



**A.F.C.S. SFIM 85 A**

**ALOUETTE III**





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# A.F.C.S. SFIM 85 A

## ALOUETTE III



**sfim**

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# AUTOMATIC FLIGHT CONTROL SYSTEM 85A

## INTRODUCTION

Following requests from many operators who wished to enhance the operational characteristics of their Alouette III helicopters (**SA3160 – SA316B – SA319**), SFIM has tailored the SFIM 85 Autopilot to this helicopter with emphasis on pilot workload, mission reliability, flight safety, low volume, low weight and finally low overall cost.

This system was designed to lower significantly the pilot's stickwork, thus allowing him to attend more intensively to his navigation, radio-communication, flight and mission management tasks, and reduce his stress and fatigue in long distance and/or poor weather flights thus inducing a higher level of flight safety.

To attain this goal, the SFIM 85 AP was developed on the basis of the following objectives :

- Research of the various missions which are performed.
- Simplification of the system, without reducing its performance, in order to reduce to a minimum the price and the weight of the system.
- Research of a system which can be used for subsequent addition of various couplers without modifying the autopilot.

The main missions that have been taken into account are :

- Observation, firing or hoisting whilst hovering, for which good pitch, roll, and heading holds are indispensable.
  - Flight in poor weather conditions, night flight or training for IFR flight, for which addition of an altitude and airspeed hold considerably reduces the pilot's workload.
  - Nap of the earth flight which requires damping of helicopter movements.
-



# GENERAL DESCRIPTION

## COMPONENTS

### 3 AXIS - A.P. SYSTEM

DESIGNATION	REFERENCES	QUANTITY
3-axis autopilot computer	418.00495.000	1
Mode controller	418.00439.000	1
Baro-Anemometric-Sensor	418.00475.400	1
Series control actuators (Pitch - Roll - Yaw)	418.00625.***	3
Trim actuators (Pitch - Roll)	418.00525.101	2
Trim computer	418.00487.002	1
Pedal movement sensor	418.00404.000	1

### PERIPHERAL UNITS

Gyro-horizon HDV 78 and/or	454.00200.000	1
Vertical gyro GV 76-2	454.00162.000	1
Gyro-compass CG 130 or	58057.82	1
Gyro-compass CG 121 or	58065.000	1
Gyro-compass CG 512	461.00303.100	1







## CHARACTERISTICS

### A.P. MODE CONTROLLER

The very small size of this component enables it to be mounted on the instrument panel with ease. The mode controller is used to implement the various autopilot functions and to display the positions of the flight control actuators.

### A.P. COMPUTER

This component generates the piloting laws from data provided by the various sensors.

- Vertical gyro or instrument panel gyro-horizon.
- Gyro-magnetic compass.
- Airspeed and altitude sensor.

The computer is used to shape the signals and their amplifications to supply the actuators which are in series in the flight controls and the trim computer.

### TRIM COMPUTER

This unit transforms the control signals from the autopilot computer to control the trim pitch and roll actuators which are mounted in parallel in the flight controls.

It also ensures flight safety by detecting any failures which could appear in the operation of the trim actuators.





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## FLIGHT CONTROL SERIES ACTUATOR

There are three limited authority electro-mechanical series types actuators installed in the flight control linkages.

They are controlled by instructions generated in the A.P. computer and act on the flight controls in such a way as to control the pitch, roll, and yaw axes of the helicopter.

Their mechanical authority is limited so as to minimize helicopter manoeuvres in case of failure, and so as to comply with the safety criteria which are used in civil aviation.

## TRIM ACTUATOR

The trim actuators are positioned in parallel in the flight controls. The various functions performed are as follows :

- Transformation of electrical instructions from the trim computer into mechanical instructions which act into the swash-plate.
- Anchoring of the cyclic stick.
- Detection of pilot's manual inputs (opening of an electrical switch).
- Providing the pilot with a force gradient, thus allowing him to move the controls progressively when he is hand-flying.



## **BARO-ANEMOMETRIC SENSOR "BARAN 87"**

This unit detects the altitude and airspeed of the helicopter and sends an altitude or speed deviation signal to the autopilot computer according to the mode selected on the mode controller.

## **PEDAL MOVEMENT SENSOR**

This component detects all pilot actions on the tail rotor pedals and transmits this information to the A.P.

## **PERIPHERAL COMPONENTS REQUIRED FOR A.P. OPERATION**

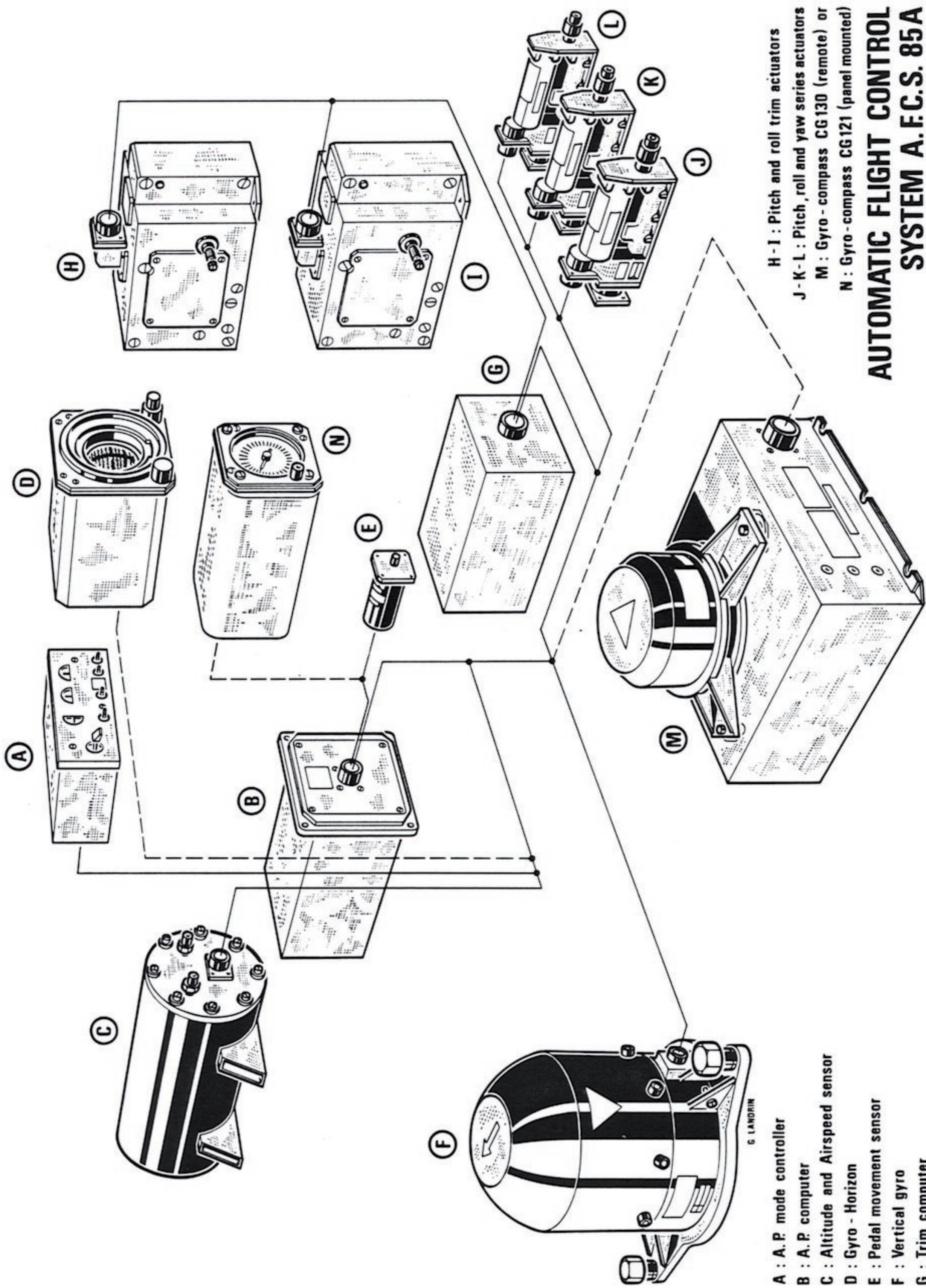
### **● VERTICAL DATA**

For stabilization of the helicopter's pitch and roll attitudes, the AP requires vertical data. These data can come from a SFIM HDV 78 instrument panel gyro horizon or from a SFIM GV 76 vertical gyro.

