

ELECTRICAL & POWER



PLUG-IN CIRCUIT BREAKER PANEL

Safran Electrical & Power's New Plug-In Circuit Breaker Panel Offers Weight Savings, Flexible Configurations, Enhanced Thermal Efficiency and Ease of Maintenance

Safran Electrical & Power's new patent pending plug-in circuit breaker panel was developed for a broad range of aerospace applications and replaces the bulky labor intensive conventional circuit breaker panels. The result is an easy to maintain approach that offers significant weight savings, enhanced thermal efficiency and a readily customizable approach to circuit protection.

Safran Electrical & Power modified its standard and Arc-Fault circuit breaker portfolio to support a socket and pin mounting scheme; that allows individual circuit breakers to be installed or replaced without mounting hardware, wiring, exposed buss work, or specialized tools.

The technology is similar to small plug in type relays or connectors and the circuit breakers mount directly on an engineered thermal matrix that makes the electrical connections without exposed wiring terminations or the need for tedious mounting hardware.

The new design eliminates traditional exposed internal point-to-point wiring, embeds the traditional buss work, and is readily modifiable without wire routing, buss work or mounting concerns.

- Significantly reduces behind the panel depth. Virtual wireless design, eliminates wire looms, busses, and mounting hardware.
- 30% to 40% weight savings compared to conventional panels.
- Operates 40°C cooler compared to conventional panels.
- Easier to install and maintain, with higher reliability.
- Integrated panel lighting options.
- Options for breaker status monitoring and reporting.



ELECTRICAL & POWER



SWITCHES, RELAYS, CIRCUIT BREAKERS & POWER DISTRIBUTION UNITS

Safran Electrical & Power is a world leader in electrical power generation and distribution systems.

By acquiring the Sarasota power management and distribution business, Safran Electrical & Power has added a major asset to its power portfolio along with decades of experience.

Since the 1970's, the Sarasota facility has been providing customers with the best of high performance, mission-critical, power distribution and management components and subsystems.

Covering aerospace, commercial, military, and industrial markets, Safran Electrical & Power is recognized as a leader in innovative reliable power solutions.

Safran Electrical & Power is the only supplier that manufactures both aerospace contactors and circuit breakers in the United States.

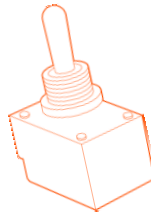


RCCB

- Qualified to demanding performance parameters of MIL-PRF-83383
- More efficient power distribution solution
- Promotes cost and weight savings through the elimination of long runs of cables
- Removes the presence of large circuit breakers from the cockpit

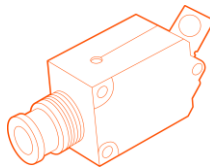
SWITCHES

- EMI/RFI Shielded Pushbutton Switches
- Environmentally Sealed Switches
- Miniature Switches
- Precision Snap Action Switches
- Pushbutton Switches
- Rocker Switches
- Switch Guards & Shields
- Toggle Switches
- Wire Terminal Systems (IWTS)



CIRCUIT BREAKERS

- Auxiliary Terminal
- Fast-Trip (Load Protection)
- High Vibration
- Hot-wire
- Indicator Control Unit (ICU)
- Long Button
- Military Approved Devices
- Random Vibration
- Remote Controlled
- Single Phase
- Temperature Compensated
- Three Phase



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RELAYS

- Remote Controlled Circuit Breakers
- Power Relays
- Hermetically Sealed Power Relays
- Lightweight Relays
- Generator Contactors
- Custom Flat Packs

