

# ARC-ALERT™

## CIRCUIT INTERRUPTER TECHNOLOGY

NEXT GENERATION OF CIRCUIT PROTECTION



# ARC-ALERT CIRCUIT INTERRUPTER

## HOW AN AEROSPACE BREAKER OPERATES

Today, in the United States there are more than 220,000 civil and military aircraft in operation. Many are over 20 years old. To maintain air worthiness, many have been retrofitted with new engines, new avionics, improved hydraulic systems and even new interiors.

However, one element in most older aircraft that will not change is the (miles and miles) of electrical wiring buried within the aging airframe. Over time these wire bundles and their protective insulation can deteriorate, providing the perfect environment for an electrical short and a potential fire hazard. Until recently, common aircraft circuit breakers, developed over 50 years ago, were considered the first line of defense. Alas, aircraft circuit breakers do not detect and react to the damage caused by the chaffing and subsequent sporadic arcing when bare wires contact metal aircraft structure or other bare conductors. When this occurs, an electrical fault, "arcing" can occur. Research has shown that arc faults, with temperatures as high as 6,000°C, can go completely undetected by common circuit breakers.

Arc Fault Protective devices are designed to detect and react to arcing faults while allowing normal aircraft operation. In addition to the unfortunate roll call of recent aircraft accidents blamed on explosions or fires suspected to have been triggered by electrical wire arcing, the potential for additional incidents may be even more sobering.

Safety reports show numerous, non-fatal incidents of smoke in the cockpit or cabin and electrical faults attributed to wire arcing.

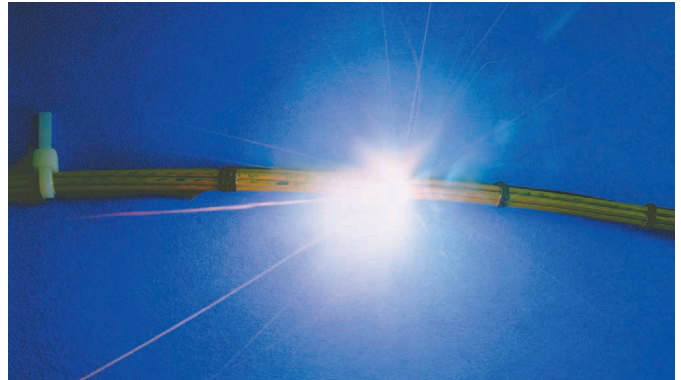
### Safran Electrical & Power's Patented Arc-Alert™ Technology — The Next Generation of Circuit Protection

**Quick Fact:**  
There have been 1,576 smoke or fire incidents on commercial aircraft since Jan 1984.

*-FAA National Aviation Safety Data Analysis Center (April 2004)*

Arc-fault protective technology introduces electronics to traditional circuit breakers to provide arc-fault identification and a means to trip the breaker, thereby disconnecting the affected circuit. In residential and aerospace arc-fault protective devices, Safran Electrical & Power uses an independent thermal circuit breaker and adds supplementary Arc-Fault detection and Circuit Interruption (AFCI) electronics.

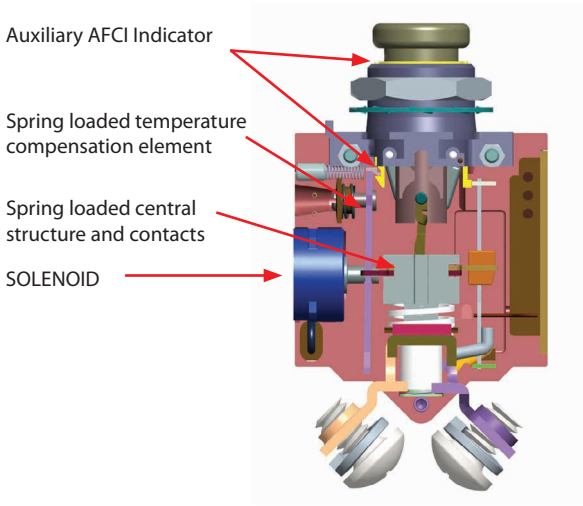
Safran Electrical & Power's design approach maintains the proven benefits of existing circuit protection while augmenting it with supplementary AFCI capability. This allows the "standard" circuit breaker portion of the device to operate normally until there is an arcing fault. Then, when an arcing fault occurs, the AFCI electronics actuate the trip mechanism and provide supplementary arc-fault protection. In this fashion the combination circuit breaker and arc-fault protective device will function as a conventional electro-thermal circuit breaker until an arc occurs. Maintaining the reliability of existing circuit protection while increasing the overall protection is a major accomplishment of Safran Electrical & Power's implementation of AFCI circuit protection.



