IARC Mission 10 Anti-Personnel Mine Simulators

Mission 10 of the International Aerial Robotics Competition will use two types of simulated anti-personnel mines. This document will explain the operation of both and also detail the construction techniques used. Teams can replicate these mines as explained herein, or can create their own designs that function identically, yet may be based on different components.

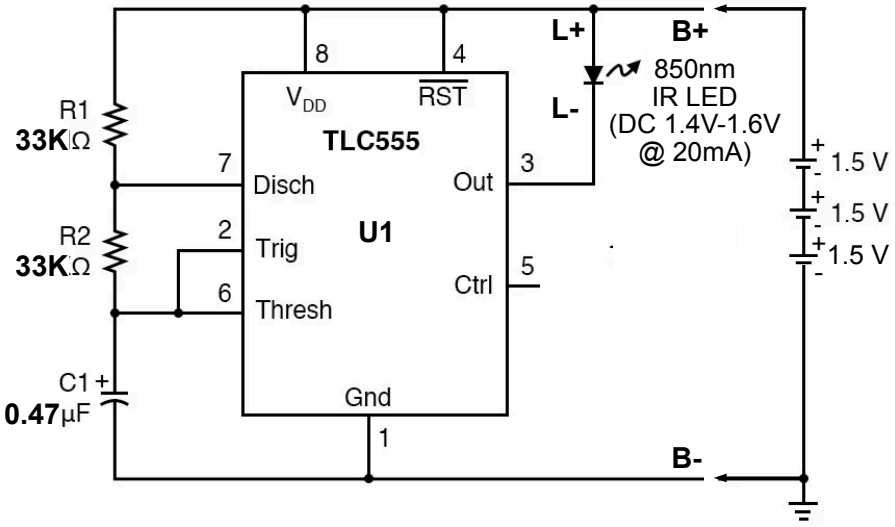
There will be two types of simulated anti-personnel mines. When actuated, both types will emit a 90 dB tone to indicate activation. The alarm is based on a "BUNKER HILL SECURITY Vibration Alarm" which is available in the U.S.A. from https://www.harborfreight.com/ . This device provides an ON/OFF switch, has the internal piezoelectric 90 dB alarm, and runs off of three LR44 batteries which we then use to run the Type 1 IR LED circuitry explained below. Note that *any* alarm can be used for testing and/or simulating the anti-personnel mines for the purpose of testing. The triggering mechanism is what is unique, and the details about its design and construction are listed in this document.

Bunker Hill Security Vibration Alarm

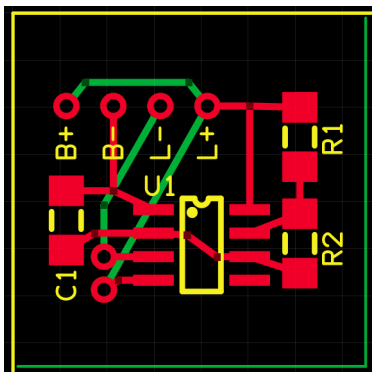
TYPE 1 ANTI-PERSONNEL MINE SIMULATOR

The Type 1 mine can be detected by its active 30 Hz IR emission. This 850nm LED emission is invisibly to humans in the area, but can be detected by drone imagers. A 3-D printed structure that is attached to the vibration alarm housing, has a 15° opening that can be viewed from above. The 850nm IR LED is driven from a circuit to produce a 30.95 Hz blink rate with a 66.67% duty cycle.