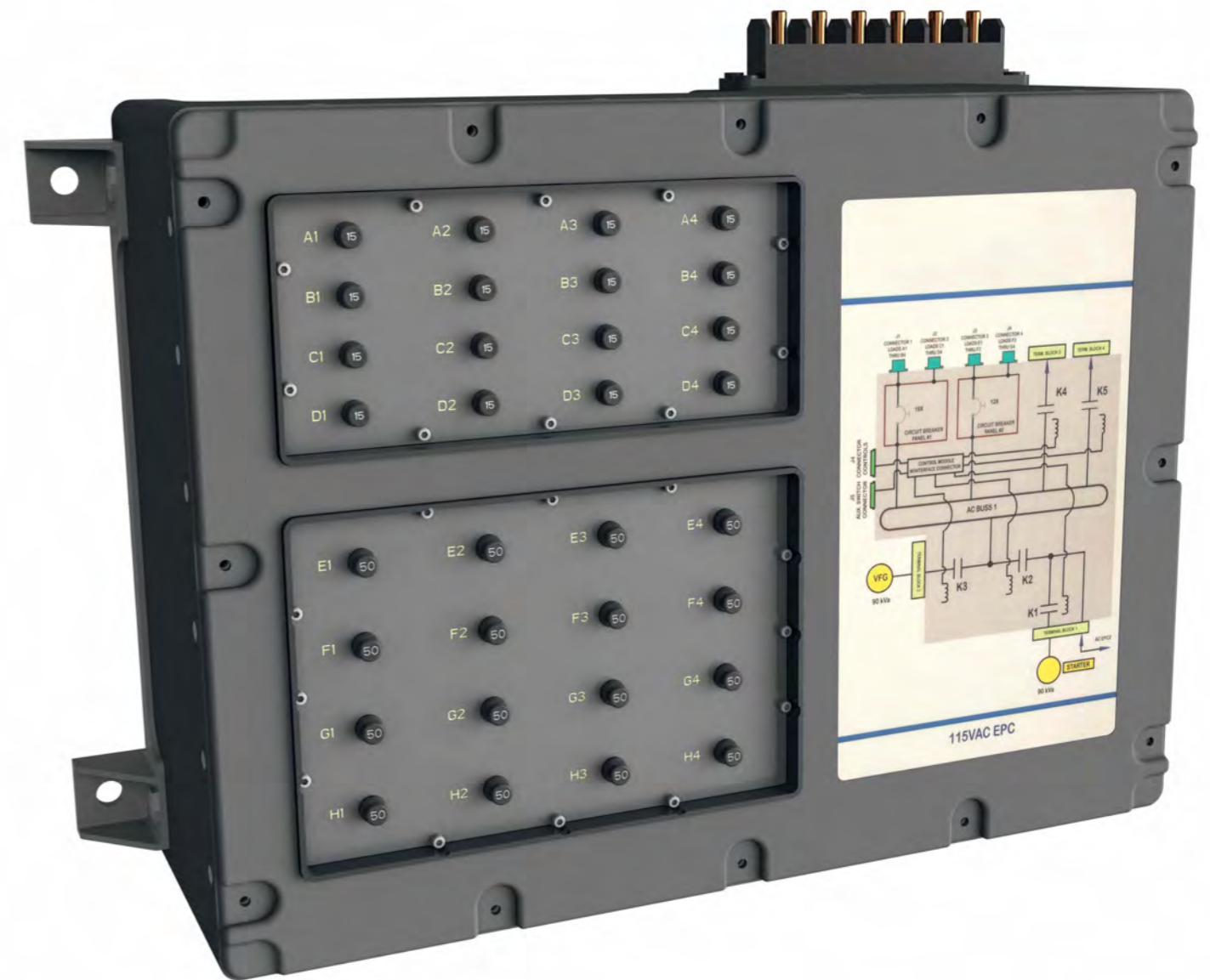
POWER DISTRIBUTION UNITS

- Superior design capabilities
- Reduced weight and size
- Reduced maintenance
- Reduced mission adaptability

INNOVATIVE INTEGRATION SOLUTIONS

- Diverse portfolio of power & load management products
- 28VDC, 115VAC, and HVDC power and load switching
- Remote control circuit breakers
- Ability to integrate arc fault technology into systems, relays and CB's
- Innovative error free design
- Integrated thermal management techniques
- Robust packaging for all environments (Military, Aerospace, Industrial)
- Over 20 years of experience with composite assemblies

ADVANCED POWER DISTRIBUTION UNIT



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Safran Electrical & Power Advanced Power Distribution Unit: A Breakthrough in Efficiency, Weight Savings, Reliability and Maintainability

Safran Electrical & Power's advanced power distribution unit (APDU) is the next-generation solution for power generation and distribution. The innovative "error free" design eliminates workmanship issues, improves thermal efficiency, reduces weight, and significantly enhances maintainability. It is an efficient use of space, lighter weight, and the next level in aerospace design.

The innovative design of Safran Electrical & Power's APDU is a result of addressing numerous application challenges over the years. By efficiently integrating proven relay, contactor and circuit breaker products into a single-line replaceable assembly, Safran Electrical & Power has developed a customizable power module. The APDU uses innovative and patented building blocks, developed by Safran Electrical & Power, that significantly reduce overall system weight and improve system-level reliability and maintainability.

