Schneider Learning Series

NEC Temporary Source of Power Requirements

Manual Transfer Switches, Docking Stations and Engine Start Signals

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ASCO Power Technologies

Life Is On Schneider Electric

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Kevin Ragbasingh is an Offer Manager at ASCO Power Technologies. Kevin's primary duties at ASCO include product development and management of 7000 Series Medium Voltage ATS and Series 300 ATS product lines. During his 4-year tenure at ASCO, Kevin has helped successfully launched the Series 300 Quick Connect Panel products as well as Manual Transfer Switch and Manual Transfer Switch with integrated quick connects products.

Before ASCO, Kevin began his career as a design and product engineer for two electromechanical switch manufacturers. His role as an engineer involved design and prototyping of new designs, monitoring quality control processes and implementing current technologies to meet the customer's needs. Throughout his career, Kevin has made it a priority to provide technical support for various products to both sales and the customer.

Kevin received a bachelor's in Electrical Engineering at Temple University with a concentration in power system design. Kevin is currently pursuing his MBA at Texas A&M Corpus Christi.

This webinar will be recorded and made available through our website.

Please use the “Q & A” feature to ask technical questions.

Learning Objectives

- Understand basic NEC Requirements for Emergency and Standby Power including NEC 2017 700.3(F) & 700.10(D)(3) changes
- Recognize temporary generator set connection provisions and applications using MTS and Docking Stations
- Explain how 16 series single pole connectors affect short circuit ratings of a docking station and WCR ratings of an MTS
- Describe start signal integrity and temporary generator set connection requirements
- Identify compliant solutions for start signal integrity

NEC Requirements for Emergency and Optional Standby Power Systems

Codes & Standards

NFPA 70 (NEC):

Article 700 – Emergency Systems

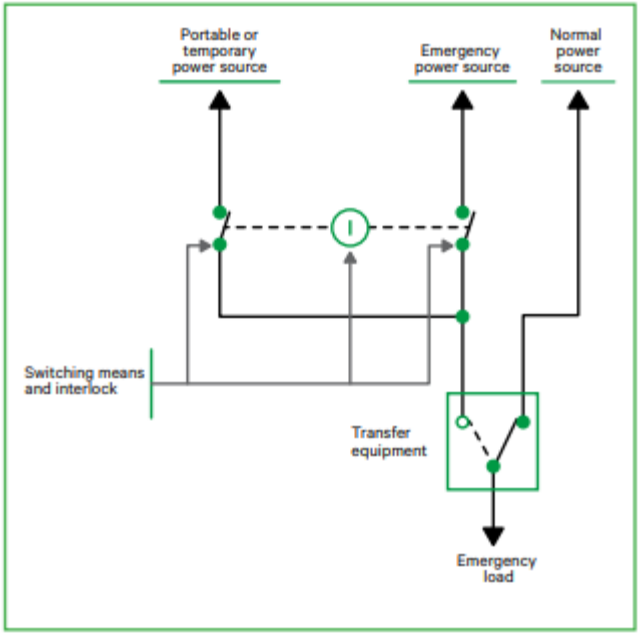
- **Emergency systems are designed to power exit lighting, fire detection and alarm systems, elevators, fire pumps, and public safety communications systems.** They might also power ventilation systems considered essential to preserving health and life, or industrial processes where power interruption would result in hazards to life or injury.
- Transfer equipment shall be automatic with a designed interlock to prevent interconnection of normal and emergency sources. (700.5)
- In the event of failure of the normal supply, emergency lighting, power or both shall be available within 10 seconds. (700.12)

Sr. Care Facility

• 700.3(F) Requirements

•*700.3 (F) " ….**If the emergency system relies on a single alternate source of power** which will be disabled for maintenance or repair, the emergency system **shall include permanent switching means to connect a portable or temporary alternate source of power** …. The **permanent switching means** to connect a portable or temporary alternate source of power **shall comply with the following**:*

1. Connection to alternate power source shall require no modification to permanent system wiring.
2. Transfer between normal and emergency power source shall meet 700.12. (10 second requirement)
3. Connection point of temporary power source shall be mark with phase rotation and system bonding requirements.
4. Device must be electronically or mechanically interlocked.
5. Switching means shall include a contact point for annunciation, that indicates the permanent emergency source is disconnected from the emergency system.



For emergency power systems with a single alternate power source, NEC Article 700.3(F) requires a means of connecting temporary or portable power.[1]

• 700.3(F) Exceptions

•The permanent switching means to connect a portable or temporary alternate source of power, for the duration of the maintenance or repair, shall not be required where any of the following conditions exists:

1. All processes that rely on the emergency system source are capable of being disabled during maintenance or repair of the emergency power source.
2. The building or structure is unoccupied and fire suppression systems are fully functional and do not require an alternate power source.
3. Other temporary means can be substituted for the emergency system.
4. A permanent alternate emergency source, such as, but not limited to, a second on-site standby generator or separate electric utility service connection, capable of supporting the emergency system, exists.

Codes & Standards

NFPA 70 (NEC):

Article 701 – Legally Required Systems

- **A system is legally required when any government agency having jurisdiction says it is.** The rules which dictate what kind of emergency loads are legally required are found in the locally adopted building code, such as International Building Code and NFPA101 Life Safety Code. **Unlike emergency systems, legally required systems do not protect the lives of the public at large.**
- Transfer equipment shall be automatic with a designed interlock to prevent interconnection of normal and emergency sources. (701.5)
- Alternate power source can supply both legally required and optional standby systems if the alternate source has adequate capacity to handle all connected loads or if selective load pickup or load shedding is provided. (60 second backup power requirement)

Fire Pump System

Codes & Standards

NFPA 70 (NEC):

Art. 702 – Optional Standby Systems

- A standby power system is *optional* when it's not required by Art. 700 or Art. 701**. These systems protect public or private facilities or property where life safety doesn't depend on the performance of the system. <u>These systems are not required for rescue operations.</u>**
- Transfer equipment can be either manual or automatic. (702.1 & 702.2)
- Portable Generators > 15KW and permanent generators with an accessible disconnecting means require line of site to building or structure where generator supply conductors terminate. (702.12 A)
- Systems with power inlets rated at 100A or greater require an interlocked disconnecting means. (702.12 C)

Gas Station

Codes & Standards

NFPA 70 (NEC):

Article 708 – Critical Operations Power Systems *(COPS)*

- **Intended for Homeland Security.** Included on the list are air traffic control centers; fire and security system monitoring; hazardous material handling facilities; communication centers and telephone exchanges; emergency evacuation centers; financial, banking, business data processing facilities; fuel supply pumping stations; hospitals; water and sewage treatment facilities; 911 centers; critical government facilities; police, fire and civil defense facilities including power for radio repeater operations; radio and TV stations; and transportation infrastructure.

