ASCO Power Technologies™

Monitoring the Integrity of Engine Start Signal Circuits

White Paper 71

Revision 1

Life Is On Schneider Electric

Monitoring the Integrity of Engine Start Signal Circuits

Strategies for Complying with the New NEC® Requirement

The 2017 edition of the National Electrical Code® (NEC®) introduced a requirement to monitor the integrity of generator start signal circuits. This paper explains how unmonitored wiring presents a reliability risk, and describes the responding NEC requirement. It also describes ASCO's solution for complying with the code, without having to rewire existing power equipment control circuits.

THE NEED TO MONITOR ENGINE START SIGNAL CIRCUITS

In order to provide an engine start signal to an emergency generator, a transfer switch typically uses a circuit controlled by a normally closed contact. During normal operation, this component is energized and the contact remains open, but closes when the Automatic Transfer Switch (ATS) requires generator power. Upon closure, the contact completes the circuit used to send a start signal to the engine of a standby generator. The engine start signal wiring is shown in Figure 1.

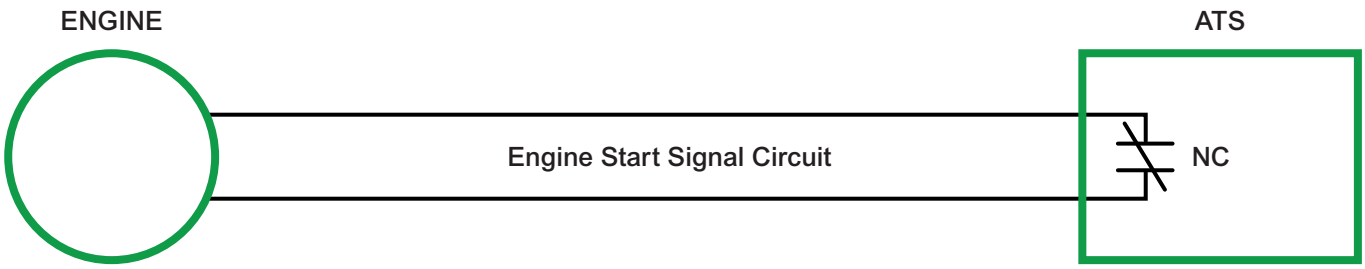


Figure 1: When utility power fails, the contact de-energizes and closes and a start signal is sent to the engine.

A problem occurs when the generator control wiring becomes discontinuous, resulting in an open fault as shown in Figure 2. This could result from modifications to the normal or emergency power systems, or when damage occurs such as accidental cutting of a conduit or wire. In these instances, the engine controller would not detect the fault because it still sees an open circuit. The problem would not become apparent until the engine failed to start following a utility power outage.