### **● HEADING DATA**

Heading stabilization requires a SFIM CG 130 or CG 121 or CG 512 gyromagnetic compass to be fitted.





**H-I : Pitch and roll trim actuators**  
**J-K-L : Pitch, roll and yaw series actuators**  
**M : Gyro - compass CG130 (remote) or**  
**N : Gyro - compass CG121 (panel mounted)**

# AUTOMATIC FLIGHT CONTROL SYSTEM A.F.C.S. 85A

**A : A. P. mode controller**  
**B : A. P. computer**  
**C : Altitude and Airspeed sensor**  
**D : Gyro - Horizon**  
**E : Pedal movement sensor**  
**F : Vertical gyro**  
**G : Trim computer**

G. LANDRIN



# SYSTEM PERFORMANCE

## LONG TERM PITCH AND ROLL ATTITUDE HOLD

In the autopilot function (switch on the mode controller in the "A.P." position) the computer generates a piloting law which is used to stabilize and to dampen the pitch and roll attitudes of the helicopter. For this purpose the computer works from data supplied by the instrument panel gyro-horizon or the remote vertical gyro. This function is particularly well adapted to flight in poor weather conditions, as it improves the static and dynamic stability of the helicopter, thus enabling the pilot to fly "hands off".

In the SAS function (switch on the mode controller in the "S.A.S." position) the automatic pilot acts as a damper. This gives greater flight control comfort when the pilot is performing nap of the earth flights.

## HEADING HOLD

The heading data from the gyromagnetic compass is processed in the A.P. computer then transmitted to the yaw actuator, thus ensuring stabilization of the heading fixed by the pilot. This mode is an important pilot aid, particularly when hovering for observation and firing.



## **ALTITUDE HOLD**

When the pilot engages the altitude mode, the BARAN 87 baro-anemometric sensor supplies altitude deviation data to the A.P. These data are used to control the pitch evolution of the helicopter. These instructions are limited so as to avoid uncomfortable manoeuvres in turbulent weather.

This mode is a highly efficient aid on liaison or convoy missions as it considerably reduces the pilot's workload. This type of flight control is particularly adapted to instrument flying.

## **AIRSPEED HOLD**

The airspeed is supplied by the BARAN 87 baro-anemometric sensor. The system functions identically to the altitude hold.

This mode is recommended for use on ILS or GCA approaches. In fact, the AP maintains the approach speed desired by the pilot on the descent plane, the rate of descent being controlled by the pilot with the collective stick.



# **OPTION**

**SFIM FDC 85**

**FLIGHT DIRECTOR COUPLER**



## SFIM FDC 85

In order to increase the operational capacity of the helicopter, the autopilot can receive, without modification, data from the SFIM FDC 85 coupler. This system is independent of the autopilot and can be used in two different ways.

### CPL MODE

Instructions from the coupler are transmitted to the flight controls by means of the A.P. As a result, the helicopter is controlled automatically according to the mode engaged on the coupler mode controller. This function relieves the pilot of all flight control tasks, thus allowing him to devote himself to the brainwork (navigation radio-communication, flight management, etc..).

### FDC MODE

Instructions from the coupler are transmitted to the command bars on the flight director horizon. The pilot must then control flight manually according to the instructions which are given to him by means of the commands bars. This mode is particularly useful in case of failure of the automatic pilot.

The modes performed by the CDV 85 can be used for the following purposes :

- Barometric Altitude Hold (ALT)
- Airspeed Hold (A/S)
- Capture and hold of the heading selected on the course indicator by the pilot. (HDG).



- Capture and hold of a Vertical Speed set by the pilot on the vertical speed indicator (V/S).
- Capture and tracking of a VOR radial (VOR).
- Capture and tracking of ILS Localizer and Glide Slope beams (V/L and G/S).
- Capture and hold of a pre-determined radio-altimeter height, at the end of an ILS - coupled approach.
- Go-around mode (G/A).
- Capture and tracking of a localizer back-beam (B/C).
- Coupling to an auxiliary navigation system, if the aircraft is capable of this function. (NAV)

The FDC 85 system is particularly well adapted to instrument flying and to approaches in bad visibility. It has been adopted on the AEROSPATIALE SA 365 N DAUPHIN and SA 355 TWINSTAR helicopters for IFR single pilot operation. It has also been adopted on the SA 322 SUPER PUMA.







# SFIM's BACKGROUND IN THE HELICOPTER AUTOPILOT FIELD

## SUPER-FRELON

A.P. TYPE	MAIN CHARACTERISTICS	PRODUCED SINCE	QUANTITY	STILL IN LINE PRODUCT.
<b>112 S</b>	Simplex 4 axes All ASW specific functions	1966	152 152 ordered	NO
<b>112 SP</b>	Ditto 112S except ASW functions but capability to			
<b>124 S</b>	Ditto 112S but no ASW capability			
<b>124 SJ</b>	Intermediate version between 112SP and 124S			
<b>1251</b>	Ditto 124 S . Rate monitored in P and Y	1968		
<b>139</b>	Simplex 3 axes Ditto 137 (technology)	1975	32 35 ordered	YES

## PUMA \_SUPER-PUMA

A.P. TYPE	MAIN CHARACTERISTICS	PRODUCED SINCE	QUANTITY	STILL IN LINE PRODUCT.
<b>127</b>	Simplex 3 axes	1968	545 555 ordered	NO
<b>137</b>	Ditto 127 - Rate monitored in Y Updated technology	1974	657 657 ordered	YES
<b>155</b>	Duplex Fail operational	1978	51 218 ordered	YES



## DAUPHIN

A.P. TYPE	MAIN CHARACTERISTICS	PRODUCED SINCE	QUANTITY	STILL IN LINE PRODUCT.
145 B	Simplex 2 axes	1977	72	YES
145 E	Simplex 3 axes	1978	84 ordered	
155	Duplex Fail operational	1978	6 97 ordered	YES

## ALOUETTE III

A.P. TYPE	MAIN CHARACTERISTICS	PRODUCED SINCE	QUANTITY	STILL IN LINE PRODUCT.
112SA	Ditto 112 S except specific sonar functions	1968	10 10 ordered	NO
146	Simplex 3 axes - Pos. $\Sigma$ Rate monitored in P Swell filtered radio height hold	1978	47 59 ordered	YES
85 A	Simplex 3 axes	1979	30 30 ordered	YES

## GAZELLE

A.P. TYPE	MAIN CHARACTERISTICS	PRODUCED SINCE	QUANTITY	STILL IN LINE PRODUCT
85G	Simplex 3 axes	1978	131 268 ordered	YES

ASTAR

## ECUREUIL

TWINSTAR

A.P. TYPE	MAIN CHARACTERISTICS	PRODUCED SINCE	QUANTITY	STILL IN LINE PRODUCT
85 E	Simplex 2 or 3 axes	1978	55 55 ordered	YES
85T	Simplex 2 or 3 axes	1980	30 50 ordered	YES



## GENERAL

VERTICAL GYROSCOPE type VG 76 was specially designed for the following purposes :

- Lowest possible cost price.
- High reliability, ruggedness and endurance.
- Maintainability.

All this while conserving the performance level indispensable for any aeronautical use.

Its use is therefore especially recommended for short range small capacity aircraft, business aircraft, aircraft, medium-sized helicopters, missiles.

VERTICAL GYROSCOPE type VG 76 is contained in a single seepage proof case with two compartments; the lower one contains the electronic circuits and the upper one contains the gyroscope.

VERTICAL GYROSCOPE type VG 76 consists essentially of a vertical-axis gyro-wheel slaved constantly to the apparent terrestrial vertical. It is mounted in two gimbals pivoted at  $90^\circ$  which transmit the attitude of the aircraft through synchro-transmitters.

The gyroscope is fitted with a retractable brake to limit roll gimbal freedom and the nutation of the gyro wheel to  $\pm 40^\circ$  during vertical gyro stoppage.

The case is secured by three points, either rigidly or through shock mounts (SFIM suspension reference 454-00166-001).

VERTICAL GYROSCOPE type VG 76 can take different options for particular needs.