Since 1998, Safran Electrical & Power has made homes safer using Fire-Guard™ Circuit Protection. Safran Electrical & Power has adapted this proven technology for the aerospace industry. Safran Electrical & Power's Arc-Alert™ Circuit Interrupter technology utilizes electronics to monitor and analyze a circuit's current waveform. This logic circuit utilizes algorithms developed over the last 10 years. These algorithms "look" directly for the randomness in the current signal to identify an arcing event is occurring.

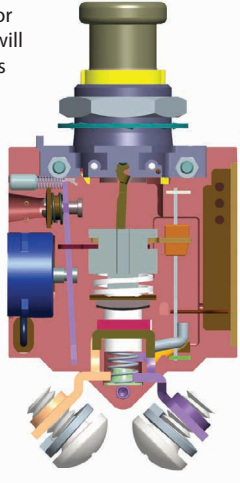
These algorithms are able to discern between normal current signatures and arcing events due to our extensive load database validation. If the logic circuit identifies an arcing fault, it sends a signal to the circuit protection device, initiating a sequence that safely shuts down the circuit in question.

HOW AN AEROSPACE BREAKER OPERATES



The auxiliary AFCI indicator (yellow hook on top left) will only deploy if the device is actuated by the solenoid

The electronics sense an arc, the Solenoid (blue) opens the device by pulling on the spring loaded temperature compensation element (purple) to the left



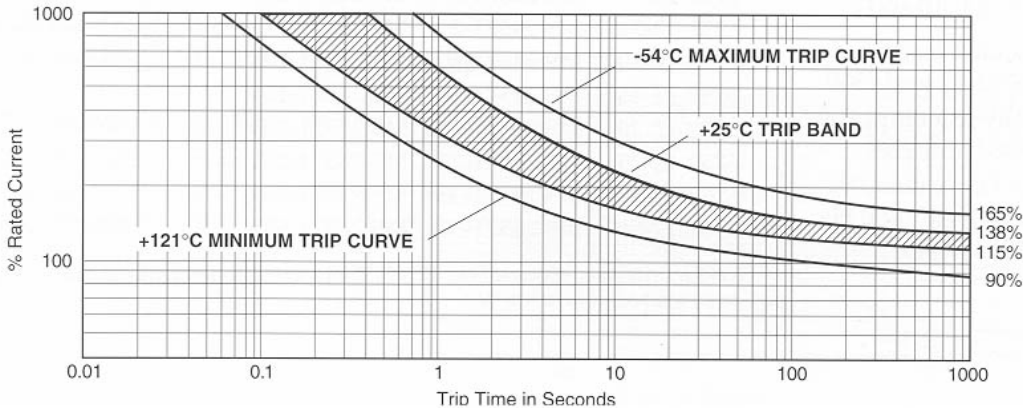
Releasing the spring loaded central structure and contacts (gray) and opening the button

The current aerospace circuit breaker provides simple over-current protection by utilizing a mechanical bi-metal trip mechanism. When a breaker is "closed," a spring is charged and a mechanical latch holds the contacts closed. This prevents the spring from releasing.

