



Eberle Design LEDguard™

1. The need for the EDI LEDguard™ function is to close a perceived loophole in the Nema Standard for signal monitoring. This applies to Nema TS-1, TS-2, as well as 210/2010 type monitors.
 - a. Nema defines the voltage levels that a monitor uses to sense the On/Off state of a field signal depending on the intention of the signal; Green, Yellow, Walk signal indicates *proceed*, Red signals indicate *stop*.
 - b. For Green, Yellow or Walk, the threshold level is 20 Vrms. The unsafe condition for a *proceed* signal is to be On when it should be Off. This level was chosen to detect the signal glowing On as early as possible as the applied voltage increases.
 - c. For Red, the threshold level is 60 Vrms. The unsafe condition for a *stop* signal is to be Off when it should be On. This level was chosen to detect the signal dimming Off as early as possible as the applied voltage decreases.

2. The problem is that while the scheme defined by Nema works well, it leaves a “grey” area in the range of 20 to 60 Vrms. Two examples best illustrate the ambiguity.
 - a. If a Red signal is driven by 55 Vrms due to a malfunction while the same phase is in Green or Yellow, the MMU may not detect this condition as a Dual Indication fault because the Red voltage level is below the 60 Vrms threshold of the Standard and thus sensed as Off. The motorist however sees a Green signal and Red signal active on the same approach. If the signals are incandescent, the Red signal would be dimmed when compared to the Green signal, but still clearly visible especially at night. If the signals are modern LED devices, and assuming a robust signal design, the Red signal could likely be as bright as the full voltage Green unit.
 - b. If a Green signal is driven by 30 Vrms due to a malfunction while the phase is in Green, the MMU would not detect this condition as a Red Fail fault (dark approach) because the Green voltage level is above the 20 Vrms threshold of the Standard and thus sensed as On. The motorist however sees a very dim Green signal or likely none at all. The current ITE LED Standard only requires an LED signal to operate down to 80 Vrms, and below that level the signal is not required to emit light. Assuming a poor signal design, the Green signal at 30 Vrms could be dark or very dim.

3. The solution is to choose the On/Off threshold not by color but by the fault condition that the monitor is trying to detect. This better matches the operation of the monitor with the way LED signals respond when voltages outside their normal operating range (80 – 135 Vrms) is applied.
 - a. For a Conflict or Dual Indication malfunction the LEDguard™ function uses the lower 20 Vrms threshold for all colors. This provides a conservative approach that assumes a robust LED signal design as the “worst case”. If any color signal has greater than 20 Vrms applied at the field terminals, then it is sensed On.
 - b. For a Red Fail malfunction the LEDguard™ function uses the upper 60 Vrms threshold for all colors. This provides a conservative approach that assumes a poor

LED signal design as the “worst case”. If any signal has less than 60 Vrms applied at the field terminals, then it is sensed Off.

4. The EDI LEDguard™ system applies to both LED and Incandescent loads and is a global setting of the monitor.
 - a. The same rationale applies to the signal heads regardless of whether they are incandescent or LED or even a mix of both types on the same output. The visual effect is just more dramatic when the LED type signal is used as noted in #2-a above.
 - b. The LEDguard™ function is now provided on the majority of EDI signal monitors.
5. A safety perspective on these types of malfunction conditions must also be noted.
 - a. A Red signal that is On when it should be Off, or a Green / Yellow signal that is Off when it should be On is arguably less of a safety concern than the typical Conflict or Red Failure condition. Yet it is still a signal malfunction that should be detected, as motorists do not have any visual guides on the signal voltage applied other than one signal being dimmer than the companion signals.
 - b. While malfunction conditions that apply voltages to the signal heads in the 20 to 60 Volt range are not common, the case of an open circuit in a daisy-chained Neutral return wire of a mast arm is a single point failure that can produce this malfunction display. In this case signal heads on an approach that are normally wired in parallel, become “reconfigured” in a series fashion where the applied 120 Vac line voltage is split between the affected signal heads. This has been commonly referred to as the “Christmas Tree” effect since the Red, Yellow and Green signals were all simultaneously illuminated, but at a lower intensity.