- Supplementary outputs in roll and pitch (2-wire outputs of  $200 \text{ mV}/^\circ$ ).
- Conditioning of the satisfactory operation signal which enables checking of the supply voltages and the rotational speed of the gyro-wheel.

There are at present two production models : VG 76-1 and VG 76-2.



## CHARACTERISTICS IN COMMON

POWER SUPPLY : 115 V - 400 Hz single phase

CONSUMPTION :

- 70 VA at start-up.
- 50 VA in normal operation.

DIMENSIONS AND ATTACHMENT : see drawing.

WEIGHT :  $\leq 2.8 \text{ kg}$ .

ROLL AND PITCH OUTPUTS : 1 standard synchro ARINC 407 : 115 V/11.8 V - 400 Hz.

OPERATIONAL CHARACTERISTICS :

- Gyro-wheel rotation : 22 000 r.p.m.
- Momentum (c.g.s. units) :  $2.5 \cdot 10^6 \text{ g.cm}^2 \cdot \text{rd/s}$ .
- Angle of freedom : Roll :  $360^\circ$  - Pitch :  $\pm 82^\circ$ .



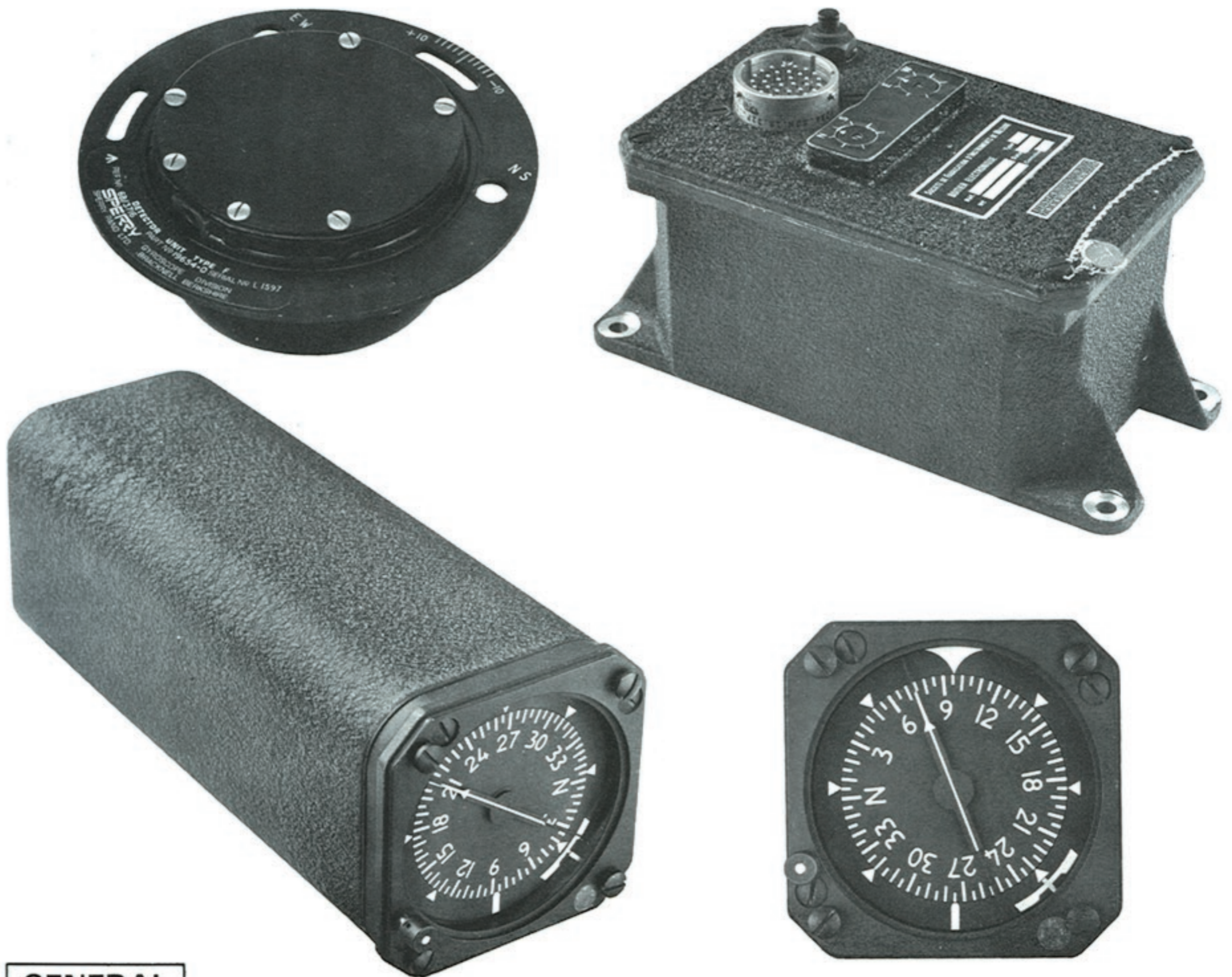




# GYRO-MAGNETIC COMPASS

S.T.Aé. certified

Type 121



## GENERAL

The SFIM type 121 gyro-magnetic compass is an instrument which is perfectly adapted to executive aircraft and private aeroplanes as also to light helicopters because of its low price, its simplicity, its ruggedness and its easy maintenance.

The SFIM type 121 gyro-magnetic compass is mounted on the instrument panel; it conforms to standard ARINC 3 AT1 and, when connected to a magnetic detector and to an electronic module, it produces the gyro-magnetic heading automatically. The compass card is graduated in intervals of 5 degrees.

The bearing given by the VOR receiver or the radio compass is transmitted by a remote setting synchro which moves a pointer in front of the compass card. The instrument is provided with built-in lighting.

## FEATURES

ENTIRELY AUTOMATIC OPERATION with high-speed initial setting sequence.

WATERTIGHT gyroscopic unit, electronic module and magnetic detector.

ELECTRICAL COMPENSATION for the magnetic detector by a system built into the electronic module.

A SYNCHRO-TRANSMITTER for the gyro-magnetic heading can be mounted on special request so as to transmit data to the connected instruments.



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# CHARACTERISTICS

## POWER SUPPLY :

Voltage : 115 V single phase 400 Hz ;  
 Power consumption at start-up : 19 VA .  
 Power consumption in normal operation : 14 VA .

Voltage : 28 V d.c. ;  
 Power consumption at start-up : 7 W .  
 Power consumption in normal operation : 3 W .

## GYRO-WHEEL :

Synchronous hysteresis motor .  
 Rotational speed : 24,000 r.p.m .  
 Momentum :  $0.86 \times 10^6$  c.g.s. units .

## DIMENSIONS :

Gyroscopic unit :  
 222.2 x 82.8 x 82.8 mm (8.74" x 3.26" x 3.26")

Electronic module :  
 170 x 90 x 85 mm (6.69" x 3.54" x 3.34")

Magnetic detector :  
 121 dia. x 72 mm (4.77" dia x 2.83")

## WEIGHTS :

Gyroscopic unit : 1.7 kg (3.74 lb)  
 Electronic module : 0.80 kg (1.87 lb)  
 Magnetic detector : 0.65 kg (1.43 lb)

## CONNECTORS :

Gyroscopic unit : 41-pin: standard PrL 54.125  
 Electronic module : 32-pin: standard PrL 54.125  
 Magnetic detector : terminal strip .