If the current flowing through the bi-metal is above the circuit breaker rating for a long enough period of time, the temperature increase will cause the bi-metal element to bend toward the trip bar. This will "free" the latch causing the charged spring to release its energy and "open" the contacts, breaking the flow of power to the circuit.

WHY A STANDARD CIRCUIT BREAKER DOESN'T WORK

- They are not designed to detect arcing faults.
- Arcing fault currents are sporadic or sputtering.
- A serious arcing current can have an RMS heating value several times the breaker's rating.
- The breaker's bi-metal cannot respond fast enough to prevent the fault from cascading to other wires.



# ARC-ALERT CIRCUIT INTERRUPTER

## Safran Electrical & Power's Arc-Alert™ Circuit Interrupter — Enhanced Capability In The Same Package

Safran's approach provides Form-Fit replacements with enhanced functionality by integrating Safran Electrical & Power's circuitry into the standard aerospace circuit breaker.

This required miniaturization of the present mechanism to make room for the necessary electronics and to provide a way to power the electronics. As a result of this effort, Safran Electrical & Power's Arc-Alert™ Circuit Interrupter has resulted in many added benefits:

- Same space requirements as current circuit breakers such as MS3320 and MS14105
- Separate indication of an arcing fault vs. over-current fault
- On-board Built-In-Test capability
- Power on LED indicator
- Redundancy. If the Arc-Alert™ Circuit Interrupter electronics fail, the breaker will continue to provide thermal over current protection.
- Nominal power draw is about 15 mA.

**Quick Fact:**  
Safran Electrical & Power is currently the only STC holder for the Boeing 737 series aircraft.

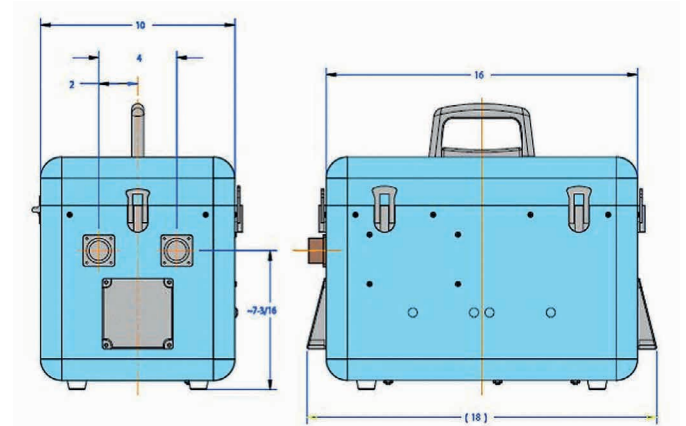
## Test Box

Safran Electrical & Power has developed a portable circuit breaker test box. This test box will verify the performance of installed Arc-Alert™ Circuit Interrupters on-board aircraft without the need to remove the breaker from the breaker panel. The test box can be used by airline maintenance crews to validate the proper operation of circuit breakers that have indicated an arcing fault.

If a trip indication occurs and no damage is found upon inspection, the Arc-Alert™ Circuit Interrupter could be reset and connected to the test unit. The test box will verify the operation of the thermal and arc detection portions of the Arc-Alert™ Circuit Interrupter device. If the test box determines the device is operating properly, then the maintenance crews could "hipot" the suspected circuit

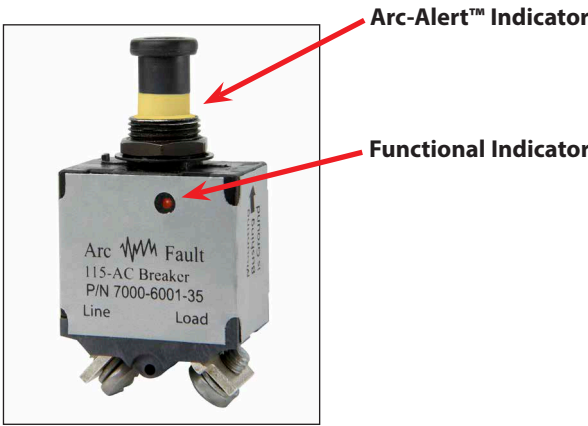
This screening procedure should highlight the need for more intrusive inspection of the installed wiring. These are optional procedures intended to supplement operator's maintenance procedures. Safran Electrical & Power continuously enhances Arc-Alert™ Test Box capabilities to provide customers with the best technology, thus the appearance may vary.

