# Relay Driver Applications Guide
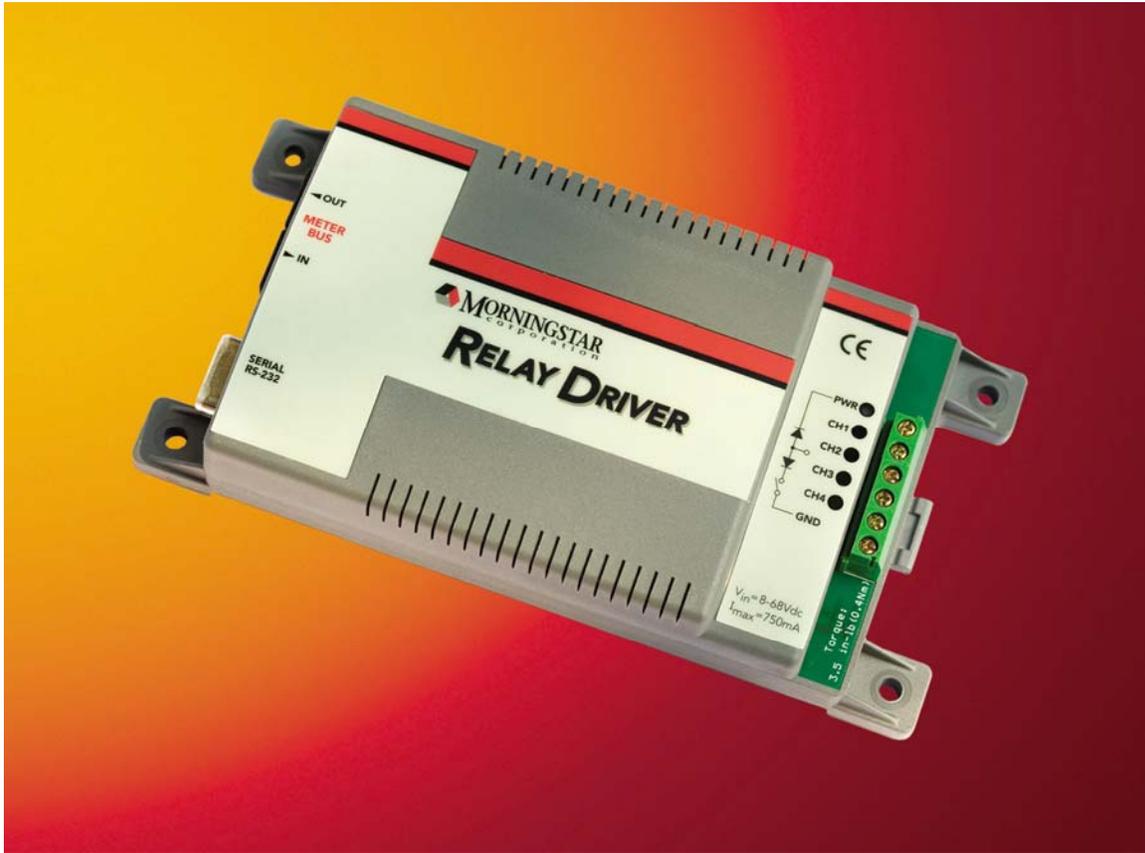
Morningstar's Relay Driver (RD) is a fully programmable 4-channel logic controller that can be used to control mechanical or solid-state relays in an AC or DC power system. A limitless number of combinations can be configured for each channel on the RD to control the switching of circuits on and off based on several variables present in the system. The purpose of this document is to explore three of the many applications and uses of this product:

Hybrid System Control
Lighting Control
Multi-Wire Generator Start

Morningstar's MSView software is used to configure the Relay Driver and its settings will be explained in each system scenario. Please visit www.morningstarcorp.com to learn more about the flexibility of the RD.