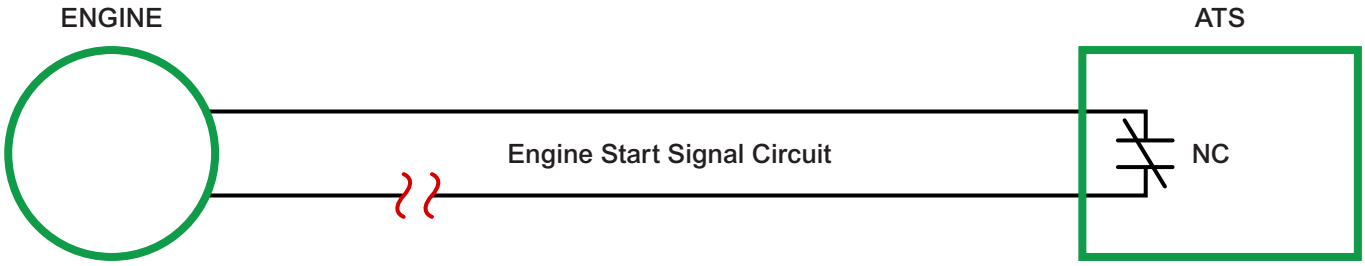
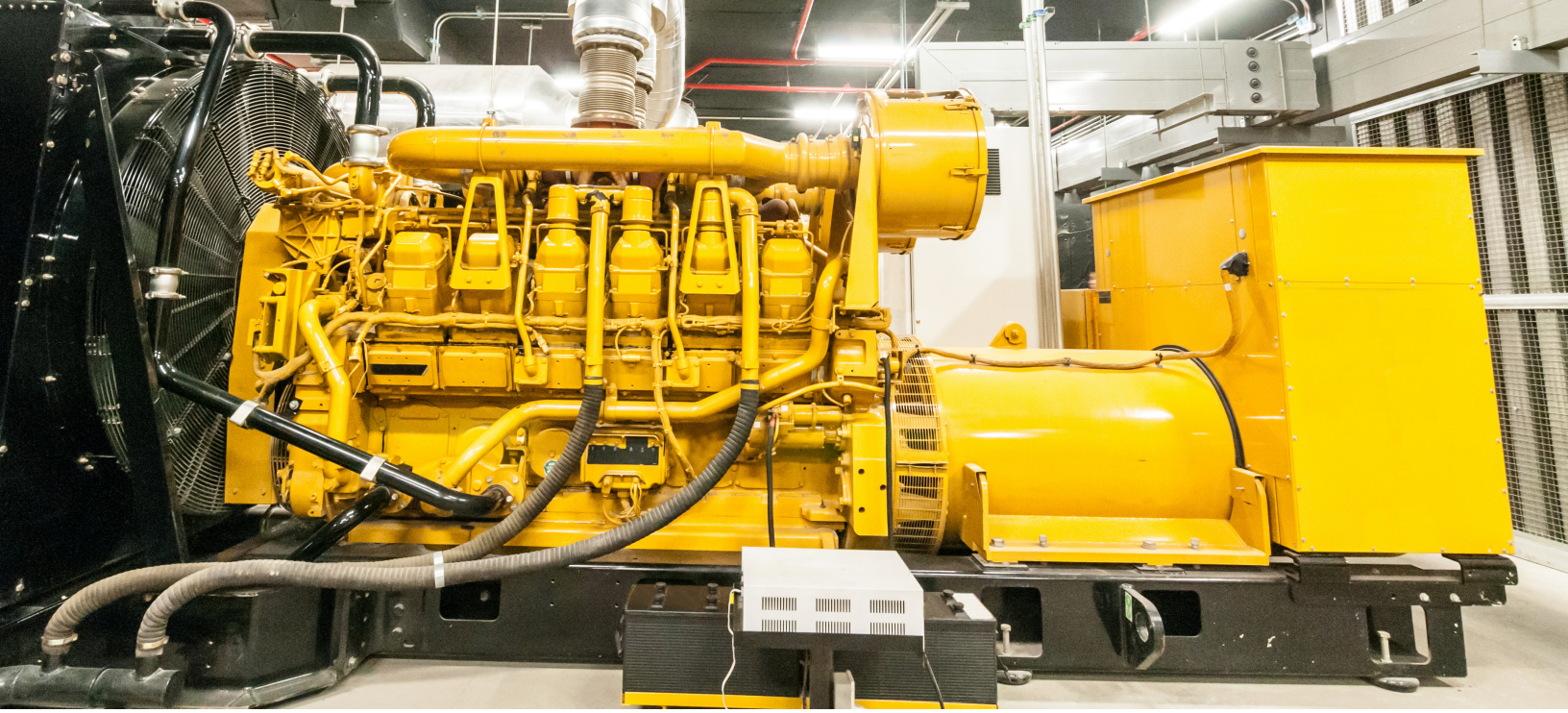


Figure 2: If an open fault is present when utility power fails, the engine will not receive a start signal because the circuit will not be completed.



Alternatively, if a short were to develop in a system that uses a normally open contact (which is held closed when generator power is unnecessary), the engine would not start even if normal utility power is unavailable. Because of susceptibility to this type of fault, the use of a start circuit equipped with a normally open contact would not fully comply with the NEC requirement. Figure 3 shows a short along a circuit equipped with a normally open contact.