Telecom Station

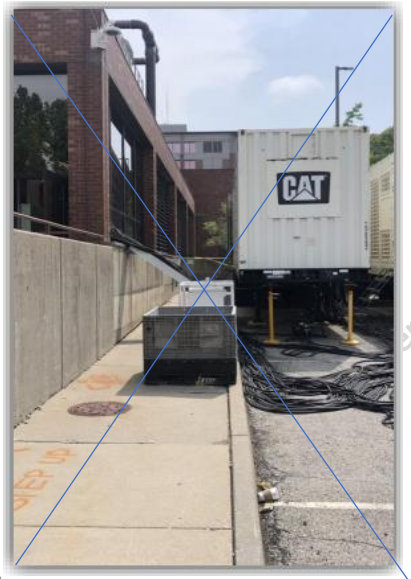
Selecting the Right Temporary Power Equipment

Generator and Load Bank Docking Stations

What is a Docking Station?

A piece of equipment that allows for a safe means for temporary connection of a generator or load bank.

- Enclosure contains mechanical or compression lugs for permanent connection, bussing and single pole connectors.
- Some include additional accessories, phase rotation monitor, auto start terminal block, disconnect breaker, receptacles.
- Typically for outdoor use only.
  - NEC requires a line of sight from permanent or portable (> 15kW) generators equipped with disconnects to docking station. 702.12 (A)
  - Enclosures are usually NEMA 3R, enclosures need to provide the same level of protection when cables are either connected or disconnected.



Input vs. Output Docking Stations

Input panels are UL or ETL listed to UL1008 annex J standards as Transfer Switch Accessory

- Male single pole connectors (Typically 16 Series male recessed Camlocks)

Output panels are ETL or UL listed to UL891 Switchboard standards

- Female single pole connectors (Typically 16 Series female Camlock)

16 Series camlocks

- Rated for 400A @ 600VAC
- Short circuit rating of 10kA
- Color configurations determine the voltage of docking station
- NEMA 3R rated

Volts	Cat Code	Phase A	Phase B	Phase C
<=240	F	Black	Red	Blue
<=480	N	Brown	Orange	Yellow
<=600	R	Black	Black	Black
Neutral, if used, is always White Ground is always Green				

Input Panel (Generator) Connector

Cable side mating – Female connector

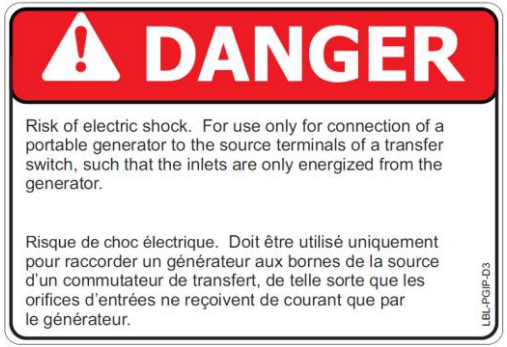
Output Panel (Load Bank) Connector

Cable side mating – male connector

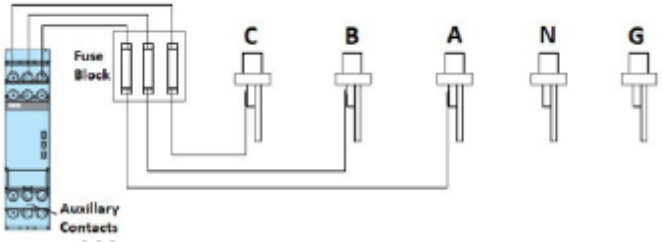
• Single vs. Dual Purpose Docking Stations

Can I connect either Load or Source to a single QCP with a single set of quick connects using piggyback cables?

No, if a connection is required for either Load or Source connections a dual purpose QCP similar to one shown should be used. An interlock should be used to prevent to connection of both perm gen and portable gen at the same time.

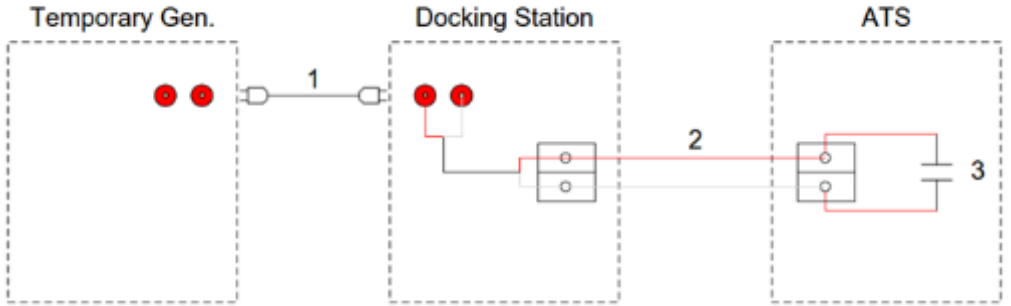


How does the Phase Rotation Monitor & Remote Start circuit work on our Quick Connect panels?