Hybrid System Control –Alarm Signals and Generator Control
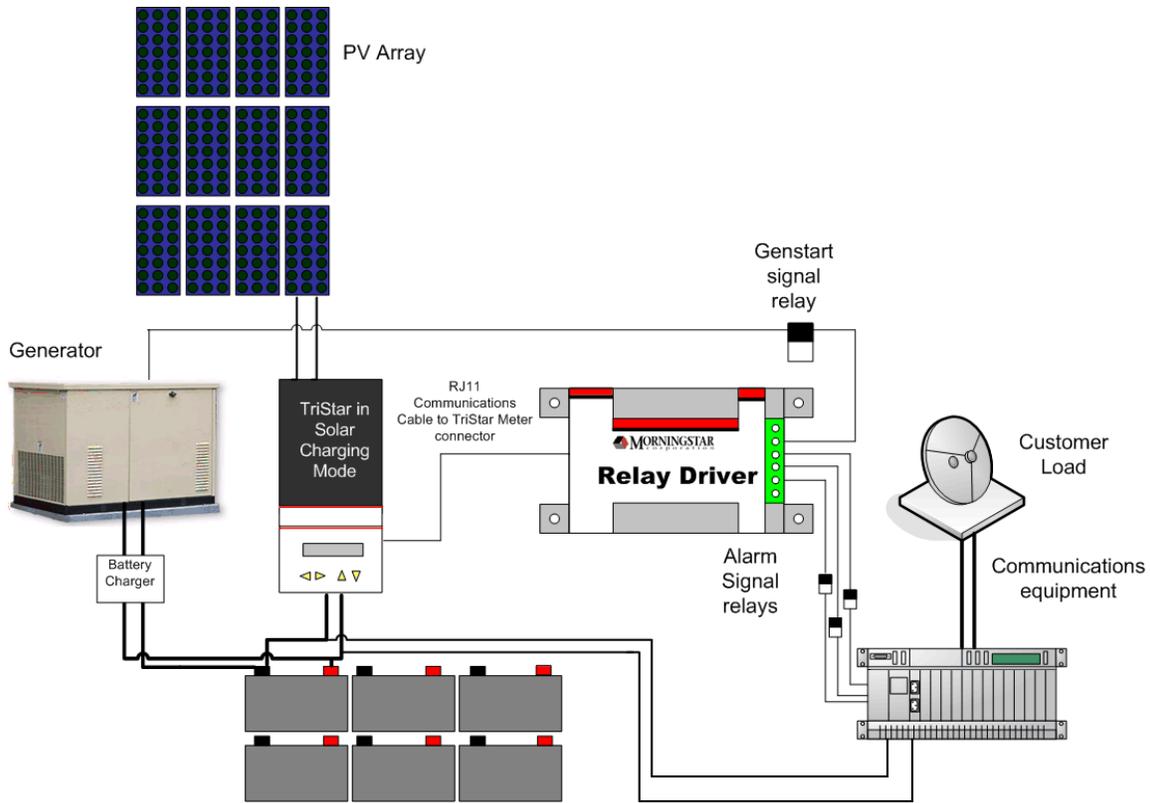
In this application, the Relay Driver is used to send voltage alarms to a communications device provided by the user at the site. It also will monitor battery voltage and start a generator whenever there is insufficient solar charging from the PV array.

The first channel controls the generator. In this particular application, the generator has its own internal warm-up and starting controls. Therefore only a single circuit is needed for the sequence to begin. The generator control mode can be used, but only one wire (the "run" signal) needs to be set up since the generator's own controls take care of the rest of the start sequence.

Two relay channel outputs (channels 2 and 3) are used to signal high and low voltage alarms on the battery bank. This alerts the user of the system (through a spare input on the communications link of their equipment) that

the battery is higher or lower than the normal operating range due to a fault of some type.

