

Protection of Automatic Transfer Switches

The desire for facilities to have continuous, reliable power has led to the use of various types of generator and transfer switch combinations. The purpose of the automatic transfer switch (ATS) is to automatically start the generator and switch from the utility power feed to the power feed from the generator when the normal utility power fails. In order to complete this task, the ATS is equipped with electronic circuits that monitor the utility feed, control the starting mechanism of the generator and control the switch that transfers the power source from the utility feed to generator feed. Further, when the utility feed comes back on-line and is stable, the ATS transfers the load back to the utility feed.

Due to the electronics involved in the ATS, the ATS is susceptible to the surge environment that is common at the service equipment (service entrance location) where the ATS is installed. Surges from the utility feed due to lightning, load switching, etc. can be detrimental to the operation of or can destroy the ATS rendering the system useless. Also, when the generator starts up, the voltage might not yet be stabilized at the instant the ATS makes the transfer. This initial surge of not yet regulated power can damage electronic systems.

One technology available that aid in correcting these issues is **surge protective devices (SPDs)**. This application note focuses on applying SPDs to an ATS system to mitigate the damage that can occur due to the expected surge environment.

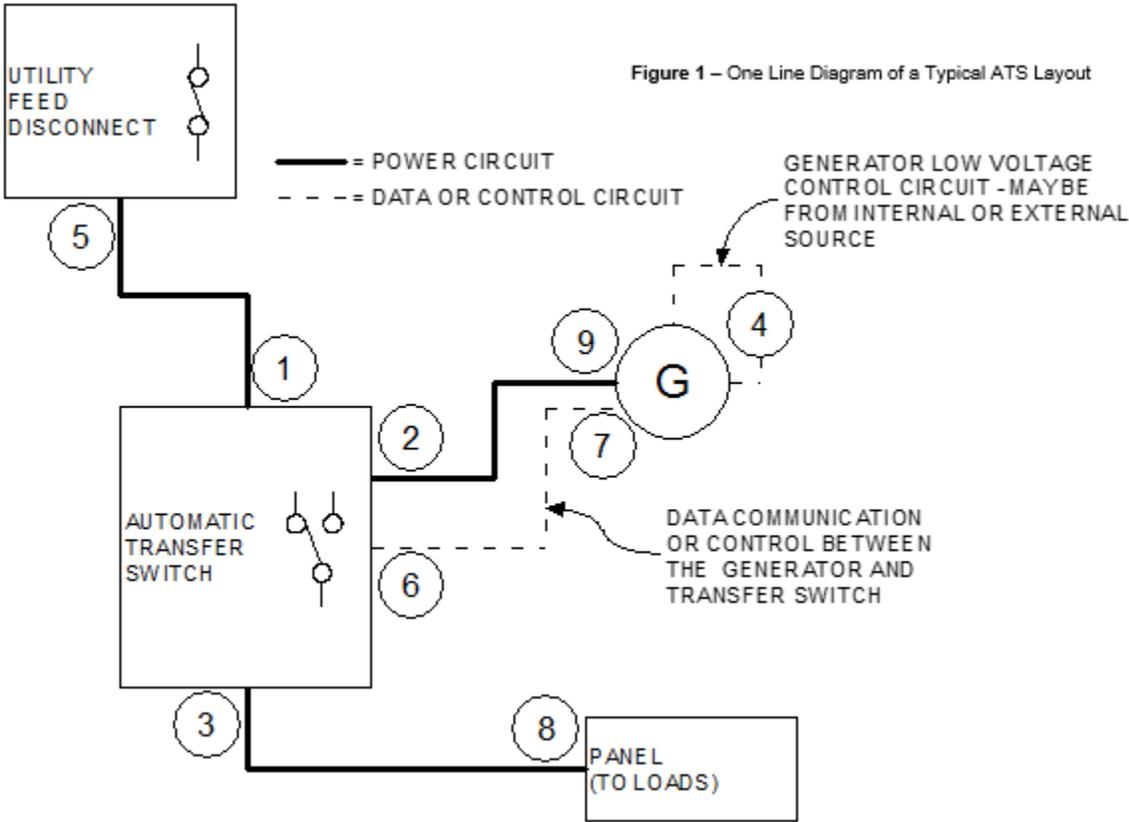


Figure 2 – An example of an ATS circuit board that burned from electrical surge.



