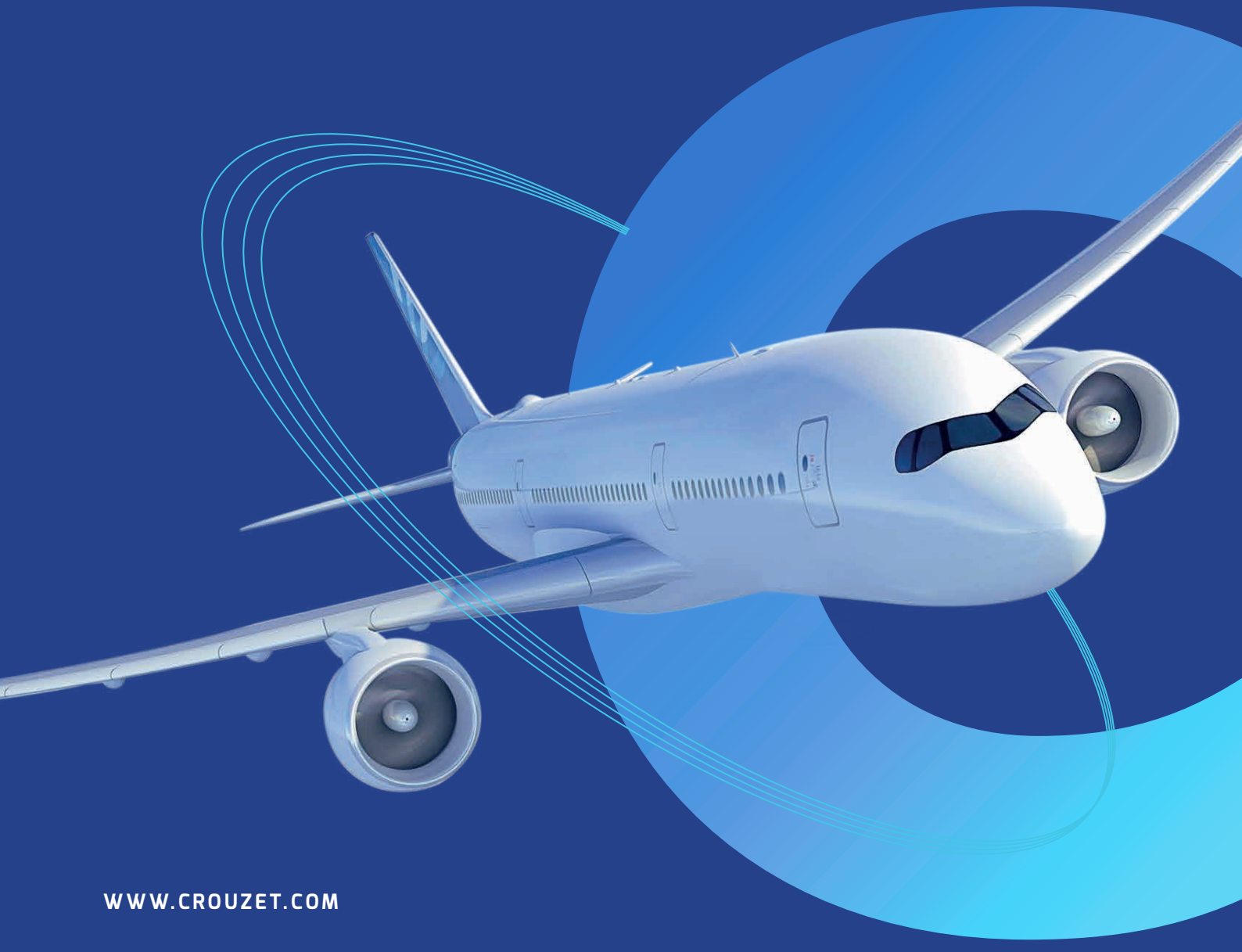
CROUZET

# MANUFACTURING THE FUTURE

## Of Aerospace Industry



WWW.CROUZET.COM

# ABOUT CROUZET

Crouzet is an independent company **manufacturing mechatronic components for demanding applications in Aerospace & Transportation, Energy, Building and Machinery Industry.**

