

DC Power Distribution Modules

Scope

- E-Plex DC Distribution Modules – 330WM, 325QMM, 326DNL, 349PDM, 366HMM, 407QHM, 411BAM, 413DWM, 422QMM, 425DRM, 436MMX

Overview

- E-Plex DC distribution modules, like any piece of electronic equipment, are subject to failure if:

1. Misapplied
2. Mishandled; or
3. Subjected to electrical conditions that exceed the electrical ratings of the product.

When energized, and actively distributing DC power, a module failure is of serious concern. E-Plex DC distribution modules include design elements intended to mitigate many of the failures and resulting risks of these three conditions. However, these design elements can be overcome and modules can fail.

DEPENDING ON THE SEVERITY OF THE DAMAGE TO THE MODULE, A FIRE OR ELECTROCUTION HAZARD CAN BE CREATED.

The intent of this bulletin is to:

- Educate the E-Plex user concerning the risks associated with mishandling and misapplication so as to mitigate the risk of a failure and the hazards that could arise.
- Introduce newly developed, supplemental, external protection that can be used in conjunction with E-Plex modules so as to mitigate the risk of failure.

Headlines

- Field history and recent analysis confirm E-Plex modules are performing to their design specifications and meet published specs. Thousands have been deployed and the product has a strong track-record. The product is safe and reliable if used properly.
- Mishandling & misapplication can destroy the modules and create a hazardous condition that is preventable.
The risk resulting from mishandling and misapplication can be mitigated via education and rigorous system validation.
- In addition, external surge protection modules can be applied to potentially mitigate hazards which can result from mishandling or misapplication.
- The specific, physical distribution of DC distribution modules in an application has a direct correlation to the total energy to which the module will be exposed in a fault condition. Additional, external surge suppression in the form of the 476SS module is recommended whenever a DC distribution module is more than 50 feet from the battery bank. Or, in the case of the 407QHM, more than 25 feet from the battery bank. Or, in the case of the 366HMM with 2 outputs paralleled, more than 25 feet from the battery bank.
- Natural phenomenon such as lightning can create faults that are impossible to predict and are impossible to totally protect against. A new E-Plex system-level, master disconnect module (473EID) will be introduced in the very near future. This module is designed to mitigate potential hazards resulting from a lightning strike or other product failures.

Misapplication

During the design process, misapplication of E-Plex DC Distribution modules creates risk as the module can be exposed to conditions they were not designed to handle.

Examples include:

Driving loads that have more inductance and amperage than the module's rating. When closing certain DC circuits, the inductance of the circuit causes E-Plex modules to be subjected to a high voltage surge. High voltage surge is managed in the module via board-level surge suppression components. These components can perform reliably and well for the life of the module. However, if the module is exposed to high voltage surges far in excess of its published specification, the suppression component will fail. This failure allows the voltage across the solid state switch to exceed 40 volts and switch damage will occur. Such damage can cause arcing; carbon bridging or short circuits that overcome the safety features integrated into the module and could, in some cases, create a catastrophic failure and hazard.

Immediate Action – A careful analysis of all loads driven by E-Plex modules must be performed to ensure that product specs are not being exceeded. Attached to this bulletin (Validation checklist) please find a validation checklist document that provides an outline of how an analysis can be performed.

Mishandling & Miswiring

During the installation process, mishandling & miswiring of E-Plex DC Distribution modules create risk as the module can be exposed to conditions they were not designed to handle. Examples include:

1. Connecting the power to the module backwards while the output is shorted out.

Immediate Action - User needs to place diodes in series with the load so this condition can not occur or use module with the diode built in (i.e., 413DWM).

2. Connecting 120 VAC to the low voltage E-Plex data bus. All E-Plex modules use a low-voltage (DC) communication protocol. These communication wires can not be connected to high voltage DC or AC power. The communication electronics within the module can not survive this condition.

Immediate Action - Care must be taken never to connect E-Plex data bus wires to AC power

3. Reverse battery potential. A fault condition will exist when the module output is being used as an input and the said input is switched to the battery negative and the battery is reversed.

An example of this type of fault is when the output of a 366HMM is used to detect the park sense on a windshield wiper. Under normal operation the park sense alternates from battery + to battery - when the wiper is operating. The park sense will create an intermittent short circuit during a reverse battery condition. This is due to the fact that all outputs are on regardless of whether they are being used as an input. Over time the module's PCB traces become hot and could start a fire.

Immediate Action - Designs should be evaluated to see if there are any inputs that are switched to battery. If there is a risk of this condition it is recommended that a 1 Kohm, 1 Watt resistor is installed between the output of the module and the park sense switch or switch to the battery.

A Supplemental Level of Protection

Because misapplication or mishandling of E-Plex modules can occur, a new surge suppression module (476SS) has been developed. This module utilizes a traditional diode array to provide supplemental surge suppression to an E-Plex network. If there is risk of mishandling or misapplication, this module, when properly deployed, can provide supplemental protection. However, misapplication and mishandling must be avoided as the 476SS module is a supplemental level of protection only. It can not protect against all forms of potential misapplication or mishandling.