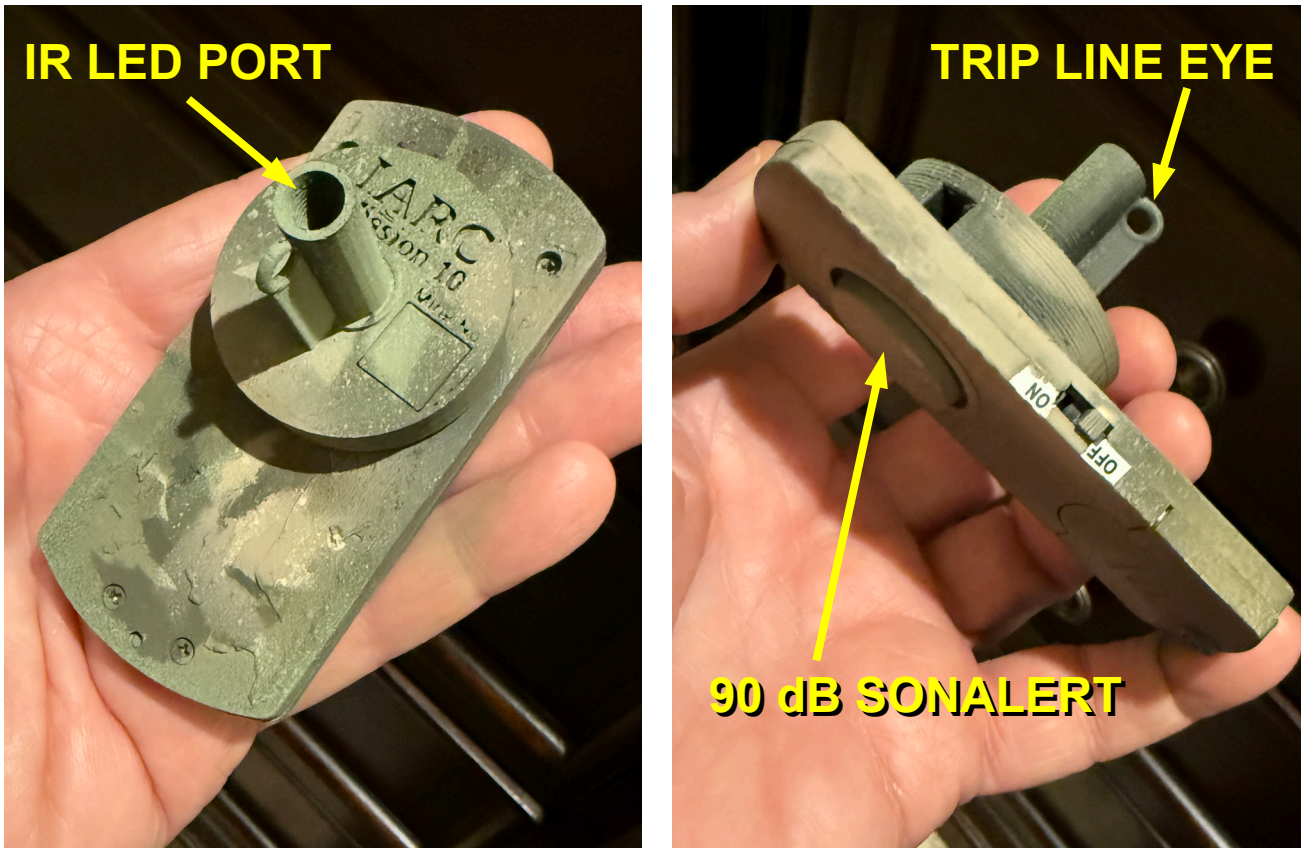
A TLC555 CMOS timer drives the IR LED and uses the 4.5VDC battery power from the vibration alarm as a power source. The circuit is built with surface-mount parts on a 0.75" x 0.75" micro-PC board that is placed within the vibration alarm enclosure.



IR LED Driver Circuit



IR LED Driver Circuitboard



Type 1 Anti-Personnel Mine Simulator

The 3-D printed section contains the IR LED (oriented vertically) in the Type 1 anti-personnel mine simulators, as well as a triad of angle sensors (each offset by 120°) which detect 5° perturbations in the anti-personnel mine simulator angle relative to the horizontal plane. Any one of those angle sensors, when triggered, will activate the 90 dB alarm, indicating that the simulated mine has been triggered and has exploded.