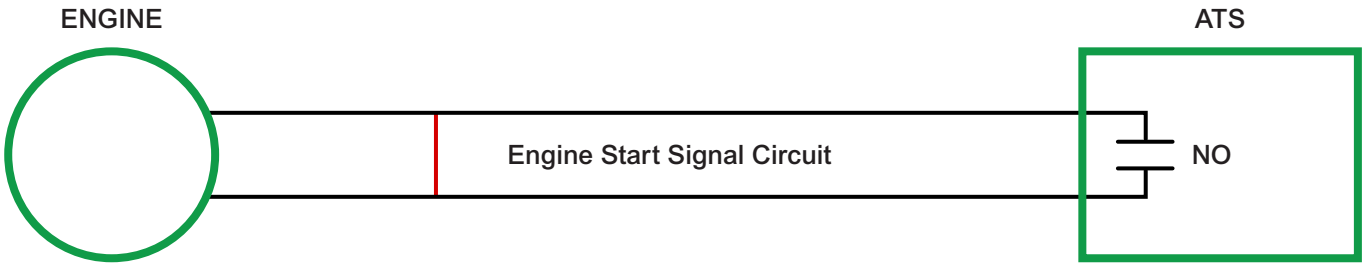


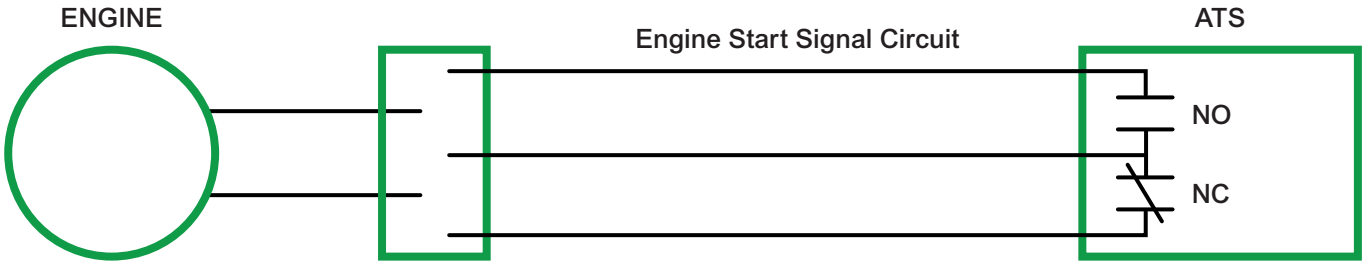
Figure 3: If a open-to-start signal is used, a short between the conductors could remain undetected until the generator fails to start.

The National Fire Protection Agency recognized the potential for damaged engine control wiring to impact generator availability, and addressed the issue in the 2017 NEC. Article 700.10(D)(3) reads as follows:

> ***Control conductors installed between the transfer equipment and the emergency generator shall be kept entirely independent of all other wiring and shall meet the conditions of 700.10(D)(1). The integrity of the generator remote start circuit shall be monitored for broken, disconnected, or shorted wires. Loss of integrity shall start the generator(s).***

DISCUSSION

To develop a solution that is easy to implement and complies with the NEC requirement, several approaches could be used to monitor the integrity of engine start circuits. For instance, a three-wire system with both normally open and normally closed (Form C) contacts could be used, as shown in Figure 4. The states of indication for this arrangement are shown in the corresponding table.



Contact Positions		Start Circuit Status
Normally Closed	Normally Open	
Closed	Open	True Start Signal
Open	Open	Start Circuit Problem
Closed	Closed	
Open	Closed	No Start Signal Needed

Figure 4: Use of Normally Closed and Normally Open Contacts

Using this solution, the two contacts should always be in opposing states. A power failure would close the normally closed contact and open the normally open contact to issue a start signal, resulting in an engine start. However, if both contacts are in the same state, then a problem exists in the start signal circuit. If an open were to develop along the start signal circuit, as shown in Figure 5, an abnormal condition may not be detected because the contacts would appear to be in a valid state. This condition would remain until a power outage resulted in an actual engine start.

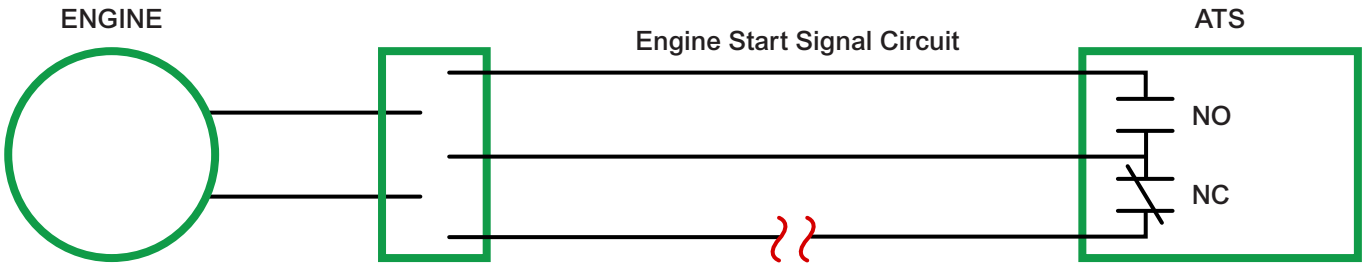


Figure 5: An open along the start signal circuit could go undetected by the normally closed contact.

ASCO ENGINE START MONITORING SOLUTION

ASCO has developed a solution for complying with the 2017 NEC Engine Start Monitoring (ESM) requirement. ASCO's ESM solution consists of the *ASCO Model 5101 ATS Module* that installs within an ATS enclosure and the *ASCO Model 5101 Generator Module* that installs on an engine-generator. The modules are shown in Figure 6. Their placement in an engine start signal circuit is shown in Figure 7.

