Transfer Switches Made Easy: A Guide for Selecting Transfer Switches

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November 20th, 2019 11:00 PDT / 13:00 CDT
(1PDH issued by Cummins)
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The views and opinions expressed in this course shall not be considered the official position of any regulatory organization and shall not be considered to be, nor be relied upon as, a Formal Interpretation.

Participants are encouraged to refer to the entire text of all referenced documents. In addition, when in doubt, reach out to the Authority Having Jurisdiction.
Course Objectives:
A Guide for Selecting Transfer switches

After completing this course, participants will be able to:

- Understand the different variants of UL1008 transfer switches and know when to use them
- Have a list of basic selection criteria and step-by-step guide to help them with their transfer switch selection process
- Have a better understanding of some of the common pitfalls in ATS selection process and how to avoid them.
Power System Building Blocks

- Paralleling Generator Sets
- Switchgear
- Transfer Switches
- Digital Master
- Digital Cloud Solutions
- Grid
- Loads
What is a Transfer Switch?

- Monitors the availability and quality of two connect power sources
- Transfers power consumed by electrical loads connected to the transfer switch output between two sources based on source availability
Key Considerations When Selecting a Transfer Switch

- Switch type
- Transition type
- Application
- Grounding schemes
- Cable sizes and entry requirements
- Enclosures
- Voltage
- Current
- Fault current
- Selective coordination
- Type of load in the systems per Codes & Standards
Different Types of Transfer Switches

Automatic Transfer Switch

Controller

Load
Different Types of Transfer Switches

Automatic Transfer Switch

Non-Automatic Transfer Switch
Different Types of Transfer Switches

- **Automatic Transfer Switch**
  - Controller
  - Electrical Switch (Local or remote actuation)
  - Generator OCPD
  - Load

- **Non-Automatic Transfer Switch**
  - Electrical Switch (Local or remote actuation)
  - Generator OCPD
  - Load

- **Manual Transfer Switch**
  - Manual Handle (Local actuation only)
  - Generator OCPD
  - Load
Different Types of Transfer Switches

Service Entrance Rated Transfer Switch

Generator OCPD

Integrated Service Disconnect

Load

ATS
Different Types of Transfer Switches

Service Entrance Rated Transfer Switch

Bypass Isolation Transfer Switch

- MTS
- ATS
- Load
- G
- Integrated Service Disconnect
- Generator OCPD
- ATS
- Load
Transfer Switch Application

Utility to Generator
For facilities with a standby power system and a single utility feed
Transfer Switch Application

**Utility to Generator**
For facilities with a standby power system and a single utility feed

**Utility to Utility**
For use in facilities with redundant feeds but no standby generator
Transfer Switch Application

Utility to Generator
For facilities with a standby power system and a single utility feed

Utility to Utility
For use in facilities with redundant feeds but no standby generator

Generator to Generator
For facilities with a prime power system using multiple on-site generators
Transition Types

There are two ways to transition the loads:

1. **Open Transition**
   - “Break before make” transfer
   - Watch out: - Inductive load residual voltage decay rates

2. **Closed Transition**
   - “Make before break” transfer
   - Watch out: - Safeguards and extensive documentation required by utility may add cost and complexity

1.a. **Delayed Transition**
   - Adjustable neutral position delay
   - Flexible, simple, reliable
   - Best option for large motors
   - Step loading generators possible

1.b. **In-Phase Transition**
   - Based on synchronization of sources
   - “Fast” – typically 30ms – 50ms delay
   - Okay for resistive loads and small inductive loads
Two Position vs. Three Position Switches

2 Position
“Double Throw”

3 Position
“Neutral Position Delay”

Good choice for switches requiring:
- Delayed Transition
- Load shed – won’t transfer to “dead” source
Concept Check

Which transition types are not suitable for stored energy loads (large motors, MRIs)?

a) Open (In Phase)
b) Open (Delayed)
c) Closed
d) Both b) and c)
Concept Check

Which transition types are not suitable for stored energy loads (large motors, MRIs)?

a) Open (In Phase)

b) Open (Delayed)

c) Closed

d) Both b) and c)
Lets Get Grounded on 3 Pole vs. 4 Pole

• Choice depends on grounding scheme of the system
• NFPA70 (NEC) requires some systems to have ground fault protection (GFP)
• Complications and errors less likely by using 4 pole transfer switches
Enclosure Types and Selection Criteria