Finally, channel number 4 signals if there is a fault with the TriStar controller itself. This may indicate a higher level hardware failure regarding the TriStar's operation that could not be detected with simple voltage readings. Each of the final channel setups are shown in Fig. 1
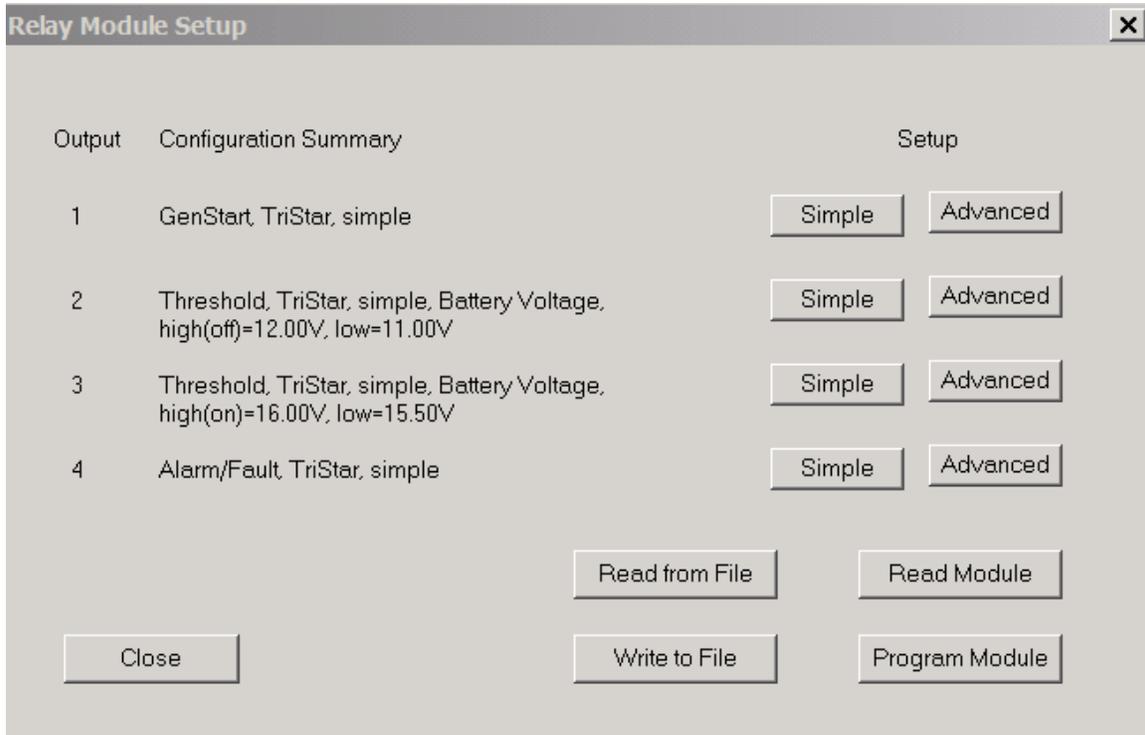
Fig. 1 Hybrid Configuration