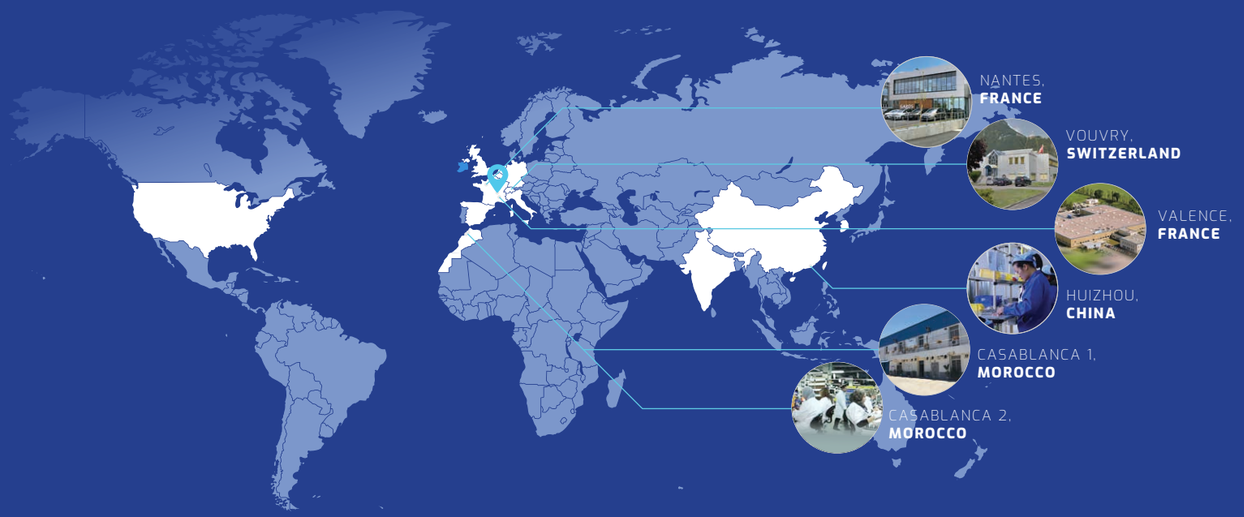
Crouzet provides **Switches and Sensors, Electromechanical Actuators, Electrical Protection Equipment, Cockpit Controls, Automation Controllers and Relays, and Instrumentation Services.**

Since 1921, Crouzet has a heritage of close collaboration with customers in the development of products, from standard components to fully customized solutions.

Crouzet's customers and partners can rely on our teams worldwide to always meet and often exceed their expectations. Driven by innovation, our experts are focused on designing and delivering the right product for the right application.

Crouzet is your trusted partner of choice to face industrial challenges of today and tomorrow.

## WORLDWIDE PRESENCE




*HEADQUARTERS* *SALES OFFICES*



# PROGRAMS

OUR REPUTATION IS RECOGNIZED GLOBALLY BY THE MAJOR PLAYERS IN THE AEROSPACE MARKET. A NON-EXHAUSTIVE LIST OF CUSTOMERS INCLUDES:



AIRBUS, AIRBUS HELICOPTERS, ANTONOV, BELL, BOEING, BOMBARDIER, DASSAULT, EMBRAER, GULFSTREAM, HAL, IAI, IRKUT, LEONARDO, LIEBHERR, MIL HELICOPTER, NH INDUSTRIE, NORDAM, PILATUS, SAFRAN LANDING SYSTEMS, SAFRAN NACELLES, SOCATA, SUKHOI, UTAS, WOODWARD...



## QUALITY OF SERVICE THROUGHOUT THE LIFE OF THE PROGRAM

- We have the internal expertise to ensure manufacturing engineering goes smoothly
- We use up-to-date logistic tools such as IDE to provide quality service
- Our quality is of the highest level: ISO 9001, ISO 14001, OHSAS 18001, AS/JIS Q/ EN 9100, NADCAP Welding, FAA approved (FAR 21 & FAR 145)
- Our production organisation is EASA part 21 approved
- Our after-market services, EASA part 145 approved, include a specific customer support department, distributors all around the world, and an AOG service
- NATO code: FA0X2

