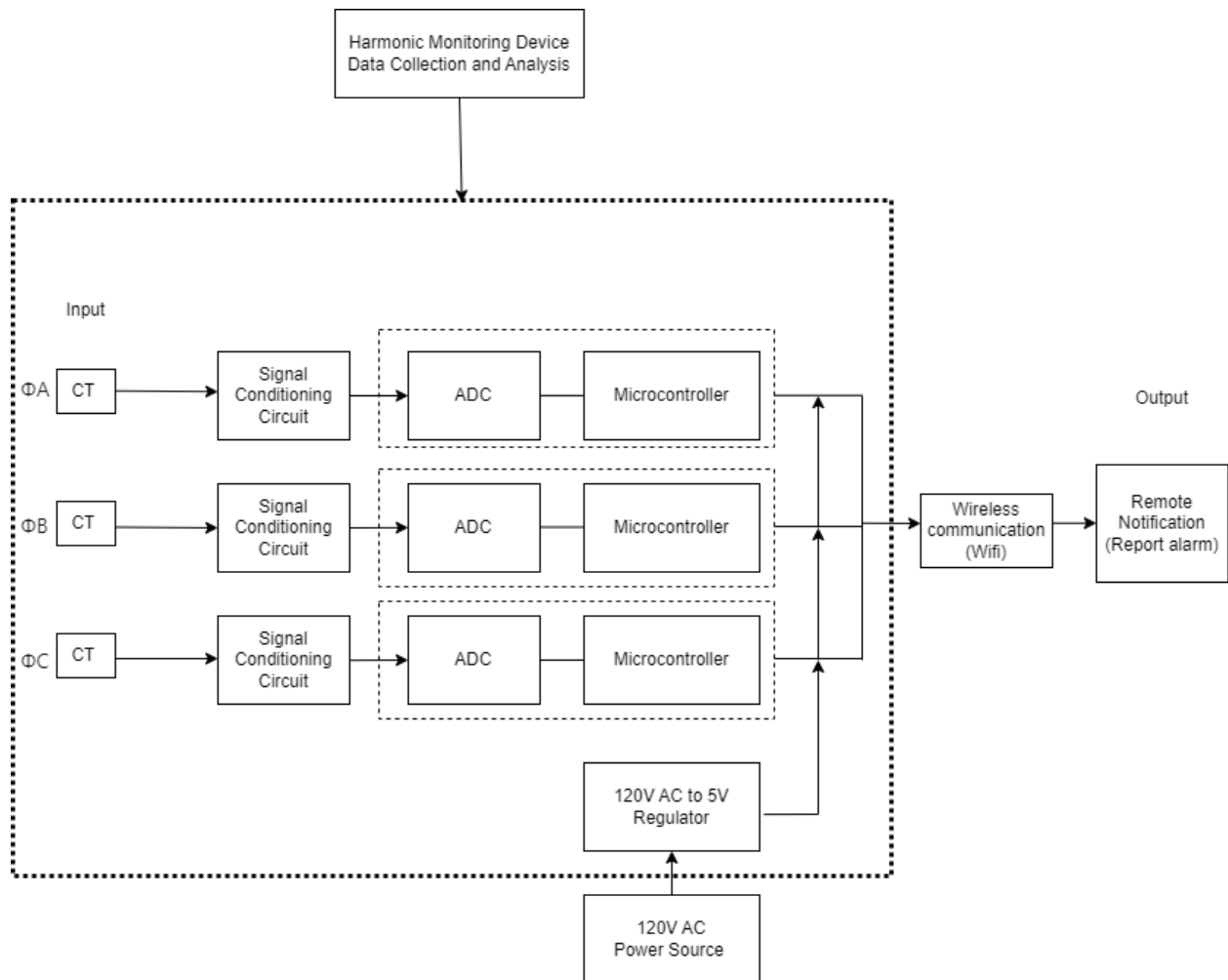- Absolute Current Magnitude

Data Collection date/time:
- Initial Data collection on the PFC unit located in ED 188 is started November 9, 2022 until November 16, 2022 (2 weeks).

Data Collection date/time (Nov 16, 2022):
- Reset the settings on the Fluke analyzer from Vnom = 120V to Vnom=277V
- There was no 'save option.' The Power Analyzer SD card was overloaded.
- Could not retrieve Data for November 9, 2022 - November 16, 2022.
- Replaced the initial SD card for a new SD card for the second set of Data Collection.
- Look into other ways to get the Data collection parameters from the PF unit.
- Possibly retrieve data of the entire education building from Facility Management as a resort.

Stage 2: Harmonic Monitoring Device Data Collection and Analysis

<u>Input</u>
X rating of current transformer (one for each phase) will gather the following data:

X current level (Amps)

Variation in measurement:

Harmonic (THD %) & Absolute Current Magnitude

Absolute measurement within 15%

Relative measurement within 85%

Signal conditioning

AC to RMS converter module: switched capacitor filters

Microcontroller

Methods to obtain amplitude in volts & phase of a sine wave
- Least square curve fitting algorithm
    X sampling rate
    X ADC resolution
    Advantages: Well studied
    Disadvantages: More computational power required

- Passing sine wave through a series of low pass filters
    Sine wave can be broken down into fundamental frequencies, with each frequency having its own intensity
    X bandwidth of filter - based on fundamental frequencies
    Advantages: Not many components - easier troubleshooting

For instance if we take 7 samples, it will give us 7 coefficients to calculate the THD %

$$THD_C = Total\ Harmonic\ Current\ Distortion = \frac{\sqrt{I_2^2 + I_3^2 + I_4^2 \ldots + I_n^2}}{I_1} \times 100\%$$

Accuracy of data: 10% tolerable
                            3% - 5% ideal

Output

Initial test: OLED screen displays
ALARM

Wireless communication for real time notification
Using wifi to connect with facilities management network

Comparison of the values collected from the power analyser and the harmonic monitoring device

Stage 3: Report Recommendations and Harmonic Monitoring Device Functionalities
Report Contents:
Provide Recommendation for Harmonic Correction

Device Functionalities:
Report alarm to client when current level exceeds X
Report alarm to client when current harmonics exceeds X
Report alarm to client when temperature exceeds X
Report alarm to client 80% of the time