The first 3 channels are just threshold settings allowing the relay to be switched on when a certain voltage is met and turned off when that level returns to the normal range. Fig. 2 shows this set up for the gen start (channel 1). The gen start mode allows a delay time to be set for start up and shut down to prevent wear and tear on the generator engine from cycling too frequently.
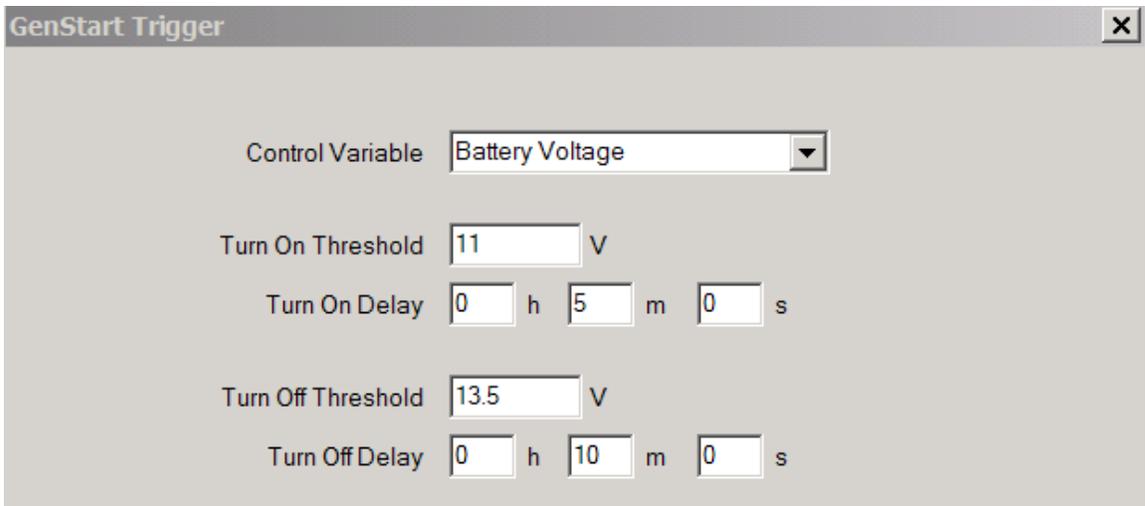
Fig. 2 Voltage Threshold Setup for Genstart

There are several alarms and faults that the TriStar is able to detect using its on-board diagnostics. Any combination of these can be monitored and linked to the Relay Driver so that relays can be opened or closed upon their detection. Fig. 3 shows a list of available faults and alarms. The user simply checks the ones to be monitored by the RD.
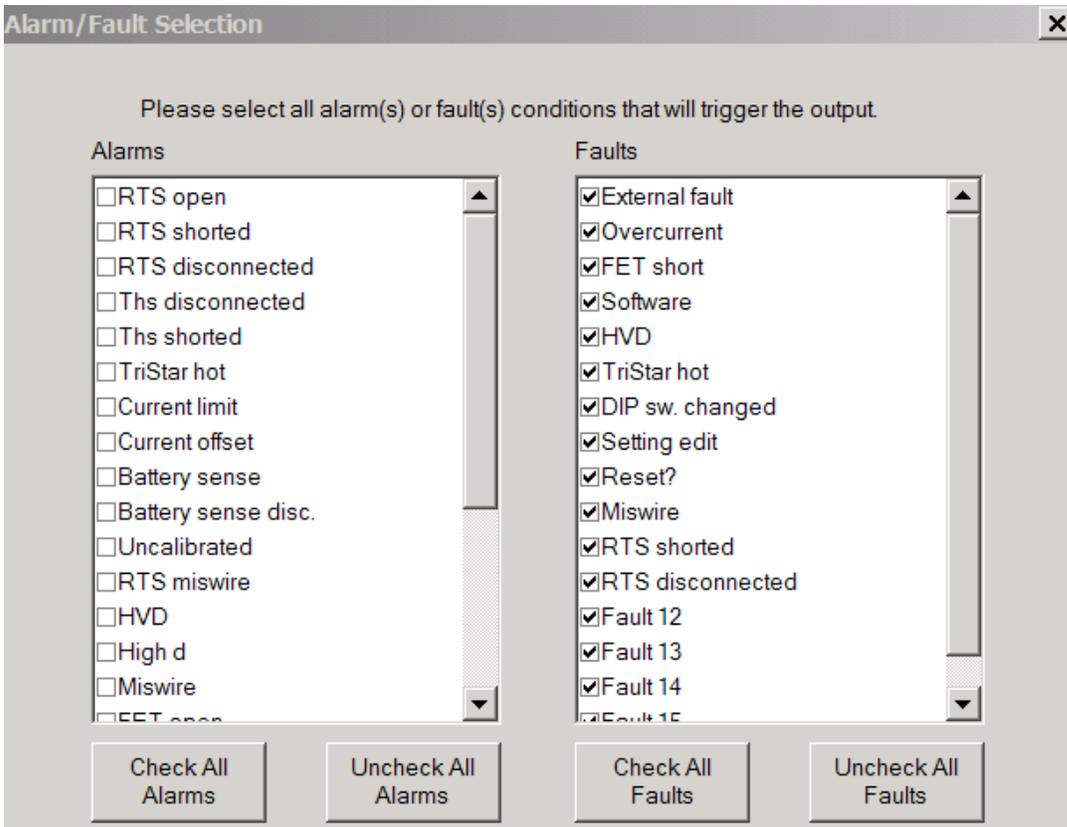
Fig. 3 TriStar Alarm and Fault Selection