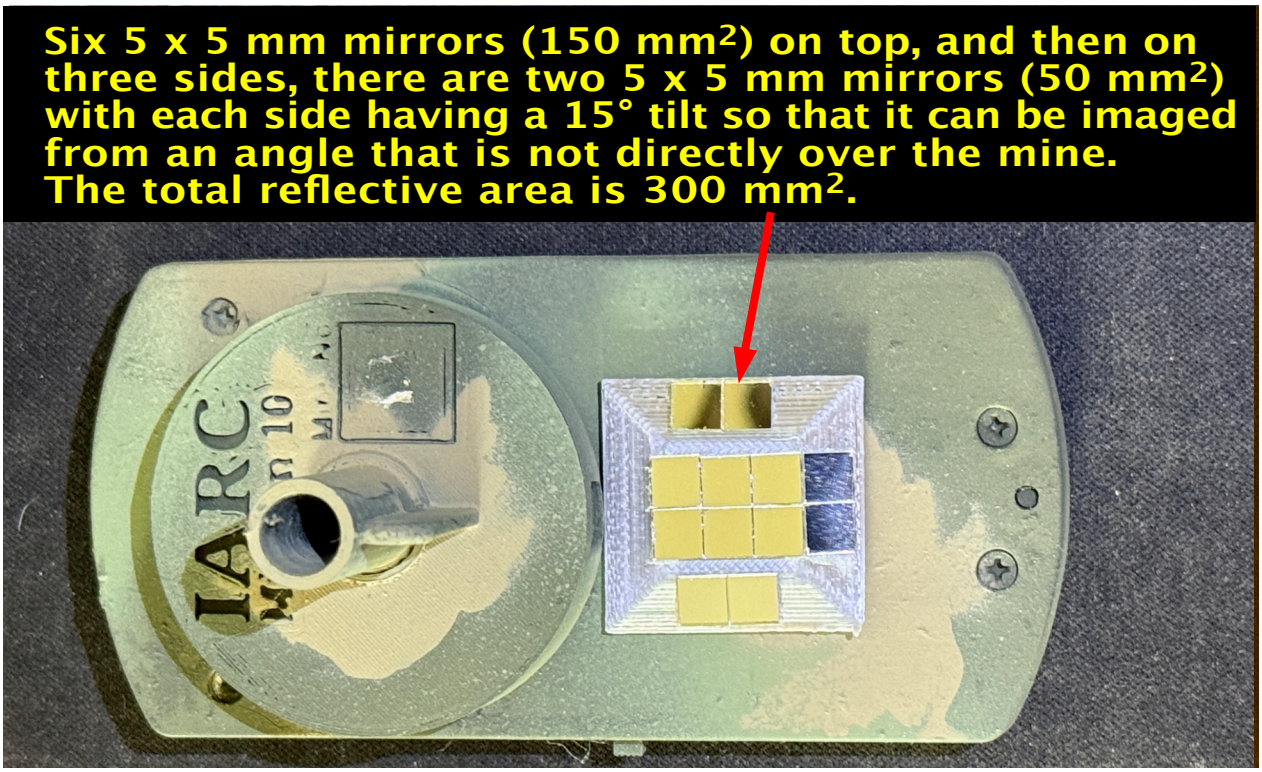
The Type 1 mines can be detected visually by recognizing their shape (although they could be buried beneath dirt or detritus), or they can be detected by their 850nm IR LED with its 30.95 Hz, 66.67% duty cycle blinking signature. In all cases, Type 1 mines will have a clear view directly above so that they can be detected.

TYPE 2 ANTI-PERSONNEL MINE SIMULATOR

The Type 2 mine is passive, and does not contain the 30.95 Hz, 66.67% duty cycle blinking signature, however it does contain a 300 mm^2 glass mirror reflector mounted to its upper surface so that it can be detected from an active source above.

The Type 2 mines can be detected visually by recognizing their shape (although they could be partially buried beneath dirt or detritus), or they can be detected by their reflective signature. In all cases, Type 1 and 2 mines will have a clear view directly above so that they can be detected.

All simulated anti-personnel mines will be placed so that they can be detected from above. Some of these mines may be deactivated “duds”, but the viability of a mine will not be discernible by an observer in the arena.



Type 2 Anti-Personnel Mine Simulator

Teams can manufacture the 3-D printed fixture by using the .stl files provided in the RESOURCES section of the IARC OFFICIAL RULES.

The metal ball tilt switch sensors can be obtained from various vendors including Amazon.com (https://www.amazon.com/dp/B0CB8JDLVB?ref=ppx_yo2ov_dt_b_fed_asin_title). The internal channels in the 3-D printed fixture are 120° apart and slanted upward toward the center at a 5° angle. The metal ball tilt switches (which act like older "mercury switches") must be oriented to be activated only when the ball rolls toward the central IR LED tube. When the 3-D printed fixture's base is horizontal, all three ball tilt switches will be deactivated. All of the wires from the ball tilt switches and (if Type 1) the IR LEDs pass through the bottom of the 3-D printed fixture and through a hole drilled in the case of the vibration alarm, where they access the internal actuation circuitry and the IR LED driver circuitry.