Note: Financial options for Safran Electrical & Power's Circuit Breaker Test Box are available to customers.



Safran Electrical & Power's Arc-Alert™ Circuit Interrupter Configurations

Safran Electrical & Power has developed several different AFCI configurations needed to meet customer requirements.



Trip Indication

Safran Electrical & Power adopted a mechanical AFCI trip indication to ease implementation concerns. There are three modes: arc-fault trip, thermal trip, and reset with an arc-fault trip indication. This approach allows the arc-fault protective device to be reset by the crew in the event of an arcing fault or thermal overload. However, the secondary Arc-Fault Trip Indication "Halo" will remain exposed above the circuit breaker bushing and will not reset by re-closing the circuit breaker. This will assist maintenance in trouble shooting the fault and record keeping when an arcing fault has occurred.

Arc Fault Indication



Thermal Fault Indication



Reset With Arc Fault Indication



Certification & Development Update

Safran Electrical & Power has been actively supporting the development of aerospace AFCI technology for over 10 years.

These device have flown on numerous aircraft such as the C9, B727, B737, B747, USAF F15, USAF KC135, US Navy H60, US Navy H53, US Navy P3, US Navy F18 and small business jets.

The 7000-5001 Safran Electrical & Power AFCI has been awarded an STC for use on the B737 and has been qualified to AS5692/2.

Pending the release of the AS5692/3 and AS5692/4 the 4310-5001 and 7000-6001 will be listed on the QPL.

Several aircraft have been identified and are scheduled for further implementation of these devices. If you are interested in participating in this process, contact Safran Electrical & Power Customer Service at (800) 955-7354.

Product Availability

Pricing will vary based on order quantity and configuration.

The following circuit breakers are available now:

- AC Single Phase (MS3320)
- AC single-phase (MS14105)
- DC single-phase (MS14105)
- AC Three Phase (MP1536)

# ARC-ALERT SINGLE POLE PERFORMANCE



## Single-Pole High Performance

The aerospace qualified product utilizes the same internal design.

### Performance Rated Circuit Breaker

The single phase model is a sub-miniature, lightweight, trip free, circuit breaker, which combines its compact size with a solid technological track record. This model's functionality is immune to extreme fluctuations in temperature, high shock, vibration and humidity.

### Qualified

Variants qualified to AS5692/2

### Lightweight

37 grams maximum (.082 lbs.)

### High Interrupting Capacity

### High Vibration and Shock Resistance

### Sub-Miniature Size

## PERFORMANCE DATA

<b>Interrupting Capacity</b>	1 to 20 amps 1000 amps per AS5592 at 120 V 400 Hz. AC 25-35 amps 1000 amps per AS5692 at 120 V 400 Hz. AC
<b>Endurance</b>	2,500 cycles; rated inductive load per AS5692 paragraph 4.7.8 5,000 cycles; rated resistive load per AS5692 paragraph 4.7.8 10,000 cycles; mechanical cycling no load per AS5692 paragraph 4.7.
<b>Overload Cycling</b>	Minimum of 100 cycles at 200% rated current per AS5692 paragraph 4.7.9 Minimum of 100 cycles of Arcing detections per AS5692 paragraph 4.7.9
<b>Dielectric Strength</b>	At sea level, 25°C, 1,500 V, AC. At 70,000 ft 71°C 500 V, AC per AS5692 paragraph 4.7.2
<b>Insulation Resistance</b>	Not less than 100 megohms at 500 V, DC per AS5692 paragraph 4.7.3
<b>Voltage Drop</b>	Varies with rating per AS5692 paragraph 4.7.19 (see "Ordering Information")
<b>Vibration</b>	10G's to MIL-STD-202, Method 204, Condition A per AS5692 paragraph 4.7.11 High level sine and random vibration levels are also available
<b>Shock*</b>	Exceeds 50G's, to MIL-STD-202, Method 213, Test A per AS5692 paragraph 4.7.12
<b>Acceleration</b>	Exceeds 10G's per AS5692 paragraph 4.7.13