Lighting Control – Primary and Secondary Lighting Configuration

Fig. 4 below shows a TriStar with Relay Driver being used in a lighting application for a large off-grid bus stop. The primary load has a ballast that requires a significant surge at startup. For this reason, a mechanical relay provides the most robust way to turn the circuits on and off. This same set up could even be used for applications where a small inverter could power AC lighting loads.
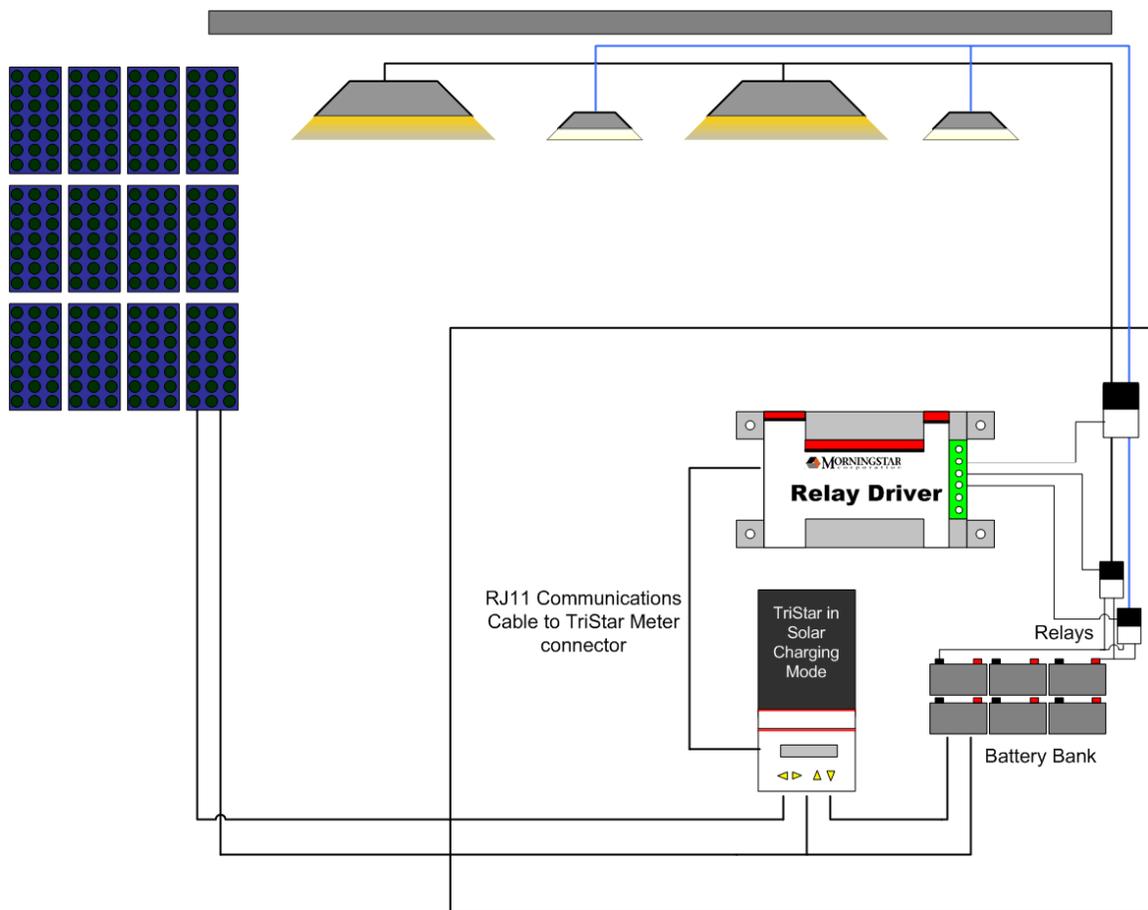