Figure 6: Each ATS is fitted with an ATS module, shown at left. Each engine is fitted with the ESM Generator Module at right.

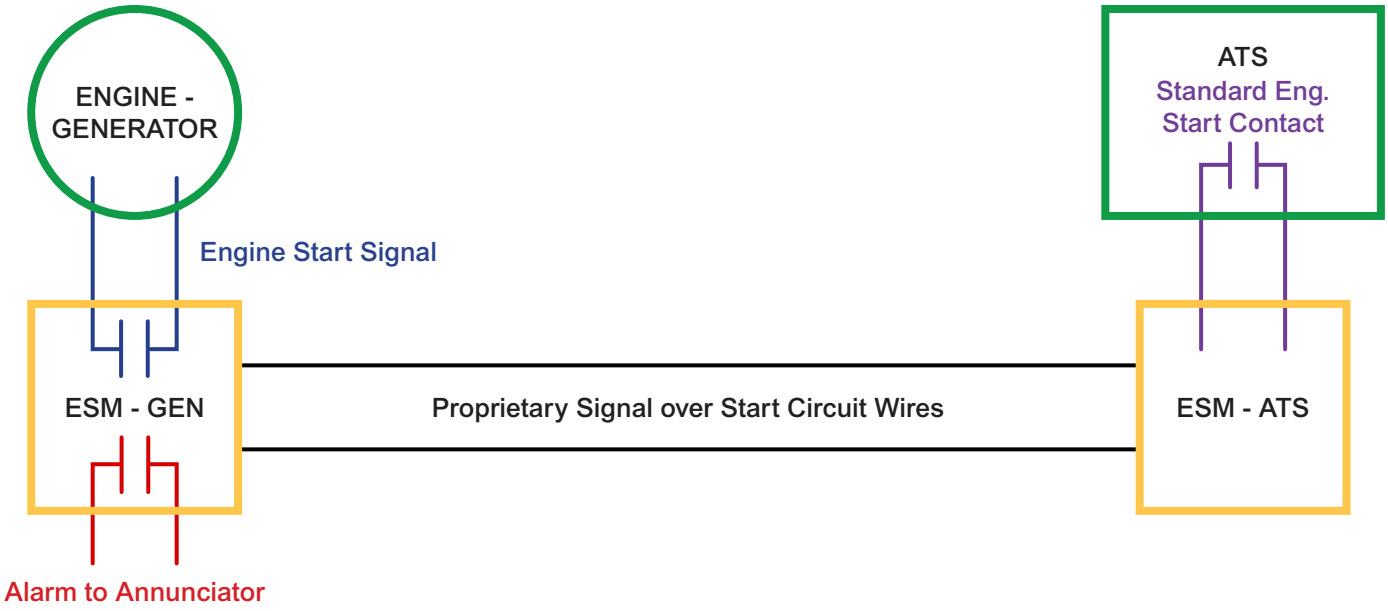


Figure 7: Schematic of ASCO Engine Start Circuit Monitoring Solution

During normal operation, the modules relay engine start signals to the engine as required. However, the modules use proprietary methods to continually monitor electrical characteristics of the start signal circuit. When a short or open fault is detected, the Generator Module immediately issues an engine start signal directly to the engine controller. This fail-safe mode ensures that the engine is operating and ready to connect to the power system if needed. The Generator Module simultaneously activates an alarm signal that can be annunciated on local and/or remote equipment. These measures ensure that facility personnel will know that the engine is running, and that investigation must be undertaken to evaluate the cause of the change in the state of the circuit.

BENEFITS

ASCO's ESM solution satisfies the NEC Article 700.10 requirement. The solution also provides continuous monitoring because the modules detect conditions that might not otherwise be revealed by conventional engine start circuit equipment. In addition, The modules immediately start the engine when faults occur, ensuring generator availability, and alarm the change in state so that personnel can promptly investigate the cause.

The solution is easy to deploy for both new and existing systems because the modules install on the traditional two-wire engine start signal wiring. This assures that new systems can be provisioned and commissioned quickly. Because the modules can be fitted to existing start signal circuits, the solution can be retrofitted to existing backup power systems without the cost and disruption of running new or additional wires. As shown in Figure 8, each Engine Module can monitor start signal circuits from up to 8 ATSs, increasing the cost-effectiveness of the solution. When multiple ATSs are served by a single Generator Module, a fault on any one of the circuits will trigger the engine start, alarming, and annunciation functions.