The specific, physical distribution of DC distribution modules in an application has a direct correlation to the total energy the module will be exposed to in a fault condition. E-Plex DC modules located greater than 50' from a 12VDC or 24VDC battery bank warrant special attention. Higher inductance of the battery cable creates the potential for the module to be exposed to high levels of energy during a fault condition. Therefore, the consequences of mishandling or misapplication are potentially more severe.

Additional, external surge suppression in the form of the 476SS module is recommended whenever a DC distribution module is more than 50 feet from the battery bank. Or, in the case of the 407QHM and 366HMM with 2 outputs paralleled is more than 25 feet from the battery bank.

Supplemental external surge suppression is recommended for applications that meet the following conditions:

- Any DC distribution module mounted more than 50' away from the bank to which they are connected
- Any 366HMM module with 2 output channels paralleled mounted more than 25' away from the bank to which they are connected
- Any 407QHM module mounted more than 25' away from the bank to which they are connected

Visit the Sensata web site and this URL to learn more about the 476SS module

<http://eplex.sensata.com/products/476SS/>

Mishandling & Misapplication Summary

1. Mishandling and misapplication is preventable. Published data on all E-Plex modules must be carefully reviewed and the specification limits of the product can not be exceeded.
2. It is critically important that a clear understanding of the electrical characteristics of each load controlled by an E-Plex module be understood. Validate all loads to confirm they do not exceed the published rating of the module is critical and the attached validation checklist can serve as a guide:
<http://eplex.sensata.com/technotes/valtestplan.pdf>
3. The new 476SS module has been introduced to provide supplemental surge protection and can be deployed to mitigate, in part, risks of a mishandling or misapplication.
4. The risk of failure and/or creation of a hazard are potentially impacted by the location of an E-Plex module on the main power bus. The farther from the battery the greater the cable inductance and the greater the potential risk. The 476SS is recommend any time a DC module is greater than 50' from the battery bank or the 407QHM or 366HMM with two outputs paralleled is greater than 25' from the battery bank.

Lightning Strikes

Lightning strikes are an unpredictable natural phenomenon that can subject E-Plex modules, or any other piece of equipment, to a tremendous amount of energy. It is impossible to fully predict the amount of energy that a lightning strike can generate and it is therefore impossible to fully protect against it.

Even a nearby lightning strike has the potential of creating an electrical coupling between the lightning bolt and a leg of an E-Plex module. Such events generate a high voltage surge that can destroy electronic components and cause a cascade of failures within an E-Plex module.

A lightning event will almost certainly cause product failure and expose the product to electrical conditions that exceed its specification. Because these events are possible, and to provide a measure of protection, additional overall system protection is recommended. The upcoming Electronic Intelligent Disconnect (473EID) module is being developed to serve as a master disconnect switch for an E-Plex network. This module utilizes a traditional circuit breaker, solid state switch and a supervisor processor.

The module monitors voltage and current on the main power bus so as to detect over voltage and over current events. 473EID will work by monitoring the battery charger / alternator and disconnecting them if the voltage goes above 32 volt for more than 5 milliseconds. This mitigates the potential of damage to the rest of the modules electronics should a voltage regulator fail in the initial surge.

The 473EID will not be intended to protect E-Plex modules from lightning strikes. It should be assumed that an E-Plex module exposed to a lightning strike will fail. However, the 473EID can mitigate, in part, potential hazards that arise from the failure. The 473EID is designed to sense an electrical anomaly and disconnect E-Plex power distribution modules from the battery. This helps ensure that any module that may have been damaged or destroyed by the strike is no longer connected to power. This mitigates the risk that a damaged or destroyed module can continue to draw power and potentially create a hazard.

The 473EID is also designed to monitor the system current and trip quickly when a maximum over current condition exists. This could occur if/when an after market user adds an additional device to the power bus and uses traditional circuit protection.

Visit the Sensata web site and this URL to learn more about this module:

<http://eplex.sensata.com/products/473EID/>

Summary & Recommendations

Field history and recent analysis confirm E-Plex modules are performing to their design specifications and meets published specs. The product is safe and reliable if used properly and has a strong track-record. Thousands have been deployed successfully. However:

- Mishandling can destroy the modules and create a hazard. These failures and any resulting hazard are preventable.
- Misapplication can destroy the modules and create a hazard. These failures and any resulting hazard are preventable and can be mitigated via rigorous system validation
- Natural phenomenon such as lightning strikes need to be considered

All customers should perform a DFMEA of all possible fault conditions and assign risk priority number (RPN)

- Mishandling
- Misapplication
- Natural phenomenon

The 476SS & 473EID are new modules that have been developed and can be deployed to mitigate, at least in part, potential conditions that have high RPNs. These modules are not a substitute for proper handling or application. However, all customers should become familiar with these modules as they represent another level of possible protection if there is a high risk of these conditions occurring.

Following the design process, and once a full system is brought on-line, a rigorous system validation should be performed. The attached validation checklist can serve as a guide.

All E-Plex DC modules located greater than 50' (or 25' in the case of the 407QHM or 366HMM with two outputs paralleled) from a 12VDC or 24VDC battery bank warrant special attention. Higher inductance of the battery cable creates the potential for the module to be exposed to high levels of energy. Therefore, the consequences of mishandling or misapplication are potentially more severe. It is recommended that applications that meet these conditions utilize the 476SS module.