Additional advantages include ease of installation and accessibility, lower on-aircraft test time, and reduced overall aircraft build time, since the Safran Electrical & Power's PDUs support both current and evolving higher power architectures.

Safran Electrical & Power has been using composite structures in aircraft power distribution units for reduced weight and thermal optimization since the early 1990's. These approaches have been supplemented in the APDU by the integration of Safran Electrical & Power's pioneering plug-in circuit breaker panels. Safran Electrical & Power's ability to readily modify standard thermal and arc-fault circuit breakers into a socket-and-pin mounting scheme allows individual protective devices to be installed, interchanged, or replaced from the front of the panel. This scalable design uses no panel mounting hardware, terminal hardware, visible wiring runs, or exposed bus work. With only a single tool, a circuit breaker can be removed or a new one added in minutes.

The new design also eliminates point-to-point wiring by embedding the current bus work within a proprietary engineered material that is thermally conductive and electrically insulative. This innovation eliminates assembly errors, reduces potential maintenance-induced wiring damage, protects from Foreign Object Damage intrusion, moderates thermal hot spots, and lowers operating temperatures. This also allows for current carrying elements to be optimized for weight and power dissipation and route primary heat sources outside the assembly.

Safran Electrical & Power's commercial relay portfolio includes more than 1,000 different relays and contactors for 28VDC, 115VAC, and HVDC applications. Current sensing, arc-fault detection, and lightweight generator contactors are all well adapted for customized power distribution units using the integrated APDU design approach. Safran Electrical & Power's new product developments in high-voltage DC contactors, variable frequency AC, and "smart" contactors with advanced control features, can be readily integrated into the APDU in a broad range of applications for commercial or military aircraft and the ground vehicle market.



COMPACT DESIGN AND USE OF ADVANCED MATERIALS

Safran Electrical & Power manufactures the APDU enclosure with a composite thermoplastic material that is lighter, stronger and more durable than materials used in the past. The compact design and low-weight structure provide component protection and structural rigidity as well as a thermal heat-optimized solution that is electrically insulated. Safran Electrical & Power's new design decreases overall weight by 25% to 35% compared to conventional units. It also reduces operating temperatures of contactors, terminals and bussing by up to 50°C, thereby decreasing thermal stress and increasing reliability.

LOWER PROFILE

Designed to replace bulky conventional panels, Safran Electrical & Power's customizable plug-in circuit breaker panel offers significant weight and space savings, flexible configurations, enhanced thermal efficiency and higher reliability.



DESIGN FEATURES THAT FACILITATE EASE OF INSTALLATION AND MAINTENANCE

Easier access enables circuit breakers and contactors to be replaced more quickly, and the virtually wireless design reduces the opportunity for errors. Fewer wiring connections strengthen reliability, and the APDU is readily adaptable for modifying or adding circuits.

INTEGRATION OF APDU ELECTRONICS WITH INTEGRATED PLUG-IN CIRCUIT CARDS USED FOR RELAY CONTROL, CURRENT MONITORING AND LOGIC FUNCTIONS

Safran Electrical & Power's integrated APDU electronics module provides voltage sensing of individual circuit breakers (open or closed), current sensing circuit of the main contactors and power busses (shunt-based design), and economizer circuits and electronic auxiliaries for the contactors/relays.



THERMALLY CONDUCTIVE/ELECTRICAL INSULATIVE BACKPLANE WITH ENCAPSULATED CONDUCTORS

Safran Electrical & Power's design embeds conductors within a thermally conductive and electrically insulative backplane that transmits heat from the primary heat sources (contacts and circuit breakers). These modules consolidate the wiring and buss work while directing heat to the mounting structure/airframe.



NEAR WIRELESS DESIGN FOR MANUFACTURABILITY AND HIGHER RELIABILITY

Safran Electrical & Power's APDU design limits point-to-point wiring by using embedded bussing and integrated wiring boards for contactor control. This reduces wiring, hardware, fasteners and assembly labor by more than 50%, significantly reduces weight, and improves overall reliability.