- Unit comes prewired to the first camlock of each phase for ABC rotation.
  - Match and confirm build rotation.
- LED indicates correct phase rotation

Circuit wired in series with automatic transfer switch



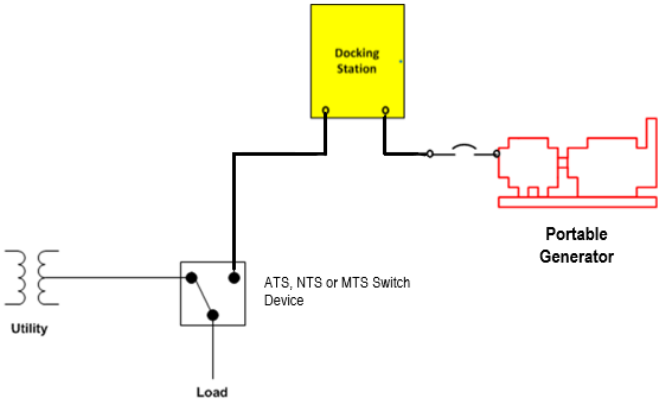
1. Temporary Conductor between Temp Gen and QCP.
2. Permanent conductors between QCP and ATS.
3. Remote start contacts within ATS.

Operation

- ATS shown in the Normal position connected to Utility Source. (Not Calling for Remote Start.)
- ATS will close contact (3) to remote start Temp gen as required.

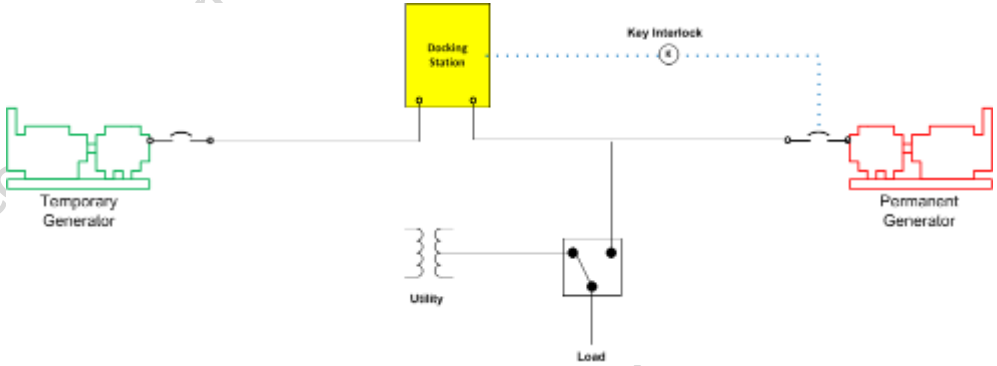
Docking Station Connections

Generator Tap (Standard Connection)



Generator Tap (Optional Standby solution)

Dock in the Middle (feed thru)

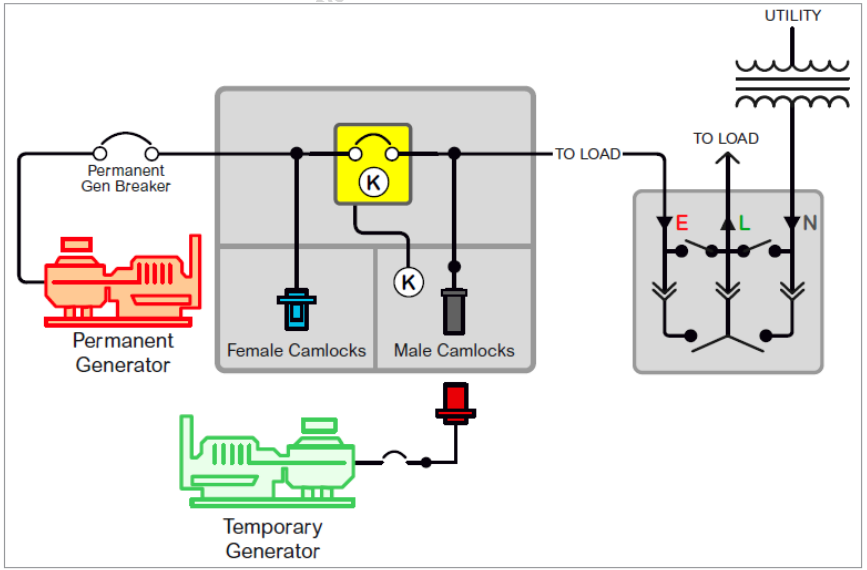


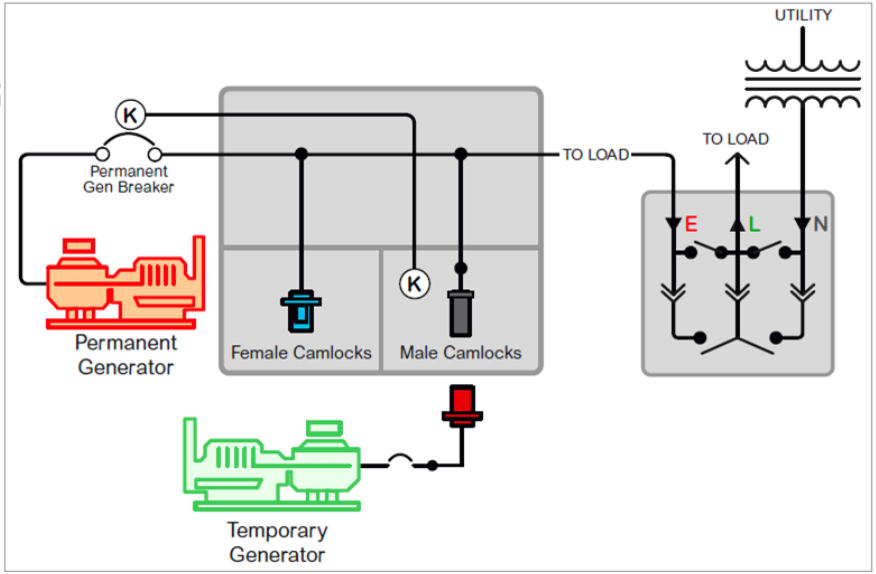
"Dock in the middle" requires interlocking method to meet 700.3

- Requires interlock between Permanent Gen and Portable Gen;
- Key is Trapped
- Line-of-sight requirement

• 700.3 QCP Docking Station Solution

Docking Station Solutions



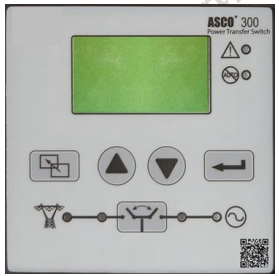


Manual Transfer Switches

What is a Manual Transfer Switch?

