

Detector Building B

Updated 3/16/2018

1. **DESCRIPTION:** Teams must design, build, program, and test an instrument that will measure changes in temperature and display the measurement using the appropriate units.

A TEAM OF UP TO: 2

IMPOUND: Yes

EYE PROTECTION: None

APPROXIMATE TIME: 50 minutes

2. **EVENT PARAMETERS:**

- a. Teams must bring their device, design & testing log, any tools required, and whatever resources (e.g. laptop) needed to program their device to respond to the changing environmental conditions.
- b. Event supervisors will provide the necessary equipment to test each device's ability to detect and signal changes in temperature at a set standard as well as across a changing temperature range.

3. **CONSTRUCTION PARAMETERS:**

- a. Each year, the environmental condition (e.g. Light Level, Sound Level, Motion, pH, CO₂ concentration, O₂ concentration) to be measured will be identified in the Event Rules. The environmental condition to be measured will be the same for all teams and at all tournaments. At each tournament, the event supervisor will inform the teams, which range the device, should be programmed to detect. These ranges will be the same for all teams at that tournament.
- b. Devices should be built using a microcontroller (e.g. TI Innovator, Raspberry Pi, Arduino), a display, LED lights, an alarm, and a sensor/probe that produces a voltage dependent on the physical stimulus provided. The device maybe connected to a laptop, or other handheld device, powered by battery without built-in/internal environmental sensors/probes that functions as a display or programming interface device. The sensor/probe should be made water proof for total immersion. Sensor/probe may not be constructed using pre-calibrated, preassembled sensors/probes (e.g. Vernier, PASCO).
- c. The device, and any associated elements, must function on an independent power supply. No element can be plugged into an electrical outlet at any time during the competition.
- d. The device must be calibrated to detect the selected environmental condition for that year. In addition, the device must respond differently to two different ranges of the designated environmental condition through the use of LED lights and/or an alarm. The exact ranges of the environmental condition detected will be provided to the competitors at the start of their 50-minute time.
- e. Teams will also need to submit a Design Log with their device at Check-In. This Design Log should contain:
 - i A detail drawing or illustration of the device identifying all the components and their function.
 - ii An explanation of the programming language used, a written copy of the programming code that is used to operate the device, and an indication of, as well as a source for, any programming code that was not originally written or developed by the competitors.
 - iii The mathematical modeling function and the calculations used to convert the sensor/probe output voltage into the calibrated output shown on the device display.
 - iv A written practice log that details at least 10 trails of the device for 2 different ranges of the environmental condition indicating the range of the environmental condition detected, the time it took to detect that condition, and the responses, or alarms, produced.
- f. Each device, and associated impounded items, must be labeled so the event supervisor can easily identify to which team they belong.
- g. Competitors must be able to answer questions regarding the design, construction, programming, and operation of the device per the Building Policy found at www.soinc.org.

4. **THE COMPETITION for 2018:**

This year the environmental condition to be measured will be temperature. Following the guidelines outlined in the Construction Parameters above, each team will build a durable temperature sensing device that will accurately measure, and display temperatures anywhere between and including 0°C -100°C. Along with the numerical display of the temperature, the device must also be able to indicate temperature zone with an LED color scheme -Blue for "Cold" temperatures, Green for "Moderate" temperatures, and Red for "Hot" temperatures. The exact starting and ending temperature of each zone will be posted at the time of the team's rotation.

- a. The device, power supply, spare parts, design log, and other materials must be impounded before the start of the competition. Tools need not be impounded.

- b. Only competitors and event supervisors are allowed in the impound and competition areas. Once competitors enter the event area, they must not leave or receive outside assistance, materials, or communications.
- c. At no point during a trial may the device be connected to a power supply.
- d. As the teams enter the room for their rotation they will be given back their device, their testing logs, a scoring sheet, and the standard thermometer that will be used to evaluate the accuracy of their device.
- e. Within the timed rotations, but before their first actual temperature determination, the students will be allowed to verify their device's calibration against this provided standard thermometer. The teams will then be allowed to make any necessary adjustments to their code, and will be expected to alter their LED code to match the posted temperature zones.
- f. Once ready, the teams will proceed to each of the four different stations where they will use their device to determine the exact temperature. The event supervisor(s) will record the team's prediction along with the actual temperature and LED display.
- g. The event supervisor(s) will determine accuracy of the temperature using the same thermometer given to each team for temperature verification at the beginning of the rotation. The temperature reading on the student's device will be used to score the LED correctness.
- h. Once the run is completed, the event supervisor will then record the data and share results with the participants.
- i. Once the four stations have been completed the team's device will be placed in boiling water for three minutes to check the devices durability. Any device that fails during this test or at any of the four stations will retain their points but be placed in Tier 2.
- j. Teams will answer a 10-question assessment over the theories behind this event. Question will range from resistance and temperature relationships, LED operations, the process of calibration, and even construction parameters. These ten questions can be answered at anytime during the rotation and its' score will be used for the sole purpose of breaking ties.
- k. Teams who wish to file an appeal must leave their design log and sensor with the event supervisor.

5. **SCORING:**

- a. Team with the highest Total Score wins.
- b. A Total Score for each team will be determined as follows:
 - i Impounding of a working Temperature sensor with functional LED indicators and visual temperature display - 50 points
 - ii Impounding of a Design Log as described in construction rules 3.e (up to 40 points max.)
 - (a) Compliance to Construction Parameter 3e.i 10 pts.
 - (b) Compliance to Construction Parameter 3e.ii 10 pts.
 - (c) Compliance to Construction Parameter 3e.iii 10 pts.
 - (d) Compliance to Construction Parameter 3e.iv 10 pts.
 - iii Accuracy of Temperature at the Four stations- (40 points max)
 - (a) +/- 0.2 degree 10 points
 - (b) +/- 0.5 degree 8 points
 - (c) +/- 1.0 degree 6 points
 - (d) +/- 1.5 degree 4 points
 - (e) +/- 2.0 degree 2 points
 - (f) > +/- 2.1 degree 0 points
 - iv LED indicating correct color at the Four Station (5 points each-20 points max)
- c. If there is a tie, the highest score on the 10 questions assessment will be used to break the tie.
- d. Teams that do not successfully complete the four stations and the final durability test will be ranked behind teams that do.
- e. Devices determined to be in violation of construction rules 3.b or 3.c will not be tested.

Recommended Resources:

TI-Innovator Hub:

<https://education.ti.com/en/products/micro-controller/ti-innovator>

Raspberry Pi:

https://en.wikipedia.org/wiki/Raspberry_Pi

<https://www.raspberrypi.org/help/videos/>