# CUSTOMER PROGRAMS

## OUR EXPERIENCE

| COMMERCIAL AIRCRAFT | | SWITCHES & POSITION SENSORS | ELECTRICAL PROTECTION | COCKPIT CONTROLS |
|---|---|---|---|---|
| AIRBUS | A318 / A319 | ● | ■ | ▲ |
| | A320 / 321 | ● | ■ | ▲ |
| | A330 | ● | ■ | ▲ |
| | A340 | ● | | ▲ |
| | A350XWB | ● | ■ | ▲ |
| | A380 | ● | ■ | ▲ |
| ANTONOV | AN148 / 158 / 178 | ● | ■ | ▲ |
| ATR | 42 / 72 | ● | ■ | |
| AVIC | ARJ 21 | ● | | |
| BAE | 146 | | ■ | |
| BOEING | 717 | ● | | |
| | 737 MAX | ● | | |
| | 747-8 | ● | | |
| | 777 X | ● | | |
| | 787 | ● | ■ | |
| BOMBARDIER | GLOBAL EXPRESS / GLOBAL 5000/6000 | ● | ■ | ▲ |
| | G 7000 / 8000 | ● | | |
| | CRJ 700 | ● | ■ | |
| | CHALLENGER 300/350 | ● | | ▲ |
| | CHALLENGER 601 | ● | ■ | |
| | LEARJET 60 | ● | | |
| | LEARJET 45 | ● | | |
| CAIGA | AG300 | | | ▲ |
| CASA | C212 | ● | | |
| CESSNA | SOVEREIGN | ● | | |
| DASSAULT | FALCON 50 | | ■ | |
| | FALCON 900 / 900 EX / 2000 / 2000 EX | ● | ■ | |
| | FALCON 5X, 7X, 8X | ● | | ▲ |
| EMBRAER | ERJ 135 / 145 | ● | | |
| | PHENOM 100 / 300 | | | ▲ |
| | ERJ 170 | | ■ | |
| | LEGACY 450 / 500 | ● | | |
| GULFSTREAM | G 150 | ● | | |
| | G 280 | ● | | ▲ |
| | G 450 | ● | | |
| | G 600 | ● | | |
| | G 650 | ● | | |
| HAWKER | HORIZON | ● | ■ | |
| LOCKHEED MARTIN | LM100-J | | ■ | |
| MITSUBISHI | MRJ | | ■ | |
| PILATUS | PC-7 / PC-9 | ● | | |
| | PC-12 / PC-24 | ● | | ▲ |
| SINO SWEARIGEN | SJ-30 | | ■ | |
| SUKHOI | SUPERJET 100 | ● | | |
| IRKUT | MC-21 | ● | | |

| HELICOPTERS | | SWITCHES & POSITION SENSORS | ELECTRICAL PROTECTION | COCKPIT CONTROLS |
|---|---|---|---|---|
| LEONARDO | A109P | ● | | ▲ |
| | A119 | | | ▲ |
| | A129 | ● | | |
| | AW139 | ● | ■ | |
| | AW149 / 169 / 189 | ● | ■ | ▲ |
| | EH101 | | | ▲ |
| BELL | CH146 | | | ▲ |
| | 412 / 427 / 430 | | | ▲ |
| DENEL | AH2 ROOIVALK | | | ▲ |
| AIRBUS HELICOPTERS | CARACAL H225M | ● | ■ | ▲ |
| | COUGAR AS532 | ● | ■ | ▲ |
| | DAUPHIN H155/H160/N3E | ● | ■ | ▲ |
| | ECUREIL AS 350 / AS 355 / H130 | ● | ■ | ▲ |
| | FENNEC AS 550 / AS 555 | ● | ■ | ▲ |
| | NH 90 | ● | ■ | ▲ |
| | PANTHER AS 565 | ● | ■ | ▲ |
| | SUPER PUMA AS 332 / AS 225 | ● | ■ | ▲ |
| | TIGER | ● | ■ | ▲ |
| | H120 / 135 / 145 / 175 | ● | ■ | ▲ |
| HAL | ALH/LCH | ● | ■ | ▲ |
| KAI | KHP | ● | | |
| MIL | MI-38 | | | ▲ |

| MILITARY AIRCRAFT | | SWITCHES & POSITION SENSORS | ELECTRICAL PROTECTION | COCKPIT CONTROLS |
|---|---|---|---|---|
| AIRBUS | A400M | ● | ■ | ▲ |
| AIRBUS Defense & Space | CN235 | ● | | |
| | C295 | | | ▲ |
| DASSAULT | RAFALE / MIRAGE | ● | ■ | ▲ |
| EUROFIGHTER | EFA (TYPHOON) | ● | | |
| HAL | LCA | ● | ■ | ▲ |
| | HJT 36 | ● | | ▲ |
| KAI | T50 (Golden Eagle) | ● | | |
| MIG | MIG 29/35 | | ■ | |
| PANAVIA | TORNADO | ● | | |
| RAYTHEON | JPATS | ● | | |
| SAAB | GRIPEN (JAS 39) | | | ▲ |
| SUKHOI | SU35 | | ■ | ▲ |




### ● SWITCHES & POSITION SENSORS

Limit switches, proximity switches and sensors:

2 technologies available for all applications

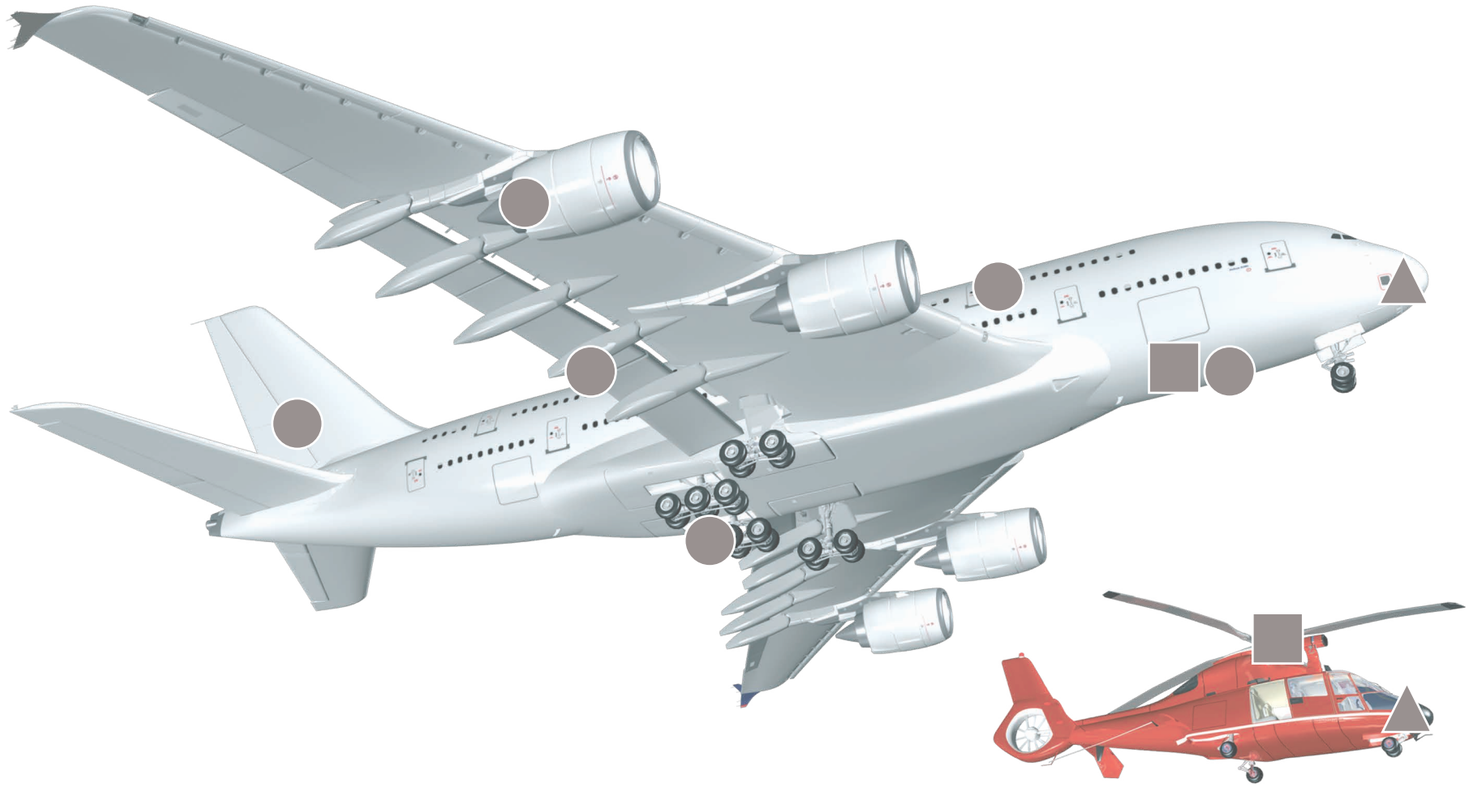
### ■ ELECTRICAL PROTECTION

A complete range of circuit breakers and modular panels to optimise your total performance

### ▲ COCKPIT CONTROLS

Feeling, ergonomics, tactile effects, electrical functions:

each program requires numerous parameters



# POSITION DETECTORS

## 2 DIFFERENT TECHNOLOGIES AT OUR DISPOSAL

*Mechanical limit switches*

### A - MECHANICAL DETECTORS

*Proximity switches*

### B - ELECTRONIC DETECTORS

*Proximity sensors combined to remote electronic board*

### B - ELECTRONIC DETECTORS

### POSITION DETECTORS

Crouzet is a market leader in custom-designed sensing solutions based on mechanical and electronic technologies.

Our large variety of limit switches (mechanical detectors) and proximity switches or proximity sensors (electronic detectors) are successfully used on civil or military aircrafts and helicopter programs.

No matter how critical or demanding the application, **Crouzet can use both mechanical and electronic technologies to provide the most suitable technical solution!**


### 3 THRUST REVERSER

- Stowed or deployed status

### 2 DOORS AND ACTUATORS

- Open or closed position and locked status

### 1 SENSOR INTERFACE MODULE SIM

- Common board for all sensors
- Protected from harsh environments

### 4 FLIGHT CONTROL

- Trimable Horizontal Stabilizer Actuator
- Spoilers
- Flap & slat

### 5 LANDING GEAR

- Weight on wheels
- Up position
- Down and locked position



### 6 CARGO LOADING

- Cargo loading latch detection (palet locked)

# POSITION DETECTORS

## IN ALL CASES CROUZET WILL FIND A WAY!

### CUSTOMISED PRODUCTS

Crouzet, with over 50 years of aerospace expertise, has the ability and capacity to develop and produce position detectors dedicated to a customer's specification.  As one of the world leaders in electronic and mechanical detection technology, we offer specific components fully adapted to requested applications and environments.