a. Manually Operated
b. Ability to transfer load between sources
c. Contactor base or breaker based
d. No controller
e. No controls or voltage sensing
f. Limited accessories
g. Listed to UL1008 as a Non-Automatic Transfer switch or UL 98

ATS vs NTS vs MTS

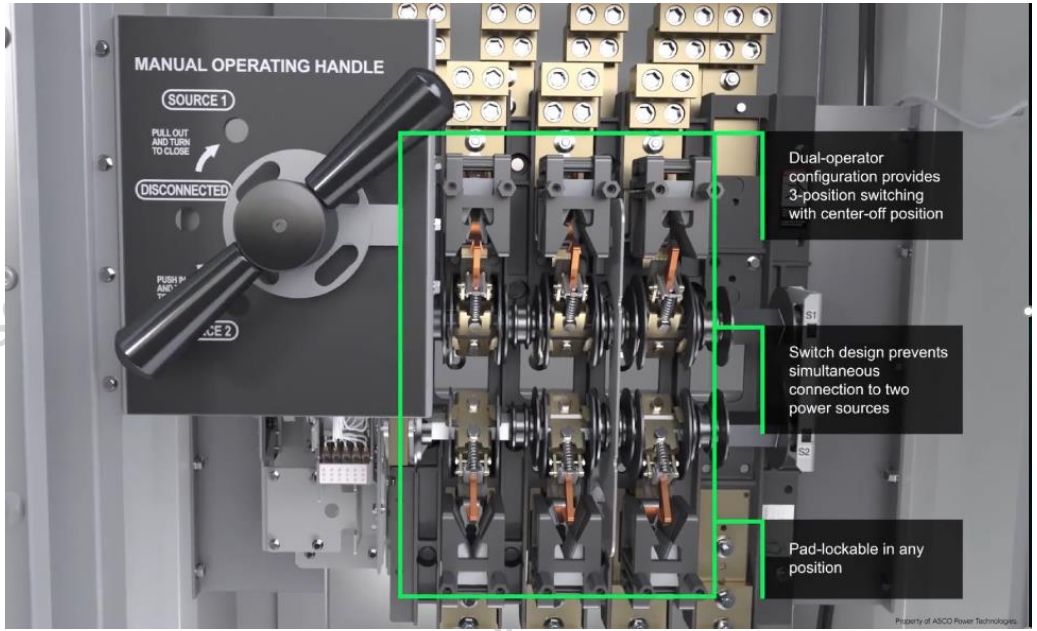


	ATS	NTS	MTS
Operation	**Monitors power conditions and automatically transfer between sources (No human intervention).**	**Transfers loads to an alternate source when prompted through electrical controls. Can only transfer if the other source is acceptable**	**Manually transfers using the operating handle on the switch. Can switch between sources at any time (whether other source is good)**
Target Markets	Necessary for Critical/Emergency/Legally Required Backup Power Applications (NEC Article 700/701)	Optional Standby Systems. Installations where transfer switches may not be easily accessed, operation can be initiated through remote annunciator. Or when transfer to other source should only occur when that source is available/ acceptable. Can be used in conjunction with a QCP to meet 700.3	Installations where transfer switches are easily accessed. No remote control. Switch can be placed in any position at any time. Good for maintenance due to lock out capabilities.
Controller	Group 5/G 	Group 5/G 	None 
UL	Automatic Transfer Switch For Emergency Systems	Non-Automatic Transfer Switch	Non-Automatic Transfer Switch

Make, break and current carrying capabilities are identical across the MTS, NTS and ATS products.

Manual Transfer Switch Design Considerations

- 3 Positions with a center-off position which isolates the load from both sources.
- Mechanical designed interlock to prevent interconnection of normal and emergency sources.
- Pad-Lockable in all three positions.
- Ability to handle the demands of motors and high inrush current.
- Visual switch position indicators for all three positions.
- Auxiliary contacts which can indicate permanent emergency source is disconnected from emergency system 700.3(F) 5



MTS Product Offering

MTS - Manual Transfer Switch

MUS - Service Entrance Rated Manual Transfer Switch

MPS - Service Entrance Breaker on Source 1 Generator Breaker on Source 2

MTQ - Manual Transfer Switch with Integrated camlocks on Source 2

MUQ - Service Entrance Manual Transfer Switch with Integrated Camlocks

MTDQ – Manual Transfer Switch with Dual Quick Connects

MGDQ – Manual Transfer Switch with Dual Quick Connects with Portable Generator Breaker

Manual Transfer Switch w/Integrated Quick Connects on Emergency (MTQ)

Manual Transfer Switch w/ Dual Quick Connects (MTDQ)

MTS, MTQ, MTDQ & MGDQ Options & Accessories

Accessory Family 170 (MTS/MTQ) & 171 (MTDQ/MGDQ)

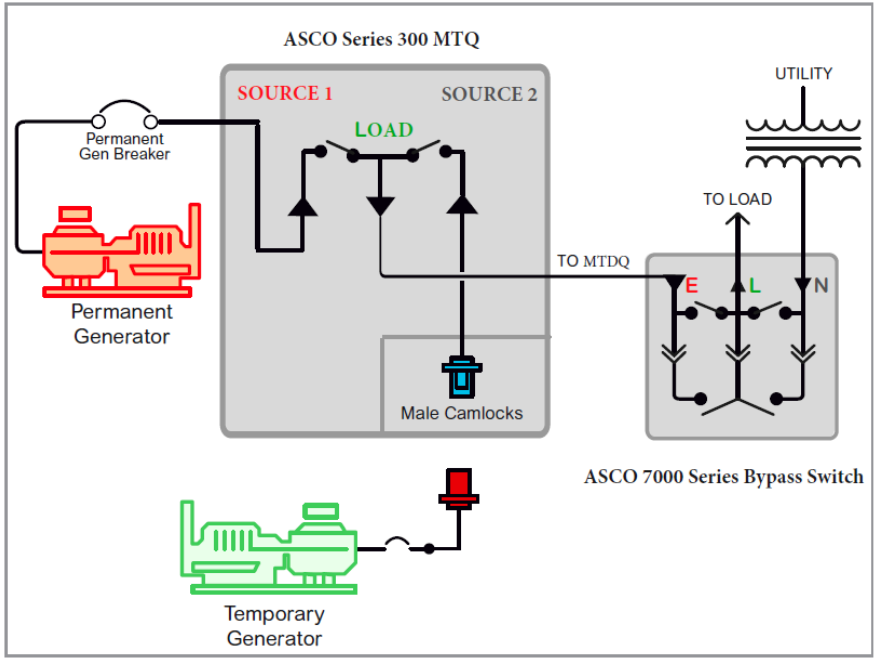
- 170 & 171 Bundles contain LEDs and contacts for
  - Source 1 Available
  - Source 2 Available
  - Load connected Source 1
  - Load connected Source 2
  - Disconnected Position
- Phase Rotation Monitor
- Maintained Engine Start Switch with Keyed Option
- I/O Module
  - Status details via Modbus TCP/IP