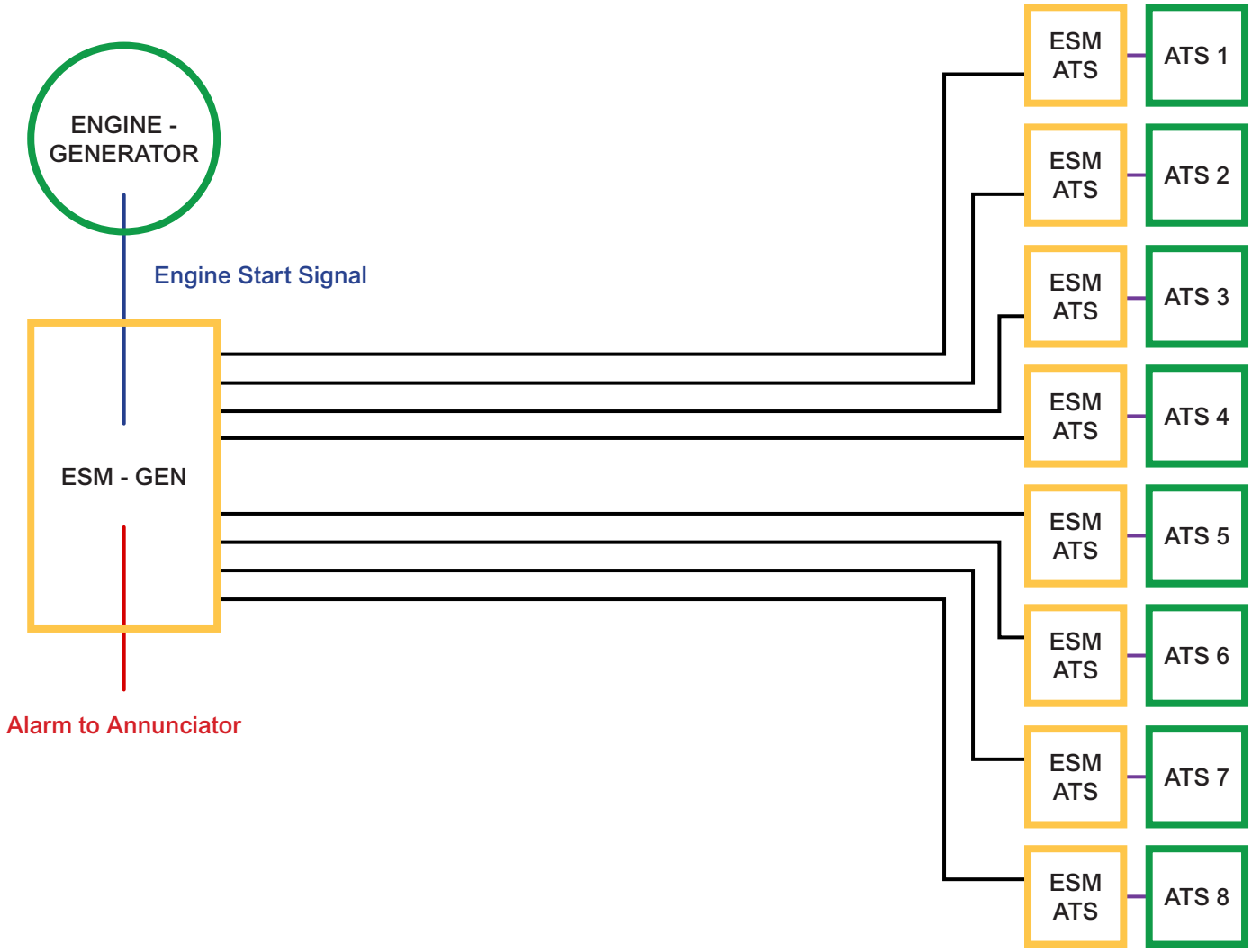


Figure 8: A single ASCO Model 5101 Generator Module can monitor start signal circuits for up to 8 ATSs.

SUMMARY

When engine start circuits are compromised by open or short faults, backup engine-generators could become unavailable without facility personnel knowing about the problem. For this reason, the NEC requires monitoring of the integrity of generator engine start circuits. ASCO's 5101 Engine Start Modules offer a simple solution for complying with the NEC requirement. They also continually monitor circuit conditions, then start generators and provide alarm signals when circuits are compromised. Because they install directly on standard engine start signal circuit wires, the 5101 modules are easy to provide with new equipment, and can be readily retrofitted onto existing systems.

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