## A - MECHANICAL DETECTORS

### LIMIT SWITCHES

- Extended temperature range
- Multi pole function
- Specific housing in terms of fixing upon request
- Activation by plunger, roller or lever upon request
- Extended attack speed range for activation
- Multi electrical output (wires, cable or connector)

*Mechanical limit switches*





## B - ELECTRONIC DETECTORS

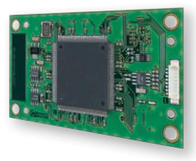
### PROXIMITY SWITCHES
### WITH FULL INTEGRATED ELECTRONIC

- Contactless detection
- Multi electrical output (wires, cable or connector)
- Full hermetic stainless steel housing
- High pressure exposure
- Extended temperature range
- Good resistance to EMI/EMC susceptibility

*Proximity switches*

### PROXIMITY SENSORS (PASSIVE CONCEPT)
### COMBINED TO REMOTE ELECTRONIC BOARD LOCATED IN SOFTER ENVIRONMENT

- Enhanced reliability with the capability to place the sensor in a harsh environment and the electronic board in a remote soft environment
- One board can multiplex 8 sensors at a time
- Contactless proximity detection and distance measurement based on a passive sensor combined to our sensor interface module (SIM) developed according to DO 254 DAL A
- Auto-calibrated sensing chain over temperature and variable cable length
- Rectangular or circular sensors available in full hermetic stainless steel housing
- Detection range up to 8 mm, distance coded over 10 bits
- Possibility of health monitoring through built in test



*Sensor Interface Module (SIM)*

*Proximity sensors*

# THERMAL
## CIRCUIT BREAKERS

*Long pushbutton*

*Three pole*

*Single pole*

*Three pole*

*Flying lead connection*

*Accessories*

1 - *Intrinsic safety: the Circuit Breaker has been designed with a fuse element to ensure that the electric circuit is opened in the extreme case of stuck or soldered contacts.*

2 - *Trip free: even if the pushbutton is maintained in a closed position, the opening of the contacts (and therefore the electric circuit) is ensured.*

### LIGHT, SIMPLE, SAFE

**› Light:**

Our single phase EN2495 and MIL MS33201 V compliant model is the lightest in the world (<20g with screws, washers and nut)

**› Simple:**

- Designed to be reused several times, spare components are not required
- Can sometimes be used as a switch (within the defined endurance limits), they therefore perform a dual function of switching and protecting

**› Safe:**

- Our intrinsic safety[1] (Fail safe) and trip free[2] conception enable a high level of safety (above 10-6 FH)
- The temperature compensation ensures high performance over a wide temperature range (usually -55°C to +125°C)
- Excellent resistance to mechanical stress

### WIDE RANGE OF TERMINALS

Depending on your need, Crouzet provides 4 types of terminals: FASTON, MS3320, EN & MS26574

*MS26574*
*Frog legs 45°*

*EN 3773-006*


*EN/MS3320*

*FASTON*



# HIGH SHOCK
## & VIBRATION BREAKERS



*Standard pushbutton*

Our High-Performance Thermal Circuit Breakers exceed the standard for shock and vibration for military applications.

It has always been troublesome for electrical system engineers to find the best suitable circuit breakers for military applications. Crouzet has developed a specific series of circuit breakers which go far beyond the current standards.

When used in the vicinity of cannons or missile launchers and in circuit breaker panels installed next to machine guns, (e.g. helicopters, jet fighters or armored vehicles) the high "shock and vibration" family avoids installing silent blocs on panels or on circuit breakers (while maintaining top circuit protection performance).

For the single pole circuit breaker the High Shock and Vibration products multiply by three the endurance level to random and sinus vibrations, compared to AS58091 level or basic MS33201 levels.

**› Random Vibration improvement**

| Test condition letter | Power spectral density | Overall rms G |
|---|---|---|
| A | .02 | 5.35 |
| B | .04 | 7.56 |
| C | .06 | 9.26 |
| D | .1 | 11.95 |
| E | .2 | 16.91 |
| F | .3 | 20.71 |
| G | .4 | 23.91 |
| H | .6 | 29.28 |

*AS58091 & AS33201 basic level* *New level*

**› New levels**

| | |
|---|---|
| Sinusoidal (MIL STD 202 method 204 D) | Contact us |
| Random (MIL STD 202 method 214 A) | Contact us |
| Shock (MIL STD 202 method 213B) | 75 g 3 halfsine 6 msec: condition B |

**› Typical circuit protection on the following military platforms:**

- Fighter Aircraft
- Military Helicopters
- Ground Air Defense Systems
- Military Land Tracked and Wheeled Vehicles
- Missile Launchers
- Naval Shipboard Applications

# DISTRIBUTION BOXES WITH
## PRINTED CIRCUIT BOARD TECHNOLOGY

*PCB*

*Single pole*

*Three pole*

### NEW CONCEPT

Using standardized EN-3373-006 and EN3774-006 FASTON circuit breakers (0.25 inch tab circuit breakers), you can design very compact and nearly “wire free” circuit breaker panels. This tremendously reduces EWIS compliancy assessment for power distribution boxes.