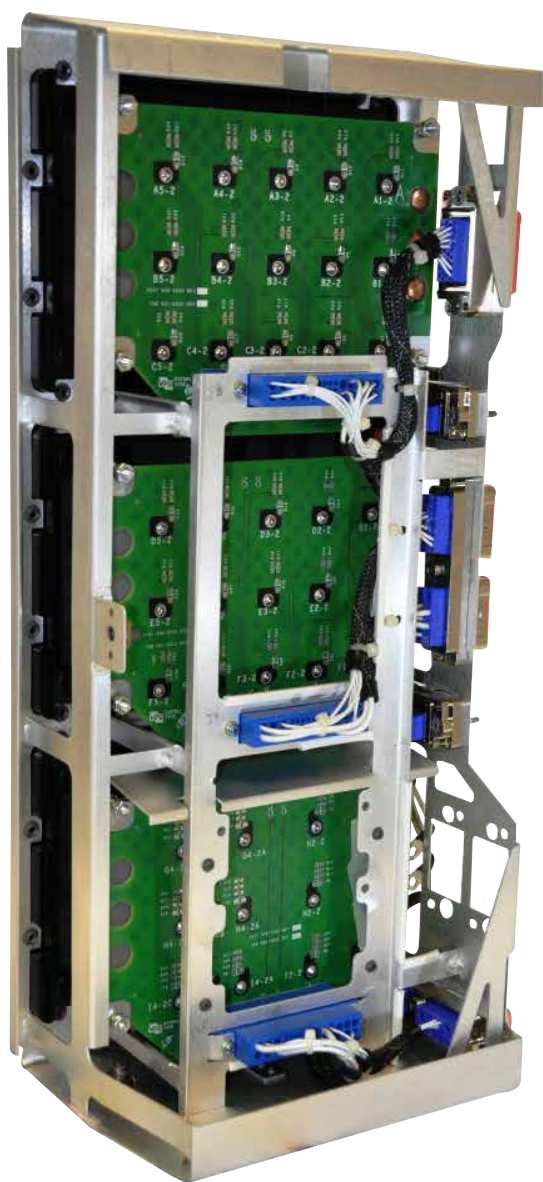
CURRENT SENSING

Safran Electrical & Power's APDU provides voltage sensing of circuit breaker position and current sensing of the main feeder current. An optional common electronics module provides contactor economizing, electronic auxiliaries and prognostics.



DESIGN COMPARISON

PLUG-IN CIRCUIT BREAKER



COST OF DESIGN AND PROGRAM EXECUTION

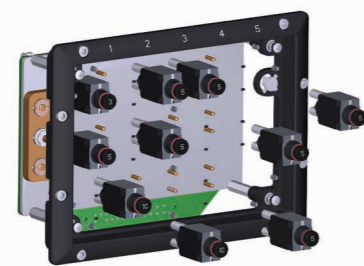
SAFRAN ELECTRICAL & POWER PLUG-IN CIRCUIT BREAKER

Circuit breakers can easily be changed to higher or lower ratings in less than 10 seconds with a simple slotted screwdriver. No specialized skill required.



No recertification required after breaker changes or additions because the integrated breaker module is already sized and certified with the maximum configurable capacity and ratings.

Breakers can be added to spare slots in seconds during the course of design by simply removing the panel, plugging in a new breaker and removing the preconfigured plug in the panels' faceplate. Last minute changes can be done without the need for recertification and also has the added benefit of being able to easily modify existing prototypes and other samples in the field quickly and cost effectively.

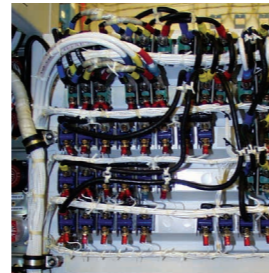


Removal of Face Plate exposes the plug & play patented circuit breaker design.

Breaker swap out could be done (although not recommended) without removing power to the breaker panel by first opening the breaker to be changed and swapping in a new breaker that is also in the open/tripped position.

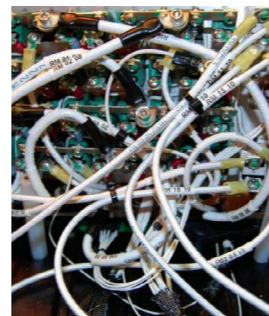
CONVENTIONAL CIRCUIT BREAKER PANEL DESIGN

Circuit breakers can only be changed by a highly skilled person taking anywhere from 10 to 20 minutes if the new breaker is at the same or lower rating. If the rating is higher, the entire wiring harness will need to be reworked and that could take several hours to complete per panel.