Application of SPDs

To aid in the description of the application of SPDs to an ATS system, please refer to Figure 1.

This figure illustrates a typical ATS layout. The incoming power system configuration can vary greatly. As noted, there are a number of opportunities for protecting the typical ATS system – each are labeled with a circled number and are described below.

- 1 **Utility Feed to the ATS.** Protecting the input of the ATS is a necessary step in protecting the backup power system. Providing protection at this location prevents surge damage due to events propagated on the electrical system from upstream sources such as lightning and switching surges created by the utility system operation.

Electronic circuitry is often included on the utility side of an ATS. These circuits require protection to ensure proper operation of the ATS. At this location, a parallel connected Type 1 or Type 2 SPD with protection from lightning induced surges and switching surges (ring waves) should be applied. Note: If the system is being equipped and certified with a Lightning Protection System, the Nominal Discharge Current Rating (I_n) of this SPD will be required to be 20 kA unless location 5 is equipped with a suitable SPD.

- 2 **Generator Input to the ATS.** Protecting the generator input to the ATS is also of great importance. This is especially true when the distance between the generator and the ATS is greater than 10 m (or approximately 30 feet) or has external or exposed wiring. In these cases, the ATS is unprotected to direct lightning strikes to the wiring between the ATS and generator and to near-by strikes to the ground or structures near the wiring.

Again, due to the electronic nature of most ATS systems, a parallel connected Type 1 or Type 2 SPD with protection from lightning induced surges and switching surges (ring waves) should be



applied. Protection against ring wave surges is recommended for this location due to the presence of switching transients or ringing transients that are often propagate between the generator and the ATS.

- 3 **ATS Output.** Protecting the immediate ATS output is highly recommended. The wiring on the output of the ATS is often routed outdoors and is, therefore, exposed to direct lightning strikes to the wiring between the ATS and loads or is exposed to near-by strikes to the ground or structures near the wiring.

Due to the electronic nature of most ATS systems, a parallel connected Type 1 or Type 2 SPD with protection from lightning induced surges and switching surges (ring waves) should be applied. Protection against ring wave surges is recommended for this location due to the presence of switching transients or ringing transients that are often propagate between the ATS and the loads connected to the output of the ATS.

- 4 **Generator Low-Voltage Control Circuit.** Protecting the generator low-voltage control circuit is an essential step in protecting the ATS system. This circuit is used to initiate generator startup when the utility power is absent as well as shut down after utility power returns. This circuit is usually 12-24 VDC (confirm the voltage and configuration). Providing protection at this location prevents surge damage to the control circuitry that starts the generator. Without this function, the ATS will not start the generator. If the distance between the ATS and the generator is greater than 10 m (or approximately 30 feet) or has external wiring, an SPD is recommended also at location 6 to prevent surge voltages from accessing the ATS electronics.

At this location, a series connected, Type 1 or Type 2 SPD with protection against both impulse and ringing surges is recommended. These circuits are often low-voltage DC circuits and/or could be fed by another source.

- 5 **Utility Feed Disconnect.** Protecting the utility feed disconnect is a recommended step in protecting the ATS when the disconnect is present in the system. Providing protection at this location creates a layered protection approach. With this approach the SPD on the utility feed disconnect mitigates the largest portion of incoming surges and limits the exposure of the SPD protecting the ATS utility input. The result is that the voltage to which the ATS is exposed is reduced which lessens the chance of failure or disruption of the ATS system. The need for protection at this location is emphasized if the distance between the utility feed disconnect and ATS is greater than 10 m (or approximately 30 feet) or has external wiring.

At this location, a parallel connected, Type 1 or Type 2 SPD is recommended. Note: If the system is being equipped and certified with a Lightning Protection System, the Nominal Discharge Current Rating (I_n) of this SPD will be required to be 20 kA.

