

LAGUNA RESEARCH

eCCR Controller Suite



HUD Operation Guide



Our HUD is a three piece unit consisting of the LED tube, and magnetically coupled top and bottom components. All of the parts are constructed from T6061 aluminum hard anodized. The locking thumb screw is nylon. The base of the HUD is curved to easily mount (via a tie wrap) to a breathing hose mouthpiece assembly. Another mounting possibility is to glue a magnet to the inside of the mask and attach the HUD top assembly to the outside of the mask.

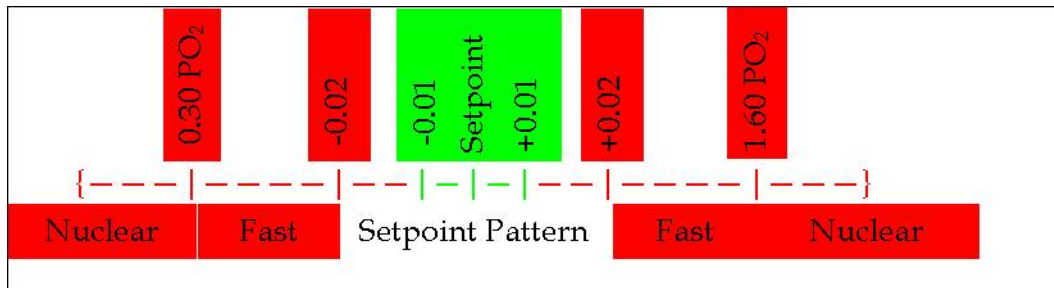
The HUD lighting is a single LED with Red, Green, or Blue output. We use a combination of color and light patterns to tell the diver what's going on:

- Blue LED is used throughout our system as an error/alert indicator.
- Green LED indicates the loop gas O_2 is $\pm 0.01 PO_2$ of setpoint
- Red LED is used to indicate the loop gas O_2 is off the Setpoint value by $\pm 0.02 PO_2$ or greater

Our controller systems have three user defined setpoints. We label these as Low, Middle and High setpoints. The LED blink pattern indicates which setpoint is currently active:

- Low Setpoint – Very Slow Blink
- Middle Setpoint – Double Blink
- High Setpoint – Triple Blink

These blink patterns are used when the PO_2 of the loop oxygen level are within reasonable levels (± 0.02 of setpoint). Outside this range, the blink pattern becomes much faster to convey a sense of urgency.



Target Zone: within ± 0.01 of the setpoint

Low Setpoint: **Green-Very Slow Blink**

Middle Setpoint: **Green-Double blink**

High Setpoint: **Green-Triple blink**

Near Warning Zone: Within ± 0.02 of setpoint but outside of target zone

Low Setpoint: **Red-Very Slow Blink**

Middle Setpoint: **Red-Double blink**

High Setpoint: **Red-Triple blink**

Far Warning Zone: Within the boundary of 0.30PO_2 and 1.6PO_2 but outside of the Near Warning Zone

Red-Fast Blink

Danger Zone: Less than 0.30PO_2 or greater than 1.6PO_2

Red- Nuclear Fast Blink, very bright

Alerts: Indicated by the Blue LED (PO₂ indications stop when the Alarm LED is operating)

5 Minute Alert: An optional user enabled condition in which the Alert LED lets the user know that 5 minutes have past and it's time to check the gauges and system displays.

Blue- 3 slow blinks

Low Level Alert: A problem exists but the system is still confident that it can calculate the PO₂

Blue- 5 fast flashes once/minute (then back to PO₂ display)

Examples of Low Level Error conditions:

- 1 or 2 sensors out
- All sensors too far apart
- PO₂ Delta error
- Low Battery conditions

High Level Alarm: A problem exists and the system cannot reliably calculate the PO₂

Blue- Nuclear Fast Blink, very bright.

If the diver is red/green color blind, then they still can obtain useful information. By seeing the setpoint blink pattern the diver knows that the loop O₂ is within ± 0.02 of the current setpoint. If the system has a fast or nuclear speed blink, then it's significantly off the target setpoint...

The setpoint indicator blink patterns have been designed to work without counting. The most complicated pattern is the triple blink pattern. If the diver is very task loaded it is still easy to distinguish at a glance, the difference between a steady, very fast blink, a nuclear fast blink and the much slower, distinct setpoint blinks.

If the system does go into the danger zones (less than 0.30PO_2 or greater than 1.6PO_2), then the extremely fast, urgent speed of the Red LED at that point is such a different pattern that even if the HUD has been psychologically phased out of conscious vision- that change in behavior tends to attract attention in any case.

By design, the HUD does not distinguish between above or below setpoint situations in order to keep it simple. It is pretty hard to get way low or way high without having some pretty good clues about the direction (like having just surfaced...). We rely on the diver not being completely brain-dead about the circumstance to understand the likely meaning and besides, the only real purpose of the HUD is to tell you when the PO₂ is OK. Anything else means check your gauges...

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