Choice based on: (1) Placement, (2) Environmental conditions

**Indoor**
- Dust
- Light/Indirect
- Splashing
- Ingress of solid foreign objects (Dust, fibers, etc.)

- NEMA Type 1
  - Not dust-tight

- NEMA Type 12
  - Knockout free

**Outdoor**
- Falling rain & ice formation
- Weather tight (weatherproof)
- Type 4 + corrosion resistance

- NEMA Type 3R
  - Not rain-tight
  - Not water-tight

- NEMA Type 4
  - Stainless steel is best

- NEMA Type 4X
Cable Size and Entry Requirements

• Detailed information is typically provided in transfer switch specification sheets and/or outline drawings

• Information to look for:
  • Cable entry
  • Lug options and capacities
    • Mechanical lugs or Compression lugs may be available
  • 90°C rated and accept copper or aluminum wire

Example: Snapshot of Cummins OTPCC ATS Outline Drawing – Type 1 Enclosure
Voltage Selection

- Transfer Switches designed to have two unsynchronized power sources connected to it
- A well designed UL transfer switch will provide adequate spacing and insulation to cope with the increased voltage stress.
- Typical AC Voltages: 120, 208, 240, 480, 600 volts, single or three phase, 50/60Hz
Current Rating Selection

- Switches are rated for continuous current → hold maximum value for three hours or more.
- Typically capable of carrying 100% of the rated current at an ambient temperature of 40° C
- Typically, the most commonly used ampere ratings range from 40 to 4000 amperes.
- Switch frame size will dictate the current rating range and WCR Ratings
- Service Entrance Rated Transfer Switches may be rated at 80%
- Anticipate future load requirements during the planning process - select a transfer switch with a continuous current rating equal to the total of the anticipated load
Overcurrent Protection

- A fault downstream of the transfer switch will result in a short circuit current flowing through the transfer switch.
- High level of fault currents will cause the following stresses on the transfer switch:
  - Thermal
  - Magnetic
- Transfer switch must be provided with overcurrent protection devices (OCPD) on both sources.
- Available fault current needs to be determined.
- Withstand and close rating of the transfer switch must matched to the available fault current.

Diagram:
- Overcurrent Protection
- OCPD
- Short circuit
- G
Selective Coordination Challenges from ATS Perspective

Selective Coordination is required for emergency, legally required standby and critical operations power systems circuits
- **NEC-2017, 700.32, 701.27, and 708.54** “…over-current devices shall be selectively coordinated…”

- Selective coordination will require time delays to be set on OCPDs
  - In the example shown, A must trip after B → Time delay on A
- Time delay setting of OCPD A will depend on the available fault current from either source & the device B trip curve characteristic
- For the duration of the OCPD A time delay, the ATS must be able to:
  - Withstand the fault
  - Close into the fault
- Transfer switches manufacturer will publish a Withstand and Close rating
UL 1008 Short Circuit Ratings

- UL 1008 requires all ATS to have a withstand and closing rating (WCR)

- Rating can either be time based or specific OCPD (breaker/fuse) based

- OCPD based ratings allow for higher WCR ratings but requires the ATS to be protected by a “listed” breaker or fuse

- Allowing for either time based or specific breaker based ratings enables flexibility for a cost effective design

<table>
<thead>
<tr>
<th></th>
<th>Breaker Rating</th>
<th>Time Duration Rating (0.05s/3cycle)</th>
<th>Short time Rating (0.5s/30 cycle)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuse/Current Limiting breaker</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

OCPD devices allowed are Listed by transfer switch manufacturer

Ease of Selective Coordination: Decrease in WCR rating, Increase in trip time
Several Short Circuit Ratings are available at each amp node

Specific overcurrent device ratings are substantially higher than time based ratings

- As high as 200,000 amps with current limiting breakers and fuses

<table>
<thead>
<tr>
<th>Amps</th>
<th>AT Model</th>
<th>Bypass Model</th>
<th>Fuse protection</th>
<th>Specific Breaker Protection (Common)</th>
<th>Specific Breaker Protection (General)</th>
<th>Time Based Ratings</th>
<th>Short Time Ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Max Fuse, Size and type</td>
<td>WCR @ Volts</td>
<td>WCR @ Volts</td>
<td>WCR @ Volts</td>
<td>Time (sec)</td>
</tr>
<tr>
<td>260</td>
<td>OTEC, OTPC</td>
<td>BTPC</td>
<td>600 A Class J, RK1, RK5 or 1200 A Class L, T</td>
<td>200,000</td>
<td>200,000</td>
<td>125,000</td>
<td>100,000</td>
</tr>
<tr>
<td></td>
<td>CHPC, CHPC</td>
<td></td>
<td>400 A Class J or T or 200 A Class RK1 or 100 A Class RK5</td>
<td>200,000</td>
<td>200,000</td>
<td>200,000</td>
<td>200,000</td>
</tr>
<tr>
<td>300</td>
<td>OTEC, OTPC</td>
<td>BTPC</td>
<td>600 A Class J, RK1, RK5 or 1200 A Class L, T</td>
<td>200,000</td>
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<td>100,000</td>
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</table>
UL1008 Listing and Operation