Recertification is typically required with configuration changes that impact the breakers and/or wiring harness.

Adding breakers to an existing panel is a very cumbersome, risky and time consuming process. It requires a considerable amount of down time and a highly skilled technician to cut into the wiring harness, route new wires (size, cut, and strip), crimp new lugs, redress and secure the wiring harness, change out the bus bar and secure the new breaker to the panel. This process can easily take an hour or two and has inherent risks of impacting the torques, crimp joints and wiring of the other circuits attached to the wiring harness.

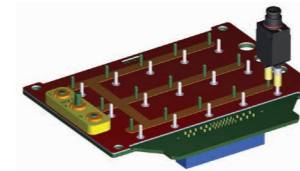


Breaker swap outs will always require power to be removed due to the highly exposed and interconnected contacts that need to be accessed behind the panel.

WEIGHT, PANEL ACCESS & INSTALLATION SPACE

SAFRAN ELECTRICAL & POWER PLUG-IN CIRCUIT BREAKER

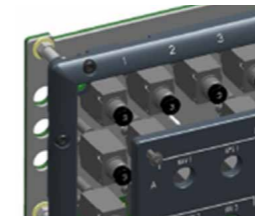
Integrated panel buss work minimizes the added weight of wiring harnesses.



Safran Electrical & Power's innovative material solutions and integrated panel design typically weighs less per square inch. That translates to a 20 to 40% reduction in weight compared to conventional breaker panels.

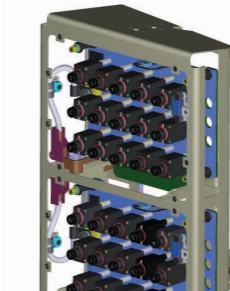


Panel access does not require any additional retaining brackets or hardware. Access is always as simple as removing the face plate with quarter turn of the captive screws.



Mounting depth requirements are typically between 3" to 5" which is significantly less than a convention panels and Safran Electrical & Power's design also has the added benefit of the entire circuit breaker panel design itself being a fully self-contained maintenance free module that will never need to be accessed again once installed.

Higher breaker density per cubic inch of space due to a smaller footprint needed per breaker without the need for wires and crimp lugs. Breakers are simply installed side by side onto the plug-in matrix.

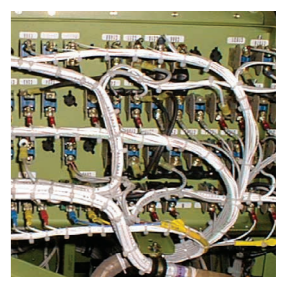


CONVENTIONAL CIRCUIT BREAKER PANEL DESIGN

Typical Panel wiring harnesses can account for an average of 25% of breaker panels weight.



Outdated standard breaker panel designs are bulky and heavy typically weighing significantly more per square inch including wiring harness, wiring loom and extra hardware needed for panel mounting and access.

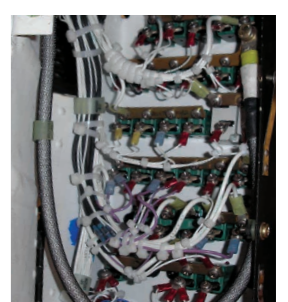


Typically uses retaining brackets, hinges, panel stops and access handles to provide fold down rear panel access to the breakers adding to overall weight of each panel.



Mounting depth requirements are typically between 5" to 8".

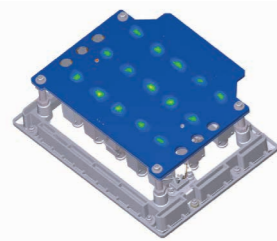
Breaker density is limited due to additional spacing needed to account for minimal safe wire bend radius, bulky crimp lugs and dielectric isolation of the close proximity open connections.



THERMAL MANAGEMENT

SAFRAN ELECTRICAL & POWER PLUG-IN CIRCUIT BREAKER

Heat from high load circuits is dissipated through multiple layers of a thermally conductive electrically isolated material thus reducing the overall heat conducted in the wiring bundles, eliminating hot spots in the panel which increases the products overall reliability.



Integrated bus work is a fully encapsulated and maintenance free design that is already sized to support a full range of breaker ratings. There is absolutely no risk of thermal concerns related to improper torque, loose connection or breaker rating mismatch.