## INPUT :

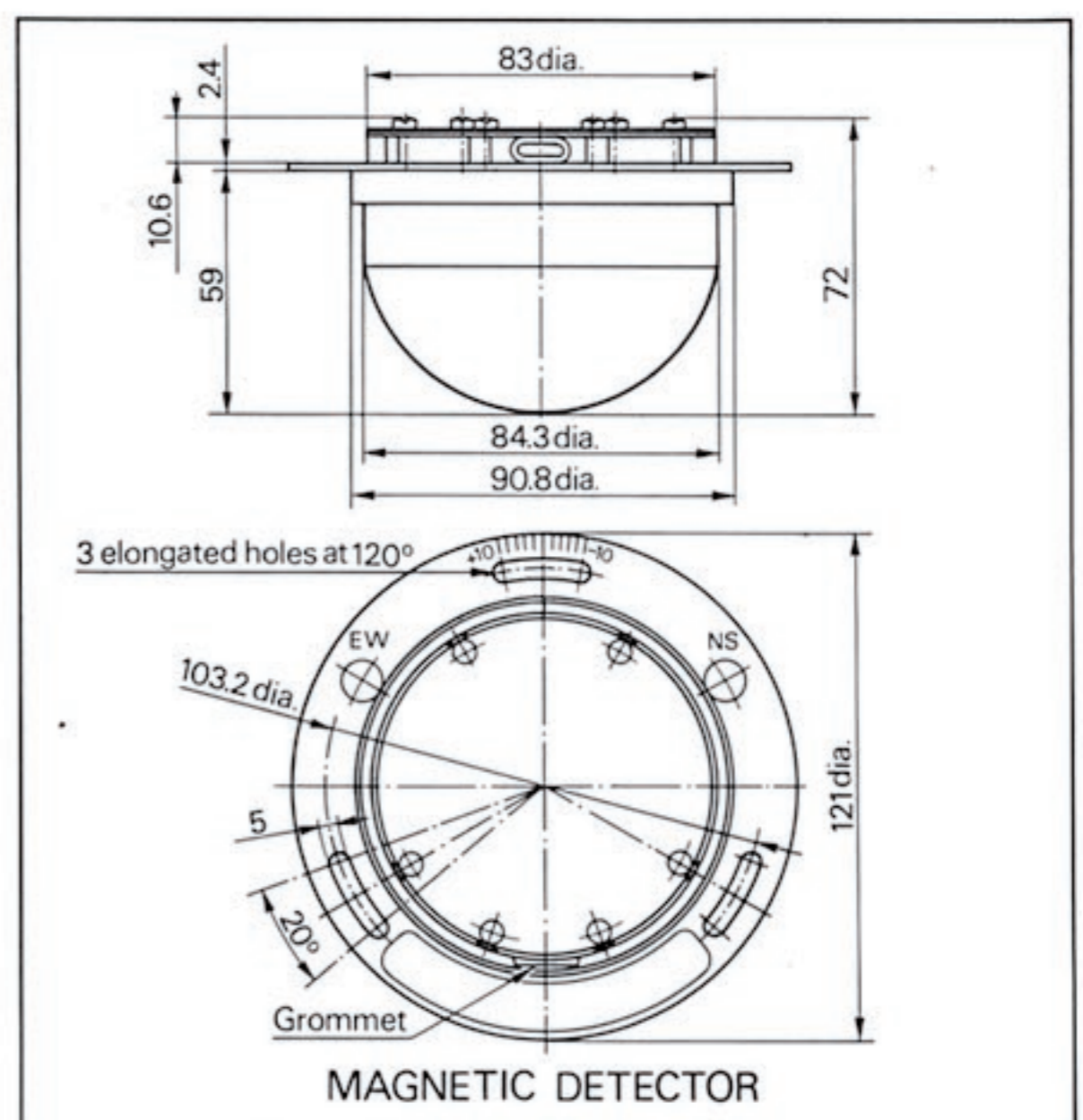
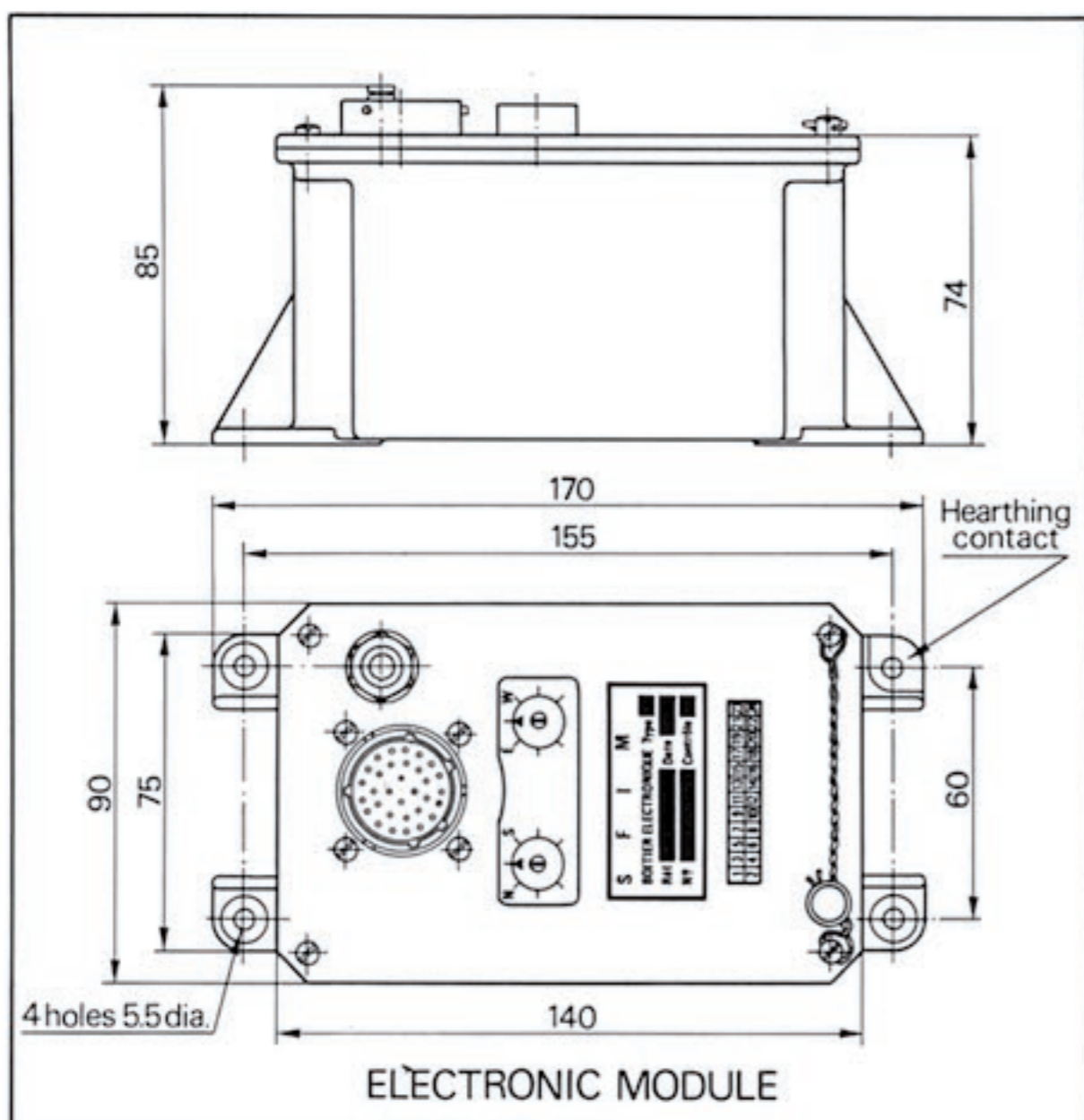
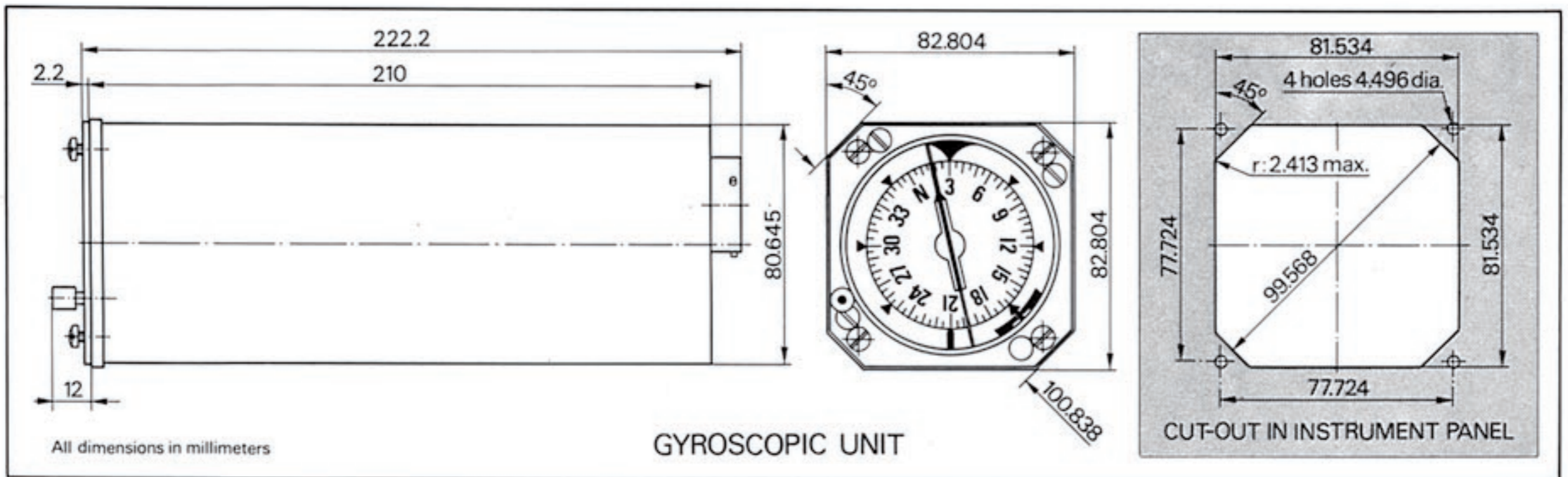
A remote setting synchro to standard ARINC 407 receives the signals from the radio compass or the VOR receivers; it drives the pointer showing the bearing of the emitting station directly .