Emergency, Legally Required, Critical Operation Power (NFPA70 – 700/701/708)
- Require UL1008 WPWR - Automatic Transfer Switches for Use in Emergency Systems
- Automatic or Bypass Isolation
- Manual/Non-Automatic not permitted

Optional Standby (NFPA70 – 702)
- Requires UL1008 WPXT- Automatic Transfer Switches for Use in Optional Standby Systems
- Automatic or bypass isolation
- Manual/Non-Automatic permitted

Healthcare (NFPA70 – 517/NFPA99/OSHPD)
- Require UL1008 WPWR - Automatic Transfer Switches for Use in Emergency Systems
- Automatic or Bypass Isolation
- While not specifically required by code in all jurisdictions, it may be advantageous to ensure ATSs are equipped with bypass/isolation capabilities.
- Health care facilities in California, governed by Office of Statewide Health Planning and Development (OSHPD) mandate the use of Bypass Isolation switches in certain systems
Concept Check

Non-automatic transfer switches are permitted for Emergency Systems, True or False

a) True
b) False
Concept Check

Non-automatic transfer switches are permitted for Emergency Systems, True or False?

a) True
b) False
Example of Typical System

# System Parameters → ATS Specification

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPSS 1 – Healthcare Emergency System</td>
<td>Switch Type – Bypass Isolation</td>
</tr>
<tr>
<td>Environmentally controlled, indoor installation</td>
<td>UL1008 Listing - Emergency System</td>
</tr>
<tr>
<td>NFPA110 – 1 sec time delay required</td>
<td>Application – Utility to Generator</td>
</tr>
<tr>
<td>Voltage – 277/480V, 3 Phase, 60Hz</td>
<td>Transition Type – Open transition, delayed</td>
</tr>
<tr>
<td>Service disconnect is available upstream</td>
<td>Voltage – 277/480V, 3 Phase, 60Hz</td>
</tr>
<tr>
<td>GFP is required</td>
<td>Current Rating – 600A</td>
</tr>
<tr>
<td>Consists of HVAC load</td>
<td>4 Pole ATS</td>
</tr>
<tr>
<td>Load current – 450A</td>
<td>NEMA Type 1 Enclosure</td>
</tr>
<tr>
<td>Available fault current – 35,000 Amps</td>
<td></td>
</tr>
<tr>
<td>Selective coordination is required with downstream MCCB breaker</td>
<td></td>
</tr>
</tbody>
</table>
Match Available Fault Current to Transfer Switch WCR Ratings

Available fault current < Selected WCR Rating?
  - Available fault current = 35,000 at 480V
  - MCCB Based WCR = 65,000 at 480V
  - Remember to check approved breaker list published by the manufacturer and select breaker based on selective coordination needs

UL withstand and closing ratings

The transfer switches listed below must be protected by circuit breakers or fuses. Referenced drawings include detailed listings of specific breakers or fuse types that must be used with the respective transfer switches. Consult with your distributor/dealer to obtain the necessary drawings. Withstand and Closing Ratings (WCR) are stated in symmetrical RMS amperes.
Summary

Transfer Switches Made Easy: A Guide for Selecting Transfer switches

• We talked about the different variants of UL1008 transfer switches
• We went over a list of basic selection criteria and step-by-step guide to help them with their transfer switch selection process
• We talked about how some common application issues can be avoided by specifying the right type of transfer switch

Key Takeaway:

When it comes to selecting the right transfer switch for a facility, engineers need to sort through a wide array of product features such as transfer switch types, operation modes, ratings, etc. Furthermore, each installation may have many variables that need to be accounted for. The content in this course covers some key criteria that may help you get started. However, to build your expertise, I recommend you dig deeper into each of the topics covered.
Additional Resources

Cummins White Papers

• Transfer switch set up for reliability and efficiency, parts 1, 2 & 3
• UL 1008 Withstand and Close on Ratings
• Grounding of AC generators and switching the neutral in emergency and standby power systems, part one & part 2

Cummins On-Demand Webinars

• Transfer Switch Operation and Application
• UL 1008 ATS Withstand and Close On Ratings

Cummins Application Manual

• Transfer Switch Application Manual, T-011
Q&A

Type your questions, comments, feedback in the WebEx Q&A box. We will get to as many questions as we can.

We will publish consolidated FAQ along with presentation and webinar recording on powersuite.cummins.com

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