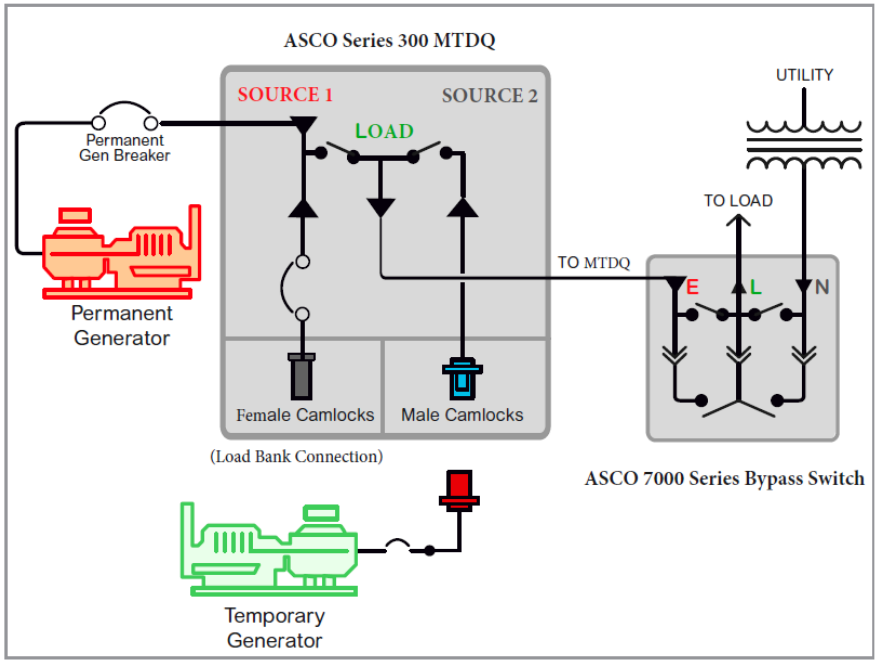
170 +	B +	P +	1
Accessory Description	User Interface/Controls	Phase Rotation	IO Module
All 170 Accessories Include LEDs and Contacts For: - Source 1 Available - Source 2 Available - Connected to Source 1 - Connected to Source 2 - Disconnected Position	B – Base (Source Indication Only. No engine start switch or common alarm) E – Maintained Engine Start Switch/Output With Common Alarm Input/LED/Contact K – Keyed Maintained Engine Start Switch/Output with Common Alarm Input/LED/ Contact	P = Phase Rotation Monitor (LED) Blank = none	1 = IO Module Blank = none

Accessory 44A - Strip heater with thermostat to prevent condensation and ice formation of water
Accessory 44G - Strip heater with Thermostat wired to Load Terminals
Accessory 73 – Surge Suppressor Rated 65kA
Accessory 135L - Power Meter
Accessory 72EE – Communication Module