Fig. 4 Lighting control

There are 2 circuits being used. The high-power ballast-controlled lights are connected to the primary circuit, and some smaller low power LED lights are connected to a secondary circuit.

The relay driver serves 2 purposes:

1. Monitor voltage of the PV array (in conjunction with the TriStar) to activate the lights at night automatically and turn them off in the morning.

2. Shut off the primary lights (which draw most of the energy) and activate the low power LED lights during periods of bad weather and low battery state-of-charge.

By observing PV voltage (that the TriStar is communicating to the RD via the RJ11 cable) the Relay Driver is able to see when night occurs and will turn the lights on and off accordingly.

As can be seen by the wiring, individual lighting circuits can be controlled independently, or all lights can be turned on and off together. Fig. 5 below shows how the PV will turn off all the lights according to night (<8V on the PV panel) and day (>10V on the PV panel). The two lights are tiered so that as battery level gets dangerously low, only low powered LED lighting is used to conserve energy. If the battery gets to a very low level (10.8V) then the LED's will also be turned off to prevent battery damage.

Relay Module Setup ✕

Output	Configuration Summary		Setup	
1	Threshold, TriStar, simple, PV/Load Voltage, high(off)=10.00V, low=8.00V		Simple	Advanced
2	Threshold, TriStar, simple, Battery Voltage, high(on)=12.80V, low=11.70V		Simple	Advanced
3	Threshold, TriStar, simple, Battery Voltage, high(on)=11.90V, low=10.80V		Simple	Advanced
4	Disabled		Simple	Advanced