## OUTPUT :

A synchro-transmitter to standard ARINC 407 can be mounted if specially requested .

# PERFORMANCE

- Accuracy of resetting onto the magnetic reference: error  $0.5^\circ$  .
- Azimuth high-speed resetting rate :  $70^\circ/\text{mn}$  .
- Magnetic monitoring rate :  $2^\circ/\text{mn}$  .
- Elevation resetting rate :  $3^\circ/\text{mn}$  .
- Free drift of the gyroscope :  $\leq 10^\circ/\text{h}$  .
- Operational temperature range :  $-40^\circ\text{C}$  to  $+70^\circ\text{C}$  .
- Storage temperature range :  $-54^\circ\text{C}$  to  $+90^\circ\text{C}$  .





# GYROMAGNETIC COMPASS

## TSO-C6c and C9c

Type 130

### 1. DEFINITION

The type 130 gyromagnetic compass is an economical magnetic heading reference for airliners or executive airplanes and for helicopters.

Entirely automatic and equipped with many outputs it can be adapted to every need.

Simple, rugged, easy to repair, its cost is lower than that of all the instruments in its category.

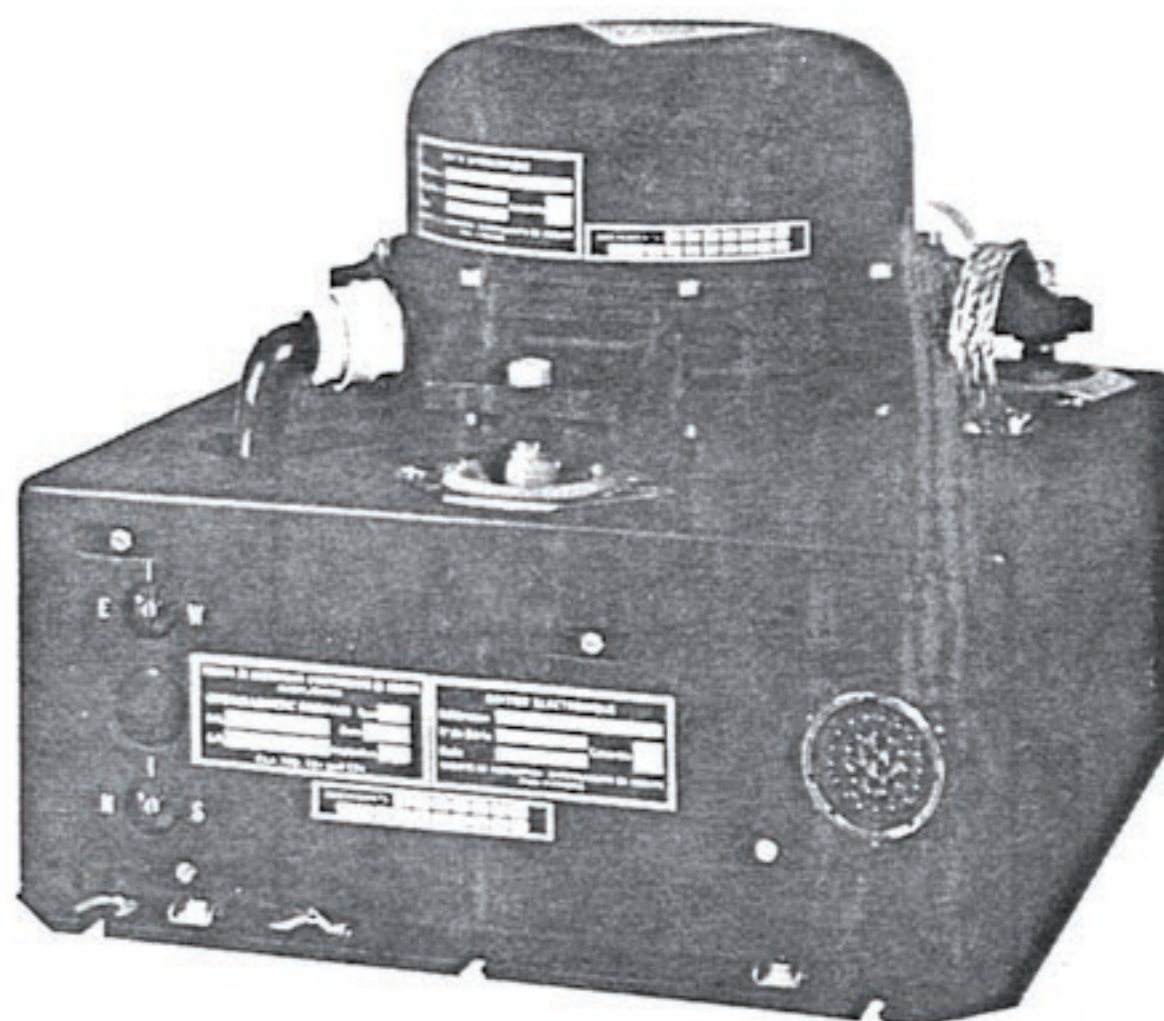
This equipment is fully TSO certified (C6c and C9c).

### 2. PARTICULARITIES

- Completely automatic gyromagnetic operation with initial fast erection sequence.
- 3 independent synchro outputs which are therefore disengageable. Other types of output on request.
- Electrical compensation of the magnetic detector.
- Satisfactory operation signal: + 28 vdc.
- Very simple maintenance. Directly accessible electronics - easily removable gyroscope.
- Choice of two magnetic detectors - BEZU-SFIM Detector or Sperry Flux Valve.

### 3. CHARACTERISTICS

- Power supply : Voltage 115 V - 400 Hz single phase.
- Dimensions - : Secured in the equipment bay in accordance with the diagram shown opposite.
- Weight : Gyromagnetic compass : 3 kg = 6.6 lb.  
Magnetic detector : 0.37 kg = 0.814 lb.  
or  
Flux valve : 0.65 kg = 1.43 lb.
- Connector : Gyromagnetic compass : 32 pin (standard PrL 54125).  
Magnetic detector : 6 pin (standard PrL 54125).  
or  
Flux valve : terminals.
- Alarm circuit : Satisfactory operation signal: + 28 vdc.
- Outputs : 3 synchro or resolver outputs to standard ARINC 407.  
Optional : one output can be clutchable for the autopilot.



### 4. PERFORMANCE VALUES

- Error in setting onto the magnetic reference : 0.5°
- Erection speed in elevation : 4°/mn
- Magnetic monitoring rate : 2°/mn
- Time for alignment onto the magnetic heading at start-up : about 1 mn.
- Operating field - DO 138 category CG A JN AAAXXXXXX.

### 5. DESCRIPTION - OPERATION

The type 130 gyromagnetic compass is a single assembly comprising a rectangular base onto which the sealed cylindrical casing containing the gyroscope is mounted by 3 dampers.

The two-degree of liberty gyroscope is made up of an horizontal axis gyro-wheel mounted in an elevation gimbal whose axis is horizontal and in a vertical axis azimuth gimbal.

The elevation gimbal is maintained horizontal by the action of a torque motor controlled by a levelling switch.

The azimuth gimbal is reset slowly onto the magnetic north by the action of a torque motor controlled by the magnetic detector.