- 6 **Data/Control between the ATS and Generator.** Some ATS systems are equipped with communication or control circuits that allow feedback from the ATS to the generator and vice-versa. These circuits can also be used to provide operational status information to operation centers often found in larger facilities. Protection at these locations is critical when this function is present in the system. This is further emphasized if the distance between the ATS and generator is greater than 10 m (or approximately 30 feet) or has external wiring. Often a remote annunciator panel will be used at a distant location that can replicate the data shown
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on the annunciator panel on the generator. This can require anywhere from four to eight 12-24 VDC circuits. In these cases, these lines are exposed to direct and near-by lightning events.

Selecting an SPD for these locations will depend upon the type of circuit used for communication or control. If these are powered circuits, a series connected, Type 1 or Type 2 SPD with protection against lightning induced surges and ring wave surges is recommended. If these are data or communication circuits, then a data-line device is recommended. Typically, data communications for this type of circuit would be relatively low speed (< 2 Mbps).

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ATS Feed to Loads. Protecting the input of the panel is a critical step in protecting the loads of the power system. Providing protection at this location provides a layered approach for the loads being protected. Although, this location is outside the scope of the ATS system, it is not any less important. Protection at this location is even more critical when the distance between the ATS and the loads is greater than 10 m (or approximately 30 feet) or has external wiring. In these cases, these lines are exposed to direct and nearby lightning events.

Selecting an SPD for this location depends on the types of loads being protected. If the loads are electronic in nature, it is recommended to use a parallel connected, Type 1 or Type 2 SPD with protection against both lightning induced surges and ring wave surges. If the loads are less critical or less susceptible to surges, then a parallel connected, Type 1 or Type 2 SPD with protection against lightning induced surges might be considered.

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Generator AC Power. Protecting the input of the generator is an essential step in providing protection for the ATS system, especially when the distance between the ATS and generator is greater than 10 m (or approximately 30 feet) or has external wiring. The goal of providing protection at this location is to protect the output windings of the generator. In addition, an electrical circuit might run from a separate building power source (normally from an emergency power panel) to the generator to power a battery charger.

At this location, a parallel connected, Type 1 or Type 2 SPD with protection against lightning induced surges is recommended. A series connected Type 1 or Type 2 SPD with protection against lightning induced surges can also be used, depending on the load current level.

Figure 3 – An example of SPD at Utility Feed Disconnect



Summary

Number/ Location	Need for Protection	Type	Notes
1 – ATS Utility Input	Critical	Parallel connected, Type 1 or Type 2 w/ with protection from lightning induced surges and switching surges (ring waves)	ATS is electronic in nature and is susceptible to surges
2 – ATS Generator Input			
3 – ATS Load Output			
4 – Generator LV Control		Series connected, Type 1 or Type 2 w/ with protection from lightning induced surges and switching surges (ring waves)	Typically low-voltage DC circuits
5 – Utility Feed Disconnect	Recommended, if present	Parallel connected, Type 1 or Type 2 w/ with protection from lightning induced surges	Provides layered approach, less stress at #1 specifically when the distance from #5 to #1 is large
6 – Data/Control to ATS	Critical, if present	Series connected, Type 1 or Type 2 w/ with protection from lightning induced surges and switching surges (ring waves) or Series connected Data/Telecom – depending on configuration	Control and Data lines are highly susceptible to induced surges, propagate surges easily
7 – Data/Control from Generator			
8 – Panel (loads)	Critical/Recommended	Parallel connected, Type 1 or Type 2 w/ with protection from lightning induced surges and/or switching surges (ring waves)	Critical when the distance between #3 and #8 is large. Recommended to provide a layered approach and to protect all loads at this point.
9 – Generator AC Power Circuits	Critical/Recommended	Parallel or series connected, Type 1 or Type 2 w/ with protection from lightning induced surges	Critical when the distance between #2 and #9 is large. Recommended to protect output windings of the generator.

Reference:

NEMA ATS Protection Note – Protection of Automatic Transfer Switches Using Surge Protective Devices (SPDs)

NEMA – National Electrical Manufacturers Association