\*Variations of these circuit breakers are capable of exceeding the standard MIL specification for endurance, vibration, and shock. Consult your customer support engineer for more information.

## THERMAL OVERLOAD CALIBRATION DATA

Specification Table	Trip Range					Test Time Parameters
	-55°C - 85°C	25°C	85°C	-55°C	115°C	
Must Hold		115%	100%	115%	80%	% For 1 Hour
Must Trip		145%	145%	170%	145%	% Within 1 Hour
200% Overload	1.5 to 50					Seconds
500% Overload	0.15 to 3.0					Seconds
1,000% Overload	0.035 to 0.8					Seconds

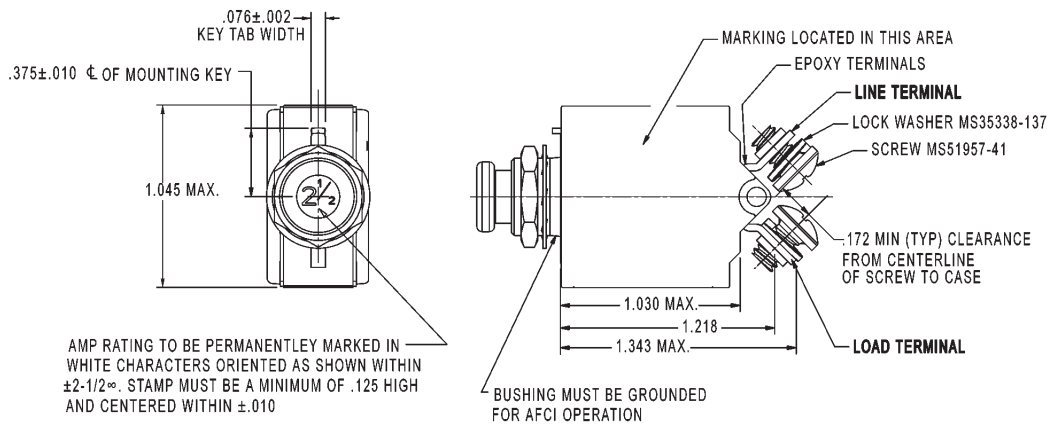
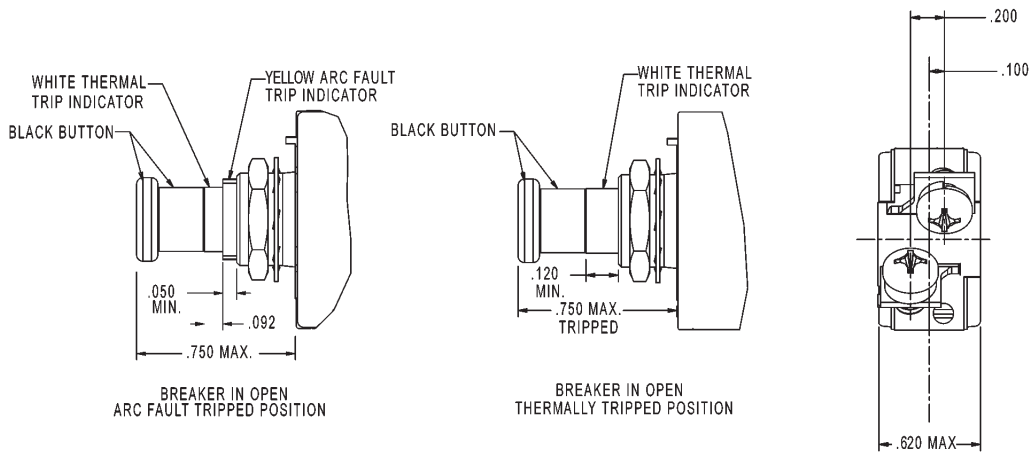
## ORDERING INFORMATION