Through suitable gearing the azimuth axis spindle drives the output synchros (standard, size 08 or size 11) set on the upper support plate.

The elevation and azimuth amplifiers are placed inside the base. At start-up, gain switching controls the fast resetting in azimuth.



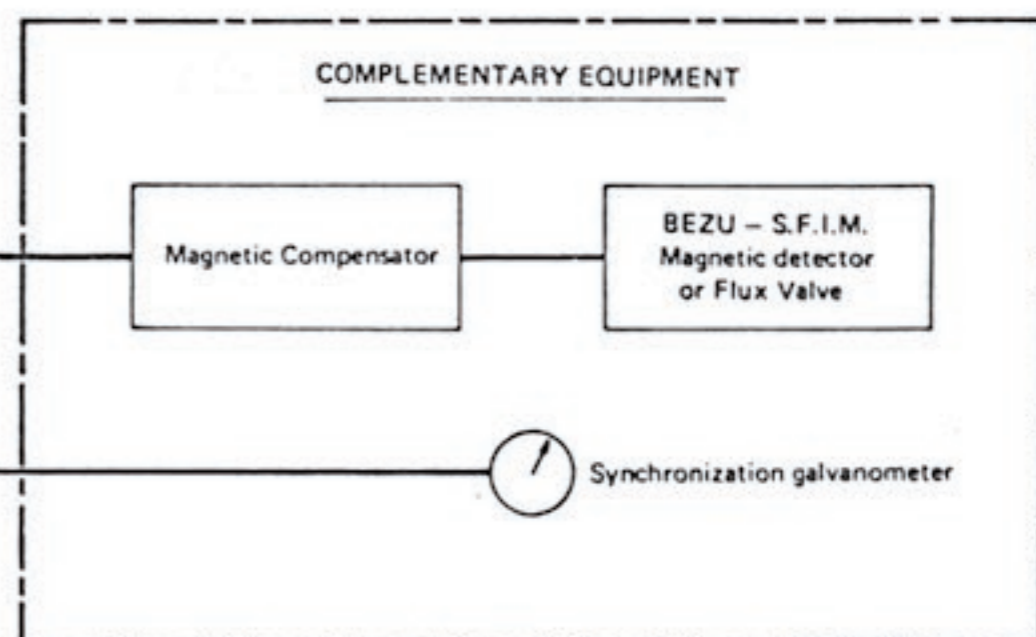
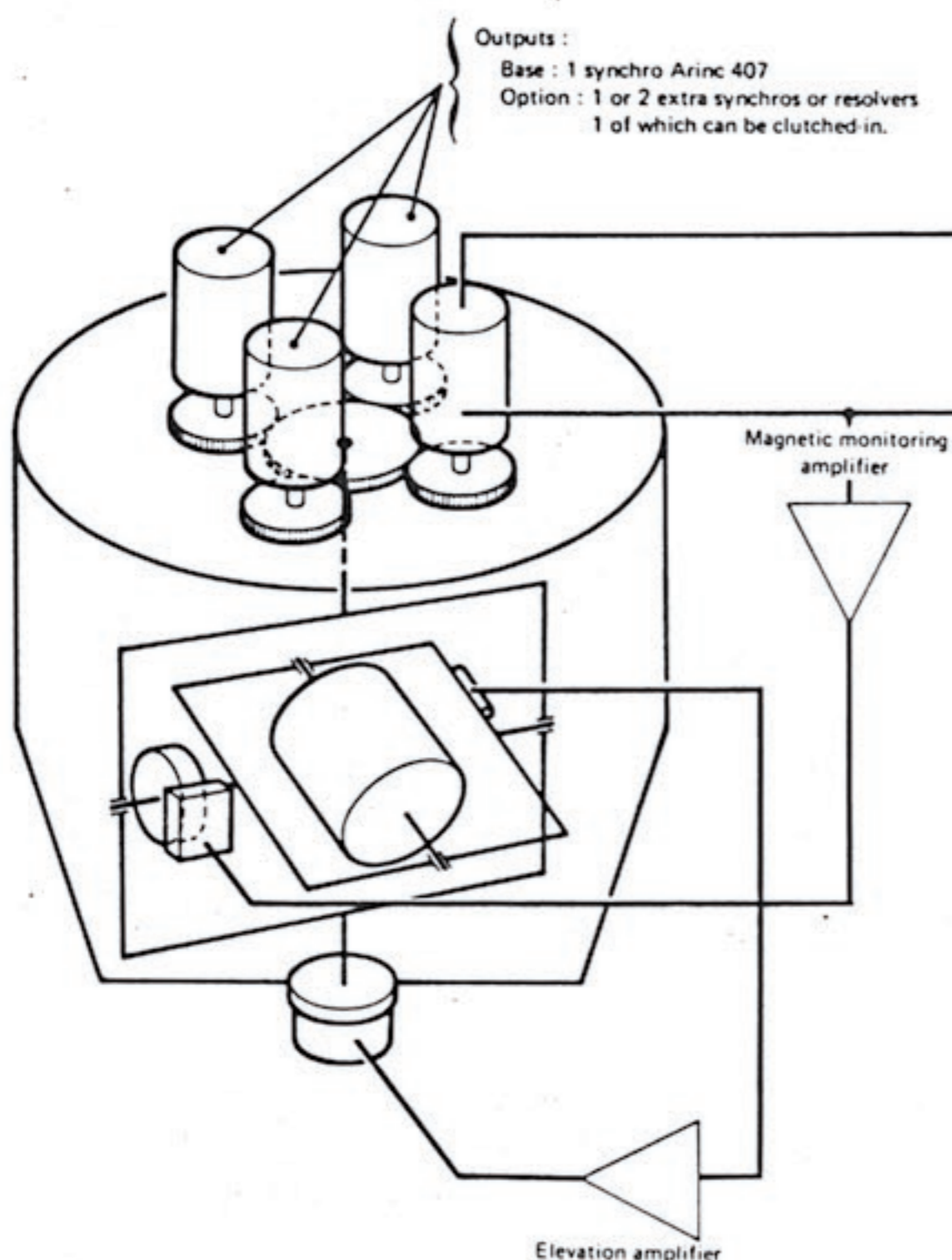
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#### 6. COMPLEMENTARY EQUIPMENT

- The Bezu-SFIM magnetic detector or Sperry flux valve,
- The magnetic compensator,
- The synchronisation galvanometer are supplied on request.

#### 7. VERSATILITY OF THE OUTPUTS

The use of interchangeable rotating machines makes for easy adaptation of the outputs to every need.