700.3 (F) MTS Solution

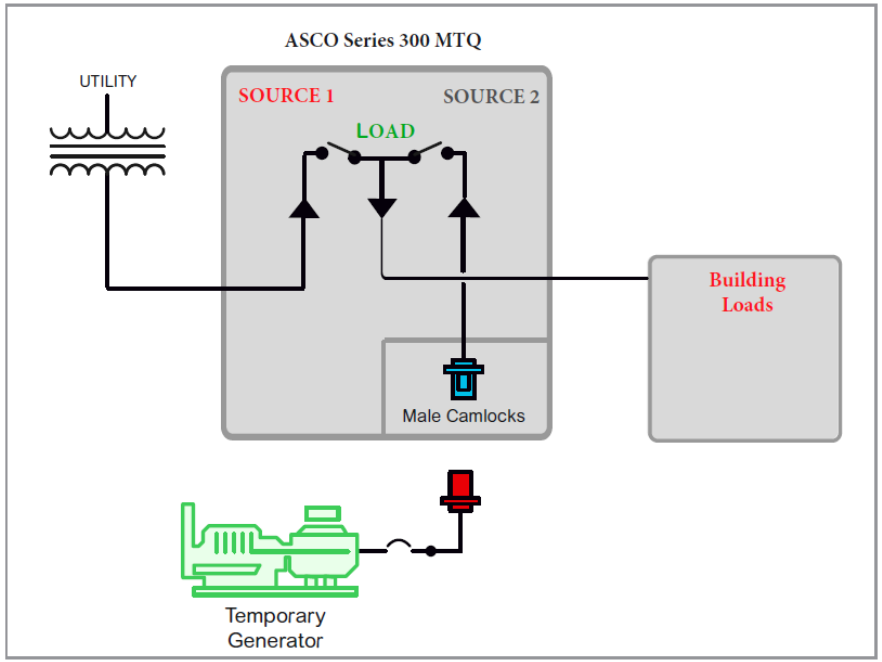
Manual Transfer Switch Solutions



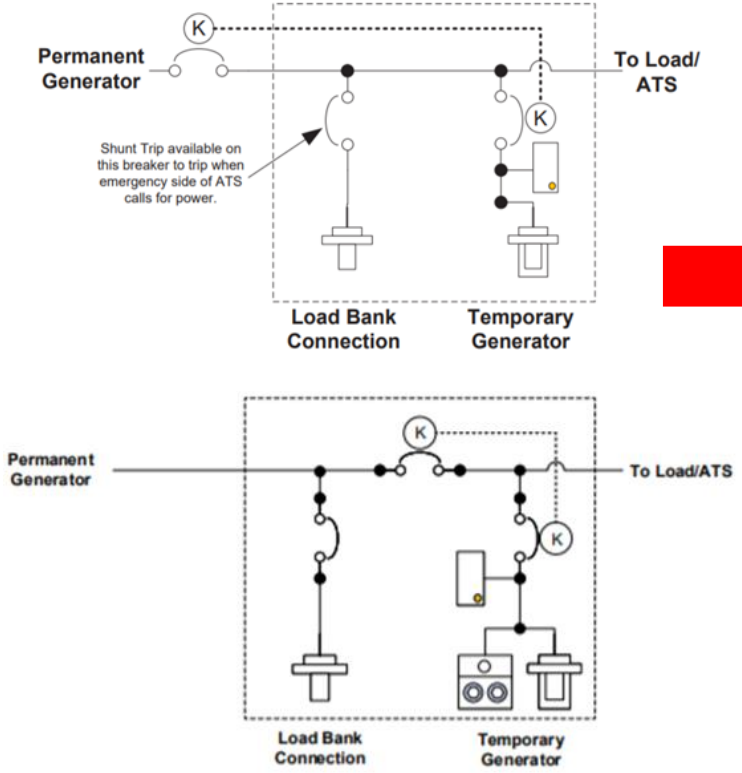


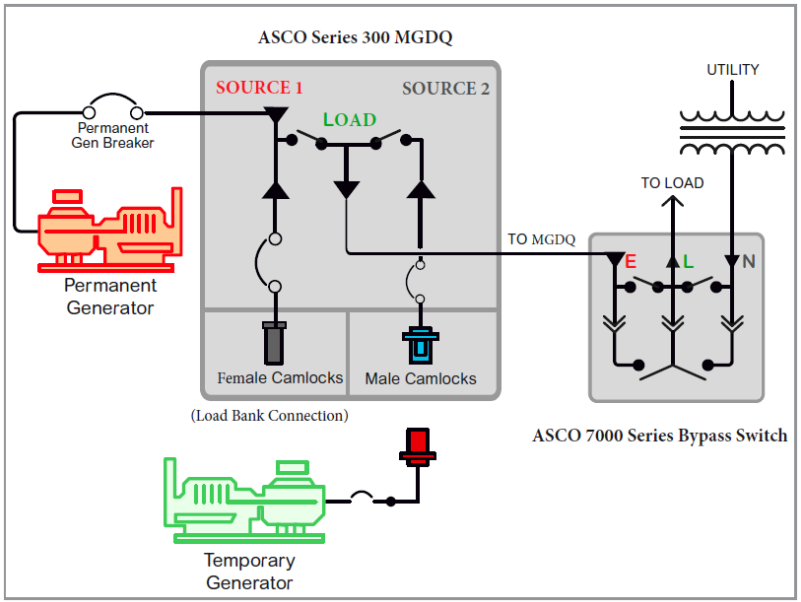
Optional Standby Art. 702

Manual Transfer Switch Solution



700.3 F Docking Station Solution (continued)





Impact of Quick Connects on short circuit ratings

•When a listed inlet is placed on a transfer switch, the short circuit rating become lower on the side the inlets are placed on because their rating reflect the power sources they are connected to. (Generators)

- Typical sub-transient reactance for a generator range from 10-20% with a typical time of 10ms.
  - Example: A 500kW gen at 480V with a worst-case scenario sub transient reactance at 10% would have a short circuit current of 7.52kA.

Through the Current

Through the Camlocks

Engine Start Circuit

NEC Article 700.10(D)(3)

- 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, with the added requirement shown in bold text:

- *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).*

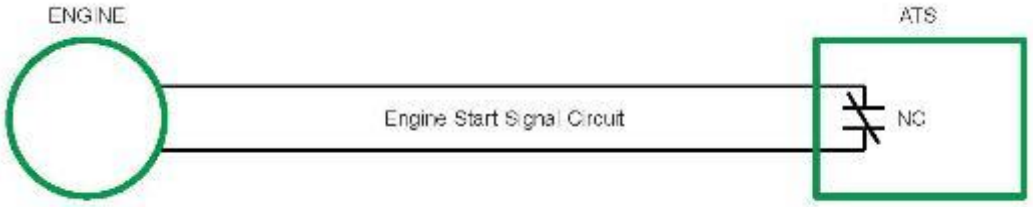
NEC-Compliant Engine-Generator

- Compliance with the new requirement thus requires three elements:
  - Monitoring of the equipment to equipment engine start signal circuit.
  - Differentiating between a normal start/stop signal vs a short or open fault.
  - Starting the generator during a fault.

- The goal is to detect any problem that may have impacted the long distance wiring between the ATS and GEN which may have gone undetected…(ex. Construction which could have broken/cut a conduit by mistake) and start the generator to make emergency power available until users intervene.

THE NEED TO MONITOR ENGINE START SIGNAL CIRCUITS

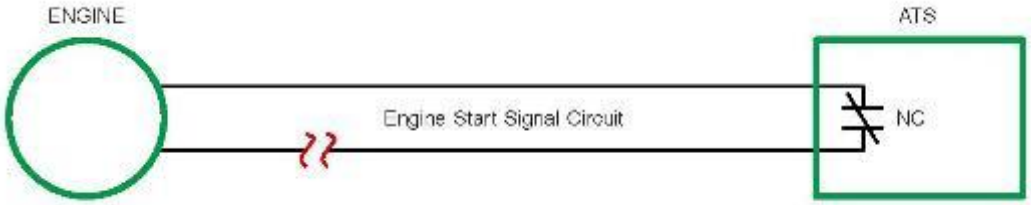
- In order to provide an engine start, signal to an emergency generator, a transfer switch typically uses a circuit controlled by a normally closed contact. During normal operation, this component is energized and the contact remains open, but closes when the Automatic Transfer Switch (ATS) requires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



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

Incomplete Circuit

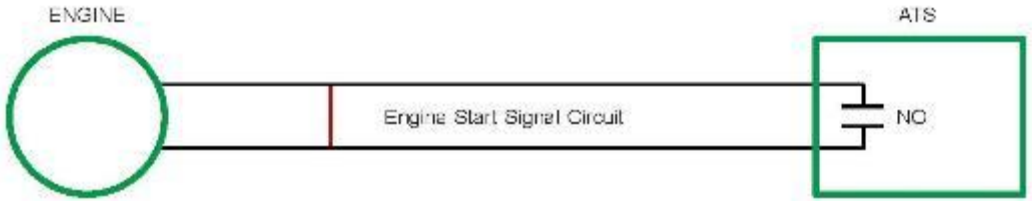
- A problem occurs when the generator control wiring becomes discontinuous, resulting in an open fault. This could result from modifications to the normal or emergency power systems, or when damage occurs such as accidental cutting of a conduit or wire. In these instances, the engine controller would 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.