Contacts are new class of power connector with a double row mesh of contact fingers made out of a performance-engineered copper alloy material offering lower voltage drop resulting in lower temperature rise than conventional connectors.

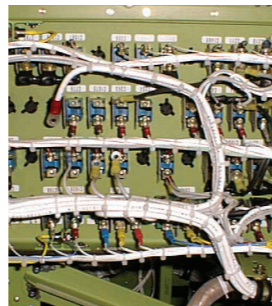


CONVENTIONAL CIRCUIT BREAKER PANEL DESIGN

Heat build-up from high load breakers cannot be actively dissipated and so is transferred directly into the wiring bundles and builds up into hot spots. These hot spots increase the risk for material breakdown and the potential for thermal events over time.



Breaker wiring is sized to breaker being used. Because of this, there is increased risk of thermal issues due to breaker connections not being torqued correctly, crimp connections becoming loose or frayed or a wire size versus breaker rating mismatch occurring due to human error when changing out a breaker.



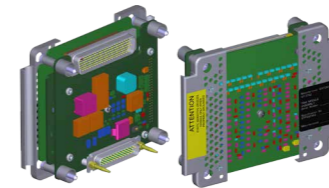
Screws or quick connect style connections with conventionally plated connectors typically have higher contact resistance which translates into higher temperature rise and loss of watts as load is added.



AUXILIARY CONTACT SUPPORT

SAFRAN ELECTRICAL & POWER PLUG-IN CIRCUIT BREAKER

Achieved with fully integrated voltage sense lines and interface board (50 CB monitoring module shown).



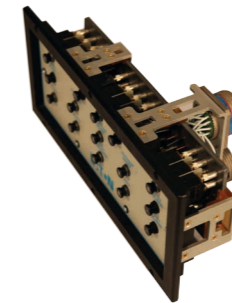
Uses standard plug in breakers.

No breaker MTBF degradation when supporting AUX sensing.

No added wiring or micro switches needed for aux sense which translates into higher reliability.

No added weight or wires needed to support AUX contact monitoring.

Protected and fully maintenance free design since the sense lines are built into the integrated panel, there is nothing to maintain and nothing that could be inadvertently impacted by maintenance personnel.



Sense lines are fully integrated and encapsulated into the panel assembly and standard modular bus work making the assembly and test error free.

CONVENTIONAL CIRCUIT BREAKER PANEL DESIGN

Achieved by adding a basic micro switch to a conventional circuit breaker.



Added breaker cost when AUX contact support is required.

Lower breaker MTBF per breaker due to the added AUX sense contacts.

Double the wiring behind the panel to accommodate the AUX sense lines.

Added weight of 2 extra wires on each breaker installed in order to support AUX contact monitoring.

Added risk of impacting other circuits if wiring bundles or panel needs to be handled in any way for maintenance.

Added cost of manufacturing, test and lower yields due to extra wiring especially if a problem is found and the technician needs to manually trace and troubleshoot the assembly and wiring bundle.

MANUFACTURING, TESTING AND RELIABILITY

SAFRAN ELECTRICAL & POWER PLUG-IN CIRCUIT BREAKER

Wireless and tool less 'plug and play' breaker installation using socket and pin approach.

Each breaker can be press fit in place in 1 to 2 seconds without the need of any tools, wiring or torquing of any connections.

Modular and error free assembly using integrated buss work.

Each breaker installs quickly and easily independently of the others without any interference.

Less risk of arc faults related to the breaker panel wiring because the design uses bus bars to connect the breakers and each bus bar is fully encapsulated within thermally conductive electrically isolated layers of material that has a dielectric isolation rating of 7500VA.

No crimp connections translates into higher reliability.

Heat from high load breakers is automatically dissipated through the integrated thermally conductive breaker mounting surface and through natural convection thus eliminating any thermal concerns and reducing overall operating temperature.

Panel connections are sealed, not accessible and never require maintenance.

CONVENTIONAL CIRCUIT BREAKER PANEL DESIGN

Hardwired breaker solution requiring wiring harness, crimp lugs, screws, nut, lock washer, wire ties and multiple tools to install a single breaker.

Each breaker must be mounted, wired and torqued into place taking several minutes for a highly experienced assembler to complete.

Error prone assembly due to the need to manually size, cut, strip, crimp, route and attach both ends of 50 to 100 wires on an average sized breaker panel. All of this extra "touch work" makes the product more likely to experience field issues due to human error.