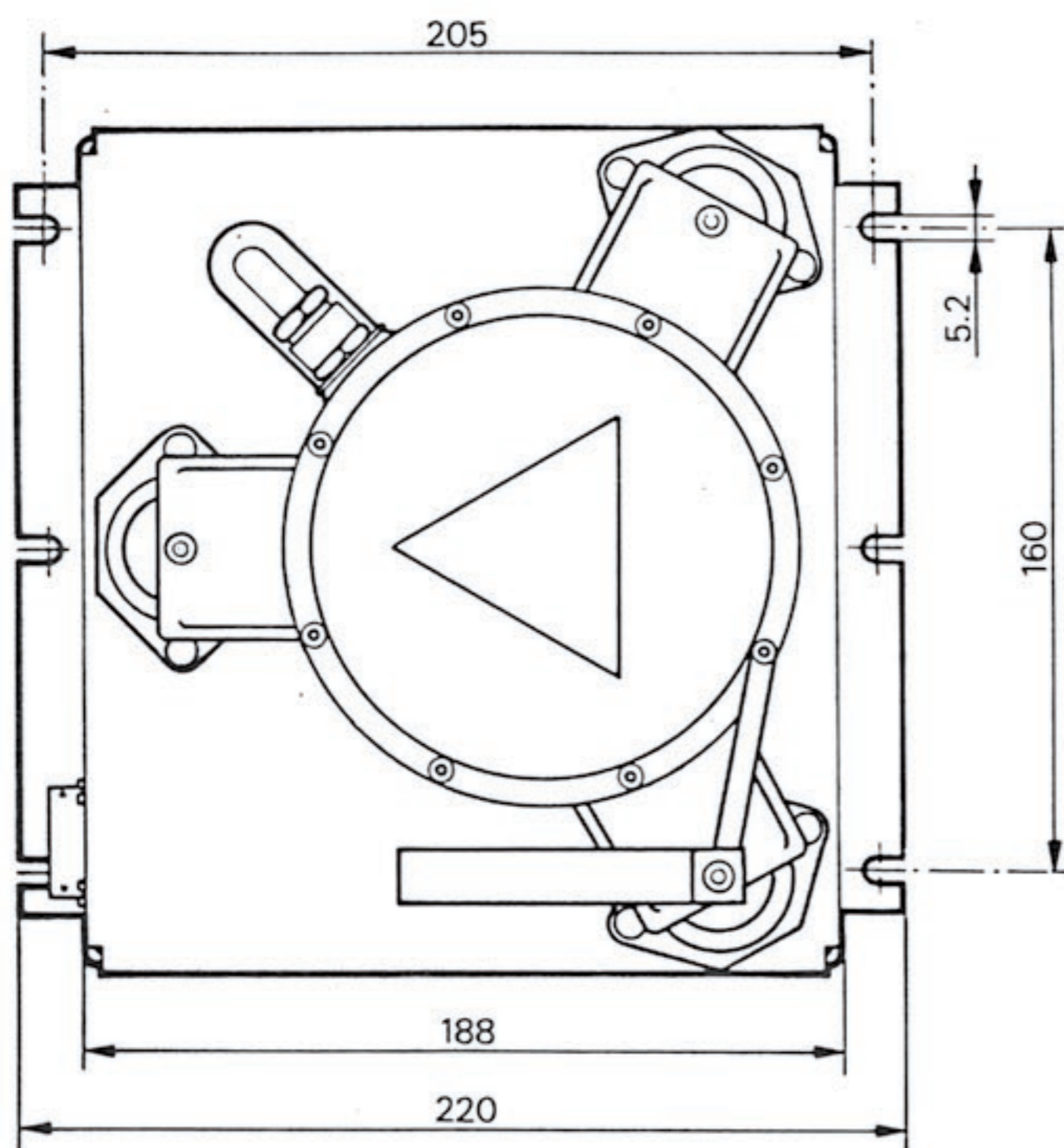
In the normal version there are 1 to 3 synchro or resolver outputs to standard ARINC 407 size 08 or 11 one of which can be clutched for the autopilot.

Special version - please consult us for any other need.

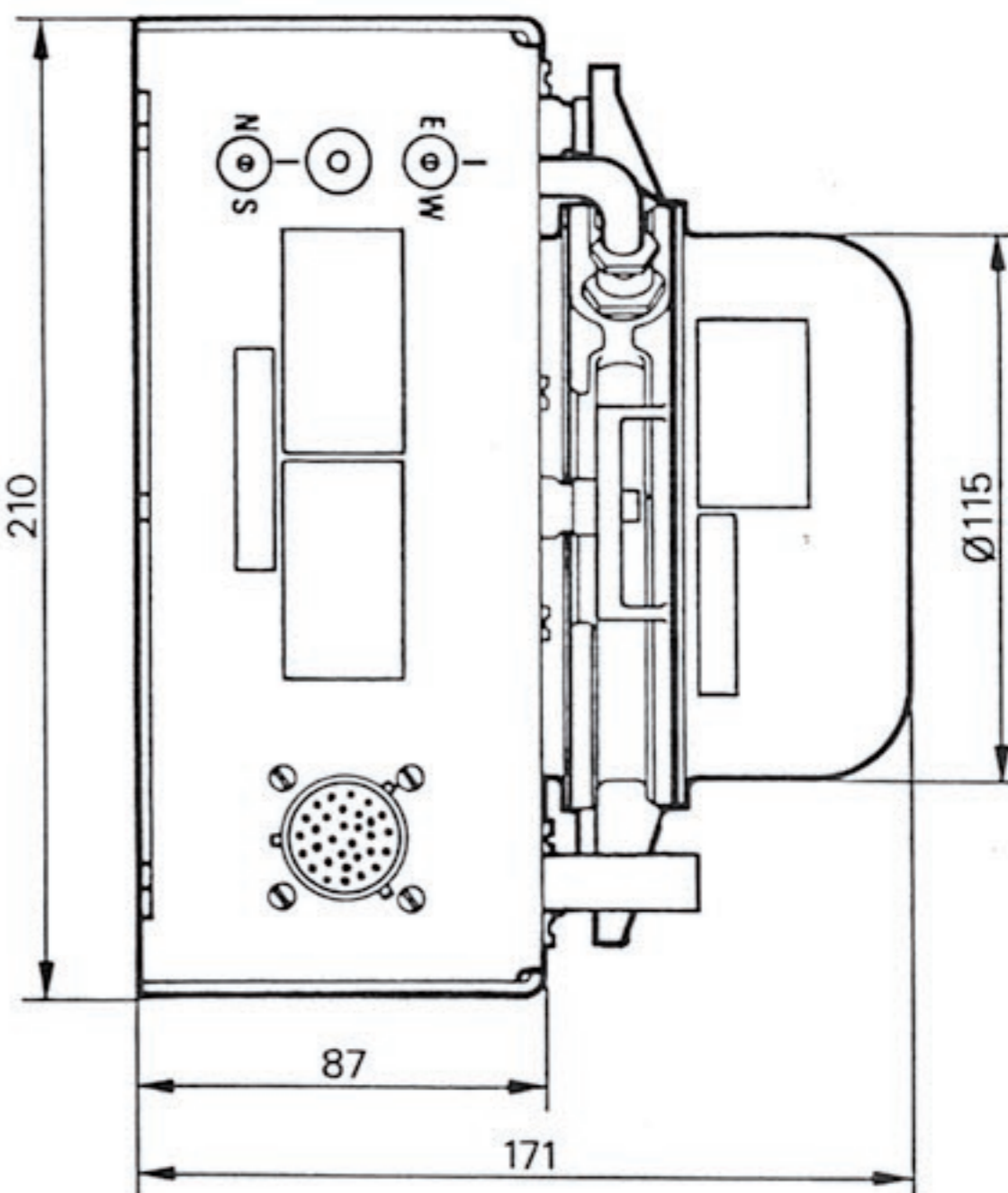
#### 8. MAINTAINABILITY

Maintenance is facilitated by :

- The immediate accessibility of the electronic circuits placed on printed circuit cards in the base.
- The possibility of replacing an output without touching the gyroscope by simply opening the top cover.
- The great simplicity of assembling the gyroscope.