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.

Shorted Circuit

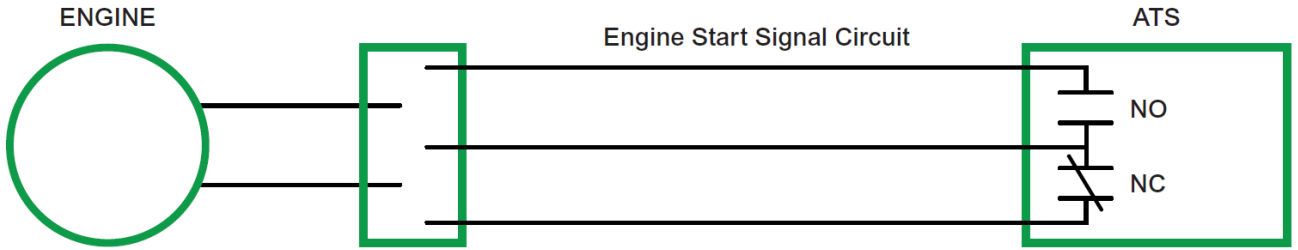
Alternatively, if a short were to develop in a system that uses a normally open contact (which is held closed when generator power is unnecessary), the engine would not start even if normal utility power is unavailable. Because of susceptibility to this type of fault, the use of a start circuit equipped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



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

Three Wire Start System

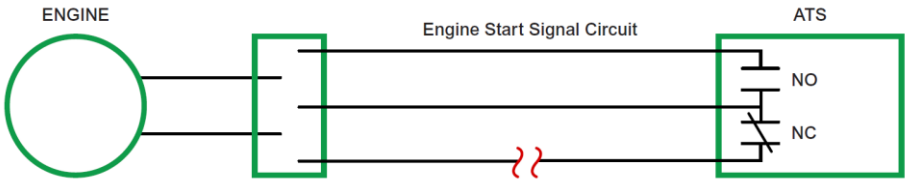
To develop a solution that is easy to implement and complies with the NEC requirement, several approaches could be used to monitor the integrity of engine start circuits. However, many solutions have at least one characteristic that does not fully conform the new NEC requirement. For instance, a three-wire system with both normally open and normally closed (Form C) contacts could be used.



Wiring Fault

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.** This solutions may have some downsides….

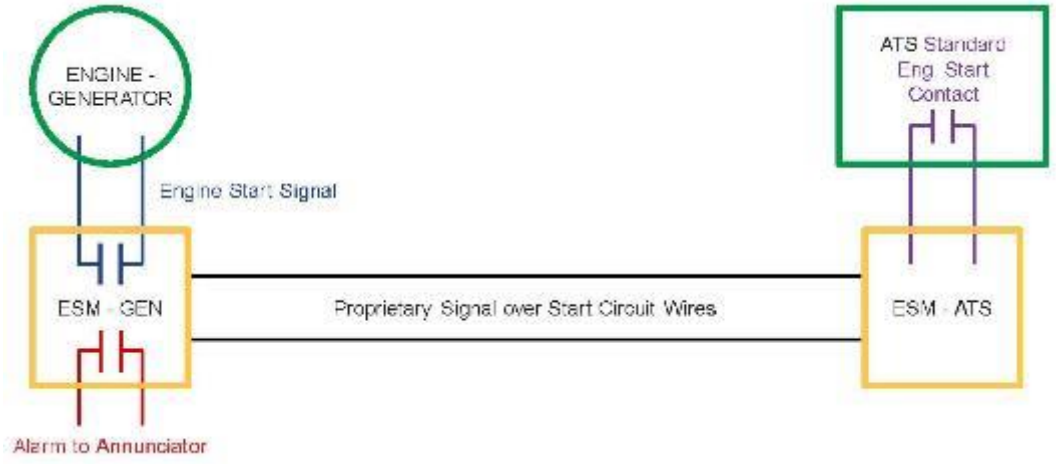
- It requires an additional wire that is not usually present with traditional two wire systems. This may make it more difficult or expensive to retrofit into existing systems.
- If a single open were to develop along the NC start signal circuit, as shown in Figure 5, an abnormal condition may not be detected when it occurs and would only be detected at the time of an outage preventing the user from addressing or being aware of the fault, which may also be impacting other adjacent conduits/wires proactively. The same is true for a short on the NO side.
- In multiple ATS systems this is usually wired in parallel, making it impossible to identify which circuit is faulty without unwiring each signal and testing them independently wasting valuable time.