Each breaker is interconnected to the wiring harness and bolted on buss work making it difficult and more time consuming to work on, assemble or alter.

Design uses wiring bundles that have multiple ties to bind and shape the harness which has the potential for pinch points, chaffing or thermal damage caused by hot spots.

Typically uses solderless connection such as crimp lugs which inherently have high resistance causing excess voltage drop across connection points. That voltage drop coupled with high load currents causes heat build-up which could potentially result in a failure of the connection and a thermal incident.

Heat from high load circuits has no active means of dissipation and must rely solely on natural convection behind crowded panels.

Breaker wiring and connections are fully accessible behind the panel door and so any panel access and/or manipulation of any kind exposes the risk of damaging or weakening existing connections. What passes HIPOT at the factory may not pass after installation or routine maintenance.

OVERALL COST OF OWNERSHIP

SAFRAN ELECTRICAL & POWER PLUG-IN CIRCUIT BREAKER

Design phase breaker rating changes or breaker additions can easily be done in seconds without significant down time and without the need for specialized and highly skilled labor.

Weight is 20% to 40% less than the conventional breaker panels and that translates into long term fuel savings and demonstrates a clear commitment to "Green Initiatives" and conserving resources.

Prototypes in the field can easily be updated to the latest design configurations without the need for specialized and highly skilled labor. If you can operate a screw driver you can easily make the change.

Compact, modular space saving footprint allows you to fit more breakers into less space which in turn makes it ideal for space critical applications and allows more room for other equipment.

Higher initial cost however the ease of maintenance and flexibility it offers will quickly pay for the difference in cost during the design cycle and this would ultimately translate into savings over the life of product.

There are no panel access "keep out" areas that must be protected for maintenance purposes since the product does not require an access door. Access to the breakers can be achieved by simply removing the faceplate from the front.

Maintenance of the breakers will not restrict movement of others around an open panel since access is done from the front and it does not require an access door. Also since changes are extremely quick and easy, there would be no significant delays associated with it.

CONVENTIONAL CIRCUIT BREAKER PANEL DESIGN

Design phase breaker changes are very labor intensive, require significant down time to complete and requires specialized and highly skilled labor.

Heavy design will consume significantly more in fuel over the life of the product and offers no "Green" advantages or savings.

Prototypes may or may not be modifiable but if they are, it is a very labor intensive process requiring significant down time to complete and specialized and highly skilled labor to complete it.

Bulky panel and wiring harness design typically requires greater cavity space to support wiring harnessing bend radiuses, large wiring looms that facilitate panel door access, and the additional door panel hinge and related hardware brackets.

Typically lower initial cost but offers no added benefits or flexibility. Overall cost will be higher once you factor in cost/time of changes during the design cycle as well as the added cost of extended down times related to maintenance or upgrades over the life of the product.

Installation area must account for the additional space needed to access the panel door within its full range of motion and therefore requires a defined "keep out" area that needs to be considered during the design phase.

Maintenance requires the panel door to be swung open into the common areas potentially restricting movement of others during the maintenance. Since maintenance on these panels is quite labor and time intensive, this could contribute to efficiency delays of other personal beyond the panel/breaker maintenance itself.

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CONDUCTIVE MATRIX

Safran Electrical & Power's plug-in circuit breaker eliminates point-to-point wiring by embedding the current buss work within an engineered material that is thermally conductive and electrically isolated. The thermally conductive material is much more resilient than a printed circuit board assembly, withstands much higher temperatures, and spreads the heat loading across the entire assembly.

Embedding the buss work in this material eliminates hot spots, reduces operating temperatures, and allows for weight optimized power dissipation networks. It also reduces the required panel depth and eliminates the need for epoxy and shields. By reducing the size of the buss work and isolating them from FOD, this eliminates the heavy and bulky individual interconnect wire looms, exposed terminations, and buss work found in conventional circuit breaker panels. It also creates a uniform error proof circuit breaker panel assembly that is easier to install, maintain, and is more reliable.

FASTER ASSEMBLY, BETTER ACCESS

Safran Electrical & Power's re-configurable panels are built in layers to facilitate ready assembly and ease of access to circuit breakers. This significantly reduces the

assembly time of a circuit breaker panel. Stand alone line replaceable units can be readily mounted in a power distribution box or aircraft with all of the electrical connection in an embedded connector.