Read from File   Read Module

Close   Write to File   Program Module

Fig. 5 Lighting Control Thresholds

Multi-Wire Generator Start

In this application there is a generator and battery but no photovoltaic system, and thus no TriStar charge controller in use. The Relay Driver is used in stand alone mode to control the function of a more sophisticated generator start sequence.
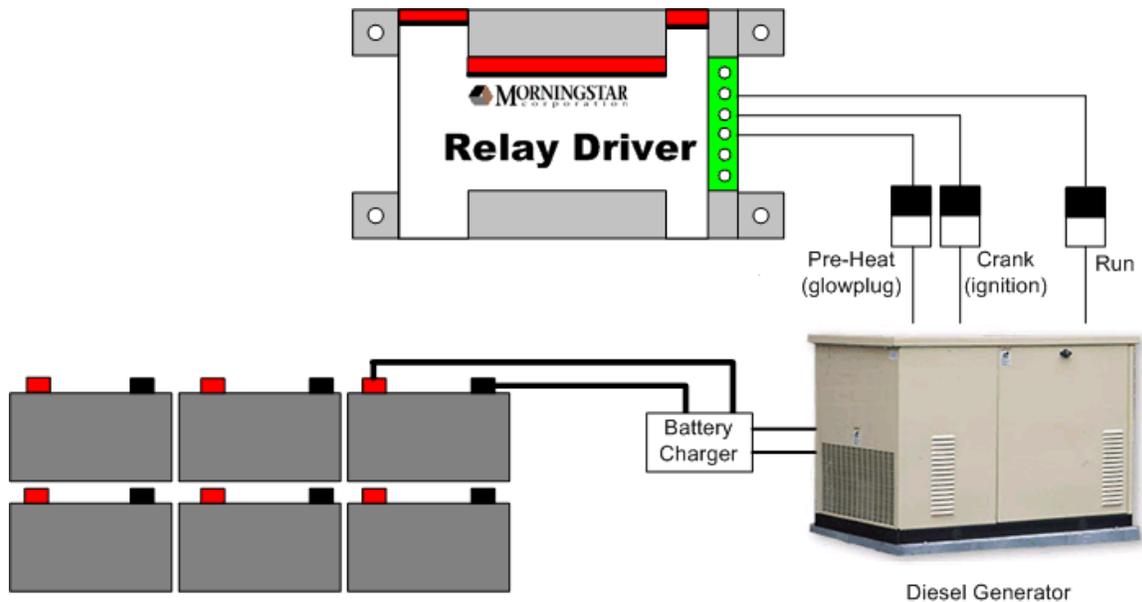
The first set up is the generator start and stop. In stand alone mode, the Relay Driver accomplishes this with battery voltage readings (taken at its own power terminals) as shown in Fig 6.
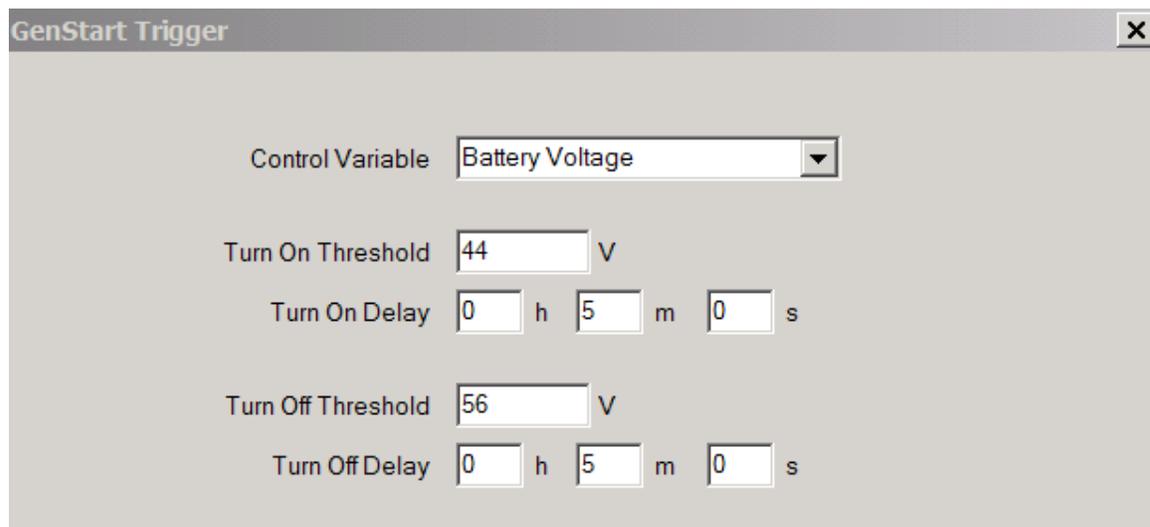
Fig. 6 Battery Thresholds