Safran Electrical & Power P/N	Ampere Rating	Voltage Drop Max (V)
4310-5001-2.5	2 1/2 amps	0.70
4310-5001-5	5 amps	0.55
4310-5001-7.5	7 1/2 amps	0.45
4310-5001-10	10 amps	0.28
4310-5001-15	15 amps	0.25
4310-5001-20	20 amps	0.25
7000-6001-25	25 amps	0.25
7000-6001-30	30 amps	0.25
7000-6001-35	35 amps	0.25

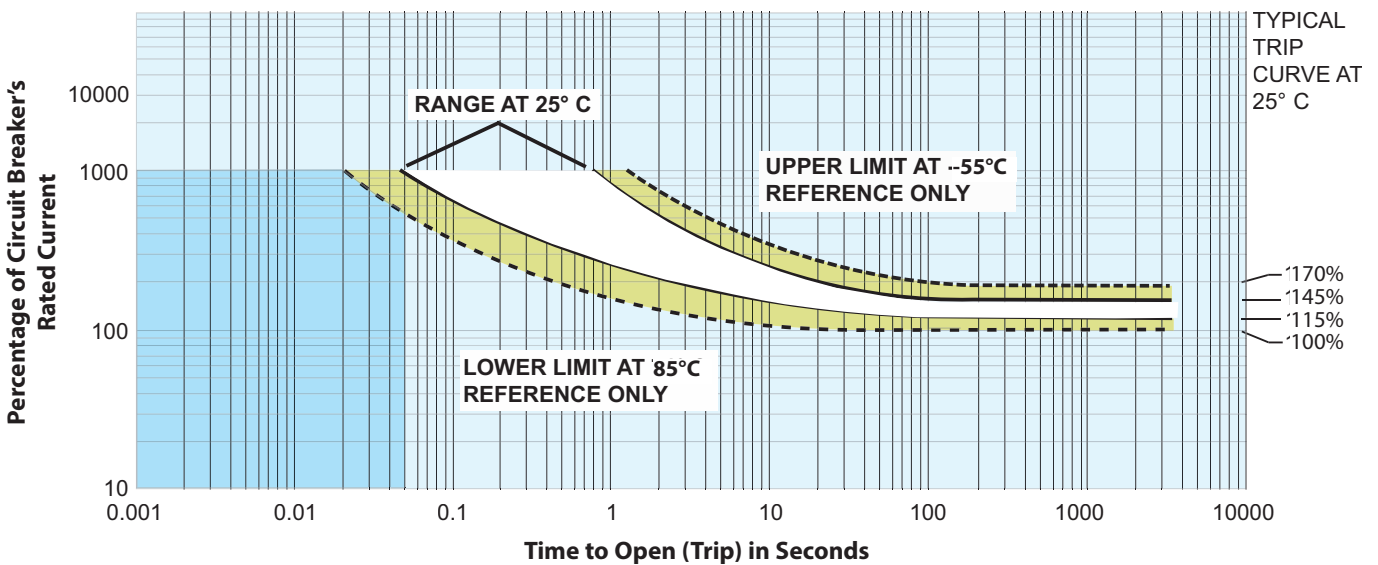
\* AT RATED NOMINAL CURRENT

For other amperage ratings and configurations, consult your customer support engineer. Pricing will vary based on order quantities and configuration.

DIMENSIONS



THERMAL TRIP CURVE



Arc-Alert™ Protected Range

Local contact (Sarasota, FL):

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