All dimensions in millimeters

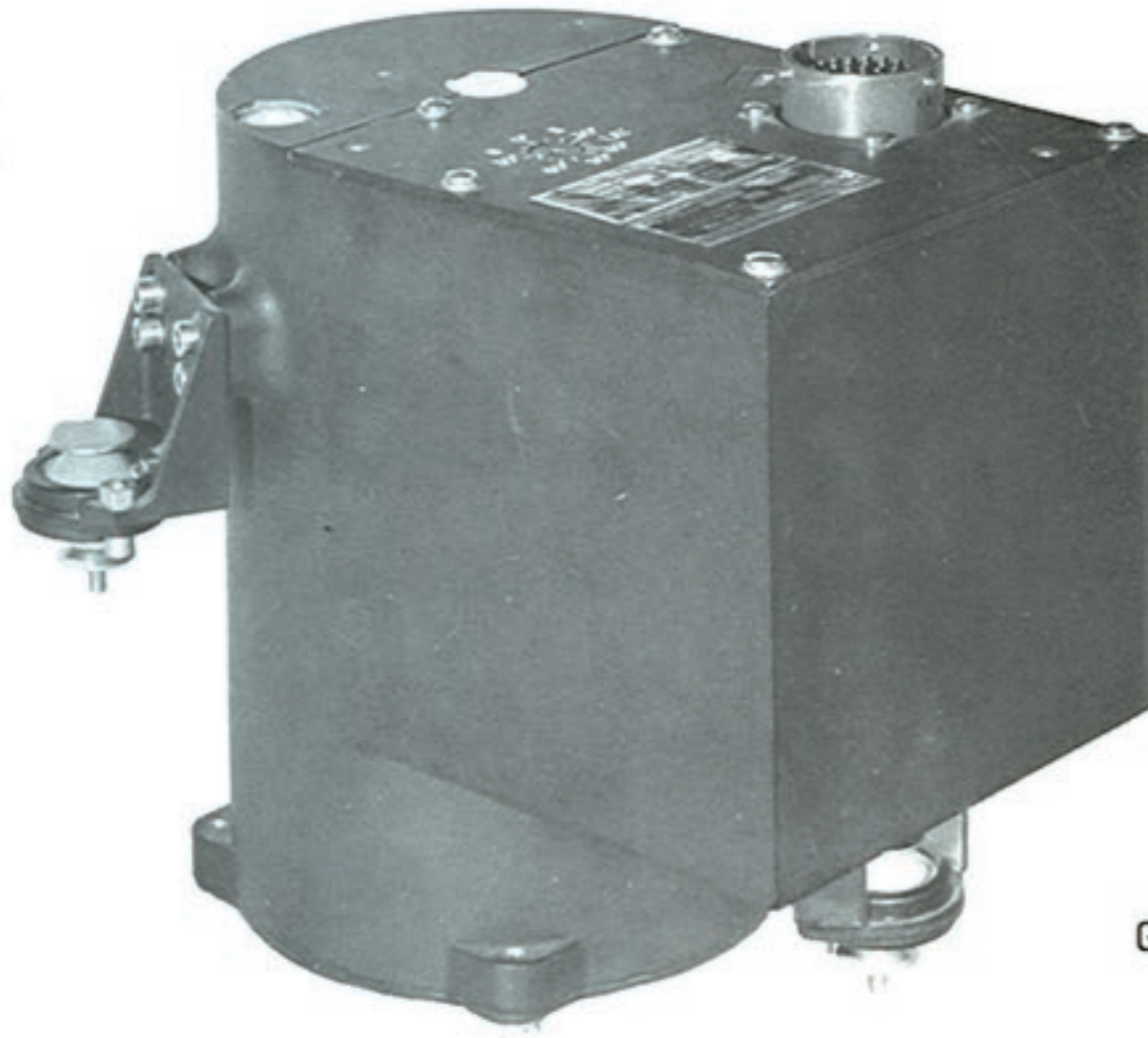




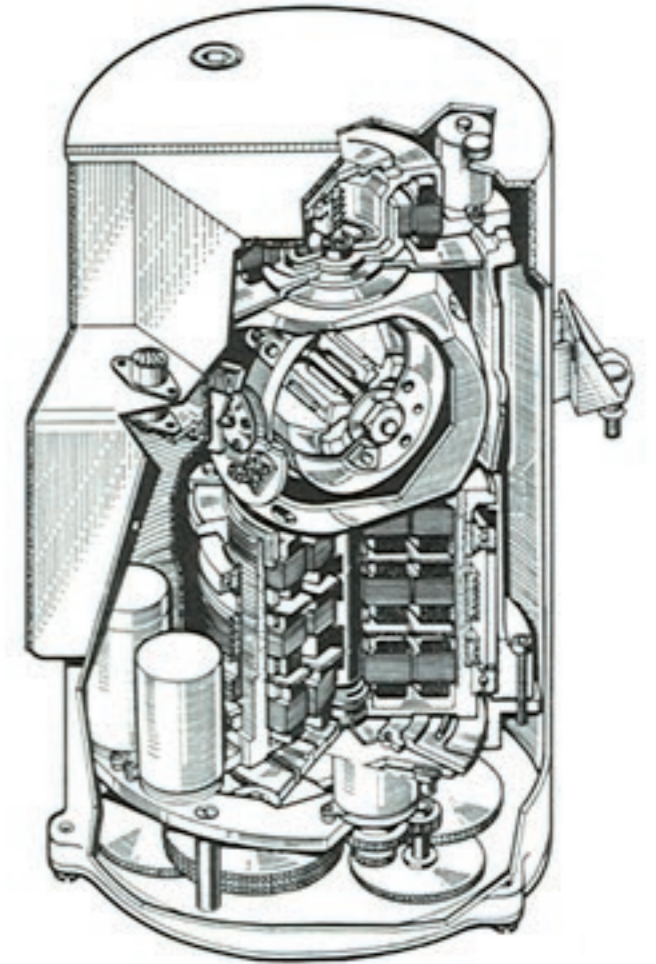
# GYROMAGNETIC COMPASS

## S.T.Aé. certified

Type 512



GYROSCOPIC PART



WG13 version



ALPHA-JET version

Two examples of the construction FUNCTION SETTING MODULE

## 1. GENERAL

The SFIM type 512 GYROMAGNETIC COMPASS is a high-quality, rugged instrument intended for equipping all categories of helicopters and aircrafts.

Entirely automatically, it produces the gyromagnetic heading, the magnetic heading or the directional heading.

## 2. DESCRIPTION

The SFIM type 512 GYROMAGNETIC COMPASS is composed of three main parts : the gyrosopic part, the magnetic detector and the function setting module.

- The GYROSCOPIC PART is made up essentially of a free directional gyroscope whose stable reference is reset, by a servo having two ratios, onto the magnetic heading. This assembly is housed in a case having two compartments : one of which is leakproof and protects the gyroscope, the other holds the associated electronic circuits. This arrangement makes maintenance very easy.
- The FLUX-VALVE which provides the installation with the local magnetic meridian can, optionally, be replaced by a SFIM MAGNETIC DETECTOR.
- The FUNCTION SETTING MODULE carries, on its front panel, the function selector, the heading manual resetting key, the synchronisation indicator and the magnetic detector compensation system. It can, optionally, feature declination setting with read-out on a meter and lamps signalling satisfactory operation of the gyroscope and heading synchro amplifier.



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### 3. PARTICULARITIES

- Entirely automatic operation with initial fast setting sequence.
- Two independent synchro outputs. One of them can be coupled to an external synchro amplifier so as to enable it to take up to 6 loads within the limit of a maximal current consumption of 1 A at 11.8 V.
- Electrical compensation for the rotation of the Earth by setting on the case of the gyroscope.
- Correction of the declination by setting on the function setting module and read-out on a meter (optional).
- Satisfactory operation signal displayed by two signal lamps located on the function setting module. The lamps show, at any particular moment, the state of the gyroscope and the quality of the heading data transmitted by the synchro amplifier (optional).
- Display, on the function setting module, of the synchronisation signal of the magnetic and directional headings.
- Operation in magnetic heading mode if the gyroscope is out of action.
- Timers enabling the real operating time of the gyroscope to be known.

### 4. FEATURES

#### POWER SUPPLY :

- 115 V - 400 Hz single phase -  $P \leq 40$  VA
- 26 V - 400 Hz single phase for synchro supply  $P \leq 3.2$  VA
- 5 V or 28 V d.c. (lighting).

#### GYRO-WHEEL

Synchronous hysteresis motor, speed : 24 000 rpm.  
Momentum :  $1.8 \times 10^6$  g . cm<sup>2</sup> . rd/s.

#### DIMENSIONS :

- Gyroscopic part : see drawing
- Magnetic detector or flux-valve : see separate sheet.
- Function setting module : width and attachment in accordance with specification BNAé PrL 63-111, height and depth variable according to option.

#### WEIGHT :

- Gyroscopic part (with suspension) : 4 kg.
- Magnetic detector or flux-valve: see separate sheet.
- Function setting module : variable according to option.

#### ELECTRICAL CONNECTION :

- Gyroscopic part : by a 41-pin connector in accordance with specification PrL 54 125.
- Magnetic detector or flux-valve: see separate sheet.
- Function setting module : variable according to option .

### OUTPUTS

- 2 synchro-transmitters to ARINC standard 407.

### PERFORMANCE

- Gyroscope drift :  $< 4\%/h$  or  $2\%/h$  according to specification.
- Error in resetting onto the magnetic reference :  $0.3^\circ$
- Accuracy of the correction for the rotation of the Earth :  $< 1\%/h$ .
- Slow speed erection in elevation :  $1\%/mn.$
- Fast erection in elevation :  $90\%/mn.$
- Magnetic monitoring speed :  $1.5\%/mn.$
- Tracking speed in emergency magnetic heading mode :  $20\%/s.$
- Manual resetting speed :  $20\%/s$  approximately.
- Operating temperature : from  $-40^\circ\text{C}$  to  $+70^\circ\text{C}$ .
- Storage temperature : from  $-54^\circ\text{C}$  to  $+90^\circ\text{C}$ .