This significantly reduces circuit breaker replacement time. Any individual circuit breaker can be removed,

upgraded, or replaced from the front of the panel. The traditional panel mounting hardware and terminal hardware is eliminated with no wiring terminations to identify or add; the entire process can be completed in less than 5 minutes with a single screw driver. The new design allows easy configurability with customized faceplates, frames, terminal blocks and connectors.

IMPROVED PANEL LIGHTING

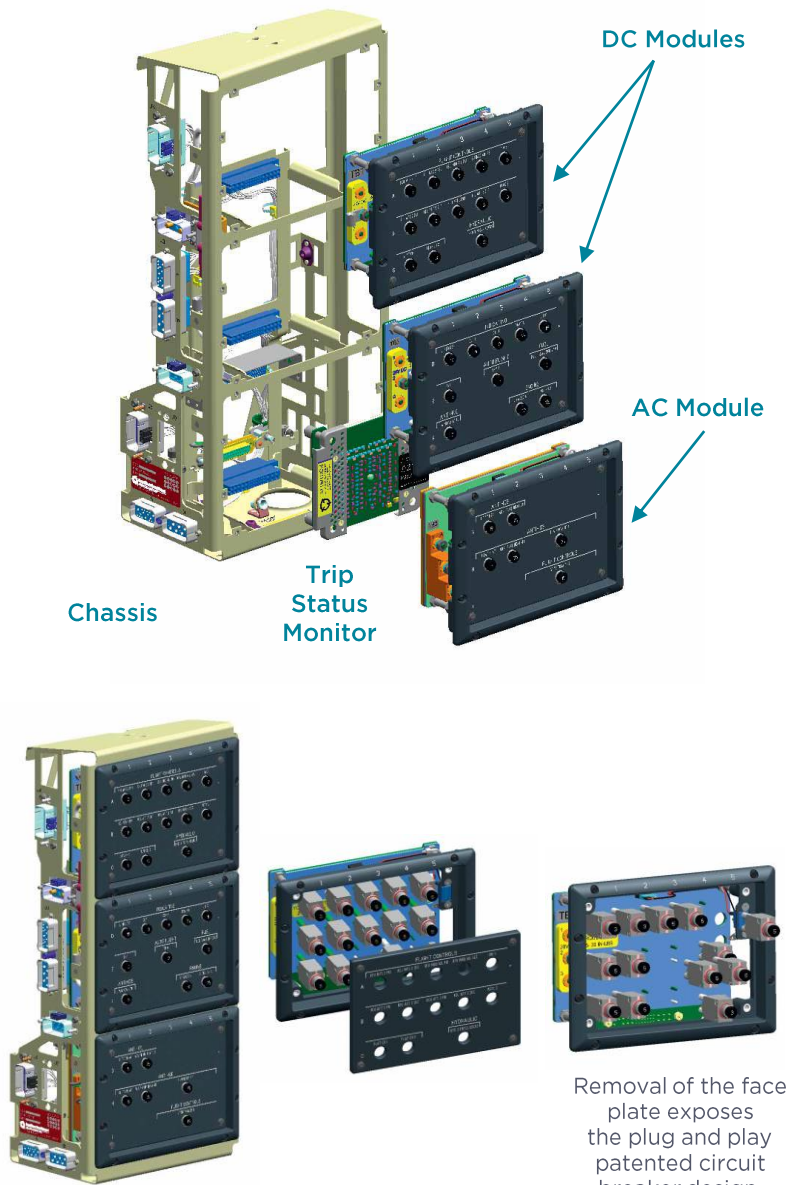
Safran Electrical & Power offers an illuminated panel option in which the circuit breaker nomenclature can double as illumination. This lighting can be a very thin electroluminescent label or for more stringent applications can be a customized LED acrylic faceplate commonly used in aerospace cockpits.

The LED and its controlling circuit board is embedded in the illuminated faceplate and can be readily replaced or modified as a line replaceable unit for customization or repair.

MODULES OPTIONS

Safran Electrical & Power's plug-in circuit breaker modules are available in various forms and are modularized to reflect unique application configurations along with built-in spares capability. Electronics for illumination, circuit breaker status monitoring, and data buss status reporting can also be integrated into the plug-in circuit breaker assemblies developed by Safran Electrical & Power.

CIRCUIT BREAKER PANEL



Each face plate is easily removable and is held to the module by four screws.

Removal of the face plate exposes the plug and play patented circuit breaker design.

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