**› Technical Advantages:**

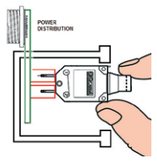
- Boxes are more compact (volume decrease)
- Each CB is lighter
- Quality is improved (no human error in wiring and quick testing)
- No nail bed needed to industrialize bundles
- Retarded circuit breaker rating definition & fast maintenance
- Automatic testing

**› Commercial Advantages:**

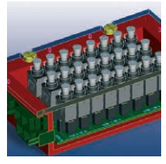
- With high volume, PCB is cheaper than human labor
- There is much less bundles definition (reducing the projects non-recurrent costs)

**› Retrofit with conservation of Form Fit Function:**

Crouzet has proven it is possible to redesign a PCB with the same volume and connector disposition without increasing weight. Thus bringing more flexibility and less EWIS concern to the re-designed distribution box.




*Quick installation and removal*



*24 Circuit Breaker prototype*

*PCB base carrying up to 16 breakers*



# SOLID STATE
## CIRCUIT BREAKERS



*SSPC 28 VDC*

*SSPC 115 VAC*

### FROM SSCB TO SSPC

Using the most recent solid state technology, Crouzet has developed 2 generic Solid State Circuit Breaker (SSCB) families. One for 28VDC applications, the other for 115VAC applications.

A Solid State Circuit Breaker is composed of a microcontroller, a switch and a data bus.

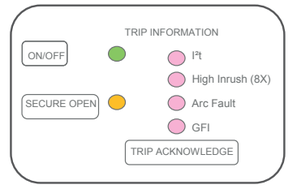
This enables a SSCB to provide more than just thermal protection; its role encompasses electrical functions such as: relay, gradator, chopper, ground fault, soft start and current measurement.

These functions can be used for light dimming, motor speed control, intermittent load command (on/off), inrush current limitation, sequential power ON of loads and load failure detection.

This is why they become Solid State Power Controllers (SSPC).

**› Easy to operate**

Both 115 VAC and 28 VDC SSPC components are delivered with a laptop/tablet interface that enables a quick appropriation of SSPC features. Command from the laptop is transferred through CAN bus. The laptop/tablet interface can be replaced by a MCU or Utilities Management System (UMS) that sends and receives data frames through CAN2.0B.

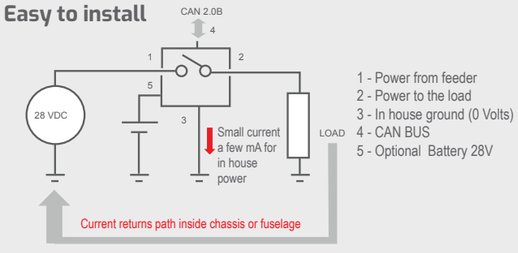



*Laptop-tablet interface*

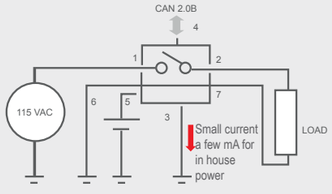
The typical set of orders/queries is:

**ON/OFF** : Powers ON/OFF the load
**RESET** : RESETS the elementary switch after arc or thermal trip
**STATUS** : Asks for trip reason
**CURRENT** : Asks for current (Ampere) value
**BACKUP** : Programs the behavior when data bus is disconnected

**› Easy to install**




1 - Power from feeder
2 - Power to the load
3 - In house ground (0 Volts)
4 - CAN BUS
5 - Optional Battery 28V




1 - 115 VAC feeder
2 - 115 VAC Power to the load
3 - In house ground (0 Volts)
4 - CAN BUS
5 - Optional Battery 28V
6 - 0 VAC feeder return (neutral)
7 - 0 VAC load return

# ARC FAULT
## CIRCUIT BREAKERS


*Single pole AFCB*


*Single pole AFCB*

## ARC FAULT TECHNOLOGY IS TARGETED TOWARDS EWIS[1] PROTECTION, CARBON COMPOSITE PROTECTION AND ENHANCED FUEL TANK PROTECTION

**› How do AFCBs work?**

Arc Fault Circuit Breakers combine the safety of standard circuit breakers and high accuracy electronics to mitigate arcing. Each standard thermal circuit breaker is equipped with an electronic board that analyzes the current waveform in real time to detect arcing.