If a generator does not offer its own control for more sophisticated timing, the different channels of the relay driver can be configured to switch each of the control wires required to run a generator. Since this is a diesel generator, a pre-heat function is needed to warm the glow plug briefly before attempting to turn on the engine (accomplished by channel 1). The second phase of starting requires that the run and ignition signals are activated at the same time (channels 2 & 3). Crank Delay is the amount of time that takes place after Pre-Crank but before the engine turns on. Fig. 7 shows a close-up of the starting cycle that the RD will go through once the low battery voltage level is reached.
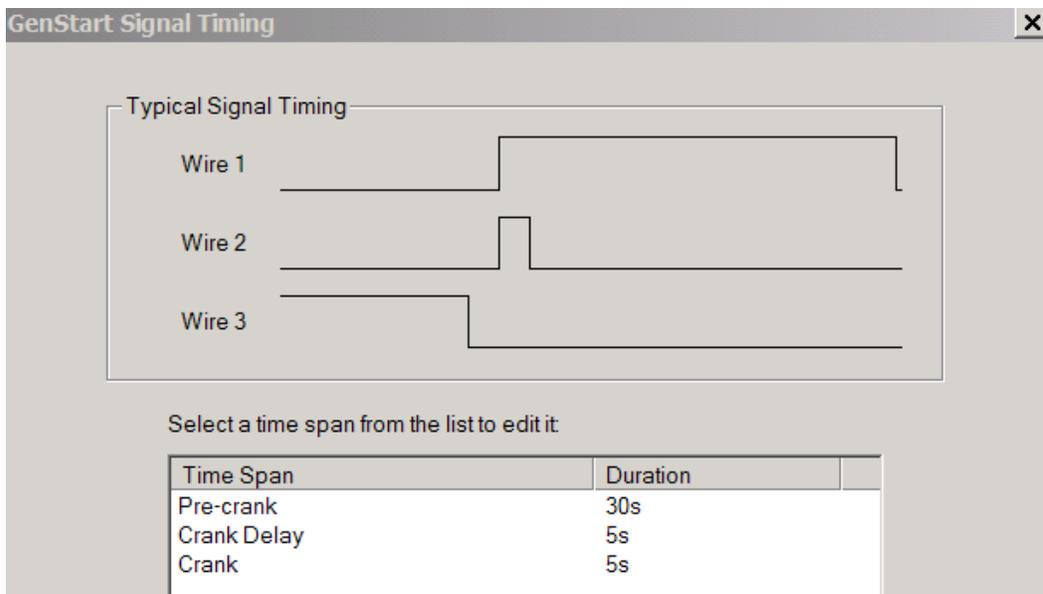
Fig. 7 Generator Starting Cycle

A maximum run time can be set in the case of a complication in which the batteries are not fully charged. These time limits are shown in Fig. 8.
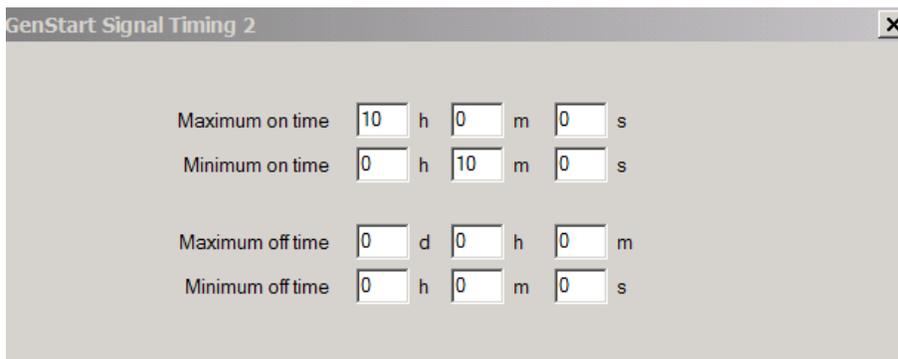
Fig. 8 Max./Min. Run Times

Conclusion

In addition to the above examples, many other types of logic are possible. Up to 750mA of current can be drawn on each channel, meaning multiple relays can run off each channel output. Also, relays may be wired in such a way that only combinations of conditions on multiple channels would activate a relay. This gives the user Boolean logic control over the system if desired.

Three of many possible scenarios that utilize the Morningstar Relay Driver were discussed in this document. Others include:

-Diversion control for wind or hydro systems.

-Temperature based control using the RD's internal temp sensor or the TriStar's optional Remote Temperature Sensor placed at the battery bank.

-Pump control using battery based, direct PV or generator based systems with float control switches monitored by the Relay Driver.

To learn more about the Relay Driver's options, please download MSView from the Morningstar company website at www.morningstarcorp.com

The RD setup wizard in MSView may be explored freely without the RD hardware.