# Main section for developing the Objectives

**Objectives**

There is a significant body of work on how radiation causes faults in electronics and embedded systems. [1] However, there is no quantitative data on how common RF (radio frequency) emissions in the range of 1 MHz to 5.5 GHz (inclusive) affects clock drift in an internal RC (resistor-capacitor) oscillator found in many microcontrollers. Usually, a clock source for a microcontroller is selected based on known factors, such as required accuracy, cost, availability of board space, and expected temperature level and variation. Without any data on the effects of RF radiation, selection of an appropriate clock source is limited to a conservative approach to this unknown. Therefore, in order to remove any guesswork associated with this unknown, the main objective of this experiment is to collect data on the effect on microcontroller’s internal RC oscillator clock drift due to common frequencies and corresponding power densities of RF emissions.

The implications of new data will affect the viability of the internal RC oscillator in embedded systems. Quantitative data on the effects of RF emissions will determine the viability of internal RC oscillators in applications where heavy RF emissions are expected to be present. Since RF emissions are extremely common due to the communications industry, designers will be able to understand how their systems will be affected by RF emissions for the first time. In addition to new data being collected, we hope to answer whether frequency or power density has more of an effect on clock drift.

* Primary Objective
  + To gather data on microcontroller internal RC oscillators exposed to RF emissions by recording the frequency of oscillation every ten seconds for an hour, totaling 360 data points per chip.
  + To test 6 units of 5 microcontroller part numbers from each of the 4 vendors (20 different microcontrollers with a total of 120 parts in all) with internal RC oscillators by exposure to RF emissions of 7 common frequencies in the range of 1 MHz to 5.5GHz inclusive and 4 power densities per frequency based on the power densities received at different distances from the source. Just curious, do we have justification on the distances?
    - The control and test groups will consist of 3 units of each part number.
    - With 120 parts total being tested under 4 power densities of 7 frequencies for an hour each, results in 3,360 individual tests totaling 3,360 hours of testing. Testing for 6 hours a day for 5 days a week, it would take 112 weeks (or 2.15 years) to complete.
* Secondary Objectives
  + To present the data collected in terms of the percent drift of the final frequency relative to the nominal frequency for each unit tested. These values will be grouped to their part numbers, and an average and standard deviation will be given to both control and test groups for each part number.
  + To present the data collected graphically for each part number with time as the independent variable and the frequency recorded at that time as the dependent variable for each set of data points for each of the 6 devices tested.

# Outline and Prototyping

1. Main Objective
   1. To determine what, if any, effect radio-frequency emissions from external sources have on clock drift.
      1. What kind of clock?
      2. Is specifying external sources needed?
      3. We need to be more specific on “radio-frequency emissions”
   2. To determine the effects of common radio-frequency emissions on external sources on clock drift.
   3. To determine the effect on clock drift due to common frequencies and corresponding power densities of radio-frequency emissions.
      1. I think we should look into a set of power densities for each frequency. This way we could better determine what affects clock drift more: the frequency, the power of that frequency, and the trend that incorporates both. This would account for real world scenarios where devices will experience various frequencies, but will receive radiation at various distances from the source. This is the equivalent of varying power density.
   4. To establish the relationship between internal RC oscillator frequency drift and radio frequency emissions.
      1. Is this too indirect?
   5. To establish the relationship between internal RC oscillator frequency drift and the energy…blah blah
2. Secondary Objectives
   1. Preparation
      1. Choose 4 popular vendors
         1. Microchip Technologies (PIC), Texas Instruments, STMicroelectronics, NXP Semiconductor.
      2. Choose 5 part numbers
         1. What are they?
            1. What is the justification of our selection method

Popularity and flexibility of devices

* + 1. To establish stable clock sources for each device being tested.
       1. Custom boards. Consistent firmware/software.
       2. Find a method to determine the stability of clock sources under test.
    2. To establish a stable system for each device
       1. External circuitry will not affect
  1. Controlling factors during the experiment to ensure valid data.
     1. To eliminate temperature factors while testing devices.
     2. To eliminate ambient radiation from the testing environment.
        1. Environment RF radiation, environment light radiation, EMI from power sources.
     3. To eliminate mechanical (sound) energy from affecting
     4. To prevent the RF radiation source from affecting test equipment to preserve the integrity of data.
  2. The experiment
     1. To determine a control for the experiment of internal RC oscillator drift by testing 3 units of 5 part numbers from 4 popular vendors

1. The problem and significance of proposed work
   1. The problem
      1. Without data on the effects of RF emissions on internal RC oscillators, clock source selection is based on a conservative approach to unknown.
   2. Significance of proposed work
      1. Collecting data on these effects will allow a method for effectively choosing a clock source based known risk and performance.
      2. Removing unknown aspects of MCU internal RC oscillators will increase their viability as a device clock source. This will ultimately lead to the potential of reducing cost and board space by removing the need for an external oscillator.
      3. To find new data on internal RC oscillators
         1. To determine the viability of the use of internal RC oscillators on devices potentially going into space.
         2. Satellites!
         3. To determine the viability of the use of internal RC oscillators on devices operating near sources of RF emissions.

* References
  + [1] Radiation Effects on Embedded Systems
  + Space radiation on astronauts
    - <http://ac.els-cdn.com/S2251729412000213/1-s2.0-S2251729412000213-main.pdf?_tid=a6001e42-5fda-11e5-a3a7-00000aab0f01&acdnat=1442783019_ee866973a42a8922bbb67e264f9c4a8b>
  + Radiation bands into space
    - <http://www.spaceacademy.net.au/spacelink/radiospace.htm>
* Notes
  + For objectives
    - What the objective is
    - Then how to do it in the research plan
  + For objectives
    - We are testing MCU
      * “To measure clock drift by X”
      * “To establish an accurate method of measuring clock drift”