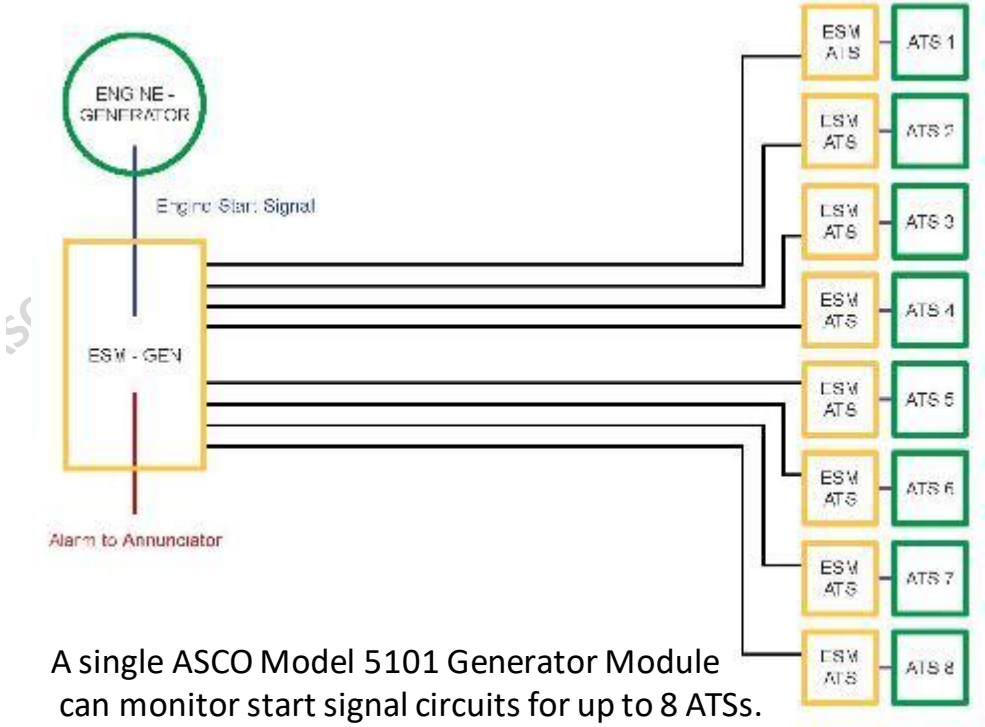
Contact Positions		Start Circuit Status
Normally Closed	Normally Open	
Closed	Open	True Start Signal
Open	Open	Start Circuit Problem
Closed	Closed	
Open	Closed	No Start Signal Needed

ASCO Modular Monitoring

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.



ASCO Modular Monitoring



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

BENEFITS

- **ESM solution satisfies all three elements of the NEC Article 700.10 requirement.** The solution 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. 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

BENEFITS

- **ESM solution satisfies all three elements of the NEC Article 700.10 requirement.**

1. ***The solution provides continuous monitoring*** - because the modules detect conditions that might not otherwise be revealed by conventional engine start circuit equipment.

2. ***The modules immediately start the engine when faults occur***, ensuring generator availability,

3. ***The solution alarms the change in state*** so that personnel can promptly investigate the cause.

BENEFITS

- **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!

- ***The Engine 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.

- ***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.***

For further information

- PDH certificate

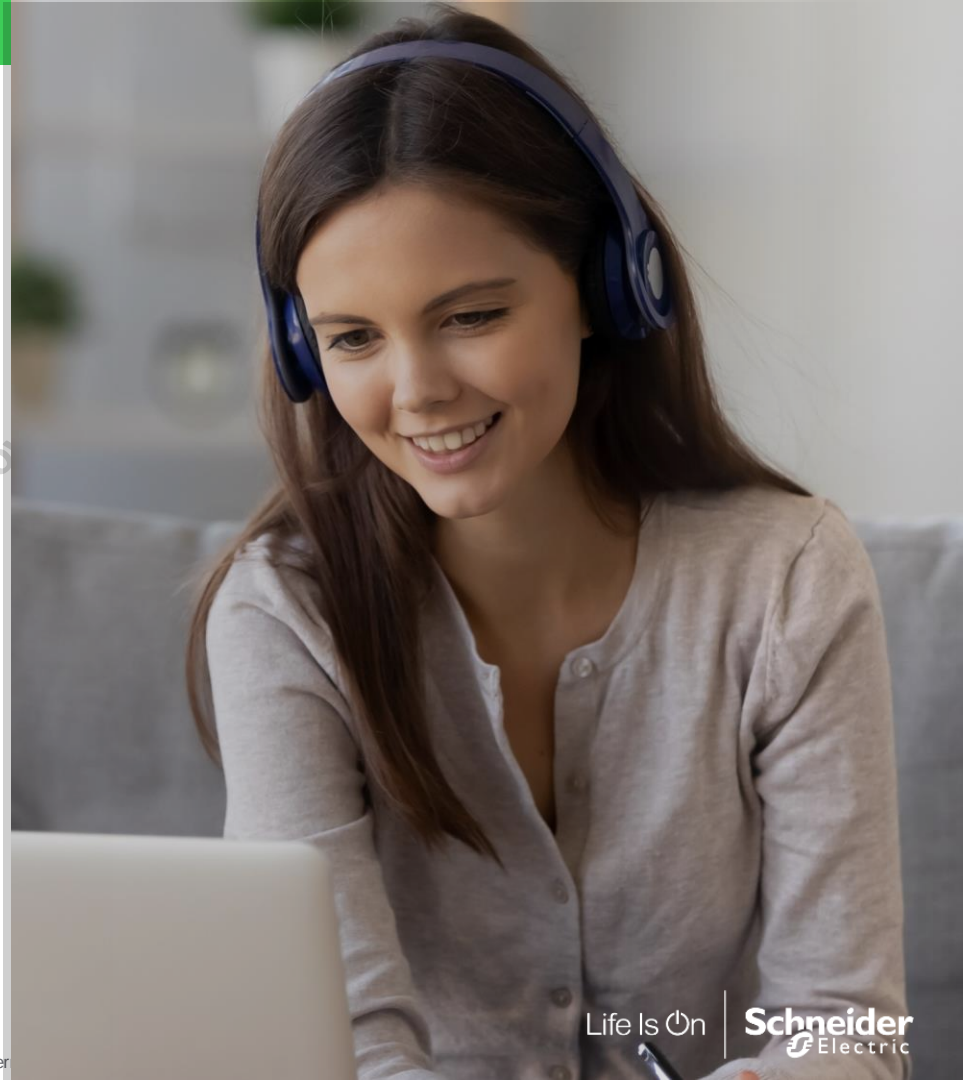
All attendees will receive an email a day after the webinar with instructions regarding the link to download your PDH certificate.

- **Speaker's contact**
  Feel free to reach out to the speaker by email should you have any questions

  Kevin.ragbasingh@ascopower.com

- **Brochures and Drawings are available at:**

ASCO Power Technologies - Official Web Site



Thank You!

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