**› EWIS protection:**

The new FAA Part 25 subpart H requirements ask aircraft OEM to consider EWIS as a system. This means that the airworthiness of the wiring must be guaranteed for the complete lifetime of the aircraft. By incorporating AFCBs your aircraft will be compliant to this new rule.

[1] *EWIS: Electrical Wiring Interconnection Systems*

**› Carbon Composite protection:**

Carbon composite (CFRP) is vulnerable to arcing.

The use of AFCB will mitigate damages and smoke hazard on CRFP material.

**› Enhanced Fuel tank Protection:**

Traditional Ground Fault Interrupters (GFI) measure current leakage to the airframe and open the line as soon as maximum current limit is detected by the current transformer. The weakness of the traditional GFI is that it does not capture line-to-line arcing and series arcing downstream of the breaker, the AGFCB (Arc and Ground Fault Circuit Breaker) does this thus going beyond:

- EASA CS-25 Book2, AMC25.981(a) fuel tank ignition precautions
- FAA-PART 25, AC25.981-1B fuel tank ignition precautions

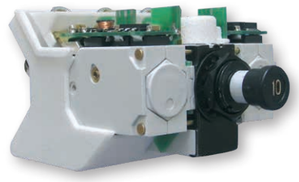
**› Compliant to**

AS5692, AS6019, ARD5568.

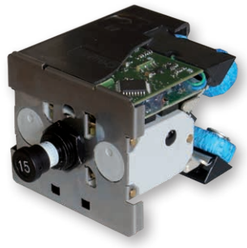


# GROUND FAULT INTERRUPTER
## CIRCUIT BREAKERS






*Three phase GFI*

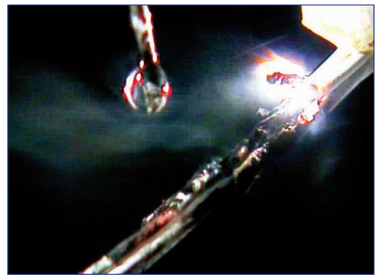



*Three phase AGFCB*

**› Why use GFI circuit breakers?**

Following SFAR88 recommendation (after Swissair 111 and TWA 800 incidents), the FAA and EASA have compelled PART 25 aircrafts to protect fuel tanks with Ground Fault Interrupters.

GFI products mitigate fuel tank ignition by reducing the amount of leakage current to the airframe inside the fuel tank.

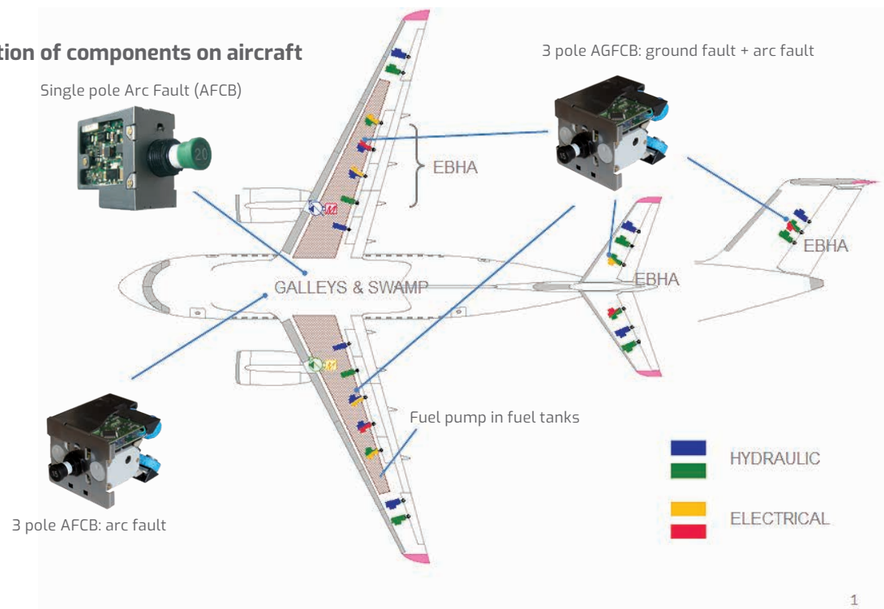


*Arcing test*

**› What about people?**

In addition to fuel tank protection, the increasing presence of higher voltages in the passenger area (115 VAC) - for instance in business class current outlets - has brought Crouzet to develop circuit breakers to protect from electrocution (the leakage current to detect is then around 30 mA).

**› Typical location of components on aircraft**



# WORLD LEADER FOR
## CONTROL WHEEL AND PILOT GRIPS





***Bizjet*** | *Commercial aircraft* | *Side stick* | *Collective grip* | *Cyclic grip*

## MORE THAN 19,000 GRIPS ARE FLYING EVERYWHERE IN THE WORLD

### EXPERIENCE

Crouzet's expertise allows us to pride ourselves in being able to assist Aircraft manufacturers in specification finalisation, thus avoiding costly mistakes.

### BECAUSE THE FIRST FEELING OF THE COCKPIT IS THE CONTROL WHEEL

Based on aluminum castings or molded in plastic composite, our control wheels combined with a large range of pushbuttons, trims, triggers or digital thumbsticks will **fit naturally under your fingers.**

The quality of the man machine interface in an Aircraft cockpit is a major concern to the Aircraft designer and the operator alike. The comfort and aesthetics of Crouzet handwheels are of great importance to us.

### CONTROL GRIPS

Our man machine interfaces for both Commercial and Military aerospace markets have been designed, manufactured and delivered for more than four decades. Crouzet's wide range of grip designs enable us to provide quick and accurate responses to any customer's needs or requirements.

### CUSTOMISED CONFIGURATION

- **Crouzet** defined the modular concept for helicopter grips. This heritage enables Crouzet to meet 100% of a customer's needs relative to ergonomy. Modifications to pushbutton configurations can be performed quickly thanks to our exclusively-incorporated removable front face, with optional backlighting.
- This unique design approach not only gives Crouzet customers increased flexibility, but it greatly reduces the customisation lead-time. Production can continue and minor changes are easily accommodated at final assembly.

## CHOOSE FROM OVER 200 REFERENCES OR LET US HELP YOU DESIGN YOUR CUSTOM COMPONENT

*Pushbutton 1 pole or 2 pole*

*4-way*

*Trim 5-way*

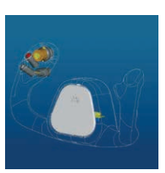
*4D Flight trim*

*Analogic transducer*

*One or two step triggers*

*QuickFix® design*

*Cyclic grip*



*3D design*

*Back lighted panel*

# **SOLUTIONS** FOR DESIGN, INNOVATION AND INDUSTRIALISATION

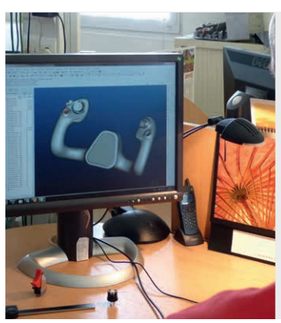
*Crouzet's factories in Valence, France*

## PROJECT TEAM

**Crouzet puts in place a project team that provides you with a partnership of experts throughout all your program phases: drawing up the specification, feasibility, development, performance testing, control of pre-production, optimisation of logistical parameters, long-term support for the design and product tracking.**

## 1. PROJECT START-UP

After first contact, Crouzet business engineers will work with you to identify your goals and constraints in order to draw up a product performance specification and to take in account the key factors of success for your projects

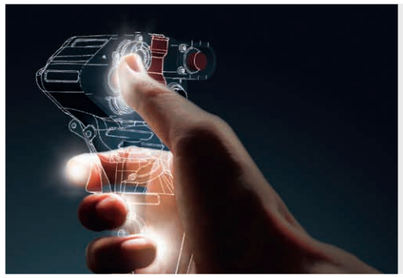


## 2. DESIGN OFFICE

With more than 50 years of experience, Crouzet has mastered the necessary technologies for developing and industrialising complete sensor offer as well as to customise products:

› Mechanical (CAD-3D)
› Magnetic
› Electromechanical
› Electronic (EMC, EMI)





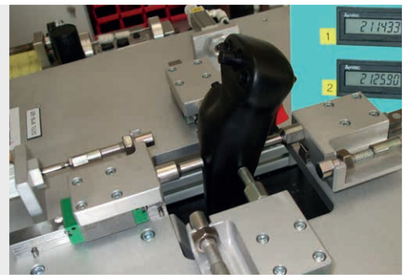
## 3. INNOVATION

Based on their experience in a wide range of sectors, Crouzet's design offices share common objectives:

› Taking an innovative approach to market standards and the best technologies
› Combining a number of technologies to create innovative concepts

## 4. TEST LABORATORY

Crouzet laboratories are equipped with facilities for testing all our products from design to production. Either with simulation or real-life tests (electrical, mechanical life and environmental withstand), Crouzet products are validated, tested and tracked throughout the project development process



## 5. PRODUCTION

Aerospace products require highly-tailored solutions for demanding applications. Our state-of-the-art production facilities certified to the highest quality standards, ensure that Crouzet products meet the level of performance that is needed in this critical environment

## 6. LOGISTICS

In order to meet the demands of the aerospace industry, Crouzet logistics are based on industry approved practices:

› Just-in-time processes
› Partnerships with our suppliers
› Capacity to deliver within 24 hours

The Crouzet delivery platform also optimizes logistics through output and guarantees your lead times

CROUZET

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